NOAA Joint Hurricane Testbed (JHT)
Mid-Year Project Progress Report, Year 2

Date:	March 30, 2015
Reporting Period:	September 1, 2014 – February 28, 2015
Project Title:	Upgrades to the Operational Monte Carlo Wind Speed Probability Program
Principal Investigator:	Andrea Schumacher, CIRA / Colorado State University
Award Period:	September 1, 2013 – August 31, 2015

1. Long-term Objectives and Specific Plans to Achieve Them:

This project seeks to complete a number of upgrades to the current Monte Carlo wind speed probability model (hereafter MC model), many of which are based on NHC feedback over the past few hurricane seasons. Specific plans to improve the MC model include replacing the linear forecast interpolation scheme with a more precise spline fit scheme, applying a bias correction to the model track error statistics to provide consistency between NHC's uncertainty products, and applying a bias correction to the radii-CLIPER used by the MC model to improve the accuracy of the wind speed probabilities for exceptionally small or large (e.g. 2012's Hurricane Sandy) tropical cyclones. Additionally, several additions to the MC model will be completed such as estimates of the arrival and departure times of 34/50/64 kt winds, an integrated GPCE parameter, and wind speed probabilities beyond 5 days (proposed to 7 days). Finally, the error statistic generation code will be consolidated into a single streamlined version that will reduce the time needed to update the MC model statistics each year.

2. Reporting Period Accomplishments:

(a) Replaced linear forecast interpolation scheme with spline fit scheme

Development of this update was completed in Year 1. Figure 1 shows the impacts of this update on the performance of the MC model over a 3-year sample. The spline update has a very small impact on the overall MC model Brier scores (<3%), with improvements seen at all forecast times for 34-kt wind speed probabilities (WSP) and for most forecast times for 64-kt WSPs. Based on these favorable verification results and the more realistic-looking realistic tracks this update produces, the spline interpolation upgrade will most likely be included in the version of the operational model running for the 2015 Atlantic and N.E. Pacific hurricane seasons.

(b) Bias correction made to MC model error statistics

The MC model uses forecast error statistics from the previous 5 years of official forecasts that do not currently exactly match the official error statistics verified by NHC. The main difference is that the MC model error statistics include some non-tropical cases (e.g., extratropical cyclones, post-tropical cyclones) that NHC does not. In order to provide consistency between NHC's uncertainty products, the MC model error statistics were adjust so they exactly match the official NHC errors reported each year in the annual Verification Reports

(http://www.nhc.noaa.gov/verification/verify3.shtml?). Figure 1 shows the impacts of this update on the performance of the MC model over a 3-year sample. Restricting the MC model error sample to only those cases verified by NHC has a moderate negative impact on Brier scores for the 34-kt WSPs that gets worse with forecast time to a maximum degradation of 8%. Almost no impact is seen on the 64-kt WSP Brier scores.

(c) Bias correction applied to MC model radii estimates

The current MC model uses a climatology and persistence model to estimate the 34-kt, 50-kt, and 64-kt wind radii for its realizations, which has been found to greatly over (under) estimate radii for exceptionally small (large) tropical cyclones. To address this issue, the MC model was adapted to use the official R34, R50, and R64 radii forecasts. Since official radii forecasts are only made out to 36-72 hours, radii at times after the last available radius forecast are estimated using a climatology-persistence method that relaxes back to climatology after 32 hours. Figure 2 shows an example of the 34-kt WSPs for Hurricane Sandy using the current method (left) and the bias-corrected method (center) in comparison to the actual observed 34-kt winds (right). As expected, this bias-correction method gives much more realistic-looking WSPs for this large storm out to 120 hours. Preliminary verification, however, suggests that this bias-correction method may be systematically over-estimating WSPs, leading to a degradation of the sample Brier scores (not shown). As time allows, other bias-correction schemes will be considered and tested to see if a methodology can be found that improves the MC model for all sizes of TCs.

