1. Emissions from a Tropical Peatland Wildfire Experiment: from Ignition to Spread to Suppression

Presenter: Yuqi Hu, Research Associate, Imperial College London, y.hu15@imperial.ac.uk

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Abstract: Smoke from peatland wildfires contributes significantly to global carbon emissions and causes transboundary haze episodes. Haze are large scale accumulation of smoke at low altitudes, especially frequent in Southeast Asia. Understanding emissions from peatland fires plays a vital role in calculating carbon budges, haze effects and climate change. However, only a handful of field studies or laboratory experiments on peat fire smoke have been conducted to date. Furthermore, there is substantial inter-study variabilities of emission factors (EFs) in those studies, and the explanation of this variability remains a challenge. In the summer of 2018 in Riau, Indonesia, we carried out the first field experiment of peatland fire (GAMBUT), aiming to understand how fires ignite, spread, and emit on degraded tropical peatland subjected to long-terms of drainage, logging, and agricultural conversion. This work presents the field measurements of gas emissions from the fire experiment. An open-path Fourier transform infrared spectroscopy was used to retrieve mole fractions of 13 gas species. EFs from 40 smoke plumes measured during different fire stages (e.g., slash and burn ignition, smouldering spread or suppression) and weather events (e.g., wind or rainfall) were calculated and reported. We present field evidence to indicate that EFs vary significantly among fire stages and weather events. Physicochemical properties of the peatland (moisture content, inorganic content and bulk density) were found to affect the EFs as well. This GAMBUT experiment advances the understanding of peat fire to enable new technologies for prevention, detection, protection and suppression, and to ultimately reduce the regional burden of peatland wildfires.

Keywords: emissions; peat fire; field experiment

Presenter Bio: Yuqi is a Research Associate in the Department of Mechanical Engineering at Imperial College London. He is working with Professor Guillermo Rein in the area of Smouldering Combustion and Fire Science in Imperial Hazelab.

He comes from China and studied Safety Engineering at China University of Geosciences (BS 2012), Safety Science and Engineering at the State Key Laboratory of Fire Science (SKLFS), University of Science and Technology of China (MSc 2015), and Mechanical Engineering at Imperial College London (PhD 2019).

His research interests include Biomass Combustion, Emissions, Fire Safety, and Geoengineering.

2. Improvements to the Estimation of Emissions from Pre-harvest Sugarcane Burning

Presenter: George Pouliot, Physical Scientist, US EPA/Office and Research and Development/Atmospheric and Environmental Systems Modeling Division, pouliot.george@epa.gov

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Abstract: Emissions from wildfires, prescribed fires, grassland fires, and crop residue burning is an important contributor to the degradation of air quality because of their impact on ozone and particulate matter levels. Emission estimates from these fires are often based entirely on remote sensing. However, remote sensing techniques do not always produce reliable estimates of area burned and cannot detect all fires. The pre-harvest burning of sugarcane provides a unique opportunity to link the temporal and spatial information of fire detections with harvested area as compiled by the United States Department of Agriculture (USDA). Using the known area harvested ,and time and location of fire detects over sugarcane fields, we have developed several improvements to the emission estimates of pre-harvest burning of sugarcane in Florida, Texas, and Louisiana. Additional research has highlighted three important parameters that impact these emission estimates and their temporal allocations; yet these three parameters are not accounted for or are outdated in the most recent 2017 National Emissions Inventory (NEI). The first important parameter is the fraction of sugarcane that is harvested mechanically without burning, sometimes referred to as "green" harvested. The second parameter is the emission factor associated with the burning of the sugarcane leaves; new updated information has appeared in the peer-reviewed literature. A third parameter is the burn rate of a sugarcane field that is not well characterized in the emission modeling system. Our work provides updated methods for estimating sugarcane emissions in an air quality modeling system. Estimates from 2003-2017 will be provided at the daily temporal scale for Florida, Texas, and Louisiana. We will also compare our updated results with the existing estimates in the NEI and modeling platforms for 2014-2016.

Keywords: National Emissions Inventory, Crop Residue Burning, Sugarcane, Emission Modeling Platform

Presenter Bio: George Pouliot has been a Physical Scientist in the Office of Research and Development at the US EPA since 2002. He area of research includes the preparation of emission inventory for modeling and the estimation of crop residue burning emissions in the National Emissions Inventory.

4. The effect of fire emission factor uncertainty on global chemistry simulations

Presenter: Rebecca Buchholz, Project Scientist I, National Center for Atmospheric Research, buchholz@ucar.edu

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Abstract: Fire emissions represent an important component of global models that help understand the influence of transport and chemistry on atmospheric composition. Several areas of uncertainty impact the creation of fire emission inventories, such as vegetation type, fire detection, fuel loading, fraction burned and emissions factors. Our study quantifies the contribution of emission factor uncertainty on the variability of subsequent simulations of atmospheric composition performed using fire emissions. We focus on carbon monoxide (CO), an important trace gas emitted from fires and produced from secondary oxidation of fire-emitted volatile organic compounds (VOCs). CO from the CMIP6, QFED2.5, GFAS1.2 and FINNV1.5 inventories are compared after being implemented in the Community Atmosphere Model with chemistry (CAM-chem). Multiple sensitivity tests are performed based on CO and VOC emission factor uncertainties. Simulations are completed for 2014, a year chosen for the relatively quiet ENSO activity. We compare model output in the 14 GFED basis regions. For some regions, emission factor uncertainty spans the results found with different inventories. Modeled CO is evaluated against observations from the Measurements of Pollution in the Troposphere satellite-based instrument. Finally, we briefly probe the impact on the oxidative environment through investigating modeled ozone. Overall, accounting for emission factor uncertainty when modeling atmospheric chemistry can lend a range of uncertainty to simulated results.

Keywords: CO, fire emissions, uncertainty, CESM2, chemistry modeling, global model

Presenter Bio: Dr Buchholz completed her PhD at the Centre for Atmospheric Chemistry at the University of Wollongong, Australia and now works in the Atmospheric Chemistry Observations and Modeling Laboratory at NCAR. Her research uses a combination of modeling and measurements to investigate the impact of fire on atmospheric chemistry and inter-annual variability, including linking climate and chemistry. She is also interested in transported versus local impacts on air quality, and the interaction of fire emissions with anthropogenic pollution.

5. A new way to predict emission factors – a compositional data approach

Presenter: David Weise, Research Forester, USDA Forest Service, PSW Research Station, david.weise@usda.gov

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Abstract: By conservation of mass, the mass of wildland fuel that is pyrolyzed and combusted equals the mass of smoke emissions, residual char and ash. For a given set of conditions, these amounts are fixed. This places a constraint on smoke emissions data which violates statistical assumptions for many of the methods currently used to analyze these data such as linear regression, analysis of variance, and t-tests. These data are multivariate and represent inherently interrelated non-negative parts of a whole. As an alternative to the widely used modified combustion efficiency, this poster will introduce a model based on log ratios to predict smoke emissions which accounts for these particularities and prevents potentially misleading results by drawing on well-founded statistical theory for compositional data analysis. The approach was applied to a data set of 18 gases measured in the smoke from laboratory burns of fuel beds representing common wildland fuel types in the southeastern and southwestern United States. Predictions comparable to the original linear regressions resulted from the compositional data approach.

Keywords: statistics, modified combustion efficiency, linear trend

Presenter Bio: Dr. Weise has been involved in wildland fire research with the Forest Service for 38 years. His academic background is forestry and statistics. His current research involves both the physical and chemical aspects of fire spread with an emphasis on prescribed burning and live fuels.

6. Emission Factors of Gaseous and Particulate Air Pollutants from the Simulated African Biomass Burning

Presenter: Rudra Pokhrel, Postdoc, Department of Physics, North Carolina A&T State University Greensboro, NC, rppokhrel@ncat.edu

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Abstract: Emissions from open biomass burning and residential cookstoves are the major sources of particulate and gaseous air pollutants. Indoor and outdoor air pollutants are responsible for multiple health impacts leading to 4-6 million premature deaths globally, with more than 90% of the population residing in low- and middle-income countries. The largest global sources of black carbon are open burning of forest and savannas and is believed to be one of the key components of air pollutants. Emissions from Africa are the major sources of global carbon emissions however they are poorly quantified due to limited or no laboratory studies. In this study, we present data from laboratory measurement of biomass burning emissions from African fuels. Emission factors of different gaseous and particulate air pollutants emitted from the burning of biomass fuels that were collected from east and south Africa will be presented. In addition, the dependence of emission factors on burning conditions of the fuel will be explored. Emission factors from African fuels will be compared with North American fuels previously studied. Furthermore, the relative importance of fuel types and burning conditions on emissions of different gaseous and particulate pollutants will be explored.

Keywords: Emission factors, Smoke, Biomass

Presenter Bio: Rudra P. Pokhrel is an atmospheric physicist/chemist working on aerosol optical, physical and chemical properties. He received his Ph.D. in Atmospheric Science in 2017 from the University of Wyoming focusing on instrument development and characterization and measurement of optical properties of biomass burning aerosols. He led the University of Wyoming group during Western Wildfire Experiment for Cloud Chemistry, Aerosol Absorption and Nitrogen (WE-CAN) 2017 campaign to measure aerosol optical properties from western US wildfires focusing on the importance of brown carbon absorption and their stability in the atmosphere and in the cloud as well as the impact of aging on aerosol optical properties. His research interests lie primarily in the area of health and climate impact of aerosols.

7. Wildland Fire Emissions Factors in North America and the new Smoke Emissions Reference Application (SERA)

Presenter: Susan O'Neill, Air Quality Scientist, USDA Forest Service, susan_oneill@firenet.gov

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Abstract: Field and laboratory emissions factors (EFs) of wildland fire emissions for 276 trace gases and aerosols sampled across Canada and the USA were compiled. An online database, the Smoke Emissions Repository Application (SERA), was created to enable analysis and summaries of existing EFs to be used in smoke management and emissions inventories. This emission factor analysis is based on a synthesis of emission factors from hundreds of publications funded by the Department of Defense Strategic Environmental Research and Development Program (SERDP) and augmented with numerous studies and publications since 2011. It represents the most comprehensive analysis of EFs for North America to date. We evaluate how EFs of select pollutants (CO, CO_2, CH_4, NO_x, total particulate matter (PM), $PM_{2.5}$ and SO_2) are influenced by combustion phase, burn type and fuel type. Of the 12,533 records in the database, over a third are represented by 23 air pollutants, most designated as Environmental Protection Authority criteria air pollutants, greenhouse gases, hazardous air pollutants or known air toxins. Among all pollutants in the database, including the most common pollutants PM, CO, CO_2 and CH_4, records are unevenly distributed with a bias towards flaming combustion, prescribed burning and laboratory measurements. Across all EFs, records are most common for south-eastern and western conifer forests and western shrubland types. Based on identified data gaps, we offer recommendations for future studies, including targeting underrepresented air pollutants, smoldering combustion phases and improved source characterization of wildland fire emissions. We also demonstrate SERA; how to execute searches by vegetation, region, combustion phase etc., and how to download the underlying data.

Keywords: Emission Factor, Smoke, Wildland Fire, SERA

Presenter Bio: Susan O’Neill is an Air Quality Scientist with the USDA Forest Service Pacific Northwest Research Station, AirFire Team, and has a Ph.D. from the Laboratory for Atmospheric Research at Washington State University. Her research interests include fire emissions calculation and atmospheric modeling of smoke plumes from wildland fire.

8. Performance assessment of Fire Inventory from the National Center for Atmospheric Research (FINNv2) wildfire emissions estimates using satellite aerosol observations

Presenter: Nathan Pavlovic, Lead Geospatial Data Scientist, Sonoma Technology, Inc., npavlovic@gmail.com

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Abstract: Wildland fires and open burning can be substantial sources of ozone precursors and particulate matter. Air quality can be affected by fire events that occur locally, regionally, or across the United States or even beyond its international borders. The Fire INventory from the National Center for Atmospheric Research (FINN) model estimates daily global emissions of trace gases and particles from open biomass burning. FINN was enhanced using new findings and data products from ongoing laboratory studies, surface and airborne field measurement campaigns, and satellite-based sensors to produce a fully operational, next-generation global FINN application (FINNv2). Fire emissions estimates for 2012-2017—a time period that includes recent years relevant to air quality modeling and planning activities in the United States—have been developed using FINNv2. In this presentation, we discuss preliminary results from a performance assessment of FINNv2 using aerosol optical depth retrievals from the Multi-Angle Implementation of Atmospheric Correction (MAIAC) applied to Moderate Resolution Imaging Spectroradiometer (MODIS) imagery. Our assessment focuses on fire events that (1) originate from within Mexico, Central America, or the Caribbean, and (2) influence air quality in the southern United States. With FINNv2 emissions inputs, we use HYSPLIT dispersion modeling and Comprehensive Air Quality Model with Extensions (CAMx) photochemical model output to compare aerosol optical depth with smoke observations in 2012-2017. We assess agreement between model output and satellite observations of AOD using a variety of accuracy metrics to understand the performance characteristics of the FINNv2 emissions estimates.

Keywords: emissions, wildfire smoke, verification, HYSPLIT, remote sensing

Presenter Bio: Nathan is Lead Geospatial Data Scientist at Sonoma Technology, Inc. Nathan's background lies in geospatial analysis of environmental challenges, and he is excited to use his GIS and remote sensing skills to contribute to innovative, ethical, science-based solutions at Sonoma Tech. He received his BS in Biology from Grinnell College in Iowa and his MS in Geography and Geographic Information Science from the University of Illinois at Urbana-Champaign.

9. Smoke tracking with SensorMap: Combining regulatory and Purple Air data to fill in gaps in the PM2.5 network

Presenter: Graeme Carvlin, Air Resource Specialist, Puget Sound Clean Air Agency, GraemeC@pscleanair.gov

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Abstract: For at least the last decade, wildland fire in Washington State has been increasing in frequency and in total acres burned. The Puget Sound Clean Air Agency provides air quality forecasting and management for a four-county region in southern and eastern Puget Sound, including the City of Seattle. The Agency has long relied on its network of regulatory-grade particulate matter monitors to track wildfire smoke, however, most of these are concentrated in areas of the greatest population density, and there are some large gaps that do not have a monitor nearby. To improve data coverage in our region and to enable better-informed air quality forecasts, we developed SensorMap, an online interface that combines data from low-cost PurpleAir monitors with data from the regulatory monitors.

Each PurpleAir sensor is calibrated to the nearest regulatory monitor, to ensure that all data on the map are directly comparable. The PurpleAir data are also put through an automatic quality control check that detects periods of sensor malfunction and removes those data. The result is greatly improved spatial coverage in our PM2.5 monitoring network and a monitoring network that grows automatically every time a new PurpleAir is connected to the internet.

Although the combined dataset cannot be used for regulatory purposes, it provides air quality forecasters with a much clearer picture of how smoke moves through our jurisdiction and, in many cases, provides residents with a near real-time measurement of local conditions. We will share our map, present our calibration and quality control methods, and provide case studies of how the combined network of sensors can improve smoke forecasting.

Keywords: Real-time monitoring; air quality forecasting; PurpleAir; low-cost sensor

Presenter Bio: Graeme Carvlin is an Air Resource Specialist with the Puget Sound Clean Air Agency. He has a PhD in Environmental Health from the University of Washington and an MS in Chemistry from UCSD. Graeme works at the intersection of air sensors and community science. Currently he is developing web tools to help the public make sense of their sensor data.

10. Validating wildfire smoke transport within a coupled fire-atmosphere model using a novel high-density instrumentation network

Presenter: Mallia Derek, Postdoctoral Fellow, University of Utah, derek.mallia@utah.edu

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Abstract: Wildfire smoke poses a significant hazard to communities and fire managers, as it can reduce visibility while also degrading air quality across areas downwind of the fire. Although many smoke modeling tools exist, accurately representating smoke production and dispersion is difficult, especially in regions with complex terrain. One of the fundamental problems associated smoke modeling is the availability of the observational data needed for model validation. The limited density of traditional air quality monitoring networks makes validating wildfire smoke transport challenging, particularly over regions where smoke plumes exhibit significant spatiotemporal variability. In this presentation, we analyze PM2.5 simulations for the Pole Creek Fire, which burned adjacent to the Wasatch Front during the of 2018. Here, smoke simulations were generated from a coupled fire-atmosphere model (WRF-SFIRE-CHEM), which can simultaneously render fire growth, fire emissions, smoke dispersion, and fire-atmosphere interaction. Smoke simulations generated from WRF-SFIRE-CHEM were validated using the University of Utah's AirU low-cost sensor and mobile TRAX PM2.5 networks. Initial results from our case study suggest that low-cost sensor networks and mobile measurements can adequately resolve the spatial heterogeneity of smoke plumes while also serving as a useful data set for validating smoke transport models. Furthermore, results presented here suggest that coupled fire-atmosphere models such as WRF-SFIRE-CHEM can realistically render local drainage flow and downwind dispersion of wildfire smoke plumes in regions of significant topographic relief.

Keywords: wildfire, WRF-SFIRE, PM 2.5, smoke modeling

Presenter Bio: Derek Mallia is a research scientist at the University of Utah's Department of Atmospheric Science. Dr. Mallia is originally from upstate New York and received his undergraduate and graduate degrees in Atmospheric Sciences. Derek is primarily interested in studying wildfire behavior and smoke transport using coupled fire-atmosphere models such as WRF-SFIRE. He has studied the impacts of smoke shading and wildfires plumes rises on local meteorology, in addition to utilizing novel low-cost instrument platforms for validating wildfire smoke transport within NWP models.

11. An Open Source R package for Purple Air Data Analysis

Presenter: Jonathan Callahan, President, Mazama Science, jonathan@mazamascience.com

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Abstract: Low-cost air quality sensors are providing an increasingly dense network of high temporal and spatial resolution air quality measurements throughout North America. This is particularly true of laser particle counters measuring PM2.5 such as those produced by Purple Air. The R statistical programming language is often used by air quality researchers and some dedicated air quality packages do exist, e.g. "openair". But there are currently no open source R packages dedicated to working with air quality data from consumer grade air quality sensors such as those produced by Purple Air.

Mazama Science has partnered with the Air Quality Sensor Performance Evaluation Center (AQ-SPEC) at the South Coast Air Quality Management District and the US Forest Service (USFS) to create an open source R package that provides a full suite of data download, analysis and visualization capabilities for data from Purple Air sensors. This presentation will review package capabilities and a USFS maintained database of archival Purple Air data. Package capabilities will be used to briefly demonstrate analysis of sensor performance as well as community impacts of wildfire smoke.

Keywords: R, open source, software, Purple Air, data analysis

Presenter Bio: Jonathan has always enjoyed understanding and explaining the natural world. His career in science began with a PhD in Chemistry, followed by a decade in a NOAA Oceanography lab, and a subsequent decade consulting with federal and nonprofit scientific organizations. Through it all, he has brought automation, data visualization and storytelling to a variety of disciplines with a focus on environmental monitoring.

12. An overview of small fire sampling during FIREX-AQ

Presenter: Jim Crawford, Senior Scientist for Atmospheric Chemistry, NASA Langley Research Center, James.H.Craawford@nasa.gov

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Abstract: While not as attention grabbing as large western wildfires, smaller fires associated with agricultural and prescribed burning contribute substantially to the integrated impact of fire emissions in the US. Small fire activity is also closer in proximity to population and more sustained throughout the year, fluctuating with season but always present. Small fires were the primary focus of research flights conducted from Salina, Kansas from 19 August to 5 September 2019 as part of the Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) campaign. Jointly sponsored by NASA and NOAA to advance understanding of the environmental impact of fire emissions, FIREX-AQ conducted seven flights and sampled nearly 90 individual small agricultural and prescribed fire plumes. Sampling was conducted using NASA's DC-8 flying laboratory which carried twenty-eight instrument teams and enabled sampling of fires across eleven states covering the central and southeastern US. Flight planning to target small fires presented a particular challenge and required climatological knowledge of fire activity, information on habits and patterns of the agricultural community, direct coordination with authorities responsible for prescribed burning, real-time satellite fire detections, and ground-level scouting of regions where burning was expected. Small fire sampling offered an excellent opportunity to compare fire emissions across a wide range of fuel types and burning conditions. The large number of small fires sampled during FIREX-AQ will provide unprecedented information on the diversity of fire emissions, providing the basis for improved constraints on fire emissions used in models.

Presenter Bio: Dr. Crawford has been involved in NASA airborne research since 1991 starting as a graduate student at Georgia Tech and continuing as a research scientist at NASA Langley since 1997. His most recent activity involved serving as one of the science leads for the FIREX-AQ field study conducted jointly by NOAA and NASA in the late summer of 2019.

13. Building the Right Solution for Real-Time Smoke Monitoring Deployments

Presenter: Zoë Fyfe, Senior Product Manager, FTS Inc., zfyfe@ftsinc.com

Abstract: When discussing air quality, technical discussions tend to focus on the sensor; however, attention to the support system is vital. In order to deploy sensors in the wildland-urban interface and more remote regions, power requirements, ease of use, and telemetry play a key role. As the only provider of remote fire weather stations meeting the NWCG PMS 426-3 standard, FTS has spent the last 40 years perfecting deployments in remote and extreme environments. Learn how to select appropriate system components using FTS experience and case studies with specific focus on:
- Alternative data transmission choices (cellular, GOES, Iridium, etc.)
- Power demands of different sensor types (continuous versus periodic readings)
- How to satisfy power requirements in a portable system (weight, autonomy, location)
- Important mechanical considerations when deploying in less accessible locations (tool-less components, durability, etc.)

Obtaining real-time smoke monitoring data in remote environments is available today. Consider this a guide towards designing the solution that best suits your specific needs.

Keywords: remote deployment monitoring system

Presenter Bio: Zoë Fyfe is Senior Product Manager at FTS, a leading manufacturer of remote environmental monitoring solutions for the fire weather, meteorology, and hydrology industries. Mrs. Fyfe graduated with a degree in Applied Science, is PMP certified, and Pragmatic Marketing Certified (PMC) Level 5. Mrs. Fyfe's earlier work as an engineer has earned her a patent and a position on an SAE International committee. More recently, she has acquired proficiency with the Internet of Things (IoT). Experience with this technology has led to speaking opportunities at three prestigious international conferences in the last two years.

14. Characteristics and evolution of particles and gases in a Canadian boreal forest wild fire plume

Presenter: Katherine Hayden, Atmospheric Chemist, Environment and Climate Change Canada, katherine.hayden@canada.ca

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Abstract: A comprehensive set of real-time aerosol and gas measurements of a Canadian boreal forest wildfire were made from the National Research Council of Canada's Convair-580. The aircraft intercepted two separate plumes by flying multiple transects at successive distances downwind of the fires with multiple altitudes flown at each transect. This Lagrangian-type flight captured the wildfire emissions and subsequent transport and transformation of pollutants. These low energy fires, ignited by lightning strikes, were characteristic of smouldering combustion. Emission factors (EF) were determined for a number of species using transects closest to the fire sources. EFs for NH_3, Hg and $PM_{2.5}$ were lower than previously reported for boreal forests by factors of 7, 3 and 3, respectively, possibly indicating an aged combustion process. Total hydrocarbons accounted for 6-8% of carbon emissions. The chemical characteristics and evolution of particles and gases are also investigated as the wild fire plume travelled downwind over a time scale of ~3 hours and spatial scale of 100 km. The dominant fraction of sub-micron aerosol showed volatilization close to the fire and marginal enhancement of secondary organic aerosol. Photochemical processes were likely influenced by smoke particle concentrations impacting the actinic flux. Differences between the two plumes are compared to gain insight into the conditions governing secondary formation processes.

Keywords: Canadian boreal forest, wildfire, evolution, emissions

Presenter Bio: Katherine Hayden is an atmospheric chemist working in air quality process research in the federal department of Environment and Climate Change Canada. Katherine has studied a variety of atmospheric processes including smog chemistry, aerosol formation including through cloud processes, and more recently understanding dry deposition using aircraft observations in the Canadian oil sands region. Current work has involved understanding the chemistry in forest fire plumes.

15. Fueled from below: Linking Fire, Fuels and Weather to Atmospheric Chemistry for FIREX-AQ

Presenter: Amber Soja, Executive/Manager Researcher, NIA / NASA LaRC, Amber.J.Soja@nasa.gov

Additional Author(s): Emily Gargulinski, Jessica McCarty, Elizabeth Wiggins, Andy Hudak, Eileen Rintsch, Kevin Hiers, Chris Schmidt and Justin Fain

Abstract: FIREX-AQ (Fire Influence on Regional to Global Environments and Air Quality) is a large-scale field campaign, led by NASA and NOAA, designed to provide comprehensive observations to investigate the impact of smoke on air quality and climate. During this campaign, both natural and anthropogenic fires were observed across the continental United States. Both wildland and prescribed fires can serve to: set the beginning and end of ecosystem succession; reduce fuels to reduce wildfire risk; maintain healthy ecosystem function (e.g., cycle nutrients); reduce total emissions and particulate matter for improved air quality; restore and promote native species; maintain natural diversity; and decrease invasive species.

We anticipate the diversity of smoke measurements sampled during this campaign will vary depending on fuel type, amount, structure, combustion environment (specifically those related to flaming vs smoldering combustion), and antecedent weather factors. Here we will present detailed daily/hourly fire-specific information for each fire with the goal of providing explanatory variables for potential differences found in FIREX-AQ data. Specific variables presented will include: fire size, location of fire over time, verified ecosystems and fuel types, fire-weather conditions, and carbon emissions. Using satellite and ground-based data, daily fire progression maps will be introduced and provided. Additionally, we will demonstrate the capability of current satellite-based products to track fires across the landscape over time as well as quantify and compare burned area and Fire Radiative Power. Fire behavior (e.g., surface, intermittent, crown) will be provided for western wildland fires. In these analyses, very-high resolution and ground-based information will serve as 'truth'.
We hope to provide insights to both prescribed and wildland fires in an effort to enhance the understanding of the connections between fuels, fire, weather, atmospheric chemistry and smoke transport, which are critical to understanding the impact of fire on air quality, atmospheric chemistry and climate. Increased understanding of fire regimes is currently compelling, because fire in human-dominated landscapes is not well defined, and extreme wildland fire is increasing, largely under the control of weather and climate, which then feeds back to these weather and climate systems (e.g., albedo change of landscapes, the atmosphere, snow and ice; smoke particle interactions in clouds; altered patterns of precipitation).

Presenter Bio: Amber Soja, Associate Research Fellow, National Institute of Aerospace Dr. Amber Soja is resident in the Climate Science, Chemistry and Dynamics Branches of Atmospheric Sciences at the NASA Langley Research Center (LaRC). She is currently an Associate Program Manager for the NASA Applied Sciences Wildland Fire program and a Disasters Coordinator for NASA LaRC. Her research focuses on using satellite, Geographic Information System, and modeled data as tools to explore the dynamic interactive relationships that exist between fire regimes, fire weather, air quality, the biosphere, atmosphere, and climate systems. She has 25 years of research experience that has primarily focused on the beautiful expansive wildlands of Siberia. Soja is proud to have worked to enhance the use of satellite data in stakeholder agencies, so our Nation benefits from the use of our applicable information. This includes working with the Environmental Protection Agency (EPA) to introduce satellite-based fire data to enhance the fire emissions portion of the National

Emissions Inventory. She holds a B.A. (1996) and a Ph.D. (2004) in Environmental Sciences from the University of Virginia.

17. Insights From Smoke Management Collaboration in the Eastern Sierra Nevada

Presenter: Sean Mueller, Air Resource Specialist, USDA Forest Service, sean.mueller@usda.gov

Abstract: Nationally, the USDA Forest Service hazardous fuel reduction acreage goals have increased throughout the 21st century, although California state smoke management rules have not been updated since 2001. This scenario presents potential conflict surrounding decision making with uncertainty and highlights the need to better understand air quality and smoke, especially at the field level. This is increasingly important on the Inyo National Forest (INF), a recreation focused forest that is tasked with effectively tripling its hazardous fuel reduction targets. Two INF case studies are presented to showcase landscape level forest restoration opportunities, challenges, and insights regarding effective smoke management: a spring 2019 prescribed burn and the 2019 Springs Fire, a naturally ignited wildland fire managed for multiple objectives, including resource benefits. We examine how a partnership of federal, state, and local agencies utilize smoke modeling and monitoring to inform decision making and balance both short and long-term public health and forest management goals in the Eastern Sierra Nevada. The successful efforts distill a framework for land management and regulator collaboration, founded in interagency trust and scientific tools. Smoke management topics for further discussion and clarification are presented from both the regulatory and land management perspectives.

Keywords: Smoke Management, Forest Service, California Air Resources Board, Interagency Partnerships, Inyo National Forest, Prescribed Fire, Managed Fire, Title 17

Presenter Bio: Sean Mueller is a Presidential Management Fellow Air Resource Specialist with the U.S. Department of Agriculture Forest Service at the Northern Region Regional office in Missoula, Montana. He completed a B.S. degree in Business Administration at Boston University, and a Master of Environmental Science and Management at the University of California Santa Barbara Bren School. Sean has a breadth of experience in air quality policy in both urban and rural settings, from the concrete jungle of Washington D.C., to the beaches of Santa Barbara, and currently the forests of Montana.

18. Practitioner Smoke Management Ignition Techniques to Mitigate Emissions

Presenter: Jen Croft, Applied Fire Ecologist, USFS, jennifer.croft@usda.gov

Abstract: A discussion related to the ignition techniques, methodologies, and considerations during prescribed fire implementation in the U.S. to mitigate smoke emissions. Elements of this discussion will include the basic principles of managing the phases of combustion to manipulate smoke production across the land management arena. As shared stewardship pace and scale increase, the inclusion of these concepts is critical to mass ignitions. This session will be important knowledge for evolving practitioners, Agency Administrators, and non-federal burners.

Keywords: ignition techniques, smoke emissions, shared stewardship, practioner

Presenter Bio: In her 23 years of fire management, Jen has served in a wide range of roles and positions. Her formal job titles include fuels' crew leader, Type 2 Crew Lead, Assistant Fire Management Officer, Fire Management Officer, and Applied Fire Ecologist. She is still an active fire behavior analyst, long-term analyst, incident commander type 3, prescribed fire burn boss type 1, and air resource advisor. Jen has a bachelor's of science in Forestry from Washington State University, a Master's in Natural Resource Management from Utah State, and a graduate certificate in NEPA. Her favorite adventures include assisting the development of the Philippine Fire Management program and completing the Armenian Fire Risk Assessment. She is among the burn boss cadre for FASMEE and continues to support the field as often as possible.

19. Campaign support forecasting facilitates information based deployment decisions

Presenter: Pius Lee, Natoinal Air Quality Forecasting Capability Project Leader, Aire Resources Laboratory / NOAA, pius.lee@noaa.gov

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Abstract: The NOAA Air Resources Laboratory has led research and pre-implementation testing activities for the National Air Quality Forecasting Capability (NAQFC) since the congressional inception of the forecasting service in 2003. Field campaigns represent potential collections of large amounts of in-situ data critical for model verification and identification of deficiencies of the chemical and/or physical processes represented in NAQFC simulations. Past experiences will be presented on how such large campaign data sets have enriched the development and improvement of the NAQFC and how procedural best practices have enabled incremental and process-specific module improvements in the forecast system. Discussion will also be provided focusing on similar benefits of utilizing the coherent and large number of high-quality observations from the large FIREX-AQ campaign to pin-point potential short-comings in the research version of NAQFC (dubbed as the "-β" version) to produce real-time forecasting support for the Firex-AQ campaign. The campaign highlighted wild fire associated emissions, and transport and removal of pollutants due to depositions. Episodic pulses of wild fire associated particulate matter (PM) emissions typically resulted in spikes of high surface level PM concentrations. Our NAQFC-β based forecasts were provided to campaign managers for consideration likely contributing to some of the deployment decisions. We will share lessons learned from how well or poorly NAQFC-β captured the episodic wild fire events by utilizing surface, remotely sensed, and in-situ aircraft data to verify and evaluate the forecasting simulations. Advantages of the semi-operational setting of NAQFC-β will be described. Further potential areas of improvement for NAQFC-β will also be shared.

