

Joint Hurricane Testbed Semi-Annual Report for Year 2

December 2008

Project title: *An Improved Wind Probability Estimation Program*
Principal Investigators: Stan Kidder, Mark DeMaria and Pat Haar
Affiliation: Kidder (CIRA), DeMaria (NESDIS) and Haar (NPS)
Project dates: August 2007-July 2009
TPC Point of Contacts: Dan Brown (replacing Rick Knabb) and Chris Lauer

1. Background Information

Under previous JHT support a new program for estimating the probability of occurrence of 34, 50 and 64 kt winds was developed. A Monte Carlo (MC) method was utilized to combine the uncertainty in the track, intensity and wind structure forecasts.

In the current proposal, three improvements are proposed to the MC model, as follows:

Topic 1: The MC wind probability estimates will be refined by making the underlying track error distributions a function of the forecast uncertainty. The current MC model uses basin-wide error statistics but recent research has shown that the spread of track forecasts from various models can provide information about the expected track error. J. Goerss from NRL developed a real-time tool to quantitatively estimate the track forecast uncertainty (the Goerss Predicted Consensus Error, GPCE), which will be incorporated into the MC model.

Topic 2: The timeliness of the MC model will be improved by optimizing and modifying the code.

Topic 3: The code that calculates the track and intensity error distributions for the MC model will be generalized to also update the “stand-alone” intensity probability product utilized by NHC. This product is provided in real time as the “wind speed probability table” on the NHC web site, and was developed from data from 1988-1997. The current version of this product only extends to 72 h even though the NHC official forecasts were extended to 120 h in 2003.

The timeline and deliverables for Year 2 of this project are listed below in the Appendix.

2. Accomplishments

Topic 2 was completed in Year 1 of the project and resulted in a speed-up by a factor of six of the MC model code.

Topic 3 was nearly completed by the end of Year 1. After successful testing and evaluation, the final task was to provide NHC with a modified version of the code that returned all of the information for the wind speed probability table. This code was

provided to C. Lauer from NHC prior to the start of the 2008 hurricane season, and was run for the entire 2008 season. Thus, topic 2 is completed.

The remaining task is to complete topic 1 above, to make the track error distributions in the MC model a function of the forecast uncertainty through the GPCE parameter. A method to stratify the NHC track errors by the GPCE parameter was developed in Year 1 and it was confirmed that the distributions have a well-behaved dependence, with wider distributions for the larger GPCE values. This initial analysis was performed with the 2002-2006 sample used in the 2007 MC model. For the 2008 testing, the track error distributions for the 2003-2007 sample were stratified in a similar manner, with similar results. In the original Year 2 timeline shown in the Appendix, it was proposed to run a parallel version of the MC model beginning in August of 2008. However, during a visit to NHC by M. DeMaria in July of 2008, it was determined that it was not feasible to modify the MC model processing during the season, so an alternate evaluation plan was developed in coordination with the NHC project focal points (Chris Lauer and Dan Brown). All 2008 cases within 1000 km of land would be re-run after the season, and the probabilities from the operational and GPCE versions of the model will be compared.

This evaluation will include both qualitative and quantitative components. For the qualitative comparison, a web site is being developed to display the probabilities over a large domain, similar to that used in the graphical products on the NHC web page (see http://rammb.cira.colostate.edu/research/tropical_cyclones/tc_wind_prob/gpce.asp). This web page also lists the cases that will be used in the evaluation (156 cases from 10 storms from the 2008 Atlantic season). Some examples of the 0-120 hr cumulative probabilities from the operational version of the model are already available for Bertha through Dolly. When completed, the page will display the probabilities for both the operational and GPCE versions of the model. To facilitate the comparison, the MC model was run on a 0.25 degree lat/lon grid, rather than the 0.5 degree grid used for the NHC products.

For the quantitative comparison of the operational and GPCE versions of the model, the 156 cases are also being run for the contiguous U.S. coastal breakpoints, similar to those used in the NHC operational text product. This will allow an evaluation for those cases most relevant to U.S. watches and warnings, and over a more focused region. The evaluation could also have been performed over the large areas shown on the web page, but the probability values are zero over a large fraction of the domain, which complicates the model comparison. A much smaller fraction of the coastal breakpoints have zero probabilities for the sample of storms that were fairly close to land. Also, the 2008 season had many forecasts close to the U.S., providing a good independent sample for the evaluation.

To quantitatively compare the two versions of model, the verification code had to be adapted to the case where the probabilities are on an irregularly spaced set of lat/lon points (the coastal breakpoints) rather than on a regular grid. This modified is complete. Also, the original plan was to calculate the Brier Score and Relative Operating Characteristic (ROC) score for both versions of the model. The Brier Score will still be used, but it was found that the ROC score is not very useful for situations where there are

large numbers of zero probabilities. Restricting the comparison to the coastal breakpoints partially addresses this problem, but not enough to make the ROC score a good measure of skill. The underlying problem is that it is based on the 2 by 2 contingency table which results from comparing the MC probabilities to the locations that actually received the wind threshold of interest. The ROC score uses all 4 elements of the table, including the lower-right element, which, using the usual convention, contains the number of cases where the probability indicated an event would not occur, and the where the event did not occur (the “No-No” box). Because this element has a value that is so much larger than the other three, it is difficult to detect differences in the ROC score. As an alternative, the threat score will be calculated for both versions of the model. The threat score uses only the three elements of the 2 by 2 contingency table (it excludes the No-No box), and provides a measure of overlap between the region where the MC model indicated an event would occur and the region where an event actually occurred. The verification code was modified to include the threat score calculation.

The remaining steps are to complete the re-runs of the MC model with the operational and GPCE versions for the 156 cases from 2008, populate the web site with the probability graphs for the qualitative evaluation by NHC, and run the modified verification code for the qualitative comparisons. These tasks should be completed by January of 2009 and results will be presented at the IHC in March of 2009.

3. Things not completed

As described above, the real-time comparison of the operational and GPCE versions of the MC model was not possible, primarily for logistical reasons. However, an alternate evaluation procedure was developed in coordination with NHC. The comparisons should still be completed by February of 2009 and reported at the IHC in March of 2009.

4. Things that did not succeed.

So far, no serious problems have been encountered.

5. Plans for the remainder of Year 2

The project should closely follow the timeline below, starting with the February 2009 task of completing the GPCE and operational versions of the MC model. This should provide NHC with adequate time for the evaluation, and to determine which version of the MC model they plan to use for the 2009 season.

Appendix

Year-2 Project Timeline and Deliverables

Apr 2008 – Coordinate with TPC for implementation of new wind probability table

May 2008 – Begin monitoring of new wind probability table

Jul 2008 – Prepare final version of MC code for parallel runs during the 2008 season

Aug 2008 – Begin parallel runs during 2008 season and monitor results during the season
Dec 2008 – Perform preliminary verifications of parallel MC runs
Dec. 12, 2008 – Provide mid-year progress report for year 2
Feb 2009 – Perform final verifications of parallel MC runs (depends on timing of final best track)
Mar 2009 – Report results at IHC
Mar 2009 – Make final modifications to MC code based upon 2009 results and assist with final operational implementation if appropriate
July 31, 2009 – Final report due