EMC FY15Q1 Upgrade Review

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GFS upgrade

Presented by:

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based on work done by Global Climate and Weather Modeling Branch

Implementation Overview

- This upgrade is planned for December 9, 2014
- System description
  - This is a change to the GDAS and GFS.
- What's being changed in the system
  - Analysis
  - Model
    - T1534 (to 10 days) Semi-Lagrangian
    - Use of high resolution daily SST and sea ice analysis
    - Physics
    - Land Surface
  - Post Processor
- Expected benefits to end users associated with upgrade
  - Upgrade in global modeling capability.
  - Improvement in forecast skill
- This implementation will put GFS/GDAS into EE process.

Analysis Highlights

- Structure
  - T574 (35 km) analysis for T1534 (13 km) deterministic
  - Code optimization
- Observations
  - – GPSRO enhancements – improve quality control
  - – Updates to radiance assimilation
    - Assimilate SSM/IS UPP LAS and MetOp-B IASI radiances
    - CRTM v2.1.3
    - New enhanced radiance bias correction scheme
    - Additional satellite wind data – hourly GOES, EUMETSAT
- EnKF modifications
  - – Stochastic physics in ensemble forecast
  - – T574L64 EnKF ensembles

Model Highlights (1)

- T1534 Semi-Lagrangian (~13 km)
- Use of high resolution daily SST and sea ice analysis
- High resolution until 10 days
- Dynamics and structure upgrades
  - Hermite interpolation in the vertical to reduce stratospheric temperature cold bias.
  - Restructured physics and dynamics restart fields and updated sigio library
  - Divergence damping in the stratosphere to reduce noise
  - Added a tracer fixer for maintaining global column ozone mass
  - Major effort to make code reproducible

Model Highlights (2)

- Physics upgrades
  - Radiation modifications -- McICA
  - Reduced drag coefficient at high wind speeds
  - Hybrid EDMF PBL scheme and TKE dissipative heating
  - Retuned ice and water cloud conversion rates, background diffusion of momentum and heat, orographic gravity-wave forcing and mountain block etc
  - Stationary convective gravity wave drag
  - Modified initialization to reduce a sharp decrease in cloud water in the first model time step
  - Correct a bug in the condensation calculation after the digital filter is applied

Model Highlights (3)

- Boundary condition input and output upgrades
  - Consistent diagnosis of snow accumulation in post and model
  - Compute and output frozen precipitation fraction
  - New blended snow analysis to reduce reliance on AFWA snow
  - Changes to treatment of lake ice to remove unfrozen lake in winter
  - Land Surface
    - Replace Bucket soil moisture climatology by CFS/GLDAS
    - Add the vegetation dependence to the ratio of the thermal and momentum roughness, Fixed a momentum roughness issue

Post - Processer Highlights

- Faster/less memory version
- GRIB2 with parallel output
- Master post file is 0.25 degree, not model Gaussian grid
- Accumulation bucket changed from 12 hour to 6 hour between day 8 and day 10
- Add user requested fields
  - frozen precipitation fraction
  - ozone at 150, 200, 250, 300, 350, and 400 mb,
  - 2m dew point,
  - wind chill and heat index,
  - instantaneous precipitation type
  - membrane SLP in GDAS pgb files
  - Improved icing algorithm in post
  - Higher precision RH
  - GDAS output symmetric with GFS
- BUFR station list to newer NAM/GFS list

Meteo Isernia
Osservatorio ufficiale molisano

Parallel Status

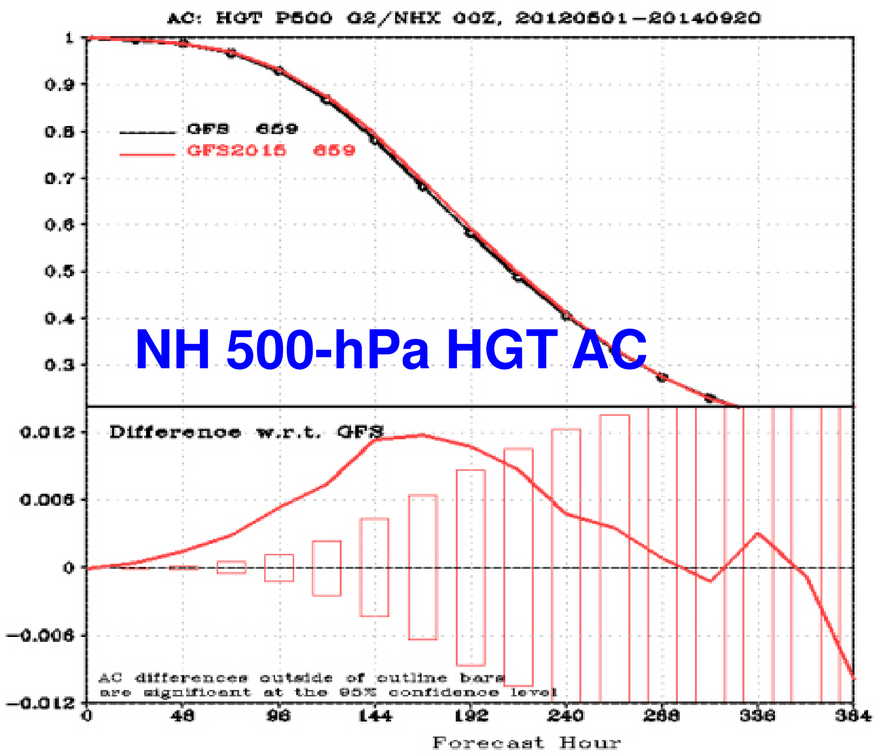
- All components of the system , including Storm-Relocation, OBSPROC, EMC-Surface, GSI, ENKF, GSM, Post-processing, were built in the EE structure, are frozen, and have been handed off to NCO for implementation.

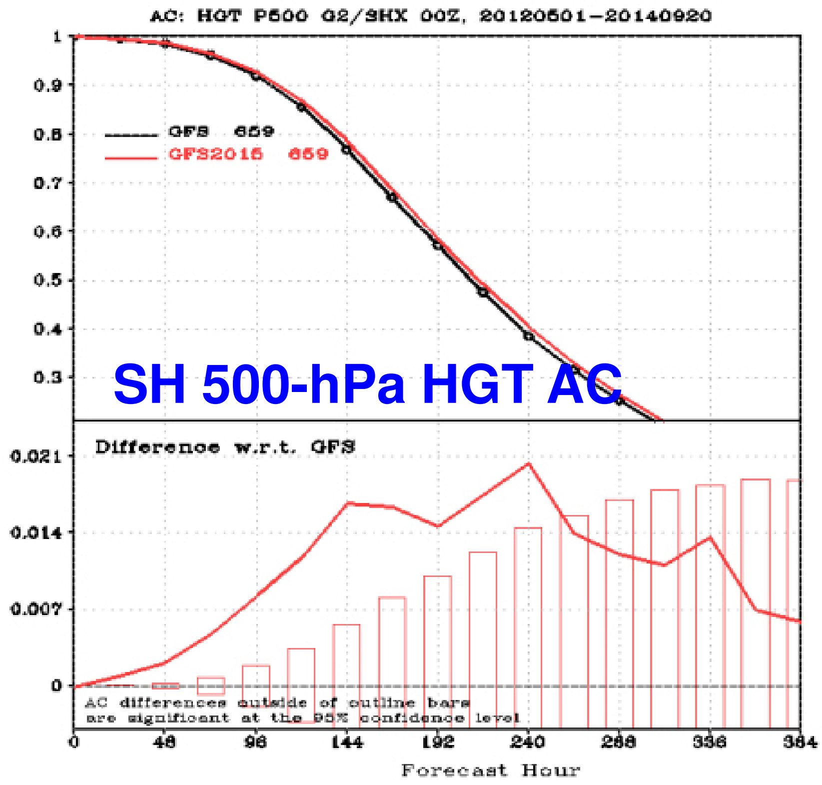
- NCO is working on setting up a 30-day pre-implementation parallel, which will be run on the development machine.

- Parallels and verification pages
  - **Prhs14: 01/01/2014 ~ present** **running**
    - http://www.emc.ncep.noaa.gov/gmb/wd20rt/vsdb/prhw14
  - **Prhs13: 05/16/2013 ~ 12/31/2013** **completed**
    - http://www.emc.ncep.noaa.gov/gmb/wd20rt/vsdb/prhs13
  - **Prhs12: 05/01/2012 ~ 11/06/2012** **completed**
    - http://www.emc.ncep.noaa.gov/gmb/wd20rt/vsdb/prhs12
  - **Prhs11: 05/20/2011 ~ 12/31/2011** **completed (on Zeus)**
    - http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/prhs11
    - http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/prhs11b/
- merged 2012/2013/2014 http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/gfs2015/

Results – Merged 2012/2013/2014

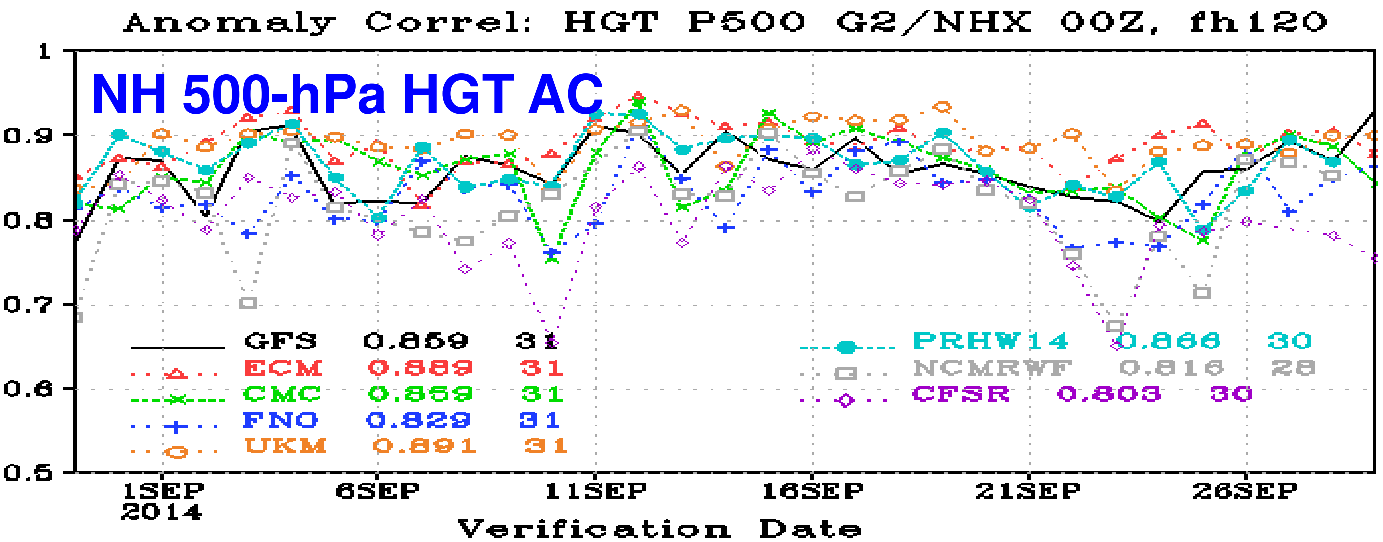
- see http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/gfs2015/ for more detail. Note that Hybrid ENKF 3D-VAR GSI was implemented into operation after May 22, 2012



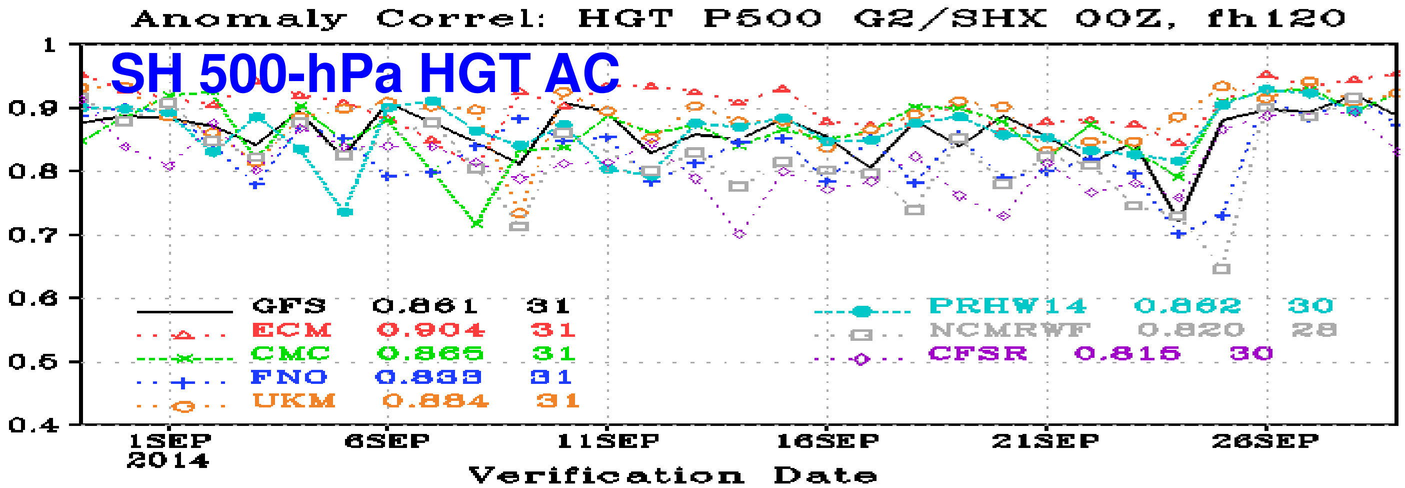


Link to scorecard http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/gfs2015/www/scorecard/mainindex.html

