UPGRADES TO THE OPERATIONAL MONTE CARLO WIND SPEED PROBABILITY PROGRAM

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OUTLINE

- Project Tasks
  - 3 improvements
    - Improve time interpolation scheme
    - Apply bias-correction to model track error statistics
    - Apply bias-correction to radii-CLIPER model when official radii forecasts exist
  - 4 additions / enhancements
    - Arrival and departure estimates of 34, 50, and 64-kt winds
    - Integrated GPCE guidance for NHC forecasters
    - Extend MC model to 7 days
    - Software upgrade
- Progress so far
- Plans for 2014 season

THE MONTE CARLO WIND SPEED PROBABILITY PROGRAM

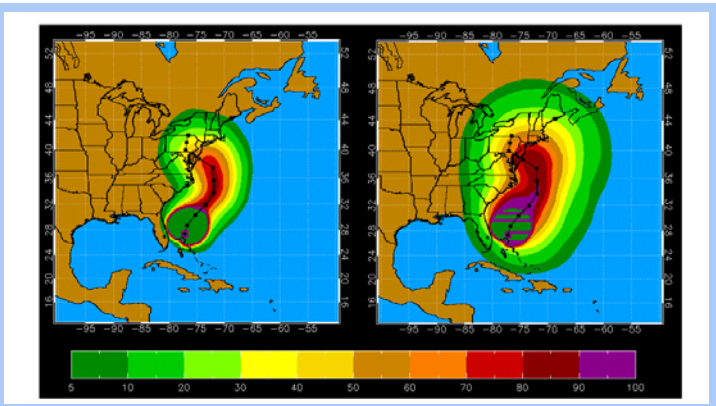
- MC Model Basics
  - Estimates probability of 34-, 50- and 64-kt wind to 5 days
  - 1000 track realizations generated from random sampling NHC track error distributions
  - Intensity of realizations from random sampling NHC intensity error distributions
    - Special treatment near land
  - Wind radii of realizations from radii CLIPER model and its radii error distributions
  - Serial correlation of errors included
  - Probability at a point computed by counting the number of realizations passing within the wind radii of interest
- Developed under JHT support
  - Implemented at NHC for 2006 hurricane season
  - Replaced Hurricane Strike Probabilities
- Improvements under JHT support
  - Inclusion of Goerss Predicted Consensus Error (GPCE)
  - Hurricane Landfall Probability Application (HuLPA)
  - Other minor corrections
- ***Experience & NHC feedback led to current project***

Example of 64-kt Wind Speed Probabilities for Hurricane Ike 2008.
http://www.nhc.noaa.gov

MC MODEL UPGRADES

Year 1 (8/13-7/14)

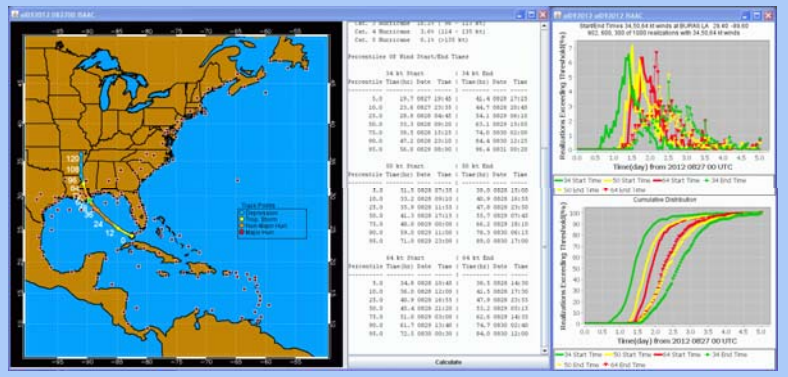
1. Improve time interpolation scheme
2. Integrated GPCE guidance
3. Bias-correction to model track error statistics
4. Bias-correction to radii-CLIPER model when official radii forecasts exist



Operational (left) and bias-corrected (right) 0-120 h cumulative 34 kt wind probabilities for Hurricane Sandy initialized at 00 UTC on 27 October, 2012.

