NCEP Operational Hurricane Modeling System

HWRF Performance Verification in 2016

The HWRF Team

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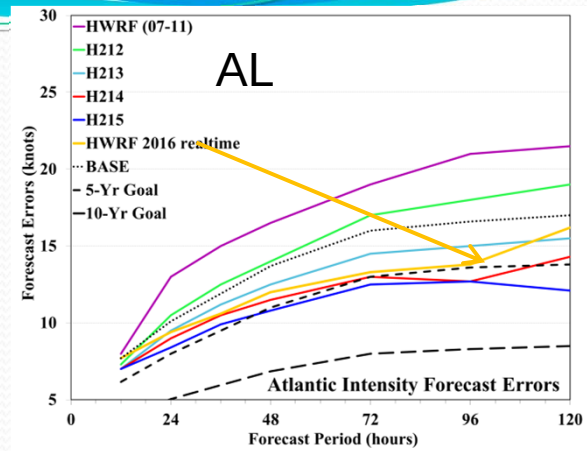
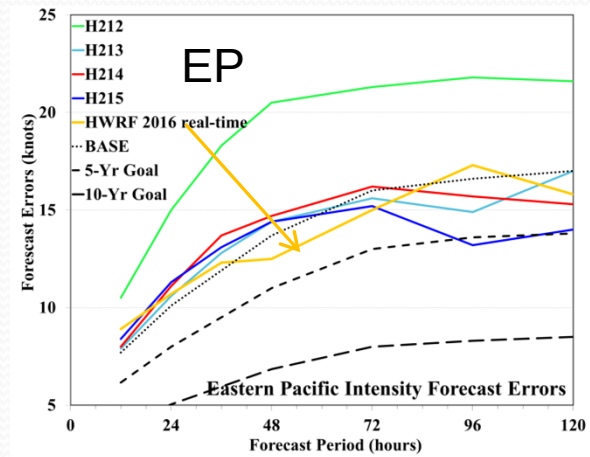
Highlights of FY16 HWRF Upgrades

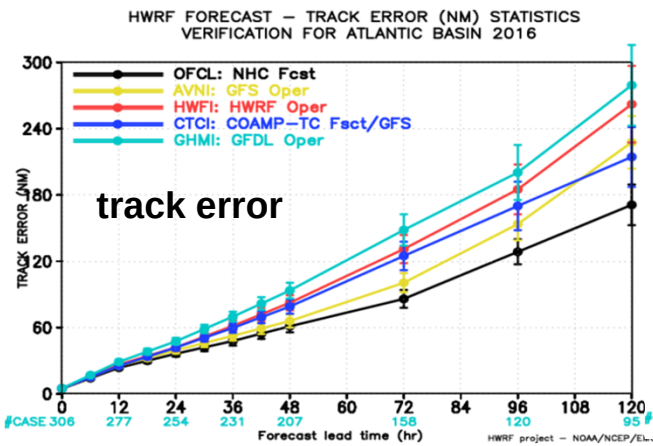
- **System & Resolution Enhancements**
  - T&E with new 2016 4D-Hybrid GDAS/GFS IC/BC
  - Upgrade dynamic core from WRF3.6a to WRF3.7.1a (with bug fixes)
  - Smaller time step (dt=30 s vs. 38 4/7 s)
  - Increase the size of nested domains
  - More products: MAG and AWIPS2
- **Initialization/DA Improvements**
  - GSI upgrades; new data sets for GSI (CrIS, SSMI/S, METOP-B changes)
  - Turn on Data Assimilation for all storms in East Pacific
- **Physics Advancements**
  - Implement new GFS PBL (2015 version)
  - Upgrade to new scale-aware SAS convection scheme for all domains
  - Update momentum and enthalpy exchange coefficients(Cd/Ch)
  - Improved vertical wind profile in the surface and boundary layer
- **First time in 2016….**
  - Implementation on WCOSS Cray
  - Use RTOFS initialization for EPAC storms to have more realistic ICs and improved RI forecasts; ocean coupling for CPAC
  - One-way coupling to wave model (Hurricane Wave Model)
  - *Use of dev-ecflow for accelerated T2O*

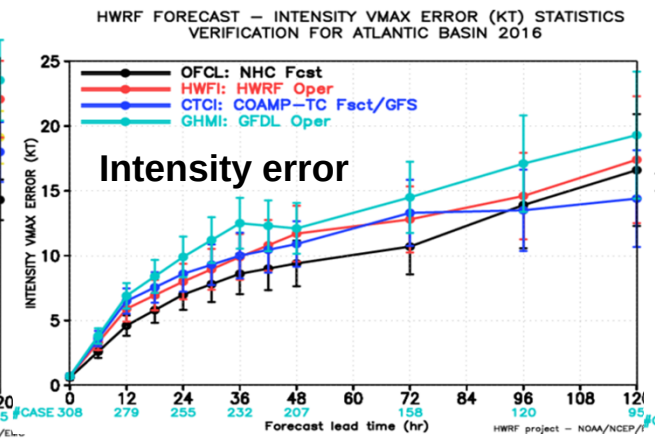


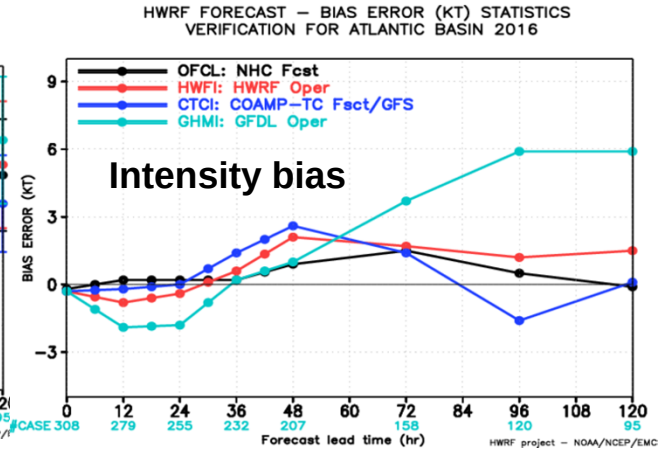


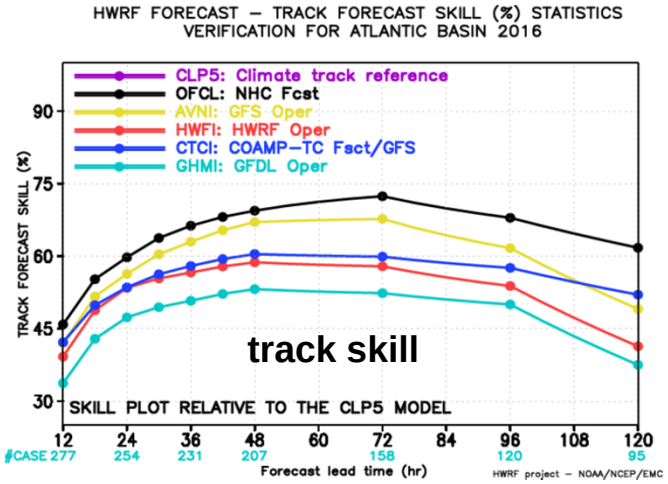
HWRF in the 2016 North Atlantic Basin (Alex to Otto)

