Enhancements to the Operational SHIPS Rapid Intensification Index

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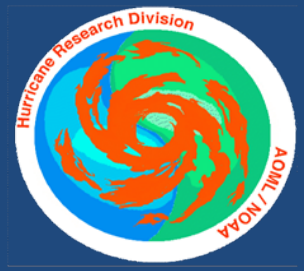

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Background

- Operational SHIPS rapid intensification index (RII) estimates the 24-h probability of RI for three RI thresholds (25-kt ,30-kt , and 35-kt) utilizing linear discriminant analysis (see Kaplan et al. 2010 for details)

- Current RII uses 8 SHIPS predictors

    - Large scale/persistence predictors (6)- Vertical shear, upper-level, divergence, low-level RH, potential intensity, ocean heat content, and persistence
    - GOES inner-core predictors (2) - Std. dev. of IR brightness T and areal-coverage of -30° C brightness T within 200 km radius

- SHIPS discriminant RII adopted for operational use in Atlantic and E. Pacific basins prior to 2008 Hurricane season

- Current JHT project seeks to improve operational RII using predictors from 3 new sources:

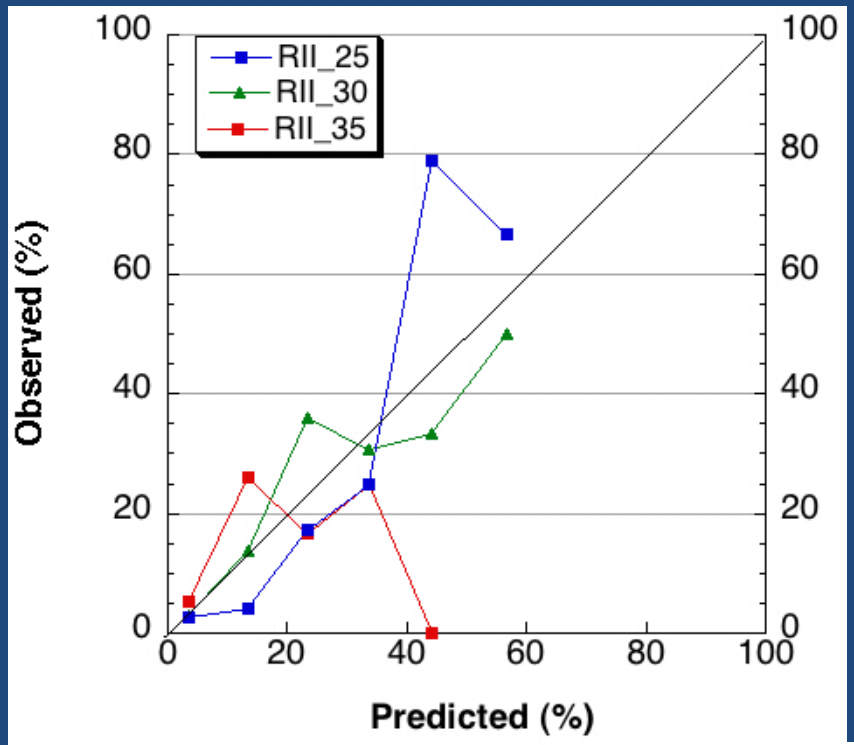
    - Total precipitable water, boundary-layer predictors derived from GFS analyses, and GOES-IR predictors derived from principle component (PC) analysis

Operational RI intensity guidance evaluation (2008-2009)

- SHIPS RII assumed to forecast RI if forecasted probability exceeded previously determined probability cut-offs (see Kaplan et. al 2010):
  - Atlantic- 30, 20, and 21% for 25, 30 and 35 kt thresholds
  - E. Pacific- 35, 31, and 28% for 25, 30 and 35 ktthresholds
- Model forecast RI if intensity change $\geq$ RI threshold
- Homogenous comparison made for all over-water 24-h time periods for tropical and subtropical systems (i.e. extra-tropical and landfall cases excluded)
- NHC best track data (as of Jan 26) used for validation