Year 2 (8/14-7/15)

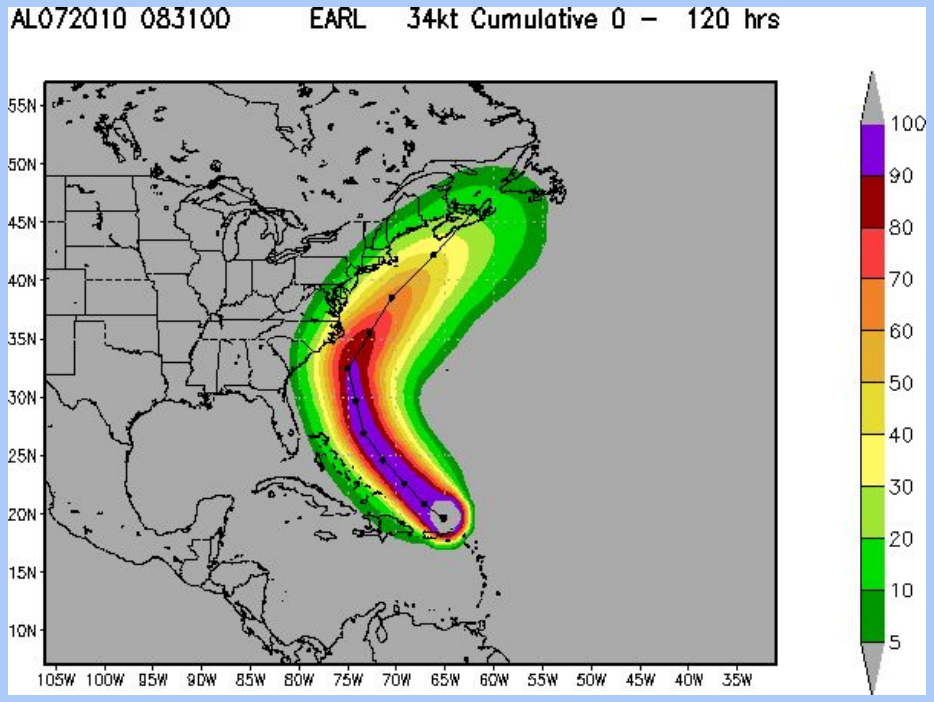
1. Arrival and departure estimates of 34, 50, and 64-kt winds (example below)
2. Extend MC model to 7 days
3. Software upgrade



Example of the HuLPA times of arrival and departure of 34, 50, and 64 kt winds at Buras, LA for Hurricane Isaac on 27 August 2012 at 0Z.

1. IMPROVE TIME INTERPOLATION SCHEME

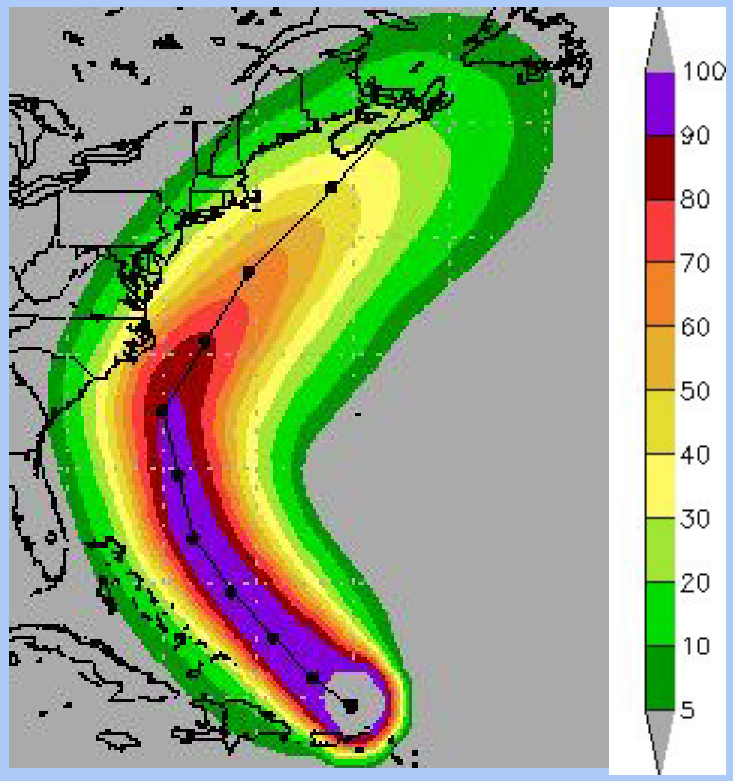
- NHC track and intensity forecasts starting point for MC model
  - available at 12h intervals to 48h and 24h intervals from 48h to 120h
- Use linear interpolation to obtain forecasts between forecast times
- Introduces errors
  - Errors larger for times between NHC forecast times
  - Eastward bias recurving TCs
  - Example Earl 2010 (right)
- Spline fit introduced to fix problem



