EMC CCB (Decisional Brief)
March 8, 2016

GDAS/GFS V13.0.0 Upgrades for 2016

Presented by:

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Based on Work Done by EMC DA, Land Surface, Ensembles, Waves and Hurricane Teams and GCWMB

GDAS/GFS upgrade

Project Status as of: 3/8/2016

Scheduling

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Milestone (NCEP)	Date	Status
Initial coordination with SPA team	6/1/15	Complete
Submit frozen codes to NCO to setup real-time and retrospective runs	8/21/15 → 8/25 →10/29/2015	Complete
Pre-CCB Briefing to EMC and OD	1/26/16 -→ 1/29/2016	Complete
Completion of full retrospective runs	2/1/16 →2/15/2016	Complete
EMC testing complete/external evaluation complete	10/22/15*→ 2/19//2016 → 2/29/2016	Complete
EMC CCB approval	10/23/15→ 2/22/2016 → 3/8/2016	**TODAY**
Management Briefing	1/15/2016 → 2/25/2016 → 3/10/2016 →3/17	Scheduled
Final GFS and all downstream codes submitted to NCO	10/27/15 → 1/15/2016 → 1/22/2016 → 1/27/2016 → 2/3/16	Complete
All non-GFS downstream codes submitted to NCO	2/9/2016 →2/19/2016 →3/4	Complete
Technical Information Notice Issued	11/30/15→ 2/23/2016 -->4/1	
SPA begins prep work for 30 day test	10/28/15 → 1/19/2016 →1/23/2016 → 1/28/16 → 2/4/2016	Complete
24-hr parallel production test	3/25/2016	
30-day evaluation begins	12/14/15→ 2/23/2016 →3/25 →3/30 →4/6	
30-day evaluation Ends	1/13/16→ 3/24 → 4/23 →4/28 →5/5	
IT testing ends	1/27/16→ 3/31/16 →4/23 →4/29	
Final Management Briefing	2/2/16→ 4/18 →4/29 →5/4 → 5/11	
Operational Implementation	2/16/16→ 4/19-→ 5/3 →5/10 →5/17	

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Project Information and Highlights

Leads:
Vijay Tallapragada, EMC, Becky Cosgrove, NCO

Scope:
1) Upgrade to 4D hybrid EnVar data assimilation
2) Produce hourly output out to 120 hrs
3) Address high bias in 2m temp. during summer*

Estimated Benefits:
1) Generally more skillful forecasts

Estimated Resources:
1) In the process of determining resources

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Issues/Risks

Issues:

Mitigation:

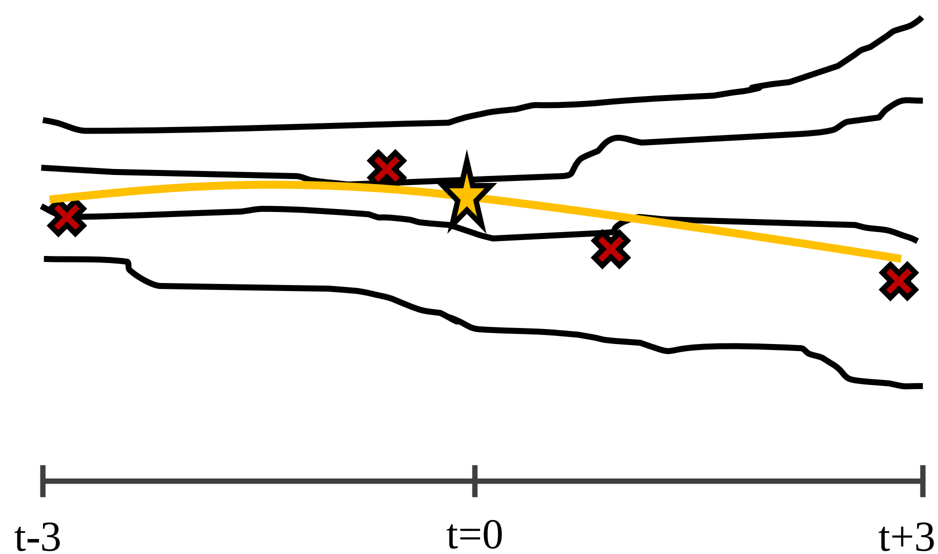
R Management Attention Required	Y Potential Management Attention Needed	G On Target

Table of Contents

Next GFS/GDAS in 2016
The 4D Hybrid En-Var

- 4-D hybrid
- Improved use of satellite radiances
- Improved use of satellite winds and aircraft observations
- Corrections to land surface to reduce summertime warm, dry bias over Great Plains
- CRTM v2.2.1
- NCEP_POST v7.0
- 3 years of forecasts produced and evaluated

4D Schematic



- The ensemble provides an updated estimate of situation dependent background error every hour as it evolves through the assimilation window. This flow dependent statistical estimate is combined with a fixed estimate.

DA and Model Changes

DA Changes: Theoretical and Observational

- 3D to 4D ensemble covariances
- Increase in ensemble contribution from 75% to 87.5%
- Reduction of horizontal localization length scales in the troposphere
- Removal of additive inflation
- Code optimization
- Limit moisture perturbations for improved minimization
- Inclusion of ozone cross-covariances
- Removal of time component for data selection
- 4D thinning of AMVs
- Aircraft temperature bias correction
- All sky microwave radiances
- CRTM upgrade

Forecast Model and Product Changes

- Convective gravity wave upgrade,
- Tracer adjustment upgrade
- ***Corrections to land surface to reduce summertime warm, dry bias over Great Plains***
- Improved icing probability products and new icing severity product
- ***Hourly output through 120-hr forecast***
- ***5 more levels above 10 hPa***

	Current 3DHybrid	Proposed 4DHybrid
Static / Ensemble Weights	25% static ; 75% ensemble	12.5% static; 87.5% ensemble
Additive Inflation	5%	0%
Tropospheric localization length scales		½ of current 3D Hybrid

Addressing Summer-time Warm/Dry Biases

GFS showed too little evaporation and too much sensible heat flux, hence Bowen ratio is too high. The factors include:

•Thermal roughness and momentum roughness
•Canopy resistance
•Soil moisture
•……..

We proposed the following parameter refinements in Q3FY16 GFS:

- **rsmin for grassland from 45 to 20**
- **rsmin for cropland from 45 to 20**
- **roughness length for cropland from 3.5cm to 12.5cm (used to address too strong surface winds)**

New Model Upgrade Evaluation Strategy

GCWMB real time (pr4devb)
period: 2015070100 - real time

GCWMB 2015 summer retrospective (pr4devbs15) --- Completed
period: 2015041500 - 2015120100 (230 days)

GCWMB 2013 summer retrospective (pr4devbs13) ---Completed
period: 2013041500 - 2013120100 (230 days)

NCO 2013-2014 winter retrospective (pr4devbw13) --- Completed
period: 2013110100 - 2014060100 (212 days)

NCO 2014 summer retrospective (pr4devbs14)---Completed
period: 2014050100 - 2014120100 (214 days)

GCWMB 2014-2015 winter retrospective (pr4devbw14) --- Completed
period: 2014110100 - 2015070100 (242 days)

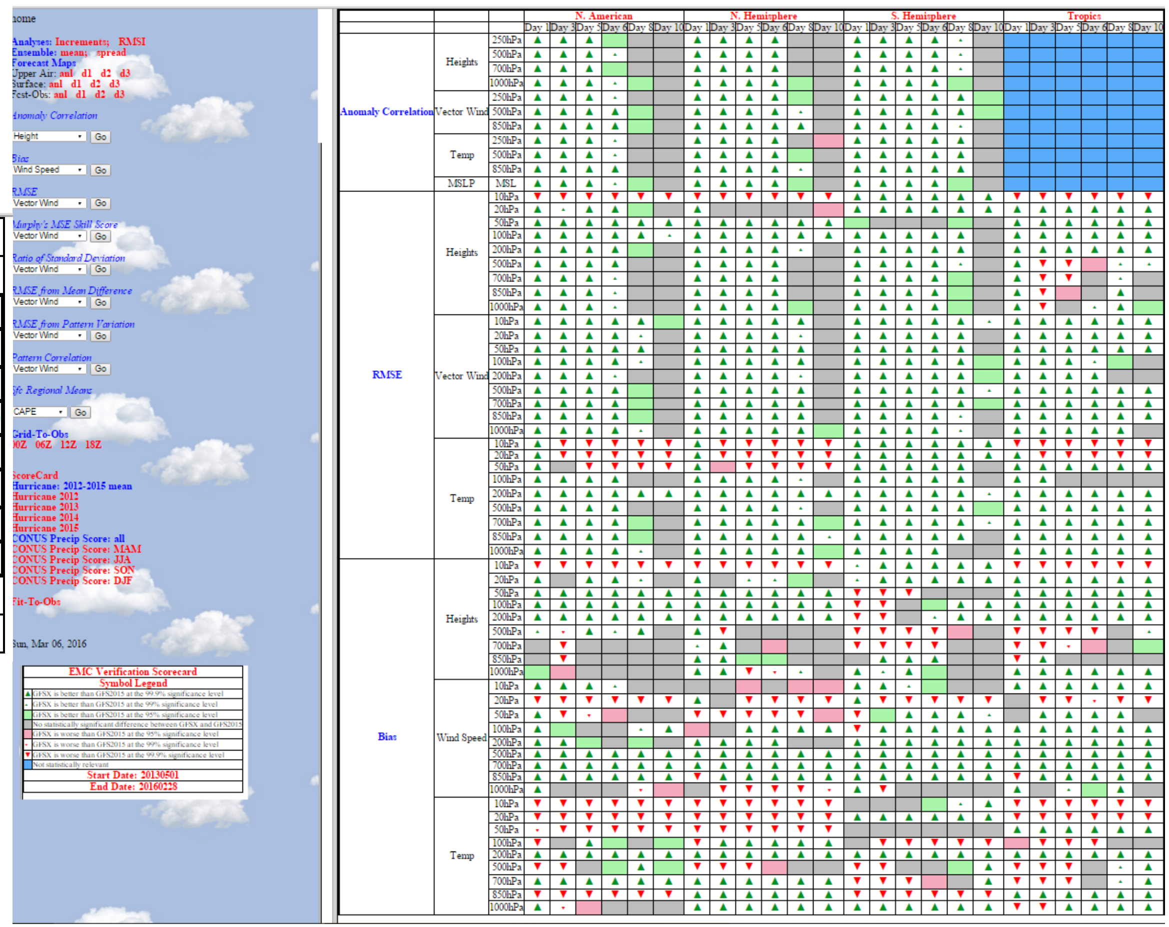
GCWMB Special retrospective for H. Sandy
period: 2012101700 - 201213100 (15 days) **--- Completed**

- **Involve field in real-time and retrospective evaluation of science upgrades --- Completed**
- **Identify case studies and provide data for extended evaluation period beyond last 30-day parallel --- Completed**
- **NCO 30-day parallel is only for IT evaluation**

Comprehensive Evaluation from EMC Part 1

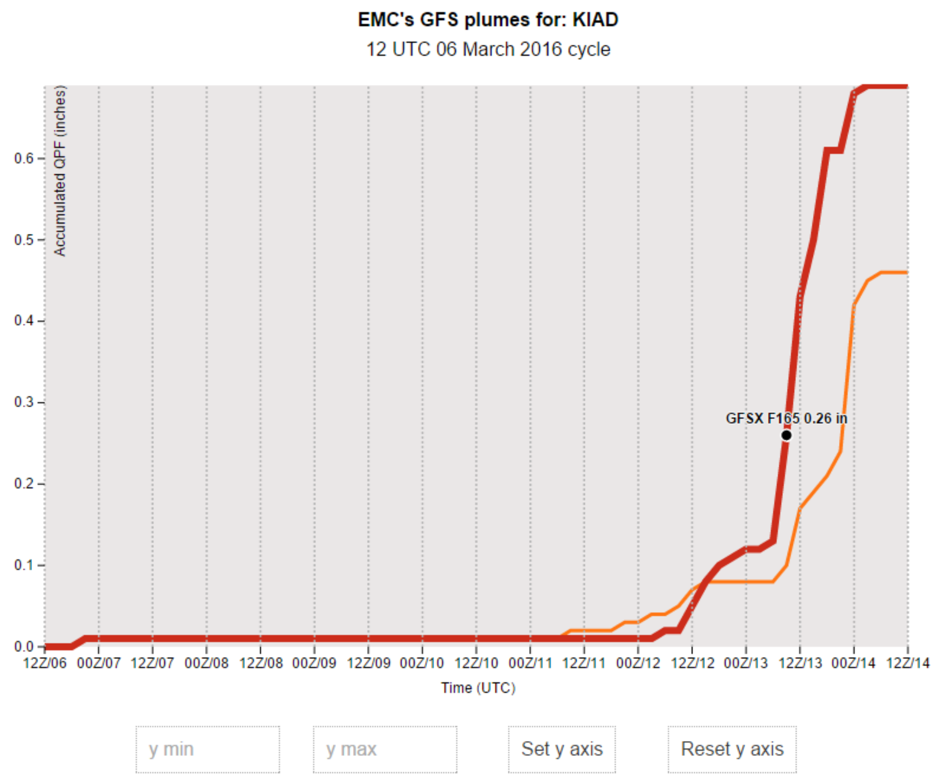
- Retrospectives—Standard verification page against own analyses, GFS2015 vs. GFS2016: http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/gfs2016/

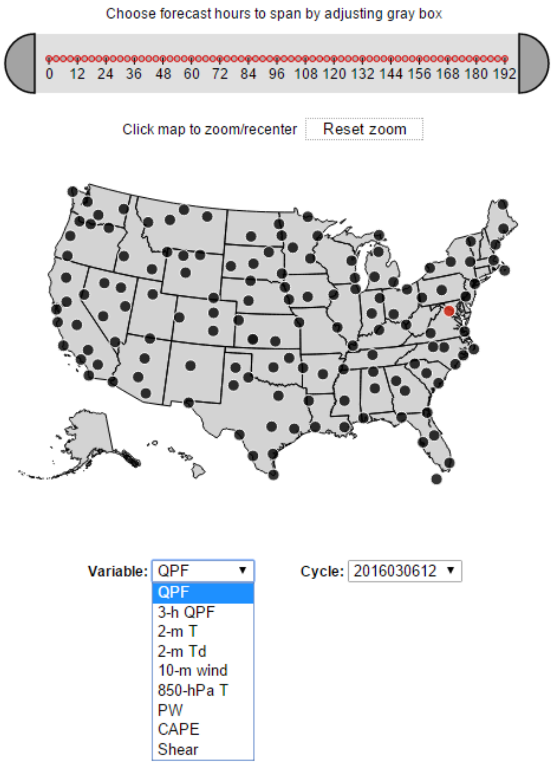
EMC Verification Scorecard	
Symbol Legend	
▲ (large green)	GFSX is better than GFS2015 at the 99.9% significance level
▲ (small green)	GFSX is better than GFS2015 at the 99% significance level
(green)	GFSX is better than GFS2015 at the 95% significance level
(grey)	No statistically significant difference between GFSX and GFS2015
(pink)	GFSX is worse than GFS2015 at the 95% significance level
▼ (small red)	GFSX is worse than GFS2015 at the 99% significance level
▼ (large red)	GFSX is worse than GFS2015 at the 99.9% significance level
(blue)	Not statistically relevant
Start Date: 20130501	
End Date: 20160228	



Comprehensive Evaluation from EMC Part 2

- Real time plots of near surface variables at representative stations: http://www.emc.ncep.noaa.gov/gc_wmb/parthab/Plume_test/GFSx/EMCGEFSplumes.html





About the plumes: Data for each station is interpolated from a 0.25-degree grid for both the GFS T1534 operational (Orange line); and GFSx T1534 (Blue line). This site is not operational; therefore, data may be missing occasionally.

Comprehensive Evaluation from EMC Part 3

- GFS Soundings available on case by case basis, real-time page for selected cities: http://www.emc.ncep.noaa.gov/gc_wmb/tdorian/meg/index.html

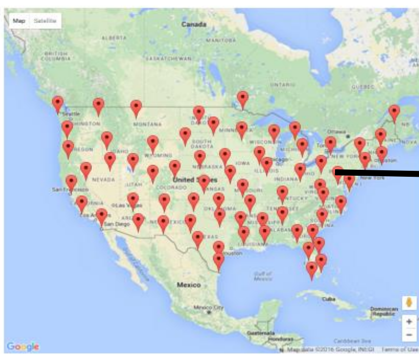
Daily Sounding Verification for the GFS and the GFSX

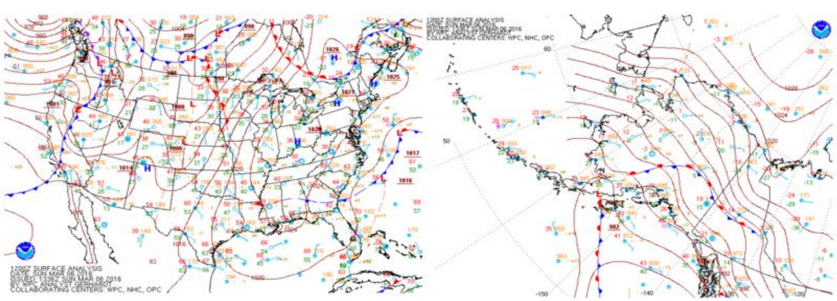
(12-h forecasts valid at 12Z)

Soundings update everyday shortly at 15UTC

** Work in Progress **

* Will add many more stations in the near future *





Please contact tracey.dorian@noaa.gov for any questions (or for archived sounding requests)

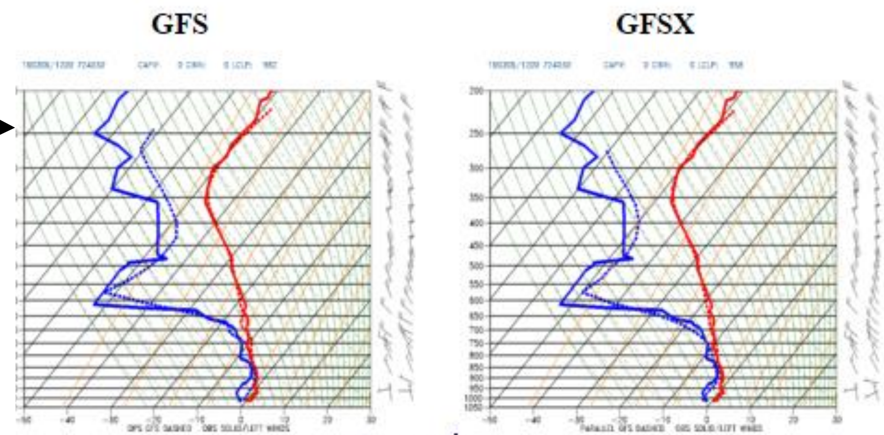
* Archived soundings go back to January 11, 2016 for most stations

12-h VERIFICATION

INITIALIZED AT 00Z

VALID AT 12Z

WASHINGTON/DULLES



Dashed = Forecast
Solid = Observations
Left winds = Observations

Comprehensive evaluation Part 4 (Centers, Regions & case studies)

Case Studies	Case Studies
MEG review of case studies proposed by WPC, Western Region and Central Region	A case study for Dec. 5-6, 2013 requested by Southern Region
MEG review of additional case studies	Blizzard of January 22-23, 2016
Presentation to WPC on case studies	Precipitation cases for WPC
Western Region/Central region case study	Height field evaluation for WPC
Central Region case study, Alaska case study and Southern Region case study	Operational and experimental GFS forecasts for Atsani (extratropical transition, Alaska region)
Case studies for Central Region March 23, 2015; April 2, 2015; June 4-5, 2015; July 6, 2015	MODE evaluations of new GFS: Precip; Total Winds; Zonal Winds; Meridional Winds; and CAPE
A case study of the Nov. 16-17, 2015 tornado outbreak in Texas and Oklahoma	WPC documentation of dry bias over the southeast US in the GFS and GFSX
Evaluation from EMC Teams: HWRF; Ensemble; Wave	Case study of GFS and GFSX cold bias over snowpack
Hurricane Joaquin and South Carolina flooding	Verification from Data Assimilation perspective
Warm dry bias over Great Plains in summer: Here and Here; Case study: Here	MEG presentations reviewing the new GFS Nov. 12 ; Nov. 19; Dec. 17; and Feb. 11
Extratropical storm tracks	Evaluation from the Centers: CPC; NHC; SPC; OPC;
Comparison of systematic errors in the GFS and GFSX	Forecast tracks for Sandy

Evaluation of Q3FY16 GDAS/GFS Upgrade:

EMC Perspective

Summary of various evaluation metrics

Evaluation	Remarks
Analysis increments	2016 GFS much smaller increments --analysis and first guess in better agreement
Score card	Significant improvements in many aspects of the evaluation metrics. *Upper Stratospheric biases showed degradation.*
500 hPa ACC	0.004 gain in NH; 0.007 gain in SH; statistically significant improvements through 168 hrs
Surface heights	Significant improvements through 192 hrs in both hemispheres
Winds	Significant reduction of RMSE through 240 hrs in both hemispheres and global tropics
Temperature RMSE	Big improvements in Southern Hemisphere. *Upper troposphere/ Stratosphere in Northern Hemisphere has increased RMSE*. 850 hPa temperatures significantly improved.
Temperature fit to obs	Better fit to obs except in the upper stratosphere. Significant reduction of RMSE in NH, SH and global tropics.

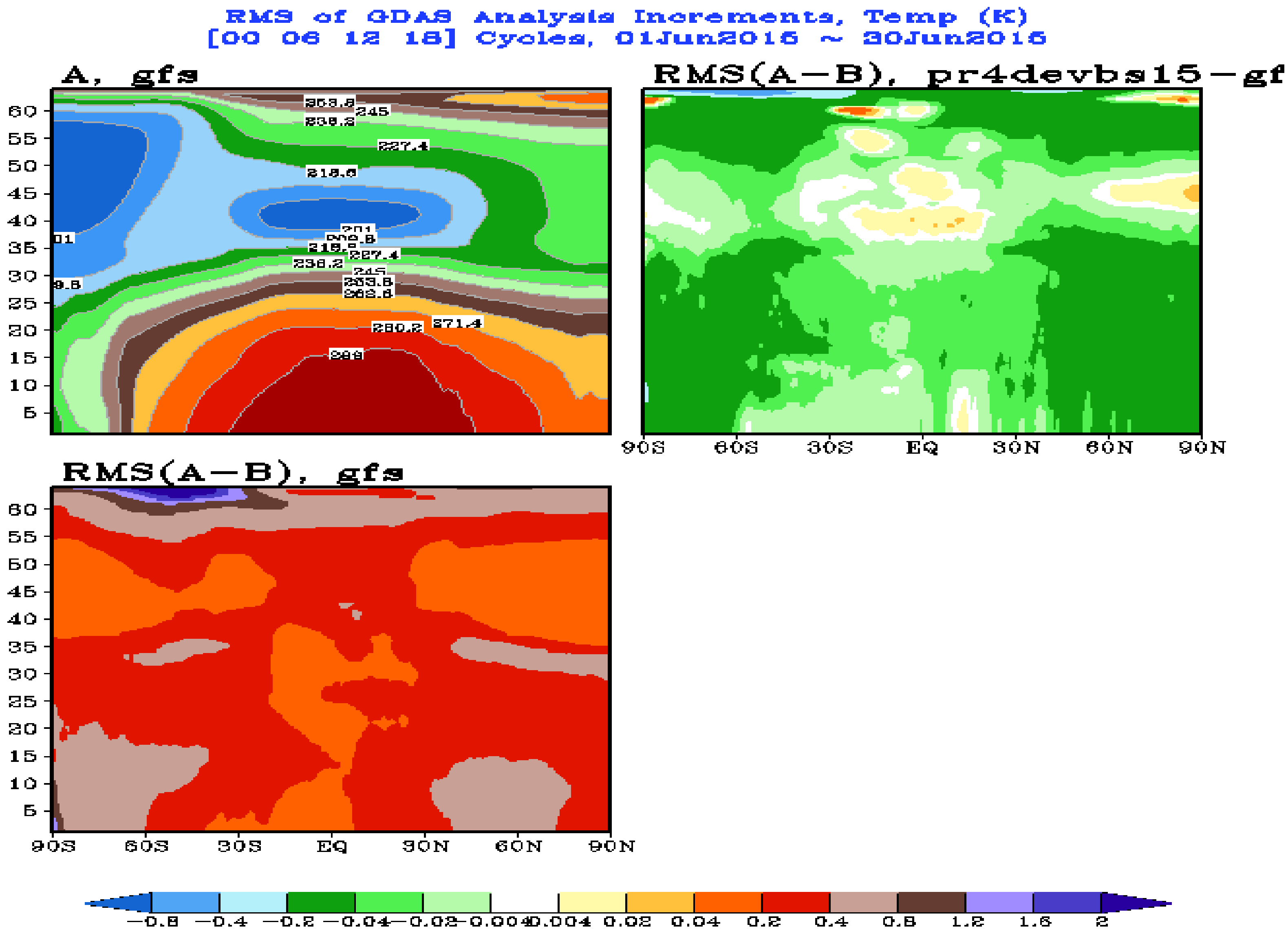
Summary of various evaluation metrics

Evaluation	Remarks
Vector wind RMSE	Better fit to obs, significant reduction of RMSE in NH, SH at 850 and 200 hPa. No significant change in global tropics.
CONUS Precip	*Rain/no rain (Threshold of 0.2 mm/day) worse in GFSX* Thresholds of 2 to 25 mm/day significantly improved
CONUS Near Surface Fields	Significant improvements in T2m, Td2m, Latent Heat, CAPE and Surface Winds
Hurricane Tracks and cyclogenesis	Positive improvements in both NATL and EPAC, for tracks and intensity. Significant improvement in tropical cyclogenesis forecasts.
TAFB	GFSP seemed to have an advantage at longer lead times for gap wind events
Extra tropical cyclone tracks	7 out 10 times, errors in GFSX are smaller than in GFSO in winter. During summer months, the errors are always smaller in parallel GFS.
OPC Evaluation	Track errors for winter season are a slight improvement shorter term and no significant improvement medium range

Summary of various evaluation metrics

Evaluation	Remarks
MODE verification	Jet Streams: GFSX generally looks "better" and closer to the ECMWF; QPF: GFSX has higher MMI (Median of Maximum Interest) values for all forecast hours except at 60-h; CAPE: GFSX somewhat better than GFS. *Both underestimate compared to RAP analysis*
Case studies from Field	GFSX better in 6 cases out of 9, *operational GFS better in 3* (subjective evaluation)
Typhoon Astani	GFSX better in 7 verification times, *operational GFS in 3 verification times*.
WPC Case studies	Of the 6 precipitation case studies (36 hour forecasts), the GFSX did better for 3 cases, *the operational GFS was better for 1 case*, and both models tied for 2 cases.
Ensemble Team verification	2014 Winter: Good for short forecast (days 1-3); *Slight degradation (days 5-10)*. 2014 Summer: Good for all lead time (out to day 12)
HWRF Team	New GFS shows improved track and intensity forecasts in the N. Atlantic and neutral impact in the E. Pacific

2016 GFS much smaller increments --analysis and first guess in better agreement



Fit to Obs Evaluation

Red: Worse
Green: Better

Temperature

	Analysis fit to radiosondes	Forecast fit to radiosondes
NH	1000-400, 150-20 hPa 200-300 hPa	30, 20 hPa 1000-100 hPa
SH	925-700, 100-20 hPa 400-200 hPa	30 hPa 1000-100 hPa
Tropics	975-100, 150-20 hPa 250, 300 hPa	850-400, 200-100, 20 hPa 300, 250, 70, 50 hPa

Winds

	Analysis fit to radiosondes	Forecast fit to radiosondes
NH	1000-500, 150-20 hPa 300, 250hPa	30, 20 hPa 1000-70 hPa
SH	1000-400, 150-20 hPa 250 hPa	1000-70, 20 hPa
Tropics	1000-400; 150-50 hPa 250, 300 hPa	1000, 850-250, 150-50 hPa

Score Card for Verification of Q3FY16

34 months of retrospectives (2013-2016)

EMC Verification Scorecard

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<="" td="">	Not statistically relevant

Start Date: 20130501

End Date: 20160228

34 months

Verified against own analyses

Anomaly Correlations & RMSE GFSX vs. GFS

			N. American						N. Hemisphere						S. Hemisphere						Tropics					
			Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10
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Biases
GFSX vs. GFS

			N. American						N. Hemisphere						S. Hemisphere						Tropics					
			Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10	Day 1	Day 3	Day 5	Day 6	Day 8	Day 10
Bias	Heights	10hPa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▴	▲	▲	▲	▲	▲	▼	▼	▼	▼	▼	▼
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		50hPa	▲	▼	▾				▼	▼	▼	▼	▼		▼		▲	▲	▲	▴		▲	▲	▲	▲	
		100hPa	▲				▴	▲			▲	▲	▲	▲	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		200hPa	▲	▲					▲	▲	▲	▲			▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		500hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
		850hPa	▲	▲	▲	▲	▲	▲	▼	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▼	▲	▲	▲	▲	▲
		1000hPa	▲				▾			▼	▼	▼	▼	▾	▲	▼					▲		▴		▲	
	Temp	10hPa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼					▴	▲	▼	▼	▼	▼	▼	▼
		20hPa	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▼	▼	▼	▼	▼	▼
		50hPa	▾	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼							▲	▲	▲	▲	▲	▲
		100hPa	▼		▲				▼	▲	▲	▲	▲	▲		▼	▼	▼	▼	▼		▼	▼	▼		
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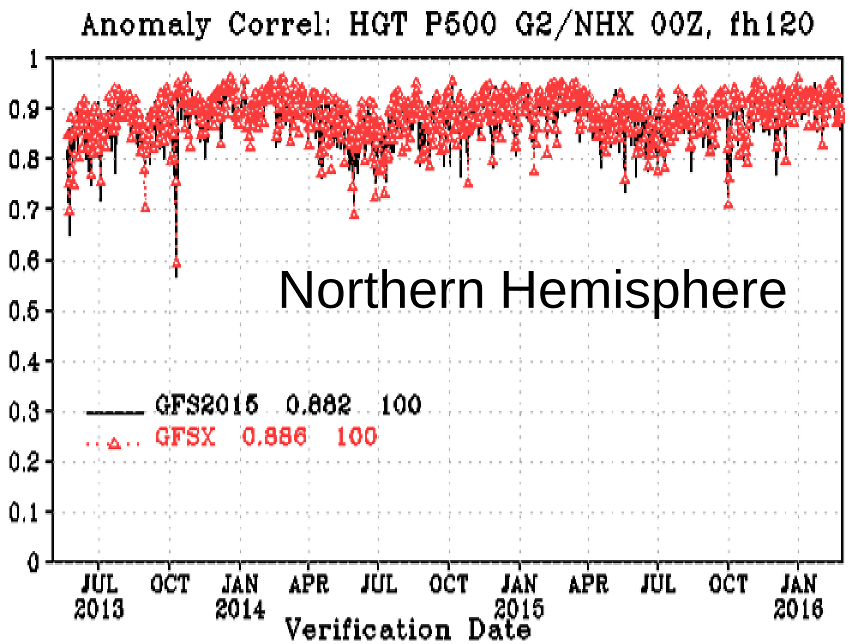
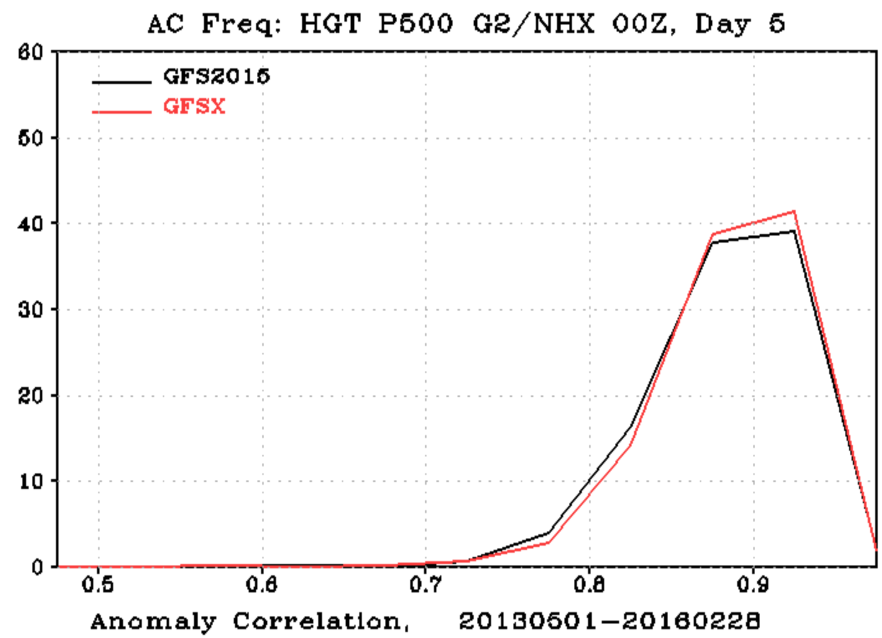
		500hPa	▼	▼			▲		▼	▼	▼				▼	▼				▲	▼	▼	▼		▴	▲
		700hPa	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▼	▼	▼			▲	▼	▼	▼		▴	▲
		850hPa	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲	▼	▼	▼	▼	▼	▼	▲	▲	▲	▲	▲	▲
		1000hPa	▲	▾					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▼	▼	▲	▲	▲	▲

Significant improvements in many aspects of the evaluation metrics.

Upper Stratospheric biases showed degradation.


