Probabilistic Prediction of Hurricane Intensity with an Analog Ensemble
NOAA Hurricane Forecast Improvement Project
Quarterly Status Report
1 August 2014 – 31 October 2014

Project Personnel

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Introduction

This project seeks to apply an Analog Ensemble (AnEn) technique (Delle Monache et al. 2011, 2013) to the problem of tropical cyclone (TC) intensity prediction. The AnEn technique will be used here to create a naturally calibrated ensemble prediction of TC intensity from a training dataset composed of the deterministic Hurricane Weather Research and Forecasting (HWRF) model. In the AnEn, a set of analog forecasts is created by searching archived HWRF forecasts that share key features in common with the ones associated with a current forecast from the same configuration of HWRF. The actual intensity observations associated with each forecast are used to produce an ensemble forecast.

The general AnEn technique applied to HWRF appears ideally suited for TC intensity forecasting for the following reasons:

- One can use a higher resolution model for an ensemble prediction (since only one real-time forecast is needed for the AnEn),
- There is no need for initial conditions and model perturbation strategies to generate an ensemble,
- The forecasts are intrinsically reliable and no post-processing is needed,
- The flow-dependent error characteristics can be determined, and
- The AnEn is ideal for TC forecasting given its ability to improve the prediction of rare events, which may enhance the skill of HWRF's rapid intensification (RI) forecasts.

Milestones Achieved This Quarter

This quarter marks the first quarter of this project. As such, a lot of the work has been preparatory in nature. Nonetheless, substantial progress has been made which should ensure that significant algorithm development can be achieved in the next quarter. The following milestones illustrate the type of work that has been carried out this quarter.

1. Access to the NOAA supercomputer, Jet

    - A significant hurdle in this project has been to obtain access to archived HWRF data, including retrospective HWRF forecasts from 2008-2013 in multiple ocean basins. This has required obtaining NOAA e-mail accounts, security training, and background checks on personnel assigned to processing data on Jet. Access has recently been granted to Jet for this project and data processing will begin soon.

2. The first set of AnEn predictors have been developed.

    - Using real-time grib2 HWRF forecast data from a 2014 case study, the scripts for obtaining predictors from the full HWRF retrospective data on Jet have been completed. These scripts produce a variety of environmental and inner-core predictors from the outer and inner nests of the 3-km real-time HWRF forecasts and produce output in netCDF format.

    - A wide variety of environmental predictors have been developed, including predictors describing sea-surface temperature, large-scale vertical wind shear, large-scale relative humidity, total precipitable water, maximum potential intensity, among other variables that are known to strongly influence TC intensity.

    - Motivated by contemporary research on TC intensity change, a large set of inner-core predictors have also been developed as well, including ones that account for inertial stability characteristics, the coupling between inertial stability and latent heating, the distribution of latent heating, turbulent surface latent and sensible heat fluxes, the wind distribution, upper-level divergence, among numerous other predictors.

    - In the AnEn development, objective feature selection will narrow the list of analog predictors down to a much smaller number.

Project timeline

This project is slated to take place over a two-year period. The project timeline was modified from the original proposal to conform to the new starting date of August 2014 and is detailed below.

Task	Activity
1	Develop predictors from the HWRF data 2008-2013 training dataset for all forecasts and lead times (definitely ATL, perhaps WPAC) (led by UW personnel) [Aug 2014 – Feb. 2016]
2	Construct the AnEn for TC intensity prediction using a manually determined set of optimal predictors to get algorithm working / Also, start objective feature selection over large number of HWRF-based predictors [Nov. 2014 – July 2015]
3	Build extended logistic regression (LR) model with the HWRF training dataset (UW/NCAR) [Nov. 2014 – March 2016]
4	Process HWRF data from 2014 season (form predictors, make forecasts) (UW/NCAR personnel) [Sep. 2014 – Dec. 2014]
5	Verification/Evaluation of the AnEn and LR model (NCAR/UW personnel) [Dec. 2014 – July 2016]
6	Real-time testing of models on 2015 hurricane season and update AnEn (UW/NCAR). [May 2015 – November 2015]
7	Develop proposal for extension of project to other prediction problems such as TC size change and other modeling platforms. (UW/NCAR). Additional proposal opportunities for research to operations. [May 2016]