Using linear interpolation

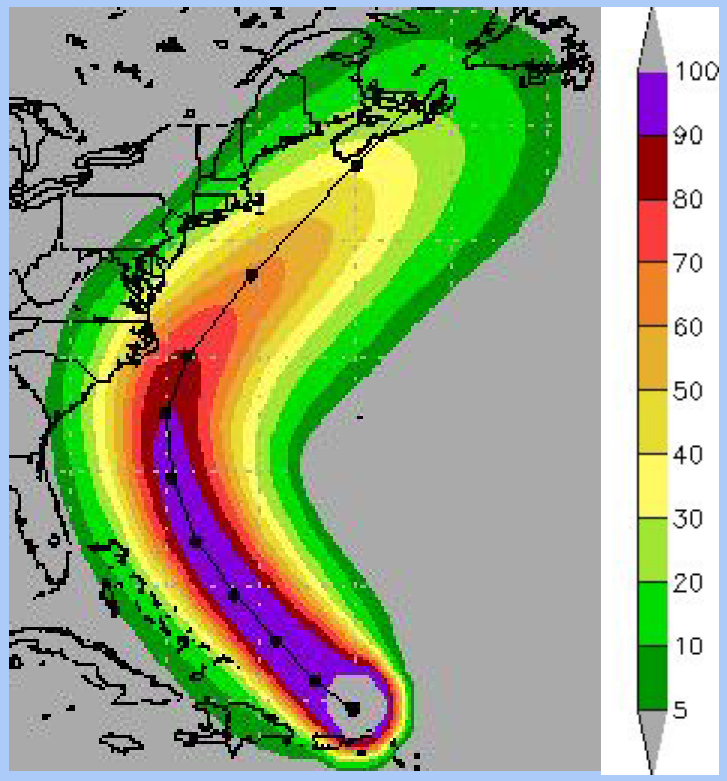
LINEAR INTERPOLATION VS. SPLINE FIT EXAMPLE: EARL ON 31 AUG 2010

Linear Interpolation



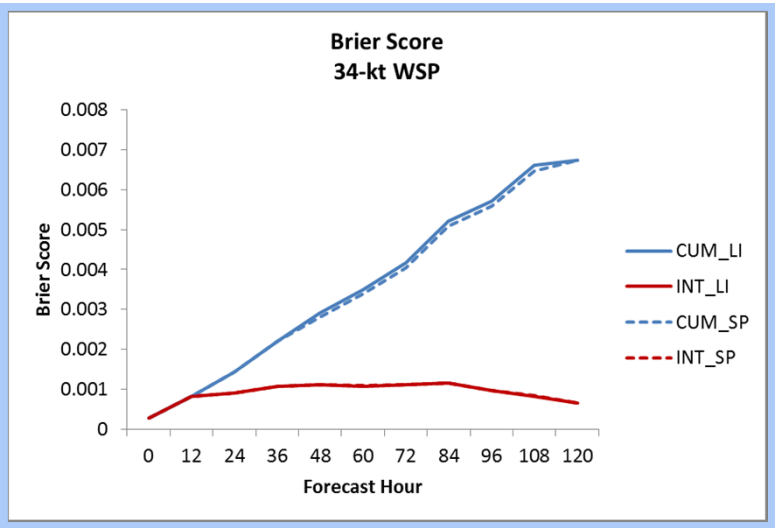
Along NC coast, highest probabilities ~ 50-60%