Keywords: smoke measurement campaign, deployment decision, forecasting support

Presenter Bio: Dr. Lee joined the Air Resources Laboratory (ARL) of the National Oceanic and Atmospheric Administration (NOAA) in February 2009. Dr. Lee has helped lead Air Quality forecasting and research at ARL and became the project leader of the National Air Quality Forecasting Capability since 2011. Among the many challenges concerning the pursuit of understanding the science of air quality modeling, it is ARL's strong interest to improve the timeliness and accuracy of the National Air Quality Forecasting Capability (NAQFC) headed by NOAA. Dr. Lee has been instrumental in spearheading a broad array of issues in support of the NAQFC.

20. Canadian Health Portfolio Wildfire Emergency Response

Presenter: Vanessa Beaulac, Head, Exposure Assessment Section, Health Canada, vanessa.beaulac@canada.ca

Abstract: The Health Portfolio of the Government of Canada manages wildfire smoke and emergency responses through the Chemicals Emergency Response and Preparedness Annex. Under this Annex, Health Canada plays a key role in wildfire responses by providing federal coordination support and an air emergency monitoring capacity. Activation of the Emergency Air Health Monitoring Unit (EahMU) during air emergencies triggers deployment of monitoring equipment to support science-based decision making through the provision of real-time outdoor and indoor air quality data.

To date, the focus of EahMU has been particulate responses. Development of a real-time response capacity for air toxics including polycyclic aromatic compounds (PACs) and volatile organic compounds (VOCs) has become a Health Canada priority. Inclusion of these chemical classes to the EahMU will be influential during urban-wildland fire scenarios or when considering health implications of exposure to smoke form the combustion of different fuel sources (e.g. boreal forests vs grasslands).

This presentation will speak to the Health Portfolio wildfire response capacity under the Chemicals Emergency Response and Preparedness Annex, with particular emphasis on the role of the EahMU. It will present an overview of current and future monitoring capacity, and describe how EahMU-derived data supported decision-making during Canadian wildfire responses in the summer of 2019. Last, we will discuss the status of wildfire smoke exposure assessment in Canada, and how this work in conjunction with EahMU deployment is influencing the development of a pan-Canadian disaster research framework from the exposure assessment and epidemiology perspectives.

Keywords: Canada, emergency, emergency air health monitoring unit (EahMU), wildfire, smoke

Presenter Bio: Vanessa has worked for Health Canada since 2008. She is currently Head of the Exposure Assessment Section, a multi-disciplinary team of scientists that conducts national field exposure research in the area of air pollution exposure, modeling, and epidemiology. In addition, she is a designated Level 1 Responder under the Chemicals Emergency Response and Preparedness Unit of the Health Portfolio. Vanessa coordinates the Emergency Air Health Monitoring Unit (EahMU), a rapid response kit available during air emergencies. Vanessa received a B.Sc.H in Biomedical toxicology from the University of Guelph, and holds a M.Sc. in Respiratory toxicology from the University of Saskatchewan.

21. Challenges of Smoke Forecasting on Mendocino Complex Fire

Presenter: Bret Anderson, Physical Scientist, USDA Forest Service, bret.a.anderson@usda.gov

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Abstract: Recognition of the growing threat that wildfire smoke poses to public health and safety has resulted in a proactive and determined response led by the USDA-Forest Service (USFS). The Interagency Wildland Fire Air Quality Response Program (IWFAQRP) was created to directly assess, communicate, and address risks posed by wildland fire smoke to the public as well as fire personnel. The program depends on four primary components: specially trained personnel called Air Resource Advisors (ARA's), air quality monitoring, smoke concentration and dispersion modeling, and coordination and cooperation with agency partners.

In August 2018, two ARA's were dispatched to the Mendocino Complex Fire to provide forecast support for fire related air quality impacts. Challenges encountered included 1) limitations of numerical weather models to properly characterize the smoke transport in a highly complex meteorological environment involving both complex terrain and land/sea interface considerations, 2) inadequate characterization of fire dynamics and behavior and their impact on use of air quality models to simulate smoke transport, and lack of familiarity with differing meteorological and air quality models used in smoke forecast systems. In this presentation, an overview of some of the tools used by ARA's in operational smoke forecasting, challenges affecting forecast quality, and work arounds will be examined in hopes that lessons learned from this event can improve the meteorological and air quality modeling tools used for operational smoke forecasting.

Keywords: Smoke transport prediction, smoke modeling, air resource advisors

Presenter Bio: Bret Anderson is an air quality meteorologist with the USDA Forest Service air resource management program, serving as the coordinator of the atmospheric modeling and regional haze programs. Bret has over 25 years of experience in the fields of meteorological and air quality modeling between the State of Nebraska, Environmental Protection Agency, and US Forest Service. He also participates in the Interagency Wildland Fire Air Quality Response Program (IWFAQRP) as an air resource advisor.

22. Model Performance and Sensitivity Analysis of 2016 Western North Carolina Wildfire Events

Presenter: Sadia Afrin, Graduate Student, Department of Civil, Construction, & Environmental Engineering, North Carolina State University, safrin@ncsu.edu

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Abstract: Wildfires are a significant source of fine particulate matter (PM2.5) emissions in the U.S. Modeling wildfire smoke is important to estimate and mitigate their impact on air quality and public health. State-of-the-art chemical transport models (CTMs) are among the most comprehensive methods to simulate wildfire smoke and estimate fire-attributable pollution impacts. In spite of the frequent use of CTMs in air quality modeling, a significant disparity exists between modeled and observed results. Correctly estimating the magnitude of pollutant concentrations and mistiming of peaks are common in most simulations evaluating wildland fire impacts at a regional scale. In this study, we use chemical transport modeling to simulate the air quality impact of the 2016 Western North Carolina wildfire events. A series of devastating wildfires burned more than 88,000 acres in this region during the last three months of that year causing enormous damage to public health and property. Using the Community Multiscale Air Quality Modeling System (CMAQ), we analyze the wildfire events that occurred during the month of November. We use the U.S. Environment Protection Agency's 2016 beta emission inventory, which uses the SmartFire-BlueSky modeling framework to estimate wildfire emissions. We evaluate model performance by comparing modeled concentrations to observed pollutant levels at monitors suspected of having fire impact. In addition, we assess the model's sensitivity to emissions inputs by substituting available wildfire emissions data with alternative emissions based on the North Carolina Division of Parks and Recreation daily reported evolution of burn area. Here, predicted concentrations underpredict the observed PM2.5 concentrations when considering the default SmartFire-based wildfire emissions. This under-prediction is likely due to satellites' inability to accurately detect smoke, as some of the heaviest wildfire days were associated with dense cloud coverage. The evaluation of model's performance after updating fire emission provides valuable insight into understanding the potential sources and causes behind this underestimation during the observation peaks. Overall, the result of this simulation study can aid in developing a more accurate representation of wildfire smoke to convey scientific conclusions and information to environmental managers.

Keywords: Wildfire-smoke, PM2.5, CMAQ, Sensitivity

Presenter Bio: Sadia Afrin is a 4th year Ph.D. student in the Department of Civil, Construction, and Environmental Engineering at NC State University, US. Her research focus is on air quality modeling and atmospheric chemistry. She has experience in data analysis and statistical modeling approach to assess the impact of wildland fires (both wildfires and prescribed fires) on air quality, climate and public health of Southeastern US. Currently, she is using a chemical transport model named Community Multiscale Air Quality Modeling System (CMAQ) to investigate the tradeoff between wildfire and prescribed smoke exposure.

25. Prescribed fires and prescriptions for health: short-term exposures, research gaps and community engagement

Presenter: Gabriela Goldfarb, Environmental Public Health Section Manager, Oregon Health Authority, gabriela.g.goldfarb@dhsoha.state.or.us

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Abstract: In February 2019, the Oregon Department of Forestry (ODF) and Oregon Department of Environmental Quality (DEQ), in consultation with the Oregon Health Authority (OHA), adopted new Smoke Management Rules related to prescribed burns. These new rules include a health-based 1-hour intrusion threshold of 70 ug/m3 that triggers advanced planning and community engagement. The goal of the revised rules is to expand prescribed fire opportunity while supporting measures to protect the health of vulnerable populations. OHA believes there is a need for strengthened science-based guidance on short-term (sub-daily, <24hr) smoke exposures and research on associated health outcomes. This presentation will discuss Oregon's public health efforts and recommendations related to prescribed fires including real-time monitoring, post-burn analyses, reporting and strengthened community engagement. Developing policy that includes health-protective expansion of prescribed fire to mitigate increased wildfire can also help communities adapt to current and anticipated climate change scenarios.

Keywords: prescribed burns, public health, short-term exposures, health outcomes, community engagement

Presenter Bio: Gabriela Goldfarb joined Oregon Health Authority in 2016 as manager of OHA's Environmental Public Health Section. She oversees the agency's programs to advance science-based actions that protect people from environmental hazards. Ms. Goldfarb served from 2012 – 2016 as a policy advisor in the Oregon Office of the Governor. Gabriela's prior experience includes a decade as an ocean and coastal policy consultant, Federal Programs Manager for the California Coastal Commission and Senior Consultant for a toxics regulatory consulting firm. Gabriela has a Master's in Public Policy from the Harvard Kennedy School and is a graduate of the University of California, Berkeley.

26. AQ Management Tools to Support Prescribed Burning Increases

Presenter: Gregory Vlasek, Program Advisor, Agricultural & Prescribed Burning Support, California Air Resources Board, Air Quality Planning & Science Division, greg.vlasek@arb.ca.gov

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Abstract: California seeks to expand biomass fuel reduction and prescribed burning on forest lands by an order of magnitude, from the current rate of tens of thousands of acres per year to hundreds of thousands of acres per year. Obstacles to expansion of prescribed burning are physiographic, economic, and cultural. CARB is developing databases, analytical tools and metrics to better evaluate the air quality and carbon lifecycle impacts of increased use of prescribed fire compared with the no-action approach of conventional suppression of catastrophic wildfires. Developing a better technical understanding of the potential net air quality benefits of well-managed prescribed burning will help secure public, legislator and regulator acceptance of the practice and support a paradigm shift toward healthier and more sustainable forests.

CARB is developing a collaboration with local air districts to increase the spatial density of hourly PM2.5 data captured near prescribed fire sites through tactical deployment of E-BAM monitors. Prescribed fire smoke monitoring data is being curated in-house using the new MonTIGo application to actively support analysis, reporting and equipment maintenance. The additional data will be available for BlueSky and other smoke forecasting models. CARB is also refining fire and smoke data collection and management capabilities through its PFIRS platform.

CARB and air districts are providing training to land managers on the new systems to facilitate understanding of their critical role in data collection.

In coordination with CAL FIRE's Fire and Resource Assessment Program (FRAP) technical team, CARB is analyzing current and historical data to review the effectiveness of its meteorology-driven, statewide burn-day forecasting system (developed in 2000 primarily for low elevation agricultural burning) and to identify opportunities to refine and localize prescribed burning decisions in forested lands. CARB is seeking tool builders to collaborate on successful solutions to significantly increase prescribed fire while protecting the public from health risk exposures and meeting regulatory requirements.

Keywords: prescribed fire, monitoring,

Presenter Bio: Greg Vlasek's career spans nearly forty years developing and executing environmental compliance programs in the private and public sector. His roles with the State of California include ten years as chief of emergency air monitoring with CARB developing the state's wildfire and industrial emergency monitoring programs. He also served as assistant secretary for local program coordination and emergency management at the California Environmental Protection Agency, and is now program advisor to CARB's newly formed Agricultural & Prescribed Burning Support program. He holds undergraduate degrees in Environmental Studies and Geography from the University of California.

27. Rx Fire Decision Making in WA State

Presenter: Carolyn Kelly, Smoke Management Field Coordinator, Washington Department of Natural Resources; Wildfire Division, carolyn.kelly@dnr.wa.gov

Abstract: A general overview of the decision making process for responding to prescribed fire burn requests including: an overview of Washington Department of Natural Resource's role and responsibilities in smoke management, the decision making process, and communications with the public, other regulators, and federal, state, tribal, and private burners.

Keywords: Prescribed fire, smoke management plan

Presenter Bio: Carolyn Kelly has worked for Washington Department of Natural Resources as Smoke Management Field Coordinator since 2017. Prior to her time with the state, she was the Air Quality Program Manager and Climate Change Coordinator for the Quinault Indian Nation where she was also a volunteer firefighter for both the tribe and local fire department Grays Harbor Fire District #8. During that time, she graduated from Fire Academy and has held several wildfire qualifications mainly responding as an Air Resource Advisor. She currently heads the Northwest Air Quality Communicators Group (NWAQC) and actively participates in the Okanogan River Airshed Partnership.

28. The Colorado Approach to Smoke Permitting for Prescribed Fire

Presenter: Boyd Lebeda, Field Liaison for Smoke Management, Colorado Department of Public Health and Environment – Air Pollution Control Division, boyd.lebeda@state.co.us

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Scott Landes, Meteorology and Prescribed Fire Supervisor, Colorado Department of Public Health and Environment – Air Pollution Control Division

Abstract: Fire has been excluded from many Colorado landscapes for over a century. Over that time, excessive fuel loading has accumulated and is available to burn. Wildfires that occur under hot, dry and windy conditions burn aggressively and result in negative outcomes. Some Colorado communities have experienced unhealthy levels of smoke from wildfires for more than a month. Prescribed fire offers a tool to address this buildup of fuel and for the re-introduction of fire by burning at more moderate conditions and enhancing the positive outcomes of fire. There are challenges related to smoke when using prescribed fire: preparing communities to tolerate some smoke and minimizing their exposure. The two primary ways that prescribed fire is used in Colorado are pile burning and broadcast burning. It is often necessary to harvest and/or mechanically treat forested areas and reduce the fuel loading via pile burning before re-introducing fire via broadcast burning. In Colorado, smoke generated from both pile burning and broadcast burning are regulated under the Clean Air Act and the Colorado Air Pollution Prevention and Control Act to protect public health and protect visibility. The Colorado Department of Public Health and Environment strives to protect public health from the negative impacts of wood smoke while recognizing the benefits of prescribed fire. The Colorado Smoke Management Program permits prescribed burn projects (piles and broadcast) that exceed the small open burn limits. Applicants can apply for standard condition permits or request non- standard permit conditions. These non-standard permits allow land managers to design larger scale projects using mitigations such as sequencing burns and burn days, modified firing techniques, collecting air quality data with a network of monitoring equipment during burns, proactive outreach with health messaging, and frequent communication about operations. These mitigations has been used successfully in Colorado to gain the support of communities. The ability for Colorado to implement a non-standard permit is a way to help make prescribed burning a viable tool to address the consequences of a century of fire exclusion while continuing to protect the health of Colorado citizens.

Keywords: Prescribed fire permitting, smoke management, smoke exposure

Presenter Bio: Boyd Lebeda started his forestry career as a volunteer on the Laramie District of the Medicine Bow National Forest in 1984. He worked 29 years as a forester for Colorado State Forest Service with an emphasis on forest management, fuels management and prescribed fire. Boyd is currently qualified as a fire behavior analyst in the Incident Command System (ICS). He recently joined the Colorado Department of Public Health and Environment as the Field Liaison for Smoke Management. Outside of work he enjoys running, mountain biking and wood working

29. Montana/Idaho Smoke: Coordinating Interstate Smoke from Prescribed Burning

Presenter: Seth Morphis, Regional Smoke Coordinator, USDA Forest Service, seth.morphis@usda.gov

Abstract: Coordinating interstate smoke impacts from prescribed fire activity involves various challenges including communication, assessing cumulative impact, and monitoring. The Montana/Idaho Airshed Group is an organization composed of federal, state, tribal, local government, and private organizations who collectively coordinate prescribed fire activity in Montana and Idaho. Members include prescribed fire practitioners and public health/environmental regulatory agencies across the two states. This inter-organizational coordination allows members to effectively use prescribed fire as a land management tool while limiting negative impacts on communities. By using a web based proposal interface and established lines of communication, members strategically coordinate ignitions on a daily basis across 24 airsheds during burning seasons. This coordination allows members to exchange information on potential prescribed fire units, assess the cumulative impact of smoke from firing operations, and monitor post ignition impacts. This presentation will discuss the Montana/Idaho Airshed Group's organizational structure and function and how it serves as a successful model to coordinate interstate prescribed fire smoke.

Keywords: Prescribed burns, smoke management, air quality, smoke exposure

Presenter Bio: Seth Morphis works out of the USFS Northern Rockies Regional Office in Missoula, MT. Seth began a career in air quality by working for several years for a state regulatory agency in the Southeast, concentrating on compliance and enforcement of the Clean Air Act. He then began a career in federal service by working for the Department of Defense, focusing on compliance and planning issues centered on air quality, including forestry management operations, on US military installations. Seth is the current chair of the National Wildfire Coordinating Group's Smoke Managers Sub-Committee and maintains an Air Resource Advisor fire qualification.

33. The JFSP Fire Science Exchange Network

Presenter: Stacey Frederick, Coordinator, California Fire Science Consortium/ UC Berkeley, ssfrederick@berkeley.edu

Abstract: The JFSP Fire Science Exchange Network (FSEN) began in 2010 with a primary goal of connecting fire managers in different regions with the research community and relevant science-based information to help them meet their management objectives. The Network now covers the entire country, with each regional exchange focusing on science and information most appropriate for the ecosystems in their region. The network is actively working to accelerate the awareness, understanding, and adoption of wildland fire science information by federal, tribal, state, local, and private stakeholders within ecologically similar regions. Our network of 15 regional exchanges provides timely, accurate, and regionally relevant science-based information to assist with fire management challenges.

This lightning talk will explain the history and mission of the FSEN. More importantly, this talk will explain how these boundary spanning organizations can be a valuable asset in disseminating emerging research and communicating the unique needs of the smoke science community.

Keywords: Communication; fire science; networking; outreach

Presenter Bio: Stacey Sargent Frederick has spent the last 5 years as the Statewide Coordinator for the California Fire Science Consortium at UC Berkeley. Her expertise and passion lies in bridging the gap between fire science and management through communication and relationships. Stacey is originally from Redmond, Oregon and holds a Bachelor's of Science in Natural Resources and Master's of Science in Forest Ecosystem and Society from Oregon State University.

34. Mapping Modeled Exposure of Wildland Fire Smoke for Human Health Studies in California

Presenter: Nancy French, Senior Scientist, Michigan Technology Research Institute, nhfrench@mtu.edu

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Abstract: Wildland fire smoke exposure affects a broad proportion of the U.S. population and is increasing due to climate change, settlement patterns and fire seclusion. Significant public health questions surrounding its effects remain, including the impact on cardiovascular disease and maternal health. Using atmospheric chemical transport modeling, we examined general air quality with and without wildland fire smoke PM2.5. The 24-hour average concentration of PM2.5 from all sources in 12-km gridded output from all sources in California (2007–2013) was 4.91 µg/m3. The average concentration of fire-PM2.5 in California by year was 1.22 µg/m3 (~25% of total PM2.5). The fire-PM2.5 daily mean was estimated at 4.40 µg/m3 in a high fire year (2008). Based on the model-derived fire-PM2.5 data, 97.4% of California's population lived in a county that experienced at least one episode of high smoke exposure ("smokewave") from 2007–2013. We are updating these concentrations with 2014-2019 modeling results. Photochemical model predictions of wildfire impacts on daily average PM2.5 carbon (organic and elemental) compared to rural monitors in California compared well for most years but tended to over-estimate wildfire impacts for 2008 (2.0 µg/m3 bias) and 2013 (1.6 µg/m3 bias) while underestimating for 2009 (−2.1 µg/m3 bias). The modeling system isolated wildfire and PM2.5 from other sources at monitored and unmonitored locations, which is important for understanding population exposure in health studies. Further work is needed to refine model predictions of wildland fire impacts on air quality in order to increase confidence in the model for future assessments. Atmospheric modeling can be a useful tool to assess broad geographic scale exposure for epidemiologic studies and to examine scenario-based health impacts.

Keywords: Exposure, health, wildland fire, chemical transport modeling, epidemiology, particulate matter, PM2.5, air pollution, population exposure

Presenter Bio: Dr. Nancy French has extensive expertise in fire ecology, smoke emissions, and geospatial data analysis, as well as skill applying multi-disciplinary research to the problem of fire and health. Dr. French is a Senior Scientist at the Michigan Technology Research Institute, and Adjunct Professor, School of Forest Resources and Environmental Science, Michigan Technological

University. Dr. French serves as a lead for the Fire and Smoke Model Evaluation Experiment (FASMEE). She has served as principal investigator on geospatial and epidemiologic research.

35. Communication Interventions for Public Health Protection from Wildland Fire Smoke: A Scoping Review

Presenter: Ryan Michael, Research Fellow, Centers for Disease Control and Prevention, obw3@cdc.gov

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Abstract: Climate-related changes to temperature and precipitation are associated with increases in wildland fire prevalence and severity. This phenomenon combined with greater population expansion into the wildland-urban interface may result in greater risks of population exposure to wildland fire smoke. Recent studies conclude that strong associations exist between exposure to wildland fire smoke and all-cause mortality and respiratory morbidity. As the risk of recurring wildland fires continues to grow, the public health community is increasingly faced with developing evidence-based interventions for reducing adverse health effects from wildland fire smoke exposure. Communication activities, such as public service announcements, social media campaigns, and emergency messaging, can act as public health interventions for wildland fire smoke. Here, we define communication interventions as activities designed to reduce risk factors or increase protective factors associated with wildfire smoke exposure and its subsequent health effects. We conducted a scoping review that classifies and evaluates existing evidence on health-related communication interventions for wildland fire smoke. We searched seven (Medline, Embase, Psycinfo, CAB Abstracts, CINAHL, Scopus, and Agricultural and Environmental Science Database) applicable databases using search terms indicative of wildland fire, smoke exposure, and communication activities ranging from episodic air quality alerts to multi-year social marketing campaigns. We included only those studies that contained evidence for changes to health behavior and, or respiratory morbidity and mortality as a result of a communications intervention. Preliminary results suggested that public health communication strategies most often associated with desired health protective actions were those developed with input from multiple stakeholders including the public, public health officials, health care professionals and state officials. Moreover, we saw evidence that hyperlocal communications channels (word of mouth, local health agencies) and message consistency across channels (e.g., common language by public health and emergency management officials) increased audience receptiveness and compliance. Compliance with response strategies such as timely evacuation or staying indoors was increased when target audiences could interact with and tailor risk information, using tools such as phone apps or online maps. Initial results also indicated that health effects from communication interventions were understudied outcomes.

Keywords: wildland fire, smoke, public health, communication intervention, scoping review

Presenter Bio: Ryan Michael is currently a CDC ORISE fellow examining atmospheric and climate factors affecting public health. Dr. Michael is interested in contributing to a deeper understanding of the factors driving urban air pollution exposures. The overarching goals of his research are to inform public policies that protect sensitive populations, contribute to improvements in community planning, design, and development, and influence population activity choices.

36. Evaluating the Acute Health Impact of PM2.5 Exposure During the October 2017 California Wildfires

Presenter: Stephanie Cleland, Graduate Research Assistant, Gillings School of Global Public Health, UNC-Chapel Hill, scleland@live.unc.edu

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Abstract: Exposure to wildfire smoke increases the risk of hospital admissions for respiratory illness, cardiovascular disease, and asthma. Due to this health risk and the increased frequency and severity of wildfires, it is necessary to develop methods for estimating a population's exposure to air pollution from wildfires. While air quality models and spatial interpolations of observations are often used for human exposure estimates, geostatistical methods can combine modeled concentrations with surface observations and satellite-based estimates to produce more accurate estimates of air pollutant concentrations across space and time. Here we use geostatistical methods to estimate daily PM2.5 concentrations across California during the October 2017 wildfires using surface monitor observations, Community Multiscale Air Quality Modeling System (CMAQ) output, and satellite-based PM2.5 estimates. The Constant Air Quality Model Performance (CAMP) Method and the Bayesian Maximum Entropy (BME) Framework are used to error-correct the CMAQ model and satellite-based PM2.5 estimations, and fuse them with surface PM2.5 observations from both permanent and temporary monitoring stations. Four different mapping methods using these three data sources are evaluated for accuracy, and the data fusion of the CAMP-corrected CMAQ model with the monitoring station observations provide the best PM2.5 estimates across California during the fires. These daily PM2.5 concentration maps are then used in a risk assessment, using wildfire-specific concentration-response functions, to estimate the number of respiratory, cardiovascular, and asthma hospital admissions attributable to the October 2017 wildfires. These numbers reveal the magnitude and locations of expected acute health impacts across California for the duration of the fires.

Keywords: wildfire PM2.5, data fusion, population smoke exposure, acute health impact, respiratory hospital admissions, cardiovascular hospital admissions

Presenter Bio: Stephanie Cleland is a MSPH candidate in the Department of Environmental Sciences & Engineering at the Gillings School of Global Public Health at UNC-Chapel Hill. Her current research focuses on using modern space-time geostatistics to map the air quality impacts of wildfires to better quantify the acute health impacts of such natural disasters. She plans to spend her career reducing the burden of disease in communities by conducting research and devising evidence-based solutions to environmental health challenges using technical skills drawn from both environmental science and computer science.

37. Hazardous Air Pollutants (HAPs) in Fresh and Aged Western US Wildfire Smoke

Presenter: Katelyn O'Dell, Graduate Research Assistant, Colorado State University, katelyn.odell@colostate.edu

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Abstract: Wildfires have a significant impact on United States (US) air quality. To understand the health impacts of wildfire smoke, epidemiology studies rely on concentrations of particulate matter (PM) as a smoke tracer. These studies have shown exposure to wildfire PM can lead to severe acute respiratory impacts, but many other potential health impacts (e.g., effects of long-term exposure) remain uncertain. While PM is a major component of wildfire smoke, there are many other hazardous air pollutants (HAPs) identified by the Environmental Protection Agency (EPA) that are also present in smoke plumes. Variability in HAPs between smoke plumes is currently unaccounted for in wildfire smoke health studies. Further, there are significant uncertainties in how smoke age may contribute to changes in the concentrations of different pollutants and in turn, how these can impact health. Using observations from the Western wildfire Experiment for Cloud chemistry, Aerosol absorption, and Nitrogen (WE-CAN) aircraft-based field campaign, we identify relationships between HAPs, PM, and smoke plume age for use in future health studies. We use these relationships, in conjunction with interpolated surface PM observations, to identify the chronic risk of HAPs in smoke from 2006-2018 across the US.

In the summer of 2018, HAPs were measured in wildfire smoke plumes during WE-CAN by the Trace Organic Gas Analyzer and a Proton-Transfer-Reaction Mass Spectrometer. PM was measured by an Aerosol Mass Spectrometer and Single Particle Soot Photometer. With these data, we identify HAPs that are elevated above health-relevant concentrations within fresh and aged smoke. We show HAPs with the largest associated health risk in smoke are correlated with PM and we calculate ratios of HAPs to PM as a function of plume age. We use these ratios with smoke-specific PM surface concentrations, estimated from satellite and surface observations, to calculate the chronic risk of HAPs in smoke from 2006-2018. The ratios of HAPs to PM we present here have the potential to be used in future, more comprehensive, health studies of smoke. The relationship between HAPs, PM, and plume age is crucial in furthering our understanding of the health impacts of acute and prolonged smoke exposure.

Presenter Bio: Katelyn O’Dell is a PhD candidate co-advised by Jeffrey Pierce and Emily Fischer in the Atmospheric Science Department at Colorado State University. Her current research is focused on quantifying gas-phase hazardous air pollutants and associated health risk in US wildfire smoke plumes. For her masters research, Katelyn worked with epidemiologists to develop improved daily smoke-exposure estimates across the US. These data have been used by several collaborators in economics and epidemiology to study the impacts of wildfire smoke exposure. Katelyn is a National Science Foundation Graduate Research Fellow and hopes to defend her PhD in summer 2021.

38. Integrating Data from Sensors with Regulatory Monitors during Wildfire Smoke Events

Presenter: Susan Stone, Senior Environmental Health Scientist, US Environmental Protection Agency, stone.susan@epa.gov

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Abstract: Wildfire smoke episodes can create highly dynamic air quality conditions, with fine particulate matter (PM2.5) concentrations having significant variation over small geographic areas, modulated by local meteorology and fire activity. During a wildfire smoke event, PM2.5 sensor data can supplement data from regulatory monitors (e.g., Federal Equivalent Methods or FEMs) and special-purpose monitors of near-FEM data quality by enhancing spatial coverage and temporal resolution of observations. However, a critical challenge is providing consistent air quality information using data with different spatial and temporal resolution. In addition, air sensor data and regulatory monitoring network data are currently shown on separate web applications with differences in how the information are presented. The integration of PM2.5 sensor data with regulatory data will help members of the public understand and reduce their exposure to wildfire smoke.

To support this integration of information, the U.S. EPA and the U.S. Forest Service have been working on approaches to present PM2.5 data from FEM monitors, special purpose near-FEM monitors and sensors on the Fires: Current Conditions map on the AirNow website in a way that provides the public with clear, consistent and up-to-date information to help reduce smoke exposure. This presentation will provide examples of the approaches under consideration for use on AirNow during the 2020 fire season. It will also show new video tools developed by EPA to quickly understand different types of data and how the data can be used.

Keywords: Air Quality Index, sensors, regulatory monitors, health communication

Presenter Bio: Susan Stone is a Senior Environmental Health Scientist, who is currently working on the reviews of national ambient air quality standards (NAAQS) for ozone and particulate matter, has worked on the reviews for ozone, particulate matter and sulfur dioxide, and led the review of the ozone NAAQS that concluded in 2015.

Ms. Stone is also the Air Quality Index (AQI) Team leader, has coauthored many of EPA's public information documents about the AQI, the health effects of criteria pollutants, and she has given presentations across the U.S. and internationally on these subjects. Ms. Stone is a member of a cross-disciplinary team sensor team at EPA that develops best practices for small non-regulatory monitors and data-fusion approaches.

Ms. Stone leads a multi-agency team that updated the document Wildfire Smoke: A Guide for Public Health Officials in 2019 and continues to develop associated fact sheets and guidance. She co-authored two web courses for health professionals, Particle Pollution and Your Patients' Health and Wildfire Smoke and Your Patients' Health; and works with ORD on smoke-related research including two epidemiological studies of the health impacts of smoke from a fire in Eastern North Carolina, communication and intervention studies, and a wood smoke controlled human exposure study. Susan Stone has an M.S. from the Gillings School of Global Public Health at the University of North Carolina at Chapel Hill.

39. Improving Smoke Management through Collaboration

Presenter: Monica Long, National Manager Fire Weather and Heatwave, Bureau of Meteorology, Australia, monica.long@bom.gov.au

Abstract: Bushfire is an inherent part of the Australian landscape. The State of the Climate 2018 report [1] showed that there has been a long-term increase in extreme fire weather, and in the length of the fire season, across large parts of Australia. These trends indicate that the frequency and extent of bushfires will increase in the future and fire agencies anticipate an increased focus on achieving planned burn targets to help mitigate the bushfire risk.

A 2017 report by the University of New South Wales [2] found that air pollution, including smoke from planned burns and bushfires, causes about 3,000 premature deaths a year in Australia. Due to the increase in fire activity, this number of deaths is also projected to increase.

Fire agencies in Australia are under increasing pressure to conduct fire operations associated with planned burns and bushfires as well as managing the impact of smoke on the community.

The Australian Bureau of Meteorology partnered with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Department of Environment, Land, Water and Planning in Victoria (DELWP) in 2013 to develop a quantitative smoke and air quality modeling system, AQFx. [3]

The model output, described by Martin Cope in a keynote presentation at ISS2, shows where the smoke from a burn will go and whether air quality thresholds will be exceeded on that day. Air quality data from the Environmental Protection Authority in each state are used to verify the forecasts.

The AQFx system has been operational in Victoria since mid-2018 and is intended to become a national system. A working group with representatives from each jurisdiction has been established to support the system expansion.

