SPECIAL SESSION ONE: Towards Efficient Large Fire Management: Monitoring, Modeling, and Accountability
Moderator: Matt Thompson

SS1.1. A Framework for Developing Optimal Response in a New Fire Management Paradigm
Christopher Dunn, Faculty Research Associate, Oregon State University
Additional Authors:
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Dave Calkin, Research Forester, Rocky Mountain Research Station, US Forest Service
Abstract: Wildfire extent and intensity have increased in recent decades as the legacy of historical management interacts with a rapidly changing climate and expanding human development. These trends stimulated management focused on fuels reduction and forest restoration. However, landscapes are not being treated broadly enough to influence large fire outcomes, and costs incurred by highly-valued resources and assets (HVRA) and agency budgets continue to increase. Researchers and managers alike are turning towards large-fire management to expand the 'right kind of fire in the right place' as a pathway to achieve ecological and economic objectives. This requires a shift in land, resource and fire management objectives and adaption of this complex system to a new fire management paradigm. As part of the special session "Towards Efficient Large Fire Management: Monitoring, Modeling, and Accountability", we present challenges and opportunities for achieving this transition, including pre-suppression planning and large-fire incident management. We then propose a new dynamic, multi-response model of large fire management that considers uncertainty in land management objectives, environmental conditions and suppression resource availability, efficiency and effectiveness. This model will aid in identifying management strategies that reduce impacts to HVRAs while limiting firefighter exposure to hazards, but requires improved data and modeling capacity. Integration of expert knowledge with this analytical approach will help fire management organizations adapt to this new fire management paradigm.
Keywords: fire management; incident response; optimal response strategies
Presenter Bio: Christopher Dunn is a Faculty Research Associate in the College of Forestry at Oregon State University. His scientific research has largely focused on fire ecology and post-fire effects. He has recently transitioned back to his fire suppression and management background and is now investigating large wildfire management effectiveness and efficiencies with the Rocky Mountain Research Station in Missoula, Montana.

SS1.2. Large airtankers in US fire management: describing historical use and discussing implications related to efficiency
Crystal S. Stonesifer, Ecologist, USDA Forest Service/ Rocky Mountain Research Station
Additional Authors:
David E. Calkin, Research Forester, USDA Forest Service, Rocky Mountain Research Station
Matthew P. Thompson, Research Forester, USDA Forest Service, Rocky Mountain Research Station
Keith D. Stockmann, Economist, USDA Forest Service, Missoula Technology and Development Center
Abstract: Airtankers are widely used in suppression of wildfires in the United States. While federal guidance suggests that they are best reserved for initial attack of new wildfire ignitions, our past work analyzing drop records from 2010-2012 has shown that the federal large airtanker fleet was used in initial attack approximately half of the time, and nearly three-quarters of IA drops were on fires that escaped containment efforts during the first operational period. Additionally, our analysis of environmental conditions of use demonstrated that airtankers are frequently used in conditions where their effectiveness may be limited by a combination of environmental factors conducive to extreme fire

behavior (e.g., late afternoon, steep slopes, timber fuel models). These patterns demonstrating widespread use under conditions when all suppression resources are known to be less effective suggest that airtankers may be viewed as a resource of last resort. Here, we briefly summarize our previous findings and then discuss the implications of utilizing large airtankers under fire conditions when all else fails. We present ideas for an alternative system that emphasizes targeted use of large airtankers under conditions where they are known to be most effective through thoughtful preplanning, efficient deployment, and utilization of the best available fire activity and behavior forecast tools. The Aerial Firefighting Use and Effectiveness study currently underway will provide valuable additional information regarding environmental conditions of use, drop intent as it related to the larger strategic fire suppression plan, and associated outcomes, which will greatly enhance our ability to improve the efficient use of the federal large airtanker fleet in the future.
Keywords: large airtankers, effectiveness
Presenter Bio: Crystal Stonesifer is an Ecologist with the US Forest Service, Rocky Mountain Research Station, Human Dimensions Program in Missoula, MT. Her research in recent years has focused primarily on resource use, risk, and efficiency in fire management. Specific areas of interest and expertise include federal fire suppression-related data systems, aviation use in fire suppression, particularly large airtankers, resource ordering practices and data, and incident-specific production calculations and risk indices.

SS1.3. Meaningful translation of aerial firefighting objectives, context and outcomes into effectiveness across the range of fire sizes for the Aerial Firefighting Use and Effectiveness Study

Keith Stockmann, Economist, USDA/ Forest Service/ Missoula Technology and Development Center

Abstract: A 2013 Government Accountability Office report critiqued interagency inability to characterize use, effectiveness and needs for aerial assets in wildfire suppression, which justified a long-term study to improve our understanding of the role and contribution of planes and helicopters in firefighting efforts. The current project takes a leap of complexity past previous investigations by designing a study that untangles the wide range of aircraft uses, focusing on expensive aircraft delivering suppressants and retardant to assist fire managers. The Forest Service's Technology and Development Centers are working with partners in fire and aviation management, USFS Research, National Interagency Fire Center information technology and the BLM. The AFUE Study has four operational modules across the western US, each with three experienced firefighters, a field coordinator, a data manager and an analyst. Collectively they developed an ESRI Collector instrument that classifies use into one of various objectives, captures drop tactics, plans, terrain, weather, and complementary resource availability/actions and also assesses outcomes at multiple scales. After refining this approach for several seasons and observing thousands of drops, it is time to translate the combinations of objectives and outcomes into a meaningful assessment of effectiveness. This is an inside look at the mechanics of this translation, anchored in firefighter perspective, but flexible enough to scale across the range of fire sizes and supported with limited quantitative analysis of fire growth and retardant survival modeling. This translation of outcomes to effectiveness is a key step towards classification and regression tree diagnosis of factors explaining success and future cost effectiveness analyses, both of which should lead to more informed and efficient use of aircraft in wildfire suppression.
Keywords: Aircraft, Airtanker, Firefighting Effectiveness, Cost Effectiveness
Presenter Bio: Keith is economist and firefighter with the US Forest Service. He holds degrees in Economics (BA), Environmental Studies (MS) and Applied Wildland Economics (PhD Forestry). His dissertation explored cost effective private versus public mitigation of home losses to wildfire. Keith now works for the Missoula Technology and Development Center serving as a nexus between research and management focused on fire and aviation management. His specialties include aviation contract optimization, aerial firefighting analysis, fuel treatment effectiveness and efficiency and burned area

emergency response economics. He is the lead analyst for the Aerial Firefighting Use and Effectiveness Study.

SS1.4. Firefighting Resource Use and Movement in the United States

Erin Belval, Research Associate, Colorado State University
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Yu Wei, Associate Professor, Colorado State University
Dave Calkin, Research Forester, Rocky Mountain Research Station, US Forest Service
Crystal Stonesifer, Biological Scientist, Rocky Mountain Research Station, US Forest Service
Matthew Thompson, Research Forester, Rocky Mountain Research Station, US Forest Service

Abstract: We studied multiple years of archived records from the Resource Ordering and Status System (ROSS) to quantify firefighting resource use and movement in the United States (US). We start by examining large fire occurrence based on a new definition of large fire; fires are defined by suppression resource usage instead of fire size. We then examine requests from large fires for several types of resources across multiple fire seasons in different geographic regions of the US. Lastly, we examine how resources are moved between regions to meet large fire suppression demand over fire seasons. Results from this study may help inform future modeling of national scale fire suppression resource deployment and movement. This presentation will be a part of the special session titled "Towards Efficient Large Fire Management: Monitoring, Modeling, and Accountability."

