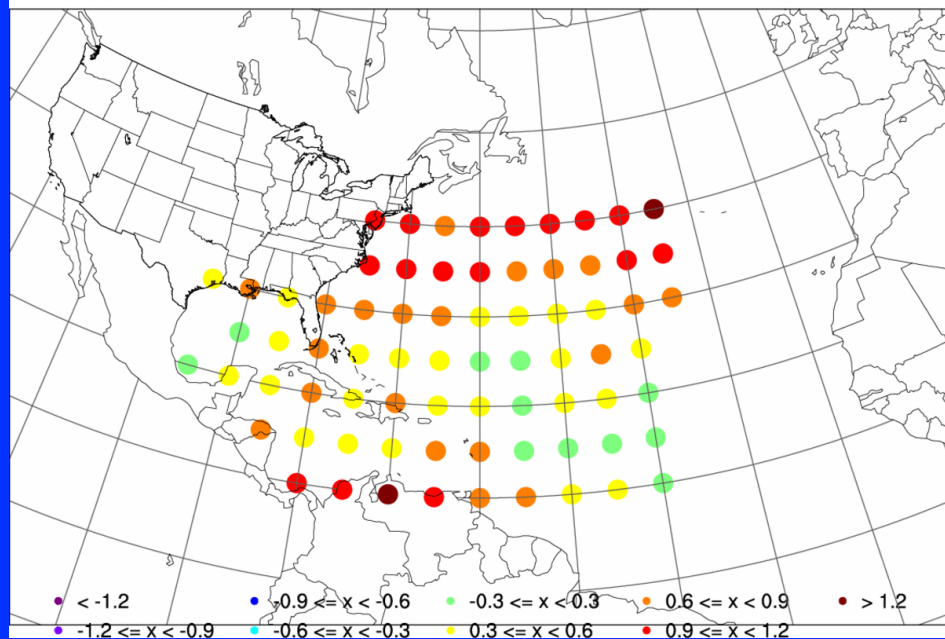# HFIP FY2012 DA Team report
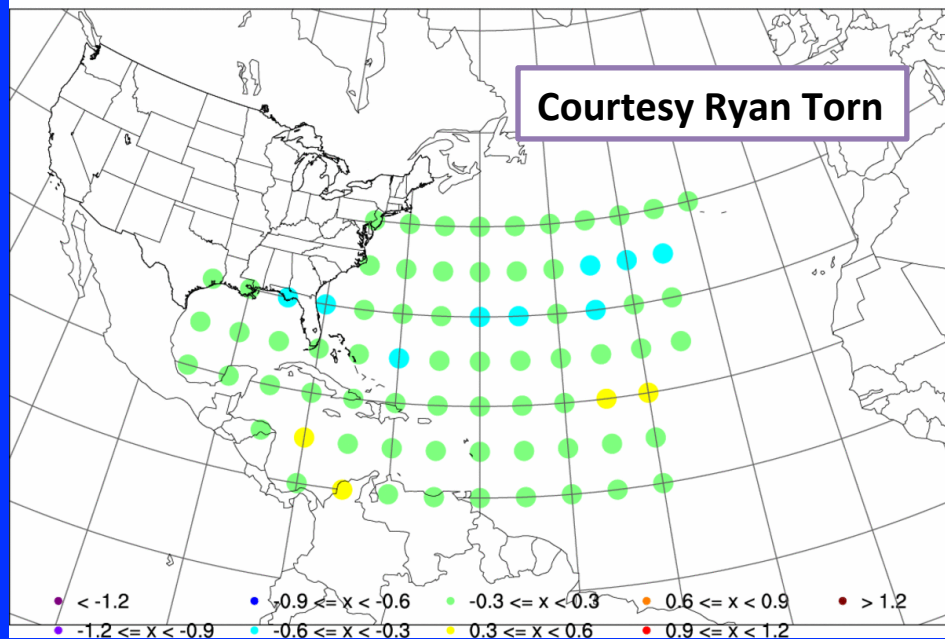
Jeff Whitaker and Tomi Vukicevic

Contributions from Jim Doyle, Ryan Torn, Mingjing Tong, Emily Liu, Xuguang Wang and Fuqing Zhang
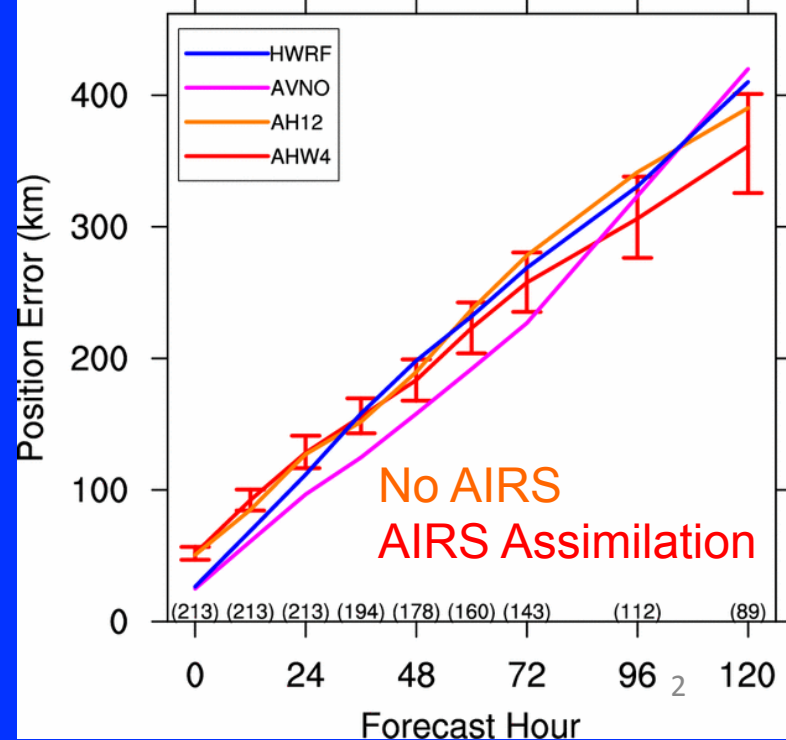
AIRS_TEMPERATURE bias (f-o) at 250 hPa

AIRS_TEMPERATURE bias (f-o) at 700 hPa

Courtesy Ryan Torn

Legend (250 hPa):
- < -1.2
- -1.2 <= x < -0.9
- -0.9 <= x < -0.6
- -0.6 <= x < -0.3
- -0.3 <= x < 0.3
- 0.3 <= x < 0.6
- 0.6 <= x < 0.9
- 0.9 <= x < 1.2
- > 1.2

Legend (700 hPa):
- < -1.2
- -1.2 <= x < -0.9
- -0.9 <= x < -0.6
- -0.6 <= x < -0.3
- -0.3 <= x < 0.3
- 0.3 <= x < 0.6
- 0.6 <= x < 0.9
- 0.9 <= x < 1.2
- > 1.2

