M.S. Defense Announcement
Brian Heffernan
Wednesday, May 22, at 10:30 am

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Defense
ATS Large Classroom (101 ATS) or [Teams]

Post Defense Meeting
ATS Chemistry Conference Room (16 Atmos Chem)

Committee:
Sonia Kreidenweis (Advisor)
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Jeffrey Pierce
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MEASUREMENT OF LOW-ALTITUDE AEROSOL LAYERS SURROUNDING CONVECTIVE COLD POOL PASSAGE OBSERVED BY UNCREWED AIRCRAFT

Convectively generated cold pools can have myriad impacts on local aerosol concentrations. Passage of cold pools may loft dust, pollen or other aerosols from the surface, and precipitation and humidity changes accompanying cold pools also impact local aerosols in several ways. The vertical profile of aerosols can have important effects on meteorology, however, the effects of cold pools on the vertical distribution of aerosol are largely unstudied. During the BioAerosol and Convective Storms (BACS) field campaigns in the Colorado plains in spring of 2022 and 2023, Uncrewed Aircraft (UA) were utilized to observe the vertical profile of aerosol, and how this vertical profile may be affected by the passage of cold pools. UAs with mounted aerosol and meteorological instrument packages were deployed in a vertical column to profile different atmospheric variables. Flights were conducted before, during, and after the passage of cold pools, and UA data were contextualized using radiosonde measurements and surface-based aerosol and meteorological instruments.

A discussion of the challenges of UA-mounted aerosol sampling is presented. Validation experiments were conducted to assess the reliability of UA-mounted Optical Particle Counters (OPCs), and analyzed to show that UA-mounted OPCs can provide reliable data under certain circumstances. Two primary issues are discussed in detail: sensor drift and suppressed OPC sampling flow. A calibration procedure was developed and utilized to address the issue of sensor drift, while suppressed OPC sample flow was addressed by removing all data below a determined critical threshold flow rate. These methodologies lead to the creation of a robust data product for the measurement of aerosol vertical profiles using UA-mounted OPCs.

Using these OPC data, an analysis of the vertical profiles observed during the BACS campaign is provided, up to 350m above the surface. We find that a common feature of a post cold pool environment is a layer of enhanced submicron aerosol concentration measured 120m above the surface. This feature and its evolution are examined in detail for several case studies, and different possible explanations are presented. Potential causes of this observed feature include pollen-rupture, low temperature inversions trapping aerosol in a low stable layer of elevated aerosol concentration, and emission and/or deposition of aerosols, but these explanations each appear to be insufficient. This feature appears to be caused by the dynamics of the cold pool, which can entrain and redistribute airmasses from different levels of the atmosphere.