DELWP have funded further work including a low-cost sensor project in primary schools in regional Victoria together with CSIRO, and a near real-time smoke observation and smoke forecast visualisation system (AQVx) with the University of Tasmania.

This presentation will include:

- a description of the AQFx system
- discussion of the challenges with extending the system nationally
- an introduction to related work in Australia including;
    - engaging schools with low-cost air quality sensors
    - near-real-time smoke monitoring

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Keywords: smoke modeling, smoke impacts, fire weather forecasting, smoke monitoring, Australia

Presenter Bio: Monica Long is a meteorologist with a background in fire weather operations. From 2010 she developed and delivered the national Fire Weather Training and Assessment Program for the Australian Bureau of Meteorology. Since 2016 she has worked closely with fire agencies, environmental protection agencies and health departments around Australia to lead improvements to the Bureau's fire weather and heatwave services, including the smoke and air quality forecasting capability.

40. Use of amateur radio during wildfires to transmit data: A low-tech solution to a high tech problem

Presenter: Vanessa Beaulac, Head, Exposure Assessment Section, Health Canada, vanessa.beaulac@canada.ca

Abstract: The Health Portfolio of the Government of Canada manages wildfire smoke and emergency responses through the Chemicals Emergency Response and Preparedness Annex. Under this Annex, Health Canada plays a key role in wildfire responses by providing federal coordination support and an air emergency monitoring capacity. Activation of the Emergency Air Health Monitoring Unit (EahMU) during air emergencies triggers deployment of monitoring equipment to support science-based decision making through the provision of real-time outdoor and indoor air quality data. Due to geographic size, transmission of air monitoring data in real-time over cellular or Wi-Fi networks is not always possible in Canada. As part of a Canadian Department of National Defence exercise, Health Canada partnered with the Yukon Amateur Radio Association (YARA) to test whether Amateur (HAM) radio could provide real-time data transmission from monitors in areas with no, or unreliable, cellular or Wi-Fi coverage to areas that had the necessary coverage.

This presentation will describe the results of this experiment, including modification to air monitoring equipment to permit transmission of data over HAM Radio. The results of this work may be applicable to HAM Radio networks across North America during emergencies in which cellular or Wi-Fi transmission are not available due to geography or the nature of the emergency.

Keywords: Canada, emergency air health monitoring unit (EahMU), wildfire, smoke, HAM radio

Presenter Bio: Vanessa has worked for Health Canada since 2008. She is currently Head of the Exposure Assessment Section, a multi-disciplinary team of scientists that conducts national field exposure research in the area of air pollution exposure, modeling, and epidemiology. In addition, she is a designated Level 1 Responder under the Chemicals Emergency Response and Preparedness Unit of the Health Portfolio. Vanessa coordinates the Emergency Air Health Monitoring Unit (EahMU), a rapid response kit available during air emergencies. Vanessa received a B.Sc.H in Biomedical toxicology from the University of Guelph, and holds a M.Sc. in Respiratory toxicology from the University of Saskatchewan.

41. Comparison of Ozone Measurement Methods in Biomass Burning Plumes

Presenter: Russell Long, Research Chemist, U.S. EPA, long.russell@epa.gov

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Abstract: The most widely used method for measuring ozone in ambient air is based upon UV photometry. Several instruments employing the UV photometric method have been designated by the U.S. EPA as Federal Equivalent Methods (FEM) and can be used for regulatory monitoring purposes. However, the UV photometric method is prone to interference from water vapor, VOCs and other UV absorbing compounds that exist in ambient air and that are commonly found in biomass burning plumes (smoke). Two newly introduced and recently designated ozone analyzers have the potential to overcome the interference issues associated with the widely used UV photometric method. The first utilizes NO-chemiluminescence (NO-CL) to measure ozone in the atmosphere where the reaction between ambient ozone and NO produce light proportional to the ozone concentration. The NO-CL method was promulgated as the new Federal Reference Method (FRM) for ozone in 2015. The second represents a variation of the UV photometric method, known as the "scrubberless" UV (UV-SL) method that specifies removal of ozone and only ozone from the sample air for the zero reference by a gas-phase reaction with NO rather than via a conventional solid chemical scrubber. Both methods, either through measurement principle, or sample treatment processes may effectively eliminate interferences to an insignificant level. The EPA has performed research on methods for the measurement of ozone in both laboratory and ambient settings including evaluation in smoke. This presentation presents the results of both laboratory and ambient based evaluations of FRM and FEM analyzers for ozone including inter-comparison between the different methods during prescribed fires at the Konza (March and November 2017) and Tallgrass (November 2017) prairies in Kansas and at the Sycan Marsh (October 2017) in Oregon and during controlled chamber burns at the U.S. Forest Service's Fire Sciences Laboratory in Missoula, MT (April-May 2018 and April-May 2019).

Keywords: Ozone, Measurement Methods, smoke

Presenter Bio: Dr. Russell Long is a research chemist In EPA's Office of Research and Development - Center for Environment al Measurement and Modeling. Dr. Long's research focuses on the development, evaluation, and application of measurement methods for criteria air pollutants. A key focus of this research area is the evaluation and application of measurement methods in smoke.

42. Connecting Crop Productivity, Residue Fires, and Air Quality over Northern India: A Long-term Inference from NASA A-train Satellites

Presenter: Hiren Jethva, Research Scientist (Earth Science), Universities Space Research Association, hiren.t.jethva@nasa.gov

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Abstract: The agriculturally fertile region of northwestern India is known as the "breadbasket" of the country producing two-thirds of food grains, with wheat and rice as the principal crops grown under the crop rotation system. Agricultural data from India indicates a 25% increase in the post-monsoon rice crop production in Punjab during 2002-2016. NASA's A-train satellite sensors detect a consistent increase in the vegetation index (net 17%) and post-harvest agricultural fire activity (net ~60%) leading to nearly 60% increase in aerosol loading over the populous Indo-Gangetic Plain (IGP) in northern India. The ground-level particulate matter (PM2.5) downwind over New Delhi shows a concurrent uptrend of net 60%. The effectiveness of a robust satellite-based relationship between vegetation index—a proxy for crop amounts, and post-harvest fires—a precursor of extreme air pollution events, has been further demonstrated in predicting the seasonal agricultural burning. Such predictions can serve as a guideline for air quality related planning and preparedness. Rising levels of crop fires and deteriorating air quality over IGP is a serious health concern demanding urgent remediation policies, such as an efficient crop residue management system, towards eliminating open field burning, thereby mitigating episodic hazardous air quality over northern India.

Keywords: Agricultural burning, smoke, air quality, long-term trends

Presenter Bio: Dr. Jethva has spent almost about a decade in learning, developing, and validating the satellite-based aerosol retrieval from different sensors on board NASA's EOS satellites. His Ph.D. thesis investigation was focused on analyzing aerosol patterns using ground and satellite measurements and suggesting improvements to the NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) operational aerosol retrieval over the Indian region. His postdoctoral fellowship at Hampton University, Hampton, VA, USA, during 2009–2011 was dedicated to the evaluation of the Ozone Monitoring Instrument (OMI) operational aerosol products and providing suggestions for the possible improvements in the algorithm. Under the NASA/USRA's GESTAR program, he is responsible to upkeep, maintain, and validate the OMI aerosol product as well as develop innovative algorithms for characterizing aerosols above clouds. He has played a lead role in developing the near-UV and visible-based techniques for the quantitative retrieval of the above-cloud aerosols from OMI, MODIS, And DSCOVR-EPIC observations.

43. Ecosystem impacts in the atmosphere: How much fuel goes up in smoke?

Presenter: Rainer Volkamer, Professor, University of Colorado at Boulder, rainer.volkamer@colorado.edu

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Abstract: There is hardly a month without wildfires in the continental U.S., yet pyrogenic emissions remain a poorly characterized source of atmospheric trace gases and aerosols. Predicting pyrogenic carbon emissions is a major challenge, in part due to the lack of measurement techniques to evaluate these predictions comprehensively and quantitatively. Accurate mass fluxes of smoke (trace gases and aerosols) on the scale of actual wildfires have recently become possible by means of the University of Colorado airborne Solar Occultation Flux (CU SOF) instrument. CU SOF measures the column absorption of a variety of trace gases above the aircraft at mid-infrared wavelengths along the direct solar beam, and quantifies carbon and aerosol mass fluxes by mass balance. This presentation discusses the first science deployment of CU SOF as part of the "Biomass burning of trace gases and aerosol" (BB-FLUX) project to exploit remote-sensing and in-situ synergies to quantify mass fluxes of CO_2, CO, aerosols and other trace gases (e.g., NH_3, NO_2, HCHO, CHOCHO, HONO, etc). BB-FLUX deployed CU SOF, upward looking DOAS and Lidar, in-situ CO, CO_2, O_3, H_2O, and aerosol volume during 38 research flights, and sampled 125+ plumes, 60+ plume profiles from 18 different fires during the 2018 wildfire season in the northwestern United States. In collaboration with NEON and the USFS the fuel amounts, fuel speciation, and aerial photographs of the Keithly, Miriam, Tepee and Watson Creek fires were characterized. The science objectives of the BB-FLUX project are to advance analytical means to better characterize emissions, evaluate plume injection height, study secondary plume chemistry, and ecosystem impacts from wildfires. This presentation focuses on new approaches that exploit synergies between remote-sensing and in-situ data to inform two question: how much fuel goes up in smoke? And what are the major uncertainties with predicting pyrogenic carbon emissions to the atmosphere?

Keywords: Technology advances; Flux measurements; wildfires; SOF; BB-FLUX

Presenter Bio: Dr. Volkamer is teaching Analytical Chemistry at the University of Colorado at Boulder. He is a Fellow of CIRES, inventor, PI of the CU SOF instrument, and leader of the 2018 "Biomass Burning Fluxes of trace gases and aerosols" (BB-FLUX) airborne field campaign to quantify emissions from wildfires. In 2019, he was awarded the AGU Ascent Award for exceptional contributions in the fields of the atmospheric and climate sciences.

44. PurpleAir PM2.5 U.S. Correction and Performance During Smoke Events

Presenter: Karoline Johnson Barkjohn, Postdoc, ORISE hosted by US EPA, Johnson.Karoline@epa.gov

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Abstract: PurpleAir particulate matter (PM) sensors are increasingly used in the United States and other countries by a variety of individuals and organizations for continuous monitoring of ambient air pollutant conditions, with additional sensors often deployed for monitoring during wildfire smoke episodes. The performance of these sensors must be evaluated during smoke impacted times, and nominally corrected for bias if necessary, to ensure accurate data are reported to inform appropriate health protective actions. Here, we use data from PurpleAir sensors collocated with regulatory-grade monitors across the United States to develop quality assurance checks and a multilinear correction equation (including temperature and relative humidity) for PurpleAir PM2.5 data. A secondary data set was included to test the data correction scheme for wildland fire smoke conditions (including wildfires and prescribed burns) – a series of research field deployments of PurpleAir sensors collocated with temporary smoke monitors that are of near-regulatory grade quality (EBAMs and E-Samplers). Results suggest that the PurpleAir raw PM2.5 data overestimate PM2.5 by ~60% in most states under various conditions. Hourly NowCast Air Quality Index (AQI) categories are calculated using the raw and corrected PurpleAir PM2.5 concentrations, as well as for the collocated reference monitor. For the national data set of sensors collocated with regulatory-grade monitors, results show that PurpleAir sensors, when corrected, accurately report NowCast AQI categories 90% of the time as opposed to uncorrected PurpleAir data, which are accurate only 75% of the time. Testing the correction scheme for the research data set of wildland fire smoke events revealed that the corrected data compared closely with the reference monitors and produced similar NowCast AQI categories.

Although this abstract was reviewed by EPA and approved for publication, it may not reflect official Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Keywords: PM2.5, air sensor, smoke, evaluation, NowCast, PurpleAir

Presenter Bio: Dr. Karoline Johnson Barkjohn is an ORISE postdoc hosted by U.S. EPA's Office of Research and Development. She specializes in quantifying the performance of air sensors. Karoline received her Bachelor of Science in Environmental Engineering degree from North Carolina State University, her Master of Science in Environmental Engineering degree from Georgia Institute of Technology, and her Doctor of Philosophy degree from Duke University.

45. Smoke Observations by LIDAR and Sun Photometer Mobile Measurements during FIREX-AQ Campaign in summer 2019

Presenter: Ioana POPOVICI, PhD, Remote Sensing Scientist, CIMEL Electronique, Paris, France, i-popovici@cimel.fr

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Abstract: Ground-based remote sensing observations in and around fires are not common in the smoke research and dedicated fields campaigns, as deploying instruments in rude environments like fires is not an easy task. Nevertheless, the smoke dispersion and smoke plume rise inside wildfires is important, especially for models. During FIREX-AQ campaign in 2019, two vehicles were equipped with LIDAR and sun photometers, performing mobile measurements in and around wildfires in Northwestern US. The two mobile systems were equipped with instruments from LOA (Laboratoire d'Optique Atmosphérique) and CIMEL company in France, partners of AERONET/NASA. Mobile measurements of vertical distribution and total loading of smoke aerosols have been conducted with two vehicles, both equipped with CIMEL micro-pulse LIDARs (emitting at 532 nm and 808 nm wavelength) and mobile sun photometers (with 3 or 8 spectral channels from UV to NIR). The measurements with the two mobile systems allowed mapping the spatial variability of smoke plumes and exploring different routes to see the areas impacted by smoke. The LIDAR profiles describe the structure of the smoke plumes vertically, while the sun photometer measurements give information on the total aerosol loading (AOD) and the optical properties of particles. Seven wildfires in Idaho (Shady, Nethker, Pinehurst), Oregon (Granite Gulch, 204 Cow) and Washington (William Flat, Pipeline) were investigated with the two mobile units, from 25 July to 30 August 2019. This allowed measuring the smoke plume extent, aerosol loading and regional transport. The acquired data is valuable for the evaluation of smoke dispersion models and atmospheric chemistry transport models. LIDAR data includes plume height and aerosol concentration inside the plume, as well as separation of fine and coarse particles vertically. Results from the ground-based remote sensing mobile measurements in and around wildfires during FIREX-AQ campaign in 2019 will be presented.

Keywords: smoke, mobile observations, LIDAR, vertical variability, spatial variability

Presenter Bio: The presenter obtained her PhD in Atmospheric Physics in 2018, on the subject of mobile measurements by remote sensing instruments. She is currently working as remote sensing scientist in the R&D department of CIMEL company in France specializing on LIDAR and sun photometer development and manufacturing. The presenter participated to several field campaigns on aerosol measurements in France, China and USA, and her expertise on LIDAR measurements and field experiments recommend her for presenting at the conference.

46. Experiments to Measure Smoldering Behavior in Simulated Wildland Fuels

Presenter: Jeanette Cobian-Iñiguez, Postdoctoral Scholar, University of California, Berkeley, jcobian@berkeley.edu

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Abstract: Accelerated tree mortality in the Sierra Nevada has led to the rapid accumulation of large downed fuels on the forest floor. The presence of these fuels represents a shift in surface fuel layer composition; from thin fuels such as grasses and debris which burn in the flaming regime, to large downed trees with a high propensity to burn in the smoldering regime. Smoldering fires are characterized by lower temperatures, heat release and spread rates than flaming fires and produce greater concentrations of gas and particulate emissions. The latter suggests that smoldering fires are highly pollutant wildfires. In addition, because smoldering fires require lower temperatures to ignite, transition from smoldering to flaming is often considered a shortcut to flaming ignition. Although smolder propagation rate has been measured for solids wooden fuels, little is known of the smolder burn rate particularly under the influence of wind. To fill this void, we aim to quantify smoldering burn rate and smoldering to flaming transition. Although our focus is on the Sierra Nevada, results can be applicable to similar ecosystems enduring heightened tree mortality. In this talk, we will present results from experiments designed to quantify smoldering fire behavior. Experiments were conducted in a bench scale wind tunnel where fuel beds were simulated using wooden cribs. We examined smoldering burning rate and smoldering to flaming behavior under various crib configurations and wind velocities. Crib permeability was varied by changing stick distance and thickness. Burning rate was calculated from measurements of mass loss rate, smoldering to flaming transition was diagnosed in the initial state of the study through visual diagnostic obtained from experiment video. Fuel temperature is measured using an infrared camera to understand ignition and transition thresholds. We present planned measurements of particulate matter, CO and CO_2 emissions and discuss implications of measured smolder fire behavior to the improved understanding of high pollutant yield smoldering wildfires.

Keywords: Wildfire, Smoldering, Burning Rate, Bench Scale, Experiments, Wind Tunnel

Presenter Bio: Jeanette Cobian-Iñiguez is a Postdoctoral Scholar at University of California, Berkeley working on smoldering fire behavior. She completed her PhD at the University of California, Riverside where she did dissertation work on chaparral fire behavior. Jeanette's research interests are in the use of experiments to gain fundamental understanding of wildfire behavior, remote sensing data to derive data driven models of regional wildfire behavior as well as in science communications and outreach. She will be starting a faculty position at the University of California, Merced, Department of Mechanical Engineering in May 2020.

47. The role of the fire-atmosphere coupling in high smoke concentration episodes in complex terrain

Presenter: Adam Kochanski, Research Assistant Professor, University of Utah, adam.kochanski@utah.edu

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Abstract: Several large wildfires burned across northern California during the summer of 2015, in areas of localized topographic relief. Persistent valley smoke hindered firefighting efforts, delayed helicopter operations, and exposed communities to hazardous air quality.
In this study, we simulate fire progression and emissions from 5 concurrent fires to investigate the impact of the fire-atmosphere coupling processes on the smoke dispersion and PM2.5 concentrations. Numerical experiments were performed using a modeling framework that couples an atmospheric, chemical, and fire spread model (WRF-SFIRE-CHEM). Modeling results examined in this study indicate that wildfire smoke reduced incoming solar radiation during the afternoon, leading to significant surface cooling, strengthening local inversions and inhibiting smoke ventilation. Sensitivity analysis revealed a non-linear relationship between the emissions and in-valley surface concentrations, associated with positive feedback processes. The smoke-induced surface cooling proved to enhance local inversions, inhibit the growth of the planetary boundary layer, and reduce surface winds, which resulted in smoke accumulation in valleys adjacent to wildfires, leading to even stronger cooling due to the smoke shading and higher smoke concentrations. As a result of this positive feedback, smoke from wildfires became trapped within mountain valleys adjacent to active wildfires leading to persistent low air-quality episodes associated with enhanced local inversions.

Keywords: Smoke dispersion, inversions, plume dynamics, radiative smoke impacts, WRF-SFIRE, WRF-SFIRE-CHEM.

Presenter Bio: Dr. Adam Kochanski is a research assistant professor working at the University of Utah Atmospheric Sciences Department. He received his M.Eng in Chemical Engineering and MBA from Technical University of Lodz (Poland) and Ph.D. in Atmospheric Sciences from the University of Nevada, Reno. His main research interests include fire-atmosphere interactions including air quality impacts of wildland fires. He is a modeler with extensive experience in running numerical simulations of fire, smoke, and regional climate on high-performance computing platforms. He is a co-developer of the coupled fire-atmosphere model WRF-SFIRE, the integrated fire and air quality system and WRF-SFIRE-CHEM, as well as the fire forecasting system WRFX. He is one the modeling leads for the Fire and Smoke Model Evaluation Experiment (FASMEE) and a member of the Rocky Mountain Center for Fire-Weather Intelligence (RMC) steering committee.

48. A Numerical Modeling Study of Smoke Dispersion and the Ventilation Index in Southwestern Colorado

Presenter: Michael Kiefer, Resarch Assistant Professor, Michigan State University, mtkiefer@msu.edu

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Abstract: In this study, FLEXPART-WRF, a Lagrangian particle dispersion model, is employed to examine the diagnostic value of the ventilation index (VI) for pollutant dispersion in complex terrain in southwestern Colorado. The VI is the product of the mixing height and transport wind speed, usually defined as the mean wind speed in the mixed layer. The VI, often in the form of a Ventilation Adjective Rating (VAR), is a standard part of fire weather forecasts issued by National Weather Service offices across the U.S., and the VAR is used by fire managers to assess the potential for dispersion of smoke from prescribed fires. This evaluation of the VI in southwestern Colorado builds upon a recent study of the VI and particle dispersion in less complex terrain in eastern Pennsylvania.

The focus of this study is a prescribed fire conducted on 10 September 2018 in the Saul's Creek area of the San Juan National Forest in southwestern Colorado. A suite of observations were collected during the Saul's Creek fire in order to characterize the background meteorological conditions and smoke plume evolution. In this study, smoke dispersion in the vicinity of the Saul's Creek prescribed fire is simulated using FLEXPART-WRF, driven by meteorological outputs from Advanced Regional Prediction System (ARPS) simulations of the background (non-fire) conditions. Before proceeding to the evaluation of VI, meteorological output from ARPS and smoke plume predictions from FLEXPART-WRF are compared to observations collected during the fire. Following the model assessment, a dense cloud of particles are released across a portion of the FLEXPART-WRF domain, and particle behavior and VI diagnostic value are evaluated in areas of the domain with differing terrain characteristics (e.g., plains, mountain top, valley; ~1 km elevation change across ~30 km distance). Results from this study are expected to help guide the application of the VI in complex terrain, and possibly inform development of new metrics for dispersion potential.

Keywords: Ventilation Index, smoke dispersion, complex terrain, wildland fire, numerical model

Presenter Bio: Michael is a Research Assistant Professor in the Geography, Environment, and Spatial Sciences Department at Michigan State University, specializing in (1) the application of weather and smoke models to wildland fires in forested landscapes, and (2) the use of gridded weather and climate datasets in agricultural applications. Michael came to MSU as a post-doctoral research associate in 2009, and became an Assistant Research Professor in 2013. He holds a BS in Atmospheric Science from SUNY Albany, and MS and PhD degrees in Atmospheric Science from North Carolina State University.

50. Environment and Climate Change Canada's wildland fire smoke modelling applications and forecast services: informing the public, delivering critical information for decision making and supporting international initiatives.

Presenter: Didier Davignon, National coordinator, Health related environmental forecast products, Environment and Climate Change Canada, Didier.Davignon@canada.ca

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Abstract: For just under a decade, Environment and Climate Change Canada (ECCC) has worked in collaboration with Natural Resources Canada (NRCan) to develop comprehensive forecast modelling capability for wildland fire smoke. This effort was driven by ECCC's responsibility to deliver timely and reliable information on current and forecasted air quality and weather, support response to environmental emergencies and provide scientific data on past and projected atmospheric pollution. Areas of application for ECCC's smoke modelling capacity include the provision of air quality forecasts and warnings to the public through the Air Quality Health Index (AQHI) program, the production of smoke forecast maps, fine scale smoke dispersion simulations for emergency response, event-based weather reports, and a posteriori impact studies.

This talk will present an overview of ECCC's activities and services related to wildland fire smoke modelling and examine some of the challenges and desired features that provide direction for future development of the modelling capacity. It will also provide a status on ECCC's engagement into international initiatives related to vegetation fire and smoke pollution.

Keywords: Modelling, Air Quality, Health, Forecast, data services

Presenter Bio: Didier Graduated with an M.Sc. in physics at University of Montreal, with a post-graduate diploma in environment, prevention and disaster management.
He worked for more than 18 years in air quality modelling at Environment and Climate Change Canada (ECCC). He was one of the main developers of a global model for atmospheric mercury chemistry, and then worked on scenario studies in support of air quality policy assessments. Didier worked as chief of ECCC's Quebec regional air quality science unit and chief of ECCC's Air Quality Modeling Applications Section (AQMAS), delivering the Canadian operational air quality forecasting system. He now works as a national coordinator for the Meteorological Service of Canada air quality and health agenda.

51. Evaluation of biomass burning smoke forecasts over the Western U.S. during the FIREX-AQ 2019 field campaign

Presenter: Pablo Saide, Assistant Professor, UCLA, saide@atmos.ucla.edu

Abstract: Biomass burning is one of the major air pollutant sources with significant global, regional and local impacts on air quality, public health, and climate. Reducing the uncertainty of biomass burning emissions predictions is critical to improve air quality forecasts and assessments of their various impacts. This work will show the development and application of a system to forecast smoke applied experimentally during the NOAA/NASA FIREX-AQ (Fire Influence on Regional to Global Environments and Air Quality) field campaign during summer 2019. A unique feature of the system is that biomass burning emissions are constrained using inverse modeling techniques and near-real time satellite observations. This system was part of an ensemble of national and international air quality models which were compiled during the deployment. The forecasts will be compared to each other and evaluated against satellite, ground-based and airborne observations. This work will facilitate near-real-time quantification of fire emissions and is expected to provide guidelines on how to improve smoke predictions.

Presenter Bio: Pablo Saide is an Assistant Professor in the Department of Atmospheric and Oceanic Sciences and in the Institute of the Environment and Sustainability at UCLA. He obtained his Ph.D. degree in Civil and Environmental Engineering at the University of Iowa and before joining UCLA he was an Advance Study Program (ASP) postdoctoral fellow and a project scientist at NCAR. His field of study is atmospheric sciences and chemistry, with a focus on regional weather and air quality modeling, aerosol-cloud-radiation interactions, satellite remote sensing and data assimilation.

52. Air quality and aerosol predictions at NOAA/National Weather Service and their applications

Presenter: Ivanka Stajner, Deputy Director, NOAA/NWS/NCEP/ EMC, NOAA/National Weather Service, ivanka.stajner@noaa.gov

Abstract: Operational air quality predictions produced by NOAA/National Weather Service include predictions of ozone, fine particulate matter (PM2.5) and wildfire smoke for the United States and predictions of windblown dust for the contiguous 48 states. Prediction maps are distributed at https://airquality.weather.gov/ and as a web service at https://idpgis.ncep.noaa.gov/arcgis/rest/services/NWS_Forecasts_Guidance_Warnings. The Community Multiscale Air Quality (CMAQ) modeling system used for ozone and PM2.5 predictions was most recently updated in December 2018, when a unified bias-correction procedure was introduced for these two pollutants. Wildfire smoke dispersion is operationally predicted using the Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT). Wildfire smoke dispersion is included in version 4 of the Eulerian High Resolution Rapid Refresh (HRRR) model that is being evaluated for operational implementation. One of the largest uncertainties for prediction of air quality over the U.S. involves specification of wildfire smoke emissions. Different smoke emission approaches used in these systems will be discussed.

In the spirit of integration of various operational prediction applications into the Unified Forecast System (https://ufscommunity.org/), NOAA is testing CMAQ predictions driven by the operational version of the Global Forecast System (GFS) that includes the Finite-Volume Cubed-Sphere (FV3) dynamical core since June 2019. This testing is allowing us to extend ozone and PM2.5 predictions to 72 hours (from 48 hours that operational predictions currently cover). As an additional unification effort, global aerosol predictions, which include biomass burning aerosols, are being tested for inclusion in one member of the Global Ensemble Forecast System (GEFS) to replace the current standalone global aerosol prediction system. An overview of this testing will be presented.

NOAA's operational air quality predictions contribute to protection of lives and health in the United States. These predictions are used by state and local air quality forecasters to issue official air quality forecasts for their respective areas. General public accesses NOAA's hourly predictions directly at https://airquality.weather.gov/. These predictions are also used in the applications about wildfire and health as well as in smoke vulnerability assessments led by our partners at the EPA and CDC.

Keywords: operational air quality prediction, smoke

Presenter Bio: Dr. Ivanka Stajner is the Deputy Director of NOAA's Environmental Modeling Center in College Park, Maryland. She managed NOAA's National Air Quality Forecast Capability that provides operational predictions of concentrations of ozone, fine particulate matter (PM2.5), wildfire smoke and windblown dust in the air we breathe.

Dr. Stajner studied stratospheric and tropospheric ozone using data assimilation techniques combining satellite observations with global atmospheric models. She earned her Ph.D. and M.S. degrees from the University of Illinois in Urbana-Champaign, and her B.S. degree from the University of Zagreb in Croatia. She is an Associate Editor for the Journal of Geophysical Research-Atmospheres.

53. Superfog-Related Traffic Accidents in Oregon

Presenter: Rick Graw, Air Qualtiy Program Manager, USDA Forest Service, rick.graw@usda.gov

Abstract: In the last two years, there have been at three documented cases of smoke-related traffic accidents in Oregon in which visibility was reported to be less than 10 feet and superfog was suspected as a contributing factor. These accidents have all occurred in October and in the hour preceding sunrise. Investigations of these events documented that all three were associated with prescribed burns within seven miles of the accident site, with smoldering fuels overnight. Although the accidents varied in location from western, central, and southern Oregon, all had localized sources of moisture, two of which were not represented by the spot weather forecast. The hourly weather observations nearest the accident site all met superfog criteria developed by researchers Gary Achtemeier and Gary Curcio. PB-Piedmont was run with archived meteorological data and did an excellent job in identifying fine-scale transport pathways of smoke and placing superfog at the accident site. As such, the superfog meteorological criteria and the use of PB-Piedmont can be used to (1) increase situational awareness by burners, and (2) used to determine what type of traffic control is appropriate to protect public safety.

Keywords: superfog, smoke-related traffic accidents, PB-Piedmont

Presenter Bio: Rick has been the air quality program manager for the Pacific Northwest region of the USDA Forest Service for the past 11 years. Prior to that he was an air quality consultant in the private sector for 20 years based in Colorado and Oregon. He has a master's degree in atmospheric science from Colorado State University and a bachelors degree in geography from the University of Colorado. He enjoys fishing in his free time and spending time with his family.

54. Identification of Persistent Fire Sources in High Northern Latitudes

Presenter: Justin Fain, Research Specialist, Miami University, fainjj@miamioh.edu

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Abstract: Persistent heat anomalies, such as those from energy extraction and industrial sites, produce confusion in satellite fire detection data. These misidentified fires can skew estimations of atmospheric pollutants and complicate source attribution. Accurate information about fire emissions is critical for assessing the impacts of air pollution on the rapidly changing Arctic. In this presentation, we explore multiple methods for the identification of non-biomass burning detections from 375 m Visible Infrared Imaging Radiometer Suite (VIIRS) VNP14IMGTDL_NRT active fire product satellite data from NASA's Fire Information for Resource Management System (FIRMS) and evaluate the impact of these non-vegetated thermal sources on fire emission calculations in high northern latitudes with a particular emphasis on short-lived climate forcers.

Keywords: Fire, Arctic, Remote Sensing, Black Carbon

Presenter Bio: Justin is a staff researcher and computational geoscientist at Miami University's Geospatial Analysis Center.

55. Impact of Anthropogenic Climate Change on the Diablo Winds Associated with Wildfires in California

Presenter: Yi-Chin (Karry) Liu, Air Pollution Specialist, Air Resources Board, karry.liu@arb.ca.gov

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Abstract: Wildfires are an ongoing threat in California as they can adversely affect air quality and lead to loss of property and life. Many of the intense wildfires in Northern California, such as the Oakland Hills fire in 1991, the Wine Country fire in 2017, and the Camp fire in 2018, have been linked to the occurrences of Diablo Winds (DWs). Our recent study (Liu et al. 2019, in submission) finds an increasing long-term trend in occurrences of DWs and extreme DWs over the past four decades, with a greater increase since 1995. In addition, the onset of extreme DWs has shifted from November to October since 1995. This study is an extension of Liu et al. (2019) with the following objectives: 1) investigate whether the increasing long-term trend and earlier occurrence of DWs are attributed to anthropogenic climate change or to natural variability, and 2) project future DWs under different climate change scenarios. The first objective will be achieved by comparing the climate simulations between the actual historical (anthropogenic + natural) and natural (pre-industrial) conditions from 1996 to 2015. The second objective will be conducted by observing future scenarios assuming global temperature increases of 1.5 Co and 2.0 Co, respectively. Data used in this study are obtained from the Climate of the 20th Century Plus Detection and Attribution project (C20C + D&A).

Presenter Bio: Dr. Yi-Chin Liu is an air pollution specialist at California Air Resources Board. Her work includes conducting regional air quality and toxics modeling for use in identifying impact on disadvantaged communities and prioritizing remedial actions, and conducting California climate studies to investigate the impact of climate change on regional precipitation, temperature, and Diablo winds.