Presenter Bio: Erin Belval is a researcher at Colorado State. Her research focuses on applying operations research methods to forestry problems to find effective and efficient solutions. Recently she has been focused on examining how firefighting resources are used in the United States. She holds a PhD in Forestry and a ME in Operations Research from Colorado State University and a BA in Physics from Reed College.

SS1.5. Develop a simulation/optimization procedure to model the daily suppression resource movement during a fire season in Colorado

Yu Wei, Colorado State University
Additional Authors:
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Michael Bevers, Affiliated Faculty, Colorado State University
Matthew Thompson, Research Scientist, USFS
Dave Calkin, Research Scientist, USFS
Crystal Stonesifer, Research Scientist, USFS
Robin Reich, Professor, Colorado State University

Abstract: Using the 2010-2013 data from the Resource Ordering and Status System and the Predictive Service 7-day Outlook, we study daily fire crew and engine demands in Colorado over each fire season. We designed a simulation/optimization procedure to move crews and engines into Colorado and between its dispatch zones. We compare model suggested crew and engine movements with historical record to identify potential improvement in resource movement efficiency. We also study how resource movements may be influenced by a constraint that requires incident assignments not exceed 14 days.

Keywords: Suppression, dispatch zones, simulation, optimization

Presenter Bio: Yu Wei got his degree from University of Minnesota in 2004. He has been working as a faculty at Colorado State University since 2005 in developing decision tools for forest management and wildland fire management.

SS1.6. Summary: Infusing Risk Management Principles into the Fire Management System

Matthew Thompson and David Calkin, Rocky Mountain Research Station, US Forest Service

Keywords: risk management; effectiveness; incident response; optimization

Presenter Bio: Dr. Thompson is a Research Forester with the Human Dimensions Program of the US Forest Service's Rocky Mountain Research Station. His work focuses on the nexus of risk and decision analysis, systems analysis, and operations research, applied to the context of wildland fire management. He has a BS in Systems Engineering from the University of Virginia, a MS in Industrial Engineering and Operations Research from the University of California, Berkeley, and a MS in Forest Management and PhD in Forest Engineering from Oregon State University. In 2013 Dr. Thompson received the Research & Development Deputy Chief's Early Career Scientist Award.

SPECIAL SESSION TWO: Wildland Fire Emission Factors – Latest research and implications for management and policy
Moderator: Shawn Urbanski

SS2.1. Emission Factors and Wildland Fire: Policy Implications and Applications

Peter Lahm, Air Resource Specialist, USDA-Forest Service

Abstract: Wildland fire emission factors are used in many land manager tools, represent fire emissions in project and land resource plan NEPA as well as by states for air quality permit purposes. A wildland fire emission factor (EF) defines the amount of a pollutant emitted per unit mass of fuel consumed. EFs are an important component in wildland fire emission calculation streams and models and allow land managers to quantify emission reduction techniques and forecast smoke impacts. Many state smoke management programs authorize prescribed fire burning and charge permit fees based on emissions. How wildland fire is represented in state and national emission inventories is a function of emission factors. These inventories represent contribution of wildland fire to overall air pollution in the US. Advances in developing EFs have been made recently. Using these new EF's for particulate matter emission estimates for 2011 for wildland fire would raise the sector from the 34% of all primary PM2.5 of all US sources (industry, mobile sources, etc.) to 48% of the total. Wildland fire would become the largest source category for this pollutant. Other pollutants would rise even more. Use of EF's is complex and impacts many training, policies and many applications leading to effects on land managers, air quality regulators, modelers, emission inventory developers and policy makers.

Keywords: Emission Factors; Smoke; Policy

Presenter Bio: Works in Washington Office of Forest Service in the Fire & Aviation Management program. Chair of NWCG Smoke Committee and head of Wildland Fire Air Quality Response Program.

SS2.2. Background to Emission Factor Development

Shawn Urbanski, Research Physical Scientist, USDA Forest Sevice
Additional Authors:
Susan O'Neill, Research Air Quality Engineer, USDA Forest Service

Abstract: This presentation provides background for the technical papers presented in the Special Session Wildland Fire Emission Factors – Latest research and implications for management and policy. We present the theory, practice and recent advances in the measurement of wildland fire emission factors. The progress of the last 30 years in characterizing the composition and intensity of fire emissions is reviewed. Our current understanding of the relationship between emission factors and fuel properties, environmental conditions, and the combustion process are discussed. The role of sophisticated analytical methods in elucidating the complex nature of aerosol and gases in fresh smoke highlighted. Special attention is given to the findings from recent large-scale field experiments.

Keywords: emission factors, smoke, air quality, land managment

Presenter Bio: Shawn's research is focused on understanding the influence of biomass burning on the chemical composition of the atmosphere. Aspects of biomass burning investigated include: smoke characterization, emission inventories, smoke plume dynamics, and the transport and air quality impact of emissions. Ongoing studies include: 1) The evaluation and development of biomass burning emission inventory systems 2) airborne and ground based experiments for the validation of smoke dispersion models and atmospheric chemistry transport models, 3) laboratory and field experiments characterizing the gas and aerosol emissions from prescribed burning, 4) the development of satellite based wildfire emission inventories for the western United States.

SS2.3. Emission Factors – Latest Research

Shawn Urbanski, Research Physical Scientist, USDA Forest Service
Additional Authors:
Susan O'Neill, Research Air Quality Engineer, USDA Forest Service

Abstract: Emission factors are an essential input to the smoke emission models used in the forecasting, assessment, and management of air quality. In recent years increased attention and improved analytical techniques have led to tremendous advances in characterizing the composition of smoke and measuring emission factors for a range of fire types. For example, nearly 200 volatile and semi-volatile organic compounds (VOC and SVOC, respectively) have been identified in fresh smoke. This presentation summarizes the new literature on emission factors. We also discuss recent laboratory and field studies that have made significant contributions to our understanding of the composition and intensity of emissions for different fuel types. An emission factor dataset synthesized from the literature is compared with emission factors from the National Wildfire Coordination Group 2001 Smoke Management Guide for Prescribed and Wildland Fire and from the USEPA AP-42. The sensitivity of estimated emission rates of key pollutants to assumptions regarding the combustion process (the mix of flaming and smoldering combustion) for different fuel types is examined. We also discuss the impact of different assumptions for applying emission factors based on field observations to fuel consumption simulated with fire effects models, which assume distinct isolated combustion phases (flaming/smoldering). This paper will be presented during the Special Session: Wildland Fire Emission Factors – Latest research and implications for management and policy.

Keywords: emission factors, smoke, land management, air quality

Presenter Bio: Shawn's research is focused on understanding the influence of biomass burning on the chemical composition of the atmosphere. Aspects of biomass burning investigated include: smoke characterization, emission inventories, smoke plume dynamics, and the transport and air quality impact of emissions. Ongoing studies include: 1) The evaluation and development of biomass burning emission inventory systems 2) airborne and ground based experiments for the validation of smoke dispersion models and atmospheric chemistry transport models, 3) laboratory and field experiments characterizing the gas and aerosol emissions from prescribed burning, 4) the development of satellite based wildfire emission inventories for the western United States.

