Real time forecast of Hurricane Sandy had track and intensity accuracy

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A real-time hurricane analysis and prediction system that effectively incorporates airborne Doppler radar information may accurately track the path, intensity and wind force in a hurricane, according to Penn State meteorologists. This system can also identify the sources of forecast uncertainty.

"For this particular study aircraft-based Doppler radar information was ingested into the system," said Fuqing Zhang, professor of meteorology, Penn State. "Our predictions were comparable to or better than those made by operational global models."

Zhang and Erin B. Munsell, graduate student in meteorology, used The Pennsylvania State University real-time convection-permitting hurricane analysis and forecasting system (WRF-EnKF) to analyze Hurricane Sandy. While Sandy made landfall on the New Jersey coast on the evening of Oct. 29, 2012, the analysis and forecast system began tracking on Oct. 21 and the Doppler radar data analyzed covers Oct. 26 through 28.

The researchers compared The WRF-EnKF predictions to the National Oceanic and Atmospheric Administration's Global Forecast System (GFS) and the European Centre for Medium-Range Weather Forecasts (ECMWF). Besides the ability to effectively assimilate real-time Doppler radar information, the WRF-EnKF model also includes high-resolution cloud-permitting grids, which allow for the existence of individual clouds in the model.

"Our model predicted storm paths with 100 km—50 mile—accuracy four to five days ahead of landfall for Hurricane Sandy," said Zhang. "We also had accurate predictions of Sandy's intensity."

The WRF-EnKF model also runs 60 storm predictions simultaneously as an ensemble, each with slightly differing initial conditions. The program runs on NOAA's dedicated computer, and the analysis was done on the Texas Advanced Computing Center computer because of the enormity of data collected.

To analyze the Hurricane Sandy forecast data, the researchers divided the 60 runs into groups—good, fair and poor. This approach was able to isolate uncertainties in the model initial conditions, which are most prevalent on Oct. 26, when 10 of the predictions suggested that Sandy would not make landfall at all. By looking at this portion of the model, Zhang suggests that the errors occur because of differences in the initial steering level winds in the tropics that Sandy was embedded in, instead of a mid-latitude trough—an area of relatively low atmospheric pressure—ahead of Sandy's path.

"Though the mid-latitude system does not strongly influence the final position of Sandy, differences in the timing and location of its interactions with Sandy lead to considerable differences in rainfall forecasts, especially with respect to heavy precipitation over land," the researchers report in a recent issue of the Journal of Advances in Modeling Earth Systems.

By two days before landfall, the WRF-EnKF model was accurately predicting the hurricane's path with landfall in southern New Jersey, while the GFS model predicted a more northern landfall in New York and Connecticut, and the ECMWF model forecast landfall in northern New Jersey.

Hurricane Sandy is a good storm to analyze because its path was unusual among Atlantic tropical storms, which do not usually turn northwest into the mid-Atlantic or New England. While all three models did a fairly good job at predicting aspects of this hurricane, the WRF-EnKF model was very promising in predicting path, intensity and rainfall.

NOAA is currently evaluating the use of the WRF-EnKF system in storm prediction, and other researchers are using it to predict storm surge and risk analysis.

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