Performance and Verification of HWRF Ensemble Prediction System in 2015 Real time Parallel Experiment

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HFIP Annual Review Meeting, November 17, 2015

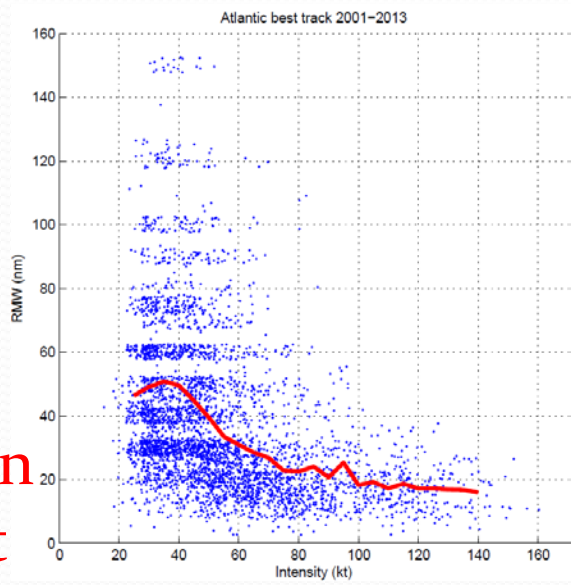
Outline

- **Configuration of HWRF Ensemble Prediction System and 2015 upgrades**
- **2015 Performance from HWRF EPS Parallel Experiment**
  - *Evaluation and verification of model performance in the NATL and WPAC basins in 2015*
  - *Statistical features of HWRF EPS;*
  - *Deterministic vs Ensemble, case study of Joaquin, 11L, 2015*
- **Scientific Challenges to Improve HWRF EPS**
  - *Improve ensemble spread, especially intensity spread*
  - *Post-process and more Ensemble Products*

2015 HWRF ensemble Configuration

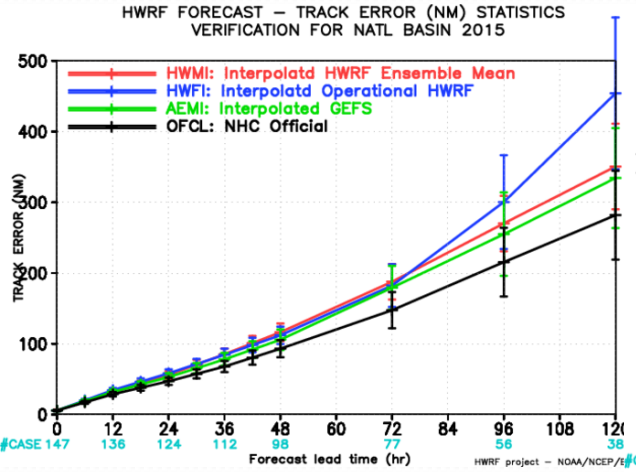
- Use 2015 operational deterministic HWRF model except for
  - Less horizontal resolution: 27/9/3km vs. 18/6/2km
  - Less vertical resolution: L43 vs. L61;
  - No GSI due to lack of GDAS data;
- IC/BC Perturbations (large scale): 20 member GEFS.

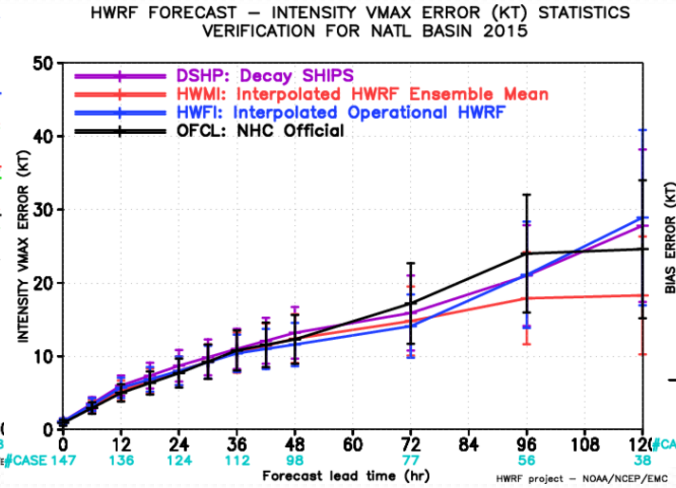
- Model Physics Perturbations (vortex scale):
  - Stochastic Convective Trigger in SAS: -50hPa to + 50hPa white noise ;
  - Stochastic boundary layer height perturbations in PBL scheme, -20% to +20%;
  - Stochastic Cd perturbation;
  - Stochastic initial wind speed and position (TCVital) perturbations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

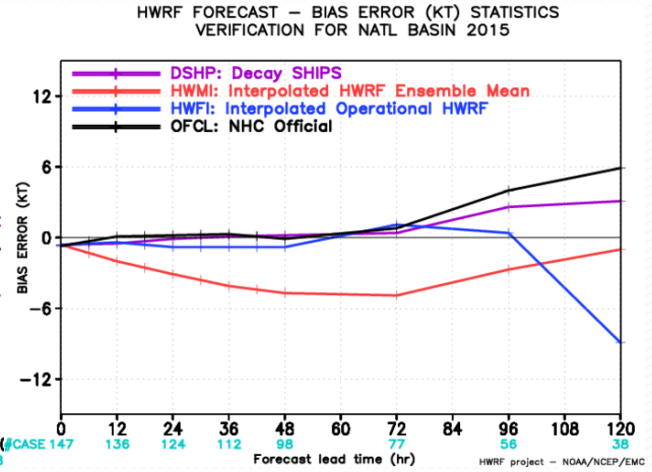


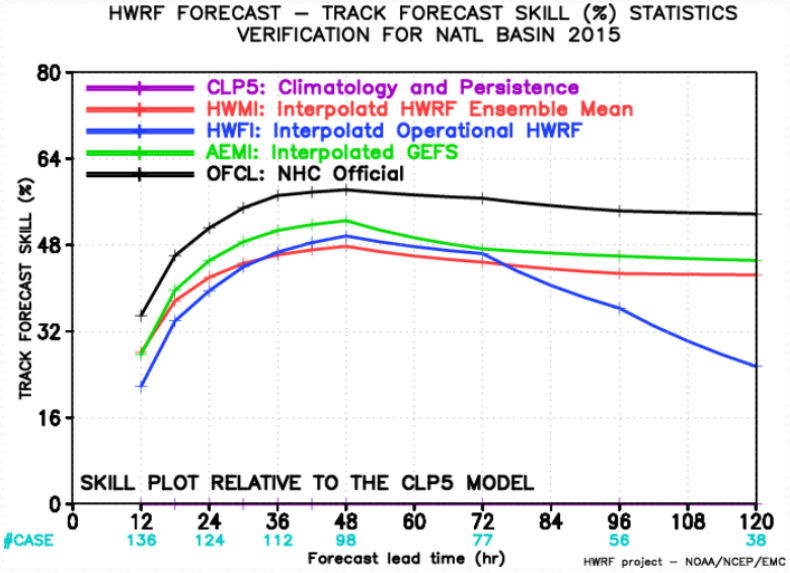
HWRF EPS in the 2015 North Atlantic Basin