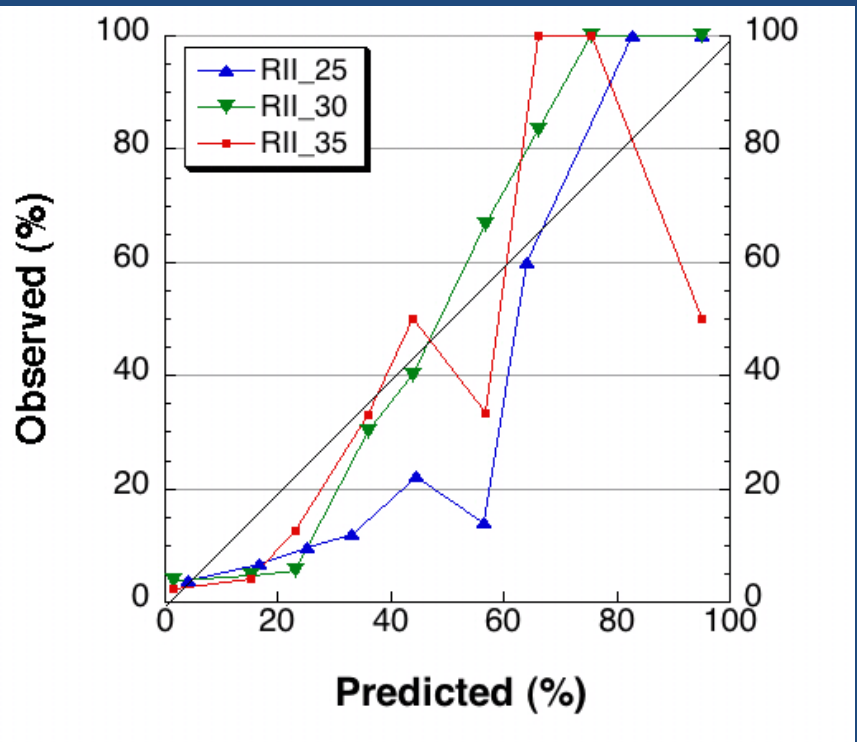
RI index (RII) predicted vs observed RI probabilities (2008-2009 operational forecasts)

