EMC FY15 Upgrade Review

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GEFS Upgrade

Presented by:

Yuejian Zhu

Update: 2/11/2014

Next GEFS (V11.0.0) configuration

- Model
  - Current: GFS Euler model (V9.0.1)
  - Plan: GFS Semi-Lagrangian model (V10.0.0)
- Horizontal resolution
  - Current: T254 (~55km) for 0-192 hours, T190 (~73km) for 192-384 hours
  - Plan: T_L574 (~33km) for 0-192 hours, T_L382(~55km) for 192-384 hours
- Vertical resolution
  - Current: L42 hybrid levels
  - Plan: L64 hybrid levels to match with GFS and DA
- Computation cost:
  - Current: 84 nodes (+ post process) for 55 minutes
  - Plan: 300 nodes (first 35 minutes), 250 nodes (2nd 30 minutes)
- Output:
  - Current: every 6-hr for 1*1 degree pgrb files
  - Plan: every 3-hr for 0.5*0.5 degree pgrb files
- Schedule:
  - Feb. 2015 – deliver codes/scripts to NCO
  - Apr. 2015 – implementation (WCOSS-phase II)

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)			

Next GEFS Sciences

- Initial perturbations
  - Base: EnKF 6hr forecast
    - TS relocation
    - Centralization
- Stochastic perturbations
  - Tune STTP amplitude for model change and initial perturbation changes
  - Turn off stochastic perturbations for surface pressure in STTP
- Expectations
  - Improve hurricane track forecast
  - Improve probabilistic forecast guidance
  - Improve predictability of HIW and extreme weather event

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

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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

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Finances

Associated Costs:

Funding Sources: EMC Base: NCO Base:

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

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 plan for 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 see if we could publish these data: pgrba data at 1.0 degree, every 6 hours, out to 16 days.
- Computation resource
  - EMC uses both of the development resource of WCOSS and research resource of R&D (zeus).

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

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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

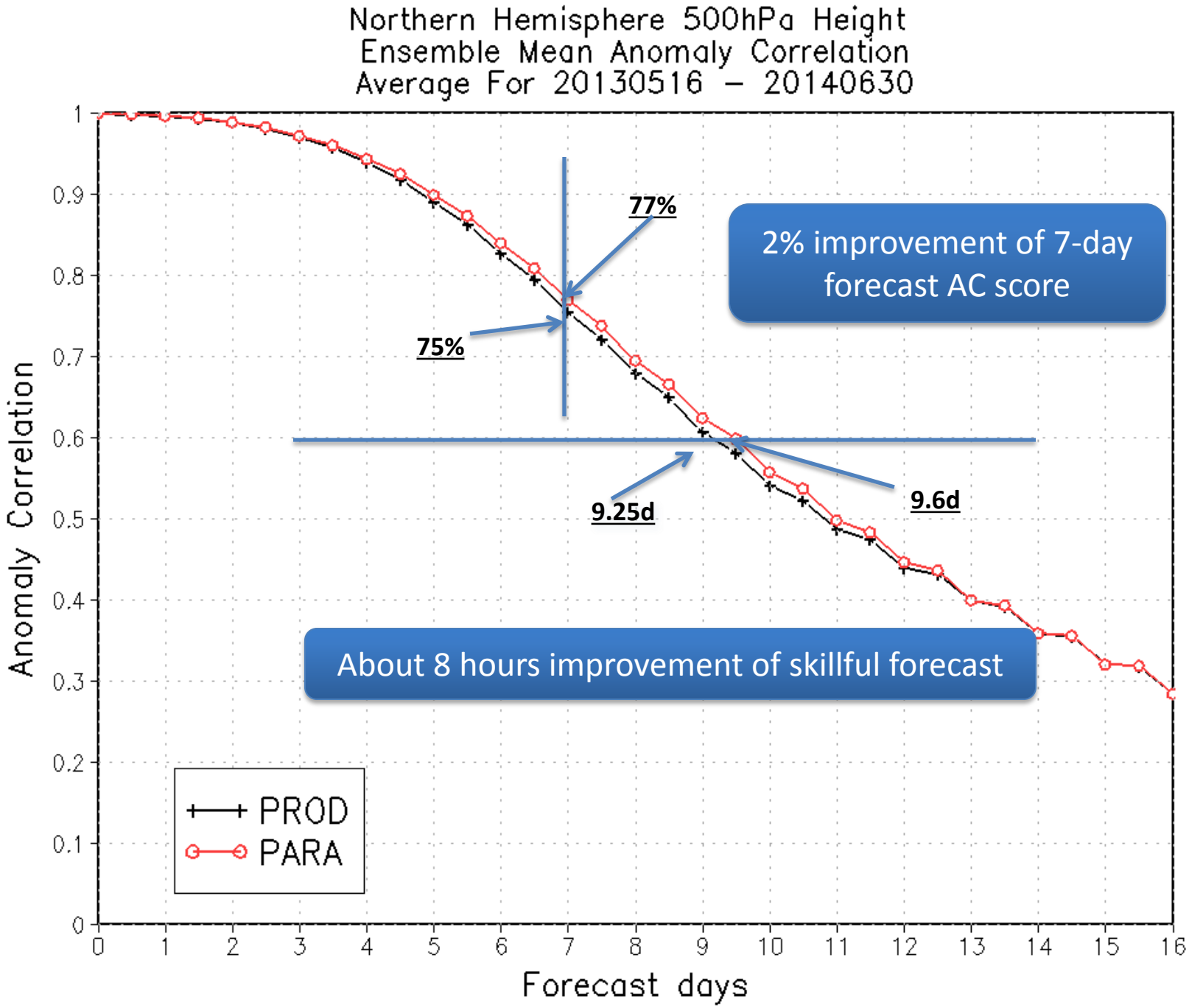
Associated Costs:

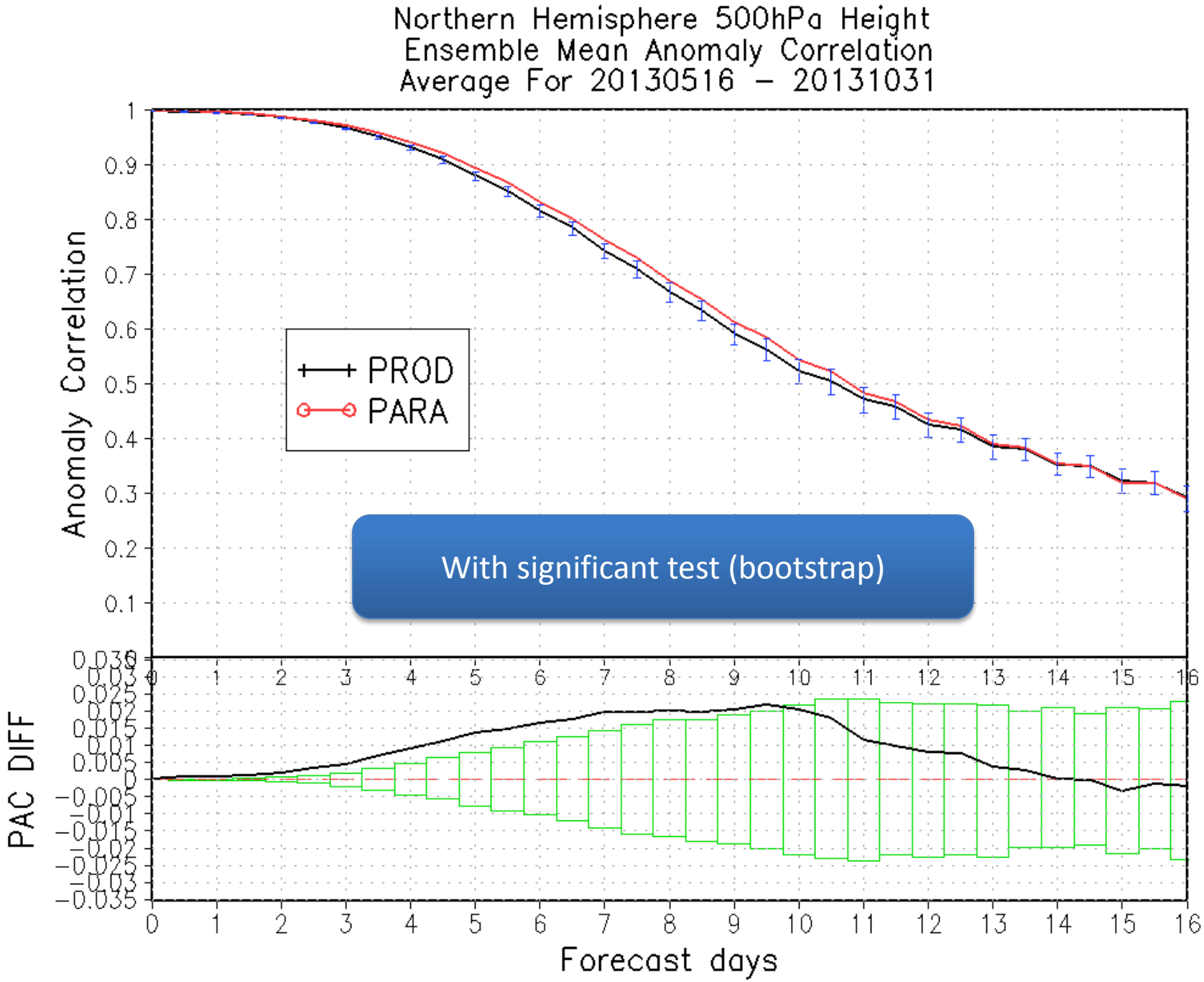
Funding Sources: EMC Base: NCO Base:

