EMC FY15 Upgrade Review

N
C
E
P

GEFS Upgrade

Presented by:

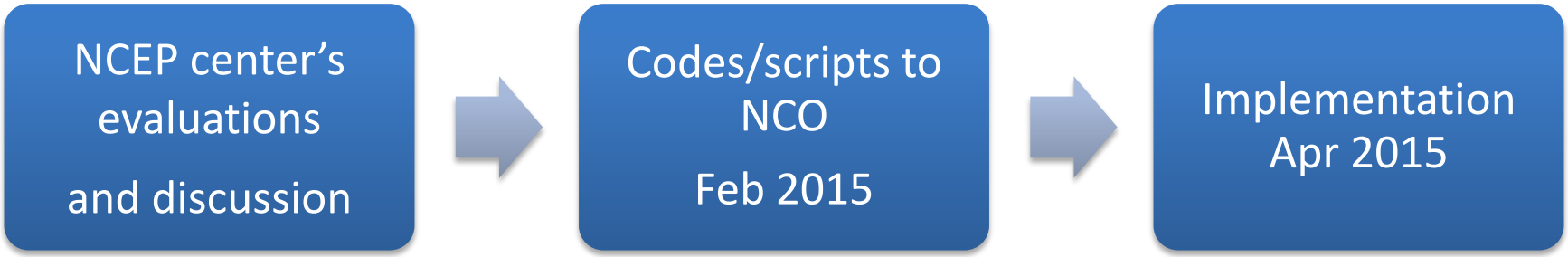
Yuejian Zhu

Update: 2/2/2014

GEFS Configuration

	V10.0.0 (OPR)	V11.0.0 (PARA)
GFS Model	Euler, 2012	Semi-Lagrangian, 2015
Resolution 0-192 h	T254 (52km) L42 (hybrid)	T_L574 (34km) L64 (hybrid)
Resolution 192-384 h	T190 (70km) L42 (hybrid)	T_L382 (52km) L64 (hybrid)
Computational Cost	84 nodes (+ post process)	300 nodes 1st segment 250 nodes 2nd segment
Execution time	55 min	35 min 1st segment 30 min 2nd segment
Output resolution	1^O x 1^O	0.5^O x 0.5^O for 0-8 days 1^O x 1^O the rest
Output frequency	6h	3h the first 8 days; 6h the rest

Schedule



Working with partners and centers to keep on schedule

Continue generation and evaluation of control member reforecast and retrospective ensemble forecast

WCOSS-phase II

Ensemble Generation Method

- Moving from BV-ETR approach to EnKF
  - A major scientific shift
- Unification DA and Ensemble Generation
  - Direct link to the hybrid 3D-Var EnKF DA system
- Perturbations are 6h forecasts EnKF with adjustments:
  - Tropical Storm Relocation
  - Centering of the perturbations on the ensemble control analysis
- Stochastic perturbation (STTP) upgrade
  - Fine-tune amplitude for changes in model and perturbation method
  - Turn off surface pressure perturbations for tropical
    - to reduce the spread growing of geopotential height

Expected improvements

- Hurricane track forecast
  - Main reason: Model and spatial resolutions
- Probabilistic forecast guidance
  - Main reason: Stochastic physics and re-forecast
- Prediction of extreme weather events
  - Main reason: DA, model and stochastic perturbations

GEFS legacy forecast

- Next GEFS implementation will be scheduled for WCOSS phase II (Q2FY15)
  - NCO will continue to run current operational GEFS (with BV-ETR cycling every 6 hours, but 00UTC forecast only) for one year
    - Current: 21 members, 00, 06, 12, 18UTC
    - Future: 21 members, 00UTC
  - Timing for legacy data delivery
    - Current: +4:50
    - Future: +4:50 to +8:00, depending on NCO resource analysis
  - Data directory for access (NCEP ftp, under discussion)
    - Current directory: …/com/gefs/prod/….
    - Future directory: …/com/gefs_legacy/prod/….
  - Data names
    - Will be the same, but in the different directory
  - No statistical bias correction
    - Raw ensemble forecast data only
    - Any products not identified by OHD, CPC and MDL as required will be stopped
  - AWIPS:
    - Only data from the new GEFS will be made available on NOAAPORT/SBN for use in AWIPS

Limited Reforecast (retrospective)

- There is no real time GEFS reforecast for next GEFS implementation.

- Based on communications with WPC, CPC, SPC, OHD, MDL and other users. EMC will provide:
  - 2-years retrospective runs (00UTC and 12UTC)
    - From May 15 2013 to the time of implementation (nearly 2 years)
    - Expect to be available: Mid of March 2015
    - Nearly 70% has been done, NCO is helping to run part of them
  - 18 years ensemble control only reforecast
    - Year 1995-2012
    - 00UTC and every other day
    - Forecasts has been finished, OHD has received the data
  - All data will be saved in HPSS tapes
    - Currently, no public ftp access, but NCEP service centers could access through WCOSS.
    - Will work with NCO to publish part of data: pgrba data at 1.0 degree, every 6 hours, out to 16 days.

Hurricane Sandy Study for GEFS

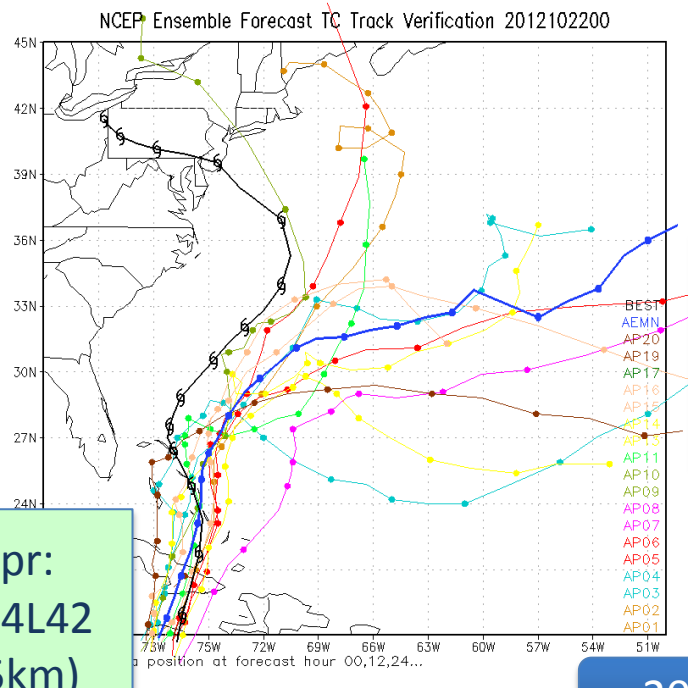
Period: 10/22 – 10/28/2012

Named: 10/23/2012

Yuejian Zhu
EMC/NCEP

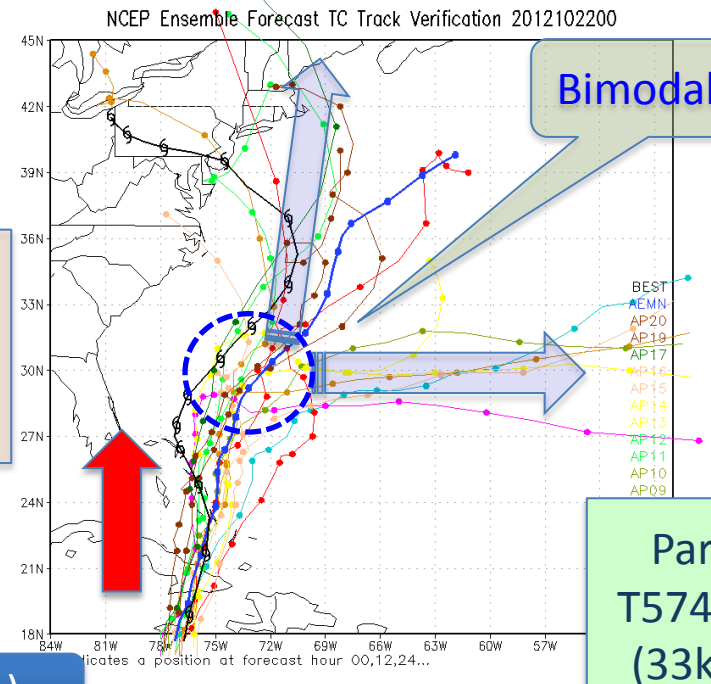
September 15 2014

Acknolegements:
Dingchen Hou, Xiaqiong Zhou and Jiayi Peng



00UTC

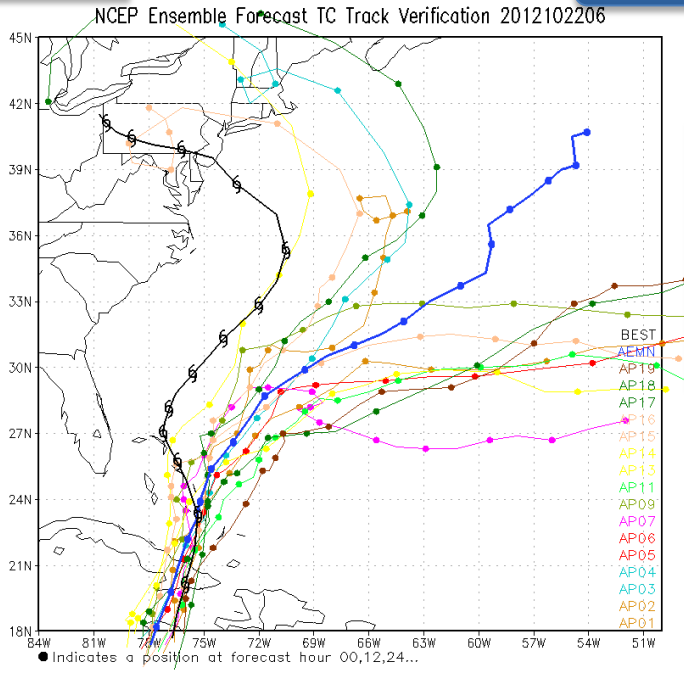
Thick blue: ensemble mean



Opr: T254L42 (55km)

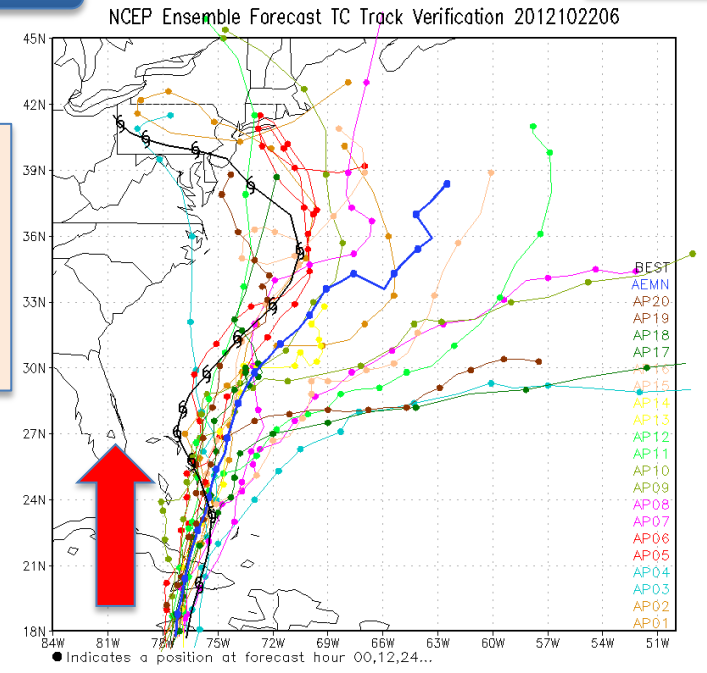
Para: T574L64 (33km)

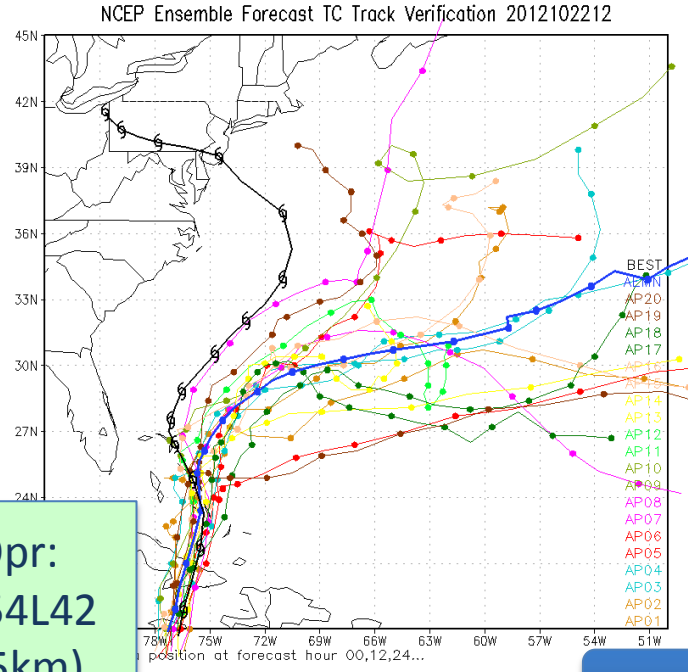
20121022 (8 days)



Red arrow means good forecast

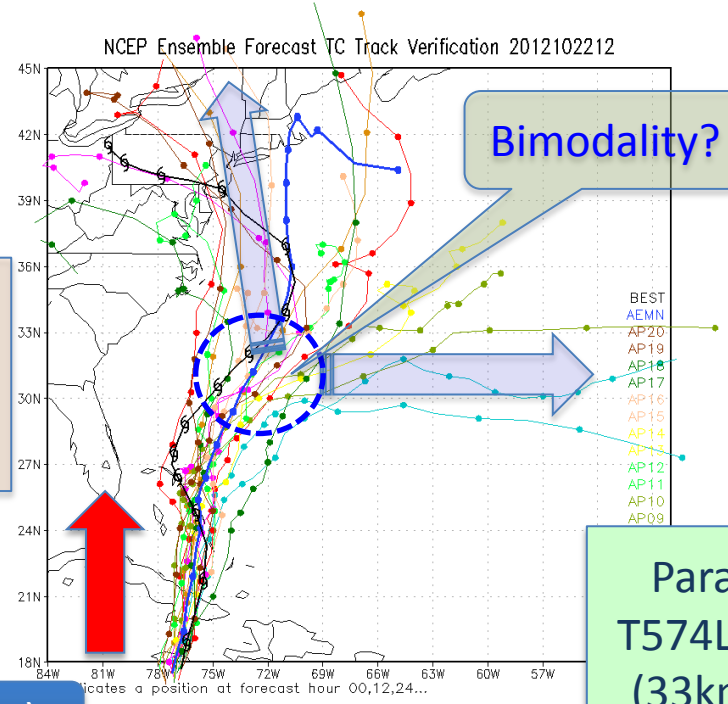
06UTC





12UTC

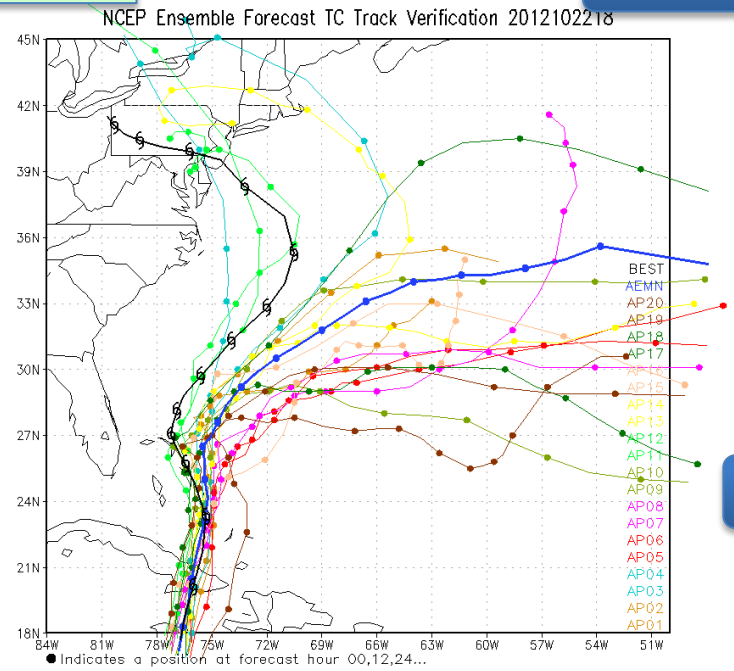
Thick blue: ensemble mean



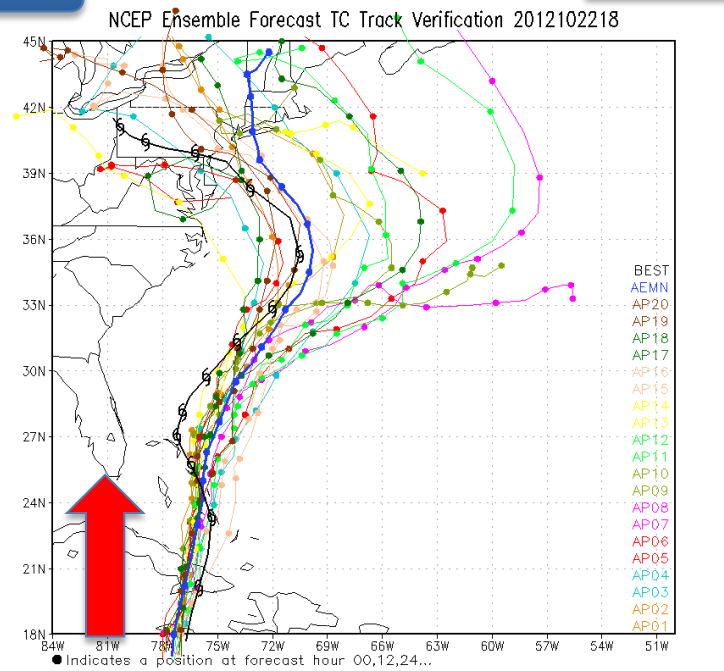
Opr: T254L42 (55km)

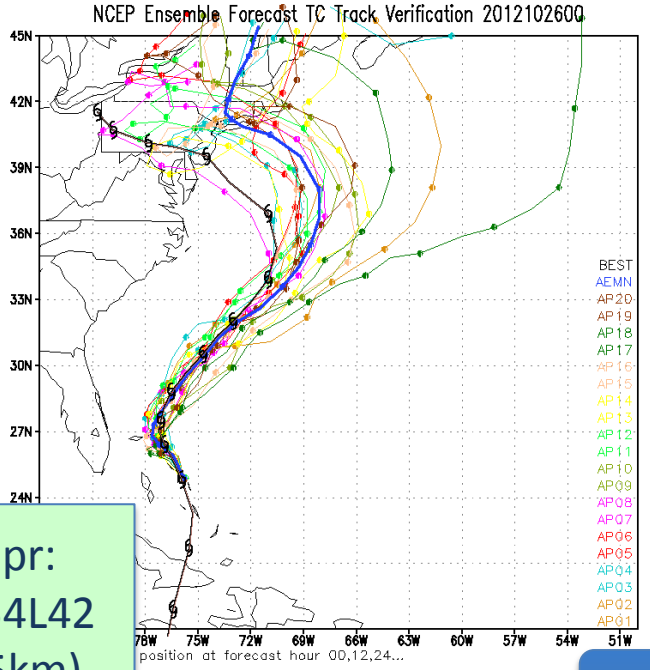
Para: T574L64 (33km)