Real-Time Parallel in the past 31 Days

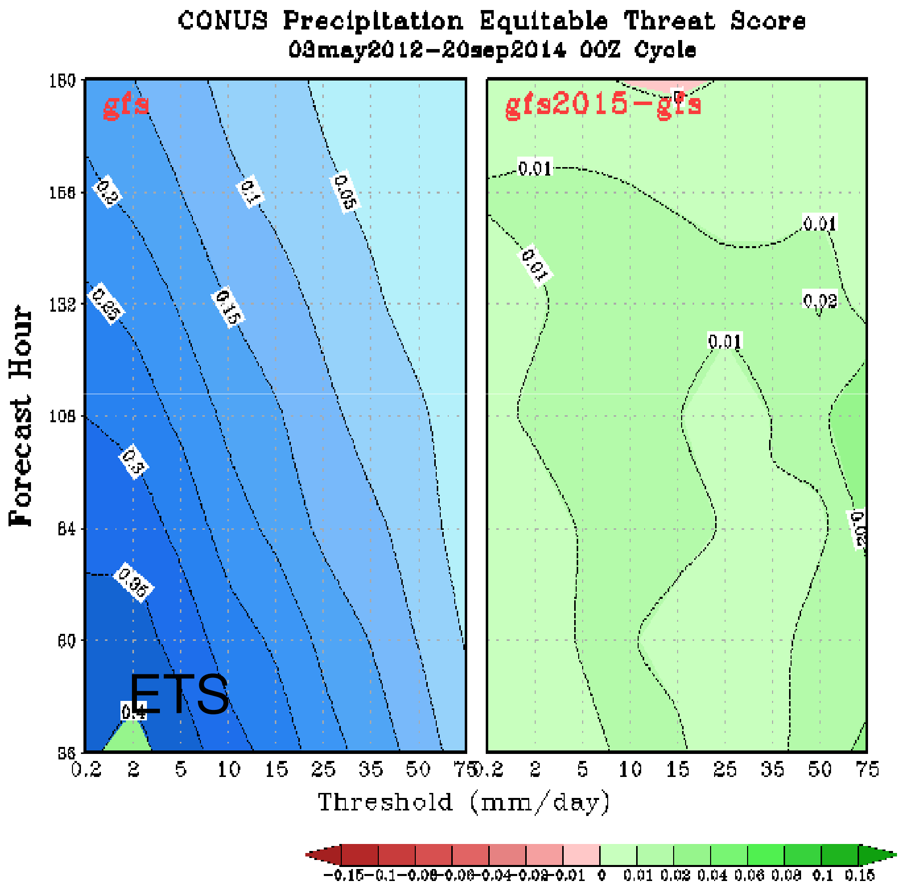


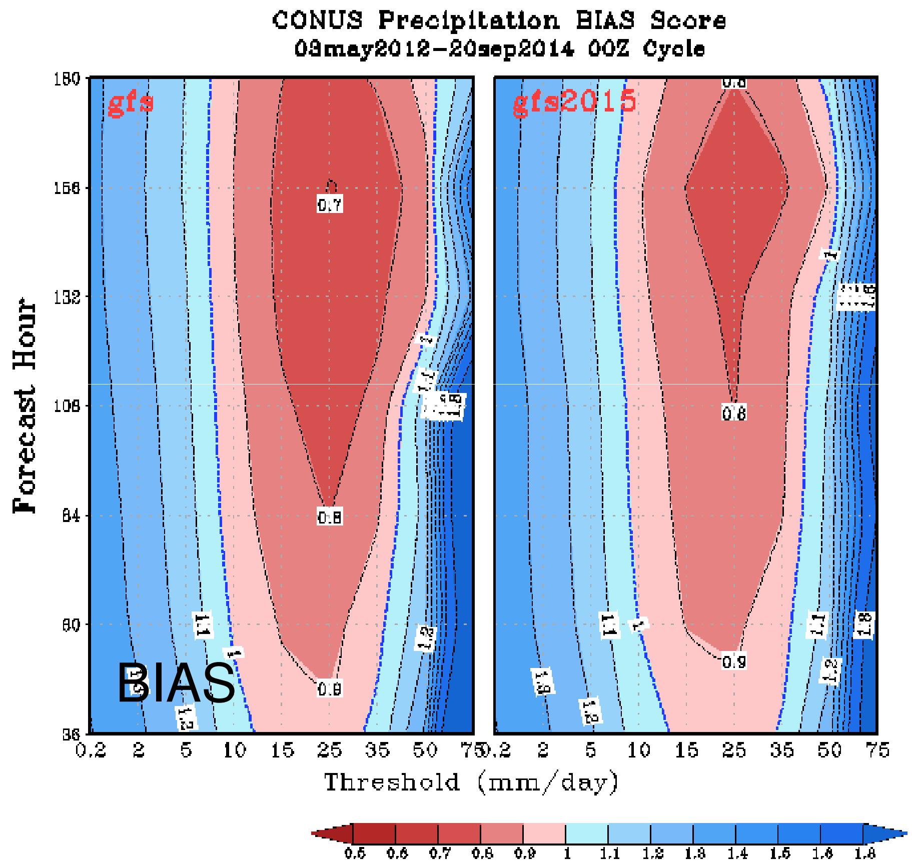
Prhw14 is T1534 parallels



http://www.emc.ncep.noaa.gov/gmb/STATS_vsdb/

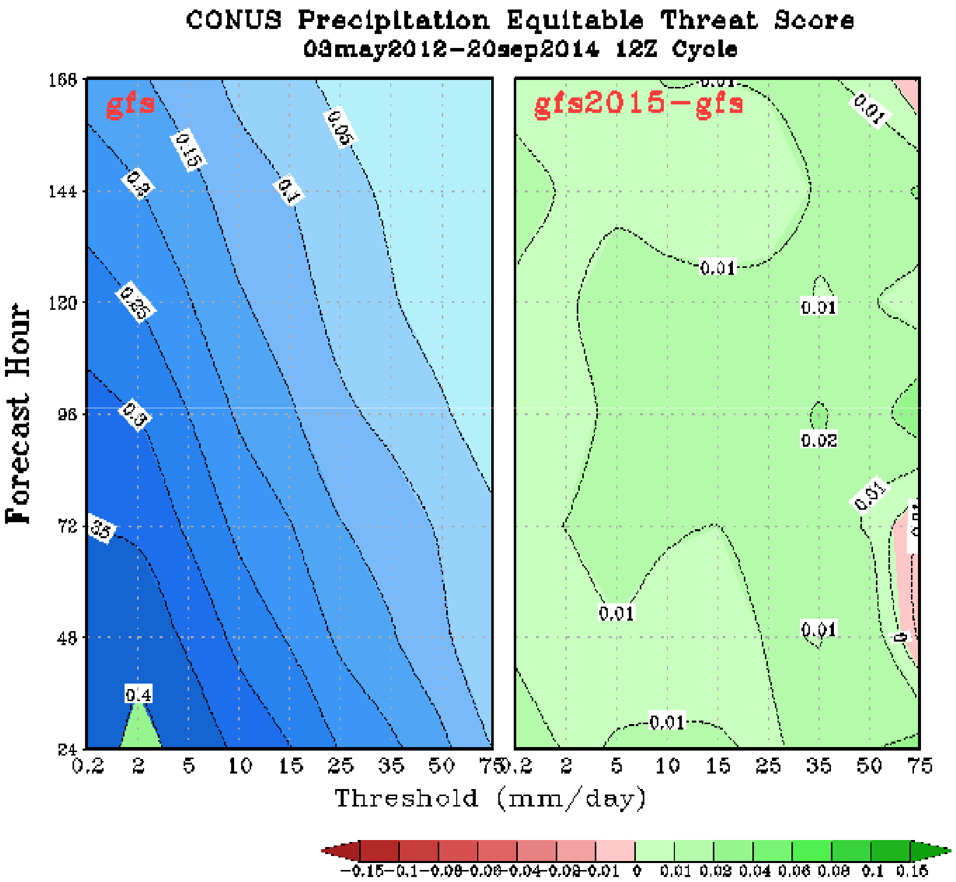
Precipitation Skill Scores, 00Z Cycle
Merged 2012/2013/2014

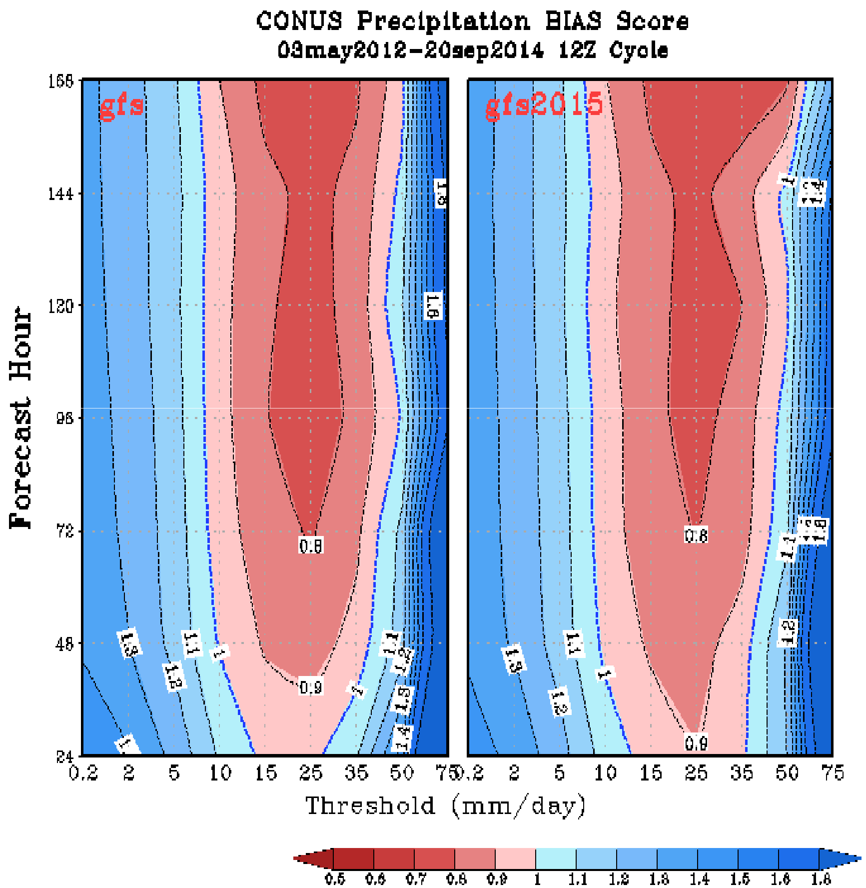




Improved ETS score and reduced forecast BIAS for all intensity and forecast lead time.

