Project Summary
Rocky Mountains Cooperative Ecosystem Studies Unit

Project Title: Experimental Determination of Secondary Organic Aerosol Production from Biomass Combustion

Discipline: Natural
Type of Project: Research
Funding Agency: National Park Service
Other Partners/Cooperators: Colorado State University, Missoula Fire Science Laboratory
Effective Dates: 9/1/2009 – 7/31/2012
Funding Amount: $317,521

Investigators and Agency Representative:
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Project Abstract: Smoke emissions from wild and prescribed fires can be a significant contributor to regional haze and to urban and regional air pollution. Fires directly emit particulate matter; they also emit gases that react in the atmosphere to form secondary organic aerosol (SOA). There is growing evidence that strongly suggests that SOA formed from fire emissions can increase total fire contributions to fine particle mass by a factor of two or more. However, we currently lack an accurate inventory of smoke SOA precursor emissions and the mechanistic understanding to predict the amount of SOA fires contribute to ambient fine particle concentrations at various distances downwind. We also lack ways to directly determine fire SOA contributions to ambient fine particulate matter (PM2.5). Although considerable evidence of substantial SOA formation in aging smoke plumes exists, we lack an accurate inventory of SOA precursor emissions as well as the mechanistic understanding to predict the amount of SOA fires contribute to ambient fine particle concentrations at various distances downwind. We also lack ways to directly determine fire SOA contributions to PM2.5 OC in collected samples.

This three year research project will begin to address these critical uncertainties, by conducting a series of focused experiments with partners at the Missoula Fire Science Laboratory, Colorado State University (CSU) and Carnegie Mellon University (CMU) these shortcomings begin to addressed. The experiments will be followed by extensive analysis. Results of this work will provide new tools for federal land managers, air quality regulators, state organizations, air quality researchers, and others to manage smoke impacts from fire and to quantify those impacts on air quality and regional haze.

This is a collaborative project between CSU, CMU and NPS to achieve the following objectives:

1. Quantify SOA production as a function of smoke age in emissions produced by combustion of a variety of important wildland and agricultural fuel types
2. Quantify emissions of SOA precursors (traditional and non-traditional) in biomass combustion smokes from wildland and agricultural fuels for incorporation into air quality models
3. Identify compounds quantitatively associated with smoke SOA production to complement use of existing primary smoke markers in determining total fire contributions to ambient $PM_{2.5}$ carbon
    a. Determine unique markers associated with SOA formed from emissions of traditional biogenic precursors associated with normal and fire-enhanced plant respiration processes (e.g. isoprene and monoterpenes) vs. non-traditional SOA precursors emitted as part of the combustion process
    b. Determine separate markers for agricultural vs. wildland fuel combustion SOA
4. Derive volatility distributions and aging matrix required to simulate fire organic aerosol concentrations in chemical transport models using the volatility basis set approach.
5. Develop simple chemical analysis techniques for SOA markers suitable for use in routine air monitoring networks such as IMPROVE
6. Effectively disseminate project findings to those involved in fire management, air quality analysis, and modeling of smoke impacts

Outcomes with Completion Dates: Two (2) paper copies and one electronic (PDF) copy of the final report shall be submitted to the Key Official by July 31, 2012.

Keywords: Colorado State University, NPS-Air Resources Division, air quality, Secondary Organic Aerosol, smoke emissions