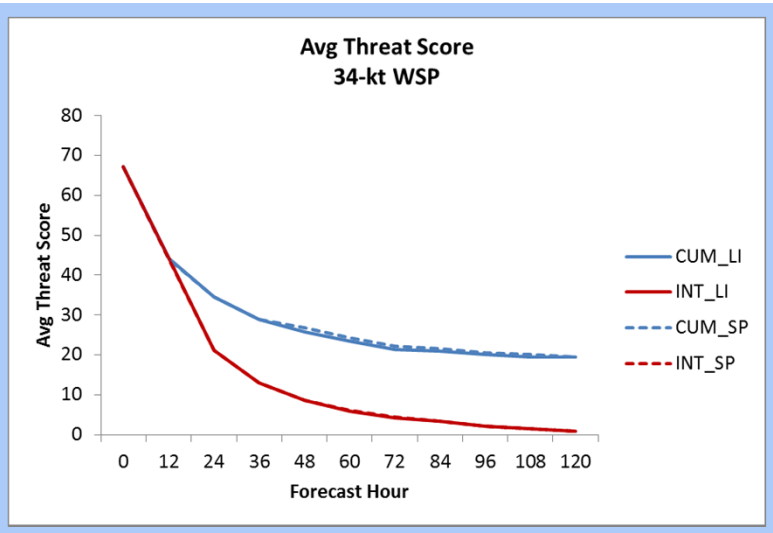
Spline Fit

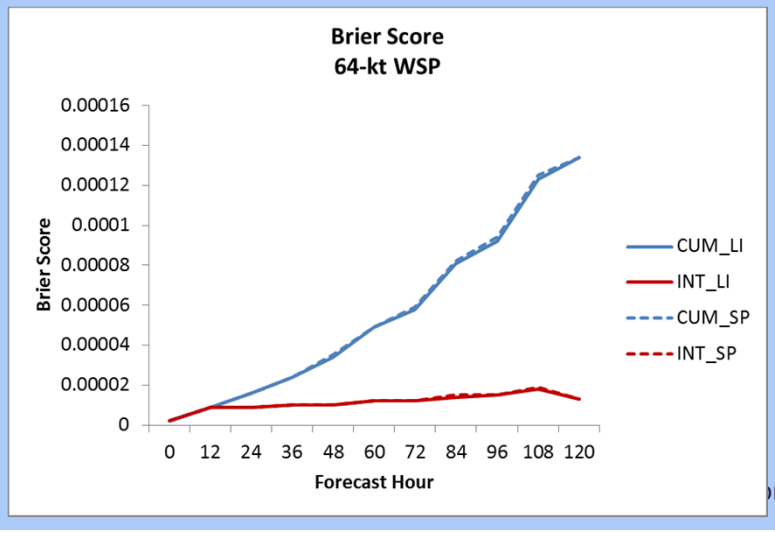


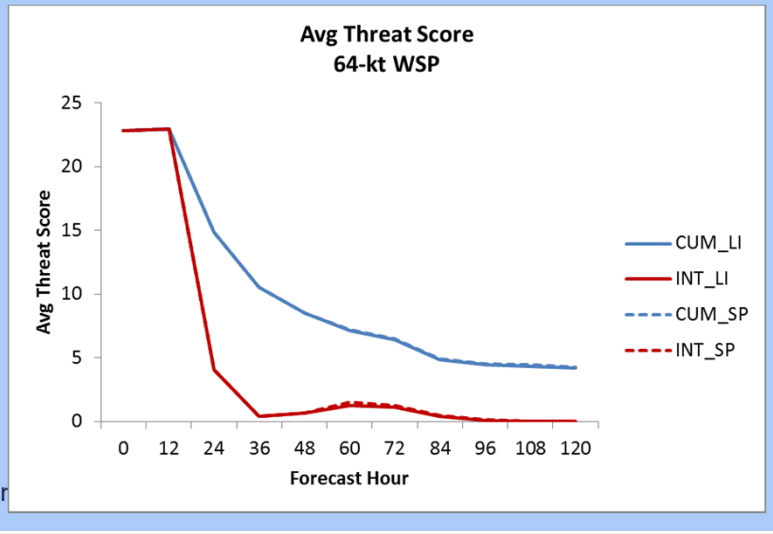
Along NC coast, highest probabilities ~ 70-80%