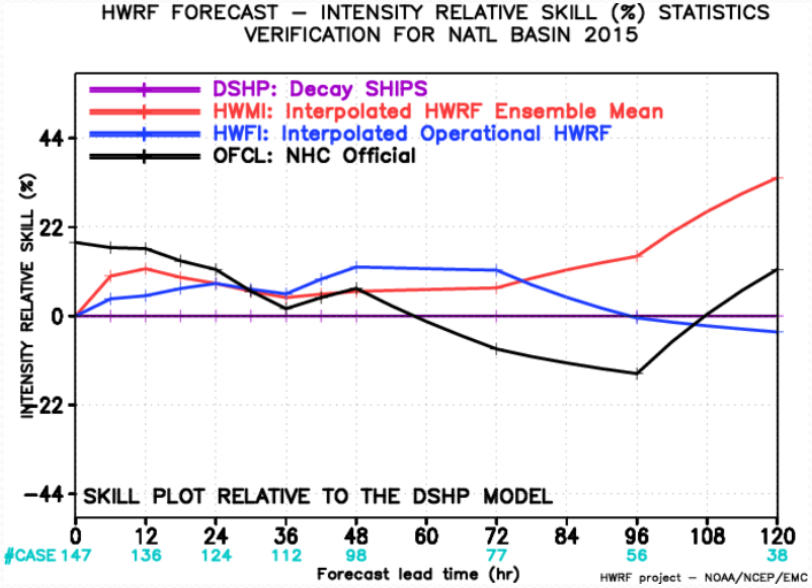
Ana-Joaquin





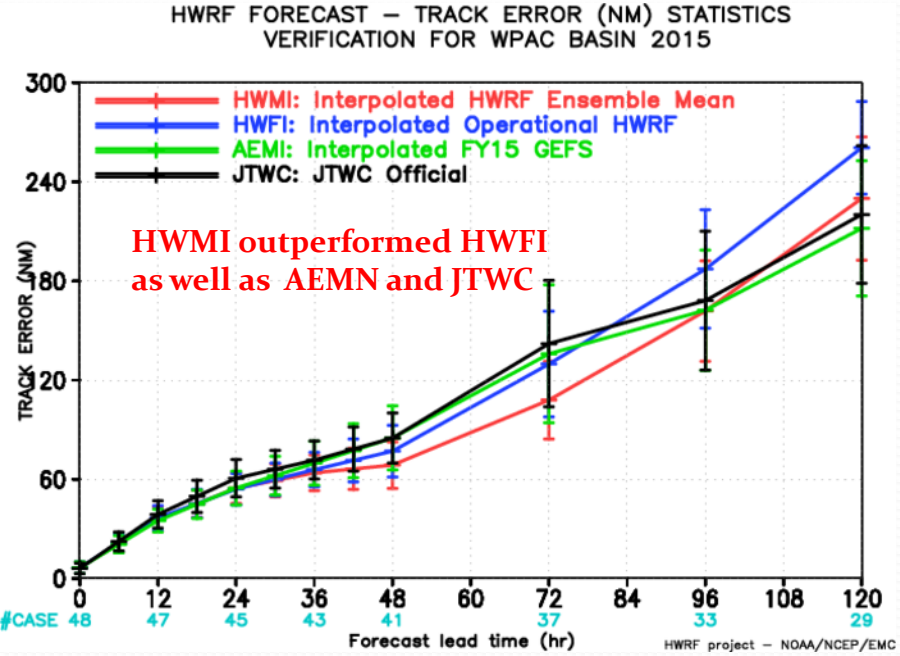


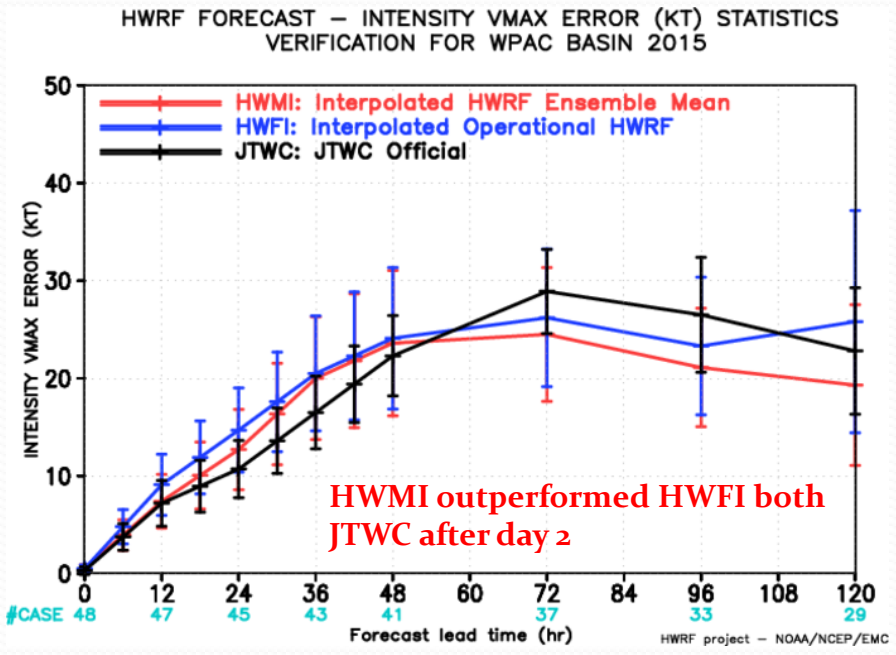


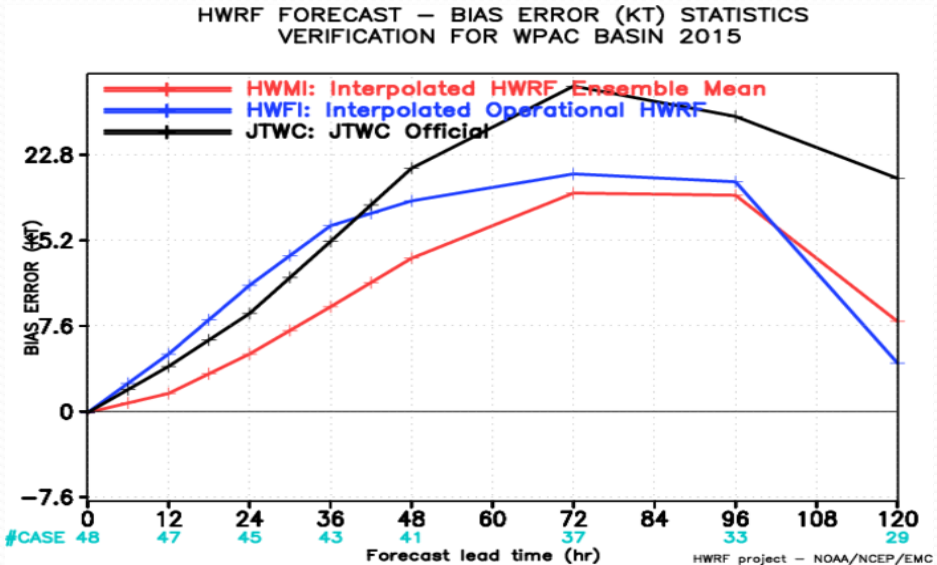


HWRF EPS in the 2015 West Pacific Basin

Chan-Hom, 09W, 2015

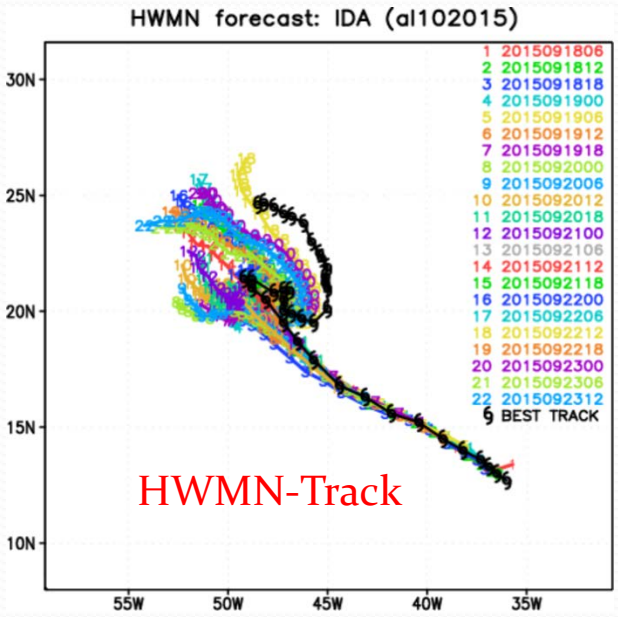


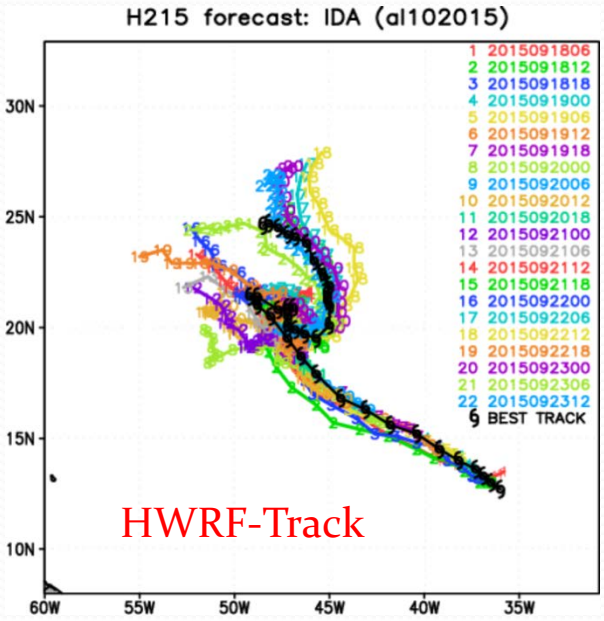


