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Sensitivity of Simulated Chemical Concentrations and Aerosol-Meteorology Interactions to Aerosol Treatments in WRF/Chem

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Atmospheric aerosols affect the Earth's radiation budget and climate directly through absorption and scattering of solar and terrestrial radiation and indirectly through acting as cloud condensation nuclei (CCN) and modifying cloud properties such as droplet number concentration and size distribution, cloud reflectivity and lifetime, and precipitation frequency. Different aerosol treatments in 3-D models may lead to different gaseous and aerosol predictions and aerosol direct and indirect effects. Online-coupled meteorology-chemistry models such as WRF/Chem provide an opportunity to study the sensitivity of simulated aerosol direct and indirect effects through aerosol-meteorology interactions to different aerosol treatments. In this study, WRF/Chem simulations are conducted over the continental U.S. for Jan. and Jul. 2001 using one gas-phase mechanism (i.e. the 2005 version of Carbon Bond mechanism (CB05)) and three aerosol modules: the Model of Aerosol Dynamics, Reaction, Ionization, and Dissolution (MADRID), the Model for Simulating Aerosol Interactions and Chemistry (MOSAIC), and the Modal Aerosol Dynamics Model for Europe (MADE) with the secondary organic aerosol model (SORGAM) (referred to as MADE/SORGAM). These aerosol modules differ in some aspects of their treatments for aerosol thermodynamics and dynamics. Simulation results are compared and evaluated against surface and satellite observations. The discrepancies between observations and simulations as well as the sensitivity of simulated gaseous and aerosol predictions and aerosol direct and indirect effects to different aerosol modules are examined. Major causes for such discrepancies are identified.