SS2.4. Assessing the limits of large diameter live and dead fuel consumption and their potential influence on emissions

W. Matt Jolly, Research Ecologist, USFS, RMRS, Fire Sciences Laboratory
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Patrick H. Freeborn, Physical Scientist, Missoula Fire Sciences Laboratory

Abstract: Woody fuels are the primary components of wildland fuel complexes, yet little is known about how their thermal, physical and chemical limit the likelihood that they will ignition and how quickly they will burn. Limited models are available to assess these changes over time and these models are fraught with untested assumptions that may have serious implications for the estimation of woody fuel consumption and subsequent fire emission. Here we explore several characteristics of live and dead woody fuels and we show how these fuel parameters influence the potential ignition and burning rate of woody fuels. We show that key factors such as low surface area to volume ratios and high moisture contents limit the likely ignition of live woody canopy fuels but dead surface fuels can sustain ignitions simply by burning in proximity to other fuels. We demonstrate how these factors interact to influence the combustion efficiency of fuel beds. Ultimately, these results challenge current assumptions regarding wildland fuel availability and they pave the way to a more complete representation of fuel consumption that may improve our ability to model wildland fire emissions.
Keywords: heavy dead fuels, live canopy fuels, consumption
Presenter Bio: Dr. Matt Jolly is a Research Ecologist in the Fire, Fuel and Smoke Science Program of the US Forest Service, Fire Sciences Laboratory in Missoula, MT. His main research interest is to improve our understanding of the roles that live and dead fuels play in wildland fires and to use this improved understanding to develop or improve predictive tools that can help support fire management decisions.

SS2.5. Will Fire Average Emission Factors Provide the Ability to Evaluate the Effectiveness of Emission Reduction Techniques?

Roger Ottmar, Research Forester, US Forest Service
Abstract: There are several fire and fuel management practices that reduce total smoke generated from prescribed fires that have the potential to mitigate air quality impacts. The techniques rely on two scientific principles: 1) smoke is not produced unless fuel is consumed and 2) lesser amounts of key air pollutants such as particulate matter and CO are generated during the flaming as compared to the smoldering combustion phase. Eliminating the fuels from the fuel bed or burning under wet conditions when the fuels will not consume produce less smoke based on the first principle. Techniques that move the majority of the fuel consumed into the flaming stage and reduces consumption of the smoldering fuels (e.g. large rotten logs, duff) rely on the second principle. Wildland fire emissions research in the 1980s and 1990s concentrated on providing emission factors and fuel consumption by combustion stage that were instituted into smoke models such as CONSUME and the First Order Fire Effects (FOFEM). This provided the opportunity to prove the effectiveness of techniques like burning under high duff and rotten log fuel moisture contents or mass igniting units to reduce the smoldering smoke production. However, newer research is now directed toward a fire average emission factor. This eliminates the ability to validate and justify the effectiveness of fire management techniques that move fuel consumption from the smoldering to flaming combustion phase. This presentation is part of the special session on Wildland Fire Emission Factors – Latest research and implications for management and policy.
Keywords: Smoke, Emission factor, smoke management
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. He has been involved with fuels, fire, and smoke related research for over 35 years. He leads the Prescribed Fire Combustion and Atmospheric Dynamics Research Experiment (RxCADRE) and the Fire and Smoke Model Evaluation Experiment (FASMEE) to provide novel and critical observational data necessary to evaluate and advance fire and smoke modeling systems.

SS2.6. Assessing New Emissions Factors for Estimating Emissions from Wildland Fires

Duncan Lutes, Fire Ecologist, US Forest Service
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Susan J. Prichard, Research Scientist, School of Environmental and Forest Sciences, University of Washington

Abstract: Scientists, managers, regulators and policy makers require improved emission estimates to aid in local to regional emissions evaluations including prescribed burn programs, emissions inventories and carbon accounting. Wildland fires, including prescribed fire and wildfires, are a significant source of fine particulate matter (PM2.5), carbon monoxide, and nitrogen oxides, which are criteria air pollutants regulated by the US EPA. Wildland fires also produce large quantities of particulate matter and the greenhouse gases carbon dioxide and methane, which play an important role in the global climate system. Emission factors are used in fire effects and emission models to estimate pollutant emissions from total fuel consumption. The First Order Fire Effects Model (FOFEM) and Consume are two models that are widely used to produce emissions estimates required for prescribed fire planning and wildland fire effects. Recently, new emissions factors that represent major fuel types and phases of combustion have been published. These emissions factors have been tested in Consume and FOFEM to estimate the changes in PM2.5, CO, VOC, and greenhouse gas emissions compared to existing emission factors. This presentation will discuss how emissions are estimated in FOFEM and Consume, the change in estimated emissions using new emission factors in the models and the sources of error encountered when making emission estimates. This presentation will be part of the Wildland Fire Emission Factors – Latest research and implications for management and policy special session.

Keywords: Emissions, emissions factors, smoke management, smoke policy, criteria pollutants

Presenter Bio: Duncan Lutes is a Fire Ecologist at the U.S. Forest Service, Fire Sciences Laboratory in Missoula, Montana. He has been involved in the development of the First Order Fire Effects Model (FOFEM), the integration of FIREMON and the Fire Ecology Assessment Tool (FFI), Fuel Loading Models, FuelCalc, the Fire and Fuels Extension to the Forest Vegetation Simulator (FVS-FFE) and FIREMON fire effects monitoring system. Duncan has a BS and MS from the University of Montana.

SS2.7. Lessons from the Smoke and Emissions Model Intercomparison Project (SEMIP)

Susan O'Neill, Research Air Quality Engineer, U.S. Forest Service AirFire Team
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Tara Strand, Research Scientist, Scion Research
Sean Raffuse, Research Scientist, University of California at Davis
Stacy Drury, Research Scientist, Sonoma Technology
Miriam Rorig, Research Meteorologist, U.S. Forest Service AirFire Team
Robert Solomon, Research Meteorologist, University of Washington

Abstract: Researchers and managers need accurate fire emissions and smoke impact modeling for a wide variety of reasons ranging from prescribed burn planning to carbon accounting to air quality health alerts. This session is dedicated to understanding the latest science around emissions factors for wildland fire. But emissions and smoke impact calculations are complex and rely on a large number of underlying steps including both models and collected datasets. It is often hard to quantify the uncertainties in such calculations and to decipher why the resulting computations do not match observations. The recent Joint Fire Science Program Smoke and Emissions Model Intercomparison Project (SEMIP) performed a number of analyses looking a large number models and cross examining them at each step of the modeling chain used in calculating emissions and smoke impacts. Using a variety of test cases ranging from a national emissions inventory to single prescribed fires, SEMIP was able to identify and rank the areas where different models are most in agreement and those areas

where they differ significantly. Additionally, SEMIP was able to quantify the impact of different model selections on the level of overall emissions. Specific rankings of how much the choices in each modeling step matter vary considerably with the overall purpose of the calculation and the level of regionalization and temporalization required of the output. Thus local smoke impact modeling has different sensitivities than national annual aggregate carbon emissions. However, in most cases there were large differences and sensitivity to the choice in fire information datasets used (e.g. ground reports vs. satellite methods), and in all cases the choice of fuel loading dataset (e.g. Fuel Characterization Classification System mapped fuels, LANDFIRE mapped fuels, or regional dataset) heavily impacted the results. Such results and others presented here may help provide a context for better understanding the current state of new emissions factors and their implications facing the wildland fire community today.
Keywords: smoke modeling, fuels, consumption, fuel moistures, emissions, intercomparison
Presenter Bio: Dr. Larkin is a climate scientist and team leader with the U.S. Forest Service AirFire Team in Seattle, Washington. He has extensive experience in smoke science and has led the development of numerous smoke related decision support systems in use today.