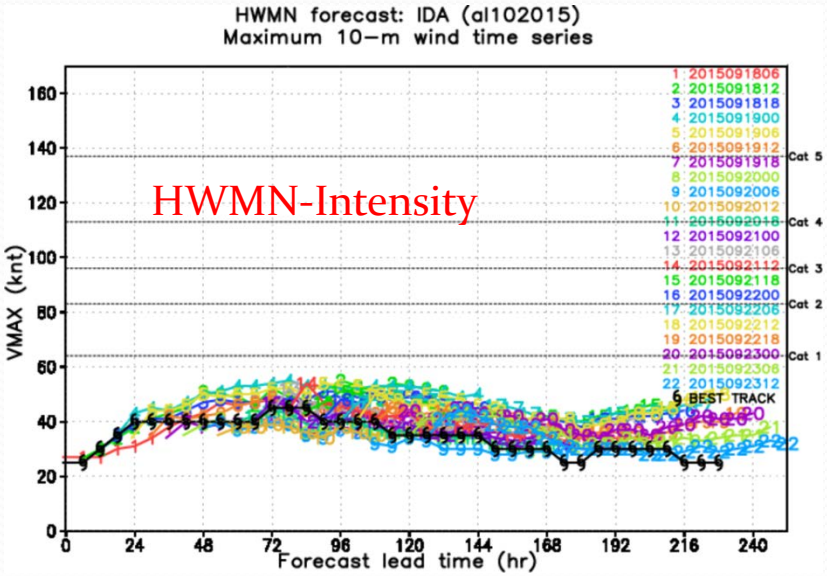


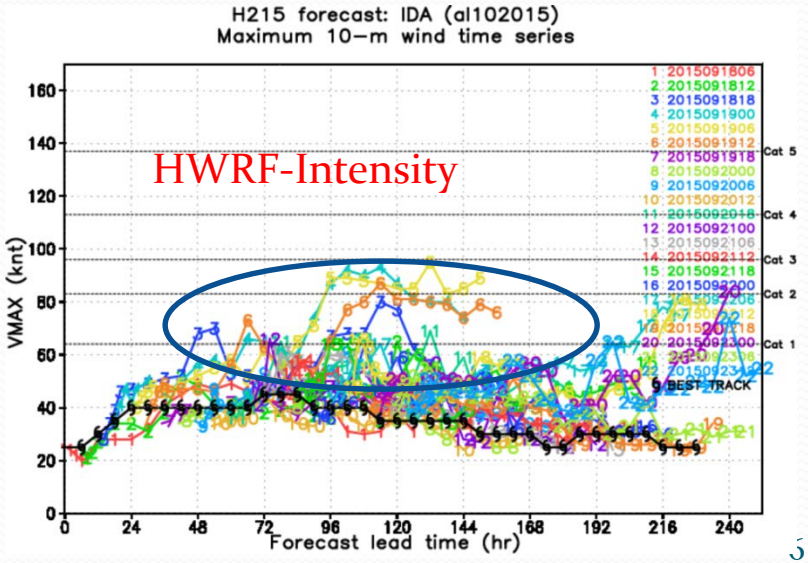
Deterministic vs Ensemble

IDA 10L, 2015



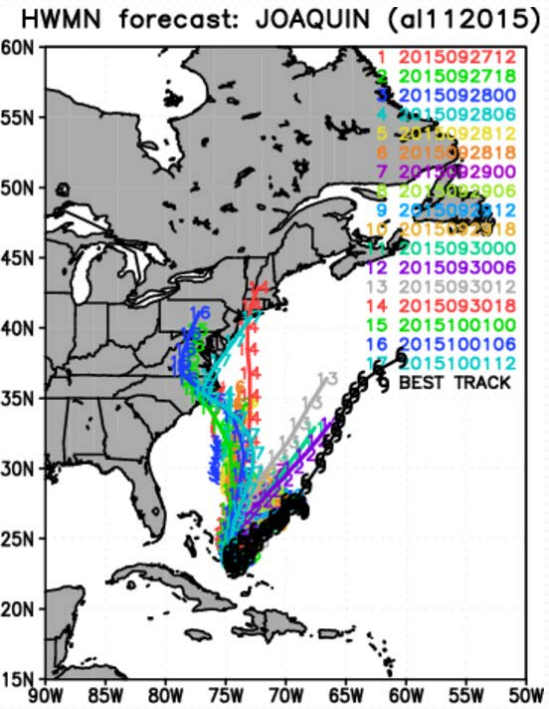




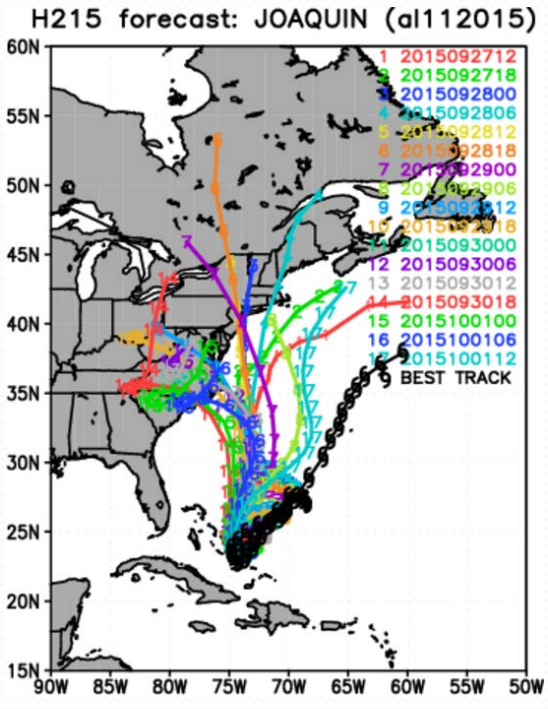


Deterministic vs Ensemble

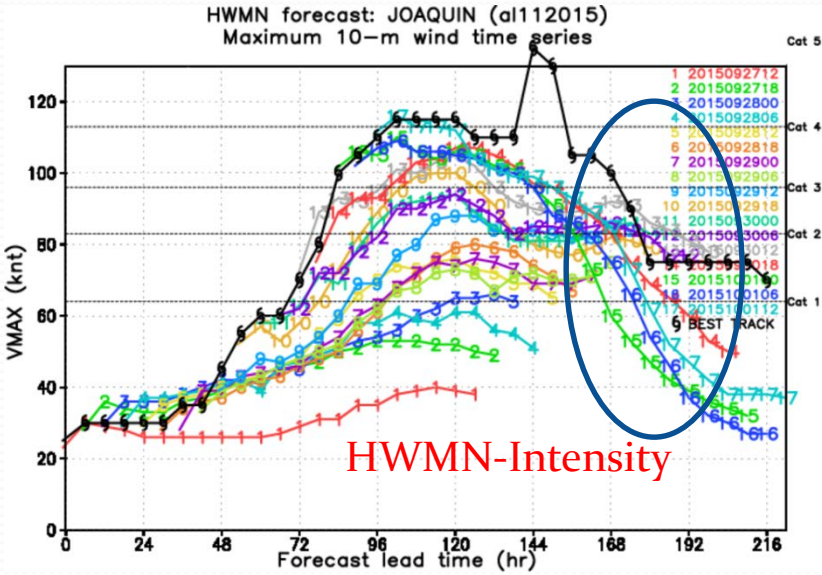
Joaquin 11L, 2015