- AIRS temperature retrievals characterized by large space and time dependent biases (top figures). Need to be removed
- Test simple bias correction scheme, which is 21 day rolling mean bias computed for all obs. In 5 deg. bins and pressure levels
- AHW assimilation and forecast system cycled from 18 August – 28 September 2010, one experiment with and without AIRS temperatures
- Forecasts each 6 h of Danielle - Nicole

Ryan Torn, University at Albany

Chart legend:
- HWRF
- AVNO
- AH12
- AHW4

Position Error (km) vs Forecast Hour

No AIRS
AIRS Assimilation

(213) (213) (213) (194) (178) (160) (143)   (112)   (89)

0   24   48   72   96   120

2

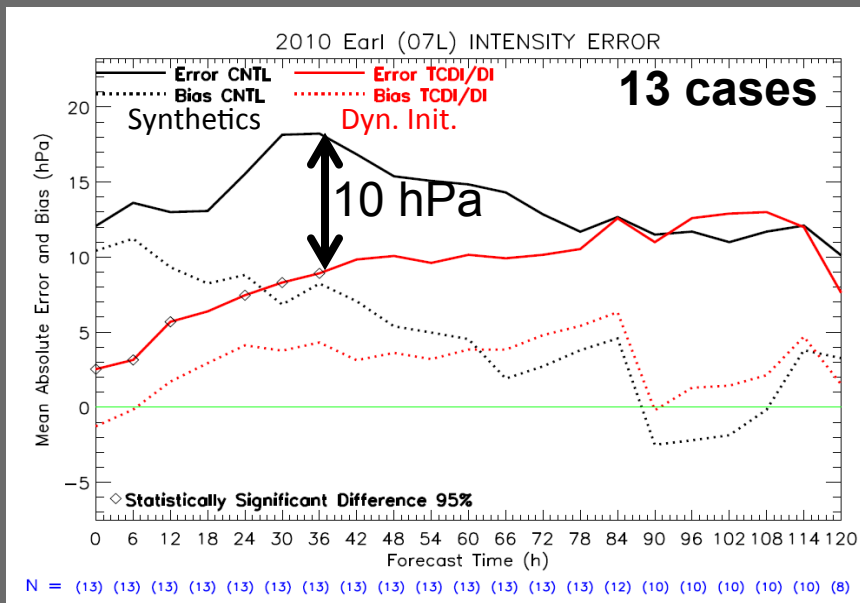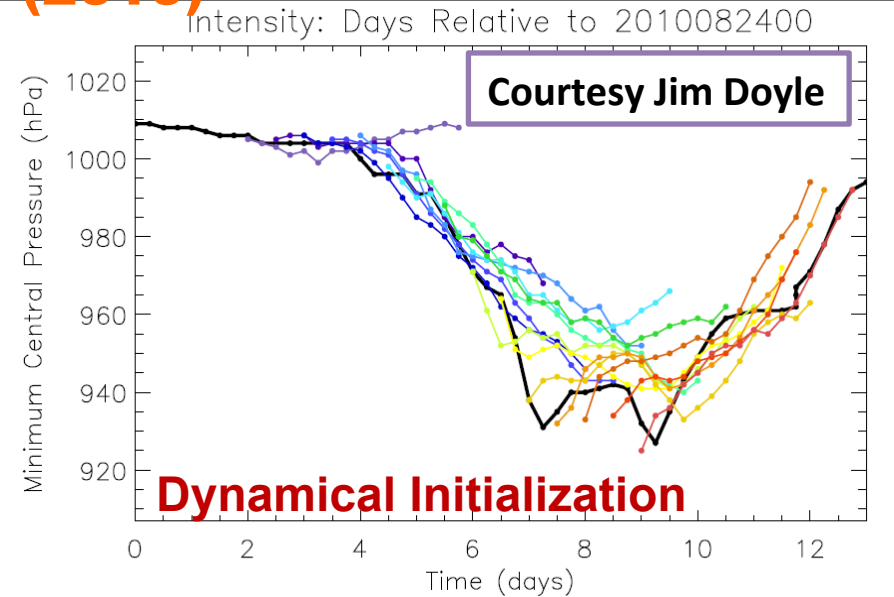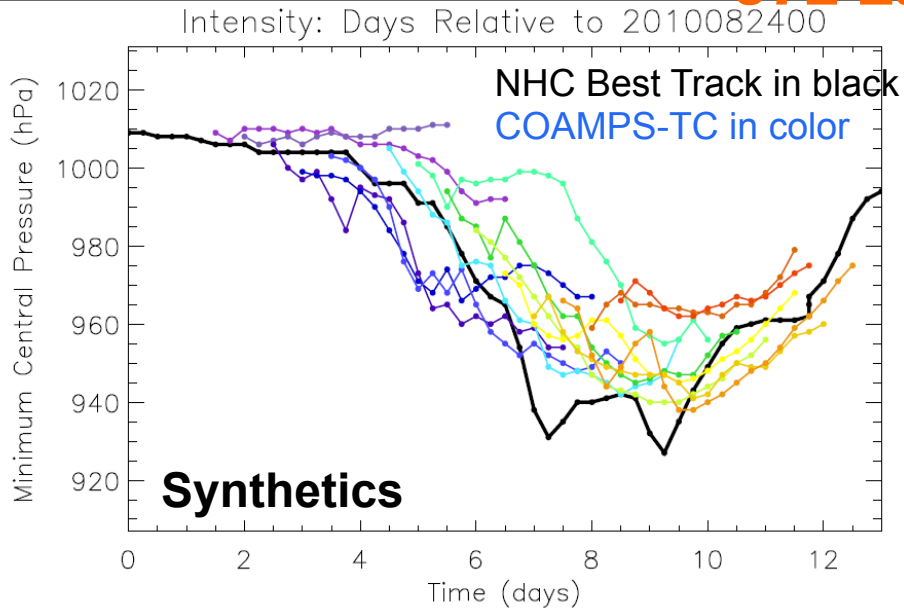# EnKF assimilation of AMSU-A into COAMPS-TC