SPECIAL SESSION THREE: Joint Fire Science Program and Smoke Science Research: Status of Progress Towards Meaningful Solutions

Moderator: Al Riebau, Doug Fox and Cindy Huber

SS3.1. Critical Assessment of Wildland Fire Emissions Inventories: Methodology, Uncertainty, Effectiveness

Wei Min Hao, Dr., USFS Rocky Mountain Research Station
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Rachel Corley, GIS Analyst, University of Montana
Shawn P. Urbanski, Research Physical Scientist, USFS
Helen Naughton, Associate Professor, University of Montana
Abstract: This JFSP Project evaluates the methodology and quantifies the uncertainty of several wildland fire emissions inventory systems (FEIS), and recommends technical and economic improvements. In this presentation, we describe two reference datasets that were developed for quantifying the uncertainty of burned area and fuel loading. The burned area reference dataset combined the Monitoring Trends in Burn Severity (MTBS) maps, MODIS MCD64 daily burn scars, fire perimeters from the NIFC ftp database, and a comprehensive spatial wildfire occurrence database. A Composite Burn Index (CBI) dataset containing ~ 5000 plots was used to characterize the uncertainty of the MTBS burned area maps. The misclassification rate of the burn severity categories provided an uncertainty estimate for the MTBS burned area. The reference fuel loading dataset combined a forest fuel classification and annual fuel loading maps for rangelands. USFS Forest Inventory Analysis (FIA) fuel estimates from over 18,000 plots were used to assemble a new forest fuel loading classification or FTG. The FTG had 26 classes with each class corresponding to an FIA forest type group. Within each FTG class the component fuel loadings were the means the FIA plot data with each FTG being derived from a few hundred to a few thousand FIA plots. The uncertainty in the fuel loading was determined using Monte Carlo simulations that sampled the underlying FIA plot data and included uncertainty of mapping errors in the FTG map. The rangeland fuel loading reference dataset was estimated with a Normalized Differenced Vegetation Index (NDVI) based biomass product using a large set of field data from the USDA Soil Survey Geographic database, MODIS derived NDVI, and landscape attributes. For organizational analysis, we summarized the FEIS release year, author agencies, funding agencies, format, emissions species, access, spatial scale,

temporal scale, geographic region, time period, satellite vs. ground work, and consumption model used. We will also present cost analysis for each FEIS.

Keywords: emission inventory, uncertainty, costs
Presenter Bio: Dr. Wei Min Hao is a senior scientist at USFS Rocky Mountain Research Station. He has published over 100 papers. He contributed to one of the Intergovernmental Panel on Climate Change (IPCC) reports in 1994. The IPCC was the co-recipient of the 2007 Nobel Peace Prize. Dr. Hao leads an interdisciplinary team to study the impacts of fires on air quality, atmospheric chemistry, and climate at regional and global scales. The team has conducted extensive field experiments to quantify fire emissions in various ecosystems worldwide. The group also studies the relationships of climate-landscape-vegetation-fire emissions in Northern Eurasia and North America.

SS3.2. Overview of the South Carolina Regional Emissions and Aging Measurements (SCREAM) Study
Sonia Kreidenweis, Professor, Colorado State University
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Taehyoung Lee, Assistant Professor, Hankuk University of Foreign Studies, Korea
Gavin McMeeking, Senior Scientist, Handix Scientific
Robert Yokelson, Professor, University of Montana
Amy Sullivan, Research Scientist, Colorado State University
Shawn Urbanski, Research Physical Chemist, RMRS Missoula Fire Sciences Laboratory
Abstract: The SCREAM study characterized the emissions from a simulated wildfire and their evolution downwind via an airborne platform hosting state of the science online measurement techniques for speciated PM1 aerosol, black carbon, water soluble particulate organic carbon, and levoglucosan, a smoke marker compound. Our project leveraged resources provided by a larger study funded by SERDP, that supported the flight hours for the airborne platform (USFS Twin Otter) and also supported complementary observations of trace gas emission factors, plume heights, meteorological data, and fuel consumption. The field study took place in October-November 2011 in South Carolina. The prescribed burns that were sampled were conducted at the U.S. Army's Fort Jackson. Fuels burned were primarily from the pine-forest understory in relatively dense longleaf pine stands that had not been disturbed by fire in over 50 years. We also sampled additional fires of opportunity.

A total of 97 trace gases were quantified in the emissions, representing one of the most comprehensive fire emissions databases to date. For the first time, a suite of monoterpenes was measured, representing compounds released from the heating of fuels prior to ignition. Significant ozone production was measured in all of the sampled plumes, indicative of vigorous photochemistry.

For the Fort Jackson prescribed burns, speciated particulate matter measurements at the fire and following the plume downwind showed a net loss of organic aerosol, particularly in the first 1.5h. Evolution of the composition of the organic aerosol was also observed, including an apparent increase in the degree of oxygenation. Although we could not rule out photochemical processes as drivers of the observed changes, we found the changes in the in-plume organic aerosol were consistent with a primarily physical evolution of the emissions, namely, volatilization of organic aerosol compounds upon dilution with background air.

Our findings represent important additions to the current state of knowledge of fire emissions and their evolution in the atmosphere, and will be used to improve models of the effects of prescribed and wild fires on regional air quality.
Keywords: smoke, particulate matter, emissions, photochemistry, field study
Presenter Bio: Dr. Sonia M. Kreidenweis is a professor of atmospheric science at Colorado State University. Her research focuses on characterization of the physical, chemical, and optical properties of

atmospheric particulate matter, and the effects of the atmospheric aerosol on visibility and climate. She has conducted field studies in several U.S. national parks to establish the sources and characteristics of particulate matter responsible for visibility degradation, with a recent focus on the impacts of prescribed and wild fires. Prof. Kreidenweis is a past president of the American Association for Aerosol Research and a CSU University Distinguished Professor.

SS3.3. Emissions and Properties of Light Absorbing Particles Emitted from Fire

Gavin McMeeking, Senior Scientist, Handix Scientific
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Taehyoung Lee, Professor, Hankuk University, South Korea, USA

Abstract: Light absorbing carbon makes up a substantial component of wild and prescribed fire smoke and has major impacts on visibility, air quality and climate forcing. The two major classes of light absorbing carbon are black carbon (BC), which is strongly absorbing across the visible light spectrum, and brown carbon (BrC), which is more weakly absorbing, but has stronger absorption at shorter wavelengths. We present a review of recent laboratory and aircraft-based light absorbing carbon measurements in smoke from a wide variety of fuels and land types. Light absorption and scattering coefficients were measured at different times and at multiple wavelengths using two photoacoustic-based commercial instruments. Black carbon particles were measured using a commercial single particle laser induced incandescence instrument. Measurements focused on laboratory investigation of globally relevant fuel types as well as fuels more commonly consumed by fires in the US. A series of aircraft measurements focused on characterizing emissions from prescribed burns in California and South Carolina. We link our measurements of light absorption and scattering to aerosol physical properties and fire behavior, as represented through the modified combustion efficiency. Emission factors for BC are also presented and related to fire properties.

Keywords: smoke emissions; black carbon; brown carbon; prescribed fires; climate change; visibility

Presenter Bio: Gavin McMeeking is a scientist with Handix Scientific, a research and development company focusing on atmospheric particle measurements. He was worked in aerosol instrumentation and measurements for over 10 years. His graduate work at Colorado State University focused on characterizing aerosol emissions from fires and their impacts on visibility in protected environments. Since that time he has been an active participant in several field and laboratory campaigns focusing on smoke measurements. His current work includes the development of small sensors for high-density measurements of smoke properties.

