Investigating the Utility of Multi-Lead-time Probabilistic Rapid Intensification Models

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Outline

- Background/motivation for statistical RI model development
- Description of RI models
- RI model performance
- Summary

Background and Motivation

- Predicting RI using deterministic intensity prediction models has proven to be quite difficult (Elsberry et al. 2007).

- Model forecasting difficulties due to the multi-scale nature of RI:
  - Environment (e.g. Molinari and Vollaro 1989; Kaplan and DeMaria 2003)
  - Inner-core (Kossin and Schubert 2001, Kieper and Jiang 2012; Chen and Zhang 2013 ; and Rogers et al. 2015)
  - Ocean (Shay et al. 2000)

- SHIPS-RII - Statistical model for estimating 24-h probability of RI using environmental data was developed (Kaplan and DeMaria 2003). SHIPS-RII became operational in 2004 (Atlantic) and 2006 (E. Pacific).

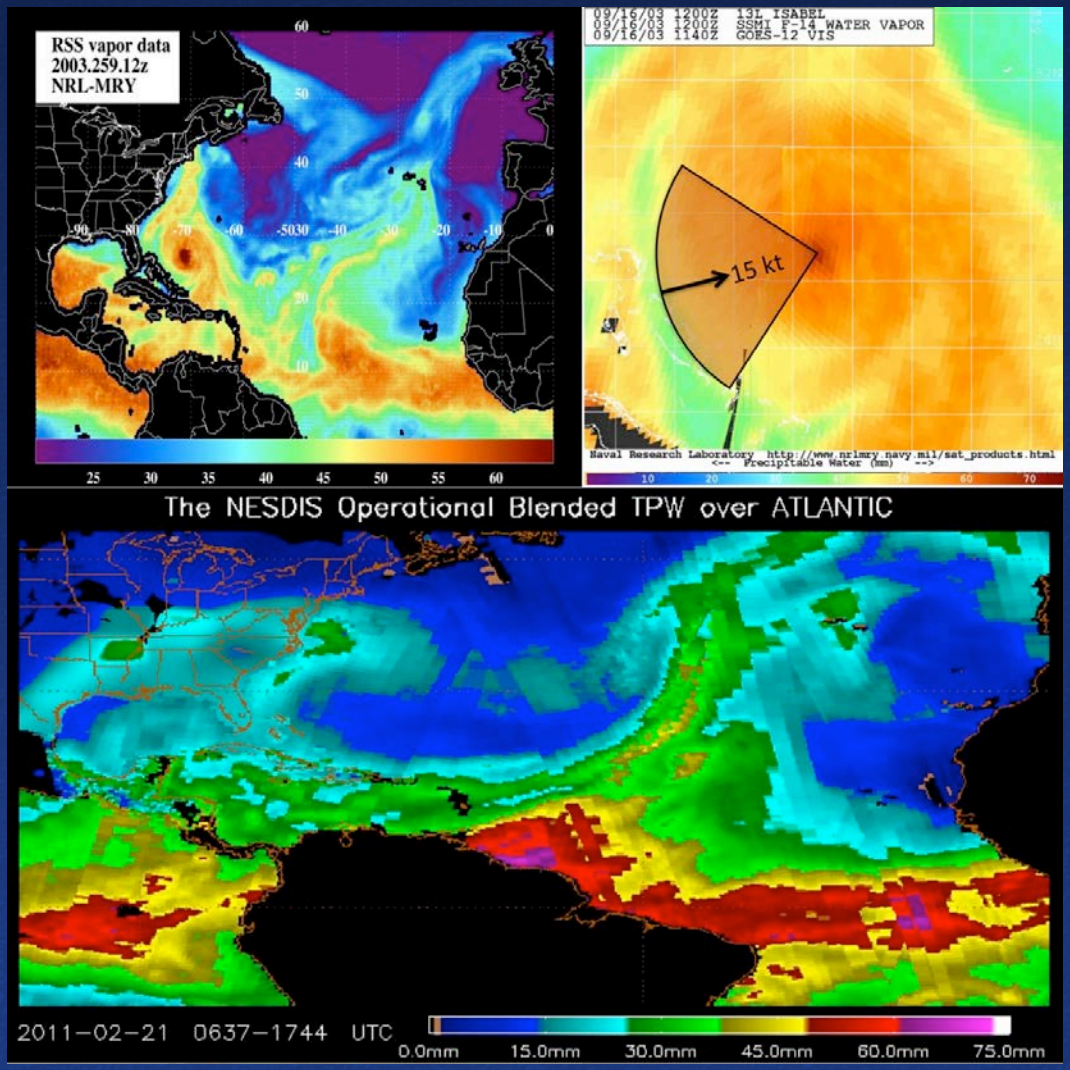
- SHIPS-RII that used environmental information + GOES-IR predictors developed based upon linear discriminant analysis. This model became operational in 2008 (Kaplan et al. 2010).