56. The impact of smoke exposure on grape and wine composition and the development of smoke taint

Presenter: Anita Oberholster, Cooperative Extension Specialist, UC Davis, aoberholster@ucdavis.edu

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Abstract: Climate experts and natural resource managers generally agree wildfires will occur with greater frequency and intensity in California and pose significant risks for many of the state's winegrowing regions. One risk is the potential for persistent exposure to smoke to compromise the quality and value of winegrapes and adversely affect wines made from smoke exposed grapes. A wine is seen as smoke impacted or tainted when there is an overpowering smoky, medicinal, chemical, burnt or ashy aroma on the nose and a distinctive retronasal ash tray-like character in the mouth. Several solutions for smoke taint have been promoted such as treatment with enzymatic enzymes, fining, reverse-osmosis and spinning cone treatments. In this study the different amelioration techniques were investigated using smoke impacted wines made from Cabernet Sauvignon grapes from Napa and Lake Counties (UC Davis Teaching and Research Winery). The impact on wine composition (smoke taint marker compounds as well as other key volatile and non-volatile compounds important for wine quality) and its sensorial characteristics were evaluated to determine its effectiveness. Additionally, the impact of the wine matrix on smoke taint expression were studied. Results indicated that although most amelioration techniques removed some smoke taint markers and decreased smoke taint perception, it lacked specificity and impacted the overall quality of the wine. It is also difficult to predict smoke taint characteristics from smoke taint markers alone due to the significant impact of the wine matrix. In conclusion, amelioration techniques are not 100% fixes of smoke taint but can significantly decrease smoke taint perception and with further research recommendation can potentially be made to the feasibility of treatment success based on the wine matrix so that winemakers can make informed decisions.

Keywords: grapes, wine, smoke taint, amelioration techniques, sensory

Presenter Bio: Oberholster received her Ph.D. in Wine Science at Adelaide University, South Australia in 2008 and joined the Department of Viticulture and Enology, UC Davis in 2011 as a Cooperative Extension Specialist. Oberholster's research focuses on both the vineyard and the winery. In the vineyard, the influence of environmental factors such as climate change on grape ripening and composition is investigated and, in the winery, the influence of different winemaking techniques on wine composition and quality is studied. Her work has been cited 807 times and she has presented her research more than 110 times.

57. Examing Recent Trends in Fires and Air Quality using SNPP VIIRS Data

Presenter: Shobha Kondragunta, Physical Research Scientist, NOAA, Shobha.Kondragunta@noaa.gov

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Abstract: The number of extreme fires and air quality associated with fires near source and downwind regions has been on the rise in the recent years due to favorable conditions such as drought, especially in the western United States (U.S.). While fires kill people and destroy property, smoke from fires is very harmful to human health exacerbating common cardiovascular/respiratory diseases such as asthma. There is a long record of fire and smoke observations from satellites including the new next generation satellite Suomi National Polar Partnership Program (SNPP) satellite jointly launched by NASA and NOAA in November 2011. The Visible Infrared Imaging Radiometer Suite (VIIRS) on SNPP observes fires at two different high resolutions (375m and 750m) and smoke aerosol at 750m resolution. For this study, we used 750m resolution fire and smoke aerosol products. Seven years of VIIRS fire data were analyzed to identify inter-annual variations and rise in fire activity. In tandem to fire data, seven years of VIIRS smoke mask and surface PM2.5 (particulate matter for particles ≤ 2.5 µm median diameter) were also analyzed. Analysis shows that significant inter-annual variability in fire intensity/counts occurs with peak fire activity being in July and August each year; certain years (2013 and 2014) showed low fire activity. Trends in surface PM2.5 data in areas such as California show similar trend as that of fire activity. This analysis shows that, as EPA has combated and reduced urban/industrial pollution over the last two decades, pollution due to smoke from fires violates PM2.5 standard. Measures to combat poor air quality due to smoke from fires does not exist. Currently, the most viable precautionary option is to warn the public to stay indoors when smoke from fires reaches populated rural, exo-urban, suburban, and urban regions.

Keywords: Fires, smoke, PM2.5 satellites, SNPP VIIRS

Presenter Bio: Dr. Shobha Kondragunta is Physical Research Scientist at NOAA NESDIS Center for Satellite Applications and Research (STAR). She has a PhD in atmospheric chemistry from the University of Maryland in College Park and a M.S in chemistry from Florida Atlantic University. She is the lead for aerosol product development and applications for GOES-R and JPSS series of satellites. She has two decades of experience developing fire and smoke products including fire emissions that are used by NOAA operational global and regional aerosol models. Dr. Kondragunta received one gold medal and three bronze medals from Department of Commerce during her tenure at NOAA.

58. A framework for assessment and mitigation of wildfire-induced air pollution considering climate change

Presenter: Michele Barbato, Professor, Civil and Environmental Engineering/UC Davis, mbarbato@ucdavis.edu

Abstract: The significant increasing trend in frequency and severity of wildfires in the western U.S. has created serious concerns for human health and climate change. Recent extensive fires (e.g., the Camp Fire and the Woolsey Fire) have exposed millions of Californians to high levels of air pollution. Increasing evidence documents exacerbations of asthma and chronic obstructive pulmonary disease from such exposures. Epidemiological research has found that the dramatically increased ambient levels of wildfire-induced air pollution (WIAP) are associated with increased respiratory and cardiovascular risks, as well as mortality, in populations living near or downwind of wildfires, particularly in disadvantaged communities. The health outcomes potentially induced by wildfire smoke exposure can lead to substantial economic costs. Each year in California alone, costs associated with fire suppression exceed \$0.5 billion, insurance costs associated with wildfires approach \$1 billion, health-related costs exceed \$1 billion, and potential economic costs from existing social-cost-of-CO2 estimates exceed \$0.5 billion. These costs have been increasing in the last 30 years and are bound to surge even more due to climate change. Wildfires are becoming an existential threat to the well-being of the U.S. population, with WIAP as one of the most severe contributors to economic and life losses. Therefore, additional research to assess and mitigate WIAP effects on human health is vital.

This paper briefly presents the research plan of a multi-/interdisciplinary project recently awarded by the UC Office of the President through the UC Laboratory Fees Research Program to develop a state-of-the-art scalable framework for assessment and mitigation of WIAP under changing climate conditions. This project will integrate and advance five different wildfire-related research areas: (1) modeling and forecasting wildfire risk under climate change; (2) wildfire emission and air quality prediction; (3) wildfire smoke health effects assessment; (4) development of wildfire mitigation strategies; and (5) scientific visualization of WIAP data. This collaborative project will involve researchers at UC Davis, UC Merced, UC Irvine, UC Los Angeles, UC Berkeley, Lawrence Livermore National Lab, and Los Alamos National Lab, as well as external collaborators at EPRI, USFS, and NASA.

Keywords: Wildfire smoke, air pollution, health effects, wildfire mitigation, climate change

Presenter Bio: Dr. Michele Barbato is a Professor of Structural Engineering & Structural Mechanics in the Civil and Environmental Engineering Department at the University of California Davis. Dr. Barbato's research focuses on high-fidelity finite element modeling and advanced probabilistic methods to develop novel design approaches and structural solutions for sustainable construction. These efforts lead to new designs and structures that are sustainable, economic, and safe. His research includes hazard/risk analyses, and assessment/mitigation of hurricane/wind/wildfire hazards under climate change. In particular, Dr. Barbato's wildfire-related research focuses on wildfire risk assessment and mitigation, electric grid hardening, and fireproof construction materials.

61. Fire And Smoke Model Evaluation Experiment (FASMEE)--Overview of the Project

Presenter: Roger Ottmar, Research Forester, USDA Forest Service, PNW Research Station, roger.ottmar@usda.gov

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Abstract: This presentation is part of a special session entitled "The Fire and Smoke Model Evaluation Experiment (FASMEE)". The Fire and Smoke Model Evaluation Experiment (FASMEE) is a large-scale multi-agency effort to identify and collect critical measurements that will be used to advance wildland fire science and smoke modeling capabilities allowing managers to increase the use of managed fire. FASMEE is partitioned into three phases including 1) analysis and planning process, 2) implementation of data collection during 3 campaigns including the western wildfire campaign, southwest, and southeast campaign, and 3) analysis and future improvements. FASMEE leverages several agency resources and Joint Fire Science Program (JFSP) and USDA Forest Service funds, and ongoing projects including the National and Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) FIREX-AQ effort, National Science Foundation (NSF) WE-CAN study, Prescribed Fire Science Consortium, and Department of Defense Strategic Environmental Research and Development Program (SERDP). This collaborative effort, with over 70 scientists participating and a planning and logistic team brought in from Tall Timbers Research Station, will facilitate integration of data across the entire smoke management continuum from fuels, fire behavior, plume dynamics, smoke production, smoke transport/chemistry, and fire effects. All data will be made available to scientists and managers from an open data repository. FASMEE is aimed at advancing operational modeling systems in use today as well as the next generation of modeling systems expected to become operationally useful in the next 5 to 10 years. This presentation will provide an overview of FASMEE that will include how we got started, collaborators, analysis and planning, data collection, and future direction.

Keywords: Smoke, fuel, fuel consumption, fire behavior, fire energy, plume, wildland fire source characterization, fire models, FASMEE

Presenter Bio: Roger Ottmar is a Research Forester with the Fire and Environmental Research Applications Team, Pacific Northwest Research Station at the Pacific Wildland Fire Sciences Laboratory located in Seattle, Washington. During his career he has been involved with fuel, fire, and smoke related research. He led the Prescribed Fire Combustion Atmospheric Dynamics Research Experiment (RxCADRE) and currently leads the Fire and Smoke Model Evaluation Experiment (FASMEE).

62. Fire And Smoke Model Evaluation Experiment (FASMEE)--Special Session

Presenter: Roger Ottmar, Research Forester, USDA Forest Service, Pacific Northwest Research Station, roger.ottmar@usda.gov

Abstract: The Fire and Smoke Model Evaluation Experiment (FASMEE) is a large-scale multi-agency effort to identify and collect critical measurements that will be used to advance wildland fire science and fire/smoke modeling capabilities allowing managers to increase the use of managed fire (https://sites.google.com/firenet.gov/fasmee/). FASMEE is partitioned into three phases: 1) analysis and planning process, 2) implementation of data collection during 3 campaigns including the western wildfire campaign, southwest, and southeast campaign, and 3) analysis and future improvements. FASMEE leverages several agency resources including Joint Fire Science Program and USDA Forest Service funds, and ongoing projects including the National and Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) FIREX-AQ effort, National Science Foundation (NSF) WE-CAN and BB-FLUX study, and the Rx Fire Science Consortium, and Department of Defense Strategic Environmental Research and Development Program. This collaborative effort will facilitate integration of datasets across the entire fire and smoke management continuum from fuels, fire behavior, plume dynamics, smoke production, smoke transport/chemistry, and fire effects. FASMEE is aimed at advancing operational modeling systems in use today as well as the next generation of modeling systems expected to become operationally useful in the next 5 to 10 years. This special session will provide an overview of the Project with 8-10 presentations that cover the latest data collected during the Western Wildfire and Southwest data collection campaigns.

Keywords: Smoke, fuel, fuel consumption, fire behavior, plume, wildfire source characterization, fire models, FASMEE

Presenter Bio: Roger Ottmar is a Research Forester with the Fire and Environmental Research Applications Team, Pacific Northwest Research Station at the Pacific Wildland Fire Sciences Laboratory located in Seattle, Washington. During his career he has been involved with fuel, fire, and smoke related research. He led the Prescribed Fire Combustion Atmospheric Dynamics Research Experiment (RxCADRE) and currently leads the Fire and Smoke Model Evaluation Experiment (FASMEE).

63. FASMEE Western Wildfire Campaign: Fuel consumption maps to reduce uncertainties in emissions

Presenter: Andrew Hudak, Research Forester, USDA Forest Service, Rocky Mountain Research Station, andrew.hudak@usda.gov

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Roger Ottmar, Research Forester, USDA Forest Service, Pacific Northwest Research Station, roger.ottmar@usda.gov

Abstract: The JFSP-funded Western Wildfire Campaign (WWC) of the Fire And Smoke Modeling Evaluation Experiment (FASMEE) is characterizing source fuels burned on 2018 and 2019 western wildfires, selected for airborne emissions sampling by two NSF-funded projects (WE-CAN and BB-FLUX) in 2018 and by the NOAA/NASA-funded FIREX-AQ project in 2019. Emissions were sampled by airborne instruments mounted on the C-130 (WE-CAN), King Air (BB-FLUX), and DC-8 (FIREX-AQ) aircrafts that flew through the smoke plumes. Our objective was to predict fuel loads by fuel type both pre- and post-fire and to estimate consumption to reduce these largest sources of uncertainty in emissions. We test three approaches for estimating fuel consumption: 1) a model-based approach based on moderate-resolution (30 m) satellite image-derived LANDFIRE maps of fuelbeds, as defined in the Fuel Characteristic Classification System (FCCS), and burned with CONSUME; 2) ground-based fuelbed measurements, sampled inside and outside the fire perimeter to represent post-fire and pre-fire conditions, respectively, within the major FCCS types that burned; 3) maps of pre- and post-fire fuel loads predicted empirically from pre- and post-fire airborne lidar, using as the response variable the plot-based observations of burned and unburned fuels. To date, we have complete datasets from three wildfires in 2018 (n=2) and 2019 (n=1). Preliminary results indicate that repeat lidar collections are best suited for refined estimates of overstory canopy consumption, with declining sensitivity to consumption of understory, surface, and ground fuels (in that order). Field measurements of all fuel components, especially of duff, will remain critical for calibrating and validating model-based estimates either with or without the fine-scale fuel structure information captured with lidar. Fire radiative energy estimates derived from active fire thermal imagery provide an alternative, independent method to estimate consumption, which we explore on the 2019 Williams Flats Fire sampled by FIREX-AQ.

Keywords: Emissions, fuel, fuel consumption, fuel sampling, lidar, wildfire source characterization

Presenter Bio: Andrew Hudak got his B.S. and Ph.D. degrees in Ecology from the University of Minnesota and the University of Colorado, respectively. He began work for the U.S. Forest Service as a postdoctoral Research Ecologist with the Pacific Northwest Research Station and since 2001 works as a Research Forester with the Rocky Mountain Research Station. He currently studies biophysical relationships between field and remotely sensed data collected at landscape to regional scales, including predicting aboveground biomass carbon from lidar and Landsat time series, predicting fuel/carbon loads from 3D point cloud metrics, and relating fuel consumption to energy flux and fire effects.

64. Direct Measurement of Flame Energy Release from Ground Based Sensors in FASMEE Manning Creek Rx Burn

Presenter: Bret Butler, Research Engineer, USDA Forest Service, bret.butler@usda.gov

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Abstract: Time-resolved radiation, convection heat flux and near ground flow data sets were collected in full scale management ignited crown fires. Comparing 3 s averaged total and radiant heat fluxes at sensor locations suggests that radiant energy decays more slowly than convective heating with distance from the flame front. Generally, 3 s averaged total fluxes incident on sensor vary from 130 60 kW/m^2. Measured fire radiant heat fluxes vary from 80 to 30 kW/m^2. Convective energy fluxes can be roughly estimate from difference between total and radiant heating and varied from 160 to 15 kW/m^2. This fire was subject to very strong winds and the data indicate that convective heating dominated the energy transport. Flame residence times were on the order of 30-50 s. Vertical flow velocities in the flames reached 42 m/s with proportional downward flow of 45 m/s. Horizontal flow in the flames in the direction of flame travel reached 42 m/s with reverse flow as high as 20 m/s.

Keywords: Direct measurement of fire intensity

Presenter Bio: Bret is a research mechanical engineer at the Fire Sciences Laboratory in Missoula, MT. His work focuses on characterizing energy transport in wildland fires.

65. Wildland fire emissions and atmospheric measurements from unmanned aircraft systems to support FASMEE

Presenter: Adam Watts, Associate Research Professor, Fire and UAS, Desert Research Institute, Adam.Watts@dri.edu

Abstract: FASMEE represents the first coordinated, multidiscipline prescribed forest burn to feature atmospheric measurements and emission sampling using unmanned aircraft systems (UAS). These UAS platforms provide logistical flexibility, safety, and the ability to collect data from previously inaccessible locations above and around wildland fires. These capabilities provided investigators with the opportunity to measure smoke plume emissions and airborne weather. We will describe UAS operations for FASMEE and provide some early results from emissions sampling and the analysis of viable airborne microbes observed in the 2019 campaign. We also will describe future plans and some of the ways these measurements will influence future airborne wildland fire campaigns.

Keywords: unmanned aircraft, drone, airborne measurement, smoke, FASMEE

Presenter Bio: Dr. Adam Watts leads DRI's node of the Nevada UAS Test Site, and also is the UAS Lead for the Fire and Smoke Model Evaluation Experiment. Dr. Watts is a Certified Wildland Fire Ecologist and Certified Wildland Practitioner, and he has previously served on the Board of Directors and as Treasurer for the Association for Fire Ecology. His recent research and project work has included interactions between fire and hydrology, climate and human-health impacts of emissions from wildfires in the Western USA and in tropical and boreal peatlands, UAS program design for public agencies and private-sector organizations, and the development of UAS-mounted sensors for real-time air-quality measurements and gas sample collection and chemical analysis.

66. Microbial Emissions affect Biodiversity and Ice Nucleation Potential in FASMEE Smoke Plumes

Presenter: Leda Kobziar, Associate Clinical Professor, University of Idaho, lkobziar@uidaho.edu

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Abstract: Smoke from biomass burning has been extensively researched to determine its chemical and physical properties, while the biological component of smoke has largely been overlooked. We conducted a series of studies across ecosystems, in a combustion laboratory, and during a recent high-intensity experimental crown fire as part of the Fire and Smoke Model Evaluation Experiment (FASMEE). Our research reveals that unique assemblages and high concentrations of microorganisms from soils, plant surfaces, and within both living and dead vegetation are aerosolized during both low- and high-intensity wildland fires, with 70-80% of cells viable. This represents a newly identified mechanism for microorganism emissions and transport with global implications for biodiversity. In addition, ice nucleation activity in smoke, predominantly associated with these bioaerosols, is 2- to 6-fold that of air without smoke, suggesting a potential role in pyrocumulonimbus cloud formation and weather. This discovery also implies that research on biomass smoke-related human health impacts should consider the living, disease-causing organisms that are concentrated in the smoke. We will discuss both the results and the variety of implications of this new line of research.

Keywords: pyroaerobiology, smoke emissions, microbes, ice nucleation

Presenter Bio: Dr. Leda Kobziar earned her PhD in 2006 at the University of California at Berkeley, and after nine years at the University of Florida as Associate Professor of Wildland Fire Science, she joined the Natural Resources and Society Department of the University of Idaho's College of Natural Resources in 2016. Dr. Kobziar's research focuses on fire use and fuels management effects on plant communities, smoke bioaerosol production, soil heating and carbon cycling, and fire behavior. Research collaborators include numerous US universities, the USDA Forest Service, the US Fish and Wildlife Service, the National Park Service, and others. She has served as the Principle Investigator for more than 20 federally-sponsored fire research grants, and has had the honor of serving as major adviser 43 graduate students since 2007. She is an Associate Editor of the journals Forests and Fire Ecology and has served on the Board of Directors of the Association for Fire Ecology from 2009-2018 and as President from 2016-2018. Dr. Kobziar is actively engaged in improving the knowledge and application of fire ecology in land management through research, outreach, and education.

67. Fire Radiative Energy for Quantifying Wildland Fire Effects using FASMEE and FIREX-AQ Data of the 2019 Williams Flats Fire

Presenter: Nancy French, Senior Scientist, Michigan Technological University, nhfrench@mtu.edu

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Abstract: The 2019 Williams Flats Fire was imaged by instruments on the NASA DC-8 and ER-2 sensing platforms for the NOAA-NASA FIREX-AQ campaign and the JFSP-funded Western Wildfire Campaign (WWC) of the Fire and Smoke Modeling Evaluation Experiment (FASMEE). These platforms, along with satellites, collected a range of data on three days in early August, 2019 (August 6, 7, and 8) during the active flaming stage of the incident. On-board the NASA DC-8 was MASTER, while the NASA ER-2 housed eMAS, HyTES, and AVIRIS-C, and other relevant instruments each of which collected data for studying the thermal properties of fire and the surrounding landscape. Relevant satellite data collected during this 3-day window were VIIRS, MODIS, and ECOSTRESS. These data are valuable for studying the thermal properties of this fire event, and can be used to assess both active fire and a variety of fire effects. Our objectives for this study is to review the available data and assess the utility of this airborne and spaceborne thermal sensing data for describing active fire and predicting fire effects. Applications to be studied include: (1) fire location and timing, which can be used in coordination with the fuels data to pinpoint the type and status of fuels burned; (2) fire power and energy, which can provide information on fire intensity, fuel consumption, and soil heating; and (3) flaming vs. smoldering mapping, a characteristics of wildland fires which is normally elusive to map, but may be achieved with the wealth of data collected over this site. The presentation will review the data used, the value of these data, and some preliminary analysis results.

Keywords: Remote sensing, active fire thermal sensing, fire radiative energy (FRE), fire effects

Presenter Bio: Dr. French has been working on applications of remote sensing to ecology and vegetation studies for 30 years. Dr. French's research has focused on wildfires and their effect on the structure and function of ecosystems and the implications to carbon cycling, energy balance, and air quality. Her research has included studies in boreal, arctic, and temperate ecosystems with a variety of remote sensing systems and geospatial technologies. Dr. French serves on the Editorial Board and as an Assistant Editor for the International Journal of Wildland Fire.

68. Modeling support for FASMEE western campaign

Presenter: Adam Kochanski, Research Assistant Professor, University of Utah, adam.kochanski@utah.edu

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Abstract: The growing air quality, health, and safety concerns associated with wildland fire emissions generate an increasing need for modeling tools that could assist in the assessment of air quality impacts of prescribed burns and wildfires. In the attempt to provide critical data needed for rigorous evaluation of the currently used models as well as the development and validation of the next-generation models, a set of experimental burns has been conducted as a part of the Fire and Smoke Evaluation Experiment. In this paper, we present modeling activities utilizing the coupled fire-atmosphere model WRF-SFIRE performed to help with the experimental planning and the execution of the actual burns.

The planning support consisted of an objective analysis of the historical weather observations, that allowed to identify the most typical historical days meeting the burn criteria. In the next step numerical simulations of the prescribed burns were conducted for these days, to assess the effectiveness of sensor placement in the context of most likely weather conditions and smoke dispersion.

Operational support encompassed two aspects. Targeted high-resolution numerical weather forecasts for the burn units, run daily to support go-no-go decisions and, the coupled fire-atmosphere-smoke forecasts executed right before the burn.

In this presentation, we describe the method including the prototype of the automated coupled fire-atmosphere-smoke forecasting framework wrfxpy and present the results of the simulations performed in support of the experimental burns conducted in the Fishlake National Forest in Spring and Fall 2019.

Keywords: FASMEE, smoke modeling, WRF-SFIRE, WRF-SFIRE-CHEM, wrfxpy, plume dynamics, plume rise

Presenter Bio: Dr. Adam Kochanski is a research assistant professor working at the University of Utah Atmospheric Sciences Department. He received his M.Eng in Chemical Engineering and MBA from Technical University of Lodz (Poland) and Ph.D. in Atmospheric Sciences from the University of Nevada, Reno. His main research interests include fire-atmosphere interactions including air quality impacts of wildland fires. He is a modeler with extensive experience in running numerical simulations of fire, smoke, and regional climate on high-performance computing platforms. He is a co-developer of the coupled fire-atmosphere model WRF-SFIRE, the integrated fire and air quality system and WRF-SFIRE-CHEM, as well as the fire forecasting system WRFX. He is one the modeling leads for the

Fire and Smoke Model Evaluation Experiment (FASMEE) and a member of the Rocky Mountain Center for Fire-Weather Intelligence (RMC) steering committee.

69. Smoke Management in the Southeast: Highlights of Highly Effective Collaboration between State Fire/Forestry, State Air Quality Agencies, and Non-Governmental Organizations (NGOs) across the Southeast

Presenter: Rick Gillam, Environmental Engineer/Air Quality Modeler, U.S. Environmental Protection Agency Region 4, Atlanta, Georgia, gillam.rick@epa.gov

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Cabe Speary: North Carolina Forest Service Fire Environment Forester: State Forestry perspective on North Carolina Smoke Management Program, cabe.speary@ncagr.gov

Abstract: This proposed "Special Session" will include multiple presentations from fire and air quality representatives, who are partnering with the North Carolina Prescribed Fire Council to showcase the successful collaboration among stakeholders in the southeast for dealing with smoke. One of the primary goals of this session is highlight the successful southeast regional approach, in the hopes that it can expand nationally and even internationally. In 2013, the U.S. EPA partnered with the Jones Center at Ichauway to bring together State Fire/Forestry and Air Quality representatives from eight southeast states at a "Southeast Fire and Air Quality Summit." The focus of this summit was to enhance collaboration and communication between the fire and air quality communities for addressing smoke management issues. Three additional Summits have been held in 2015, 2017 and 2019. The partnerships that have developed out of these Summits have improved smoke management and have continued to foster the increased use of prescribed fire that is critical in combating the loss of species diversity and the growing threat of wildfires. An excellent example of the outcomes from the Southeast Summits is the enhanced collaboration between state forestry and air quality personnel in North Carolina which resulted in significant improvements to their State Smoke Management Program. The session will highlight how State Smoke Management Programs can be the solution to increasing the use of prescribed fire as a resource management tool.

Keywords: Smoke Management, Prescribed Fire, Air Quality, Collaboration

Presenter Bio: Rick Gillam is an environmental engineer working with the U.S. EPA in Atlanta, Georgia. He has been with EPA for 27 years, including 19 years of experience in air quality modeling. He currently serves as the EPA Region 4 Air Modeling Team Leader. Rick is also the EPA Region 4 technical lead for smoke management from wildland and prescribed fires, with over 12 years of experience working with fire and air quality stakeholders in the southeast. Rick has a B.S. in Mechanical Engineering from Ohio University.

70. Confronting the Issues Air Quality and Wildland Smoke In South Carolina

Presenter: Darryl Jones, Forest Protection Chief, South Carolina Forestry Commission, djones@scfc.gov

Abstract: Prescribed fire is a very common across the southeast, especially during early spring. In South Carolina, smoke from more than 350 prescribed fires and wildfires per day is not uncommon, and air quality concerns frequently arise. Beginning in 2009, the SC Forestry Commission and SC Department of Health & Environmental Control, who jointly administer the state Smoke Management Guidelines, began providing cross-training to ensure that staff in both agencies were aware of prescribed fire methods, air quality monitoring, regulations, and smoke management plans in the state. The two agencies worked together to develop educational materials, guidance for agency staff, and to provide opportunities for air quality personnel to view and participate in prescribed burns. In 2013, the SCFC and the SC DHEC convened a group of burning practitioners, air quality specialists, homeowners that live adjacent to landscapes managed, by fire, and citizens with respiratory issues that had concerns about smoke impacts. The South Carolina Prescribed Fire & Air Quality Working Group began meeting, creating a moderated forum where prescribed fire managers, local citizens, local government representatives, and state agencies could discuss air quality impacts, smoke management practices, and public notification methods. The work of this group, and similar efforts in nearby southeastern states, has greatly improved the understanding of the natural role of fire on the landscape.

Keywords: Prescribed fire, smoke management

Presenter Bio: Darryl Jones is the Forest Protection Chief for the South Carolina Forestry Commission. His responsibilities include oversight of wildfire suppression, fire prevention, emergency response, law enforcement, forest health, training & safety, and administration of South Carolina's Certified Prescribed Fire Manager, Smoke Management, and prescribed burning programs. Darryl is a Wildland Firefighter, Certified Prescribed Fire Manager, and a Registered Forester, as well as a past president and current steering committee member of the SC Prescribed Fire Council. He holds a B.S. degree in Forest Resource Management from Clemson University.

71. Southeast Prescribed Fire and Air Quality Workgroup: Addressing Tomorrow's Challenges Today

Presenter: R. Scott Davis, Chief, Air Planning and Implementation Branch, U.S. Environmental Protection Agency, Region 4 (Southeast), Davis.ScottR@epa.gov

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Abstract: Many surveys have identified challenges that fire managers and landowners face related to prescribed fire use in the United States. Although informative, these surveys do not address the challenges state agencies navigate in managing fire programs. In particular, it is often overlooked that the states are actually responsible for administering prescribed fire use. States operate independently to develop policy and regulations that work for their own interests; as a result, prescribed fire programs differ greatly by state and region. In 2013, state forestry and environmental protection agencies from eight southern states, as well as the U.S. Environmental Protection Agency, convened a first of its kind forum to discuss issues and concerns related to prescribed fire, smoke management, and air quality. The result was the identification of prescribed fire coordination needs, at a multi-state scale, that benefit both the southeast region and individual states. The outgrowth of the inaugural meeting has been the development of the "Southeast Prescribed Fire and Air Quality Workgroup." The workgroup's primary goal is to foster collaborative efforts to support and increase the appropriate use of prescribed fire as a natural resource management tool to enhance forest health and public health and safety.

Keywords: Smoke Management, Air Quality, Prescribed Fire, Collaboration

Presenter Bio: Scott Davis has been with the U.S. Environmental Protection Agency for 29 years and is currently Chief of the Air Planning and Implementation Branch, where his responsibilities include managing the Air Regulatory Management and Air Permitting Sections. These sections work on implementation of national ambient air quality standards, state implementation plans, air permitting, and support for voluntary air quality programs for the eight Southeastern states. Scott received his Bachelor's degree in Industrial Engineering from the Georgia Institute of Technology. He is also a retired Lieutenant Colonel in the U.S. Air Force Reserve, where he served as a C-130 Squadron Commander at Maxwell Air Force Base in Montgomery, Alabama and flew over 500 combat hours as a C-130 Navigator during service in Afghanistan and Iraq in 2004-2005.

72. Development and Implementation of a Smoke Management Program in North Carolina

Presenter: Cabe Speary, Fire Environment Forester, North Carolina Forest Service, cabe.speary@ncagr.gov

Abstract: Fire has been an important process in North Carolina's forests for millennia. In the latter half of the 20th century, forestry professionals began to realize that burning of the forests in a controlled manner produced many benefits. Land clearing operations and other controlled burning impacted populated areas for extended periods. Concerns about smoke effect on health and roadway visibility became evident, and voluntary smoke management guidelines based on the conservative Ventilation Index System (VIS) were implemented. By the 90s, the population of the state was increasing dramatically, especially in the Wildland Urban Interface (WUI). Lawsuits and tort claims against prescribed burners threatened to severely curtail the practice. The NC Legislature passed the Prescribed Burning Act in 1999 to give liability relief for off-site smoke effects to Certified Burners who followed the guidelines. At the same time, computerized smoke models were being refined. Several research burns were conducted using smoke modeling, demonstrating that smoke could be properly managed from some burns that would not have been allowed under VIS. Therefore, Atmospheric Dispersion Modeling (ADM) along with VIS, are now part of a comprehensive Smoke Management Program (SMP). The use of ADM within the SMP has increased the number of allowable burning days, increased treated acreage and maintained the liability protection for all burners within the NC Prescribed Burning Act.

Keywords: Prescribed fire, smoke management, smoke modeling

Presenter Bio: Cabe Speary is the Fire Environment Forester for the NC Forest Service. His responsibilities include development of policy, products and training for field personnel related to fire weather, fire danger, fire behavior, forest fuels, and smoke management. Cabe is a Wildland Firefighter and a NC Registered Forester, as well as chairman of the NC Interagency Fire Environment Committee. He holds a B.S. in Natural Resources from The University of the South and an MF in Forest Management Science from Duke University.