Precipitation Skill Scores, 12Z cycle Merged 2012/2013/2014

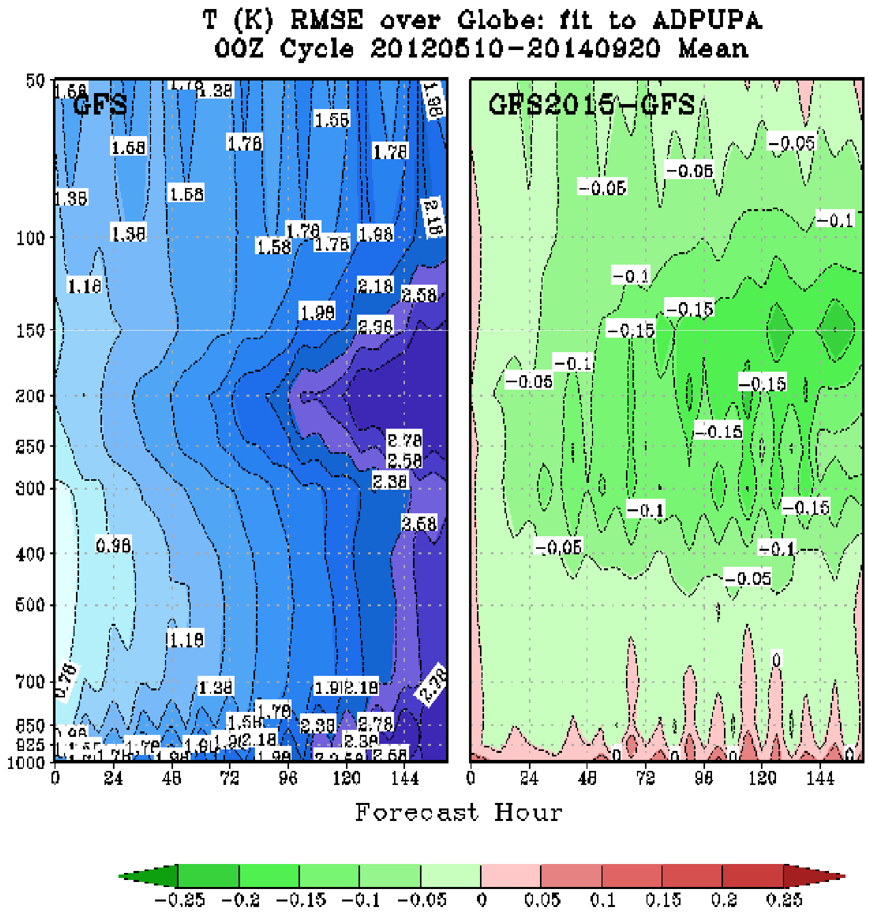




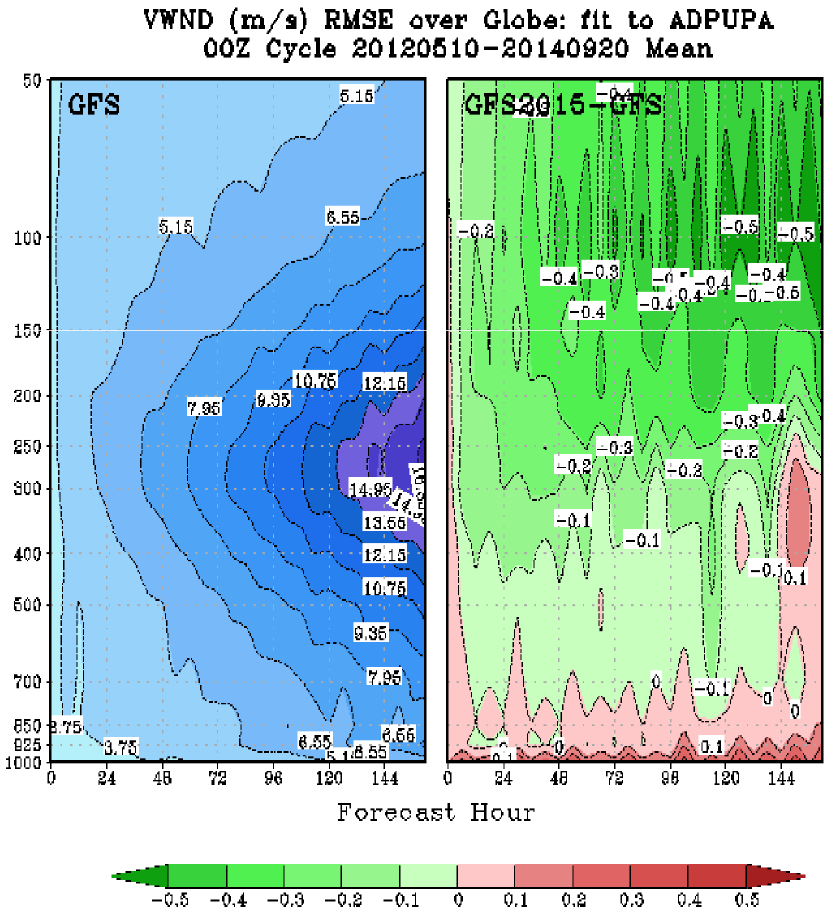
Improved ETS score and slightly reduced forecast BIAS for all intensity and forecast lead time.

Fit to RAOBS, RMSE
Merged 2012/2013/2014

Global Mean Temperature RMSE



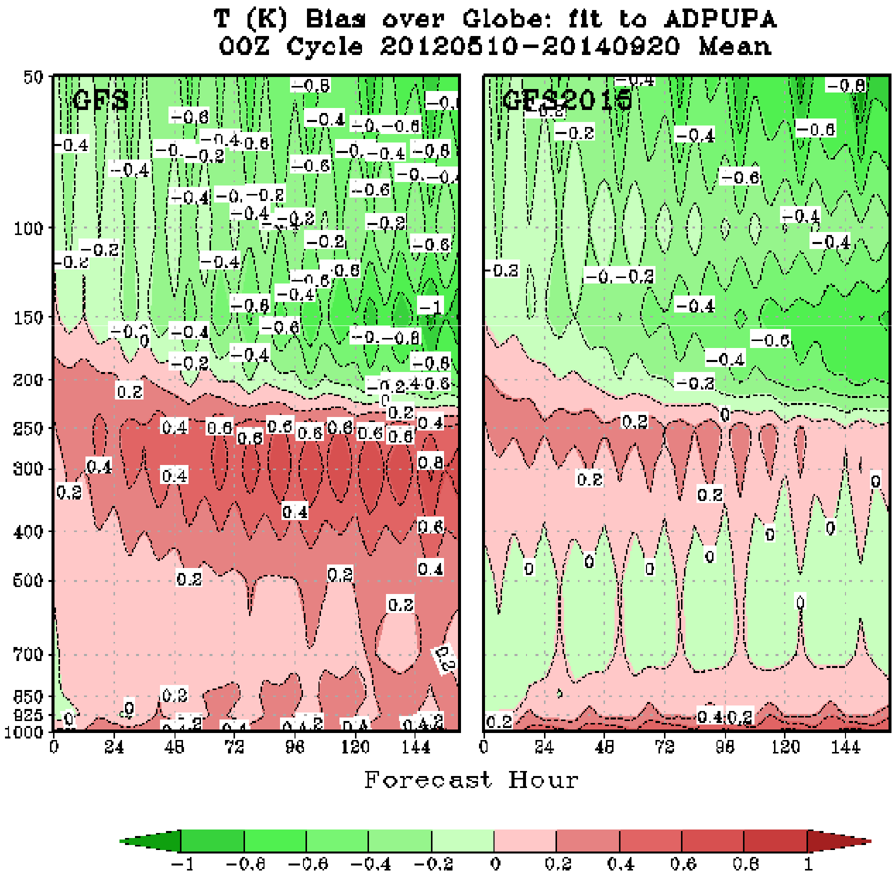
Global Mean Wind RMSE



http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/gfs2015/g2o/index.html

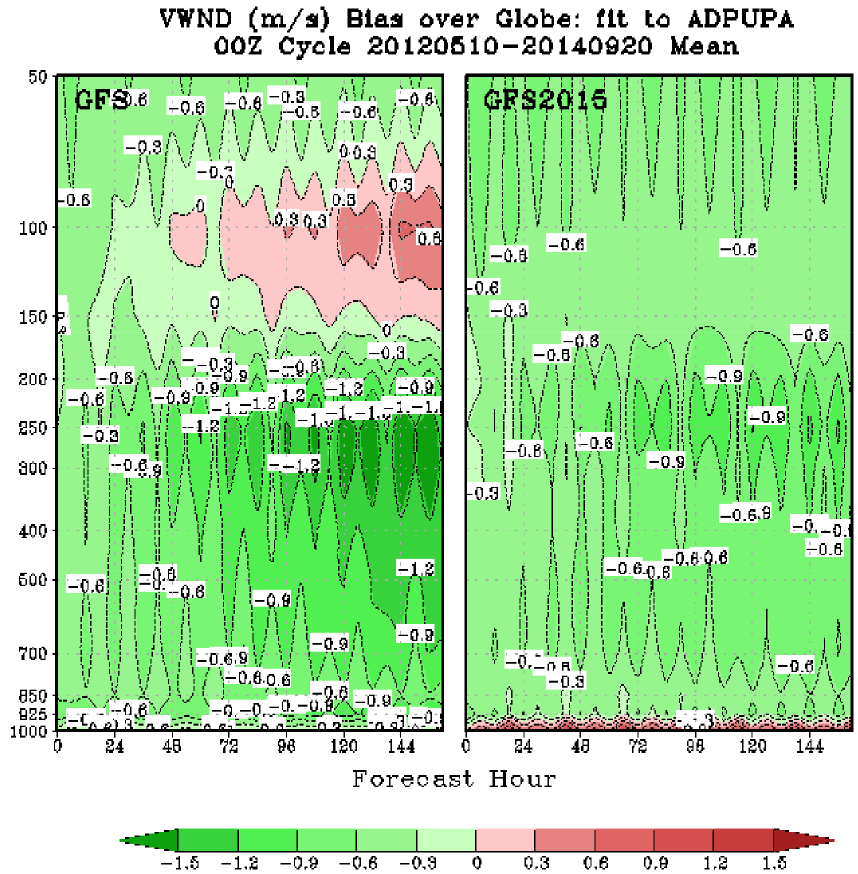
Fit to RAOBS, Bias
Merged 2012/2013/2014

Global Mean Temperature Bias



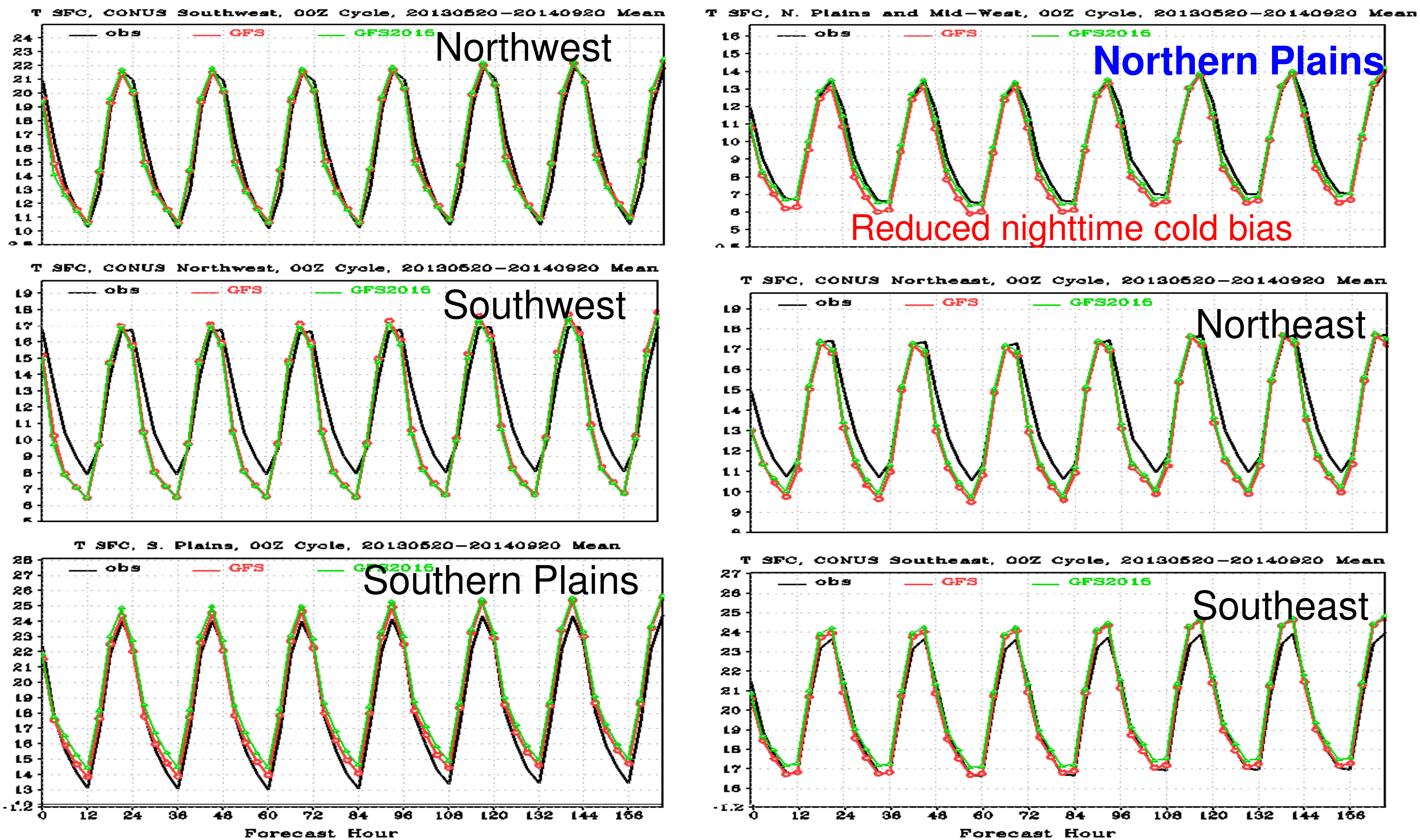
Reduced tropospheric warm bias, increased near surface warm bias

Global Mean Wind Bias



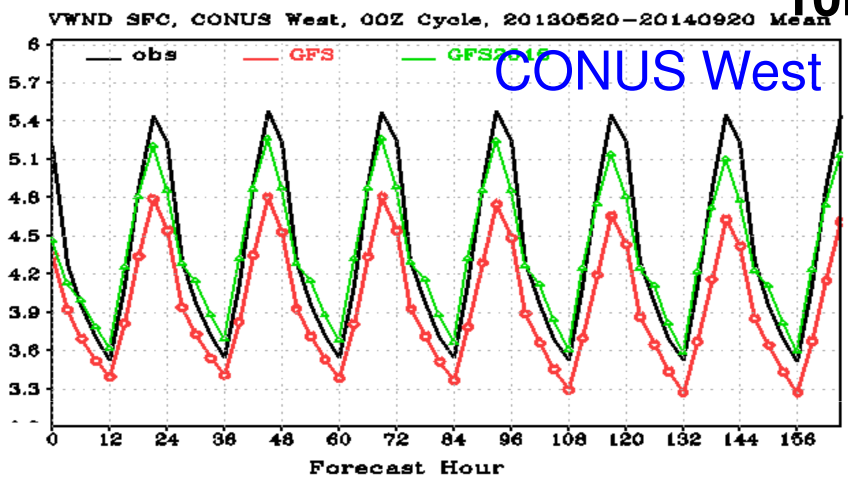
Strengthened tropospheric wind, slightly weakened stratospheric wind