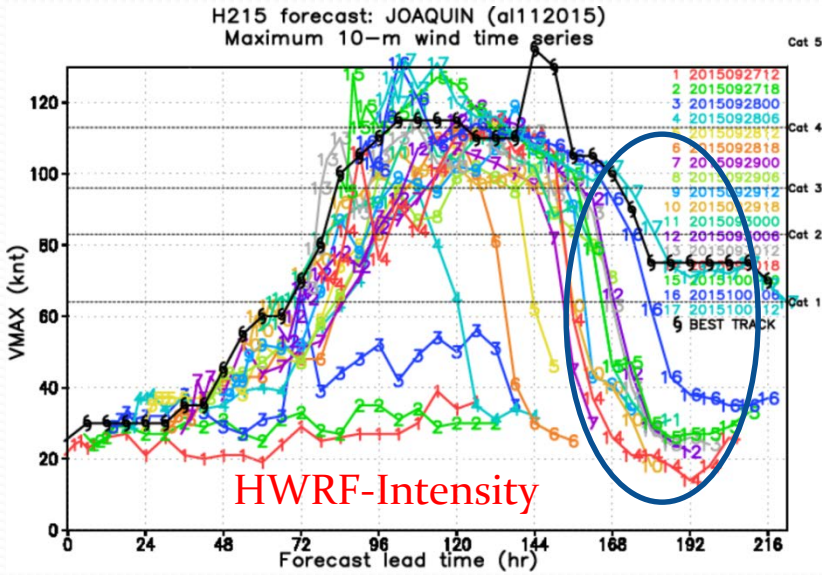


HWMN-Track



HWRF-Track



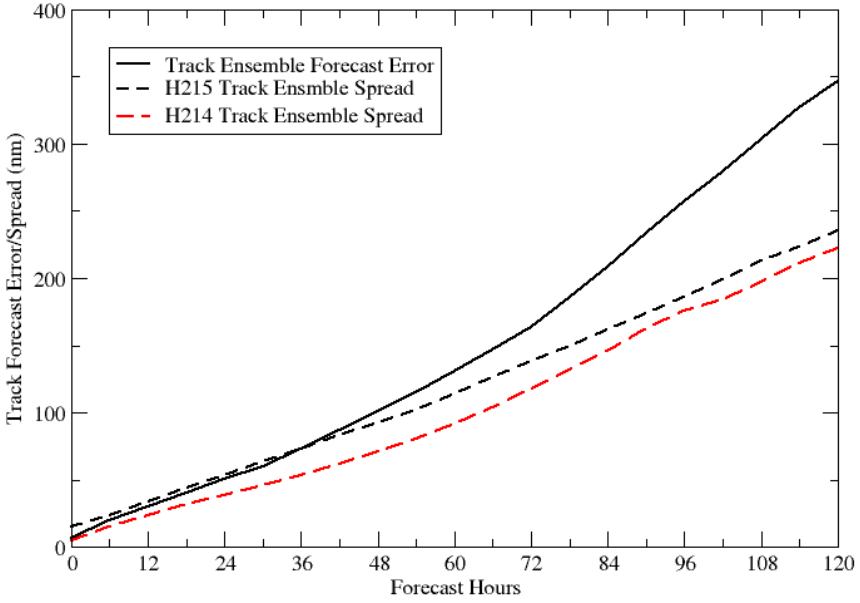


1. HWMI had better track forecasts than its deterministic version;
2. Higher resolution EPS needed to predict better in RI;
3. Ensemble has smaller intensity forecasts errors in later forecast hours

