Improved Landfalling Tropical Cyclone Wind Forecasts

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Introduction

•Accurate prediction of the tropical cyclone wind field after landfall is one of the greatest challenges for operational forecasters.

•Many past studies have examined the evolution of the tropical cyclone wind field after landfall (Wong et al. 2008; Bhowmik et al. 2005; and Kaplan and DeMaria 2001).

•The results of these studies have not been routinely incorporated into the techniques used by NWS forecasters in operational prediction.

NWS Forecast Process

A survey of local WFOs was conducted to develop a better understanding of the process of developing a wind speed and gust forecast for a tropical cyclone. There was a consensus among forceasters on the following points:

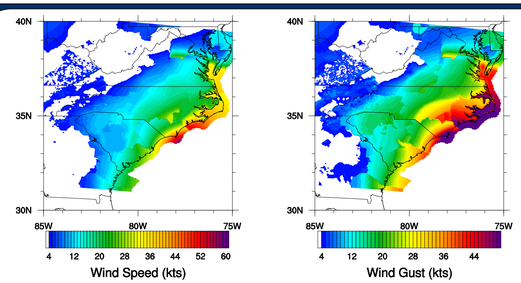
•Forecasters use a Smart Tool in the Graphical Forecast Editor called TCMWindTool that takes the four quadrant NHC highest wind forecast and interpolates it to a 5 km x 5 km grid.

•Forecasters then make adjustments to the output from TCMWindTool through a largely subjective process.

- Land reduction factors range from 10-40%, depending on distance from coast and tropical cyclone characteristics.
- Gust factors range from 15-40% above sustained wind speeds, depending on forecasted degree of mixing and tropical cyclone characteristics.

•The choice of a background wind field for the TCMWindTool is highly subjective. interpolating the 12-hour TCM wind forecast onto hourly grids is another significant source for error.

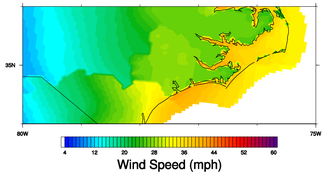
•The lack of collaboration between offices for the above processes often leads to differences in forecast wind speeds and gusts.



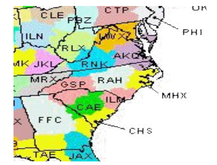
(NDFD wind speed and gust forecast from 00z 05 Sept. valid at 06z 06 Sept.)

Purpose: The overall goal of this study is to thus to improve the currently used methodology for operational forecasts of wind speed and wind gusts associated with tropical cyclones.

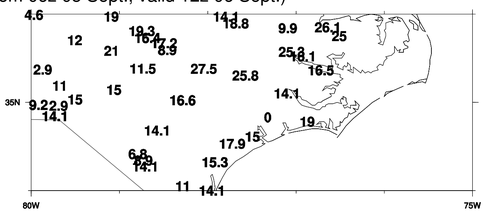
Hannah (2006) Forecast



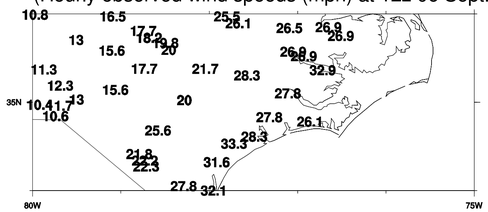
(NDFD wind speed forecast from 06z 05 Sept., valid 12z 06 Sept.)



(WFO Offices)



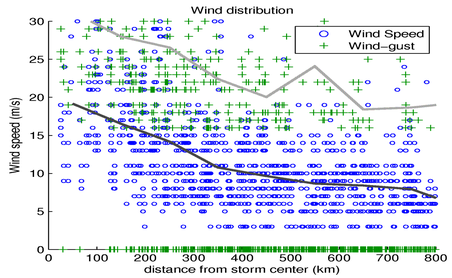
(Hourly observed wind speeds (mph) at 12z 06 Sept.)



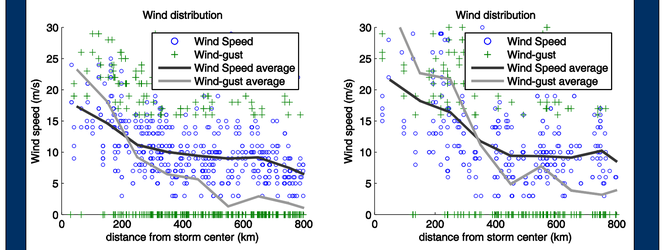
(NDFD interpolated wind speeds (mph) at 12z 06 Sept.)

- Generally weaker observed winds in coastal regions than forecasted. In far inland areas, some areas where forecasted winds were weaker than observed.

- Combination of subjective nature of forecasts, low-resolution initial condition for model, and complex synoptic conditions lead to forecast errors



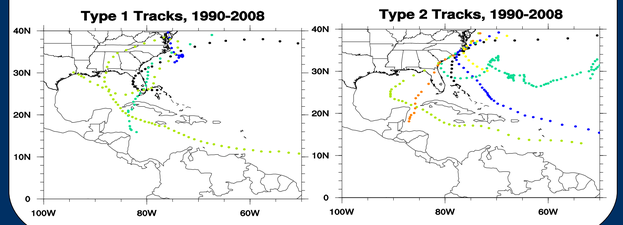
(Distribution of wind and wind gusts as a function of distance of the measuring station from the center of the storm)

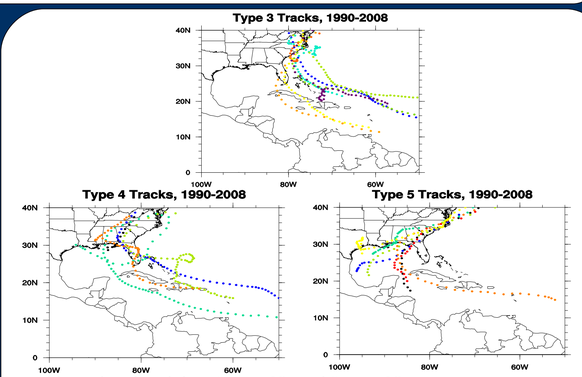


(Same as previous figure, but broken down by quadrant)

Tropical Cyclone Tracks

- Tropical cyclones affecting North Carolina 1990-2008 broke down by track. Five major tracks identified:





- Hypothesized that "type 2" and "type 3" storms most poorly forecasted

Future Work

The NDFD forecasts will be compared to the observed sustained wind speeds and gusts for each storm in each track type. A statistical calculation of bias will be computed.
A gust factor will be calculated for each track type. Common synoptic and mesoscale features will be identified among the various identified cases that will help explain land reduction and gust factors. A statistical and dynamical model will be built to model winds and wind gusts associated with these landfalling tropical cyclones. This will be accomplished by combining the above climatological observations-based analysis with specific high-resolution numerical simulations of select cases.

References

Bhowmik, S.K.R., S.D. Kotal, and S.R. Kalsi, 2005: An Empirical Model for Predicting the Decay of Tropical Cyclone Wind Speed after Landfall over the Indian Region. *J. Appl. Meteor.*, **44**, 179-185.

Kaplan, J., and M. DeMaria, 2001: A note on the decay of tropical cyclone winds after landfall in the New England area. *J. Appl. Meteor.*, **40,** 280-286.

Wong, M.L.M., J.C.L. Chan, and W. Zhou, 2008: A Simple Empirical Model for Estimating the Intensity Change of Tropical Cyclones after Landfall along the South China Coast. *J. Appl. Meteor. Climatol.*,**47**, 326-338.

Acknowledgements

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