NCEP Operational Hurricane Modeling System

HWRF Performance Verification in 2015

The HWRF Team

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& Several collaborators (extended team members) at NHC, JTWC, HRD/AOML, GFDL, URI, ESRL, DTC, HFIP/JHT PIs and various international agencies

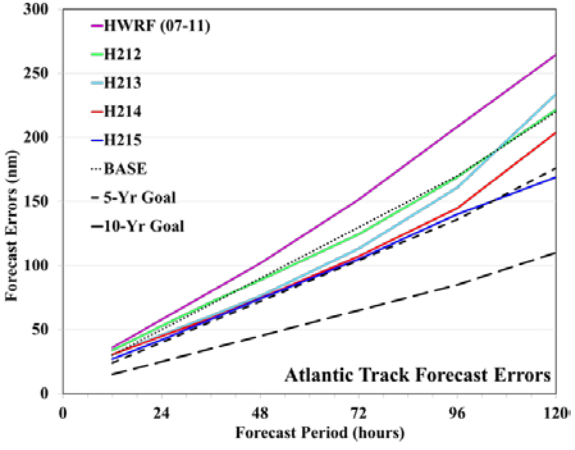
Outline

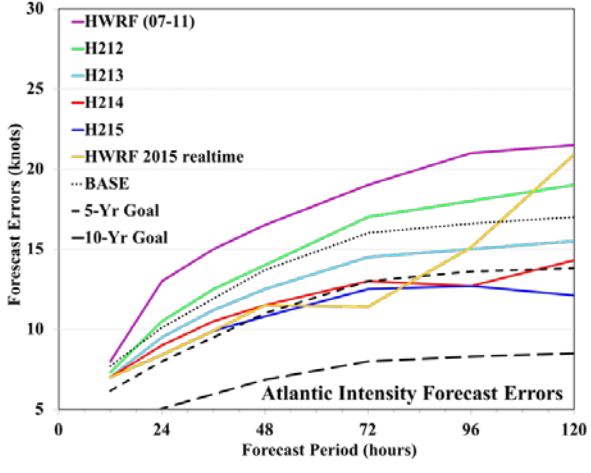
- Verification of operational HWRF track/intensity forecasts in NATL/EPAC/CPAC/WPAC/NIO basins in 2015;
- Verification of RI in 2015 operational HWRF;
- Individual storm verification in each basins;
- Summary/Concluding Mark

Highlights of 2015 HWRF

- **System & Resolution Enhancements**
  - Replace current partial HWRF python based scripts with complete Python based scripts for a unified system
  - GFS data Upgrades
  - *Increase the horizontal resolution of atmospheric model for all domains from 27/9/3 to 18/6/2 km.*
- **Initialization/Data Assimilation Improvements**
  - Upgrade and improve HWRF vortex initialization scheme in response to both GFS and HWRF resolution increases
  - Upgrade Data Assimilation System with hybrid HWRF-based EnKF and GSI system.
- **Physics Advancements**
  - Upgrade Micro-physics process (Ferrier-Aligo)
  - Upgrade GFDL radiation to RRTMG scheme with partial cloudness
  - Upgrade surface physics and PBL, momentum and enthalpy exchange coefficients(Cd/Ch)
  - Upgrade current GFDL slab model to NOAH LSM.
- **First time in 2015….**
  - *Self cycled HWRF ensembles based warm start for TDR DA*
  - *Expand HWRF capabilities to all global (including WP/SH/IO) basins through 7-storm capability in operations to run year long*

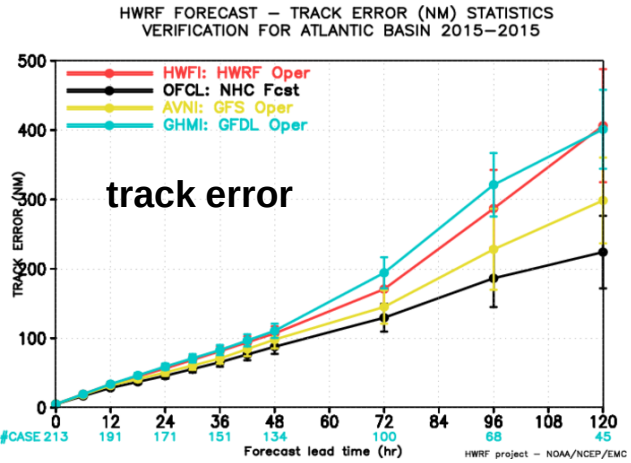
Pre-implementation Results

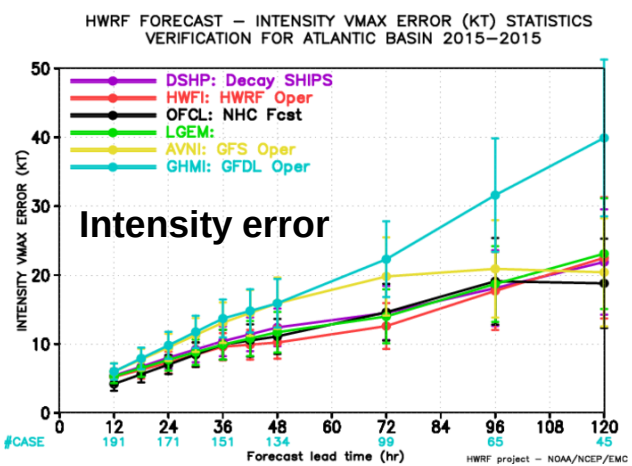


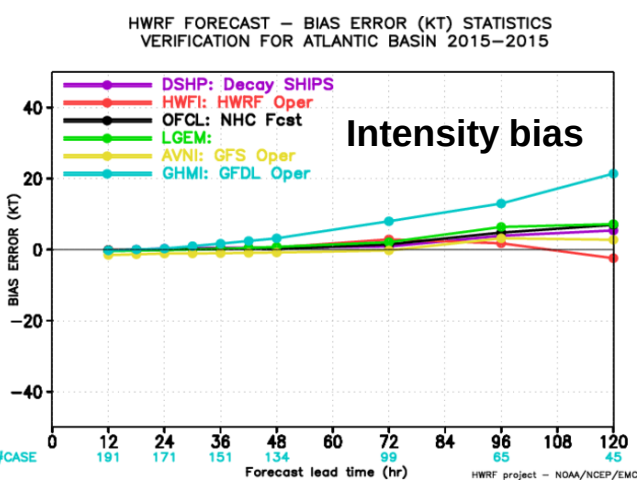


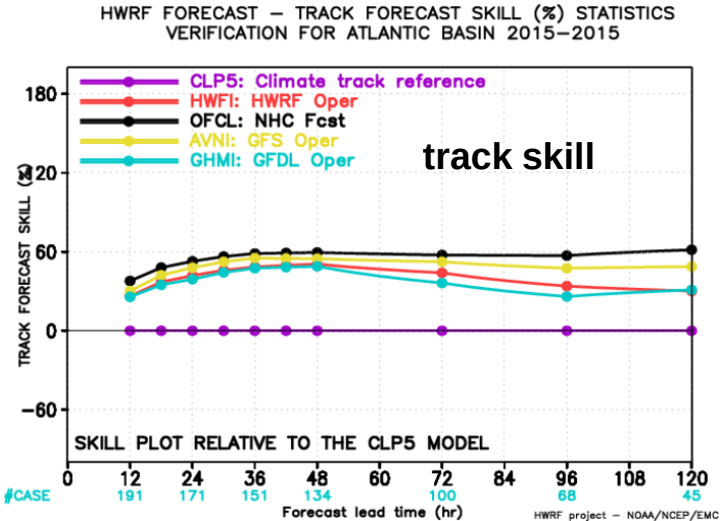
HWRF in the 2015 North Atlantic Basin (Ana-Kate)