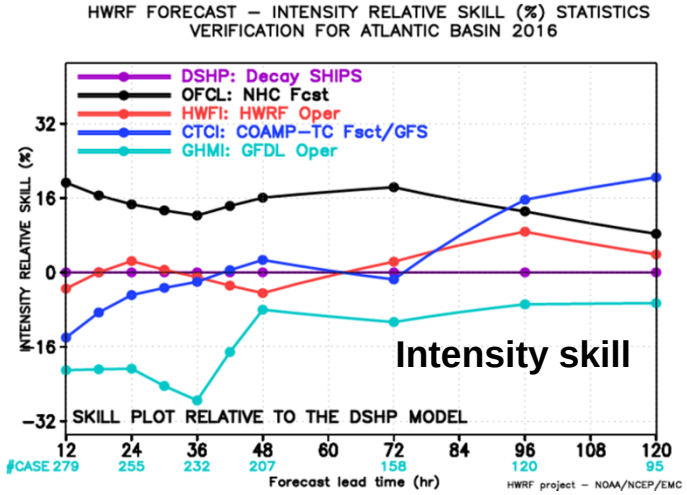
Real-Time Performance





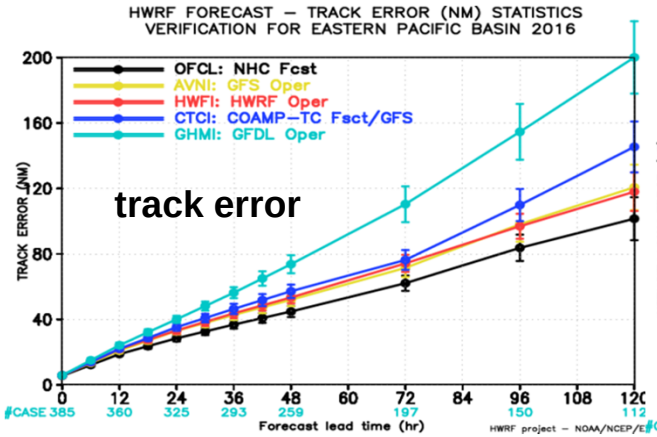


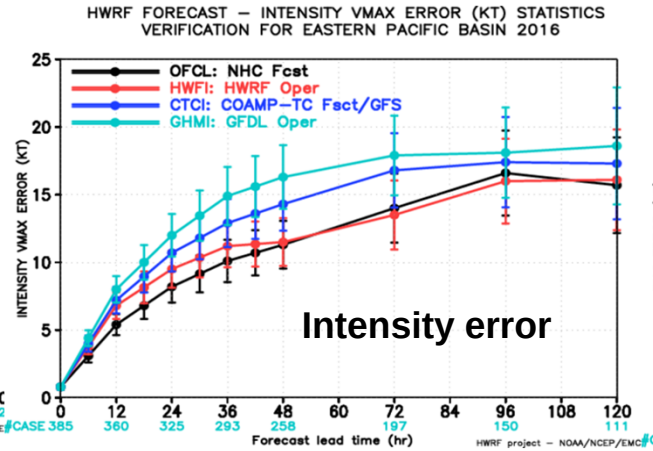


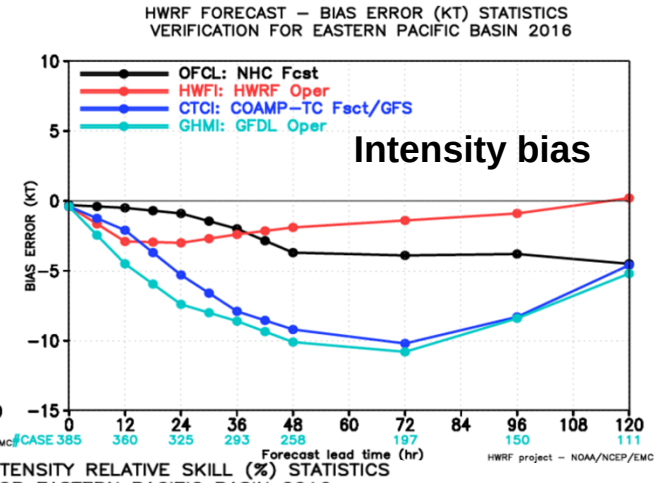


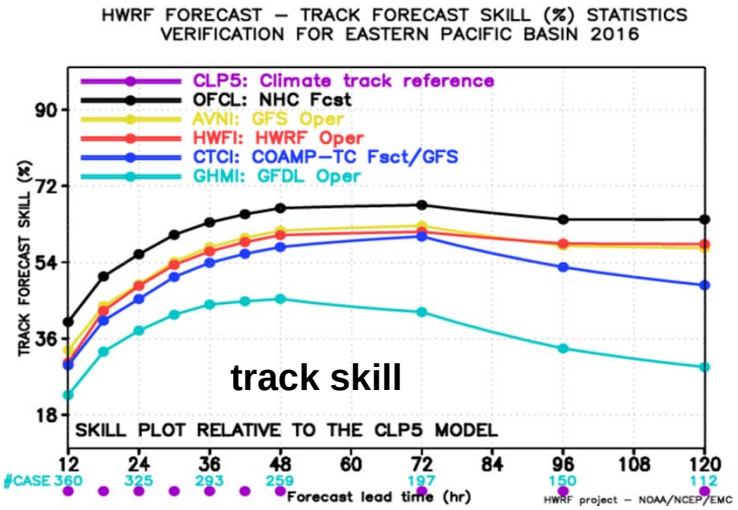
HWRF in the 2016 Eastern Pacific Basin (Agatha-Otto)

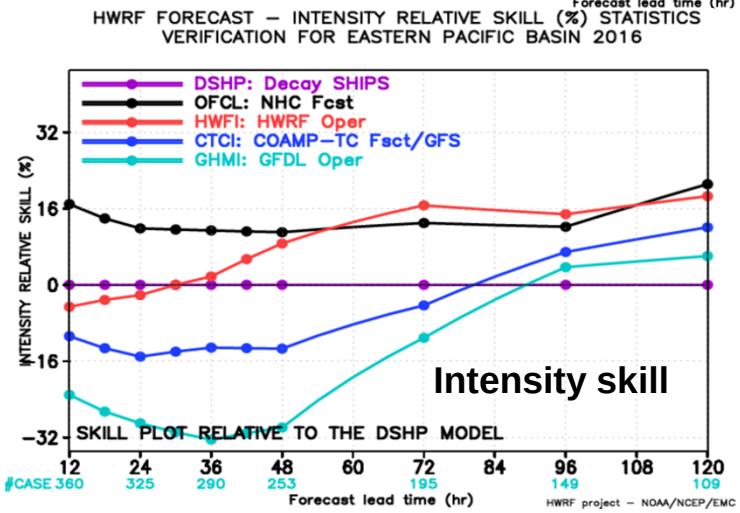
Real-Time Performance





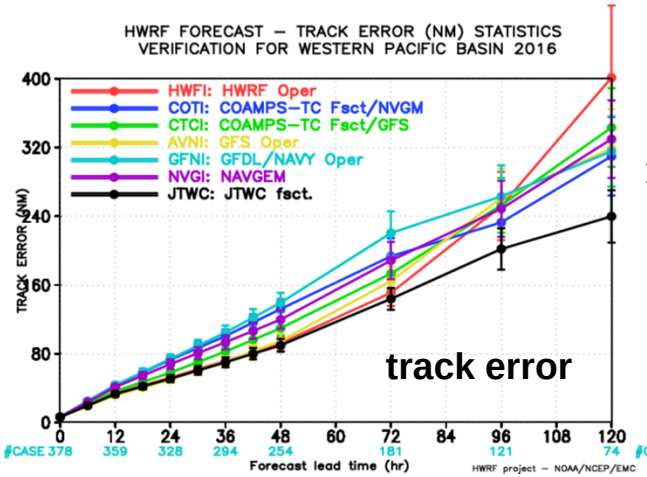


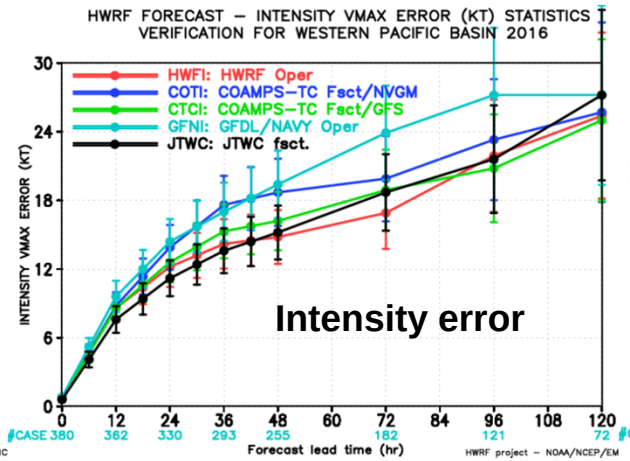


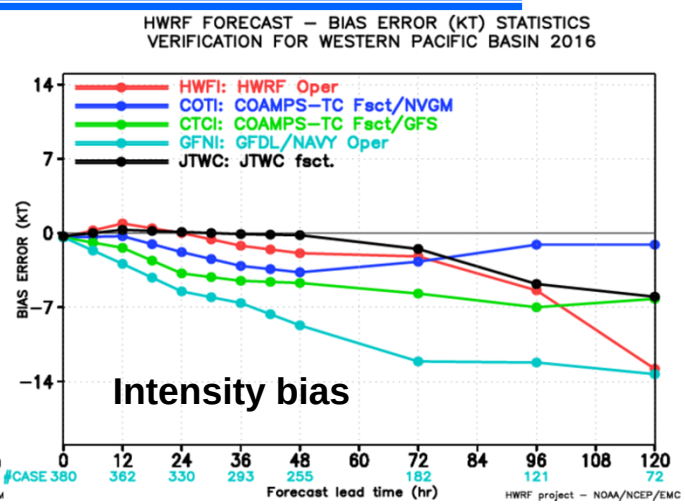


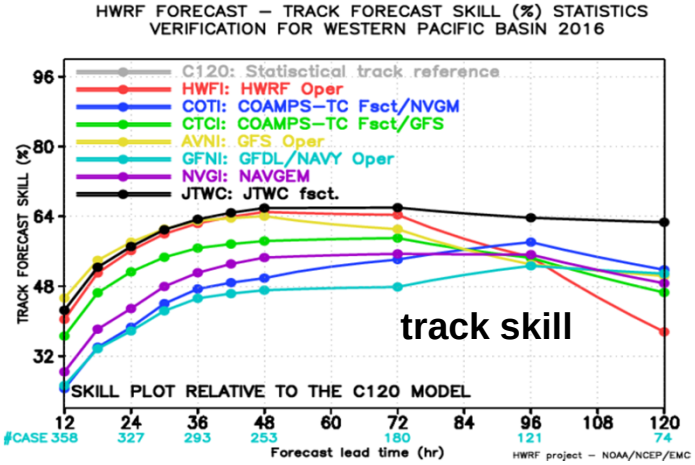
HWRF in the 2016 Western Pacific Basin (Nepartak to Nock-Ten)