20121022 (7.5 days)

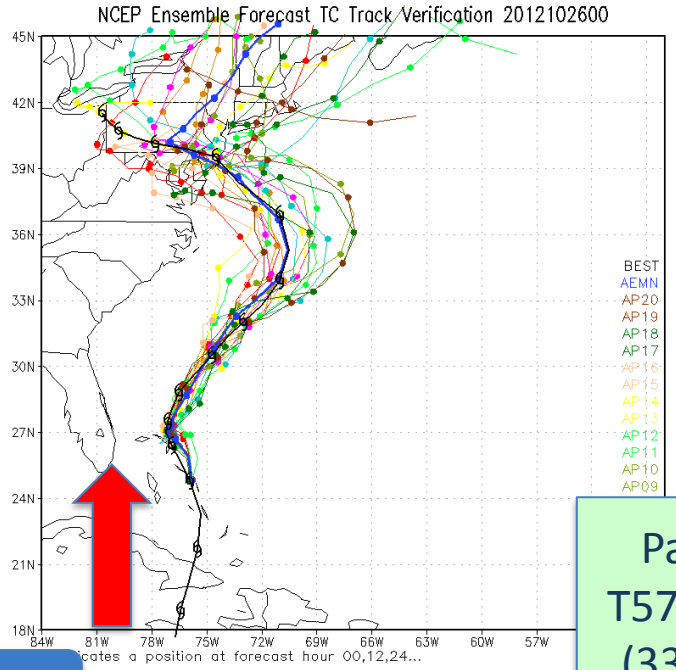


18UTC





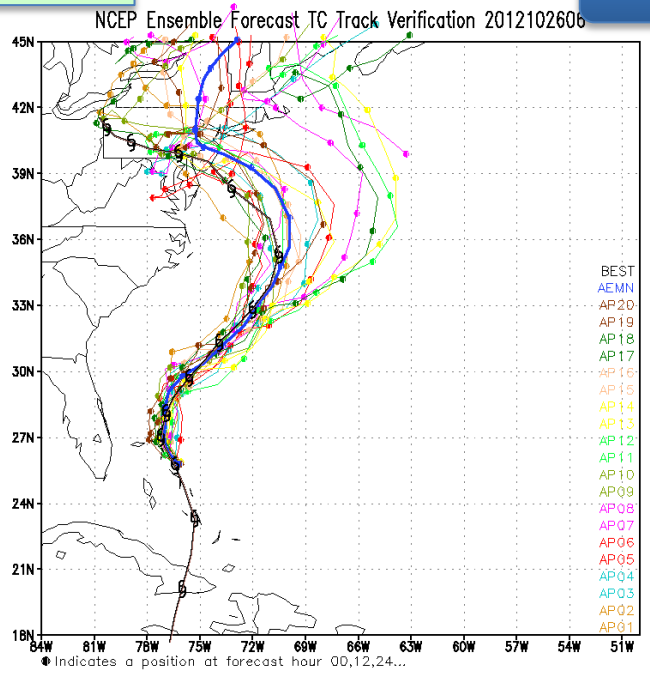
00UTC



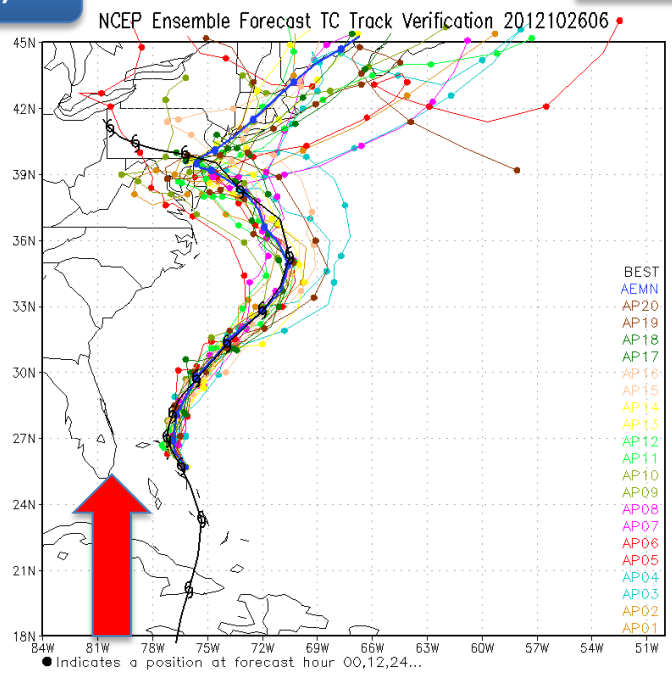
Opr:
T254L42
(55km)

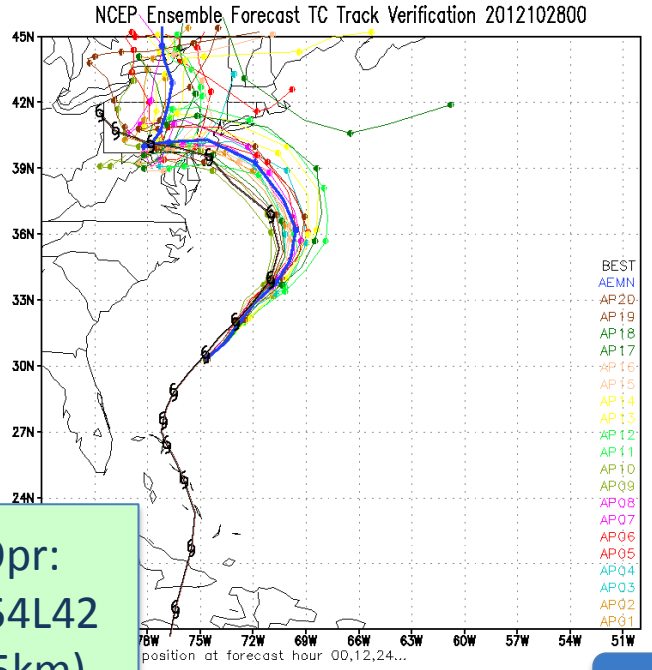
Para:
T574L64
(33km)

20121026 (4 days)

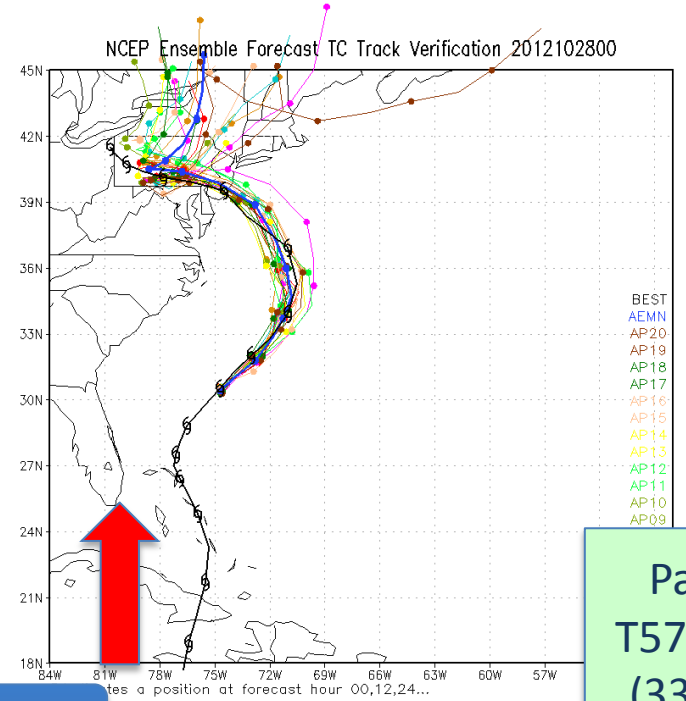


06UTC





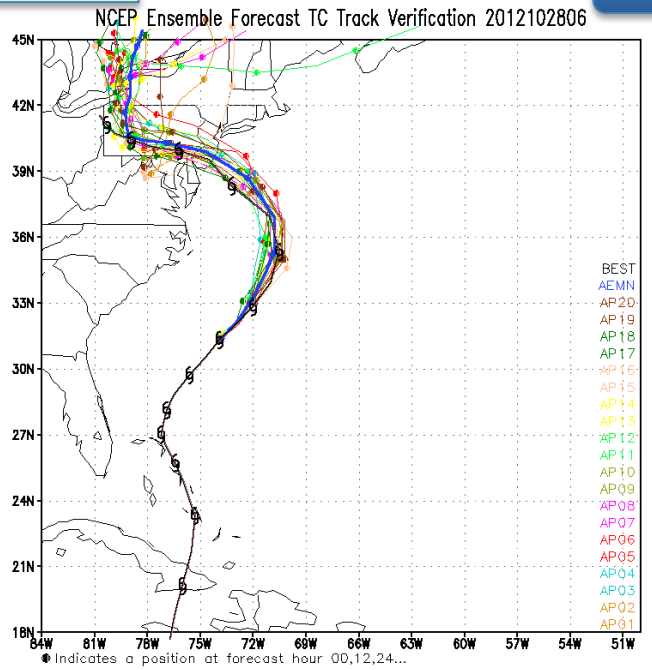
00UTC



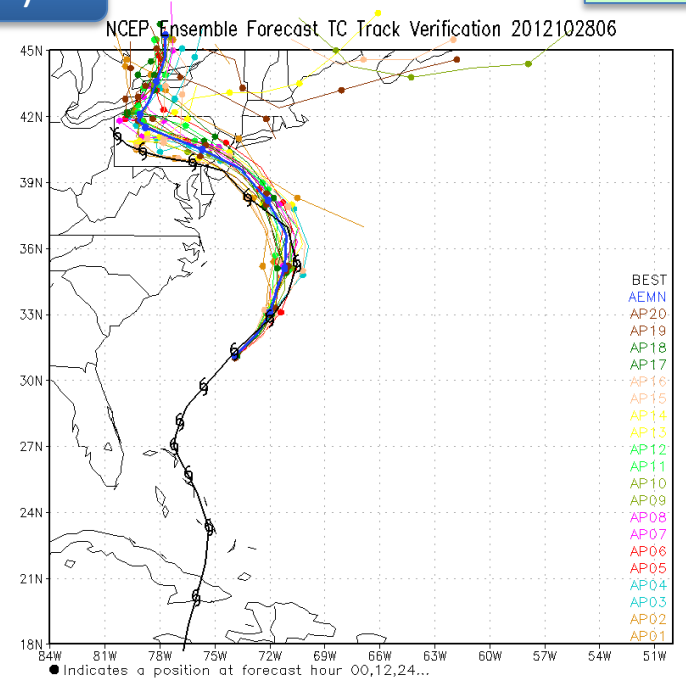
Opr:
T254L42
(55km)

Para:
T574L64
(33km)

20121028 (2 days)



06UTC



Short Summary for Sandy case

- Higher resolution and new model improve the forecast skill (and predictability) for most lead-time, especially for longer lead-time (day 7-8).
- Bimodality (or uncertainties) of forecast tracks is clearly for early lead-time – around 30-32N
- Very good forecasts for short lead-time (less than 4-5 days) of both production and parallel
- Problem/concern:
  - Forecast inconsistency from cycle to cycle since initial condition changes, especially for Oct. 23 - 24

Review of 2015 NE Blizzard

01/26 12UTC – 01/28 12UTC 2015

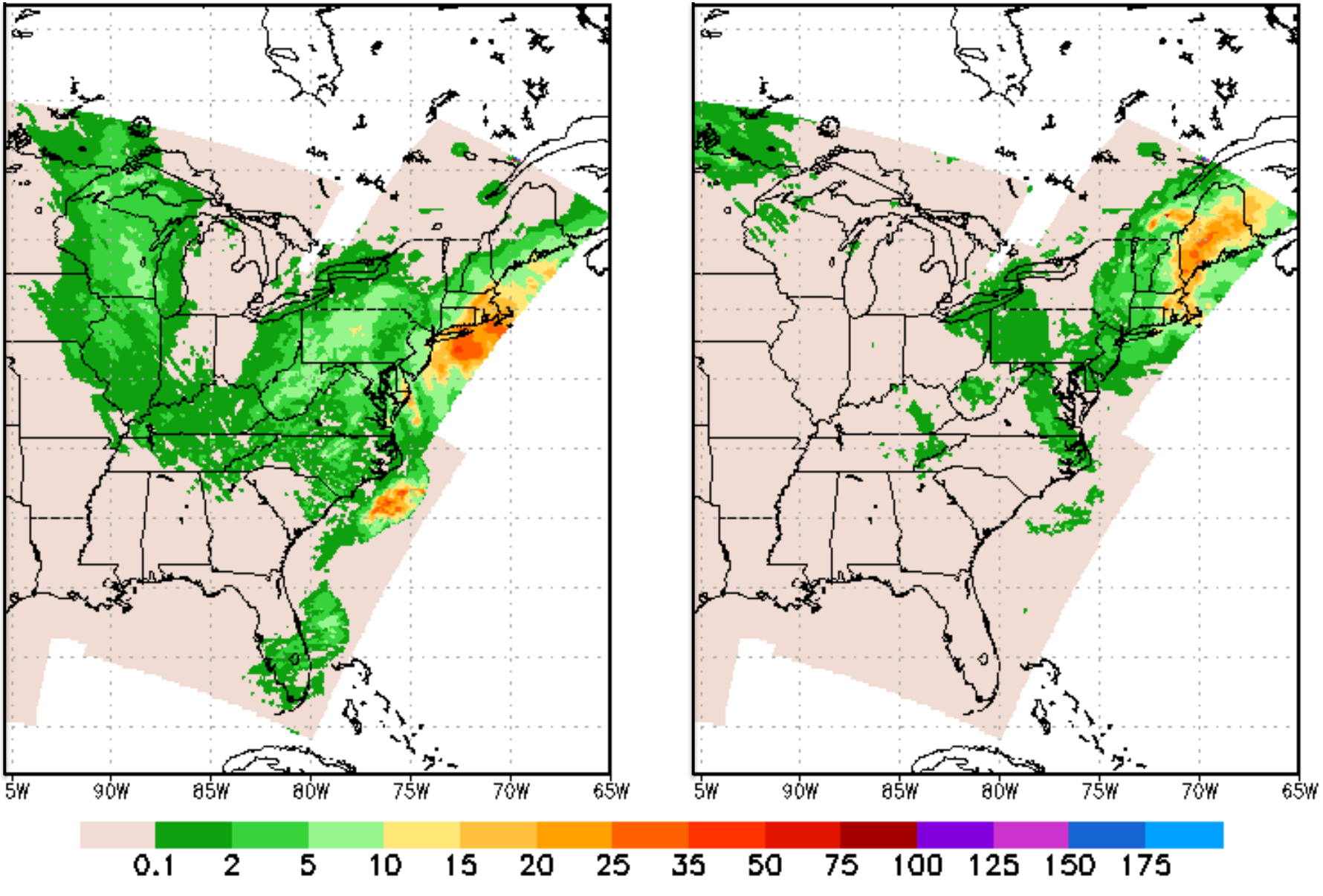
Yuejian Zhu
EMC/NCEP/NWS
Jan. 30 2015

Acknowledgements:
Hong Guan, Yan Luo and Xiaxiong Zhou

CCPA 24 hours accumulation (mm)

ENDING 12 UTC 20150127

ENDING 12 UTC 20150128



Ensemble Based Probabilistic Quantitative Precipitation Forecast (PQPF)
Valid: 2015012612 – 2015012712 Amount 24hr >25.4mm (1 inch)

