CIRA UPDATES FOR THE 2018 SEASON FOR WIND SPEED PROBABILITIES AND TO NHC'S OPERATIONAL GUIDANCE SUITE

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HFIP Teleconference – 07/25/2018

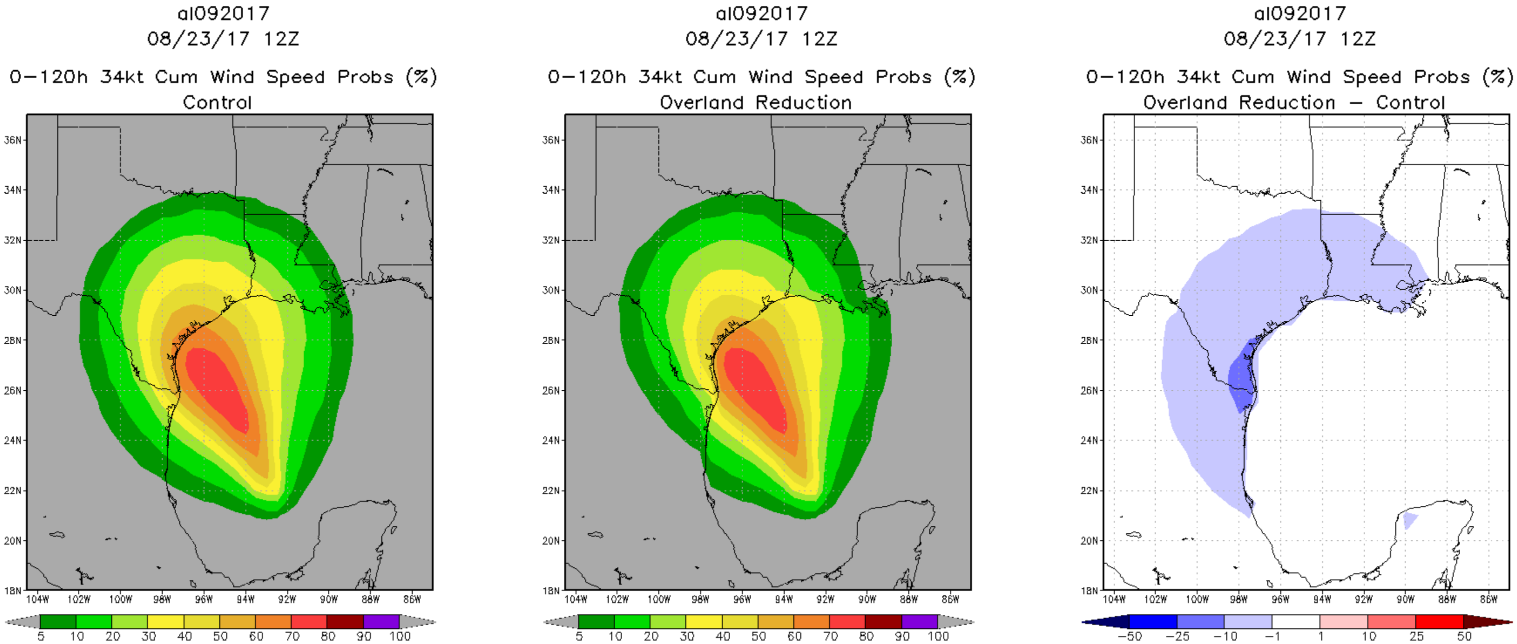
INLAND WIND SPEED PROBABILITY CORRECTIONS

Implemented in 2018 NHC WSPs

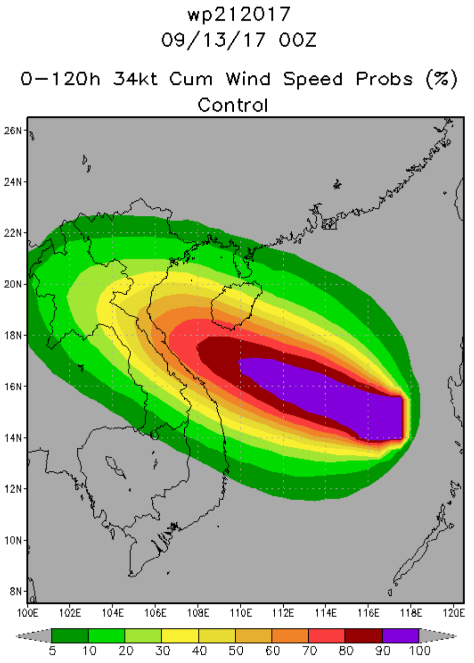
Updates to improve WSPs over land

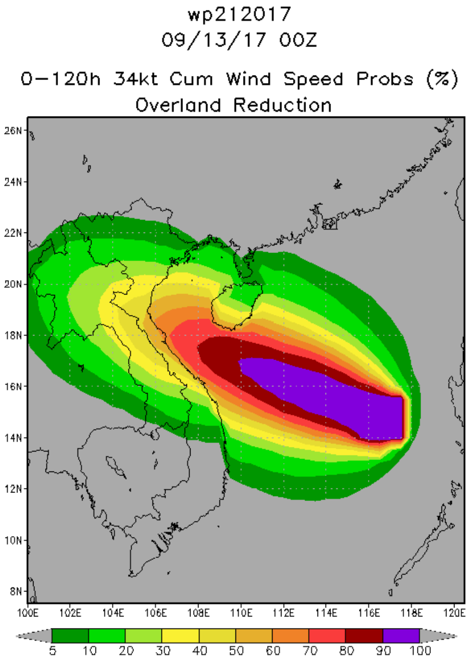
- WSPs tended to have a high bias over land
- Two updates were made to address this issue
- 1 – Adapted part of the code that applies a reduction factor to near-surface wind speeds to account for increased friction of land (vs. ocean) to use a smaller time step
- 2 –Adapted code to use reduced R34/R50/R64 for overland grid points when TC center is still over water
- The result of both of these corrections is reduced, and hence more realistic, wind speed probabilities over land

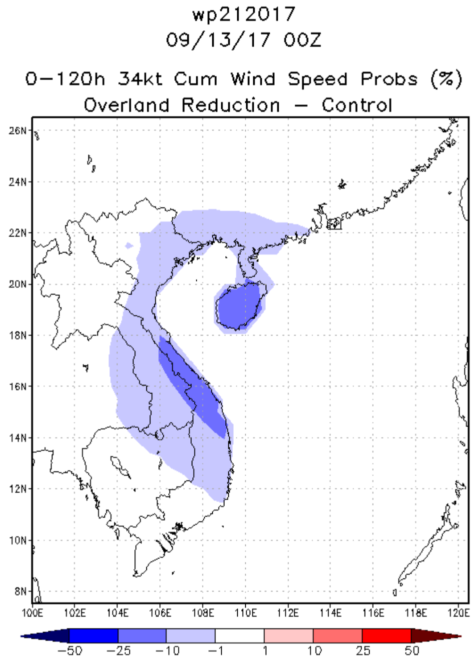
Impact of Inland Correction
Harvey 2017 34-kt WSPs



Impact of Inland Correction WP21 2017 34-kt WSPs







BUD Graphics Archive:
5-day Probability of Tropical-Storm-Force-Winds

Legacy Cone	Cone w/ Wind Field	Wind Speed Probabilities	Arrival Time of TS Winds	Wind Field
3-day no line	3-day no line	34 kt (39mph)	Most Likely	Initial Wind Field
3-day with line	3-day with line	50 kt (58mph)	Most Likely & WSP	Wind History
5-day no line	5-day no line	64 kt (74 mph)	Earliest Reasonable	
5-day with line	5-day with line		Earliest Reasonable & WSP	