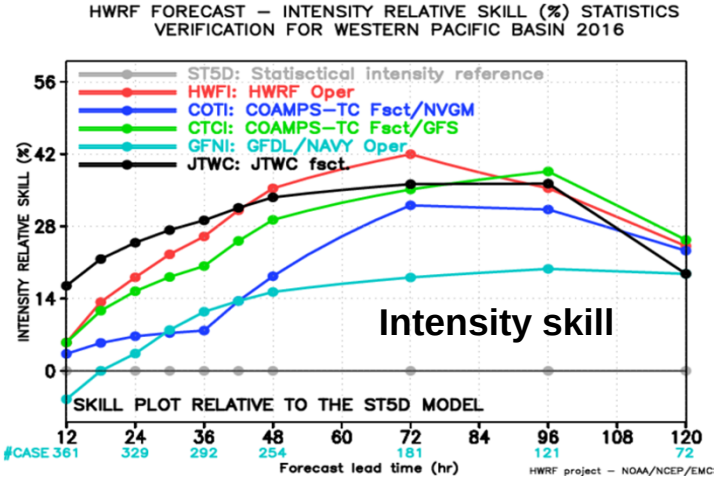
Real-Time Performance





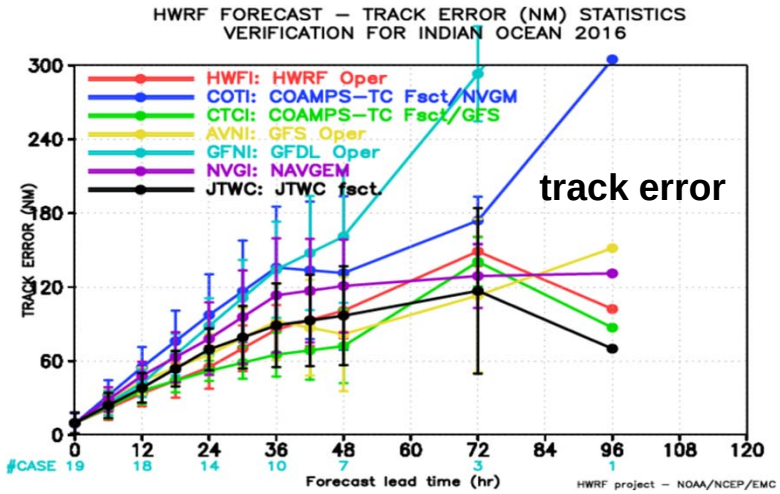


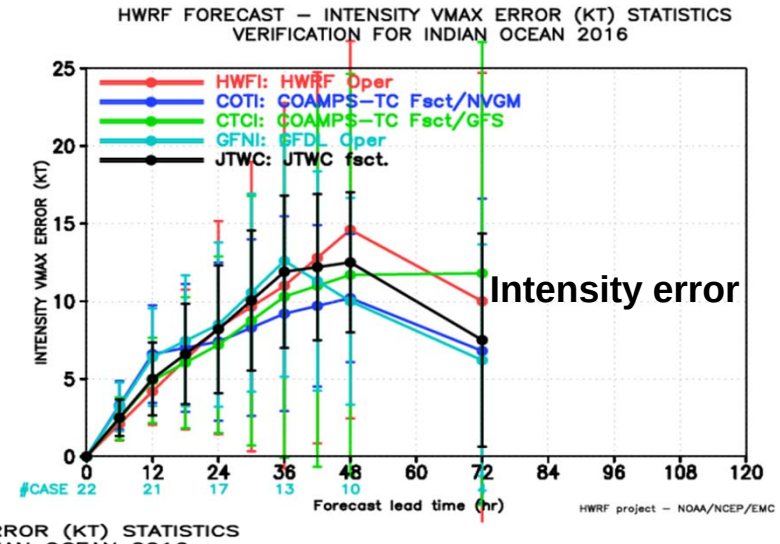


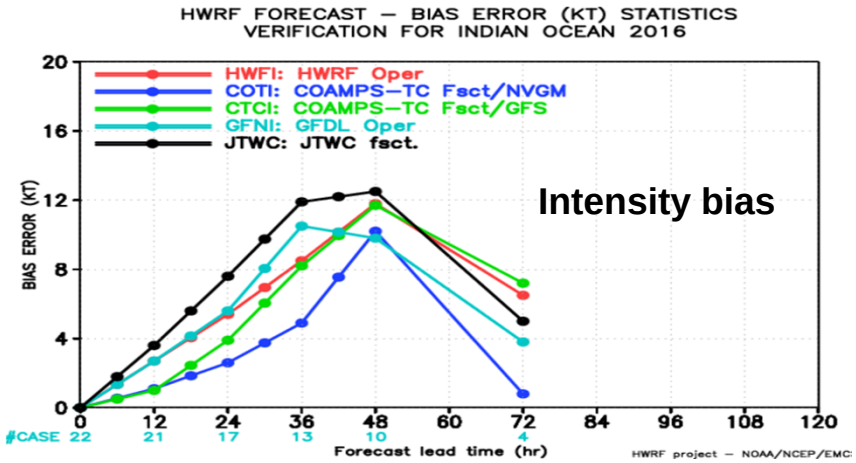


HWRF in the 2016 North Indian Basin (Roanu-Vardah)

