Evaluating the Use of Lightning Data Assimilation in WRF to Improve the Simulation of Parameterized Deep Convection

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Deep convection influences weather, air quality, and climate through its effects on radiation, rainfall, trace gas transport, and mass redistribution throughout the atmosphere. Thus, accurate simulation of deep convection is an essential component of improving retrospective modeling used to study these impacts. This study applies a simple lightning data assimilation (LDA) technique to improve the simulation of two observed cases of deep convection using the Weather Research and Forecasting Model (WRF): An Oklahoma supercell on 29 May 2012 and a mesoscale convective system (MCS) on 11 June 2012. Both cases occurred during the Deep Convective Clouds and Chemistry (DC3) campaign. The LDA technique uses temperature and moisture perturbations to trigger deep convection within the Kain-Fritsch cumulus parameterization where lightning is observed; deep convection (but not shallow) is suppressed when lightning is not present. The LDA is evaluated in terms of basic meteorological parameters, simulated rainfall, and cloud top heights. We use MET object-based verification and traditional grid point-based statistical techniques to evaluate the simulated storms. Our findings show that the LDA technique produces considerably improved statistical metrics (correlation, RMSE, MAE) of convective rainfall in both the supercell and MCS cases. The LDA also provides more accurate cloud top heights for the supercell case. However, the LDA exhibits relatively less success regarding areal cloud coverage for the MCS case. Altogether, this study suggests that this simple WRF LDA approach is an effective way of improving the simulation of different deep convective storm types in retrospective modeling.