Performance and Verification of HWRF Ensemble Prediction System in 2016 Real time Parallel Experiment

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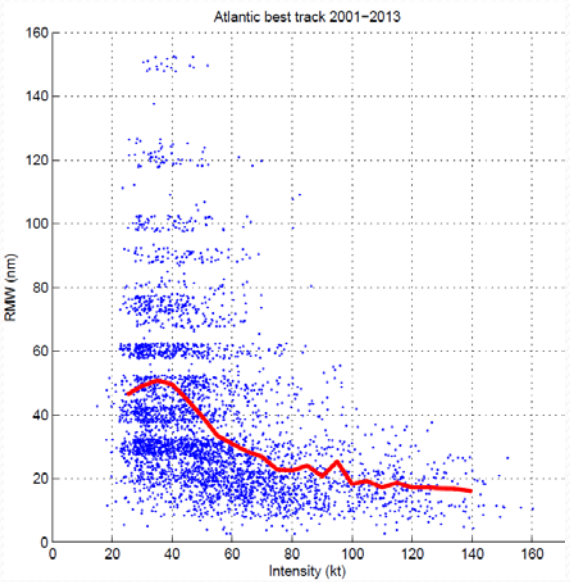
Background

- **Two jet real time reservations;**
- **HWRF EPS real time parallel for one AL storm;**
- **Multi-Model Combined Ensemble Prediction;**
- **80-member HWRF EPS for SHOUT, intensity change guidance for Global Hawk.**

2016 HWRF ensemble Configuration

- 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.