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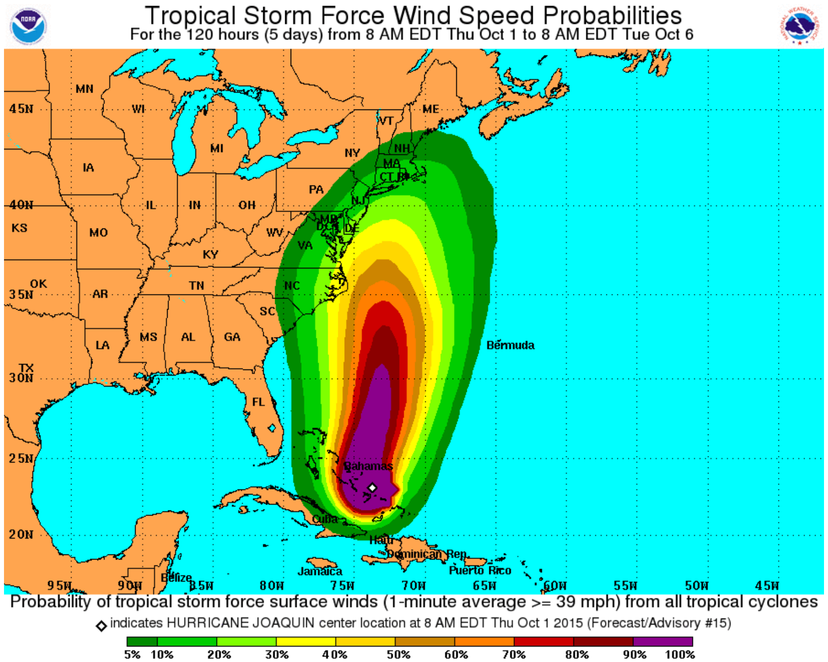
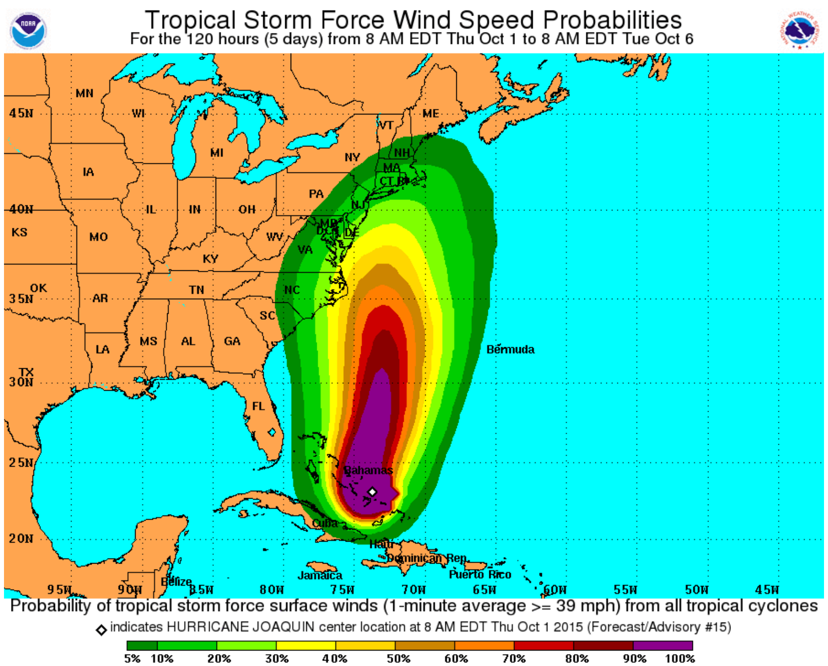
INCORPORATING ENSEMBLE TRACKS INTO THE WIND SPEED PROBABILITIES

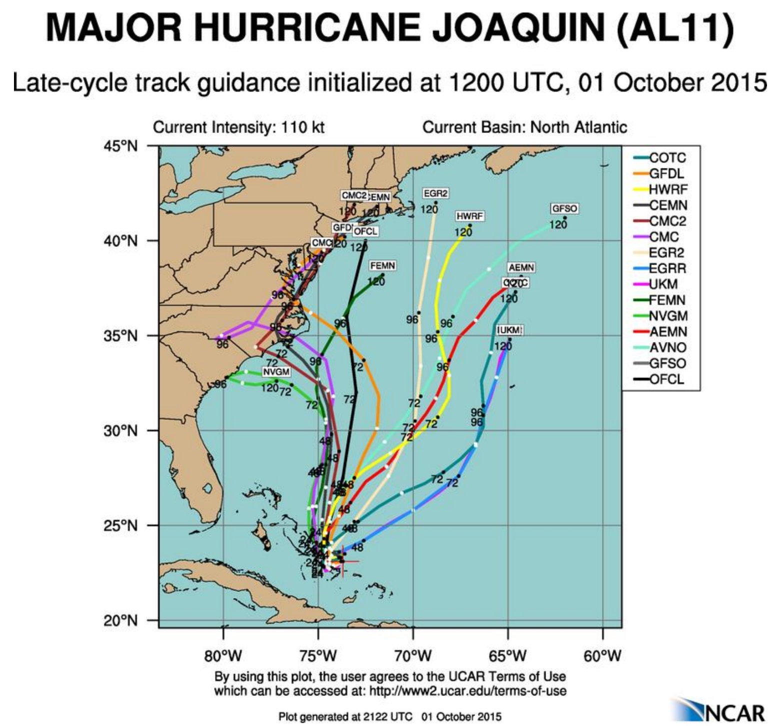
Monte Carlo Wind Speed Probability Model



- Creates "realizations" based on the official forecast and random sampling of past forecast errors
- Provides information about track, intensity, and structure forecast uncertainty in a single set of public products
- Represents very little situation-specific uncertainty

Incorporating Situation-Specific Uncertainty – Why?

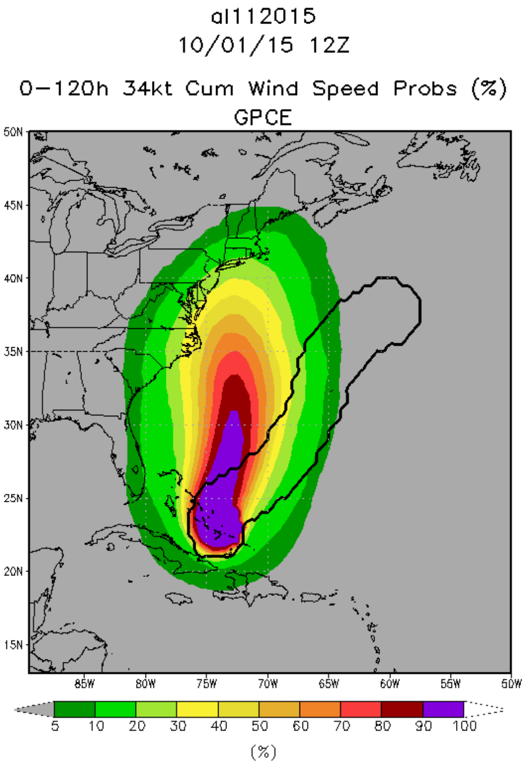


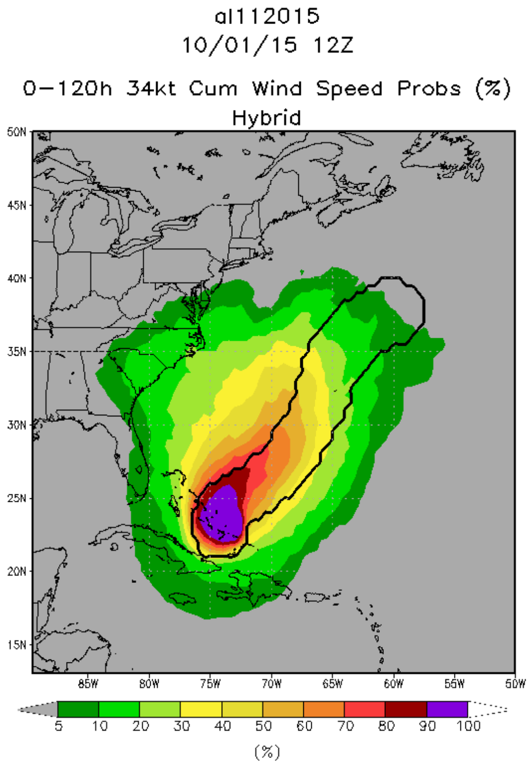


Two plausible track scenarios (landfall SC-VA or NE out to sea)