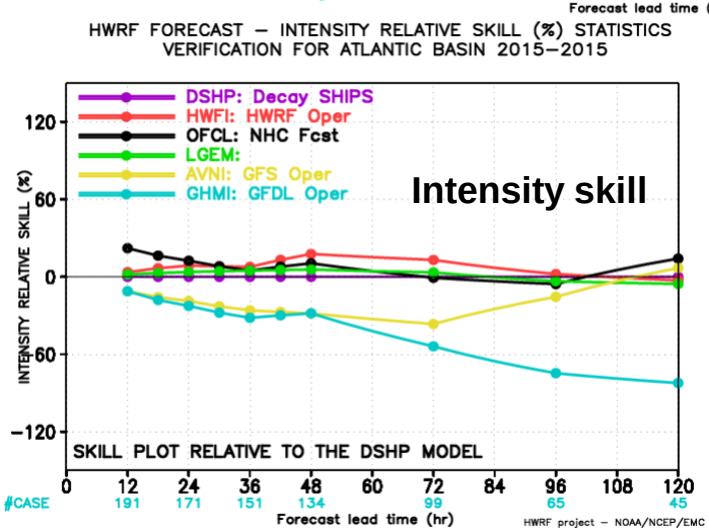
Real-Time Performance





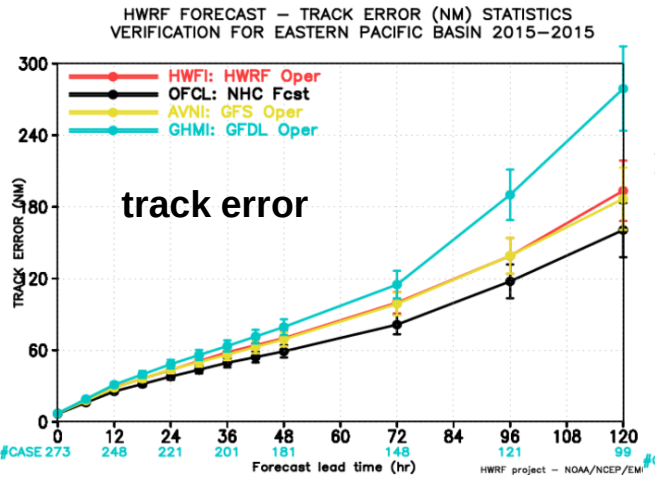


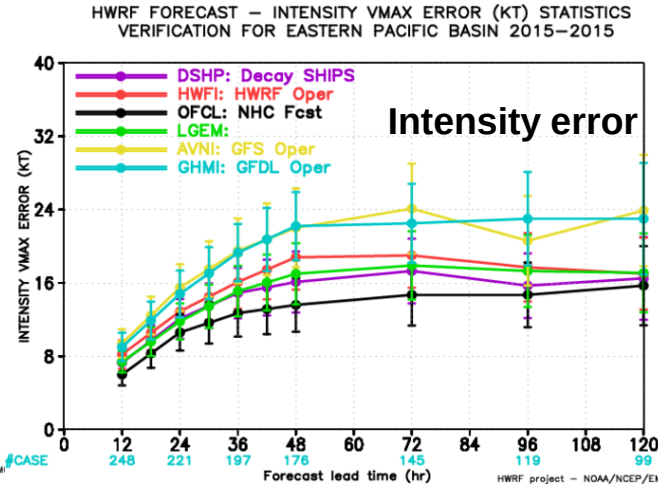


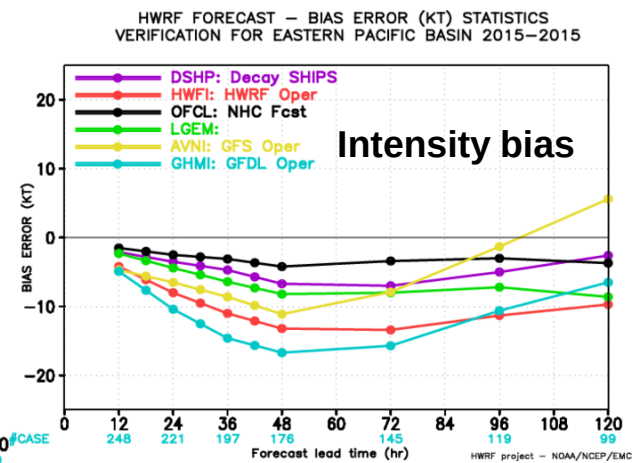


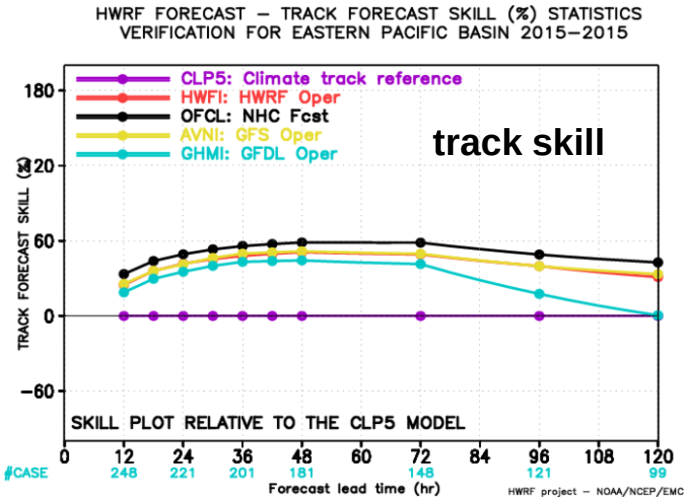
HWRF in the 2015 Eastern Pacific Basin (Andres-Patricia)