LINEAR INTERPOLATION VS. SPLINE FIT 2013 VERIFICATION



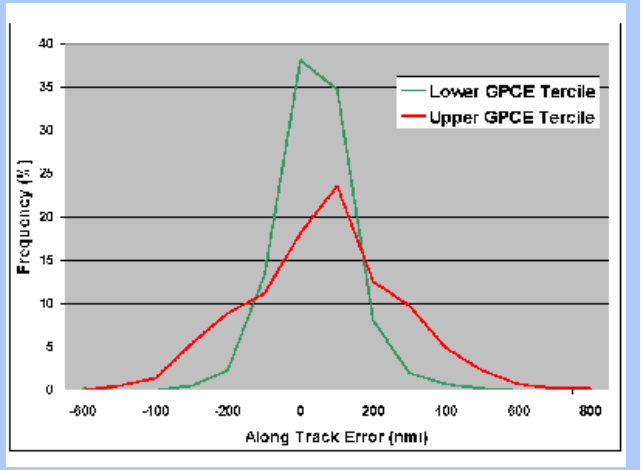






2. TIME-INTEGRATED GPCE GUIDANCE FOR NHC FORECASTERS

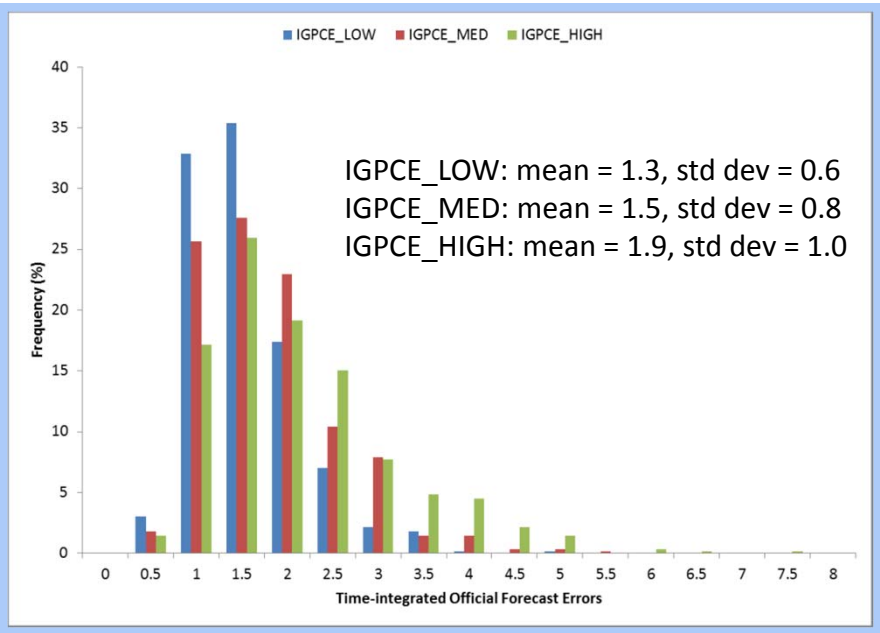
- DeMaria et al. 2013 showed NHC track forecast errors can be separated into terciles based on GPCE value
  - Low (high) GPCE values correspond to less (more) spread
  - Motivated use of GPCE parameter in MC model
    - GPCE value determines error statistics used
- Proposed developing time-integrated measure of GPCE information used in MC model
  - Provide forecasters 3-category measure of confidence of track forecast
  - Relay to users in discussion product
  - Used to modify cone of uncertainty



