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Convective-scale data assimilation in the Weather Research and Forecasting model using a nonlinear ensemble filter

Jonathan Poterjoy, Jeffrey Anderson, and Ryan Sobash
National Center for Atmospheric Research, Boulder, United States (poterjoy@ucar.edu)

Assimilating measurements of convective-scale processes poses a large challenge for data assimilation techniques currently used in atmospheric science. A part of this challenge lies in the nonlinear system dynamics, as well as nonlinearity in the mapping between the model state and remotely sensed data used to provide evidence of the true system state. In this presentation, we discuss recent applications of a nonlinear data assimilation system, based on the particle filter (PF), for convective-scale data assimilation in the Weather Research and Forecasting model. The new data assimilation technique, denoted the local PF, operates in a manner similar to traditional PF methods, except the impact of observations on posterior particles (or ensemble members) is restricted to local neighborhoods of observations. We compare the local PF with a conventional ensemble Kalman filtering method in idealized data assimilation experiments performed for a developing mesoscale convective system. In these experiments, the local PF provides improved representations of cloud properties in posterior particles, which leads to a reduction in short-range forecast errors over the ensemble Kalman filter. This study presents the first successful application of a particle filter in a high-resolution weather prediction model.