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Mineral Dust over West Africa: Radiative Forcing and Feedbacks on African Monsoon

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Aerosol, including mineral dust, can affect climate directly by scattering and absorption of radiation (both solar and terrestrial), and indirectly by modifying microphysical and radiative properties of clouds and precipitation processes. Western Africa has experienced the devastating droughts during the last three decades, which has been attributed to the changing Atlantic sea surface temperatures and/or atmosphere-land interactions. However, it is still not clear if the dust radiative forcing plays a significant role on the monsoon circulation and climate there. In this study the Weather Research Forecast (WRF) model with on-line aerosol modules (WRF-CHEM) is used to investigate the possible effects of dust direct and indirect radiative forcing on the western Africa precipitation and monsoon circulation through its impacts on the atmosphere and surface. Firstly, the WRF-CHEM model with two different dust emission schemes and two different aerosol treatments is applied over West Africa during the dry season from January to March of 2006. The model simulations of dust spatial distribution and its optical properties and radiative heating profiles are evaluated using surface, aircraft and satellite measurements collected during the winter Special Observation Period of the African Monsoon Multidisciplinary Analysis project, and by the DOE Atmospheric Radiation Measurement (ARM) and by the NASA MODIS and MISR satellites. Using the evaluated WRF-CHEM model, a serial of simulations are performed during the monsoon season: with and without dust radiative forcing, with and without land-surface feedbacks, with and without prescribed sea surface temperatures. Through these experiments the role of dust radiative forcing and feedbacks on monsoon circulation and precipitation is analyzed.