SS3.4. Investigation of particle and vapor wall-loss effects on controlled wood-smoke smog-chamber experiments

Jeffrey Pierce, Assistant Professor, Colorado State University
Additional Authors:
Emily Bian, Post-doctoral scholar, Colorado State University
Andrew May, Assistant Professor, The Ohio State University
Sonia Kreidenweis, Professor, Colorado State University

Abstract: Smog chambers are extensively used to study processes that drive gas and particle evolution in the atmosphere. A limitation of these experiments is that particles and gas-phase species may be lost to chamber walls on shorter timescales than the timescales of the atmospheric processes being studied

in the chamber experiments. These particle and vapor wall losses have been investigated in recent studies of secondary organic aerosol (SOA) formation, but they have not been systematically investigated in experiments of primary emissions from combustion. The semi-volatile nature of combustion emissions (e.g. from wood smoke) may complicate the behavior of particle and vapor wall deposition in the chamber over the course of the experiments due to the competition between gas/particle and gas/wall partitioning. Losses of vapors to the walls may impact particle evaporation in these experiments, and potential precursors for SOA formation from combustion may be lost to the walls, causing underestimations of aerosol yields. Here, we conduct simulations to determine how particle and gas-phase wall losses contributed to the observed evolution of the aerosol during experiments in the third Fire Lab At Missoula Experiment (FLAME III). We limit the scope of our study to the dark periods in the chamber before photo-oxidation to simplify the aerosol system for this initial study.

Our model simulations suggest that over one-third of the initial particle-phase organic mass (41 %) was lost during the experiments, and over half of this particle-organic mass loss was from direct particle wall loss (65 % of the loss) with the remainder from evaporation of the particles driven by vapor losses to the walls (35 % of the loss). We perform a series of sensitivity tests to understand uncertainties in our simulations. Uncertainty in the initial wood-smoke volatility distribution contributes 18 % uncertainty to the final particle-organic mass remaining in the chamber. We show that the total mass loss may depend on the effective saturation concentration of vapor with respect to the walls as these values currently vary widely in the literature. Finally, we discuss how our findings may influence interpretations of emission factors and SOA production in wood-smoke smog-chamber experiments.

Keywords: Smoke, Aerosol properties, Laboratory experiments

Presenter Bio: Dr. Pierce is an assistant professor in Atmospheric Science at Colorado State University. His work specializes in understanding the climate and health impacts of atmospheric pollution with a substantial focus on smoke aerosol from wildland fires.

SS3.5. Data and Tools for Analysis of Smoke Impacts on Ozone and Particulate Matter

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Mark Fitch, Smoke Mgmt. Lead, National Park Service
Michael George, Air Quality Lead, Intermountain Region, National Park Service

Abstract: The Joint Fire Sciences Program has funded two leveraged projects under their Smoke Science Plan: the Deterministic and Empirical Assessment of Smoke's Contribution to Ozone (DEASCO3) and the Particulate Matter Deterministic and Empirical Assessment of Impacts on Levels (PMDETAIL), to assist fire and smoke managers in analyzing the contributions of smoke to elevated ozone and particulate matter episodes. The DEASCO3 project was completed in Fall 2013, and the PMDETAIL project completing Winter 2015-16 builds on DEASCO3, extending the analysis over a longer retrospective analysis period of 10+ years to address PM impacts, with both projects and supporting data delivered via the WRAP Tools website. The projects' collaborator teams, organizational approaches, website architecture, tool development, and documentation will be presented. The PMDETAIL project's Vulnerability Tool and key project outcomes will also be reviewed.

Keywords: smoke, fire emissions, air quality, ozone, particulate matter

Presenter Bio: Tom is the Air Quality Program Manager for the Western Regional Air Partnership (WRAP) and works for the Western States Air Resources Council (WESTAR), the association of state air quality agencies for 15 western states. Tom has led numerous regional air pollution studies and analysis projects, held management positions in state and local government and worked as an environmental consultant. Before joining WESTAR, he managed WRAP activities for the Western Governors' Association. Previously, he led air quality monitoring and analysis activities for the Arizona Department of Environmental Quality for more than a decade, where he assisted in the development and led the implementation of health and visibility monitoring networks throughout the state. Tom has also served on national advisory groups for air quality health standards and regional haze.

SS3.6. A causal inference analysis of the effect of fire smoke on ambient air pollution levels

Alexandra Larsen, Associate professor, North Carolina State University
Additional Authors:
Brian Reich is an associate professor of statistics at North Carolina State University. His research focuses on development of spatial and high-dimensional techniques for environmental applications.
Alexandra Larsen, graduate student, North Carolina State University
Ana Rappold, Principle Investigator, Environmental Protection Agency

Abstract: Forest first smoke is major contributor to ambient air pollution levels. In this talk, we develop a method to estimate the contribution of fire smoke to overall air pollution in different regions of the county. We combine numerical model output with observational data in a causal inference framework. Our methods account for aggregation and potential bias of the numerical model simulation, and addresses uncertainty in the causal estimates. We apply the proposed method to ozone and fine particulate matter in the US.

Keywords: air pollution, causal inference, statistics, uncertainty

Presenter Bio: Alexandra Larsen is a 3rd year PhD student in the North Carolina State University Department of Statistics. Her current research interests are in Bayesian and spatial statistics with applications to environmental areas such as air pollution. Her dissertation focuses on the impacts of wildfires on air quality.

SS3.7. Comparative Study of Emission Factors and Mutagenicity of Red Oak and Peat Smoke from Smoldering and Flaming Combustion

Yong Ho Kim, NHEERL
Additional Authors:
Sarah Warren1, Todd Krantz1, Charly King1, Richard Jaskot1, Michael Hays2, Matthew Landis3, Mark Higuchi1, David DeMarini1, M. Ian Gilmour1
1NHEERL, 2NRMRL, and 3NERL, US EPA, RTP, NC, USA

Abstract: Wildfire events produce massive amounts of smoke and thus play an important role in local and regional air quality as well as public health. It is not well understood however if the impacts of wildfire smoke are influenced by fuel types or combustion conditions. Here we developed a novel combustion and sample-collection system that features an automated tube furnace to control combustion conditions and a multistage cryotrap system to efficiently collection particulate and semi-volatile phases of smoke emissions. The furnace sustained stable flaming and smoldering biomass (red oak and peat) burning conditions consistently for ~60 min. The multi-stage cryo-trap system (-10°C followed by -47°C, and ending in -70°C sequential impingers) collected up to 90% (by mass) of the smoke. Condensates were extracted and assessed for mutagenicity (polycyclic aromatic hydrocarbons (PAHs)- and nitroarene-type activity) in Salmonella strains TA100 and TA98+/-S9. Carbon dioxide, carbon monoxide (CO), and particulate matter (PM) concentrations monitored continuously during the combustion process were used to calculate modified combustion efficiency (MCE) and emission factors (EFs). We found that the MCE during smoldering conditions was 74% and 71% and during flaming conditions was 99% and 96% for red oak and peat, respectively. Red oak smoldering EFs for CO and PM were 209 g/kg and 147 g/kg, whereas flaming EFs were 16 g/kg and 0.6 g/kg, respectively. Peat

smoldering EFs for CO and PM were 301 g/kg and 59 g/kg, respectively, whereas peat flaming EFs were 47 g/kg and 3 g/kg, respectively. The ranking of the mutagenicity-emission factors (revertants x 105/MJth in TA100 and TA98+S9, respectively) was red oak smoldering (14.1 and 6.3) > peat smoldering (13.7 and 4.1) > peat flaming (2.5 and 0.8) > red oak flaming (0.3 and 0.1). The greater mutagenicity in TA100+S9 than TA98+S9 indicates that the mutagenicity was associated with PAHs. The results demonstrate that 1) type of fuel and combustion conditions have dramatic differences in emission characteristics and mutagenicity, and 2) the presented system can be useful for the health risk assessment from inhalation exposure to wildfire smoke. [This abstract does not represent official USEPA policy.]