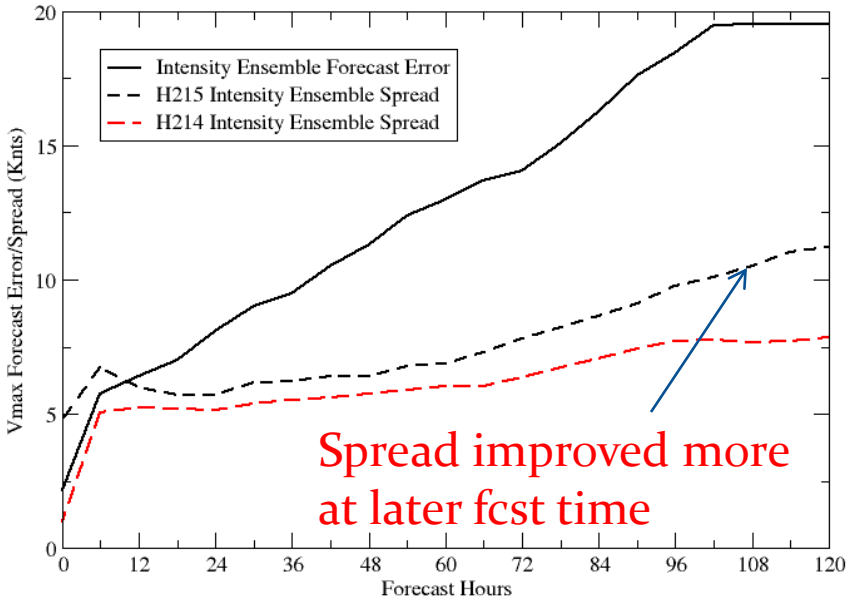
Forecast Errors vs Ensemble Spread

All 2015 AL Storms

Track

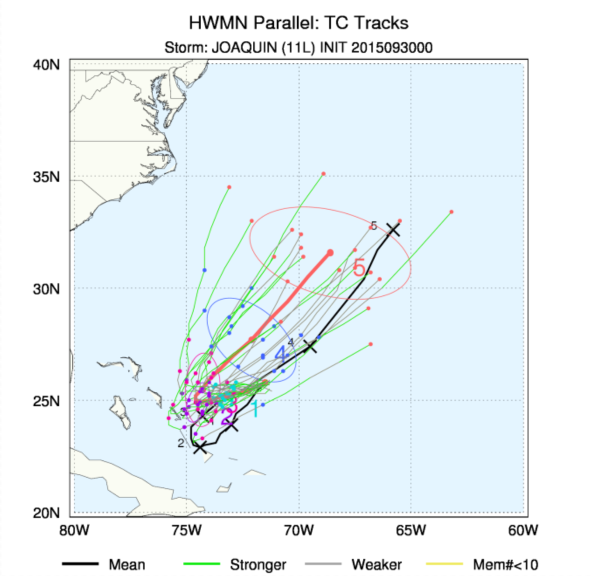


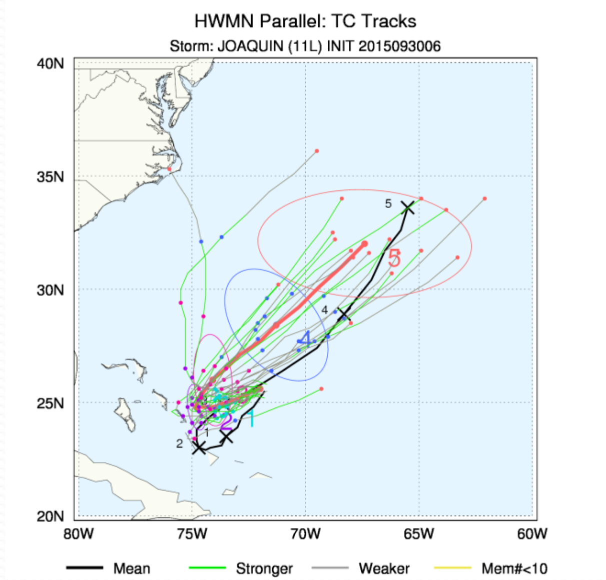
Intensity

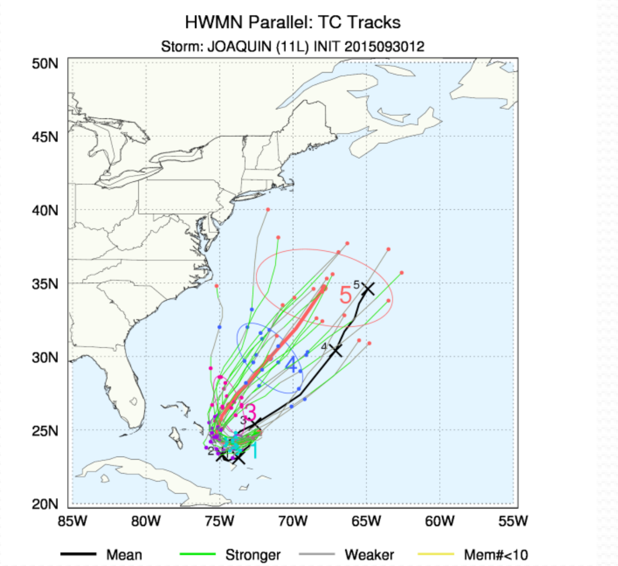


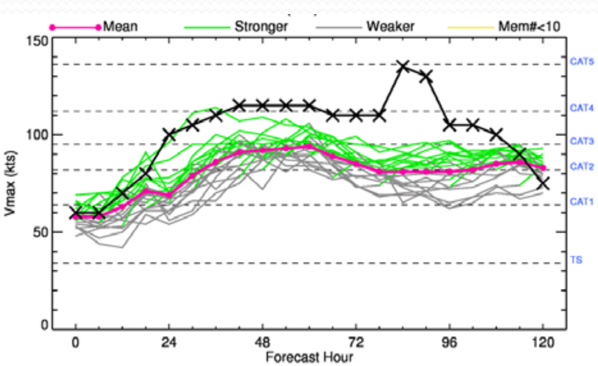
H215 ensemble spread is improved over H214, although still under-dispersion in terms of both track and intensity

