MS Defense Announcement
Samuel O'Donnell
Monday, May 9, at 10:30 a.m.

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May 9, 2022
10:30 a.m.

Defense
ATS Large Classroom (101ATS) or Teams

Post Defense Meeting
ATS Main Conference Room (209 ATS)

Committee:
Jeffrey R. Pierce (Adviser)
Sonia Kreidenweis
Shantanu Jathar (Mechanical Engineering)

Probing the vertical profile of new particle formation and growth in the planetary boundary layer using a column model with surface- and aircraft-based observations

The process of new particle formation (NPF) and subsequent particle growth is an important contributor to cloud condensation nuclei (CCN) concentrations, and CCN have important implications for climate from their impact on planetary radiative forcings. While the ubiquity and importance of NPF is generally understood, the vertical extent and many of the governing mechanisms of NPF and particle growth in the lower troposphere are uncertain. In this work, we present a two-part analysis of the vertical profile of NPF during the HI-SCALE field campaign at the Southern Great Plains observatory in Oklahoma, USA. Firstly, we analyzed airborne and ground-based observations of four NPF events. Secondly, we used a column aerosol chemistry/microphysics model along with the observations to probe the factors that influence the vertical profile of NPF and growth. From our analysis of observations, we found several instances of enhanced NPF occurring several hundred meters above the surface; however, the spatio-temporal characteristics of the observed NPF made comparisons between airborne- and ground-based observations difficult. The model was largely able to represent the observed NPF and particle growth (or lack of NPF) at the surface. The model predicted enhanced NPF rates in the upper parts of the mixed-layer, and sensitivity simulations showed that these simulated enhancements are primarily due to the temperature dependence in the NPF schemes. The simulations were sensitive to the initial vertical profile of gas-phase species provided by the measurements, such that vertical mixing in the model can either enhance or suppress NPF rates, aerosol number concentrations and particle growth rates at the surface. Finally, our model uncertainty and vertical sensitivity analysis provides insights for future field campaigns and modeling efforts investigating the vertical profile of NPF.

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