M.S. Defense Announcement
Nicole June
Thursday, March 24, at 9:00 a.m.

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March 24, 2022
9:00 a.m.

Defense
ATS West Seminar Room (121 ATS West) or Teams

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Jeffrey R. Pierce (Adviser)
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Aerosol size distribution changes in FIREX-AQ biomass burning plumes: the role of plume concentration on coagulation and OA condensation/evaporation

The evolution of organic aerosols and aerosol size distributions within smoke plumes are uncertain due to the variability in rates of coagulation and organic aerosol (OA) condensation/evaporation across different smoke plumes and potentially in different locations within a single plume. We use aircraft data from the western US portion of the FIREX-AQ campaign to evaluate differences in aerosol size distribution evolution (growing by 10s to over 100 nm in several hours), OA mass, and Oxygen to Carbon ratios (O:C) under different concentrations and amounts of dilution. The observations show diameter increasing more quickly in more concentrated plumes despite these plumes generally having more OA evaporation than in the less concentrated plumes. Initial observations of OA and O:C suggest that evaporation and/or secondary OA formation between emission and the first measurement is also influenced by plume concentration. We estimate the isolated role of coagulation on size changes using model simulations, and we estimate the role of OA condensation/evaporation on size changes using the observed time evolution of the observed OA enhancement. We find that coagulation alone explains the majority of the diameter growth in the transect averages, with more growth occurring in plumes with higher initial number and OA concentrations. Overall, for each of the smoke plumes analyzed, including OA evaporation/condensation has a relatively minor impact on the simulated diameter compared to the changes due to coagulation. Additionally, we examine differences in evolution between the dilute and concentrated sections of the plume based on CO concentration to expand the range of plume concentrations represented in the observations. To determine if these in-plume concentration gradients could be used to understand smoke plumes outside of the range of the sampled average concentration, we simulate the dilute and concentrated plume regions independently (no mixing). In these simulations of each smoke plume region, the model underestimates particle growth in the less-concentrated regions of the plume and overestimates particle growth in the more-concentrated regions. This poor comparison suggests that turbulent mixing between the more- and less-concentrated regions is occurring on timescales too fast for the regions to evolve independently, but slow enough that aerosol size differences are still seen between the regions. The mixing in the plume limits the ability for our conclusions on variations in growth and condensation/evaporation within a plume to be applied to other plumes of a similar concentration. Overall, we conclude that coagulation dominates growth with plume concentrations being important in determining how much coagulational growth is observed.

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