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Evaluation of cloud-resolving modeling of haboobs using in-situ and remotely sensed observations

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Arabian Peninsula is one of the major dust generation regions that at present is severely under-sampled. In this study, we combine unique aircraft observations of aerosol and fine-resolution simulations to better quantify dust generation and transport in deep convective storms called haboobs. The aerosol observations were obtained during the "Kingdom of Saudi Arabia Assessment of Rainfall Augmentation" research program that was conducted in the Central and Southwest regions of Saudi Arabia for the years of 2006 through 2009. We ingest the observations from the first phase of the project conducted in the central Arabian Peninsula near Riyadh in April 2007 and focus on the observational cases when the aircraft sampled high concentrations of dust within haboobs. These data are indispensable for assessment of dust properties during periods of extreme aerosol loading. We perform cloud-resolving 2-km simulations using the coupled meteorology-chemistry WRF-Chem model with 8-bin MOSAIC aerosol microphysics scheme that accounts for direct and indirect aerosol effects. The model is validated using observations from surface weather stations, Doppler weather radar network, AERONET stations, MODIS and SEVIRI satellite aerosol sensors. We also compare the model results with recent MERRA-2 reanalysis that assimilates aerosols and chemical components. The model captures the spatiotemporal variability of atmospheric circulation and aerosol properties and calculates contributions of different aerosol species. We specifically compare the simulated aerosols with the aircraft measurements to evaluate the vertical extent and the structure of dust layers in haboobs. The simulated column-averaged dust size distribution compares reasonably well with AERONET and aircraft measurement. Despite total aerosol optical depth in simulations and MERRA2 reanalysis are quite similar, the vertical distribution and regional dust emission fluxes in the model and reanalysis differ significantly. The presentation will provide insights on differences between the observations and simulations.