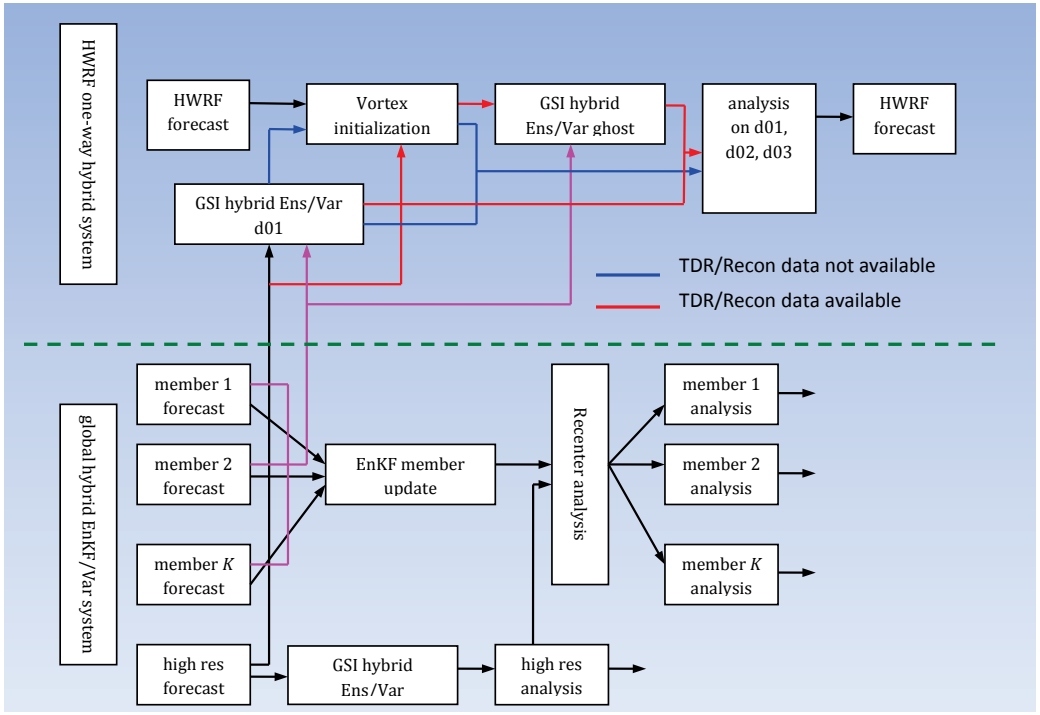
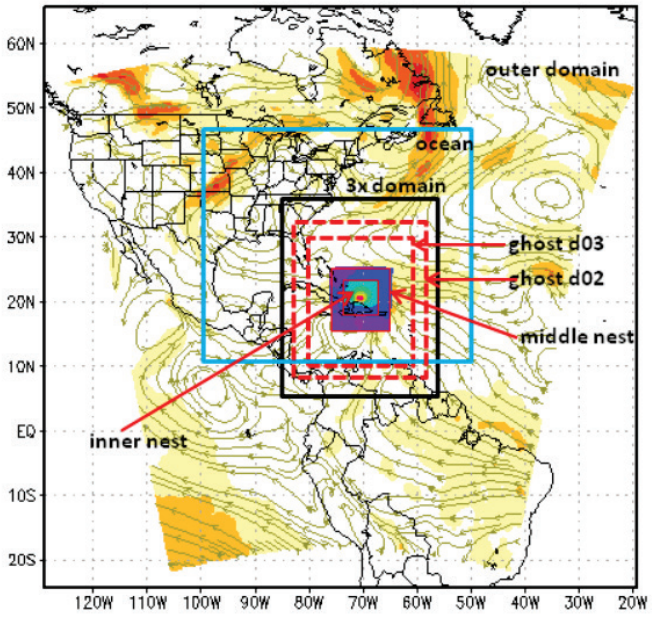
Discussion on HFIP RDITT Experiments

Proposal for extending the life of RDITT for one more year:

Future Plans from Individual Groups

EMC: Modifications to one-way hybrid ensemble-variational data assimilation and assimilation of Recon/TDR data in FY14 HWRF



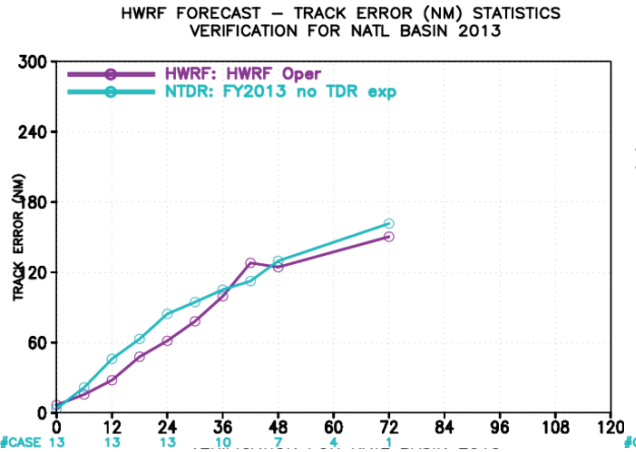


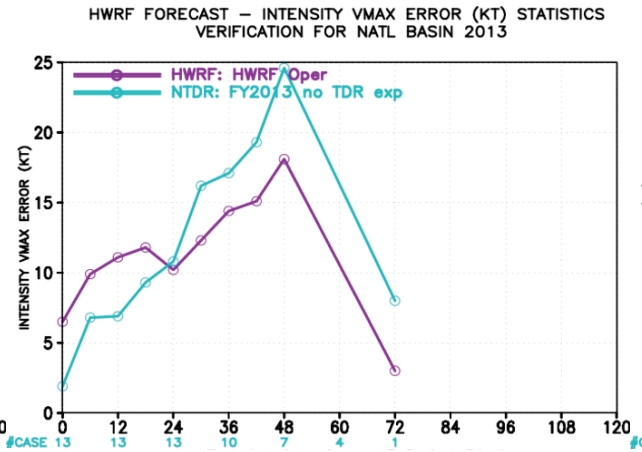
System configuration:

