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Convection-permitting ensemble forecast system design

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Forecasting convective precipitation remains a considerable challenge for the weather community, but much progress has been made through continued research on convective processes, advances in numerical models, and access to larger computing capacity that collectively has improved forecast guidance. Moreover, applying high-resolution ensemble forecasts to create probabilistic forecast guidance for rare, high impact events shows considerable merit to improve decision-making. Yet, little is established to date on best practice in storm-scale ensemble forecast system design to achieve routinely skillful and reliable predictions.

The National Center for Atmospheric Research (NCAR, Boulder, CO, USA) began (in April 2015) to operate a real-time ensemble analysis and convection-permitting ensemble forecast system to investigate convective-scale predictability for a wide range of high-impact phenomena. Executing an ensemble adjustment Kalman filter within the Data Assimilation Research Testbed (DART) toolkit produces the ensemble initial conditions, in a continuously cycled ensemble analysis, where the physics suite for the NCAR Weather Research and Forecasting (WRF) model has been selected based on observation fit statistics. Convection-permitting forecasts use the same physics suite as the cycled analysis (sans cumulus parameterization). Our team also developed a variety of approaches to visualize probabilistic forecast information for high impact hazard prediction. Further, we apply several methods in neighborhood probabilistic and object-based verification to assess forecast skill and reliability, particularly for high impact weather events (e.g. tornadoes, hail, damaging local winds, flash flooding, and winter hazards).

At present, the real-time forecast system relies on a mesoscale ensemble analysis with only conventional observations assimilated, which is appropriate for next-day hazard prediction. Our current aim is to improve short-term hazard prediction (0-12 h), which will require initializing ensembles from the same convection-permitting grid as the current forecasts to 1) reduce forecast errors owing to initial model spin-up and ongoing convection; and 2) to diagnose errors in the forecast model. The new analysis will include frequent assimilation of radar and satellite observations, in addition to conventional observations, to improve the initial representation of ongoing precipitation systems.

At the conference, we will give a brief description of the ensemble analysis and forecast system design, highlight probabilistic guidance for select high-impact severe weather forecast events from our ongoing real-time forecast system, and will share our latest progress in developing a large area convection-permitting ensemble analysis over the conterminous United States.