Initial Time

2015012400

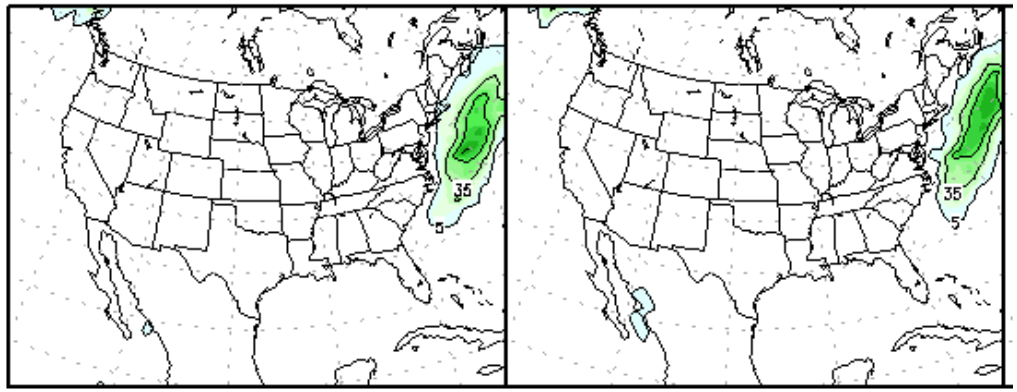
2015012500

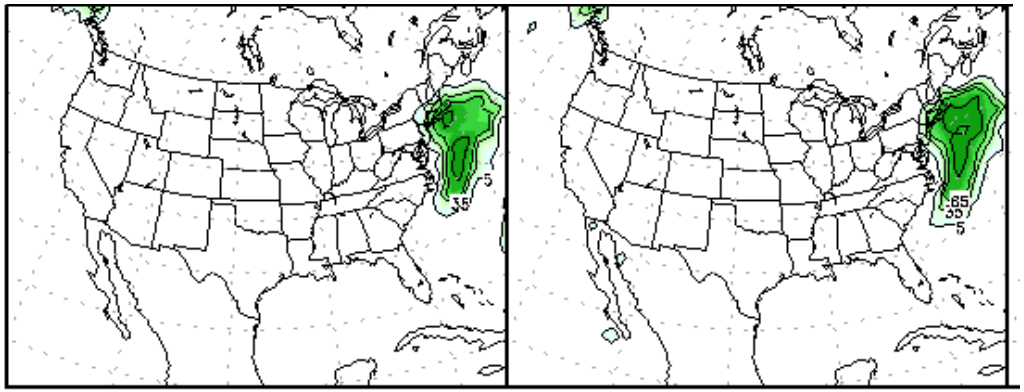
2015012600

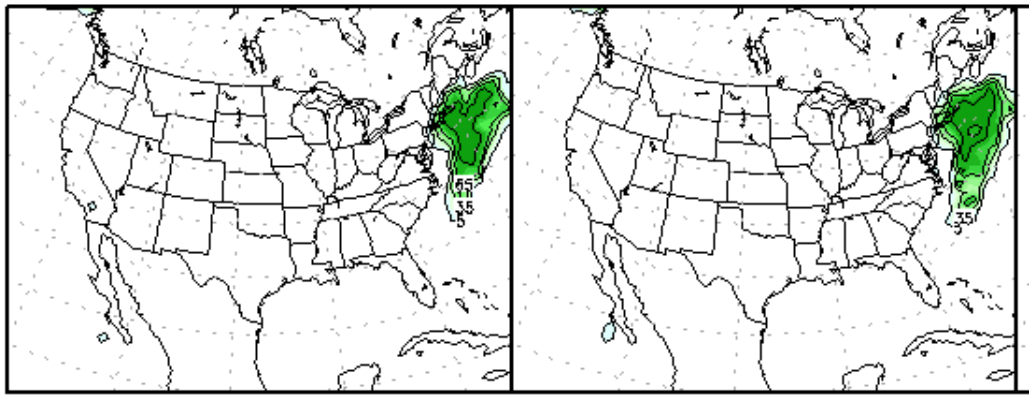
60–84 hr fcst

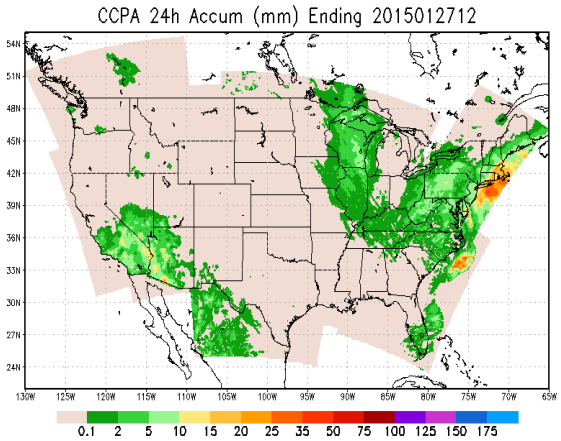
36–60 hr fcst

12–36 hr fcst









NCEP GEFS
PROD/PARA
Forecast difference

PROD **PARA**

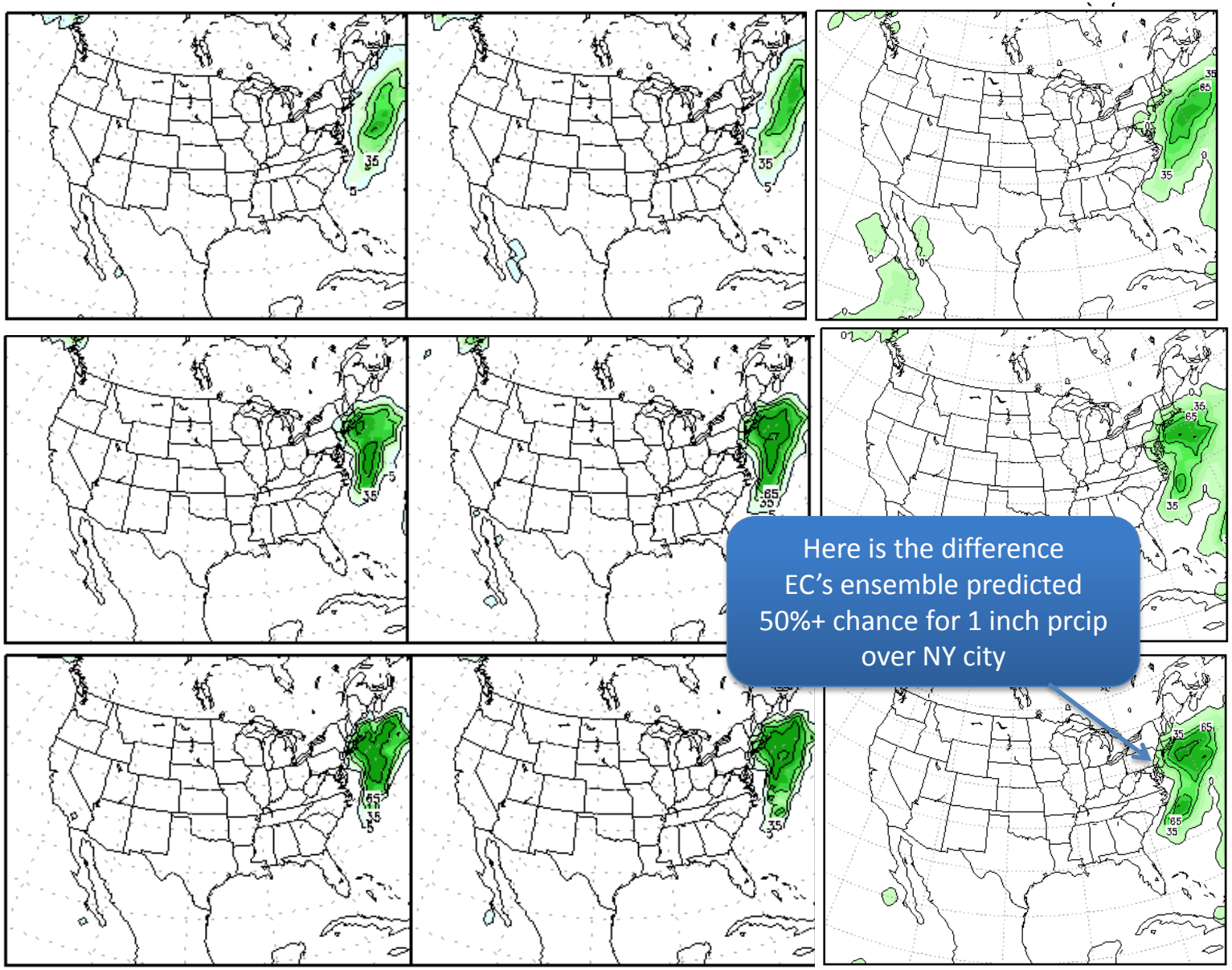
Ensemble Based Probabilistic Quantitative Precipitation Forecast (PQPF)
Valid: 2015012612 – 2015012712 Amount 24hr >25.4mm (1 inch)

Initial Time

2015012400 60–84 hr fcst

2015012500 36–60 hr fcst

2015012600 12–36 hr fcst

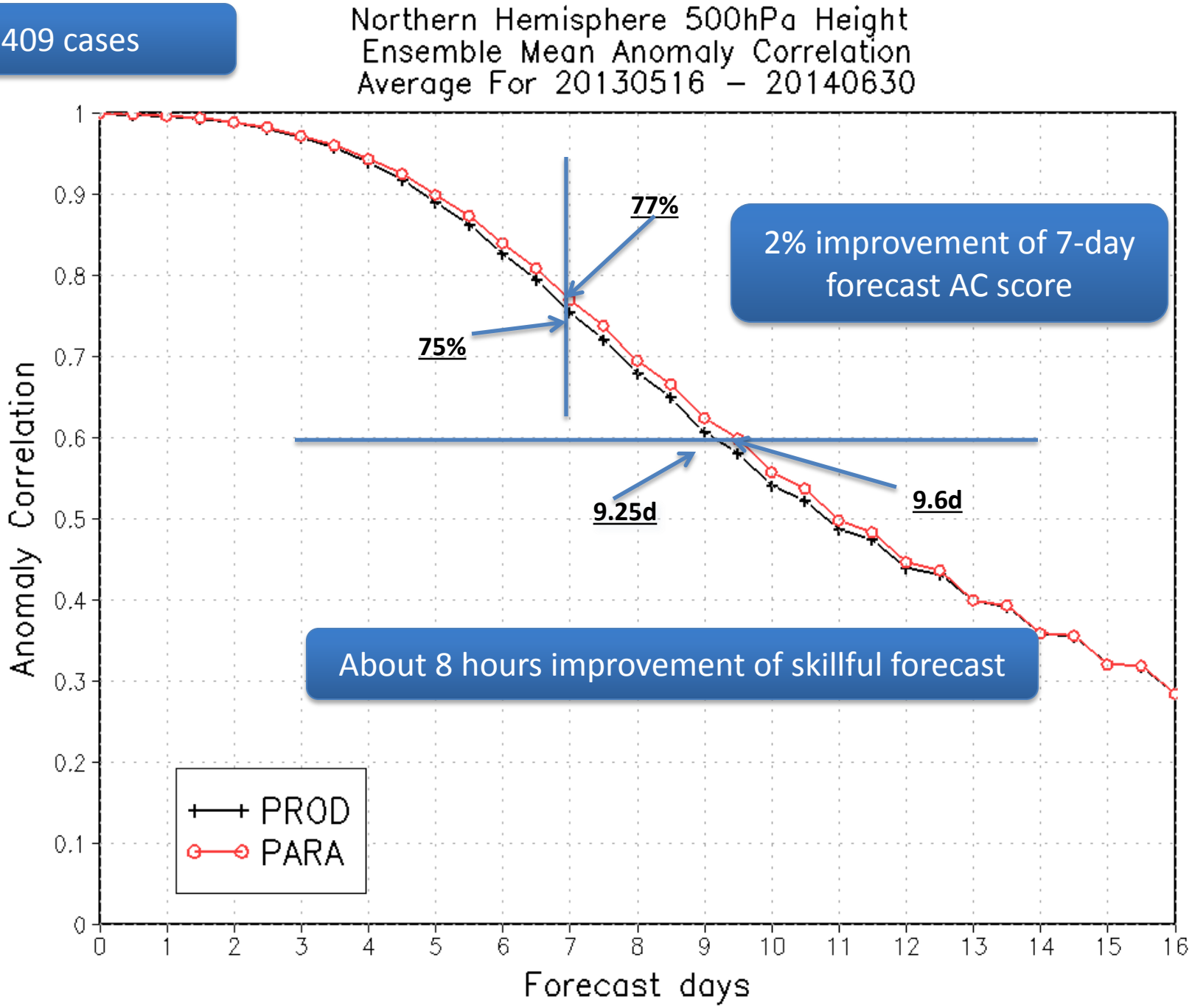


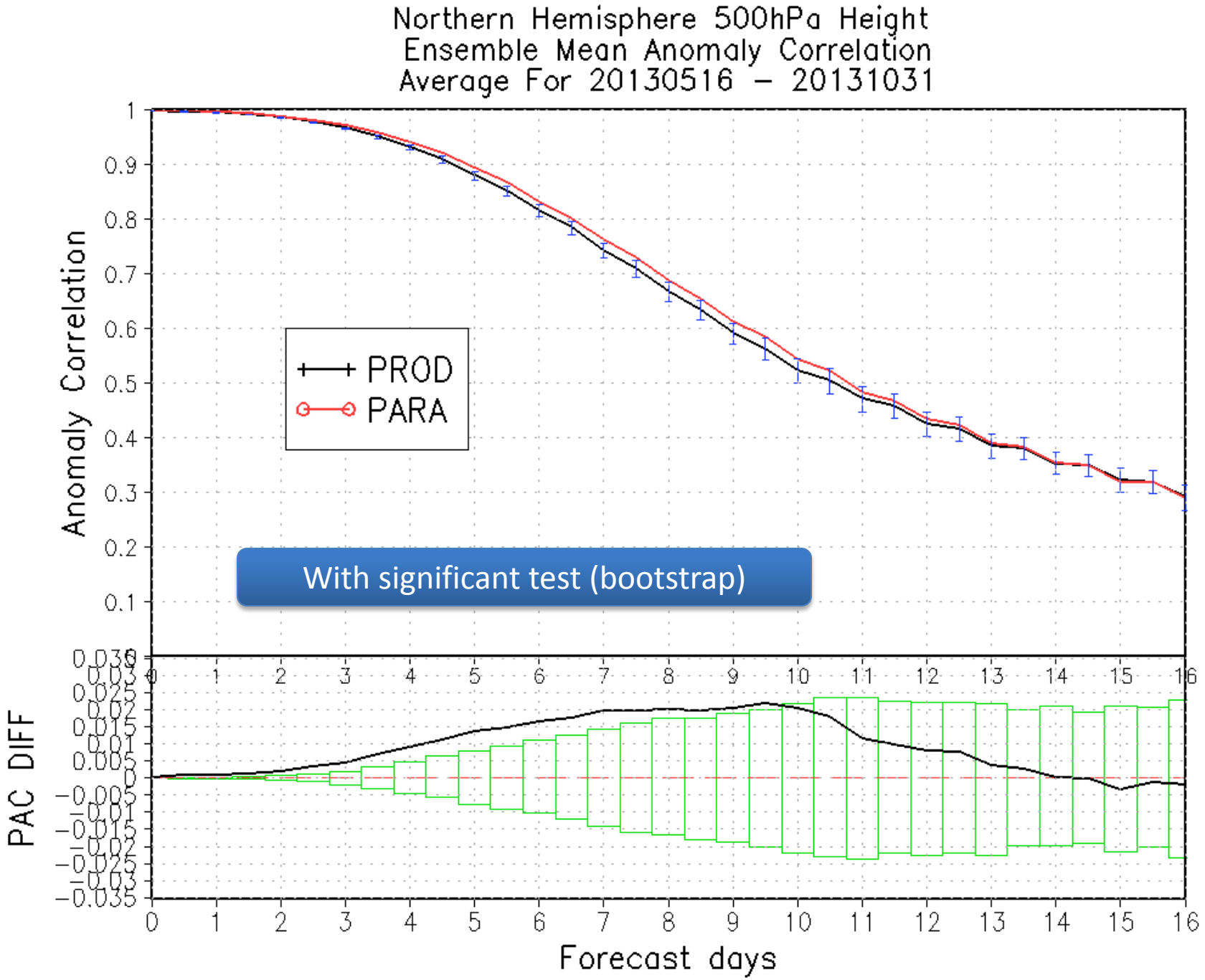
PROD **PARA** **ECMWF**

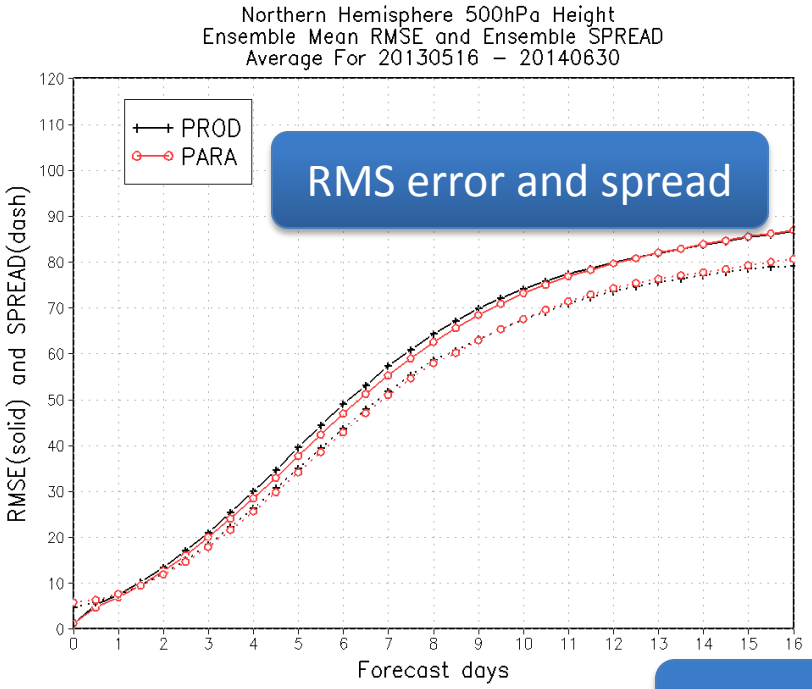
Evaluation for next GEFS

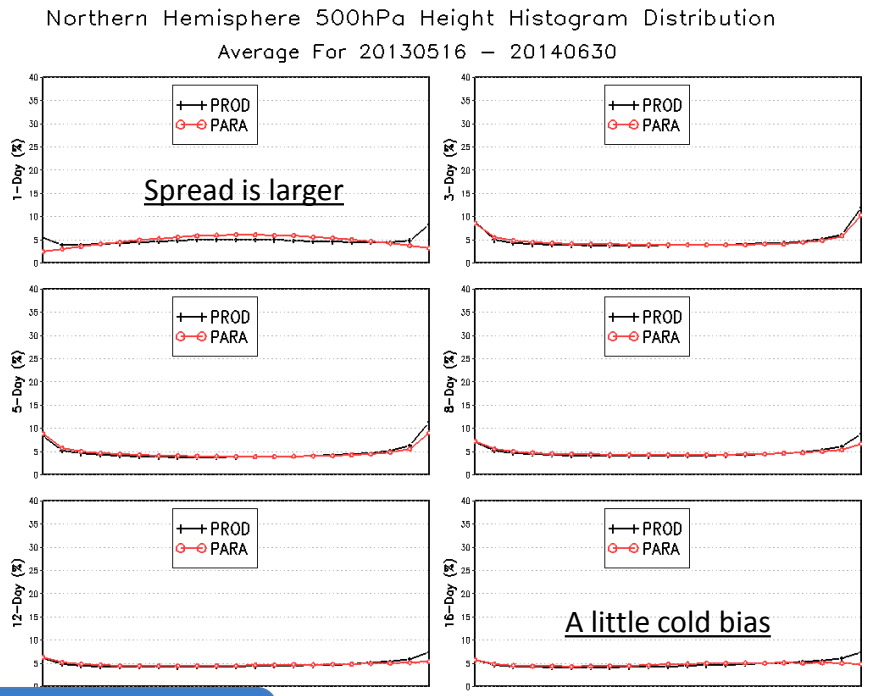
- Based on one-year (plus) retrospective runs
  - Upper atmosphere
  - Near surface
  - Precipitation
  - TC track
- Based on 18 year ensemble control only reforecasts
  - Upper atmosphere
  - Near surface