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

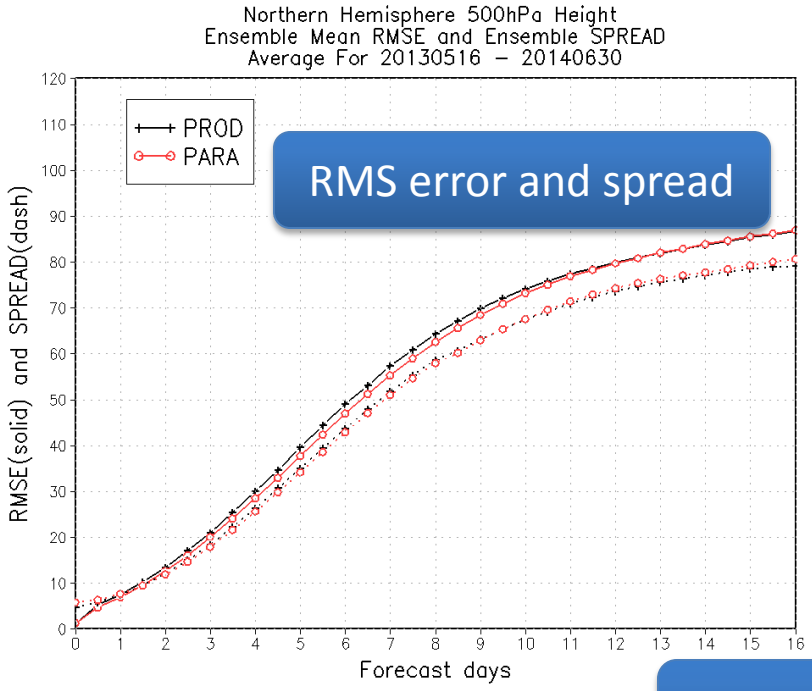
Evaluation for next GEFS

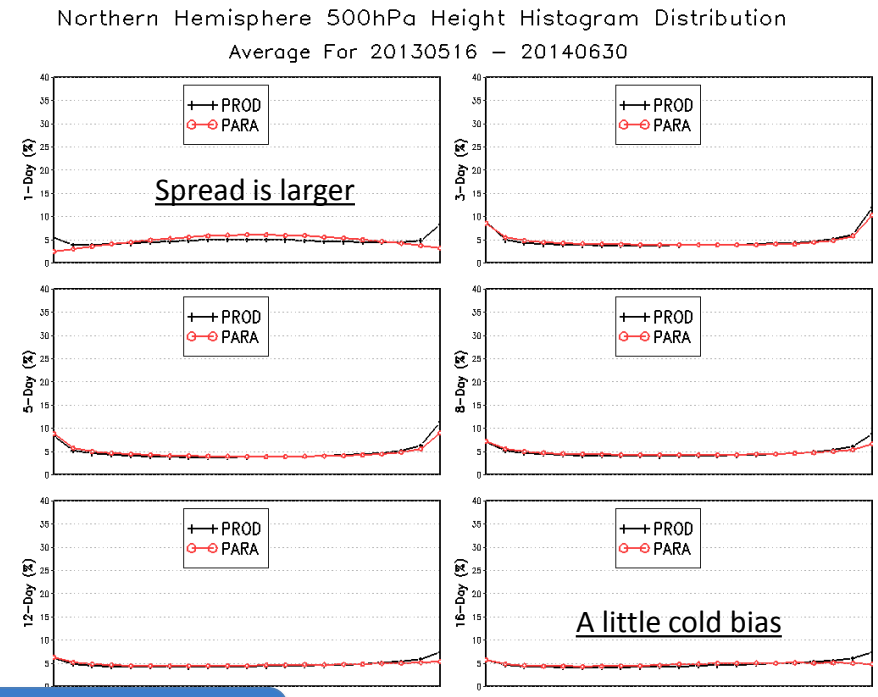
- Based on one-year (plus) retrospective runs
  - Upper atmosphere
  - Near surface
  - Precipitation
  - Hurricane track
- Based on 18 year ensemble control only reforecasts
  - Upper atmosphere
  - Near surface


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

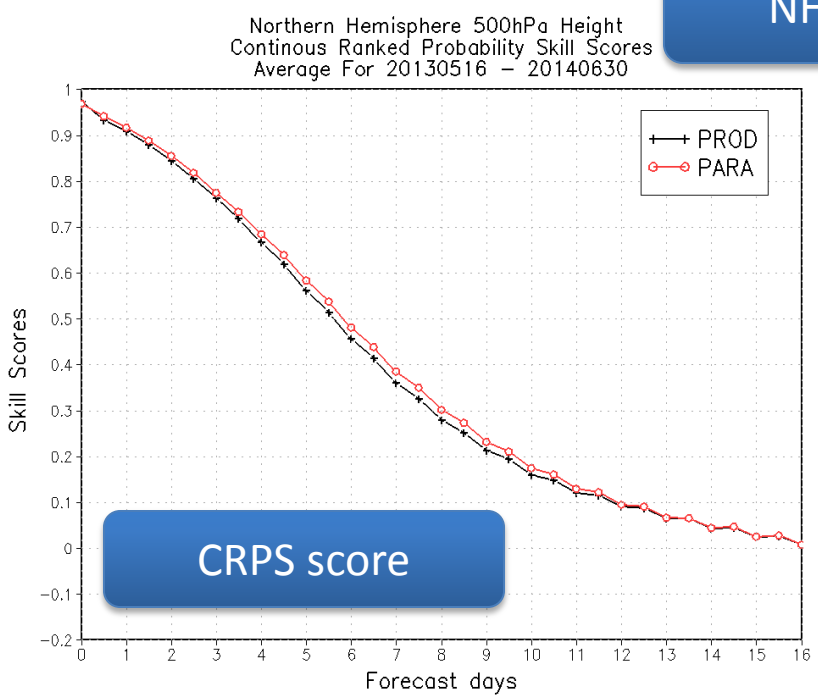


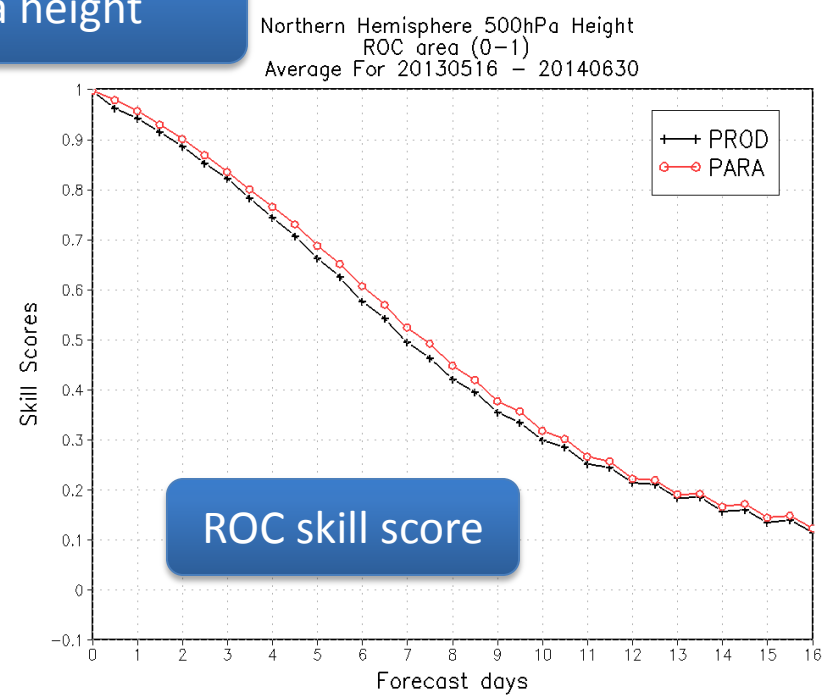
With significant test (bootstrap)