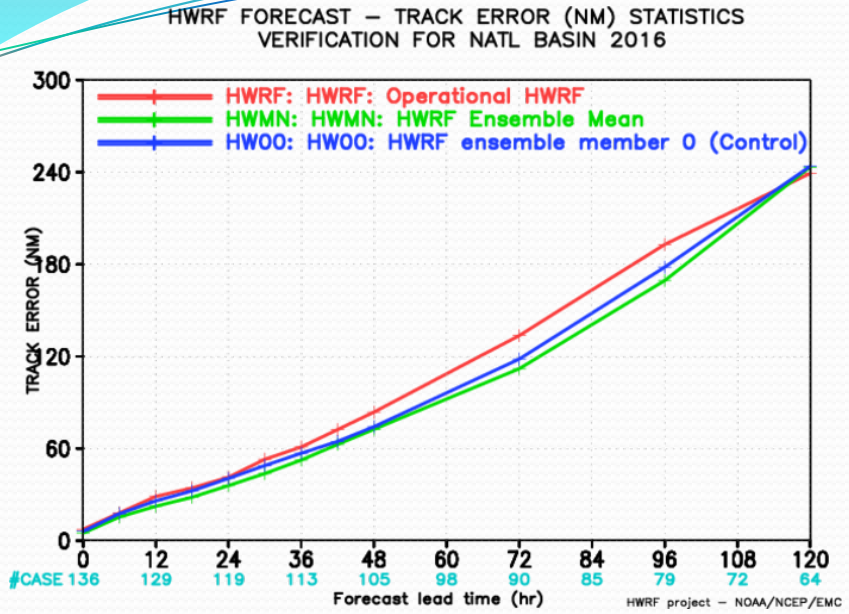


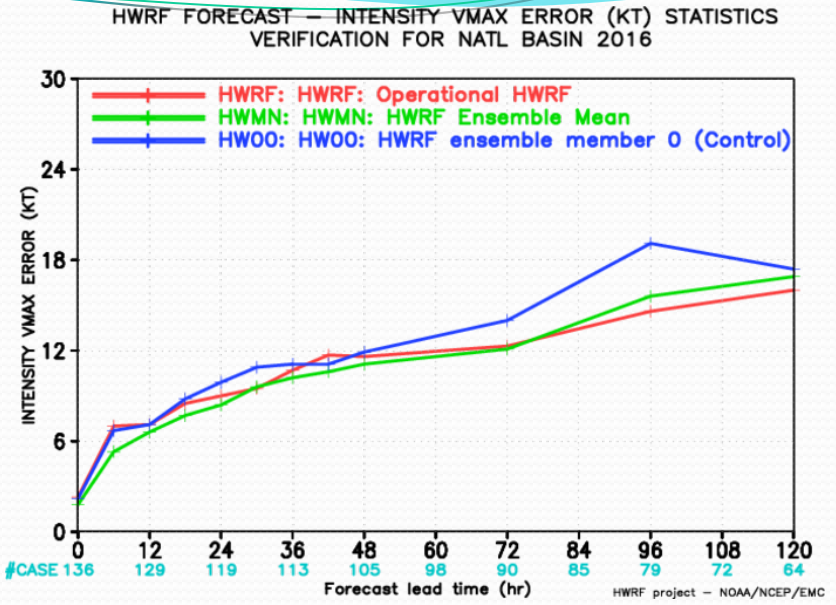
Difference from 2015 HWRFES:

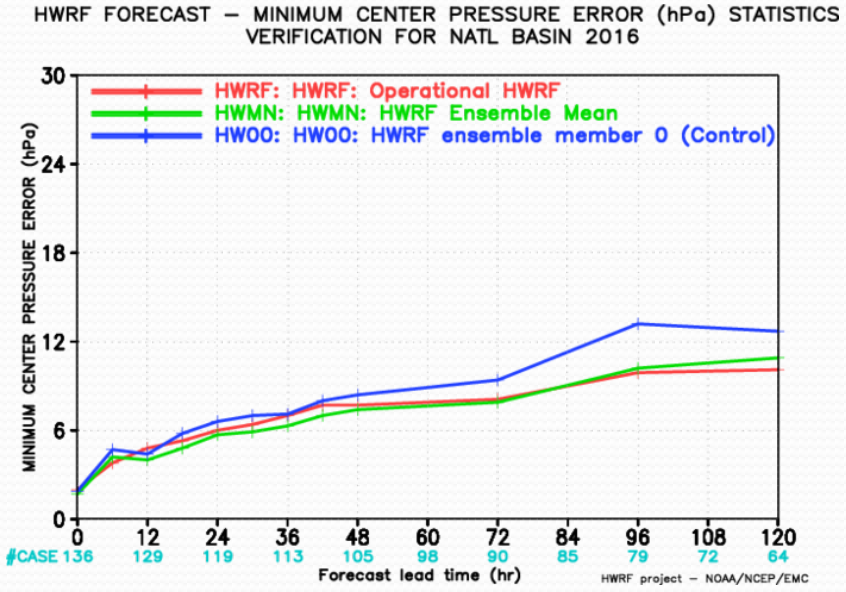
1. Larger D02 and D03;