409 cases

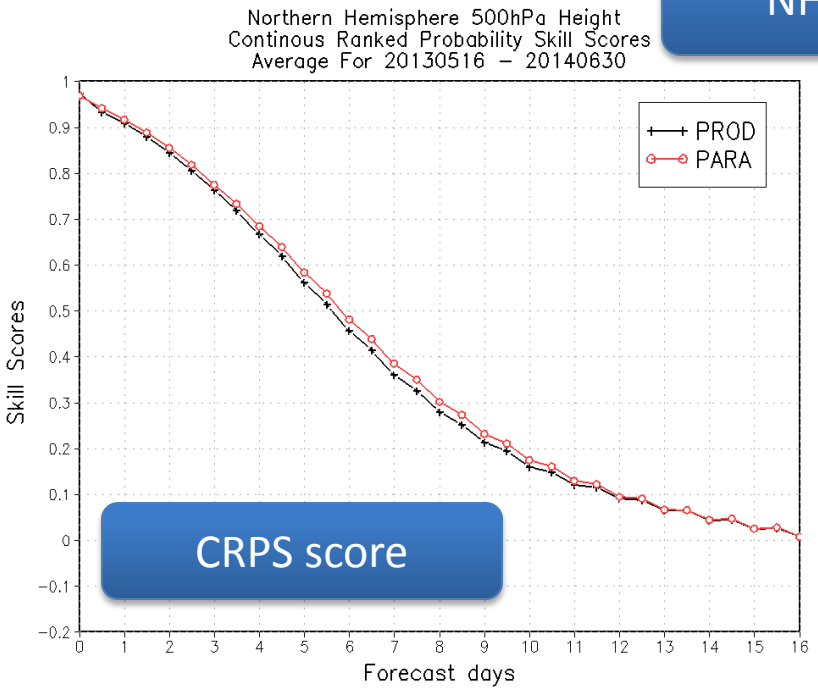

Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20130516 – 20140630
Anomaly Correlation
Forecast days
PROD
PARA
77%
75%
9.25d
9.6d
2% improvement of 7-day forecast AC score
About 8 hours improvement of skillful forecast

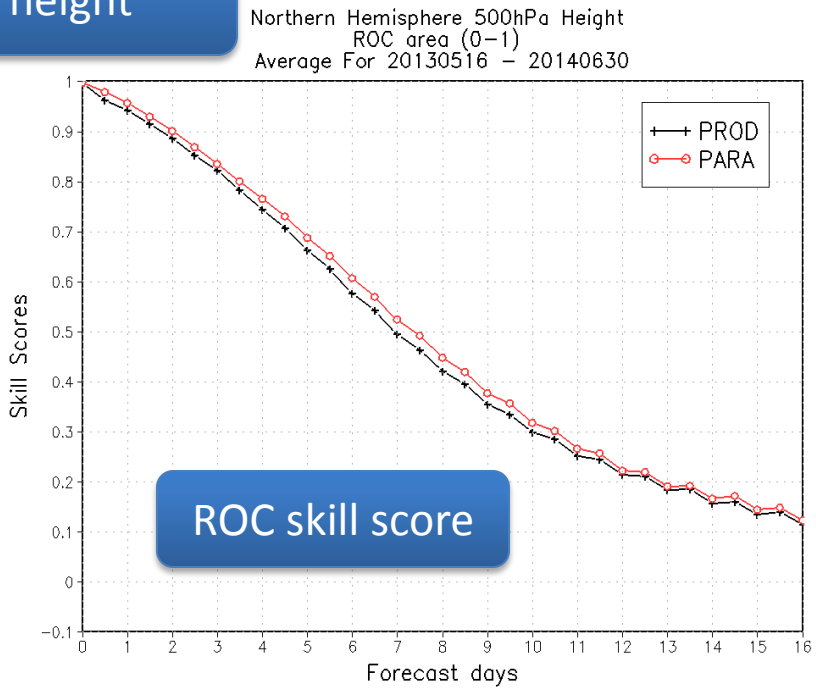

Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20130516 – 20131031
Anomaly Correlation
PROD
PARA
With significant test (bootstrap)
PAC DIFF
Forecast days

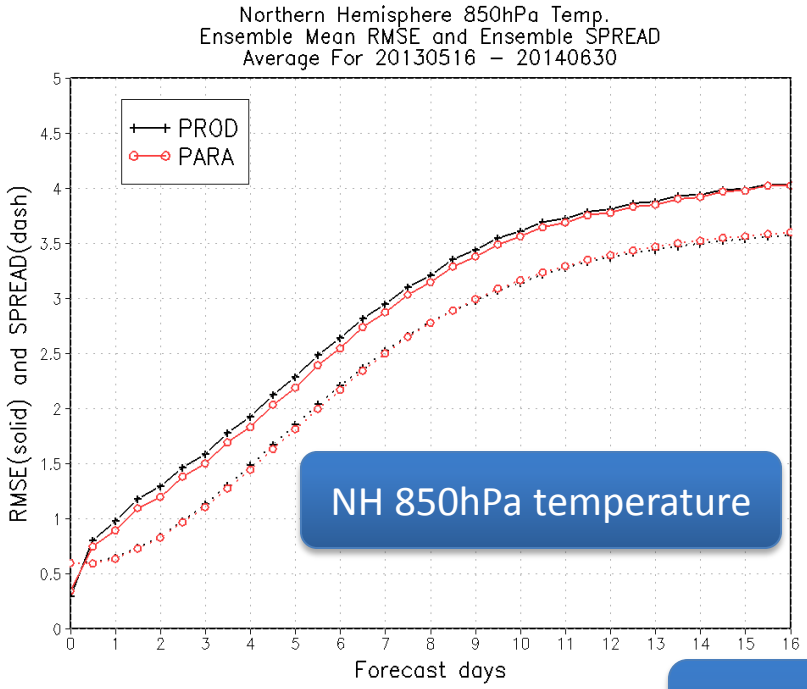


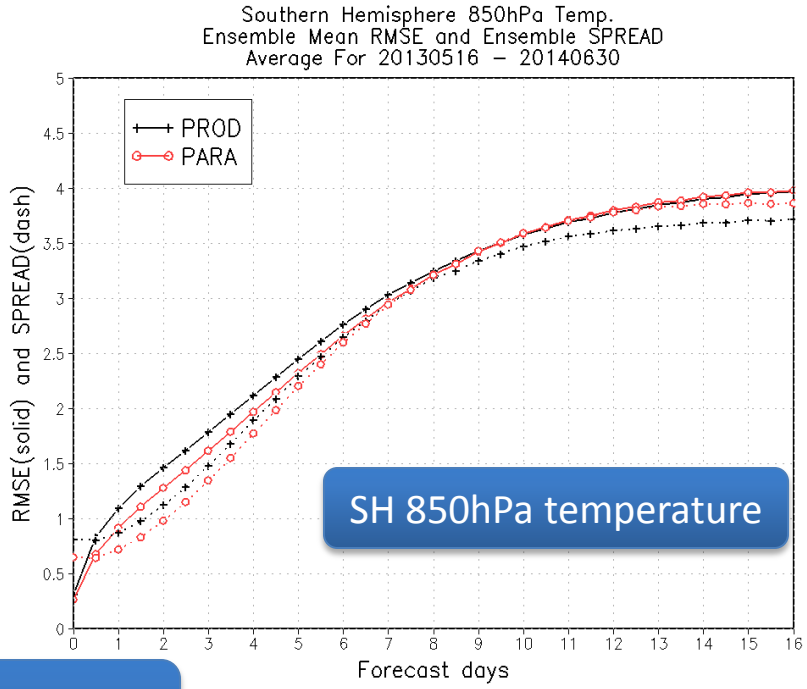


NH 500hPa height

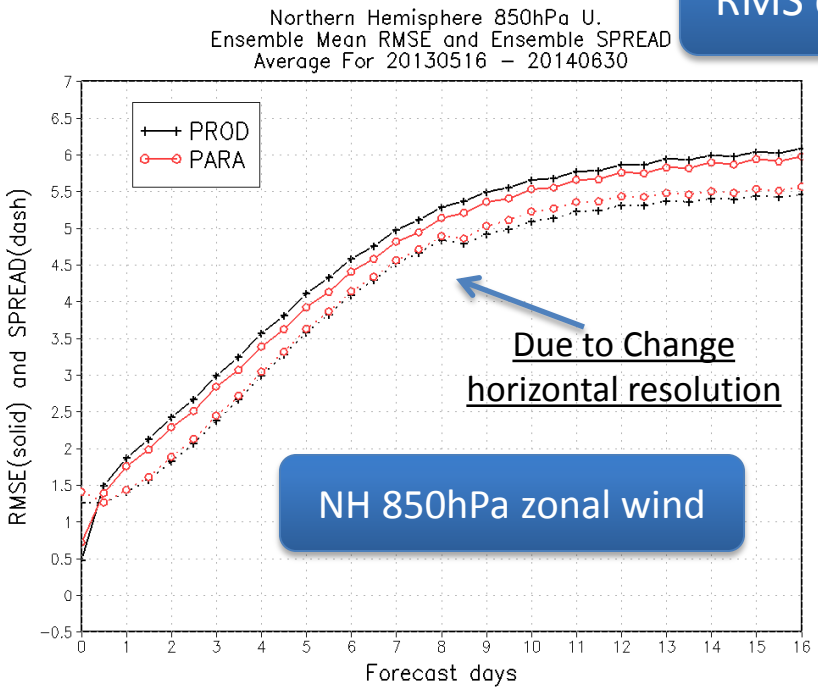


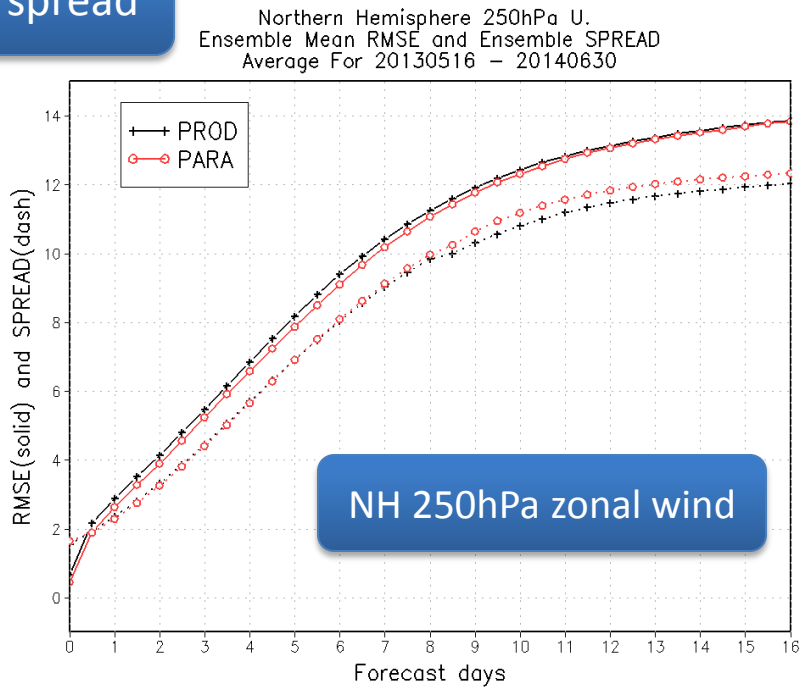


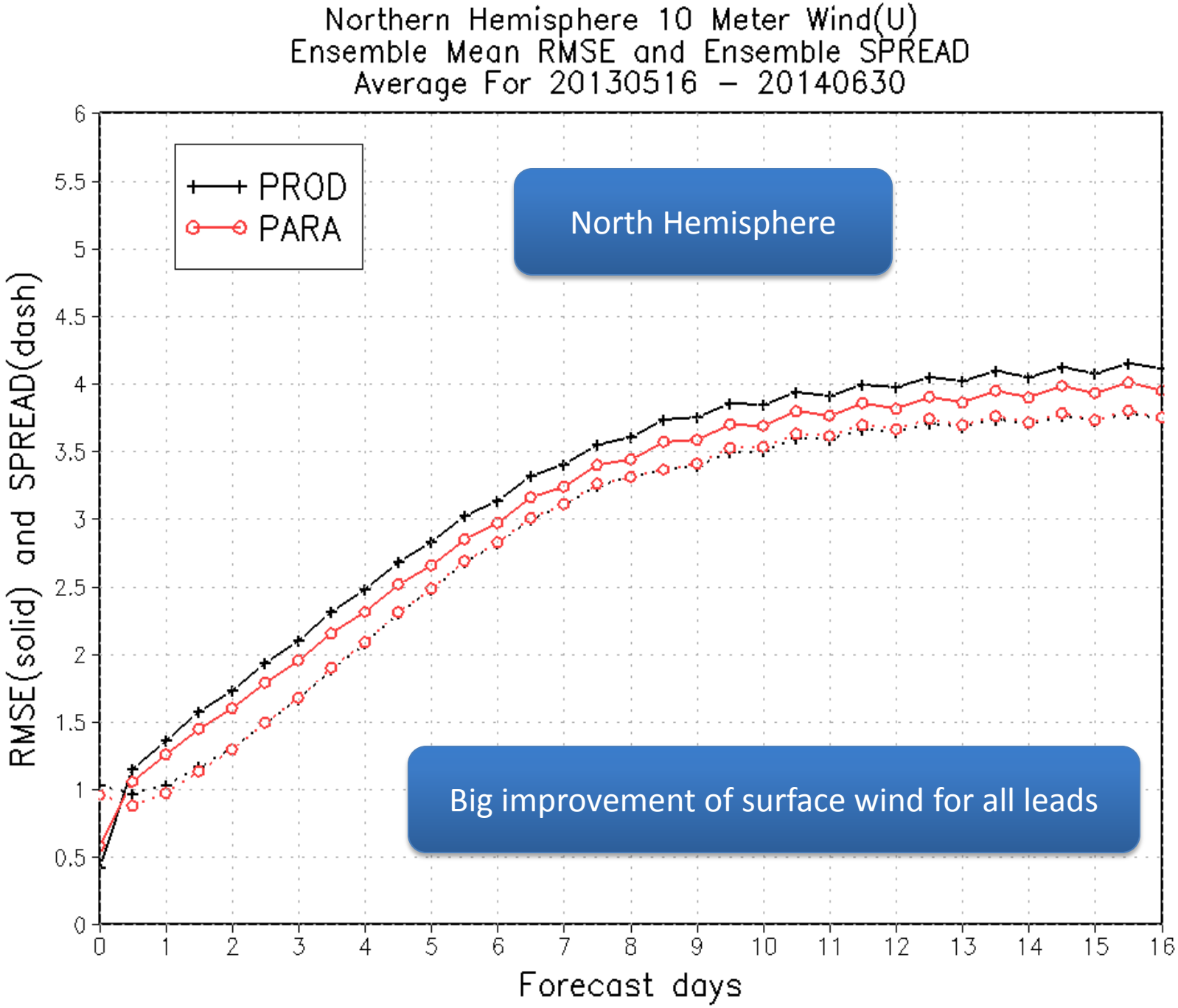


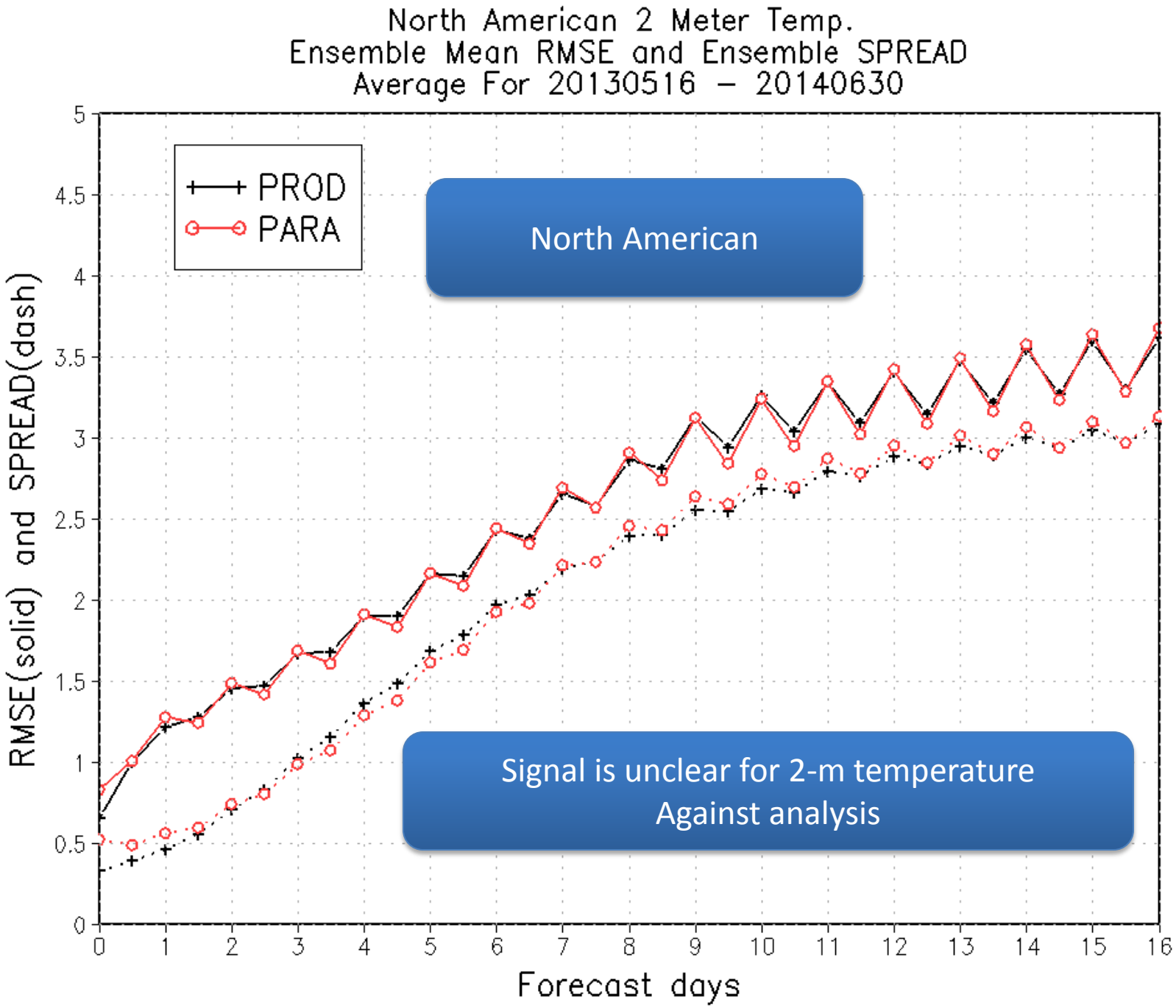


RMS error and spread






Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20130516 – 20140630
PROD
PARA
RMSE(solid) and SPREAD(dash)
Forecast days
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
North Hemisphere
Big improvement of surface wind for all leads


North American 2 Meter Temp.
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20130516 – 20140630
PROD
PARA
RMSE(solid) and SPREAD(dash)
Forecast days
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
North American
Signal is unclear for 2-m temperature
Against analysis