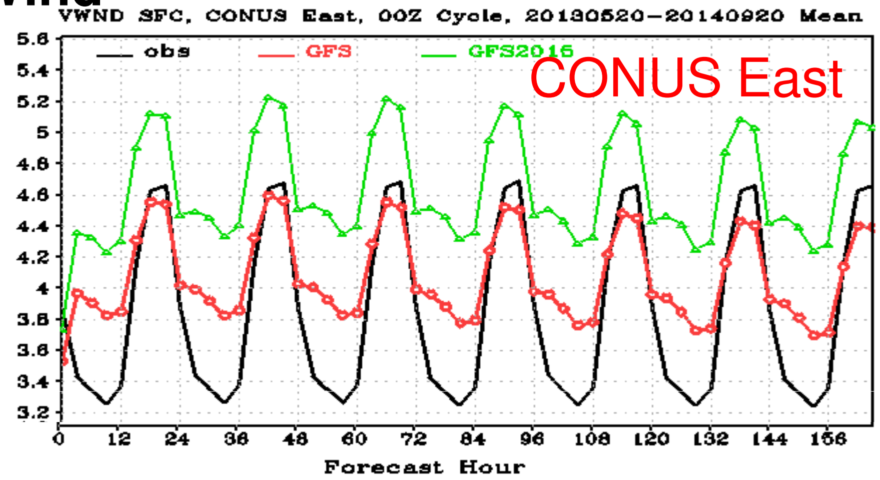
CONUS T2m, Fit to Sfc Obs
Merged 2013/2014



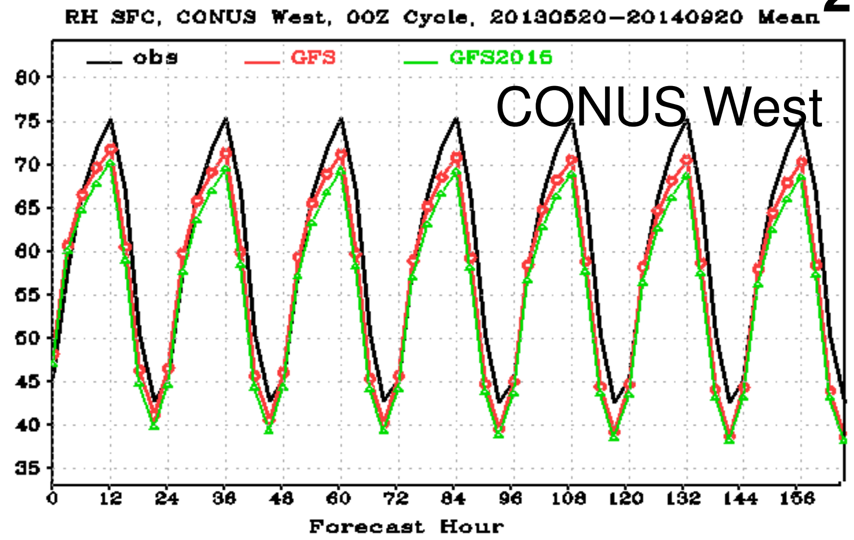
10-m Wind and 2m RH, Fit to Sfc Obs Merged 2013/2014

