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Ensemble Sensitivity-Based Subsetting Overview and Evaluation Activities at the 2018 NOAA HWT

Brian Ancell, Austin Coleman, and Aaron Hill
Texas Tech University, Geosciences, Lubbock, TX, United States (brian.ancell@ttu.edu)

Ensemble sensitivity is a statistical tool applied within an ensemble that reveals the atmospheric flow features (e.g. position of a jet streak, or magnitude of a low-level moisture plume) at early forecast times that are related to a chosen forecast response later in the forecast window. The response function is chosen to diagnose forecast features of interest such as maximum updraft helicty over a specified area, or number of grid points of simulated reflectivity exceeding 40 dBZ over a specified area. Since ensemble sensitivity can highlight the features early in a forecast important to the prediction of high-impact weather, it is possible that by comparing ensemble members to analyses or observations at early forecast times, a subset of members with the smallest errors in sensitive regions can be chosen that improves probabilistic forecasts of the response relative to the full ensemble. This can be done quickly once an ensemble has been run, and sensitivity-based subsets can typically be generated well before the next extended forecast can be run within a cycling storm-scale data assimilation and forecasting system, providing important improvements in lead time. This procedure can be viewed as a real-time data mining technique, adjusting the ensemble based on information specific to the prediction of chosen high-impact events.

Real-time ensemble sensitivity-based subsetting was tested within the Texas Tech University operational ensemble system at the 2018 NOAA HWT. Day 1 response function areas (usually around 24-hr forecast time) were chosen daily through a graphical user interface to diagnose the forecast problem of the day (usually an area of high uncertainty of updraft helicity) within the 0000 UTC ensemble run. Once the area was chosen, an objective subsetting algorithm calculated the sensitivity of maximum 2-5km updraft helicity, number of grid points exceeding 25 m2/s2 2-5km updraft helicity, and number of grid points exceeding 40 dBZ simulated reflectivity. The sensitivity was calculated with respect to variables aloft at 6-hr forecast time including 700-hPa temperature, and 300- and 500-hPa temperature, winds, and geopotential height. The 10 members from the full 42-member ensemble with the smallest errors in the most sensitive regions at 6-hr forecast time were chosen to compose the subset, and new probabilities were calculated for Day 1 updraft helicity and simulated reflectivity for evaluation the next day against storm reports and SPC practically perfect probabilities (compared with full ensemble probabilities). While survey results showed a majority of participants believed the subsetting technique was successful, results were highly variable. Here we discuss the nature of the changes the subsetting produced relative to the full ensemble, and describe some of the specific success and failure cases. Future plans for the further development of the subsetting technique will be discussed.