Dynamics and Predictability of the Intensification of Hurricane Edouard (2014)

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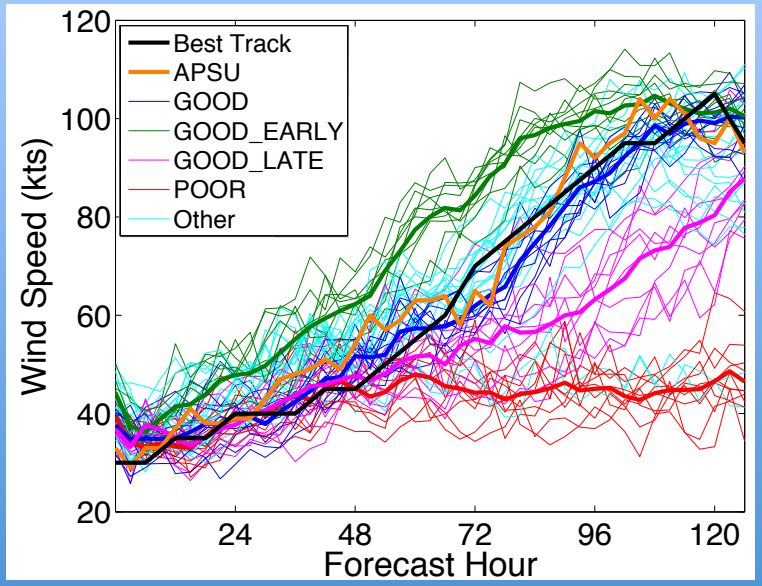
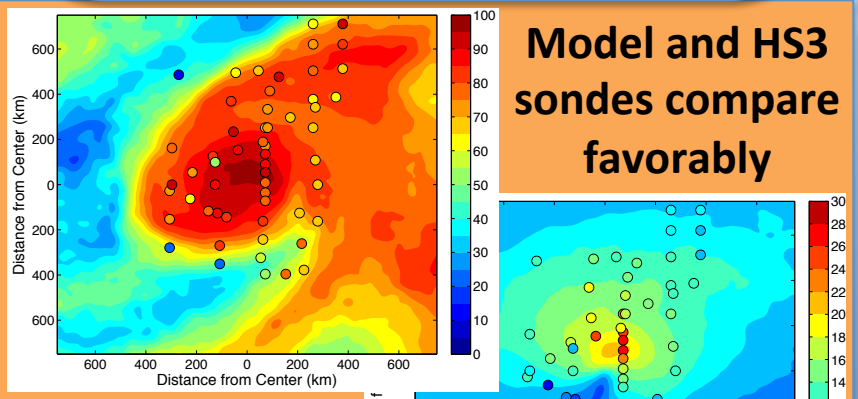
Using convection-permitting ensemble forecasts and HS3 dropsonde data, the predictability and dynamics of the onset of Edouard's significant intensification period is explored. The timing of intensification is primarily related to the impacts of deep-layer shear on the subsequent evolution of the vortex tilt and associated convection.

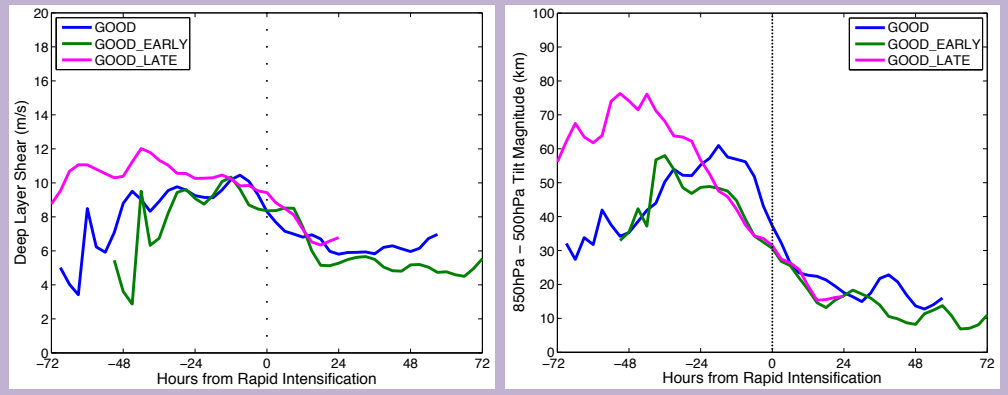
Ensemble Maximum 10-m Wind Speed Evolutions





Model and HS3 sondes compare favorably

700-hPa RH (top left) and 950-hPa winds (right)



Deep-layer shear (m s^{-1}; left) and tilt magnitude (km; right) decrease in developing members 12–24 h prior to intensification

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Data sources: Dropsondes from the Airborne Vertical Atmospheric Profiling System (AVAPS) from the 2014 HS3 field campaign are shown, and the analysis in this study utilized data from the first two flights into Hurricane Edouard (Sept. 11-12 and 14-15).

Technical Description of Figures:

Upper right: 5-day maximum 10-m wind speed (kt) forecasts for the 1200 UTC 11 September 2014 initialization of Hurricane Edouard from the 60 member PSU WRF-EnKF ensemble forecast system. Members are placed in composite groups of 10 according to their RI-onset time; GOOD – RI-onset at the Best Track RI (72 h; blue), GOOD_EARLY – RI 24 h earlier than Best Track RI (48 h; green), GOOD_LATE – RI 24 h after Best Track RI (96 h; magenta), and POOR – RI does not occur in the simulation window (red). The composite means (thick), the NHC Best Track (black), and the APSU deterministic forecast (orange) are also plotted. The remaining ensemble members not classified in composite groups are in cyan. Despite very similar initial conditions, there is as much as 48–60 h of simulation time between intensification onset of the earliest and latest developing members. An additional 10–15 members do not substantially intensify at all.

Lower right: Evolution of the magnitude (m s^{-1}) of deep-layer (850-hPa–200-hPa) wind shear (left) and tilt magnitude (km; 850-hPa–500-hPa) for the means of the composite groups GOOD (blue), GOOD_EARLY (green), and GOOD_LATE (magenta) plotted in relation to the intensification onset time of the composite groups. Both the shear and tilt magnitudes begin to decrease approximately 12–24 h prior to intensification.

Lower left: Storm-centered horizontal cross-section of 700-hPa relative humidity (contours filled every 5%; upper left) and 950-hPa winds (contours filled every 2 m s^{-1}; lower right) for the GOOD composite group at 0900 UTC 12 September 2014 (21 h). Markers indicate storm-centered positions of the AVAPS dropsondes that were deployed during the 12 September HS3 flight and are filled according to the values of relative humidity and winds recorded closest to the corresponding modeled pressure levels. The mid-level relative humidity field compares favorably between the model and the HS3 dropsondes, and the vortex structure is also well represented with the strongest winds on the northern side of Edouard's circulation (although the modeled winds are slightly weaker).

Scientific significance, societal relevance, relation to future missions: The data gathered by the Global Hawk during HS3 throughout the lifetime of Hurricane Edouard is beneficial to scientific research concerning tropical cyclone predictability and ensemble modeling. The model verification from the HS3 dropsondes is crucial to ensuring the representativeness of the ensemble, which allows for additional diagnoses of the most sensitive dynamical features throughout the tropical cyclone evolution. In addition, the HS3 dataset provides significant opportunities for continued ensemble data assimilation, which facilitates the further examination of the predictability limits associated with tropical cyclone forecasting.