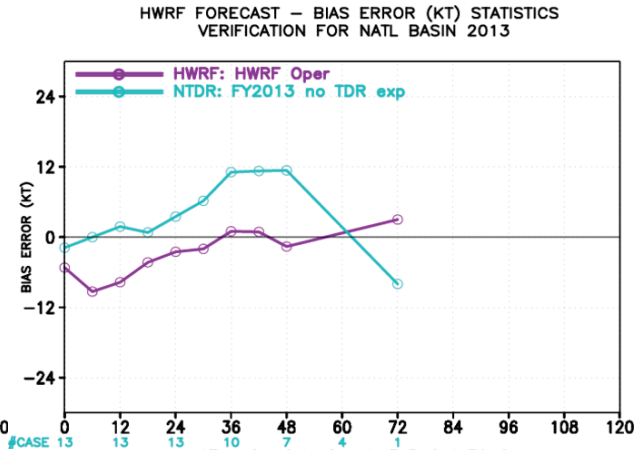
No data assimilation performed on outer domain. GFS analysis serves as initial conditions for the outer domain.
Run GSI on 20x20 ghost d02 (9km resolution) with all data (conventional, satellite and TDR/Recon) assimilated using blended GFS-HWRF coordinate. First guess: TC environment cold start from GDAS forecast; TC vortex cycled from HWRF forecast
Run GSI on 10x10 ghost d03 (3km resolution) only assimilate conventional data and TDR/Recon data.

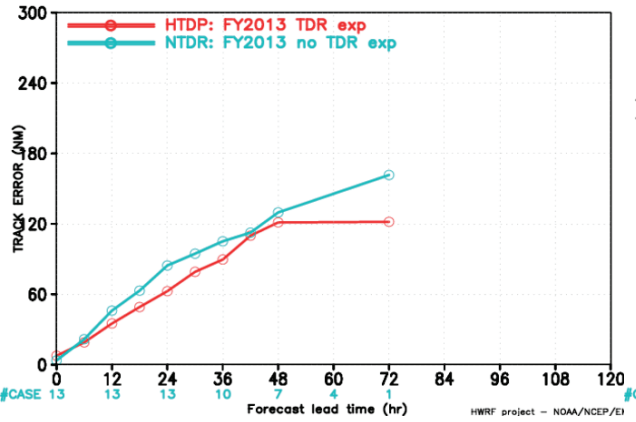
Results from RDITT experiments:

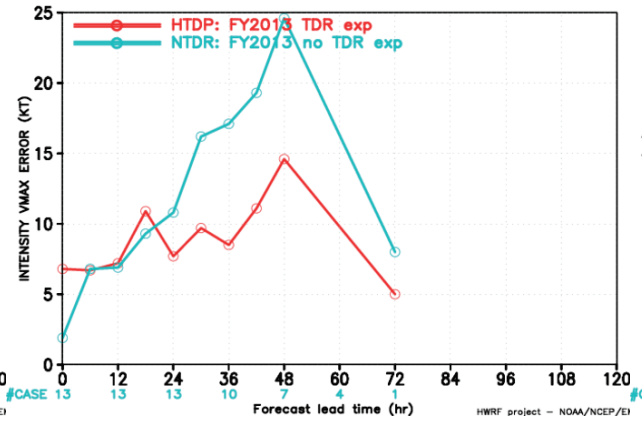
- In general, the assimilation of TDR data improved track forecast and intensity forecast from 24 hours forecast lead time (upper panels) upon the case when only vortex initialization is used to initialize TC vortex.
- The assimilation of TDR data consistently improved both track and intensity forecast for tropical storm Karen. The first cycle with TDR data assimilated for Karen changed the forecast scenario of this storm and had positive impact on the forecast guidance of NHC.
- The initial forecast spin-down of Hurricane Ingrid contributed to the lager short-term intensity forecast error and the negative intensity bias.
- **Through detailed diagnose of the Ingrid case, it was found that too much cooling in the warm core area and super-gradient wind introduced by the analysis may caused the spin-down. More data are needed to constrain the thermodynamic fields.**
- **After adding dropsonde temperature and moisture observations (red curves in lower panels), intensity forecast is improved and the initial forecast spin-down and negative intensity bias are largely reduced.**