DEVELOPING A TIME-INTEGRATED GPCE PARAMETER

- Must combine 12-120 h track forecast errors and into a single parameter
- Need to normalize errors so long term forecasts don't dominate
- Use same methodology as Time Averaged Normalized Intensity Errors (TANIE)
  - Normalize official track forecast errors by error standard deviation (2008-2012)
  - Average normalized errors from 12 to 120 h
- Must also combine 12-120 h GPCE values into a single metric
- As a first attempt, use same methodology to obtain a single GPCE parameter for each forecast
  - Further testing to use unequal time weighting
  - Weight long term errors more than shorter term

TIME-INTEGRATED GPCE GUIDANCE – PRELIMINARY RESULTS



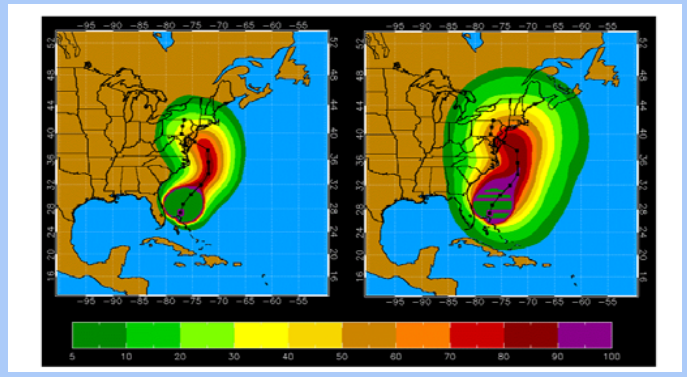
- This first attempt at defining time-integrated GPCE parameter (low/med/high) from MC model shows reasonable separation of corresponding track forecast errors
  - Tercile with smallest GPCE values (IGPCE_LOW) has smallest mean track forecast errors and smallest standard deviation (i.e., spread)
  - Tercile with the largest GPCE values (IGPCE_HIGH) has the largest mean track forecast errors and largest standard deviation (i.e., spread)

3. APPLY BIAS CORRECTION TO MODEL TRACK ERROR STATISTICS

- In principle, cone of uncertainty information should be able to be determined from MC model track realizations
- Advantages
  - Improve consistency between NHC uncertainty products
  - Cone size would increase and reduce based on track forecast confidence obtained from GPCE parameter
- Preliminary testing suggests cones don't match
  - Different samples (MC model include extratropical cases)
  - Error serial correlation introduces small bias
- Fix (In Progress)
  - Standardize error samples
  - Bias correction to account for serial correlation
- Change likely to improve error statistics of all products obtained from the MC model

4. APPLY BIAS CORRECTION TO RADII-CLIPER MODEL

- Official wind radii not available for all forecast periods to 5 days
  - 72 h for R34 and R50
  - 36 h for R64
- MC model uses radii-CLIPER for 34, 50, and 64-kt wind radii estimates at all times
  - Contribution of persistence e-folding time of 32 h (DeMaria et al. 2009)
  - For TCs much smaller (larger) than climatology radii-CLIPER potentially overestimates (underestimates) radii for t > 32 h
- Introduces bias to wind speed probabilities
  - Eg. Hurricane Sandy (right)
  - R34 much larger than climatology
  - Along NJ coast, probabilities 50-60% (left)
  - With bias correction, probs 70-80% (right)



- Fix (In Progress)
  - Develop method to use all available wind radii from NHC forecast to consistently bias correct radii-CLIPER
  - Use error serial correlation to extend influence beyond NHC radii forecast

PLANS FOR 2014 SEASON

- Next few months
  - Further testing time-integrated GPCE parameter
    - Feedback from POC
  - Complete development of bias corrections by May 2014
  - Prepare final updated version of MC model
  - Implement on IBM or JHT workstation and at CIRA by **July 2014**
- During season
  - Run experimental updated MC model in parallel to operational MC model

QUESTIONS?

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