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Supercell Predictability: Exploring Ensemble Sensitivity to Initial Condition Spread

Montgomery Flora (1), Corey Potvin (1,2,3), Louis Wicker (3), Patrick Skinner (2,3), Dustan Wheatley (2,3), Kent Knopfmeier (2,3)

(1) School of Meteorology, University of Oklahoma, Norman, Oklahoma, United States, (2) Cooperative Institute for Mesoscale Meteorological Studies, University of Oklahoma, Norman, Oklahoma, United States, (3) NOAA/OAR National Severe Storms Laboratory, Norman, Oklahoma, United States

The sensitivity of full-physics ensemble forecasts of supercells to initial condition (IC) uncertainty is investigated. The motivation for the study largely stems from the NOAA Warn-on-Forecast (WoF) program, where the primary objective is to develop a storm-scale ensemble prediction system that will generate probabilistic guidance for severe weather forecasts and warnings. The three sets of initial/boundary conditions for our simulations were generated from the real-time NSSL Experimental WoF System for Ensembles (NEWS-e) during the 2016 NOAA Hazardous Weather Testbed Spring Forecasting Experiment. In accordance with WoF, each ensemble was initialized with developing thunderstorms and integrated for 3 hours. Our primary goal was not to replicate observed supercell evolution, but rather to isolate the effect of IC uncertainty using a perfect- model assumption with a horizontal grid spacing (1 km) that can resolve the storm's mesocyclone reasonably well.

The forecast sensitivity to IC uncertainty is assessed by successively reducing the initial 3-km ensemble perturbations to 50%, 25%, and 10% of the original perturbations, which are downscaled to the 1-km grid. Forecast spread was substantially reduced with decreasing initial condition uncertainty. The intrinsic predictability was primarily related to growth in amplitude spread (i.e. uncertainty in intensity) rather than in phase spread (i.e. uncertainty in location). The predictability of individual supercell features (e.g., updraft and low-level mesocyclone) was correlated - an indication that features organized on larger scales can enhance the predictability of smaller features.

Experiments also explored the importance of IC uncertainty within vs. outside of the storm. Increased intra-storm certainty greatly reduced forecast spread early on, while at longer lead times, forecasts benefited more from increased environment certainty.