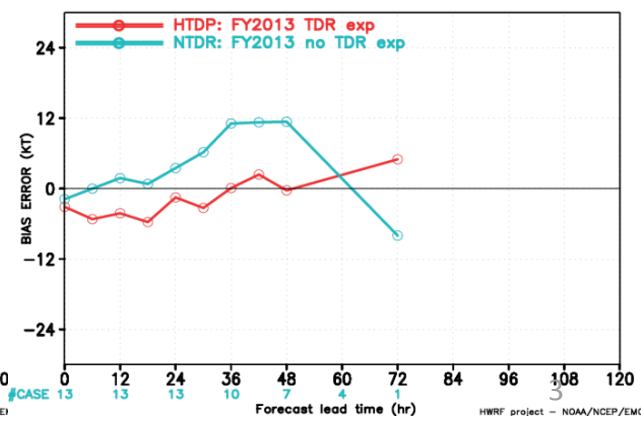




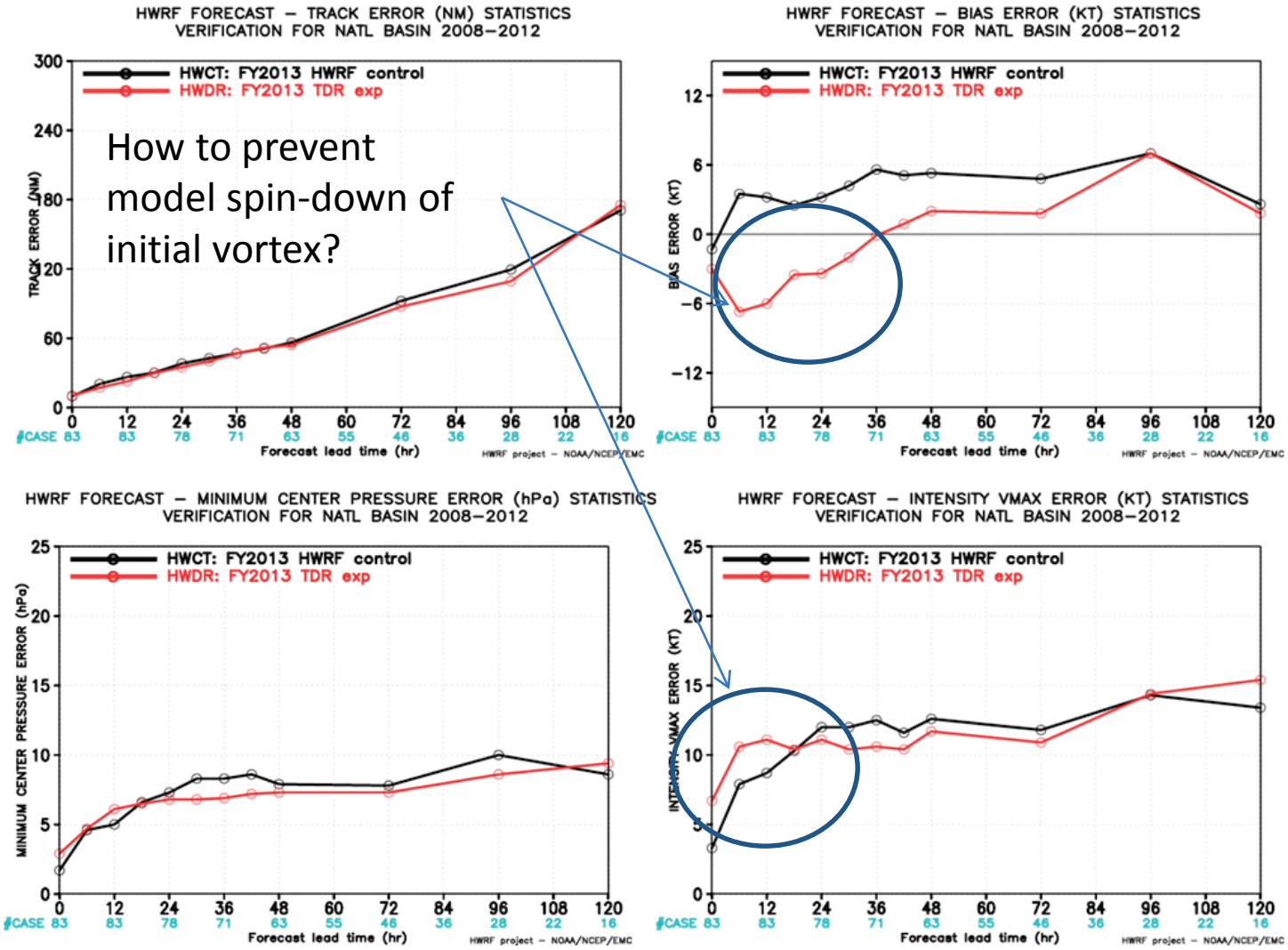








TDR data impact



TDR data impact

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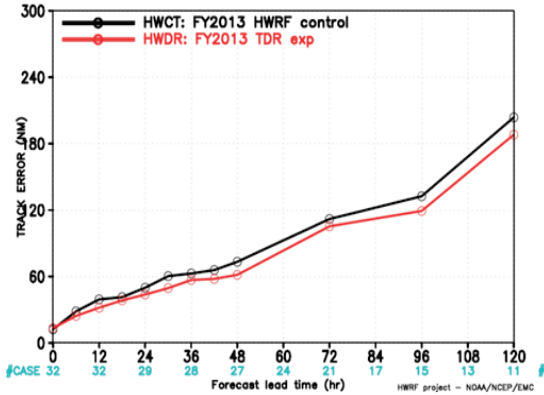