Sample HWRF-EPS Forecast
Joaquin 11L, 20150930

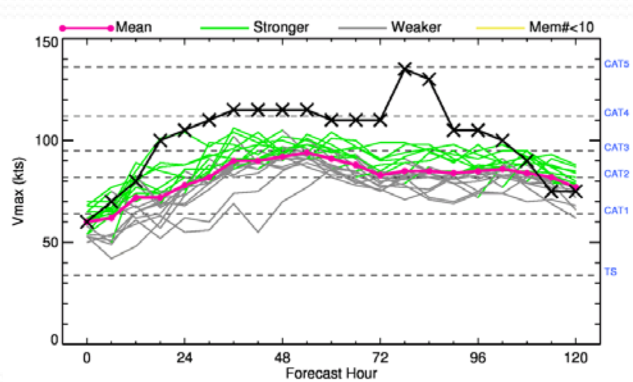








00Z



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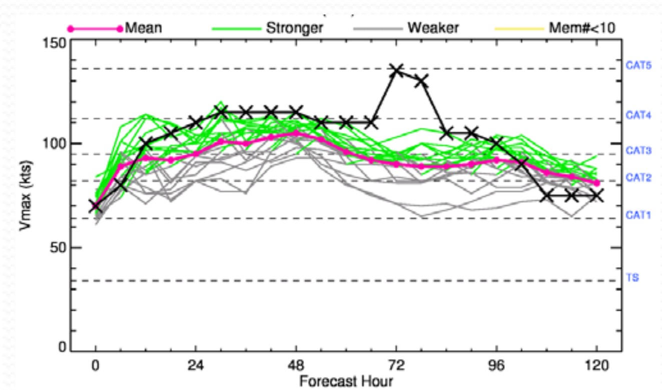
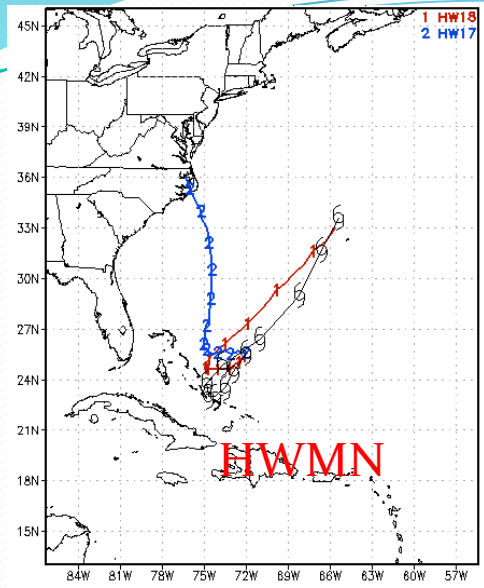
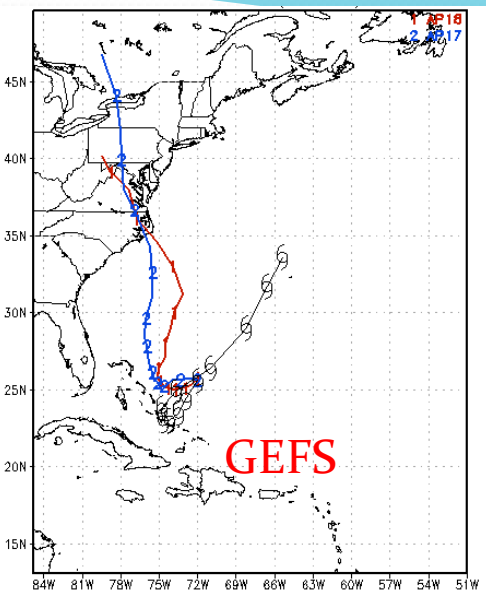