2. Scale-aware convection scheme turned on for all domains.

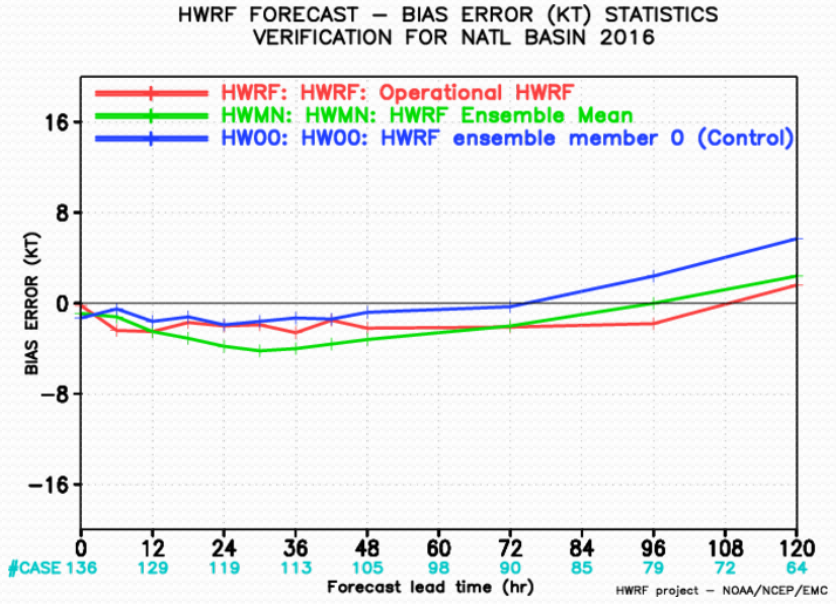
(Degrees/ Sec)	18 km	6 km	2 km
2015 HWRF	75 x 75 38 4/7	12 x 12 12 6/7	6.5 x 7 4 2/7
2016 HWRF	75 x 75 30	25 x 25 10	8.3 x8.3 3 1/3