- Multi-lead time SHIPS-RII and new probabilistic Logistic regression, Bayesian, and Consensus RI models (Rozoff and Kossin 2011) were developed for **12-h**, **24-h** , **36-h**, and **48-h** lead times (Kaplan et al. 2015). These models became operational in 2016.

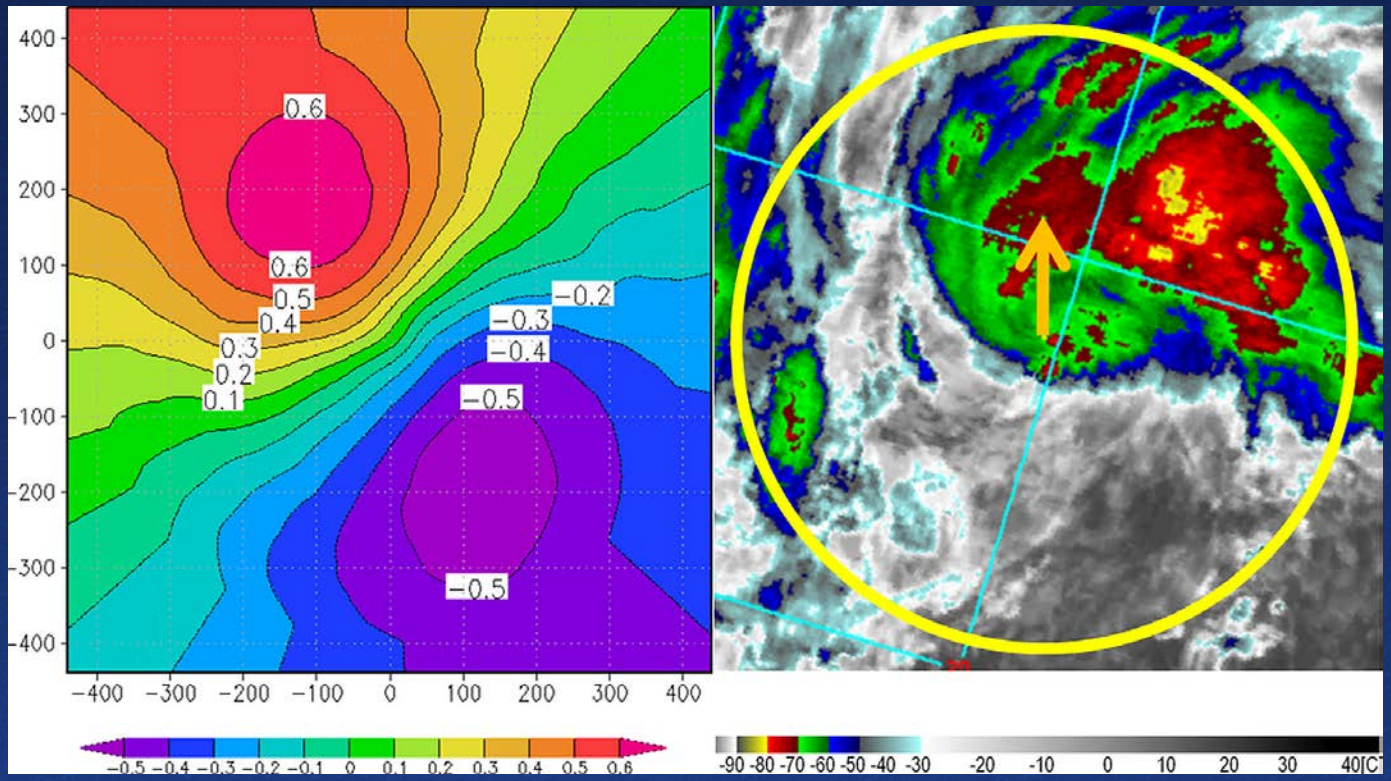
Predictors used in operational 2016 SHIPS-RII