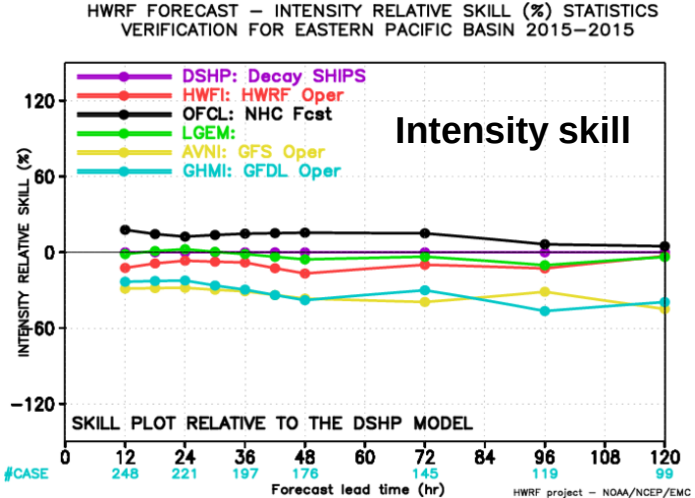
Real-Time Performance





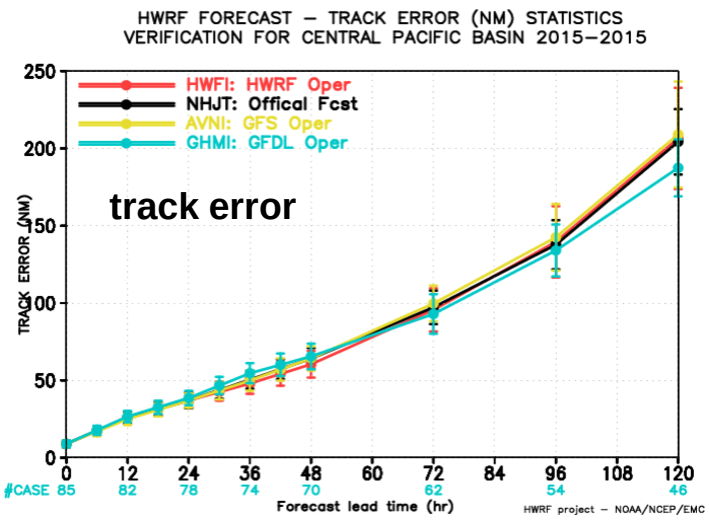


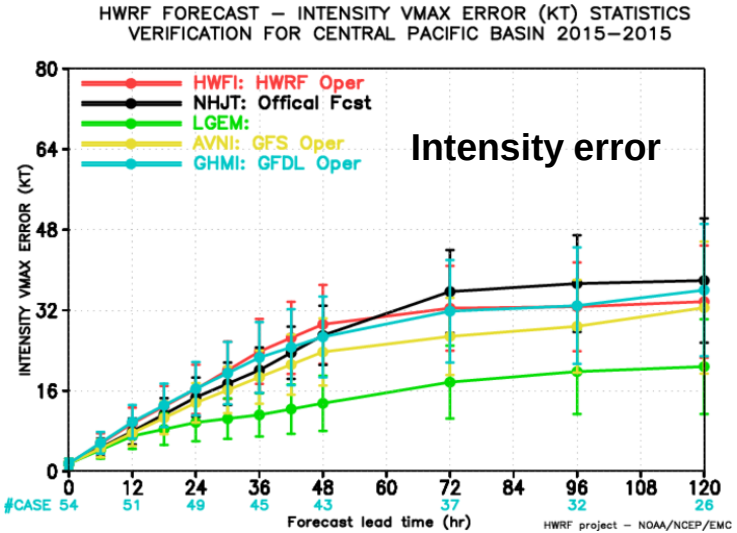


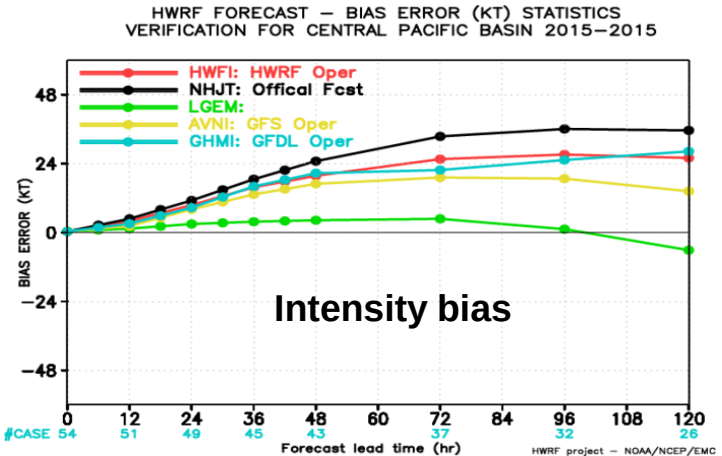


HWRF in the 2015 Central Pacific Basin (Halola-Eight)

Real-Time Performance

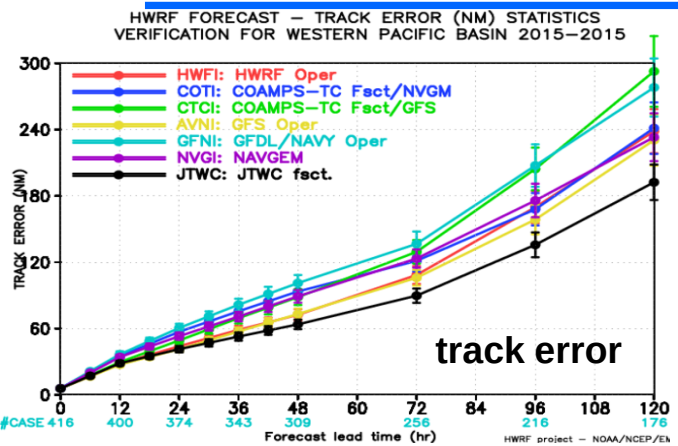


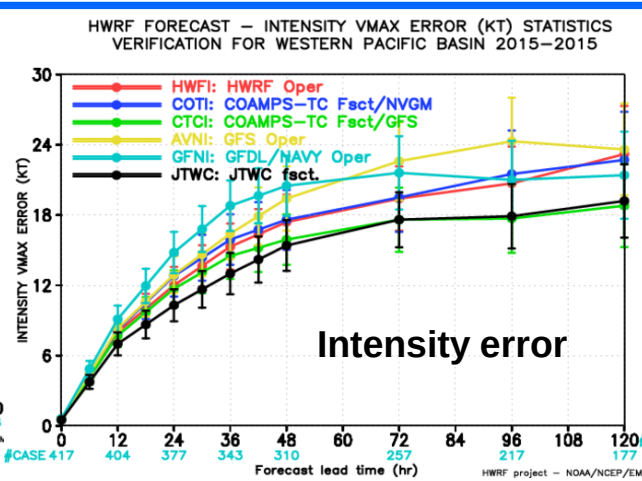


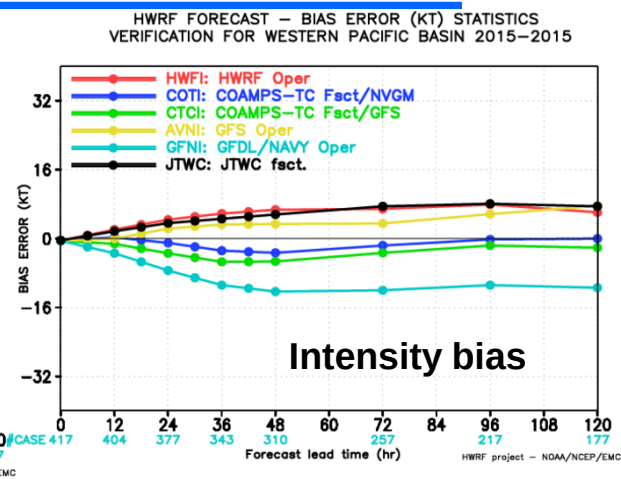


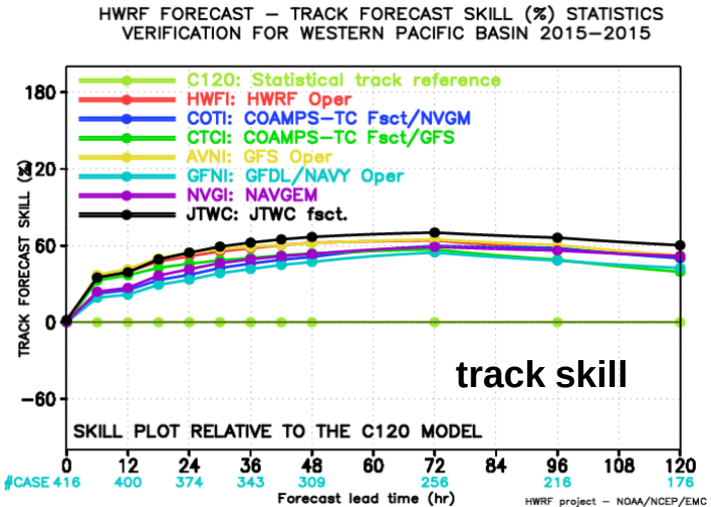
HWRF in the 2015 Western Pacific Basin (Higo-Champi)