Anomaly Correl: HGT P500 G2/NHX 00Z, fh120
Northern Hemisphere
GFS2015 0.882 100
GFSX 0.886 100
Verification Date
JUL 2013
OCT
JAN 2014
APR
JUL
OCT
JAN 2015
APR
JUL
OCT
JAN 2016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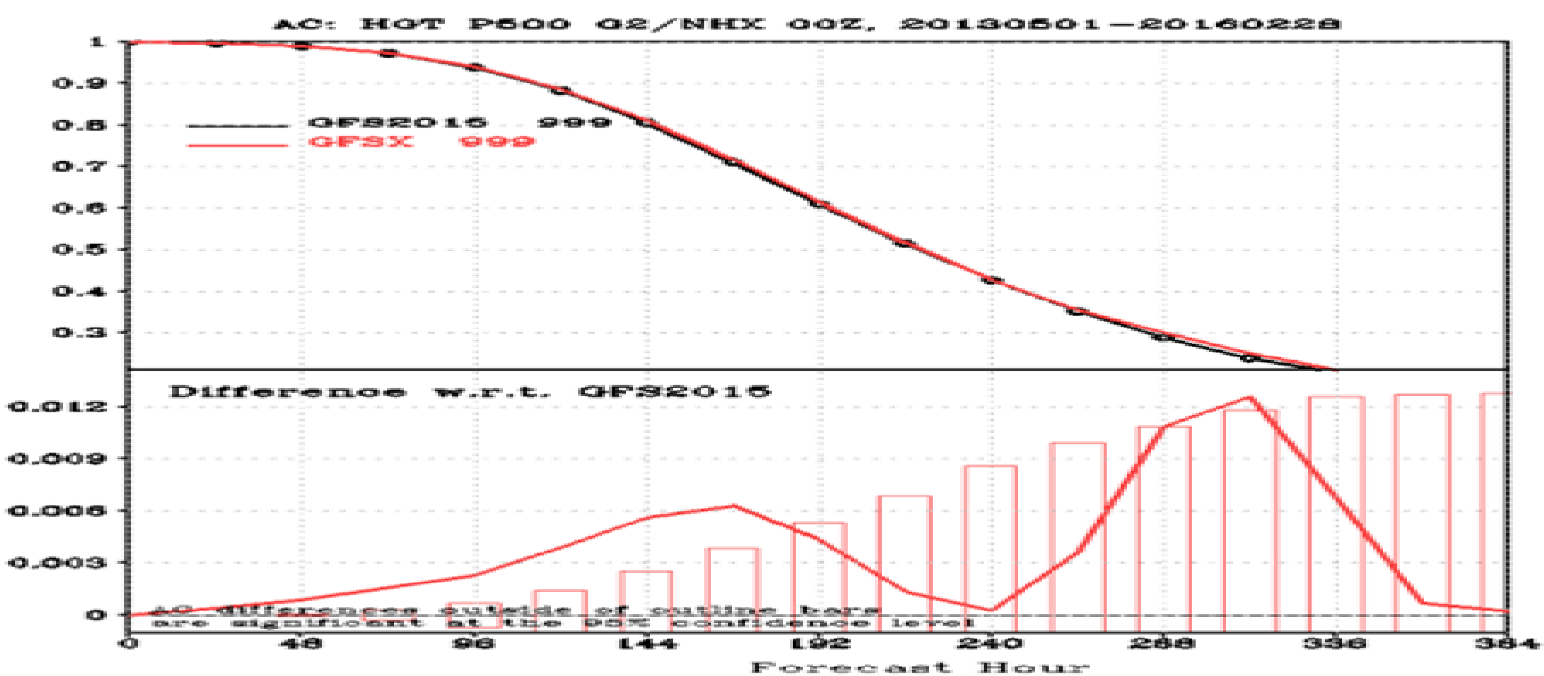
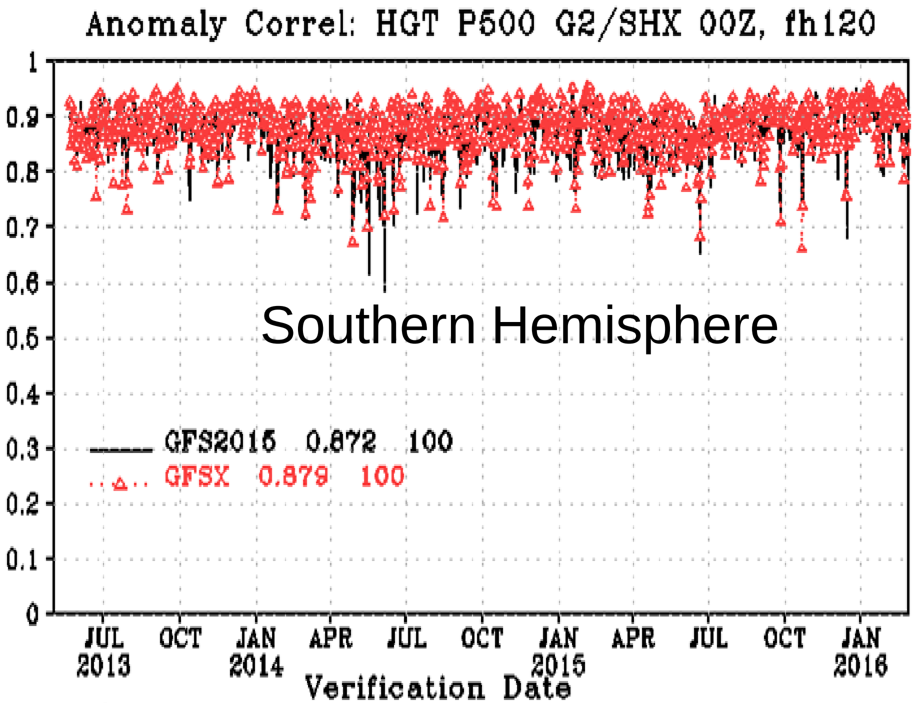
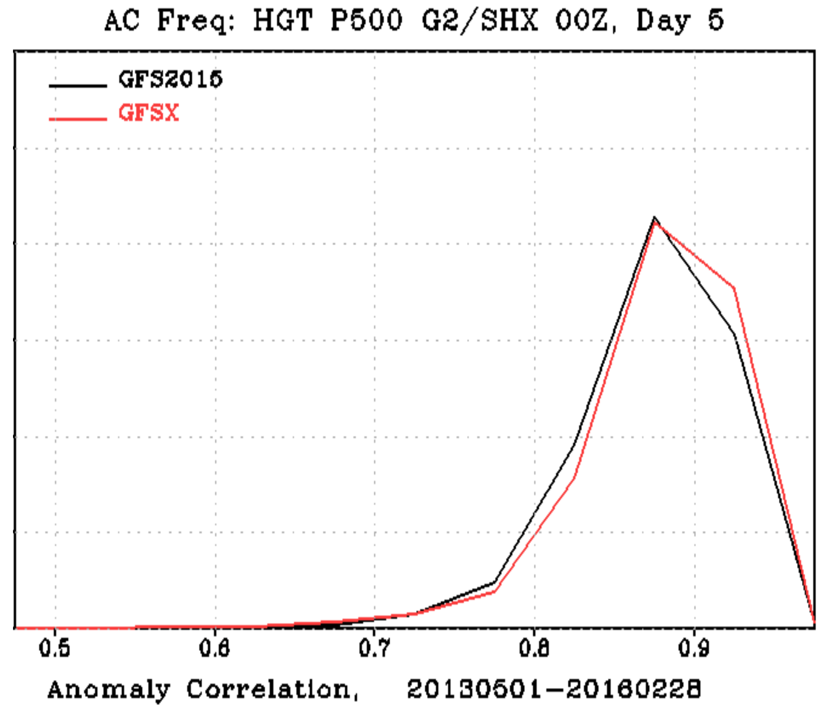
GFS2015
GFSX
Anomaly Correlation, 20130501-20160228


GFS2015 999
GFSX 999
Difference w.r.t. GFS2015


Anomaly Correl: HGT P500 G2/SHX 00Z, fh120
Southern Hemisphere
GFS2015 0.872 100
GFSX 0.879 100
JUL 2013
OCT
JAN 2014
APR
JUL
OCT
JAN 2015
APR
JUL
OCT
JAN 2016
Verification Date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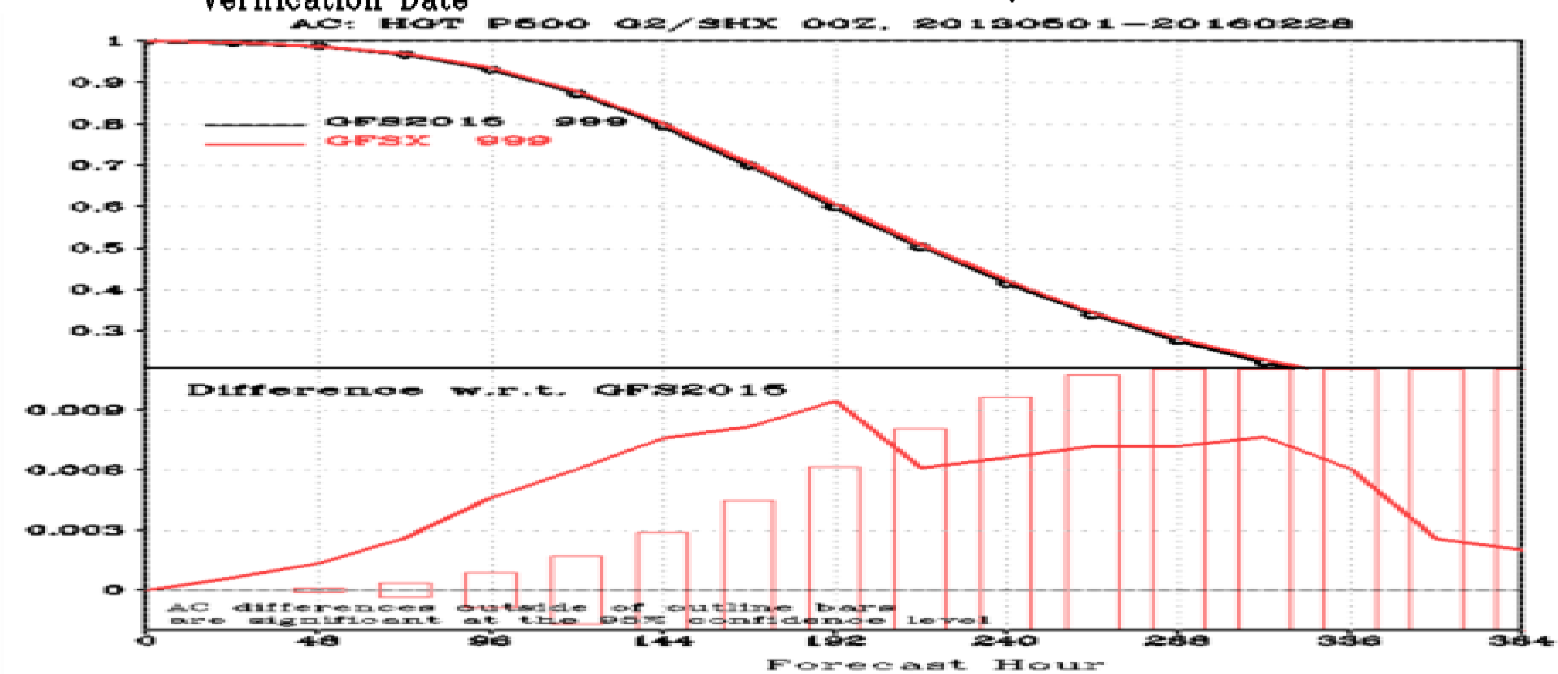
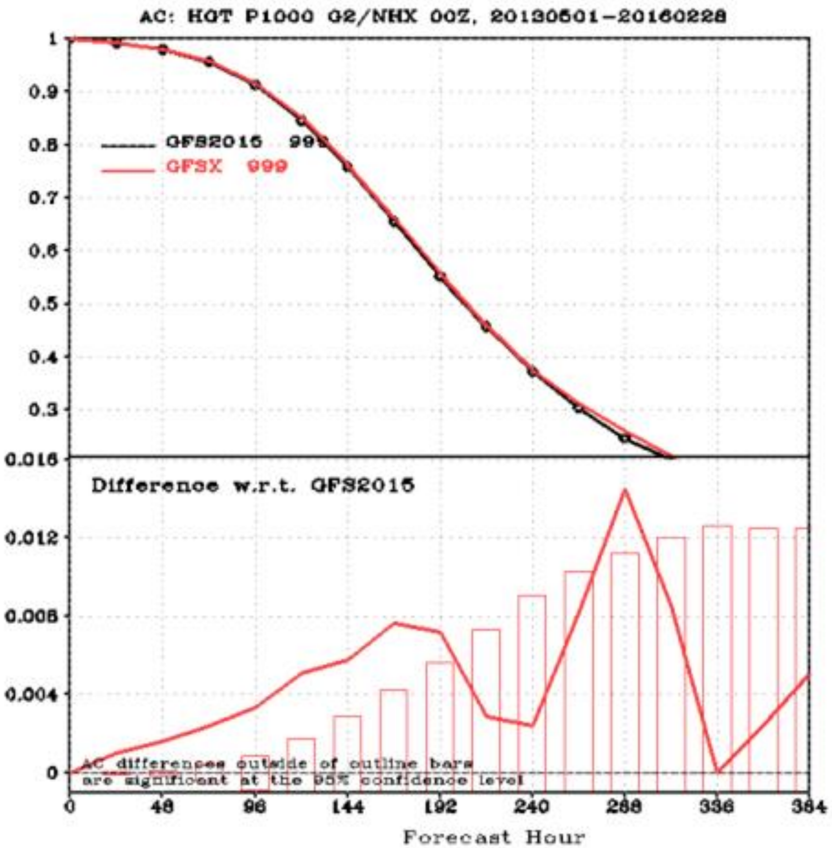
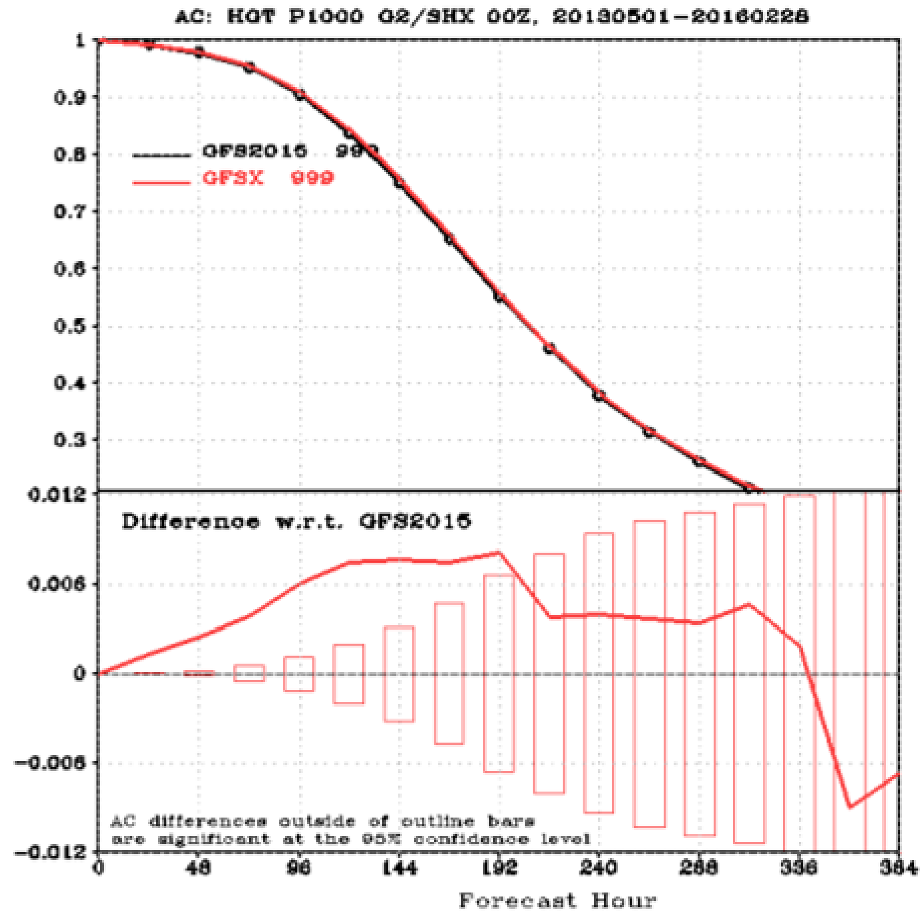
GFS2015
GFSX
Anomaly Correlation, 20130501-20160228


AC: HGT P500 G2/SHX 00Z, 20130501-20160228
GFS2015 999
GFSX 999
Difference w.r.t. GFS2015
AC differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

Surface heights



Northern Hemisphere



Southern Hemisphere

Assessment of impact of LSM changes

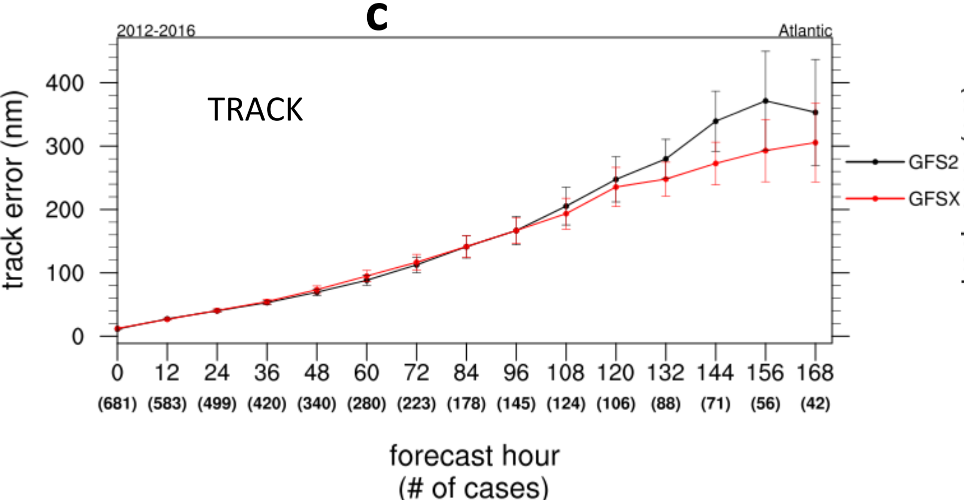
- 2m T cooler, bias is worse over the Northern Plains and Northeast,   Better over southern plains and southeast
- RMS error improved over northern and southern plains, Southeast and Alaska, worse over northwest
- 10 m winds decreased, RMS error improved

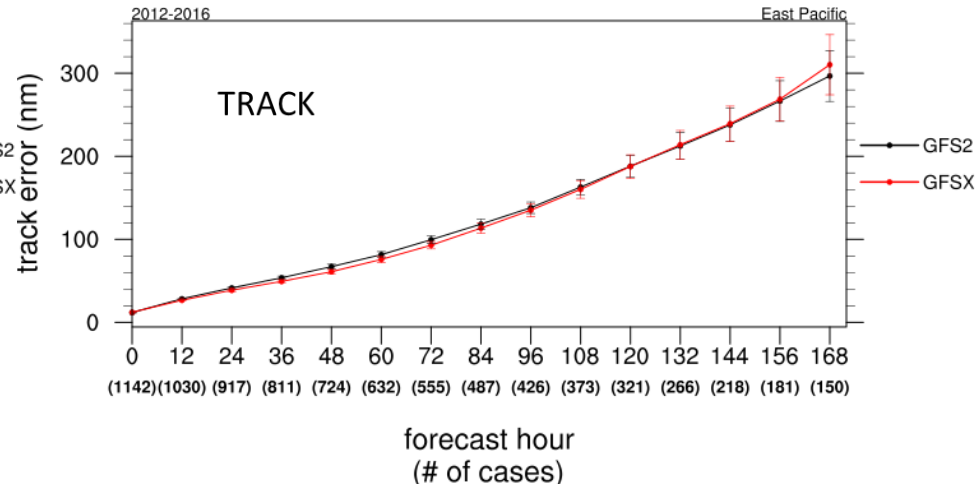
- **The land surface parameter refinements have significantly reduced the warm/dry biases in the summer**

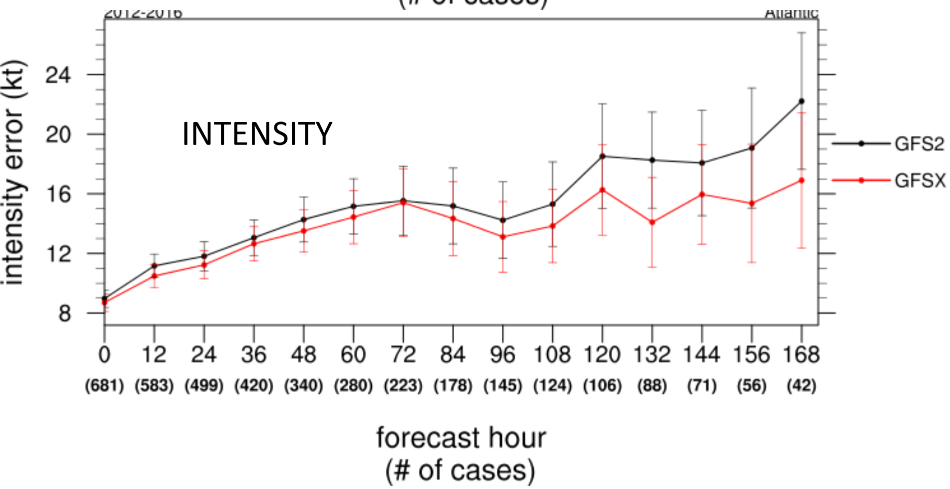
- **The change has little impact in the winter. However there are some degradations in the spring/fall. Also it is worst in 00Z (sunset). Some of them will be addressed in the next GFS physics implementation.**

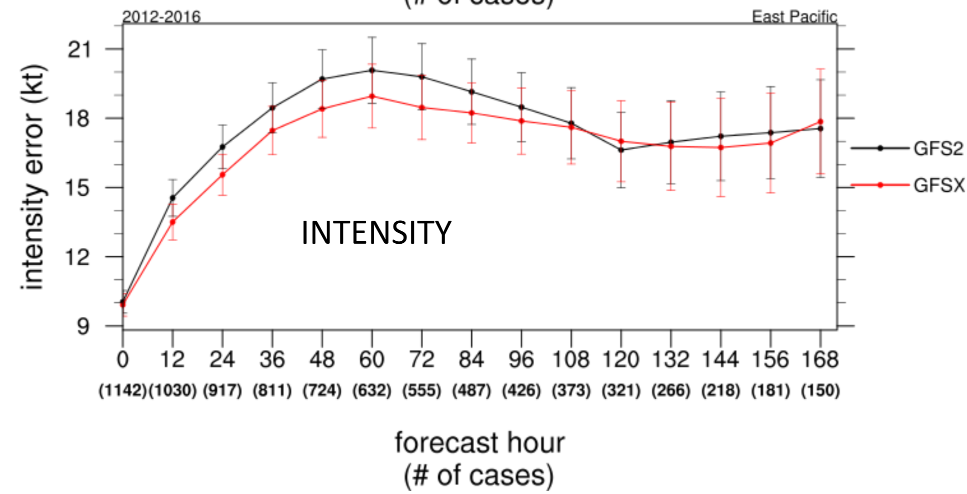
Impact on Hurricanes: NHC Evaluation

2012-2016 **Atlantic** **Track/Intensity Error** **East Pacific**







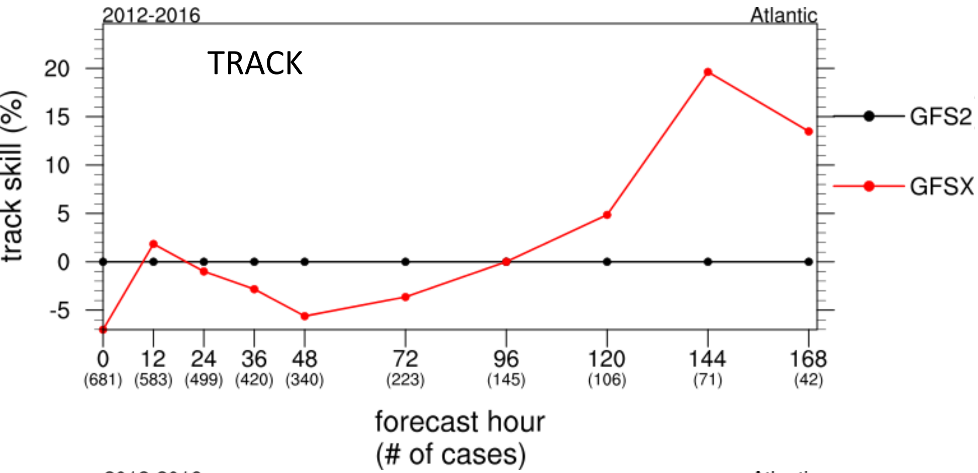


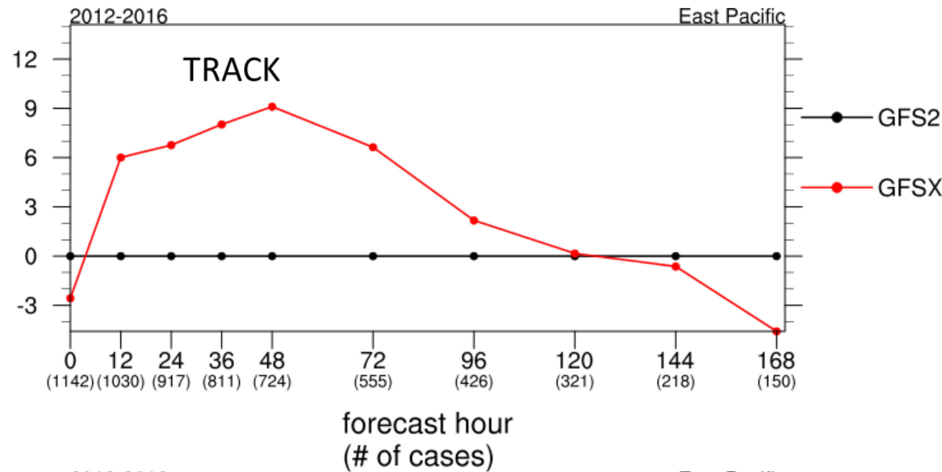
Impact on Hurricanes: NHC Evaluation

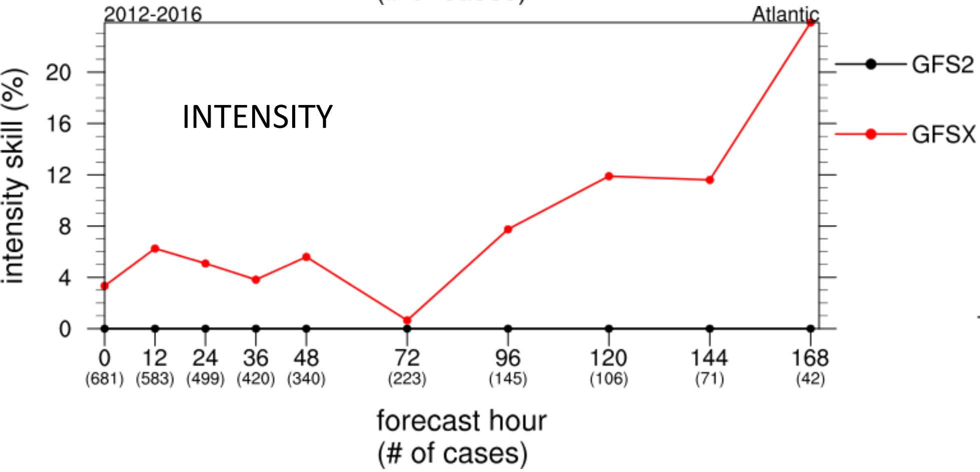
2012-2016 **Atlanti c**

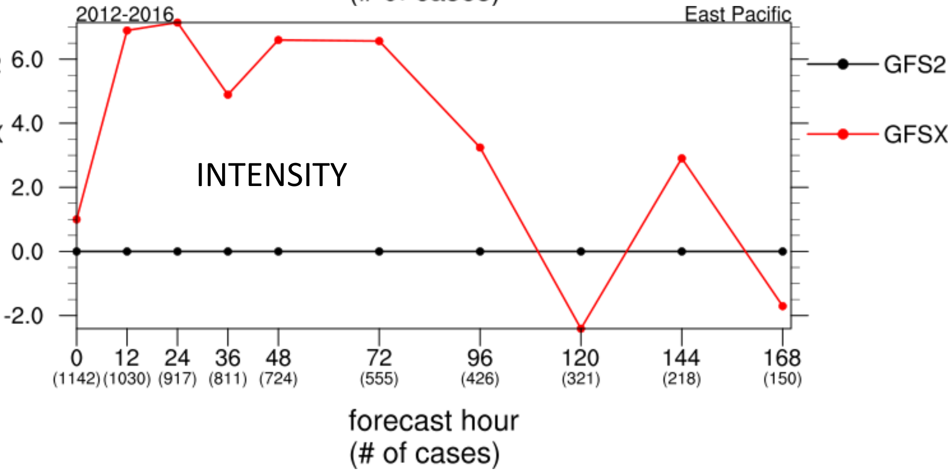
Track/Intensity Skill (with respect to GFS2)

East Pacific







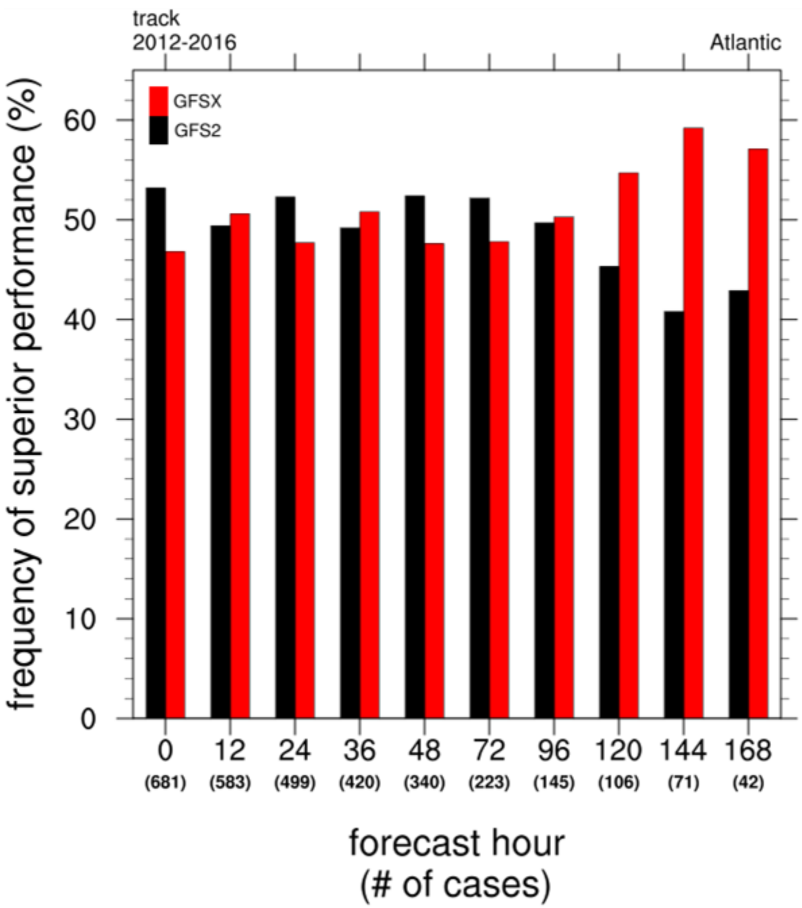


Impact on Hurricanes: NHC Evaluation

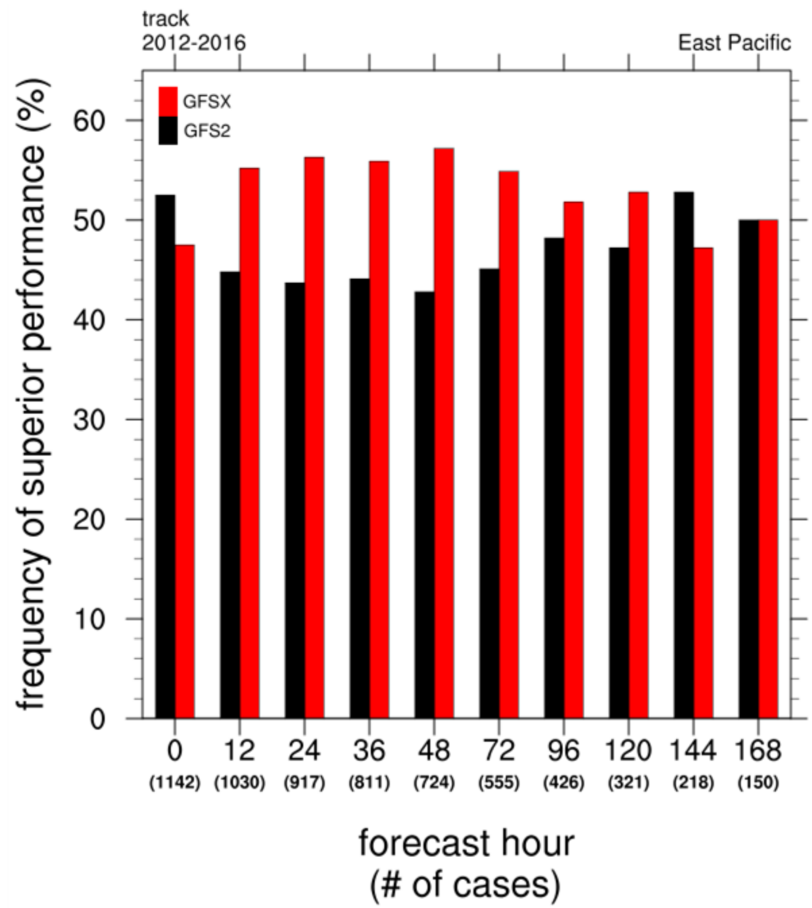
2012-2016

Frequency of Superior Performance - Track

Atlantic



East Pacific

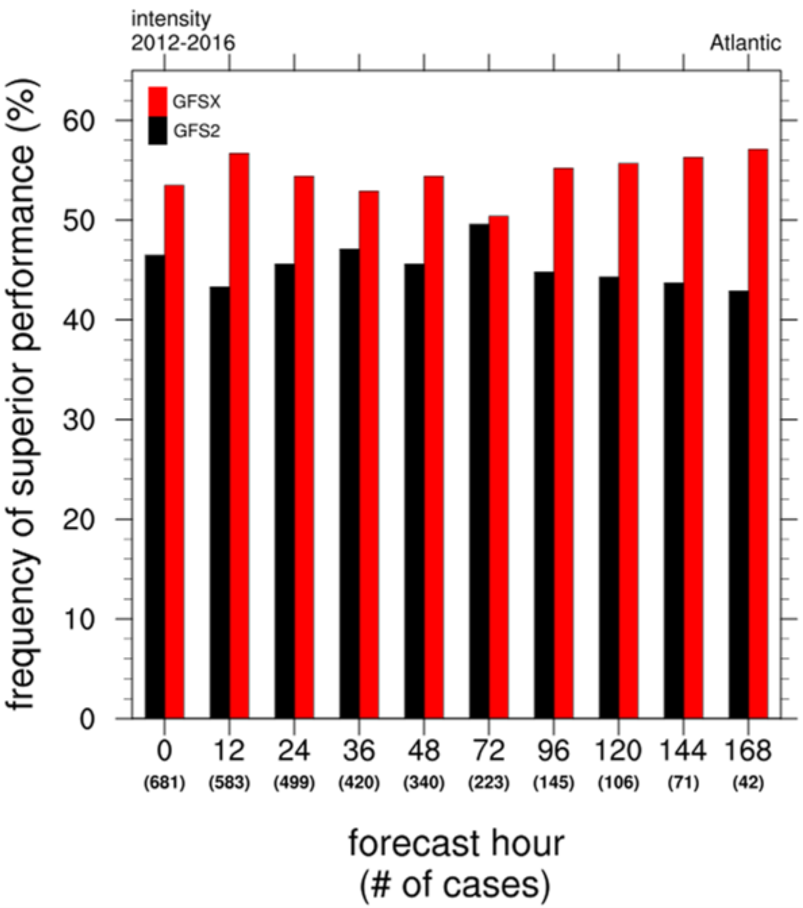


Impact on Hurricanes: NHC Evaluation

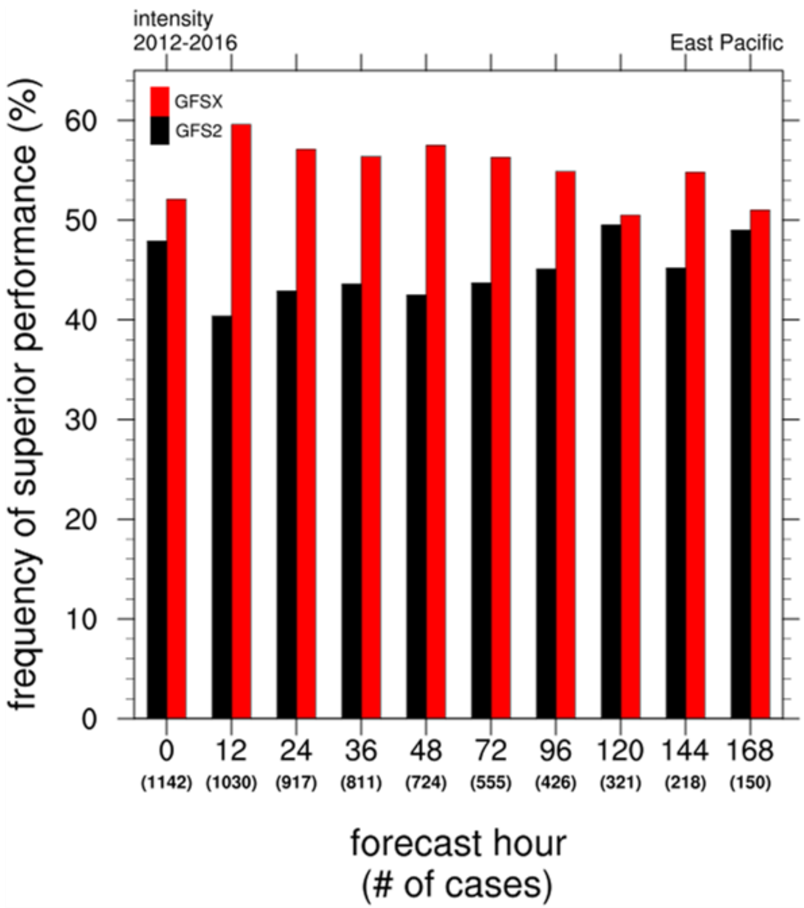
2012-2016

Frequency of Superior Performance - Intensity

Atlantic



East Pacific



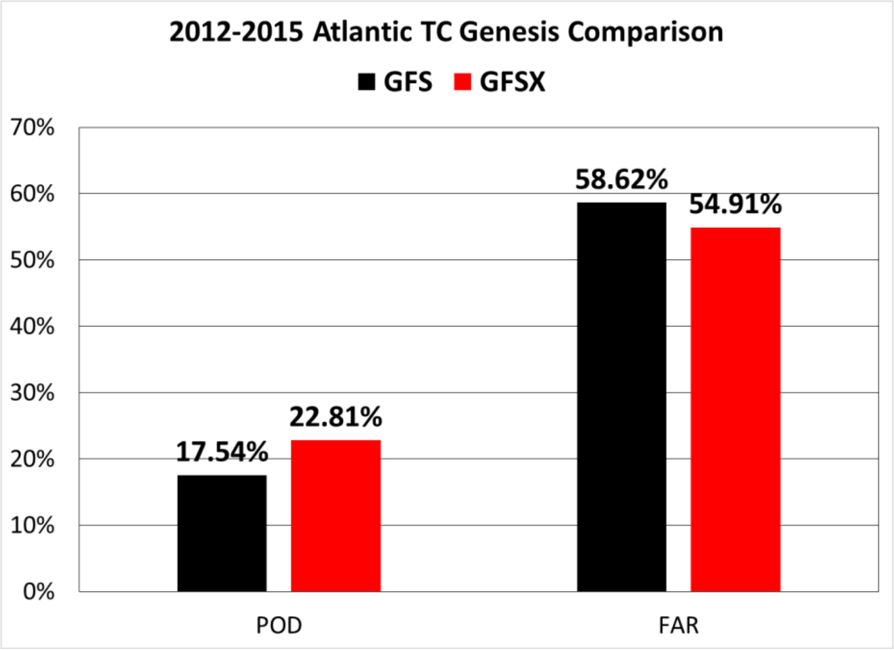
Impact on Hurricanes: NHC Evaluation

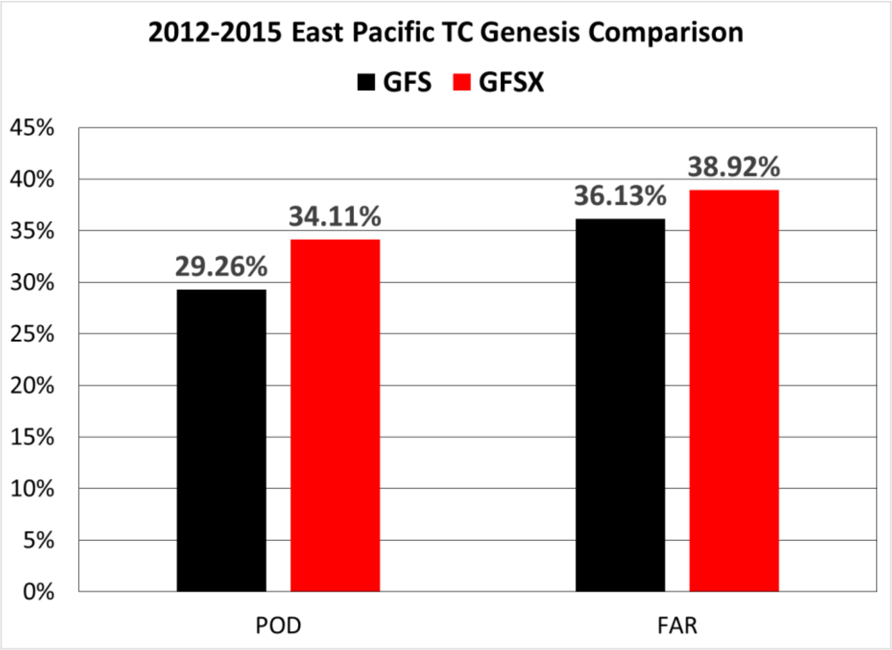
AL	Track	Intensity
0-48 h	- 3%	+5%
72-120 h	+7%	+ 11%

EP	Track	Intensity
0-48 h	+5%	+5%
72-120 h	+1%	+2%

Track and intensity error improvements/degradation of Q3FY16 GFS vs. 2015 GFS for the 2012-2016 retrospective runs, by basin

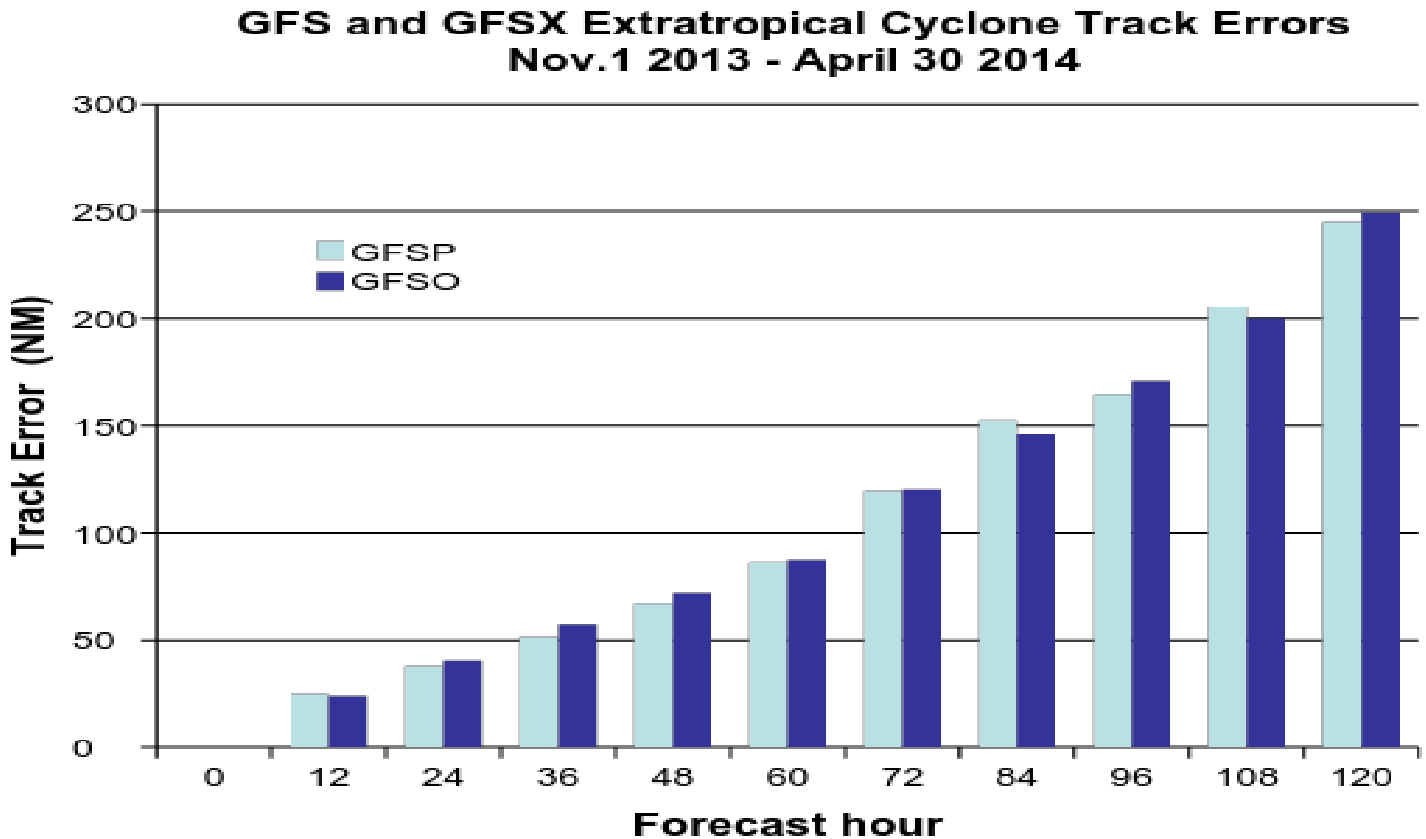
Verification of TC cyclogenesis in the GFSX – comparison to current and previous version of the GFS (courtesy of Dan Halperin and Bob Hart)





Comments from NHC and TAFB

- GFSP has mostly improved TC track and intensity forecasts in comparison to current GFS.
- GFSP in general handles gap wind events a little better than the current GFS, especially at longer time ranges.
- In comparison to the current GFS, the GFSP has a higher POD for TC genesis in both basins and a lower FAR in the Atlantic, but a higher FAR in the east Pacific – so overall the new GFS is better at predicting genesis.
- Based on limited cases with archived operational GFS on 1° grids and the retrospectives (GFSP) on 0.5° degree grids
- Results were a mixed bag, but the GFSP seemed to have an advantage at longer lead times
- Since the impact of the GFSP on the HWRF and GFDL hurricane models remains unknown, NHC cannot endorse this implementation. However, NHC does not oppose it.

