Semi-annual Report for JHT Project entitled:

Quantifying Tropical Cyclone Track Forecast Uncertainty and Improving Extended-range Tropical Cyclone Track Forecasts Using an Ensemble of Dynamical Models

James S. Goerss, Principal Investigator

Summary of Work

A new consensus forecast model, CONU, was formulated and tested for the 2001-2003 Atlantic and eastern North Pacific hurricane seasons. Unlike GUNA, which requires the availability of forecasts from all four of the interpolated forecast models (AVNI, GFDI, UKMI, and NGPI), CONU only requires the availability of forecasts from at least two of those four models plus GFNI. For the 2001-2003 Atlantic hurricane seasons it was found that the TC track forecast errors for CONU were comparable to those for GUNA but that the forecast availability for CONU greatly exceeds that for GUNA. Similar results were found for the eastern North Pacific. Based on a suggestion made at a seminar presented at TPC /NHC by the PI, another consensus model, CONO, was formulated and tested for the same test periods. CONO is identical to CONU but includes the interpolated official forecast (OFCI), when available, along with at least two of the aforementioned five forecast models. The performance for CONO was found to be almost identical to that for CONU out to 72h and was slightly better than that for CONU at 96h and 120h for the Atlantic. The performance for CONO was found to be better than that for CONU at all forecast lengths greater than 24h for the eastern North Pacific.

The primary purpose of this project is to determine to what extent the TC track forecast error of consensus models can be predicted prior to the time when official forecasts must be issued. The correlations between CONU and GUNA forecast error and a number of possible predictors were determined for the 2001-2003 Atlantic hurricane seasons. Consensus model spread is defined to be the average distance of the member forecasts from the consensus forecast. The original set of predictors investigated included: consensus model spread, initial TC intensity, initial TC location, TC speed of motion, and the number of models available (for CONU). Based on a suggestion made at the TPC/NHC seminar three new predictors were also investigated: forecast TC intensity and forecast displacement of TC location (latitude and longitude). Using stepwise linear regression and the pool of predictors, regression models were found for each forecast length to predict the TC track forecast error of the consensus models. Using these linear regression models, the percent variance of CONU TC track forecast error that could be explained for the 2001-2003 Atlantic hurricane seasons ranged from just under 20% at 24 and 48h to roughly 50% at 96 and 120h. Similar results were found for GUNA. Using the predicted error from these regression models, circular areas containing the verifying TC position 73-76% of the time were drawn around each of the CONU forecast positions. Based on the size of these areas, a forecaster can determine the confidence that can be placed upon the consensus forecast and use that information in the process of producing the official forecast. Finally, independent data testing was performed using a jackknifing technique that indicated that one can expect only a small degradation of this predictive capability in practice.

Presentations

Seminar entitled "Predicting Tropical Cyclone Track Forecast Error" presented at TPC/NHC, 18 December 2003.

Seminar entitled "Predicting Tropical Cyclone Track Forecast Error" presented at NOAA/AOML, 20 January 2004.

Abstract entitled "Predicting Tropical Cyclone Track Forecast Error" submitted for presentation at the 58th Interdepartmental Hurricane Conference, March 1-5, 2004.

Extended abstract entitled "Estimation of Tropical Cyclone Forecast Uncertainty" completed and accepted for presentation at the 26th AMS Conference on Hurricanes and Tropical Meteorology, May 3-7, 2004.

Remaining Work

Complete the regression analysis for the eastern and western North Pacific basins.

Perform independent testing for those two basins.

Create a graphic conveying the uncertainty of the consensus forecasts that can be used by the TC forecasters. Install the graphic on the ATCF to be used as "experimental guidance" by the NHC hurricane specialists.

Make any necessary adjustments to the entire process based on feedback from the hurricane specialists and JTWC personnel.

Comments

The support from the JHT and TPC/NHC personnel has been outstanding. Thanks to Alison Krautkramer, Chris Sisko, and Chris Juckins I was up and running productively on the local computer systems in less than a week after my arrival on November 1. James Franklin initiated me into the use of KaleidaGraph, which has proved invaluable to this work. Colin McAdie graciously provided me with linear regression software and instruction upon its use, another key element to this research. Jim Gross provided me with some interpolation software, which was also vital to certain aspects of this work. This research has also benefited greatly from many discussions with TPC/NHC personnel, too numerous to document here.