Since WSPs not a deterministic forecast, they have the potential to represent multiple track scenarios

Past Work – Using Ensemble Tracks to Define Realizations





<u>“Hybrid” methodology </u>- Uses 133 tracks from 5 global model ensemble prediction systems (GFS, ECMWF, FNMOC, UKMET, CMC), intensity and radii estimates use same statistical technique as current WSP model

Issues with Hybrid Methodology

- Latency and availability
  - Many ensembles only available at 0 and 12 Z
  - Some ensembles have latency up to 10 hours
- Forecast Skill
  - Improved Brier skill scores for specific cases, especially those where model track spread is large
  - However, slightly degrades Brier skill scores over 4-year sample (2013-2016)
- Forecast Consistency
  - Not necessarily consistent with other NHC forecast products
  - This is a BIG DEAL in terms of forecast communication

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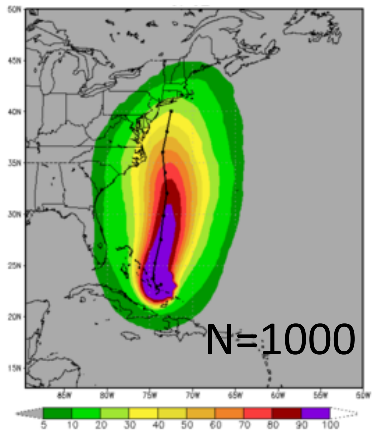
Methodology – Consensus of Ensembles (CoE)

GPCE WSPs



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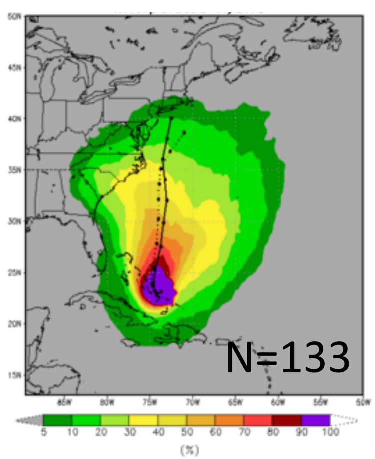
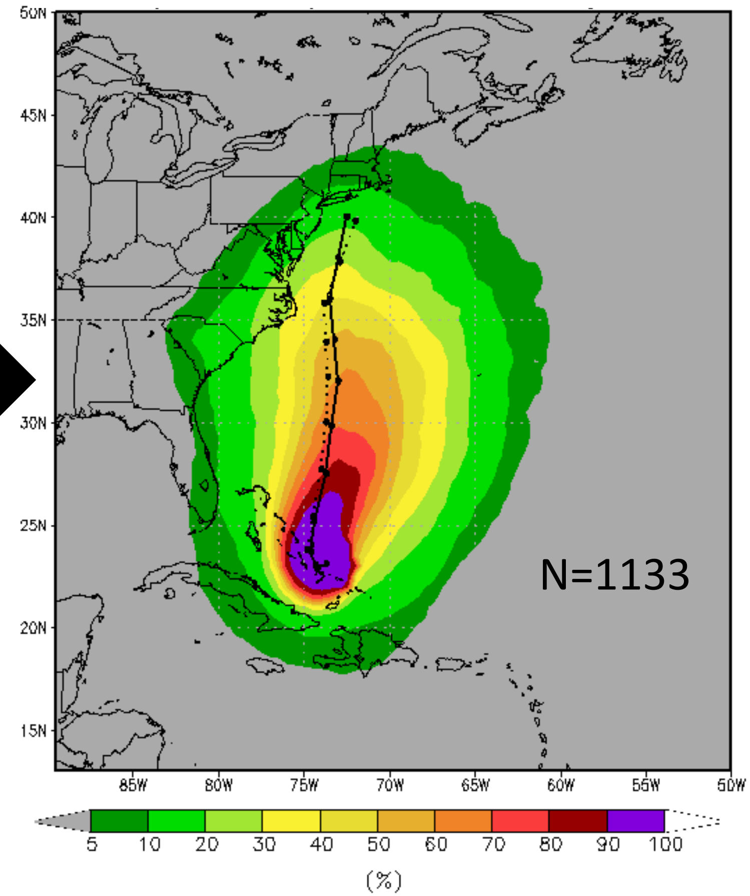
Hybrid WSPs



Combined Consensus WSPs

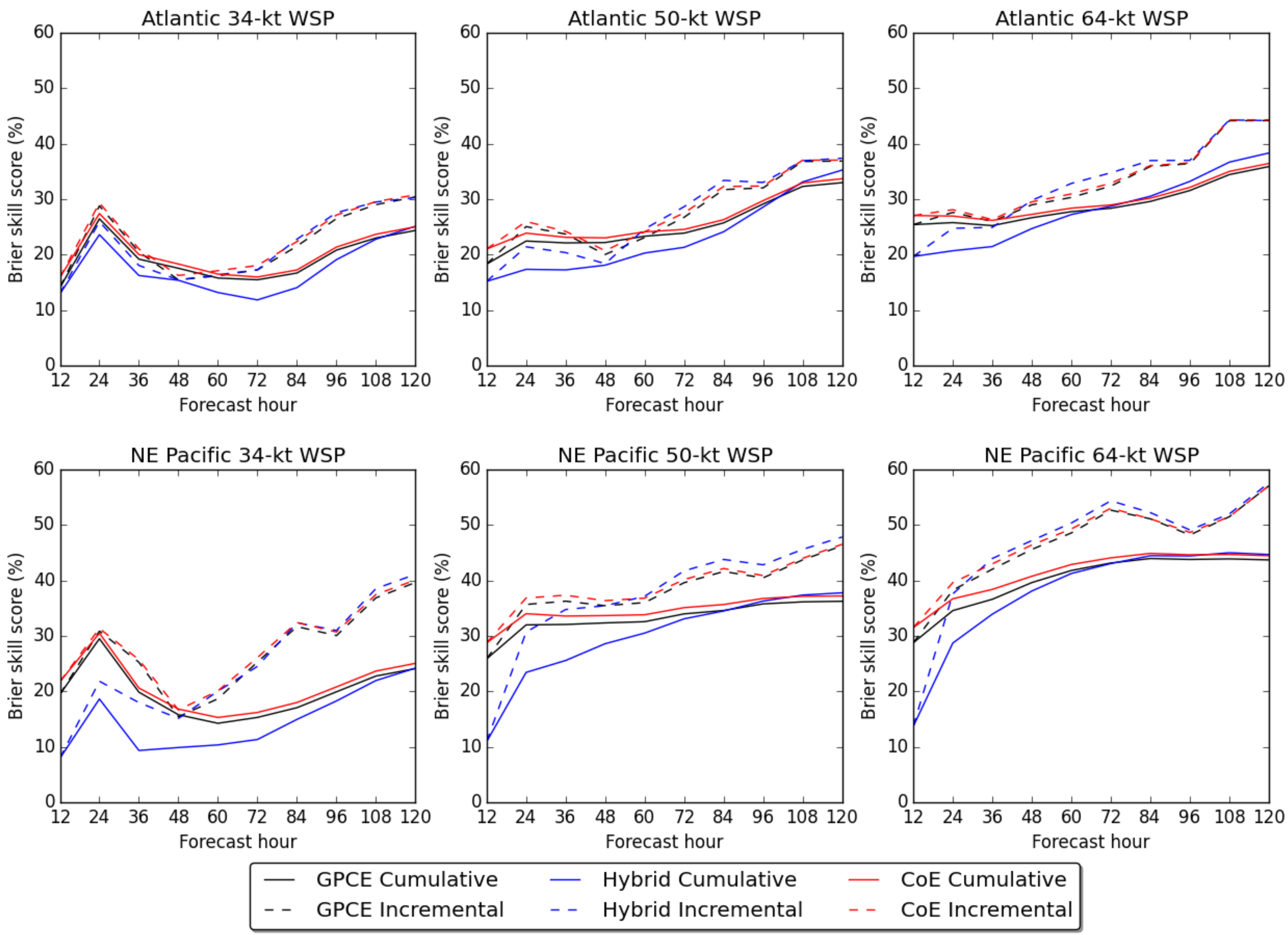


Verification Metrics (2013-2016)