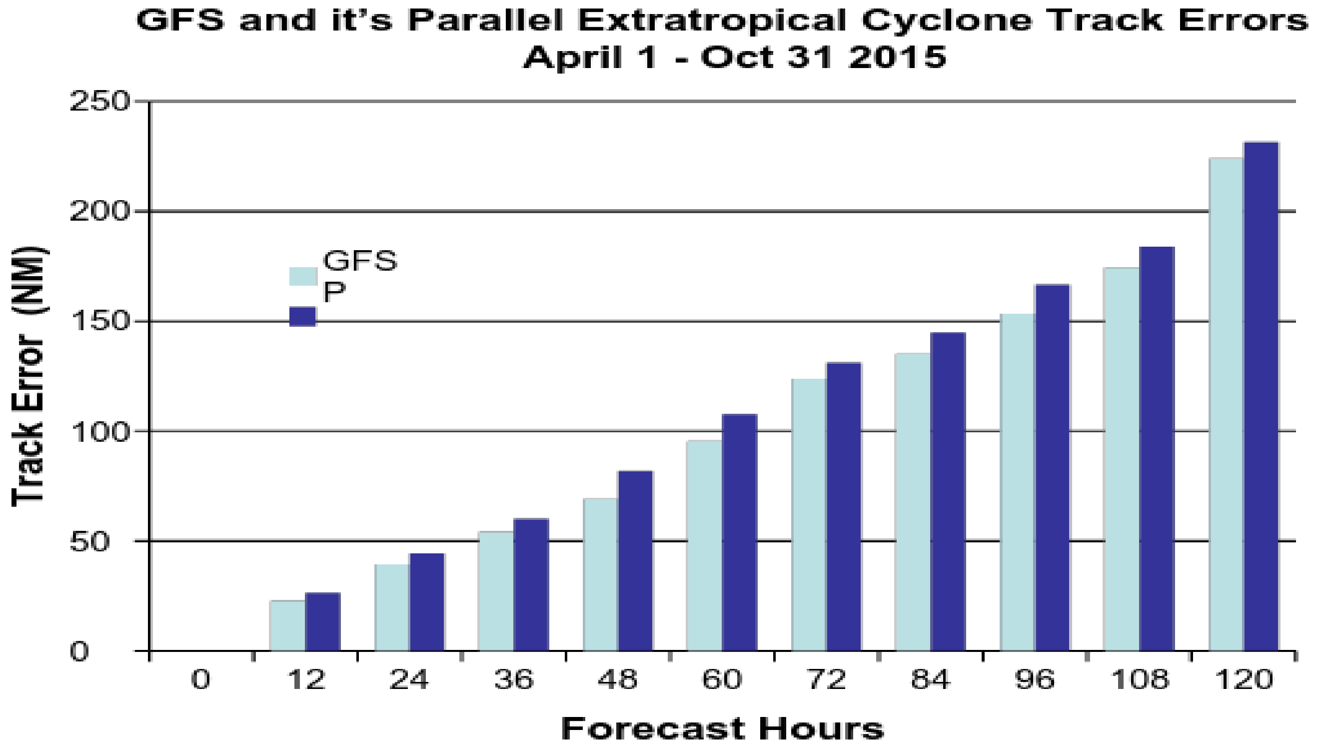


GFSO (blue) – Control GFS; GFSX (cyan) – Parallel GFS

7 out 10 times, errors in GFSX are smaller than in GFSO.

Fcst hr	0	12	24	36	48	60	72	84	96	108	120
Cases	520	508	487	391	259	155	98	62	42	29	22

Guang Ping Lou



GFSO (blue) – Operational GFS (Control); GFSP (cyan) – Parallel GFS

Errors in GFSX are smaller than in GFSO.

Fcst hr	0	12	24	36	48	60	72	84	96	108	120
Cases	1093	1075	1011	687	366	201	104	64	35	26	17

Guang Ping Lou

Case Studies from the Field: EMC Evaluation

GFSX 6/9 GFS 3/9

Case	Model Performance
CR 1/29-2/2/2015	GFSX somewhat better
WR 10/3-10/4/2015	GFSX slightly better
WR 11/8-11/10/2014	GFS slightly better
WR 11/20-23/2014	GFSX better
WR 8/28-8/30/2015	GFSX slightly better

Case	Model Performance
SR 12/5-12/6/2013	GFSX did better
CR 3/23/2015	GFSX did slightly better
CR 6/4-6/5/2015	GFS did slightly better
CR 7/6/2015	GFS did slightly better

Typhoon Astani Findings

Focus on 12Z 8/20/15 cycle
Forecasts 108-192 valid 00Z 8/25/15 – 00Z 8/29/15

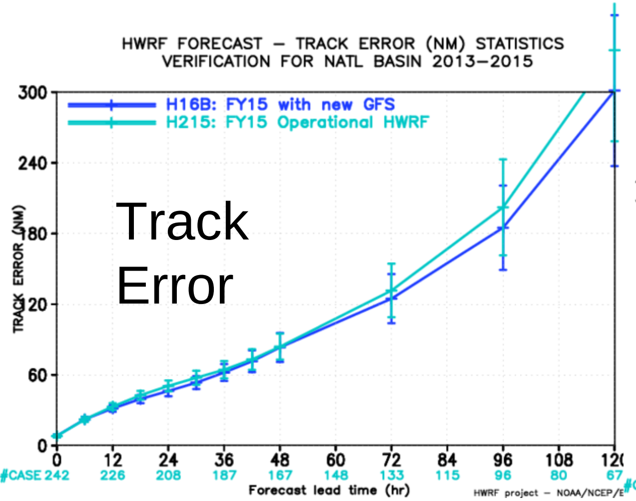
- Starting with 108-h forecasts and going to 204-h, GFS too far to the north and east, then too far to the east, followed by too far to the north (except for 204-h forecast, GFS too far south)
- Starting with the 108-h forecasts and going to 204-h, GFSX started off with good position for Atsani, then was too far south and east, then slightly too far north, was too far south for 204-h forecast
- In general, the GFSX was closer to analysis

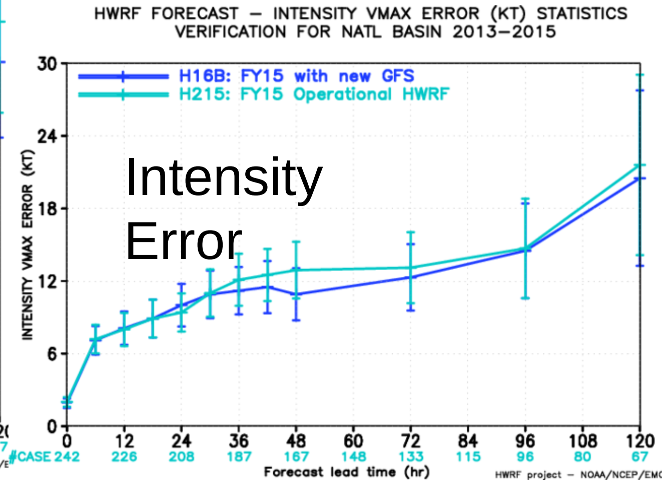
Forecasts	GFS	GFSX
108		✔
120		✔
132		✔
144	✔	✔
156		✔
168	✔	
180		✔
192		✔
204	✔	

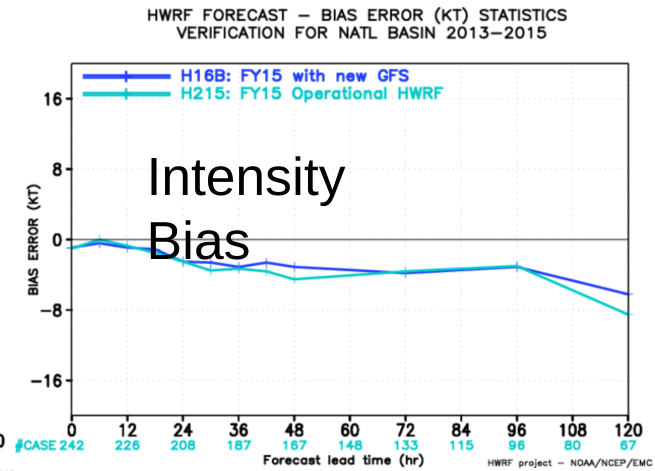
* Extra-tropical transition around 12Z 8/25/15

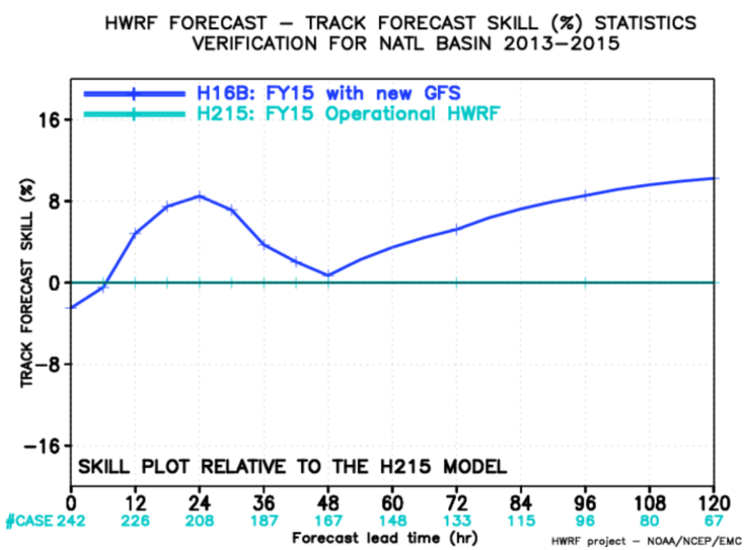
WPC Case Studies	Remarks
Tornado outbreak over Kansas, Texas Nov. 16-17, 2015	GFSX better in forecast from 000 GMT Nov. 16
Sandy Oct .22-30, 2012	GFS, GFSX track errors similar
Joaquin Sept. 25-Oct. 4, 2015	GFSX better track, adopted out to sea track 6 hours before operational GFS
South Carolina flooding Oct. 3, 4, 2015	GFS, GFSX similar
GFS dry bias in southeast US autumn 2015, winter 2015-2016	GFS, GFSX similar
GFS cold bias over snow cover	GFS, GFSX similar
Blizzard Jan. 22-23, 2016	GFS, GFSX similar
Warm, dry bias Great Plains 000 GMT Aug. 16	GFSX better
New England blizzard Jan 26-27 2015	GFSX better 2.5 day forecast

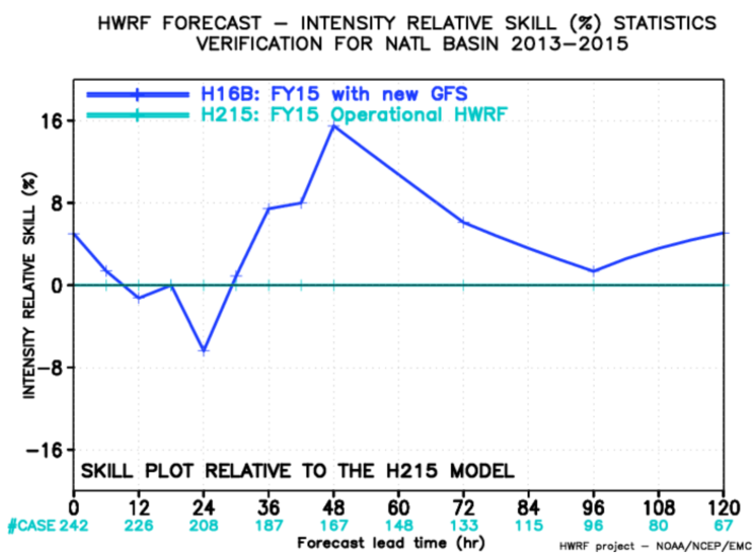
HWRF Evaluation: H16B vs. H215, AL (242/578)







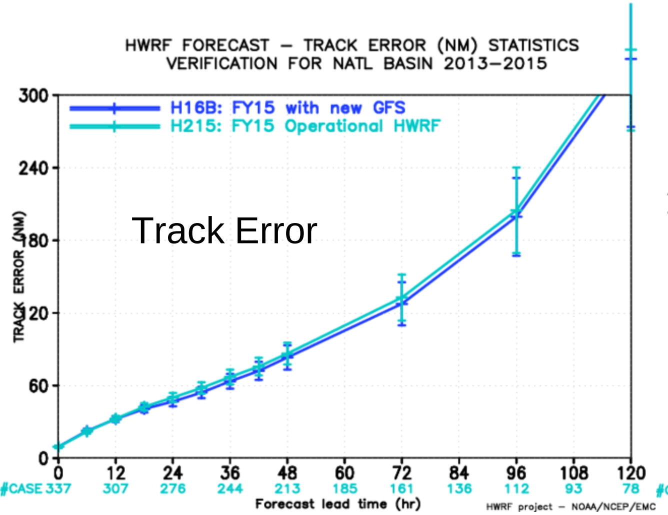


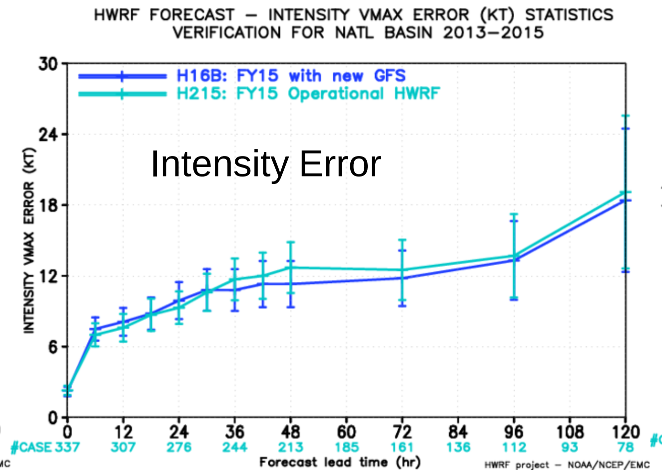


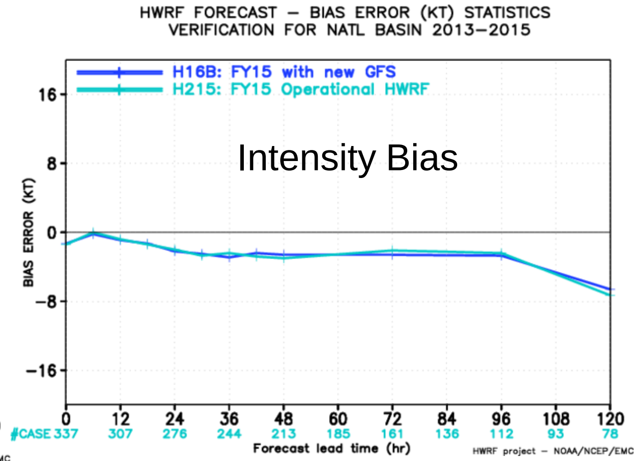
Track Skill improvement

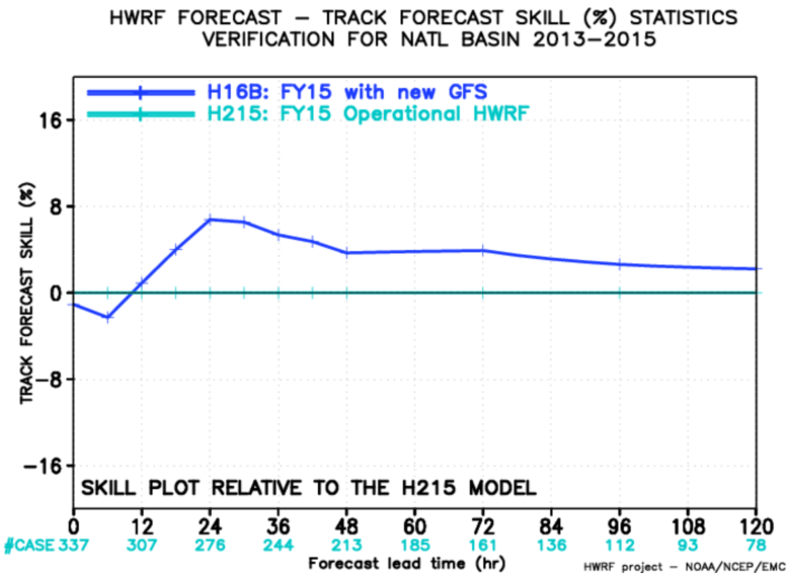
Intensity Skill improvement

H16B vs. H215, AL (337/578)

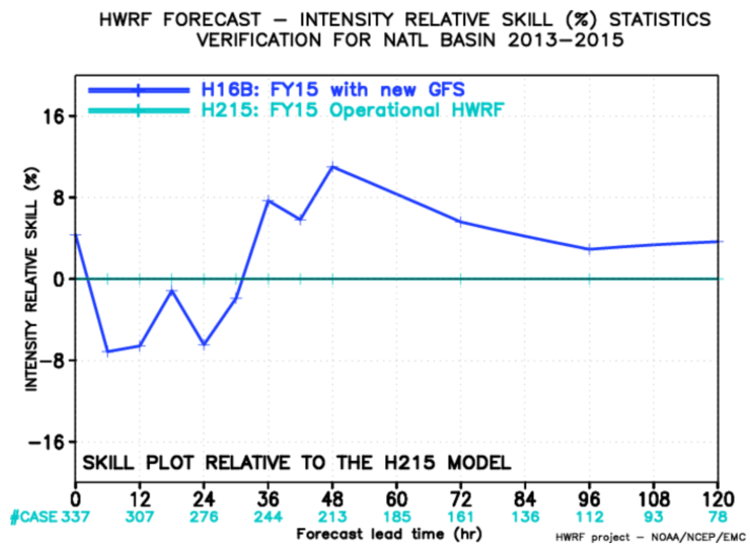






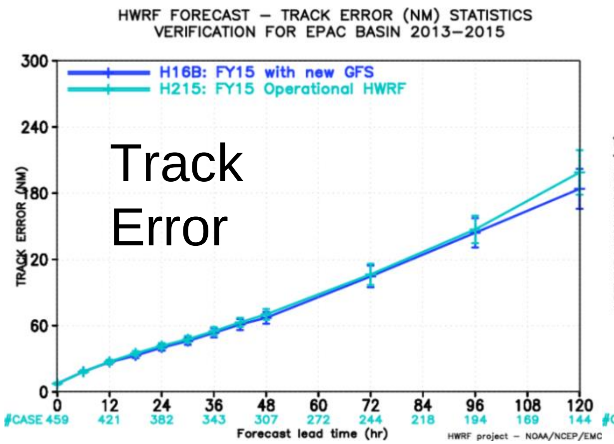


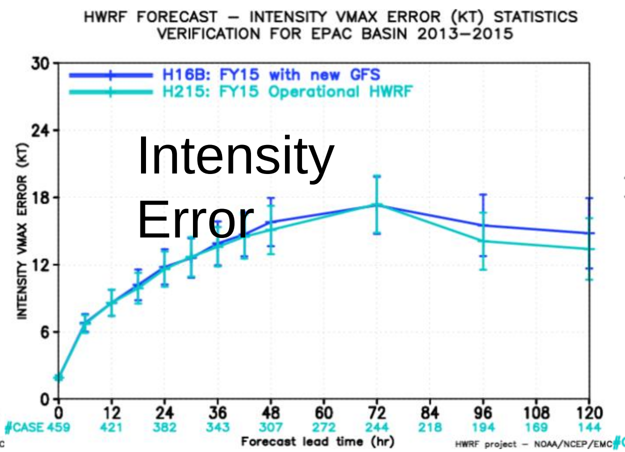
Track Skill improvement

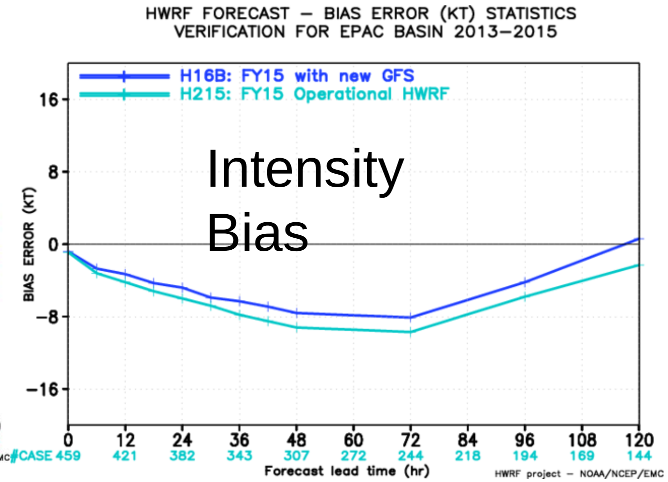


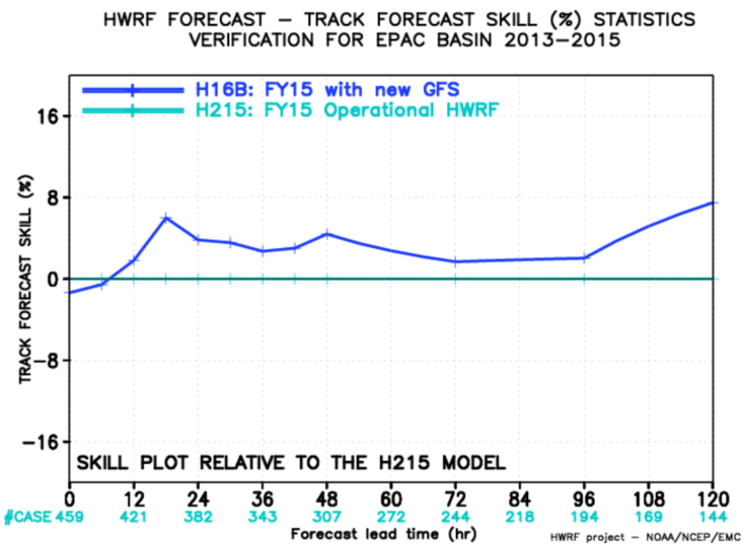
Intensity Skill improvement

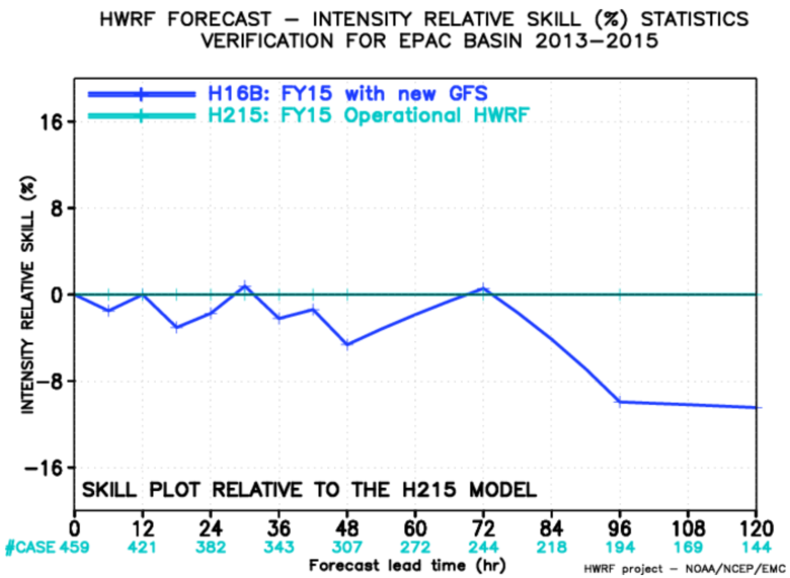
HWRF Evaluation: H16B vs. H215, EP (459/942)







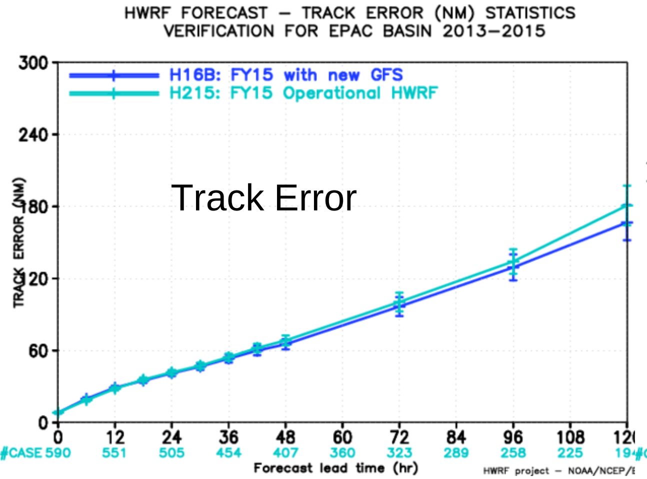


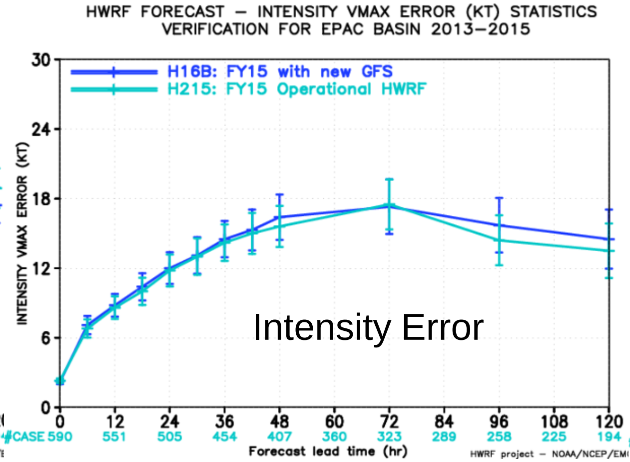


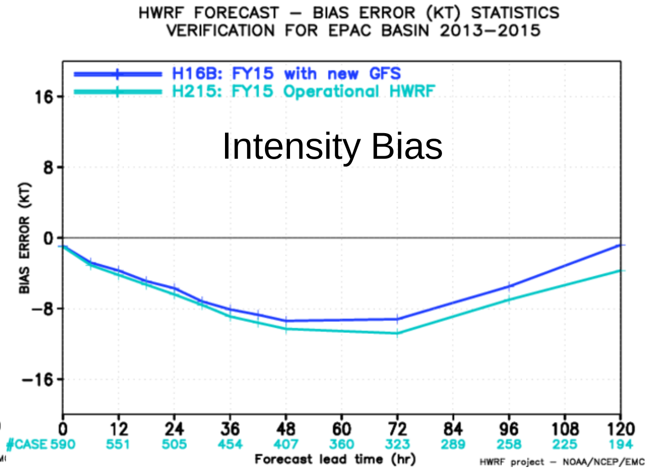
Track Skill improvement

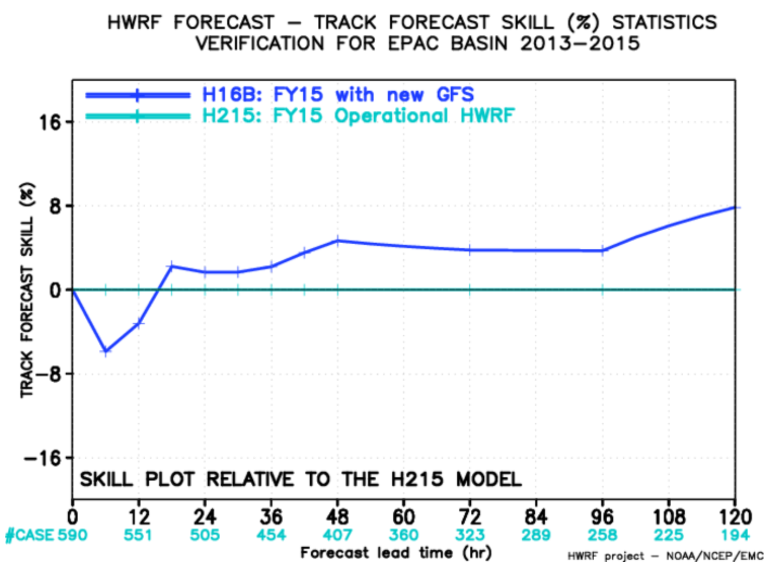
Intensity Skill improvement

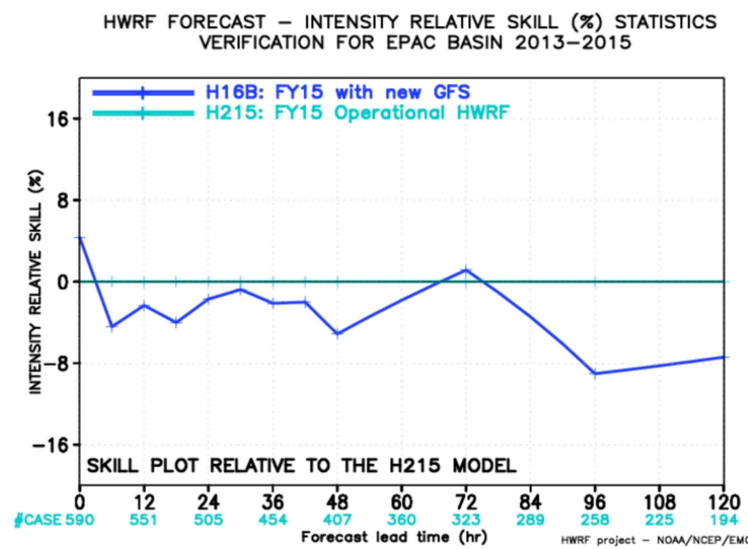
H16B vs. H215, EP (590/942)











Track Skill improvement

Intensity Skill improvement

Endorsements from Stakeholders

Region/Center	Recommendation	Remarks
Western Region	Implement	Neutral
Central Region	Implement with reservations	Little improvement
Southern Region	Implement	No striking differences
Eastern Region	Implement	Minor improvements
Pacific Region	Implement	Models performed well with Winston
Alaska Region	Implement	No specific problems
WPC	Implement	Similar, GFSX slightly better sometimes
NHC	Neither endorse nor oppose	Improved tropical forecasts, downstream tests incomplete

Endorsements from Stakeholders

Region/Center	Recommendation	Remarks
AWC	Implement	Better winds, temperatures
CPC	Implement	Large errors upper stratosphere
OPC	Implement	Extratropical storm tracks better
SWPC	Implement	Need improvements in upper atmosphere
MDL	Implement	Redeveloped MOS better
NWC	Implement	Hourly files should improve NWC fcsts
SPC	Implement	Improved in warm season
Weather It Is Ltd. (Prof. Barry Lynn)	under situations where the observational network is more dense, there has been improvement in the initial state (and lateral boundary conditions) of the GFSX compared to GFS	
AccuWeather	Hourly output is of significant value for Weather Industry	

EMC/GCWMB Assessment

- Positive evaluation (significantly positive improvements in majority of the metrics)
- DA upgrades have been effective in reducing the forecast errors in the short-range, and improving analysis increment for almost all prognostic variables
- Results shown significant improvement in week 1 forecasts verified against own analyses except for heights and temperatures in stratosphere
- Rain no rain forecasts worse, but overall conus precipitation improved significantly

EMC/GCWMB Assessment

- 2m temperature, dewpoint, 10 m wind forecasts against station obs over CONUS, Alaska improved.
- CAPE forecasts over CONUS improved
- Forecasts of tropical storm genesis. track and intensity forecasts improved.
- Mode verification of CAPE, Jet Streams, QPF and winds shows GFSX slightly better
- Synoptic evaluations of GFSX produced no red flags. GFSX, GFS similar; GFSX slightly better in some cases
- Forecasts of heights, temperatures, winds significantly improved except for heights and temperatures in stratosphere. Large errors in upper stratosphere
- CONUS precipitation forecasts improved for thresholds of 2-25 mm/day, worse for thresholds of 0.2 mm/day

Hourly Output from GFS through 120 hrs & Additional Fields

- Hourly GFS forecast output at 0.25 deg. resolution (grib2) will be made available through 120 hr (ftp only)

- GFS Post is adding output on 5 more pressure levels in stratosphere **1, 2, 3, 5, and 7 mb** per request of CPC.

  Each additional level has 6 records:
- Geopotential Height (HGT); Temperature (TMP); Relative Humidity (RH);
- U- and V Components of Wind (UGRD & VGRD)
- Ozone Mixing Ratio (O3MR)

- Two New Products: Icing probability and Icing Severity are also added to Aviation Weather (WAFS)

Q3FY16 GFS/GDAS New Vertical Structure

https://svnemc.ncep.noaa.gov/projects/gfs/branches/

gdas.v13.0.0

parm|ush|sorc|

Jobs|scripts|exec

JGDAS_TROPCY_QC_RELOC
JGDAS_NCEPPOST
JGDAS_EMCSFC_SFC_PREP
JGDAS_TROPC
JGDAS_MKNAVYBULLS
JGDAS_GEMPAK_META
JGDAS_BULLS
JGDAS_GEMPAK_NCDC
JGDAS_GEMPAK
JGDAS_ENKF_INFLATE_RECENTER
JGDAS_ANALYSIS_HIGH
JGDAS_ENKF_SELECT_OBS
JGDAS_ENKF_UPDATE
JGDAS_ENKF_POST
JGDAS_ENKF_INNOVATE_OBS
JGDAS_ENKF_FCST
JGDAS_FORECAST_HIGH

gfs.v13.0.0

parm|ush|sorc|

Jobs|scripts|exec

JGFS_PRDGEN_MANAGER
JGFS_POST_MANAGER
JCPC_GET_GFS_6HR
JGFS_NPOESS_PGRB2_0P5DEG
JGFS_CYCLONE_TRACKER
JGFS_FBWIND
JGFS_AWIPS_G2
JGFS_PGRB2
JGFS_AWIPS_20KM
JGFS_AWIPS_1P0DEG
JGFS_TROPCY_QC_RELOC
JGFS_PGRB2_SPEC_POST
JGFS_SMINIT
JGFS_NCEPPOST
JGFS_EMCSFC_SFC_PREP
JGFS_WAFS_GRIB2
JGFS_WAFS
JGFS_WAFS_BLENDING
JGFS_WAFS_GCIP
JGFS_PGRB2_SPEC_GEMPAK
JGFS_GEMPAK_UPAPGIF
JGFS_GEMPAK_NCDC
JGFS_POSTSND
JGFS_GEMPAK_META
JGFS_FAX
JGFS_ANALYSIS
JGFS_FORECAST_LOW
JGFS_FAX_WAFS
JGFS_GEMPAK
JGFS_FORECAST_HIGH

global_shared.v13.0.0

parm|ush|sorc|
scripts|exec

No jobs

Included Packages

GSI & Enkf (analysis)
GSM (forecast)
ncep_post
emcsfc
tropcy_qc_relo
wafs
gfs_post (downstream)
Gempak (downstream)
smartinit
misc

Will be included

MinMon (monitoring)
RadMon (monitoring)

Unification of EMC parallels with NCO Operational structure

Q3FY16 GFS/GDAS New Vertical Structure

https://svnemc.ncep.noaa.gov/projects/gfs/branches/

gdas.v13.0.0

parm|ush|*sorc*|
Jobs|scripts|exec

- Getsigensmeanp_smooth_ncep.fd
- recentersigp.fd
- Adderrspec_nmcmeth_spec.fd
- getsfcensmeanp.fd
- enkf_update.fd
- build_enkf.sh
- gdas_trpsfcmv.fd
- gridbull.fd
- navybull.fd
- build_gdas_gridbull.sh
- build_gdas_navybull.sh
- build_gdas_trpsfcmv.sh

gfs.v13.0.0

parm|ush|*sorc*|
Jobs|scripts|exec

- awc_wafavn.fd
- gcip.fd
- wafs_blending.fd
- build_wafs_wcoss.sh
- cnvgrib2_wafs.fd
- gfs_bufr.fd
- tocsbufr.fd
- smartprecip.fd
- smartinit.fd
- overpdtg2.fd
- gfs_flux.fd
- build_smartinit_wcoss.sh
- build_tocsbufr_gfs_flux_wcoss.sh
- wintemv.fd
- makewafs.fd
- fbwndgfs.fd
- build_gfs_wintemv.sh
- build_gfs_overpdtg2.sh
- build_gfs_fbwndgfs.sh

global_shared.v13.0.0

parm|ush|*sorc*|
scripts|exec

- ncep_post.fd
- supvit.fd
- tave.fd
- gettrk.fd
- syndat_getjtbul.fd
- syndat_maksynrc.fd
- vint.fd
- gsi.fd
- emcsfc_ice_blend.fd
- relocate_mv_nvortex.fd
- emcsfc_snow2mdl.fd
- syndat_qctropcy.fd
- build_ncep_post.sh
- build_emcsfc.sh
- build_tropcy.sh
- build_gsi.sh
- global_sfchdr.fd
- global_chgres.fd
- global_sighdr.fd
- global_cycle.fd
- global_fcst.fd
- build_gsm_wcoss.sh

Included Packages

- GSI & Enkf (analysis)
- GSM (forecast)
- ncep_post
- emcsfc
- tropcy_qc_relo
- wafs
- gfs_post (downstream)
- Gempak (downstream)
- smartinit
- misc

Will be included

- MinMon (monitoring)
- RadMon (monitoring)

Unification of EMC parallels with NCO Operational structure

GCWMB requests EMC Director to approve implementation of Q3FY16 GDAS/GFS upgrade package.

