Ph.D. Defense Announcement
Anna Hodshire
December 18, 2019 at 9:30 a.m.

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Ph.D. Defense

Wednesday, December 18, 2019
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Defense
ATS West Seminar Room (121 ATS West)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Jeffrey Pierce (Advisor)
Shantanu Jathar (Co-advisor)
Jeffrey Collett
Sonia Kreidenweis
Delphine Farmer (Chemistry)

From forests to the remote ocean to smoke plumes: aerosol microphysics in diverse environments

Atmospheric aerosol are produced from terrestrial and marine sources, exist throughout the troposphere, and have impacts on climate and human health. Aerosol may be emitted directly or form in the atmosphere through gas-to-particle conversion. Once emitted, these particles are hardly static: they may grow or shrink through condensation or evaporation of vapors, coagulate together, and eventually settle out of the atmosphere through dry or wet deposition. This dissertation focuses upon the former processes, also known as aerosol microphysics: how do aerosol form, grow through condensation, shrink through evaporation, and coagulate within the atmosphere? How does the relative importance of each process change for different conditions, such as in an ambient forested environment or within biomass burning smoke plumes?

For conciseness, this presentation will focus upon aerosol microphysics within smoke plumes. We review all available field and laboratory data on near-field (within a few hours of emission) aging of aerosol mass and composition markers. On average, the field data shows no increase in dilution-corrected aerosol mass with aging but laboratory data shows a net increase in aerosol mass with aging. Conversely, both field and laboratory data show clear changes in compositional markers that are indicative of aerosol aging. Based on these data as well as current research directions, we propose and discuss the following hypotheses for why laboratory and field measurements do not agree on aerosol mass enhancements: (1) differences in emissions and chemistry, (2) losses in chambers and lines within laboratory campaigns, and (3) differences in timing of the initial measurement, and (4) differences in dilution rates and entrainment.

The final hypothesis, differences in dilution rates and entrainment, forms the basis for two further studies that will be briefly discussed here. First, we show results for changes in aerosol mass and size from a theoretical study in which we simulate fires between 10^{-4} and 100 km^2 in initial size using an aerosol microphysics model that simulates plume dilution with Gaussian dispersion. Then, we discuss aerosol and gas-phase observations from the Biomass Burning Observations Project (BBOP) field campaign. BBOP sampled wildfire smoke in pseudo-Lagrangian transects in the Pacific Northwest, and we separate each transect into whether the plane was sampling in the edge or core of the plume. We show that the initial aerosol mass of the plume, which can serve as a proxy for dilution rate, can help predict changes in smoke aerosol aging markers and particle size diameter. As well, we see new particle formation and enhanced ozone formation along the edges of the plumes.