Vertical transport and wet scavenging of aerosols in WRF simulations for deep convection during the SEAC^{4}RS field campaign

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Abstract

Deep convective clouds affect aerosol distributions and concentrations through vertical transport and wet scavenging. Aerosol wet scavenging is a complex atmospheric process and is a major source of uncertainty in atmospheric models, especially for parameterized convective clouds. We use the Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) to simulate the wet scavenging of sulfate, ammonium, nitrate, organic aerosol, and black carbon mass concentrations in convective storms observed on 2 September 2013 near Jackson, MS during the NASA Studies of Emissions and Atmospheric Composition, Clouds, and Climate Coupling by Regional Surveys (SEAC^{4}RS) field campaign. WRF-Chem is configured with three domains ranging from the regional scale (Δx = 12 km) over the conterminous US (CONUS) to convective-permitting scale (Δx = 1.3 km) over the Mississippi region. Using NCEP Stage IV precipitation data and NEXRAD radar reflectivity, WRF-Chem produced precipitation and storms similar in character to those that were observed. Vertical profiles of the aerosol mass concentrations are evaluated in the clear air region near the storms with the University of Colorado Aerosol Mass Spectrometer aboard the NASA DC-8 aircraft. Scavenging efficiencies for the aerosol mass concentrations are determined by analysis of the storm inflow and outflow regions, which can be evaluated with estimated scavenging efficiencies derived from the aircraft data. Comparisons between the outer domain over CONUS and the convective-permitting domain over Mississippi provide information on the capabilities of the WRF-Chem with parameterized convection (using the GF scheme) representing aerosol vertical transport and scavenging.