Data Assimilation and Initialization in HWRF

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The Hurricane Ensemble Data Assimilation System (HEDAS) is an Ensemble Kalman Filter designed to create initial conditions for the Hurricane Weather Research and Forecast (HWRF) Model. HEDAS has been shown to provide accurate initial conditions for HWRF deterministic model runs in its various configurations, and has been used to study the impact of real observations on forecasts (Observing Systems Experiments) and of proposed observation types (Observing System Simulation Experiments), as well as helping to design optimal sampling strategies for real and proposed observational platforms.

Three topics concerning the data assimilation using HEDAS and initialization of the HWRF model will be presented:

1. Assimilation of dropwindsonde data: Current practice is to transmit dropwindsonde data using the TEMPDROP format, which provides only the release location and time with 0.1° latitude–longitude (about 11 km), and 1-h resolutions, respectively. The current dropwindsonde has a fall speed of approximately 15 ms-1, so the instrument will be advected faster horizontally than it descends if the wind speed exceeds this value. Where wind speeds are greatest, such as in tropical cyclones, this will introduce large errors in the location of the observations, especially near the surface. A technique to calculate the correct time and location of each observation in the TEMPDROP message is introduced, and the impact of using this technique on HEDAS analyses is presented.
2. Initialization of HWRF with vertical velocity and microphysical analyses: In HWRF, the vertical velocity variable is in the form of (1-dw/dt), but that variable does not appear in files used to initialize the model. Therefore, each model run start with a uniform base value of 1-dw/dt and no vertical velocity, and it takes on the order of a half hour for the vertical velocity to grow to 10 ms-1 according to the HWRF documentation. This suggests that a lag in the development and sustenance of the tropical cyclone secondary circulation exists. HEDAS is able to initialize HWRF with non-zero vertical velocity and vertical accelerations. The result of such initialization, and the initialization of total water content, ice mixing ratio, and rain mixing ratio is presented.
3. HEDAS has been run at 3-km resolution in the tropical cyclone core, and the operational HWRF has been upgraded to 2-km resolution there. Recent small, intense hurricanes such as Danny and Patricia have suggested that, in some cases, even this resolution is not sufficient for proper analysis and numerical forecasts. Analyses and forecasts at 3-, 2-, and 1-km resolutions are presented.