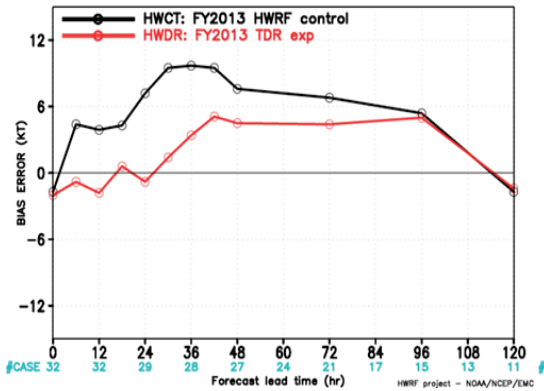
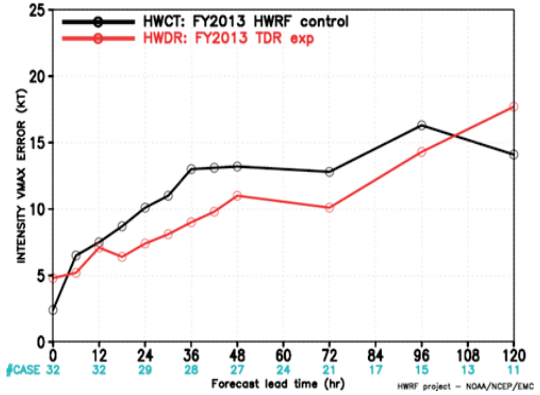
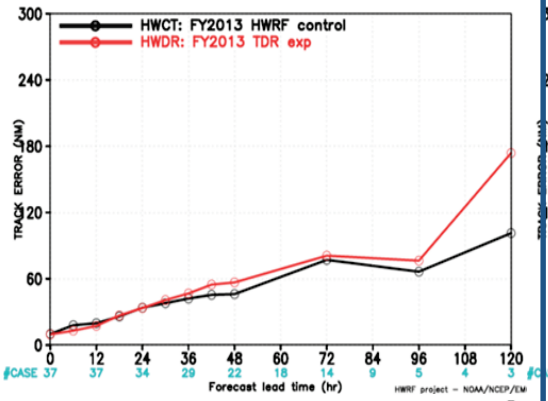
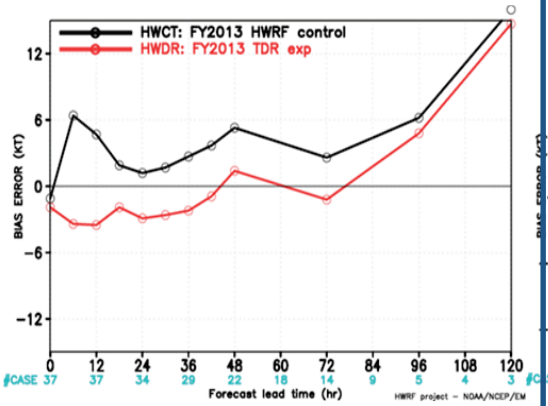


