Mid-year Report for Year 1 of Proposal Entitled
TC Dressing: A Probabilistic Approach to Providing State-Dependent, Non-Isotropic Forecast Track Error Guidance

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The original work plan assumed that extensions to TC Dressing would result in a product superior to GPCE. This result was not realized. It was determined that size of available ensemble track forecasts was too small for TC Dressing to be effective, and large spreads were required for each kernel to ensure that the dressed distribution was reliable. The resulting distributions were able to reliably bound verification, but the associated area bound by the 70% isopleth was larger than the climatological error area on average. Idealized studies (perfect model, all error distributions are isotropic, all ensemble members have same weight and spread) indicate that an ensemble size of at least QQQ is necessary to outperform a distribution based on climatological errors (e.g. the cone of death). Figure 1 plots the average area bound by the 70% isopleth produced by TC Dressing as a function of ensemble size. The area bound by the 70% isopleths of the climatological distribution is given by the horizontal line.

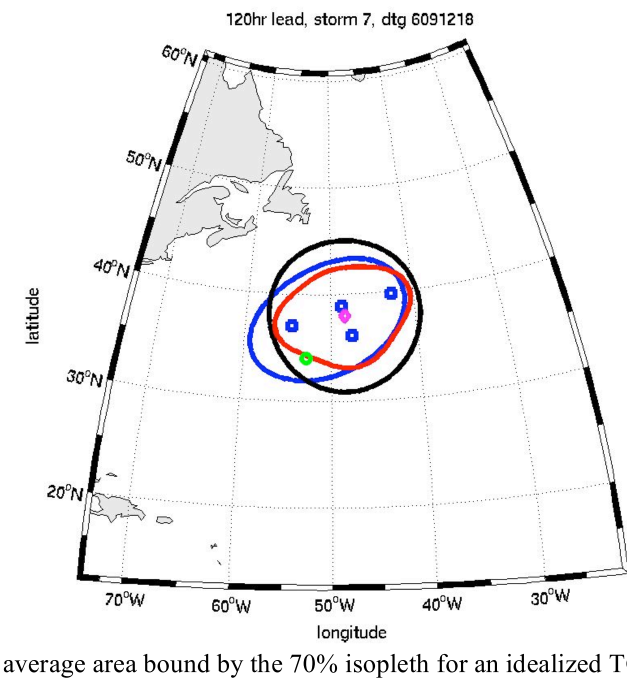

Figure 1: A plot of average area bound by the 70% isopleth for an idealized TC dressing scenario as a function of ensemble size. The horizontal bar is the area of a climatological error distribution.

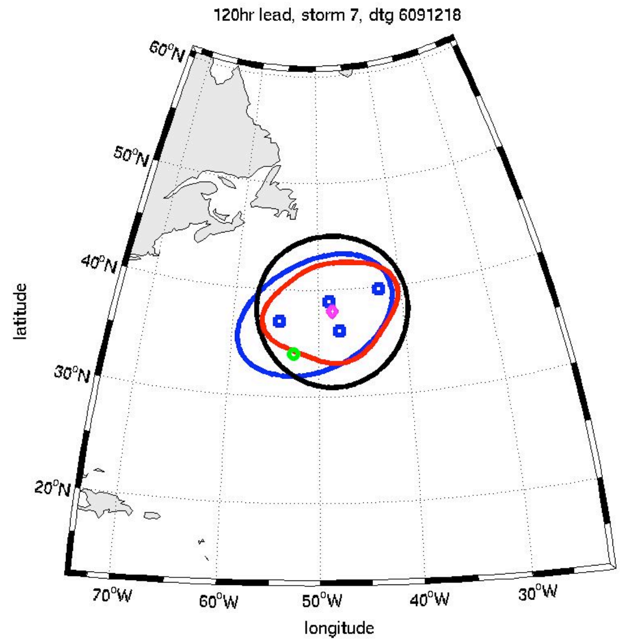

Figure 2: An example of GPCE (black), GPCE-AX (blue), and TC Dressing (red) TC track 120hr error distributions. Blue squares are members of GUNA, the magenta diamond is consensus, and the green circle is verification.

A hierarchy of products to predict the distribution of track error was developed to act as null hypotheses for distributions produced by TC Dressing. These include

- Isotropic climatological error
- Lat/Lon climatological error with bias correction
- Across/along climatological error with bias correction
- GPCE
- Across/along GPCE (GPCE-AX) with bias correction

All focused on GUNA, and all used the period 2002-2005 as a training set (dependent) and 2006 as a test set (independent).

The bias correction was unconditional, and it was found to result in RMSE that was an improvement relative to consensus. The non-isotropic climatological error distributions (lat/lon and across/along) outperformed the isotropic climatological error distribution in terms of sharpness (area of the 70% isopleths). GPCE and GPCE-AX both outperformed all climatological error distributions. The GPCE-AX error distributions outperformed the GPCE error distributions both in terms of reliability (ability to bound 70% of the actual errors) and sharpness (GPCE-AX areas were smaller than GPCE areas on average). An example of the error distributions produced by GPCE, GPCE-AX, and TC Dressing is given in figure 2. A comparison of GPCE and GPCE-AX reliability and sharpness is shown in table 1. For GUNA, trained over the period 2002-2005, the 2006 results indicate that GPCE-AX is more reliable than GPCE at all leads and has an average area bound by the 70% isopleths that ranges between 10% and 31% less than the GPCE area.

