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Editorial

Special Issue Air Quality and Smoke Management

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The Atmosphere Special Issue "Special Issue Air Quality and Smoke Management" explores our ability to simulate wildland fire smoke events and the potential to link such modeling to future studies of human health impacts. The Issue consists of five papers spanning topics from fine scale modeling of forest canopy effects on smoke dispersion and differences in emissions between wildfires and prescribed fires to larger scale case studies of smoke exposure.

The four modeling papers explore a range of areas from emissions modeling and the influence of tree canopies on smoke dispersion to atmospheric chemical transport modeling to assess smoke exposure for human health studies. These papers seek to highlight deficiencies in our current ability to simulate wildland fire smoke events either by directly exploring a particular process that is not currently well understood or by examining a particular case study. The work of Josephson et al. explores differences in particle emission between fires burning under conditions representative of both wildfires and prescribed fires through the coupling of a particulate emissions model to a computational fluid dynamics-based fire behavior model. Simulations were performed for fuels representative of both a chaparral shrubland and a southeastern pine forest. The resultant particle emission profiles reveal similarity in particle size distributions for both wildfires and prescribed fires, but wildfires exhibit greater total mass emissions and a greater potential to loft particles higher into the atmosphere. Charney et al. look at how the forest canopy impacts smoke concentrations for prescribed fires in the New Jersey Pine Barrens using a numerical weather prediction model coupled with a Lagrangian particle dispersion model. The simulations reveal that the presence of a forest canopy alters smoke dispersion by reducing the surface wind speeds while increasing turbulent mixing and buoyancy. A key challenge highlighted by this study is the ability to simulate meteorological conditions and smoke concentrations at fine scales where these interactions between vegetative structure, the fire, and the atmosphere are occurring. Miller et al. use the BlueSky smoke modeling framework to examine conditions that lead to smoke intrusions from prescribed fires on the Deschutes National Forest into the nearby city of Bend, Oregon, USA. The analysis of smoke intrusions demonstrated the utility of dispersion modeling for anticipating smoke impacts, however the region's complex terrain emphasized the importance of model resolution as higher-resolution 1-km simulations showed improved predictions over 4-km simulations. These three modeling studies provide a glimpse into the range of processes and scales requiring continued investigation to further our understanding of both wildland fires as emissions sources and how those emissions interact with the atmosphere to govern their dispersion.

Wildland fire smoke exposure affects a broad proportion of the U.S. population and there are many public health questions surrounding its effects. Using an atmospheric chemical transport model, Koman et al. examined general air quality with and without wildland fire smoke particulate matter (PM2.5) to assess potential smoke exposure in California, USA. Comparisons of model predictions of wildfire impact on daily average PM2.5 carbon (organic and elemental) to rural monitors in California were good for most years with a tendency toward over-estimating wildfire impacts. Simulations isolated wildfire PM2.5 from other sources for both monitored and unmonitored locations, illustrating the utility of atmospheric chemical transport models for assessing broad geographic scale exposure for health impact studies.

Simulating smoke from wildland fires requires integrating information across a broad range of disciplines. As such, the modeling tools have become more sophisticated, and the data required to test and evaluate such models will need to be equally sophisticated to support continued advancement. Pritchard et al. provide an overview of the Fire and Smoke Model Evaluation Experiment (FASMEE), a project designed with the specific intent of collecting integrated observations from large wildland fires to provide evaluation datasets for new modeling tools. The integrated measurements cover ground-based observations of fuels and fire behavior, estimates of fire-emitted heat and emissions fluxes, and observations of near-source micrometeorology, plume properties, smoke dispersion, and atmospheric chemistry. The FASMEE campaign design included significant collaboration between measurement and modeling groups to devise a study plan suited for capturing model-relevant measurements in a range of forest types.

The goals for this Special Issue was to assess the current science related to smoke from wildland fire, identify tools and technologies for improving smoke management, and identify knowledge gaps limiting our ability to manage smoke and mitigate smoke impacts. Improving our understanding of the differences in emissions between wildfires and prescribed fires along with understanding the role of vegetative structure on smoke dispersion will advance our ability to safely implement prescribed fire as a mitigation strategy against future wildfire emissions. However, these modeling advancements require the integration of data across relevant disciplines in a coordinated manner. Together these five papers touch upon a range of issues requiring further research to advance our understanding of wildland fire smoke.

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