- COAMPS-TC ensemble tested assimilating AMSU-A brightness temperature observations
- Assimilated channels 5-10 from NOAA-15,16,18,19 and METOP-A
- Model top raised to 50-km to capture full weighting function
- Global DA systems (NAVDAS-AR) bias correction coefficients used
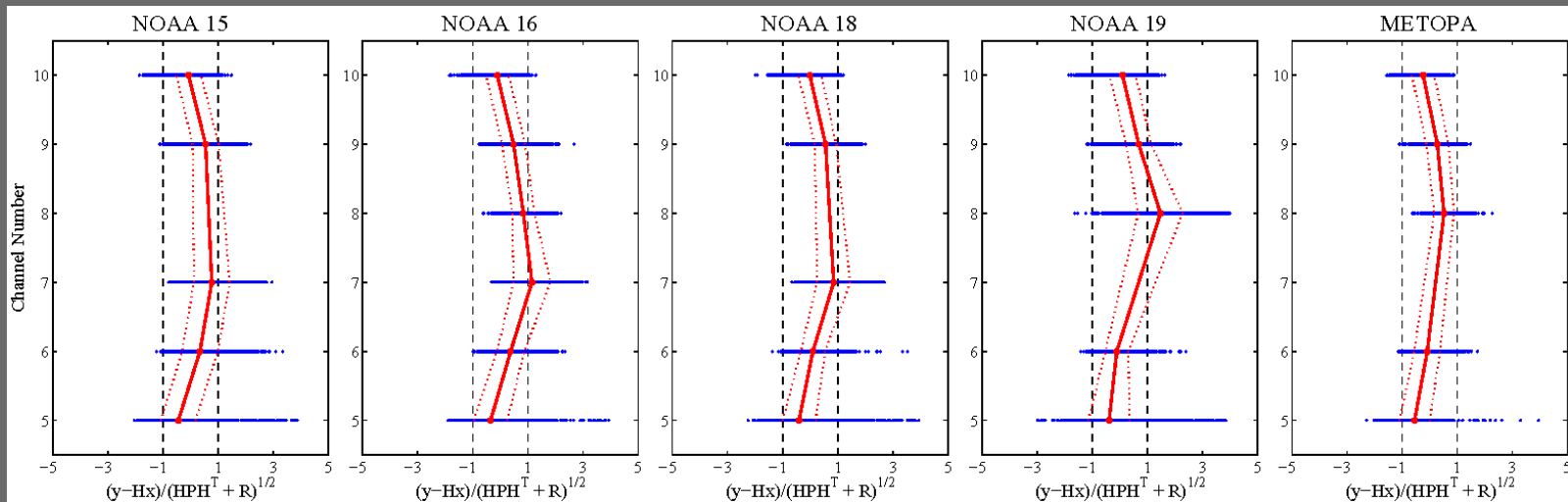
- Time mean innovations show relatively low bias for channels 5, 6, and 10, and slight positive bias for channels 7 and 8.
- Analysis of track error sensitivity is currently underway.

3

Dynamical Initialization in COAMPS-TC
07L Earl (2010)

Intensity: Days Relative to 2010082400

NHC Best Track in black
COAMPS-TC in color

Synthetics

Intensity: Days Relative to 2010082400

Courtesy Jim Doyle

Dynamical Initialization

2010 Earl (07L) INTENSITY ERROR

Error CNTL   Error TCDI/DI
Bias CNTL   Bias TCDI/DI

Synthetics   Dyn. Init.

13 cases

10 hPa

◇ Statistically Significant Difference 95%

N = (13) (13) (13) (13) (13) (13) (13) (13) (13) (13) (13) (13) (13) (13) (12) (10) (10) (10) (10) (10) (8)

- **Dynamic initialization (DI) method developed for COAMPS-TC to improve vortex initialization and balance.**
- **Results show significant intensity error reductions for Earl by using dynamical initialization.**

4

Hybrid Data Assimilation for Basin-scale HWRF

• Model: single domain covering both Atlantic and East Pacific basins with 0.09x0.09 degree (13.5 km) horizontal resolution, 61 vertical levels with model top at 2 mb, no ocean coupling

• GSI hybrid analysis using T254 GFS EnKF ensemble that provide 75% background error covariance

• Cold start from GDAS forecast after relocation

• Conventional data plus MSLP data from tcvital assimilated every 6 hours

• Update lateral boundary condition after analysis followed by 126 hours forecast

• Running in real time parallel mode during 2012 hurricane season
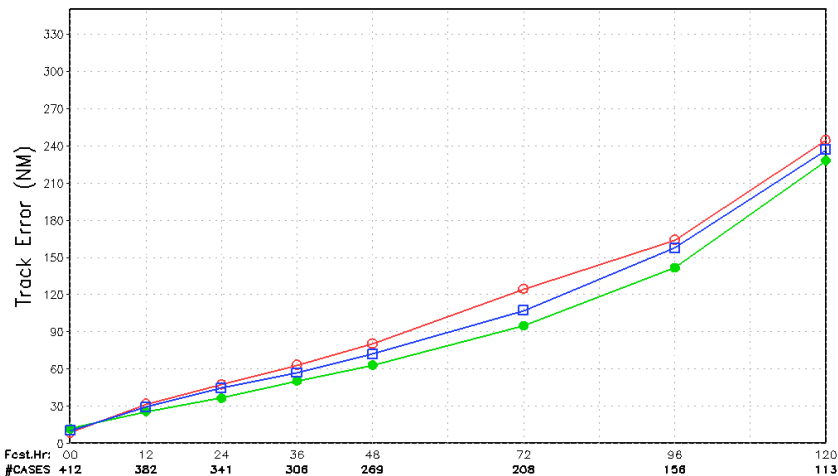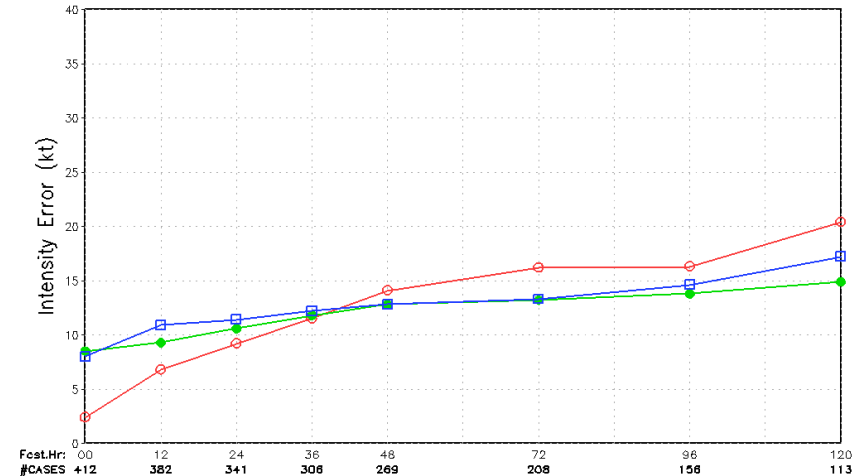
2012 Hurricane Season Operational HWRF Parallel Run with
NOAA-P3 Tail Doppler Radar (TDR) Data Assimilation

• Model: 3 domains with 0.18-0.06-0.02 degree (27-9-3 km) horizontal resolutions, 43 vertical levels with model top at 50 hPa, with ocean coupling

• GSI hybrid analysis using GFS EnKF ensemble

• TC environment cold start from GDAS forecast, TC vortex cycled from HWRF forecast

• Conventional data plus TDR data

• Modified gross error check, re-tuned observation error and rejected data dump with very small data coverage for TDR data