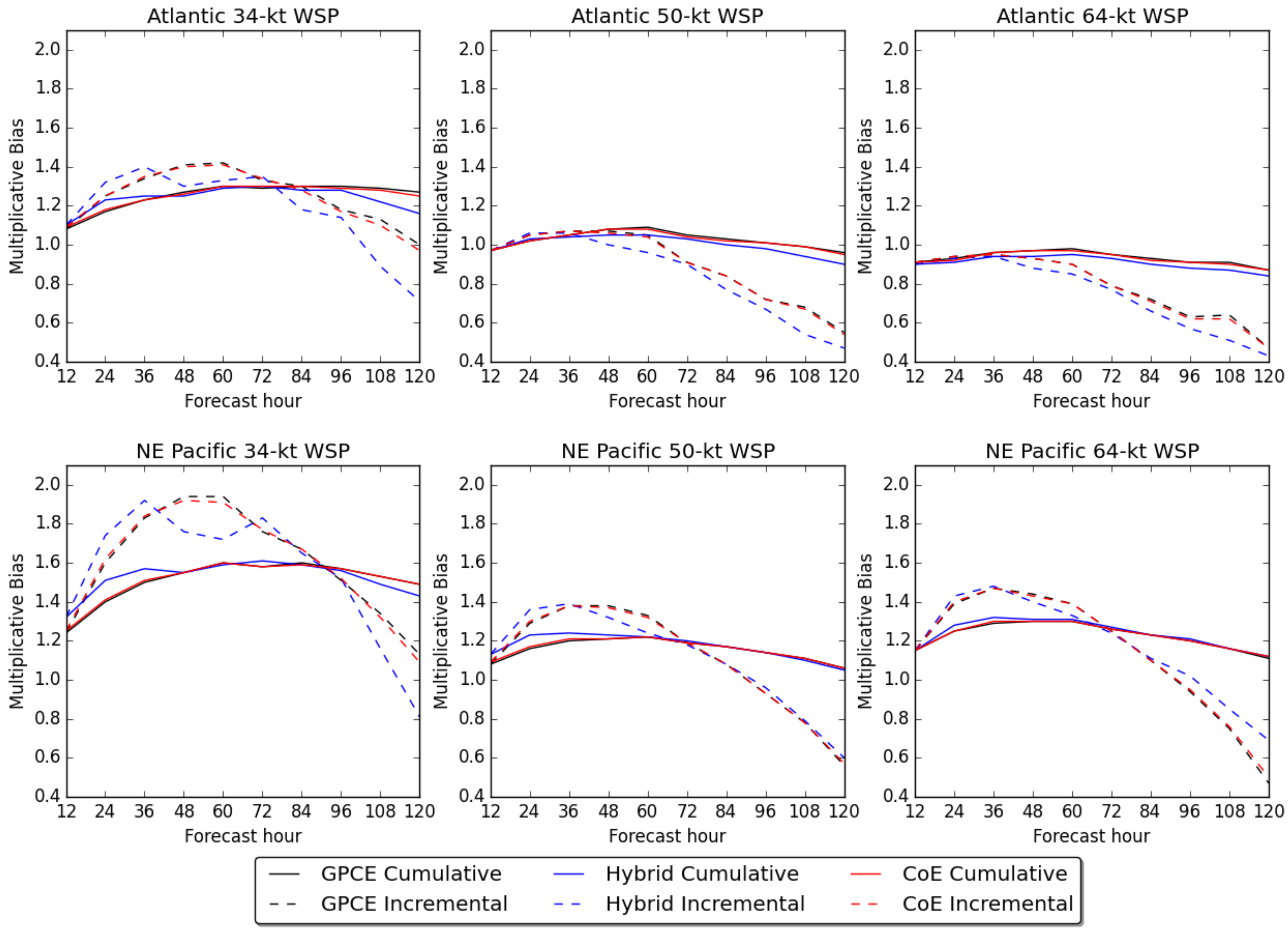
- Brier skill score, $BSS = \frac{BS}{BS_{ref}}$
  - **Answers the question**: What is the relative skill of the probabilistic forecast over that of climatology, in terms of predicting whether or not an event occurred?
  - **Range:** -∞ to 1, 0 indicates no skill when compared to the reference forecast. **Perfect score:** 1.
- Multiplicative Bias, $Bias = \frac{\frac{1}{N}\sum_{N}^{i=1} F_i}{\frac{1}{N}\sum_{N}^{i=1} O_i}$
  - **Answers the question:** How does the average forecast magnitude compare to the average observed magnitude?
  - **Range:** -∞ to +∞. **Perfect score:** 1.
- Optimal Threat Score, $TS = \frac{hits}{hits+misses+false\ alarms}$
  - Probability threshold used to distinguish prediction of events from non-events varied by 1% from 1% to 100%
  - **Answers the question:** How well did the forecast "yes" events correspond to the observed "yes" events?
  - **Range:** 0 to 1, 0 indicates no skill. **Perfect score:** 1.
- Reliability
  - **Answers the question:** How well do the predicted probabilities of an event correspond to their observed frequencies?

Reference: http://www.cawcr.gov.au/projects/verification/

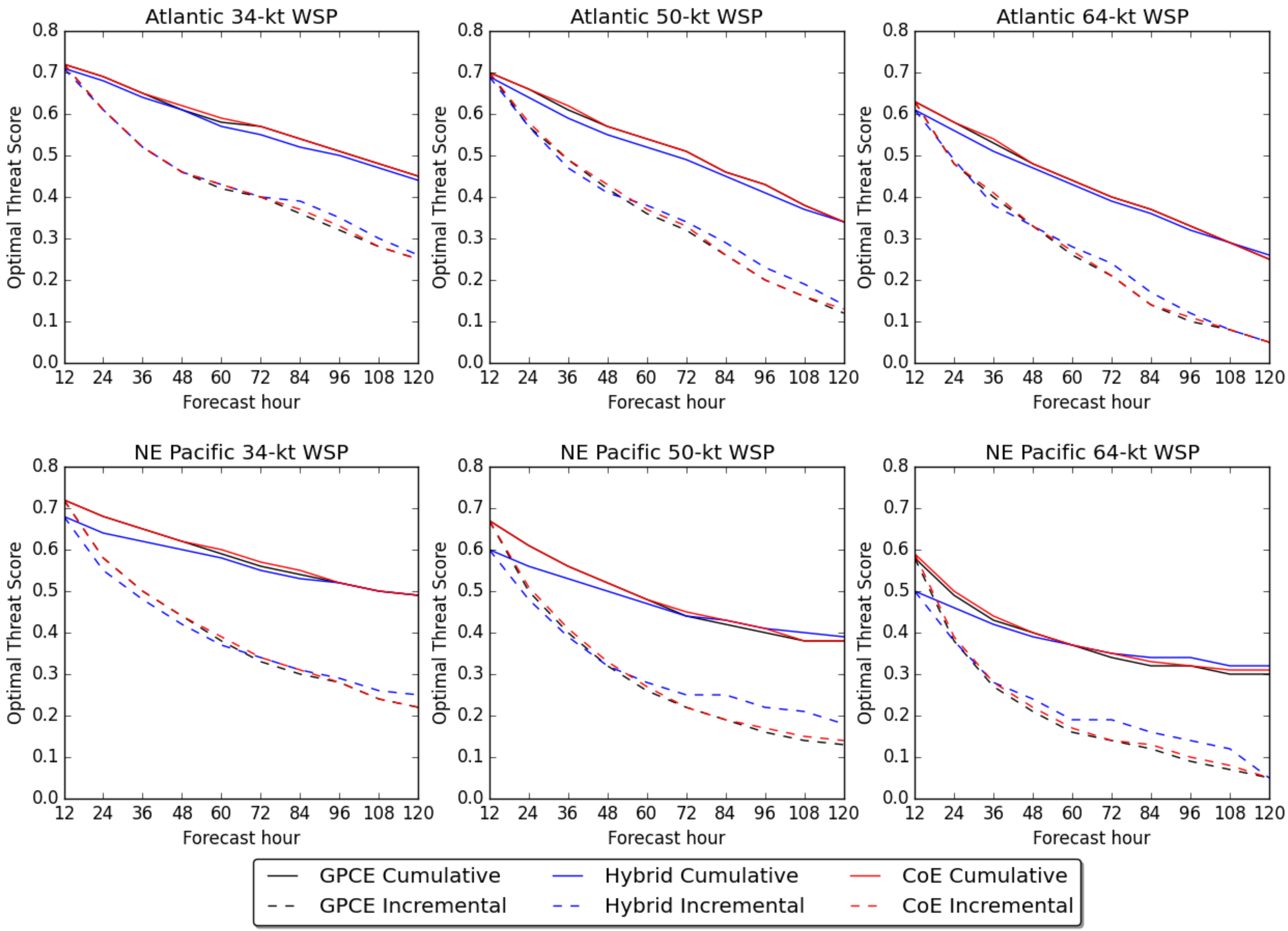
Brier Skill Scores (x100)