73. Collaboration Between Agencies for Protection of Air Quality in North Carolina

Presenter: Randy Strait, Chief, Planning Section, North Carolina Division of Air Quality, randy.strait@ncdenr.gov

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Abstract: Air pollution associated with open burning in North Carolina is regulated by the Department of Environmental Quality/Division of Air Quality (NCDAQ) under its open burning rule (Title 15a North Carolina Administrative Code (NCAC) 2D .1900). The rule provides for prescribed burning of forest and agricultural lands to be conducted without an air quality permit. The state relies on the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) and North Carolina Forest Service (NCFS) to manage the impacts of smoke from prescribed burning on air quality. To enhance and reaffirm understanding and advance agency goals, the agencies jointly developed a memorandum of understanding (MOU) in 2009 which was updated in 2017. The intent of the MOU is to reduce air pollution resulting from the open burning of combustible materials, but not affect the authority of the NCDA&CS and NCFS to use open burning as an acceptable agricultural or apicultural practice for disease and pest control or an acceptable land management practice. The MOU sets forth the principles of the working relationship between the agencies by defining roles and responsibilities for enforcement, cross-training, and communication and outreach to the public. This model has worked well for the agencies and provides a framework for on-going success in supporting the goals of each agency.

Keywords: agency collaboration, smoke management, air quality management

Presenter Bio: Randy Strait is Chief of the Planning Section of the North Carolina Division of Air Quality. Randy has 36 years of experience in the air quality field with a focus on developing state, regional, and national emission inventories to support air quality modeling studies and developing plans to attain and maintain compliance with the National Ambient Air Quality Standards. He holds a Master’s degree in Environmental Management from Duke University and Bachelor’s degree in biology from Northland College in Wisconsin.

74. Advances in the science of prescribed fire and smoke management: an NGO perspective on achieving successful smoke management through coproduction

Presenter: Kevin Hiers, Wildland Fire Scientist, Tall Timbers Research Station, jkhiers@talltimbers.org

Additional Author(s):
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Dr. Rodman Linn, Senior Scientist, Los Alamos National Laboratory

Abstract: Recent advances in the science of prescribed fire have resulted in enhanced fire behavior modeling, smoke modeling, and improved understanding of fire-atmospheric interactions that will collectively advance the safe and effective application of prescribed fire. In an increasingly complex landscape, being able to apply these advances to predict both fire behavior and smoke dispersion are critical for sustaining the use of prescribed burning in rapidly urbanizing areas. This presentation demonstrates the application of two models, FIRETEC and QUIC-Fire, to predict prescribed fire behavior and smoke outcomes from different ignition patterns. Both tools apply 1-5 m 3D depictions of vegetation that allow for the coupling of fire-atmospheric feedbacks. These feedbacks are critical to model projections of fire behavior and resulting near-field plume rise. Applying these advances to management has leveraged a novel partnership called the Prescribed Fire Science Consortium. This collaboration is an effort to link researchers and managers through a process of co-production. Managers throughout the country have been engaged from the outset of tool development, resulting in training products, new research ventures, and effective beta-testing of model performance.

Keywords: Prescribed fire, smoke management, smoke modeling, co-production

Presenter Bio: J. Kevin Hiers is a Wildland Fire Scientist at Tall Timbers Research Station where he leads research projects in fire behavior, fire management, fuel moisture, fire weather, and the fluid dynamics of fire effects. He has worked at the interface of science and management for 25 years to help enhance tools and techniques to safely apply prescribed fire for management objectives. He has served as fire ecologist and fire program manager at Eglin AFB, which burned on average 100,000 acres per year. He has co-authored more than 90 peer-reviewed research publications, and was an author of the 4th National Climate Assessment released in 2018.

76. The Mother of all PyroCbs: How did the Pacific Northwest PyroCb Event in 2017 Stand Out?

Presenter: Michael Fromm, Meteorologist, Naval Research Lab, mike.fromm@nrl.navy.mil

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Abstract: On 12 August 2017 a cluster of pyrocumulonimbus (pyroCb) storms erupted in Washington state (USA) and British Columbia (Canada). It has already been established that the resultant stratospheric smoke plume was unprecedented in the satellite era (since 1979). However, to date, this Pacific Northwest pyroCb event (PNPE) has not been thoroughly quantified in a manner that establishes its source term in relation to other big pyroCb events. We use an assortment of space- and ground-based remote sensing to characterize the number of pyroCbs, eruption timeline, initial stratospheric perturbation, plume height and transport in the first five days after the eruption event. We also compare the metrics we establish for the PNPE with other notable pyroCb events, such as Norman Wells (Northwest Territories Canada, August 1998), Chisholm (Alberta Canada, May 2001), Canberra (Australian Capital Territory, January 2003), Great Divide (Victoria Australia, December 2006), Black Saturday (Victoria Australia, February 2009), and Great Slave Lake (Northwest Territories, Canada, August 2014). We find that with respect to UV absorbing aerosol index--a trustworthy signal of optically dense and high-altitude smoke and ash plumes--the PNPE stood out strongly from all other pyroCb events, even though plume height and optical depth were not unusual. We also report that, like the other pyroCb cases listed, the pyroconvective pathway fully explains the source term for the noteworthy and unprecedented plume observed around the Northern Hemisphere stratosphere for several months.

Keywords: smoke stratosphere climate pyroconvection

Presenter Bio: Principal Investigator of NRL's Upper Troposphere Lower Stratosphere and Remote Sensing of Volcanic Clods projects. Prime responsibility is to bring satellite and other remotely sensed data to bear on processes occurring at the interface between the troposphere and stratosphere. Lead on POAM II and III stratospheric aerosol and cloud studies, including algorithm development, database management, and meteorological analysis. UARS guest investigator and a member of NASA's SOLVE, SOLVE II, SOSST, and Aura science teams. Member of the NCAR UTLS Science Working Group. Developed a 20-year polar stratospheric cloud database unifying SAM II, SAGE II, and POAM aerosol aerosol extinction measurements. Discovered boreal forest fire smoke in the stratosphere and its connection with pyrocumulonimbus storms.

77. Using column measurements to evaluate the impacts of wildfires: Emission fluxes and enhancement ratios

Presenter: Kyle Zarzana, Postdoctoral research associate, University of Colorado Boulder, kyle.zarzana@colorado.edu

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Abstract: Biomass burning emissions are a complex mixture of gases and particles that can vary rapidly over short spatial and temporal scales, and this variability can be difficult to capture using in situ measurements. Column measurements along the direct solar beam integrate over the vertical variability, and when made from an airborne platform can be used to determine mass fluxes on the scale of a wildfire. Additionally, column enhancement ratios for many chemically important trace gases can be calculated and compared to in situ enhancement ratios to assess plume inhomogeneities and calibration factors. In this work we present measurements from the Biomass Burning Flux Measurements of Trace Gases and Aerosols (BB-FLUX) campaign that was conducted in the northwest United States during the summer of 2018. The University of Colorado Solar Occultation Flux (CU SOF) instrument was used to quantify vertical column densities, emission fluxes and enhancement ratios of infrared absorbing trace gases from wildfires including but not limited to CO, NH3, C2H4, C2H6, HCN, PAN, and HCHO, while the CU Zenith Sky Differential Optical Absorption Spectroscopy instrument measured slant column densities of several relevant species not easily accessible in the IR such as HONO and NO2. Measurements of fluxes from fire with a variety of fuel types, locations, and fire intensities will be presented, along with comparisons to in situ emission ratios measured during the 2018 WE-CAN project.

Keywords: Emission ratios, mass fluxes

Presenter Bio: Dr. Zarzana received his BS in Chemistry from Harvey Mudd College and a PhD in Atmospheric Chemistry from the University of Colorado Boulder, working for Prof. Maggie Tolbert on aerosol optical properties. After a post doc with at NOAA, he has worked on biomass burning emissions with Prof. Rainer Volkamer.

78. Using lower cost sensors to establish citizen-based monitoring networks in smoke-impacted regions

Presenter: Bonne Ford, Research Scientist, Colorado State University Department of Atmospheric Science, bonne@atmos.colostate.edu

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Abstract: Wildfires are a significant source of fine particulate matter (PM2.5, particles with an aerodynamic diameter smaller than 2.5 μm) in North America. Exposure to smoke PM2.5 is associated with many negative health impacts; thus, it is important for communities and individuals to know what their exposure levels are during wildfire smoke events. However, wildfire smoke often occurs in regions with sparse surface monitoring. Thus, there is great potential for using lower-cost sensors to fill monitoring gaps in these regions.

The aerosol mass and optical depth (AMOD) device was developed in order to be deployed by citizen scientists to measure both PM2.5 and aerosol optical depth. These lower-cost, portable instruments have been deployed by citizen scientists in Denver and northern Colorado to measure local air quality, and several smoke events were captured by our AMODs in 2018 and 2019.

In this presentation, I will discuss the design of the AMOD and show measurement results from several of these smoke events. In addition, I will discuss the development of (1) our mobile application that allows citizen scientists to easily interact with the AMOD and (2) our website, which allows for real-time viewing of measurement data. Both components are crucial for a successful citizen-based monitoring network. Finally, I will discuss our plans to deploy these instruments in other smoke-impacted regions.

Keywords: measurements, low-cost sensors, citizen-science

Presenter Bio: Bonne Ford is a Research Scientist at Colorado State University in the Department of Atmospheric Science, where she also received her PhD. Her research focuses on surface air quality and estimating exposure concentrations with a recent emphasis on wildfire smoke. Her projects are interdisciplinary and include collaborators across many different departments. Recent work with her collaborators looked at the associations between wildfire smoke exposure and different health outcomes and with crime. Her work has included using a variety of different tools and data sets such as surface monitors, satellite observations, atmospheric models, social media, and low-cost sensors.

79. Western wildfire observation during Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ)

Presenter: Carsten Warneke, Research Scientist, CIRES CU Boulder and NOAA ESRL, carsten.warneke@noaa.gov

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Abstract: NOAA/NASA FIREX-AQ (Fire Influence on Regional and Global Environment Experiment) brought together hundreds of scientists from around the world to obtain detailed measurements of trace gas and aerosol emissions from wildfires and prescribed fires from aircraft, satellites and ground-based instruments. The goal was to understand how fuel and fire conditions at the point of ignition influence the chemistry of smoke, what conditions control the rise of smoke plumes, what happens to smoke as it is distributed in the atmosphere, and how does the chemical transformation of smoke impact air quality, and to a lesser degree weather, downwind. Finally, lessons learned from FIREX-AQ will be used to assess and improve the effectiveness of satellites for estimating the emissions from wildfires and prescribed burns. (http://www.esrl.noaa.gov/csd/projects/firex/)

In this presentation we will present an overview and first results from the wildfire portion of the FIREX-AQ research effort. The measurements were centered in Boise, ID and included the NASA DC-8, the NASA ER-2, two NOAA Twin Otter aircraft, two mobile laboratories, and ground site measurements, together with modeling forecasts and analysis for fire, fuels and air quality.

The NASA DC-8 flew 14 different wildfires with remote and in-situ data collection; some fires were sampled on multiple days. In addition, the DC-8 sampled a PyroCb, encountered nighttime smoke, one day old smoke, and smoke from different fuels such as grass and timber. The various FIREX-AQ aircraft and mobile laboratories coordinated on several flights. The flights were designed to be able to measure the emissions of trace gases and aerosols with multiple close in transects and capture the chemical transformation of these emissions in downwind transect. The emissions are linked to the fuels consumed and fire radiative power by overflights of the fire and smoke plume using remote sensing instrumentation. First results on all these topics will be presented.

Keywords: Smoke measurements during FIREX-AQ

Presenter Bio: Dr. Carsten Warneke is an atmospheric researcher at the University of Boulder, CO and the Earth Systems Research Laboratory of the National Oceanic and Atmospheric Administration (NOAA). He is one of the principle investigators of the NOAA/NASA led FIREX-AQ campaign, which is a multi-year, multi-agency measurement campaign focused on the impact of fires on climate and air quality from western North American wild fires. His main expertise is in air pollution on regional and global scales.

80. Wildfire aerosol and gas-phase measurements from a NOAA Twin Otter during the 2019 Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) Study

Presenter: Ann Middlebrook, Research Chemist, NOAA Earth System Research Laboratory Chemical Sciences Division, ann.m.middlebrook@noaa.gov

Abstract: The Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) was a comprehensive investigation on the impact of wildfire and biomass smoke on air quality and weather in the continental United States. It involved scientists from NOAA, NASA and more than 40 partners to explore the chemistry and fate of trace gases and aerosols in smoke with instrumented airplanes, satellites, UAVs and ground-based instrumentation in the northwestern and southeastern U.S. during the summer of 2019. One measurement platform, the NOAA-CHEM Twin Otter, was deployed to Boise, ID and Cedar City, UT in August and early September for detailed emissions, near-field photochemistry and nighttime chemistry in coordination with ground-based and other mobile research platforms. The NOAA-CHEM Twin Otter focused on the variability of the emissions measured close to several wildfires for extended time periods, the fast evolution of smoke in the first few hours after emission, and the vertical distribution in the concentration, composition and optical properties of smoke in impacted western areas. Here we provide an overview of the scientific goals, instrumentation, measurement strategy, and initial results from this aircraft.

Keywords: western wildfire airborne observations

Presenter Bio: Dr. Middlebrook is a Research Chemist at NOAA's Earth System Research Laboratory (ESRL) in Boulder, Colorado. Her principle research interest is the chemical measurement of atmospheric aerosols to advance the understanding of their formation, chemical transformations and transport in the atmosphere, and the impact of these aerosols on air quality and climate. She has participated in several NOAA ground-based and airborne field programs and was part of the NOAA CHEM Twin Otter team for the 2019 FIREX-AQ study.

81. Ceilometers and other tools for determining vertical distributions of smoke

Presenter: Phil Swartzendruber, Air Resource Specialist, Puget Sound Clean Air Agency, phils@pscleanair.gov

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Abstract: Wildfire smoke forecasting remains a challenge. Development of smoke models is still in its early stages and is often highly inaccurate. Air quality monitors provide surface concentrations, only describing a very small percentage of the overall smoke depth. Satellites can track smoke plumes, but mostly provide vertically integrated measurements, telling us little about how smoke is distributed throughout the air column.

The Puget Sound Clean Air Agency uses a ceilometer and vertical profile modeling to measure and predict the vertical distribution of smoke within its jurisdiction (in western Washington State). These three-dimensional tools, in addition to air quality monitoring and satellite observations, enable us to better predict plume height, smoke exposure, and plume transport. These tools are also more suitable for further smoke model development and verification. We propose a network of ceilometers throughout the western U.S. for smoke tracking. Such a network could potentially be achievable using currently-deployed ceilometers operating at hundreds of ASOS airport weather stations across the country, if they were to be configured to release a data stream tailored to smoke monitoring.

Keywords: Ceilometer; vertical profile; curtain plot; plume tracking; plume height

Presenter Bio:

82. BBOP Shows Rapid Changes in Aerosol Properties in the Near Field

Presenter: Arthur Sedlacek, Atmospheric Scientist, Brookhaven National Laboratory, sedlacek@bnl.gov

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Abstract: During the summer and fall of 2013, the Department of Energy's Atmospheric Radiation Measurement (ARM) program sponsored an aircraft study to investigate the near source evolution (< 5 hrs) of BB aerosol particles. This field campaign, known as BBOP (Biomass Burning Observation Project), represented the first time that near source evolution of BB aerosol particles was exclusively targeted with research aircraft.This campaign is providing new insights into this under-investigated subject. For instance, modeling calculations, used to explore the impacts of these events, are often based on BB emission inventories derived from laboratory experiments due to the severe paucity of field measurements and the complexity of the emissions.However, results from BBOP indicate that BB aerosols undergo very rapid changes in their chemical, microphysical, and optical properties near the source and these changes may not be fully captured in laboratory studies. I will present findings on the formation and near source evolution of changes in BB aerosol chemical, microphysical, and optical properties.

Keywords: BBOP, biomass burn aerosol, microphysical properties, tar balls

Presenter Bio:

83. Use of Lightning Data as a Supplementary Tool for Smoke Monitoring

Presenter: Chris Vagasky, Meteorologist, Solutions Manager, Vaisala Inc, chris.vagasky@vaisala.com

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Abstract: Remote sensing plays a vital role in monitoring fire activity and smoke trajectories. Smoke is frequently detected by weather radar and geostationary satellites. The newest satellites, including Himawari-8, GOES-16, and GOES-17, even offer data products to detect and characterize fire and smoke, helping first responders rapidly react to fire events. The addition of lightning data provides additional benefits to those responding to fire events. Lightning is a significant threat to firefighting efforts, with the potential to injure or kill first responders and start new fires. We review two pyrogenetic lightning events to reveal how regional and global lightning detection networks can be used to monitor the behavior of smoke plumes.

The Mallard Fire was triggered by lightning on 8 May 2018. Extreme fire behavior on 11 May 2018 resulted in lightning in the smoke plume and triggered additional small fires. A severe thunderstorm eventually developed from the pyrocumulonimbus and produced large hail. The National Lightning Detection Network detected nearly 6000 lightning events in the smoke plume and severe thunderstorm.

Australia has seen a spate of extreme fire behavior in recent years, frequently resulting in pyrocumulonimbus and pyrogenetic lightning. The January 2013 Wambelong fire in New South Wales, Australia, was the impetus for increased monitoring of these type of events. The Global Lightning Dataset GLD360 is used to examine the lightning from an Australian pyrocumulonimbus event to illustrate the capability of a global lightning detection network to detect pyrogenetic lightning.

Incorporating lightning data into smoke monitoring strategies helps protect first responders, improves understanding of fire behavior, and identifies regions for potential new fire starts.

Keywords: Pyrocumulonimbus, lightning, remote sensing

Presenter Bio: Chris Vagasky is a meteorologist and solutions manager with Vaisala Inc, based in Louisville, Colorado. He works with customers to develop measurement solutions for unique requirements and researches uses of lightning data in non-traditional applications. Chris holds both a BS and MS in meteorology from Mississippi State University and is a recognized early career leader in the American Meteorological Society.

84. A review of approaches to estimate wildfire plume injection height within large-scale atmospheric chemical transport models

Presenter: Saulo Frietas, USRA/GESTAR & NASA Goddard Space Flight Center, saulo.r.freitas@nasa.gov

Abstract: Landscape fires produce smoke containing a very wide variety of chemical species, both gases and aerosols. For larger, more intense fires that produce the greatest amounts of emissions per unit time, the smoke tends initially to be transported vertically or semi-vertically close by the source region, driven by the intense heat and convective energy released by the burning vegetation. The column of hot smoke rapidly entrains cooler ambient air, forming a rising plume within which the fire emissions are transported. The characteristics of this plume, and in particular the height to which it rises before releasing the majority of the smoke burden into the wider atmosphere, are important in terms of how the fire emissions are ultimately transported, since for example winds at different altitudes may be quite different. This difference in atmospheric transport then may also affect the longevity, chemical conversion, and fate of the plumes chemical constituents, with for example very high plume injection heights being associated with extreme long-range atmospheric transport. Here we review how such landscape-scale fire smoke plume injection heights are represented in larger scale atmospheric transport models aiming to represent the impacts of wildfire emissions on component of the Earth system. In particular we detail (i) satellite Earth observation data sets capable of being used to remotely assess wildfire plume height distributions and (ii) the driving characteristics of the causal fires. We also discuss both the physical mechanisms and dynamics taking place in fire plumes and investigate the efficiency and limitations of currently available injection height parameterizations. Finally, we conclude by suggesting some future parameterization developments and ideas on Earth observation data selection that may be relevant to the instigation of enhanced methodologies aimed at injection height representation.

Keywords: plume rise, air quality modeling, plume injection height, fire smoke

85. Plume Rise Models: An Evaluation of Implementation and Performance

Presenter: Shawn Urbanski, Reserach Physical Scientist, USDA Foreser Service, shawn.p.urbanski@usda.gov

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Abstract: Wildfires are a major source of fine particulate matter pollution (PM2.5). In the US and Canada, wildfires are a recurring, episodic source of air pollution that can be a major threat to public health. Limiting exposure is the principal measure available to mitigate health impacts during smoke episodes. State and local agencies rely on smoke air quality forecasts to minimize exposure risk. This includes issuing air quality advisories/warnings and initiating mitigation options, such as voluntary and mandatory actions to reduce pollutant emissions and opening clean air shelters. Improved forecasting of acute or extended duration smoke events would enable air quality managers and public health officials to implement mitigation efforts and improve public response more effectively.

The ability of plume models to accurately simulate the vertical distribution of smoke at the source remains a major uncertainty in forecasting smoke impacts. In order to improve smoke forecasts, we evaluate the performance of a widely used plume rise model and its sensitivity to driving variables: temporal fire activity, biomass consumption, and heat release. The summer of 2017 saw significant wildfire activity across the western US and Canada, with communities experiencing severe pollution episodes, some lasting weeks, due to a combination of smoke from local and regional wildfires. Our study focuses on the fires that impacted western Montana in August-September, 2017. We combine air quality monitor data, meteorological observations, and remote sensing data from multiple platforms to assess the performance of wildland fire emission and plume rise models. Validation data for temporal fire activity is based on sub-hourly GOES-16 fire detections and daily infrared fire perimeters from fire management teams. Fire radiative power from MODIS and VIIRS satellite sensors and post-fire LANDSAT burn severity assessments provide constraints on biomass consumption and fire heat release. Simulated plume rise is evaluated against NEXRAD radar observations.

Keywords: emissions, plume rise, plume model

Presenter Bio: Shawn has been a Research Physical Scientist for the Rocky Mountain Research Station, Missoula Fire Sciences Laboratory, since April 2004. His research tasks are focused on understanding the influence of open biomass burning on the chemistry and composition of the atmosphere. Several aspects of biomass burning are investigated in his research program, including smoke characterization, emission inventories, smoke plume dynamics, and the transport and air quality impact of emissions. Ongoing studies include: evaluation and development of emission inventory systems, airborne and ground-based experiments for the validation of smoke dispersion models, and laboratory and field experiments characterizing emissions.

87. How Well Can We Estimate Fire Emissions Using Satellites? Assessing Five Bottom-up and Top-down Fire Products during the 2018 Camp Fires in California

Presenter: Daniel Tong, Associate Professor, George Mason University, Fairfax, qtong@gmu.edu

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Abstract: As drought becomes the new normal in many western states, wildfires have exerted increasing effects on air quality and human health and welfare in the United States, examplified by the 2018 Camp Fires in California. Fire emissions are essential to accurate prediction of fire/smoke dispersion and trasnsformation and subsequent impacts on air quality and human health. This study uses the HYSPLIT and CMAQ models and a suite of in-situ and remotely sensed observations to assess the accuracy of five fire emission products derived from satellites, the only type of products enabling timely emission updates to drive fire/smoke forecasts. These products include four top-down emission datasets (GBBEPx from NOAA, FLABME from Naval Research Lab, FEER from NASA, and GFAS from ECWMF) and one bottom-up emission dataset (BlueSky from US Forestry Service). Comparisons of fire emisisons show large variations of PM2.5 estimates by these datatsets, caused by both emission algorithms and fire detection capability of different satellite sensors. We conducted 84 model simulations to investigate the sensitivity of plume injections to different meteorology inputs (GDAS, NAM12, NARR, and WRF), planetary boundary layer (PBL) conditions, plume rise schemes (Briggs 1969, and Sofiev 2012). Results show that the simulated injection height is highly dependent on the PBL height and that the injection height calculated using the Sofiev 2012 scheme is higher than using the Briggs 1969 scheme. Finally, we showed the results of evaluations of the 84 simulations against the MISR and CALIPSO observed plume heights, as well as the ground PM2.5 concentration observation from the EPA Air Quality System network.

Keywords: emission, satellite, air quality modeling, injection height, ensemble modeling

Presenter Bio: Daniel Tong is an associate professor of atmospheric sciences at George Mason University, and the emission scientist of the US National Air Quality Forecast Capability (NAQFC) program. Daniel is a member of NOAA JPSS Proving Ground and Risk Reduction team, and the NASA Health and Air Quality Applied Science Team.

88. CALIOP-based Biomass Burning Smoke Plume Height

Presenter: Amber Soja, Executive/Manager Researcher, National Institute of Aerospace, NASA Langley Research Center(LaRC), Amber.J.Soja@nasa.gov

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Abstract: Carbon and aerosols are cycled between terrestrial and atmosphere environments during fire events, and these emissions have strong feedbacks to near-field weather, air quality and health, and longer-term climate systems. Fuels (e.g., mass, structure), fire severity and burned area are largely under the control of weather and climate, and fire emissions have the potential to alter numerous land and atmospheric processes that, in turn, feedback to and interact with climate systems (e.g., changes in patterns of precipitation, black/brown carbon deposition on ice/snow, species composition, alteration in landscape and atmospheric/cloud albedo). When modeled smoke plume detrainment heights are incorrect, then the simulated transport and deposition of those emissions will also be incorrect.

The heights to which smoke is injected and detrained governs short- or long-range transport, which influences surface pollution, cloud interaction (altered albedo), and modifies patterns of precipitation (cloud condensation nuclei). We are working with the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) team and stakeholders to generate a biomass burning (BB) plume height database using multiple platforms, sensors and models (CALIOP, MODIS, NOAA HMS, Langley Trajectory Model). These data have the potential to provide enhanced smoke plume injection height parameterization in regional, national and international climate and air quality models.

Statistics that link fire and weather to plume rise are crucial for verifying and enhancing plume rise parameterization in local-, regional- and global-scale air quality, chemical transport, and climate models. Specifically, we will present: (1) a methodology that links BB height and CALIOP air parcels to specific fires; (2) the daily evolution of smoke plumes for specific fires; (3) compare CALIOP-derived smoke plume injection to CMAQ modeled smoke plume injection; and (4) provide statistics from numerous fires burning in multiple ecosystems (e.g., Tripod, Santa Rosa, Rim, Sabine CAN, Charleston, Juniper, Columbia Complex, Pine Ridge, Millard, Black Pulaski, Mendocino, Carr, agricultural fires). These results have the potential to provide value to local, national, and international modeling communities and to public land, fire science, and air quality management and rules and regulatory communities.

Keywords: remote sensing, aerosols, climate, fire feedbacks, fire emissions

Presenter Bio: Amber Soja, Associate Research Fellow, National Institute of Aerospace Dr. Amber Soja is resident in the Climate Science, Chemistry and Dynamics Branches of Atmospheric Sciences at the NASA Langley Research Center (LaRC). She is currently an Associate Program Manager for the NASA Applied Sciences Wildland Fire program and a Disasters Coordinator for NASA LaRC. Her research focuses on using satellite, Geographic Information System, and modeled data as tools to explore the dynamic interactive relationships that exist between fire regimes, fire weather, air quality, the biosphere, atmosphere, and climate systems. She has 25 years of research experience that has primarily focused on the beautiful expansive wildlands of Siberia. Soja is proud to have worked to enhance the use of satellite data in stakeholder agencies, so our Nation benefits from the use of our applicable information. This includes working with the Environmental Protection Agency (EPA) to introduce satellite-based fire data to enhance the fire emissions portion of the National Emissions Inventory. She holds a B.A. (1996) and a Ph.D. (2004) in Environmental Sciences from the University of Virginia.

89. Quantifying the Impact of Intense Pyroconvection on Stratospheric Aerosol Loading

Presenter: David A. Peterson, Meteorologist, Naval Research Laboratory, Monterey, CA, david.peterson@nrlmry.navy.mil

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Abstract: Intense heating by wildfires can generate deep, smoke-infused thunderstorms, known as pyrocumulonimbus (pyroCb), which can release a large quantity of smoke into the upper troposphere and lower stratosphere. Recent work has shown that an extreme pyroCb event can significantly influence the lower-stratosphere in a manner similar to a moderate volcanic eruption. However, the seasonal impact of pyroCb activity on stratospheric aerosol loading remains almost completely unconstrained. This study quantifies the total aerosol particle mass injected into the lower stratosphere during active fire seasons in North America. The particle mass originating from a wide variety of individual pyroCb events is examined, as well as an accumulated fire season total. A systematic inventory of intense fire activity and ensuing pyroCb events is constructed to confirm the source of these plumes. PyroCb smoke plume properties are analyzed using the combination of lidar and ultraviolet aerosol index observations. This analysis also employs the first comprehensive in situ dataset from pyroCb outflow obtained during the 2019 FIREX-AQ field experiment. Results highlight the spatial and temporal variation in the pyroCb source, and its correlation with total wildfire activity. These results indicate that pyroCb activity, occurring as either large singular events or smaller events accumulated over a fire season, can significantly influence the composition of the lower-stratosphere. Integration with meteorological data suggests that stratospheric injection of smoke particles can be expected every fire season in favored regions of the Northern Hemisphere. This work sets a foundation for understanding the relative contribution of pyroCb activity to seasonal and inter-annual variation in stratospheric composition, and their corresponding effects on circulation and radiative forcing.

Keywords: PyroCb, stratosphere, FIREX-AQ, convection, smoke transport, extreme fire behavior

Presenter Bio: Dr. David Peterson is a meteorologist at the US Naval Research Laboratory in Monterey, CA. He has broad scientific interests in both meteorology and satellite remote sensing. Dave currently supports the US Navy's global aerosol modeling efforts, with a focus on extreme wildfires and smoke transport. He is a leading expert on thunderstorms caused by intense wildfires (pyrocumulonimbus), and the ensuing impact on stratospheric composition.

90. Improving Daily Surface Particulate Matter Estimates during Extreme Fire Events using a Novel NASA Satellite Plume Injection Height Algorithm

Presenter: Marcela Loria-Salazar, School of Meteorology, University of Oklahoma and Atmospheric Sciences Program, Department of Physics, University of Nevada Reno, mloria@ou.edu

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Abstract: Climate change has increased the frequency of droughts in recent decades and consequently, the occurrence and severity of wildfires have amplified, especially in the western U.S. Wildfires are important to maintain the ecological equilibrium of the landscape but smoke emissions represent a global public health problem impacting vulnerable populations and the economy. Near extreme fire events, satellite characterization of thermal anomalies is desired because it can capture the horizontal extent of the smoke plume. However, air quality (AQ) models based on satellite retrievals have been challenged during fire periods due to the limitations in detecting small fires, high-altitude injection smoke (e.g. smoke-produced pyrocumulus clouds), and the underestimation of aerosol loading due to very rigorous fire filters in the satellite algorithm. Satellite fire radiative power provide daily burning areas but the information is very localized and not designed to estimate the transport of the plumes to other areas away from the source. With these limitations in mind, this research presents an AQ fire ratio (AQFR) which can distinguish the vertical distribution of aerosols as the smoke plumes were transported downwind, and if the smoke was able to reach the surface or penetrate the free troposphere using a combination of numerical weather prediction model outputs and a novel plume injection height algorithm from NASA ASHE VIIRS during the fire seasons of 2013-2014 in the U.S. Preliminary results in the western U.S. using the MODIS version of the ASHE algorithm have shown that differences in meteorological conditions affecting the planetary boundary layer (PBL) physics during the day can impact the percentage of confinement of the fire plumes within the PBL. The use of this novel AQFR will aid in quantifying the health effects and can improve AQ forecasting models due to wildfire smoke.

91. Detecting Nighttime Fire Combustion Efficiency and Characterizing Plume Rise from Space

Presenter: Jun Wang, Professor, the University of Iowa, jun-wang-1@uiowa.edu

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Abstract: An accurate estimation of biomass burning emissions is partially limited by the lack of knowledge of fire burning phase (smoldering vs. flaming). In recent years, several fire detection products have been developed to provide information of fire radiative power (FRP), location, size, and temperature of fire pixels, but no information regarding fire burning phase is retrieved. Here we present a novel method to derive visible energy fraction (VEF) for night time fires at the satellite pixel level from space. VEF is defined as the visible light power (VLP) to FRP for each fire pixel retrieved from the VIIRS 750 m active fire product. A global distribution of VEF values, and thereby the fire combustion efficiency, is quantitatively obtained, showing smaller VEF values in regions with mostly smoldering wildfires, such as peatland fires in Indonesia, larger VEF values in regions with flaming wildfires over grasslands and savannas in the sub-Sahelian region, and the largest VEF values associated with gas flaring in the Middle East. We also present a case study showing how the air temperature, relative humidity, and wind speed affect the Camp fires. Finally, we will illustrate the potential of using multiple satellite sensors to characterize smoke plume rise.

