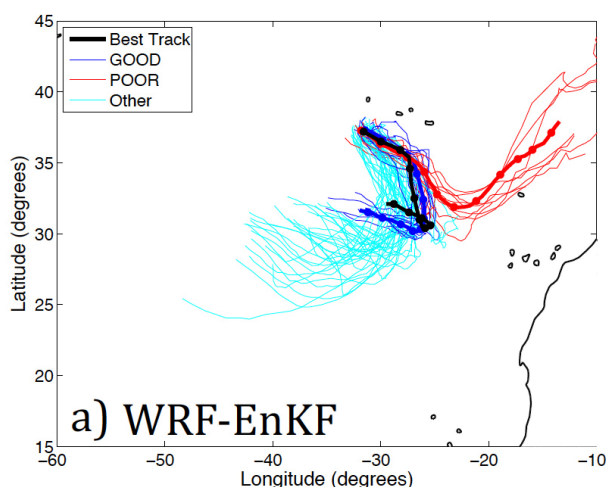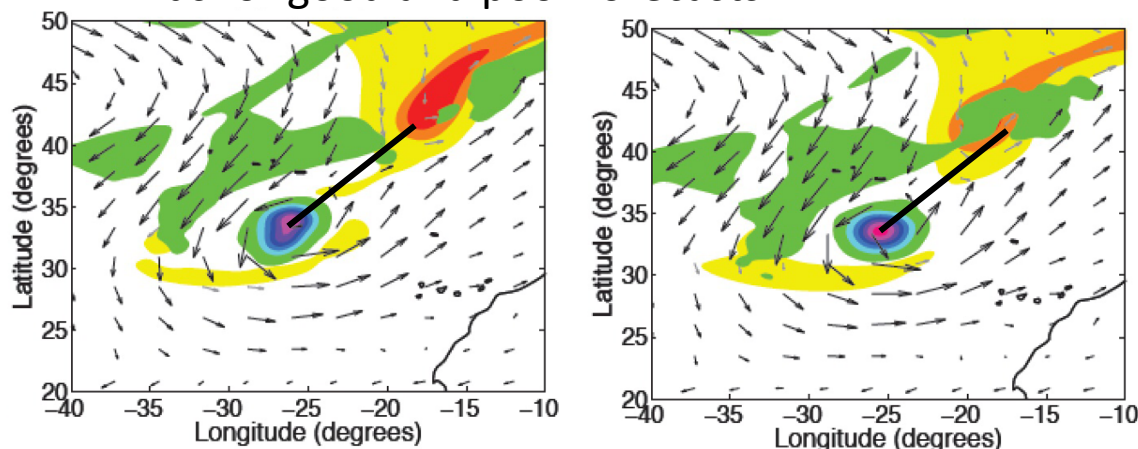# Predictability of Hurricane Nadine's (2012) Track During HS3
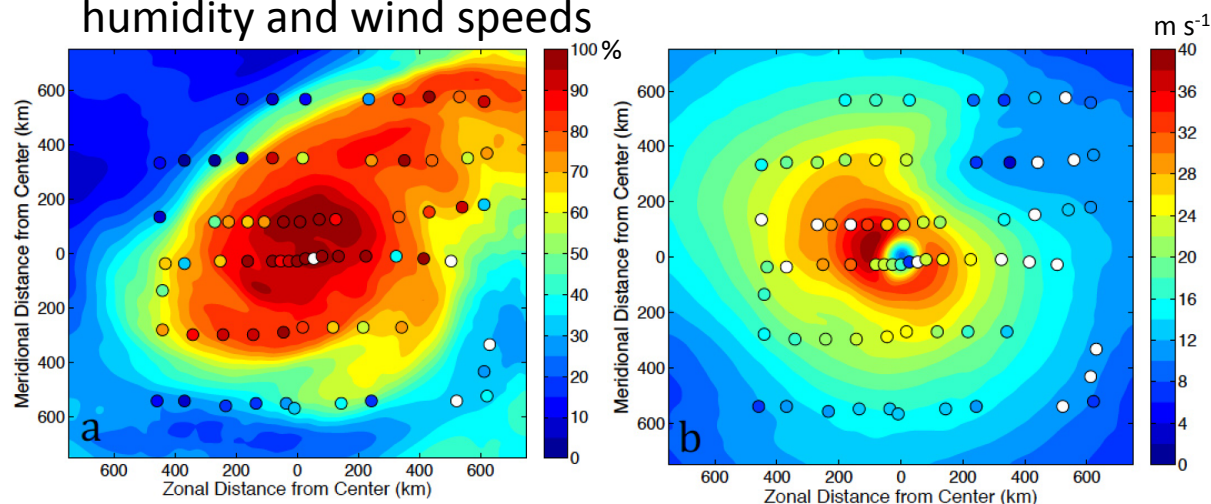
Track forecasts from 30-member ensemble

