Mineral dust acting as giant cloud condensation nuclei: aircraft measurements of dust-cloud interactions in Saudi Arabia

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Significant uncertainties exist with dust-cloud interactions for which complex microphysical processes link the dust aerosol and cloud properties. Under almost all environmental conditions, increased aerosol concentrations within polluted air masses will enhance cloud droplet concentration relative to that in unperturbed regions. The interaction between dust particles and clouds are significant, yet the conditions in which dust particles become cloud condensation nuclei (CCN) are uncertain. In order to quantify this aerosol effect on clouds and precipitation, measurement campaigns were conducted in central Saudi Arabia as well as in the Asir region of Saudi Arabia.

Ground measurements of aerosol size distributions, hygroscopic growth factor, CCN concentrations as well as aircraft measurements of cloud hydrometeor size distributions were done in Saudi Arabia from 2007 to 2009. Research aircraft operations focused primarily on conducting measurements in clouds to study their microphysical characterization, especially the preconditions necessary for precipitation. Aerosol measurements were also done during the climb to cloud base height and just below the cloud base.

Dust storms and regional background conditions were encountered during the study period. Under dusty conditions, the coarse (supermicrometer) fraction resembles freshly crushed rock. The particles are almost exclusively mineral dust grains and include common rock-forming minerals. The fine (submicrometer) fraction is dominated by particles of anthropogenic origin, primarily ammonium sulfate and combustion-derived particles. We studied the relationships between the properties of the aerosol and the droplet microphysics of cumulus clouds that formed above the aerosol layer. Under dusty conditions, when a large concentration of coarse-fraction mineral particles was in the aerosol, cloud drop concentrations were lower and droplet diameters larger than under regional background conditions, when the aerosol was dominated by submicrometer sulfate particles.

The presentation will include a summary of the analysis and results with a focus on the characterization of the dust aerosol and the microphysical properties of convective clouds in the central and Asir region of Saudi Arabia.