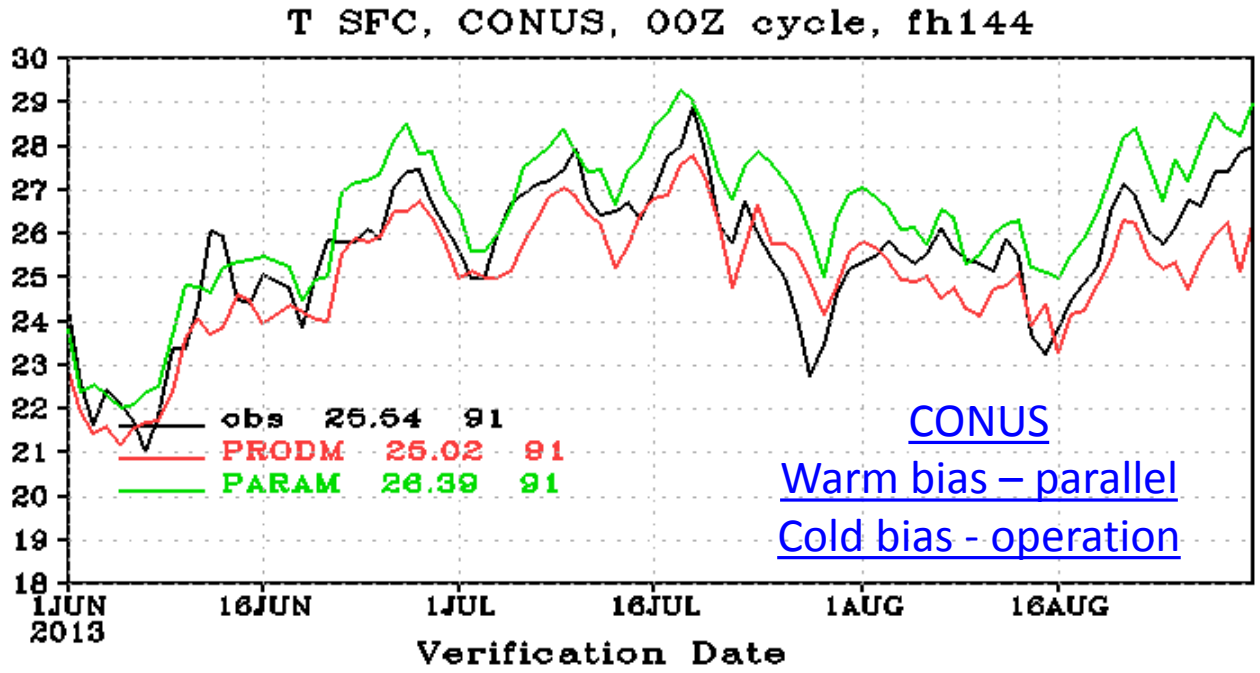
2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Summer 2013

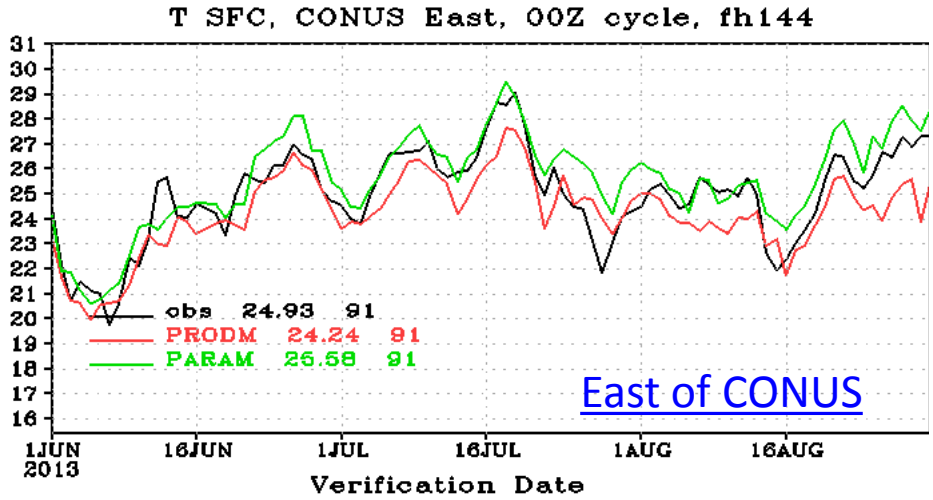
3 months



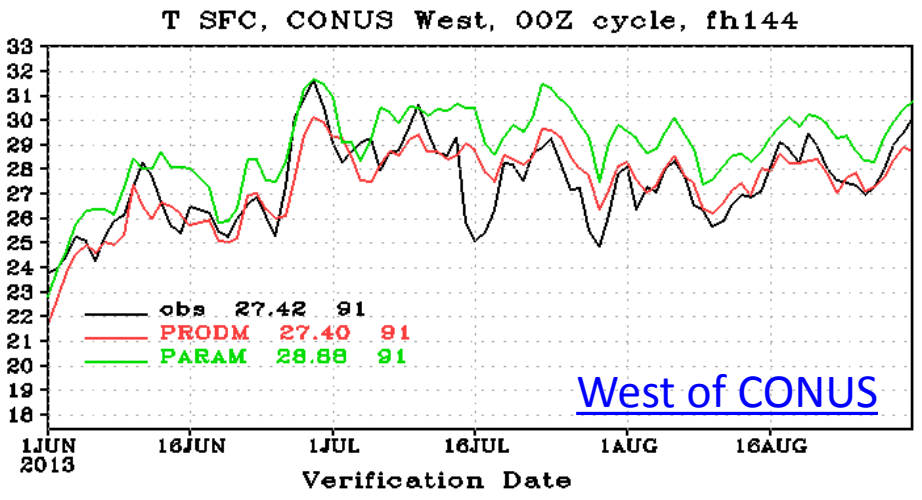
CONUS

Warm bias – parallel

Cold bias - operation



East of CONUS



West of CONUS

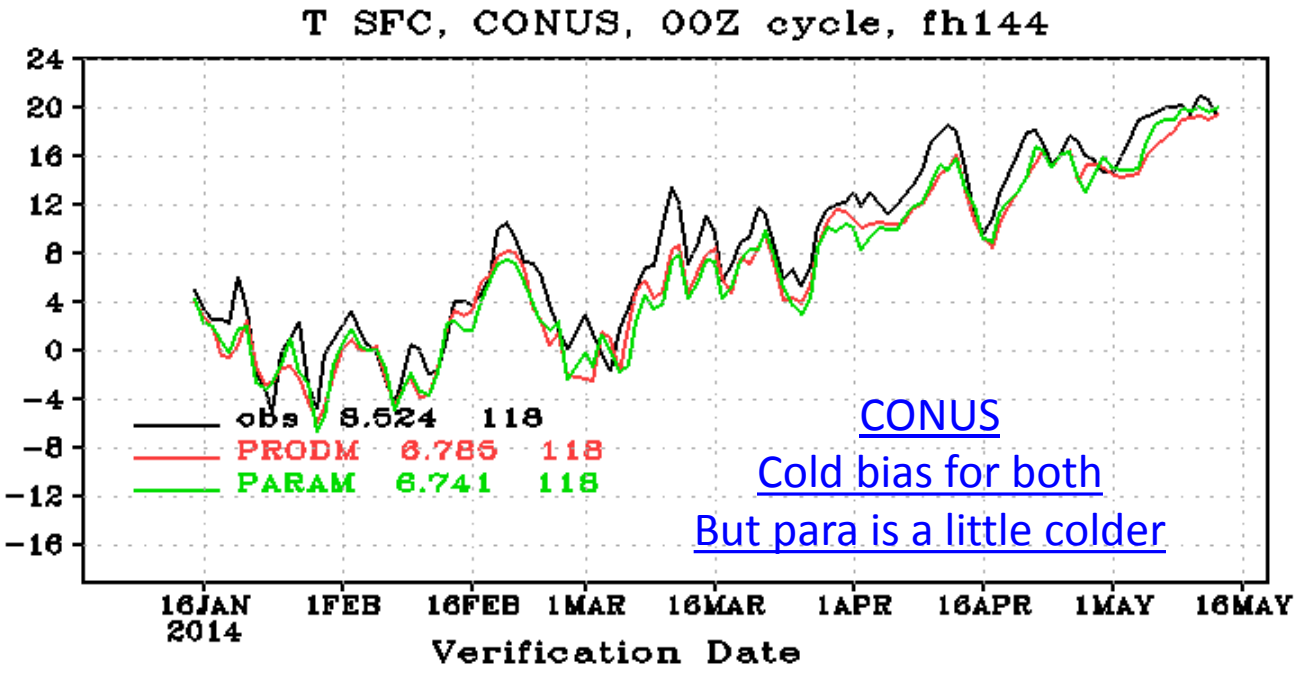
2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Winter-Spring 2014