a) WRF-EnKF

Upper (yellow-red) and lower (green-blue) PV & winds for good and poor forecasts
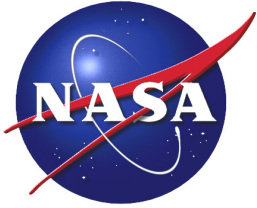

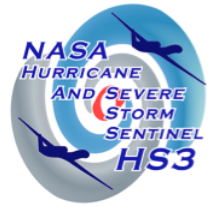Simulated (shaded) versus observed (circles) relative humidity and wind speeds

Small differences in the coupling of upper and lower PV anomalies leads to track divergence.

Storm winds overpredicted due to inadequate coupling with the ocean.

Name: Scott Braun, NASA/GSFC, Code 612
E-mail: scott.a.braun@nasa.gov
Phone: 301-614-6316

Publication: "Dynamics and predictability of Hurricane Nadine (2012) evaluated through convection-permitting ensemble analysis and forecasts with NASA HS3 field campaign observations" by Erin Munsell (Penn State Univ.), Jason Sippel (NASA/GESTAR), Scott Braun (NASA), Yonghui Weng (PSU), and Fuqing Zhang (PSU). Mon. Wea. Rev., (conditionally accepted).

Data sources: Data from the HS3 2012 field campaign (from Sept. 19-20 and 22-23) are assimilated into forecasts with the Penn State Hurricane Weather Research and Forecast (WRF) model. The goal of the study was to examine forecast sensitivity to environmental conditions that led to track bifurcation (some ensemble members moved the storm back to the west while others moved it eastward). Results found that the track divergence was caused by small differences in the mean environmental steering flow that resulted from uncertainties in the position and strength of a nearby midlatitude trough. They also found that forecast intensity was particularly sensitive to whether the sea-surface temperature field was updated frequently to account for storm feedbacks on the ocean versus keeping the SST constant with time (as is often done).

Technical Description of Figures:

Top leftt: Five-day track forecasts for the WRF ensemble. The observed track is the bold black line. "GOOD" forecasts (the 10 forecasts with the smallest RMSE track error) are indicated in dark blue, "POOR" forecasts (highest RMSE error) in red, while the remaining forecasts are light blue. Bold blue and red lines show the composite GOOD and POOR forecasts. The figure highlights the difficulty of the track forecasts during this forecast period.

Upper right panels: Upper level (300-200 hPa average, filled warm colors) and lower level (850-700 hPa average, filled cool colors) potential vorticity (PV) composites for GOOD (left) and POOR (right) forecasts at 42 h into the forecast. In the POOR forecasts, the storm (bullseye pattern) and trough to the northeast are closer together so that the trough moves the storm to the east, while in the GOOD forecasts, the storm is sufficiently separated from the trough that it is able to move back to the west. The black line (left) shows the separation between the storm and the trough. In the right panel, the exact same line is shown and it can be seen that the trough is farther west and south than in the GOOD forecasts.

Lower: Storm-centered horizontal cross sections of 700 hPa relative humidity (%, left) and 950 hPa tangential winds (m s^{-1}, right) during 19-20 September. Color shaded contours are from the GOOD composite while color-filled circles are from the Global Hawk dropsonde observations. The dropsonde data show that the relative humidity field is well reproduced by the model, but that the model over-intensifies the tangential winds.

Scientific significance, societal relevance, relation to future missions: The Global Hawk provides a valuable capability for mapping out large regions of the storm and its environment. The study highlights the potential causes of extreme track divergence and HS3 observations were important for determining in which ways the model performed well and where it performed poorly. Even when SST fields were updated over the course of the forecasts, simulated intensities were too intense, suggesting that a more sophisticated approach, such as a coupled ocean-atmosphere model, is needed.