Special acknowledgements:

John Derber, Russ Treadon, Glenn White, Fanglin Yang, Tracey Dorian, Partha Bhattacharjee, Lin Gan, Boi Vuong, Qingfu Liu, Guangping Liu, Diane Stokes, Dennis Keyser, Yali Mao, Eugene Mirvis, George Gayno, Zhan Zhang, Lin Zhu, Cathy Thomas, Ed Safford, Rahul Mahajan, Jeff Whitaker, Yuejian Zhu, Steven Earle, Jen Yang & Becky Cosgrove

Next Steps

- Code Hand-off to NCO: Completed
- All non-GFS downstream codes submitted to NCO: Completed
- Collect Evaluation Reports from the field: Completed
- Final EMC CCB: Today (Completed)
- OD Briefing: 3/17/16 (Scheduled)
- TIN: 4/1/2016 (on track)
- 30-day evaluation: 4/06 – 5/5
- Final OD Briefing by NCO: 5/11
- Implementation: 5/17

Backup Slides

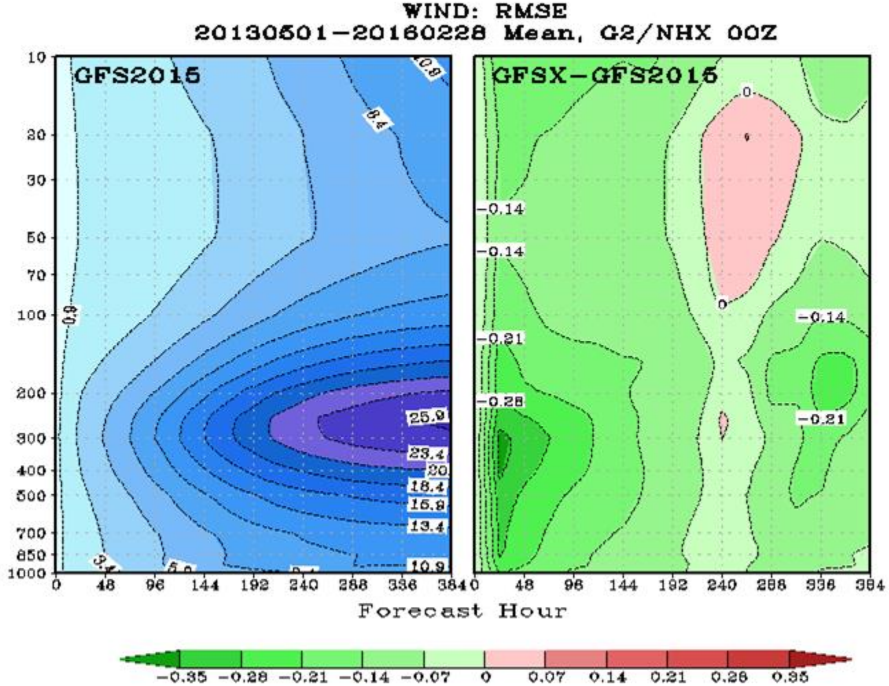
Fit to Obs Evaluation with aircraft Obs

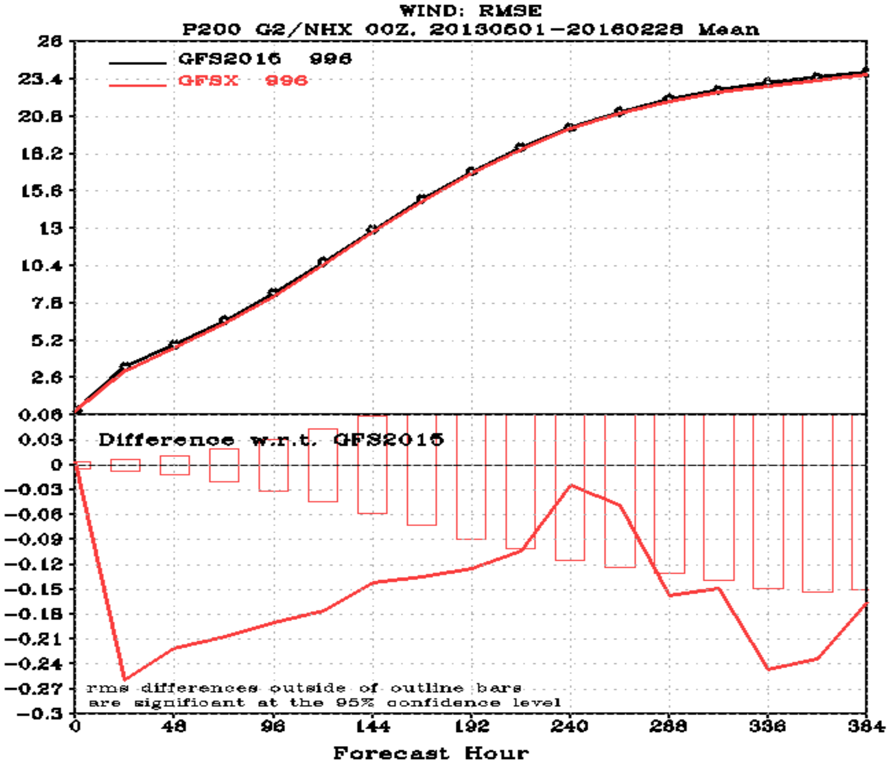
GFSX analyzed temperatures fit aircraft obs better all 3 layers
forecast temperatures fit aircraft obs better in upper and lower layers

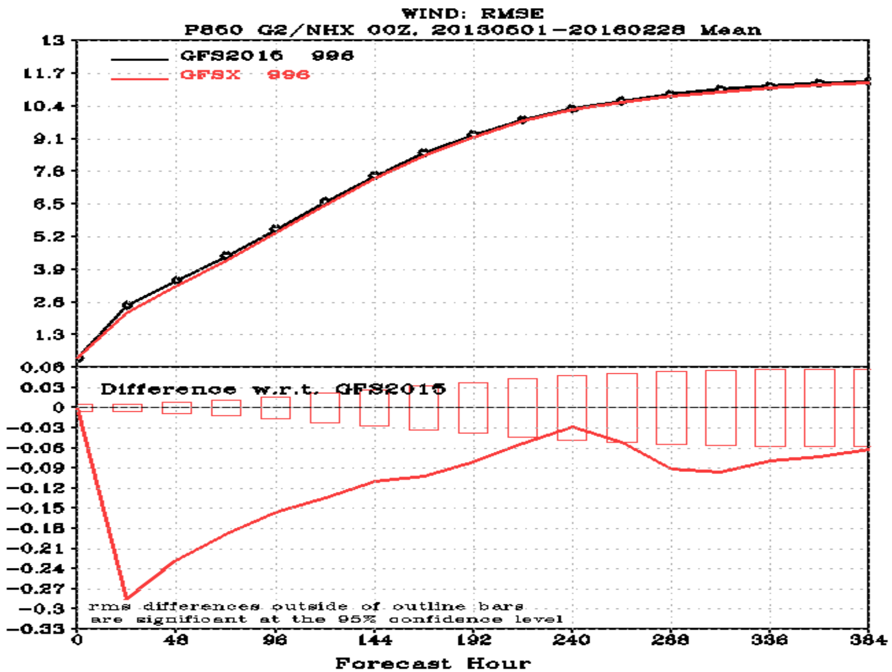
GFSX analyzed and forecast winds fit aircraft obs better in all 3 layers

GFSX analyzed temperatures fit ACARS obs better in all 3 layers
forecast temperatures fit ACARS obs better in lower layer

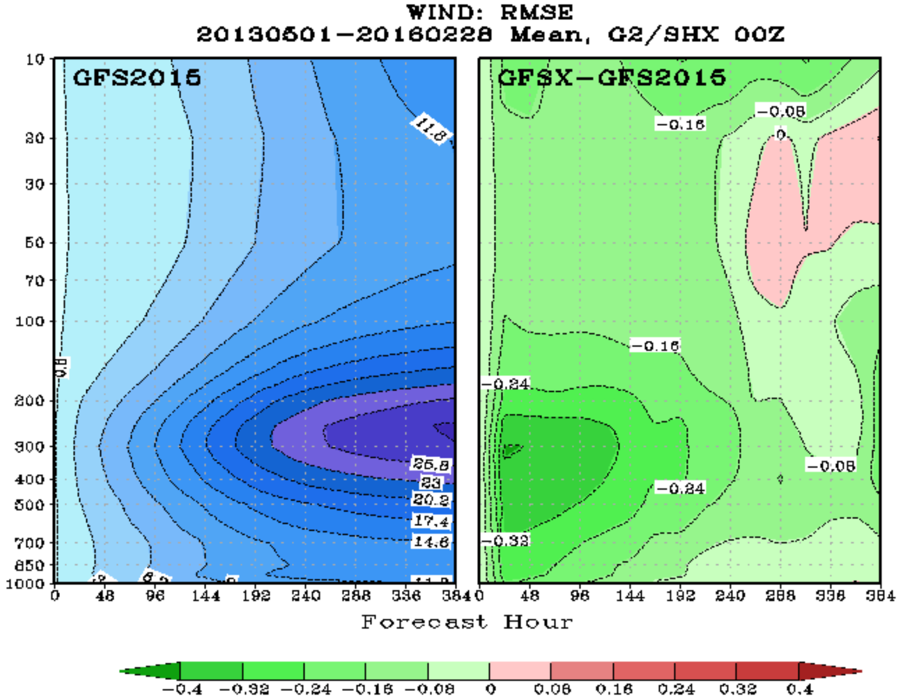
GFSX analyzed and forecast winds fit ACARS obs better in all 3 layers

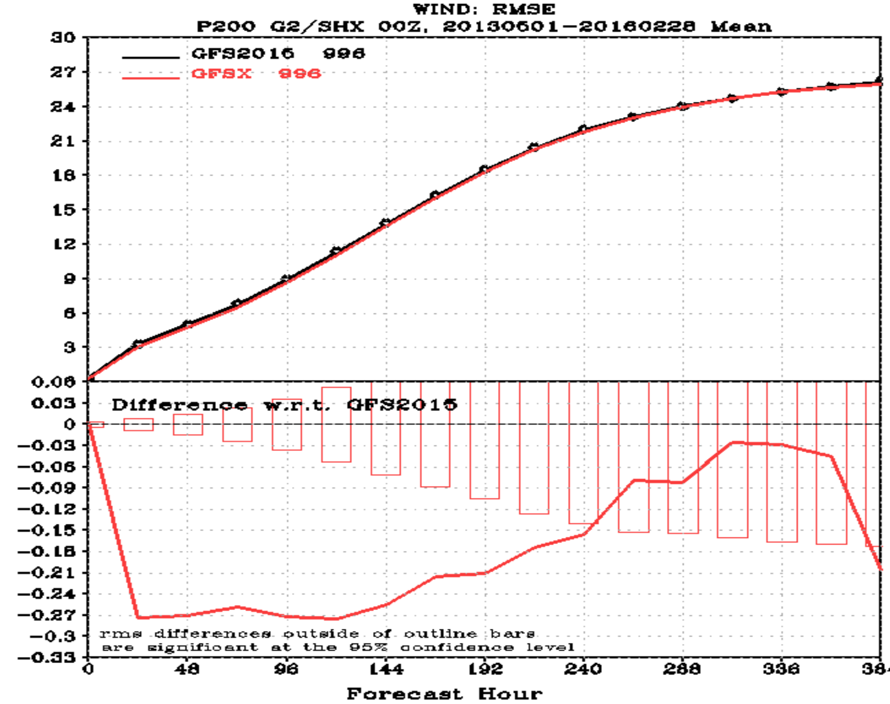


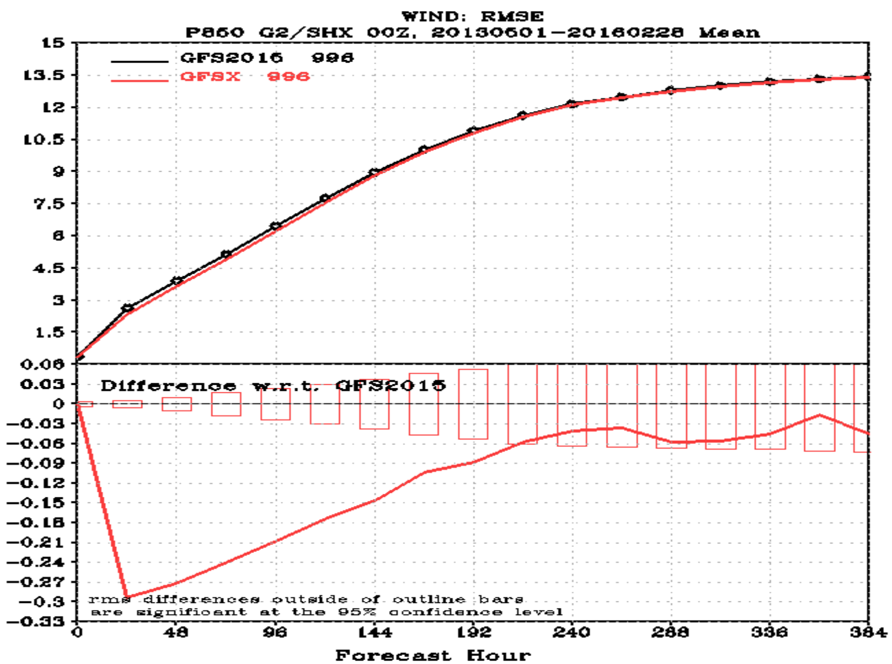




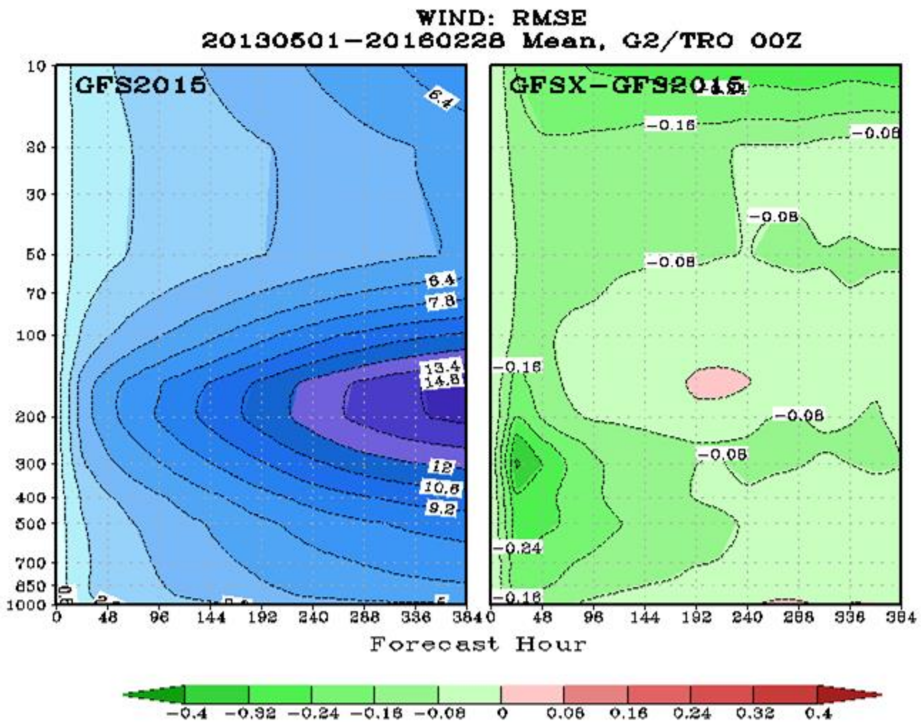
Northern Hemisphere Winds RMSE

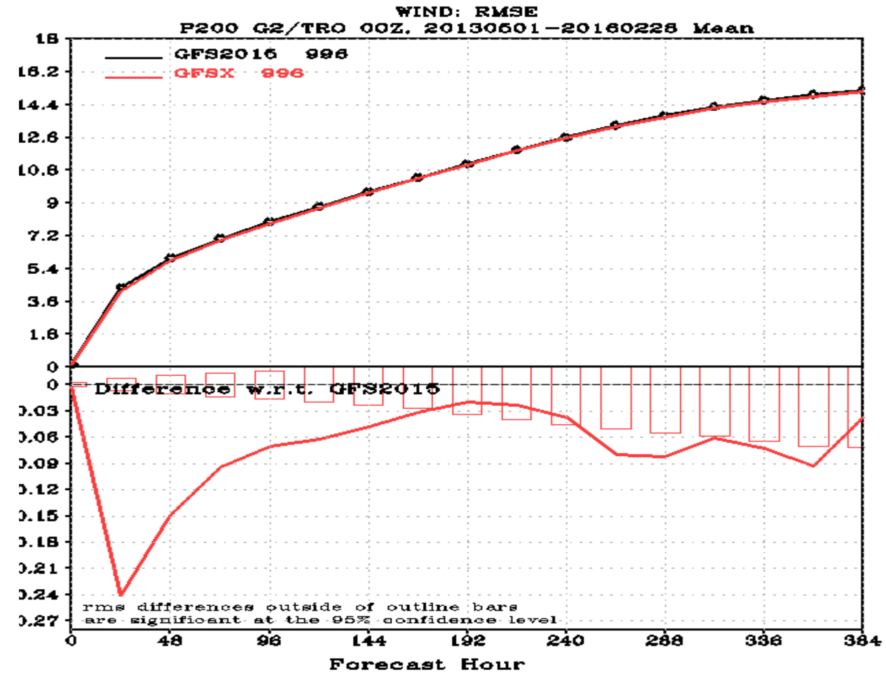


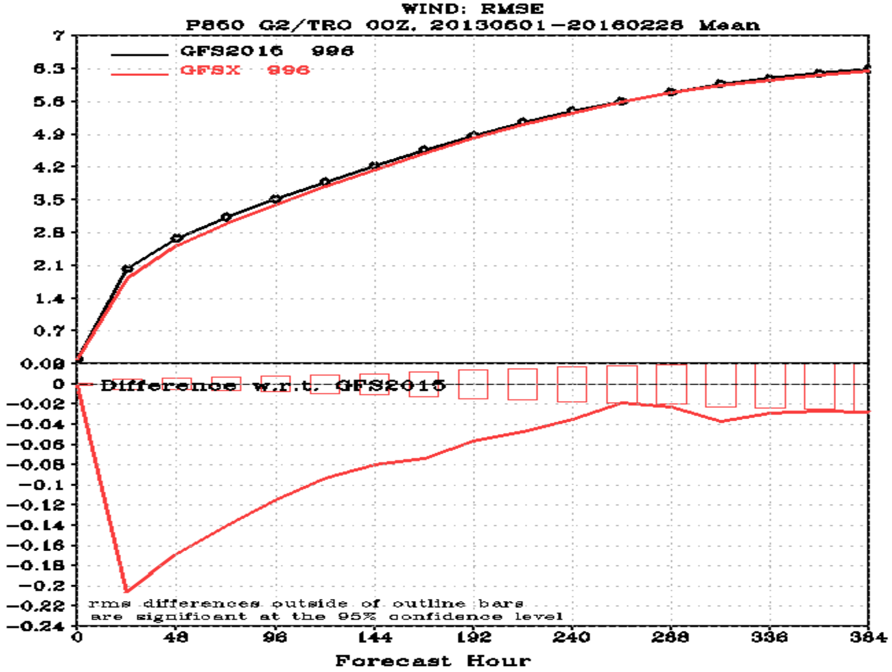




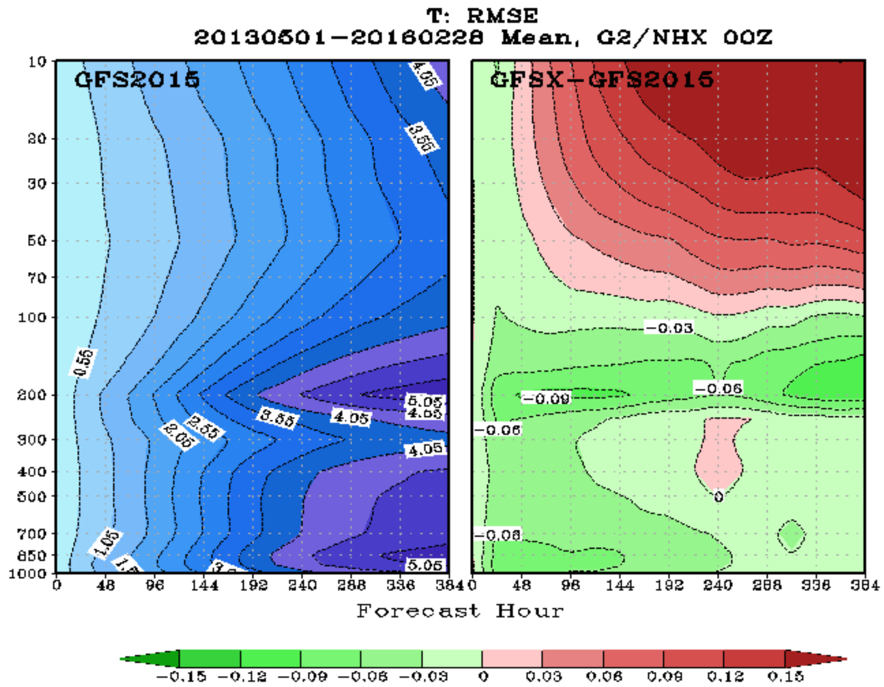
Southern Hemisphere
Winds RMSE

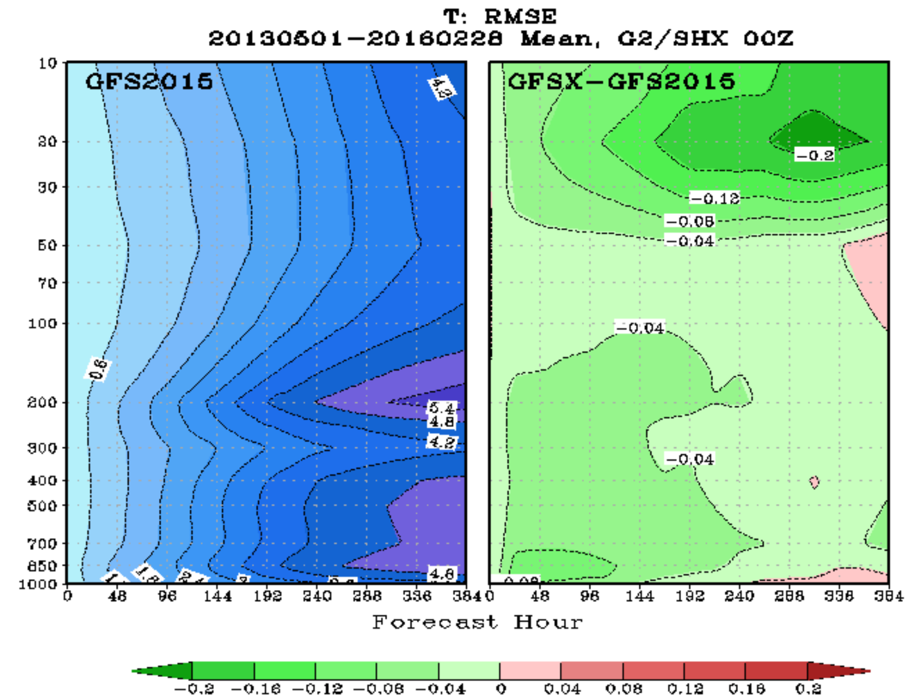


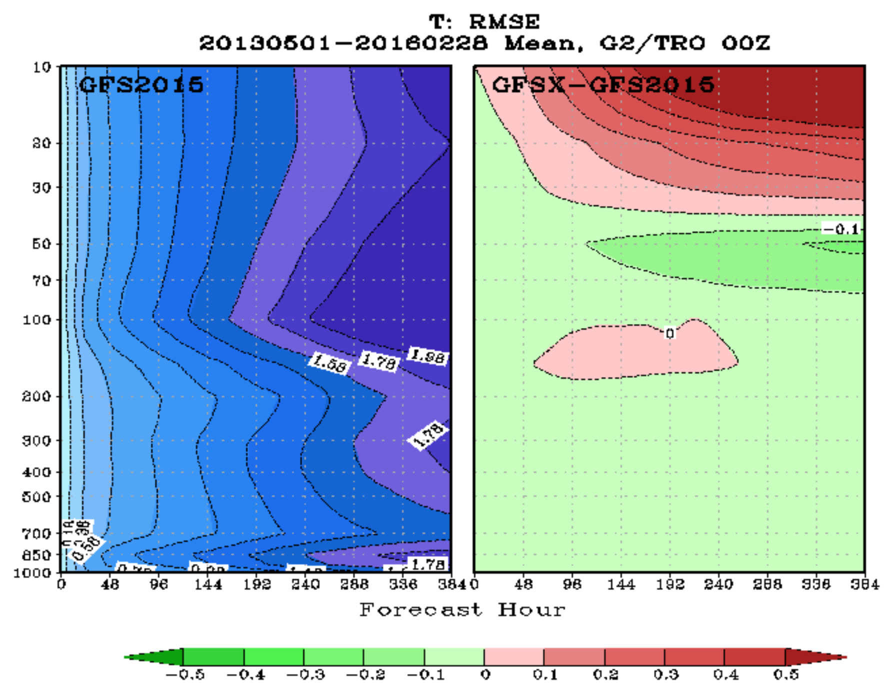




Global Tropics
Winds RMSE



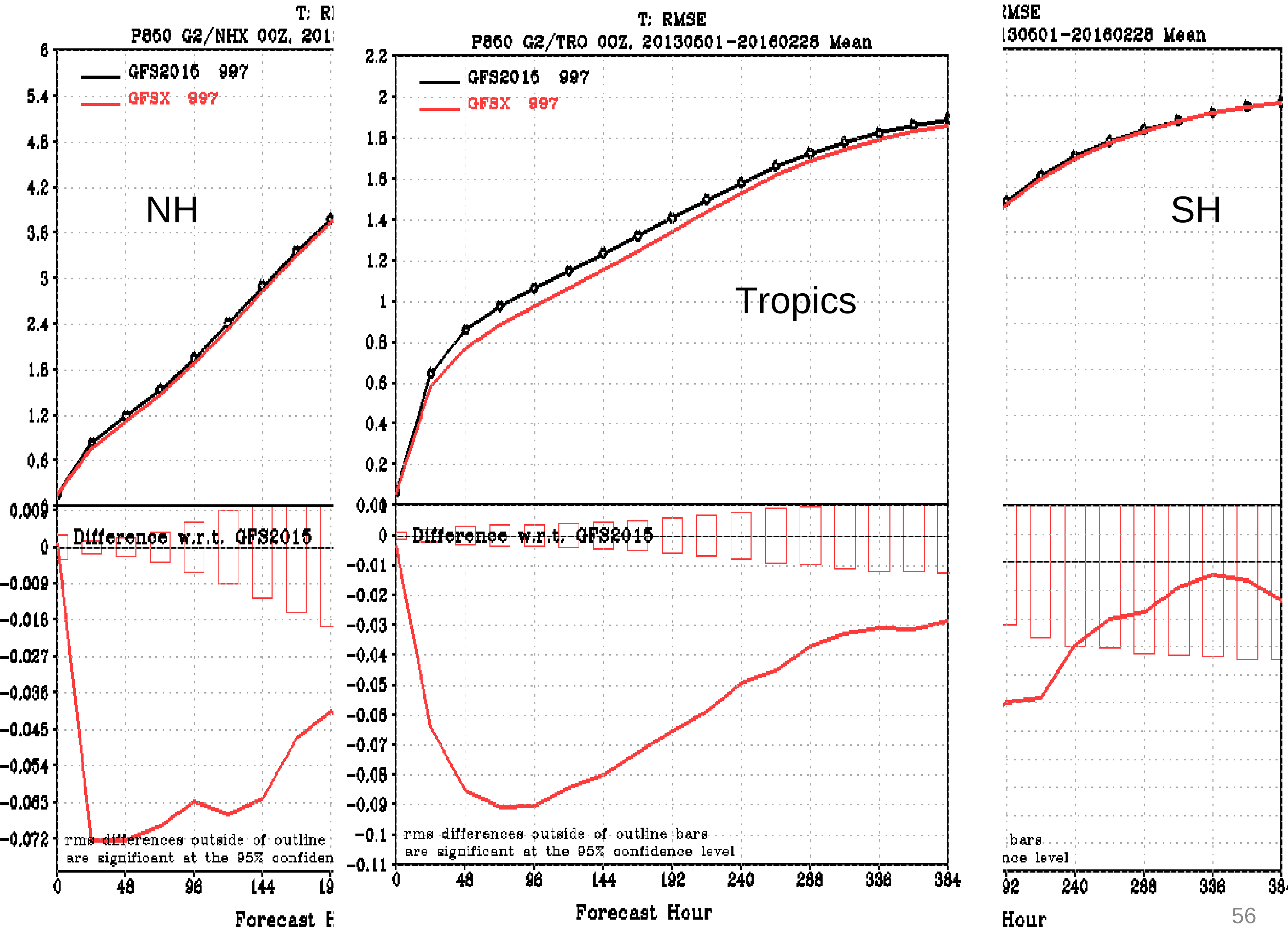




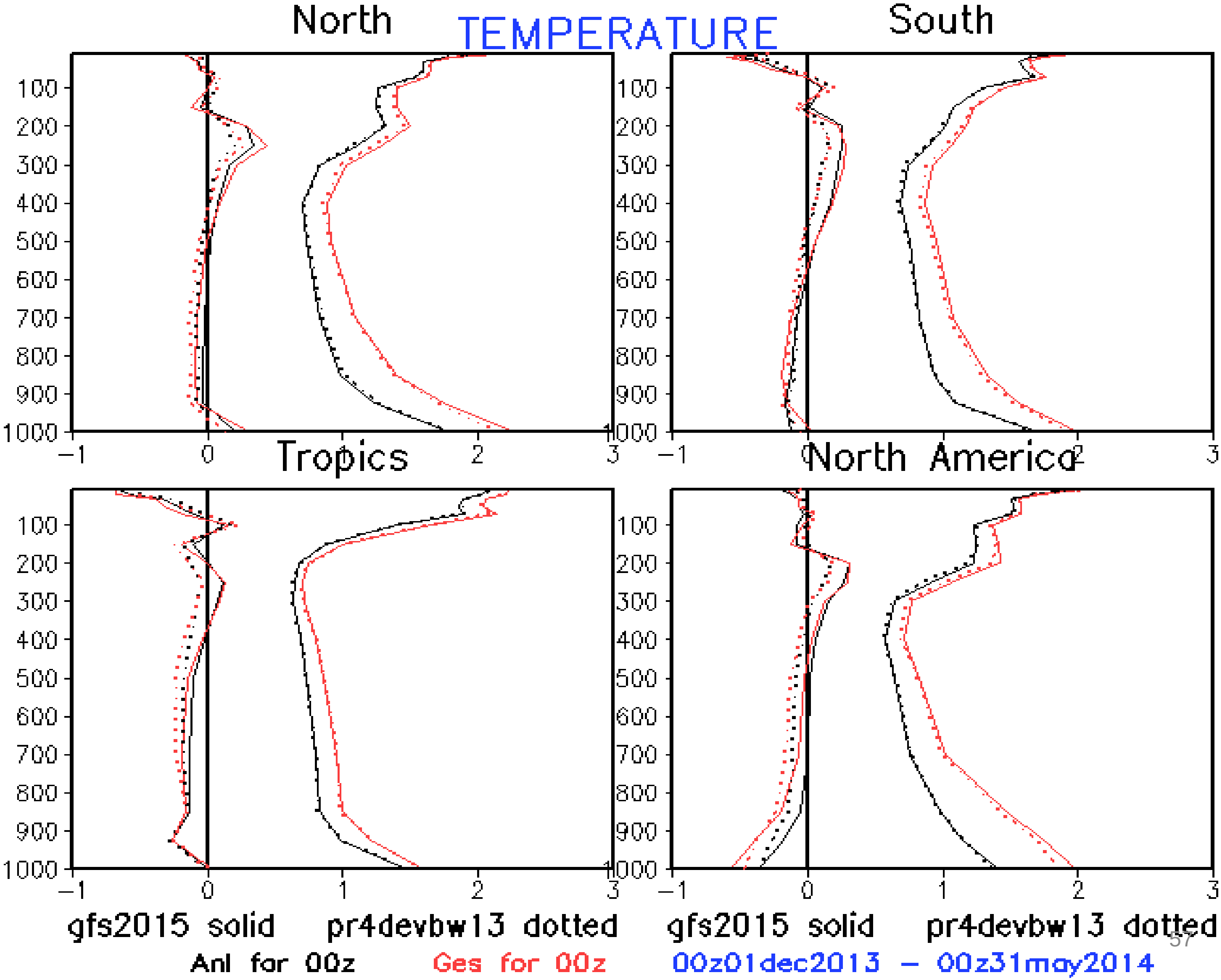
Temperature RMSE

Big improvements in Southern Hemisphere

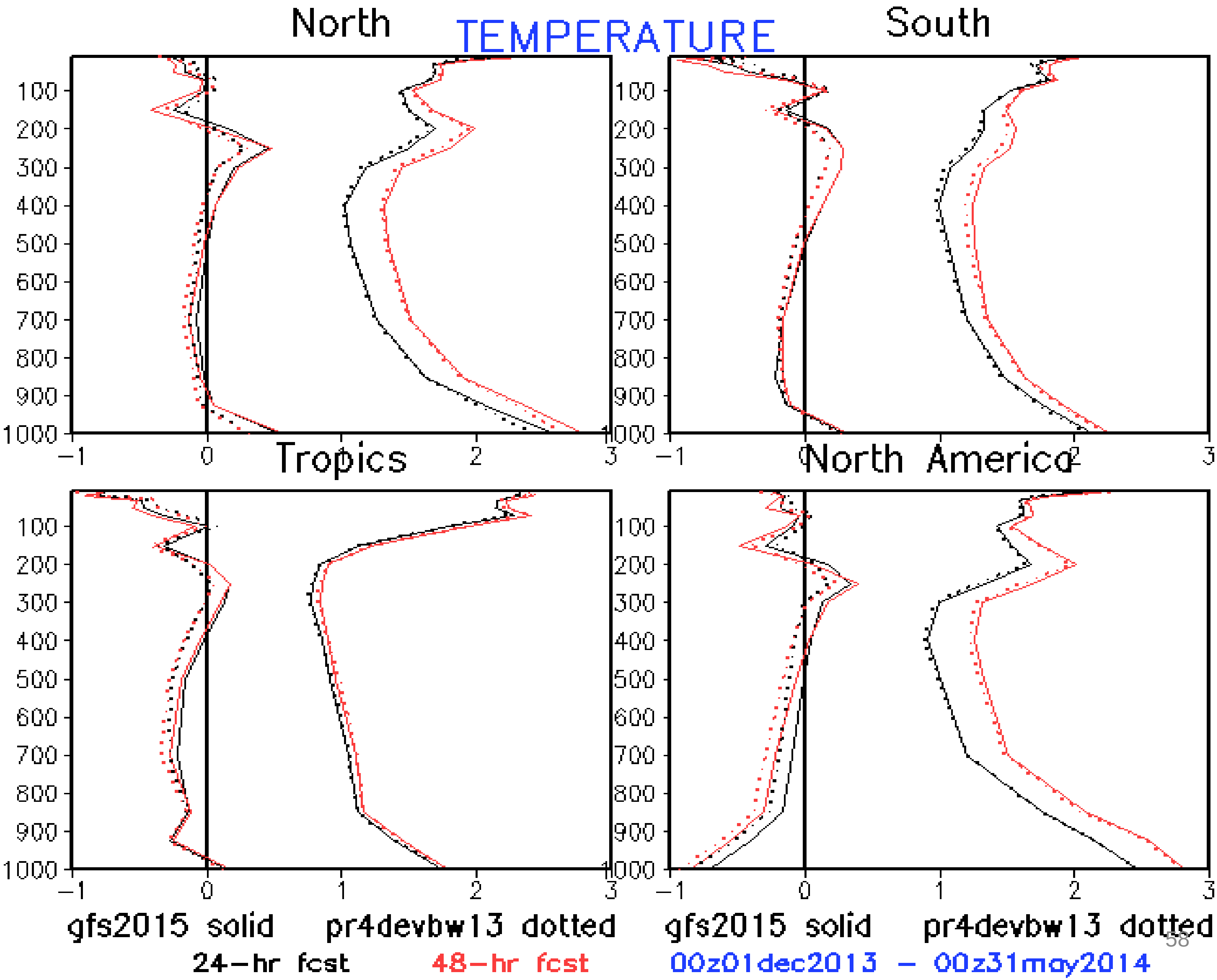
Upper troposphere/Stratosphere in Northern Hemisphere has increased RMSE

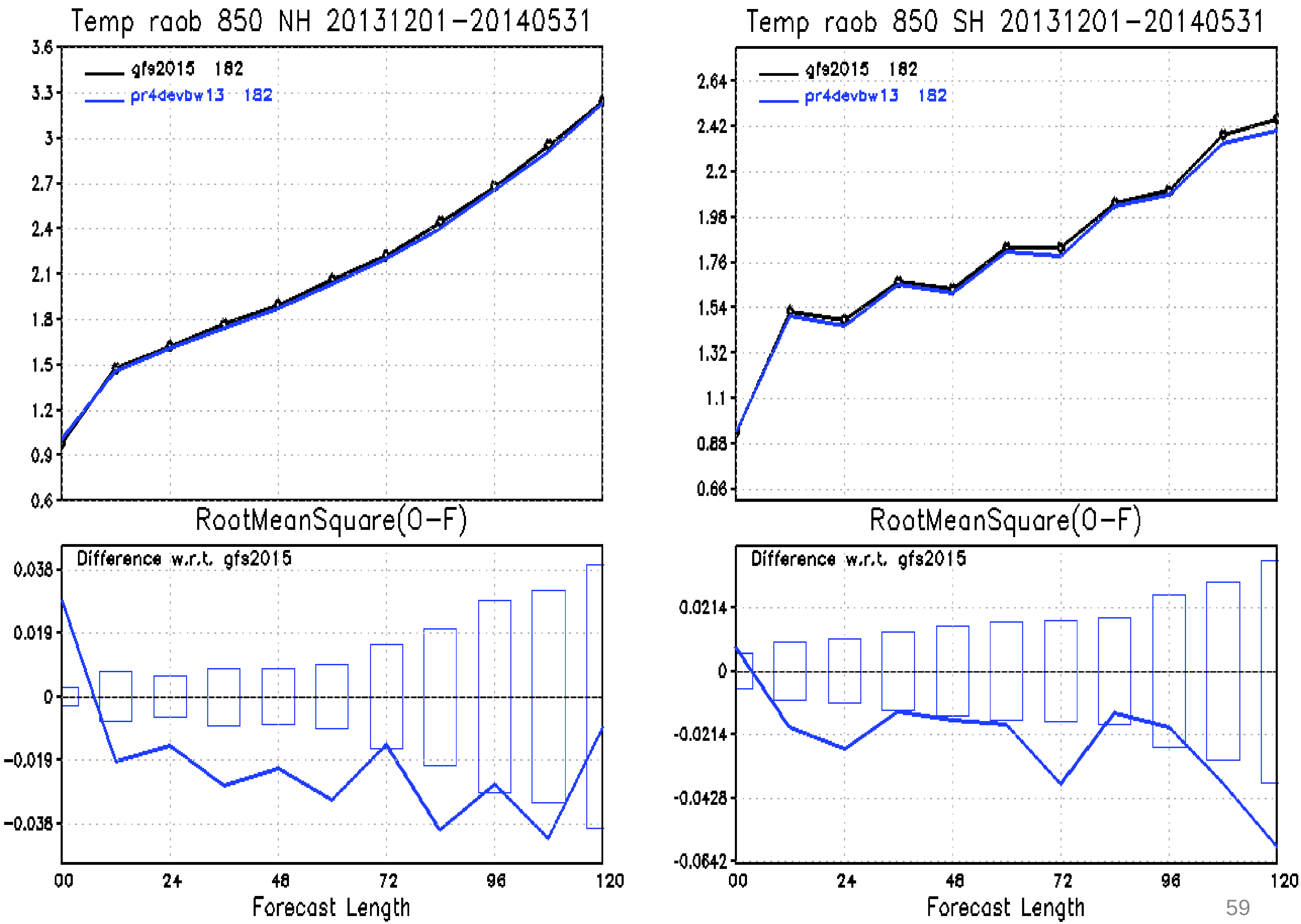


T: RMSE
P850 G2/TRO 00Z, 20130601-20160228 Mean
GFS2016 997
GFSX 997
NH
Tropics
SH
Difference w.r.t. GFS2016
rms differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