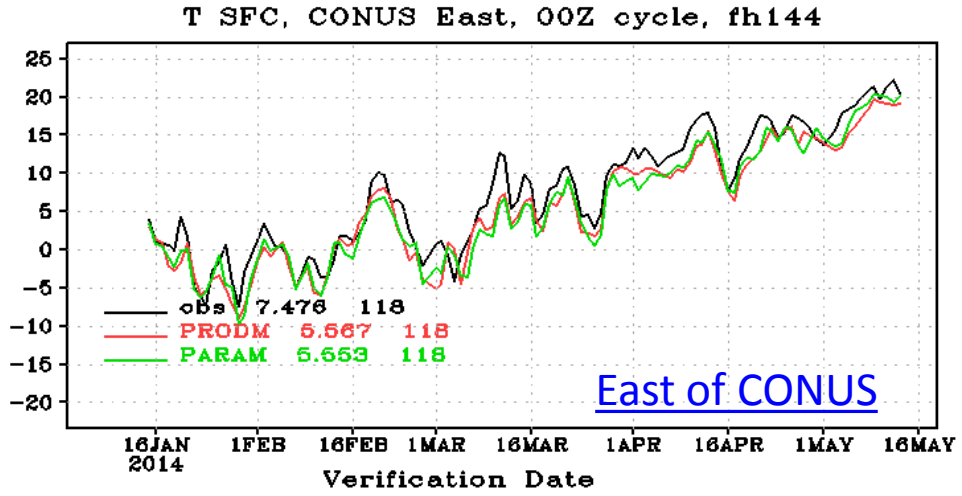
4 months



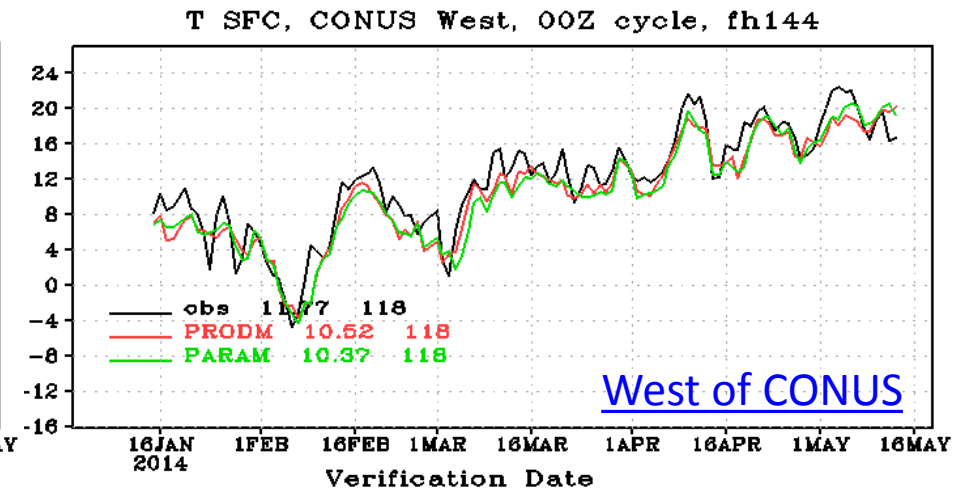
CONUS

Cold bias for both

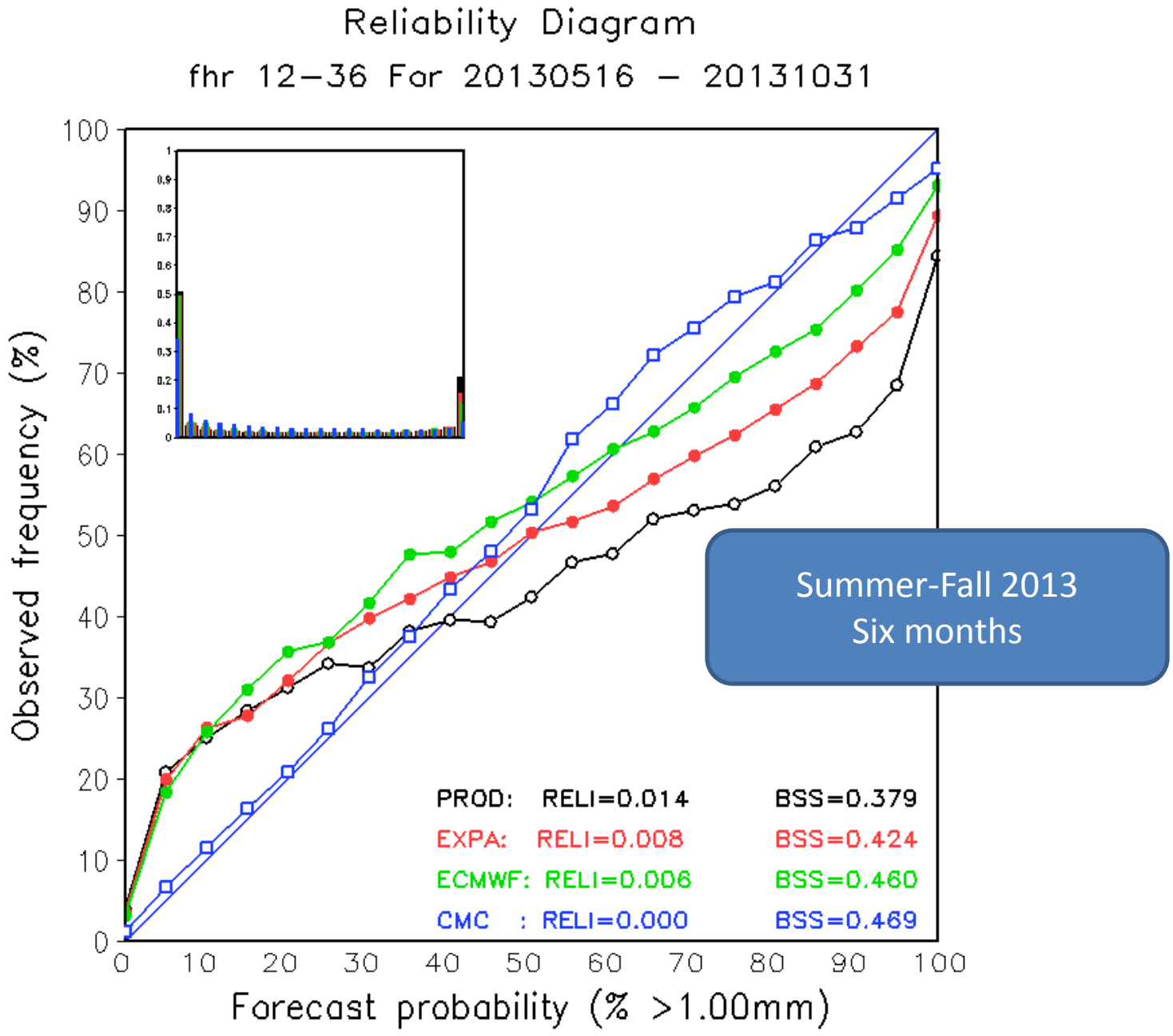
But para is a little colder



East of CONUS

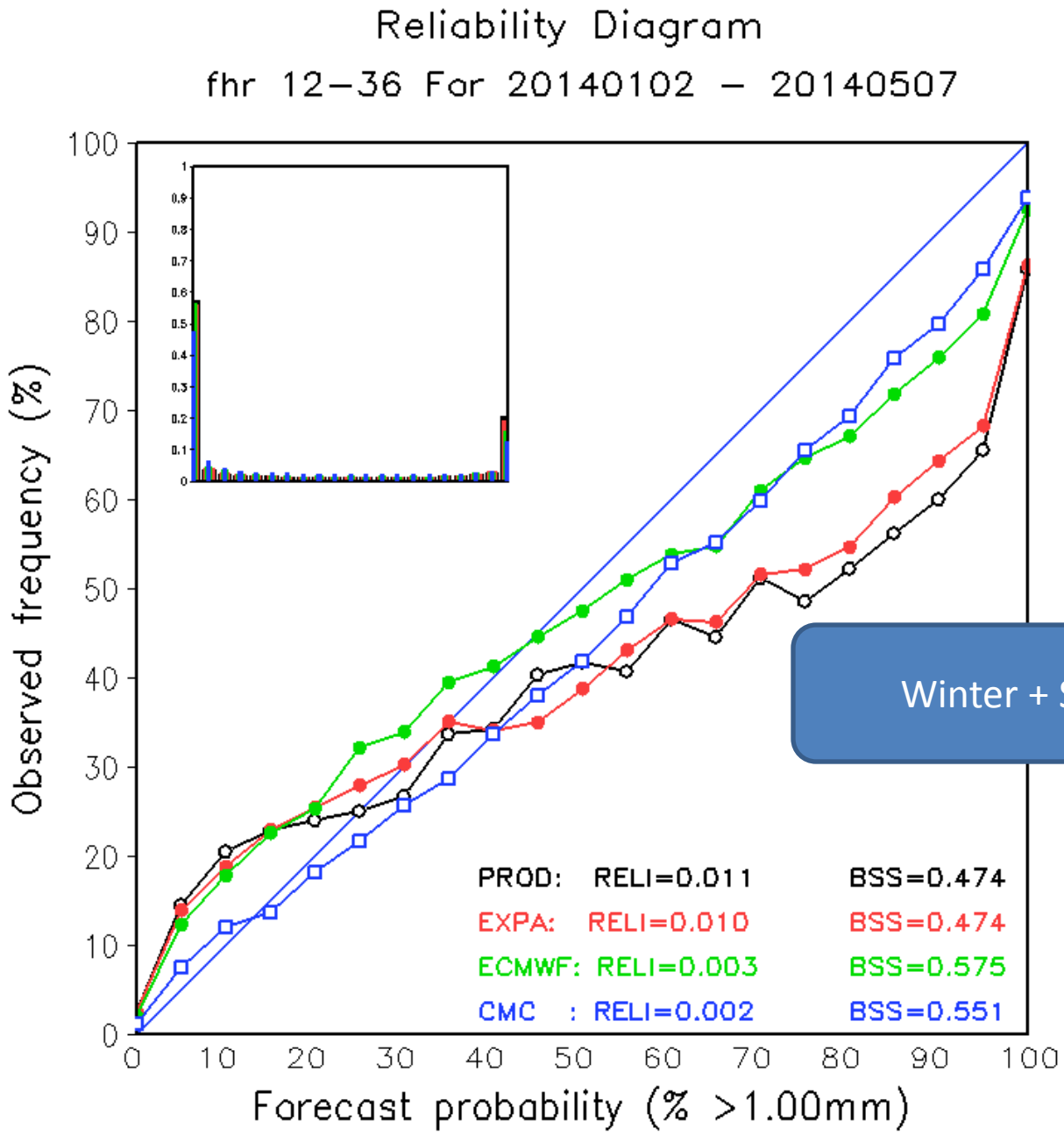


West of CONUS



Summer-Fall 2013
Six months

Precipitation reliability for 12-36hr and greater than 1mm/day



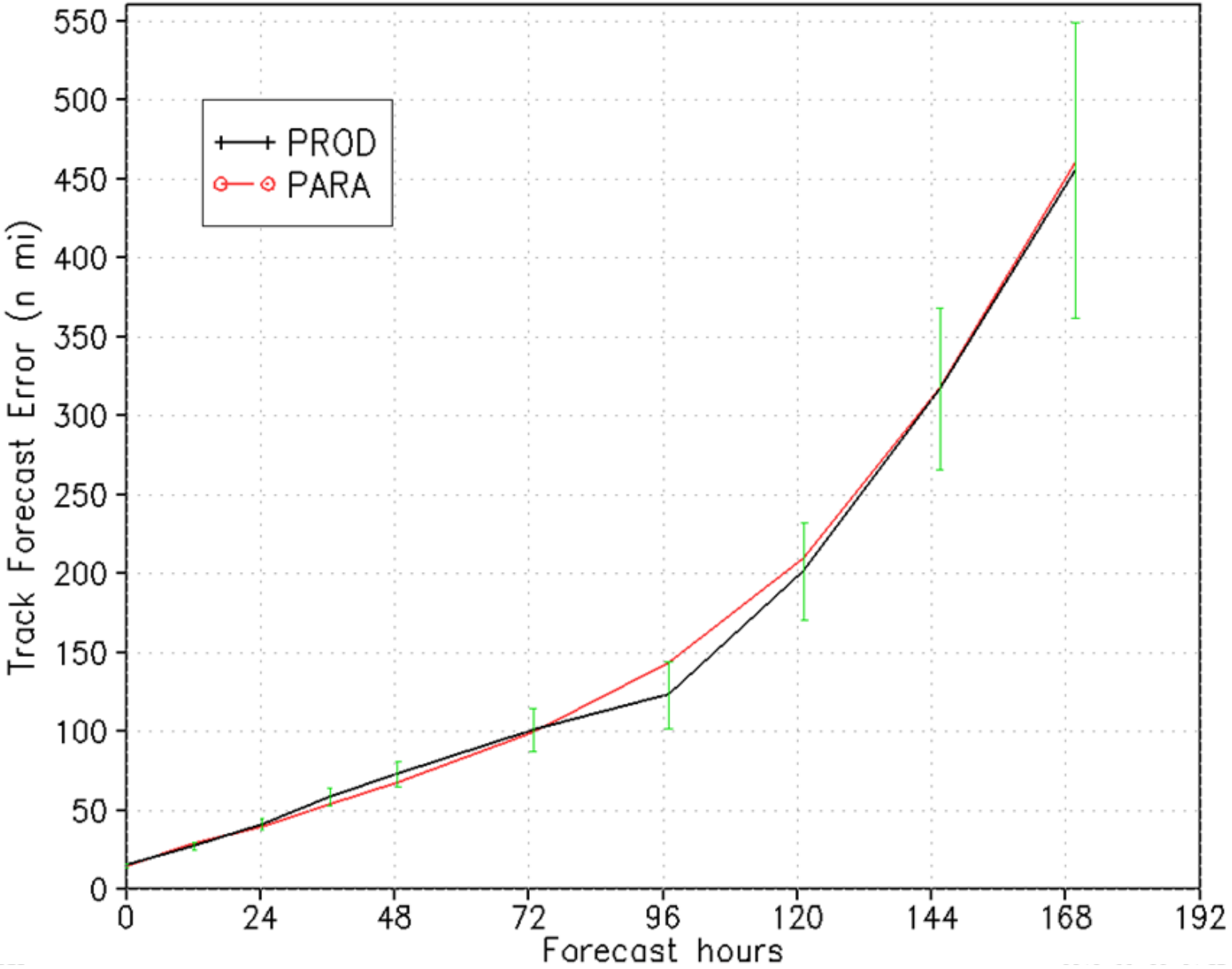
Winter + Spring 2014

Precipitation reliability for 12-36hr and greater than 1mm/day

Hurricane tracks verification

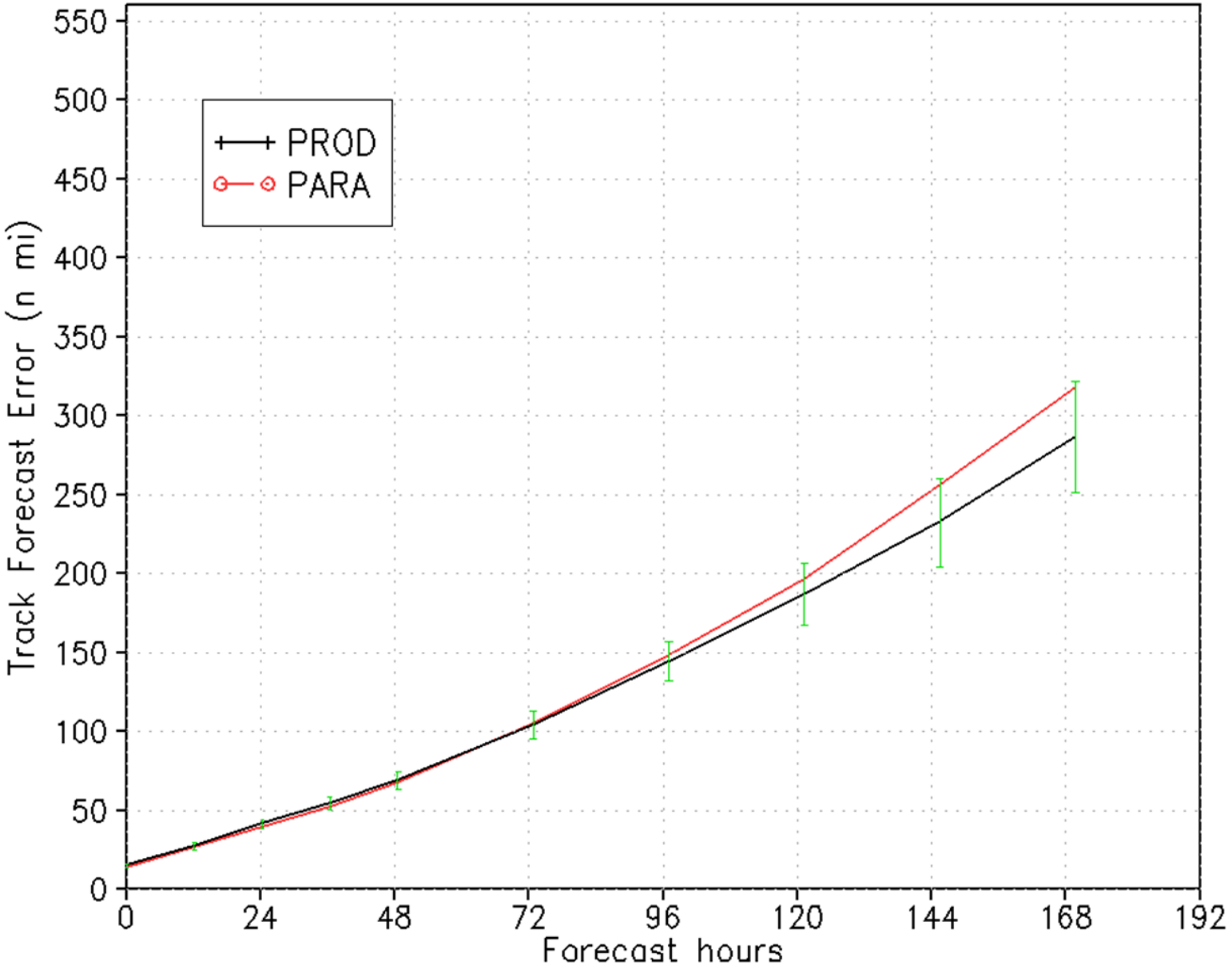
- Limited cases
  - 00UTC – 05/15/2012 – 9/6/2012
  - 00, 06, 12, 18UTC for Sandy period
  - 00UTC – summer of 2013
  - 12UTC – part of summer of 2013
  - 00UTC – summer of 2014
- Three main basins
  - Atlantic
  - East Pacific
  - West Pacific

TC track verification for 2012-2013-2014 (Atlantic)



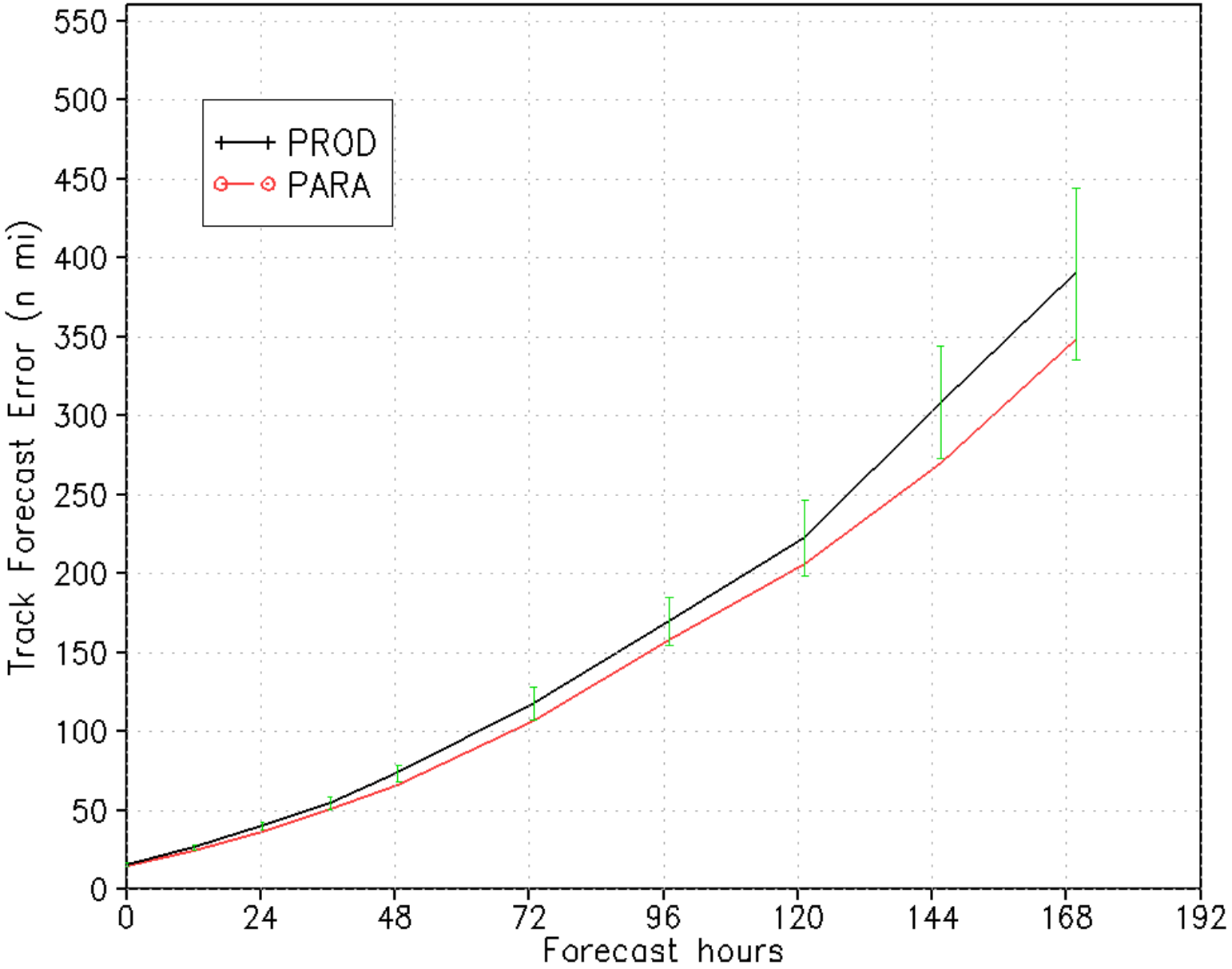
CASES	187	161	129	95	65	47	31	20

TC track verification for 2012-2013-2014 (E. Pacific)



CASES	294	266	225	188	145	104	69	43

TC track verification for 2012-2013-2014 (W. Pacific)

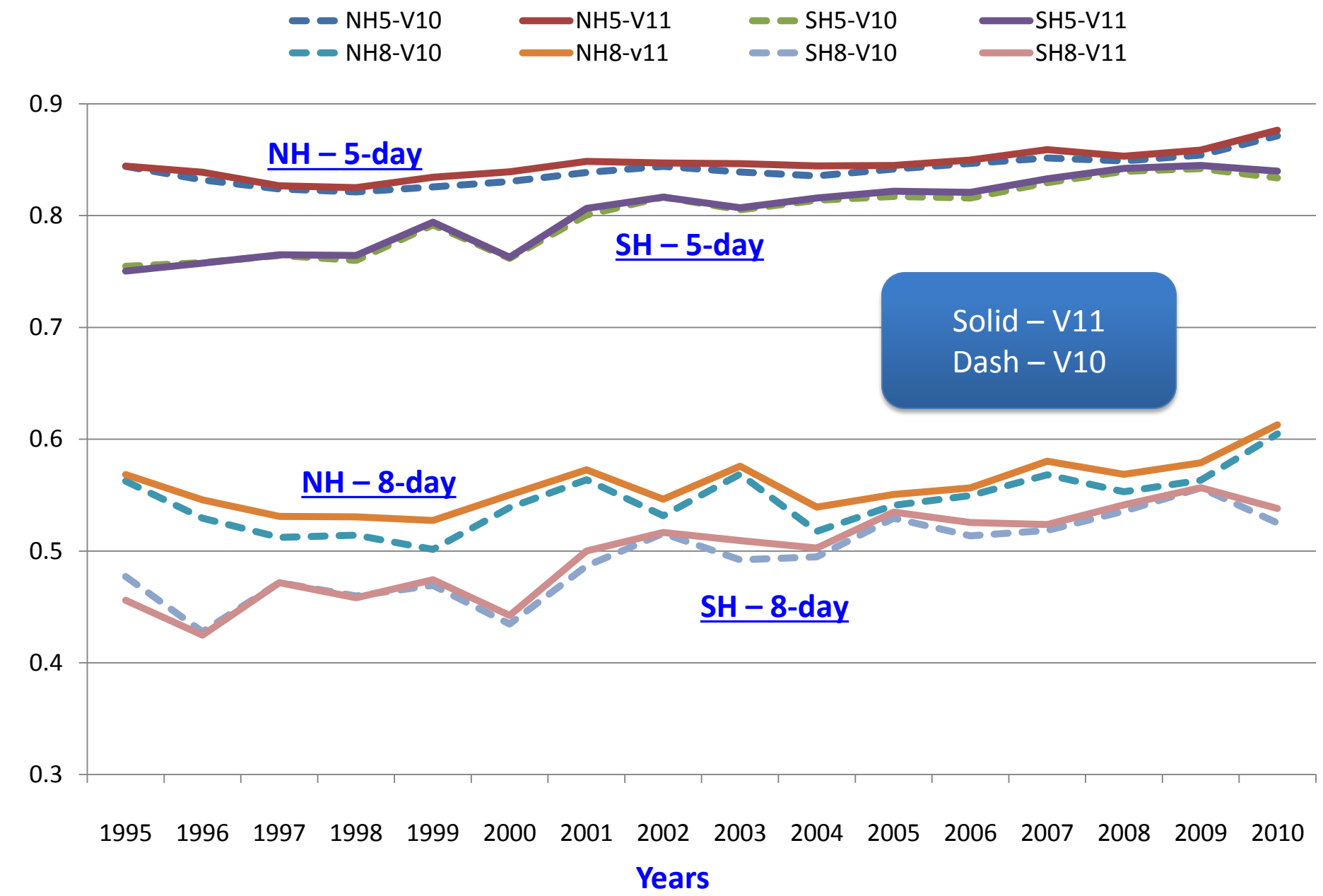


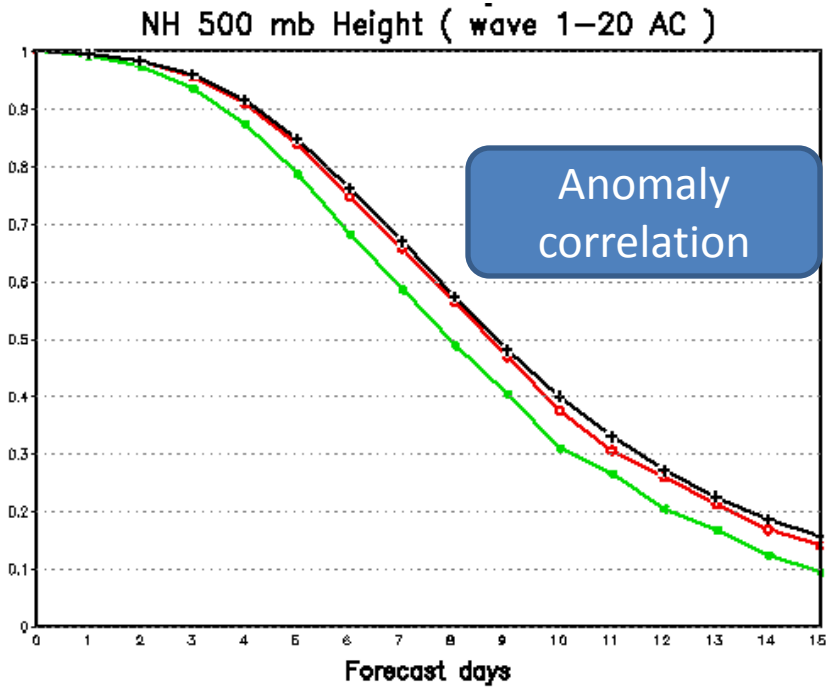
CASES	326	292	238	178	127	86	57	36

Summary

- Extended summer (05/15 – 10/31/2013)
  - Improvement:
    - Over-all large scale circulation in terms of AC, RMS error, CRPS and other measures
    - Surface temperature – improved for east of CONUS slightly (from cold bias to warm bias)
    - Surface wind
    - Precipitation – improved reliability and skill
    - Hurricane tracks out to 3-4 days (less sample beyond 4 days, especially for Atlantic basin), out to 7 days for West Pacific
  - Neutral:
  - Degrade:
    - Surface temperature – degraded for CONUS (large warm bias against obs)
- Extended winter (01/1 – 05/14/2014)
  - Improvement:
    - Over-all for many atmospheric variables
    - Surface wind
  - Neutral:
    - Surface temperature errors and bias for CONUS (against obs)
    - Precipitation
  - Degrade:

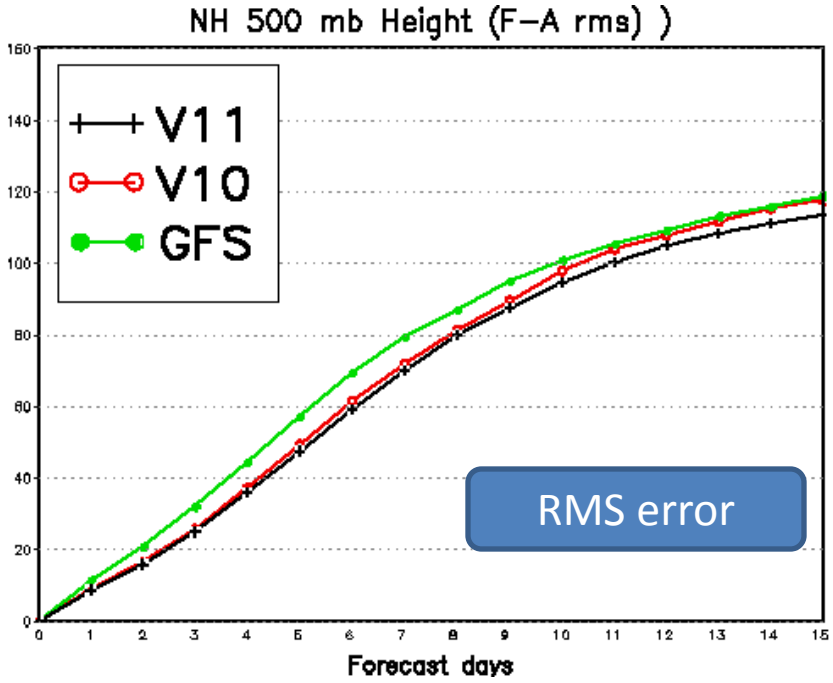
500hPa Anomaly Correlation for Control Only Reforecast (V10 .vs V11)

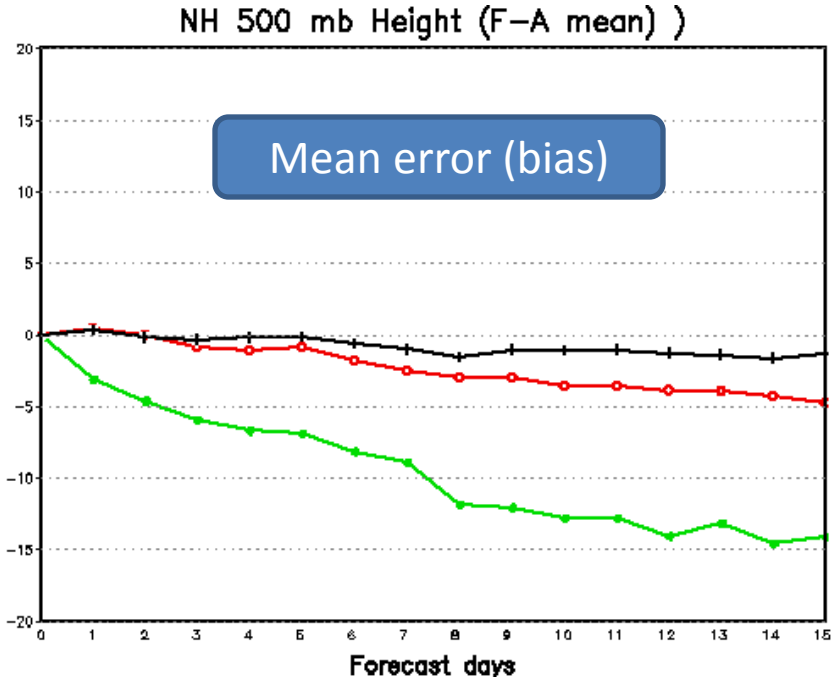




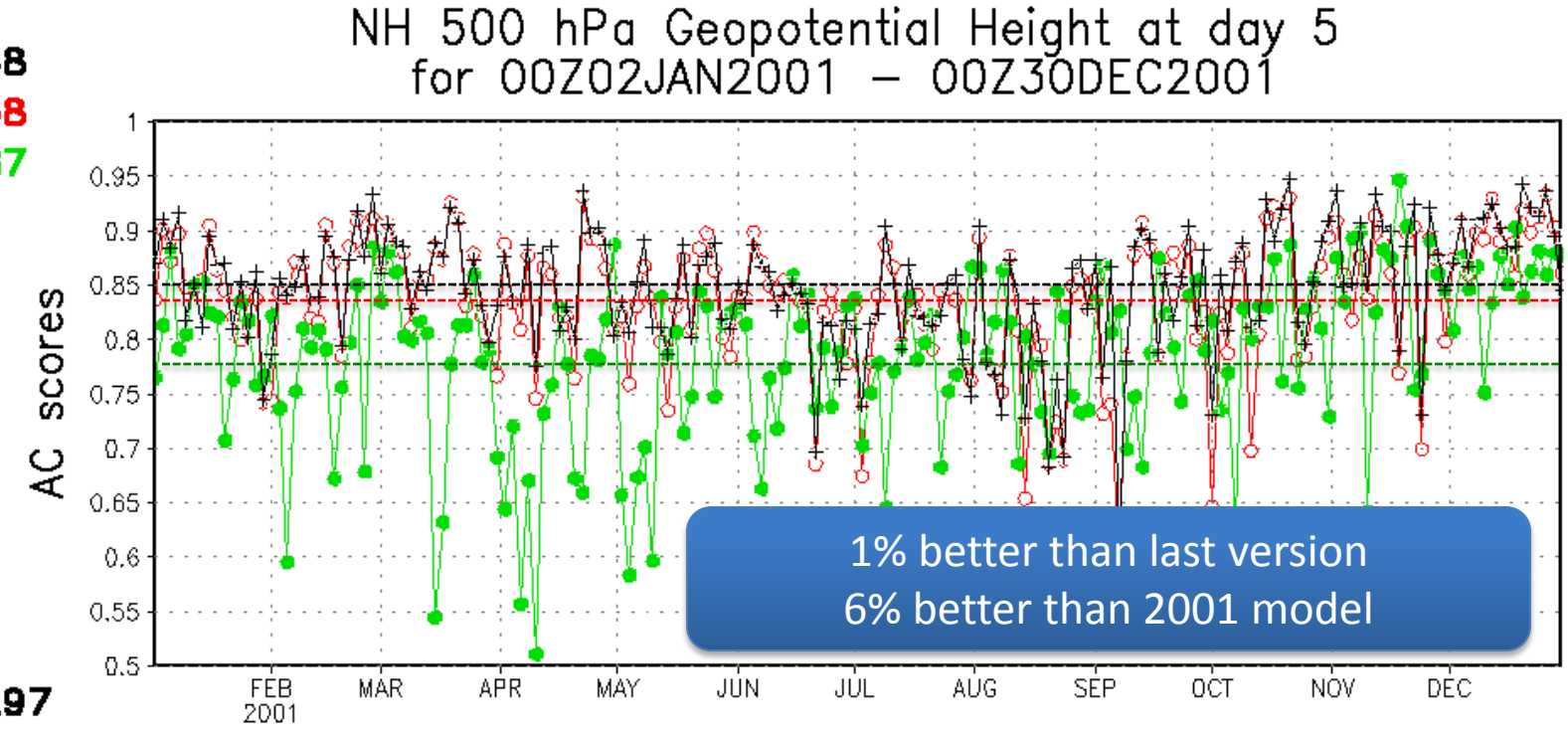
Statistical period: 01/01/2001 – 12/31/2001 (183 cases)

Ensemble control only
T_L574L64 (0-192h)
T_L382L64 (192-384h)

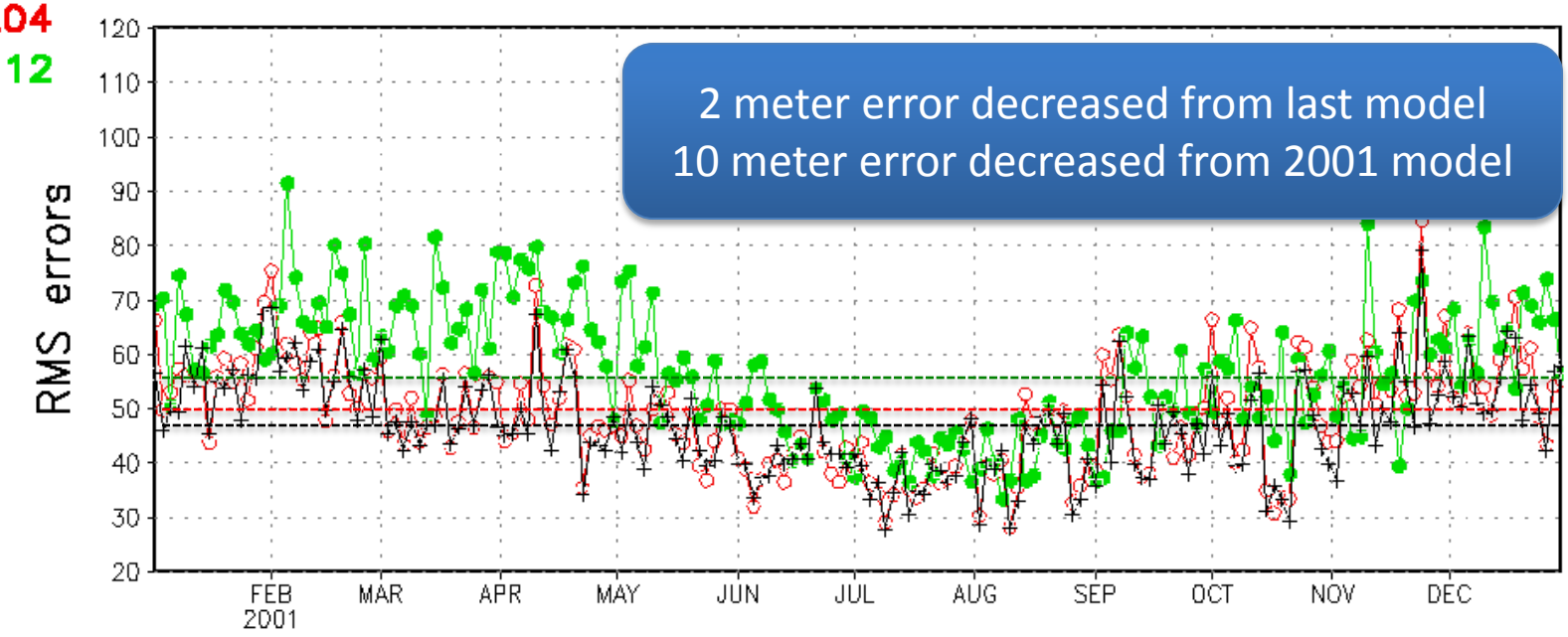




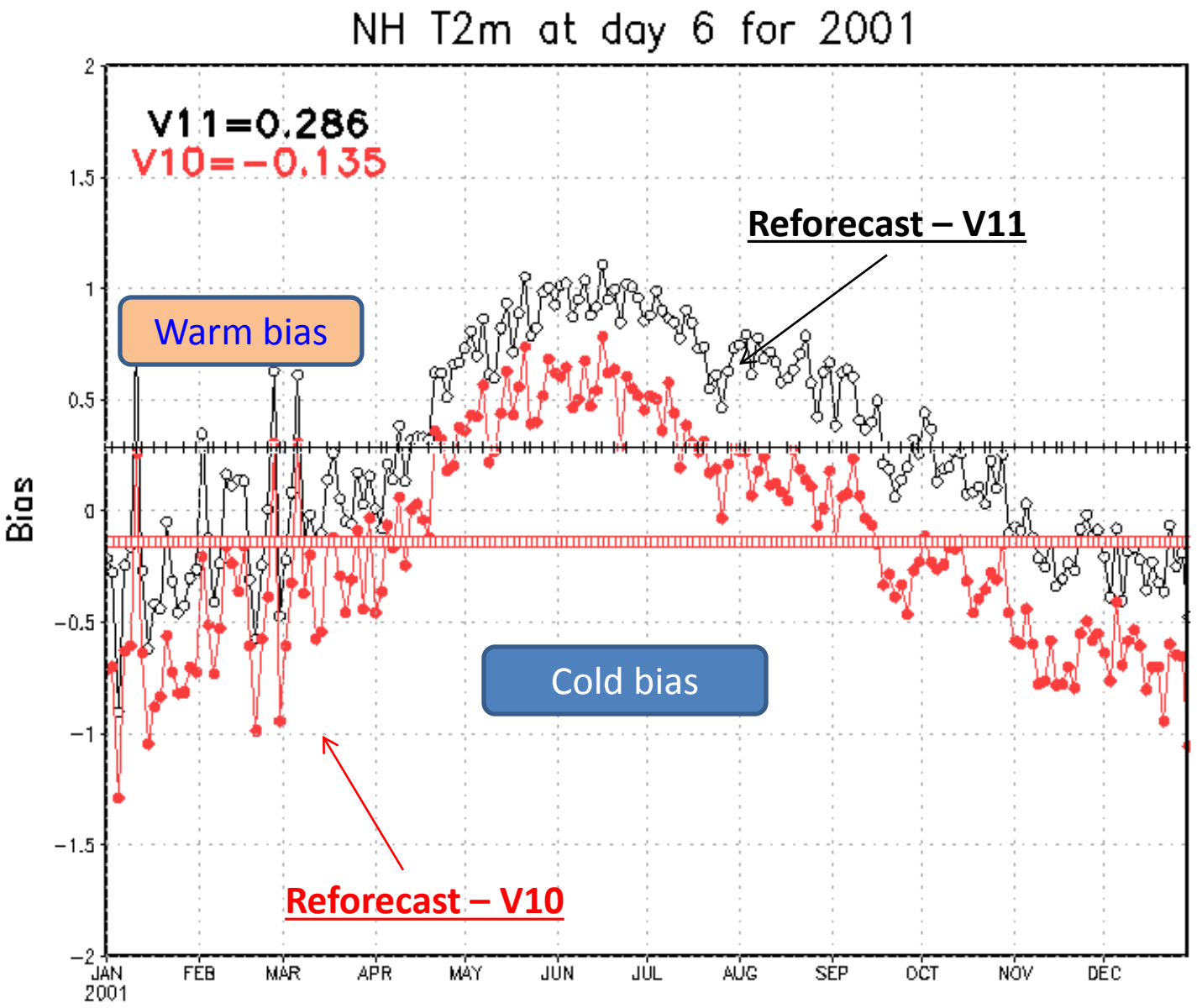
V11=0.848
V10=0.838
GFS=0.787



V11=47.297
V10=49.204
GFS=57.112



2-meter temp. bias of 2001 (fcst: 144 hours)



Where/when can you get data?

- For NCEP service centers
  - All retrospective forecasts have been saved on HPSS.
  - Selected variables for short period are on disk
- For general public users
  - Will publish part of retrospective forecast for public access (soon)
  - Selected variables (80 NAEFS exchange variables)
  - Period: 5/13/2013 – current: 00UTC forecast only
  - 1x1 degree and every 6 hrs, out to 16 days
  - 18year control only reforecast – possible to have limited variables for anonymous ftp access (request only)
- NCO will run real time parallel in March 2015
  - Real time data access through NCEP ftp
  - 0.5d and 3 hrly pgrb data for first 8 days will be available

NAEFS Global Grid Exchange Variables for 1.0d

Update: June 2013

Variables	Levels and Categories	Total 80
GHT	Surface, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11
TMP	2m, 2mMax, 2mMin, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	13
RH	2m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11
UGRD	10m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11
VGRD	10m, 10, 50, 100, 200, 250, 500, 700, 850, 925, 1000 hPa	11
PRES	Surface, PRMSL	2
PRCP	APCP, CRAIN, CSNOW, CFRZR, CICEP	5
FLUX (surface)	LHTFL, SHTFL, DSWRF, DLWRF, USWRF, ULWRF	6
FLUX (top)	ULWRF (OLR)	1
PWAT	Total precipitable water at atmospheric column	1
TCDC	Total cloud cover at atmospheric column	1
CAPE	Convective available potential energy, Convective Inhibition	2
SOIL/SNOW	SOILW(0-10cm) , TMP(0-10cm down), WEASD(water equiv. of accum. Snow depth), SNOD(surface)	4
Other	850 hPa vertical velocity	1
Notes	Current NAEFS grids at 1*1 degree	

For More Information ….

- GEFS configuration/verification website at EMC
  http://www.emc.ncep.noaa.gov/gmb/yzhu/html/imp/201412_imp.html
- GFS description website at EMC
  http://www.emc.ncep.noaa.gov/gcwmb/doc.php
- Contacts at EMC Ensemble Team
  - Yuejian.Zhu@noaa.gov
  - Dingchen.Hou@noaa.gov

Acknowledgements:

- EMC ensemble team members:
  - Dingchen Hou, Richard Wobus, Xiaqiong Zhou, Jiayi Peng, Hong Guan, Malaquias Pena, Yan Luo, Bo Cui, Water Kolczynski and Wei Li
- EMC GWCMB staffs:
  - Hui-ya Chuang, Dana Carlis, Fanglin Yang, Kate Howard, Diane Strokes, Mike Young, Shrinivas Moorthi, Suranjana Saha, Mark Iredell, John Derber.
- NCO staffs:
  - Luke Lin, Rebecca Cosgrove, Simon Hsiao, Steven Earle

Background !!!