SS3.8. Fire and Smoke Model Evaluation Experiment (FASMEE)

Roger D. Ottmar, Research Forester, USFS Pacific Northwest Research Station
Additional Authors:
Narasimhan Larkin
Tim Brown
Susan Prichard
Adam Watts

Abstract: The primary objective of the Fire and Smoke Model Evaluation Experiment (FASMEE) is to provide critical observational data necessary to evaluate and advance fire and smoke modeling systems. The FASMEE planning phase will occur between March 2016 and June 2017 and will provide a comprehensive study plan that will include sampling methodology, safety, logistics, and data management. The FASMEE field campaign will be initiated in the fall of 2018 and extend through 2021. It will be conducted on 4 to 8 large (>500 acres) operational prescribed burns targeting heavy fuel loads and high intensity burn events located in the western and southeastern United States. Multiple agencies (i.e. NOAA, NASA, EPA, DoD) are being recruited to participate in the research project and assist in funding. Discipline leads have been identified through a Funding Opportunity Notice (FON) during the fall of 2015. Observational teams will be identified through a FON in the fall, 2016. Both groups will assist in completing the study plan development, observational data collection, reduction and analysis, data management, and initial model evaluation.

SS3.9. Airborne-Based Smoke Marker Ratios from Prescribed Burning

Amy Sullivan, Research Scientist, Colorado State University
Additional Authors:
Andrew A. May, Senior Research Associate, The Ohio State University
Taehyoung Lee, Assistant Professor, Hankuk University of Foreign Studies
Gavin R. McMeeking, Senior Scientist, Handix Scientific
Sonia M. Kreidenweis, Professor, Colorado State University
Sheryl K. Akagi, Graduate Student, University of Montana
Robert J. Yokelson, Professor, University of Montana

Abstract: Biomass burning is one of the main sources of water-soluble organic carbon (WSOC) aerosols. Therefore, it is important to be able to determine the contribution of biomass burning to the WSOC concentrations. The most common approach used to make this determination is through the use of smoke marker measurements. The entire key to this approach is that the ratio of the smoke marker to the total WSOC concentration must be known at the source. However, there is still much uncertainty in these source ratios, especially from wildfires and prescribed burning. Therefore, we made smoke marker measurements from aboard a Twin Otter aircraft as it flew through smoke from prescribed burning activities taking place in South Carolina in November 2011. Results were obtained by coupling a Particle-into-Liquid Sampler (PILS) with a Total Organic Carbon analyzer for real-time measurement of

WSOC and a fraction collector to provide off-line samples for smoke marker analysis by high-performance anion-exchange chromatography with pulsed amperometric detection. Airborne results for smoke markers, including levoglucosan, mannosan, galactosan, and potassium, from a number of different prescribed burns will be presented. Smoke marker ratios from controlled laboratory burn source samples collected at the Fire Science Lab in Missoula, MT during the FLAME (Fire Science at Missoula Experiment) studies will be compared to the results from the airborne measurements. How parameters such as fuel type and aging might play a role will also be discussed.
Keywords: smoke markers, levoglucosan, prescribed burning
Presenter Bio: Amy P. Sullivan is a Research Scientist at Colorado State University. Her research focuses on the composition of organic aerosols, especially from biomass burning and aqueous secondary organic aerosols.

SS3.10. How future fire activity will affect mid-century air quality over the United States

Jeffrey Pierce, Assistant Professor, Colorado State University
Additional Authors:
Maria Val Martin, Sheffield University
Colette Heald, MIT
Fang Li, Chinese Academy of Sciences
David Lawrence, NCAR
Francis Vitt, NCAR
Abstract: Emissions of aerosols and gases from fires have been shown to adversely affect US air quality at local to regional scales as well as far downwind regions. Fire activity is strongly related to climate and human activities. Existing predictions based on climate scenarios and future land cover projections from socioeconomic developments agree that fire activity will rise dramatically over the next decades. Here we present an analysis on the changes in future wildfire activity and consequences on air quality over the United States. We focus on PM2.5 and ozone, and employ the global Community Earth System Model (CESM) with the new IPCC RCP projections. Within CESM, we use a process-based global fire parameterization to project future climate-driven and human-caused fire emissions.
Keywords: smoke, future predictions, climate change
Presenter Bio: Dr. Pierce is an assistant professor in Atmospheric Science at Colorado State University. His work specializes in understanding the climate and health impacts of atmospheric pollution with a substantial focus on smoke aerosol from wildland fires.

SS3.11. Megafire, Fuel Loading, and Emissions in the Continental United States under Changing Climate

Yongqiang Liu, Center for Forest Disturbance Science, UDFA, Forest Service
Additional Authors:
Hanqin Tian, Bo Tao, Jia Yang
Auburn University
Abstract: A JFSP project was conducted to quantitatively estimate the historical and future changes in megafire and fuel loading and their air quality impacts in the continental U.S. due to climate change. Megafire was projected based on historical drought-fire relationships and future regional climate change scenarios provided by the North American Regional Climate Change Program (NARCCAP). Fuel loading was projected using the Dynamic Land Ecosystem Model (DLEM). An algorithm was used to incorporate model vegetation types into the default (contemporary) fuel load map developed by the Fuel Characteristic Classification System (FCCS) to generate high resolution fuel load datasets that reflected the spatial-temporal dynamics of fuel load from present to future in response to climate change. It was found that the historical megafire activity shifted from an inactive fire period during

1980-1996 to an active fire period during 1997-2013. Megafire occurrence is likely to increase in many U.S. regions, roughly doubling by middle this century. Fuel loading would increase in most regions, especially the inter-mountains, but decrease in the southeastern coast. Wood biomass and live herb would increase, while woody debris and litter and duff would experience obvious decrease. The PM2.5 emissions from megafires have increased by about 500% from the inactive to the active fire period. The increasing trend is expected to continue this century. The combined increases in megafire occurrence and fuel loading would lead to PM2.5 emission increase by nearly 80% by middle of this century.

Presenter Bio: Dr. Yongqiang Liu is a Research Meteorologist and Team Leader in Center for Forest Disturbance Science, USDA Forest Service. His research interests include smoke measurement and simulation, the air quality and climate interactions, and future fire and smoke trends under climate change.