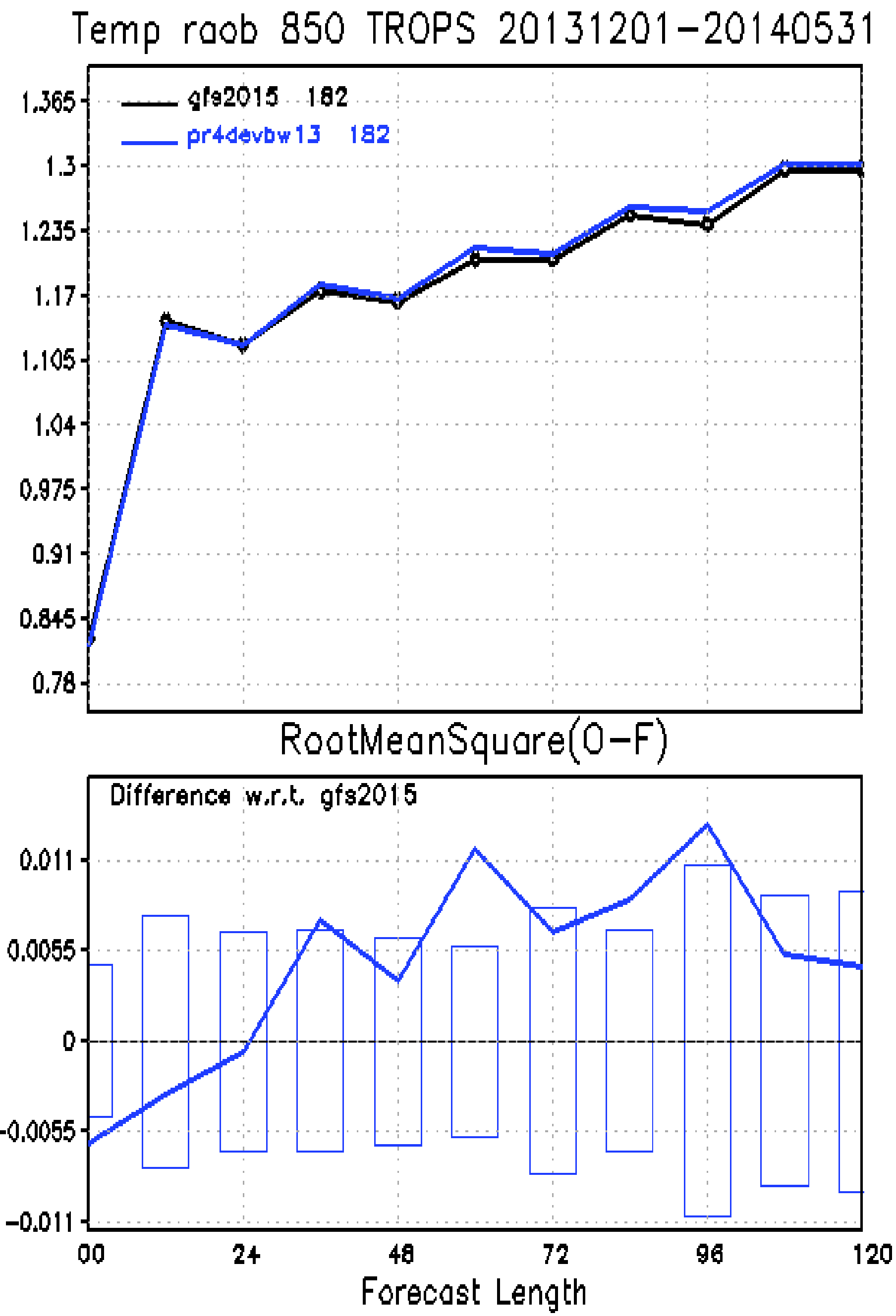


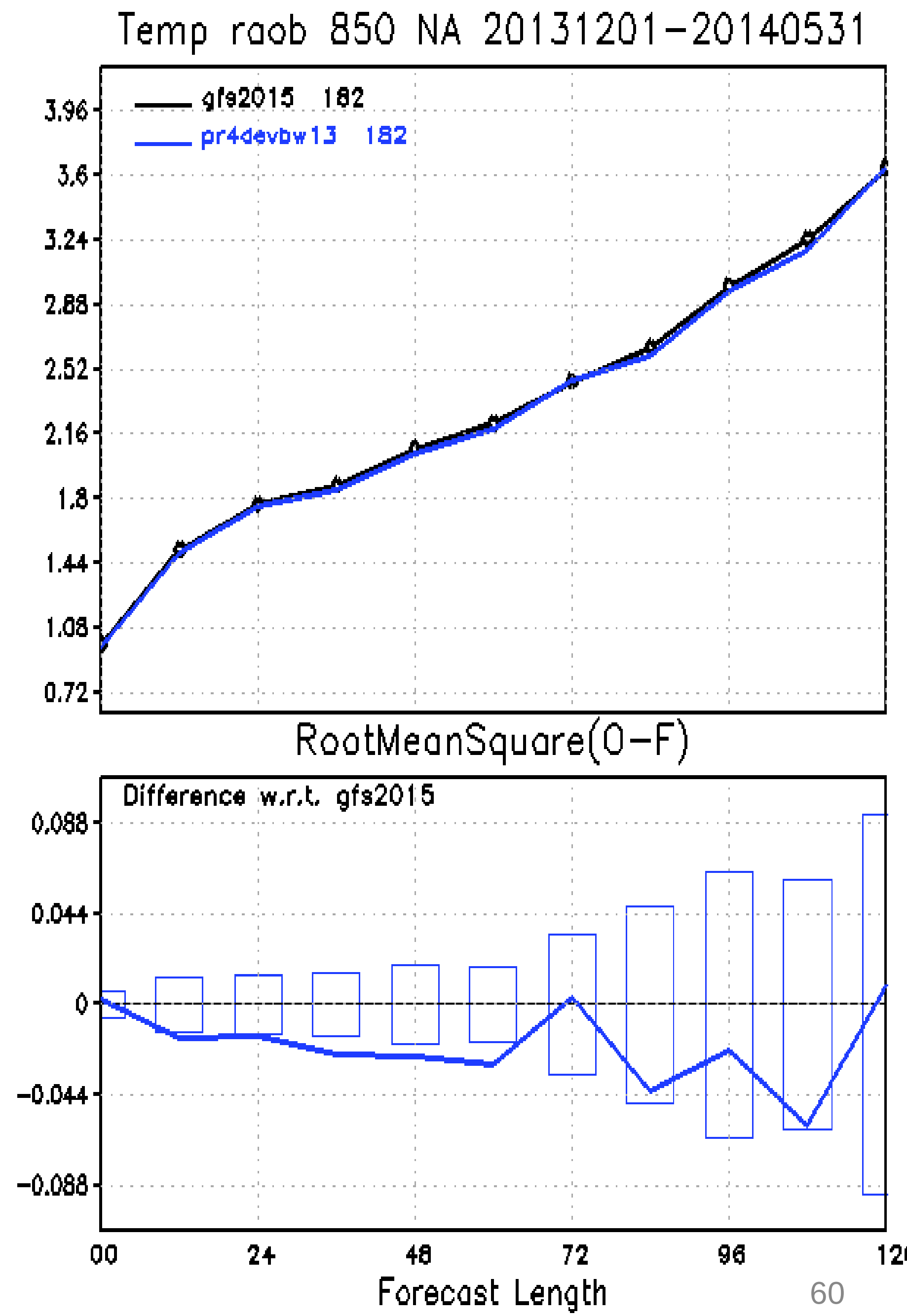
TEMPERATURE
North
South
Tropics
North America
100
200
300
400
500
600
700
800
900
1000
−1
0
1
2
3
gfs2015 solid
pr4devbw13 dotted
Anl for 00z
Ges for 00z
00z01dec2013 – 00z31may2014

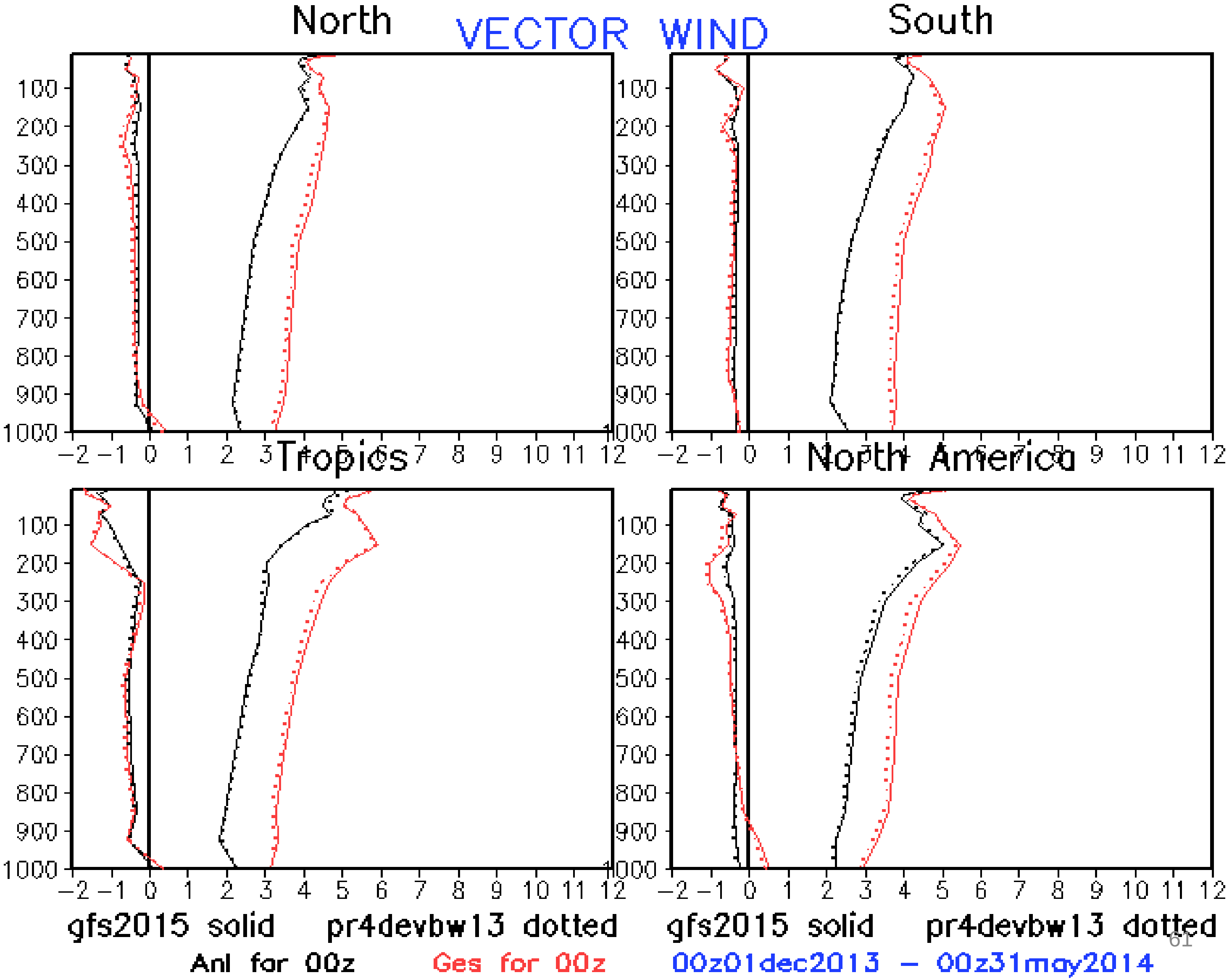

TEMPERATURE
North
South
Tropics
North America
100
200
300
400
500
600
700
800
900
1000
−1
0
1
2
3
gfs2015 solid pr4devbw13 dotted
gfs2015 solid pr4devbw13 dotted
24−hr fcst 48−hr fcst 00z01dec2013 − 00z31may2014

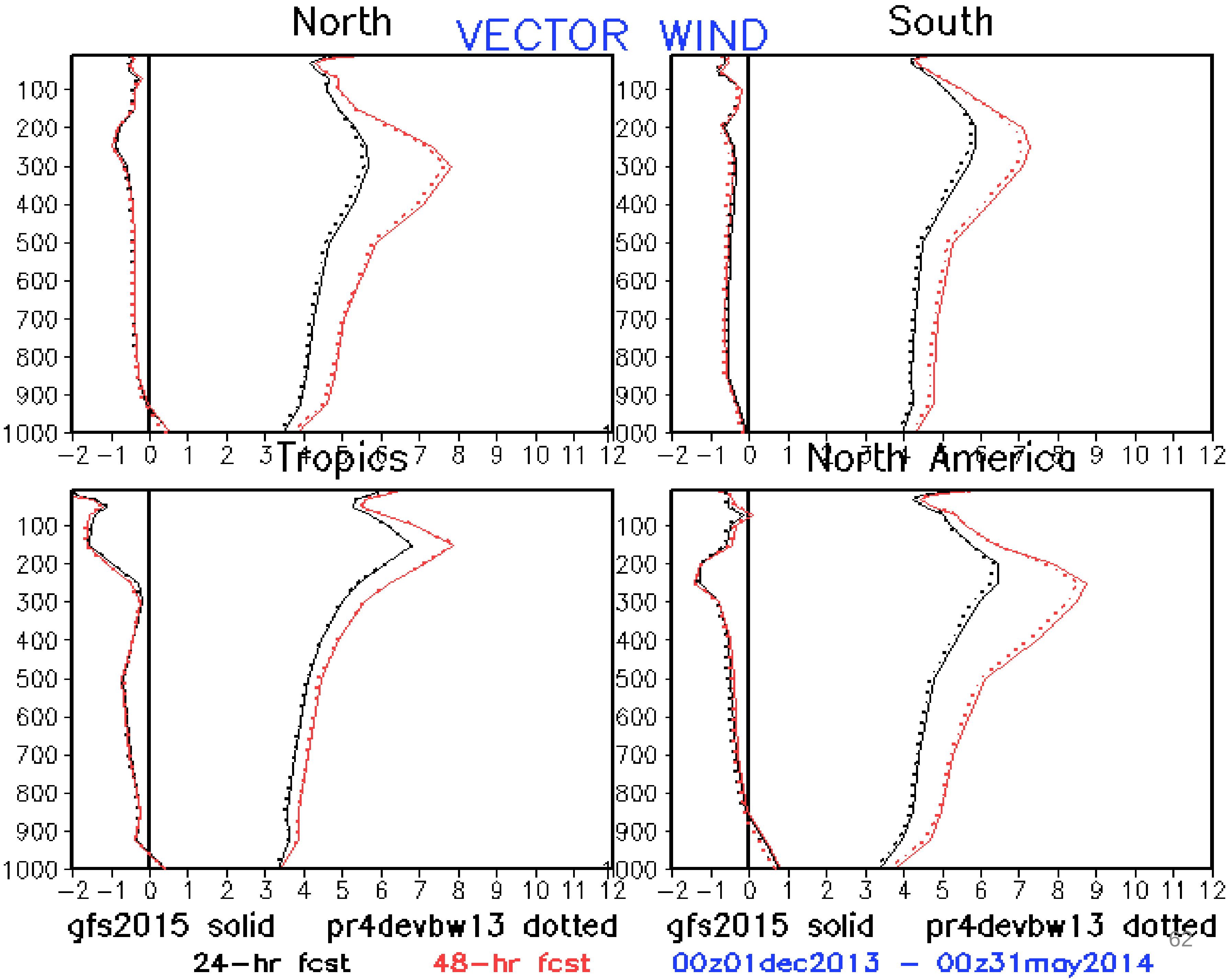


Temp raob 850 NH 20131201-20140531
gfs2015 182
pr4devbw13 182
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
Forecast Length
Temp raob 850 SH 20131201-20140531
gfs2015 182
pr4devbw13 182
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
Forecast Length

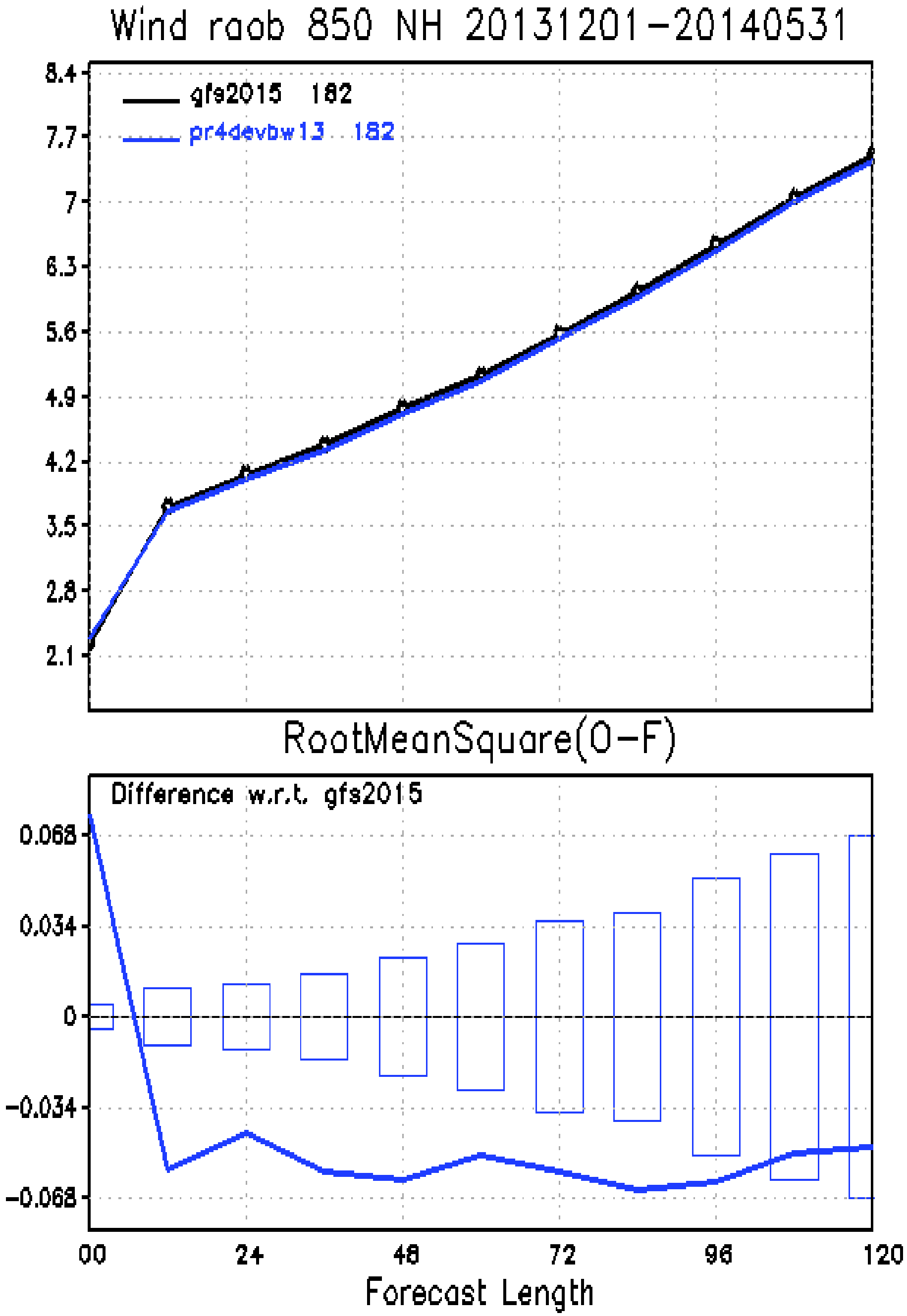

Temp raob 850 TROPS 20131201-20140531
gfs2015 182
pr4devbw13 182
1.365
1.3
1.235
1.17
1.105
1.04
0.975
0.91
0.845
0.78
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.011
0.0055
0
-0.0055
-0.011
00
24
48
72
96
120
Forecast Length

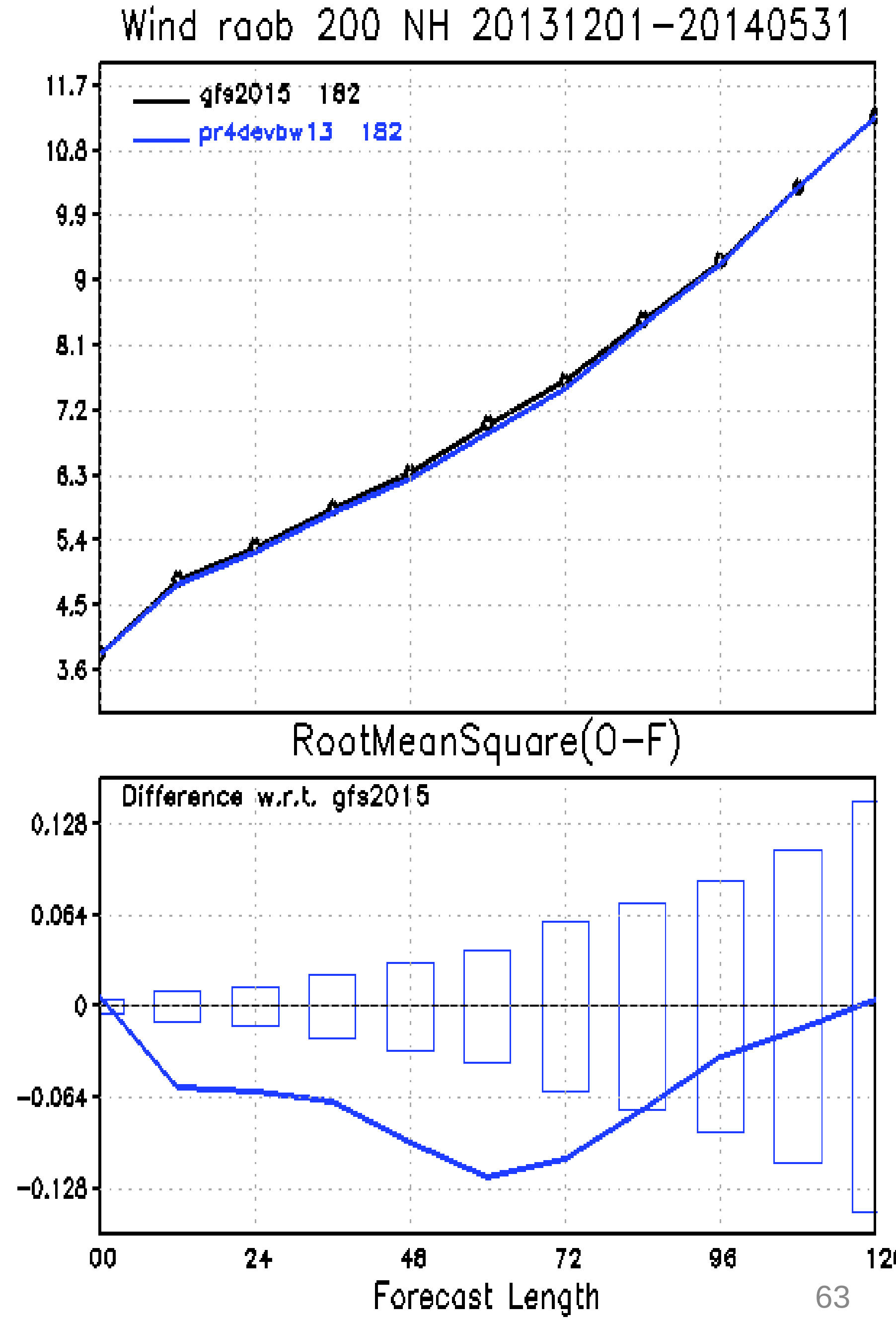

Temp raob 850 NA 20131201-20140531
gfs2015 182
pr4devbw13 182
3.96
3.6
3.24
2.88
2.52
2.16
1.8
1.44
1.08
0.72
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.088
0.044
0
-0.044
-0.088
00
24
48
72
96
120
Forecast Length

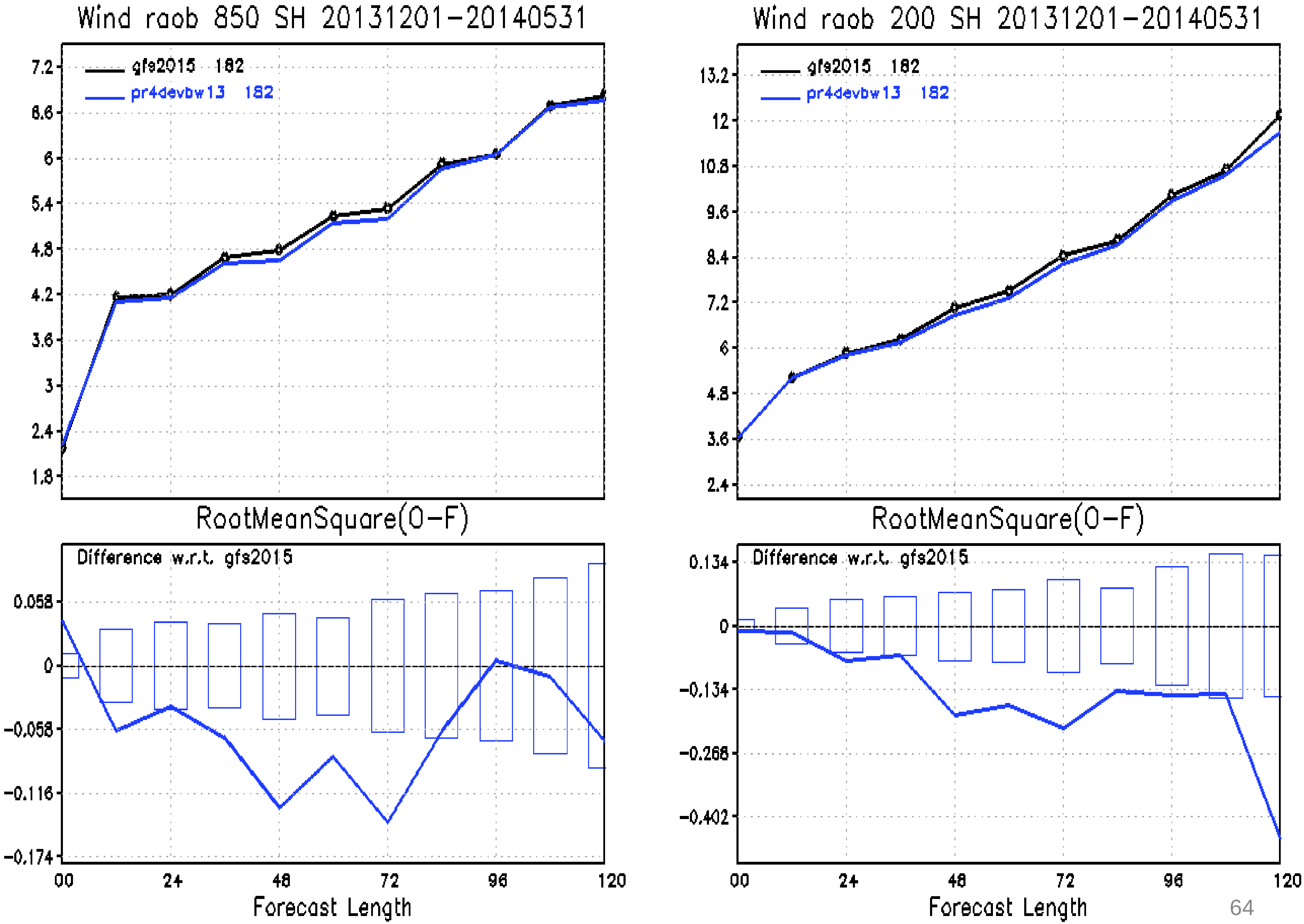

VECTOR WIND
North
South
Tropics
North America
100
200
300
400
500
600
700
800
900
1000
-2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12
gfs2015 solid pr4devbw13 dotted
Anl for 00z
Ges for 00z
00z01dec2013 - 00z31may2014



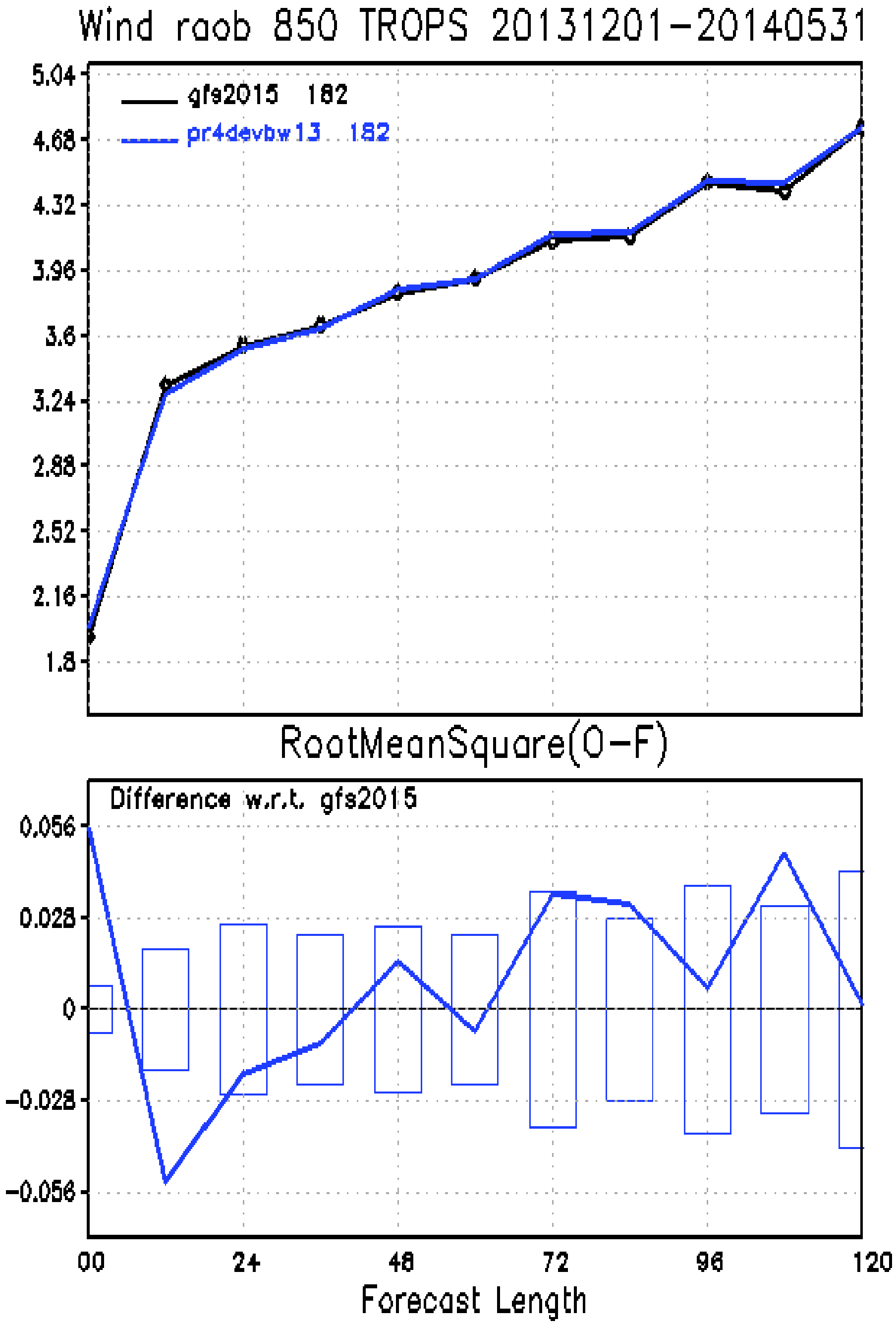
VECTOR WIND
North
South
Tropics
North America
gfs2015 solid pr4devbw13 dotted
24-hr fcst 48-hr fcst 00z01dec2013 - 00z31may2014

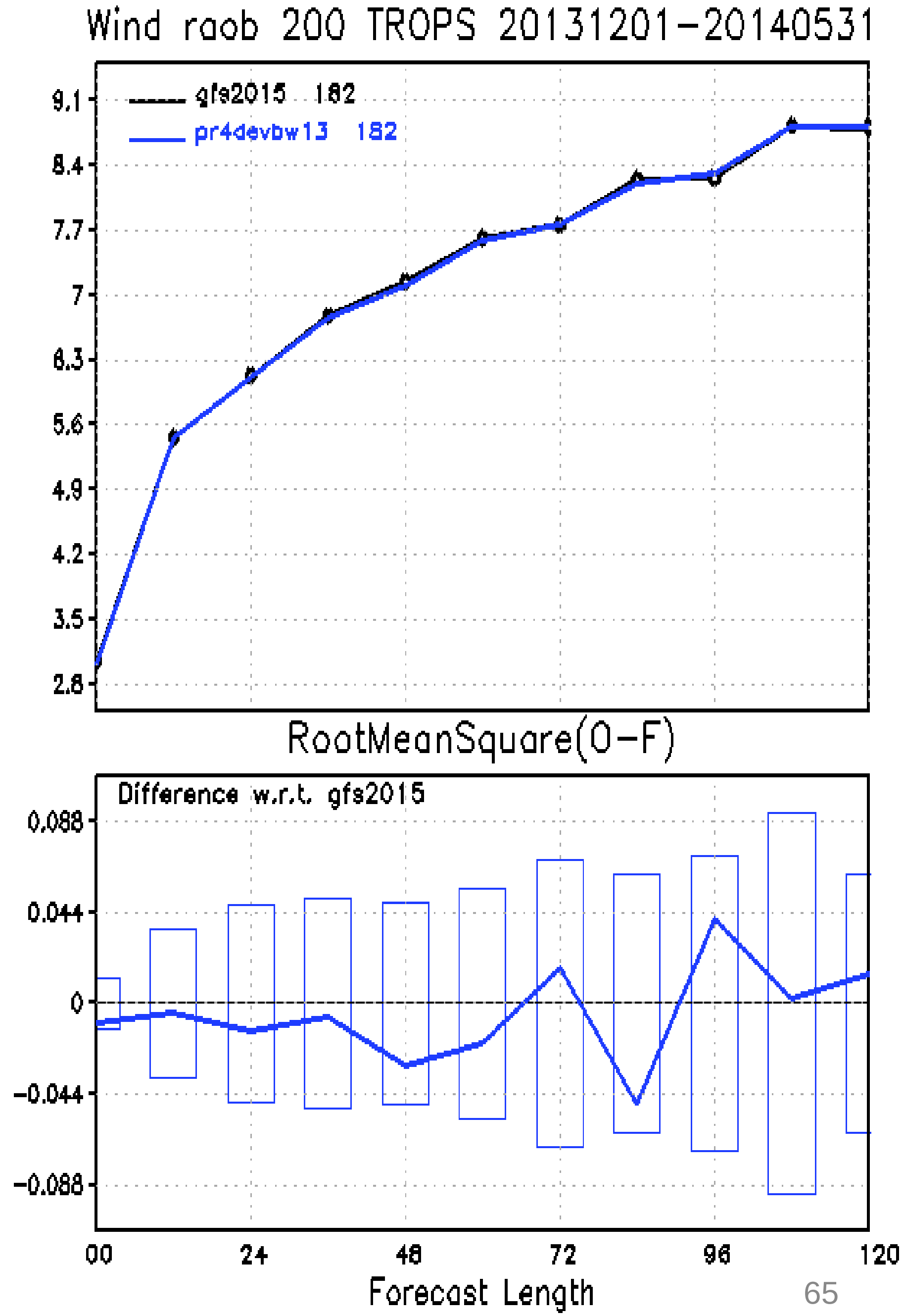

Wind raob 850 NH 20131201-20140531
gfs2015 182
pr4devbw13 182
8.4
7.7
7
6.3
5.6
4.9
4.2
3.5
2.8
2.1
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.068
0.034
0
-0.034
-0.068
00
24
48
72
96
120
Forecast Length

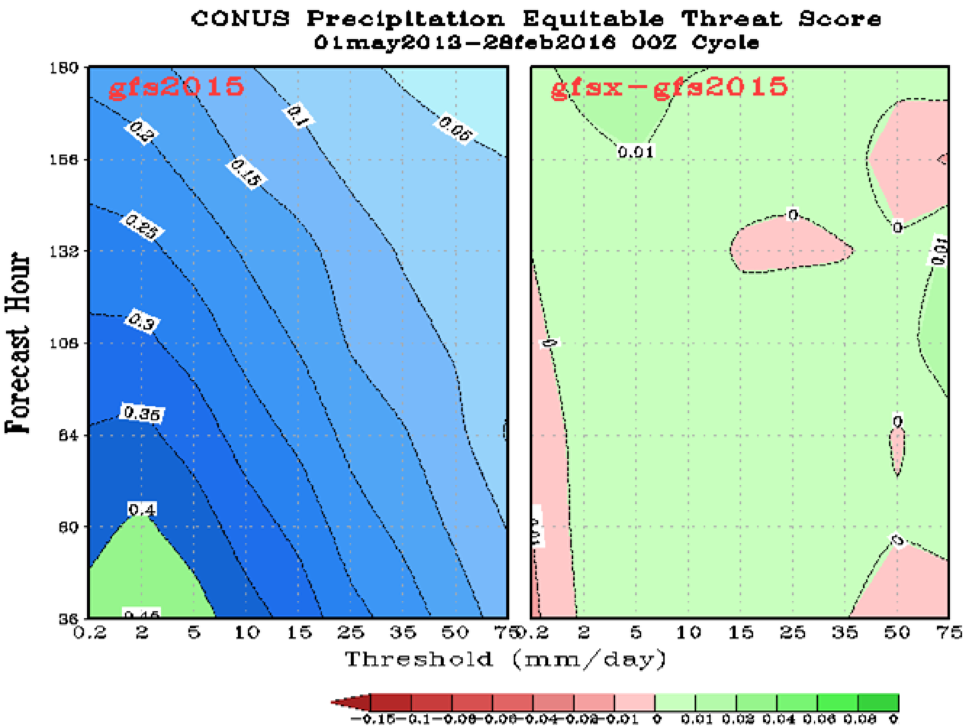

Wind raob 200 NH 20131201-20140531
gfs2015 182
pr4devbw13 182
11.7
10.8
9.9
9
8.1
7.2
6.3
5.4
4.5
3.6
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.128
0.064
0
-0.064
-0.128
00
24
48
72
96
120
Forecast Length