Evolution of NCEP GEFS configuration (versions)

Version	Implementation	Initial uncertainty	TS relocation	Model uncertainty	Resolution	Forecast length	Ensemble members	Daily frequency
V1.0	1992.12	BV	None	None	T62L18	12	2	00UTC
V2.0	1994.3				T62L18	16	10(00UTC) 4(12UTC)	00,12UTC
V3.0	2000.6				T126L28(0-2.5) T62L28(2.5-16)		10	
V4.0	2001.1				T126(0-3.5) T62L28(3.5-16)			
V5.0	2004.3				T126L28(0-7.5) T62L28(7.5-16)			00,06,12, 18UTC
V6.0	2005.8		TSR		T126L28			
V7.0	2006.5	BV- ETR					14	
V8.0	2007.3						20	
V9.0	2010.2			STTP	T190L28			
V10.0	2012.2				T254L42 (0-8) T190L42 (8-16)			
V11.0	2015.04	EnKF (f06)			T_L574L64 (0-8) T_L382L64 (8-16)			

GEFS (V11.0.0) Upgrade (Q3FY15)

Project Status as of 11/30/2014

G Project Information and Highlights

Lead: Yuejian Zhu, EMC, Becky Cosgrove, NCO

Scope:

- Latest GFS model (SLG version with improved physics).
- Configurations: T574L64 and T382L64 out to 384 hours
  - 0-192hr - T574 (T382 for physics – 33-35km
  - 192-384hr – T382 (T254 for physics) – 51-54km
  - L64 – the same vertical resolution as EnKF, GFS
- Initial perturbations
  - EnkF 6h forecast with improved TS relocation and centralization
- Stochastic physics
  - Tuning parameters for STTP to upgrade GFS model
  - Turn off stochastic perturbation of log surface pressure
- Forecast data output
  - All GRIB II format
  - 0.5degree data for pgb files
  - 3 hourly output frequency (out to 192 hours)

Expected Benefits:

- Improve TS track forecast
- Increase probabilistic forecast skill
- Improve predictability of HIW and extreme weather event

G Scheduling

Milestone (NCEP)	Date	Status
EMC testing complete/ EMC CCB approval	2/10/2015	
Initial Code Delivery to NCO	2/10/2015	
Technical Information Notice Issued	2/15/2015	
Initial Test Complete		
CCB approve parallel data feed		
IT testing begins		
IT testing ends		
Parallel testing begun in NCO (Code Frozen)	03/01/2015	
Real-Time Evaluation Ends	04/01/2015	
Management Briefing		
Implementation		

G Issues/Risks

Issues: N/A

Risks:

Mitigation:

Current: ~100 nodes – 60 minutes
Future ~300 nodes – 60 minutes

G Finances

Associated Costs:

Funding Sources: EMC Base: NCO Base:

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

Legacy GEFS (00UTC only) (Q2FY15)

Project Status as of 09/09/2014

G Project Information and Highlights

Lead: Yuejian Zhu, EMC, Chris Magee, NCO

Scope:

- Continue to run current GEFS (00UTC only – once per day)
- Configurations: T254L42 and T190L42 out to 384 hours
  - 0-192hr – T254 – 33-35km
  - 192-384hr – T190 – 51-54km
  - L42 – for all lead times
- Initial perturbations
  - BV-ETR cycling (every 6-hr) with TS relocation
- Stochastic physics
  - Stochastic Total Tendency Perturbation (STTP)
- Forecast data delivery
  - All GRIB II format and raw data only
  - Data will not be for public access
  - Expect time to finish < +8hrs (?)
- Scripts/codes structures
  - Will keep current operational structure (not vertical)

Expected Benefits:

- Downstream applications
- OHD (RFCs) and CPC

G Scheduling

Milestone (NCEP)	Date	Status
EMC testing complete/ EMC CCB approval	02/10/2015	
Initial Code Delivery to NCO	02/10/2015	
Technical Information Notice Issued	02/15/2015	
Initial Test Complete		
CCB approve parallel data feed		
IT testing begins		
IT testing ends		
Parallel testing begun in NCO (Code Frozen)	03/01/2015	
Real-Time Evaluation Ends	04/01/2015	
Management Briefing		
Implementation		

G Issues/Risks

Issues: N/A

Risks:

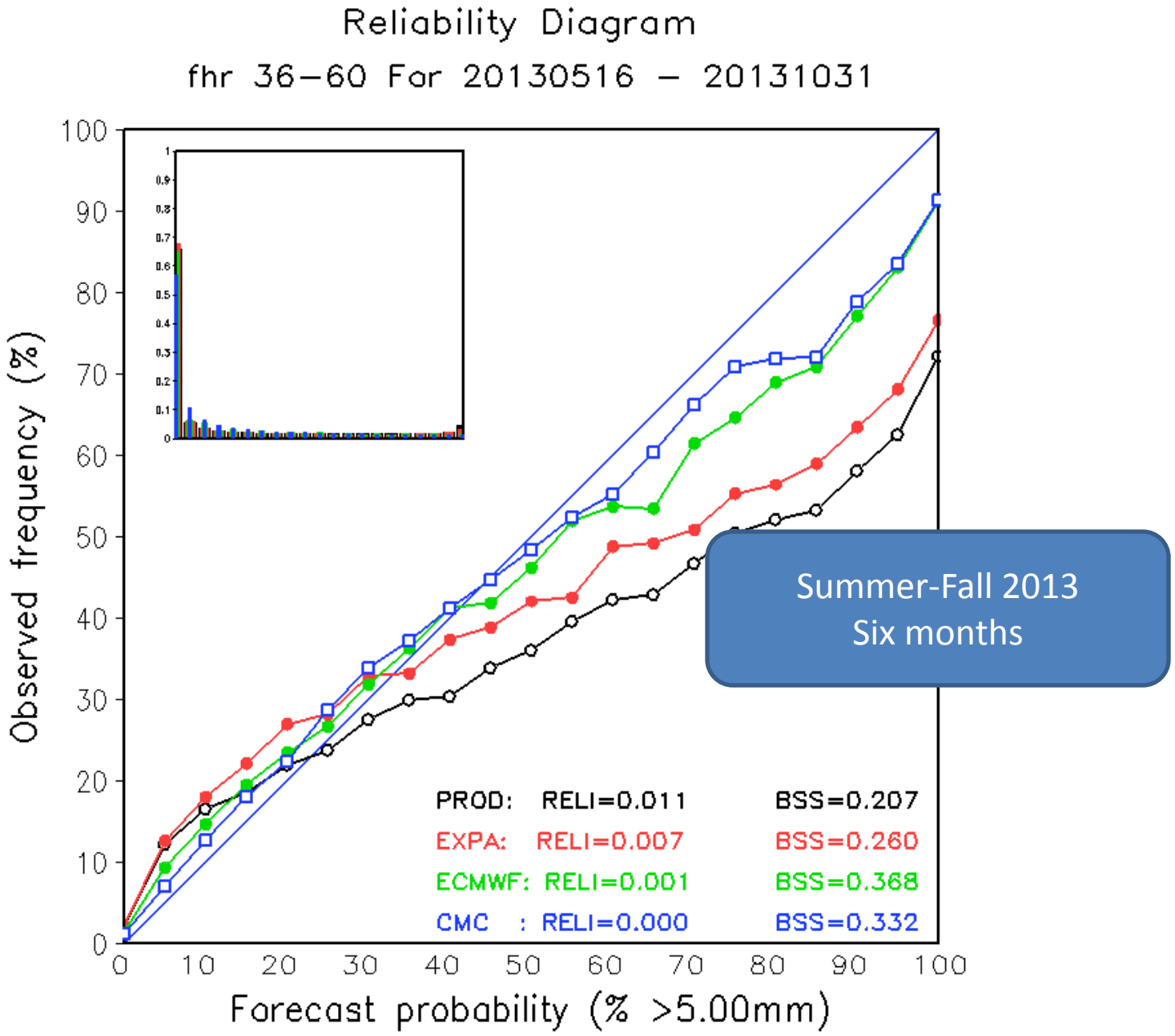
Mitigation:

G Finances

Associated Costs:

Funding Sources: EMC Base: NCO Base:

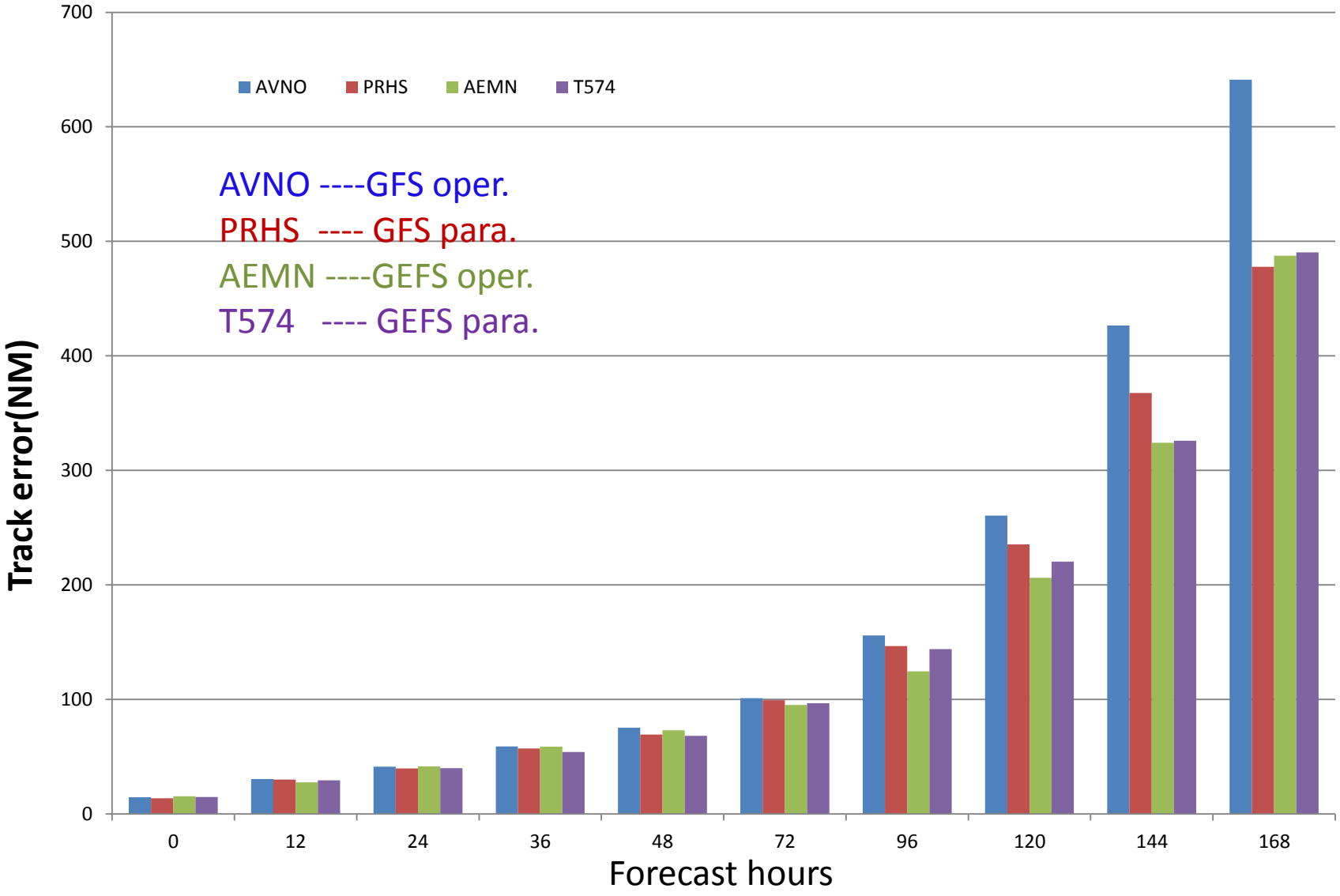
R	Management Attention Required	Y	Potential Management Attention Needed	G	On Target



Summer-Fall 2013
Six months

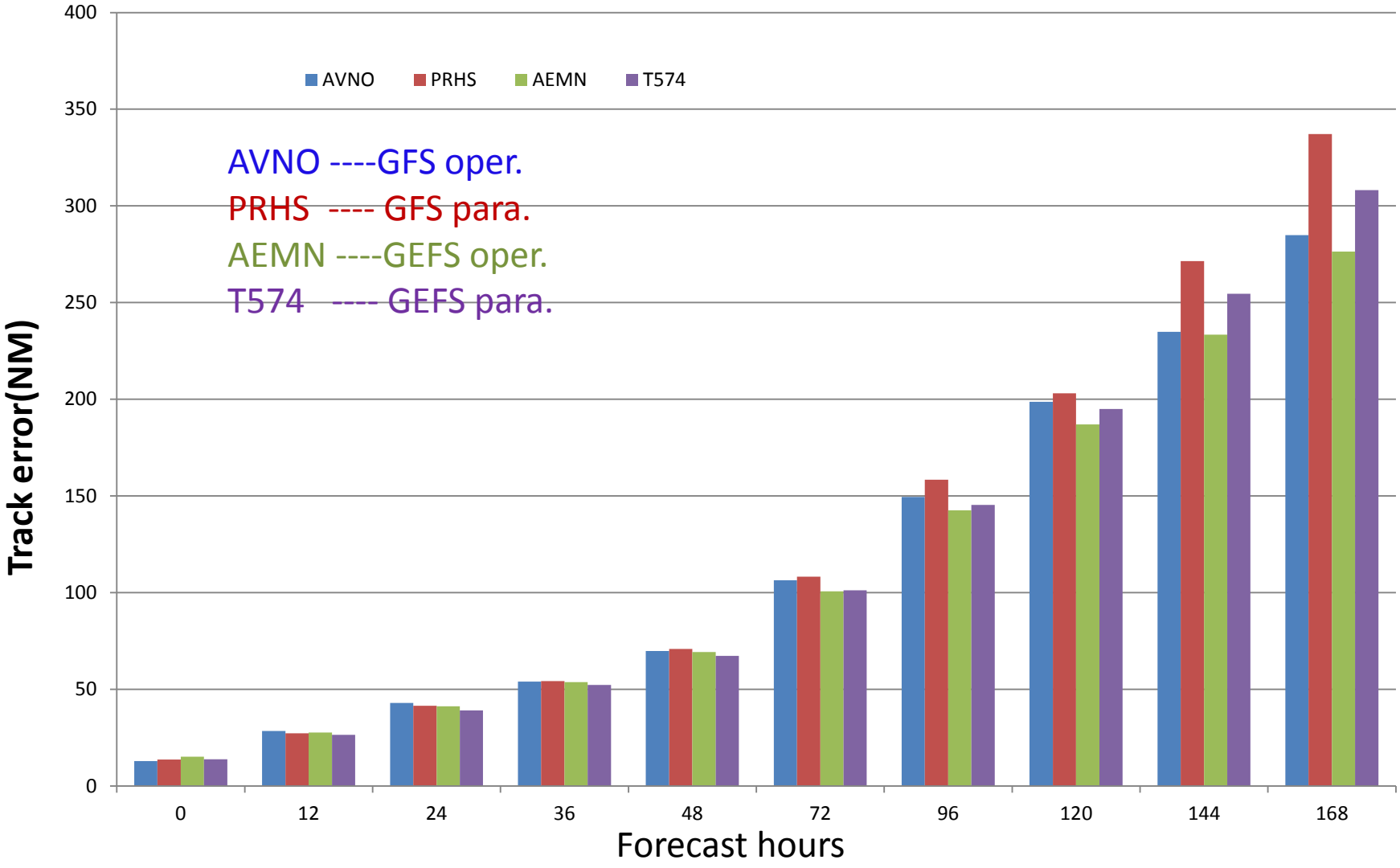
Precipitation reliability for 36-60hr and greater than 5mm/day

Atlantic TC, 2012-13-14



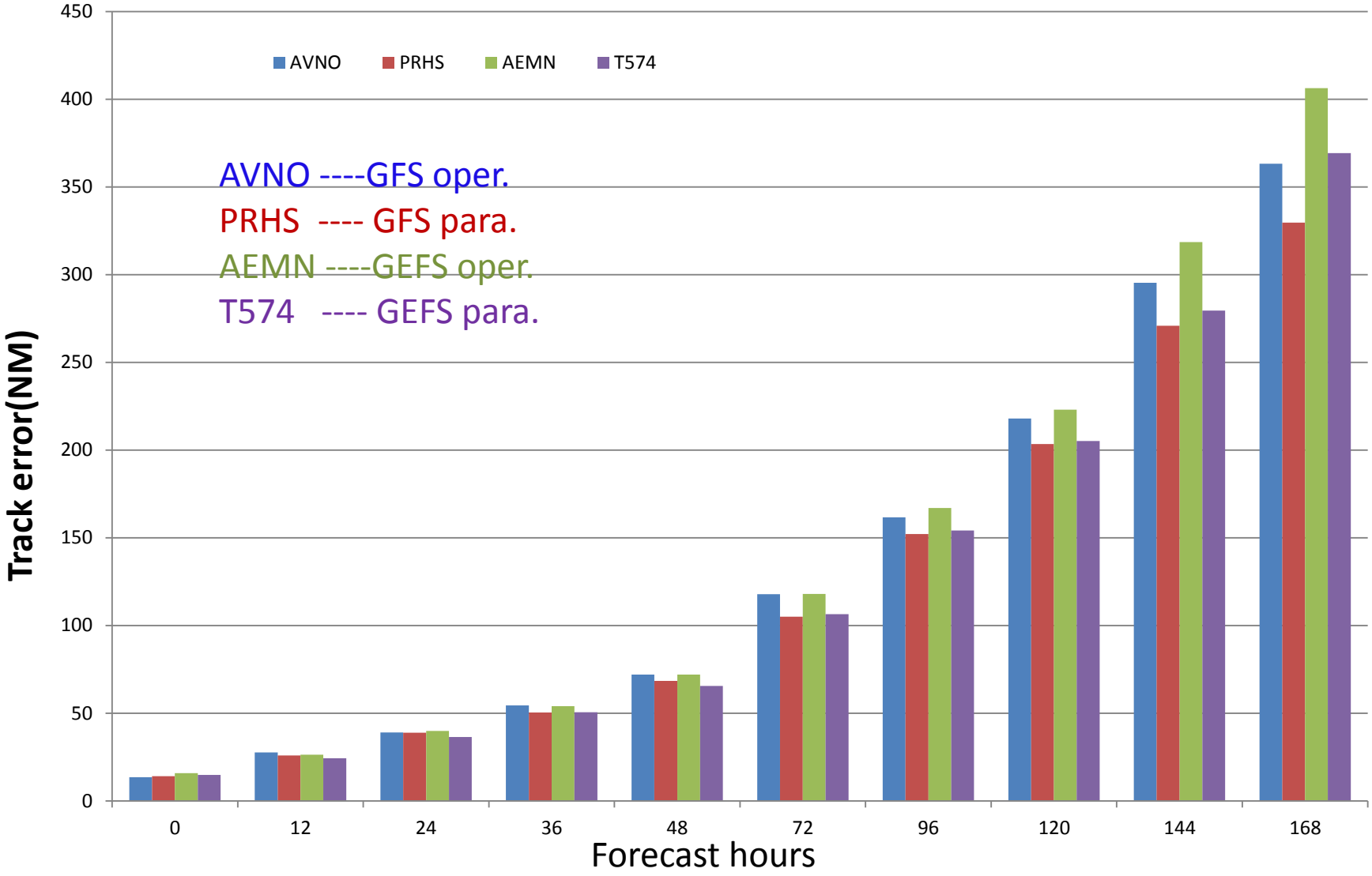
CASES	187	173	159	145	121	89	56	40	26	16

East Pacific TC, 2012-13-14



CASES	290	278	259	238	217	176	138	100	64	40

West Pacific TC, 2012-13-14



CASES	325	308	285	260	230	173	122	81	52	31