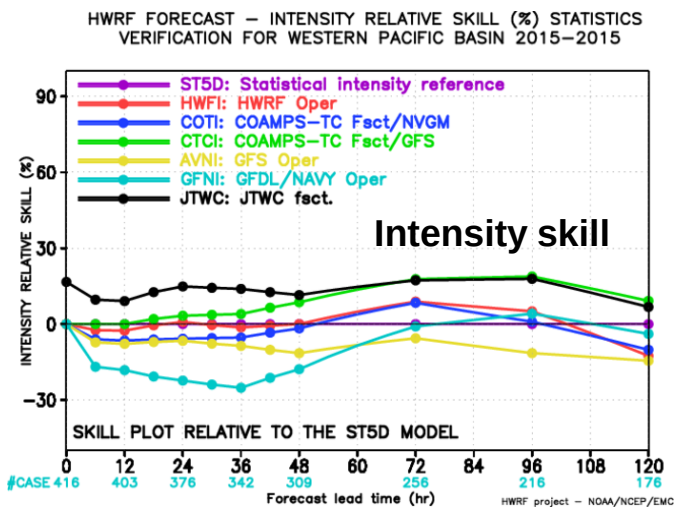
Real-Time Performance





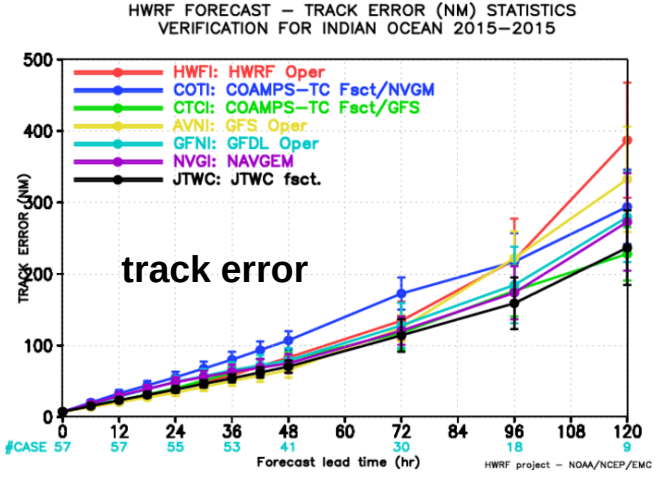


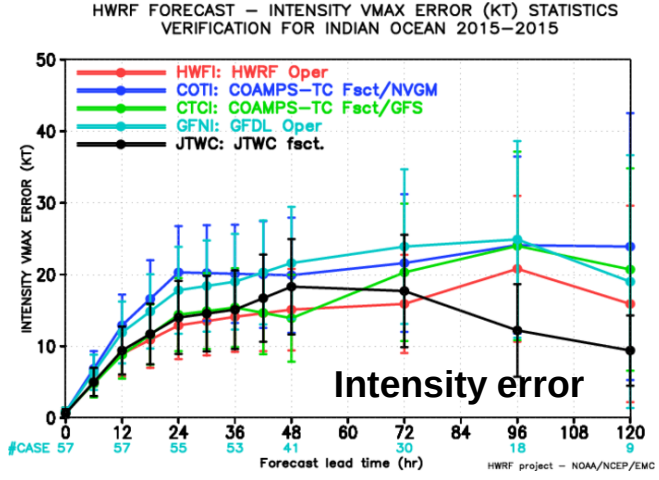


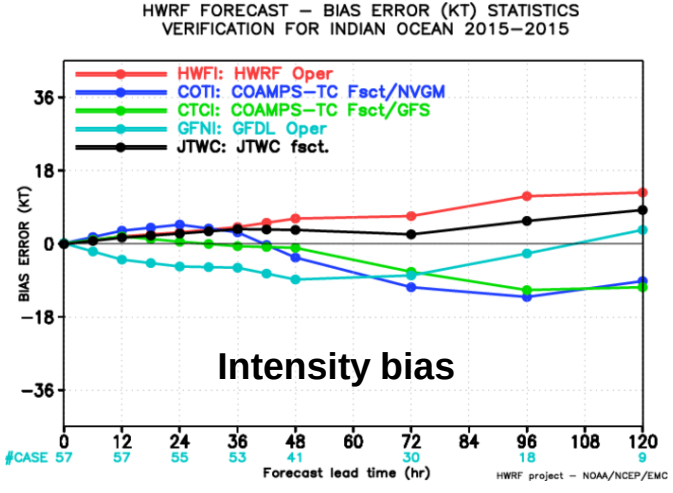


HWRF in the 2015 North Indian Basin (Ashobaa-Megh)

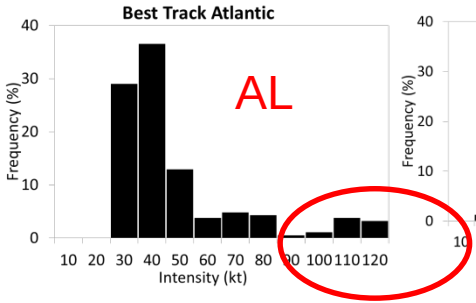
Real-Time Performance

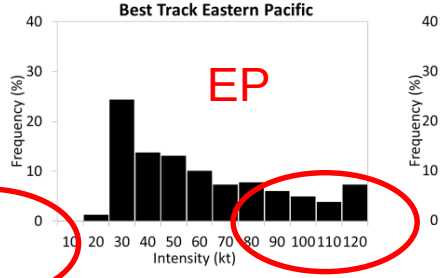


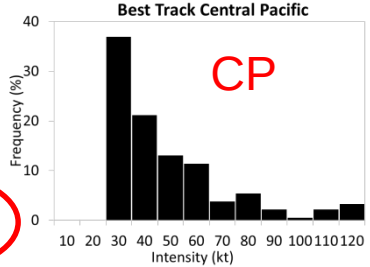


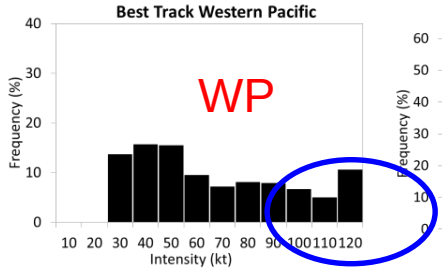


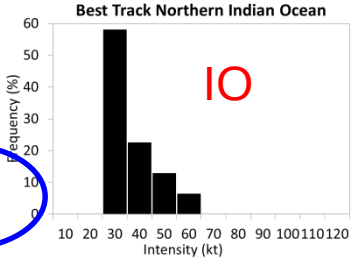
PDF Comparison of HWRF Predicted Intensity and Observed Intensity