SS3.12. Future megafires and smoke impacts

Narasimhan Larkin, Research Physical Climatologist and Team Leader, U.S. Forest Service
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Crystal Kolden, University of Idaho
Donald McKenzie, U.S. Forest Service

Abstract: “Megafire” events, in which large high-intensity fires propagate over extended periods, can cause both immense damage to the local environment and significant air-quality impacts on cities and towns downwind. Overall wildfire risk is expected to increase under climate change, which includes the potential for future very large fires. This project (Joint Fire Science Project #11-1-7-4) analyzed and ranked locations across the contiguous United States (CONUS) based on their potential for very large wildfires at mid-century (2046-2065). A variety of climate, weather, and other indices were utilized to analyze past very large wildfire occurrence statistically and project future very large wildfire potentials. The potential for large-scale smoke impact effects from very large fires was also examined. This includes the overall potential for smoke emissions, as well as the potential for downwind transport to sensitive receptors. Smoke emissions and downwind transportation are combined to create an overall metric of Smoke Impact Potential (SIP). Combining future very large fire projections with site-specific Smoke Impact Potentials allows for the ranking of areas across CONUS based on the potential for large-scale smoke impacts from very large fires. Overall, while the future potential for very large wildfires or megafires is high in many parts of the western U.S., as well as in more limited areas along the east coast and the upper Midwest, the potential human population exposure from such fires is heavily concentrated in California, Minnesota, and along the eastern seaboard.

Keywords: megafires, wildfire, climate change, smoke imapcts

Presenter Bio: Dr. Larkin is a senior scientist and team leader with the U.S. Forest Service AirFire Team in Seattle, Washington. He has led the development of many smoke modeling systems and tools in use today.

SS3.13. Modeling evaluation of the contribution of wildland fire emissions on BC deposition rates in the western U.S

Serena Chung, Associate Research Professor, Washington State University
Additional Authors:

Dr. Serena Chung is an Associate Research Professor in the Laboratory for Atmospheric Research, Department of Civil and Environmental Engineering, at Washington State University. Her research focuses on developing, improving, and applying models to better
Brian K. Lamb, Professor, Washington State University
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Joseph K. Vaughan, Associate Research Professor, Washington State University
Narasimhan K. Larkin, USFS AirFire Team Leader, USFS
Abstract: Wildland fires are a major source of particulate emissions, including black carbon (BC). In combination with other pollutants, BC causes air quality degradation, both locally and regionally. BC can also affect climate in various ways, including by decreasing reflectivity of ice- and snow-covered surfaces. BC emission reduction is a potential strategy for mitigating global warming because it is emitted in large quantities and has a relatively short lifetime in the atmosphere in comparison to long-live greenhouse gases.
Regional air quality simulations using the WRF-BlueSky-CMAQ modeling framework were performed for 2011 to assess the contributions of wildfires vs. prescribed fires to BC deposition rates to glacier and snow-covered areas in the western U.S. While seasonal trends in relative contributions of wild and prescribed fires to BC concentrations followed closely the seasonal trends in their emissions, their relative contributions to BC deposition onto glacier and snow-covered surfaces were related to specific relationships, such as fire locations and wind direction relative to snowpack locations and the relative plume rise lofting heights of wild vs. prescribed fires.
Non-fire sources dominated annual total BC deposition rates to glacial areas, but monthly contributions during summer from wildfires and during fall and winter from prescribed fires were significant (> 40%). For BC deposition to snow-covered surfaces, prescribed fires in Washington, Oregon, Idaho, Wyoming, and Colorado were significant contributors (40% to more than 90%) in large portions of these states during November. Prescribed fire contributions were also significant in central Colorado during December. These were the months when high emissions from prescribed fires coincided with the snow season. Because wildfires occurred predominantly during warmer months when the snow-covered areas were small, contributions from wildfires were generally negligible except for some small regions in October and May. Because fire activities and snow amounts vary significantly from year to year, the analysis performed here should be extended to include more years.
Keywords: black carbon deposition, wildfires, prescribed fires

SS3.14. Examining Climate Impacts on Future Wildfire Emissions and Southeastern US Air Quality
Uma Shankar, Research Associate, University of North Carolina-Institute for the Environment
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Uma Shankar is a Research Associate at the University of North Carolina - Institute for the Environment. Her research focuses on developing and evaluating process-based algorithms for atmospheric particulate matter (PM) chemistry, transport and microphysi
Jared Heath Bowden, Research Associate Professor, University of North Carolina-Institute for the Environment
Kevin Talgo, Research Associate, University of North Carolina-Institute for the Environment
Don McKenzie, Research Fire Ecologist, Pacific Wildland Fire Sciences Lab, US Forest Service
Limei Ran, Research Associate, University of North Carolina-Institute for the Environment
Mohammad Omary, Research Associate, University of North Carolina-Institute for the Environment
Abstract: Rising temperatures and changes in atmospheric circulations as a result of climate change are expected to have significant impacts on future wildfire regimes, but these impacts are likely to vary widely across different regions of the US. Projecting smoke consequences of future wildfires on the

regional scale requires a multidisciplinary approach that involves reconciling complex physical and biological processes at vastly different scales in space and time. In this ongoing study of climate change, wildfire, and air quality in the Southeastern US, we have dynamically downscaled general circulation model (GCM) output to construct an ensemble of regional climate simulations to examine the wildfire and air quality impacts in 12 annual periods. The selected years cover a historical decade (1996-2010), and a future decade (2040-2050) under two different scenarios of climate warming, for two extremes of fire potential. Our approach includes vegetation from coupling land cover to the GCMs; empirical fuel loadings at fine scales, projected into the 2040s with a delta method; a stochastic coarse-scale fire generator, and regional air quality assessments of the fire emission impacts with the Community Multiscale Air Quality (CMAQ) model. Results are presented for the precursor emissions and the ambient concentrations of ozone and particulate species. We examine the changes in the smoke emissions and resulting air quality from the historical decade to the future, and their sensitivity to the GCM and the climate warming scenario used for the climate downscaling.
Keywords: Climate change, projecting wild fires, future air quality

SPECIAL SESSION FOUR: Managing Wildfire for Resource Benefit: Increasing Opportunities, Improving Ecosystems
Moderator: Laurie Kurth

SS4.1 Where are we and where can we go with managing fire and what do we need to get there?
Jim Hubbard

SS4.2 Where have we been with managing fire for resource benefits?
Laurie Kurth, Frankie Romero, Henry Bastian

SS4.3 Do We Need Wildland Fire Use Back?
Francisco Romero, Fire Use and Fuels Management Program Specialist, USDA Forest Service, National Interagency Fire Center, Boise, Idaho, USA
Abstract: In proceedings from the 2014 Large Fire Conference in Missoula, MT, Dr. Carl Seielstad offered the perspective that in the U.S.A., changes in federal policy and practices may have unintentionally hampered efforts to promote the intentional use of naturally occurring wildfires to achieve resource benefits (Keane et. al. 2015). This paper reflects on Dr. Seielstad's views and finds agreement as well as competing perspectives. The notion that better planning and communication is needed well in advance of an ignition is supported as is the idea that our workforce needs to increase its capacity to conduct wildland fire risk analysis in order to improve the quality and timeliness of initial response decisions when a fire is first detected. A competing view is offered to Dr. Seielstad's recommendation that Wildland Fire Use (WFU) be reinstituted as a distinct practice from other types of fire management with its own procedures, policies, and specialized workforce. The author contends that reverting to these previous practices is not the best way forward because creating strict specializations within the workforce will actually reduce capacity and reduce efficiencies by creating more bureaucracy and less synergy. It is suggested rather that promoting a fire use ethic among a greater proportion of the fire management workforce and expanding beyond the federal agencies to include local and state partners, will create a larger, more skillful workforce that is better prepared to produce more favorable fire management outcomes on a more meaningful scale.