Atlantic Basin



N(25-kt)	40	112	92	24	19	6
(30-kt)	144	104	25	13	3	4
(35-kt)	248	23	12	8	2	

E. Pacific basin

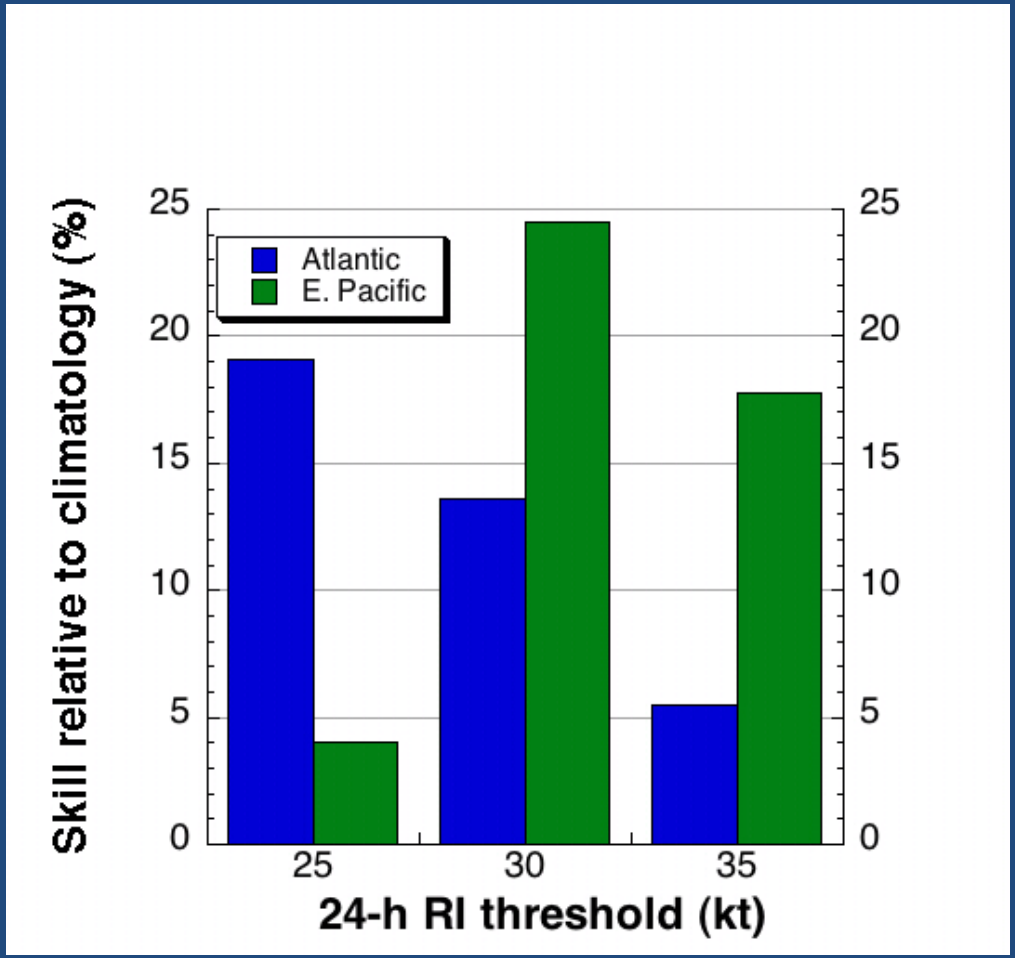


N(25-kt)	157	45	113	92	9	7	10		5	3
(30-kt	212	87	105	10	5	3	6	2	2	2
(35-kt)	260	98	64	3	4	3	5	2		2

Skill of the 2009-2009 operational RII forecasts

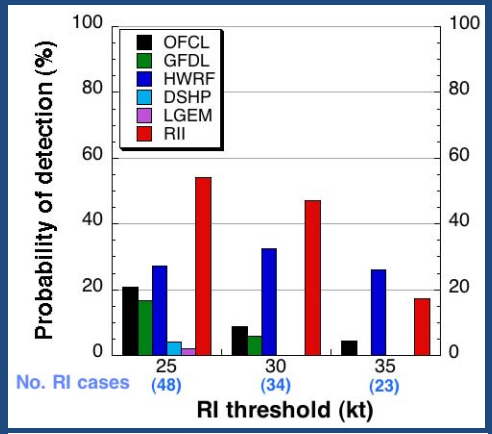
Atlantic (N=293)

E. Pacific (N=441)

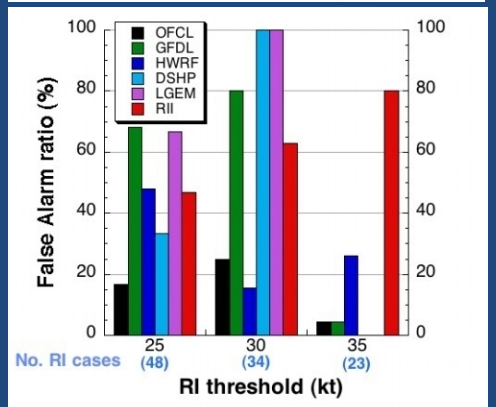


Operational RI intensity guidance performance (2008 and 2009)