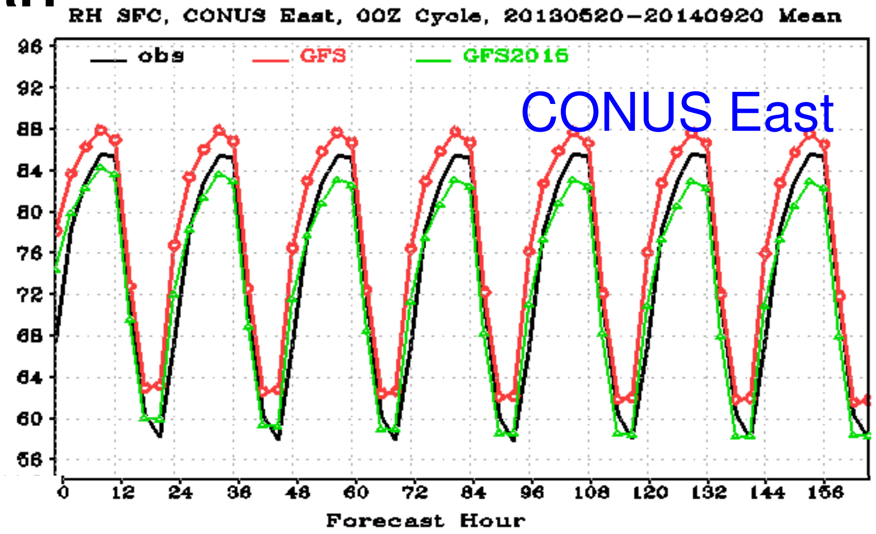
10m Wind



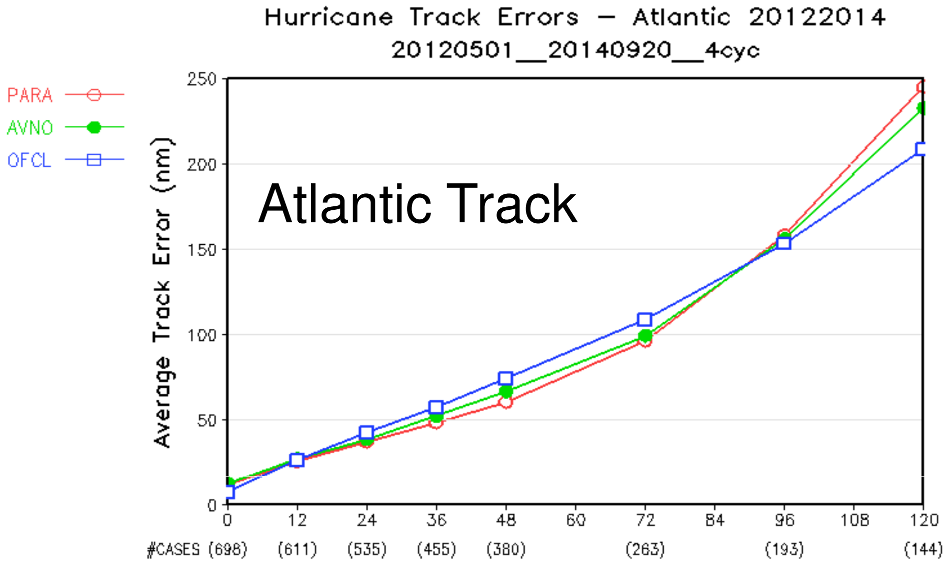


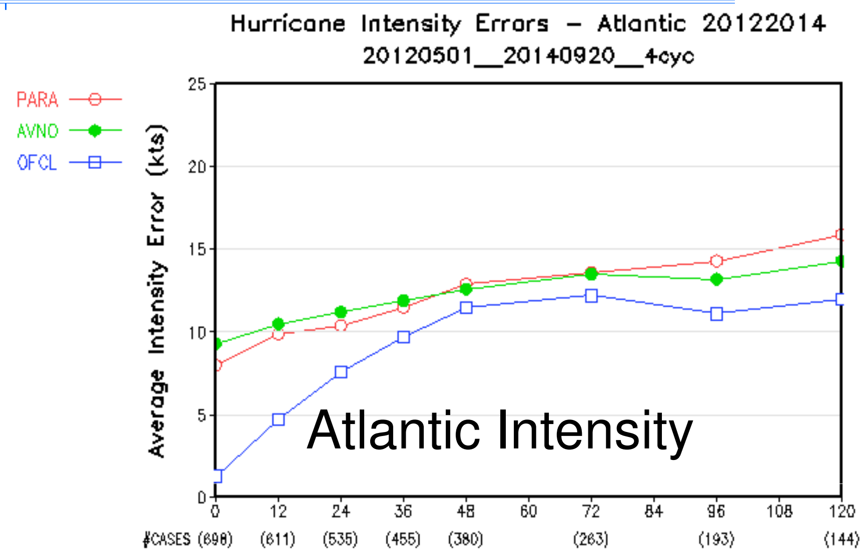
2m RH

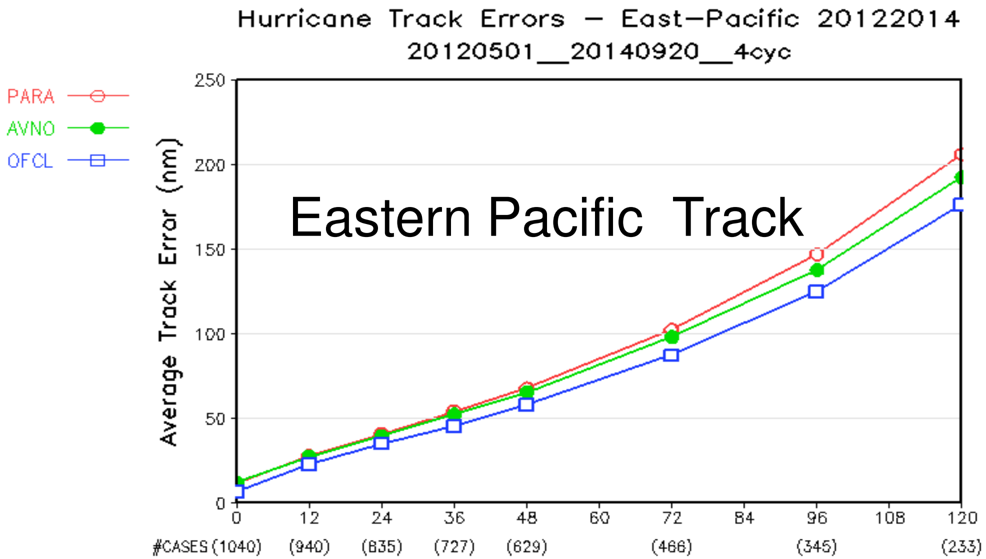


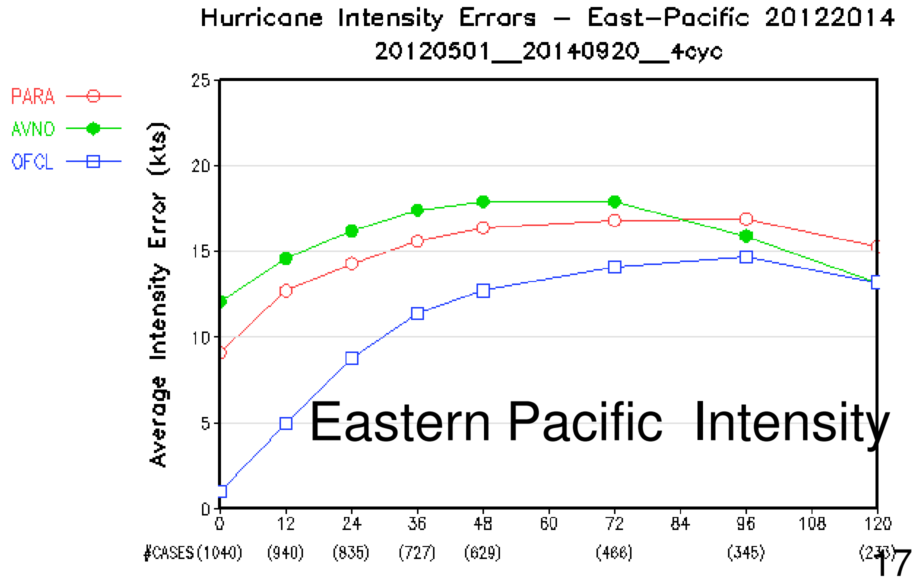


Hurricane Verification 2012/2013/2014

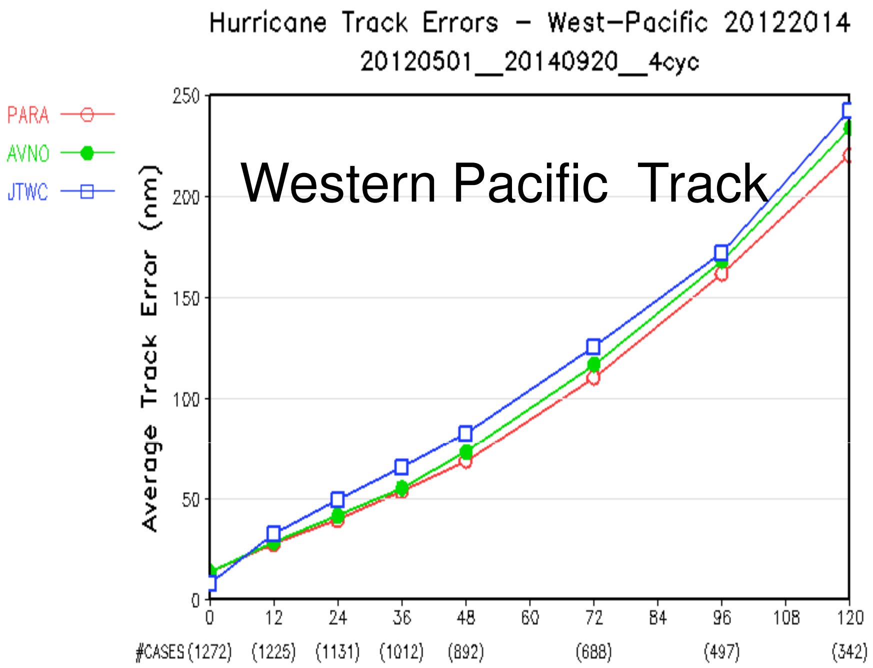


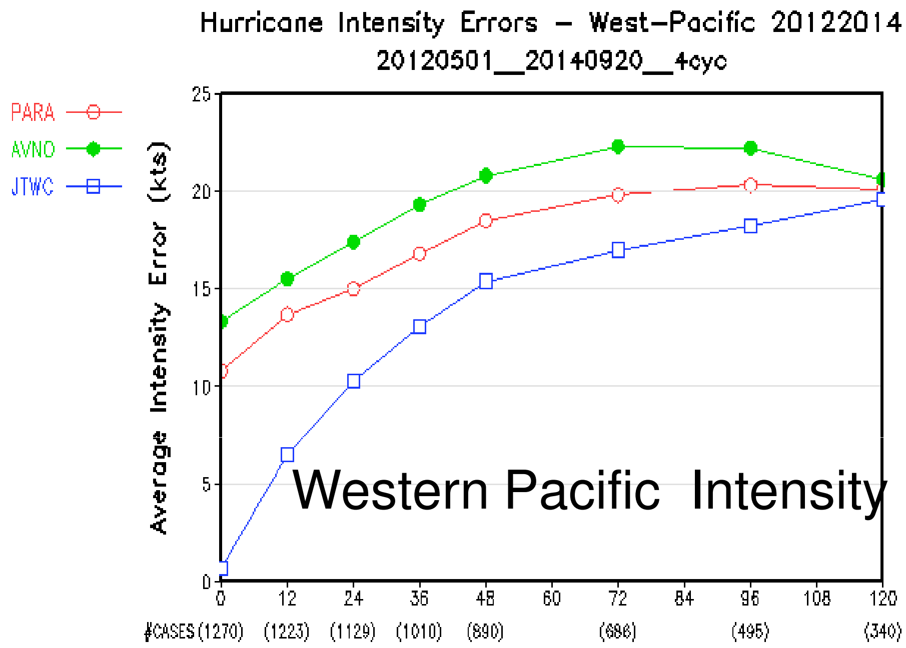




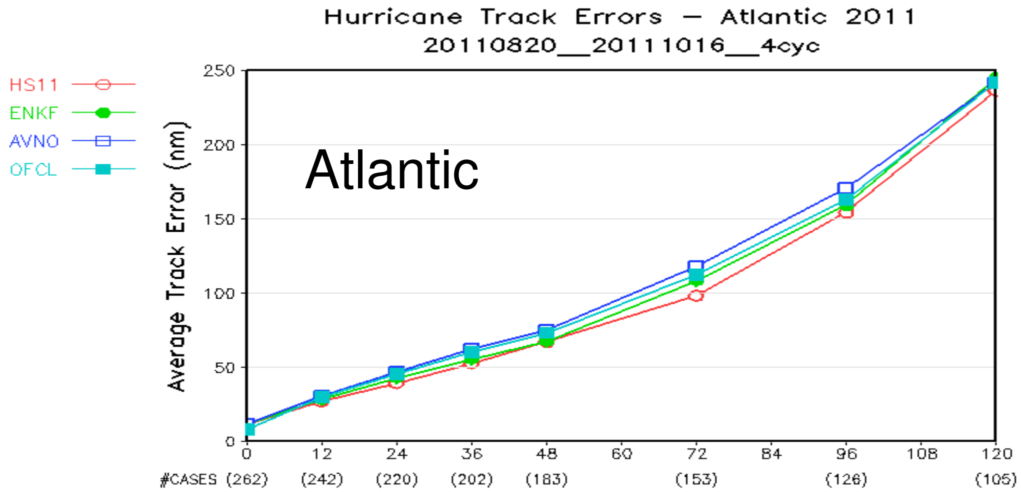


Hurricane Verification 2012/2013/2014



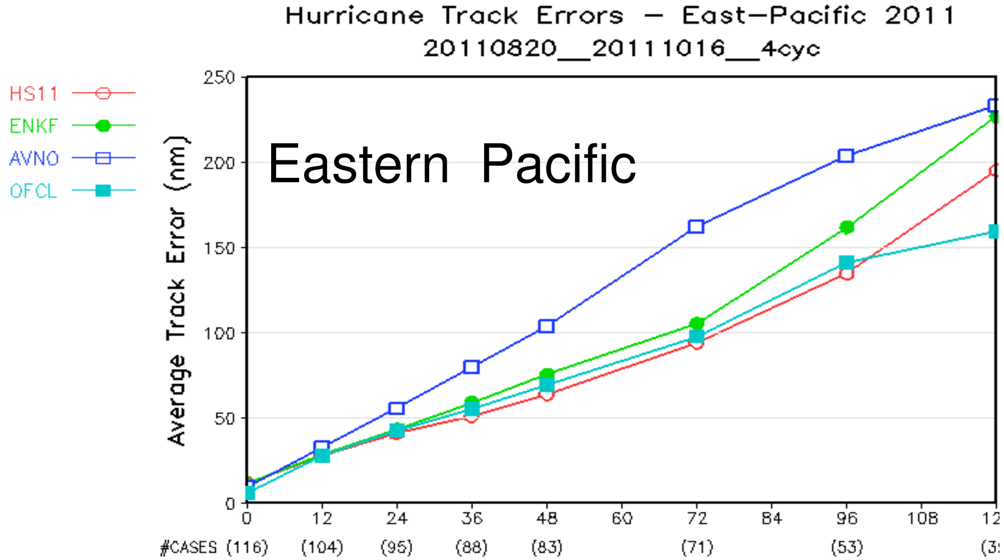


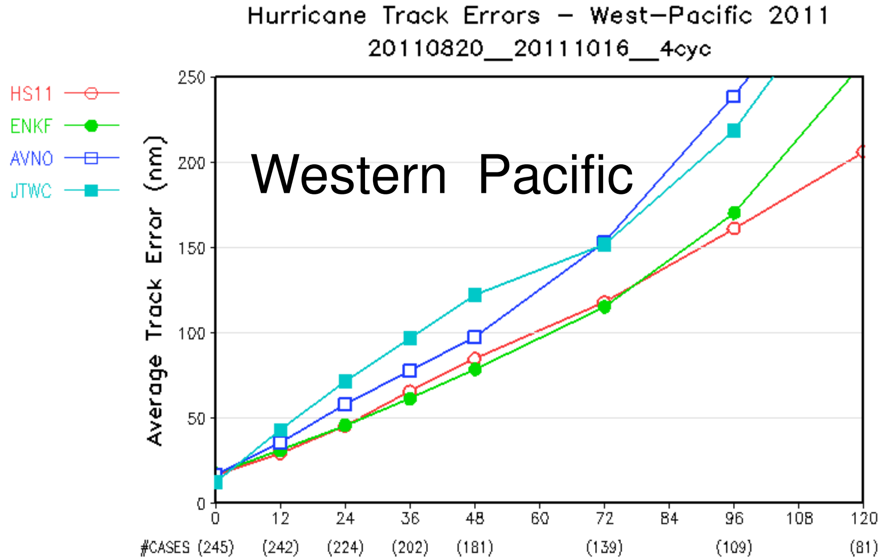
Hurricane Track Verification, 2011



HS11: T1534 parallel
ENKF: T574 ENKF-3DVAR parallel

ENKF was run only for part of the 2011 hurricane season (08/20/2011 – 10/16/2011)





2012 Hurricane Sandy

Summary:

- At day 7, HS12 is significantly better than AVNO. HS12 showed the tendency to move Sandy northwestward.

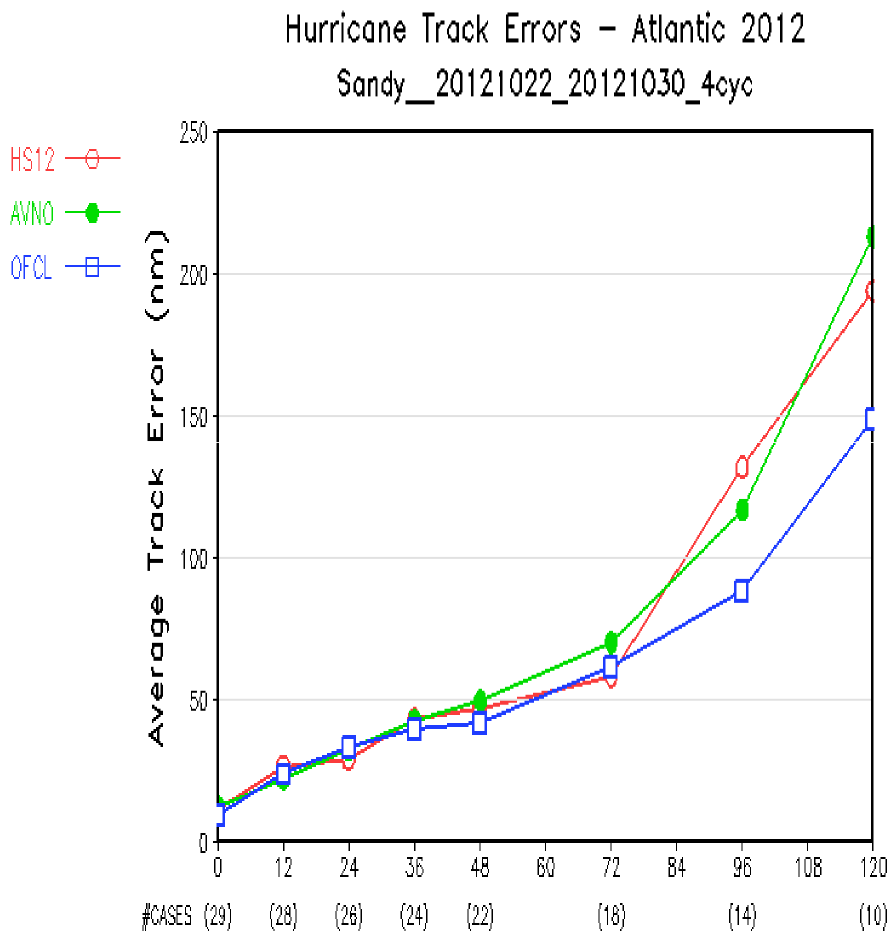
- At day 6, HS12 is slightly better than AVNO, but the difference is small.

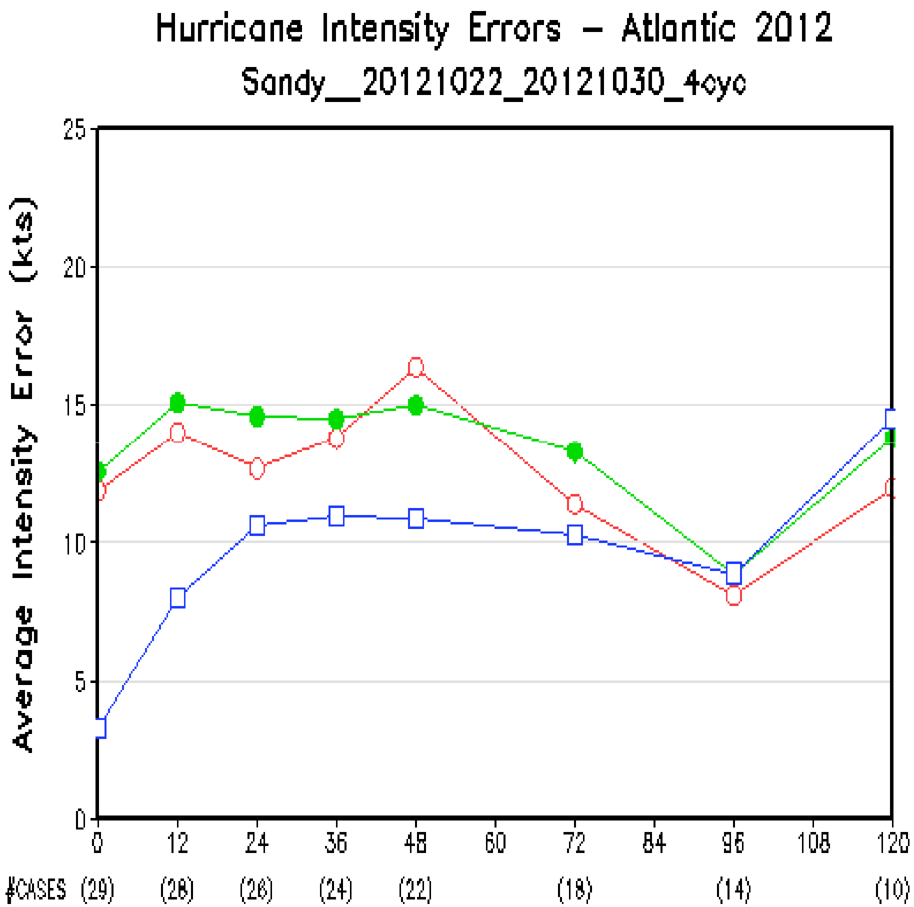
- At day-5 and day-4, the results are mixed. HS12 is better than AVNO for certain cycles but worse for other cycles.

- At day 3 and less, HS12 is much better than AVNO.   HS12 forecast is as good as or slightly better than ECMWF forecast.