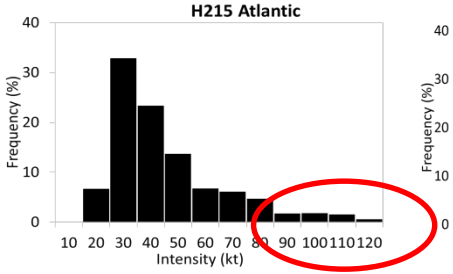


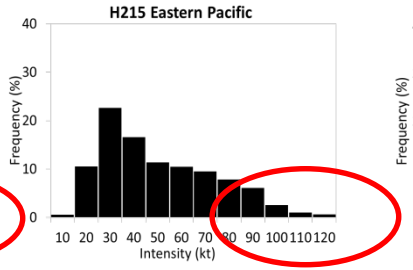


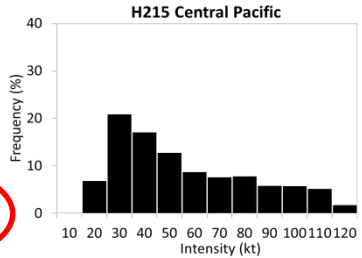


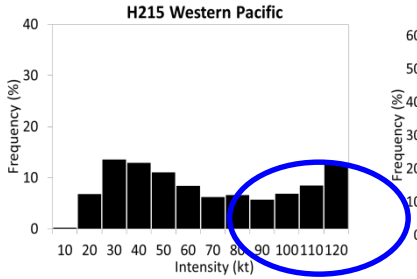


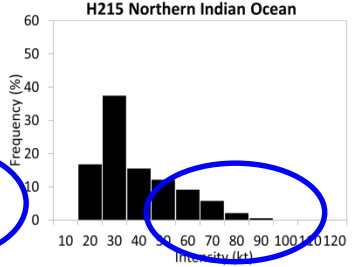


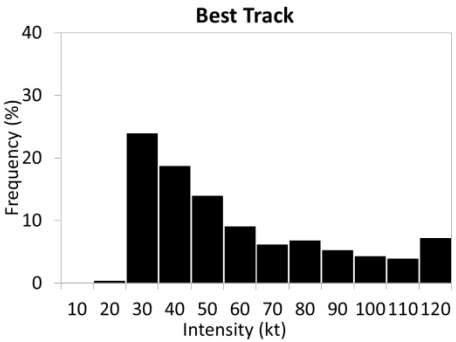


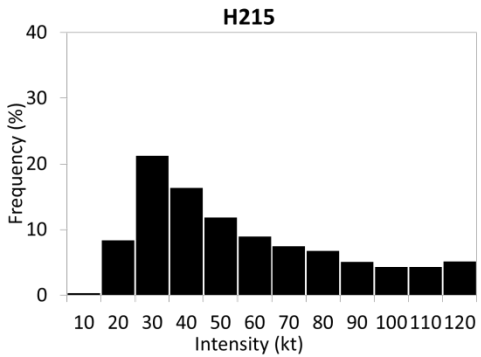




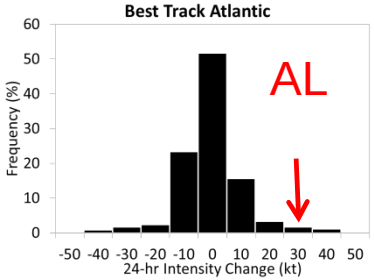


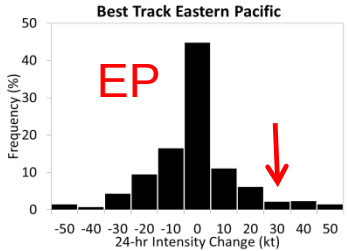


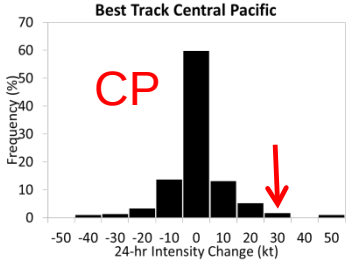


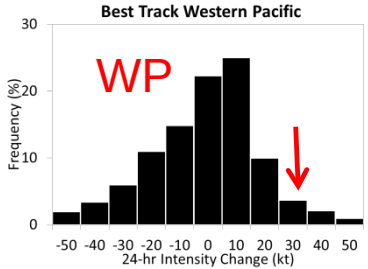


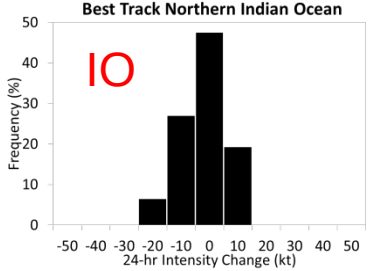
PDF Comparison of HWRF Predicted 24h Intensity Changes and Observed 24h Intensity