Keywords: fire combustion efficiency, smoke plume rise, satellite remote sensing

Presenter Bio: Dr. Jun Wang is Professor in the University of Iowa (UI). His current research focuses on the integration of satellite remote sensing and chemistry transport model to study air quality, wildfires, and climate change. Jun Wang has authored or co-authored ~120 citable works in the peer-reviewed literature. He has been a science team member of several NASA missions. He and his present and former students have developed algorithms to retrieve sub-pixel fire radiative power, characterize fire combustion efficiency, and mitigate the fire emission uncertainties due to inherent limitations in satellite-based fire data. His research team also has interated satellite-based emission into regional weather and climate models to understand smoke transport as well as air quality and climate impacts. More about Prof. Wang's research can be found at: http://arroma.uiowa.edu.

92. How are We Addressing and Preparing for the Risks of Smoke?

Presenter: Peter Lahm, Air Resource Specialist, USDA Forest Service, pete.lahm@gmail.com

Abstract: Smoke from wildland fire at high levels pose a risk to fire fighters and the public alike. Whether through reduced visibility due to wildland fire smoke on roads or through public health effects of at-risk members of the public, there are a number of strategies to mitigate smoke impacts. Preparation for smoke impacts is absolutely critical for personnel and the public. The Forest Service has been working with many partners to develop tools and approaches which will allow greater planning for smoke and subsequent implementation of smoke impact mitigation strategies. Organizationally, land and fire managers will need to be aware of the risks posed by smoke, how they can be planned for and how they can be mitigated if utilization of fire is to play a key role in creating and maintaining forest resilience. From a wildland fire fighter exposure viewpoint, how is this community trained and prepared for the risks posed by smoke? As land management agencies strive to manage wildfires and utilize prescribed fire, understanding how to quantify risks of smoke for different communities is becoming more important for decisions and strategies. Identification of smoke risks and their magnitude, recent approaches such as Smoke-Ready Communities, can help in the mitigation of smoke impacts. These approaches allow for better risk management when wildland fire strategic and tactical decisions are being made.

Keywords: smoke, exposure, risk

Presenter Bio: Pete Lahm is the Air Resource Specialist for the USDA Forest Service, State and Private Forestry, Fire and Aviation Management, in Washington, DC. He leads the Wildland Fire Air Quality Response Program which provides personnel, technical specialists called Air Resource Advisors, smoke modeling and monitoring capabilities to develop forecasts for areas adversely affected by smoke. Starting in 2004, Pete has led the Forest Service's national smoke management efforts developing technical approaches and policies related to smoke impacts from prescribed fire and wildfires. Since 2006 he has chaired the National Wildfire Coordinating Group's Smoke Committee.

93. Smoke Management: The Risk Factor

Presenter: Ann Hobbs, Associate Planner, Placer County Air Pollution Control District, ahobbs@placer.ca.gov

Abstract: Each year, air district staff work with land managers on prescribed fire operations, essentially making "go / no go" burn decisions for air quality. There is always risk however, and measures are included, as part the approved smoke management plan, to ensure that the burns go according to plan with minimal smoke impacts.

Furthermore, making the burn approval decision, "the go", in the Lake Tahoe area, provides its own challenge. As this a large geographic basin surrounded by a huge cold-water lake, there are always concerns, especially with how much smoke could settle during the overnight hours. This is an overview, a story if you will, about the Placer County Air Pollution Control District staff's fall 2019 decision-making on an approved underburn, the ensuing smoke issues, the decision making considered, and above all the lessons learned.

Keywords: Smoke Management, Public Information Notification, Smoke Forecasts, Prescribed Burning, Air Districts

Presenter Bio: Ann Hobbs is an Associate Planner for the Placer County Air Pollution Control District, where she manages the Smoke Management Program for agricultural and prescribed burning. With a Bachelor of Science degree in the Conservation of Natural Resources from the University of California - Berkeley, Ann's education has provided a foundation to better understand burning initiatives along with the health impacts that can occur from smoke. Ann is also part of the planning team, which reviews environmental documents for air quality impacts. Ann also participates with the public information team regarding air quality issues.

94. Incorporating the newest satellite fire detection information into smoke modeling for public health research

Presenter: Sean Raffuse, Research Scientist, UC Davis Air Quality Research Center, sraffuse@ucdavis.edu

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Abstract: The recent launches of the GOES-16 and GOES-17 satellites have dramatically increased capabilities for detecting wildfires via remote sensing. In particular, the high time resolution allows for improved fire activity estimation that can be used in both operational smoke prediction and retrospective fire emissions inventory modeling. However, the new products require new methods to process and understand. We examine the new GOES fire products and their use in developing fire activity, emissions, and plume injection heights. The methods have been applied for large wildfires in Northern California in 2017 and 2018 for use in several wildfire smoke health studies.

Keywords: fire activity, modeling, remote sensing, health effects, California

Presenter Bio: Sean Raffuse is a researcher with the Air Quality Research Center at UC Davis. His work focuses on improving fire and smoke modeling for real-time forecasting and retrospective analysis, with a particular emphasis on the use of satellite remote sensing.

95. The US Forest Service Scientific Assessment for Wildland Fire Smoke

Presenter: Sarah McCaffrey, Research Forester, Rocky Mountain Research Station, sarah.m.mccaffrey@usda.gov

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Abstract: More and more people in the United States, as well as around the world, have been affected by wildfire smoke in recent years. This has led to growing interest in understanding smoke dynamics and social impacts in order to improve and better inform smoke management. The U.S. Forest Service is working with other agencies and organizations to develop a scientific assessment for wildland fire smoke. This document will review and evaluate the current science of wildland fire smoke, identify knowledge gaps, and assess tools and technologies for improving smoke science and management. As a first step, a two-day workshop was held in June 2019 in which panels of scientists and resource managers provided and discussed brief summaries of the existing scientific knowledge and research needs for specific topics. A book is in preparation with a focus on the state of science and management implications for six components of smoke science: fuels and consumption; fire behavior; plume dynamics, transport and emissions; smoke chemistry; and social impacts. This presentation will provide an overview of the assessment and key points identified for each of the six topic areas.

Keywords: Health Impacts, Emissions, Smoke Management, Smoke Modeling

Presenter Bio: Sarah McCaffrey is a Research Forester for the USDA Forest Service. Her research focuses on the social aspects of fire management. This work has included projects examining risk perception, social acceptability of fuels treatments, and social issues that occur during fires such as evacuation decision making and agency-community interaction during fires. More recent work involves examining barriers to increased use of fire as a management tool and assisting with the development and coordination of a scientific assessment for wildland fire smoke. She received her PhD in Wildland Resource Science in 2002 from the University of California at Berkeley.

96. Evaluating the Performance of Multi-Pollutant Sensor Pods in Biomass Combustion Smoke

Presenter: Matthew Landis, Senior Research Environmental Health Scientist, U.S. EPA Office of Research and Development, landis.matthew@epa.gov

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Abstract: Wildland fires can emit substantial amounts of air pollution that may pose a risk to those in close proximity (e.g., first responders, nearby residents) as well as downwind populations. Quickly deploying multi-pollutant air measurement capabilities in response to incidents to provide actionable information to incident management teams and public health officials has been limited to date by the cost, complexity of implementation, and measurement accuracy. Emerging technologies including miniaturized direct-reading sensors, compact microprocessors, and wireless data communications provide new opportunities to detect and quantify air pollution in real time. USEPA and USFS share the desire to advance wildland fire air measurement technology to be easier to deploy, suitable to use for high concentration events, durable to withstand difficult field conditions, with the ability to report accurate high-time resolution data continuously and wirelessly. Several commercially available sensor pods along with multiple sensor prototypes capable of measuring $PM_{2.5}$, CO, CO_2, NO_2, and O_3 during wildfire episodes were evaluated over a large dynamic range of smoke concentrations. Evaluations were conducted in the USFS Missoula Fire Sciences Laboratory combustion chamber and during response operations on the MP-97 (Oregon) and Williams Flats (Washington) wildfire events in 2019. Sensor performance characteristics including accuracy, precision, linearity, operability, and data telemetry will be presented and discussed.

Keywords: sensors; $PM_{2.5}$; CO, CO_2, O_3, NO_2

Presenter Bio: Dr.. Landis received his M.S. (1995) & Ph.D. (1998) in Environmental Health Science - Air Quality from the University of Michigan. He is currently a Senior Environmental Health Research Scientist with U.S. EPA Office of Research and Development (ORD) and a wildland fire research principal investigator in the ORD Center for Environmental Measurement and Modeling (CEMM). Dr. Landis has over 95 published papers and book chapters and his current research interests are wildland fire emissions, biogeochemical cycling of heavy metals, particulate matter characterization, atmospheric wet & dry deposition, and source apportionment modeling.

97. Using climate models to schedule future prescribed fires: A case study from Central Washington, USA

Presenter: Harry Podschwit, Phd. Candidate, University of Washington, hpodschwit@gmail.com

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Abstract: Although the application of prescribed fires can achieve multiple beneficial land management objectives, problems with air quality and smoke often impede its practice in the United States. Despite a number of measures that can reduce the impacts of prescribed fire to the air quality, land manager preferences can be hindered by potential smoke impacts. Unfavorable wind directions can blow smoke into sensitive areas, stifling the size and frequency of planned prescribed fire treatments. Near densely populated areas - where a slight deviation in acceptable burning conditions can result in large human impacts – the constraints to prescribed fire are likely worse. Given the increased potential of smoke impacts, it is prudent that proposed increases in prescribed fire activity develop plans for mitigating the increased risk. Climate models may be helpful tool to this end, as climate models may inform of the impacts and feasibility of future prescribed fire application. In this presentation, we will apply climate model output to a real-world problem of scheduling for increased prescribed fire in the Lake Chelan area of Washington state. Linear programming techniques will identify a feasible schedule of when and where to ignite prescribed fires to achieve treatment objectives in a manner that minimizes smoke impacts. These schedules will be based upon climate model output, as well as historical patterns of prescribed fire activity. The sensitivity of these solutions to structural uncertainties in the climate models are also explored. Robust patterns in the optimal scheduling solutions will be identified and the implications for planning of future prescribed fire in the Lake Chelan area will be discussed.

Keywords: optimization, prescribed fire, climate change

Presenter Bio: Harry Podschwit is a Phd. candidate in the Quantitative Ecology and Resource Management (QERM) program at the University of Washington. His research interests include using statistical and mathematical modeling to advance wildfire research and improve decision making. He is particularly interested in the role and proper communication of model uncertainties. He obtained his M.S. in the QERM program in 2017, and his B.S. in Applied and Computational Mathematical Sciences in 2013.

99. Impacts of sugarcane fires and sugar mills on PM2.5 air quality in South Florida

Presenter: Holly Nowell, Postdoctoral researcher, Florida State University, hak07@my.fsu.edu

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Abstract: Sugarcane fires are a highly visible source of airborne particulate matter in South Florida. Each year, from October to March, cane fields are burned before the harvest. Fire permits from the state of Florida show that 9,900 of these fires burn about 1.6 x 105 ha (395,000 acres) annually, which we estimate produces 4.9 x 106 kg of primary PM2.5. These fires are tightly clustered around the south shore of Lake Okeechobee, surrounding the cities of Belle Glade and Clewiston, and 10-40 km from the densely populated coastal cities of South Florida, which is home to over 6 million people. Residents in this area complain of frequent ash fall and smoke during the burning season and some have launched lawsuits to stop the burning. Two sugarcane processing plants in the same area emit up to 2.9 x 106 kg of primary PM2.5 per year also degrading the local air quality.
We quantify the impacts of these fires and processing plants on regional air quality and health using satellite and ground-based aerosol measurements, the HYSPLIT atmospheric dispersion model, and health data. In the southeast United States, PM2.5 concentrations are typically greatest in the summer months, and lower in the winter. Satellite data show that this pattern for PM2.5 holds true over Florida, except for the region where sugarcane fields are present; this area experiences the greatest PM2.5 concentrations during the winter, which coincides with the sugarcane harvest season. This pattern is also confirmed using ground-based Environmental Protection Agency (EPA) PM2.5 monitors.

We use Florida Forest Service (FFS) burn authorizations and regional fuel-specific crop and emission factors to simulate the PM2.5 concentrations that can be attributed to sugarcane fires and sugar mills using the HYSPLIT atmospheric dispersion model. For the sugarcane fires, we examine the sensitivity of simulated PM2.5 contributions to plume rise using several approaches: satellite-derived plume heights, surface release, Brigg's plume rise theory, and uniform distribution in the mixed layer. We evaluate the resulting model against EPA surface monitoring sites and satellite data and use the results to infer the impact of the smoke on regional mortality and public health.

Keywords: sugarcane; pm2.5; HYSPLIT; public health

Presenter Bio: Dr. Holly Kreutzer Nowell is a postdoctoral researcher at Florida State University. Her research focuses on wildland fires in the Southeastern United States with an emphasis on prescribed burns. Previous research titled A new picture of fire extent, variability, and drought interaction in prescribed fire landscapes: Insights from Florida government records has been published in Geophysical Research Letters. Current research includes smoke plume transport and emissions modeling of prescribed fires and health impacts of local residents. Dr. Nowell was also a participant in the FIREX-AQ mission.

100. PB-Piedmont a Decision Support Tool for Wildland Smoke on Roadways

Presenter: Gary Curcio, Fire Environment Forester, IPA Fire Environment Specialists, LLC, gary.curcio@gmail.com

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Abstract: PB-Piedmont is an underutilized but a highly accurate ground level (≤ 6 feet) dispersion model that identifies the geographic track of wildland smoke associated with prescribed fire and wildfire. It excels under stagnant to light wind conditions (<5 mph). In post analysis it has performed excellently in verifying Superfog Events and location of accident sites. PB-Piedmont needs to be used as a preplanning, preemptive decision support tool. It is an integral part of the Roadway Smoke Risk Assessment Process. It identifies where and when smoke will impact roadway visibility. The impact can be caused by smoke, fog, smoke induced fog, and/or Superfog. PB-Piedmont is available in a rare PC version or the readily accessible web-based version. This later version is provided and supported by Dessert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications (CEFA). PB-Piedmont has been used in many after action reviews concerning roadway smoke accidents. The most complex modeled incident was the HeHe Burn, October 13th, 2018, in central Oregon. The Superfog plume was modeled to travel 7 to 8 miles before it reached the accident site at 8:01 AM. This was the second time Superfog reached and crossed Hwy 26. The accident occurred at 8:11 AM. PB-Piedmont has recently been augmented with the incorporation of the Superfog Potential Index. This provides a more clear interpretation of the surface plume. Outputs are displayed in three colors (Yellow =smoke, Red = smoke and fog or smoke induced fog, and Blue = Superfog). This greatly aids user interpretation and more importantly the ability to mitigate reduced visibility impacts before they occur. With the advances made in predicting and averting wildland smoke reducing roadway visibility incidents, smoldering smoke is still viewed by other fire disciplines (weather, behavior, danger, emission, occurrence and training) as solely a smoke community issue when it is truly an interdisciplinary. PB-Piedmont provides an opportunity, a breakthrough, for other fire disciplines to recognize the need to cooperate and to coordinate on this interdisciplinary national dilemma.

Keywords: surface smoke, decision support tool, interdisciplinary national dilemma

Presenter Bio: Gary Curcio is IPA Fire Environment Specialist's lead forester. A practicing Air Resource Advisor-smoke specialist, his work emphasizes wildland smoke mentoring, modeling, and training. Having worked on several national committees, he remains active as a technical specialist for NWCG Smoke Committee and NC Prescribed Fire Council. Work projects involve the advancement of Fire Weather, Forest Fuels (organic soil & duff), Prescribe Fire, Smoke Management and Wildland Smoke Roadway Safety. New developing concepts include: Roadway Visibility Smoke Matrix, Roadway Smoke Risk Assessment Process, Projecting Roadway Visibility Distance when impacted by Smoke Surface Plume, and a new methodology for determining Mixing Height.

101. Recent Enhancements to Smoke Dispersion Models to Facilitate Meteorological/Fire Behavior/Air Quality Model Integration

Presenter: Bret Anderson, Physical Scientist, USDA Forest Service, Bret.A.Anderson@usda.gov

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Abstract: At ISS2, the US Forest Service (USFS) presented a concept of how to more fully integrate smoke model system components (meteorological, fire behavior, and air quality) currently used in the current operational smoke modeling framework utilized by the US Forest Service. In this presentation, we provide an update on work that the USFS has completed on the Lagrangian particle dispersion models which comprise the core of dispersion modeling technology for the USFS smoke modeling framework, which includes changes in source characterization which facilitate more seamless coupling with fire behavior models, and also dynamic plume rise, which does not specify particle injection heights a priori to the execution of the dispersion model (the current modeling paradigm), but rather is determined from the heat of the fire and the micrometeorology near the active area of the fire. In this manner, particle trajectory evolution is able to react to the local meteorological environment that is influenced by the topography and fire feedback, which should result in a more realistic smoke dispersion simulation.

Keywords: Plume rise, source characterization, fire behavior, Lagrangian Particle Dispersion Model

Presenter Bio: Bret Anderson is a meteorologist with the air resources management program of the USDA Forest Service (USFS) and coordinates the atmospheric modeling program for the USFS-National Forest Systems. He has over 25 years of experience in meteorological and air quality modeling, and participates in the USFS Air Resource Advisor program.

102. Emissions, Transport, and Chemistry of Smoke from Western U.S. Wildfires

Presenter: Megan Bela, Research Scientist, Cooperative Institute for Research in Environmental Sciences (CIRES) University of Colorado / NOAA ESRL Chemical Sciences Division, megan.bela@noaa.gov

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Abstract: Air quality forecasts using regional chemical models provide key information for affected communities and smoke management efforts, yet many models fail to accurately predict ozone (O3) and particulate matter levels during fire events. The satellite-based emissions and plume rise are large sources of model uncertainty. To improve emissions and plume rise parameterizations, we utilize aircraft and ground-based data from recent field campaigns, such as the 2018 NSF/CU Biomass Burning Fluxes of Trace Gases and Aerosols using SOF on the Wyoming King Air (BB-FLUX) and NSF/CSU Western wildfire Experiment for Cloud chemistry, Aerosol absorption and Nitrogen (WE-CAN) field campaigns, and the 2019 NOAA/NASA Fire Influence on Regional and Global Environments Experiment – Air Quality (FIREX-AQ) field campaign. Hourly fire emissions based on Geostationary Operational Environmental Satellite (GOES)-16/17 fire radiative power are implemented in WRF-Chem and compared with estimates based on field measurements and satellite data. Emission factors (EFs) are updated from estimates from FIREX Fire Lab and BB-FLUX/WE-CAN/FIREX-AQ field observations, and separate EFs are implemented for flaming and smoldering combustion. Uncertainties in emissions and plume injection heights in the model are quantified by comparison with aircraft- and satellite-based estimates. WRF-Chem simulations are also compared with satellite retrievals of trace gases and aerosols, and are used to quantify fire air quality impacts and examine formation/aging mechanisms for O3 and SOA.

Presenter Bio: Dr. Megan Bela earned a BS in Environmental Engineering and a MS in Environmental Fluid Mechanics and Hydrology from Stanford University. She then worked in Brazil as a Fulbright Scholar at the University of Sao Paulo, and as research scientist at the National Institute for Space Research. She completed her PhD in Atmospheric and Oceanic Sciences from the University of Colorado. In 2016, she joined NOAA ESRL GSD as an NRC Postdoctoral Fellow, and since 2017 has worked as a Research Scientist with the Cooperative Institute for Research in Environmental Sciences (CIRES) University of Colorado / NOAA ESRL CSD.

103. Impact of horizontal resolution on wild fire smoke plume rise

Presenter: Jeffery McQueen, Meteorologist, NOAA/NWS/NCEP, jeff.mcqueen@noaa.gov

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Abstract: ional Air Quality Forecasting Capability (NAQFC). NAQFC provides nationwide operational predictions of ozone and particulate matter. Predictions are produced twice per day (at 06 and 12 UTC cycles) at 12 km resolution and 1 hour time intervals through 48 hours and distributed at http://airquality.weather.gov. The NOAA National Centers for Environmental Prediction (NCEP) operational North American Multi-scale (NAM) 12 km weather prediction is used to drive the Community Multiscale Air Quality (CMAQ) model. Recently, NCEP with other NOAA labs and research communities has developed the Next Generation Global Prediction System (NGGPS) based on the Finite Volume Cubed Cubed-Sphere dynamic core (FV3) as its Unified Forecasting System (UFS). The latest implementation of NOAA's Global Forecast System (GFSv15) uses the FV3 dynamic core and is run at similar resolutions (13 km) to the NAM while mainly using the with relatively minor upgrades to the GFS physics suite. The transition to FV3 should allow for unification of regional and global atmospheric composition predictions models. This study will evaluate the use of NAM, GFSv15, and an experimental high resolution Stand Alone Regional (SAR) configuration with 3 km grid spacing to drive plume rise in the HYSPLIT transport and dispersion model. The evaluation will take place during the Summer 2019 FIRE-X field experiment.

The boundary layer mixing schemes used by NAM and GFS employ very different mechanisms (eg: local vs non-local vertical mixing) that could have important impacts on plume rise. This presentation will also evaluate the ability of the GFS and SAR for capturing boundary layer processes important during FIRE-X as compared to the operational NAM. The weather models will be evaluated with emphasis on the performance of meteorological fields important to plume rise prediction (eg: near surface winds, temperatures, moisture and boundary layer heights, cloud cover).

Keywords: Air Quality, Smoke, Plume rise, FV3, GFS, boundary layer, NWP, NCEP

Presenter Bio: Jeff McQueen has nearly 30 years of experience in numerical weather prediction modeling with emphasis on planetary boundary layer physics and air quality forecasting. Jeff has led the NCEP Operational air quality and dispersion modeling team for over 15 years and has been acknowledged for his work in transitioning the Nation's first operational air quality forecasting capability. Jeff also represents NOAA on several WMO committees related to emergency response dispersion modeling and co-chairs the OFCM Joint Action Group on Atmospheric Transport and Dispersion.J

104. Investigation of fire smoke plume injection height sensitivities during the 2017 Northern California wildfires

Presenter: Joseph Wilkins, Physical Scientist, US EPA/ORD, Wilkins.joseph@epa.gov

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Abstract: One of the critical goals of the NASA Health and Air Quality Applied Science Team (HAQAST) is to assess the effects of wildfire smoke on air quality and human health burden. Using the October 2017 Northern California wildfires as an example, we studied the sensitivity of plume injection heights using a combination of satellite data, air quality modeling, and health risk information. Smoke impact estimates were highly influenced by the various plume injection heights utilized. The recurrence of wildfires in California and other fire prone areas make it vitally important to develop a system that can accurately estimate the impacts of wildfire smoke. Particularly, a system that can not only estimate impacts in terms of production of fine particulate matter (PM2.5), but one that can also gauge short-term exposure-response relationships, will be useful to emergency response planning for the protection of public health. Here, we present a novel approach that uses area plume tops from two different algorithms and three outputs to infer model sensitivities to plume rise. We test algorithms in the modeling system to determine optimal results for the wildfire event in October 2017. In addition, we run sensitivity studies with the CMAQ model looking at various model inputs and configurations. Lastly, we compare CMAQ model results with satellite-derived aerosol and plume height retrievals.

Keywords: Plume rise, CMAQ, wildfire

Presenter Bio: Dr. Wilkins is a Physical Scientist at the US Environmental Protection Agency within the Office of Research and Development. Dr. Wilkins received his doctorate in Meteorology with a concentration in atmospheric chemistry, air quality, and pollution from Saint Louis University. His research focus has revolved around wildland (Prescribed and wild) fires and their impacts on human health and the environment. His work focuses on developing innovative techniques for data collection methods concerning pollution and wildfires emissions. Dr. Wilkins has participated in several field campaigns, published multiple peer reviewed journal articles, and has been an invited speaker at conferences and meetings.

105. Evaluation of smoke modeling tools used for estimating prescribed burning air quality impacts

Presenter: Megan Johnson, Graduate Research Assistant, North Carolina State University, mmjohns7@ncsu.edu

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Abstract: Prescribed burning is an important land management practice used across the U.S. by private and public landowners alike. While this technique is beneficial for fuel management and ecological purposes, smoke management is perceived as a significant barrier to its use. There are several modeling tools available for use by land managers to estimate smoke transport from a prescribed burn. These vary in scientific complexity, data requirements, and ease of use, which may impact smoke plume predictions and likelihood of adoption by users not familiar with air quality modeling. However, there are few systematic comparisons and analyses of these tools. Here, commonly used smoke modeling tools are evaluated for the purpose of estimating prescribed fire smoke impacts from the perspective of planning a burn. Using data from all prescribed burning activity in North Carolina State Parks in 2016, we model and compare smoke plumes from two of the most commonly used tools, VSmoke-Web and HYSPLIT, as well as from the state-of-the-science chemical transport model CMAQ. Model output is compared using spatial plume overlap, population smoke exposure, and predicted PM2.5 concentrations. The tools are further evaluated by considering ease of use for land managers when planning prescribed burns. This comparison of smoke transport from past operational burning activity provides insight into potential public impacts in areas that may frequently experience prescribed burning, highlights the feasibility of using these modeling tools to support prescribed burning decision-making, and accentuates research needs for improving these tools.

Presenter Bio: Megan M. Johnson is a PhD student in the department of Civil, Construction, and Environmental Engineering at North Carolina State University. She has previously worked at the South Carolina Bureau of Air Quality and the National Ecological Observatory Network. She earned an M.S. in atmospheric science from the University of Nevada, Reno, and a B.S. in environmental engineering from the University of Colorado Boulder.

106. Introducing the California Joint Prescribed Fire Monitoring Program

Presenter: Joe Restaino, Fuels and Fire Effects Specialist, CALFIRE, joe.restaino@fire.ca.gov

Abstract: The California Air Resources Board (CARB) and the California Department of Forestry and Fire Protection (CAL FIRE) recently established a Joint Prescribed Fire Monitoring Program to support California's goal to increase the pace and scale of prescribed fire use. The primary goal of this presentation is to provide an overview of the program objectives, and to outline California's approach to characterizing smoke from the expanded use of prescribed fire. Our program collects both air quality and fuel consumption data by monitoring prescribed fires in select locations across both the spectrum of ecosystems and land ownership within the state. Project monitoring consists of evaluating near-term (direct) effects, as well as long-term (indirect) effects of fire, and is designed to evaluate the effectiveness of an individual burn or a burn program beyond just the number of acres burned. The characterization of near-term and long-term effects will allow our program to use real data from prescribed fires to communicate to the public, landowners, and the California legislature the benefits of prescribed fire as a management tool, and how well we are meeting our fire management objectives. Coordinated fire effects and air quality monitoring will also help air and land managers to adapt management strategies and improve current best management practices for mitigating potential smoke impacts to public health from the expanded use of prescribed fire.

Keywords: Prescribed fire, air quality, fire effects, fuel consumption

Presenter Bio: Joe is a Senior Environmental Scientist at CALFIRE and leads their Prescribed Fire Monitoring Program. Previously, he was a Research Scientist at the University of Washington and helped manage a nationwide network of research projects across a range of topics within fire ecology; fuels characterization, carbon assessments, fuel treatment effectiveness, pile burning, combustion physics, restoration, and fire behavior model evaluation. He also has collaborated with the National Institute of Standards and Technology to reconstruct timelines of Wildland-Urban Interface fire behavior and chronicle the effectiveness of defensive actions. He received his MS degree from the University of Washington in Forest Resources and his Bachelor's Degree from UC Berkeley and has worked extensively with the University of California: Center for Forestry.

107. Modeled Effects of Fuel Reduction on Rim Fire Daily Smoke Emissions

Presenter: Leland Tarnay, Ecologist, USDA Forest Service/Pacific Southwest Region/Remote Sensing Lab, leland.tarnay@usda.gov

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Abstract: 2018 has been called the most destructive fire season in California history, with thousands of homes burned and many metropolitan areas formerly unaccustomed to "very unhealthy" to "hazardous" levels of wildfire smoke experiencing such levels for days on end, far from the wildland urban interface and the smoke sources. A significant characteristic of some recent megafires has been a rapid rate of spread and the subsequently large daily emissions produced by such fire behavior. But exactly how exceptional are the daily emissions numbers we are seeing today, both in the context of the last couple decades and in the context of historical emissions that California experienced? How much lighter were the fuels and what difference would the lighter fuels loads and lower tree densities have made in the daily loading to the atmosphere? This work leverages recent advances in spatial analysis frameworks that unify plot-to-landscape imputation of fuel loads, fire emissions estimation, and coupled atmosphere-wildland fire modeling to explore how the daily progression and emissions from the Rim Fire might have been different had fuels and forest structure in the area been maintained by an active fire regime. Specifically, we use the F3 fuels mapping framework to find biophysically analogous areas nearby that have experienced one or more fire returns in the last 30 years and create a "treated fuelbed" for the area burned by the Rim Fire. Using this "treated fuelbed" and the actual fuelbeds as model inputs, we examine modeled Rim Fire growth and behavior using the CAWFE coupled atmosphere-wildland fire model, and we explore the extent to which present-day fuel (vs. our estimated historical) loadings might have contributed to the fire-atmosphere coupling that produces such unprecedented large-scale fire behavior and daily pollutant emissions values witnessed in the Rim (and likely other Sierra megafires).

Keywords: Rim Fire, daily smoke emissions, fire modeling, fuels reduction, CAWFE model, F3, Landfire

Presenter Bio: Dr. Leland (Lee) Tarnay is an ecologist working for the USDA Forest Service Region 5 Remote Sensing Lab. Lee received his Bachelor of Science in Biology from the University of California, Davis (1995), and his Ph.D. from the University of Nevada, Reno (2001). He spent 10 years as Yosemite National Park's air resource specialist before joining the Forest Service in 2015. While he is generally interested in all interactions between land and the atmosphere, his current core expertise is in smoke monitoring, emissions estimation, dispersion modeling, and mapping of forest fuels and structure.

108. Historical requests and occurrence of weather conditions for prescribed fires in Chelan County, Washington State, USA

Presenter: Colton Miller, Graduate Student, University of Washington, cwm4@uw.edu

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Abstract: Air quality in Chelan County in north central Washington State has been negatively impacted by recent wildfires, with consequences impacting human health, aesthetics of scenic areas, and tourism to the area. In 2017 and 2018, PM2.5 concentrations exceeded National Ambient Air Quality Standards for extended periods of time due to nearby wildfires (PM2.5 24-hr rolling average exceeded 35 ug m-3 on 28 days in 2017 and 36 days in 2018). One method for managing the risk of large fires and their effect on air quality is to increase the use of prescribed fire during the offseason. To facilitate prescribed fire use, we analyzed past requests to the Washington State Department of Natural Resources for ignition authorization in the region as well as the occurrence of meteorological conditions necessary for conducting prescribed fires. We found an average of 53.66 (+ 4.74) days with prescribed fire requests of which 42.3 days (+ 4.68) had approvals, 5,400 (+ 717) total acres approved, and 43,194 (+ 5973) tons approved for consumption with decreasing inter-annual trends in all three variables. We performed a separate analysis of meteorological windows for prescribed fire in tree-dominated ecosystems and found that opportunities peaked in the spring and the fall, occurring approximately 40-60% of days during those months. The average weather conditions throughout the year and the cumulative distribution functions for meteorological variables indicated that increasing the threshold for temperature and lowering the threshold for RH may result in more opportunities for conducting prescribed fire. Additionally, we explored the effects of climate change on meteorological variables used to define potential burn windows.

Keywords: PM2.5, prescribed fire, meteorological burn windows

Presenter Bio: Colton Miller is a PhD student at the University of Washington. He works with the Pacific Wildland Fire Sciences Lab and the Remote Sensing and Geospatial Analysis Lab to understand the consequences of fire in forest ecosystems, both wildland and prescribed. Prior work includes research on smoke dispersion and occurrence of weather conditions for prescribed fire, the impacts of forest restoration on ecosystem carbon in western North America, and relating remotely sensed data to burn severity.