12Z

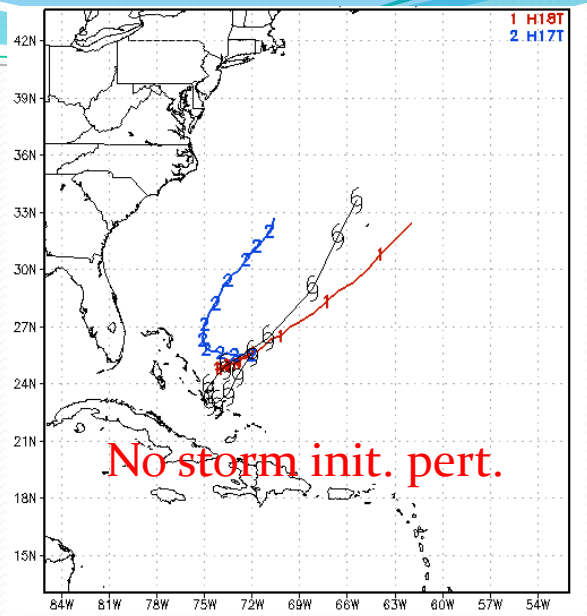
HWRFEPS: M17, M18



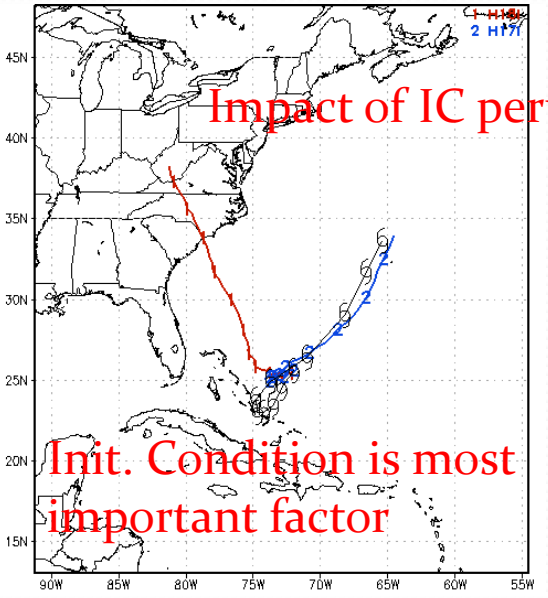
GEFS: M17, M18



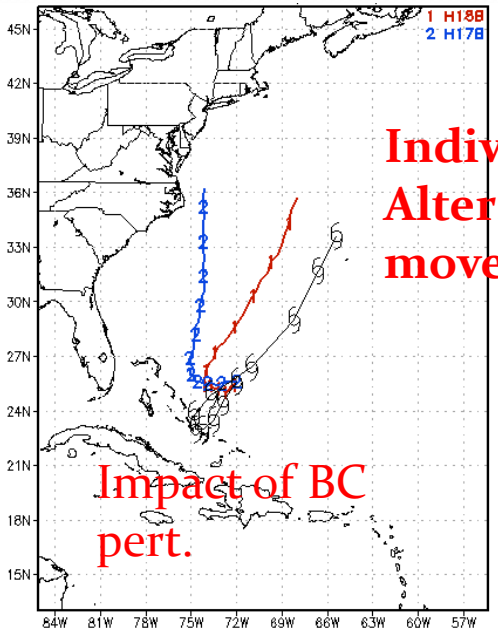
No Init: M17, M18



Switch IC: M17, M18

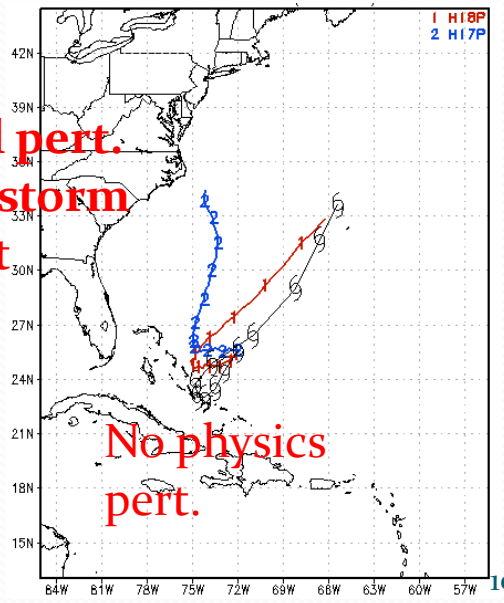


Switch BC: M17, M18

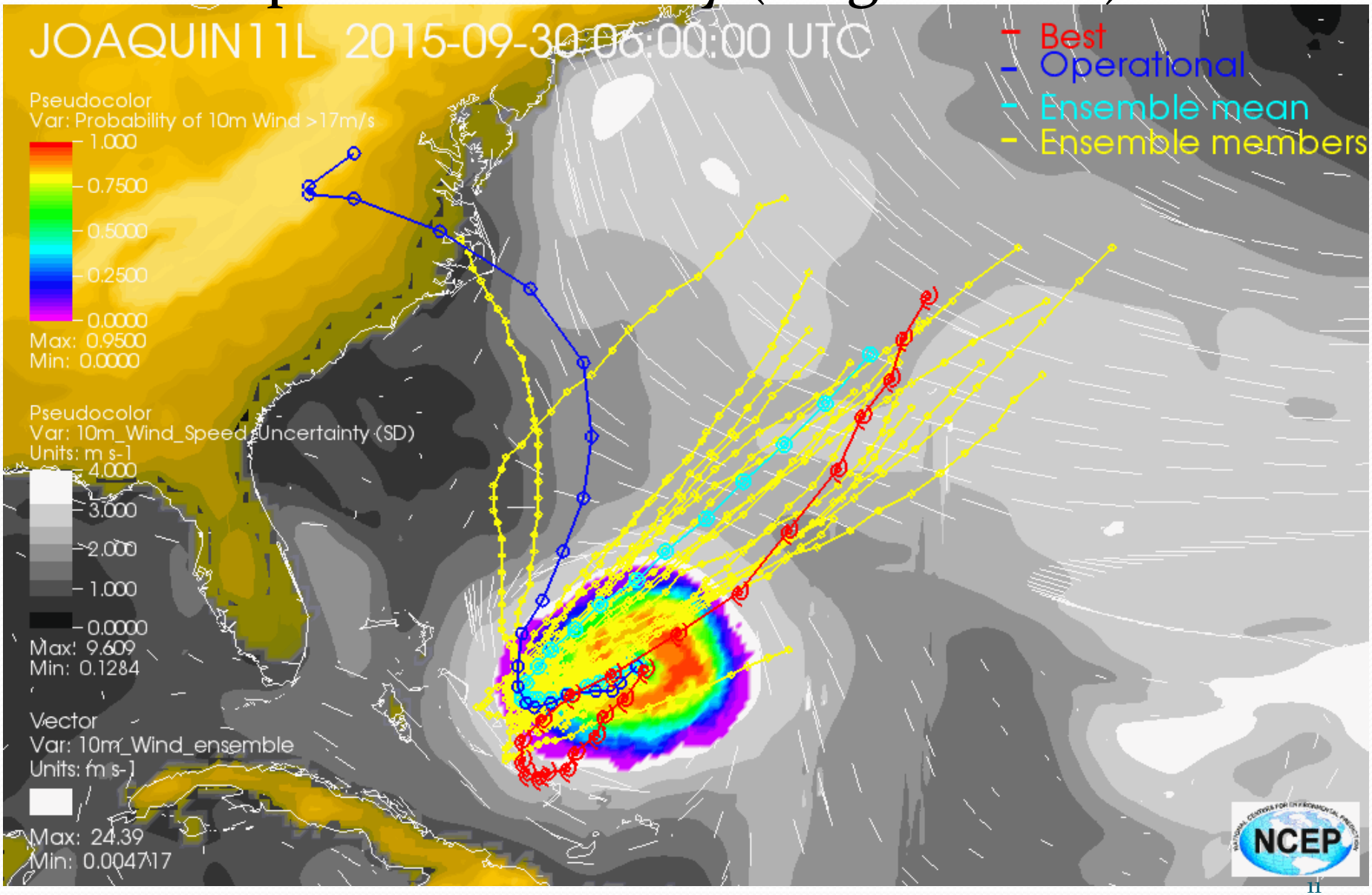


Individual pert. Alters the storm movement

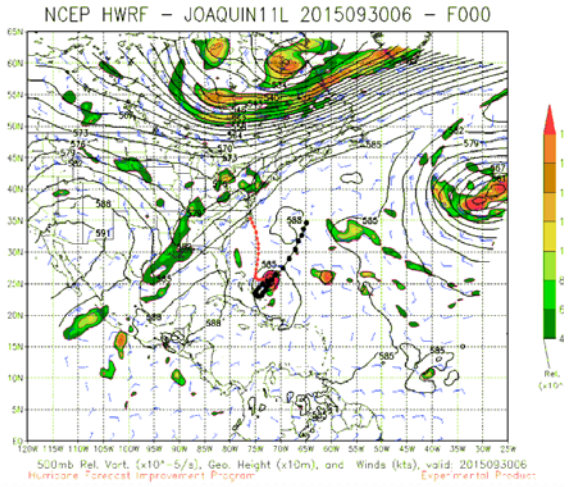
No phy pert: M17, M18



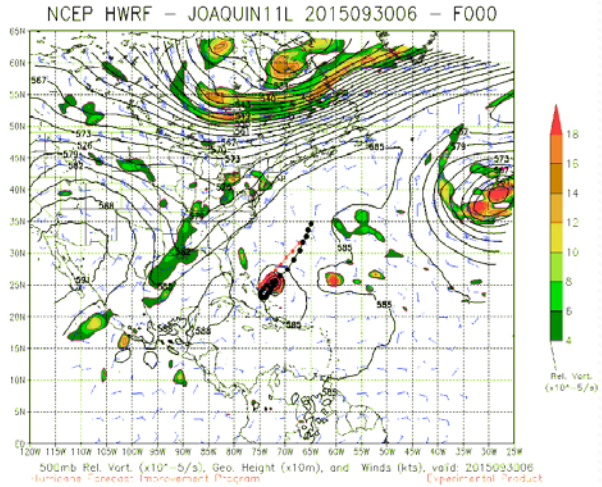
Wind Speed > 17m/s (color) and 10m Wind Speed uncertainty (Bright white)



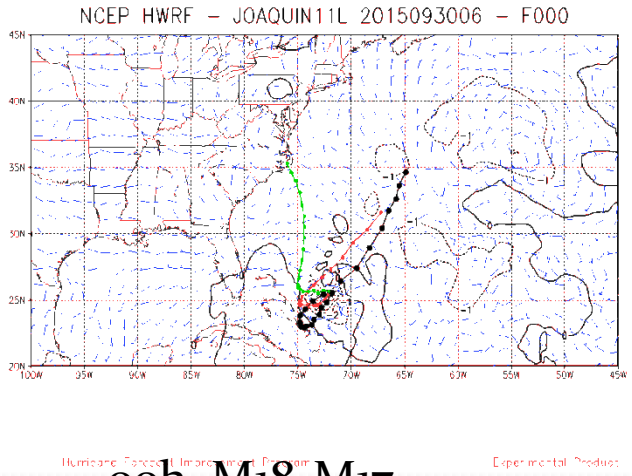
500hPa Height and Vorticity fields, 2015093006