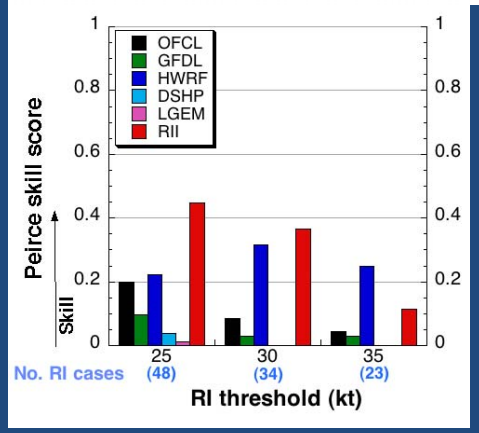
Atlantic basin



Probability of detection

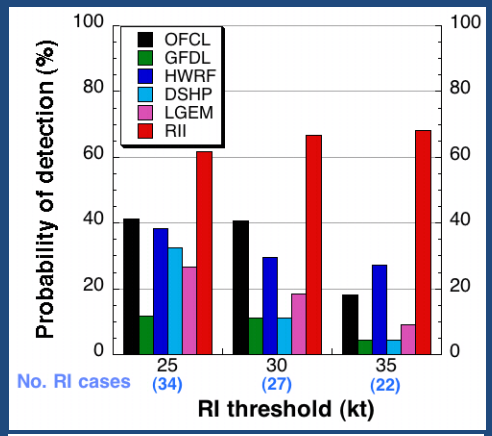


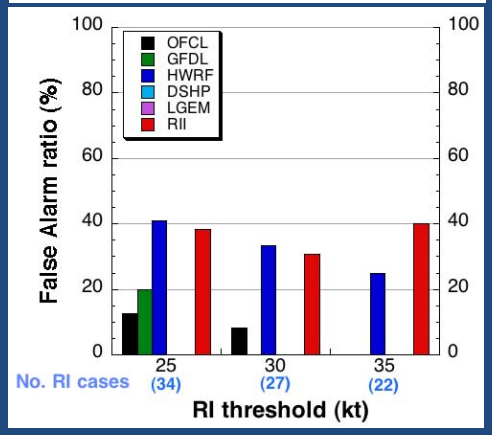
False alarm ratio

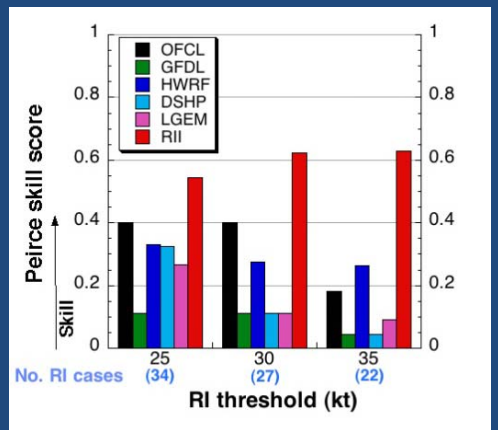


Peirce skill score

E. Pacific basin







Current JHT Efforts to improve operational RII

- Predictors from three new sources tested for inclusion in new experimental Atlantic RII:
  - Total precipitable water (TPW)
  - Boundary-layer (BL) predictors from GFS fields
  - GOES-IR predictors from principle component (PC) analysis
- New predictors that yielded largest increase in skill of RII when used in place of current RI predictors when tested on 1995-2008 dependent sample chosen for inclusion in experimental RII
- Slightly modified use of current potential intensity and persistence predictors also introduced
- New Atlantic RII for 40 kt RII threshold developed (Eric Blake)

IR Principle Component Methodology

Principle components (PCs) for motion relative imagery calculated from CIRA IR image archive (1995-2008)

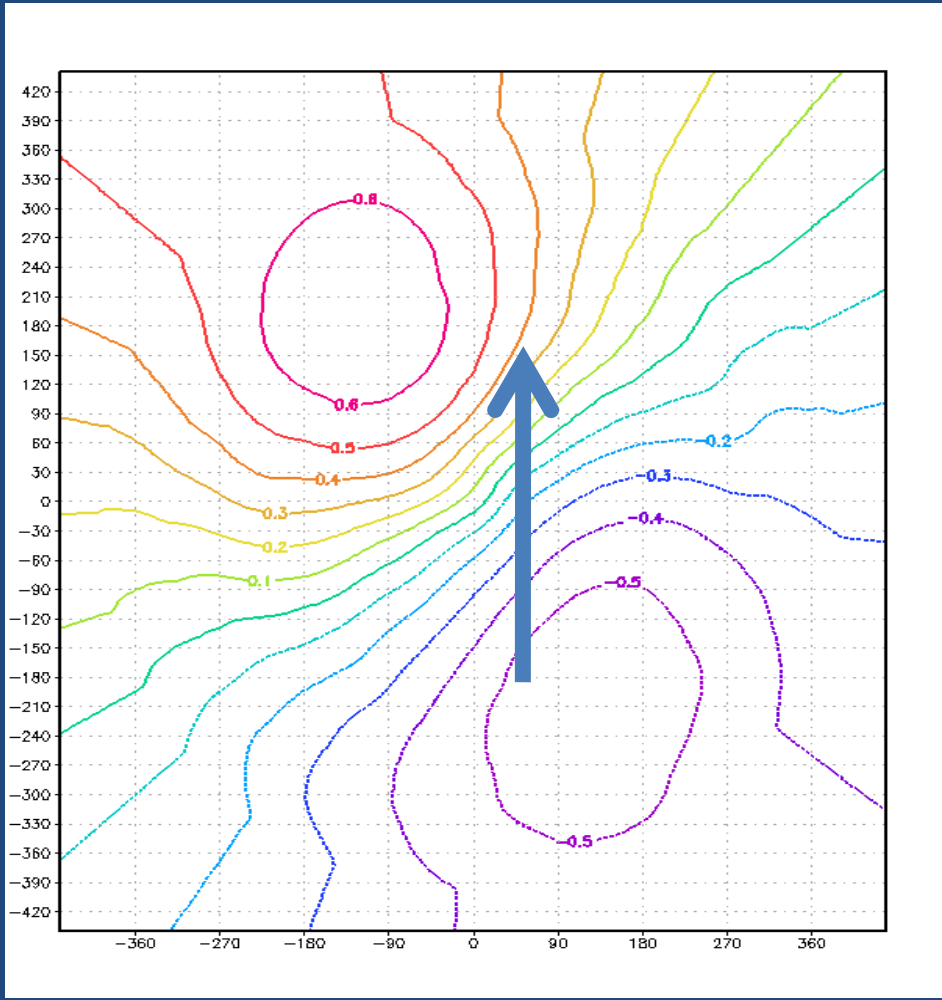
IR brightness temperatures are analyzed on a cylindrical grid (5 degrees by 440 km)