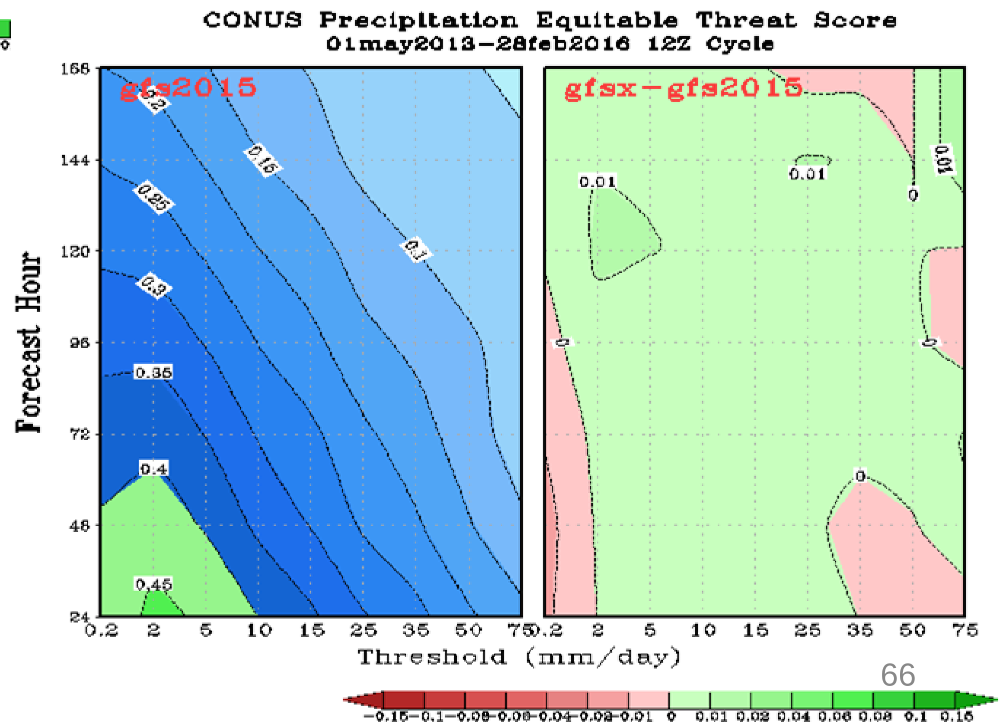
Wind raob 850 SH 20131201-20140531
gfs2015 182
pr4devbw13 182
7.2
6.6
6
5.4
4.8
4.2
3.6
3
2.4
1.8
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.058
0
-0.058
-0.116
-0.174
00
24
48
72
96
120
Forecast Length
Wind raob 200 SH 20131201-20140531
gfs2015 182
pr4devbw13 182
13.2
12
10.8
9.6
8.4
7.2
6
4.8
3.6
2.4
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.134
0
-0.134
-0.268
-0.402
00
24
48
72
96
120
Forecast Length

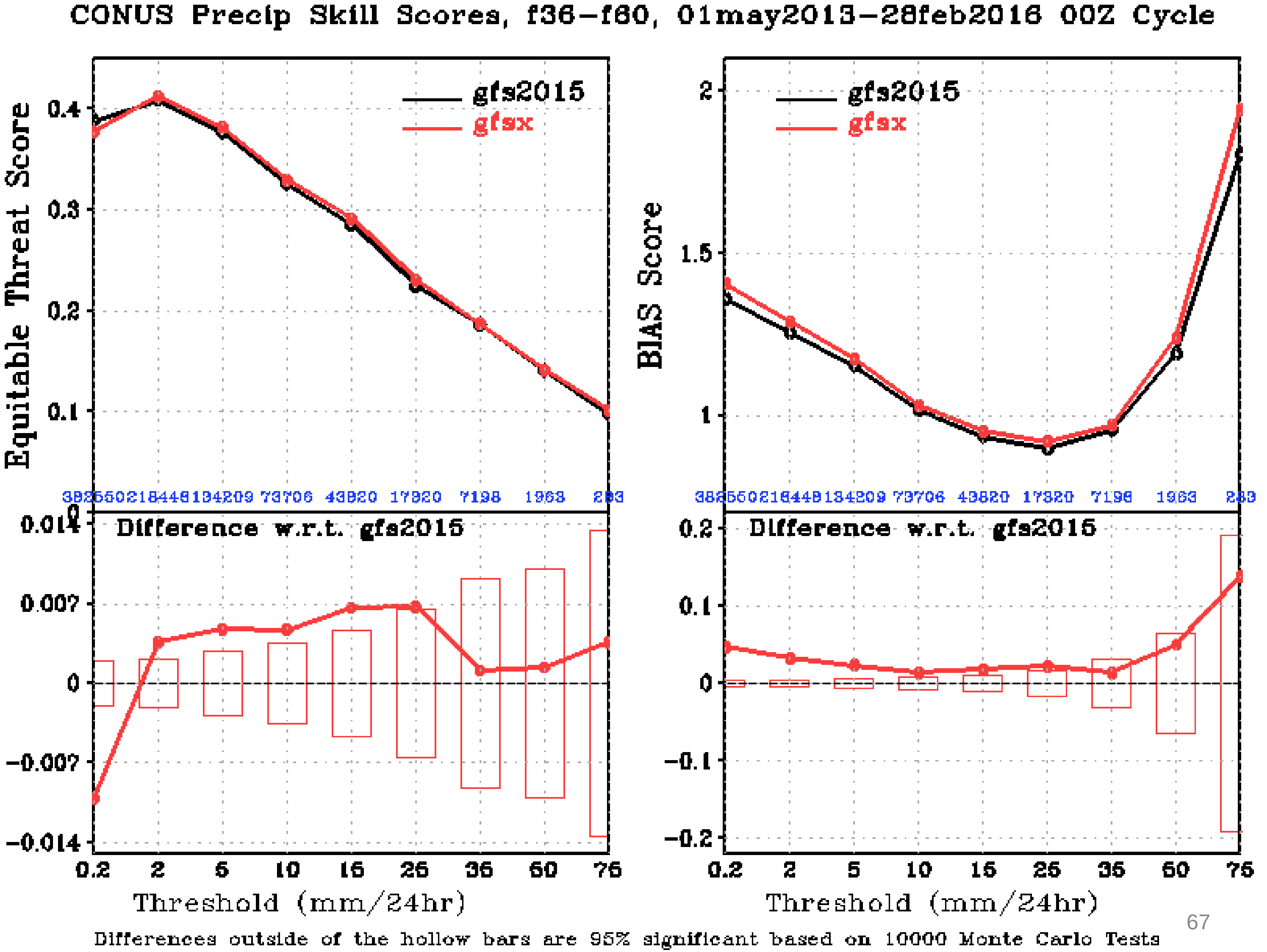

Wind raob 850 TROPS 20131201-20140531
gfs2015 182
pr4devbw13 182
5.04
4.68
4.32
3.96
3.6
3.24
2.88
2.52
2.16
1.8
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.056
0.028
0
-0.028
-0.056
00
24
48
72
96
120
Forecast Length


Wind raob 200 TROPS 20131201-20140531
gfs2015 182
pr4devbw13 182
9.1
8.4
7.7
7
6.3
5.6
4.9
4.2
3.5
2.8
RootMeanSquare(O-F)
Difference w.r.t. gfs2015
0.088
0.044
0
-0.044
-0.088
00
24
48
72
96
120
Forecast Length



CONUS Precip ETS (00Z & 12Z)




CONUS Precip Skill Scores, f36-f60, 01may2013-28feb2016 00Z Cycle
Equitable Threat Score
gfs2015
gfsx
0.4
0.3
0.2
0.1
Difference w.r.t. gfs2015
0.014
0.007
0
-0.007
-0.014
0.2
2
5
10
15
25
35
50
75
Threshold (mm/24hr)
BIAS Score
2
1.5
1
0.2
0.1
-0.1
-0.2
Differences outside of the hollow bars are 95% significant based on 10000 Monte Carlo Tests

Equitable threat and bias scores for May 2013-February 2016 for CONUS

14 forecast lengths 00-24 hr to 156-180 hr for 00Z and 12Z forecasts

Nine Thresholds of 0.2 mm/day to 75 mm/day

GFSX forecasts for thresholds of 0.2 mm/day significantly worse for 0-24 to 84-108 h forecasts
Worse wet bias for thresholds of 0.2 mm/day

GFSX forecasts for thresholds of 2, 5, 10 mm/day significantly better for 35/42 fcst lengths
for thresholds of 15 mm/day significantly better 7/14 fcst lengths
for thresholds of 25 mm/day significantly better 3/14 fcst lengths
Slight tendency for less of dry bias 15-35 mm/day

Rain/no rain (Threshold of 0.2 mm/day) worse in GFSX

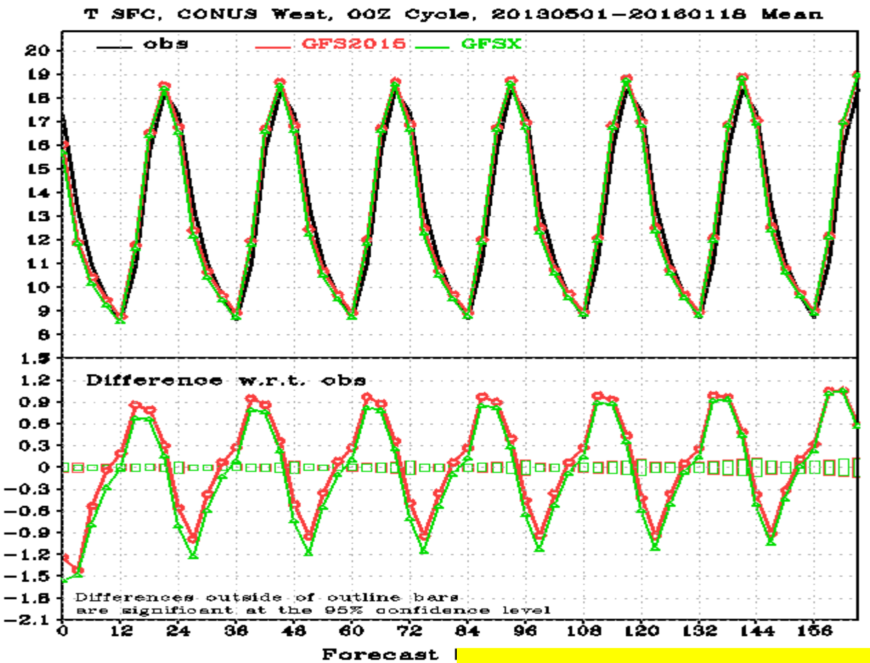
Thresholds of 2 to 25 mm/day significantly improved

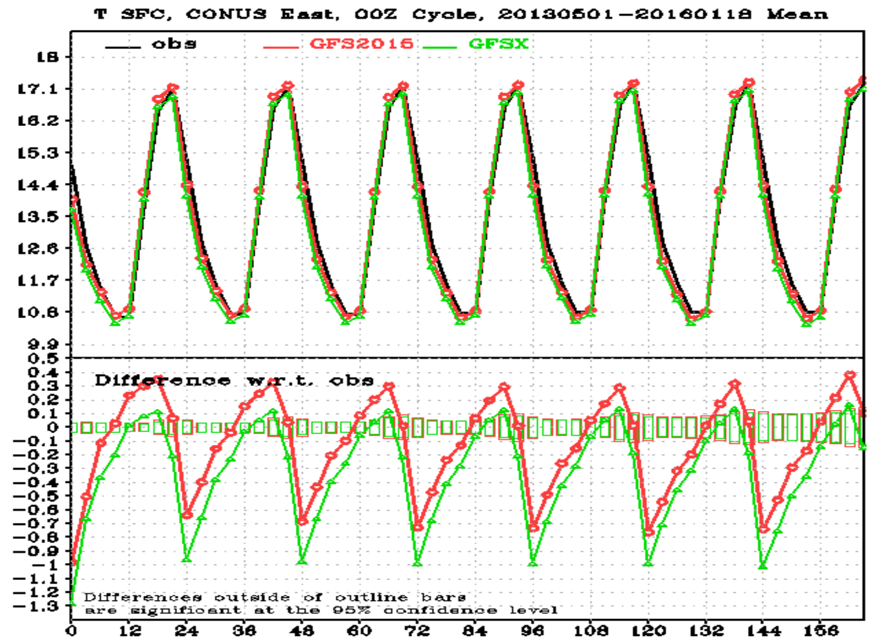
Verification of near surface fields against surface observations

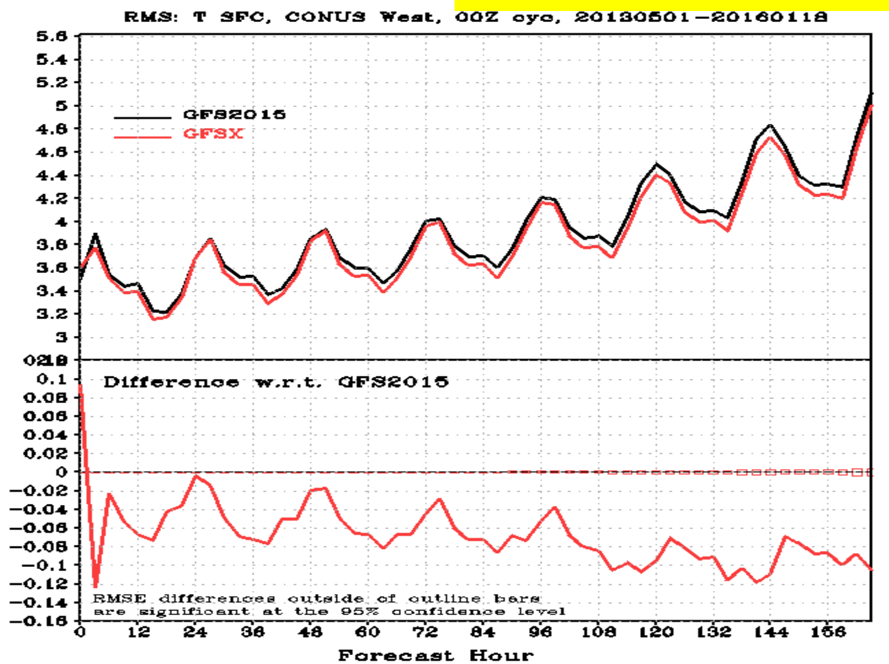
CONUS (six regions, also west and east) and Alaska

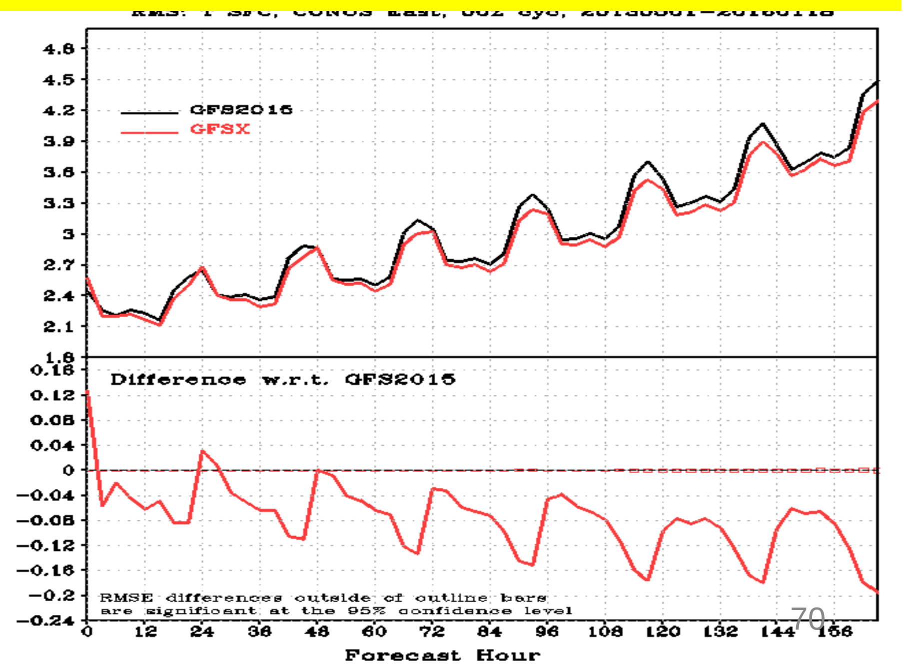
Two years 0 and 12Z forecasts
One year 6 and 18Z forecasts

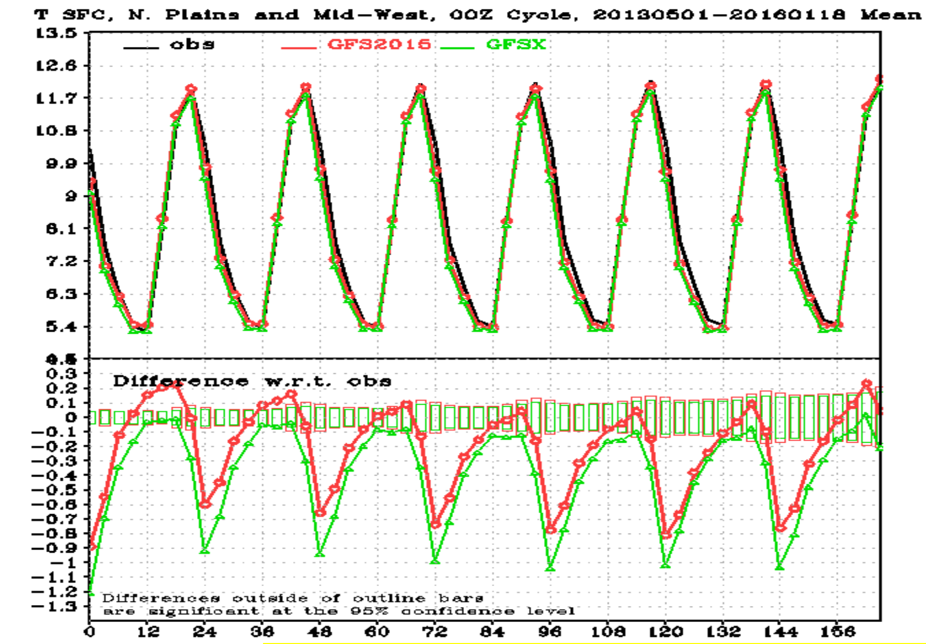
Surface Temperature, CONUS West and East, 00Z Cycle

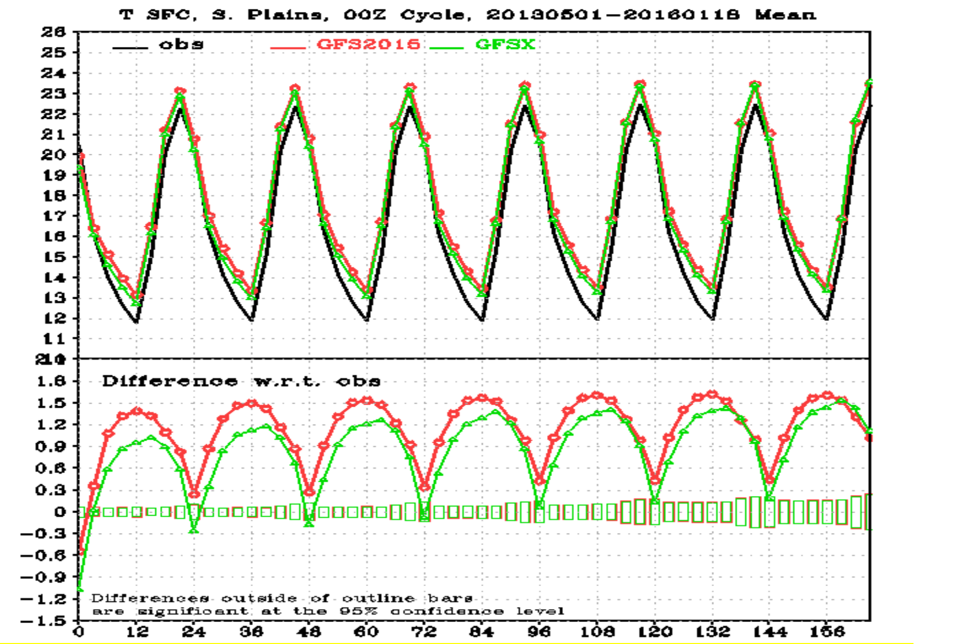




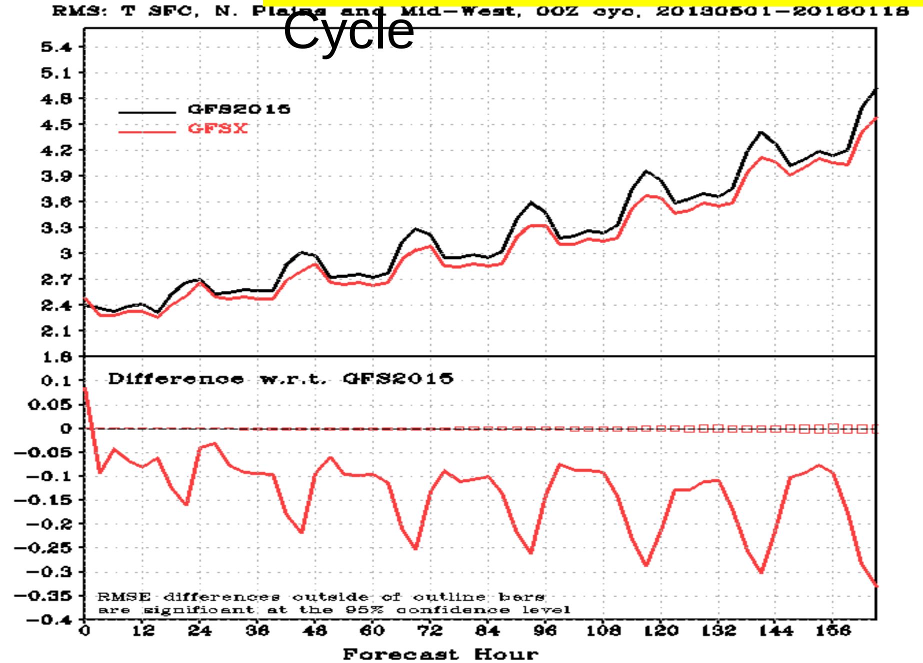


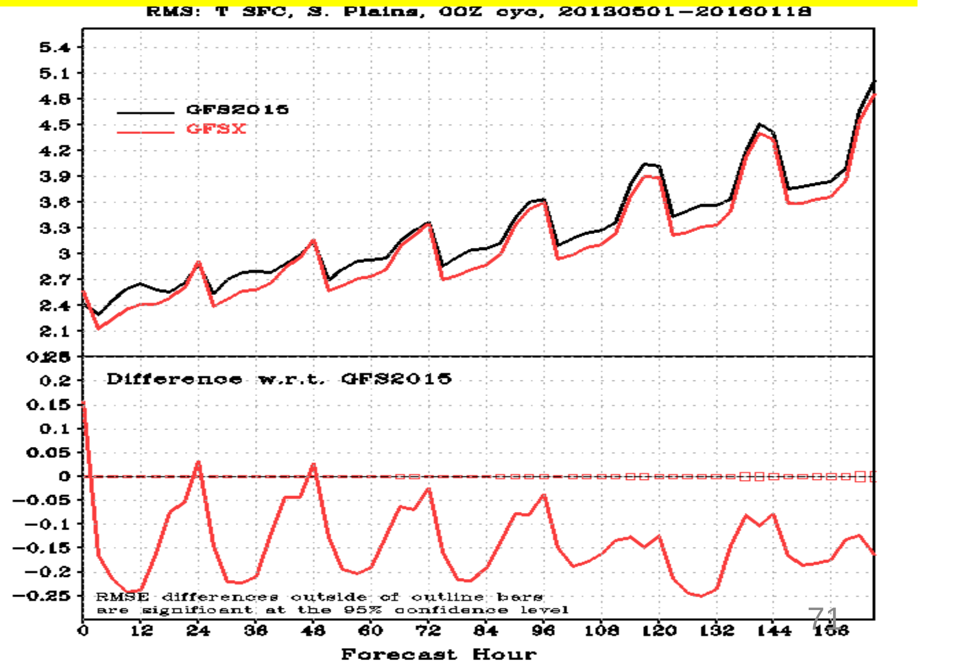


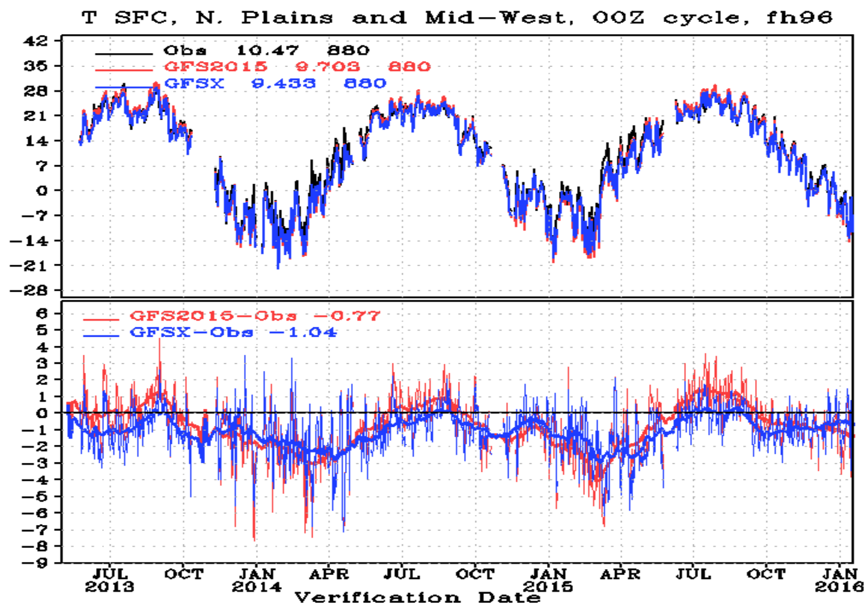


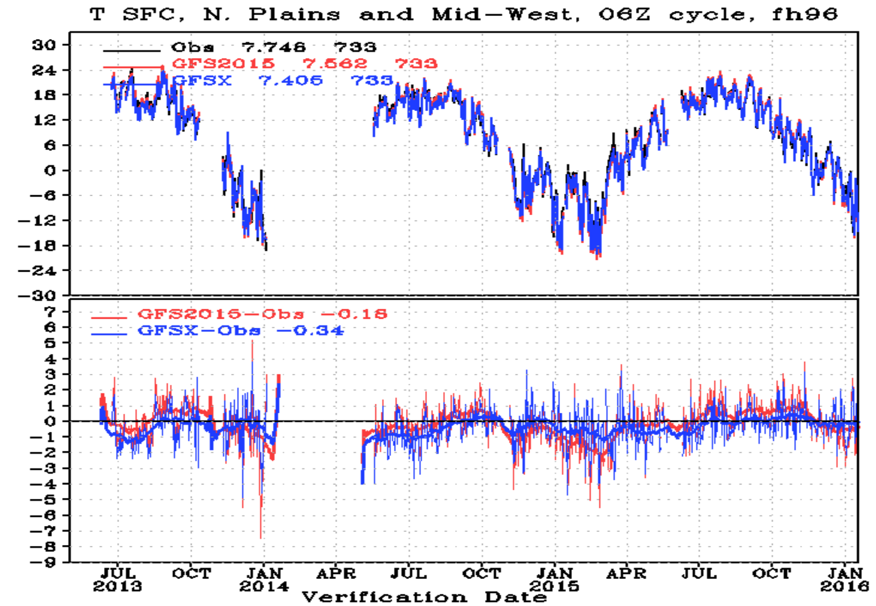


Surface Temperature, N. Plains and Mid-West, S. Plains 00Z Cycle

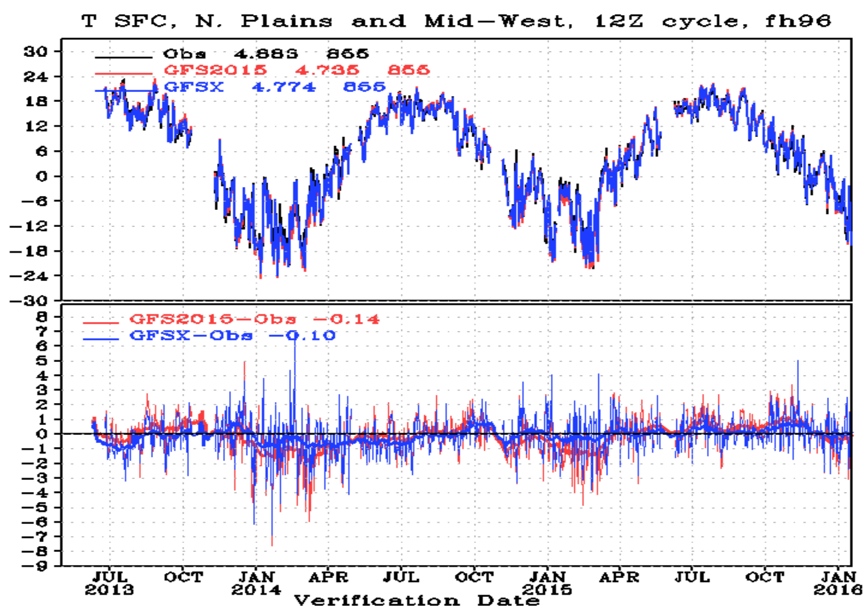


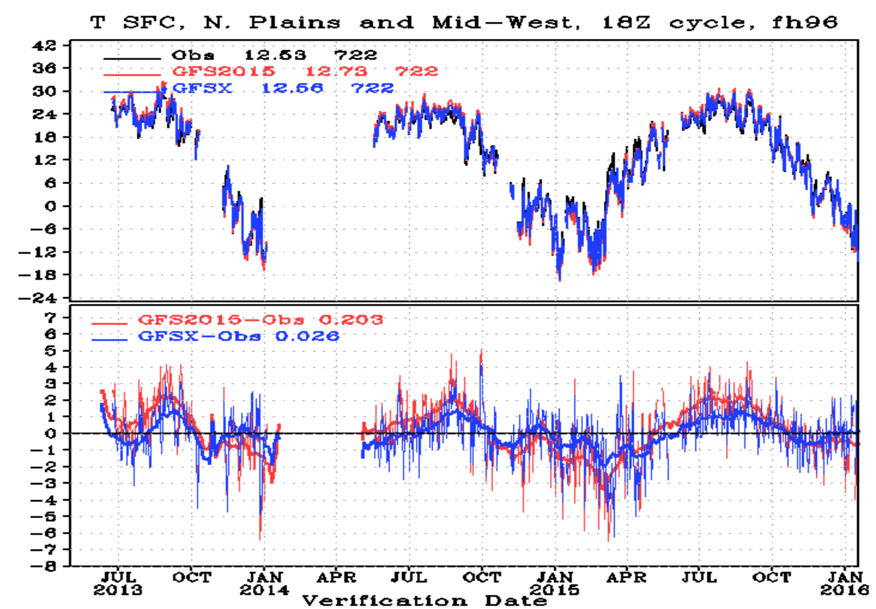


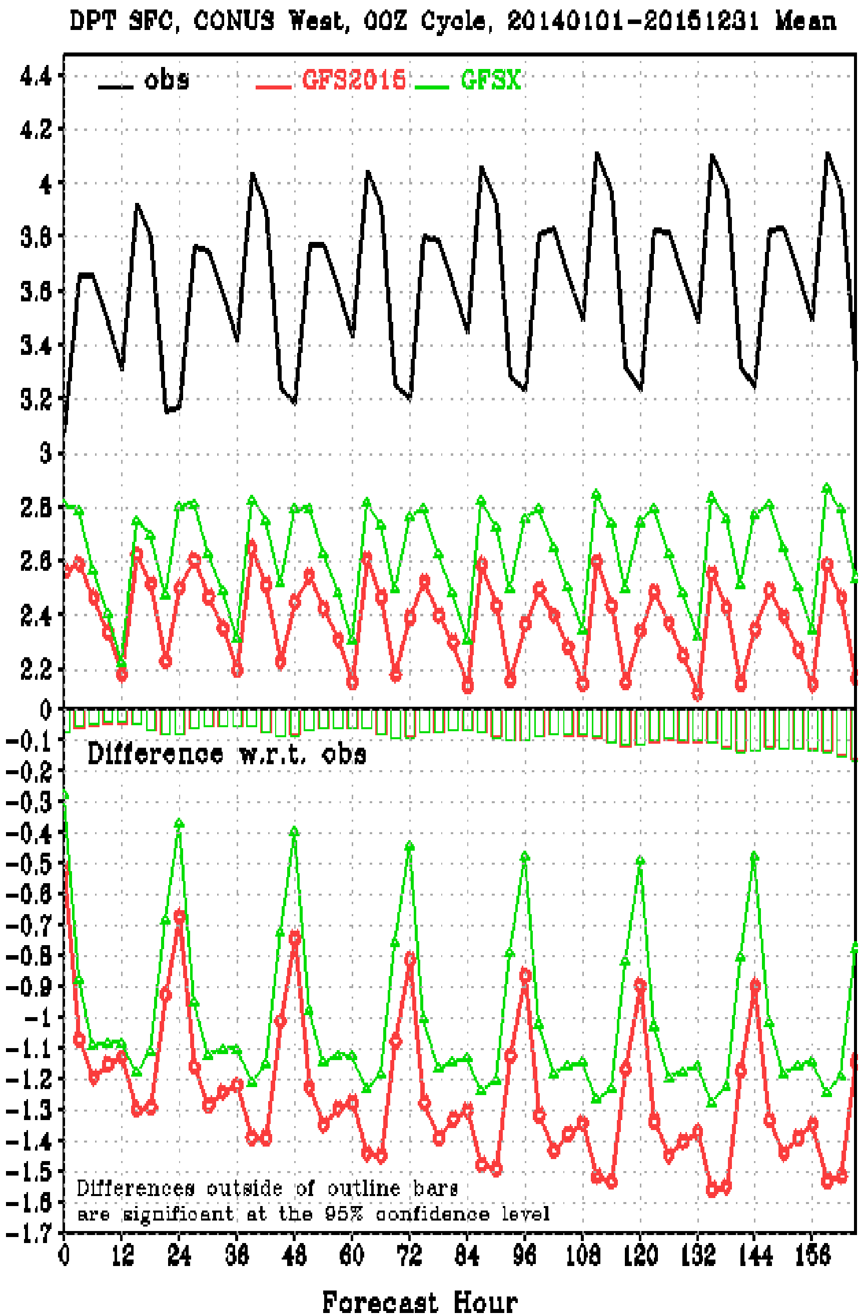


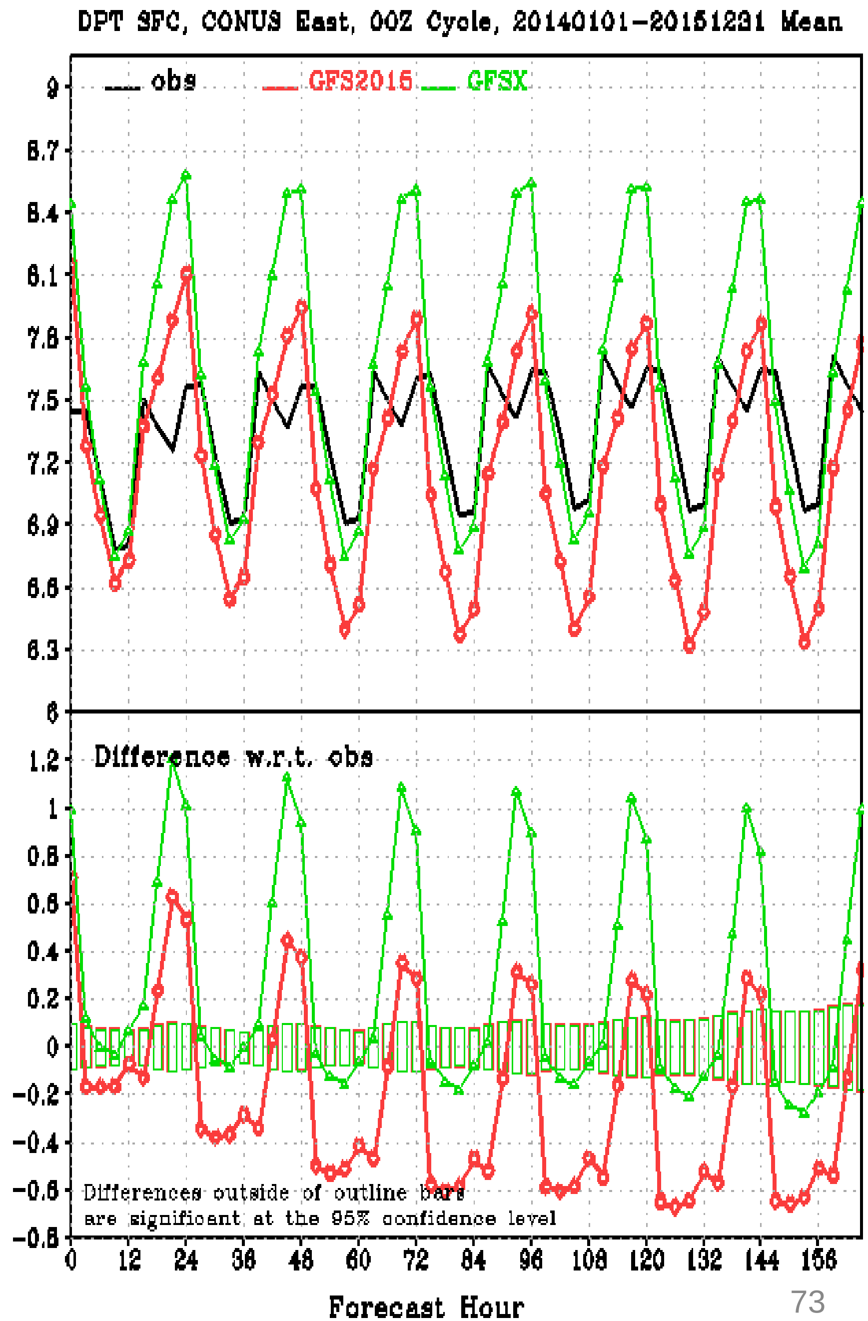


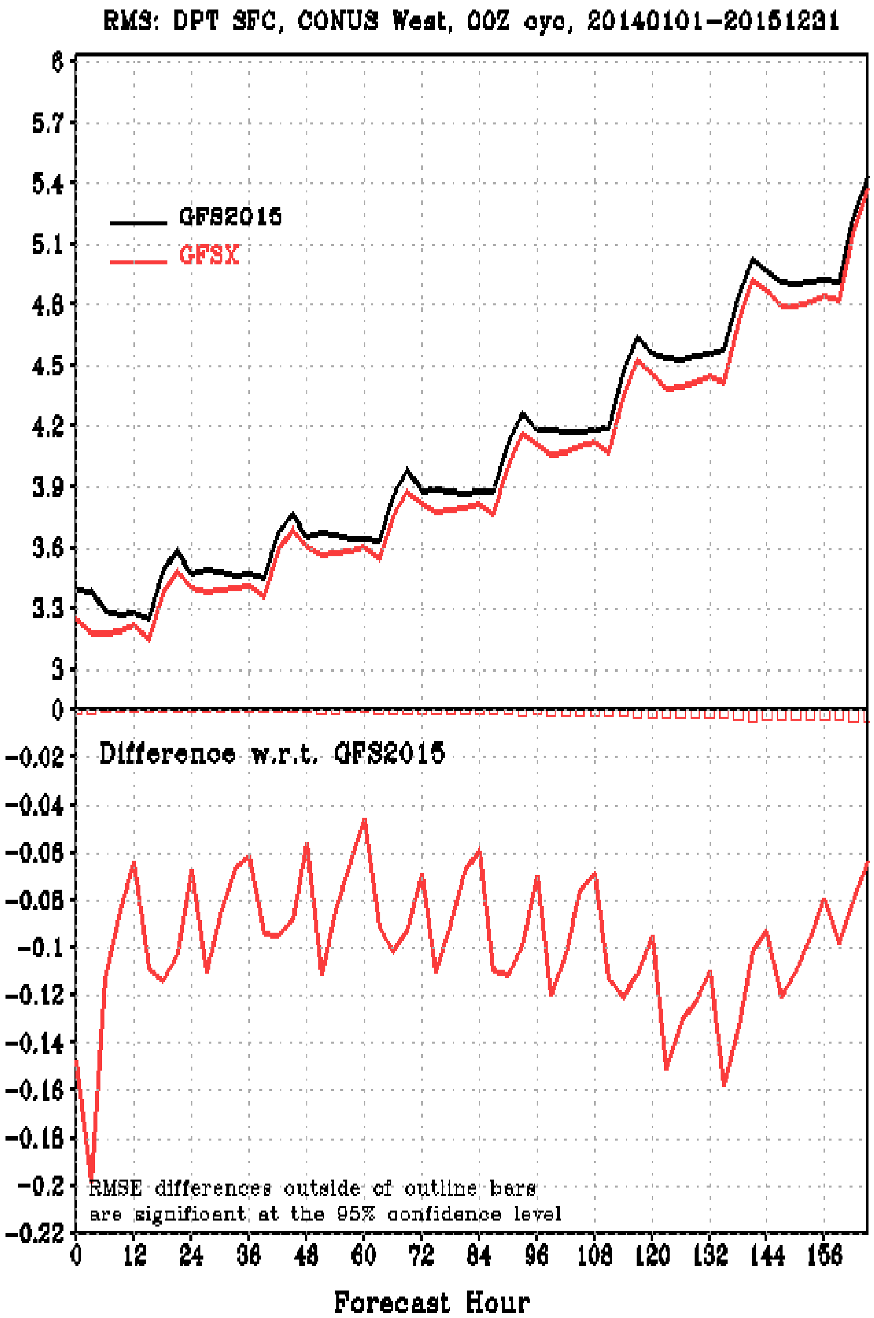
Surface Temperature, N. Plains and Mid-West, All four cycles