109. A New Reporting System for Wildfire and Prescribed Fire Air Monitoring

Presenter: Antonio Morales, California Air Resources Board, Antonio.Morales@arb.ca.gov

Additional Author(s):

Abstract:

Keywords:

Presenter Bio:

110. Apportioning Smoke Impacts of 2018 Wildfires on Eastern Sierra Nevada Sites

Presenter: Sean Mueller, Air Resource Specialist, USDA Forest Service, Northern Region Regional Office, sean.mueller@usda.gov

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Abstract: The summer of 2018 saw some of the most intense and longest lasting smoke impacts ever observed on the Eastern side of the Sierra Nevada. These impacts were undoubtedly due to several simultaneous, very large wildfires burning in heavy fuels in the Sierra Nevada to the north, south, and west of these sites, but not necessarily solely due to the closest of those wildfires (e.g., the Lions Fire), which for some periods of that summer was managed for multiple objectives, including resource benefits. Perimeter-based emissions estimates show that emissions for some of the farther-flung fires for many of the days in question were much higher (2-5x) than those of the Lions Fire, however emissions can be a poor indicator of the relative contribution of one fire versus another because dispersion often matters more than absolute emissions in determining impacts at a given site. Furthermore, the strength of the transport from a given fire often varies widely on a daily, even hourly basis, requiring a high temporal resolution estimate of both emissions and dispersion efficiency. Our approach leverages recently developed remote sensing techniques to create hourly resolution emissions estimates from satellite-derived (GOES-16) fire detections to explicitly model (via the BlueSky framework) dispersion from each of the fires that contributed to smoke measured at Eastern Sierra sites. By layering those modeled impacts and then comparing that to the actual measured smoke impacts, we develop a relative daily apportionment of the impacts from each contributing wildfire at several Eastern Sierra sites. These daily apportionments then give us a more objective basis for understanding the extent to which decisions to manage the Lions fire for resource benefit objectives could have affected eastside air quality at important sites in the Eastern Sierra Nevada that summer.

Presenter Bio: Sean Mueller is a Presidential Management Fellow Air Resource Specialist with the U.S. Department of Agriculture Forest Service at the Northern Region Regional office in Missoula, Montana. He completed a B.S. degree in Business Administration at Boston University, and a Master of Environmental Science and Management at the University of California Santa Barbara Bren School. Sean has a breadth of experience in air quality policy in both urban and rural settings, from the concrete jungle of Washington D.C., to the beaches of Santa Barbara, and currently the mountains of Montana.

111. Smoke impacts from Prescribed Burns in NSW Australia

Presenter: Owen Price, Associate Professor, University of Wollongong, Australia, oprice@uow.edu.au

Abstract: We conducted field work and fire severity mapping on 20 prescribed burns in eucalypt forests near Sydney, NSW to understand fuel consumption, smoke production and smoke dispersion. Fuel consumption consisted of pre and post-fire measurements of fine fuel. Particulate, CO and CO2 emissions were measured using low cost sensors near the perimeter of the fire. Particulate dispersion was measured using a combination of time-lapse photography, low cost monitors and the permanent air quality network. Fire severity was mapped using a random forest model of Sentinel 2 satellite imagery.

Fuel consumption varied greatly among the fires from 2 to 10 t/ha due mostly to wide variation in burn severity. In most cases, particulate pollution had only a local effect (up to ~2 km from the fire) and was quickly dissipated over the sea or unpopulated areas. However, three of the fires affected populations further afield, including one which caused an Air Pollution exceedance across much of Sydney, a city of 5 m people. This fire produced about 480 tonnes of PM2.5 which was enough to cause an air quality exceedance over an area of 9000 km2. A prediction system based on atmospheric dispersion modelling tended to predict the spatial patterns of particulates well, but substantially underestimated concentrations on some of the fires.

These preliminary results suggest there is some scope to reduce air pollution from prescribed fires by avoiding adverse weather, but the consequence will be fewer suitable burn days.

Keywords: Exposure, prescribed burning, particulates

Presenter Bio: Owen began his research career in 1988 in wildlife ecology in the UK and then tropical Australia, and in the mid-2000s gradually moved over to fire ecology and fire risk research. He has been at the Centre for Environmental Risk Management of Bushfire since 2007, where he has studied the effectiveness of risk mitigation (mostly prescribed burning). He is currently researching bushfire smoke exposure.

113. Suppression of Peat Fire by Rain

Presenter: Shaorun Lin, The Hong Kong Polytechnic University, 18042043r@connect.polyu.hk

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Huang Xinyan, Assistant Professor, The Hong Kong Polytechnic University, xy.huang@polyu.edu.hk

Abstract: Smoldering wildfire in peatlands contributes significantly to the global carbon emissions and regional haze events. Peat fire is one of the largest wildfires and most persistent combustion phenomena. Here we assess the impact of natural rain up to 400 mm·h-1 on suppressing the smoldering fire in the shallow peat layer through laboratory experiments. We show that the minimum rainfall intensity to suppress the peat fire is roughly 4 mm·h-1, so that the light rain cannot extinguish peat fire. The suppression duration (Δt) of peat fire decreases with the rainfall intensities (I) as $\lg(\Delta t)=-1.15\cdot\lg(I)+3.3$, that is much longer than that of flaming wildfire. However, the short suppression duration can also wet the fuel and decelerate the smoldering spread to some extent. We show that the required rainfall depth gradually decreases with the rainfall intensity and approaches a minimum value of 13 mm under violent rain. As the rainfall intensity increases, the carbon emission flux from peat fire also decreases. Therefore, we conclude a short-term violent rain is most effect to suppress the persistent peat fire. This research helps evaluate the influence of weather on the development of peat fire and can improve the prediction of carbon emissions from peat fire with the weather model.

Keywords: rainfall; rainfall intensity; suppression duration; smoldering wildfire; carbon emissions.

Presenter Bio: Shaorun Lin is currently a Ph.D student at the Hong Kong Polytechnic University. His research fields include fire safety engineering, building safety and resilience, wildland fire and fire ecology, smoldering fire and self-ignition, fire protection and so on. He will join UC Berkeley as visiting student research from Feb. 2020. Before, he performed research on the construction and building materials and construction waste management during his bachelor (2018) at Shenzhen University.

114. Can peat soil support a flaming wildfire?

Presenter: Shaorun Lin, PhD student, The Hong Kong Polytechnic University, flynn.lin@connect.polyu.hk

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Abstract: Smoldering wildfire in peatlands is one of the largest and longest fire phenomena on Earth, but whether peat can support a flaming fire like other surface fuels is still unclear. Our experiments demonstrate the piloted flaming ignition of peat soil with moisture up to 100 wt.% under external radiation, indicating that flame may rapidly spread on peatland before transitioning to the conventional smoldering peat fire. Compared to smoldering ignition, flaming ignition of peat is more difficult, requiring a higher minimum heat flux and triple ignition energy. The propensity for flaming increases with a drier peat and a larger external heating. We also found that the flaming ignition temperature increases from 290℃ to 690℃, as the peat moisture increases to 100 wt.%. The flame of peat is much weaker than that of pine needles and wood, and it eventually transitions to smoldering. The heat of flaming is estimated to be 13 MJ·kg-1, close to the heat of smoldering. The measured CO/CO2 ratio of flaming peat fires is less than 0.02, much smaller than 0.2 of smoldering peat fires. This research helps to understand the development of peat fire and the interaction between flaming and smoldering wildland fires.

Keywords: Peatland; Smoldering; Piloted ignition; Ignition energy; Moisture; Critical heat flux.

Presenter Bio: Shaorun Lin is currently a Ph.D student at the Hong Kong Polytechnic University. His research fields include fire safety engineering, building safety and resilience, wildland fire and fire ecology, smoldering fire and self-ignition, fire protection and so on. He will join UC Berkeley as a visiting student researcher from Feb. 2020. Before, he performed research on the construction and building materials and construction waste management during his bachelor (2018) at Shenzhen University.

115. Wildfire Smoke Readiness in Canada using the Air Quality Health Index (AQHI)

Presenter: Celine Audette, AQHI Program lead, ECCC-MSC, celine.audette2@canada.ca

Abstract: Using the Air Quality Health Index program, Canada has implemented a PM2.5 based AQHI to improve the alerting system and health messages for Canadians during Wildfire Smoke events. Wildfire smoke contains toxic air pollutants, including fine particles that can penetrate deep into our lungs and sometimes lead to serious health effects. Those at greater risk of these effects are young children, pregnant women, the elderly, people with respiratory and cardiovascular conditions and people involved in strenuous outdoor work or sports.

The Air Quality Health Index developed and in use since 2005, is based on a 3hr weighted average of three pollutants, NO_2, O_3 and $PM_{2.5}$. This formula reports an index number that informs the public of pollution levels and how to minimize their risk to health. During wildfire events, the 3 pollutant AQHI is unresponsive to changing conditions. Based on the respiratory research from the BC-Center for Disease Control and the BC Environment PM2.5 pilot program from May 2018 to October 2019, ECCC is implementing nationally an AQHI using PM2.5 for wildfire smoke events (will refer to this method as AQHI+). The revised formula is PM2.5 concentration in micrograms per meter cubed divided by 10, the ceiling value is used to calculate the new AQHI+ value. AQHI+ = (ceiling [PM2.5]/10) To increase its coverage of measurements, a small sensor project implementation is underway for the 2020 season to measure PM2.5 in remote, under serviced and Indigenous territories. Small sensors track the measurements of Federal Equivalent Method (FEM), however, it is a known issue that they overestimate the PM2.5 values by 50-60%. By collocating the sensors with stationary monitoring, ECCC will develop correction factors for the PM2.5. This network of sensors will offer real time observation of PM2.5 for remote communities to detect smoke. This work will also support prediction-related goals and regional service and prediction operations.

The new AQHI formula for wildfire smoke using PM2.5 and subsequent health messaging will better inform the public on how they can self-calibrate to protect their health and minimize their risk during these adverse events.

116. Evaluating the implementation of an emergency regulation to protect California's outdoor workers from wildfire smoke exposure

Presenter: Kathryn Conlon, Kathryn Conlon, University of California Davis, kcconlon@ucdavis.edu

Abstract: Following increasingly frequent and sizeable wildfire events, the California Occupational Safety Health Standards Board (Cal/OSHA) proposed an emergency regulation to protect outdoor workers' health from hazardous air quality related to wildfire smoke. The regulation, effective July 29, 2019, requires that designated workplaces identify when hazardous air is present, communicate the health hazards of wildfire smoke, and provide training and education on protective behaviors (i.e., use of N95 respirators) for outdoor workers to limit wildfire smoke exposure. The goal of this study is to systematically collect baseline data regarding farmworkers' and agricultural employers' knowledge, attitudes, and practices in response to the emergency regulation. Information collected through focus groups and surveys will be used to assess key factors influencing the implementation of the regulation. Such evidence is instrumental for building an evidence base of the effectiveness of wildfire smoke policy interventions intended to protect the health and well-being of agricultural workers. This presentation will detail the emergency regulation, the dynamic factors associated with farmworkers' well-being during wildfire smoke events, and preliminary results from farmworker focus groups and surveys.

Keywords: farmworkers, policy, intervention

Presenter Bio: Kathryn Conlon, PhD MPH, is an Assistant Professor of epidemiology at UC Davis. Her research focuses on building an evidence base of climate and health interventions, which are critical for effective climate change adaptation.

117. Case Controlled Comparison of Wildfire and Non-Wildfire Burn Injuries

Presenter: Tina Palmieri, MD, Professor, Department of Surgery, UC Davis, Shriners Hospital for Children Northern California, tlpalmieri@ucdavis.edu

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Abstract: Introduction: Climate change, the encroachment of populations into wilderness, and carelessness have combined to increase the incidence of wildfire injuries. With the increased incidence has come an increase in the number of burn injuries. Prolonged extrication, delays in resuscitation, and the extreme fire and toxic air environment in a wildfire has the potential to cause more severe burn injury. The purpose of this study is to examine the demographics and outcomes of wildfire injuries and compare those outcomes to non-wildfire injuries.

Methods: Charts of patients admitted to a regional burn center during a massive wildfire in 2018 were reviewed for demographic, treatment, and outcome. We then obtained age, gender, and burn size matched controls from within 2 years of the incident, analyzed the same measures, and compared treatment and outcomes between the two groups.

Results: A total of 20 patients, 10 wildfire (WF) burns and 10 non-wildfire (NWF) burns, were included in the study. Age (59.6±7.8 WF vs. 59.4±7.4 years), total body surface area burn (TBSA) (14.9±4.7 WF vs. 17.2±0.9 NWF) and inhalation injury incidence (2 WF and 2 NWF) were similar between groups. Days on mechanical ventilation (24.3±19.4 WF vs. 9.4±9.8 NWF), length of stay (49.9±21.8 WF vs. 28.2±11.7 days) and intensive care unit (ICU) length of stay (43.0±25.6 WF vs 24.4±11.2 NWF) were higher in the WF group. WF patients required twice the number of operations. Mortality was similar in both groups (1 death/group).

Conclusions: Wildfire burn injuries, when compared to age, inhalation injury, and burn size matched controls, require more ventilator support and have more operations. As a result they have longer length of stay and have a prolonged ICU course. Burn centers should be prepared for the increased resource utilization that accompanies wildfire injuries.

Keywords: Wildfire burn injury, outcomes, comparison

Presenter Bio: Dr. Tina Palmieri is Professor/Director of the UC Davis Firefighters Burn Institute Burn Center Assistant Chief of Burns at Shriners Hospital for Children Northern California. She is Past-President of the American Burn Association. As a founder of the Burn Multicenter Trials Group, she successfully conducted international burn multicenter prospective outcome trials. She is editor/author of national burn disaster austere care guidelines, developed national burn disaster triage tables, and led burn triage efforts for both the Tubbs and Camp Wildfires. She coauthored >150 peer reviewed articles. She is board certified in surgery and critical care and treats burned adults and children.

118. Investigating Protective Health Decision-Making in Response to Wildfire Smoke in California

Presenter: Francisca Santana, PhD Candidate, Stanford University, fsantana@stanford.edu

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Abstract: Wildfires are expected to be more frequent and intense in the future due to climate change. In addition to the direct impacts from wildfires, exposure to wildfire smoke poses severe health risks. The risks are especially acute for vulnerable groups such as children, the elderly, and individuals with chronic health issues. Despite these increasing risks, the pathways involved in individual response to wildfire smoke are not well-understood. What are the decision-making processes related to exposure to wildfire smoke? In what ways do individuals use information about wildfire smoke and air quality, as well as environmental and social cues to make decisions about how to protect their health? Are the differences in these individual processes influenced by social vulnerability, social support, or chronic exposure to poor air quality? This study seeks to address these motivating questions by using approaches and methods from decision science, social psychology, and sociology. Through over thirty in-depth interviews, we investigate the decisions and lived experiences of residents of East Palo Alto, Fresno, and Sacramento who were exposed to the Camp Fire smoke plume in November 2018. Through qualitative analyses of our interviews, we generate hypotheses that can 1) contribute to scholarly frameworks, such as the protective action decision model (PADM) and health belief model (HBM) that seek to explain human behavior and 2) help public health efforts improve communication of wildfire smoke exposure. Initial findings suggest that people worried about their exposure to smoke, constantly checking the air quality index (AQI) despite no change in smoke conditions. Moreover, some exhibited maladaptive behaviors in response to the threat of smoke such as wearing a mask even if suffering from asthma or putting a scarf over their face for protection. Some did so because of lack of clarity around effective smoke mitigation actions, whereas others did so to feel engaged in protecting their health, even if those actions made little impact. Additionally, the findings of this interview-based study will be used to inform the development of an app-based survey and individualized air quality monitoring study. This future work can provide additional, and more generalizable, insights into the pathways and processes of protective health decisions in wildfire smoke conditions.

Keywords: protective health behaviors, decision-making and response, wildfire smoke communication

Presenter Bio: Francisca Santana is a PhD Candidate in environment and resources at Stanford University. Using theories and methods from the behavioral sciences and sociology, she studies how individuals and groups respond to environmental change and climate risk. Before her work at Stanford, Francisca worked in climate advocacy in the nonprofit and government sectors. She received a master's degree in environmental science and management from UC Santa Barbara and a BA in history from Yale University.

119. Smoke Exposure of an Operational Prescribed Burning Program

Presenter: Sadia Afrin, Graduate Student, Department of Civil, Construction, & Environmental Engineering, NC State University, safrin@ncsu.edu

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Abstract: Prescribed fire smoke is an important contributor to fine particulate matter (PM2.5) pollution in the Southeastern U.S. Evaluating prescribed burning smoke exposure is, therefore, an important research need to minimize air pollution and associated health costs in the region. A limited number of studies have attempted to assess the impacts of prescribed fire on ambient PM2.5, likely due to the challenges associated with compiling burn data. In this study, we use chemical transport modeling to explore the air quality and potential public health impacts of an operational prescribed burning program in North Carolina. The NC Division of Parks and Recreation (NC State Parks) maintains an active and growing prescribed burning program with detailed information for all fires that have occurred within State Parks land over multiple years. Using the Community Multiscale Air Quality Modeling System (CMAQ), we analyze NC State Park fires that occurred during a full year and estimate the associated individual and population smoke exposure over the state of North Carolina. In 2016, the Division's land management program conducted 57 prescribed burns, treating over 4,700 acres of NC State Parks land. In addition, two major wildfires occurred within the NC Parks in 2016, rendering this year a unique opportunity to serve as a case study. We compare public smoke exposure from these two wildfires to that of the prescribed fires within the 2016 burning program. Emissions for all fires are estimated using the BlueSky modeling framework based on NC State Parks' fire records. Additionally, we analyze the potential health hazard associated with these air pollution impacts. The comparison between the air quality impacts of prescribed fires and wildfires can be valuable in understanding the trade-offs between prescribed fire and wildfire risk. In addition, the findings of the analysis can serve as an initial step in developing more complete cost-benefit analyses of operational land management programs.

Keywords: Prescribed fire, PM2.5, Smoke exposure, CMAQ

Presenter Bio: Sadia Afrin is a 4th year Ph.D. student in the Department of Civil, Construction, and Environmental Engineering at NC State University, US. Her research focus is on air quality modeling and atmospheric chemistry. She has experience in data analysis and statistical modeling approach to assess the impact of wildland fires (both wildfires and prescribed fires) on air quality, climate and public health of Southeastern US. Currently, she is using a chemical transport model named Community Multiscale Air Quality Modeling System (CMAQ) to investigate the tradeoff between wildfire and prescribed smoke exposure.

121. Nitrogen in wildfire smoke: how much is there and what happens to it?

Presenter: Jakob Lindaas, Graduate Research Assistant, Colorado State University, jlindaas@rams.colostate.edu

Abstract: The abundance, form, and fate of reactive nitrogen in wildfire smoke has important implications for human health and climate. Reactive nitrogen participates in oxidation chemistry within smoke plumes, influencing the formation and destruction of ozone, the oxidation of organic gases and aerosol, and the formation of inorganic aerosol, as well as the optical and radiative properties of smoke. We report on in situ gas phase and aerosol measurements of reactive nitrogen species made on board the NSF/NCAR C-130 aircraft during the Western wildfire Experiment for Cloud Chemistry, Absorbing Aerosol, and Nitrogen (WE-CAN) field campaign in July and August 2018. First, we investigate the variability and distribution of reactive nitrogen emissions and their form (phase/species/oxidation) across 16 large western U.S. wildfires. Next, we focus on measurements of different aged smoke plumes in order to investigate the contribution of gas phase ammonia and nitric acid to the formation potential of inorganic ammonium nitrate in different parts of the western U.S. atmosphere.

Keywords: reactive nitrogen, nitrogen oxides, ozone, ammonia, inorganic aerosol

Presenter Bio: Jakob is a PhD student at Colorado State where he has participated in two smoke field campaigns: WE-CAN and FIREX-AQ, making measurements of ammonia and glyoxal respectively. Predictably, he enjoys running, skiing, and eating ice cream in his free time.

122. Smoke Particle Size Distributions and Their Downwind Evolution Observed During FIREX-AQ

Presenter: Richard Moore, Research Scientist, NASA Langley Research Center, richard.h.moore@nasa.gov

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Abstract: Biomass burning is a significant source of atmospheric particle emissions that have adverse impacts on both local air quality as well as regional-to-global climate. While it is essential that we better understand the magnitude of these emissions, it is also important to capture the evolution of these particles in the near-field environment that is some hours removed from the fire. An ideal method for capturing this temporal evolution is via in situ sampling of the smoke plume from aircraft. Here, we present airborne observations of smoke particle properties and size distributions as measured by the NASA Langley Aerosol Research Group (LARGE) during 2019 FIREX-AQ. Emissions from both large wildfires in the western United States and smaller agricultural fires in the southeastern United States are examined. Repeated transects of the wildfire plumes at multiple downwind distances allow us to chart the evolution of the total and non-volatile particle number concentrations and size distributions as a function of plume age and after CO2-correction for plume dilution, while the agricultural fire plume transects were generally too short to assess aging impacts. It is found that both the total and non-volatile size distribution mode diameters shift toward larger sizes as the aircraft sampled farther downwind from the wildfires. The implications of this work for the improvement of the representation of wildfire particle size distributions in models will be discussed.

Keywords: FIREX-AQ, Particle, Size Distribution, Aircraft, In Situ Measurements, Plume Evolution

Presenter Bio: Dr. Richard Moore leads the NASA Langley Aerosol Research Group (LARGE) team for the NASA FIREX-AQ field campaign. He has been making measurements of atmospheric particles from aircraft for over a decade with research interests including the atmospheric evolution of aerosol optical and hygroscopic properties and aerosol-cloud-climate interactions. His research has been recognized with multiple awards including a Presidental Early Career Award for Scientists and Engineers (PECASE), a NASA New Investigator Award, and a NASA Early Career Achievement Medal.

123. Field data? FIELD DATA! – Learning more about smoke from small fires during the NOAA/NASA FIREX-AQ campaign

Presenter: Jessica McCarty, Assistant Professor & Graduate Advisor, Miami University, mccartjl@MiamiOH.edu

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Abstract: Crop residue and rangeland burning is a common practice in the United States but verified ground-based estimates for the frequency of these fires is sparse. In this Ignite talk, we present a comparison between known fire locations collected during the summer 2019 NOAA/NASA FIREX-AQ field campaign with several satellite-based active fire detections to estimate the occurrence of small-scale fires in agroecosystems. Field data was collected in the southern Great Plains and Mississippi Delta of the United States in late August 2019, with a focus on collecting data to quantify fuel types, fuel conditions, burned area, and to relay important mission information on where and approximate height of smoke plumes. All in situ fire locations were combined with 375 m Visible Infrared Imaging Spectrometer (VIIRS), 1 km Moderate Resolution Imaging Spectroradiometer (MODIS), and 2 km Geostationary Operational Environmental Satellite (GOES) active fires to determine which active fire product most closely aligned with location and timing of small fires. Fuel types gathered in the field were compared with the 30 m U.S. Department of Agriculture Cropland Data Layer (CDL) for year 2019. Approximately 41% of the small fires documented during the FIREX-AQ field campaign were not detected by GOES, VIIRS, and MODIS active fires. If GOES detections were excluded, only 5% of the field-verified fires were detected. This suggests that a large amount of cropland and rangeland burning – and associated smoke - are not detected by current active fire products from polar orbiting satellites like MODIS and VIIRS, with implications for regional air pollution monitoring, emissions inventories, and climate impacts of open burning. Subsequent field campaigns to study atmospheric chemistry of smoke will need field-based and community-level input to provide accurate locations of smoke plumes from small fires.

124. Environmental Controls on the Physical and Optical Properties of Biomass Burning Aerosols Measured during FIREX-AQ

Presenter: Elizabeth Wiggins, Postdoctoral Research Fellow, NASA Langley, elizabeth.b.wiggins@nasa.gov

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Abstract: Biomass burning is a significant source of atmospheric aerosols that degrade air quality and exert a substantial radiative forcing on the climate system. Biomass burning derived aerosols have highly variable physical and optical characteristics that create large uncertainties in their representation in models and their influence on human health and the climate system. During the summer of 2019 we collected in-situ measurements of the physical and optical properties of biomass burning aerosols emitted from wildfires in the Western US and agricultural fires in the Southeastern US as part of the joint NASA-NOAA mission FIREX-AQ. We measured aerosol number, size, and volume distributions for bulk aerosols and non-volatile aerosols along with their absorbing and scattering properties at three optically relevant wavelengths. Our airborne measurement platform allowed for high time resolution measurements of both fresh emissions and aerosols that have undergone varying degrees of atmospheric aging in isolated smoke plumes. The fires we sampled represent a rich variety of fuel types and compositions, environmental conditions at the time of burning, and fire characteristics such as combustion completeness. We compared our aerosol measurements to ground-based fire characteristics to better understand the factors that influence the physical and optical properties of biomass burning aerosols. The results of this study will reduce variability in size resolved particle emission factors by isolating the influence of select fire characteristics and ultimately improve the representation of biomass burning aerosols and their radiative influence in atmospheric models including smoke forecasting and climate models.

Keywords: wildfire, agricultural fire, aerosol, emissions

Presenter Bio: Liz Wiggins is a Postdoctoral Research Fellow at NASA Langley. She completed her PhD at the University of California Irvine with Dr. Jim Randerson. Liz is on the science team for FIREX-AQ and spent this past summer flying on the DC-8 to measure the properties of smoke emitted by fires in the US.

125. In-Situ Trace Gas Ratios Measured During the 2019 FIREX-AQ Airborne Field Campaign

Presenter: Hannah Halliday, Physical Scientist, US EPA, Halliday.Hannah@epa.gov

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Abstract: FIREX-AQ was a joint NASA-NOAA airborne field campaign to measure and characterize smoke plumes over the continental United States from July to September of 2019. High time resolution data was collected from the NASA DC-8 airborne platform, and the mission targeted both wildland and agricultural fires. In-situ trace gas ratios are used to characterize smoke plume characteristics, including the modified combustion efficiency (MCE) and enhancement ratios which can be used in the calculation of emission factors. In addition to using generalized ratios over a full plume, trace gas ratios can be calculated with a rolling window. These short-term rolling correlations between trace gas species provide additional information for trace gas analysis and have been used to characterize chemical signatures between transport regimes in polluted regions. This work characterizes how these rolling calculations of trace gas ratios can be applied to smoke plume data, using both 1 hz and 5 hz data. Considerations such as window width, the impact of correlation cutoff, and quality control of the resulting ratios are discussed. Finally, we show how these short-term correlations provide additional information to trace gas ratios calculated with the more typical plume-identification techniques.

Keywords: FIREX-AQ, fire emissions, trace gas, airborne measurements, enhancement ratios

Presenter Bio: Hannah Halliday is a Physical Scientist and Federal Postdoc at the US EPA working on wildland fires and air quality. She received her PhD in Meteorology from the Pennsylvania State University in 2016. Prior to joining the EPA she was a NASA Postdoctoral Fellow at the Langley Research Center in Airborne Science, working on in-situ trace gas measurements.

126. Combining global observations and models to monitor wildfires, smoke and their impact on air quality

Presenter: Mark Parrington, Senior Scientist, European Centre for Medium-Range Weather Forecasts (ECMWF), mark.parrington@ecmwf.int

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Abstract: Given the significance of wildfires as a source of pollution in the Earth system, there is a clear requirement for operational monitoring and forecasting of smoke emissions, their impact on chemistry in the atmosphere and surface air quality. The Copernicus Atmosphere Monitoring Service (CAMS), implemented by ECMWF on behalf of the European Commission, provides a unique perspective on the transport and impact of atmospheric pollution associated with wildfire emissions, using near-real-time satellite observations of wildfire locations and emissions of aerosols and trace gases. Five-day forecasts of global air quality, operationally produced twice a day at 0 UTC and 12 UTC at a spatial resolution of approximately 40 km, are initialized from analyses which assimilate the latest satellite observations in a state-of-the-art global model. Regional air quality forecasts for Europe in CAMS utilize a suite of regional models which take lateral boundary conditions from the global system. In addition to this, CAMS produces global reanalyses, providing consistent multi-year (2003 to present) datasets of global atmospheric composition and air quality. This presentation will use examples of acute wildfire cases in recent years (including Indonesia, Portugal and California) to highlight how CAMS products work in real situations for monitoring and evaluating global wildfire emissions in relation to atmospheric composition and air quality.

All Copernicus and CAMS data are free and open access and the products also include global fire emissions based on active fire data and newly developed inventories of anthropogenic and biogenic emissions.

Keywords: Wildfire Emissions, Smoke, Air Quality, Earth Observation

Presenter Bio: Mark is a scientist with more than 10 years experience investigating the role of wildfire emissions in atmospheric composition and air quality using satellite remote sensing and in situ observations. Currently he is a senior scientist working in the Copernicus Atmosphere Monitoring Service on global fire emissions, air quality, and science communication.

128. Accounting for prior wildfires decreases area burned and emissions under projected climate in the Sierra Nevada

Presenter: Matthew Hurteau, Associate Professor, University of New Mexico, mhurteau@unm.edu

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Abstract: Regionally, there is a strong relationship between area burned and temperature and precipitation. Empirical data demonstrate that in the western US, area burned has increased substantially and this correlates with increased temperature, earlier snowmelt, and increased fuel aridity. Projections of future area burned built on these relationships show a substantial increase under projected climate in the Sierra Nevada Mountains. However, the relationship between climate and area burned neglects the influence of vegetation. We sought to account for the vegetation feedback in area burned under projected climate by simulating vegetation dynamics under projected climate and accounting for the influence of prior fire events on subsequent area burned. We ran simulations under projected climate from three global climate models across three transects (southern, central, northern) in the Sierra Nevada. At each decadal time-step we used the simulated area burned during the prior decade to estimate a distribution of area burned for the subsequent decade using generalized Pareto distributions of log-area burned (dynamic). We also ran simulations with area burned distributions driven only by projected climate (static). We estimated emissions from the two scenarios using the FINN model algorithm.

We found that the largest decrease in cumulative area burned under the dynamic scenario occurred in the southern transect (-21.8%), followed by the northern (-14.5%) and central (-9.8%) transects. At the scale of the mountain range, the area-weighted mean cumulative area burned decreased by 2563 km^2 when we accounted for the effects of wildfires in the previous decade on vegetation. This equated to a 14.3% reduction in area burned when accounting for the vegetation-fire feedback. As a result of reduced area burned, cumulative carbon dioxide emissions decreased by 38.3 Tg and particulate matter (PM_1) decreased by 0.6 Tg. Our results demonstrate the importance of accounting for the influence of prior fire events on the vegetation community and how that factor feeds back to limit area burned. While the vegetation-fire feedback does constrain projected area burned, the proportion of the Sierra Nevada projected to be impacted by wildfire and the resultant emissions will pose air quality challenges for California.

Keywords: climate change, wildfire, vegetation, emissions

Presenter Bio: Matthew Hurteau is an Associate Professor of Quantitative Ecology at the University of New Mexico. He has a BS in Forestry from Northern Arizona University and a PhD in Ecology from the University of California, Davis. His research focus is on climate change mitigation and adaptation in forest systems.

129. Future fire and smoke trends in the western United States under changing climate

Presenter: Yongqiang Liu, Research Meteorologist, US Forest Service, yongqiang.liu@usda.gov

Additional Author(s):
Fengjun Zhao, Yang Liu, Joshua Fu, Cheng-en Yang, Xinyi Dong

Abstract: Wildfires, especially megafires, have increased dramatically in the western United States in recent decades. Fires and smoke are getting more and more to urban areas, leading to severe air quality and human health impacts. This study projects the future trends in wildfire and smoke in this region under changing climate. Future fires were projected using a fire model developed based on the extreme value theory. The dependent variable is occurrence of fires at a certain size range. The independent variables are the Keetch-Byram Drought Index at various anomalous levels and the corresponding moisture anomalies. Fuel loading was determined based of simulations of a dynamical global vegetation model. Fire emissions were calculated using the Fire Emissions Production Simulator (FEPS). Smoke processes, including transport, dispersion, and chemical reactions, were simulated using the Community Multiscale Air Quality (CMAQ) model. The future climate change scenarios were obtained from WRF downscaling of the NCAR Community Earth System Model (CESM) climate change projection. Wildfires are expected to increase from the beginning to middle of this century. The increasing rates depend on fire size, less than 10% for small fires but over 80% for megafires. The emissions and atmospheric concentrations of PM2.5 are likely to increase accordingly in both the fire sites and many urban areas. As a result, increasing air pollution and public health threats of smoke are expected in the western United States.