Predictor	Definition	More Favorable
DV12	Previous 12-h intensity change	Larger
VMAX	Maximum sustained wind (t=0 h)	Avg. of RI sample
IRSD	Std. dev. of 50-200 km GOES-IR brightness temperatures (t= 0 h)	Smaller
IRPC	2nd principle component of GOES-IR image (0-440 km radius) (t= 0 h)	Front left-quadrant
SHRD	850-200 mb shear 0-500 km radius (time-avg.)	Smaller
D200	200-hPA divergence from 0-1000 km radius (time-avg.)	Larger
TPW	Percent area with TPW < 45 mm within 500 km 90 deg. up-shear (t=0 h)	Smaller
CFLX	Inner-core dry-air predictor/flux (time-avg.)	Smaller
POT	Potential intensity (Current intensity – MPI) (time-avg.)	Larger
OHC	Oceanic heat content (time-avg.)	Larger

Sample TPW predictor for Hurricane Isabel (2003)



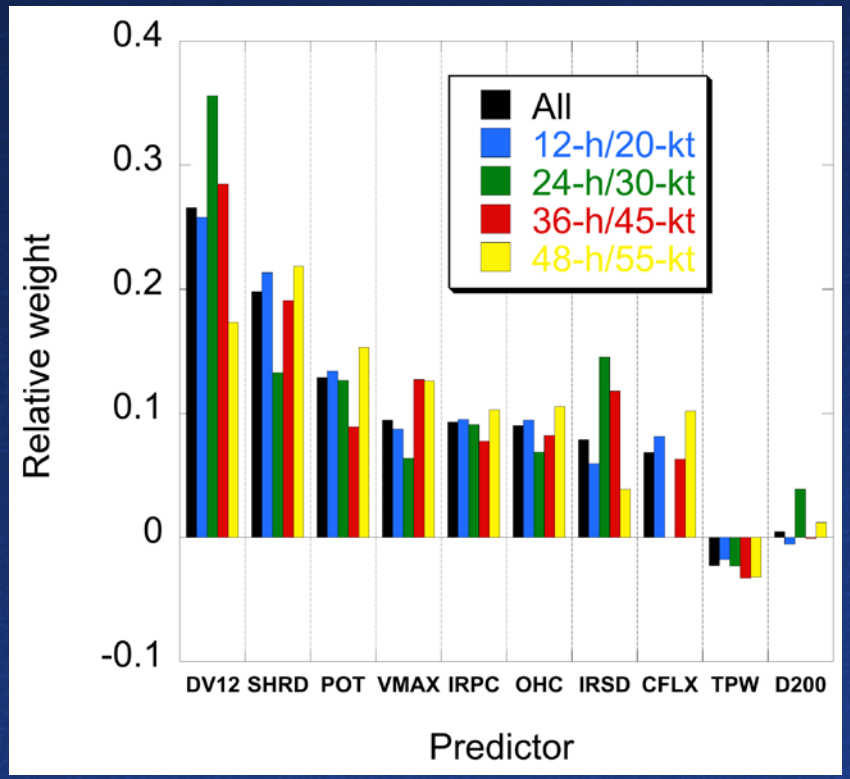
Sample IRPC predictor for Hurricane Wilma (2015) at 1800 UTC on October 17