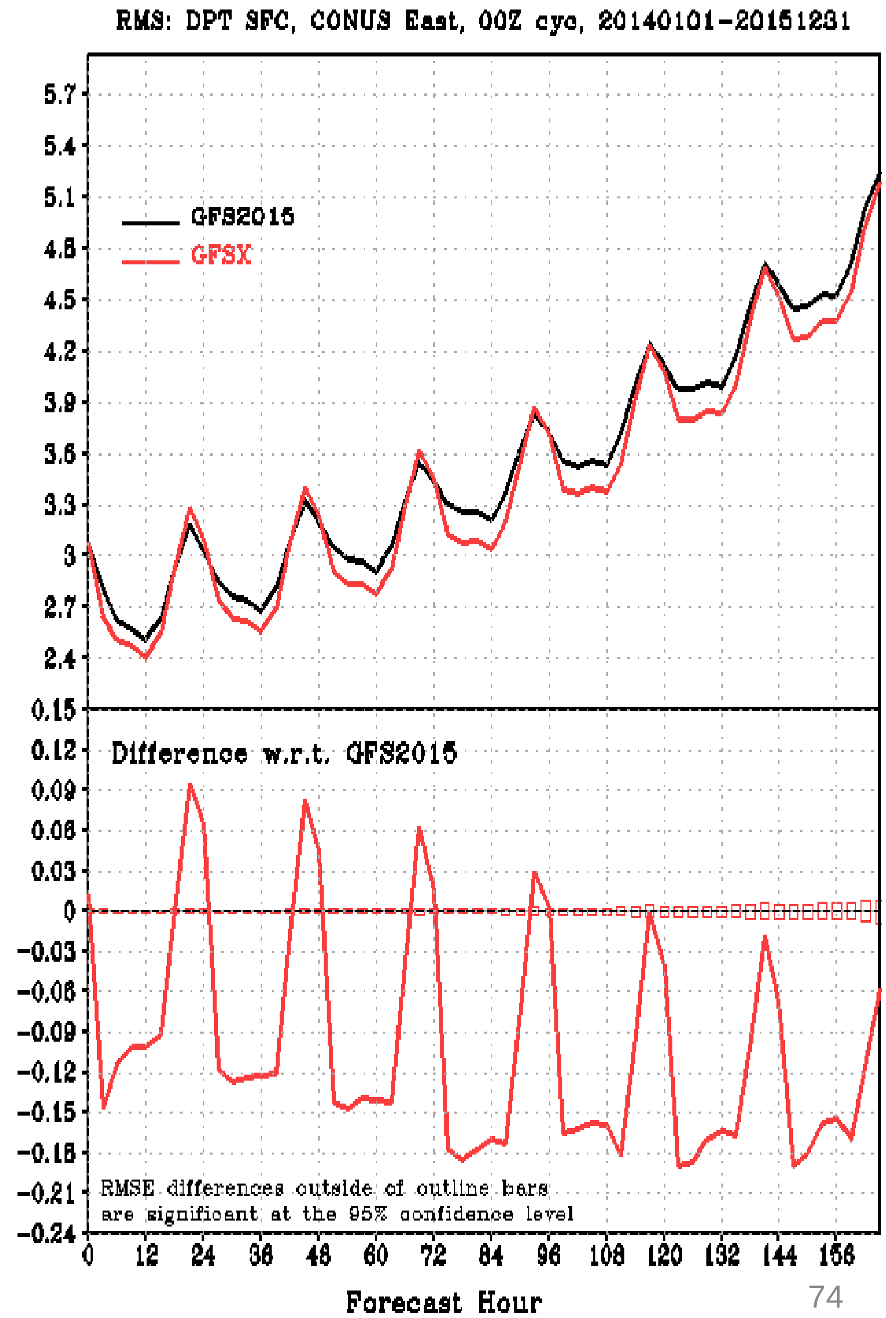


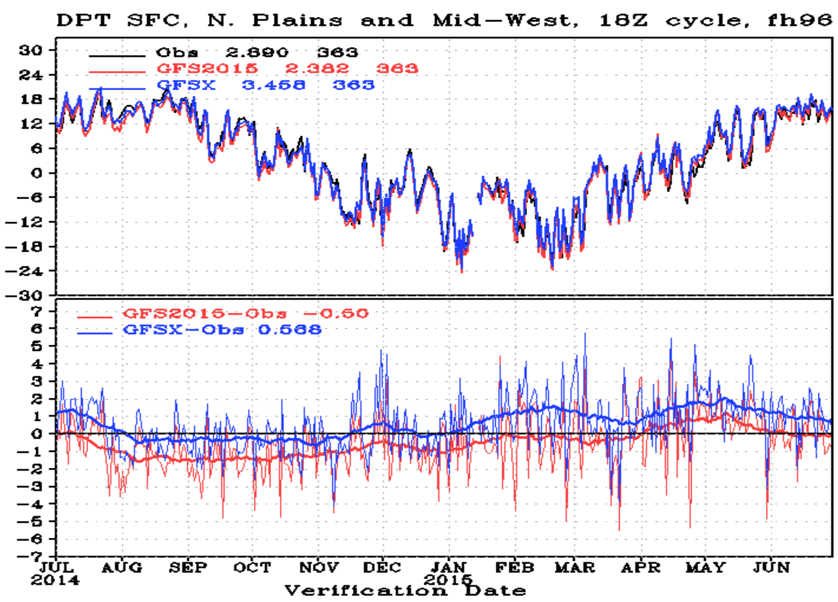


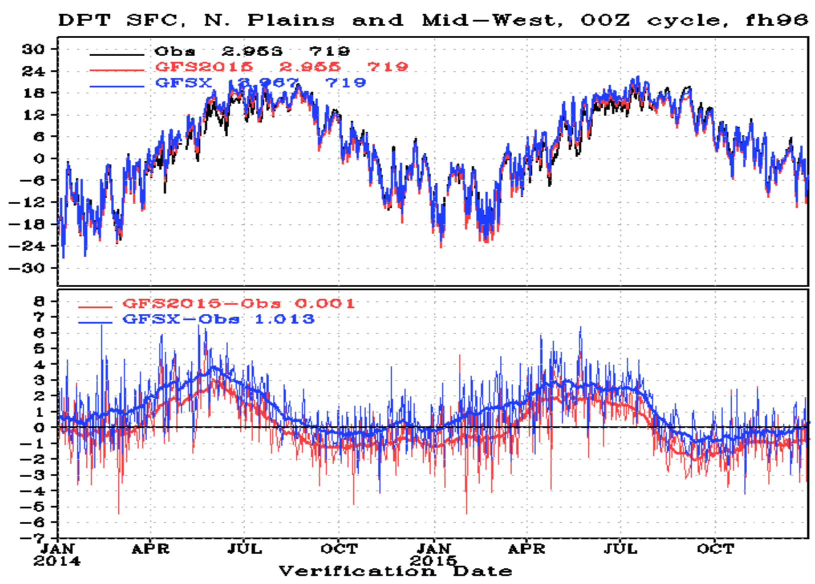

DPT SFC, CONUS West, 00Z Cycle, 20140101-20151231 Mean
obs
GFS2016
GFSX
Difference w.r.t. obs
Differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour


DPT SFC, CONUS East, 00Z Cycle, 20140101-20151231 Mean
obs
GFS2016
GFSX
Difference w.r.t. obs
Differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

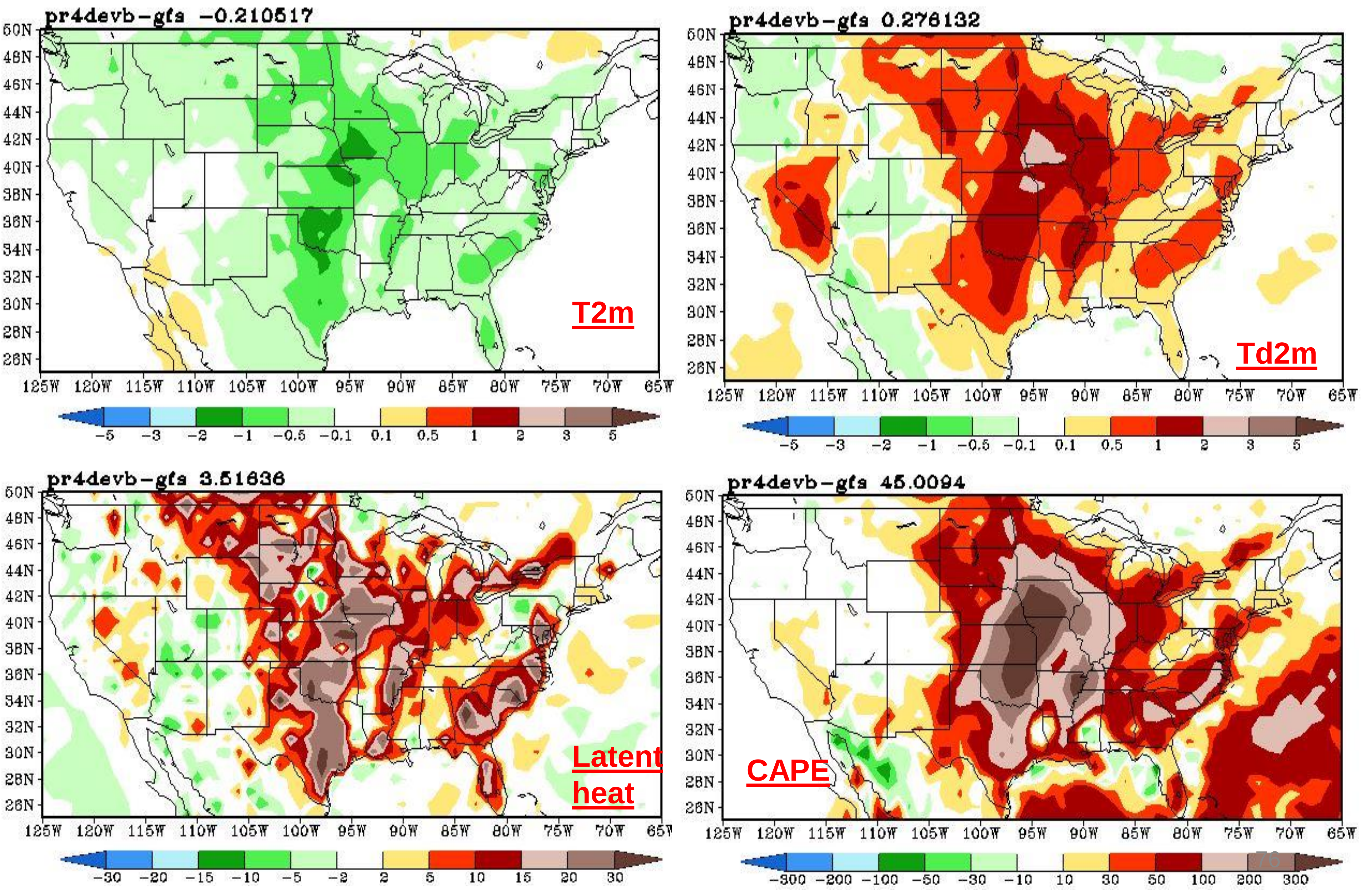

RMS: DPT SFC, CONUS West, 00Z cyc, 20140101-20151231
GFS2015
GFSX
Difference w.r.t. GFS2015
RMSE differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

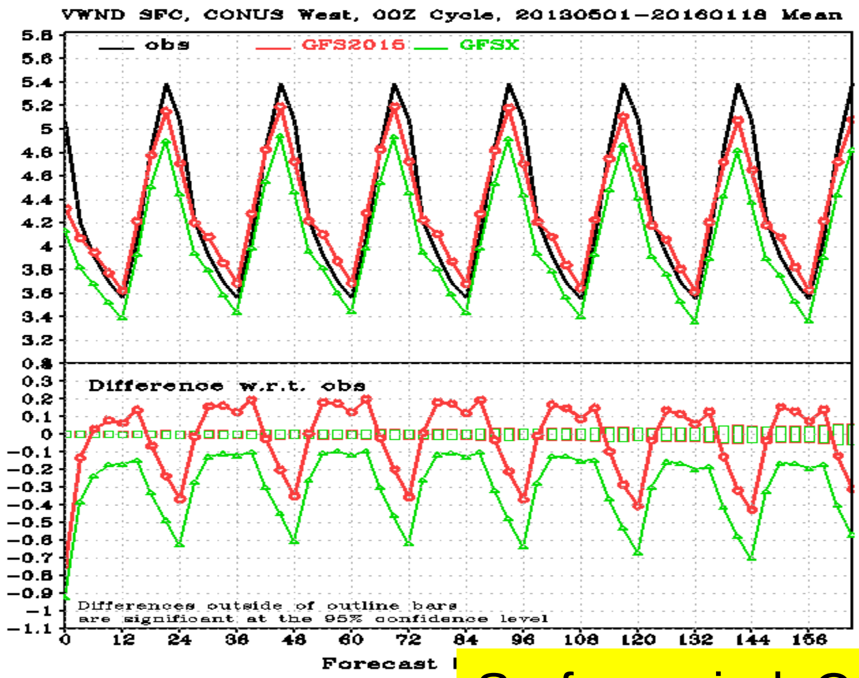

RMS: DPT SFC, CONUS East, 00Z cyc, 20140101-20151231
GFS2015
GFSX
Difference w.r.t. GFS2015
RMSE differences outside of outline bars
are significant at the 95% confidence level
Forecast Hour

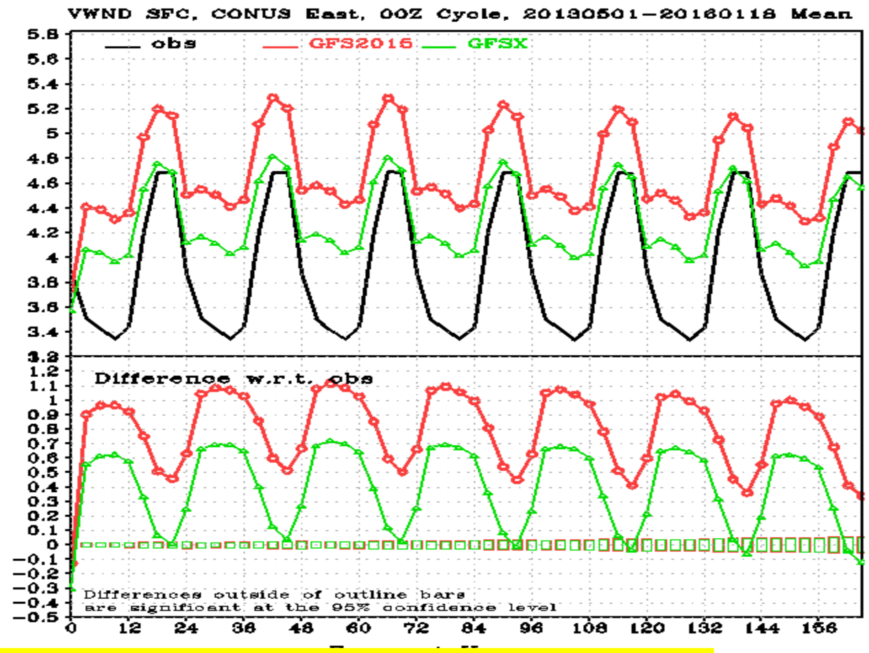

DPT SFC, N. Plains and Mid-West, 18Z cycle, fh96
Obs 2.890 363
GFS2015 2.382 363
GFSX 3.458 363
GFS2015-Obs -0.50
GFSX-Obs 0.568
JUL 2014
AUG
SEP
OCT
NOV
DEC
JAN 2015
FEB
MAR
APR
MAY
JUN
Verification Date


DPT SFC, N. Plains and Mid-West, 00Z cycle, fh96
Obs 2.953 719
GFS2015 2.955 719
GFSX 719
GFS2016-Obs 0.001
GFSX-Obs 1.013
JAN 2014
APR
JUL
OCT
JAN 2015
APR
JUL
OCT
Verification Date

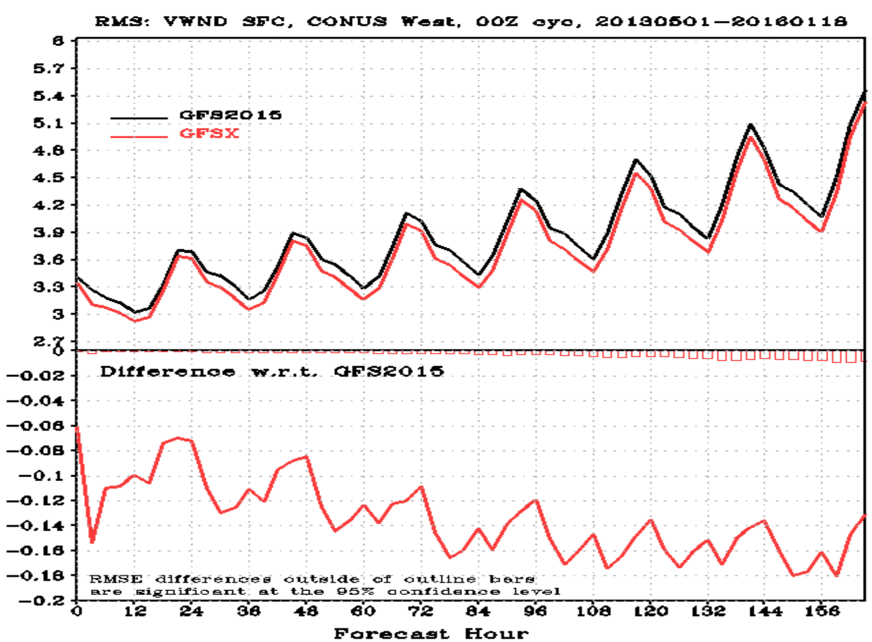
Significantly improve the biases brought up in the EMC MEG meeting

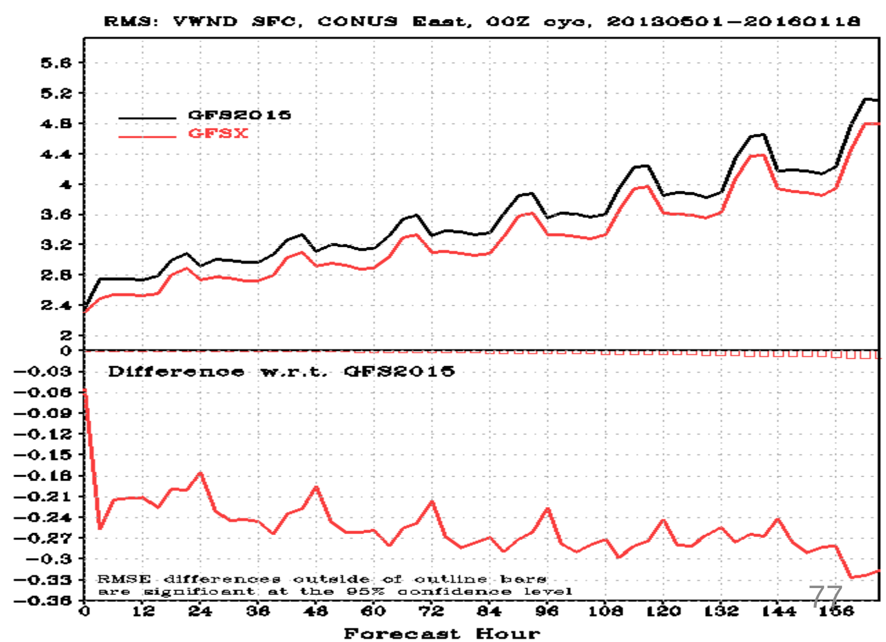






Surface wind, CONUS West and East, 00Z Cycle





Preliminary assessment of impact of LSM changes

- 2m T bias is worse over the Northern Plains and Northeast, Better over southern plains and southeast
- RMS error improved over northern and southern plains, Southeast and Alaska, worse over northwest
- 10 m winds decreased, RMS error improved

- **The land surface parameter refinements have significantly reduced the warm/dry biases in the summer**

- **The change has little impact in the winter. However there are some degradations in the spring/fall. Also it is worst in 00Z (sunset). Some of them will be addressed in the next GFS physics implementation.**

CPC Evaluation of GFSX

- D+8 & Week 2; - Stratosphere

Craig Long & Jae-Kyung Schemm

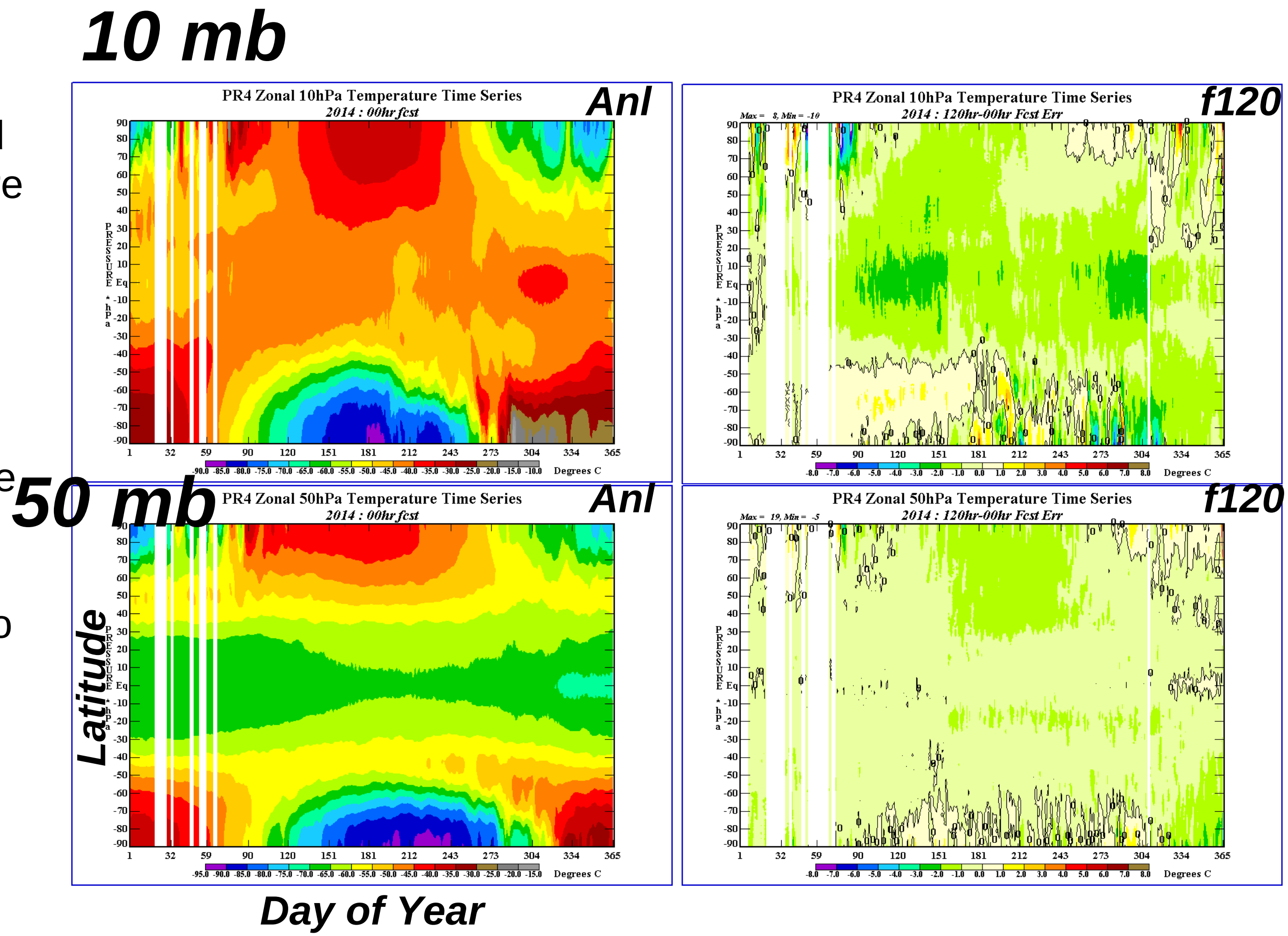
- 500 hPa height and 850 hPa temperature AC scores and RMS error were compared for NH extra-tropics and the PNA sector for period Jun 1, 2013 – Nov 30, 2015.
- The skill comparisons show no significant changes in forecast performance at all leads to 15 days over the operational GFS during the test period except slight degradation at longer leads during boreal summer season over the NH and PNA sector.
- There is no negative impact in D+8 and Week 2 forecasts from this upgrade.
- Comparisons of GFSX analyses with MLS show GFSX temps to be about 1 deg colder from 200 to 10 mb. GFSX then become warmer between 10 and 1mb by as much as 4-6 degrees,
- Comparison of GFSX f120 with Anl show that f120 is 5-10 deg warm in winter hemisphere temp gradient latitudes above 10mb and about 5 deg cooler in summer hemisphere above 10mb.

GFSX Temperature Analysis and 120hr Forecast Err : 2014

-Temperature analyses and forecasts in stratosphere are quite good in the lower stratosphere at all latitudes and seasons.

-Based upon comparisons with MLS temperatures (see slide 4-8)

-But forecast errors begin to increase in middle stratosphere and become seasonally dependent.



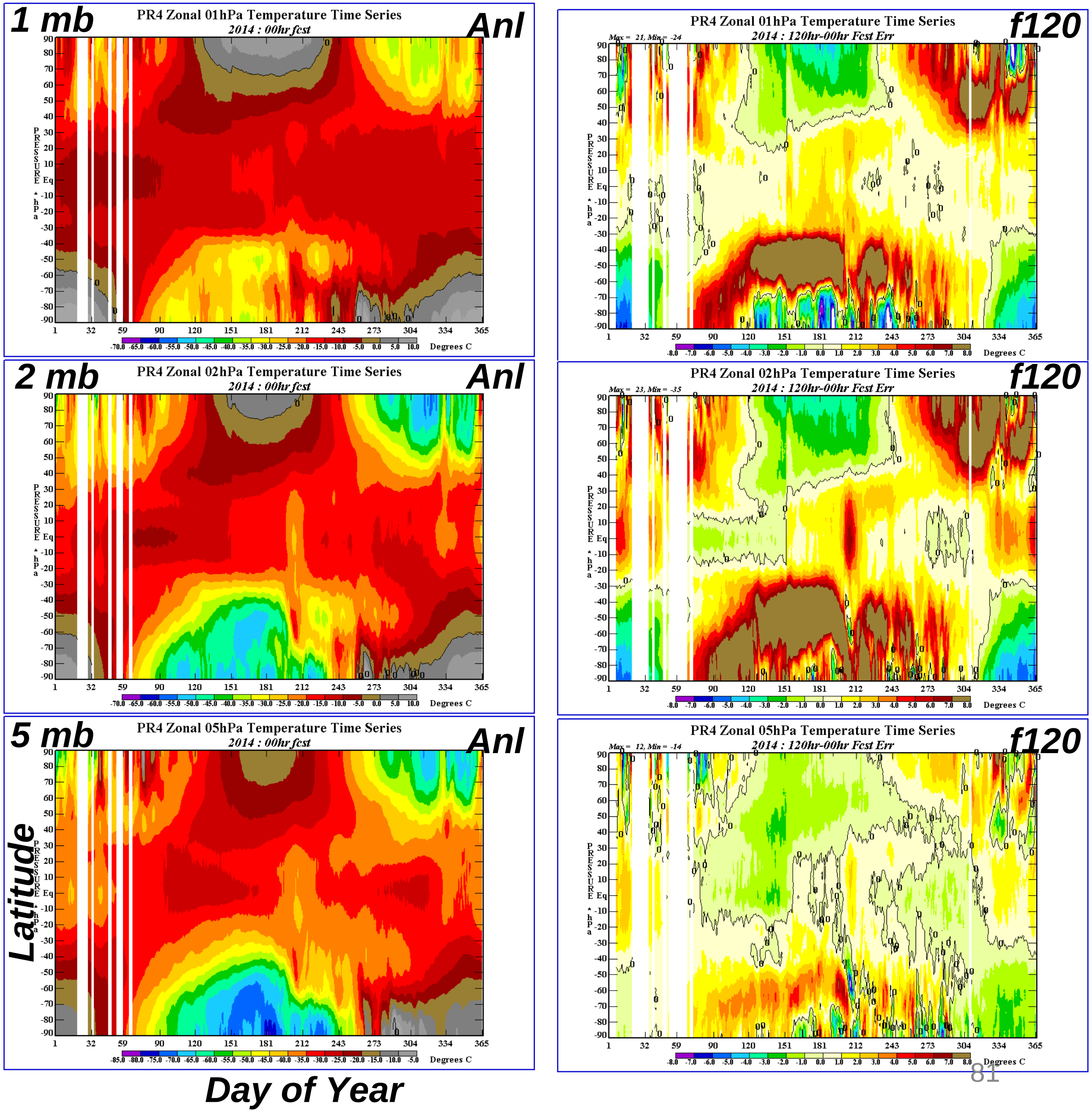
Craig Long, CPC

GFSX Temperature Analysis and 120hr Forecast Err : 2014

-In upper stratosphere forecast errors are seasonal in each hemisphere's extratropics being greatest + in winter months and greatest – errors in summer months. This means that the gradient across the polar vortex is decreased with fcst time. And summertime fcst temperatures are to cold by 5-10 degrees.

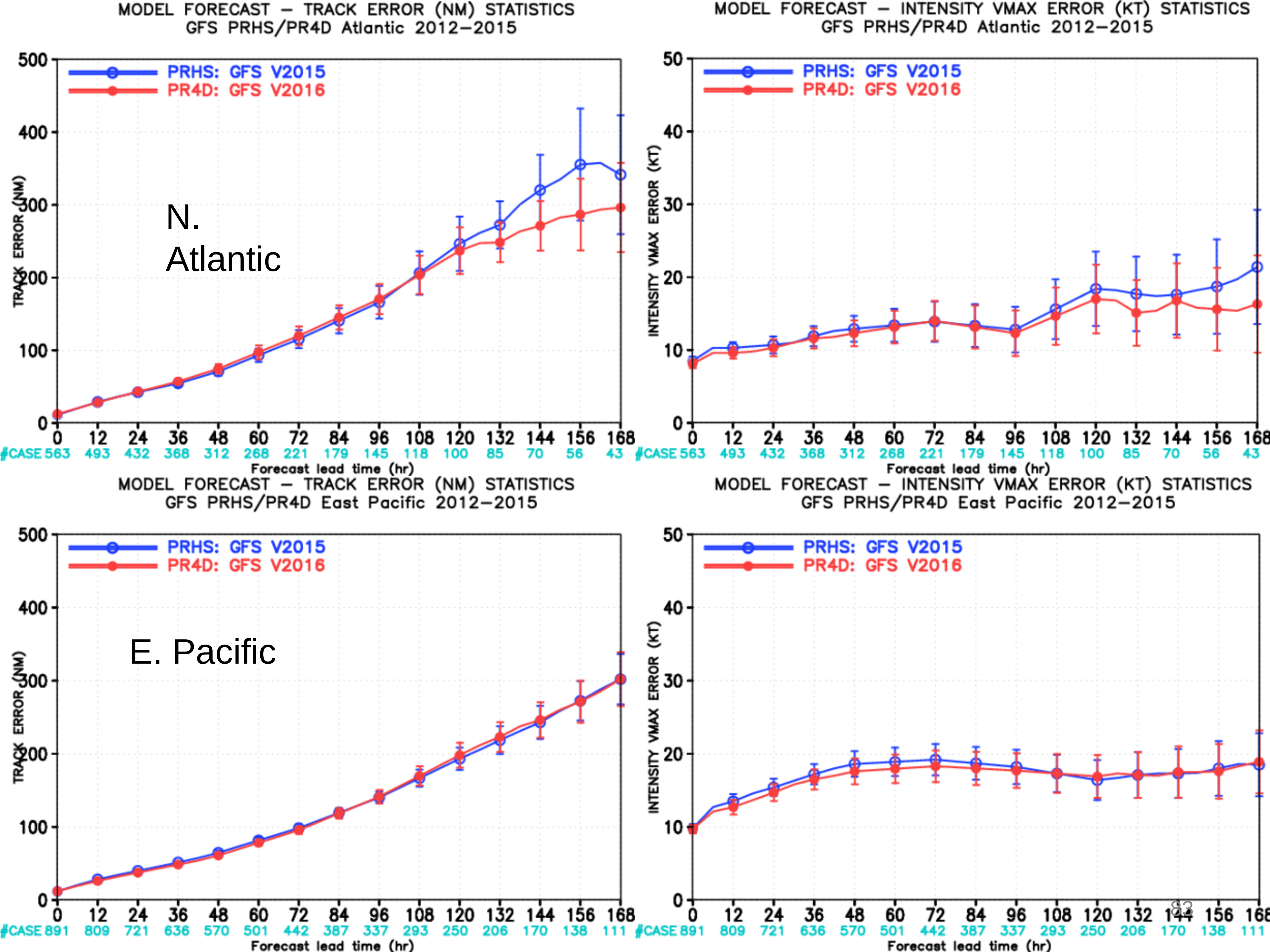
-The decrease in temperature gradient will affect zonal wind speed and PV barrier strength.

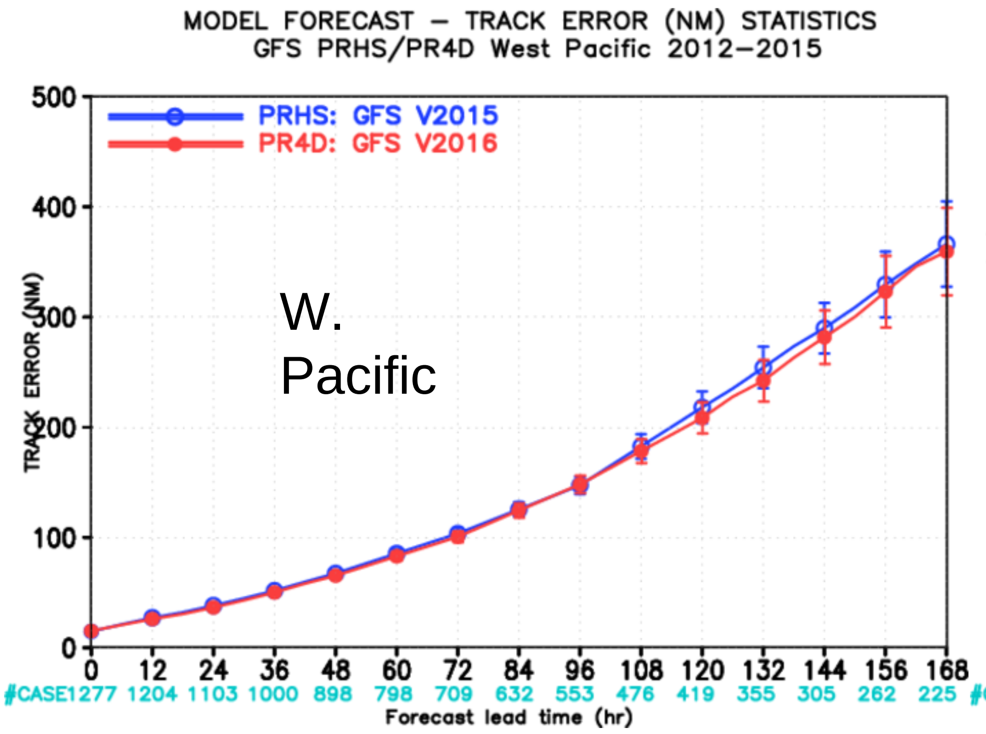
Craig Long, CPC

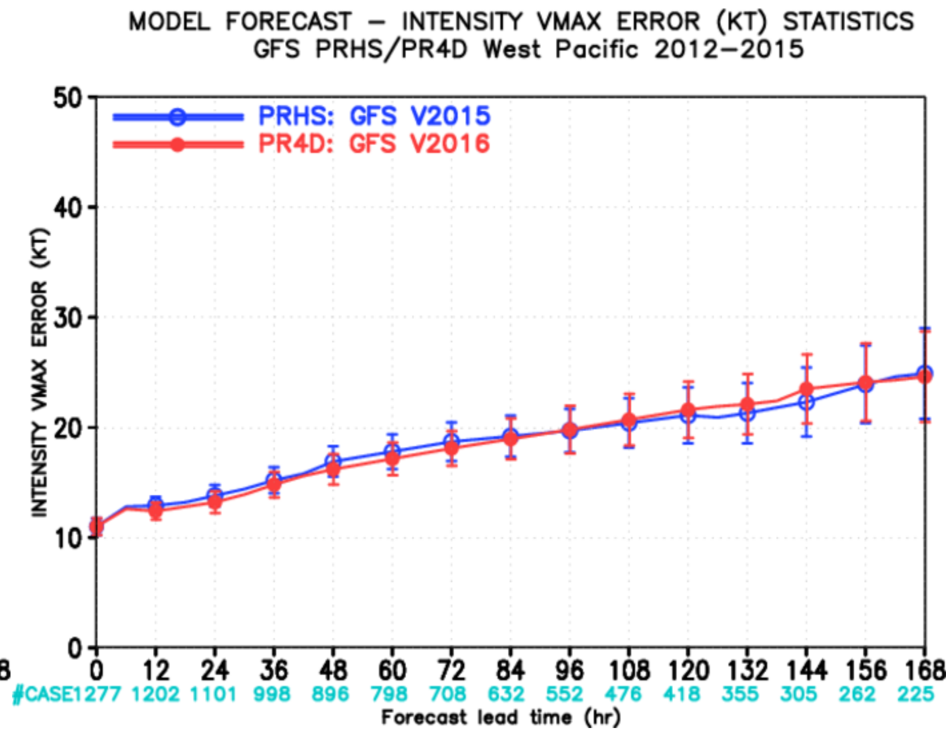


Overall Evaluation - Stratosphere

- **Recommendations:**
  - Not a show stopper since there is not adverse effects to the troposphere, but large temperature forecast errors need to be examined for a cause.
  - These results hopefully will improve when the GFS model top is lifted and more levels are added to the upper stratosphere/lower mesosphere (USLM).
  - Currently the top AMSU channel 14 is not assimilated because there are not enough model levels in the USLM for the foreward model to generate a good guess.
  - Adding more levels will allow the usage of AMSU channel 14 (unbias corrected) and should improve the temperature analysis in the USLM.