Verification: HWRF-EPS vs Deterministic HWRF at AL

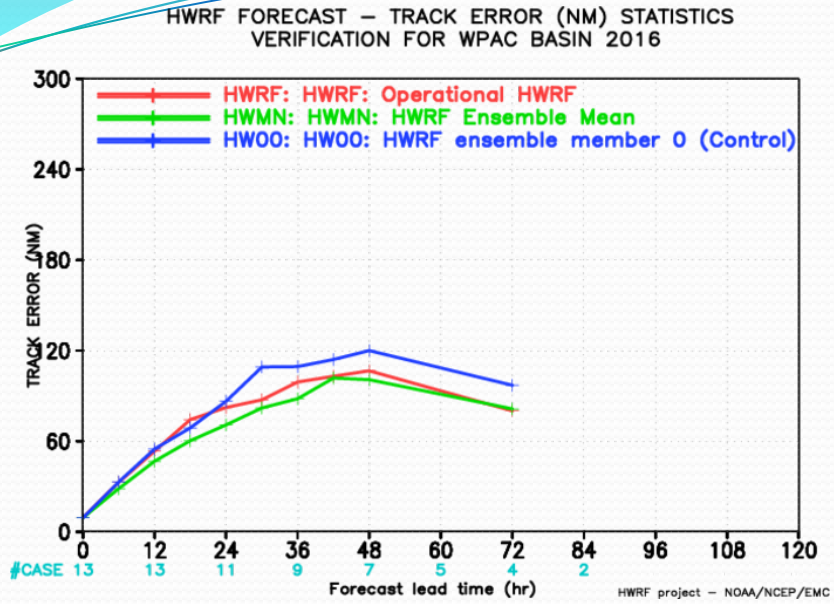


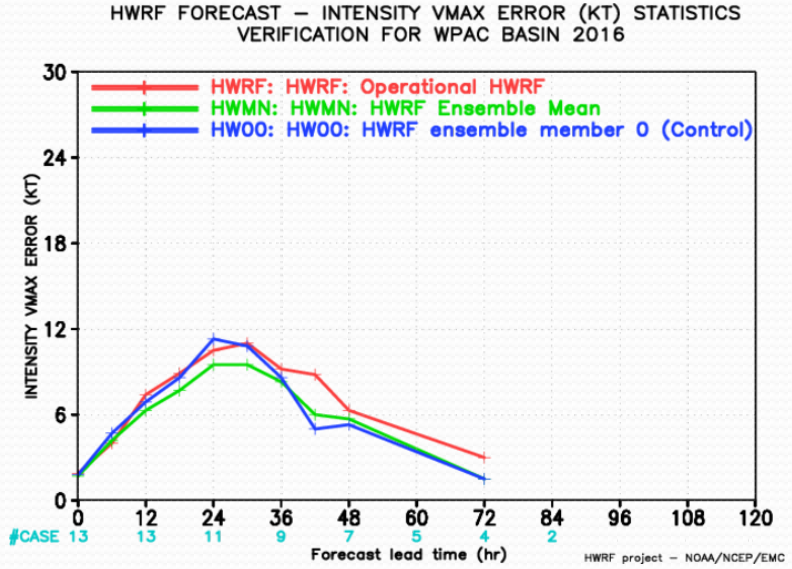


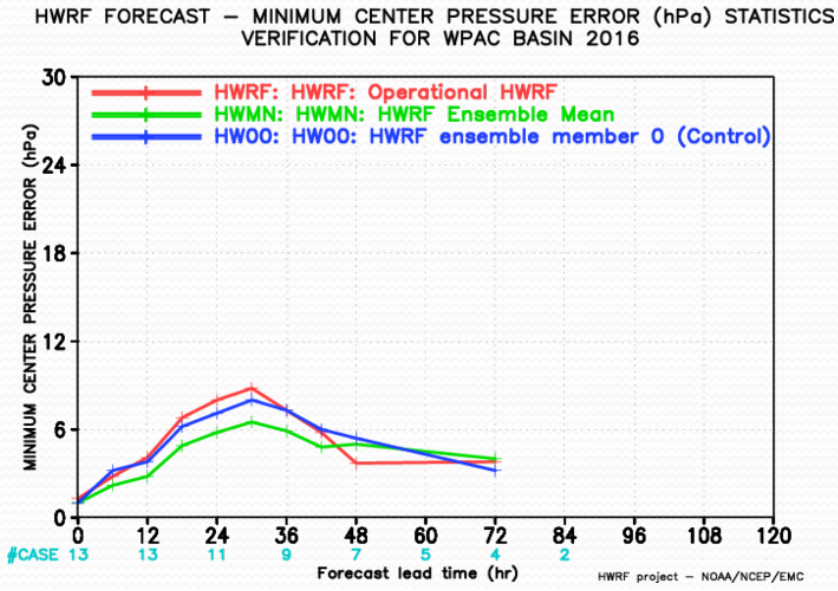


