Evaluating the Performance of High-Resolution Hurricane Prediction Modeling System

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Introduction
An experimental version of the Hurricane Weather Research and Forecasting System (designated HWRFx) is currently being used at NOAA’s Hurricane Research Division (HRD) to evaluate possible improvements to the prediction of both track and intensity of tropical cyclones. Observations obtained from NOAA’s aircraft missions are combined with the HWRFx output for a specific storm, using a technique called data assimilation. In what is known as cycling, HRD’s Hurricane Ensemble Data Assimilation System (HEDAS) sequentially updates the dynamic and thermodynamic fields of the model in the vicinity of the storm. In each cycle the update is computed by an Ensemble Kalman Filter (EnKF) algorithm in which ensemble-based covariances between observations and model fields are utilized (Figure 1). The combined data in a form of gridded fields from the final update cycle, called analysis, are then used to initiate HWRFx to generate a forecast. In this study, the performance of different experiments that were carried out with HEDAS for a case of Hurricane Bill of 2009 is analyzed.

Methods
• Different experiments were carried out by HRD’s data assimilation group (Figure 3).
• Output files were provided to evaluate the performance of each experiment.
• Time cycles of different variables (T, Q, Theta-e, MSLP, CIWM, U, V, W) were analyzed.
• Final analyses of each experiment were compared to observations when available.
• The ensemble covariance data were analyzed for the experiment that showed the best performance, to understand the behavior of the model when updating the physical variables within the cycle.

Results

Conclusions
• Results showed HEDAS had a good performance for the study case of Bill, but it could be improved.
• The experiment with no inflation and no covariance relaxation showed the best skill among the experiments that were run with HEDAS.
• The thermodynamic field should always be updated even when only the winds are the observations being assimilated.
• The covariance calculation showed realistic patterns of vortex dynamics, but further research is required for a better interpretation.

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Related Work
Results from other experiments done with HEDAS will be presented at the 15th Conference on Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface (IOAS-AOLS), Iroko J11.3, J11.4, and J11.5, AMS Annual Meeting, 2011.