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Evaluation of the importance of wet scavenging for the May 29, 2012 DC3 severe storm case using results from WRF-chem simulations

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Deep convective thunderstorms affect the vertical distribution of chemical species through vertical transport, wet scavenging of soluble species as well as aqueous and ice chemistry. This work focuses on the impact of wet scavenging on the vertical distribution of chemical species in the May 29 Oklahoma thunderstorm from the DC3 (Deep Convective Clouds and Chemistry) field campaign, which took place in the central US in May-June 2012. Cloud-resolving simulations were conducted with the Weather Research and Forecasting with Chemistry (WRF-Chem) model, with a 15 km grid encompassing the continental US. The wet scavenging scheme from Neu and Prather (ACP, 2012), implemented for MOZART chemistry, is coupled to the Morrison microphysics scheme. The Grell 3D convective scheme, RRTMG radiation and the GOCART aerosol scheme with direct radiative effects are utilized, as well a lightning NO_x scheme based on Price and Rind (1992) using the parameterized level of neutral buoyancy. Chemical initial and boundary conditions are provided by the MOZART global chemistry model and meteorology was forced with DART analyses from the field campaign. Emissions are estimated from the 2005 National Emissions Inventory (NEI), NCAR's Fire Inventory (FINN) emissions model and the Model of Emissions of Gases and Aerosols from Nature (MEGAN).
Simulations with and without wet scavenging are conducted to evaluate the impact of wet scavenging within the storm on vertical distributions. The simulation meteorology is evaluated by comparison with upper air and precipitation analyses and NEXRAD radar reflectivity, as well as meteorological soundings and surface station data. Vertical distributions of chemical species of varying solubilities within the storm and immediately surrounding the storm are compared with observations from the GV and DC8 aircraft in storm inflow and outflow regions. NO_x is underpredicted by the model in upper levels, likely due to underestimated lightning NO_x production. In the simulations without wet scavenging, soluble species are overpredicted in high levels, indicating that material is convectively lofted from the boundary layer in the storm inflow region and either removed by wet scavenging or incorporated into cloud water and ice.