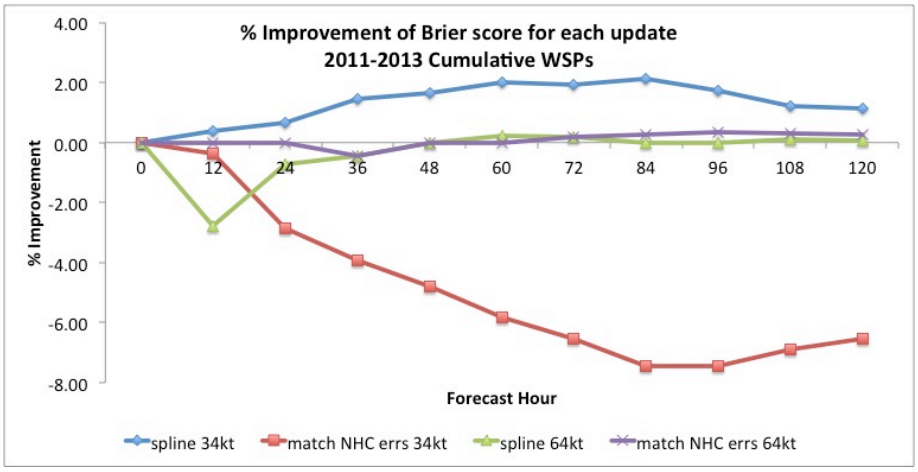

Figure 1. Improvement in Brier score for 34-kt and 64-kt wind speed probabilities for 2011-2013 Atlantic tropical cyclones.

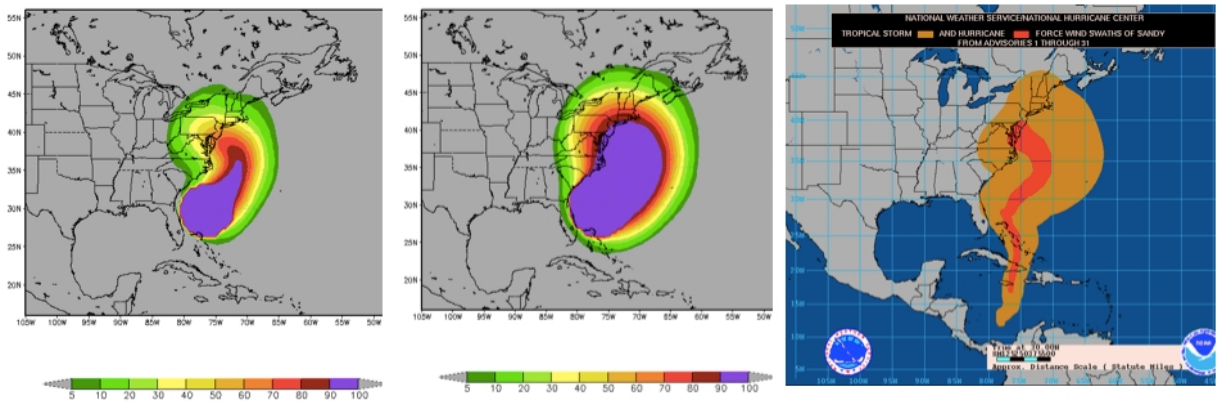

Figure 2. 34-kt wind speed probabilities for Hurricane Sandy before (left) and after (center) radii bias correction. Observed 34-kt winds are shown for comparison (right, in orange).

(d) Development of time-integrated GPCE parameter

It has been shown that past NHC track forecast errors can be separated into terciles based on their corresponding GPCE value, and that track forecast errors in the low (high) terciles tend to correspond to less (more) spread in forecast errors (DeMaria et al. 2013). This finding motivated the use of a GPCE parameter in the MC model. At present, this GPCE parameter determines the track error statistics used by the MC model to estimate wind speed probabilities, but the GPCE categories (low, medium, high) are not output directly. It was proposed that a time integrated GPCE parameter be developed from the GPCE information used by the MC model. This information could be relayed to users through the NHC discussion product, and could potentially be used to modify the cone of uncertainty. A preliminary time integrated GPCE parameter was developed last year, and was further refined during this reporting period after discussions with NHC forecasters. The integrated GPCE parameter has been added as an option to the MC model.

(e) Time of arrival/departure estimates

Work on this update was led by NHC focal points and is near completion.

(f) Presented project accomplishments at the 69th Interdepartmental Hurricane Conference

A. Schumacher presented a project update during the 69th Interdepartmental Hurricane Conference, which was attended remotely from the National Hurricane Center from 3-5 March 2015. During this time, the science team and NHC points of contact met to discuss preliminary project outcomes and to refine the goals and timeline for the remainder of Year 2.

3. Remaining Year 2 Efforts:

May 2015 - Complete development of 7-day forecast error statistics
Jun 2015 - Begin consolidating MC model error statistics development code
Aug 2015 - Finalize MC model code for product enhancements / additions and software

upgrades, coordinate with JHT and TSB staff to implement MC model upgrades approved for operational implementation.

Aug 2015 - Year 2 final report.