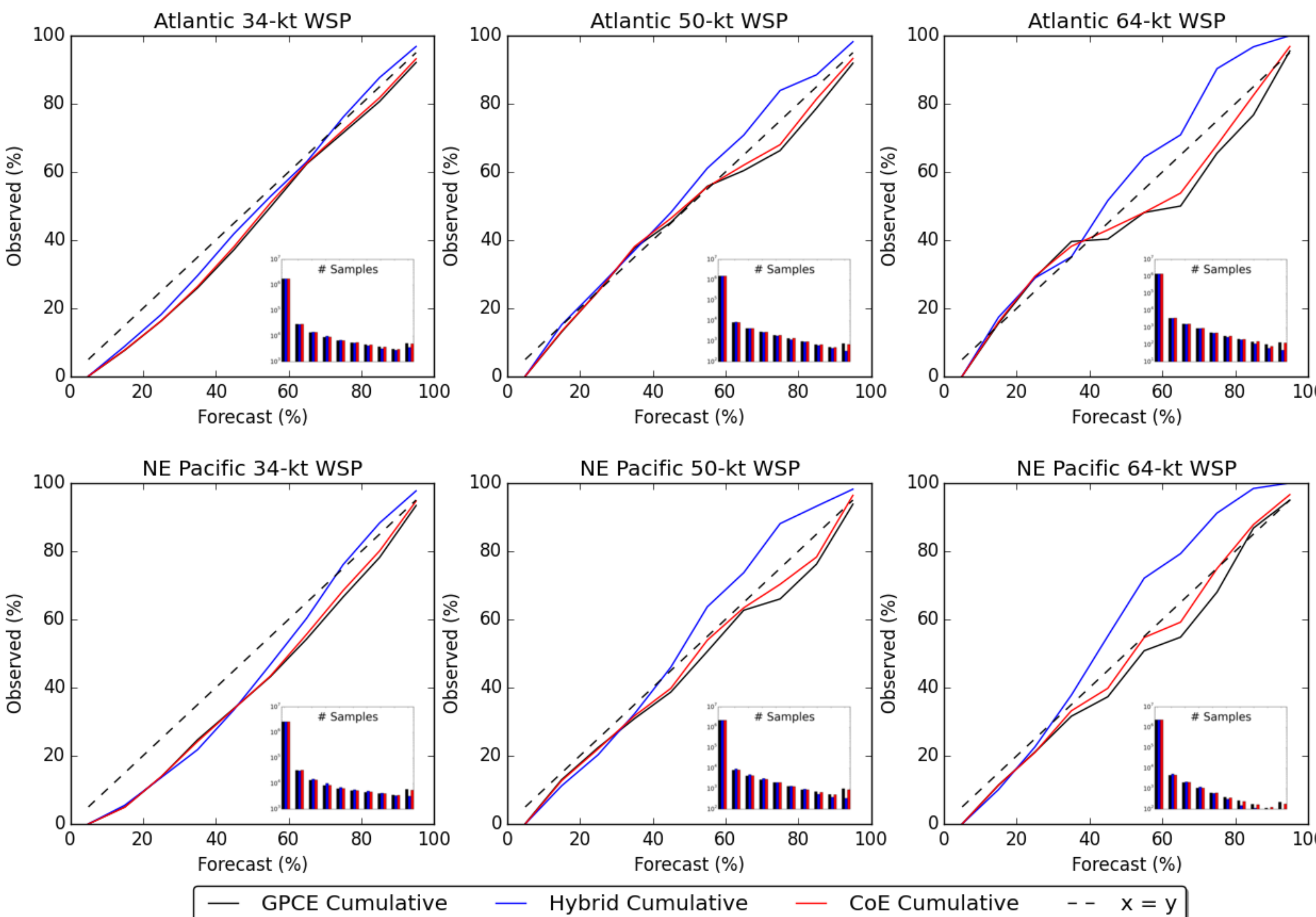
Multiplicative Bias



Optimal Threat Score



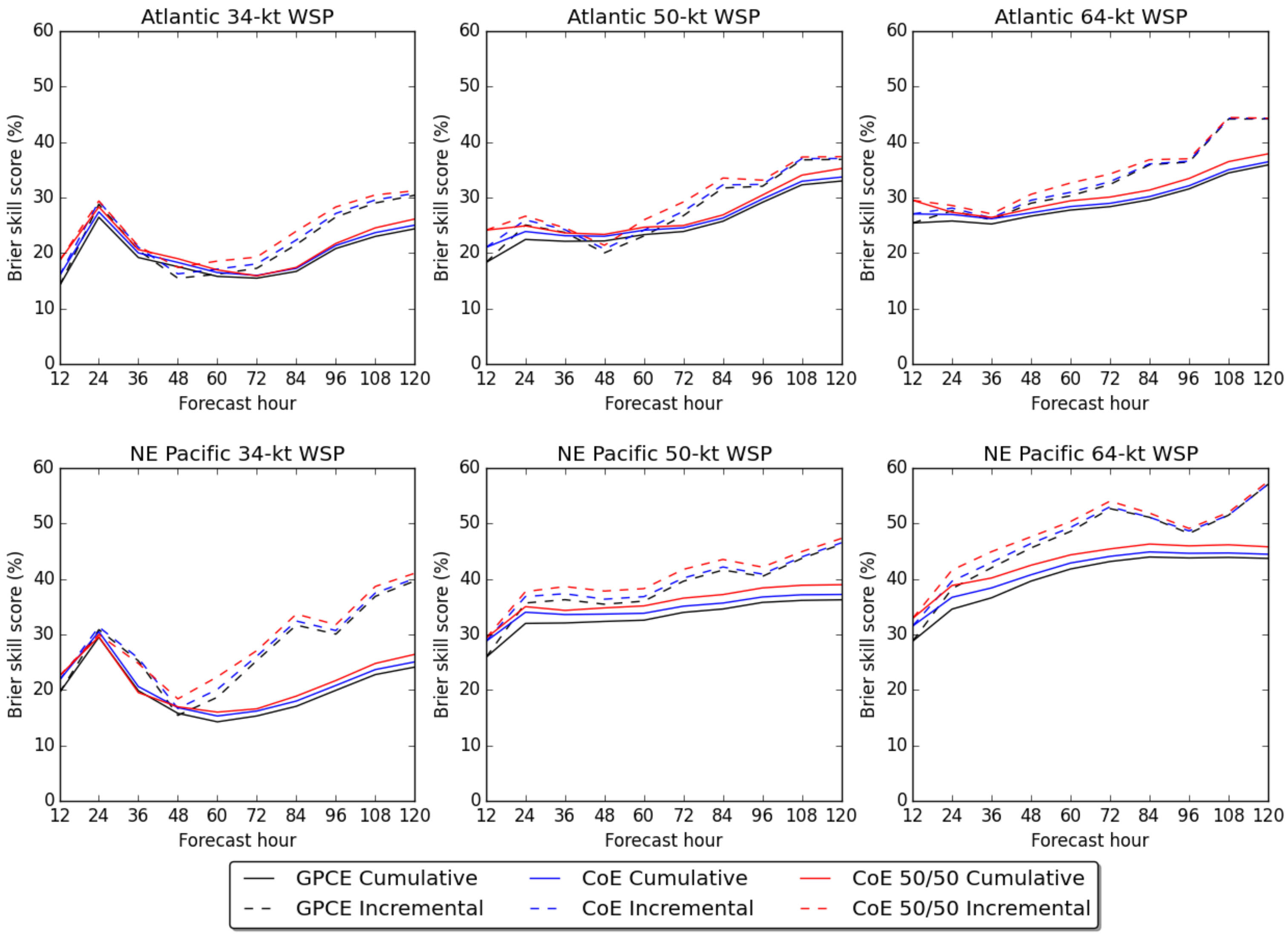
Reliability (0-120h Cumulative)