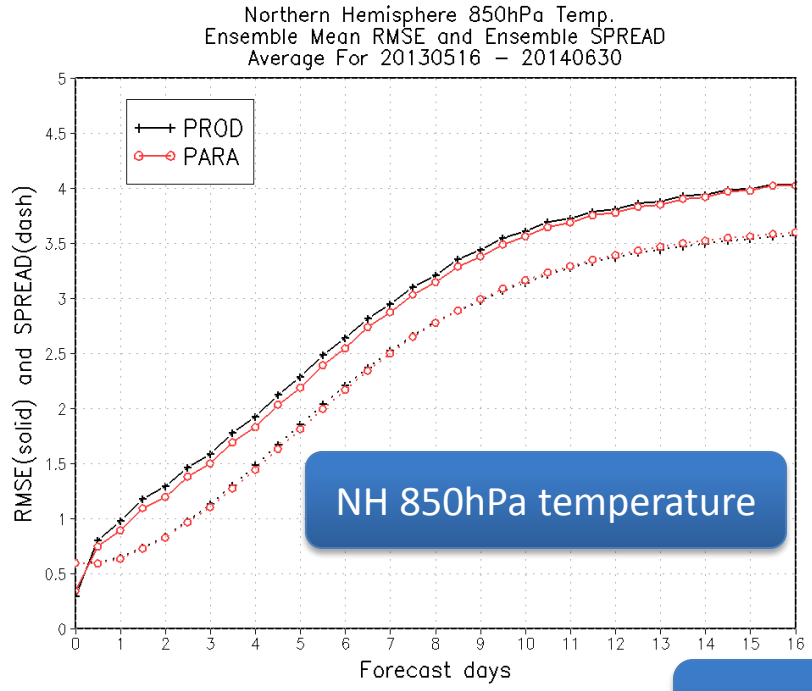


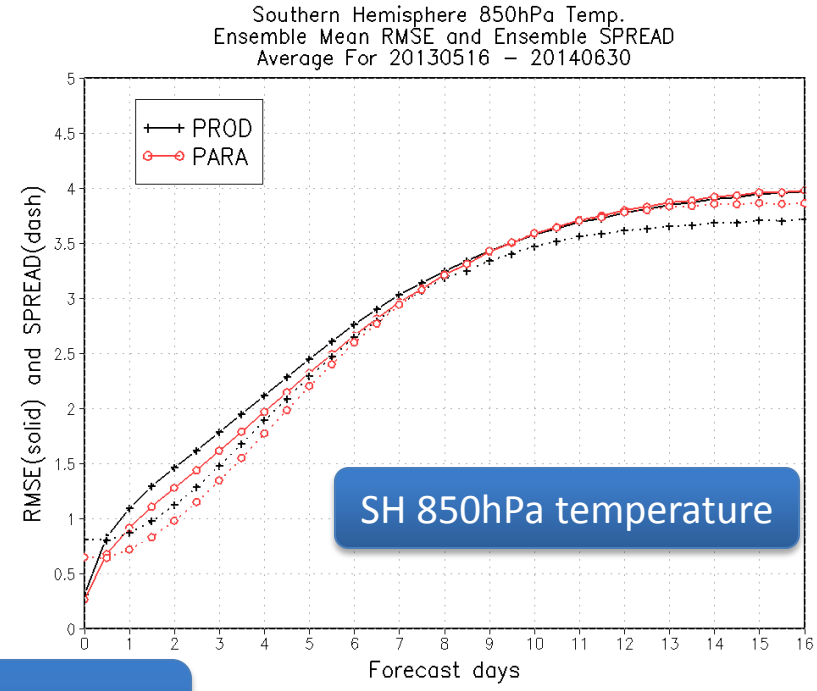


NH 500hPa height

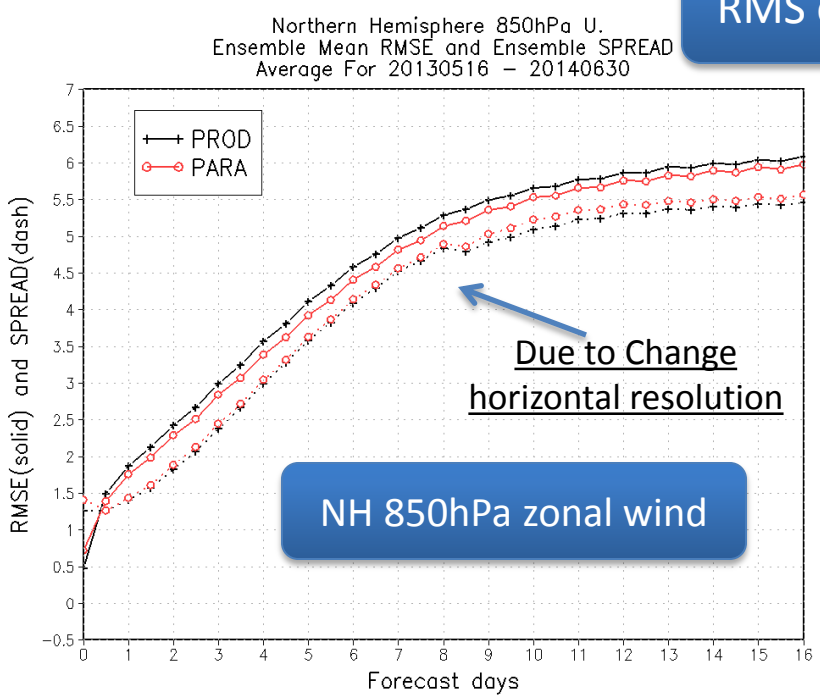


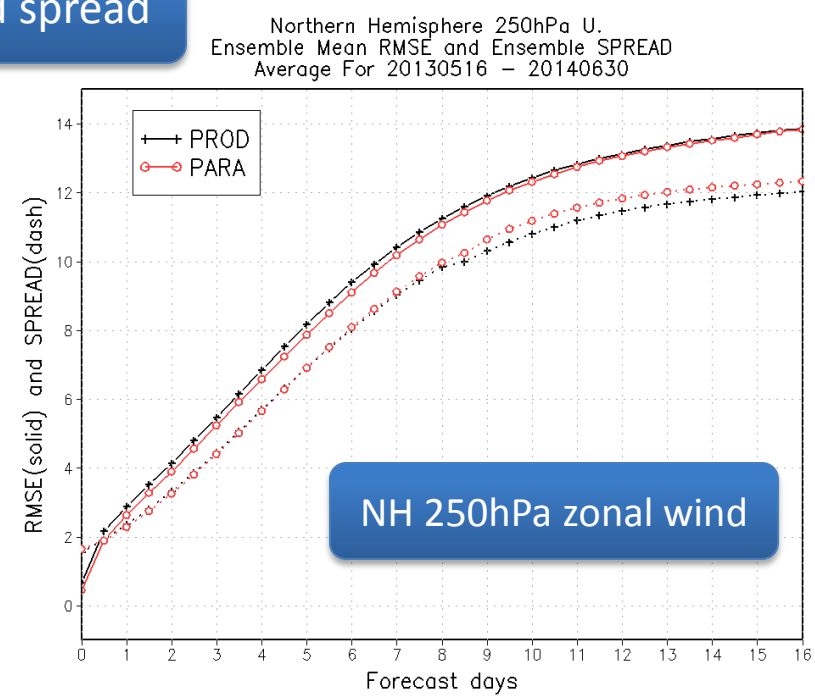


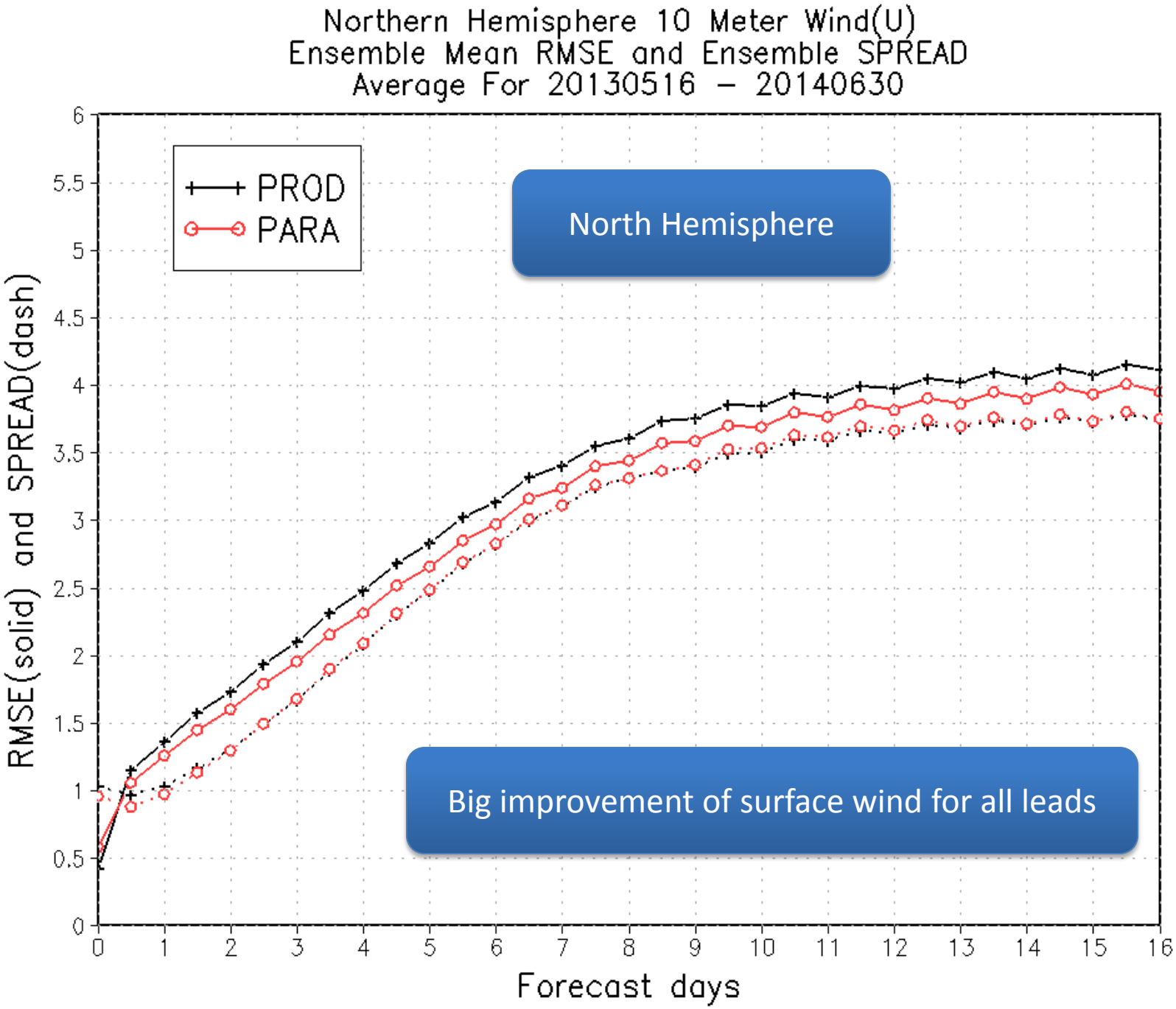


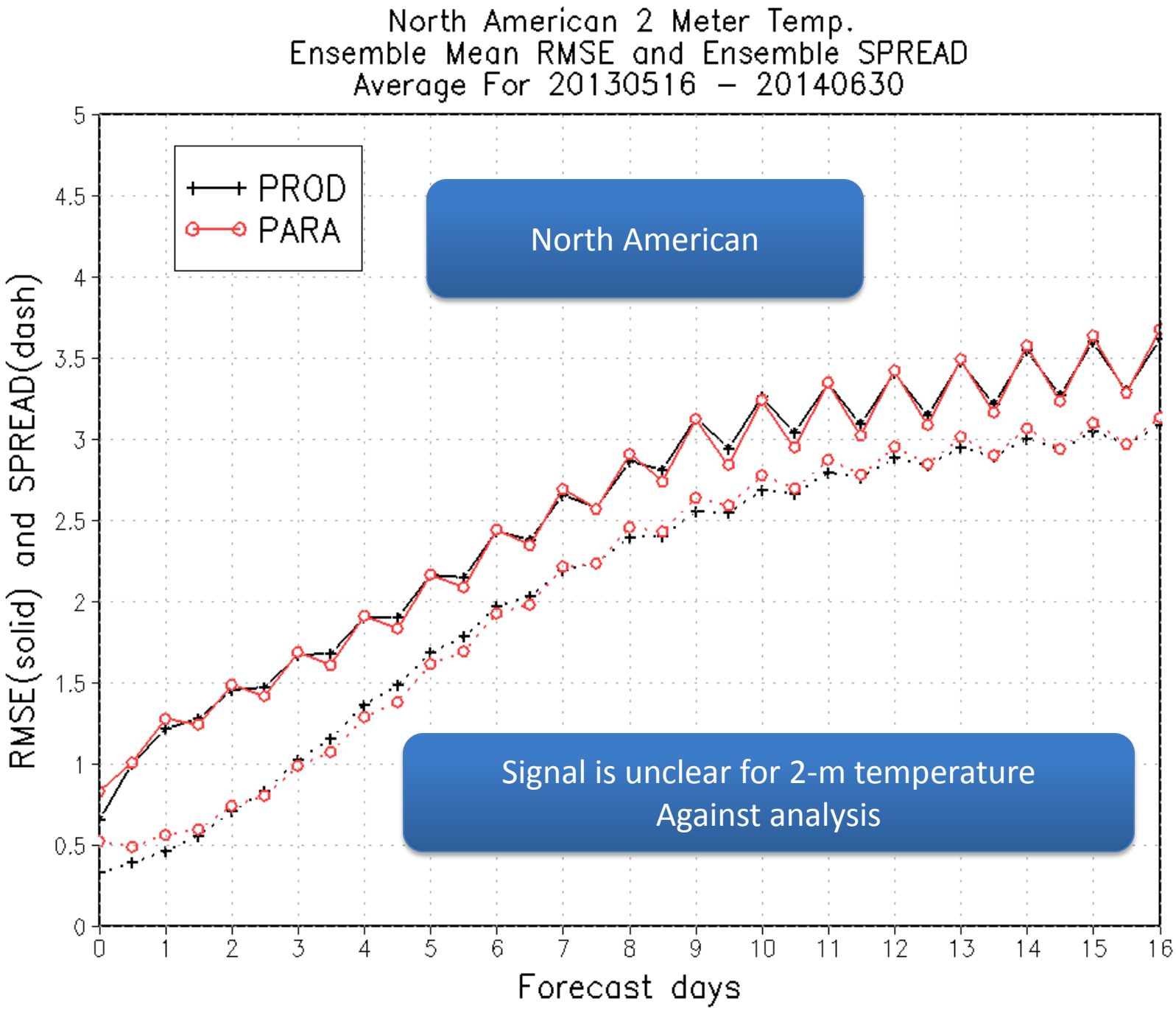


RMS error and spread






Northern Hemisphere 10 Meter Wind(U)
Ensemble Mean RMSE and Ensemble SPREAD
Average For 20130516 – 20140630
PROD
PARA
North Hemisphere
Big improvement of surface wind for all leads