• Totally 19 TDR missions for Hurricane Isaac, Leslie and Sandy
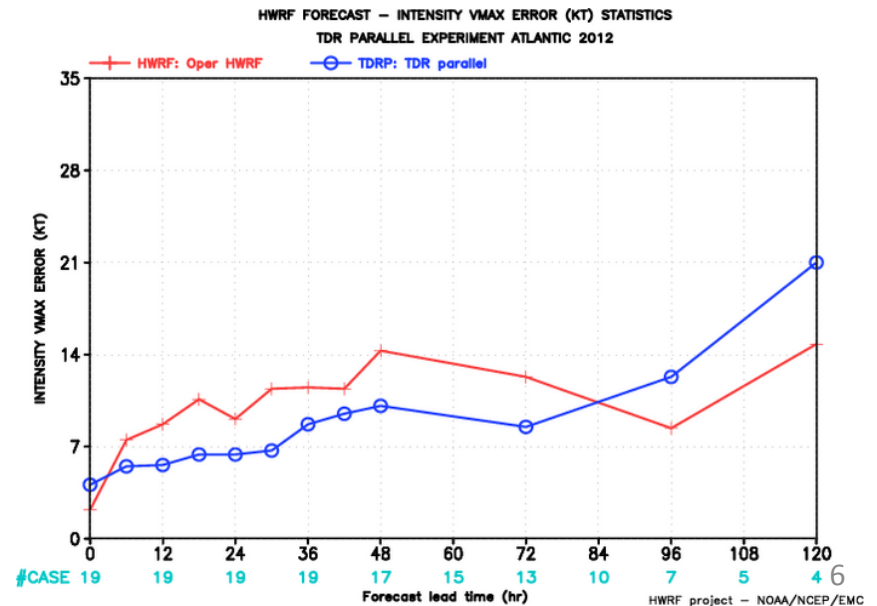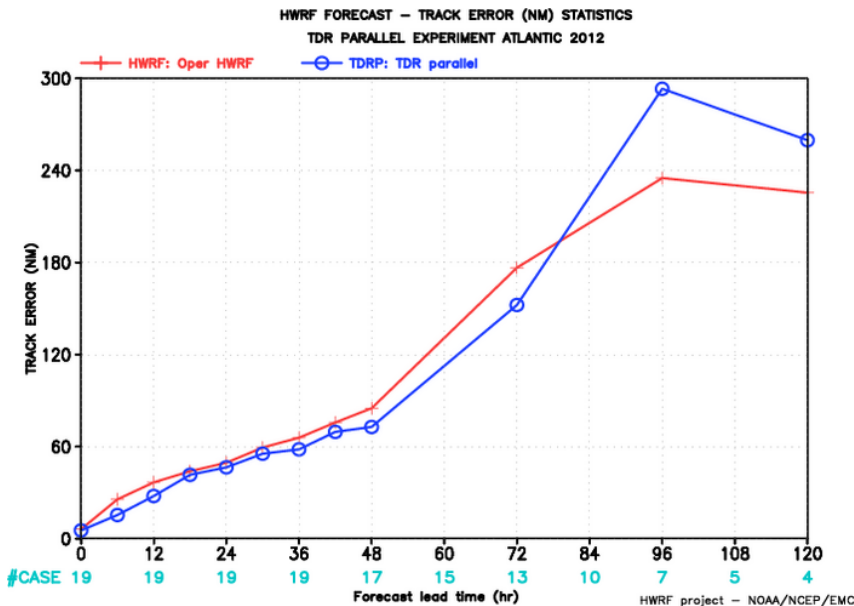
Assimilation of Satellite Radiances in Basin-scale HWRF

- **Current Issues**
  - Short cycling period and variable sample size make the spin up of bias correction problematic
  - Lower model top (2 hPa) makes the use of high peaking channels difficult
  - No ozone profiles in HWRF background and this may lead to biases in the simulated brightness temperature, especially for IR instruments
- **Solutions**
  - Use global-regional blended vertical coordinate to obtain better vertical resolution in stratosphere and extend the model top up to 0.3 hPa
  - Use bias correction estimation from GFS
  - Use ozone profiles from GFS in HWRF
- **Improvements**
  - More data assimilated in the upper troposphere and stratosphere
  - Cost function for minimization greatly reduced for IR instruments

OMF BT (BC) AMSUA_METOP-A 2012082700 HB01

OLD
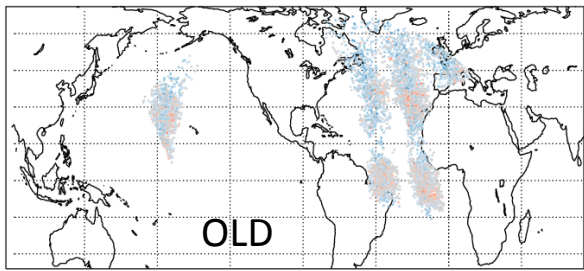
Channel 12 Freq 57.29 GHz Mean -0.16 STD 0.25

OMF BT (BC) AMSUA_METOP-A 2012082700 HB03

NEW
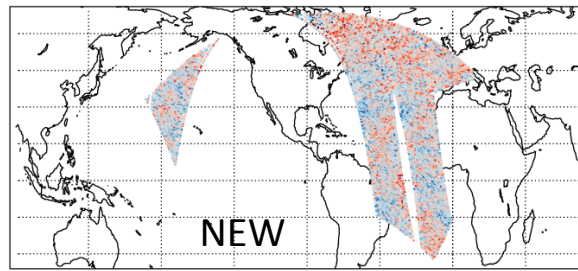
Channel 12 Freq 57.29 GHz Mean -0.03 STD 0.38