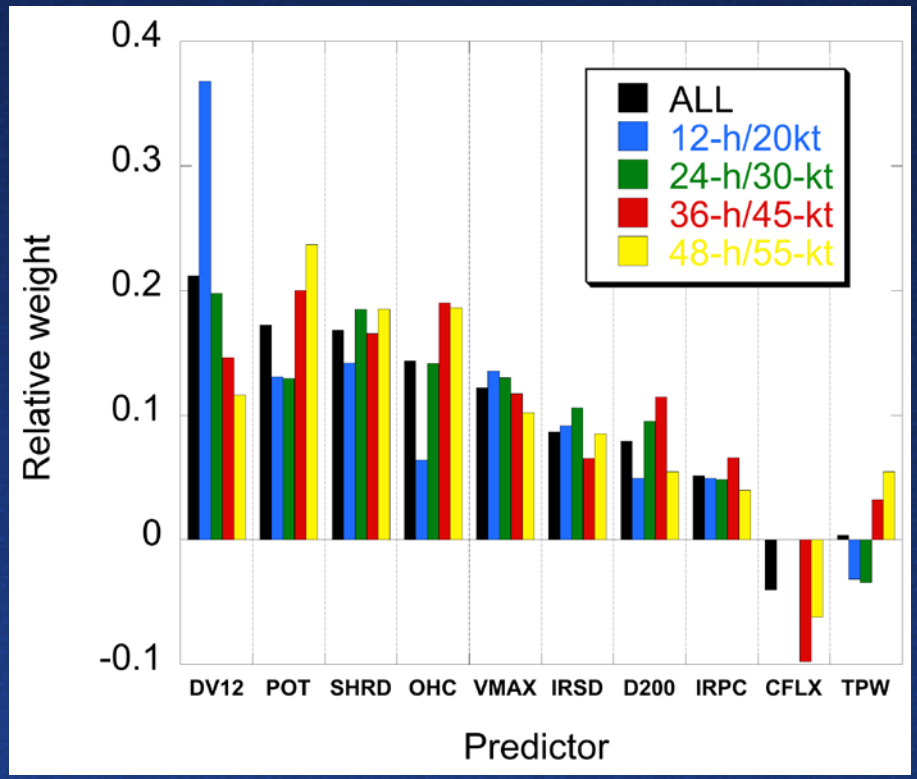
Relative predictor weights of the 2016 SHIPS-RII

(for 12-h/20-kt, 24-h/30-kt, 36-h/48-kt and 48-h/55-kt RI thresholds based upon 1995-2016 developmental data)