Ensemble Weighting

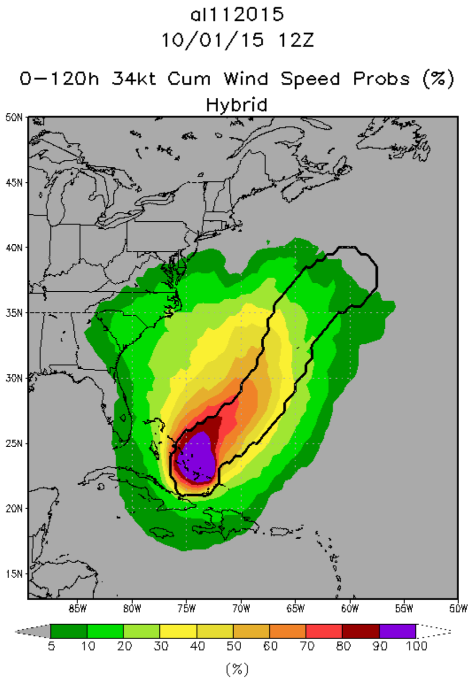
- CoE approach gives each member equal weighting
  - Statistical members, 1000/1133 = 88%
  - Dynamical members, 133/1133 = 12%
- Another approach would be to choose weightings for each group of ensembles (i.e., statistical vs. dynamical)
- Tested statistical/dynamical weightings of 25%/75%, 50%/50%, and 75%/25%
- Only showing results for 50%/50% here

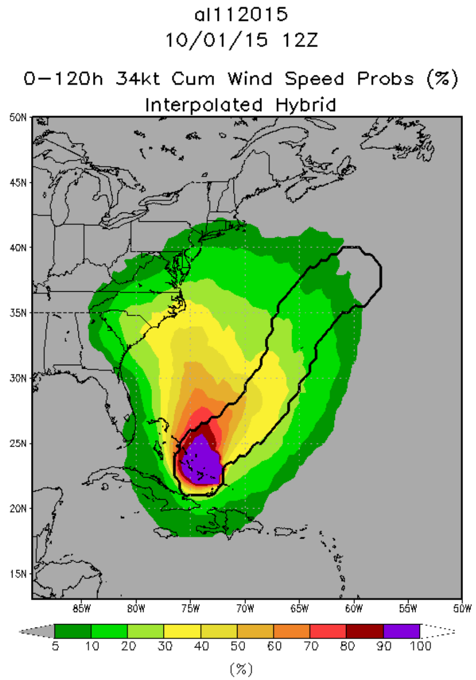
BSS – Equal weighting of dynamical & statistical ensembles



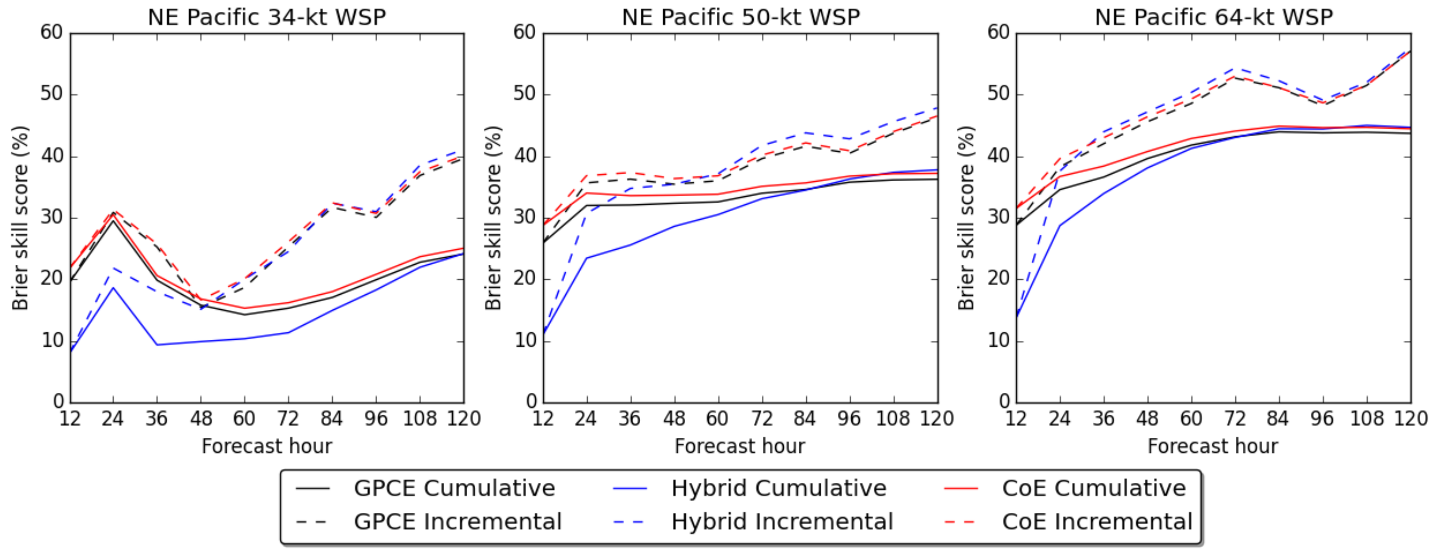
Global Model EPS Latency

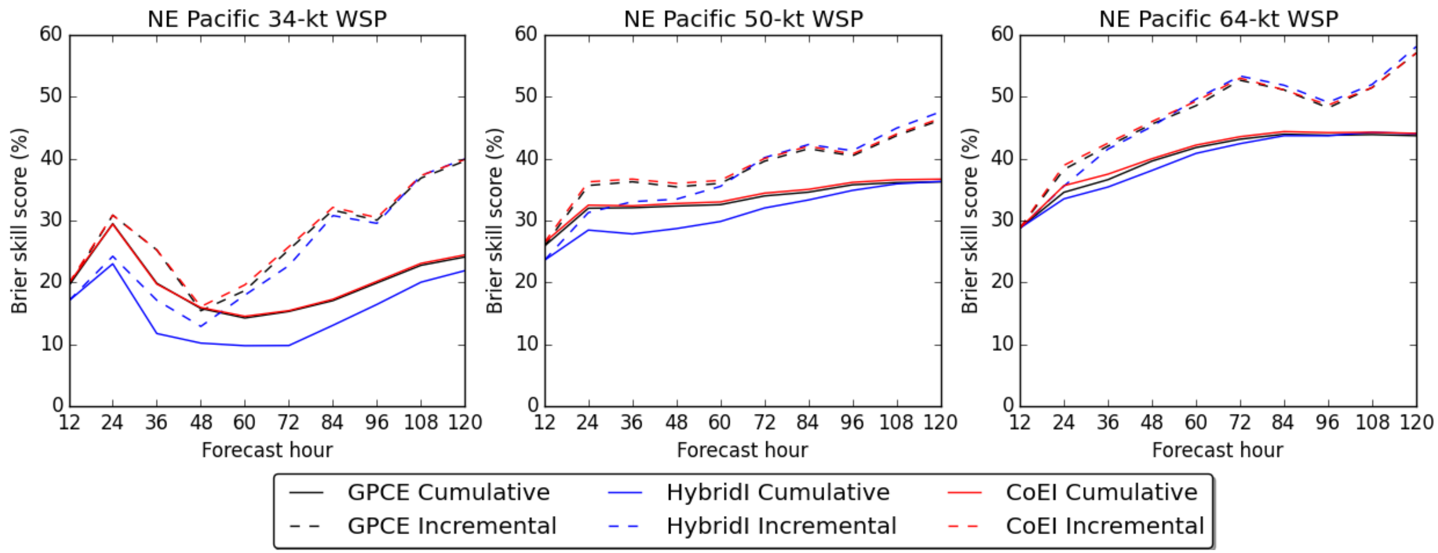
- CoE methodology does not address the issue of ensemble latency
- Some ensembles aren't available until 10+ hours after synoptic time
- Potential solution: interpolate ensembles from 12-hours prior (using methodology similar to that used to generate AVNI)