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 American

Signal is unclear for 2-m temperature
Against analysis

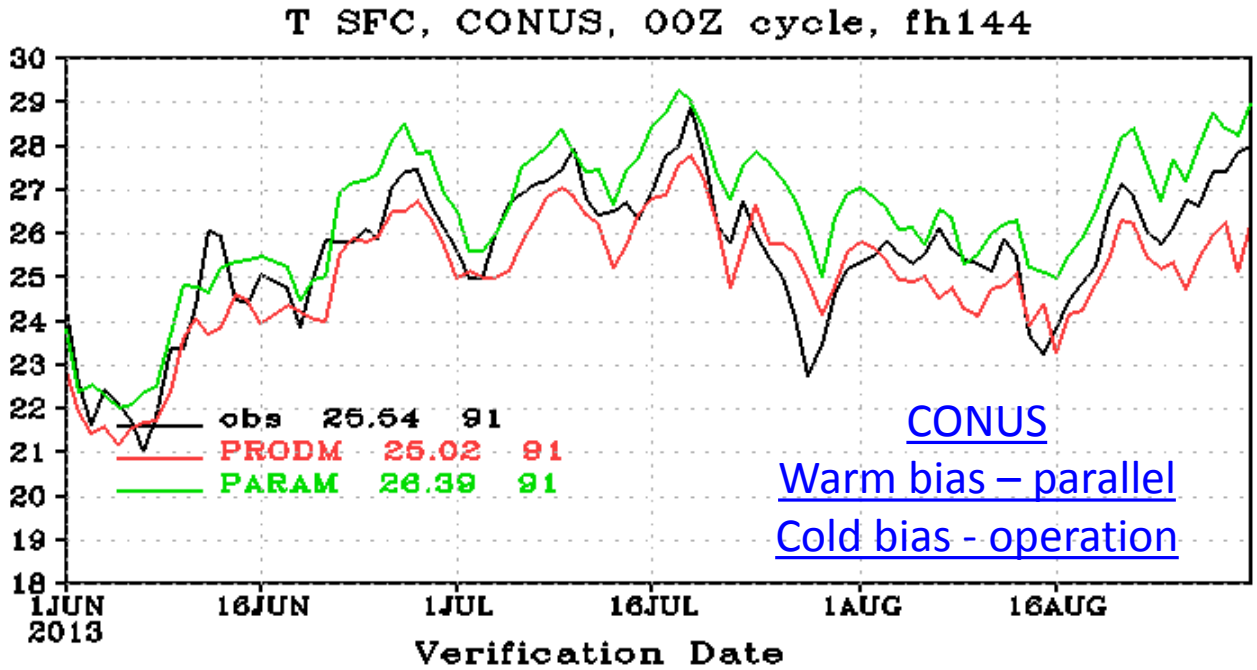
2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Summer 2013

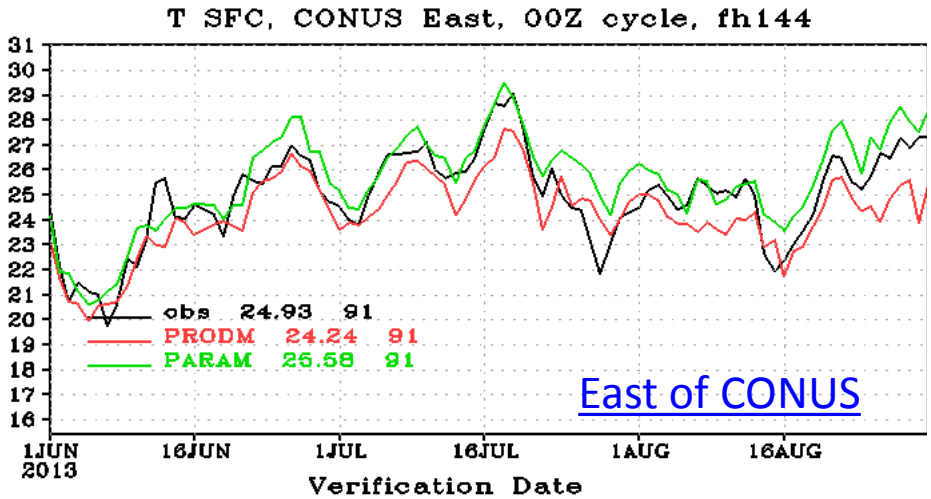
3 months



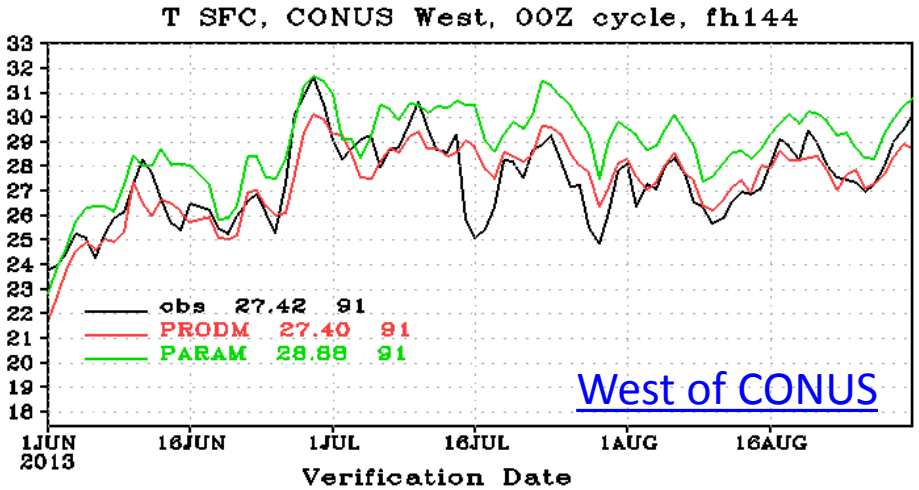
CONUS

Warm bias – parallel

Cold bias - operation



East of CONUS



West of CONUS

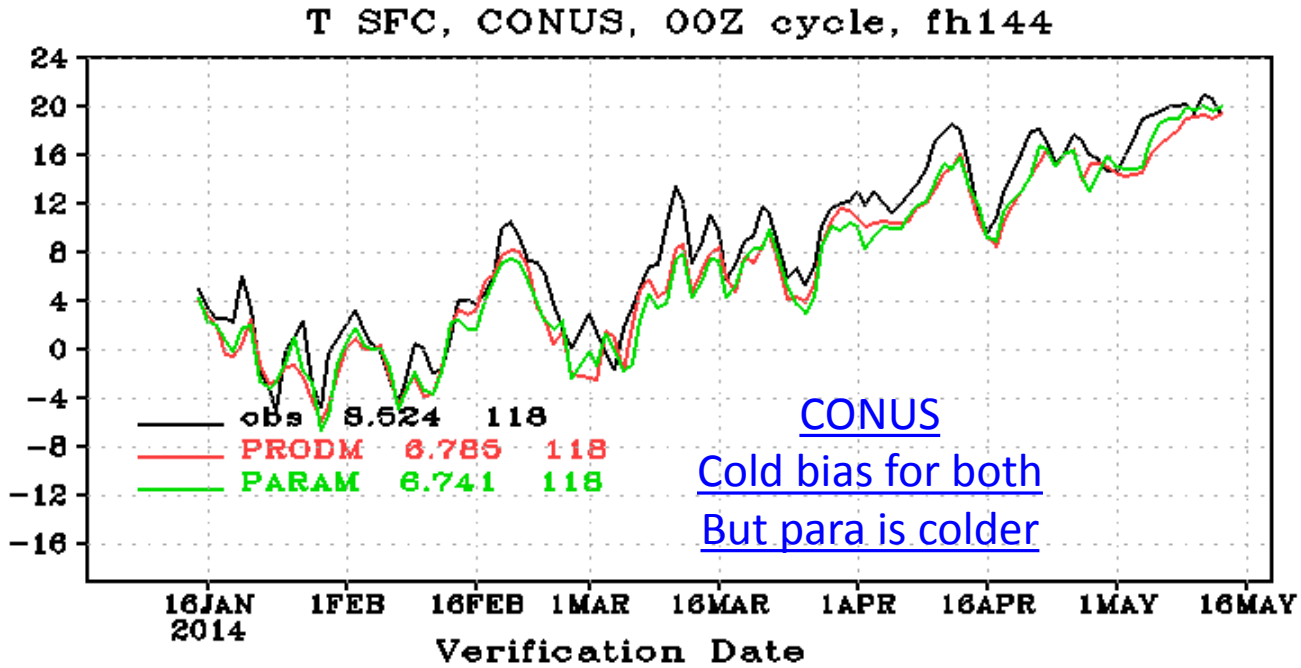
2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Winter-Spring 2014