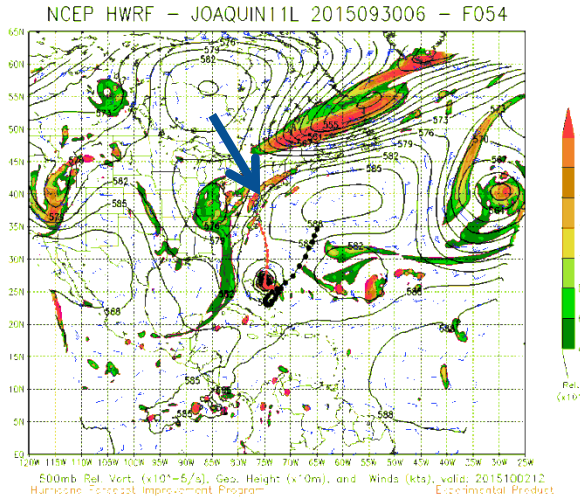
00h, M17



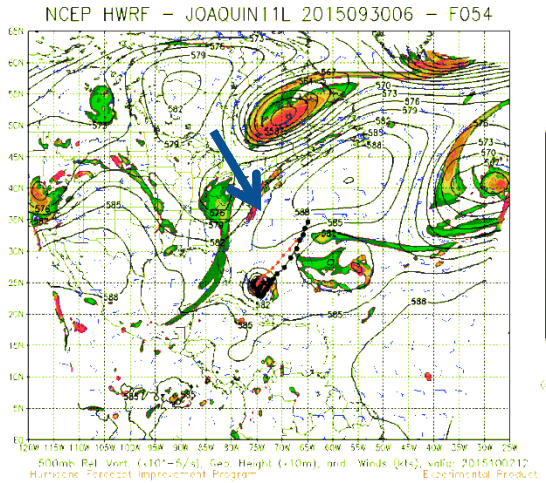
00h, M18



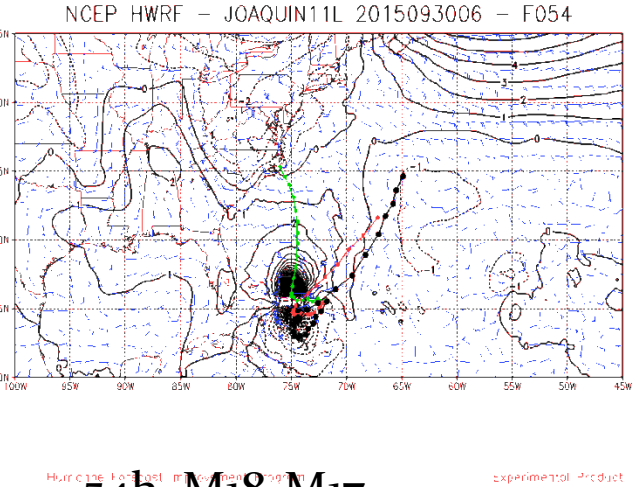
00h, M18-M17



54h, M17

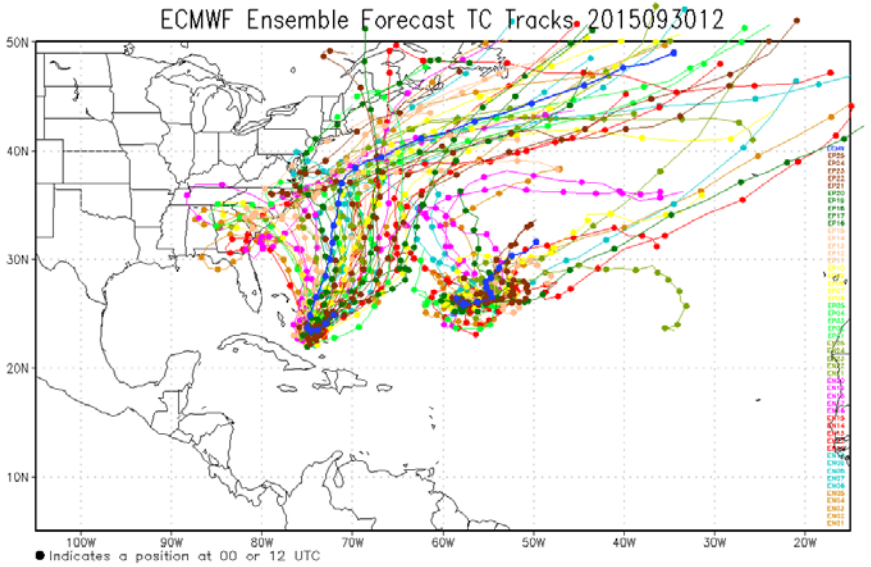


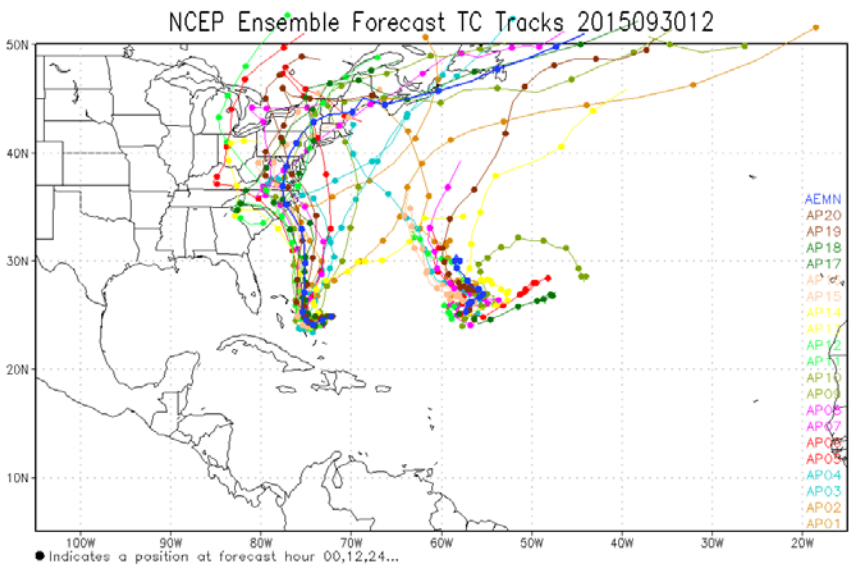
54h, M18



54h, M18-M17

ECMWF EPS vs GEFS, 12Z, 20150930





Track forecasts from ECMWF ensemble have large ensemble spread

Summary/Concluding Remarks

- HWRF EPS outperformed its deterministic version in terms of both track and intensity forecasts in 2015 hurricane season in NATL and WPAC basins (limited samples);
- HWRF EPS predicted north-east movement of Joaquin 3-days earlier;
- Analysis of Joaquin forecasts from HWRF EPS indicated while the track forecast is sensitive to all perturbations, uncertainties are mainly caused by initial large scale environment;
- The track/intensity forecasts of HWRF EPS are under-dispersed. How to efficiently perturb model physics remains a major challenge

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