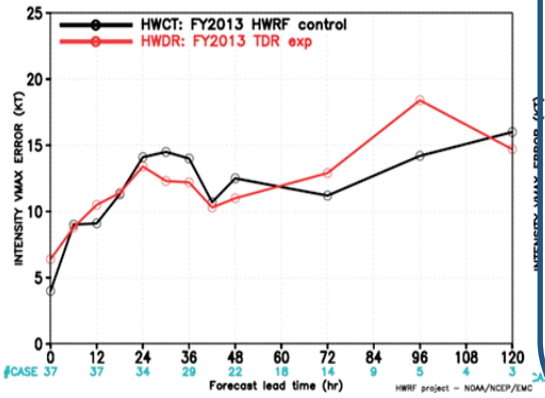




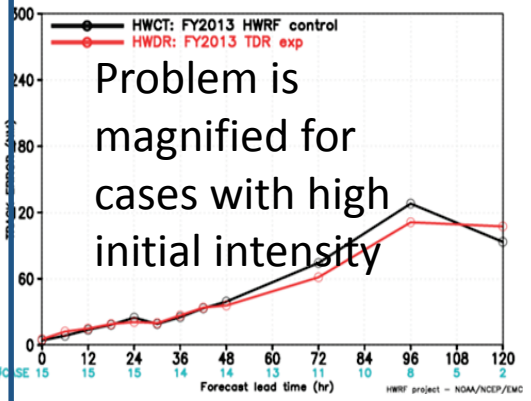
Category: H1-2



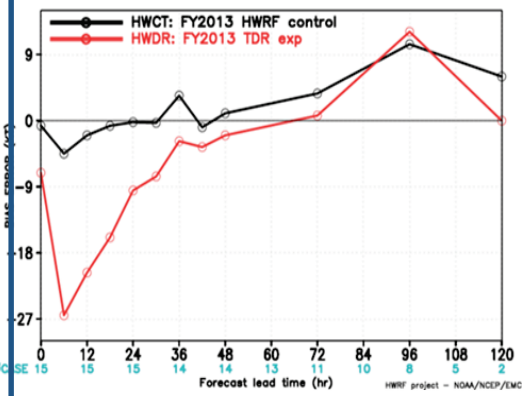


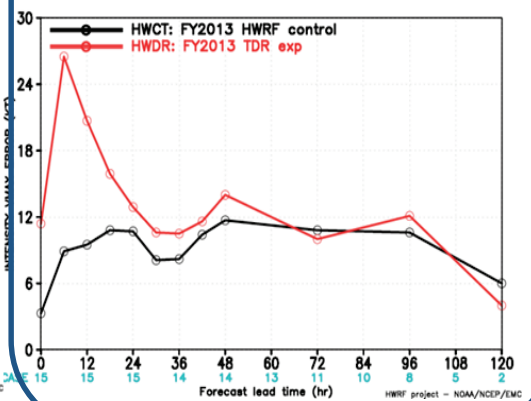


Category: MH

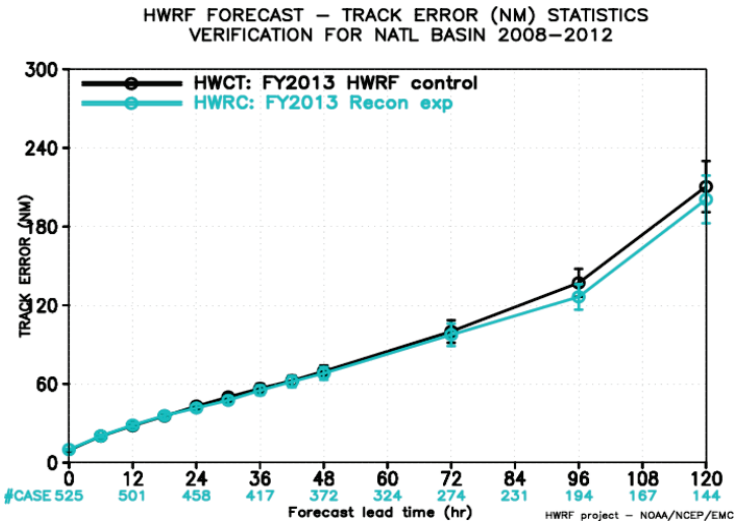


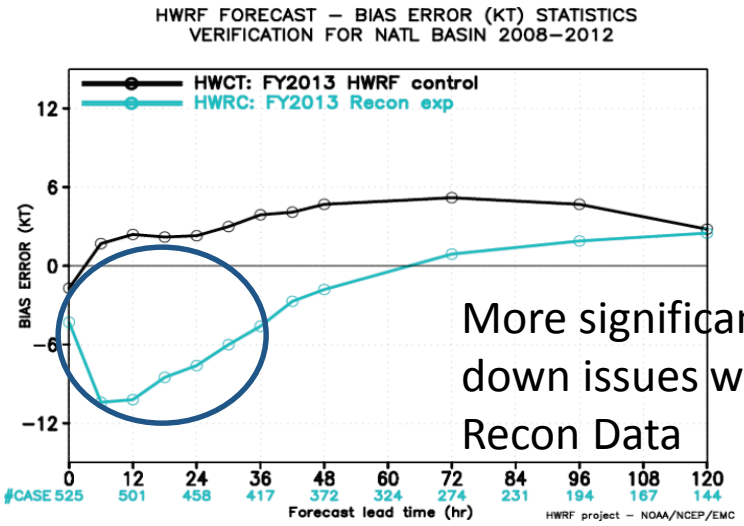
Problem is magnified for cases with high initial intensity



