Aerosol Effects in a Simulated Supercell Thunderstorm
Evan A. Kalina¹, Katja Friedrich¹, Hugh Morrison², and George H. Bryan²

¹Department of Atmospheric and Oceanic Sciences (ATOC), University of Colorado, Boulder, CO
²The National Center for Atmospheric Research (NCAR), Boulder, CO

email: evan.kalina@colorado.edu

1. Motivation
1. How do the microphysical processes in a supercell thunderstorm change across the range of aerosol concentrations observed in our atmosphere?
2. How do aerosol-induced changes in the microphysical processes affect the cold pool and the spatial distribution of precipitation?
3. Do these changes increase monotonically with increases in aerosol concentration, or are there nonlinear effects?

2. Atmospheric Aerosol Concentration: Typical Values

Above: Observations from the Southern Great Plains (Lamm, OK)

1. Tremendous variation in CCN concentration: 100 cm⁻³ - 15 000 cm⁻³
2. Peak concentration is smaller on thunderstorm days: 9000 cm⁻³
3. We therefore test 15 different CCN concentrations: 100 - 10 000 cm⁻³

3. Configuration of the Weather Research and Forecasting (WRF) Model

Model is initialized with the default [left] sounding shown below. Different soundings (low relative humidity, loRH; high relative humidity, hiRH; and high vertical wind shear, NWs) are also tested (section 7).

4. Results: Aerosol Effect on Cloud Microphysics

A. Changes in hydrometeor mass mixing ratio, number concentration, and diameter

B. Changes in microphysical process rates: Polluted vs. clean

C. Changes in microphysical process rates: All runs

5. Results: Aerosol Effect on the Cold Pool

CCN = 100 cm⁻³, CCN = 750 cm⁻³, CCN = 10 000 cm⁻³

6. Results: Aerosol Effect on Precipitation

Above: In the most polluted run, accumulated precipitation along the left- and right-moving updraft tracks is up to 24 mm larger.

7. Sensitivity to Initial Environmental Sounding

8. Conclusions

Acknowledgements

Funding support was provided by the National Science Foundation (Grant No. OISE-1000213) and the Department of Energy (Award No. DE-SC0001376).