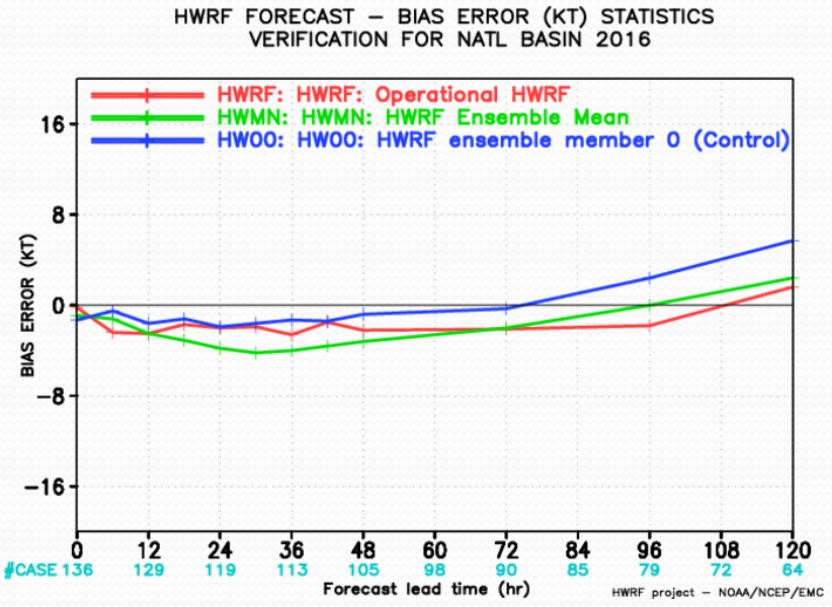


Verification: HWRF-EPS vs Deterministic HWRF at WP

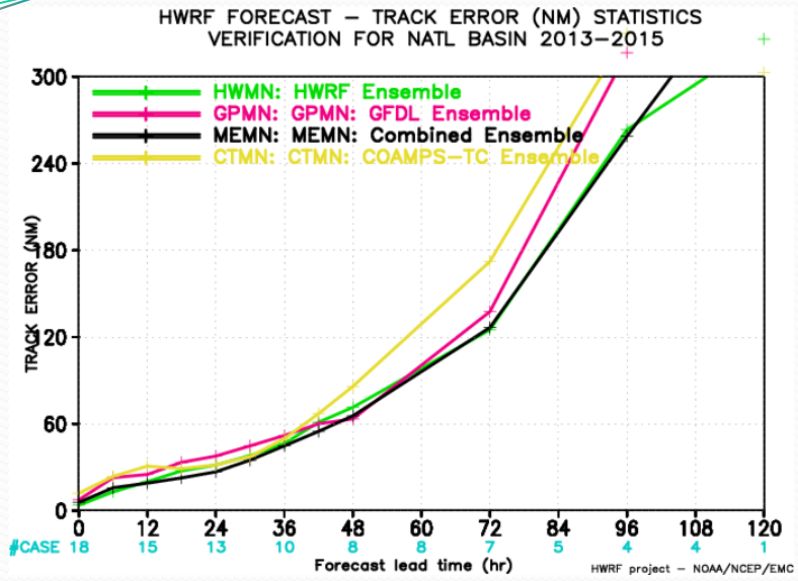