Real-Time Performance

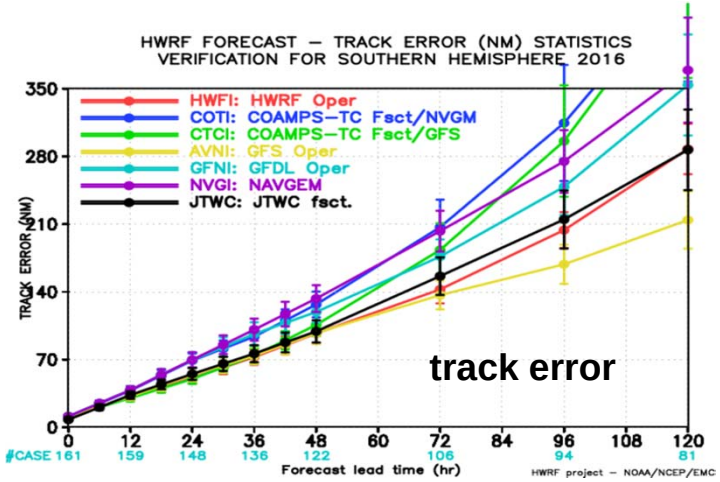


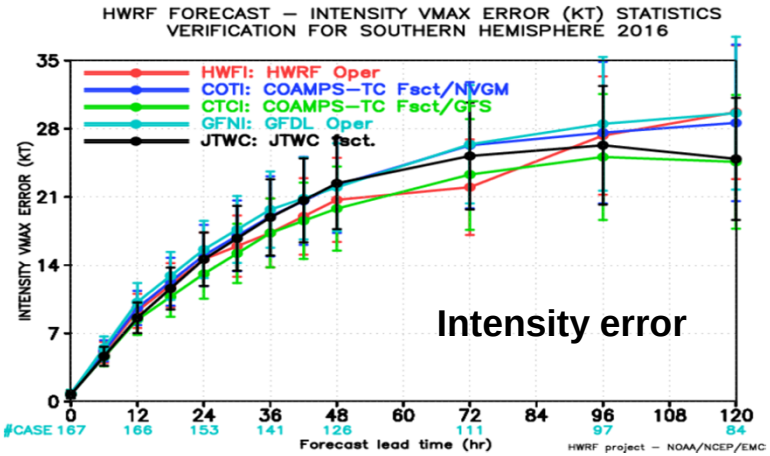


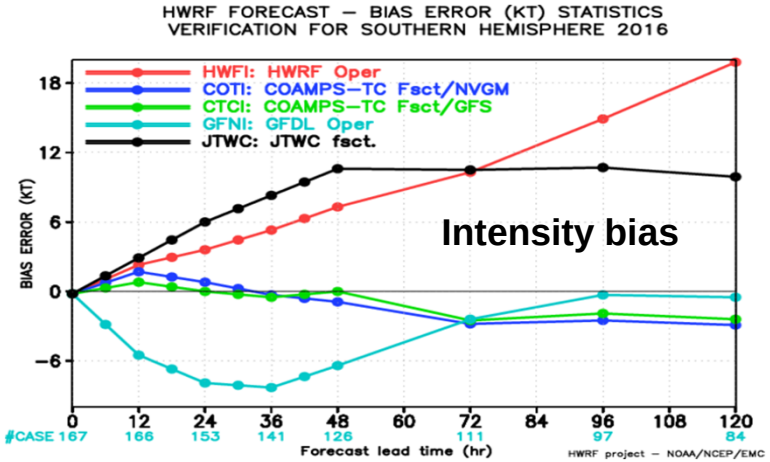


HWRF in the 2016 Southern Hemisphere

Real-Time Performance

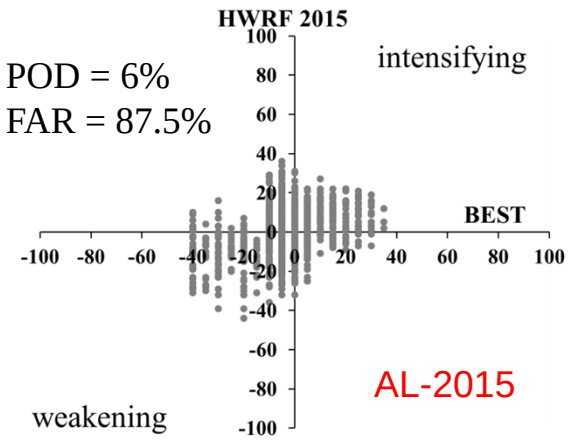


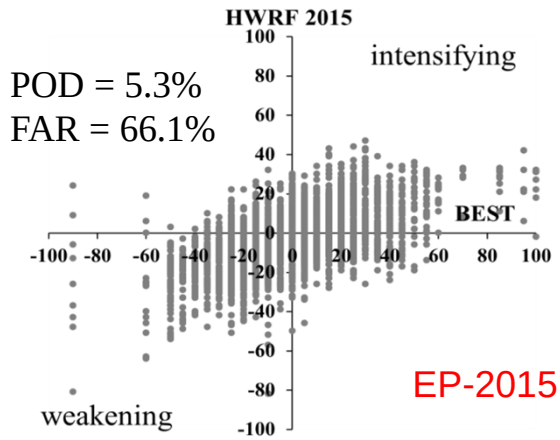


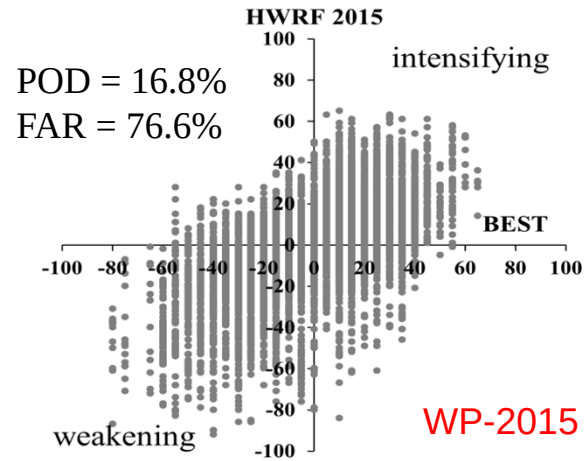


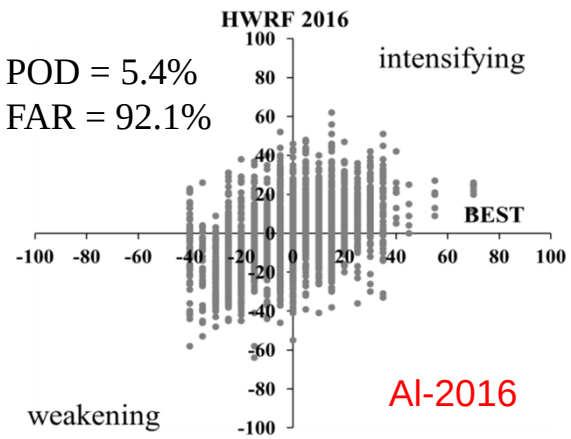
RI POD in AL/EP/WP Basins

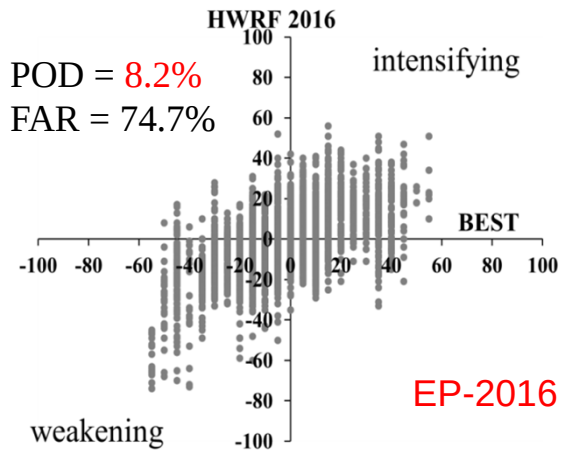
(From 2016 real time)

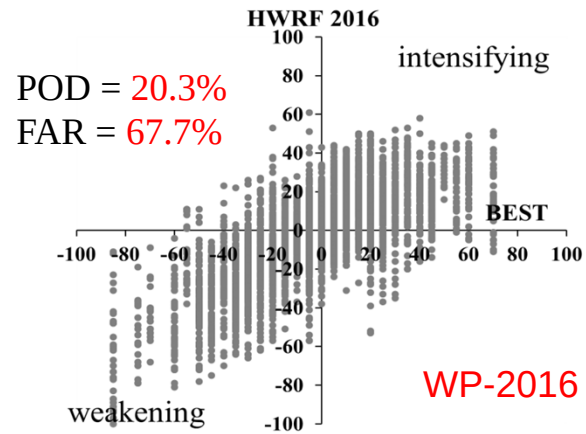






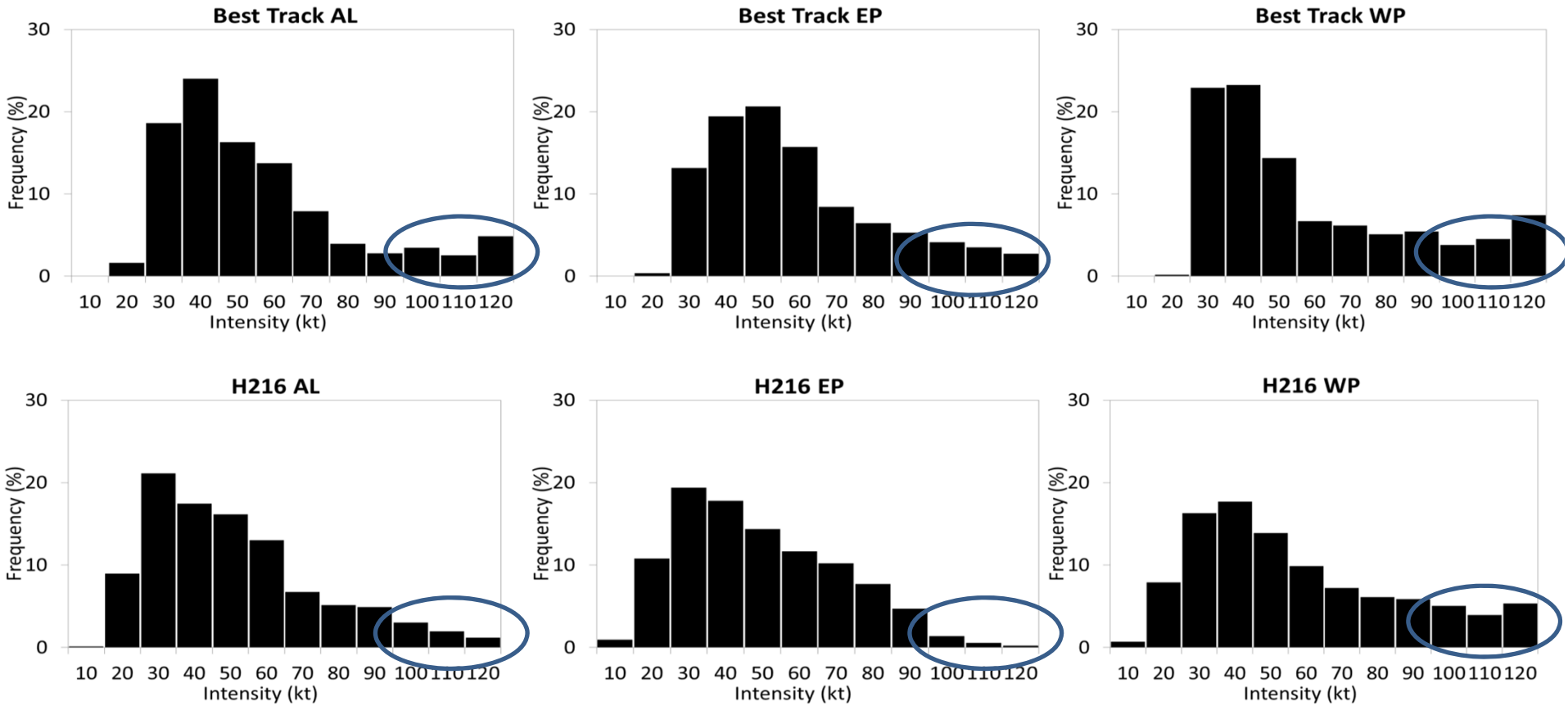






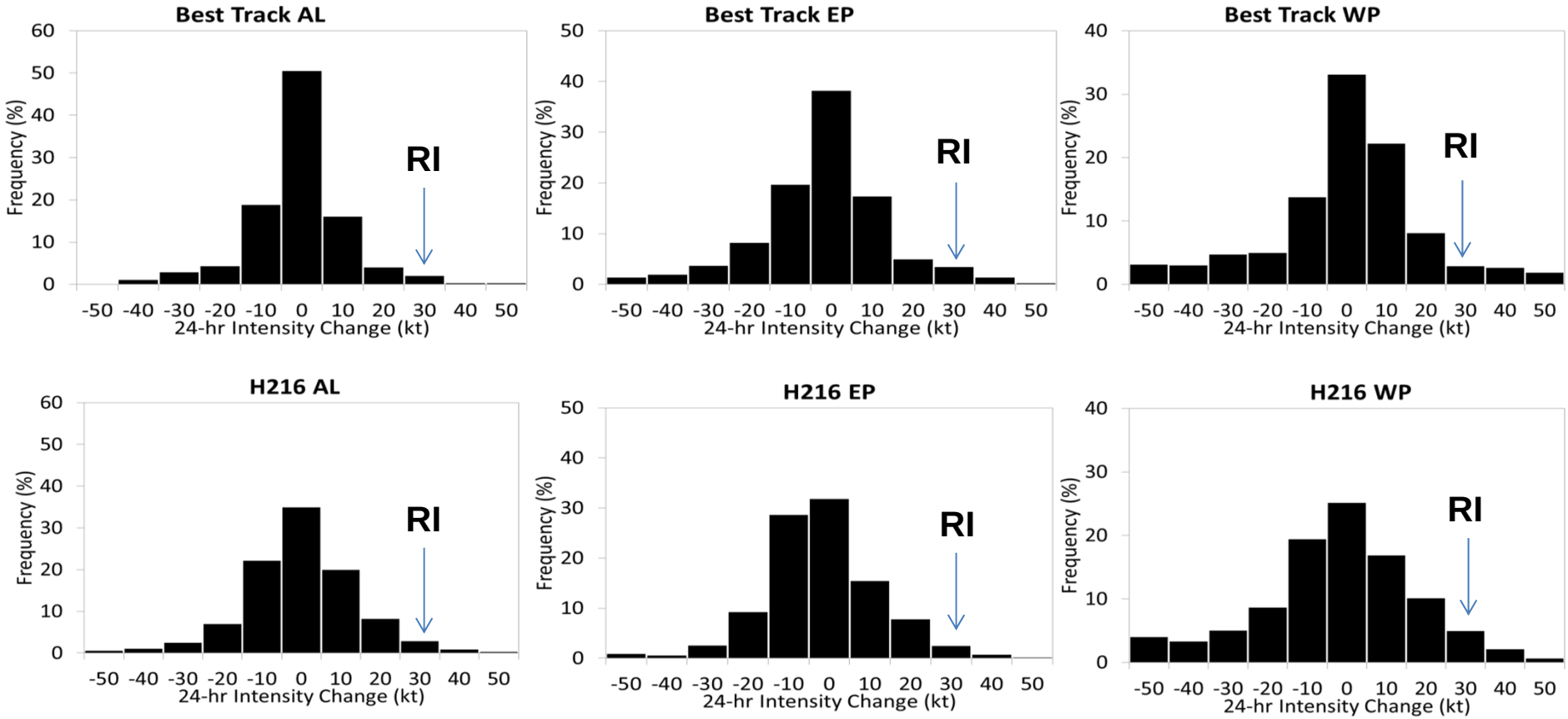
Intensity Distribution

(From 2016 real time)



