Multiscale Ensemble Data Assimilation and Forecasts of a Tornadic Supercell Storm

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The numerical experiments over the past few years indicate that incorporating environmental variability is crucial for successful convective-scale forecasts [1-2]. To explore the impact of mesoscale environmental variability and its uncertainty to very short-range (0–1 h) convective-scale forecasts, combined mesoscale-convective scale ensemble data assimilation and forecast experiments are conducted for the 8 May 2003 Oklahoma City tornadic supercell storm. Two sets of 36-member WRF-ARW model mesoscale ensemble adjusted Kalman filter (EAKF) data assimilation systems with continuous cycling on a continental United States domain are conducted using either fixed physics or multiple physics parameterization schemes across the ensemble members to provide background environmental conditions. Two 36-member convective-scale ensembles are initialized at 3-km grid spacing, one using background fields from the fixed physics and the other using background fields from multiple physics mesoscale ensemble analyses. Reflectivity and radial velocity observations from four operational WSR-88D radars are assimilated into the convective-scale ensemble members using the ARPS model based three-dimensional variational (3DVAR) data assimilation system for a 40-min period and 1-hr ensemble forecasts are launched.

Comparisons between the two convective-scale ensemble forecasts show that the ensemble with background fields from multiple physics mesoscale ensemble provides more realistic forecasts of significant tornado parameter (STP), dryline location and structure, and near surface variables than the ensemble from fixed physics mesoscale background fields. In addition, the probability of strong low-level mesocyclone track of the tornadic supercell correlates better with the observed rotation track from the multiphysics ensemble than that from the fixed physics ensemble. This suggests that incorporating physics diversity across the ensemble is important to successful probabilistic convective-scale forecast of supercell thunderstorms, which is the main goal of NOAA's Warn-on-Forecast [3] initiative.

References

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