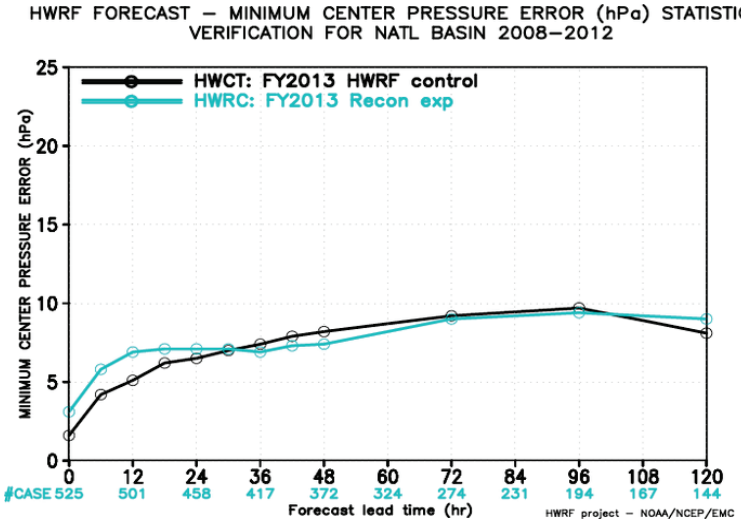


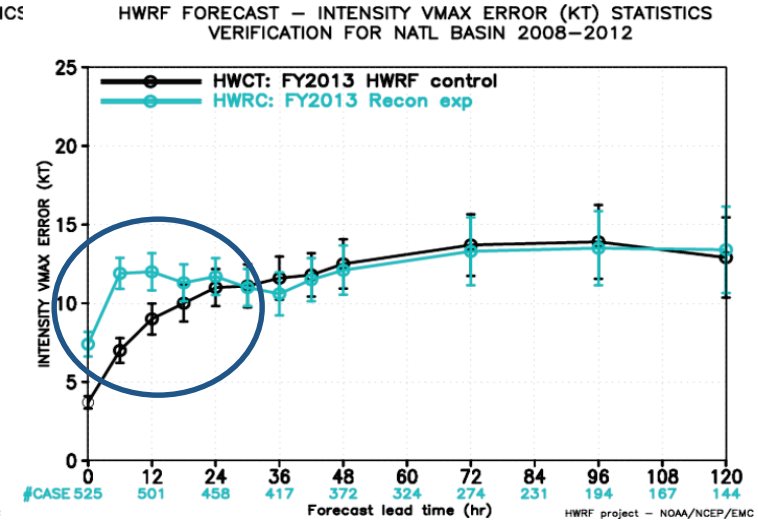
HDOB data impact

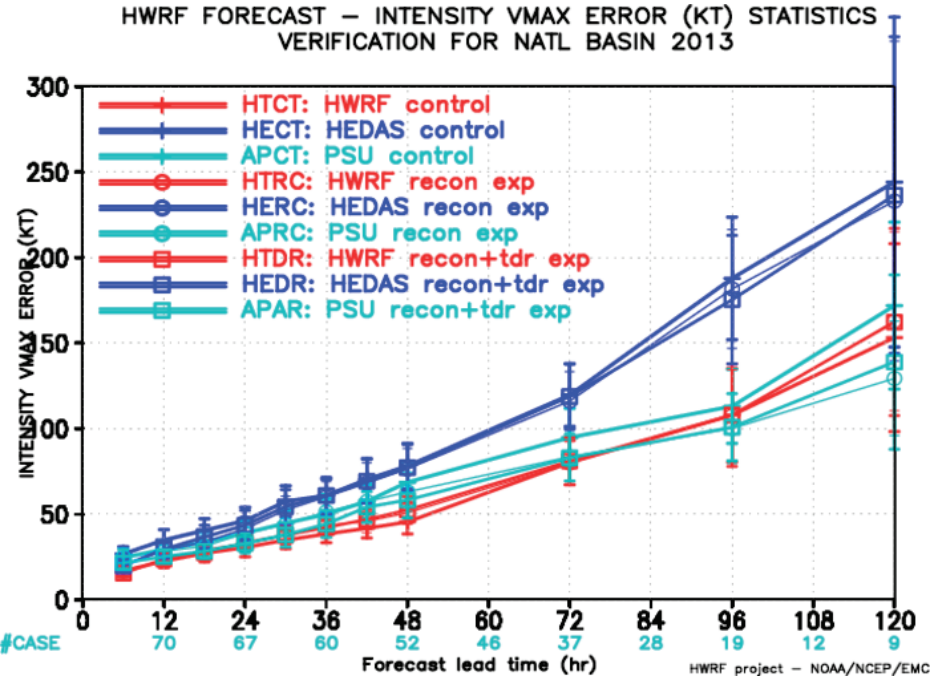


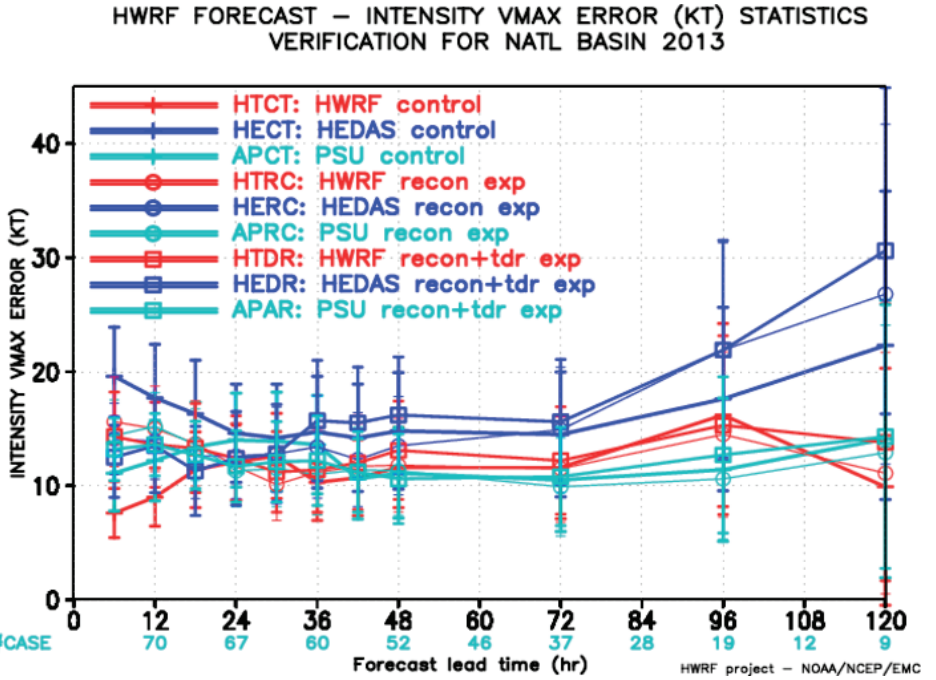


More significant spin-down issues with Recon Data