SS4.4 Managing Fire – Working with partners to protect communities and other values, reduce risk, and improve ecosystems

Panel Members:
Forest Schafer – Lake Tahoe Fire Districts
Darren Borgias – The Nature Conservancy
Judy Reese – State of Alaska
Judy Knobel – Washington Department of Natural Resources
Dave Baker – Livestock rancher
Abstract: Wildfire fire and its effects rarely are contained within one agency's or land owner's boundaries, Successful management of fire requires working collectively to ensure protection of communities, health, important values, and other interests. Support for managing fire for resource benefits can be garnered through cooperative planning that recognizes land management objectives across ownership boundaries; proactive measures that prevent negative impacts of fire to communities and values; and preplanned mitigation measures that accommodate existing uses that may be impacted by fire. Members of this diverse panel will discuss concerns regarding fire on the landscape, efforts to work collaboratively to address multiple land management objectives, and even some unexpected benefits of fire. The discussion will be a moderated question/answer format with the audience invited to bring questions to the table. Through this dialogue, attendees will better understand some social and political complexities of managing fire and gain insights for working on their landscape to increase opportunities for improving ecosystems.

SS4.5 Risk Assessment in the Southern Sierras
Matt Thompson, Phil Bowden

SS4.6 Rogue Basin – Wildfire Risk Assessment Across Land Ownership Boundaries
Kerry Metlen, Forest Ecologist, The Nature Conservancy
Additional Authors:
Darren Borgias, Southwestern Oregon Program Director, The Nature Conservancy and
George McKinley, Executive Director, Southern Oregon Forest Restoration Collaborative
Abstract: The Southern Oregon Forest Restoration Collaborative and partners are developing an all lands Cohesive Forest Restoration Strategy (RBS) across the 4.2M acre Rogue Basin that balances human needs, ecological restoration and wildfire risk mitigation. A quantitative wildfire risk assessment (RA) developed collaboratively with an all-lands, all-hands approach provides guidance for where treatments could be placed to mitigate risk, as well as a performance metric for evaluating management scenarios developed using the RBS. The RA incorporates fire behavior modeling using the large wildfire simulator, FSim, to characterize large wildfire likelihood and intensity as well as a stakeholder/expert driven process to identify high value resources and assets (HVRA) and their wildfire susceptibility. This RA was unique in the level of collaborative development and ownership. Three workshops attended by >50 participants representing 22 organizations were held to ensure rigorous and broad-based input, understanding, and support. Participants included general public, non-governmental organizations, federal, state, county, and municipal representatives.
The RBS explicitly integrates wildfire risk reduction for human communities and Northern Spotted Owl habitat as key objectives, along with forested landscape resilience objectives informed by the natural range of variability and land facets predicted to be resilient to climate change. Collaboratively developed restoration principles guide the strategic placement of mechanical restoration treatments combined with managed low-mixed severity fire, promoting forests that are fire resistant and dominated by large trees of fire tolerant species in appropriate landscape settings while retaining variation in forest density and species composition across the landscape. Resulting restoration could generate 900M bft of economically viable restoration byproduct on 208,000 acres, 1.2 billion bft restoration byproduct requiring subsidy and non-commercial treatments on 1.1 million acres. The RBS and the RA are

informing an ongoing conversation about how mechanical treatments in conjunction with managed fire can produce a landscape both resistant and resilient to fire that promotes dry-forest adaptation to a changing climate and minimizes state changes undesirable for complex habitats and human well-being.

Presenter Bio: Kerry Metlen is the technical lead for the team developing the Rogue Basin Cohesive Forest Restoration Strategy, an all-lands decision support framework for conservation planning that integrates wildfire threat to communities, promoting and protecting enduring habitats, restoring landscape resilience, and promoting the capacity of natural communities to adapt to climate change. As Forest Ecologist for The Nature Conservancy since 2010, he is a core member of several collaborative technical working groups, coordinates multiparty monitoring for the Ashland Forest Resiliency Project, conducts research on reference forest conditions in mixed conifer/hardwood forests, and supports TNC in Oregon's Forest Team.

SS4.7 Application of landscape-scale wildfire risk assessment results to incident management

Joe H. Scott, Pyrologix LLC presented by Phil Bowden or Matt Thompson

Abstract: A quantitative framework for assessing the effects of wildfire on highly valued resources and assets—both positive and negative—has been developed over the last decade (Finney 2005, Scott and others 2013). The main purpose of the framework is to support landscape-scale land and resource management decisions. However, certain results from the framework can be combined with incident-level fire modeling (FSPro) to provide a whole new suite of information to support wildfire incident management decisions. In this webinar, we will briefly review the risk assessment framework and its implementation on the Southern Sierra Risk Assessment (SSRA), and then show how the usefulness of FSPro results can be greatly improved by coupling them with SSRA conditional risk results. We will also demonstrate the use of extreme value analysis—or exceedance probability—for quantifying incident-level wildfire risk.

SS4.8 Case Study - Bald Knob Fire, Pisgah NF

Riva Duncan

SS4.9. The High Meadow Wildfire: A Natural Ignition Managed for Multiple Objectives In a Complex Social Environment

Mark Rosenthal

Abstract: The High Meadow wildfire began on July 14, 2015 as a lightning strike in the ponderosa pine ecosystem of Mount Trumbull. The wildfire was similar to many in the southwest, but the back story is where it gets interesting.

For twenty years, the Mount Trumbull area has been the focus of efforts by federal and state agencies, private landowners, and Northern Arizona University to return an overstocked, southwest ponderosa pine ecosystem to pre-EuroAmerican settlement stocking levels and ecological function. Mount Trumbull is located in the Grand Canyon-Parashant National Monument which is jointly managed by the National Park Service and BLM. It is bordered to the south by the Grand Canyon National Park and is adjacent to several private ranches and Arizona State Land. Close by is a 650-acre area of privately owned land containing several houses and out buildings.

High Meadow, was the third wildfire managed for multiple objectives that season on the Grand Canyon-Parashant National Monument. The largest, Mount Emma, was over 4,400 acres when High Meadow started. It had burned on both BLM and National Park Service land.

By the time the High Meadow fire was called out, all of the partners from the Mount Trumbull restoration project had been engaged, over 1,300 acres had been touched by the fire, heavy air tankers were used to prevent fire movement onto the privately owned land, two Wildland Fire Modules and

several hand and engine crews working for a Type 3 Incident Management Team were used to manage the fire.
What laid the foundation for success on this fire?

SS4.10 Case Study - Paradise Fire, Olympic NP
Todd Rankin

Abstract: On June 14, 2015, a 300 acre wildfire was discovered in a remote area of the Queets rain forest within Olympic National Park. It is believed that the fire was ignited by lightning several weeks earlier, but had remained undetected until weather and fuel conditions prompted increased fire activity. The fire area is categorized by extremely long fire return intervals of 500+ years. This event highlighted the record warm, dry weather conditions that much of the western United States had been experiencing that year. Although the park has a fire management plan that allows for managing naturally caused wildfires within wilderness for resource benefit, the initial decision was to take suppression action due to external influences such as the drought conditions, time of season, and the potential for above normal fire activity in much of the west, which would create heavy competition of wildfire resources. The park's message to the public was that while this was a beneficial, natural fire in a remote wilderness location, it was not the right time to commit to long-term incident management.

When the initial suppression actions failed to contain the fire within the initial perimeter area and the fire became established on extremely steep terrain, a confinement strategy was developed to mitigate risks to firefighters and limit impacts to wilderness values. The fire continued to grow for several months while being managed by a series of incident management teams. During this time, the political and social implications of having a fire burn in a rain forest challenged park and incident personnel. It also raised the question of how to manage fire as a natural process in an area of long fire return intervals when the only opportunity for fires to occur coincide with drought cycles that generally preclude the decision to manage fire.