Means are removed

Standard EOF analysis was performed and first nine PCs were examined

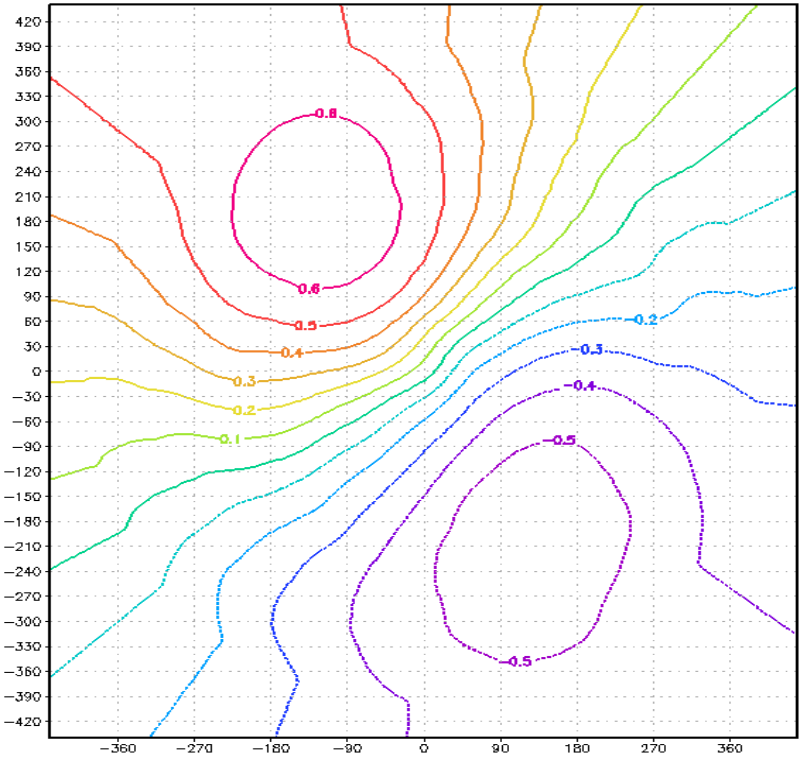
PC2 used as new RI predictor in place of areal-coverage of -30° C brightness T