	IASI	AIRS
OLD	0.62	0.60
	307743	176881
NEW	0.23	0.26
	382407	218753

Penalty   Used Obs. Count

Hurricane Isaac --- preliminary results

- **Configuration**
  - Modified vertical analysis grid: global-regional blended vertical coordinate
  - Observations: satellite radiance data used in operational GFS model along with conventional data and minimum sea level pressure from tcvital
  - Bias correction estimations from GFS
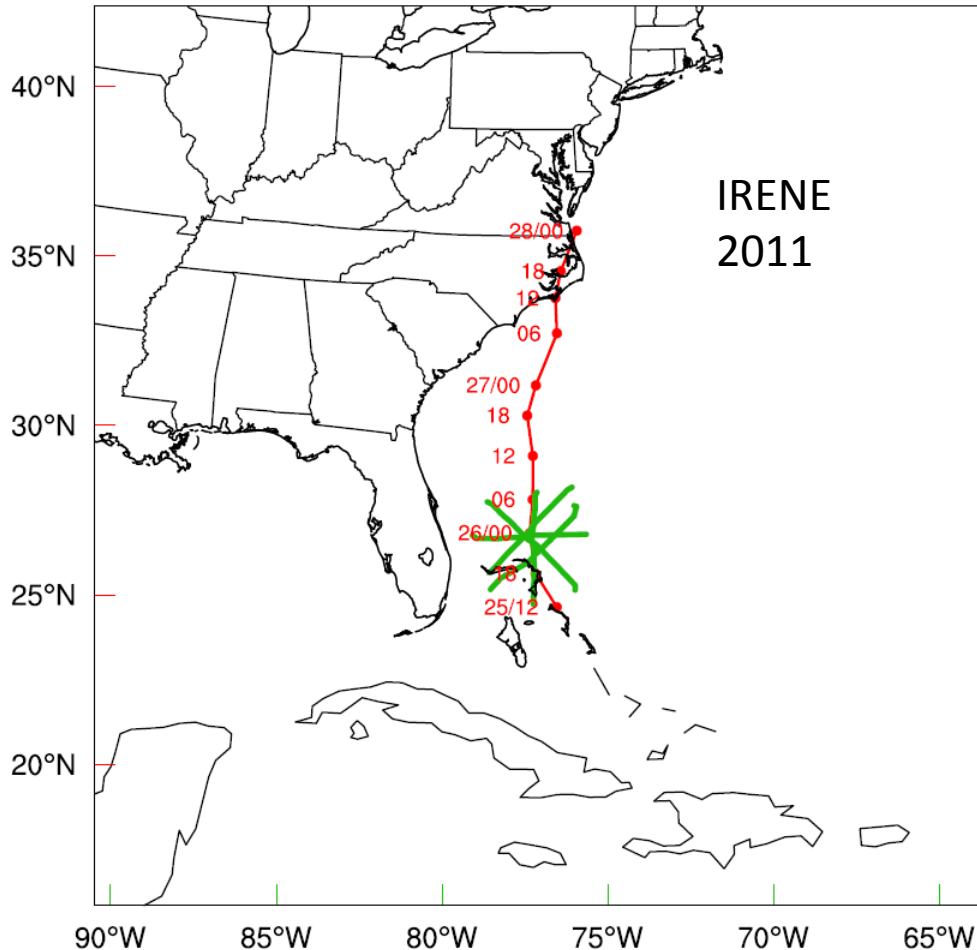 - Ozone profiles from GFS
- **Preliminary results (HBMB vs. HB03)**
  - Hurricane track errors are generally improved by satellite radiances.
  - Hurricane intensity errors and biases are slightly improved by satellite radiances during the 126-hour forecast except for hours between 48-72.
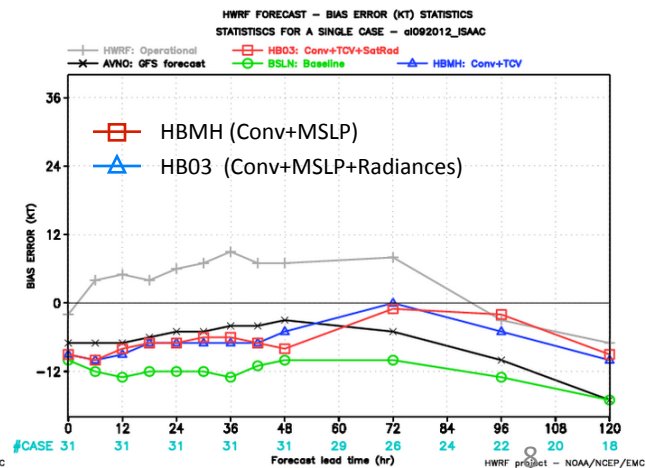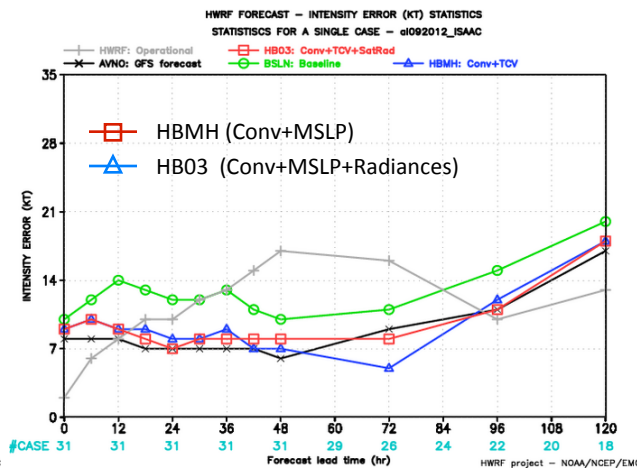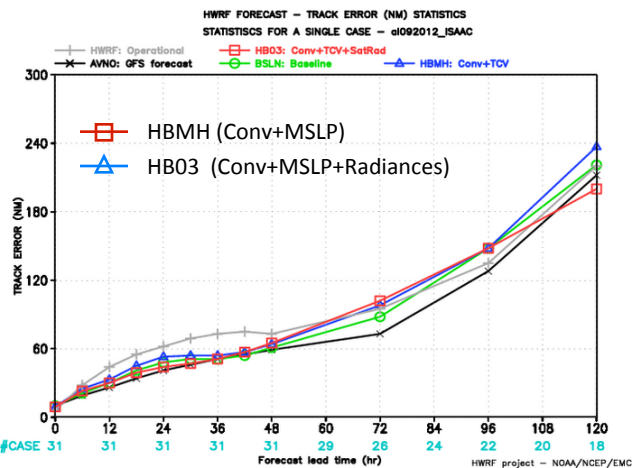
IRENE
2011

- Model: HWRF Δx=9km

- Observations: radial velocity from Tail Doppler Radar (TDR)