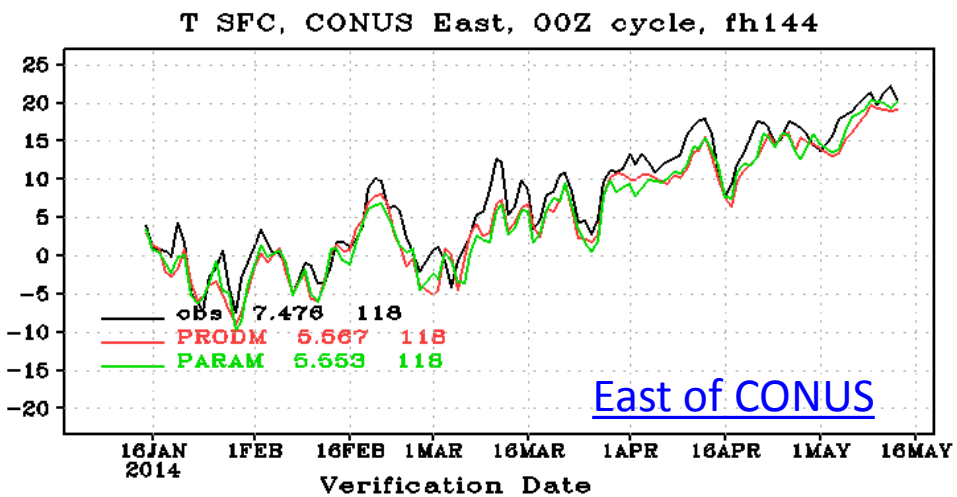
4 months



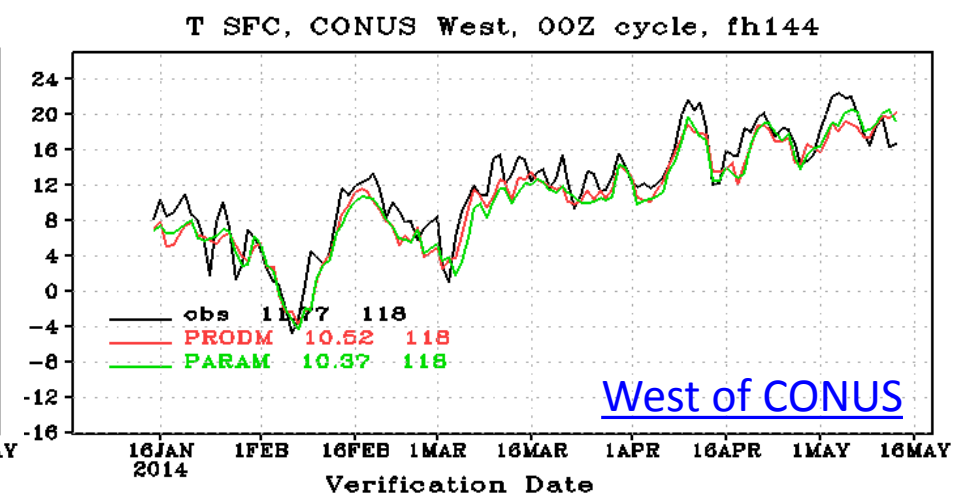
CONUS

Cold bias for both

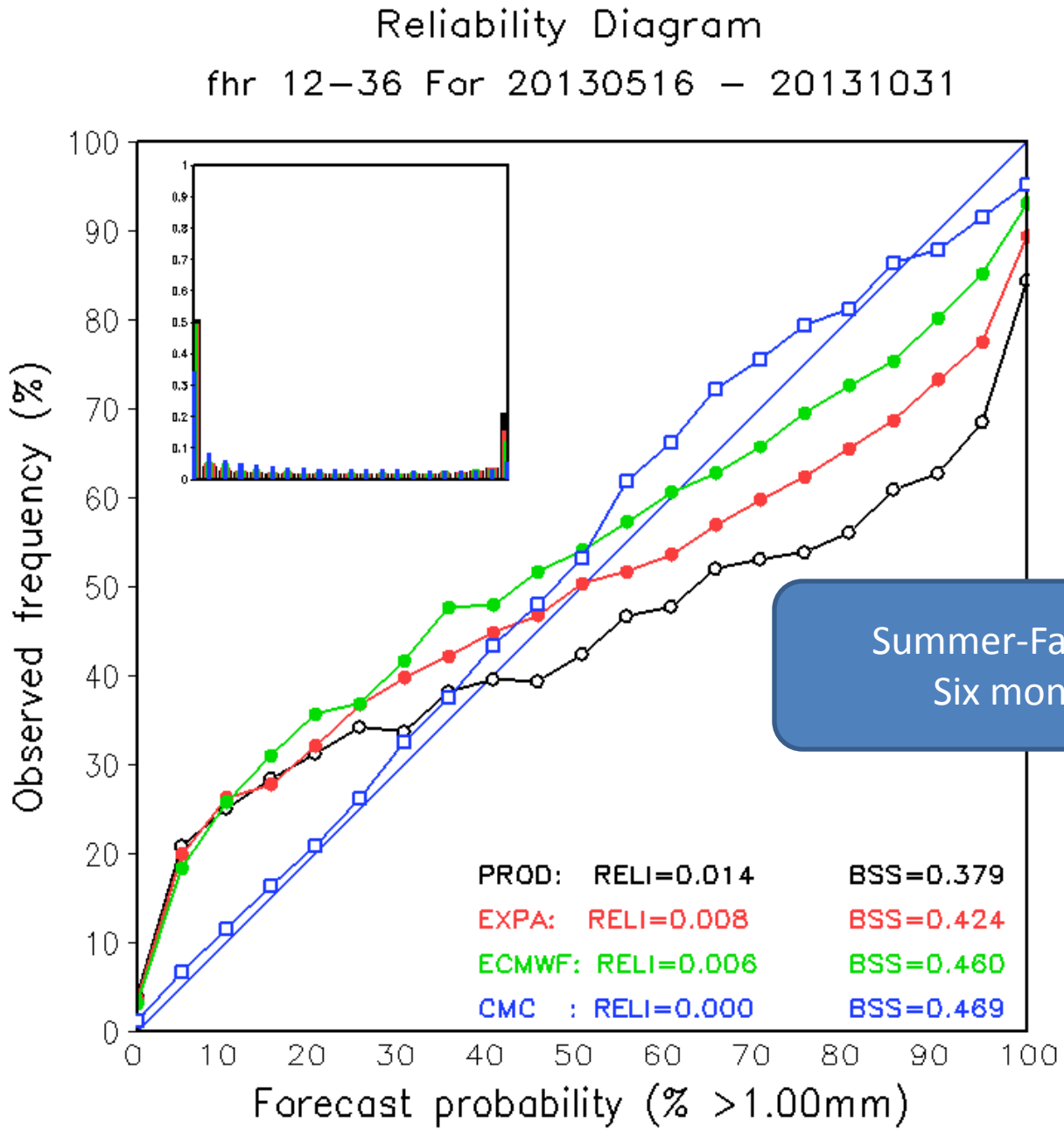
But para is colder



East of CONUS

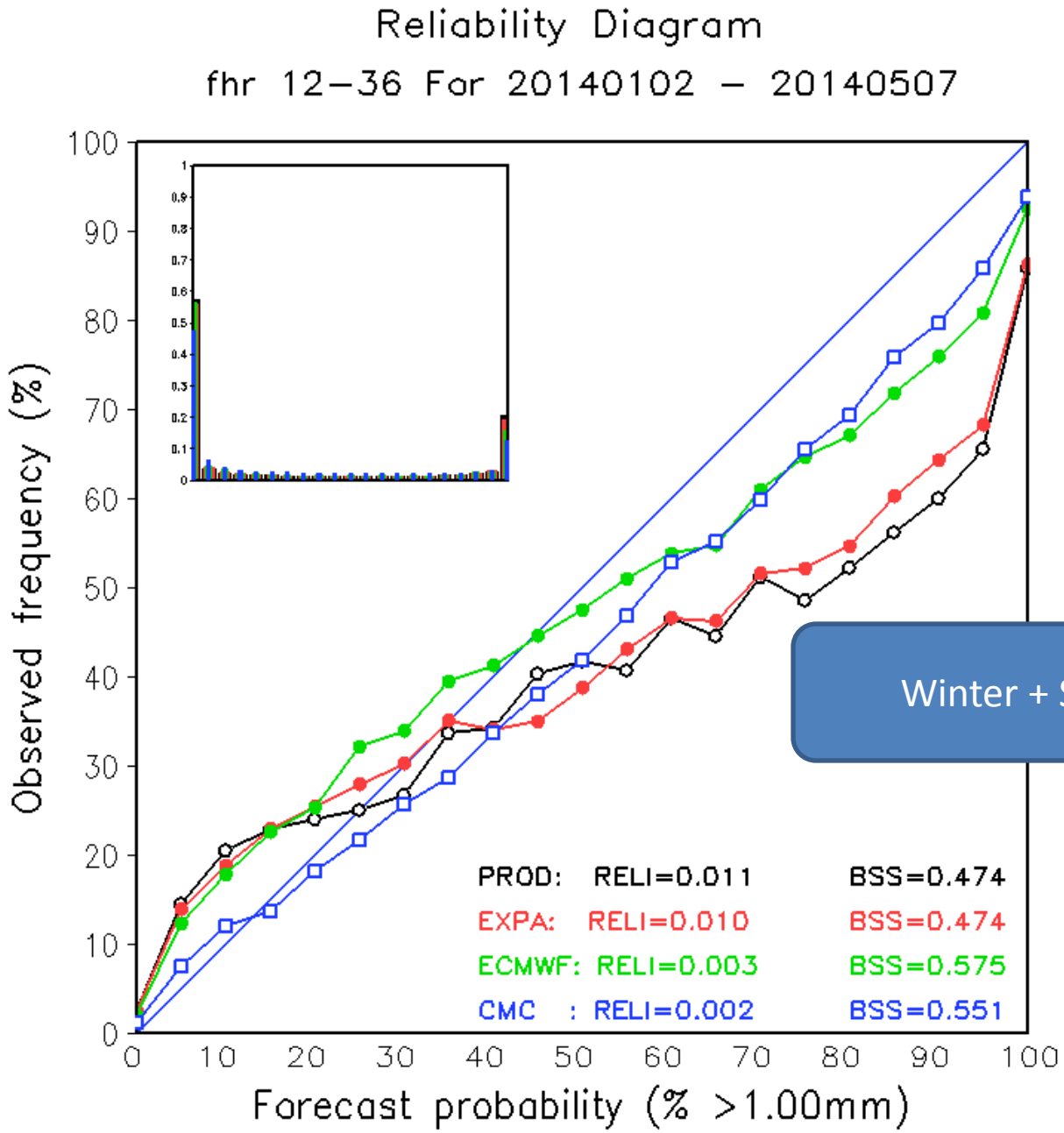


West of CONUS



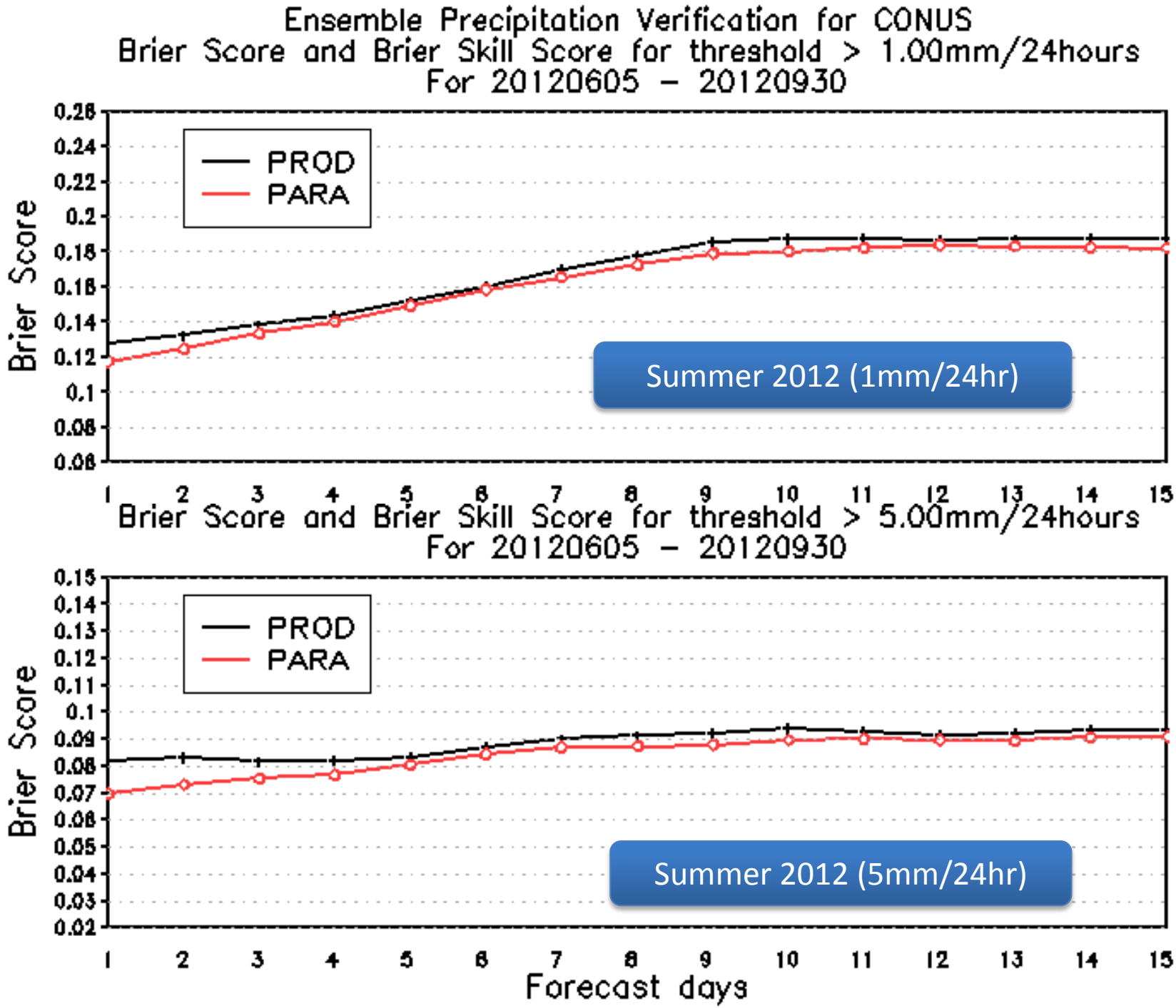
Summer-Fall 2013