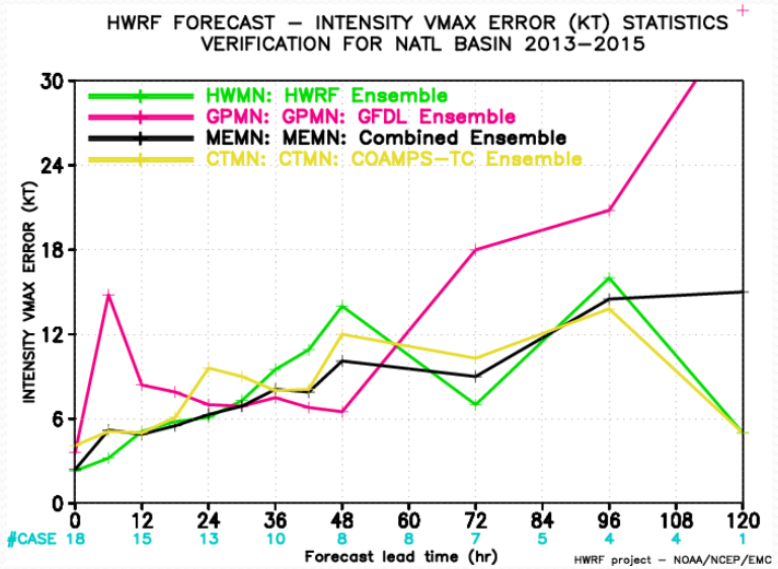


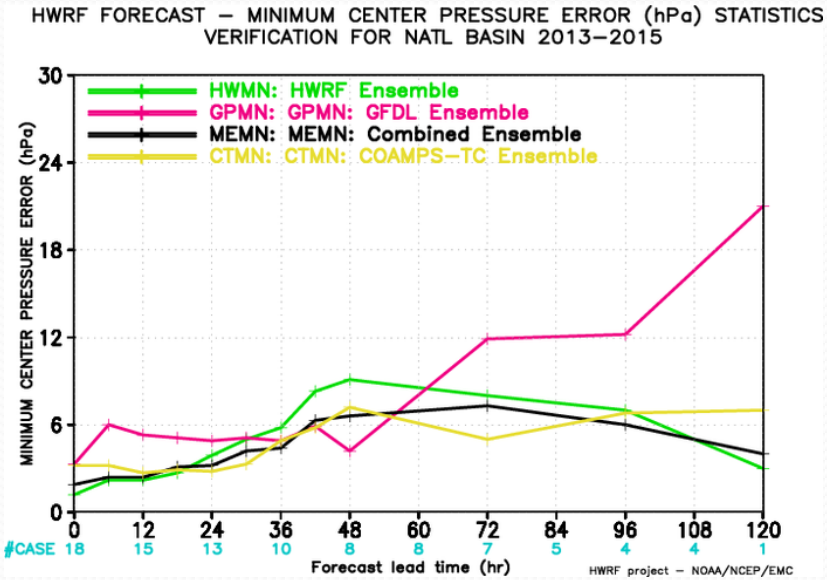


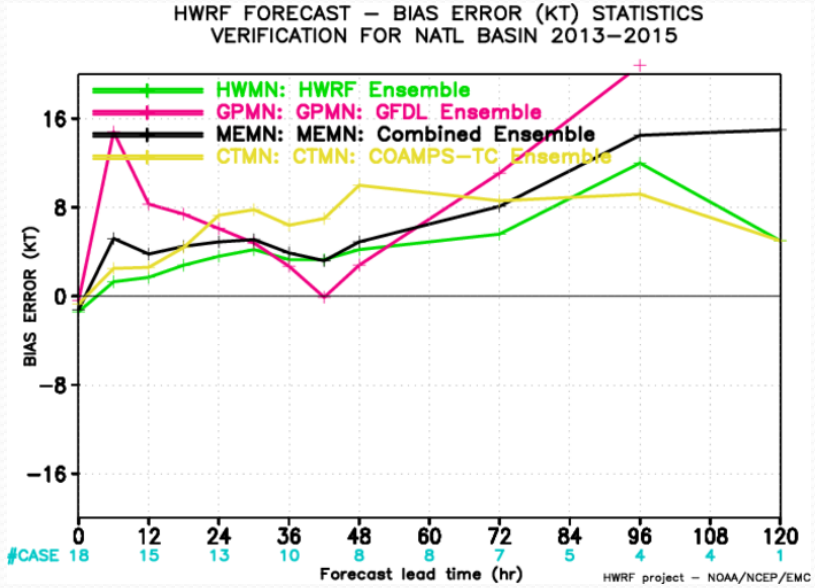


Verification: Multi-Model EPS