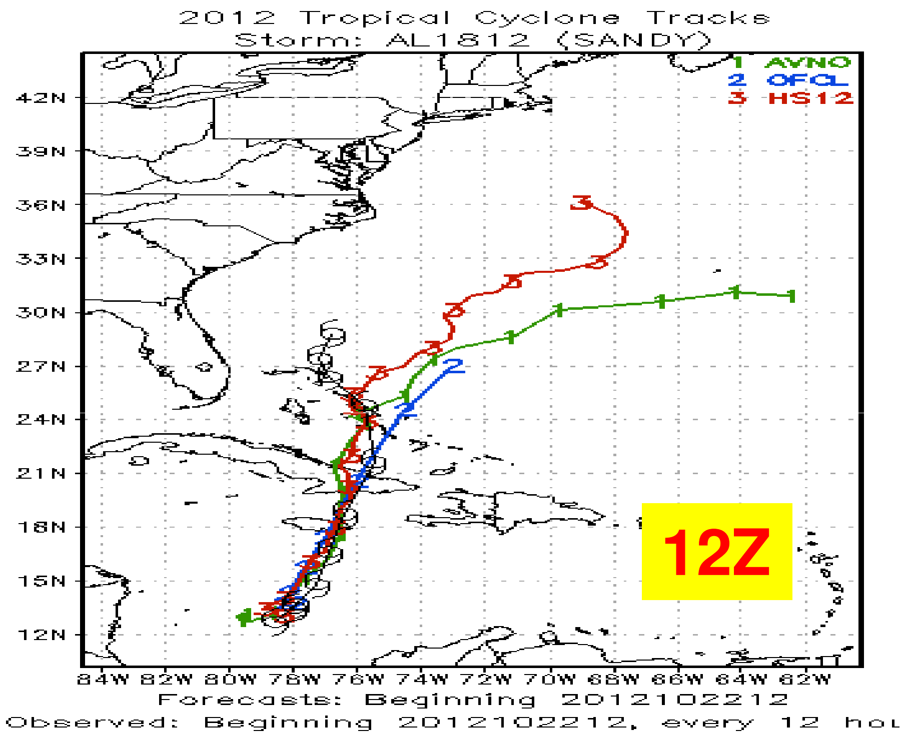
- **Overall, the forecast of hurricane Sandy's track is improved in the experimental T1534 semi-lag GFS in comparison with the operational T574 Eulerian GFS. The improvement is most significant for short-lead forecast within 72 hours.   Long-lead 6 to 7-day forecasts showed improvement for certain cycles.**

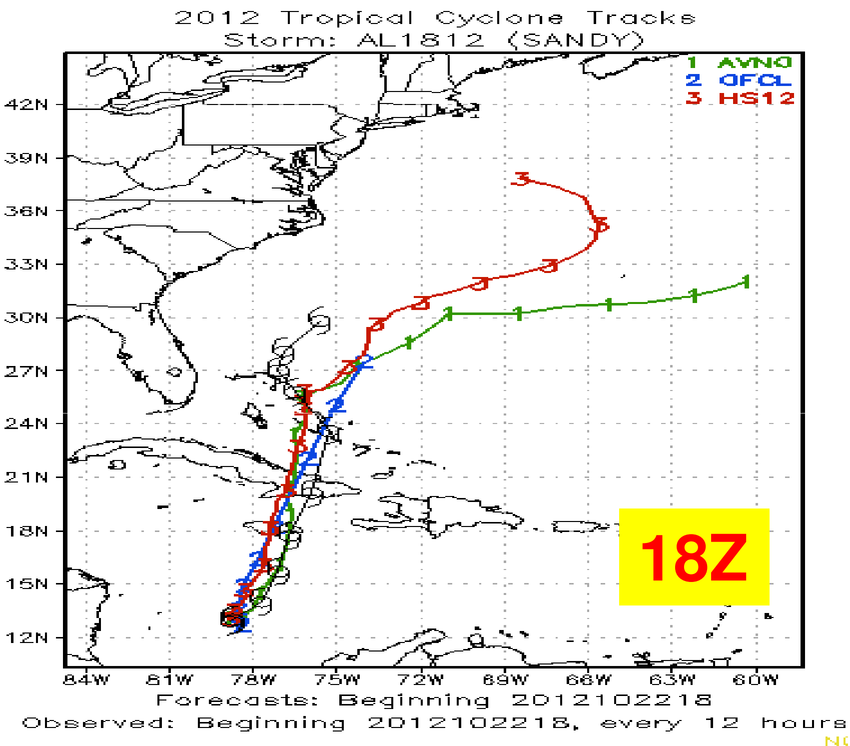
Mean Track and Intensity Errors
22 - 30 October 2012, 4 cycles/day



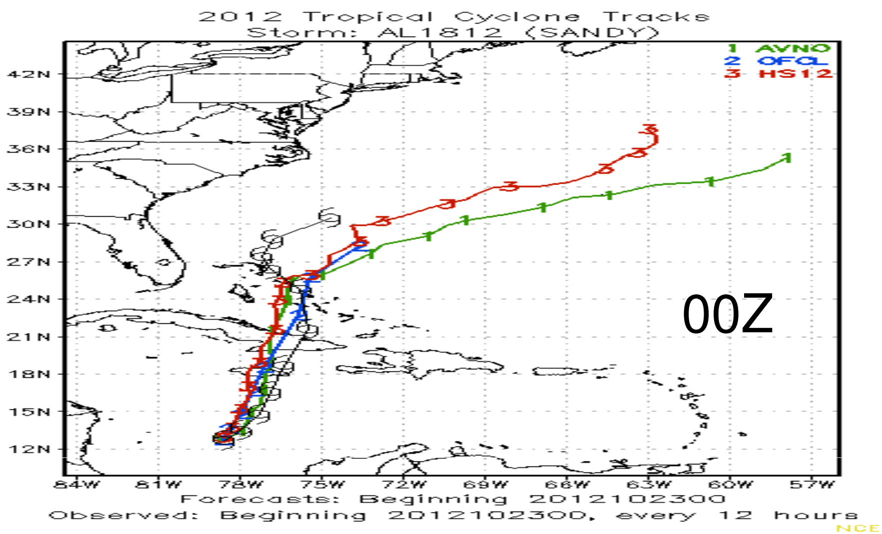


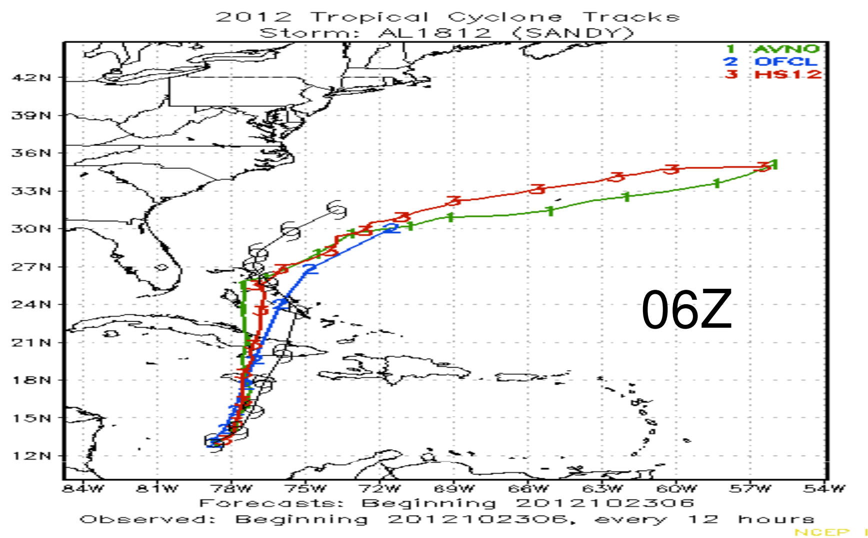
Tracks from Forecast Cycles 20121022: 12Z and 18Z
7 days before landfall

