Aircraft Observations Used to Improve Physics in Operational Hurricane Models

Supported by National Oceanic and Atmospheric Administration (NOAA) Hurricane Forecast Improvement Program (HFIP), scientists at Cooperative Institute for Marine and Atmospheric Studies (CIMAS) in collaboration with Atlantic Oceanographic and Meteorological Laboratory (AOML) Hurricane Research Division are improving physics in the operational Hurricane Weather Research and Forecasting (HWRF) model by implementing an observation-based parameterization of turbulence mixing in the planetary boundary layer (PBL) scheme. The observational data were collected within the intense eyewalls of Hurricanes Allen (1980) and Hugo (1989).

Background: Theoretical and numerical studies have shown that turbulent transport processes in the boundary layer play an important role in the intensification and maintenance of a tropical cyclone. However, in part because of safety constraints, direct measurements of turbulence in the inner-core region of intense hurricanes have been limited. To obtain the needed observations requires research aircraft to fly in the low-level boundary layer of the intense eyewall of a category four or five hurricane. Moreover it must be equipped with a probe that can measure three dimensional wind velocities high frequency sampling rates.

Significance: This project demonstrates how hurricane model physics can be improved using aircraft observations. For the first time, turbulent momentum flux, turbulent kinetic energy (TKE) and vertical and horizontal eddy diffusivities have been estimated from in-situ observations in the hurricane boundary layer at surface wind speeds higher than 30 ms^{-1}. These estimates were used to validate key parameters used in the PBL scheme of the operational HWRF model which enabled the identification of a bias in vertical eddy diffusivity. Correcting this bias resulted in significantly improved simulations of hurricane structure and intensity. Doing so directly addresses a major programmatic priority of NOAA's *HFIP* research initiative. The improvements made have been incorporated into not only HWRF but also other hurricane forecast models such as the Geophysical Fluid Dynamics Laboratory (GFDL) operational model.

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