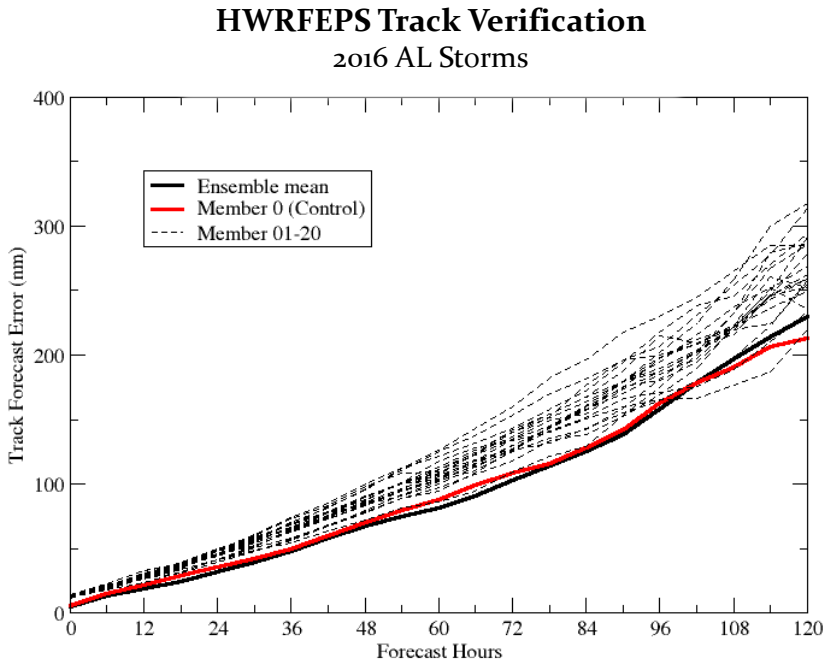


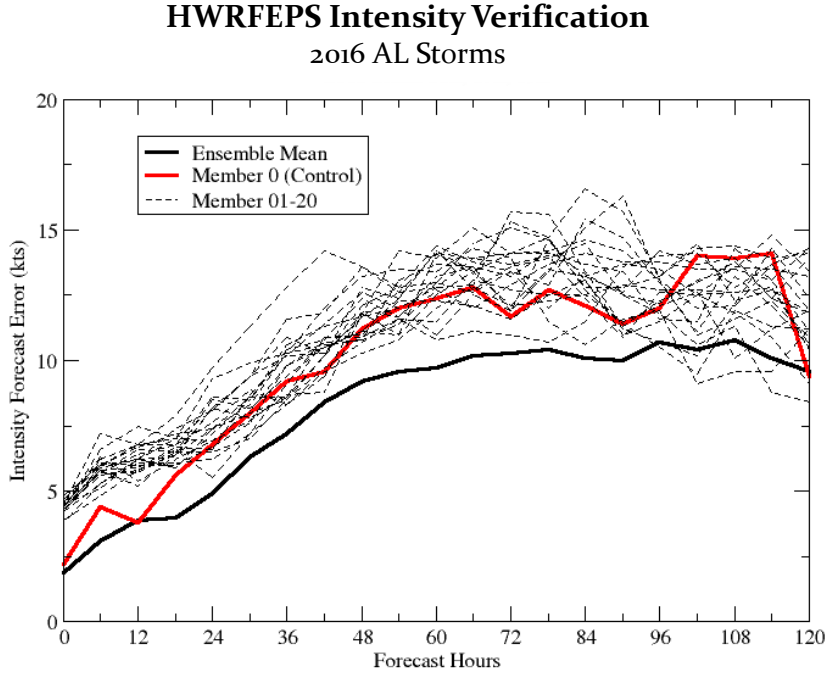






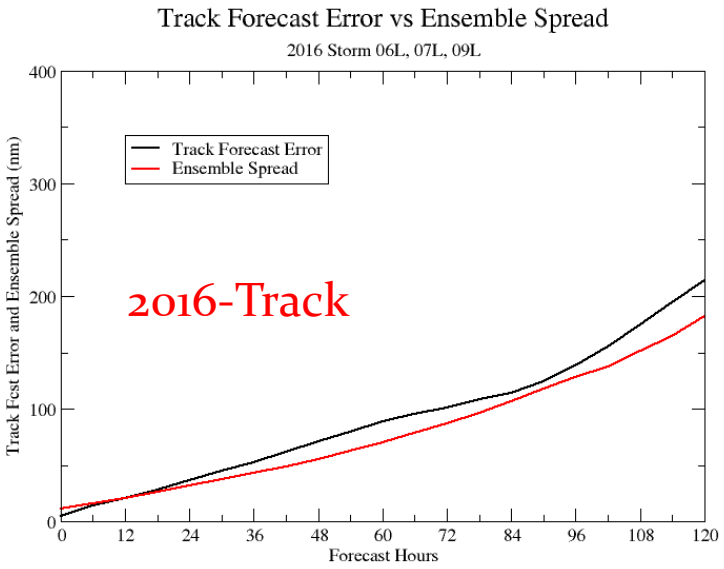
Verification: Individual Members vs Ensemble mean