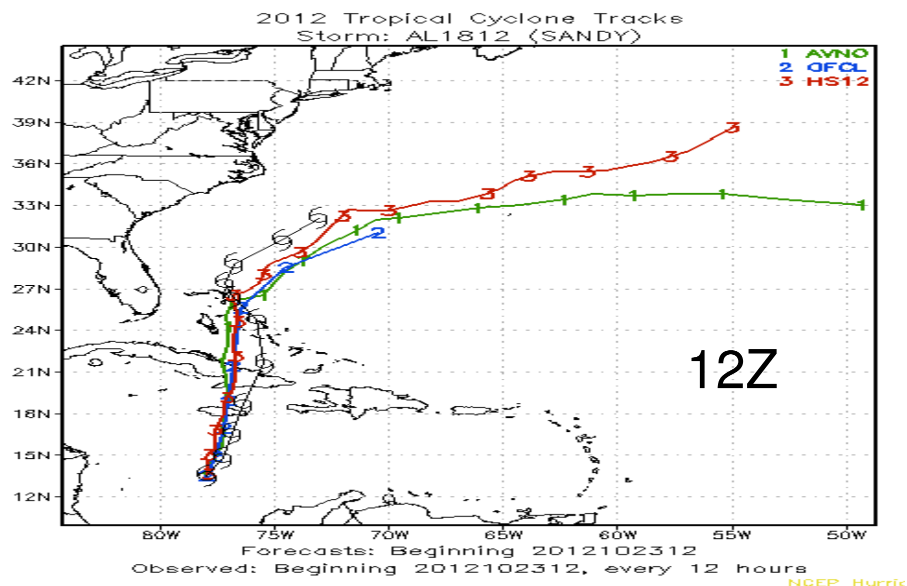


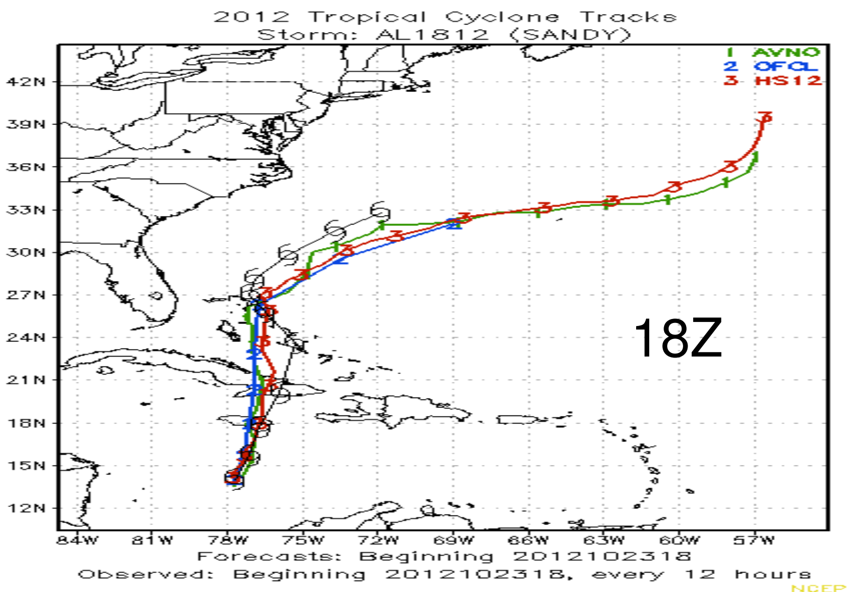


Tracks from 20121023: 00Z, 06Z, 12Z and 18Z Cycles
6 days before landfall

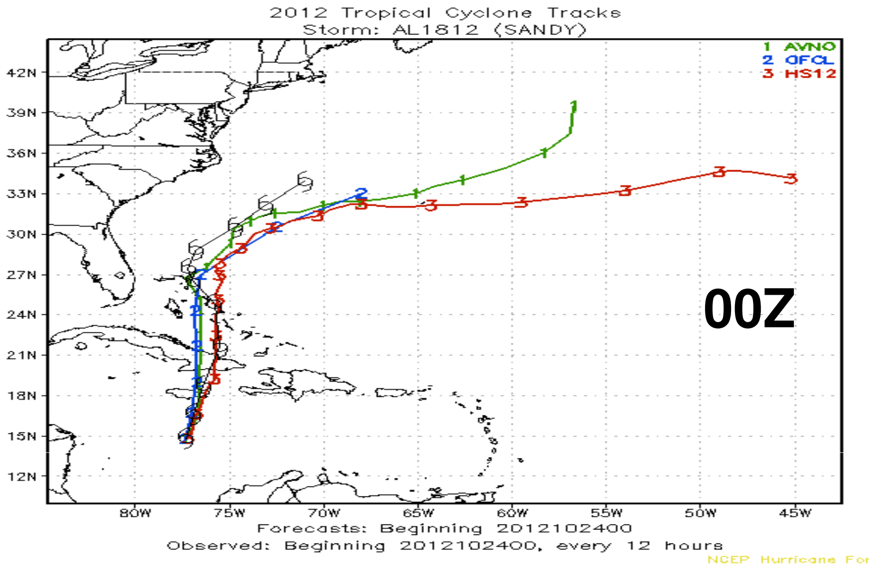


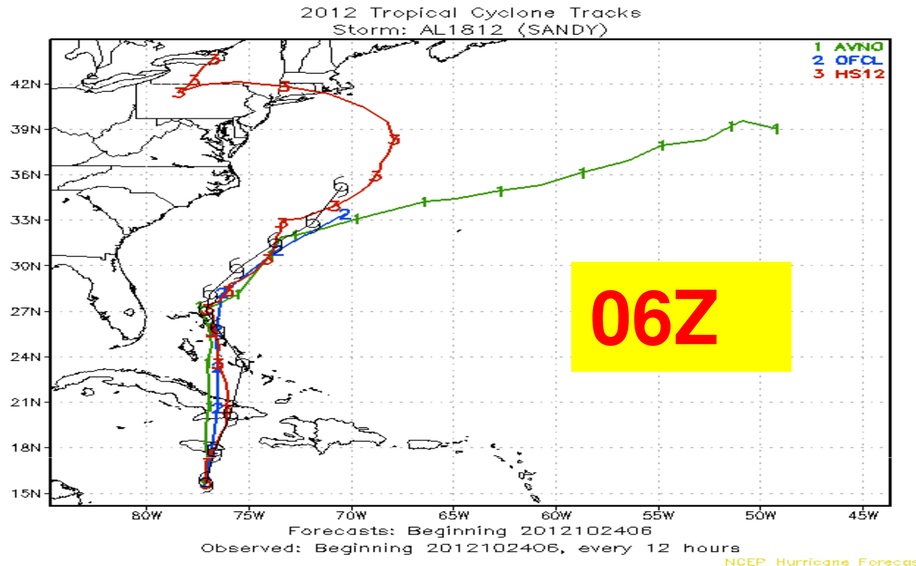


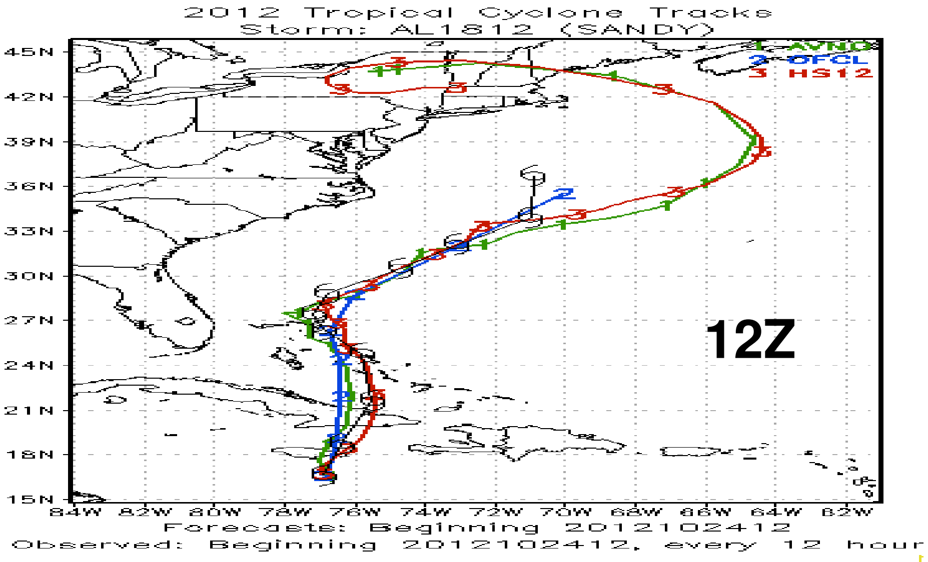


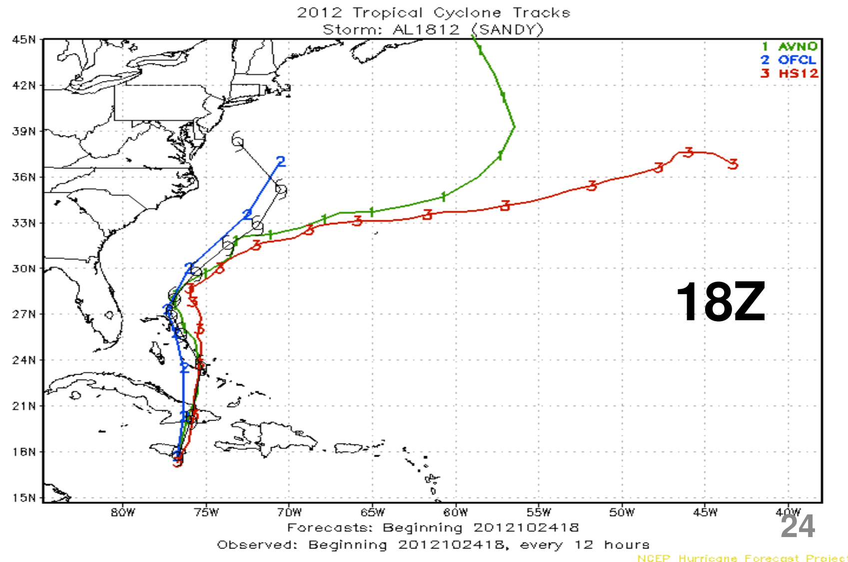


Tracks from 20121024: 00Z, 06Z, 12Z and 18Z Cycles
5 days before landfall

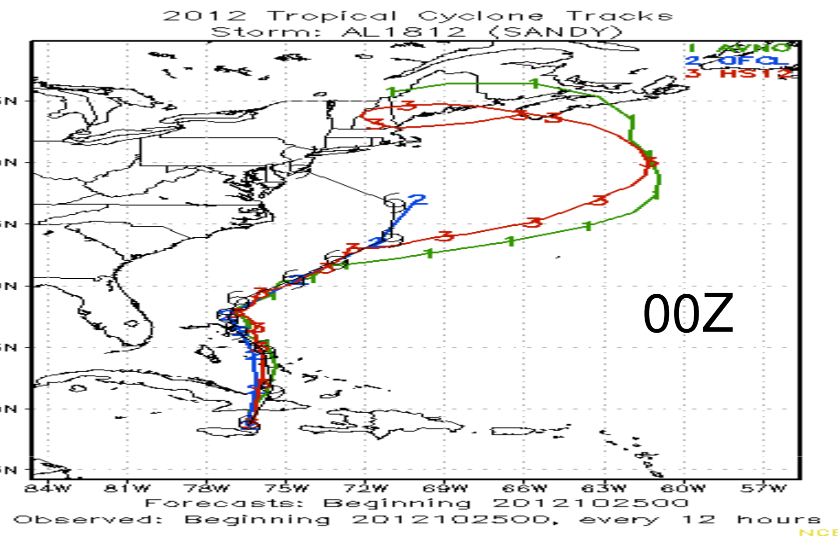


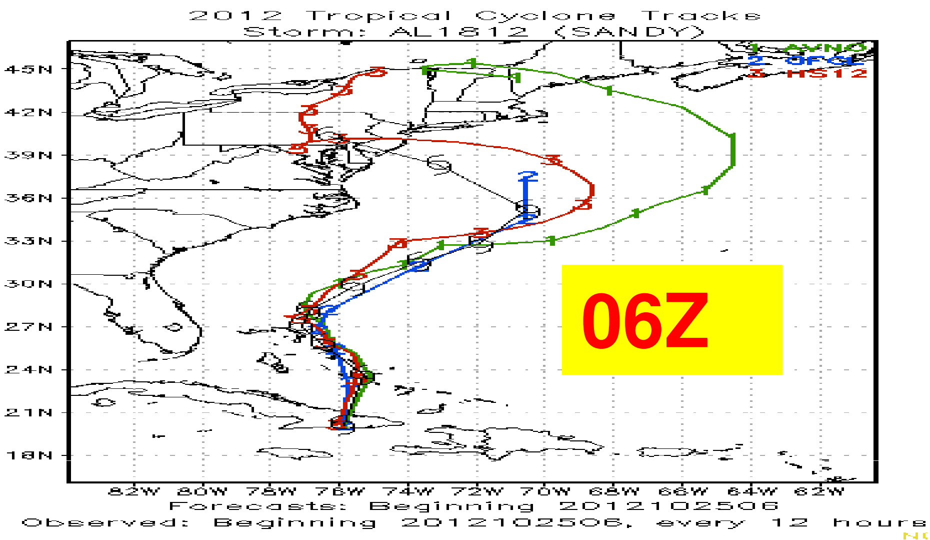


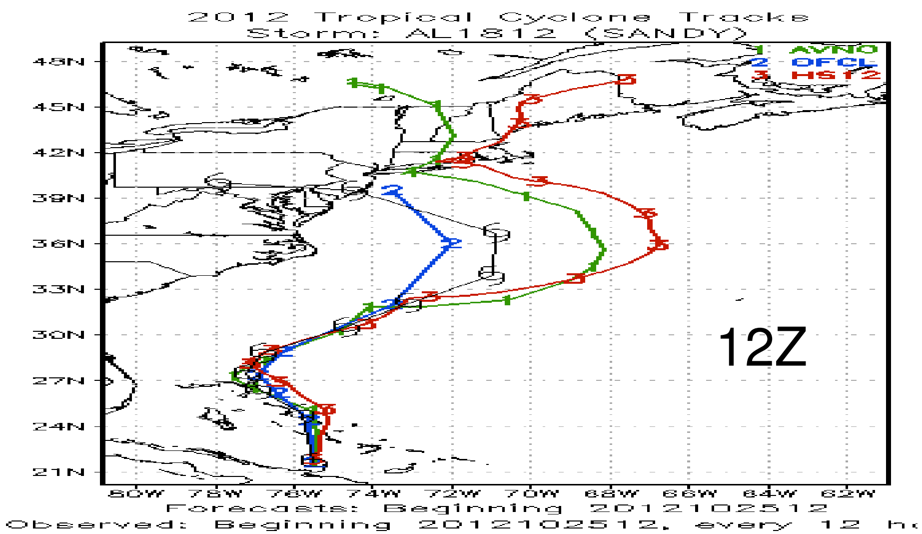


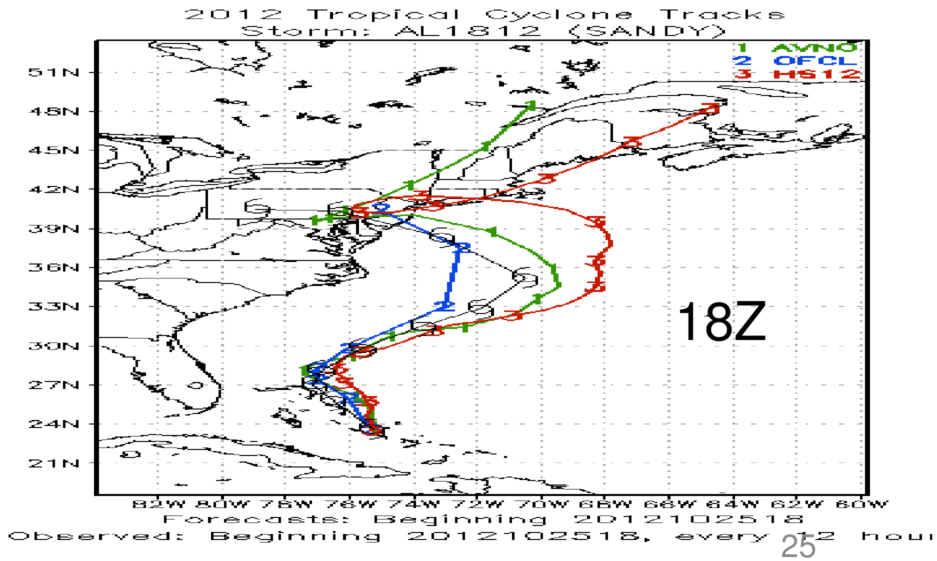


Tracks from 20121025: 00Z, 06Z, 12Z and 18Z Cycles
4 days before landfall

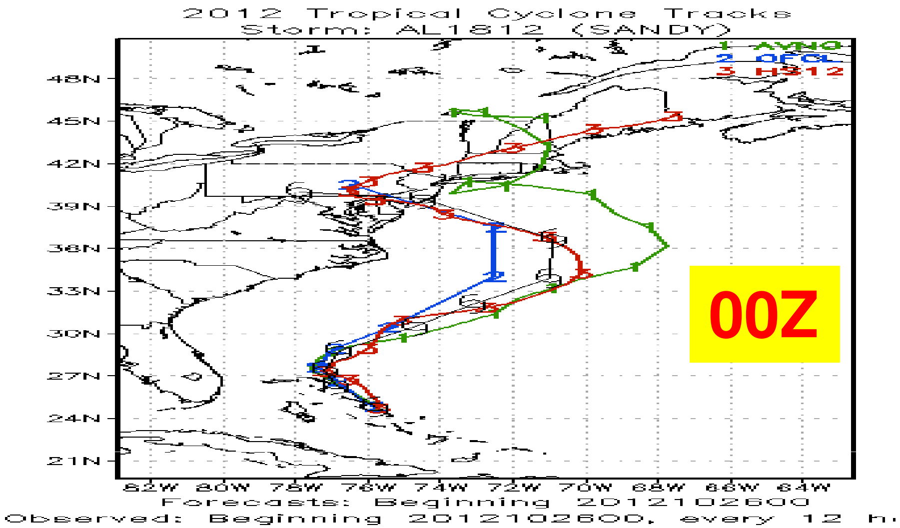


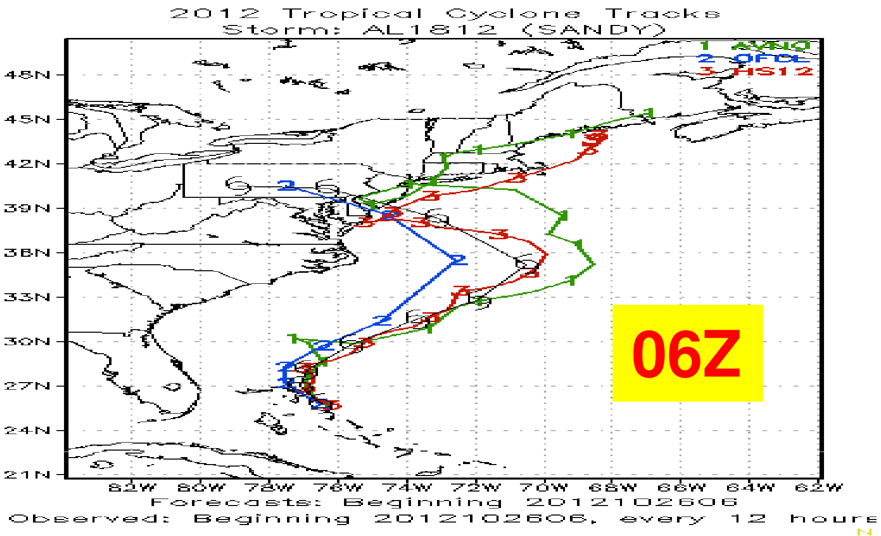


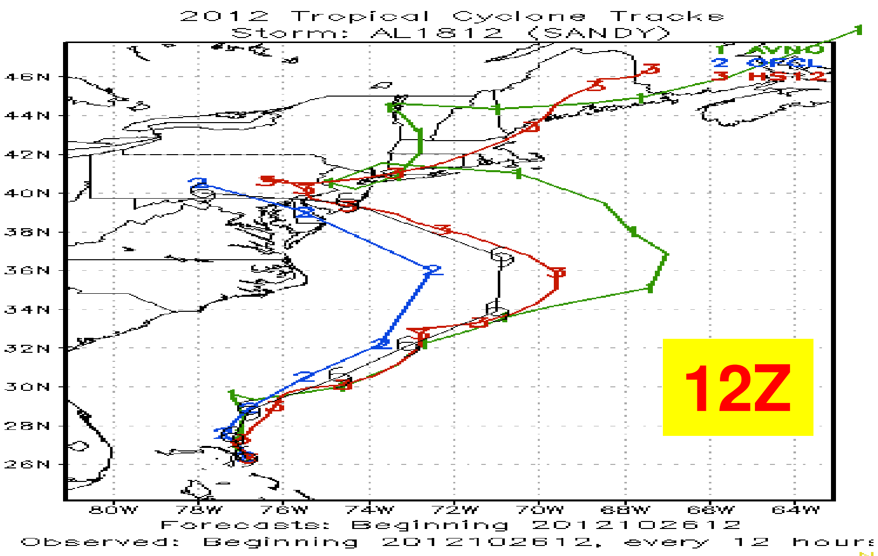


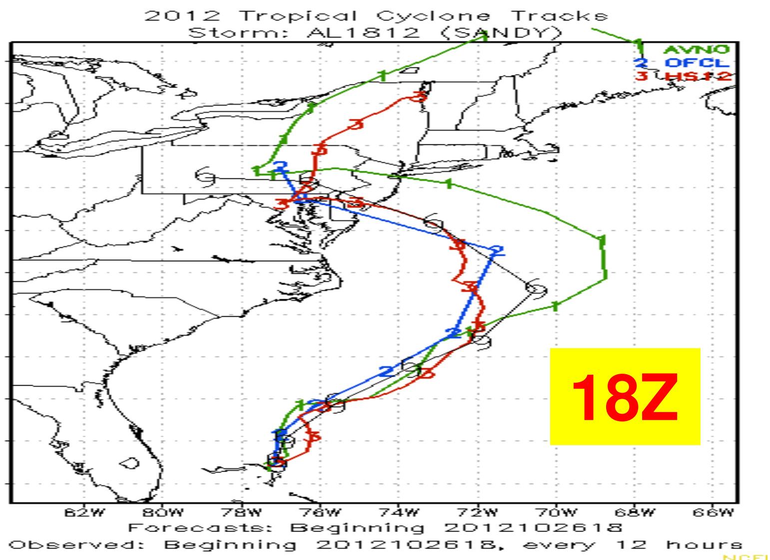


Tracks from 20121026: 00Z, 06Z, 12Z and 18Z Cycles
3 days before landfall

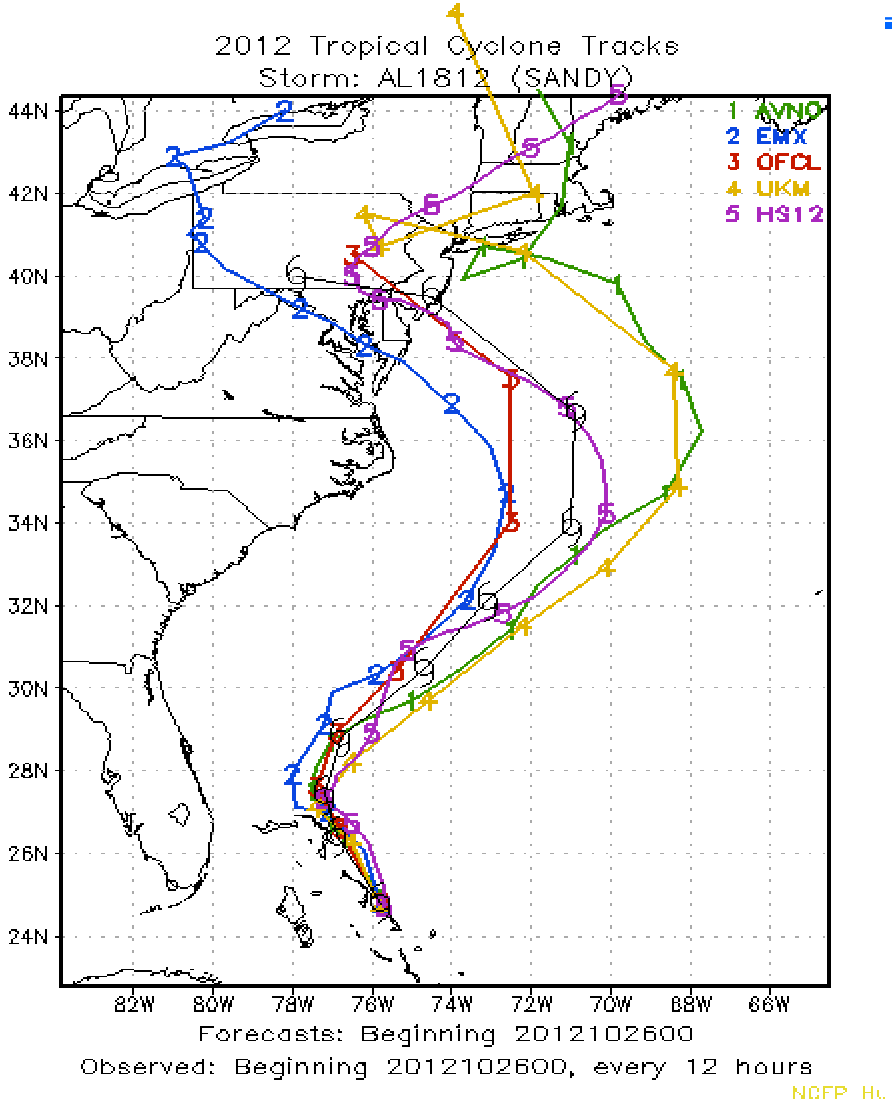


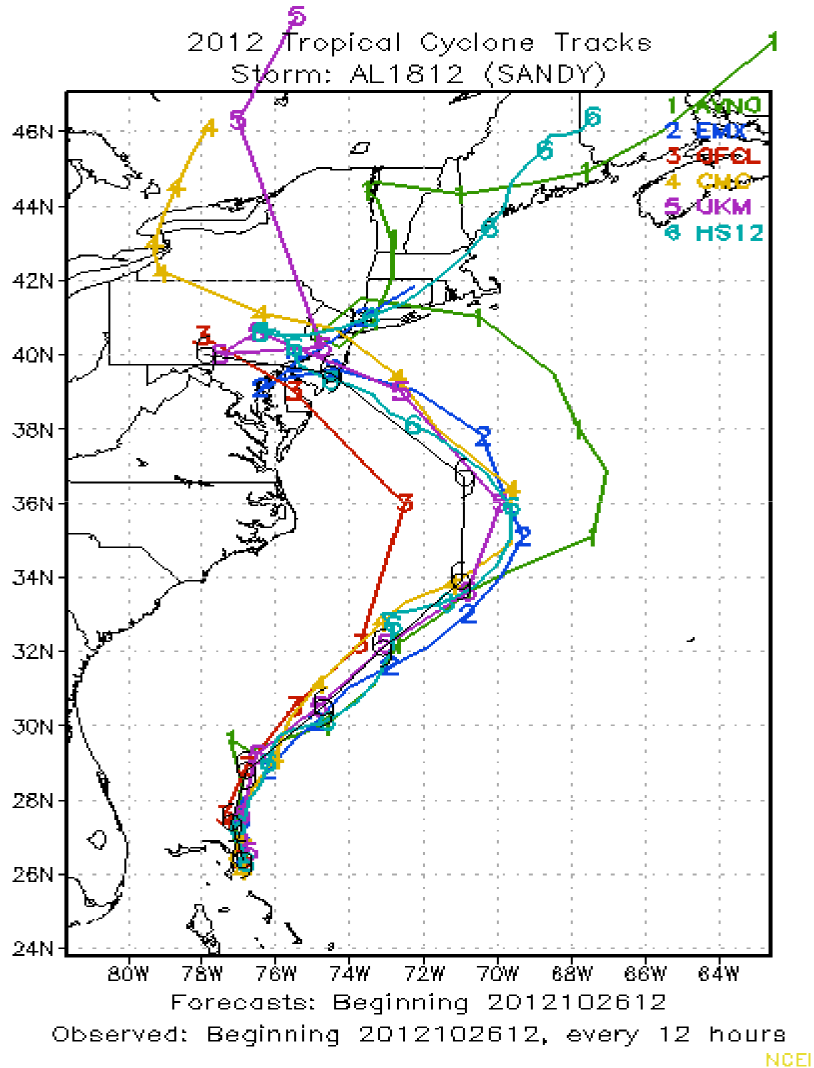






Tracks from Forecast Cycles 20121026 00Z and 12Z
3 days before landfall

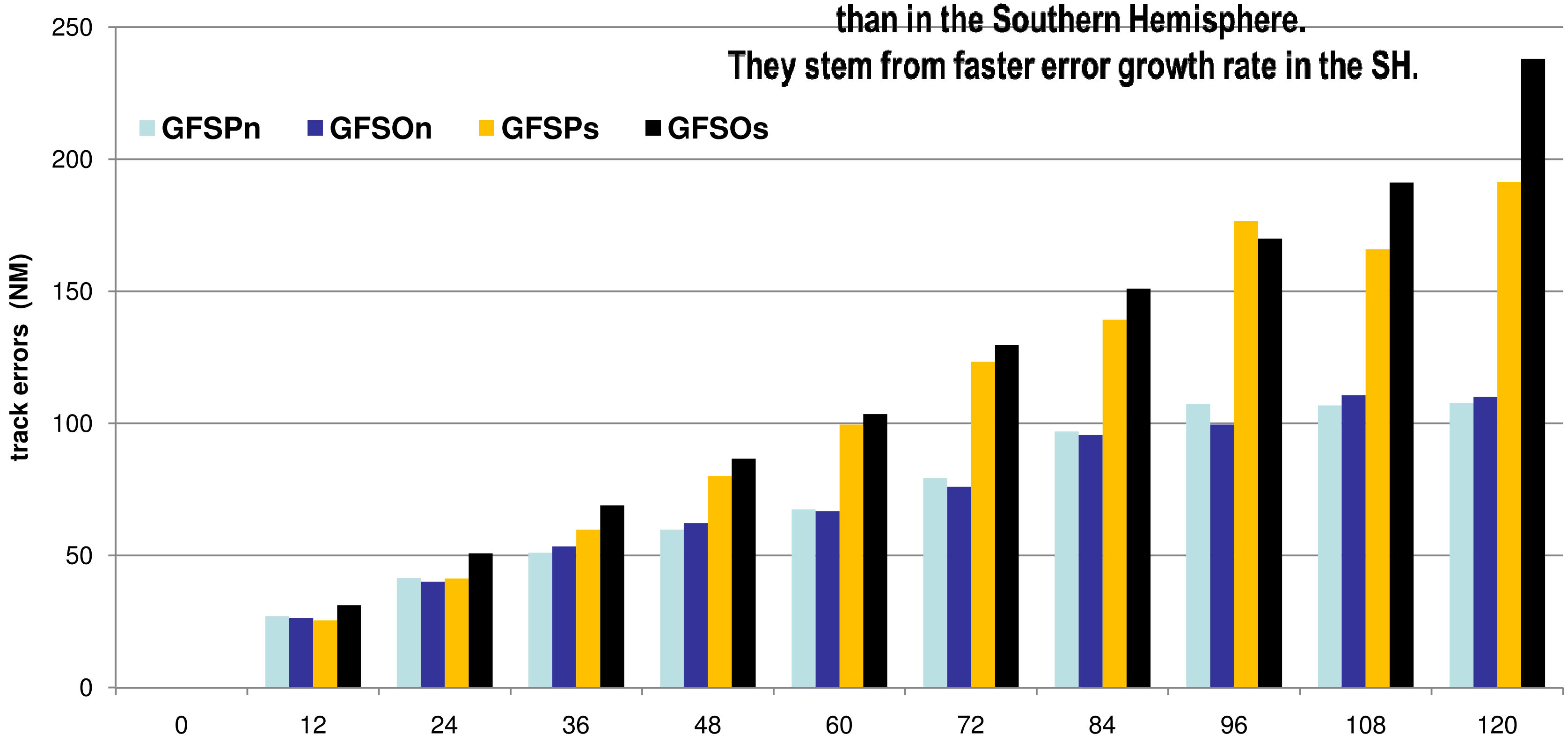




Extratropical Cyclone Track Errors (fcst cs analy)
June-Aug 2014 (Lat > 20N/S)

Courtesy of Guang Ping Luo

Track errors in the Northern Hemisphere is much smaller than in the Southern Hemisphere.
They stem from faster error growth rate in the SH.



GFSPn (blue) – Parallel GFS (NH); GFSOn(red) – Operations GFS (NH);
GFSPs (green) – Parallel GFS(SH); GFSOs (purple) – Operations GFS (SH).

fcst hr	0	12	24	36	48	60	72	84	96	108	120
NH cases	2145	1995	1752	1248	793	513	331	217	135	97	71
SH cases	1880	1742	1545	1014	564	309	157	79	43	19	8

Summary

- **All codes are now frozen, built in EE structure, and handed off to NCO for implementation.**

- Results are reasonable
  - Improved precipitation skill scores
  - Improved hurricane track in Atlantic and Western Pacific, but worsened in Eastern Pacific; Reduced intensity errors in all basins.
  - Reduced mid-latitude storm track errors.
  - Reduced global mean temperature bias in the upper troposphere; strengthened (improved) tropospheric winds but slightly weakened stratospheric winds.
  - Reduced nighttime 2m temperature cold bias over the Northern Great Plains. Large biases still exist in Northeast and Southwest.
  - improved 500-hPa HGT AC in both the Northern and Southern Hemispheres.