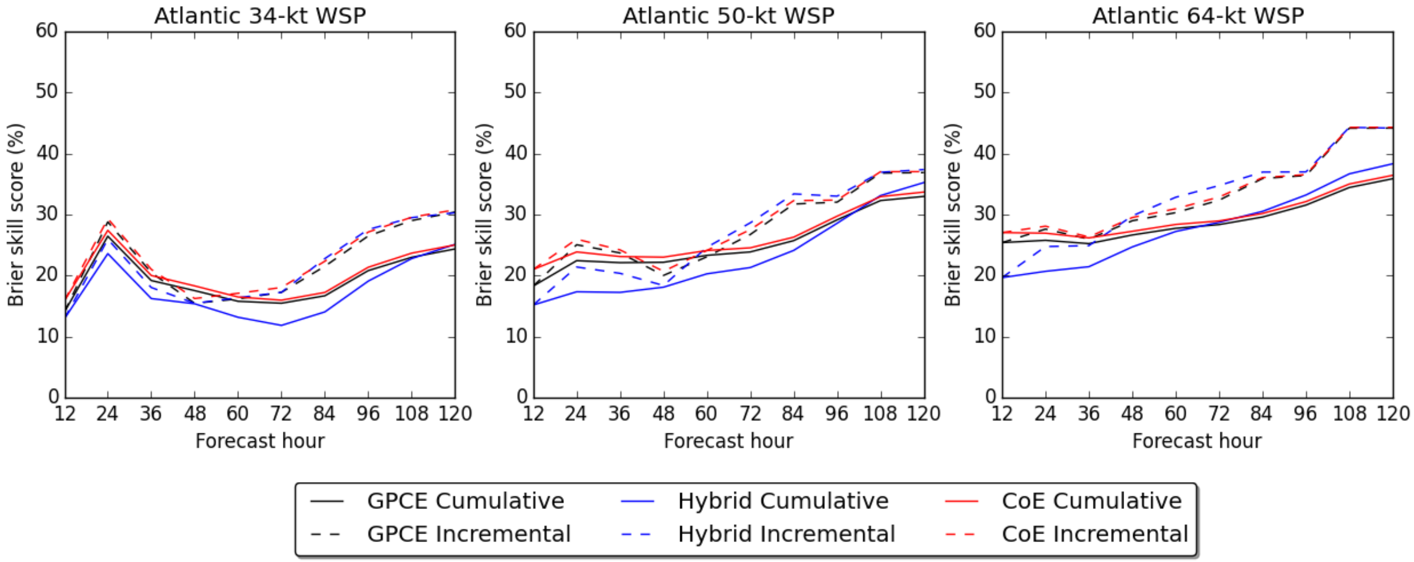


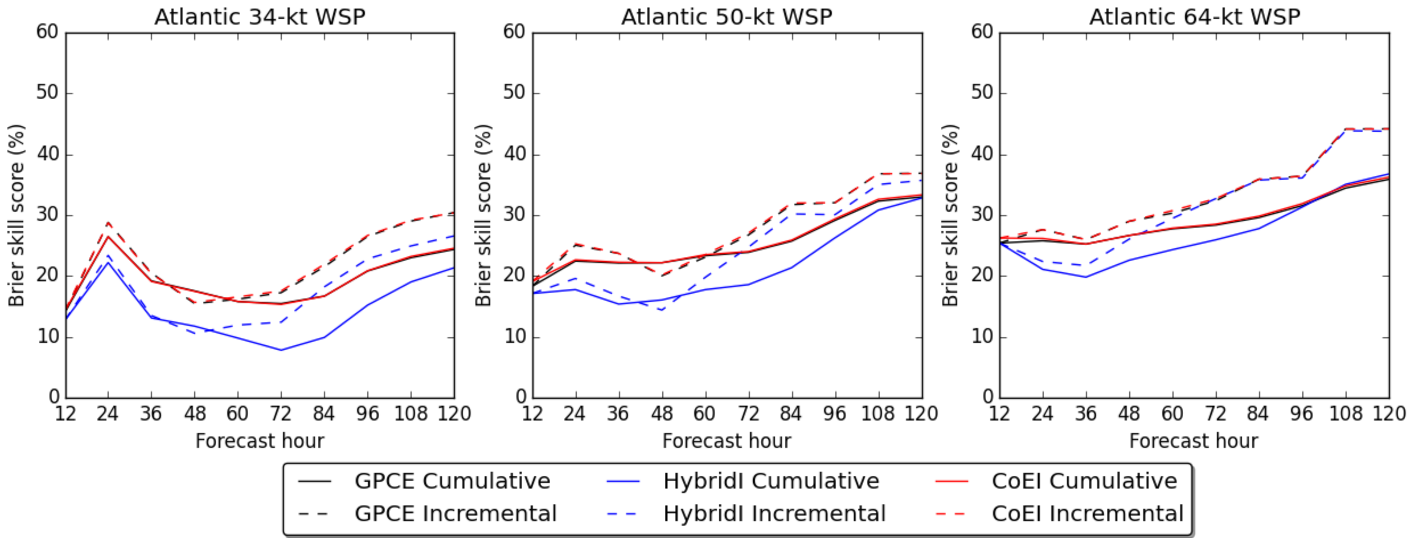
BSS – Interpolated (NE Pacific)





BSS – Interpolated (Atlantic)





Hybrid/CoE WSP Summary

- Consensus of ensembles approach, where dynamical and statistical realizations are combined into a single consensus, improved forecast skill in both the Atlantic and NE Pacific by most verification metrics examined
- CoE approach generates WSPs that are relatively consistent with NHC official track and intensity forecasts
- Weighting of dynamical vs. statistical members of the CoE can be optimized to improve forecast skill. However, the less the statistical members are weighted, the higher the potential for forecast inconsistencies
- Latency is still an issue. Using 12-hour interpolated ensembles provides far less improvement in forecast skill, degrading skill in some cases. More work needed.