Atlantic



E. Pacific

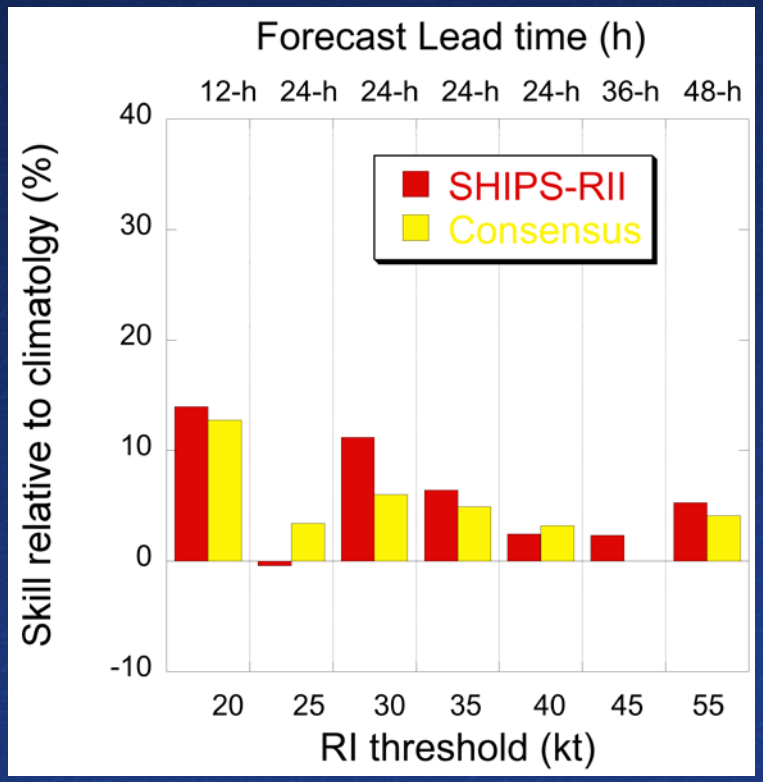


Skill of the 2016 operational RI model forecasts

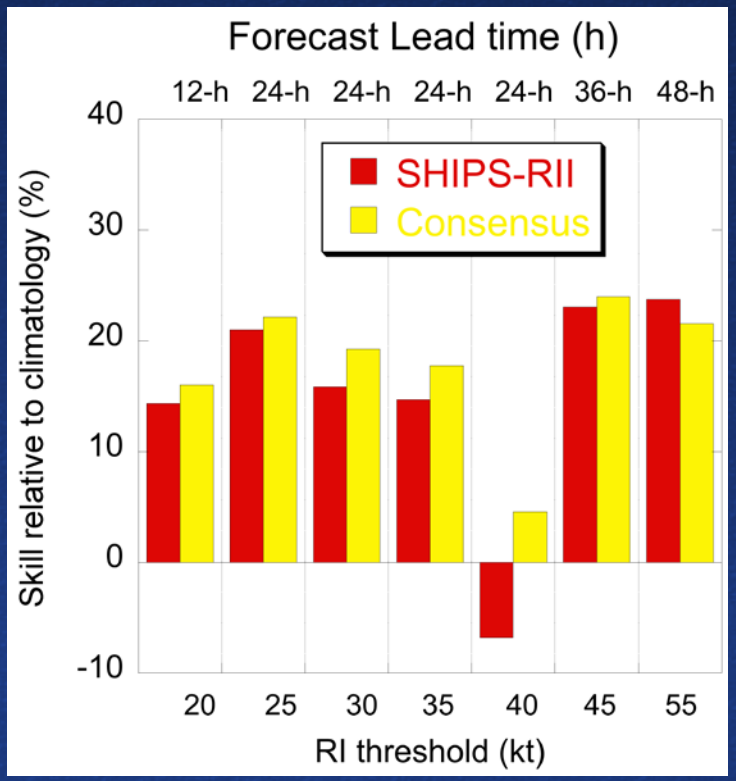
Forecasts verified for all tropical and subtropical over-water cases (using NHC best track data) and evaluated by comparing the Brier skill scores of the RI model forecasts to those based upon climatology (1995-2014) for each RI threshold and basin.

Consensus model- Arithmetic average of SHIPS-RII, Logistic regression, and Bayesian RI model probabilities.