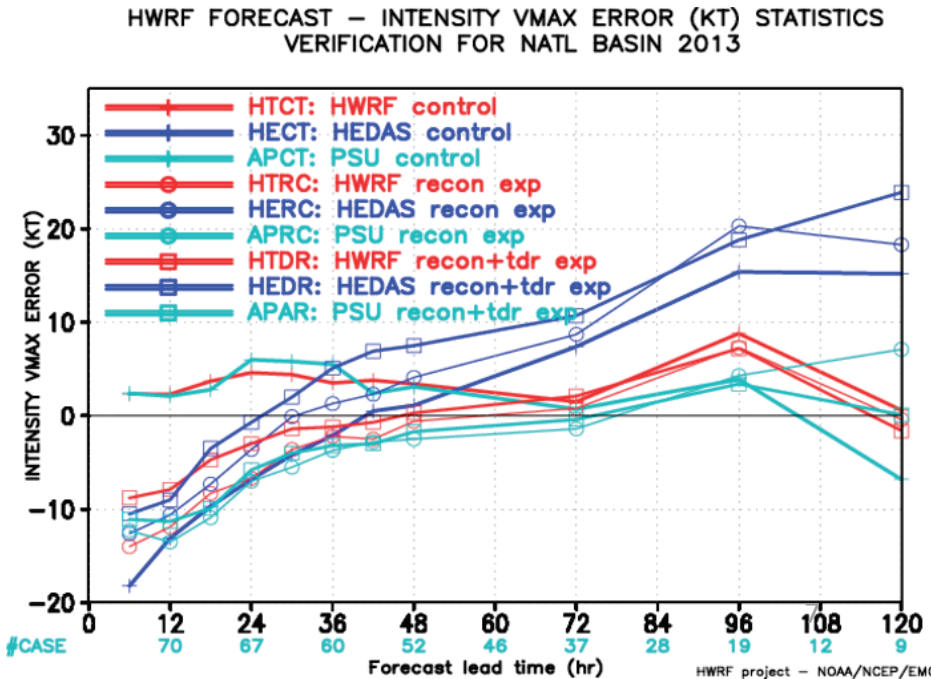




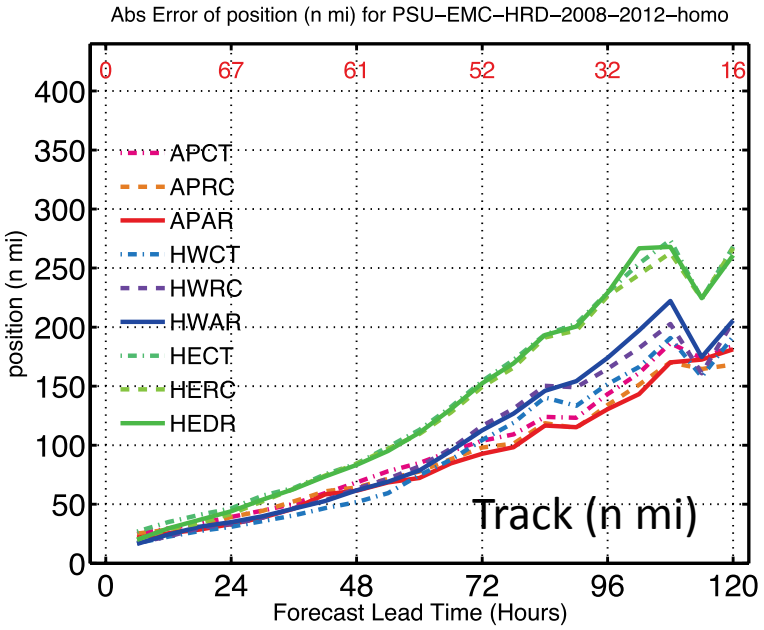


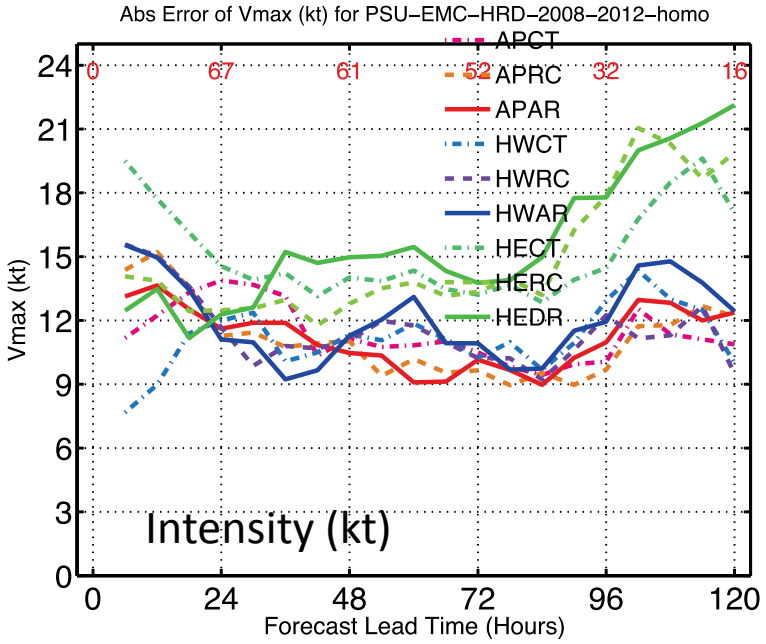


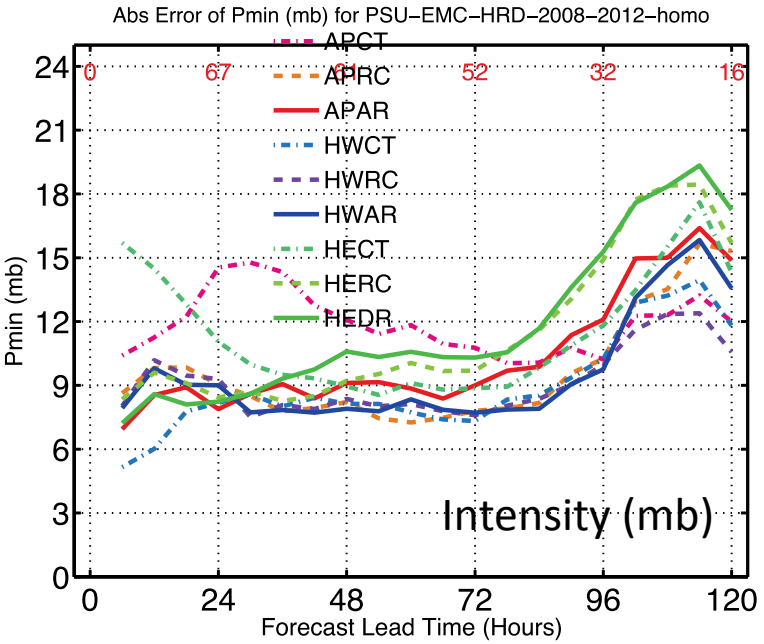
Homogeneous verification of all RDITT experiments

