# Ph.D. Defense Announcement
# Samuel Atwood
# December 18, 2019 at 1:30 p.m.

**Samuel Atwood**
**Ph.D. Defense**

Wednesday, December 18, 2019
1:30 p.m.

Defense
ACRC Classroom (212B ACRC)

Post Defense Meeting
ATS Main Conference Room (209 ATS)

Committee:
Sonia Kreidenweis (Advisor)
Jeffrey Pierce
Susan van den Heever
Daniel Cooley (Statistics)

VARIABILITY IN OBSERVED REMOTE MARINE AEROSOL POPULATIONS AND IMPLICATIONS FOR HAZE AND CLOUD FORMATION

In many oceanic regions of the planet, once pristine environments are known to have a high degree of sensitivity to changing aerosol populations and perturbations from anthropogenic emissions. However, difficulties in modeling and remote sensing efforts in remote marine regions have led to continued uncertainties in aerosol-cloud-climate interactions. Numerous properties of the aerosol and environment affect these interactions in complex and often non-linear ways. In this work, I examine the variability in observed remote marine aerosol properties and its implications for classifying aerosol impacts on cloud development and radiative transfer in the atmosphere.

The results from several field campaigns that measured aerosol and environmental properties relevant to these processes in marine and coastal regions are first presented. An unsupervised classification methodology was used to identify periods of impacts associated with distinct fine-mode aerosol population types and to quantify the observed range of variability associated with these types. A specific focus was placed on differentiating between internal variability in relevant properties within a given population type and external variability between the average values for each population type. The result was a set of aerosol population type models observed in marine regions that allowed for further investigation of the impact of different sources of variability on subsequent atmospheric processes.

Next presented are the results of several observationally driven sensitivity studies using the aerosol models. First, initial cloud properties were investigated using a cloud parcel model driven by the observed aerosol population types to examine relative sensitivity to updraft velocity, extensive aerosol properties including number concentration, and a range of intensive aerosol properties. It was found that the parameter space across which initial cloud property sensitivity to variability in the observed aerosol dataset was investigated could be simplified to incorporate relevant intensive aerosol properties into a single population type parameter. Previous work using simpler mono-modal aerosol populations had identified several regimes of sensitivity of initial cloud properties to updraft velocity and total particle number concentration. When driven by the more complex and atmospherically relevant marine population types additional sensitivity to population type was identified through portions of these two regimes, and a new regime was identified that was more sensitive to population type than either of the other parameters.

A Monte Carlo optical reconstruction model was then used to investigate sensitivity of atmospheric optical properties to observed variability in aerosol and environmental properties. As expected, aerosol dry mass concentrations were the largest contributors to overall sensitivity of extensive optical properties. However, in terms of intensive optical properties, the range of expected variability due to internal variability within a given population type was on the same order as impacts expected due to differences between population types. Specific aerosol population type models may therefore provide little advantage for further constraining expected optical property variability in this dataset. Additionally, the combined impacts of variability in environmental relative humidity (RH) and intensive aerosol properties within a nominally consistent population type could be quantified with coefficients of variation on the order of 0.3 in
this dataset—a value that was relatively constant and independent of total mass concentration, aerosol population type, and RH.

Overall, this work produced new representations of fine-mode aerosol types encountered in marine environments that were broadly consistent with those currently applied in remote sensing and climate modeling. However, the models presented here can account explicitly for the effects of ambient relative humidity, and thus may be useful for next-generation modeling that includes those effects. Future work focused on similar observationally-constrained model development for the marine and littoral coarse mode would be beneficial, as large particles are often significant fractions of optical depth in these regions