Reconnaissance Data Impact on Hurricane Intensity Prediction with the real-time WRF-EnKF System

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An experimental next-generation hurricane prediction system based on the cloud-permitting Weather Research and Forecasting (WRF) model and an advanced data assimilation technique known as the ensemble Kalman filter (EnKF) has been developed at Penn State University (PSU). The system uses the EnKF to ingest high-resolution airborne Doppler radar observations of the hurricane's inner core to provide better initial conditions to the WRF model, which in turn yields more accurate forecasts.The PSU WRF-EnKF hurricane analysis and prediction system had been operated in real-time for Atlantic storms for 5 years with airborne Doppler radar data assimilation and performed remarkably well for all landfalling hurricanes from 2008 through 2012: averaged over all 102 applicable airborne Doppler missions, errors in forecast intensity for lead times of 1 to 5 days were 15-43% less than the corresponding official forecasts issued by the National Hurricane Center.

Since 1982, dropwindsondes were released from 2 WP-3D aircrafts, reconnaissance data had been become a significant data source in hurricane prediction. This study exams the impact on hurricane intensity prediction with the PSU real-time hurricane analysis and prediction system to breakthrough the limitation of the small TDR sample size. To establish a baseline level of hurricane intensity prediction accuracy, a control run without any Reconnaissance data assimilation by the cycling WRF-EnKF system is designed. Two experiments are designed: one is to assimilate flight-level and dropsonde observations, and another one is to assimilate flight-level, dropsonde and TDR observations. The preliminary result shows,

1) The control run with the cycling assimilation system largely reduces the system bias than the cold-started WRF forecasts initialized with GFS operational analysis;
2) The assimilation of fligh-level and dropsonde observations can reduce 5~15% error during the 12~96 h lead-time;
3) The assimilation with all inner-core observations including flight-level, dropsonde and TDR data can provide very realistic initial vortex, made the intensity bias very small and improve both the track and intensity prediction.

References

F. Zhang, Y. Weng, J. A. Sippel, Z. Meng & C. H. Bishop, Cloud-resolving Hurricane Initialization and Prediction through Assimilation of Doppler Radar Observations with an Ensemble Kalman Filter: Humberto (2007). *Mon. Wea. Rev*., **137**, 2105-2125 (2009). doi: 10.1175/2009MWR2645.1.

F. Zhang, Y. Weng, J. F. Gamache & F. D. Marks, Performance of Convection-permitting Hurricane Initialization and Prediction during 2008-2010 with Ensemble Data Assimilation of Inner-core Airborne Doppler Radar Observations. *Geophysical Research Letters*, **38**, L15810 (2011). doi:10.1029/2011GL048469.

Y. Weng & F. Zhang, Assimilating Airborne Doppler Radar Observations with an Ensemble Kalman Filter for Convection-permitting Hurricane Initialization and Prediction: Katrina (2005). *Monthly Weather Review*, **140**, 841-859 (2012). doi: http://dx.doi.org/10.1175/2011MWR3602.1.