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Simulating SAL formation and aerosol size distribution during SAMUM-I

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To understand the formation mechanisms of Saharan Air Layer (SAL), we combine model simulations and dust observations collected during the first stage of the Saharan Mineral Dust Experiment (SAMUM-I), which sampled dust events that extended from Morocco to Portugal, and investigated the spatial distribution and the microphysical, optical, chemical, and radiative properties of Saharan mineral dust. We employed the Weather Research Forecast model coupled with the Chemistry/Aerosol module (WRF-Chem) to reproduce the meteorological environment and spatial and size distributions of dust. The experimental domain covers northwest Africa including the southern Sahara, Morocco and part of the Atlantic Ocean with 5 km horizontal grid spacing and 51 vertical layers. The experiments were run from 20 May to 9 June 2006, covering the period of most intensive dust outbreaks. Comparisons of model results with available airborne and ground-based observations show that WRF-Chem reproduces observed meteorological fields as well as aerosol spatial distribution across the entire region and along the airplane's tracks. We evaluated several aerosol uplift processes and found that orographic lifting, aerosol transport through the land/sea interface with steep gradients of meteorological characteristics, and interaction of sea breezes with the continental outflow are key mechanisms that form a surface-detached aerosol plume over the ocean. Comparisons of simulated dust size distributions with airplane and ground-based observations are generally good, but suggest that more detailed treatment of microphysics in the model is required to capture the full-scale effect of large aerosol particles.