24hr Intensity Change Distribution

(From 2016 real time)



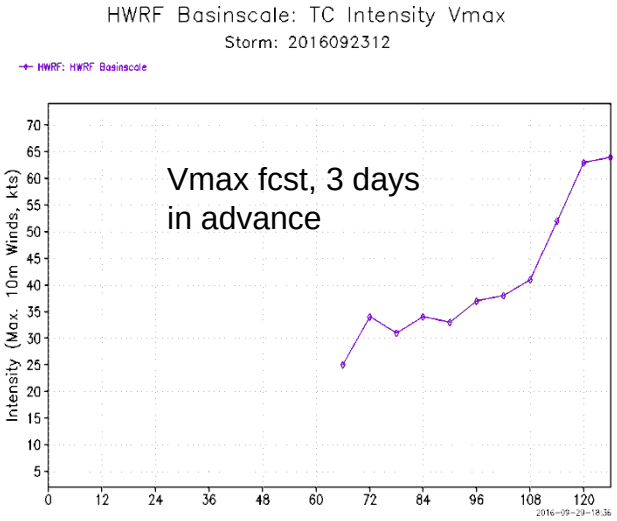
Basin-scale HWRF Real time Parallel

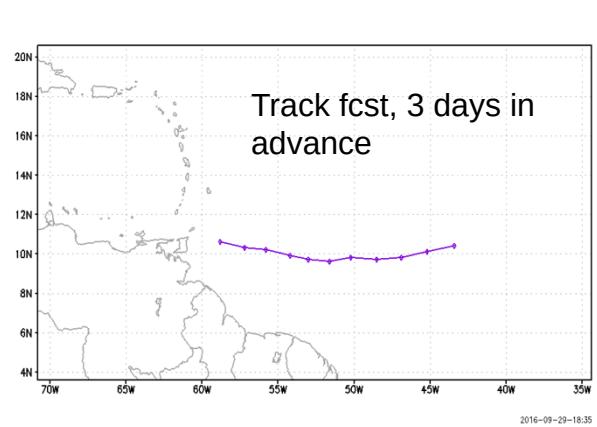
Basin-scale Configuration:
nx=864, ny=632 (160°x60°),
dx=0.09, dy=0.09, ~12km
domain center fixed at (80.0W, 25.0N)

The basin-scale model does have the ability to forecast the formations of almost all storms.

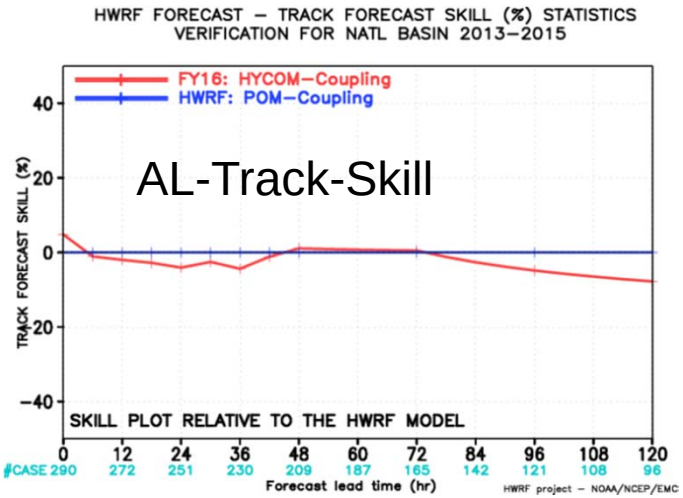
Hurricane Matthew (14L 2016) became a named storm at 15:00 UTC 28 September 2016.

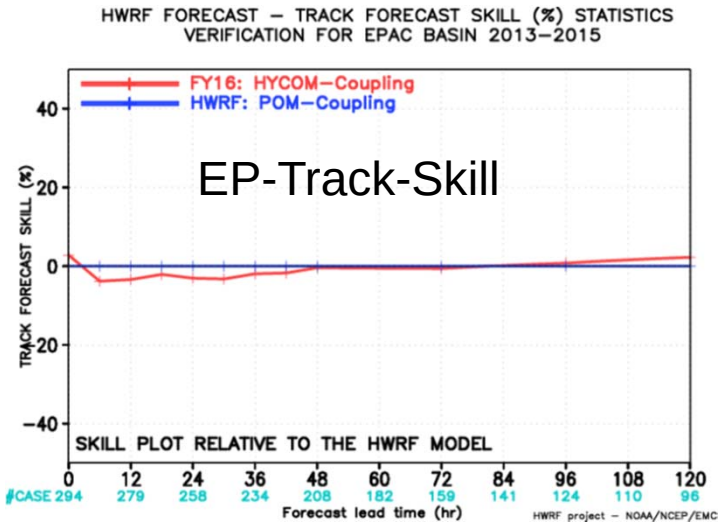
Basin-scale HWRF forecast its formation at 12:00 UTC 23 September 2016.

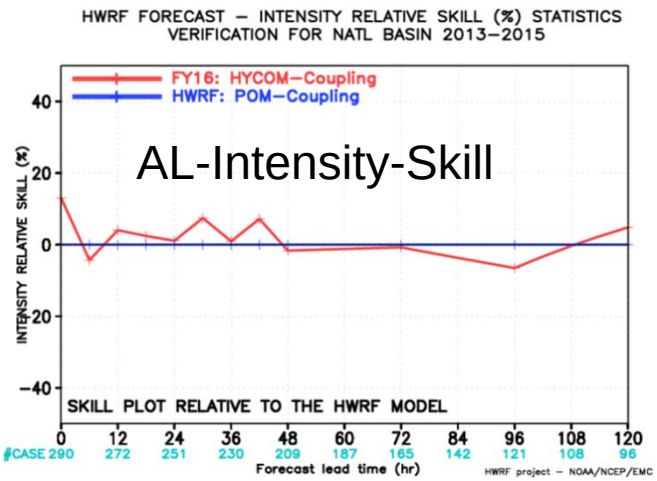


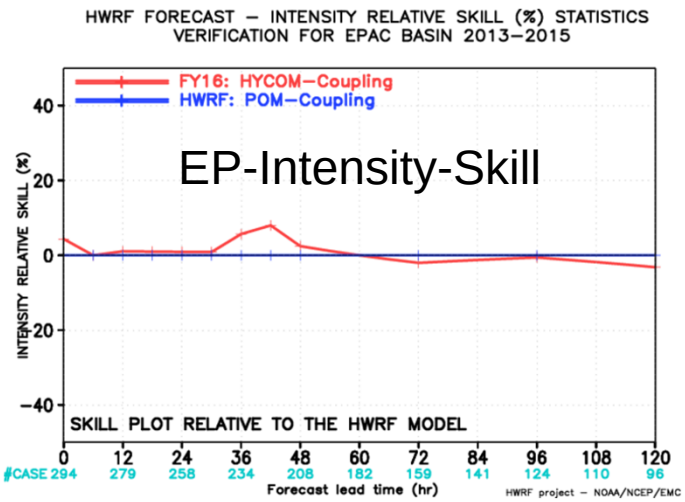


HYCOM-HWRF Coupling Real Time Parallel









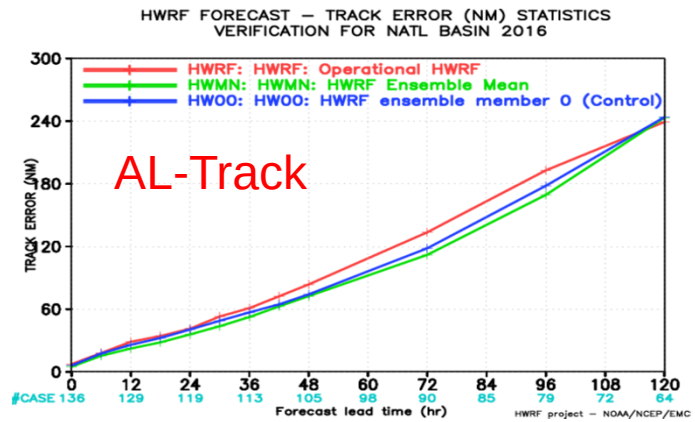
HWRF based ensemble Real time Parallel

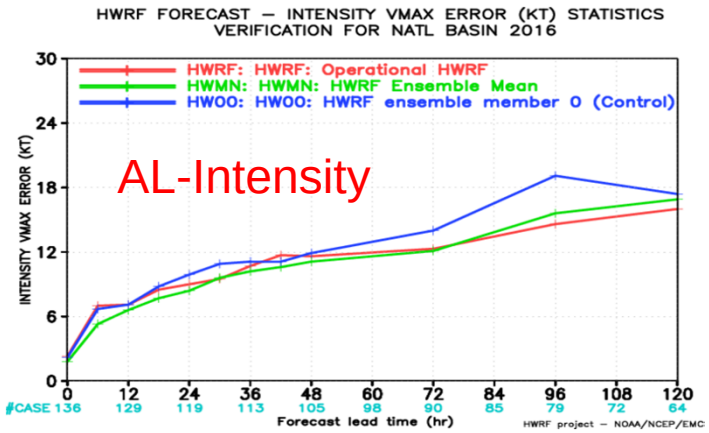
- Use 2016 operational deterministic HWRF model except for
  - Less horizontal resolution: 27/9/3km vs. 18/6/2km
  - Less vertical resolution: L43 vs. L61;
  - No GSI due to lack of GDAS data;
- IC/BC Perturbations (large scale): 20 member GEFS.

- Model Physics Perturbations (vortex scale):
  - Stochastic Convective Trigger Perturbations in SAS: -50hPa to + 50hPa white noise ;
  - Stochastic boundary layer height perturbations in PBL scheme, -20% to +20%;
  - Stochastic Cd perturbation;
  - Stochastic initial wind speed and position (TCVital) perturbations considering best track uncertainty.