Future work will focus on extending GPCE-AX to all basins and transitioning the product to ATCF.

GPCE-AX is based on absolute errors. It is not designed to provide information about whether verification is more likely to fall to the left of track or to the right of track, nor is it designed to provide information about whether the consensus is likely to be slow or likely to be fast. To address these questions, an independent analysis was performed to predict the probability of verification falling to the left, right, front or back of the consensus. Logistic regression was performed using the same potential predictors as GPCE and GPCE-AX, but with predictands that were either a 0 or 1 (e.g. left or right, front or back). Left/right probabilities were found to be more robust than front/back probabilities. It was found that if a probability of 70% or greater for being to the left/right, or front/back of consensus was predicted, slightly hedging in the predicted direction resulted in improved RMSE relative to the un-hedged track forecast. Further work is needed to develop a method for communicating this information.

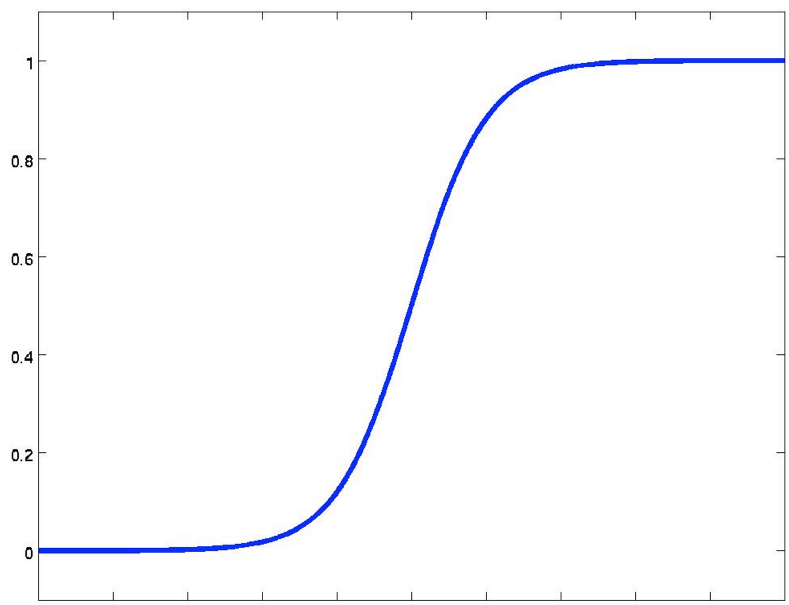

Figure 3: The logit function. Predictors are along the x-axis, predictands are along the y-axis. Instead of straight line relating predictand and predictor (as in linear regression), logistic regression ensures that the maximum and minimum probabilities are 1 and 0, respectively.

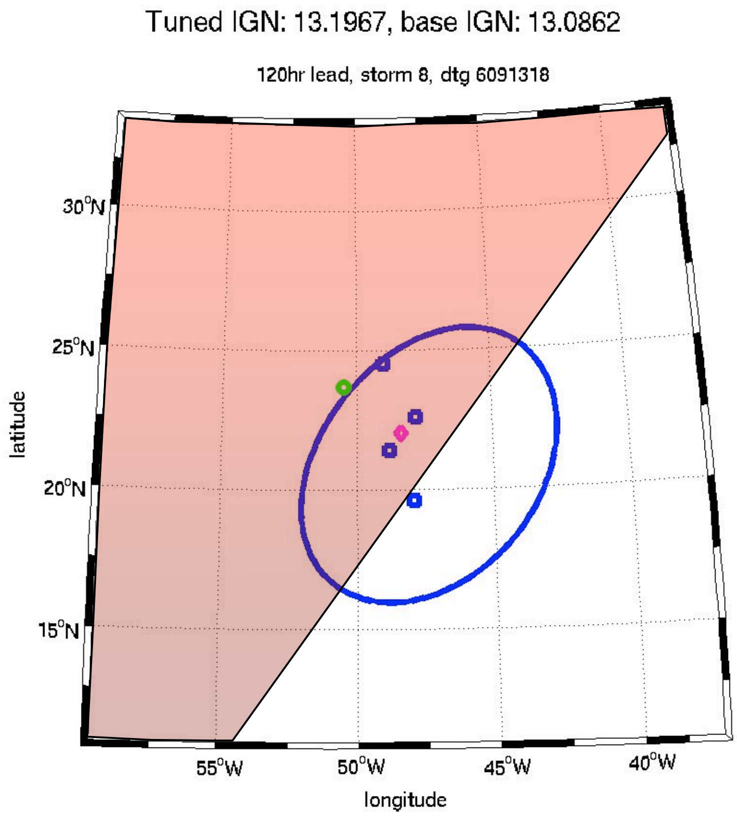

Figure 4: One method to communicate hedging information. The blue ellipse is the GPCE-AX forecast error distribution (note that bias correction means it is not centered on consensus). The red shaded area indicates there is a 70% or greater probability that verification will fall in front of the center of the GPCE-AX distribution.