Presenter Bio: Dr. Yongqiang Liu is a Research Meteorologist from USDA Forest Service, Center for Forest Disturbance Science, Athens, GA, USA. His research is focused on climate-forest ecosystem interactions to understand forest disturbances (wildfire, land cover change, and forest water stress), the interactions with climate, and the environmental consequences. The combined approach of field measurement, data analysis, and numerical modeling is used to investigate the processes, mechanisms, and impacts of the disturbances and to develop evaluation and prediction techniques. The findings are expected to help strategy development and implementation to reduce forest vulnerability to forest disturbances and their adverse environmental impacts. He has published over 100 journal papers.

130. Informing the use of N95 respirators by the general public during wildfires

Presenter: Kaitlyn Kelly, MPH Candidate, University of Washington, kkelly2@uw.edu

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Abstract: Climate change is increasing the frequency, intensity, and duration of wildfires. To reduce personal exposure to wildfire smoke and resulting adverse health effects, N95 respirators have been used by the general public to filter out particulate matter present in smoke. However, the mandatory use of N95 masks in an occupational setting requires medical clearance, proper training, and fit testing. This practice is not currently being followed by the lay public. The goal of this project is to quantify the transference of knowledge from different training communication mediums into N95 respirator fit in a convenience sample of individuals not formally trained. This study will help evaluate the appropriateness of N95 masks, and publicly available training materials, as a public health intervention for reducing personal wildfire smoke exposure. A pre/post-test, quasi-experimental study will assess how three communication mediums currently available to the lay public for N95 respirator use translate into proper fit. An OSHA regulated respiratory fit test will be done prior to and after each participant receives their randomly assigned communication medium to determine their individual fit factor. Statistical methods will be used to assess the effect size of the knowledge transfer of each communication medium. A third respiratory fit test will be done to see the effect of correct respirator size, in addition to training, on proper fit. A Knowledge, Attitude and Practices (KAP) survey will be administered, as well as an analysis of the observed behavior of participants, to identify challenges and gaps in knowledge and actions for proper use of N95 respirators. We predict that these results will inform recommendations for training materials for the lay public surrounding N95 respirator use.

Presenter Bio: Kaitlyn Kelly is a graduate student at the University of Washington, where is she currently working on her MPH in Environmental and Occupational Health Sciences. Her research interests are in wildfire smoke and public health interventions. She has her BS in Environmental Health from Baylor University. Kaitlyn is also the new ambient air quality policy specialist at the WA State Department of Health.

131. Increasing Wildfire Smoke Readiness in the Washington State Public Health System

Presenter: Kaitlyn Kelly, Ambient Air Quality Policy Specialist, Washington State Department of Health, kaitlyn.kelly@doh.wa.gov

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Abstract:
Background: Wildfire smoke events have been growing in Washington with smoke covering the state during the last two summers, and the frequency of wildfires is expected to continue to increase.

Problem: Wildfire smoke adversely impacts health with minor to severe symptoms. Health officers and local health jurisdictions rely on direct health guidance to protect public health. Increases in wildfire smoke have led to a greater need for statewide preparedness, communication resources, and consistency in public health actions and health messages.

Methods: At the request of leadership from local health jurisdictions, the Wildfire Smoke Impacts Advisory Group was convened by the Washington Department of Health to address key topics to assist local, state and tribal jurisdictions and decision makers to protect public health. In 2019, the advisory formed 3 workgroups to develop: 1) a custom toolkit for local outreach and communication, 2) guidance for school and outdoor event closures, and 3) guidance for low-cost sensors to use for health decisions. These activities are targeted at improving public outreach and communication and providing evidence-based guidance.

Results: A custom toolkit to serve as a plan for public health outreach and communication, including ready-to-use templates that can be customized by local agencies, was developed and is available for use. Development of guidance for school closures and outdoor event cancellations during wildfire smoke episodes is complete, and a pilot study that uses air sensors to inform health decisions about indoor air quality is underway.
Implications:

Communication resources with consistent and audience-specific messages related to pre- and during wildfire season are now available and customizable for agencies; and recommendations for school closure and outdoor event cancellation will support local decision makers. These resources and recommendations will improve readiness and response to wildfire smoke events across the Washington State public health system.

Keywords: smoke readiness, smoke response, communicating impacts

Presenter Bio: Kaitlyn Kelly is the ambient air quality policy specialist at the WA State Department of Health. At WA DOH, Kaitlyn investigates the health impacts of wildfire smoke and provides policy recommendations. Kaitlyn is a member of the Wildfire Smoke impacts Advisory Committee to develop guidance for statewide wildfire smoke response. Kaitlyn has a BS in Environmental Health from Baylor University and is currently working on her MPH at University of Washington, where her focus is on risk communication and public health interventions for wildfire smoke.

132. Health Impact Analysis of Wildfire Smoke in Canada

Presenter: Carlyn Matz, Senior Evaluator, Health Canada, carlyn.matz@canada.ca

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Abstract: Smoke from wildfires contains many air pollutants of concern including particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOX), methane (CH4), polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs), and contributes to formation of ozone (O3) and secondary PM. Epidemiological studies have identified associations between exposure to wildfire smoke PM2.5 and mortality and respiratory morbidity, and a possible association with cardiovascular morbidity. For this study, air quality modelling was performed using a retrospective analysis of Environment and Climate Change Canada's FireWork PM2.5 forecasts, to quantify the exposure to wildfire-PM2.5 across the Canadian population. The model included wildfire emissions from across North America for a 5-month period from May to September (i.e. wildfire season), between 2013 and 2018. Large variations in wildfire-PM2.5 were noted year-to-year, geospatially, and within fire season. The model results were then used to estimate the national population health impacts attributable to wildfire-PM2.5 using Health Canada's Air Quality Benefits Assessment Tool (AQBAT). The analysis estimated annual premature mortalities ranging from 54-240 premature mortalities attributable to short-term exposure and 570-2500 premature mortalities attributable to long-term exposure, as well as many non-fatal cardiorespiratory health outcomes. Combined these health impacts have an estimated value of $4.6B to $20B per year. The health impacts were greatest in the provinces with populations in close proximity to wildfire activity, though health impacts were also noted across many provinces indicating the long-range transport of wildfire-PM2.5. Understanding the population health impacts of wildfire smoke is important as climate change is anticipated to increase wildfire activity in Canada and abroad.

Keywords: health impact analysis, wildfire smoke, Canada

Presenter Bio: Carlyn Matz, PhD, is a Senior Evaluator in the Air Program of Health Canada. She has experience conducting risk assessments of vehicle exhausts and traffic-related air pollution. She also has experience evaluating health impacts attributable to changes in air quality.

132. Health Impact Analysis of Wildfire Smoke in Canada

Presenter: Carlyn Matz, Senior Evaluator, Health Canada, carlyn.matz@canada.ca

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Abstract: Smoke from wildfires contains many air pollutants of concern including particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOX), methane (CH4), polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs), and contributes to formation of ozone (O3) and secondary PM. Epidemiological studies have identified associations between exposure to wildfire smoke PM2.5 and mortality and respiratory morbidity, and a possible association with cardiovascular morbidity. For this study, air quality modelling was performed using a retrospective analysis of Environment and Climate Change Canada's FireWork PM2.5 forecasts, to quantify the exposure to wildfire-PM2.5 across the Canadian population. The model included wildfire emissions from across North America for a 5-month period from May to September (i.e. wildfire season), between 2013 and 2018. Large variations in wildfire-PM2.5 were noted year-to-year, geospatially, and within fire season. The model results were then used to estimate the national population health impacts attributable to wildfire-PM2.5 using Health Canada's Air Quality Benefits Assessment Tool (AQBAT). The analysis estimated annual premature mortalities ranging from 54-240 premature mortalities attributable to short-term exposure and 570-2500 premature mortalities attributable to long-term exposure, as well as many non-fatal cardiorespiratory health outcomes. Combined these health effects have an estimated value of $4.6B to $20B per year. The health impacts were greatest in the provinces with populations in close proximity to wildfire activity, though health impacts were also noted across many provinces indicating the long-range transport of wildfire-PM2.5. Understanding the population health impacts of wildfire smoke is important as climate change is anticipated to increase wildfire activity in Canada and abroad.

Keywords: Health impact analysis, wildfire smoke, Canada

Presenter Bio: Carlyn Matz, PhD, is a Senior Evaluator in the Air Program of Health Canada. In this role, she conducts risk assessments related to air quality issues, including wildfires and traffic-related air pollution, as well as developing risk communication products for various audiences.

133. Knowing Your Audience: A Typology of Smoke Sense Participants to Inform Wildland Fire Smoke Health Risk Communication

Presenter: Mary Clare Hano, Environmental Health Social Scientist, U.S. Environmental Protection Agency, hano.maryclare@epa.gov

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Abstract: Central to public health risk communication guidelines is understanding and tailoring messaging to the intended audience. In the context of wildland fire smoke, that task is particularly challenging given that the audience may encompass entire communities and regions, and there may be a range of perspectives and values among individuals who need the information. We examine individuals' perspectives on the issue of wildfire smoke as a health risk and what role these play in engagement with a health risk communication citizen science project called Smoke Sense.
We used cluster analysis to identify perception traits based on: health status, experience with wildland fire smoke, risk perception, self-efficacy, access to exposure-reducing resources, health information needs, and openness to health risk messaging. We used multinomial logit modeling to examine whether these perceptions are a function of an individual's demographics, and to assess how engagement with the app differs across clusters we used analysis of variance. Finally, we mapped these traits to the Precaution Adoption Process Model to indicate where each trait lies in adopting recommended health behaviors and suggested messaging strategies that may be suitable for each trait.

Health status, risk perception, self-efficacy, and health information needs of the participants were the most influential factors in defining five perception traits of shared perspectives on the issue of wildfire smoke as a health risk. The five traits included those who were individuals who were simply Unengaged with the issue; those who were Cautious about their health and air quality; those who tended to be Proactive with their health; individuals who are highly Susceptible to health effects of air pollution; and those who are decided health Protectors. Trait profiles were not defined by demographics, and engagement in the app varied by perception traits. Individuals in the Susceptible trait engaged the most thus meeting their informational needs.

Understanding the intended audiences is critical to increase the effectiveness of health risk communication messaging about wildland fire smoke.

Disclaimer: The views in this paper belong to the authors and are not necessarily those of the U.S. Environmental Protection Agency.

Keywords: Smoke Sense, Health, Citizen Science

Presenter Bio: Mary Clare Hano is a social scientist with U.S. EPA's Office of Research and Development. Currently her research focuses on practical strategies for increasing community capacity and resilience in the context of wildfire smoke and health.

134. Emissions from Fires at the Wildland Urban Interface

Presenter: Amara Holder, Mechanical Engineer, US Environmental Protection Agency, holder.amara@epa.gov

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Abstract: Fires that occur in the wildland urban interface (WUI) often burn structures, vehicles, and the items contained within them as well as biomass in the natural landscape. Because these fires often burn near population centers, their emissions may have a sizeable impact on public health, necessitating a better understanding of criteria and hazardous air pollutants emitted from these fires, and how they differ from wildland fires. Previous studies on the toxicity of emissions from the combustion of building materials and vehicles have shown that these fires emit numerous toxic compounds such as HCN, HF, HCl, isocyanates, PAHs, dioxins and furans, and a range of toxic organic compounds (benzene toluene, xylenes, styrene, formaldehyde, etc.) and metals (Cr, Cd, As, etc.). We surveyed the literature to create a comprehensive list of emission factors of hazardous air pollutants from the combustion of building materials and compared them to those from wildland fires. Emission factors for some toxic compounds like polycylic aromatic hydrocarbons (PAH) and toxic organic compounds were 5 – 2,500 times greater than those from natural fuels. However, large gaps in the data remain, particularly on the emissions of toxic metals, dioxins, and inorganic gases like NH_3, NO_x and SO_x. Additionally, accurate estimates of fuel consumption in the built environment and natural environments are still needed to understand the impact of emissions from fires in the WUI, particularly as we expect more wildland fires to extend into the WUI in the future.
The views expressed in this abstract are those of the authors and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Keywords: Emission factors, Structure Fires, Vehicle Fires, Toxic Air Pollutants

Presenter Bio: Dr. Amara Holder is a research mechanical engineer with the U. S. EPA in the Office of Research and Development. She received a PhD in mechanical engineering with a focus on combustion from the University of California Berkeley. She joined EPA in 2011 where her research has focused on characterizing emissions from a variety of combustion sources including wildland fires.

135. Spatially refined biomass burning emissions inventory in Chile

Presenter: Patricia Oliva, Assistant Research Professor, Hémera Centro de Observacion de la Tierra, Facultad de Ciencias, Universidad Mayor, patricia.oliva@umayor.cl

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Abstract: In an era of increasing wildfire frequency and intensity, an accurate estimation of the emissions released to the atmosphere is essential to analyze and reduce their impacts. In 2017 Chile suffered the most devastating fire season recorded. This study presents an approach to improve the estimation of GHG emissions from biomass burning in the native sclerophyll forest of Chile. We apply the IPCC equation to estimate emissions, which considers the burned area, biomass (dry matter), the percentage of biomass combusted (called burning efficiency), and emission factors. We used the burned area perimeters produced by the National Forest Corporation, and the emissions factors from the literature, using the most similar vegetation types available. In this study, we improve the accuracy of our estimations by introducing field measurements of biomass and adapting the burning efficiency (BE) factors to different levels of burn severity computed from Sentinel-2 data. The biomass measured in the field complemented the data found in the literature and demonstrated that an updated field-based biomass estimation is needed in highly endemic ecosystems to improve the accuracy of the estimations. The BE estimations were calculated from measures taken on the field comparing areas affected by the fire and adjoining non-affected areas. These measures were calculated in several levels of burn severity, assigning then a BE factor to each burn severity and vegetation type. The missing values were computed by interpolation. We compared the field-based values with the values in the literature, expressing the need for burn severity dependent BE factors. The emissions derived were compared with the emissions from the GFED product showing a good agreement, although GFED values were higher than ours, suggesting that GFED may overestimate the emissions due to their coarse resolution and the generalized BE factors which are applied to large ecosystems.

Keywords: Emissions, burning efficiency, combustion completeness, fire, burn severity, Sentinel-2

Presenter Bio: Dr. Patricia Oliva is an Assistant Research Professor at Hemera Earth Observation Center at University Mayor, Chile. She graduated from the University of Alcala (Spain), where she also completed the Ph.D. program on Cartography, SIG and Remote Sensing in 2010. She is a dedicated teacher with more than 14 years of experience working with satellite data, has participated in 12 research projects, and published 11 papers. She is currently leading two research projects to study the effects of forest fires emissions on public health and to develop an automatic burned area mapping algorithm for Chile.

136. Effect of moisture content and fuel type on emissions

Presenter: Priya Garg, PhD Student, University of California, Berkeley, pgarg12@berkeley.edu

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Abstract: The effects of fuel moisture content (FMC) on emissions under both flaming and smoldering combustion conditions were studied for a variety of wildland fuels found across the United States. A mixture of particulate matter and gaseous species are emitted during the event of a wildfire and it negatively impacts the health of first responders, nearby populations, and the earth climate system. Recent studies have shown both short and long-term health effects from these emissions to the pulmonary and cardiovascular systems. Earth-climate simulations also rely on estimates of global carbon production from fires. Many previous studies measuring the emissions from field burns and laboratory experiments are available; nonetheless, they often do not isolate the effect of fuel type, fuel-moisture content (FMC) and mode of combustion on emissions.

In this study, a custom linear tube-heater apparatus was developed to produce a steady-state emission from different combustion modes over a wide range of FMC. The concentration of particulate matter and gaseous species showed a significant relationship with FMC for both flaming and smoldering combustions. As expected, smoldering combustion had an increase in the production of CO, particulate matter and unburned hydrocarbons when compared to the flaming combustion. Flaming-mode emission factors were significantly correlated with FMC while it had little influence on emission factors for smoldering combustion when considering the dry mass of the burned fuel. These variations occurred for certain fuel species, but not for all, representing that the type of fuel plays an important role and this may be due to the chemical makeup of moist and recently live fuels. The results were discussed and compared with previous measurements, where good agreement was observed.

Keywords: Flaming, Smoldering, Emissions, Wildland Fuel, Fuel Moisture Content

Presenter Bio: Priya Garg is a Ph.D. student in the Department of Mechanical Engineering at the University of California, Berkeley. She graduated in Aerospace Engineering from SRM University, India in 2014, and she received her MS in Space Engineering from Politecnico di Milano, Italy in 2017. Her research is focused on the quantification of emissions from wildland fires.

137. Global Biomass Burning Emissions Product from MODIS and VIIRS Active Fire Detections

Presenter: XIAOYANG ZHANG, Professor, South Dakota State University, xiaoyang.zhang@sdstate.edu

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Abstract: Biomass burning emissions (BBE) deteriorate air quality and impact carbon budgets because of a large amount of aerosols and trace gases released into the atmosphere. Accurate BBE estimates are crucial for air quality monitoring and forecasting. To serve aerosol model applications, we developed the Global Biomass Burning Emissions Product eXtended (GBBEPx V3, using Fire Radiative Power (FRP) retrieved from MODIS on both Terra and Aqua and VIIRS on both SNPP and NOAA-20 satellites. Specifically, the MODIS FRP flux is first employed to calculate daily BBE using coefficients that are determined by comparing the FRP flux with Global Fire Emissions Database and MODIS aerosol optical depth (AOD). By taking MODIS-FRP-derived BBE as a reference, FRP retrieved from SNPP VIIRS and NOAA-20 VIIRS are then associated to daily biomass burning emissions species of CO_2, CO, SO_2, OC, BC, $PM_{2.5}$, NO_x, and NH_3. The GBBEPx V3 is produced daily by blending BBE estimated from MODIS and VIIRS fire FRP, which contains a set of output products that include average FRP and BBE with a grid size of 0.25°×0.3135°, 0.1°×0.1°, and FV3 C384 grid. The GBBEPx emissions are evaluated using the $PM_{2.5}$ estimated from inverting MODIS AOD during Terra (~10:30 am local time) and Aqua (~13:30 pm local time) overpasses over the wildfire regions across the United States from 2016 to 2018. The evaluation show that the GBBEPx $PM_{2.5}$ is significantly correlated to AOD-based $PM_{2.5}$ estimates (R^2=0.58, p<0.001), and that the GBBEPx $PM_{2.5}$ is likely to be underestimated by about 16% due to the omission error of satellite fire detections. Finally, the GBBEPx V3 will be enhanced by fusing FRP observations from MODIS, VIIRS, and GOES-16 ABI to generate diurnal FRP pattern. As a result, the next version of GBBEPx will be able to produce hourly biomass burning emissions to improve the aerosol model application.

Presenter Bio: He received the Ph.D. degree from the King's College London in 1999. He is a professor and senior scientist with the Geospatial Sciences Center of Excellence at South Dakota State University (SDSU). He was a Research Associate and Research Assistant Professor with the Department of Geography at Boston University (1999 to 2005). As a Senior Research Scientist in the Earth Resources Technology (2005-2012) and a visiting Associate Research Scientist in the University of Maryland (2012-2013), he worked at the NOAA/NESDIS/STAR. His research focuses on land surface dynamics and biomass burning emissions from polar-orbiting and geostationary satellites.

140. A comparative study of fire emissions and smoke transport in two major wildfire regions of China

Presenter: Fengjun Zhao, Scientist, Research institute of Forest Ecology, Environment and Protection, Chinese Academy of Forestry; Forest Protection Laboratory of National Forestry and Grassland Administration, Beijing 100091, China, zhaofengjun1219@163.com

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Abstract: Wildfires, especially large wildfires, emit a large amount of air pollutants. Their environmental consequences are especially significant in China, one of the regions in the world with the severe air pollutions including frequent occurrences of haze and smog. Local sources such as vehicle exhaust and factory fossil fuel combustion have been quantified but little is known about the contributions from wildfire emissions to air pollutions in China. This study investigated this issue by examining 10 large wildfires with burned areas over 100 hm2 in recent decades, focusing on comparisons between the Northeast and the Southwest. The Northeast has typical cold temperate forests with the dominant vegetation type of cold temperate coniferous forest. This region has the largest burned areas in China. In contrast, the Southwest has warm subtropical forests with coniferous forests, broad-leaved forests, mixed forests, and shrub forests. This region has the most frequent fires in China. The fire emissions were calculated based on burned areas and fuel loads. The atmospheric transport was simulated using the HYSPLIT model. The results show remarkable differences in fire emissions, smoke transport, and the air quality impacts between the two regions. Wildfires had longer burning durations, larger fire areas and emissions, and longer smoke transport ranges in the Northeast than the Southwest. However, the air quality impacts were larger in the Southeast because of much denser population and the fires were closer to residential areas. Burns of the cold-temperate coniferous forests had the largest emissions, followed by temperate coniferous forests, mixed forests, temperate broad-leaved forests, and temperate shrubs and meadows. Meteorological conditions, especially wind direction and wind speed, were the key factors the smoke transport ranges and the concentrations of PM2.5 and other air pollutants.

Presenter Bio: Dr. Fengjun Zhao is a scientist from Chinese Academy of Forestry, Beijing, China. Her research areas include fire and smoke, forest fuels, and weather-fire interactions. Besides research in China, she also has worked on a number of international fire and smoke projects through collaborations.

141. Comparing Smoke Impacts from Future Wildland Fires under Alternative Forest Management Regimes

Presenter: Jonathan Long, Research Ecologist, USDA Forest Service Pacific Southwest Research Station, jonathan.w.long@usda.gov

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Abstract: In California and throughout western North America, smoke exposure from wildfires has become a growing public health issue, yet managers and scientists have also recommended using wildland fires to restore forests and reduce the impacts of smoke from poorly controlled wildfires. Addressing this two-sided sword requires science to understand tradeoffs. However, it is challenging to shift evaluations from the scale of individual fires to long-term fire regimes under different management strategies. To confront this challenge, we integrated three widely-used modeling tools to analyze smoke impacts across different management scenarios within a future of changing climate. We applied this framework to a case study in the Lake Tahoe basin, in which managers proposed scenarios that involved varying levels of hand and mechanical thinning treatments and prescribed fires. First, we modeled fuel loads and associated daily fine particulate emissions from wildfires using the LANDIS-II model. Second, we modeled smoke transport to downwind communities from representative future fires using the BlueSky smoke dispersion model. Third, we estimated human health impacts resulting from the modeled smoke using the U.S. Environmental Protection Agency's BenMAP model. Due to computation challenges, we only modeled the long term regime dynamics through the first step of daily emissions; we modeled dispersion and health impacts based upon events selected to be representative of different management scenarios. Our results indicated that forest thinning treatments would reduce emissions from wildfires over decades, which may yield health benefits great enough to support substantial increases in fuels management. We also found that prescribed burning would reduce the health impacts associated with large wildfires, but would result in much more frequent moderate emissions. Furthermore, individual prescribed fires could have substantial impacts given unfavorable dispersion. Because dispersion and resulting impacts vary so greatly with weather conditions, more extensive analyses is needed to better quantify impacts of different management regimes. Our framework illustrates how to evaluate tradeoffs more comprehensively, provided that data management and processing challenges can be overcome with more powerful computers, continued model enhancements, and better linkages between models.

Keywords: air quality, smoke modeling, emissions modeling, California, USA, particulate matter, wildland fire, prescribed burning, economics, tradeoffs

Presenter Bio: Jonathan W. Long is a research ecologist with the Pacific Southwest Research Station in Davis. He leads a variety of interdisciplinary research projects to help managers restore forests and wetlands to support important social and ecological values. For over two decades he has been engaged in collaborative research with tribes. He worked previously for the Rocky Mountain Research Station, University of Arizona Cooperative Extension, and the White Mountain Apache Tribe in Arizona.

142. Wildfire and Prescribed Fire Guidance under the Exceptional Events Program

Presenter: Denise Scott, Exceptional Events Program Staff Lead, US EPA, scott.denise@epa.gov

Abstract: The Environmental Protection Agency (EPA) revised the Exceptional Events Rule in 2016 to include, among other things, language confirming that wildfire events are natural events. The revised rule also offers air agencies some regulatory flexibilities when considering emissions from wildland and prescribed fires that satisfy the Exceptional Events Rule criteria. Since 2016, EPA has issued two guidance documents to assist air agencies in preparing exceptional events demonstrations for wildfire and prescribed fires. The most recent document, "Exceptional Events Guidance: Prescribed Fire on Wildland that May Influence Ozone and Particulate Matter Concentrations," was released in August 2019. This presentation provides an overview of the Prescribed Fire guidance document.

Keywords: Exceptional Events; Fire Guidance

Presenter Bio: Denise Scott is an Environmental Protection Specialist in the Air Quality Policy Division of the Office of Air Quality Planning and Standards (OAQPS). She is the staff lead for the Exceptional Events program. Denise has more than 25 years of experience supporting air quality programs for OAQPS. She holds a bachelor's degree in biology from UNC-Chapel Hill and a master's degree in environmental science and engineering from Virginia Tech. While her primary area of expertise is air pollution, Denise has multimedia experience in water, groundwater, and hazardous waste. She has experience working for state and federal regulatory agencies and in the private sector.

143. Current operational products for smoke management, Part 1: Desert Research Institute

Presenter: Tim Brown, Research Professor, Desert Research Institute, Tim.brown@dri.edu

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Abstract: New and improved operational smoke analysis and prediction products have recently been coming online to support wildland fire management and air quality agencies. In the first of two linked talks, we discuss tools developed by or incorporated into operations at the Desert Research Institute (DRI) in partnership with the U.S. Forest Service. At DRI a web-based version of Piedmont-PB is now available for identifying and forecasting Superfog events. These are events where smoke and high atmospheric humidity combine to often rapidly restrict visibility. This tool can be used in preplanning to help assess road visibility impacts from smoke. Related, Superfog Analysis Model (SAM) was developed in 2012 to aid land managers by enabling them to quickly assess situations as favorable or unfavorable to the formation of Superfog. Originally developed as a PC version, online access is now available to also support assessment of potential road impacts from smoke. Related to Superfog, climatology maps of Superfog for the continental U.S. are now available online. These maps depict frequency counts of Superfog potential based on gridded numerical weather output. Bluesky version 4 has recently been linked with California's Prescribed Fire Incident Reporting System (PFIRS). In this system, BlueSky modelling output informs prescribed burning from the PFIRS framework in order to assist land managers and air regulators with prescribed burning decisions. The Western Regional Climate Center (WRCC) at DRI serves as the USFS fire cache smoke monitor data archive, providing real-time data displays and maintaining the historical dataset. These tools and the underlying data are largely available and accessible by researchers and public, making these systems a resource not only for communication with the public but also additional research into the human health and economic impacts of wildland fire smoke. In this presentation we provide an overview of these products and highlight their utility in providing decision-support for smoke related activities.

Keywords: smoke modeling, operational decision support, smoke management

Presenter Bio: Dr. Tim Brown is a Research Professor and conducts applied research at the Desert Research Institute (DRI) in Reno, Nevada. His primary academic interests include wildland fire-climate-weather connections; the fire environment; applications development for wildland fire management planning, decision-making and policy; and interfacing between science and decision-making. He is Director of the Western Regional Climate Center (WRCC) and the Program for Climate, Ecosystem and Fire Applications (CEFA) at DRI. He is graduate faculty in the University of Nevada, Reno Atmospheric Sciences Program and quandom Adjunct at the Monash University School of Earth, Atmosphere and Environment Science Faculty, Clayton, Victoria, Australia.

143. Current operational products for smoke management, part 2: Interagency Wildland Fire Air Quality Response Program

Presenter: Narasimhan Larkin, Research Scientist, USDA Forest Service AirFire Team, sim.larkin@usda.gov

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Abstract: New and improved operational smoke analysis and prediction products have recently been coming online to support wildland fire management and air quality agencies. In the second of two linked talks, we discuss tools developed by or incorporated into the US Forest Service (USFS) led Interagency Wildland Fire Air Quality Response Program (IWFAQRP). This includes recent developments in aggregating ground monitoring data and new map systems for displaying and analyzing results. The daily BlueSky smoke forecast runs done by the USFS AirFire Team now includes an updated version of BlueSky and including CMAQ runs. BlueSky has been rewritten for version 4, making it more modular, faster, and incorporating updated model versions. These runs use a new Fire Information System that has been developed that aggregates multiple satellite detection systems and statistical ways to assign fire size. These detects are also applied in a revised way by the BlueSky Smoke Modeling Framework version 4. BlueSky version 4 is also used within the new BlueSky Playground version 3 customizable modeling system. Updated formats for Smoke Outlooks issued by IWFAQRP Air Resource Advisors have been developed. These tools and the underlying data are largely available and accessible by researchers and public, making these systems a resource not only for communication with the public but also additional research into the human health and economic impacts of wildland fire smoke.

Keywords: Smoke Modeling, Operational Smoke Tools

Presenter Bio: Sim Larkin is a research scientist and team leader with the US Forest Service AirFire Team. He has led the development of the BlueSky Smoke Modeling Framework, daily smoke forecasting systems, and operational smoke tools for over a decade, and leads technical development for the new International Wildland Fire Air Quality Response Program.

144. Rapid Update Automated Smoke Forecasting

Presenter: Martin Cope, Dr. Martin Cope, CSIRO, martin.cope@csiro.au

Abstract: In Australia, the occurrence of wildfires correlates with the onset of extreme fire weather- dry fuel loads, low humidity, strengthening winds and elevated temperatures. Under such conditions, fires can be readily ignited by lightning, power line failures, or human intervention. Rapid growth in the area and intensity of the fire front may then follow.

Minimisation of direct fire impacts is achieved when emergency response centres can rapidly coordinate and deploy assets to control the fire while it remains constrained in size and intensity. While this approach necessarily focuses on the protection of life and infrastructure in the near field, an externality of the wildfire is the production of smoke and ash, which has the potential to rapidly impact communities far downwind of the fire. This can lead to population health impacts resulting from the exposure to smoke. Population consternation and anxiety is also an outcome when reduced visibility; ash fall; or smoke odour is associated with the presence of a wildfire.

Fortunately, it is possible to preempt such population outcomes by providing advanced warning of potential smoke impacts. In this presentation, we will introduce a framework which has been developed to provide rapid forecasts of smoke impacts following the automated detection of smoke downwind of recently ignited wildfires. The following components of the framework will be discussed.

1. Automated detection of wildfire smoke using (10 minute updated) geostationary satellite multi-spectral observations coupled with a machine learning algorithm trained to identify smoke plumes.
2. A computationally efficient fire behaviour model coupled with a smoke emissions model.
3. A regional chemical transport model which is forced by pre-calculated daily weather forecasts.
4. Modules to calculate the population exposure, ash deposition and visibility reduction resulting from the wildfire smoke plume.

We will present a case study based on an observed smoke event in the Northern Territory, Australia, where smoke from a remote and evolving wildfire impacted the city of Darwin.

Keywords: Smoke forecasting, machine learning, rapid response, satellite observations, early warning system

Presenter Bio: Martin has worked in the area of air quality modelling and applications for over 30 years. He has been employed by the Australian Commonwealth Science and Industrial Research Organisation as a Principal Research Scientist for the last 20 years. Martin's research is focused on the atmospheric sources, wind-borne transport, chemical reaction, and population exposure of fine particles. Most recently, he has been contributing to the development of a short-term (24-72 hour) smoke forecasting system, which is now run operationally by the Bureau of Meteorology for the Australian region.