- Case: IRENE 2011

- Initial and LBC ensemble: GFS global hybrid DA system

- Ensemble size: 40

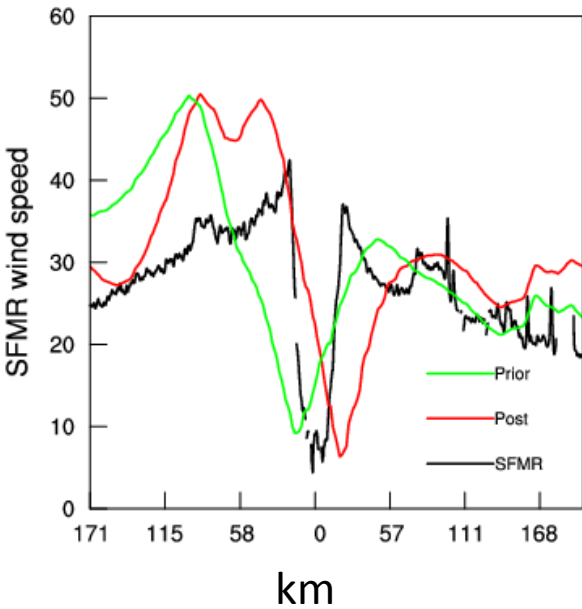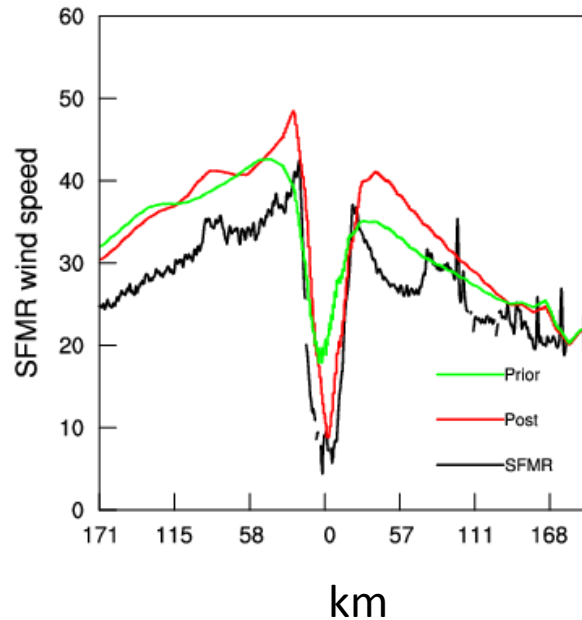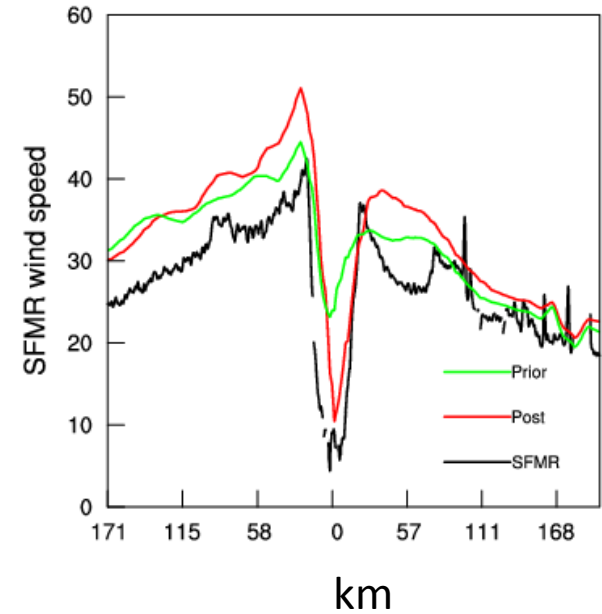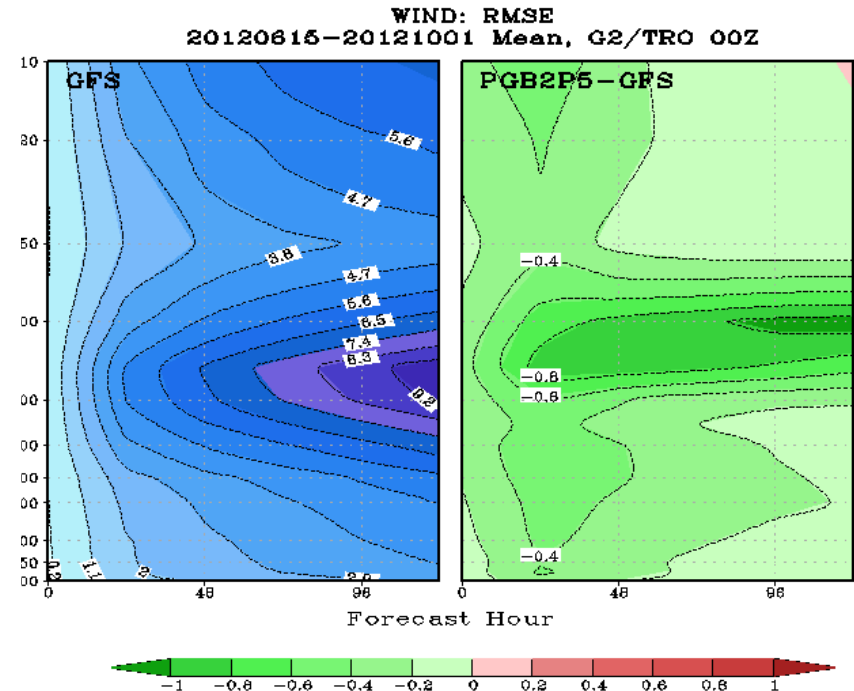# Verification against SFMR wind speed

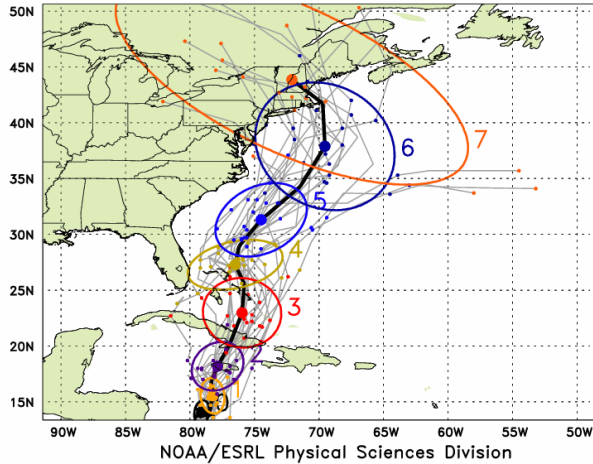Last Leg

GSI

EnKF

Hybrid

High-res Global Hybrid DA

- T878 control forecast, T382 ensemble (operational is T574/T254)
- Retuned parameters in physics.
- Eulerian (not semi-lagrangian) model. T1148/T574 SL is actually 50% cheaper because of longer time step.

- Results
  - Improved tropical wind scores
  - TC tracks not improved – problems with initial TC position in some cases (relocation not done as in operations).
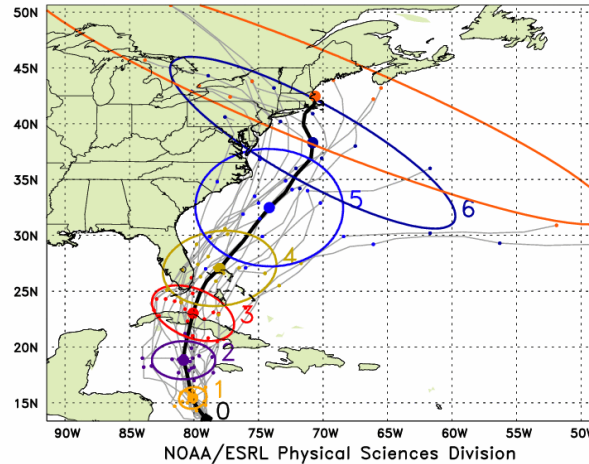