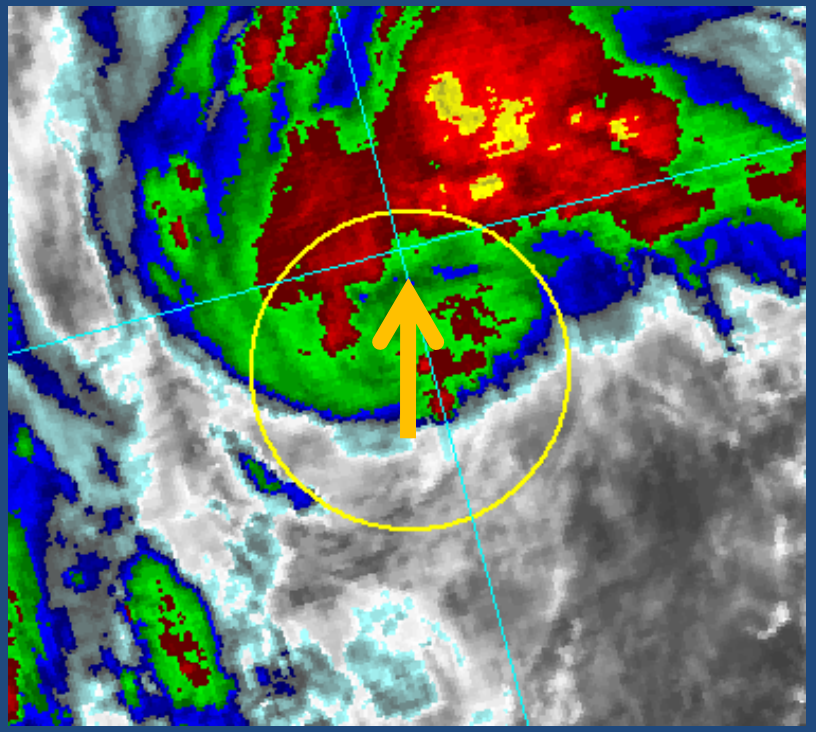
Storm motion is UPWARD



Spatial Weightings of EOF 2

Hurricane Wilma 17 October 1745 UTC





PC2 = -1.32

Total Precipitable Water (TPW) RII Predictor

TPW Dataset

-Remote Sensing Systems

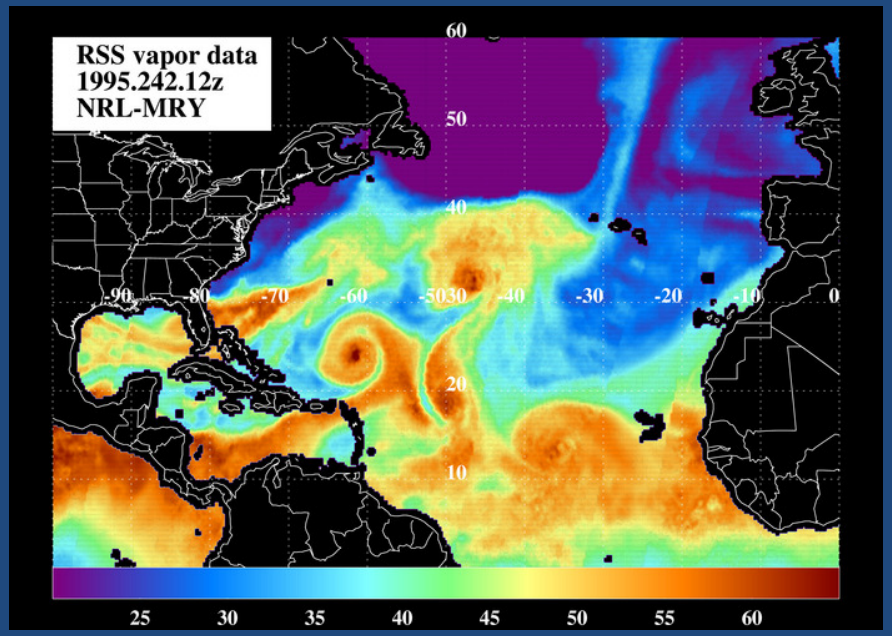
-14 yr dataset (1995-2008)

-1/4 degree global grid

-6 hourly images (~+/- 9 hr data windows)

-SSM/I, TMI (TRMM) and AMSRE-E (Aqua)

-derived using the 19/22/37 GHz channels



21 Atlantic TPW predictors tested & identified

Atlantic TPW Predictor chosen-
%TPW pixels <45 mm
(r=0-500 km, 90 deg quad centered upshear)

replaces old 700-850 hPa RH predictor

Boundary-layer predictors

- GFS moisture and temperature analyses and Reynolds SST data used to derive new thermo-dynamic boundary-layer RI predictors (Total of 22 predictors developed and tested; 28 others also developed and partially tested)

- Inner-core dry air predictor worked best (replaced heat content)

$$\textit{Inner-core dry air predictor} = (q10_{layer} - q10) * Vmx$$

- q10 is the inner-core 10 m specific humidity estimated using the 1000 mb 200- 800 km environmental RH and T