Atlantic

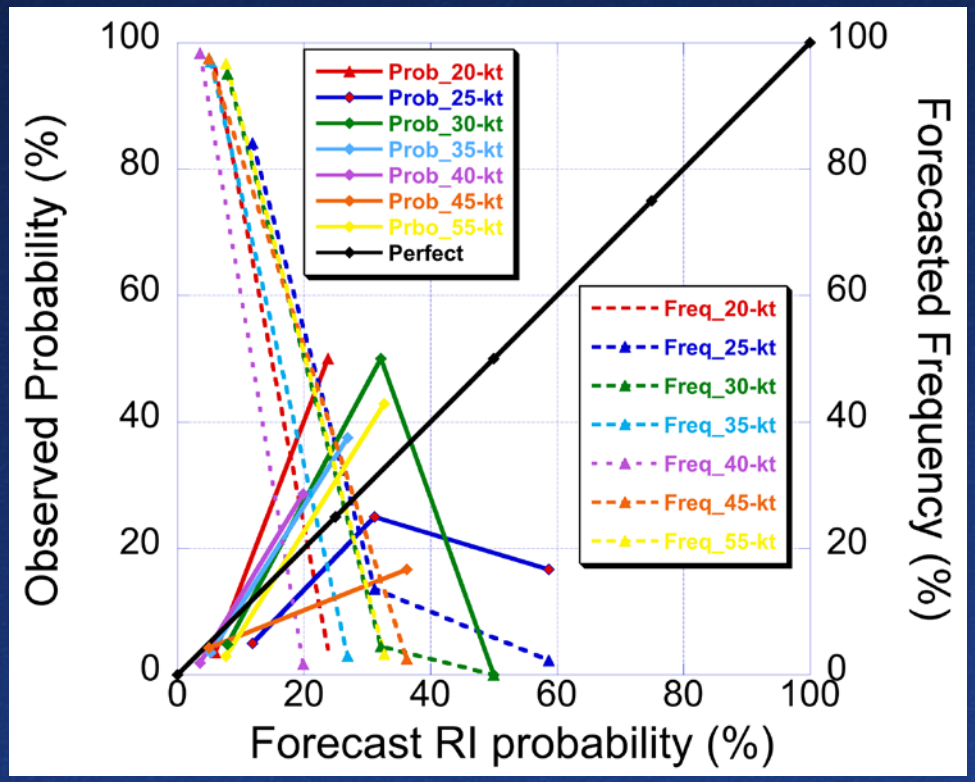


E. Pacific

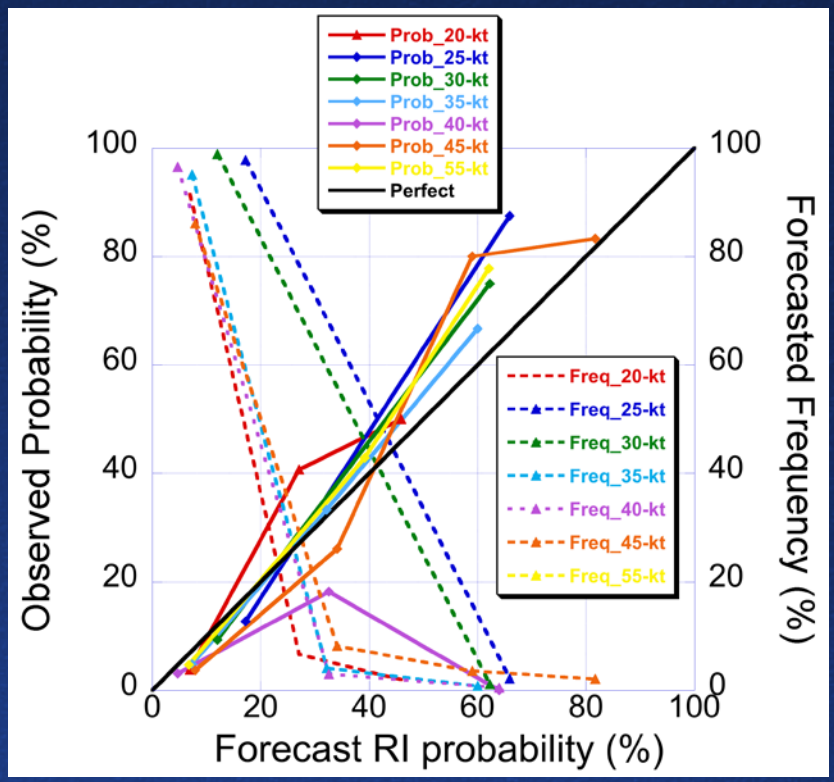


Reliability of 2016 operational SHIPS-RII forecasts

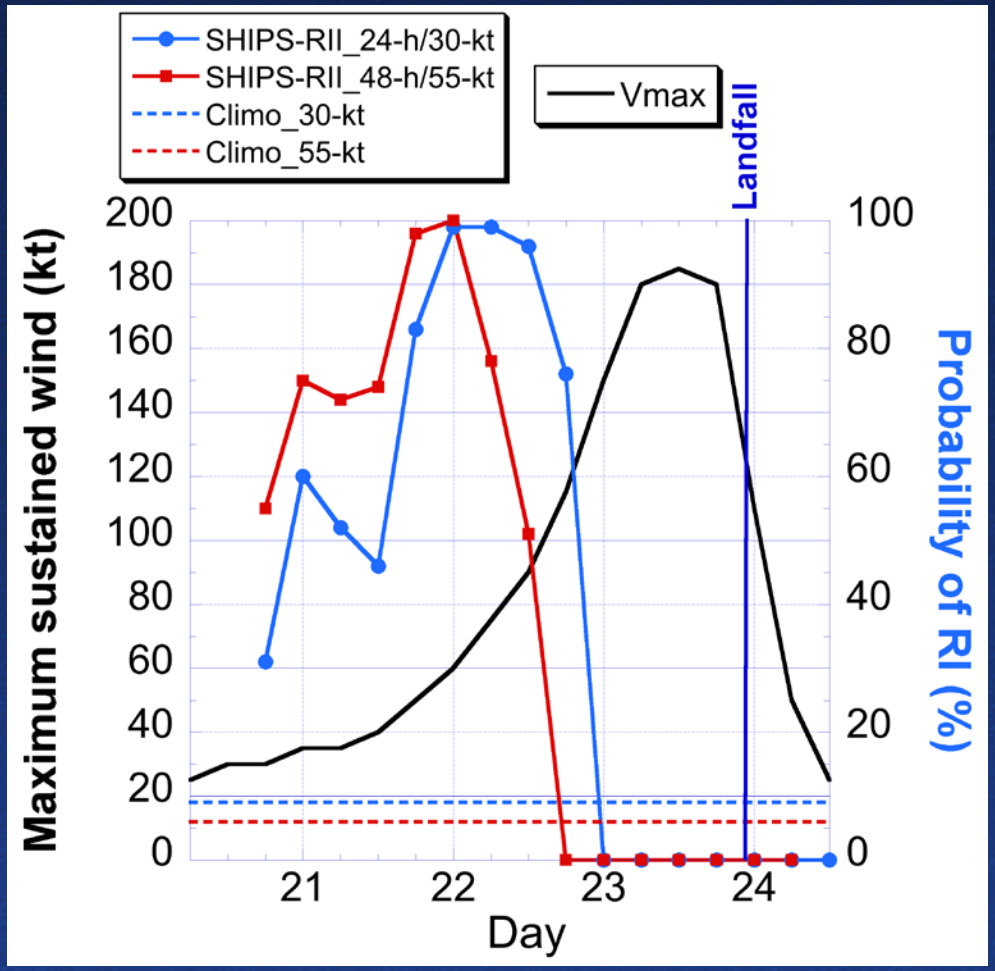
Atlantic



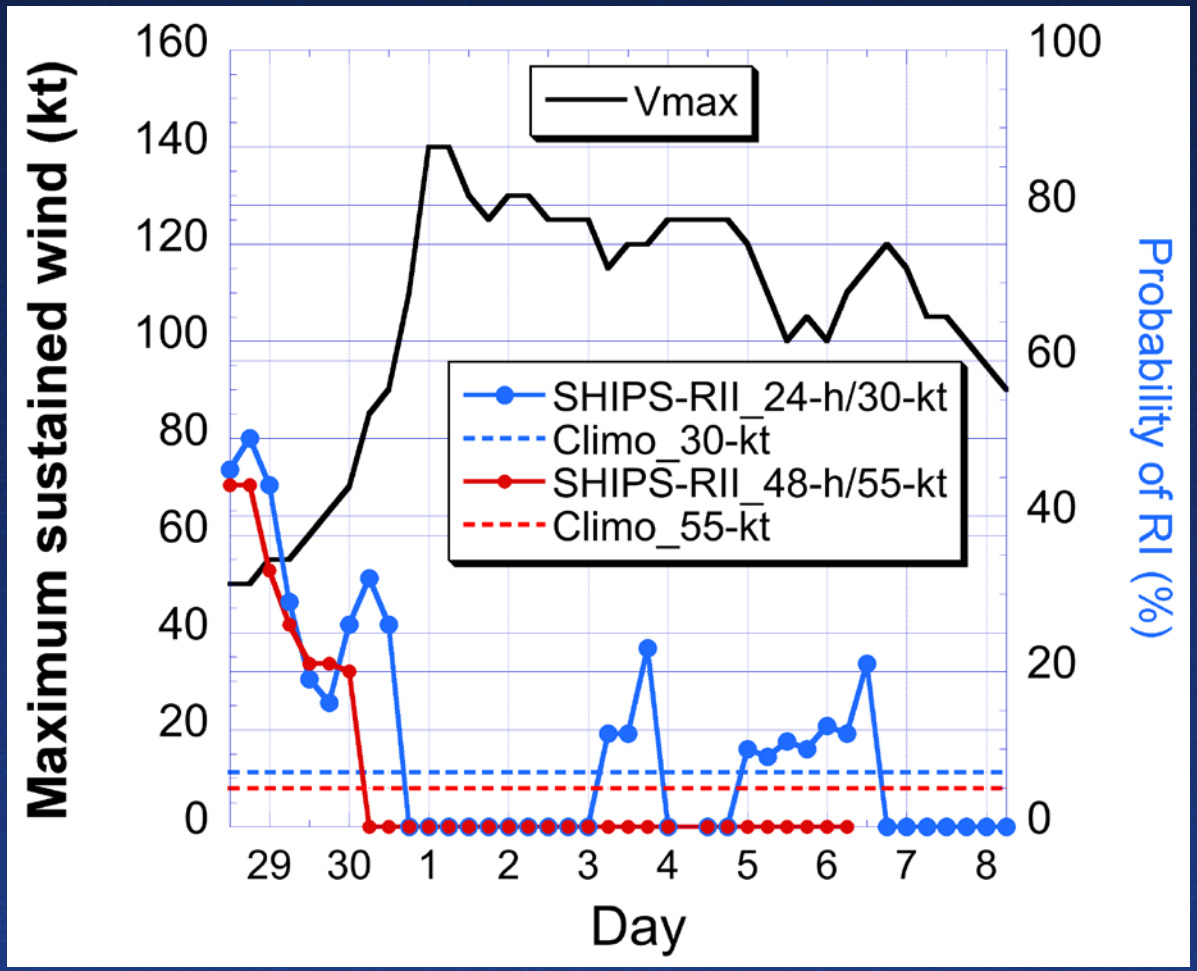
E. Pacific



SHIPS-RII independent 2016 RI model rerun forecasts for E. Pacific Hurricane Patricia (2015)



SHIPS-RII operational RI model forecasts for Atlantic Hurricane Matthew (2016)



Summary

- The new operational multi-lead time SHIPS and consensus RI model forecasts generally exhibited a small amount of skill in the Atlantic and a modest degree of skill in the E. Pacific during the 2016 season.

- SHIPS-RII independent rerun forecasts for Patricia (2016) indicated a relatively high likelihood of RI prior to that storm's observed period of RI but the operational SHIPS-RII forecasts indicated only a moderate probability of RI prior to the period of very rapid intensification that was observed for Hurricane Matthew (2016).

- Study results underscore the greater difficulty that exists in predicting RI in the Atlantic vs. the E. Pacific but also show the importance of accurately measuring and predicting the large-scale environment.

- New versions of the SHIPS, Logistic regression, and Bayesian RI models that provide RI forecasts for a 72-h lead time and that address recent changes to the methodology for analyzing TPW and GOES IR-PC predictors are currently being evaluated for potential implementation for the upcoming 2017 Hurricane Season.