Difference from 2015 HWRFES:

1. Larger D02 and D03;
2. Scale-aware convection scheme turned on for all domains.





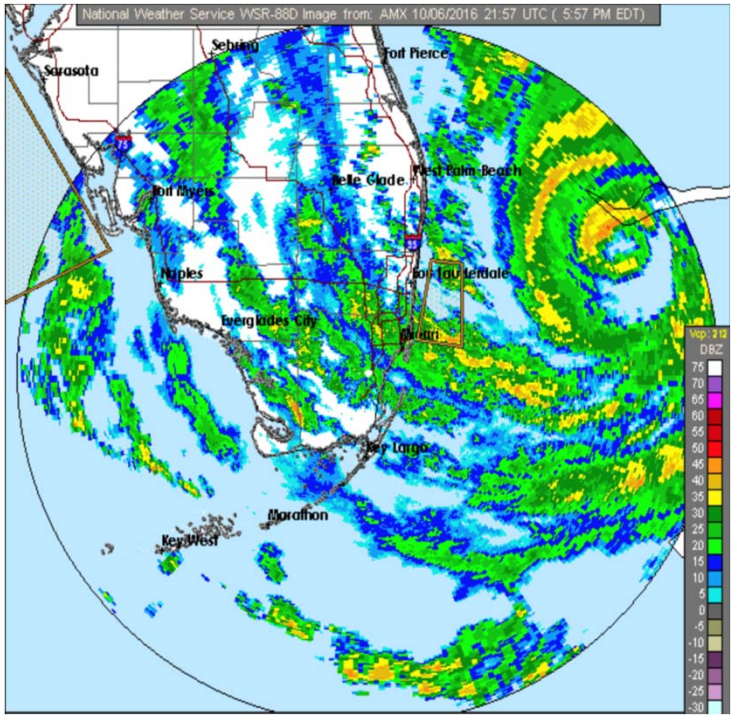
Secondary Eyewall in HWRF

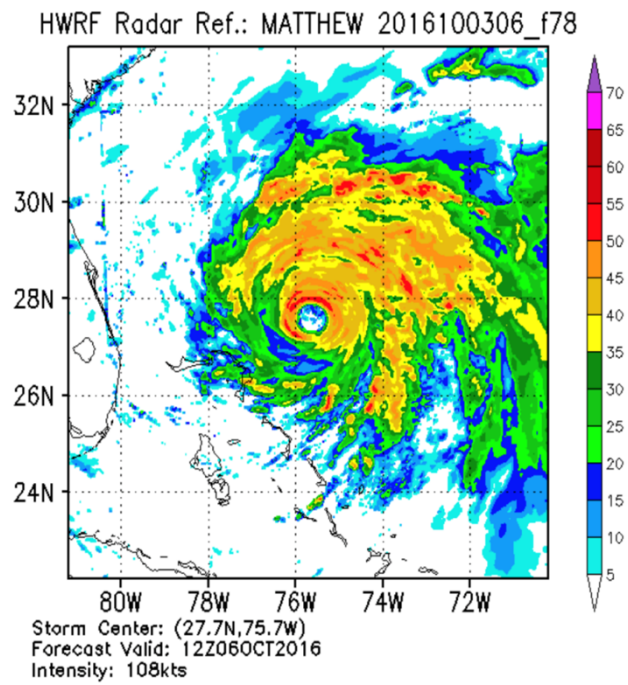
Matthew,14L, 2016

Operational cycles:

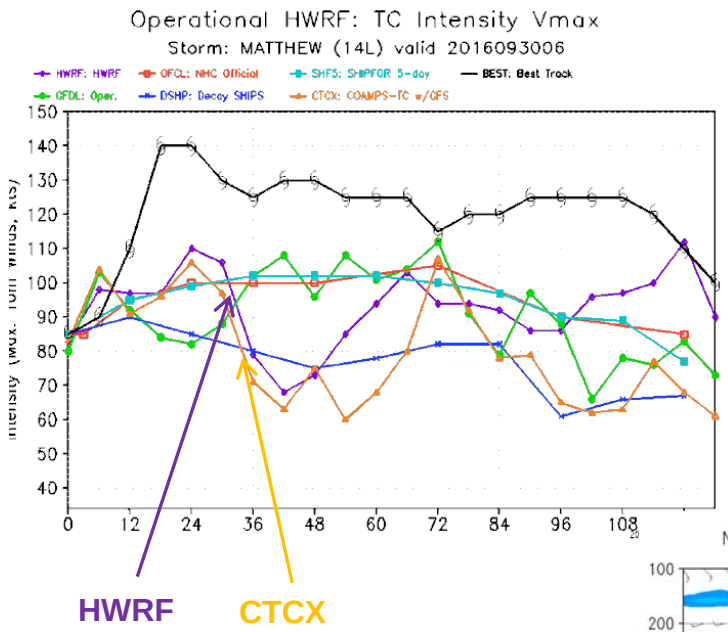
-September 28-31, **~30% of the cycles show a SE** towards the end of the integration

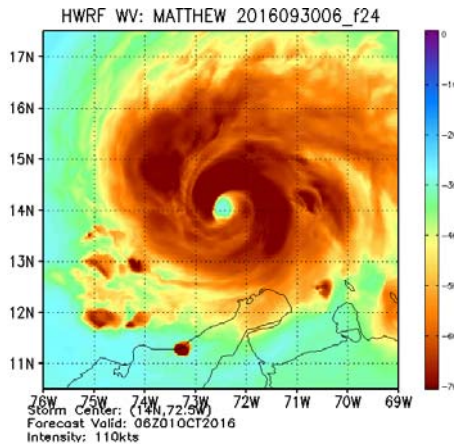
-October 01-05, **~80% cycles show SE & ERC**

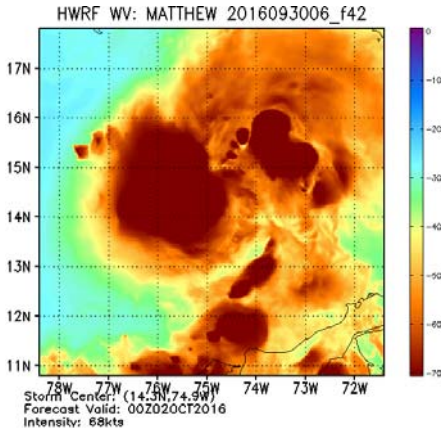


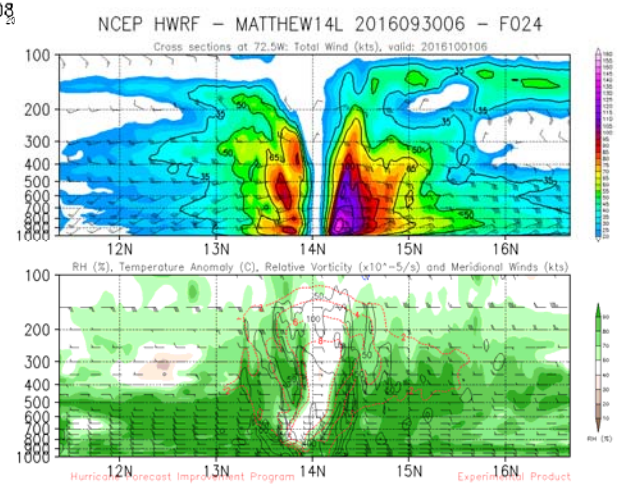


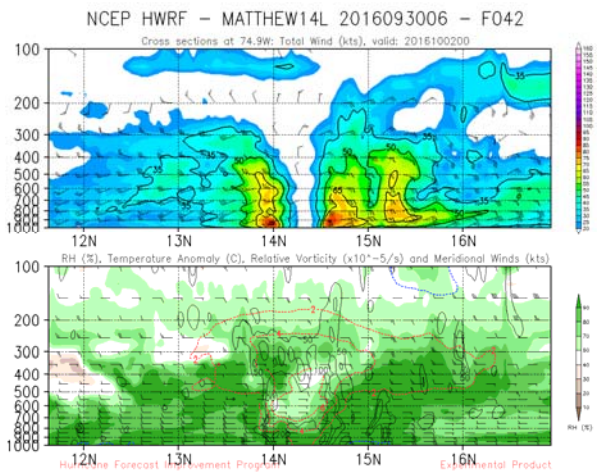
HWRF Simulated Intensity Oscillation and Hurricane Hook for Matthew 14L, 2016