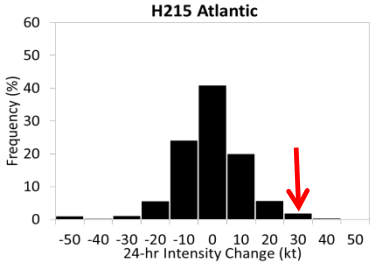


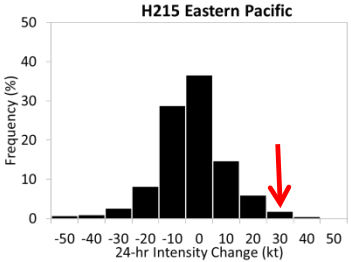


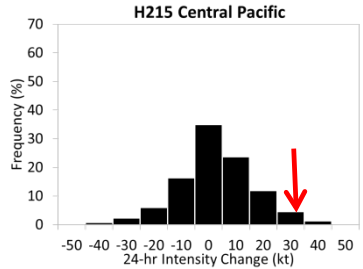


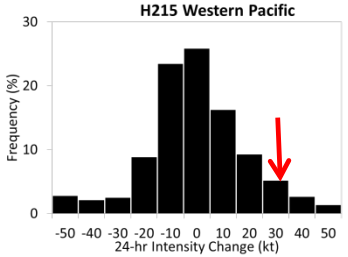


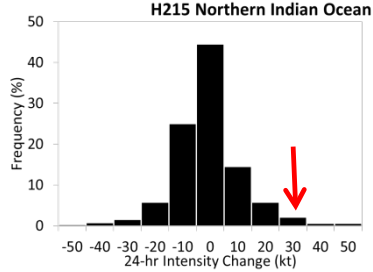


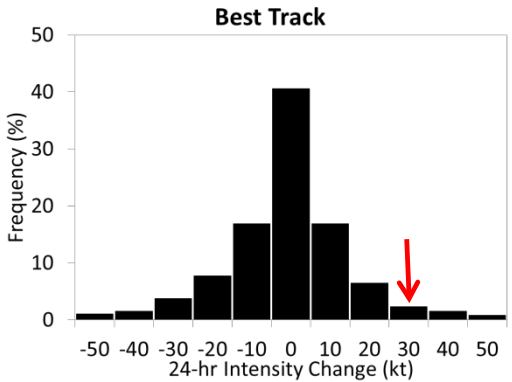


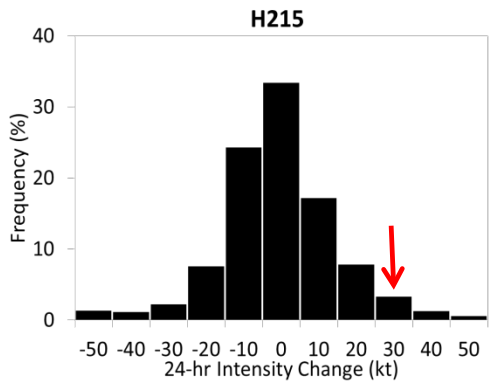




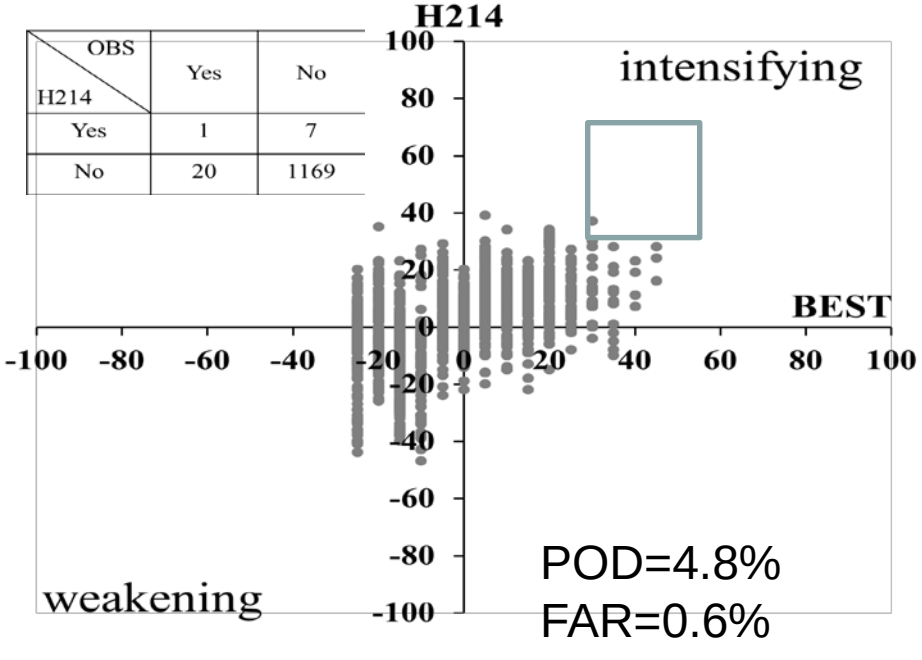






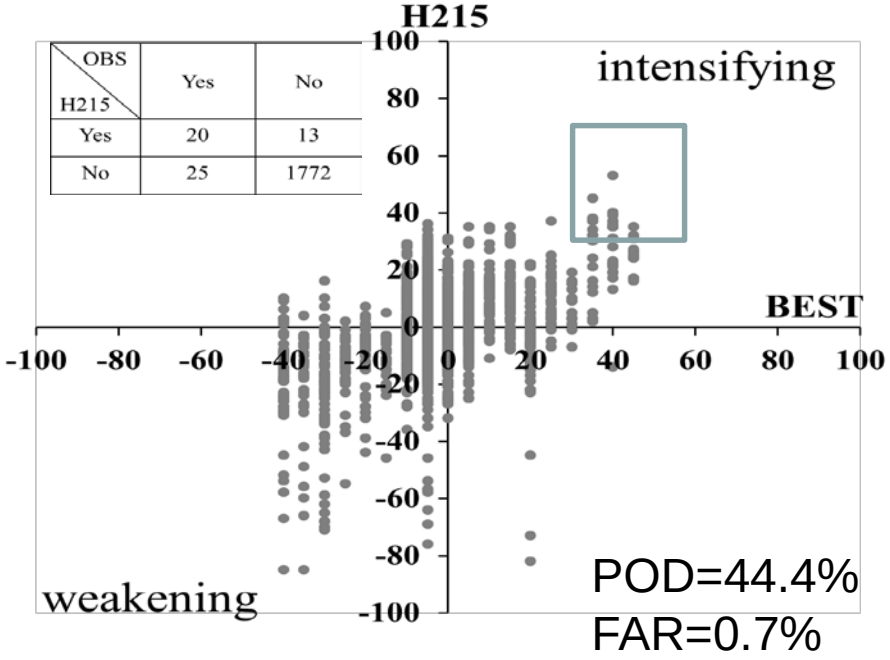


POD Improvement in North Atlantic Basin



OBS / H214	Yes	No
Yes	1	7
No	20	1169

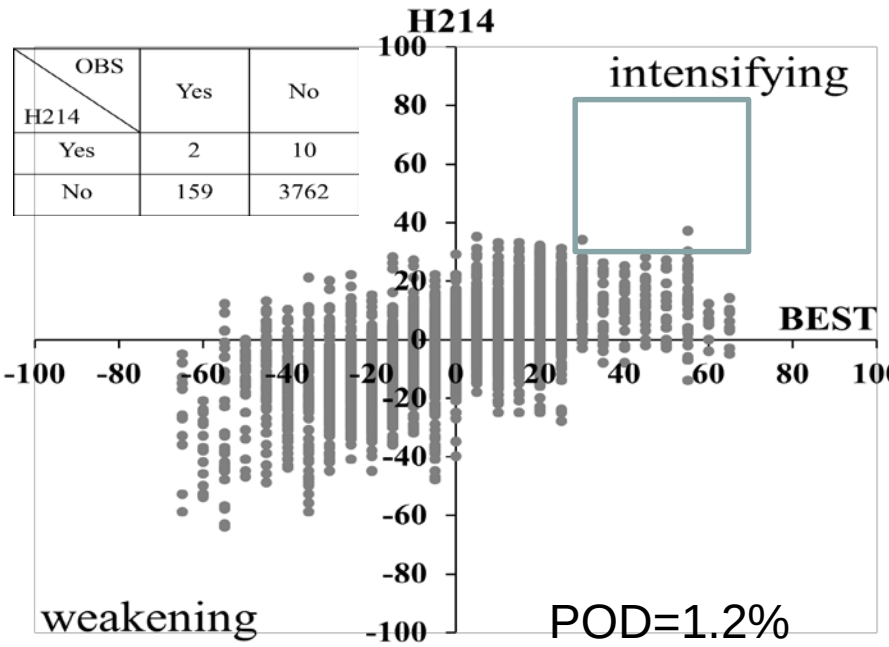
POD=4.8%
FAR=0.6%



OBS / H215	Yes	No
Yes	20	13
No	25	1772

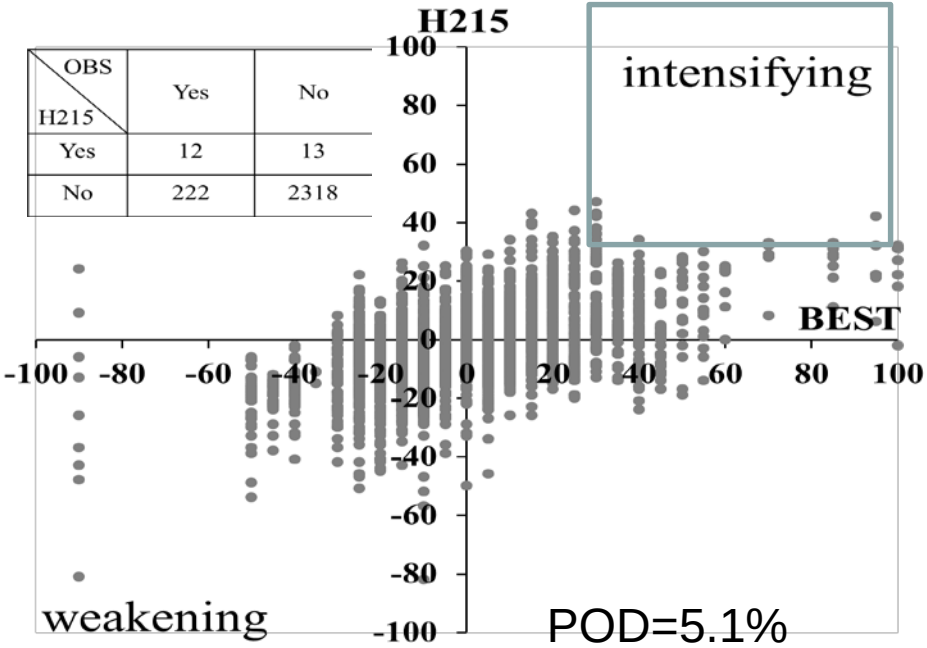
POD=44.4%
FAR=0.7%

POD Improvement in Eastern Pacific Basin



OBS / H214	Yes	No
Yes	2	10