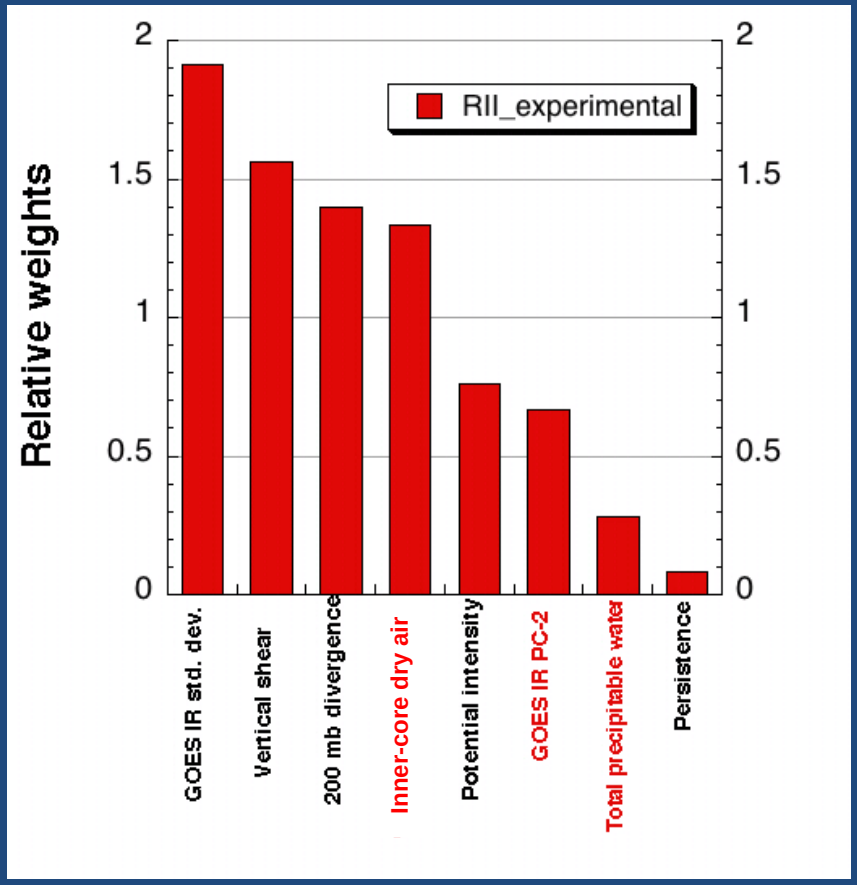
- $q10_{layer}$ is the 10m inner-core specific humidity estimated using 200-800 km environmental layer-mean RH between 1000 mb and 300 mb

-Vmx is the NHC maximum surface wind

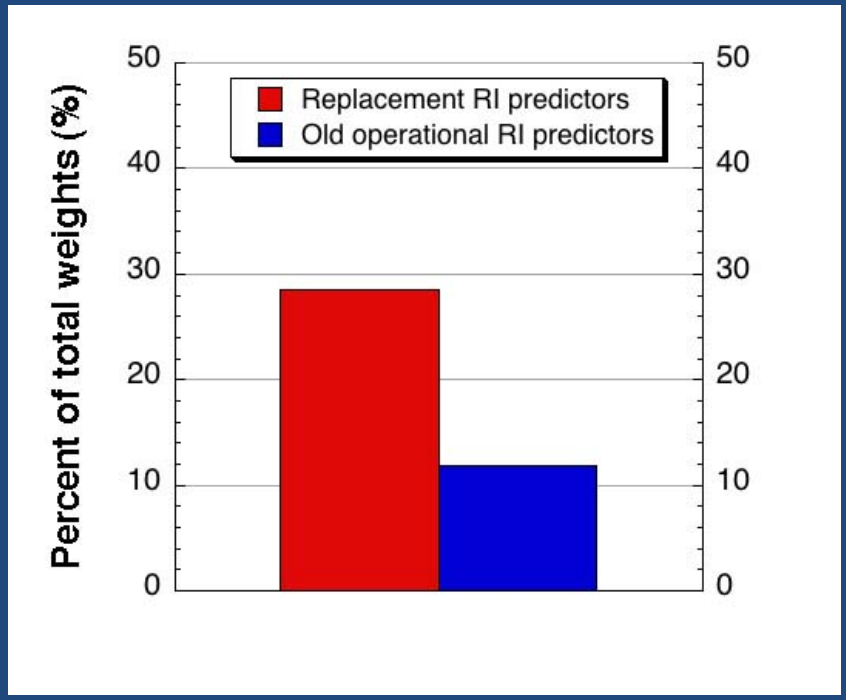
- Small values of this predictor (indicating less potential for the mixing of dry air down to surface) favored for RI

