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The effects of mineral dust particles on cloud microphysics, dynamics and precipitation

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One of the most important challenges in current cloud physics research is to study the impact of different types of aerosols on clouds and precipitation. Mineral dust particles are one of the most abundant aerosol types in the atmosphere. These particles are unique in their possible impact on clouds since they can act both as Ice Nuclei (IN) and as giant Cloud Condensation Nuclei (GCCN).

In this study, data from ground and airborne measurements collected during the rainfall enhancement assessment project in Saudi Arabia were used and compared with cloud model simulations in order to investigate the effects of mineral dust particles, typically present in that region, on cloud development and precipitation formation processes. On 9 April 2007 the region was affected by a dust storm that caused high Aerosol Optical Depth values of about 0.9. The airborne measurements of the aerosol properties as well as the atmospheric sounding were used as initial conditions in simulations of microphysical cloud processes using the Weather Research and Forecasting (WRF) model coupled with a new bin microphysics scheme.

The simulations show that adding GCCN results in earlier initiation of precipitation but the contribution of these particles to the simulated total precipitation is not always positive due to the dynamic feedback. The fast formation of large droplets and efficient production of raindrops reduce the evaporation rate of the droplets during sedimentation and suppress evaporation cooling. Suppression of evaporation cooling stabilizes the atmosphere and prevents or at least reduces the formation of further convection areas which reduce precipitation consequently. This chain of events is meaningful particularly in a dry atmosphere as in Saudi Arabia.

The presentation will include brief overview on the new WRF bin microphysics scheme and a summary of the methodology and results.