No	159	3762

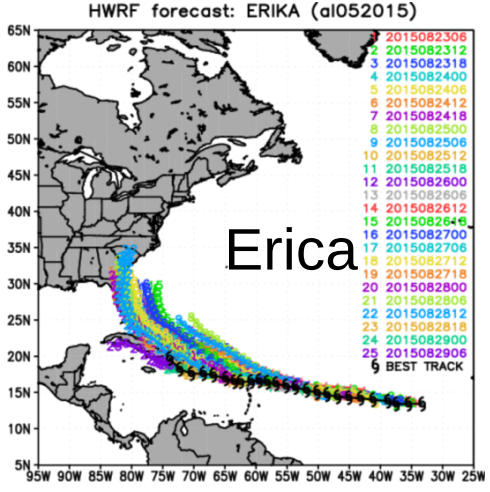
POD=1.2%
FAR=0.26%

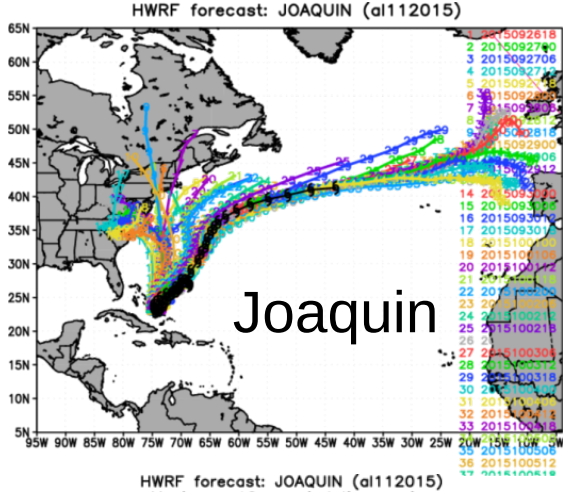


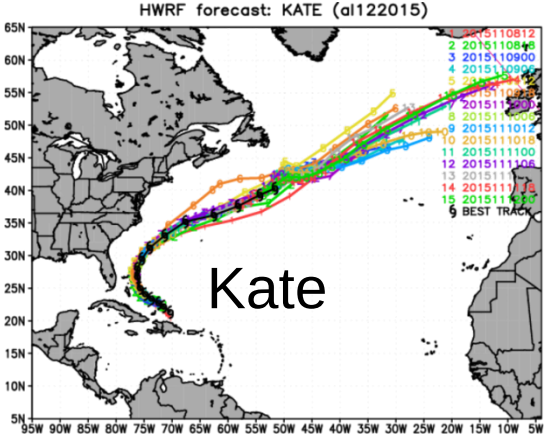
OBS / H215	Yes	No
Yes	12	13
No	222	2318

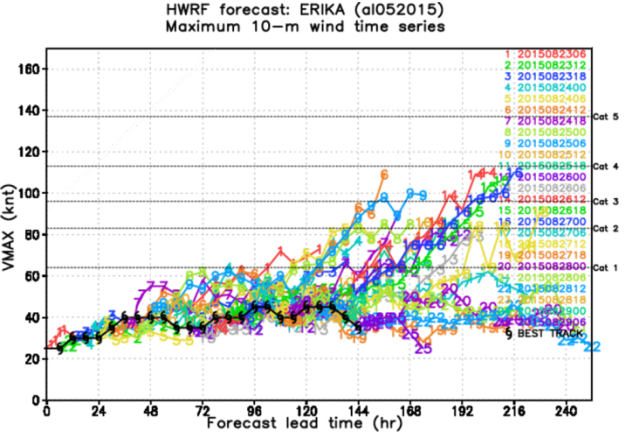
POD=5.1%
FAR=0.55%

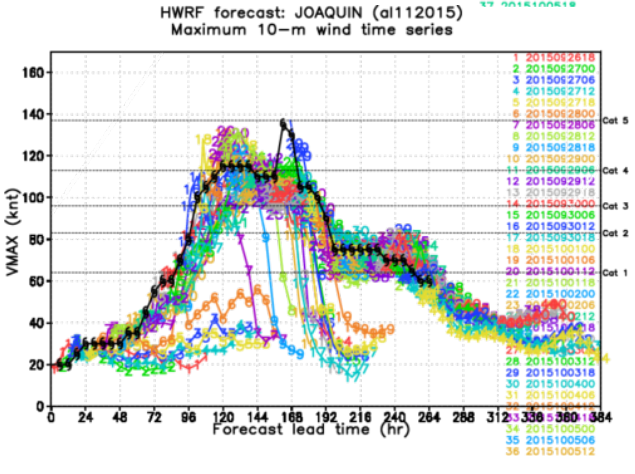
Highlight from real-time operational HWRF in 2015 Atlantic Basin

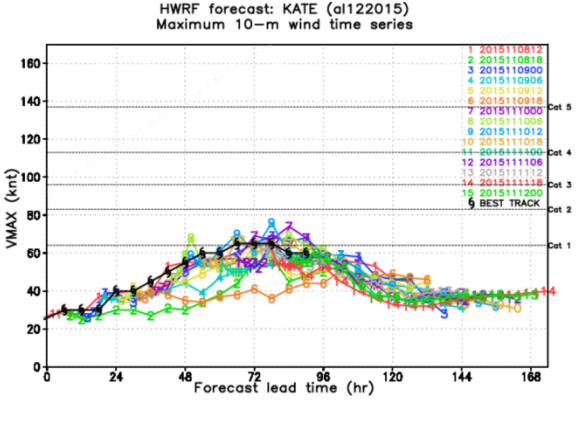




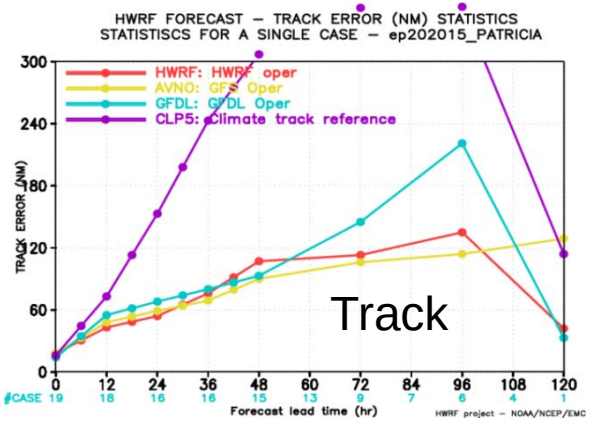


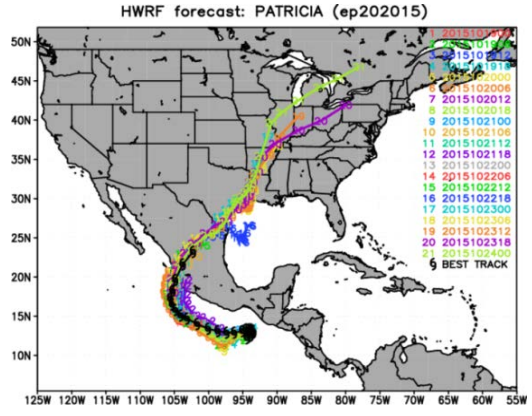


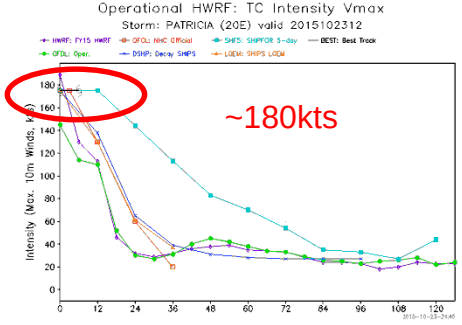


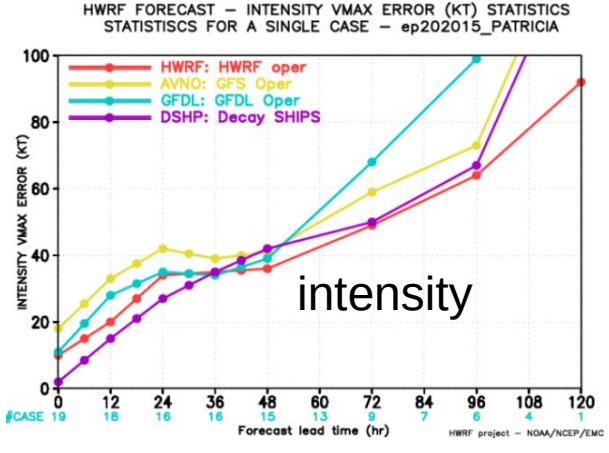


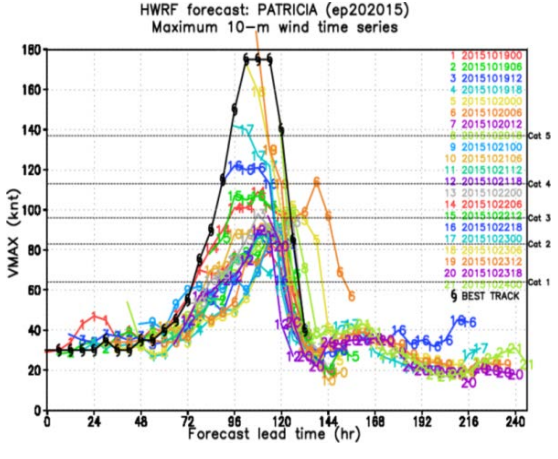
Highlight from real-time operational HWRF in 2015 Eastern Pacific Basin (Patricia, 20E)