Discriminant weights of the experimental Atlantic RII

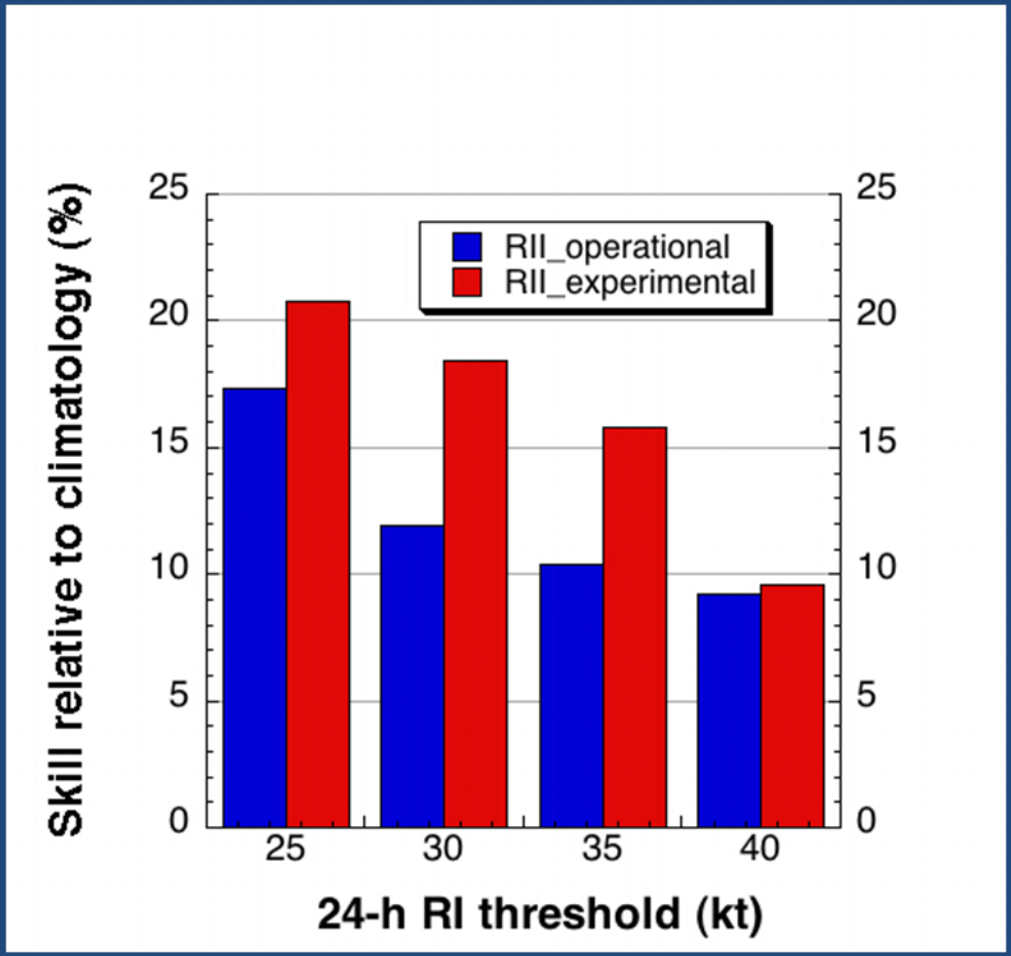
Relative weights of RI predictors for experimental Atlantic RII



Comparison of contribution of new replacement and old operational predictors to the sum of discriminant weights of all 8 RII predictors



Skill of Atlantic RII for the cross-validated 14 year (1995-2008) sample



Summary

- Operational RII exhibited skill for the 2008-2009 sample for both the Atlantic and E. Pacific basins when tested in a probabilistic and deterministic manner

- Experimental Atlantic RII developed using three new RI predictors exhibited an average improvement of 4% (33% relative improvement) for the 4 RI thresholds examined with improvements as high as 6.5 % (50% relative improvement) for the cross-validated 14 yr sample

- New version of the RII developed for the 40 kt RI threshold also showed some skill for that same sample

Future work

- Continue to refine experimental Atlantic RII

  - Perform real-time tests of new Atlantic RII during2010 season (August 15?)

- TPW data

  - generate TPW predictors for E. Pacific
  -correct offset of RSS vs NESDIS TPW
  -set up real-time access of NESDIS TPW for 2010 season

- GOES PC analysis

  - Perform PC analysis on E. Pacific cases (1995-2008)

- Boundary-layer predictors

  - Refine boundary-layer predictors f or Atlantic and E. Pacific basins

- Develop new experimental RII for E. Pacific basin
- Explore potential of using microwave imagery in RII as part of GOES-R proposal