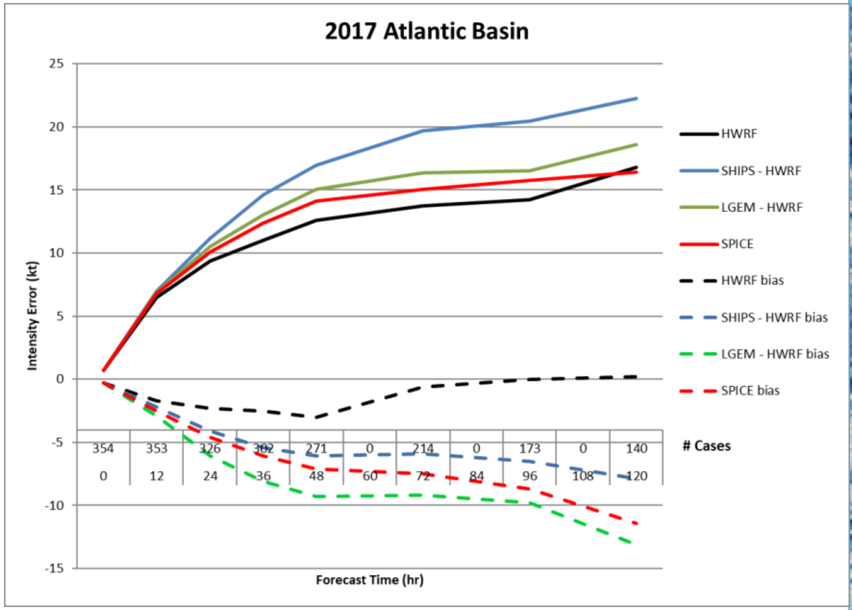
NHC’S OPERATIONAL GUIDANCE SUITE

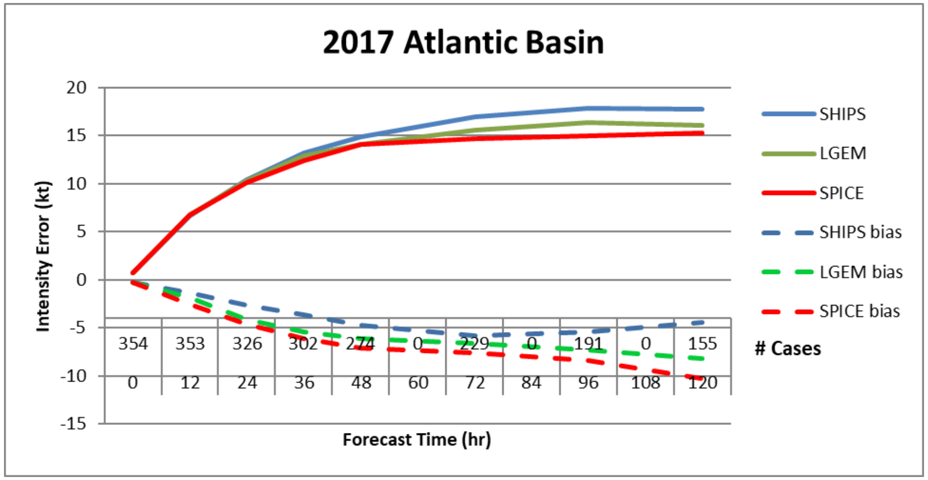
SHIPS/LGEM/RII updates

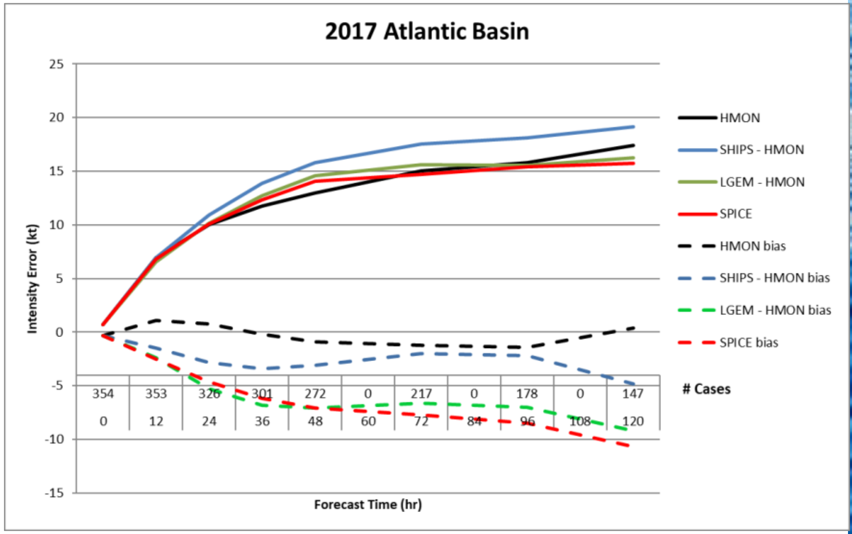
- GOES-16 ingest incorporated into the SHIPS/LGEM processing
- Meteosat ingest currently being developed in cooperation with NHC
- SHIPS developmental databases updated to train 2018 version
- Process to run SHIPS from ECMWF fields streamlined
- Coordinating with NHC to trouble-shoot delivery of e-deck RI guidance; in the meantime CIRA continues delivery to NCAR of post-processed e-decks from operational RII
- Adding the forecast of wind radii to SHIPS/LGEM/RII processing, to be run semi-operationally at NHC

SPICE

- Examined the replacement of GFDL with HMON in SPICE in 2017
- SHIPS and LGEM run from HWRF fields showed large errors and large negative biases – runs are being investigated for any particular environmental parameters
- Will be delivered in demonstration

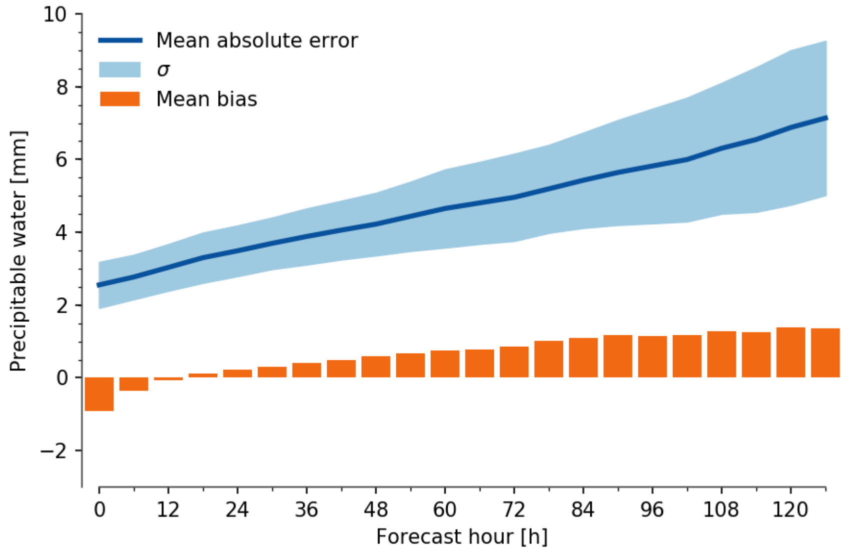






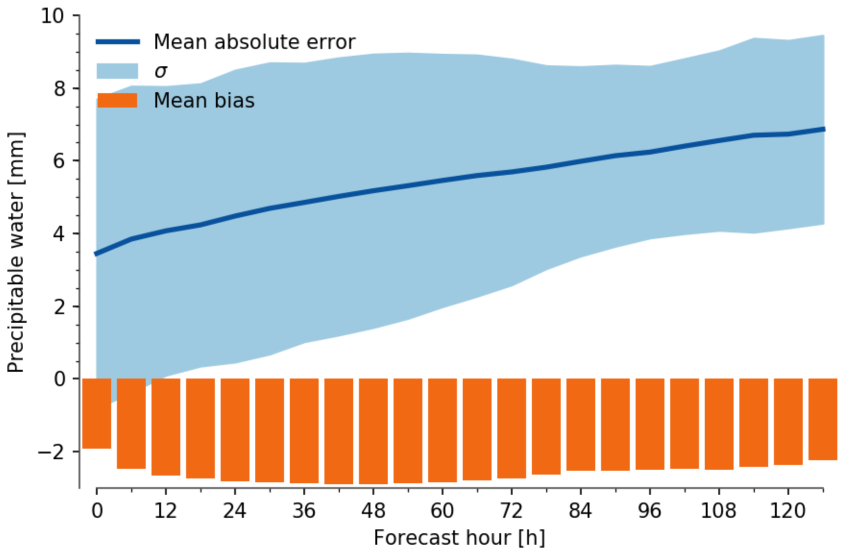
TPW - Mean absolute error & bias

2017 Atlantic HWRF



- HWRF starts out with a slight dry bias (this behavior is different than 2015-2016 seasons)
- As convection develops in the model, a moist bias develops
- The moist bias grows through out the model simulation

2017 Atlantic HMON



- Less constancy in the moisture errors, which is exemplified by large spread
- Dry bias stabilizes within the first 24 hours of the simulation

The role of inner-core and boundary layer dynamics on tropical cyclone structure and intensification – Chris Slocum; Advisers: Wayne Schubert & Mark DeMaria

- Explore applicability of wave-vortex theory to tropical cyclones, which provides an alternative balance to gradient balance
- Analytically solve for vortex potential vorticity development in response to diabatic heating distribution in this framework
- Examine the impact of Burgers' equation and shock dynamics on boundary layer evolution in response to various gradient profiles in axisymmetric and line-symmetric frameworks