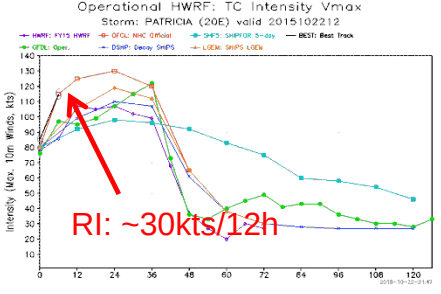


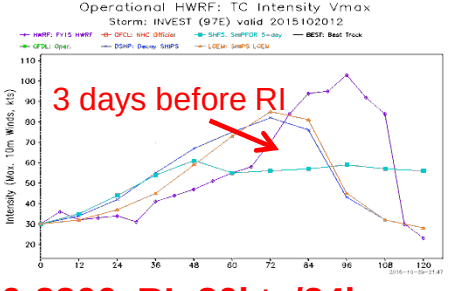








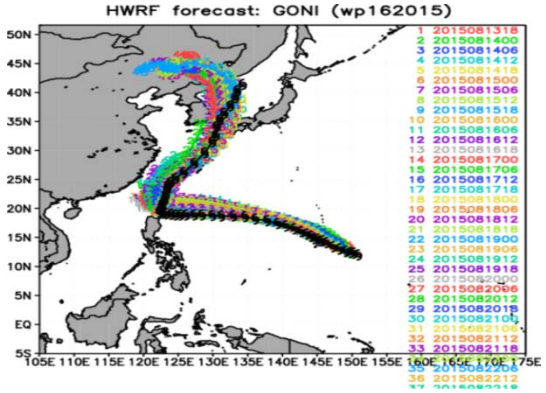


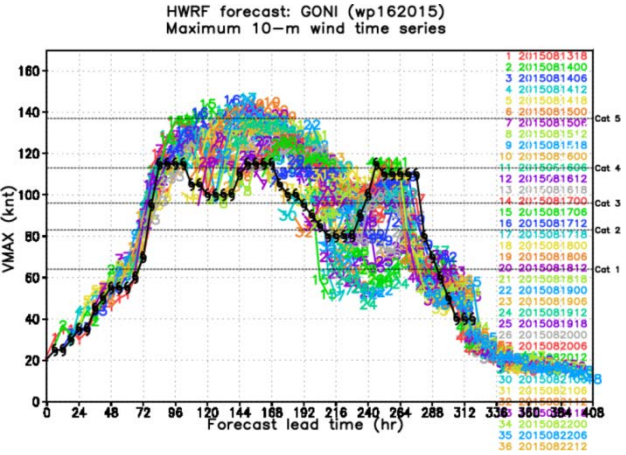


HWRF captured most of RI, 11/17 in Patricia intensifying period: 1900-2300. RI: 30kts/24h

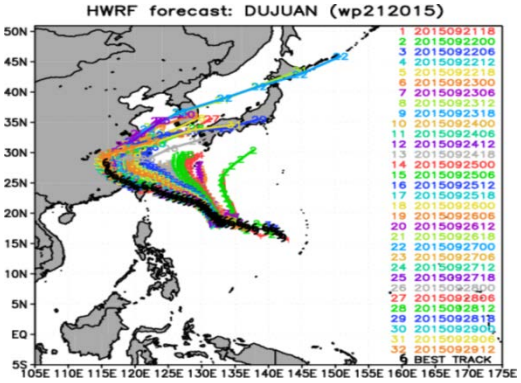
Highlight from real-time operational HWRF in 2015 WPAC and NIO Basin

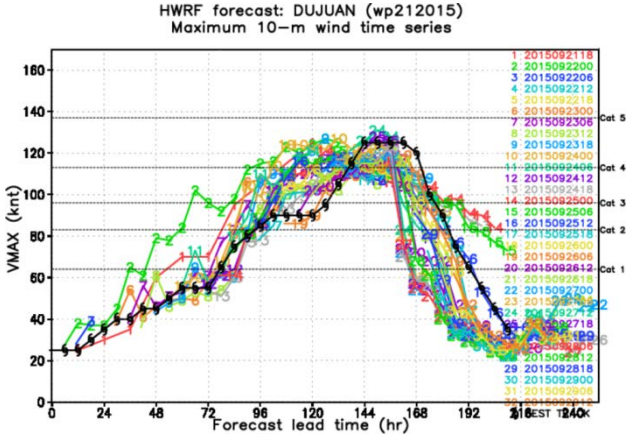
Goni, 16W



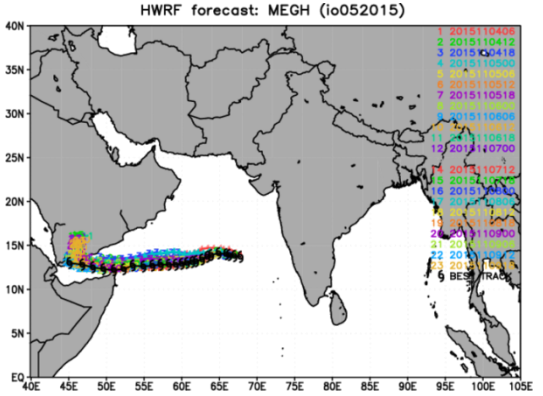


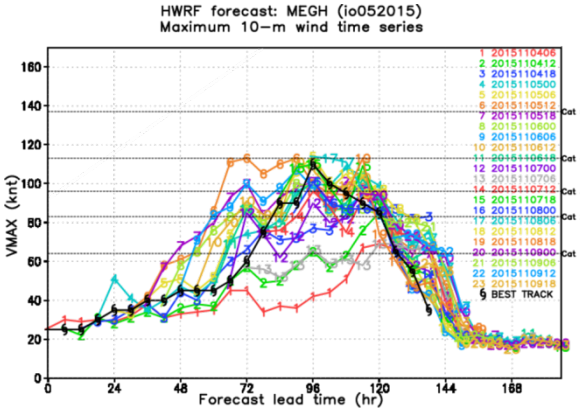
Dujuan, 21W





Megh, 05A





Summary/Concluding Remarks

- **HWRF maintained its good track/intensity forecast skills in 2015 season, and has performed consistently better than other regional models in all global tropical cyclone basins, with exception of intensity forecasts at WP that CTCI has smallest intensity forecast errors;**
- **RI forecast is greatly improved in 2015 HWRF. HWRF is able to predict most of rapid intensity (RI) cycles, but not extreme strong intensity (e.g. Patricia);**
- **The HWRF intensity forecast has large negative bias at EP, this is probably is due to use of climatology of ocean temperature profile at initial time.**

Acknowledgements: ***HFIP Management; Collaborations with national and international operational and research agencies and academia***