4.066 Microphysical and chemical processes affecting wet removal of soluble trace gases in deep convection observed over the central U.S..

Early Career Scientist

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Abstract:

We examine wet scavenging of soluble trace gases in storms observed during the Deep Convective Clouds and Chemistry (DC3) field campaign. We perform high-resolution simulations (dx = 600m-3km) with the Weather Research and Forecasting model with Chemistry (WRF-Chem) of a severe storm in Oklahoma, a discrete ordinary convective storm in Alabama, and a mesoscale convective system over Arkansas/Missouri/Illinois/Mississippi. Sensitivity simulations are conducted varying the fractions of soluble gases retained in ice (r_f) when liquid water is transformed into frozen precipitation. Scavenging efficiencies (SEs) are calculated from the model and aircraft observations. A significantly higher SE for CH_2O is seen for the Alabama than Oklahoma

storms. On the other hand, significantly more H_2O_2 is scavenged in the MCS than in the Oklahoma storm, which removes more H_2O_2 than the Alabama storm. We show that aqueous chemical sinks are not significant relative to the amount of scavenging of CH_2O and H_2O_2 in these three storms, and therefore do not explain the observed differences in SEs. We then explore differences among storms in precipitation production, temperature-dependent solubilities of the gases, and entrainment of background air as possible explanations for the observed differences in SEs. Finally, higher r_f values for CH_2O, CH_3OOH, H_2O_2 are required in the simulations of the Alabama storm and MCS than of the Oklahoma storm to produce SEs consistent with observations. To determine whether these higher r_f values are necessary to compensate for model errors in dynamics or microphysics that affect SEs, we evaluate the simulated vertical velocity and graupel mass and volume fields with those retrieved from polarimetric radar. Improved understanding of processes affecting net deep convective transport of CH_2O and peroxides is important to predicting the production of ozone (O_3) in the upper troposphere, where ozone affects radiative forcing and downwind air quality.