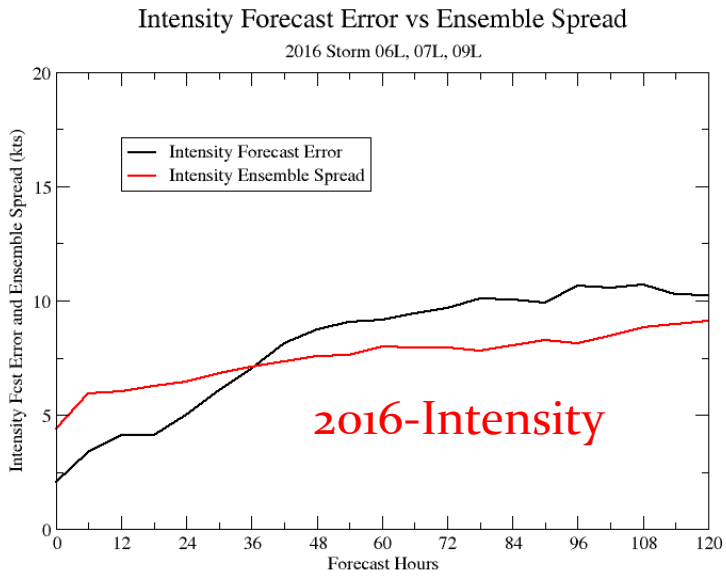


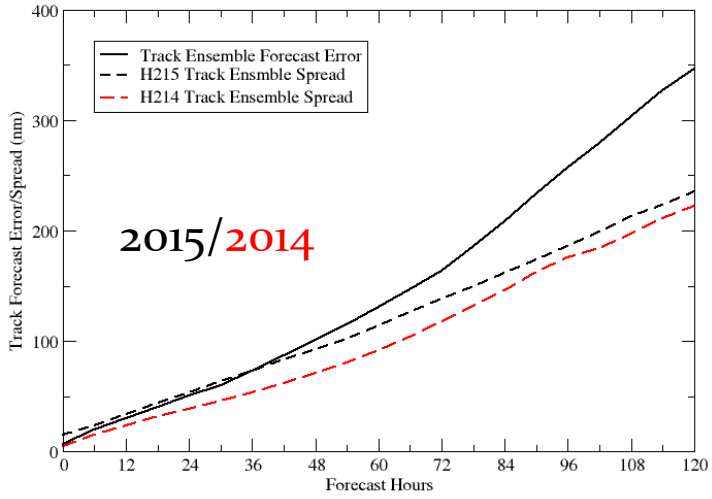


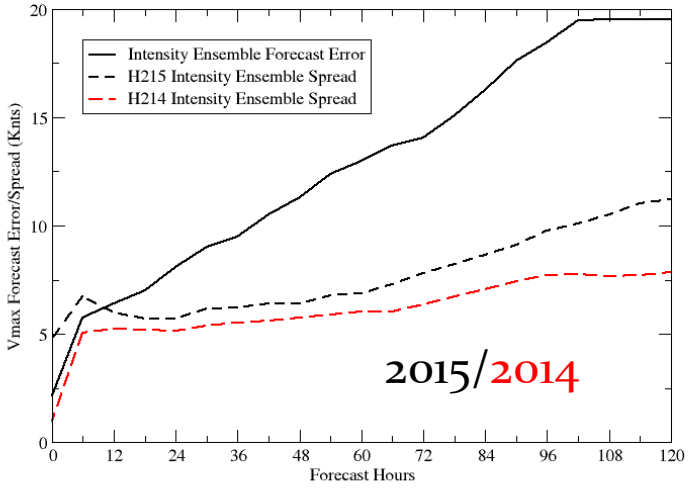
1. HWRF EPS outperforms both the operational HWRF and its control (HW00) in terms of track and intensity;
2. HWRF ensemble mean has the smallest forecast errors compared to its individual ensemble members.

Forecast Error vs Ensemble Spread









Future Plan for HWRF based Ensemble Prediction System

- Improve representation of HWRF model error in EPS
  - Improve perturbations in scale-aware convection scheme
  - Evaluating Methods of Parameterizing Model Error in the HWRF Ensemble Prediction (Ryan Torn)
  - Characteristics of Hurricane Intensity Error Growth and Predictability Limit in the HWRF Model (Chanh Kieu)
- Improve representation of initial uncertainties, including initial SST uncertainties in HWRF EPS
- Develop more post-processed deterministic products: including medium value of track/intensity, select best member to represent EPS;
- Develop more probabilistic products, visualization of model variable uncertainty fields
- Continue HWRF EPS real time demo distribute the track/intensity forecast in a-deck file;
- Combined HWRF/GFDL/COAMPS-TC multi ensemble system in 2017
- Run 10 member HWRF-based EPS operationally in 2018