Six months

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

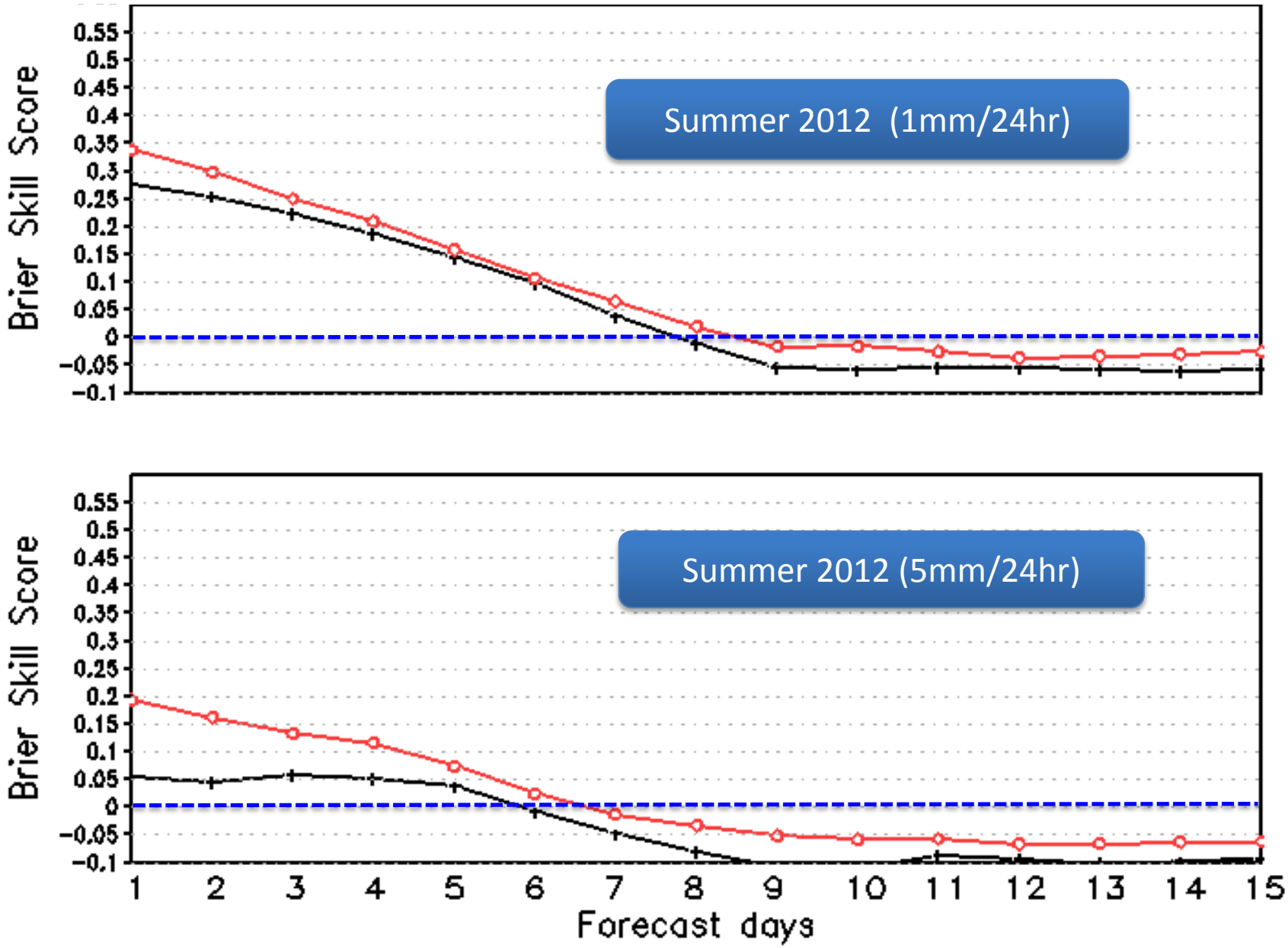


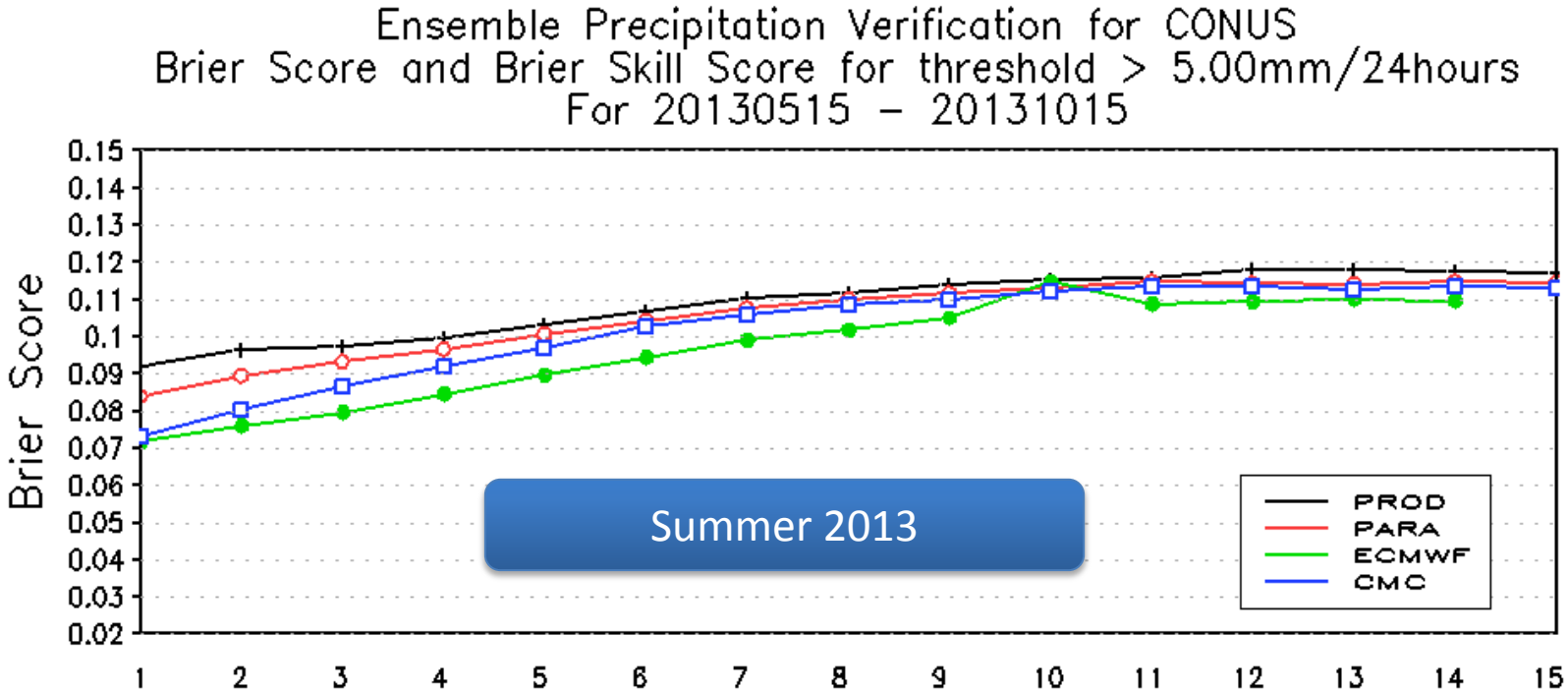
Winter + Spring 2014

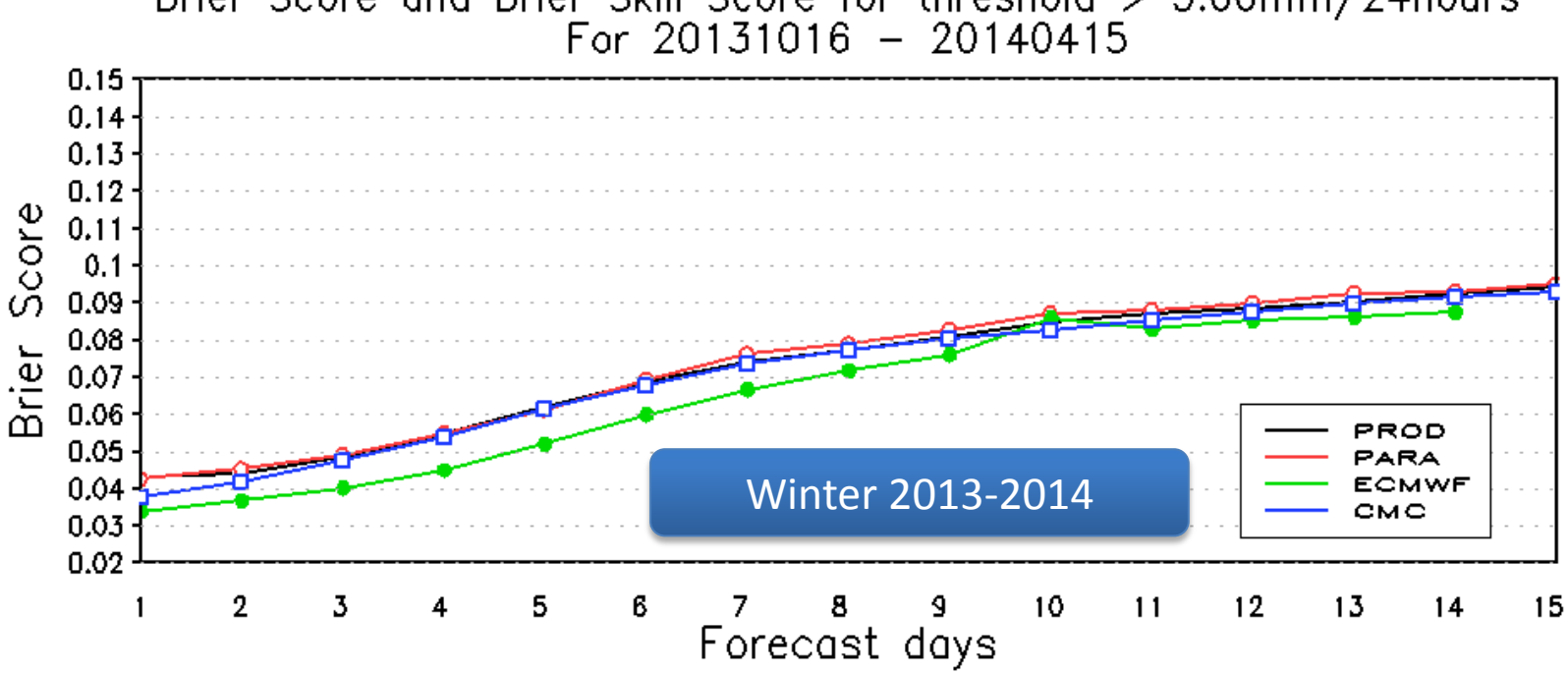
Precipitation reliability for 12-36hr and greater than 1mm/day

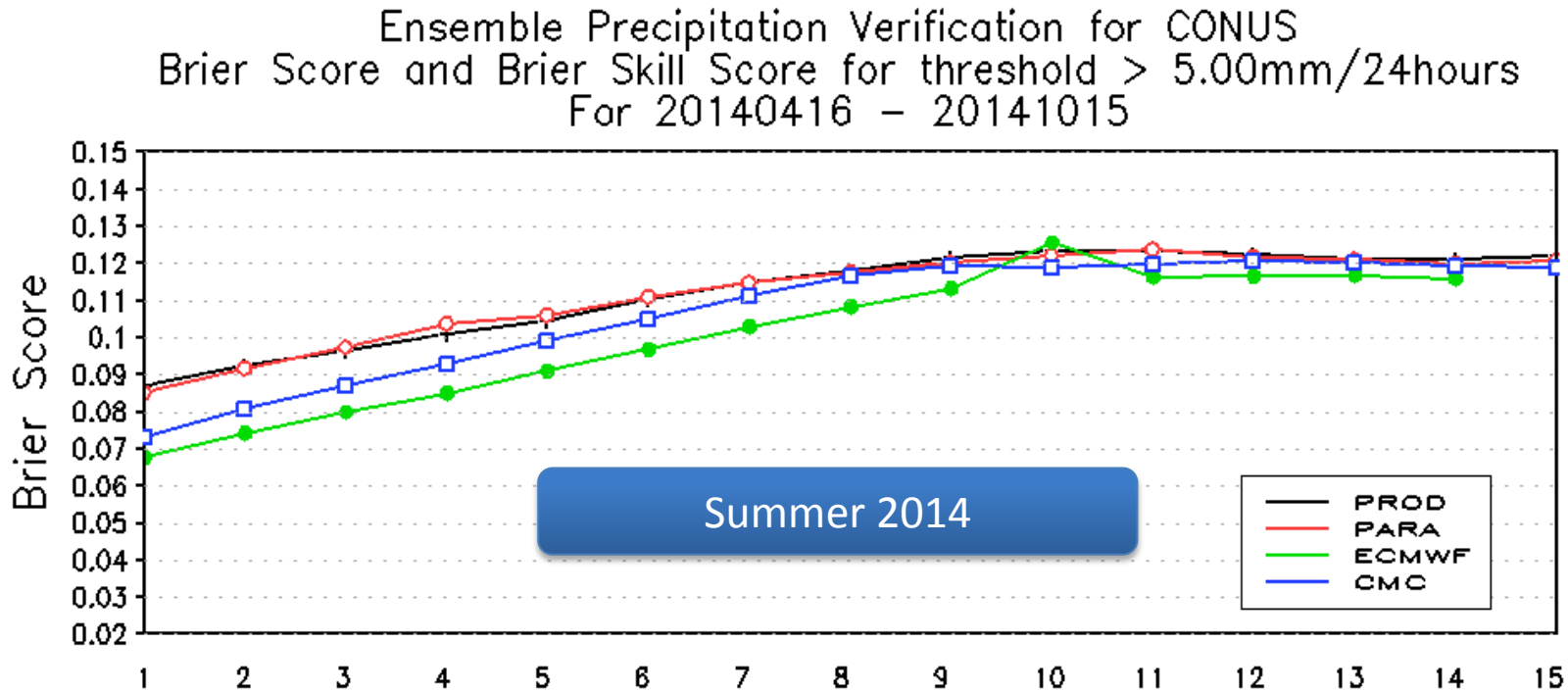

Ensemble Precipitation Verification for CONUS
Brier Score and Brier Skill Score for threshold > 1.00mm/24hours
For 20120605 - 20120930
Brier Score
PROD
PARA
Summer 2012 (1mm/24hr)
Brier Score and Brier Skill Score for threshold > 5.00mm/24hours
For 20120605 - 20120930
Brier Score
PROD
PARA
Summer 2012 (5mm/24hr)
Forecast days