WIND: RMSE
20120615–20121001 Mean, G2/TRO 00Z

11

2012102300 initialization

T382 GFS/EnKF 10-m wind ens 156-hr fcst for 18L from 2012102300
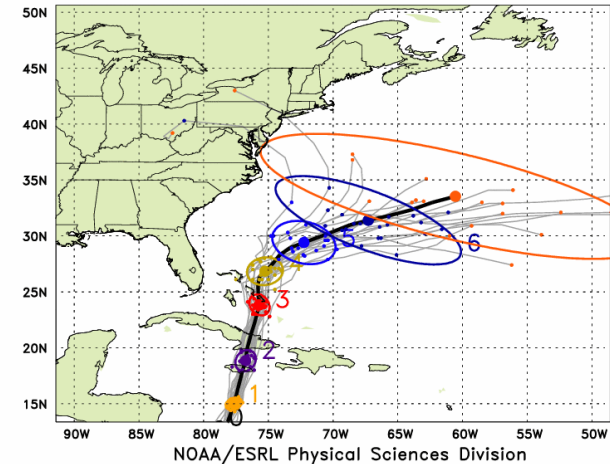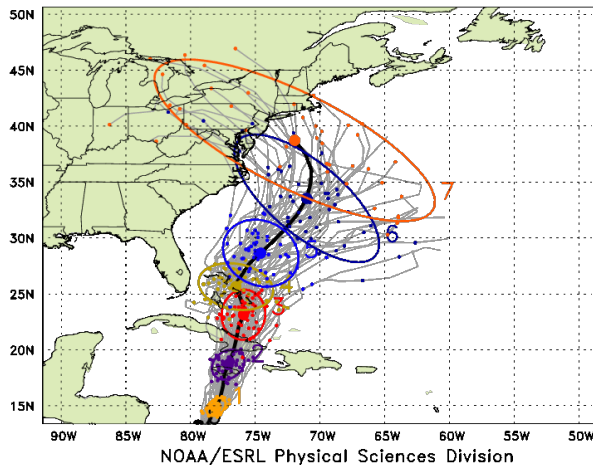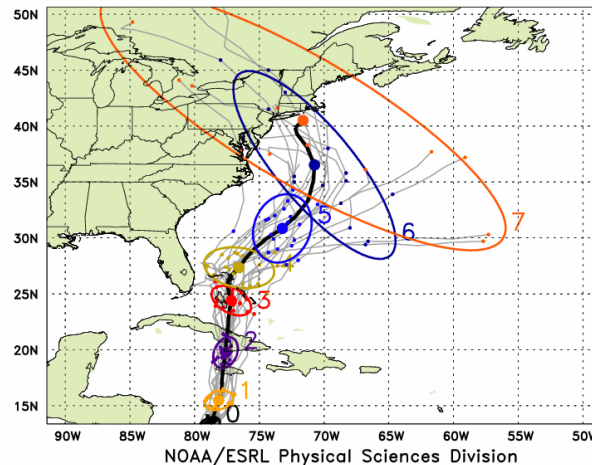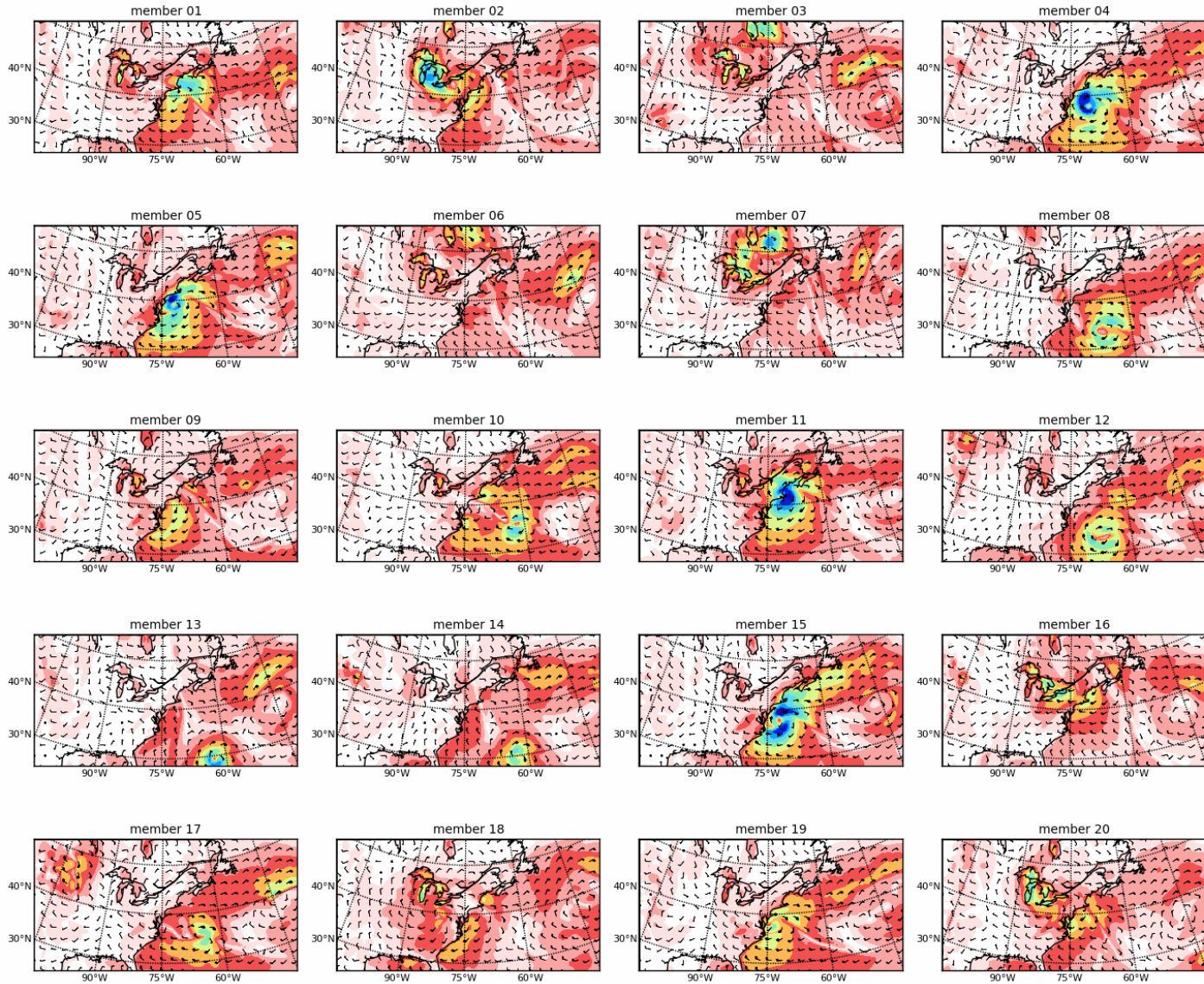
NOAA/ESRL Physical Sciences Division

wind speed (knots)
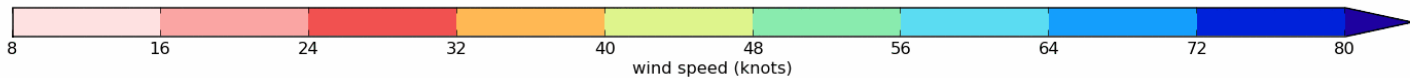
PSU/EnKF results for Sandy