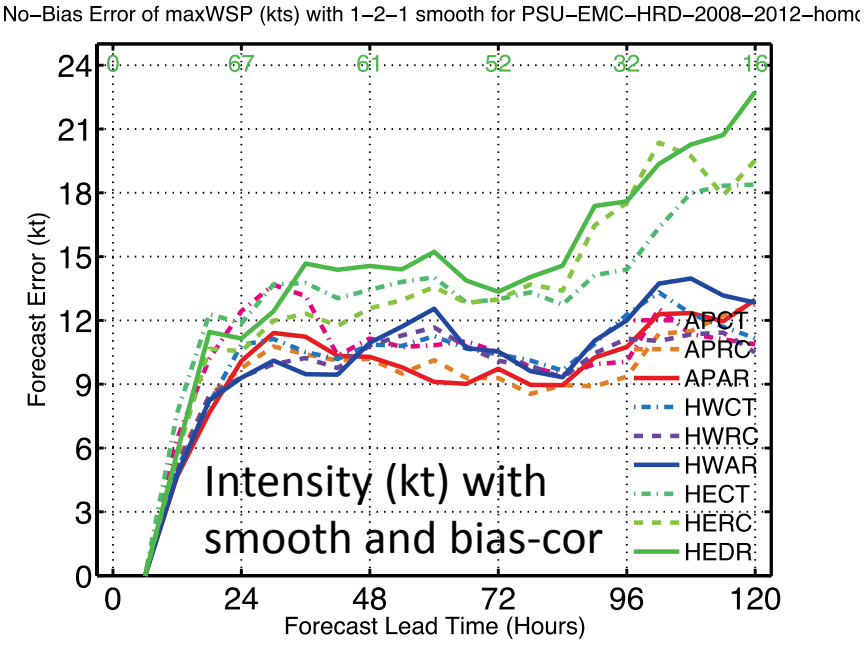


RDITT Absolute Error: homogeny for all 9 experiments









- Suggested Plans for Improved DA and initialization
- **EMC:**
  - Use High-Resolution HWRF ensembles for providing background error covariances (instead of global)
  - Provide better thermodynamic constraints and vertical structure adjustments in the vortex initialization through use of satellite data and dropsondes (when available)
  - Better experimental design for more systematic evaluation of direct impacts of each type of data (without interference from vortex cycling)
  - Thorough diagnostics of increments due to recon/TDR data in the inner core for identifying sources of spin-down

Plans for HEDAS/HRD

1. Do TDR wind data improve other aspects of the forecast? Systematically examine the impact of assimilation on the forecast using alternative metrics such as structure and low-wavenumber wind fields.

2. Is the lack of impact of TDR data a data or data assimilation related issue, or is it related to the model itself? Systematically examine the impact of TDR data on HEDAS analyses to discern whether the lack of impact on forecasts is related to suboptimal analysis.

A. To improve the assimilation:

Hypothesis: TDR wind data do not show additional impact because they lack the direct thermodynamic information.

- Examine the ensemble to see whether covariances between wind and thermodynamic quantities are well expressed.
- Examine ways to extract more information from existing covariances and/or to improve the ensemble to contain better covariances.
- Examine whether improving the thermodynamic analysis with independent observations (satellite, reflectivity) will improve the impact of the TDR wind data.

Plans from HEDAS/HRD, Contd.

B. To improve the impact of the initial condition in the model:

Hypothesis: The lack of impact from improved initial conditions is due to model spindown or imbalances in the initial condition.

- Quantify the model spindown from the HEDAS initial condition.
- Evaluate balance in the HEDAS initial condition.
- Examine the importance of cycling in establishing balance in the HEDAS initial condition
- Examine whether hybrid DA would lead to better balance in the initial condition due to the explicit application of balance constraints explicitly - but then the question remains: what balance condition to impose for vortex-scale DA?

Plans from PSU/EnKF

- In collaboration between EMC and PSU, systematically compare the RDITT performance of the HWRF running by EMC with the WRF-ARW EnKF performed at PSU, as well as the PSU HFIP stream-1.5 realtime runs (APSU) in terms of vortex initialization and structure, and to ultimately improve the vortex initialization for the HWRF model.

- (1) Examine the issue of HWRF vortex initialization for strong storms through comparison with PSU ARW EnKF;
- (2) Explore the use of full 3-km EnKF for the HWRF system, either with the PSU version or with Jeff Whitaker's system, including the economically feasible number of ensemble members; and
- (3) In collaborations with Xiaolei Zou and Fuzhong Weng, including the satellite radiance in the tests of items (1) and (2) listed above.

- Comments from Ryan Torn:
  - I would be interested to see a breakdown of the results for only the first time an aircraft sampled a TC. The aircraft data should provide the biggest impact for the first time an aircraft samples a TC, especially if the data assimilation system is cycling, because subsequent assimilation times should include the information from assimilating aircraft data at earlier times.

- **Discussion points:**

  - Quality of the control configurations for assessing the DA impacts
  - Need evaluation/verification of 3D vortex structure (intensity and size) using the aircraft observations
  - Is there a need (if so, how) to isolate the impacts of vortex initialization/cycling from DA impacts
  - Can the DA substitute or completely replace the vortex initialization when recon data is available? Focus on increased use of satellite data (clear sky and cloudy radiance) for continuous assimilation
  - Use of coarse resolution GFS ensembles vs. high resolution ensembles from the same forecast model … what is the optimal strategy? Dual resolution? How to optimize number of ensemble members
  - What is most important for DA? Assimilation of winds or thermodynamics or both?
  - Role/impact of vertical velocity updates in DA; Digital Filter initialization?
  - Ensemble based DA or physical/dynamical initialization?