Ph.D. Defense Announcement
Peter Marinescu
February 4, 2020 at 3:00 p.m.

Peter Marinescu
Ph.D. Defense

Tuesday, February 4, 2020
3:00 p.m.

Defense
ATS Large Classroom (101 ATS)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Susan van den Heever (Adviser)
Sonia Kreidenweis (Co-adviser)
Michael Bell
Richard Eykholt (Physics)

OBSERVATIONS OF AEROSOL PARTICLES AND DEEP CONVECTIVE UPDRAFTS AND THE MODELING OF THEIR INTERACTIONS

Within cloud updrafts, cloud droplets form on aerosol particles that serve as cloud condensation nuclei (CCN). Varying the concentrations of CCN alters the concentrations of cloud droplets, which in turn modifies subsequent microphysical processes within clouds. In this dissertation, both observational and modeling studies are presented that reduce the uncertainties associated with these aerosol-induced feedback processes in deep convective clouds.

In the first study, five years of observations of aerosol particle size distributions from central Oklahoma are compared, and useful metrics are provided for implementing aerosol size distributions into models. Using these unique, long-term observations, power spectra analyses are also completed to determine the most relevant cycles (from hours to weeks) for different aerosol particle sizes. Diurnal cycles produce the strongest signals in every season, most consistently in the accumulation mode and the smallest (diameters < 30 nm) particles. The latter result suggests that these smallest particles may play a more important role in the CCN budget than previously thought. Ultimately, in understanding which, when and why different aerosol particles are present in the atmosphere, we can better assess the impacts that they have on clouds.

The types and number of aerosol particles that can serve as CCN depend on the amount of supersaturation, and thus the magnitude of the cloud updraft vertical velocities. However, in situ updraft observations in deep convective clouds are scarce, and other vertical velocity estimates often have uncertainties that are difficult to characterize. In the next study, novel, in situ observations of deep convective updraft vertical velocities from targeted radiosonde launches during the CSU Convective Cloud Outflows and Updrafts Experiment (C3LOUD-Ex) are presented. Vertical velocities of over 50 m s-1 are estimated from radiosonde observations taken in Colorado. Radar data are used to contextualize the radiosonde measurements and to provide an independent estimate of the updraft magnitudes for comparison. These observations are valuable in that they: 1) contribute novel estimates of the vertical velocities within deep convective clouds, 2) demonstrate that in situ observations of vertical velocities complement estimates from other platforms and 3) will allow for better assessments of the supersaturation magnitudes, and thus the amount of CCN that are present within deep convective clouds.

While the first two studies focus on observing aerosol particles and updrafts separately, the third study within this dissertation presents simulations of their interactions from an international model intercomparison project. Seven models from different institutions simulated the same case study of isolated deep convective clouds with both high and low CCN concentrations. The range of the responses in updrafts to varying CCN concentrations are calculated for this model suite. Despite the various physical parameterizations that these models utilize, all the models simulate stronger updrafts in the High-CCN simulations from near cloud base through ~8 km AGL, with diverging results above this altitude. The vertical velocity tendency equation is analyzed to explain which processes are causing the consistent and inconsistent updraft responses to varying CCN concentrations amongst the models.
The three studies in this dissertation each reduce the uncertainties related to aerosol effects on deep convective cloud updrafts. This work also assisted in motivating the DOE Tracking Aerosol Convection Interactions Experiment (TRACER), which will further connect observational and modeling research to reduce the uncertainties in aerosol-cloud interactions.