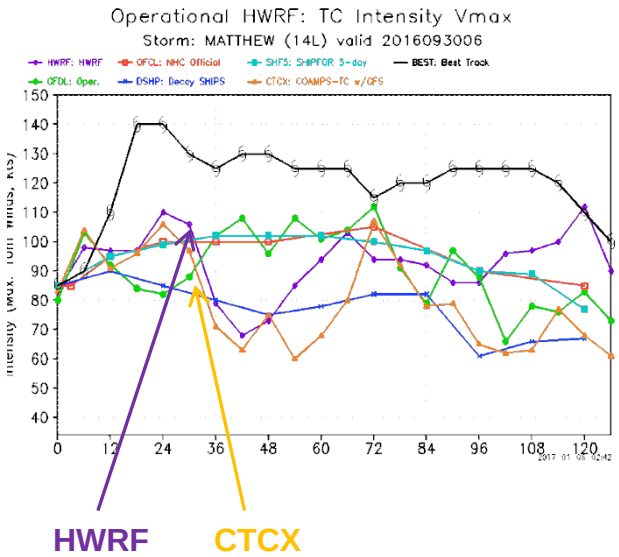


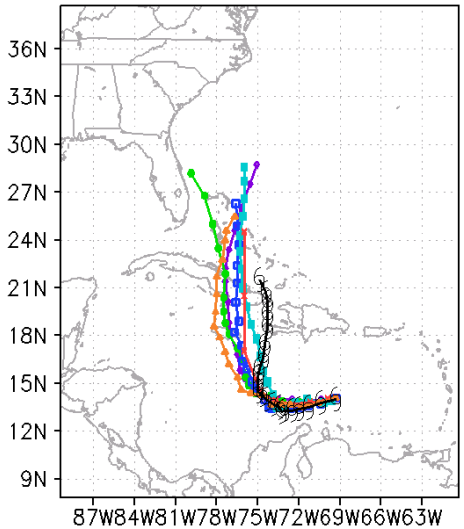


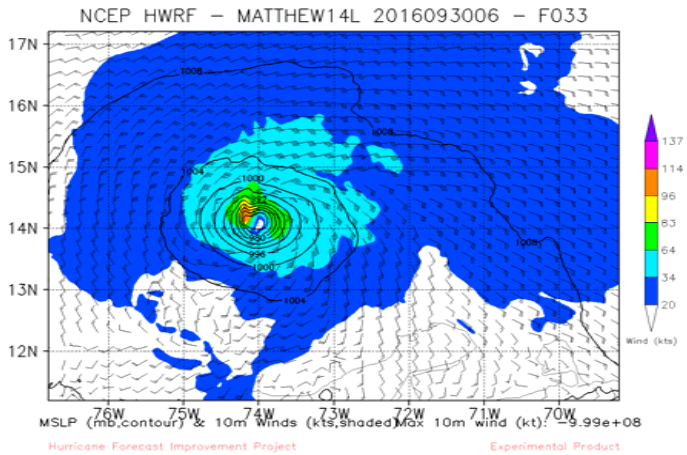


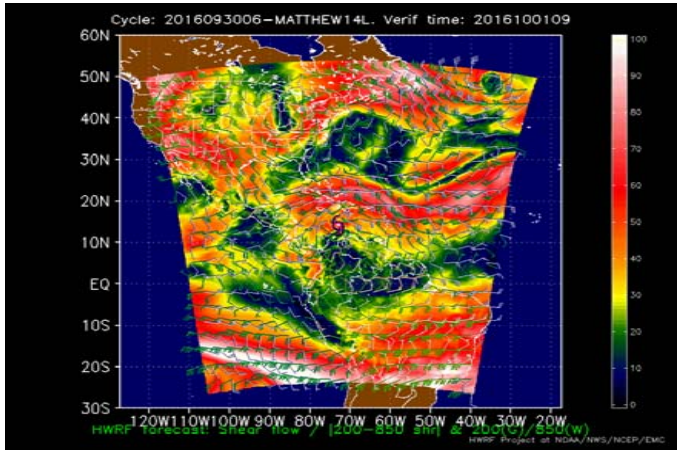
- Large fluctuations in intensity in model forecasts
- Storm structure collapse
- Not happened in observation

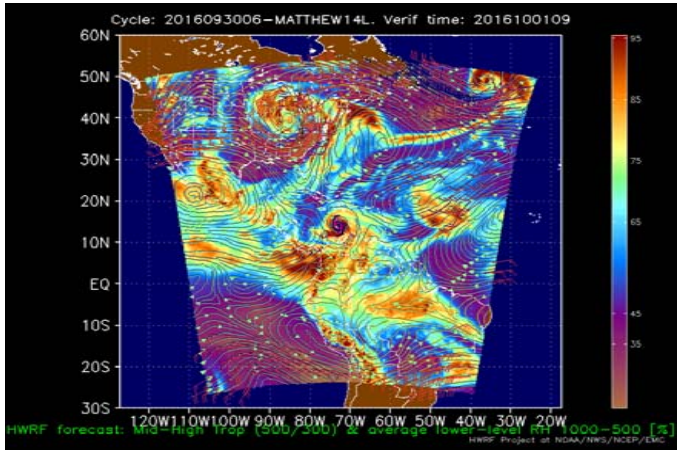
HWRF Simulated Intensity Oscillation and Hurricane Hook for Matthew 14L2016



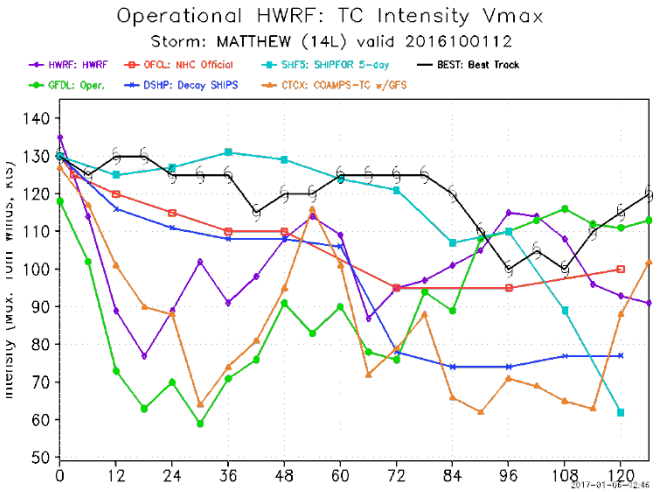


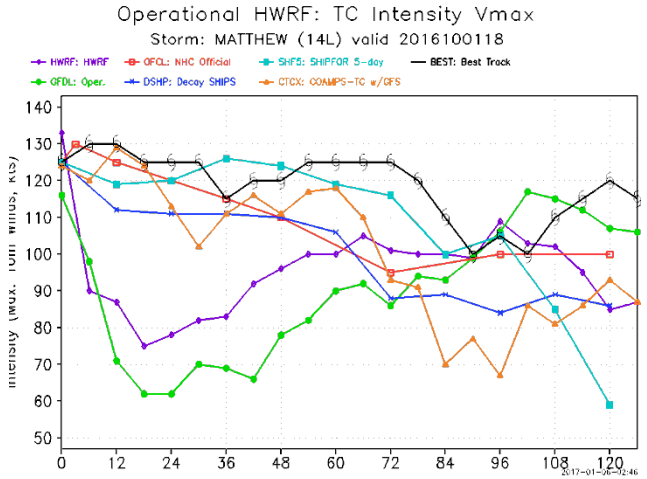


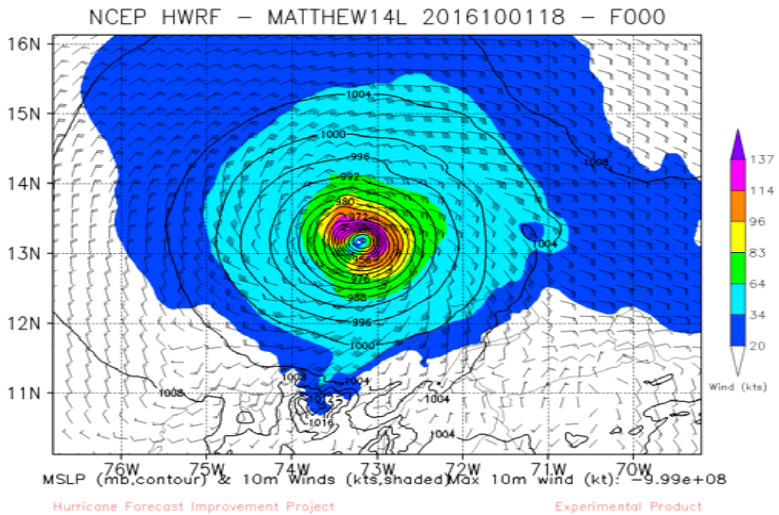




Intensity Oscillation and Spin-Down due to both VI/DA and Hurricane Hook

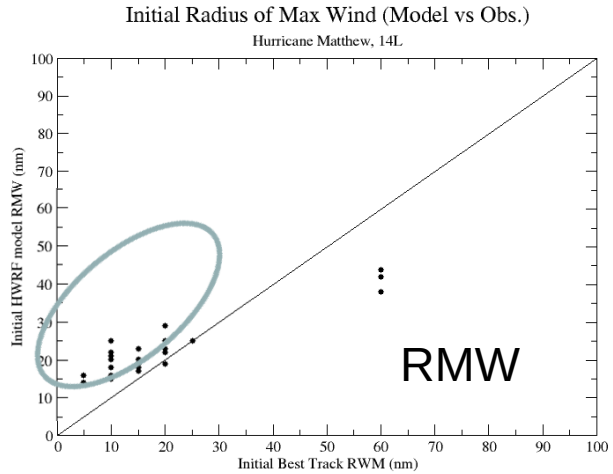


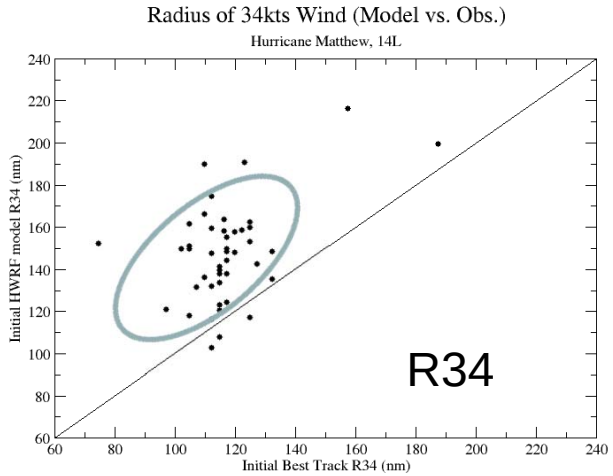




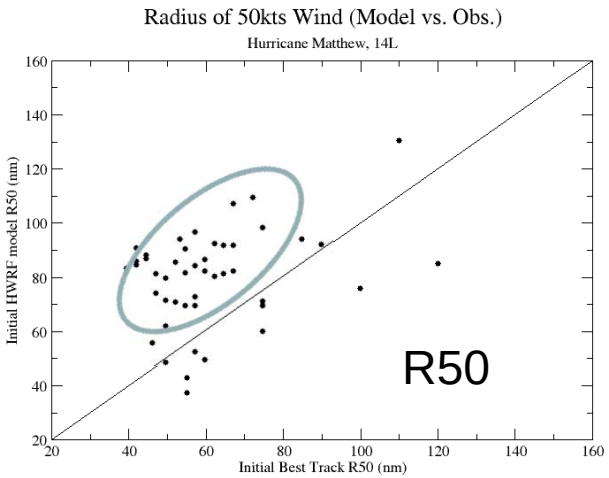
Comparison of Initial Storm Sizes (Model vs. Best)