MODEL FORECAST – TRACK ERROR (NM) STATISTICS
GFS PRHS/PR4D Atlantic 2012–2015
PRHS: GFS V2015
PR4D: GFS V2016
N. Atlantic
TRACK ERROR (NM)
#CASE 563 493 432 368 312 268 221 179 145 118 100 85 70 56 43
Forecast lead time (hr)
MODEL FORECAST – INTENSITY VMAX ERROR (KT) STATISTICS
GFS PRHS/PR4D Atlantic 2012–2015
PRHS: GFS V2015
PR4D: GFS V2016
INTENSITY VMAX ERROR (KT)
#CASE 563 493 432 368 312 268 221 179 145 118 100 85 70 56 43
Forecast lead time (hr)
MODEL FORECAST – TRACK ERROR (NM) STATISTICS
GFS PRHS/PR4D East Pacific 2012–2015
PRHS: GFS V2015
PR4D: GFS V2016
E. Pacific
TRACK ERROR (NM)
#CASE 891 809 721 636 570 501 442 387 337 293 250 206 170 138 111
Forecast lead time (hr)
MODEL FORECAST – INTENSITY VMAX ERROR (KT) STATISTICS
GFS PRHS/PR4D East Pacific 2012–2015
PRHS: GFS V2015
PR4D: GFS V2016
INTENSITY VMAX ERROR (KT)
#CASE 891 809 721 636 570 501 442 387 337 293 250 206 170 138 111
Forecast lead time (hr)


MODEL FORECAST – TRACK ERROR (NM) STATISTICS
GFS PRHS/PR4D West Pacific 2012–2015
PRHS: GFS V2015
PR4D: GFS V2016
W. Pacific
TRACK ERROR (NM)
Forecast lead time (hr)
#CASE1277 1204 1103 1000 898 798 709 632 553 476 419 355 305 262 225


MODEL FORECAST – INTENSITY VMAX ERROR (KT) STATISTICS
GFS PRHS/PR4D West Pacific 2012–2015
PRHS: GFS V2015
PR4D: GFS V2016
INTENSITY VMAX ERROR (KT)
Forecast lead time (hr)
#CASE1277 1202 1101 998 896 798 708 632 552 476 418 355 305 262 225

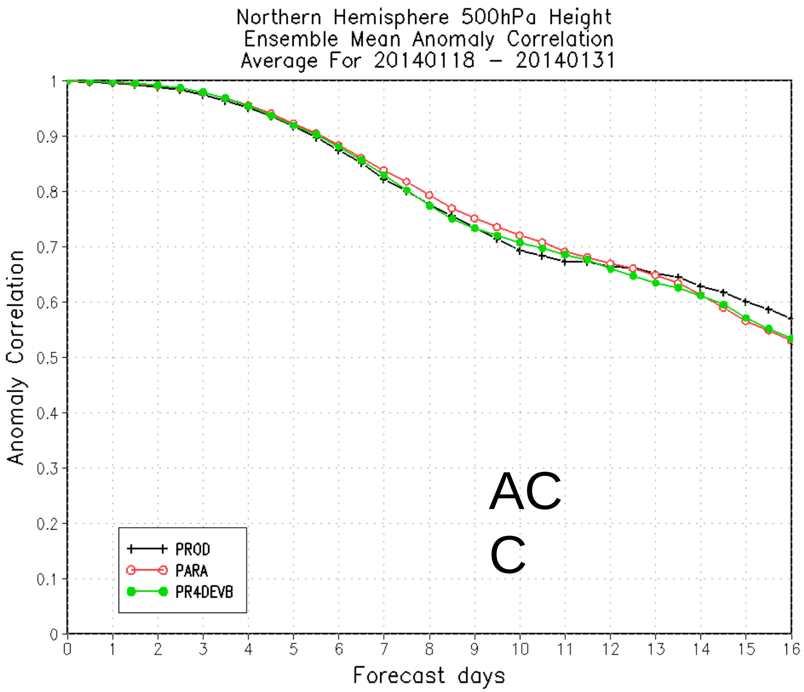
Mode Verification: GFS vs. GFSX

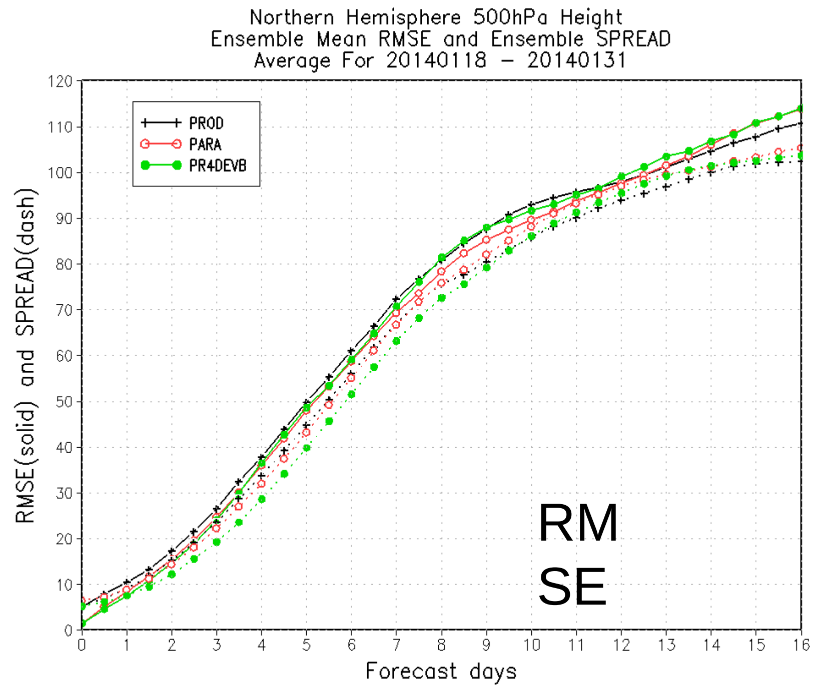
- Jet Streams: Overall models forecast jets well but present possible systematic biases according to MODE & GFSX generally looks “better” and closer to the ECMWF
- QPF: GFSX has higher MMI (Median of Maximum Interest) values for all forecast hours except at 60-h where it is lower than GFS and statistically significant; GFSX generally forecasts more objects than GFS and observations
- Total winds at 250mb: GFSX did seem a little bit better than the operational GFS based on the MODE statistics. Will look at meridional winds (which already show bigger differences between the GFS and GFSX) and then zonal winds.

Blizzard of January 2016

- High predictability of the 22–24 January 2016 blizzard that affected the East Coast: Medium-range models had a signal for a significant low along the East Coast about a week in advance of the storm
- Forecasts for the Mid-Atlantic were good. GFS, GFSX, and EC shifted the northern extent of the precipitation shield southward as the event neared, which caused uncertainty in the NYC area

DOWNSTREAM MODEL EVALUATION: GEFS & HWRF





GEFSv11 with different initial analysis/perturbation

PROD (black) – GEFSv10 – older production

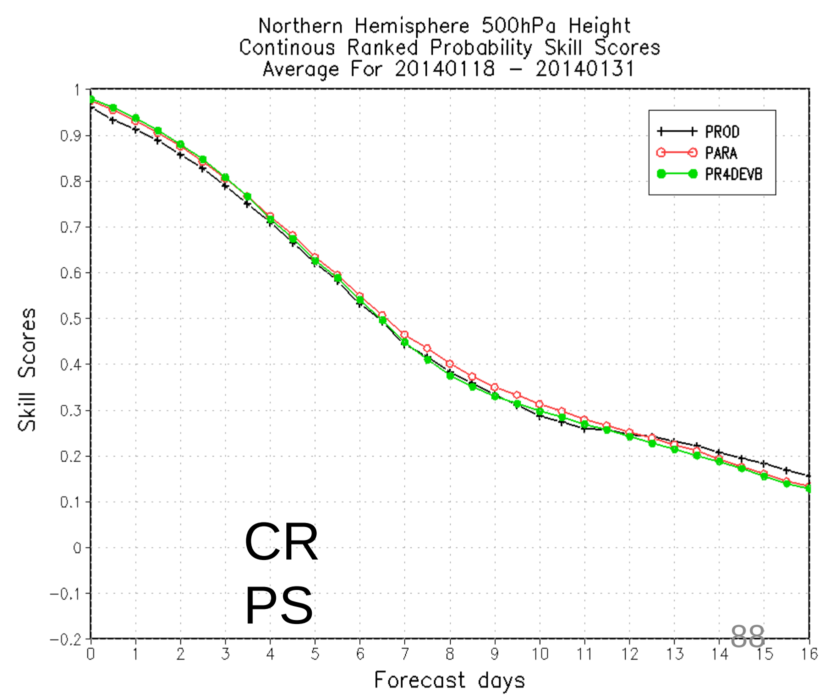
PARA (red) – GEFSv11 operation

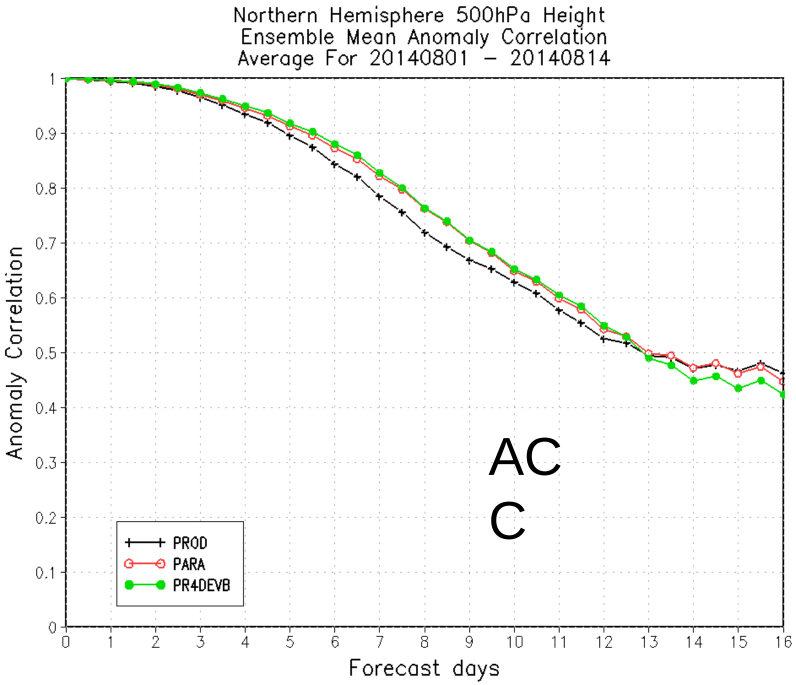
PR4DEVB (green) – Testing

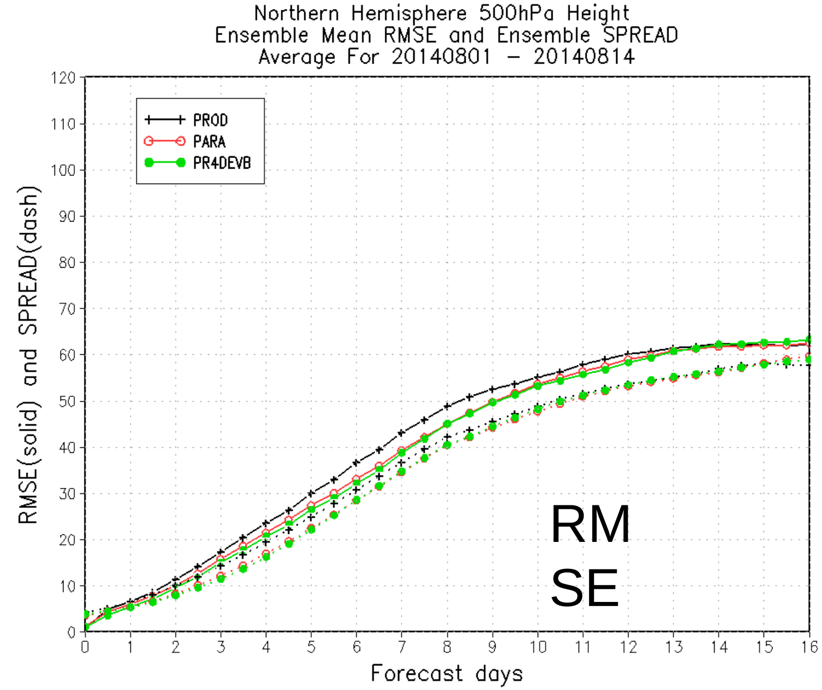
2014 Winter

Good for short forecast (days 1-3)

Slightly degradation (days 5-10)







GEFSv11 with different initial analysis/perturbation

PROD (black) – GEFSv10 – older production

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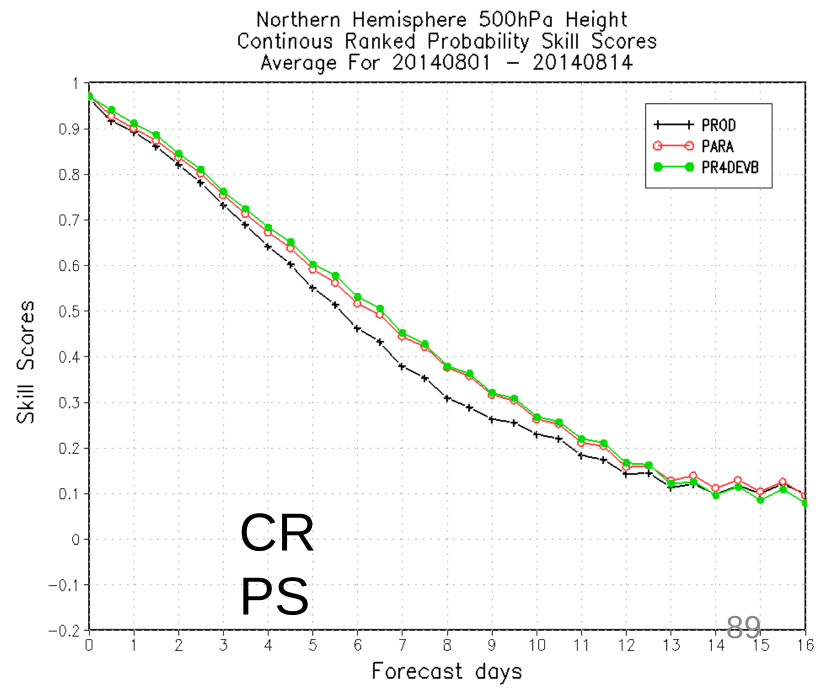
PR4DEVB (green) – Testing



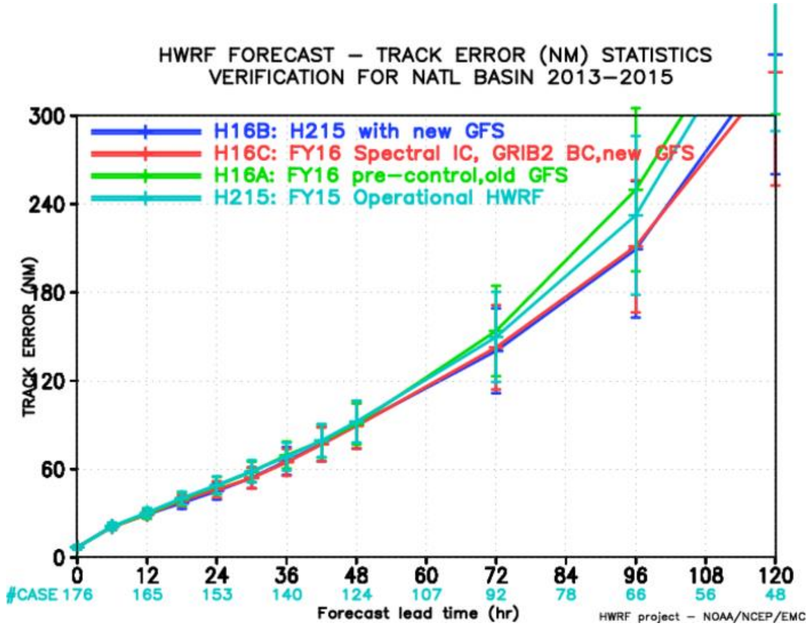
2014 Summer

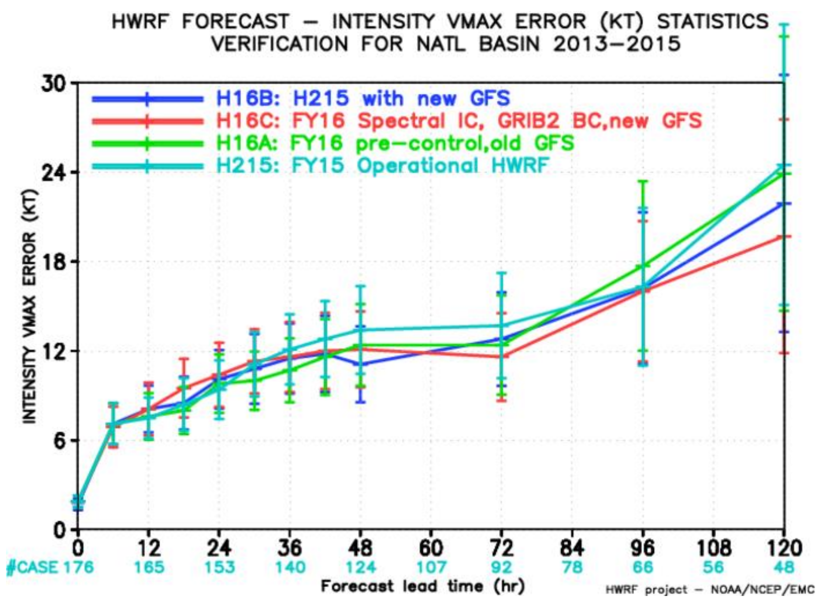
Good for all lead time (out to day 12)

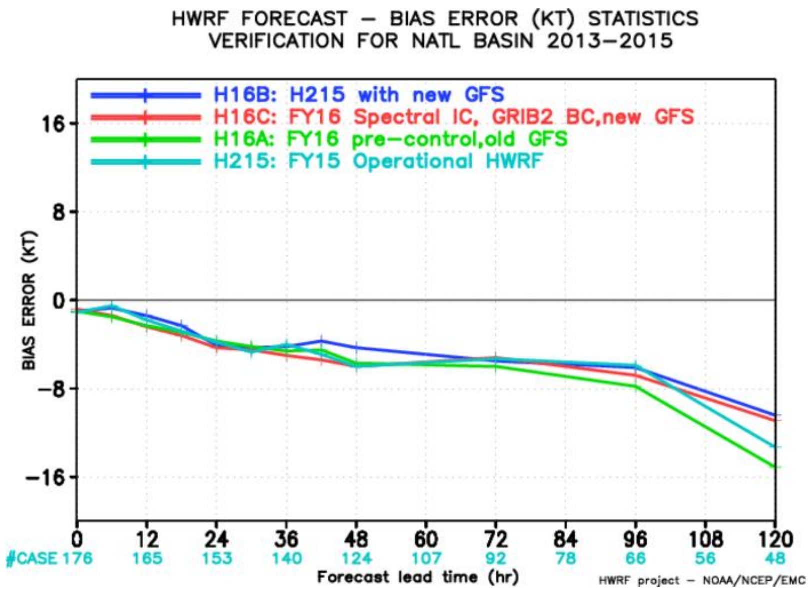
Overall:

- initial spread is smaller than before
- Growth of spread is similar to current

2015 HWRF with new GFS, ATL



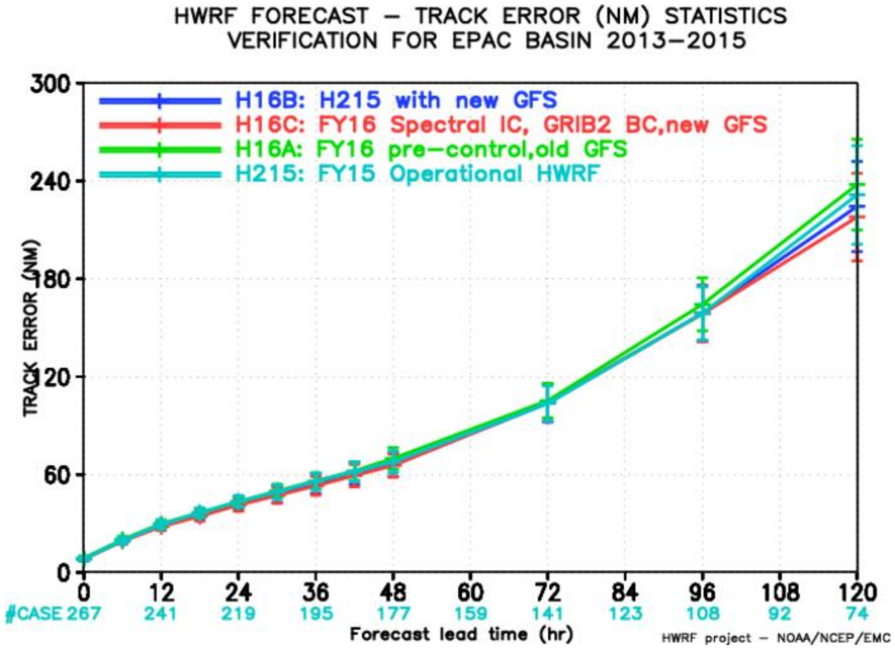


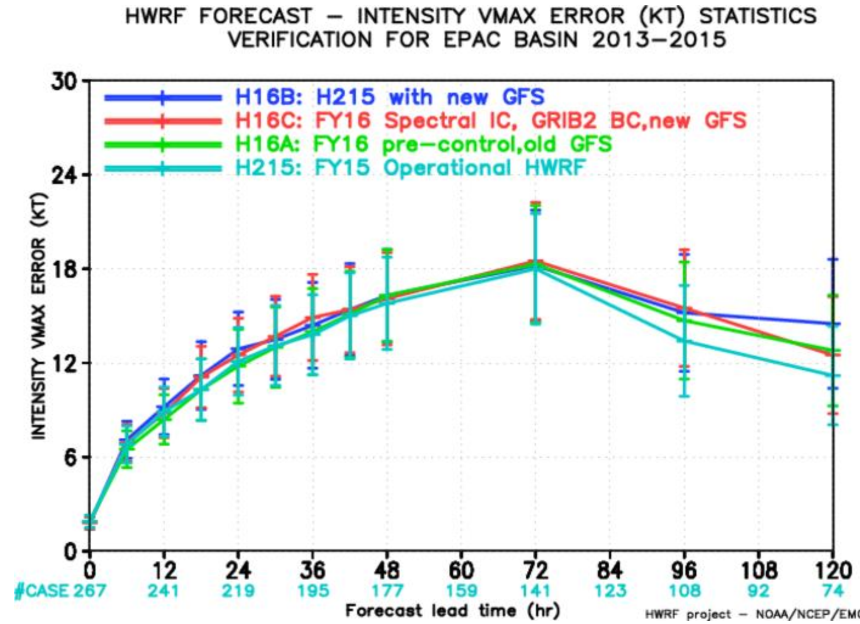


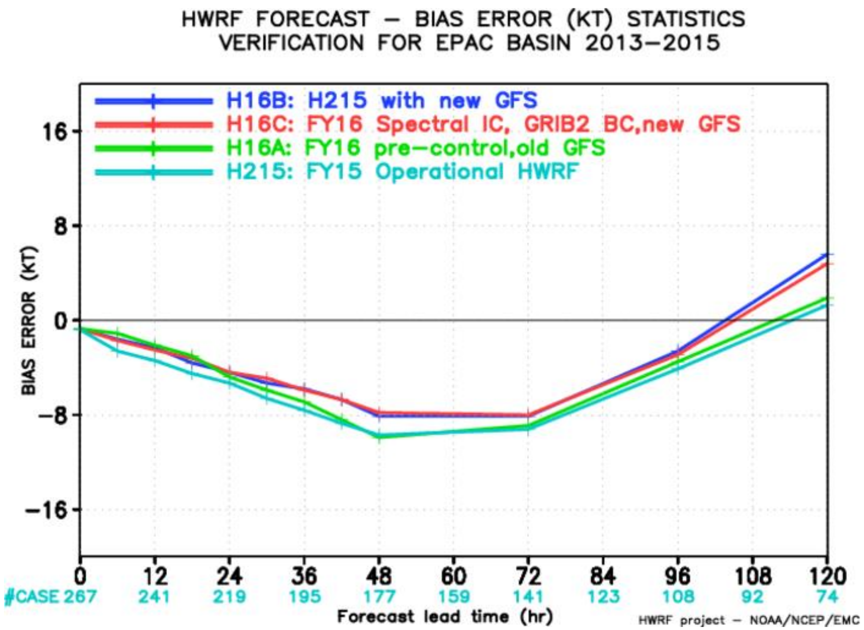
H16A, FY16 HWRF, Current GFS
H16B, FY15 HWRF, new GFS
H16C, FY16 HWRF, new GFS
H215, FY15 HWRF, current GFS

New GFS (blue/red) shows improved track and intensity forecasts in the N. Atlantic

2015 HWRF with new GFS, EPAC







H16A, FY16 HWRF, Current GFS
H16B, FY15 HWRF, new GFS
H16C, FY16 HWRF, new GFS
H215, FY15 HWRF, current GFS

New GFS (blue/red) shows neutral impact on track and intensity forecasts in the E. Pacific

Extratropical Tracks

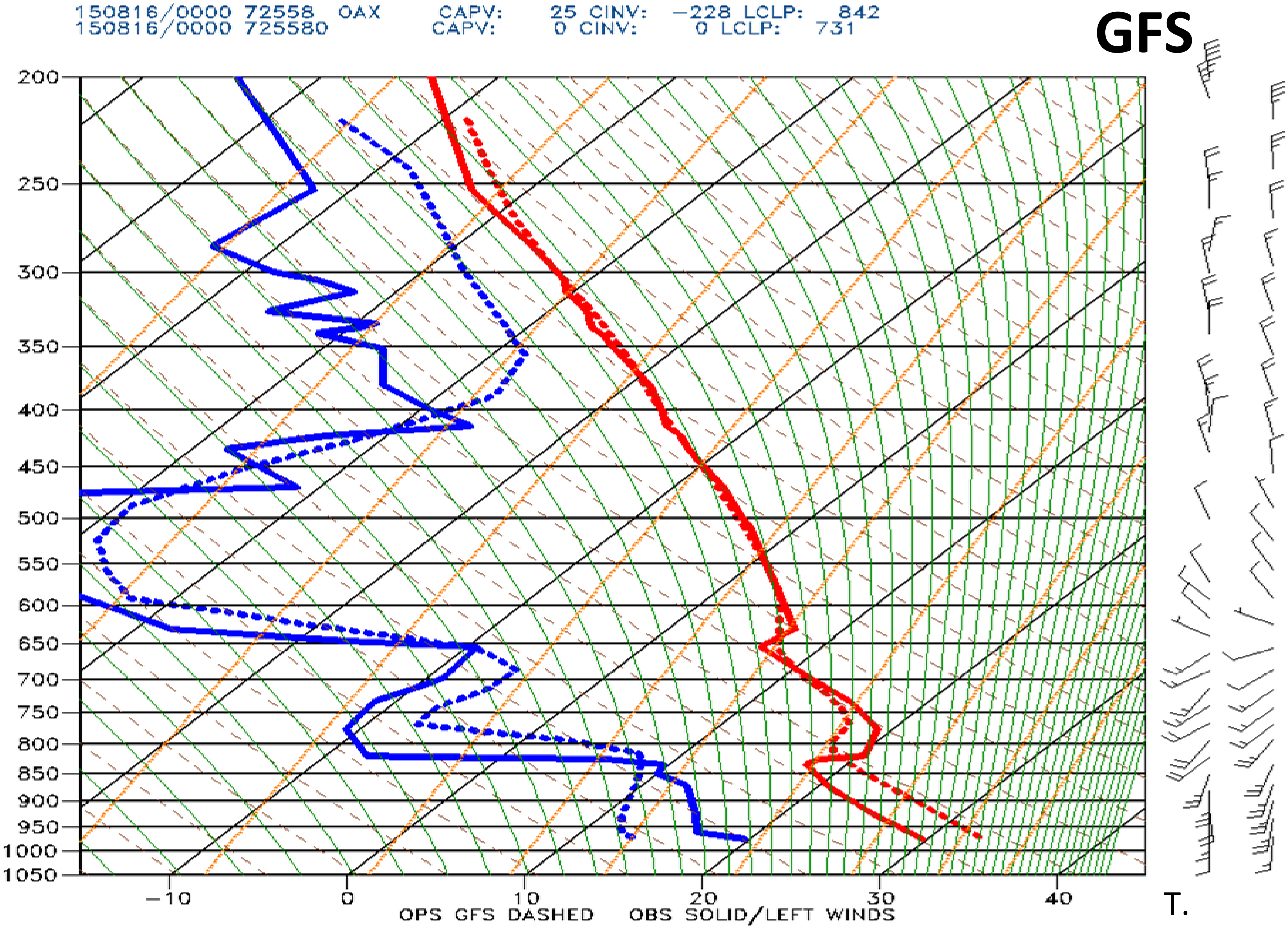
- For the winter, Nov.1 2013 - April 30 2014, position error is smaller in GFSX than in GFS control seven out of ten forecast hours (0 - 120hr in 12hr interval).
- For the summer, April 1 2015 - Oct. 31 2015, GFSX errors are always smaller than GFS control's.

Sounding and Height Case Studies

- For sounding case studies, GFSX looked better than operational GFS for North Platte, NE, looked the same for Aberdeen, SD, and looked much better near the surface for Omaha, NE for Aug. 16, showing reduction in warm dry bias

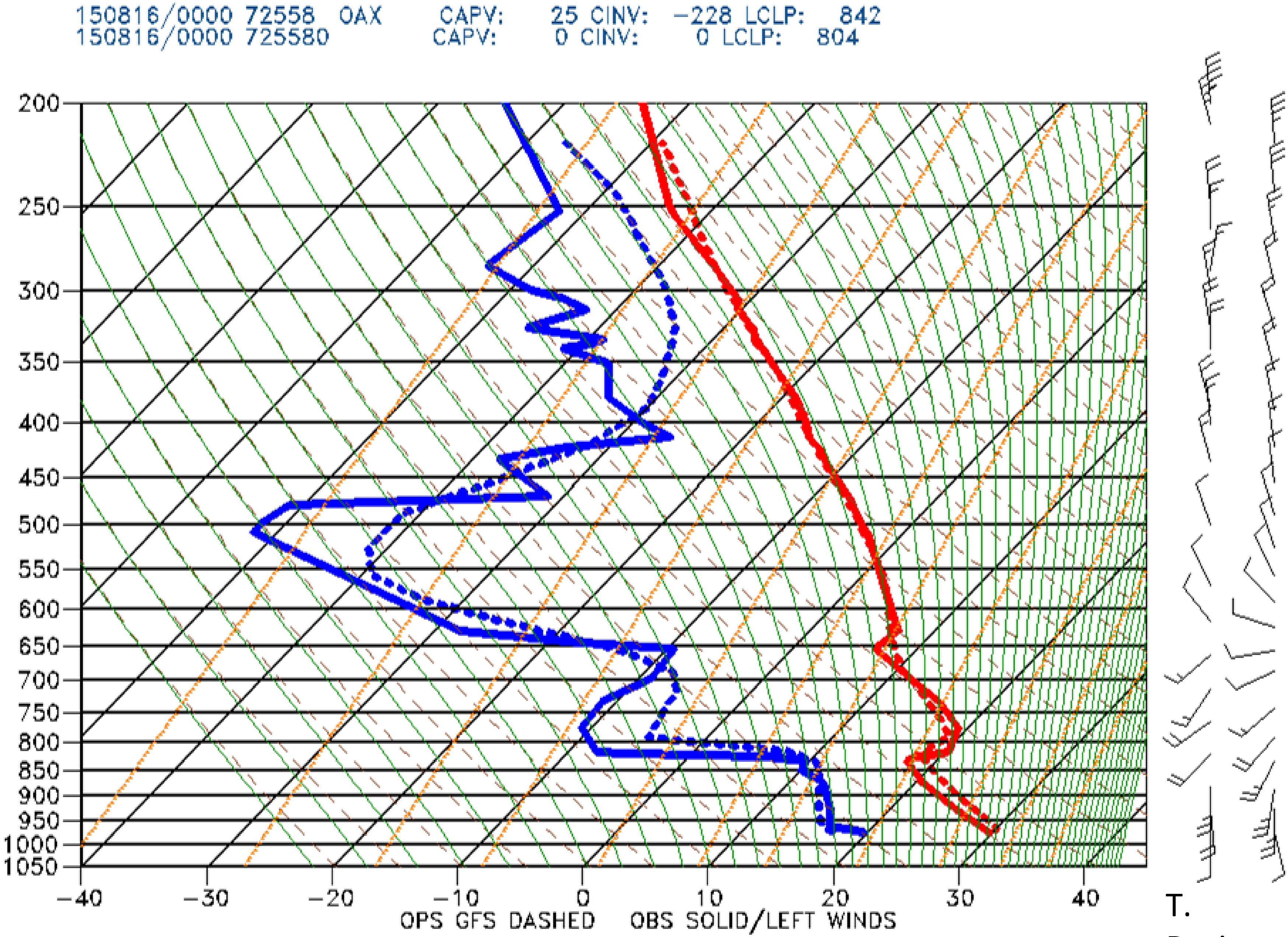
- For the spaghetti plots of a height contour, of 5 cases requested by WPC, GFSX did better for 3 cases, did the same for 1 case, and did worse for 1 case. The case the GFSX did worse on was the 180-h forecast from 00Z 12/7/14 valid on 12Z 12/14/14.

12h GFS FCST vs OBS for Omaha, NE



T. Dorian

GFSX



T. Dorian

Super Typhoon Atsani Findings

- GFS too far to the north and east, then too far to the east, followed by too far to the north (except for 204-h forecast, GFS too far south)
- GFSX started off with good position for Atsani, then was too far south and east, then slightly too far north, then too far south for 204-h forecast
- In general, the GFSX was closer to analysis

Forecast Lead Time	GFS	GFSX
108		✔
120		✔
132		✔
144	✔	✔
156		✔
168	✔	
180		✔
192		✔
204	✔	

Compute / runtime changes
GFS/GDAS Forecasts for hourly output through 120 h

Job Step	Current phase 1 production, (slow bacio)		Proposed phase 2 production, (fast bacio)	
	Nodes /Tasks	Runtime (min)	Nodes /Tasks	Runtime (min)
gfs_fcst_high (hourly output for the first **12** hours, then 3 hourly up to 240 hours)	432/108	83.0	390/65	82.2
gfs_fcst_high (hourly output for the first **120** hours, then 3 hourly up to 240 hours)			**540/90**	**81.2**
gfs_fcst_low (12 hourly output, from 240 to 384 hours)	216/27	15.0	216/18	14.5
gdas_fcst_high (hourly output up to 9 hours)	432/108	10.5	258/43	8.5

Current operation takes 48*6GB=288GB for the first 120 hours of forecast.
Additional 73*6GB=438GB disk is required for storing hourly output up to 120 hours.

Evaluation plans for Q3FY16 GDAS/GFS

- Hurricane tracks days 6 and 7 (done) with statistical significance
- ***Data to NHC for assessing forecasts of tropical cyclone genesis and other evaluation* --- Completed**
- EMC producing Gempak files from real time parallel
- MAG evaluation page activated
- Western Region using side by side maps for N. America, N. Pac, WPC also using Gempak files
- Files for hourly output data developed (evaluated by CPC and NWC)
- Data from real time parallel on paraNOMADS (NCO) (problem with availability time)
- Synoptic maps and daily precip verification for real time parallel available on EMC web pages
- g2o (near surface verification) for all 4 cycles (done)
- Precip, jet stream, CAPE MODE verification
- Worked with Western, Central, Alaska, Southern, Eastern and Pacific Regions **--- Completed**
- Worked with WPC, NHC, NCO, CPC, SPC, AWC, OPC, SWPC, MDL, NWS, Academia and private industry **--- Completed**

Continuity objective score-needs long term development

Evaluation plans for Q3FY16 GDAS/GFS

- GFS Soundings—available on case by case basis, real-time web page for selected cities

- Real time plots of near surface variables at representative stations –available for GFS, GEFS
http://www.emc.ncep.noaa.gov/gc_wmb/parthab/Plume_test/GFSx/EMCGEFSplumes.html

- Retrospectives—Standard verification page—against own analyses, GFS2015 vs. GFS2016
http://www.emc.ncep.noaa.gov/gmb/wx24fy/vsdb/gfs2016/

- ***Case studies— Hurricane Sandy: http://www.emc.ncep.noaa.gov/gmb/wd20rt/vsdb/pr4devbs12/***

- ***Case studies from Centers and Regions***
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/MEGGFSxCaseStudies.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/RetroRunsWRcases.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/26Mar2015CentralRegion.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/CentralRegionJune45.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/CentralRegionCaseJuly6.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/centralnov17.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/joaquinsum.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/WPCstudies226.pptx
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/GFSXEvaluations.pptx

- ***EMC could plot basic maps and place online, could make data for cases available***

- ***Examine time-means, systematic errors***

- ***Synoptic assessment of PBL structure and other fields by MEG; Revisit MEG cases***
http://www.emc.ncep.noaa.gov/gmb/noor/4dGFS/docs/extracasesMEGa.pptx

--keep websites comparing GFS and GFSX up
until implementation

--start to plan next implementation procedure March 18

real time—experimental GFS in AWIPS
`
retrospective—generate synoptic maps dprog/dt
(Western Region program?)
zoomable? Differences, errors?
precipitation verification maps (Fanglin Yang)
enable forecasters (SOOs?) to do case studies

Future work

Reduce "socialist rain"

Increase amount of moderate rain

Cold bias over snow

Improve upper stratospheric forecasts

Reduce near surface biases, improve diurnal cycle

Improve boundary layer

Reduce dry bias in southeast US