2012al18 Sandy Track
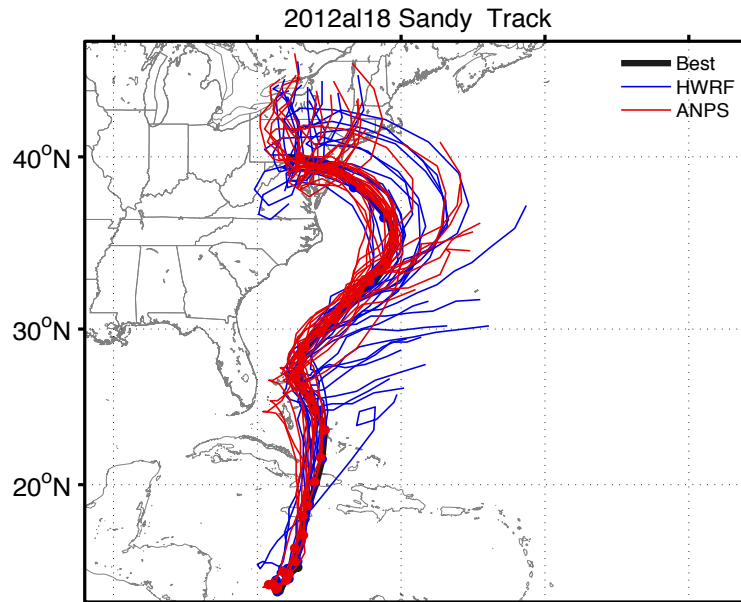
Courtesy Fuqing Zhang

Homo Abs Error of position (km) for d2012

Homo Abs Error of maxWSP (kts) for d2012

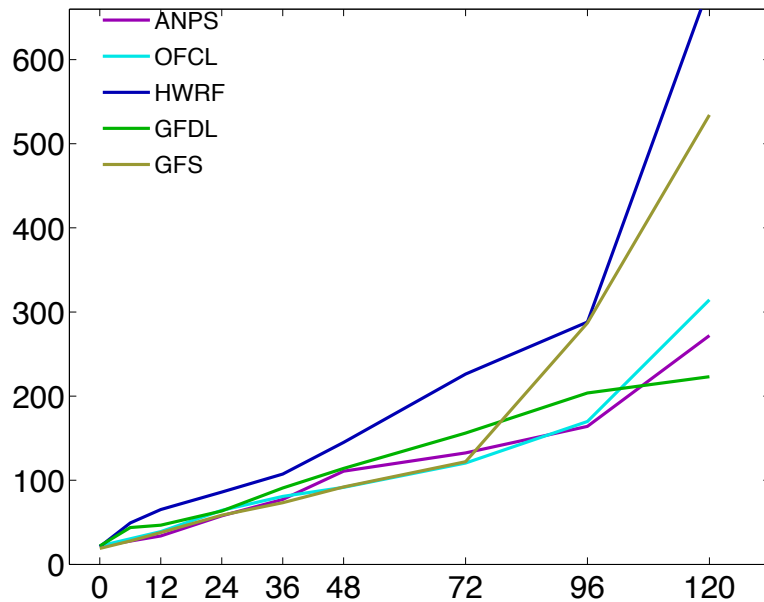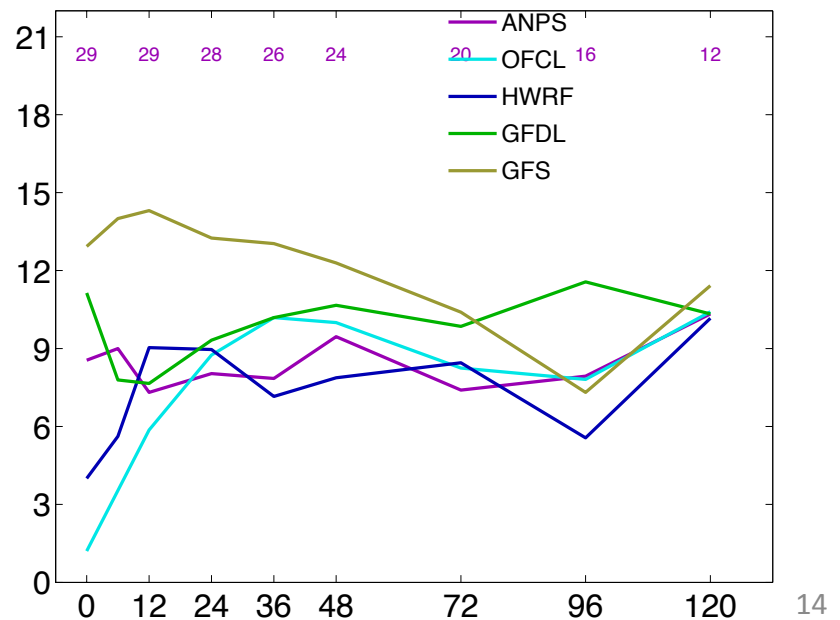# FY2012 Milestones

- Develop and test regional HWRF basin-scale hybrid Var/EnKF system (ESRL and EMC)
  - Preliminary testing done.
  - Need to decide soon on a stream 1.5 system for next year (GFS or HWRF ensemble? Cold or warm start? Blend in GFS background in stratosphere so GFS bias correction can be used for radiances? TC relocation (both ensemble and control)?)
- Inner-core DA (EMC/HRD/PSU/Univ of OK)
  - PSU system performed well for Sandy.
  - TDR data can now be used in GSI/EnKF hybrid.

FY2012 Milestones

- Global high-res hybrid DA using GFS at T878/T382 (EMC/ESRL)

    - Tropical wind scores improved.

    - Some problems with initial TC position (relocation not done)

    - Good forecasts for Sandy.

    - Candidate for FY13 GFS upgrade (along with T1148/T574 semi-lagrangian hybrid system)

FY2012 Milestones

- Hybrid DA development (ESRL/EMC)
  - HWRF capabilities added, bugs fixed.
  - Modifications to allow blending of GFS background in stratosphere so that global bias correction can be used (and more radiances assimilated).
  - Assimilation of TC position vs TC relocation (both in global and regional).
- Satellite radiance assimilation
  - See 2nd bullet above
  - TC/COAMPS tests
  - AIRS retrievals in NCAR/U of Albany system.

FY2012 Milestones

- Model-error covariance estimation (ESRL/EMC)
  - Stochastic physics parameterizations added to GFS (SPPT, Vorticity Confinement and pertrubed PBL humidity). See Ensemble team report. Testing in DA just beginning (but promising).