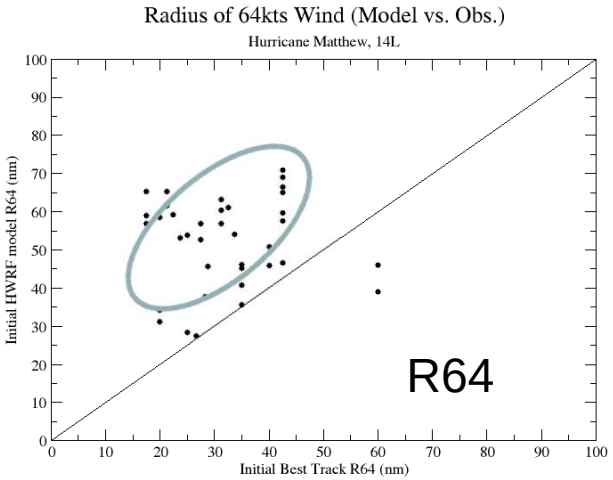
Hurricane Matthew, 14L, 2016



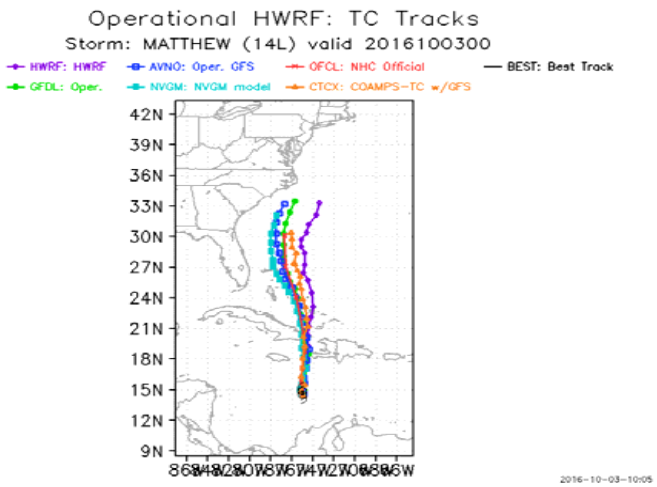


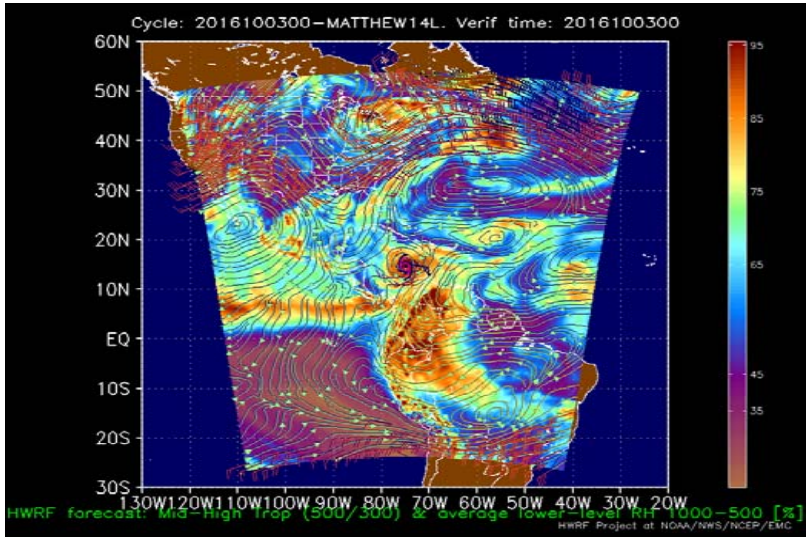
In most of cycles, model initial storm sizes are bigger than Obs.

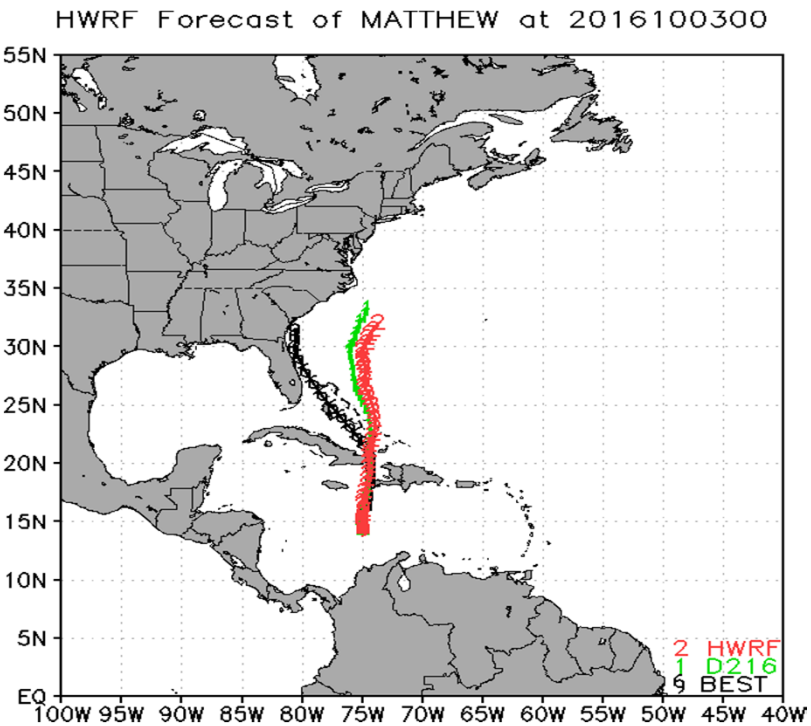




Consider Storm's Meridional Movement when Choosing Domain Center

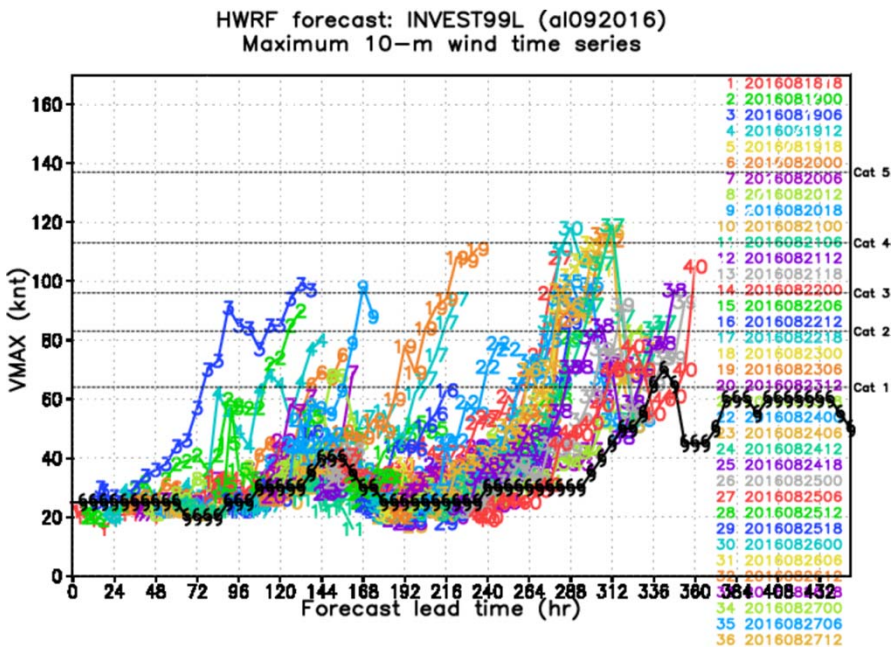


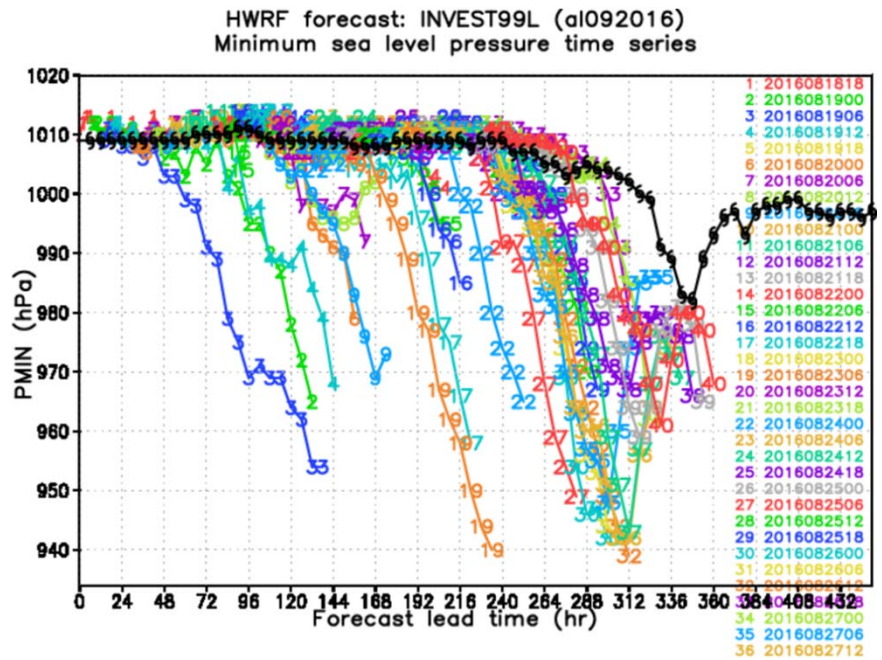




Strong Intensity Forecast Bias for INVEST

INVEST 99L





Challenges and Issues

- Large fluctuations in intensity forecasts
- Initial intensity spin up/down
- Track forecasts impacted by LBC
- Over-prediction of intensity for INVEST storms