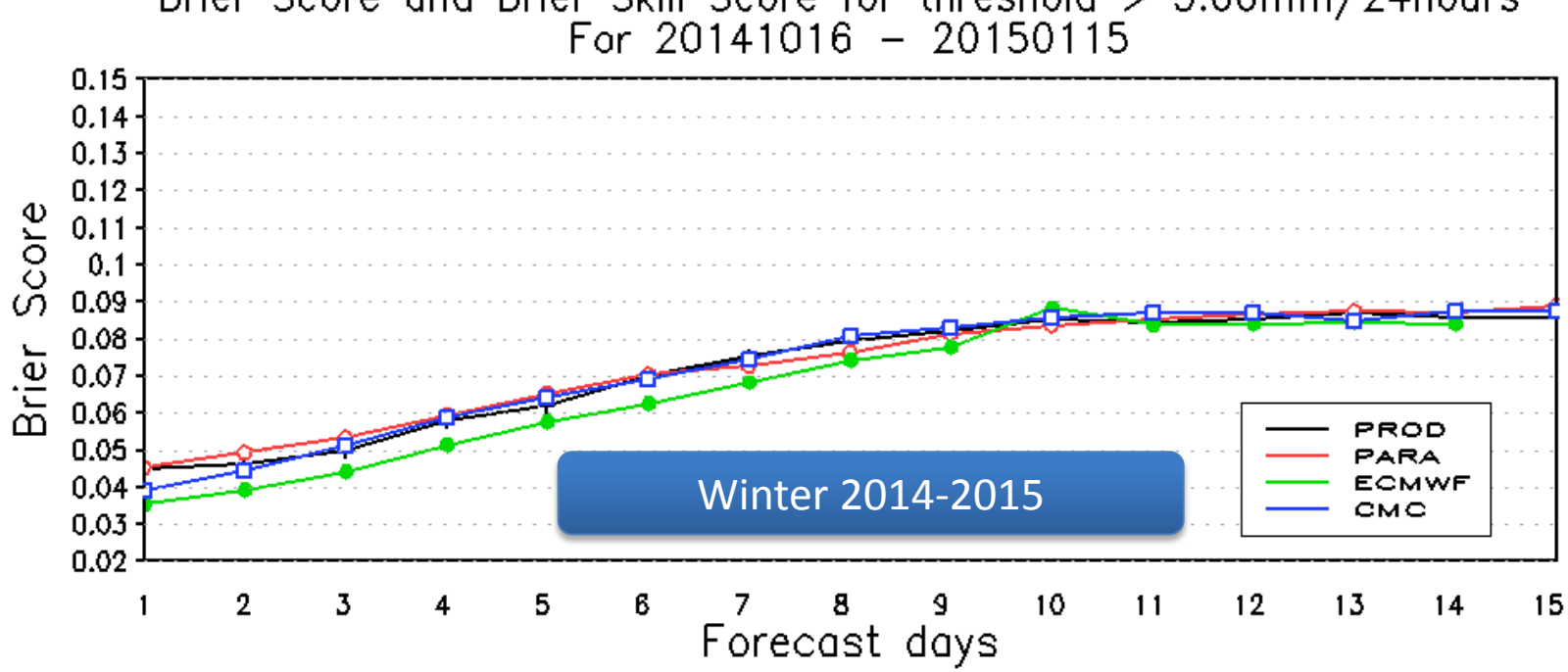
Ensemble Precipitation Verification for CONUS
Brier Score and Brier Skill Score for threshold > 1.00mm/24hours
For 20120605 – 20120930




Ensemble Precipitation Verification for CONUS
Brier Score and Brier Skill Score for threshold > 5.00mm/24hours
For 20130515 - 20131015
Brier Score
Summer 2013
PROD
PARA
ECMWF
CMC


Brier Score and Brier Skill Score for threshold > 5.00mm/24hours
For 20131016 - 20140415
Brier Score
Winter 2013-2014
PROD
PARA
ECMWF
CMC
Forecast days

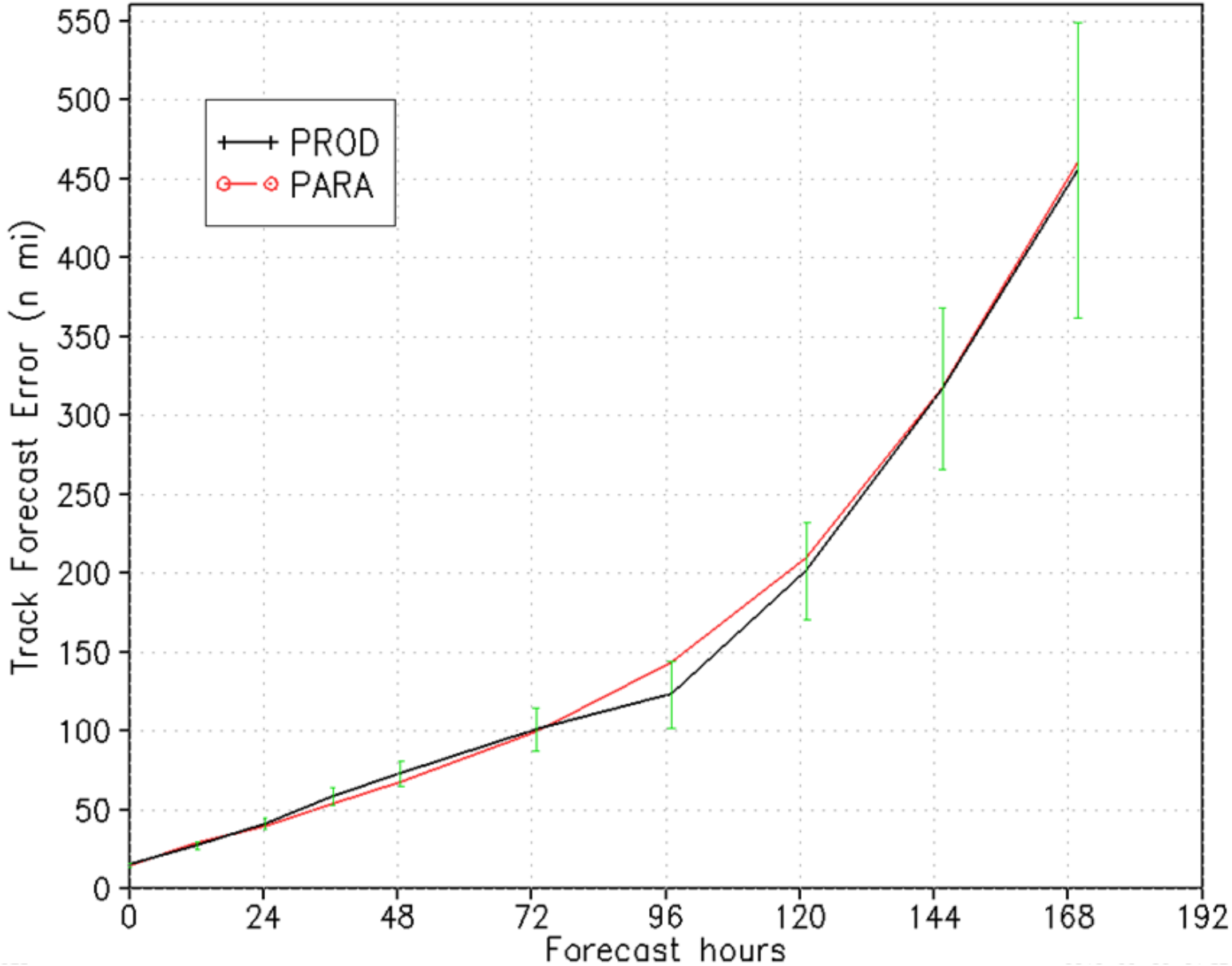

Ensemble Precipitation Verification for CONUS
Brier Score and Brier Skill Score for threshold > 5.00mm/24hours
For 20140416 - 20141015
Brier Score
Summer 2014
PROD
PARA
ECMWF
CMC


Brier Score and Brier Skill Score for threshold > 5.00mm/24hours
For 20141016 - 20150115
Brier Score
Winter 2014-2015
PROD
PARA
ECMWF
CMC
Forecast days

Hurricane tracks verification

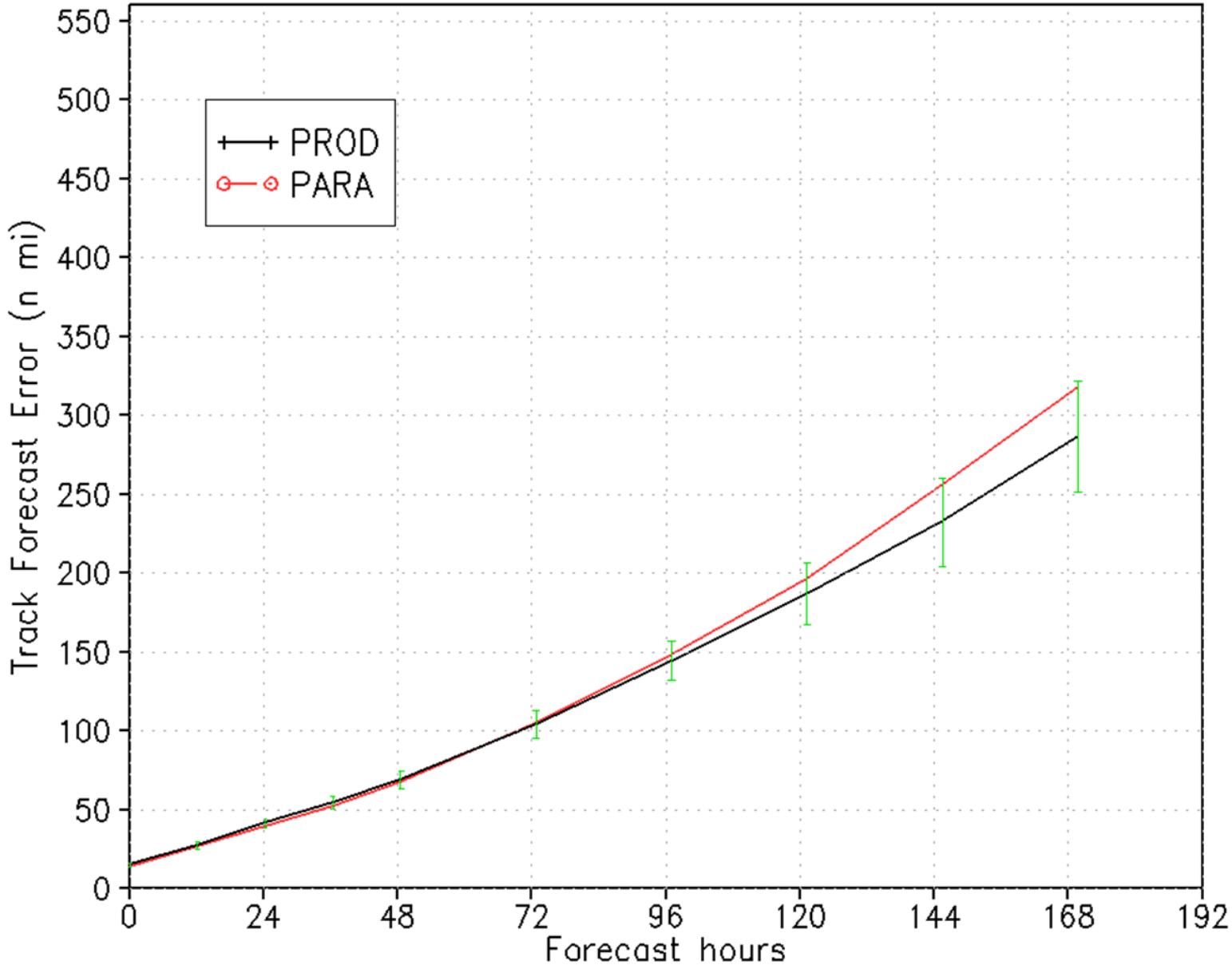
- Limited cases
  - 00UTC – 05/15/2012 – 9/16/2012
  - 00, 06, 12, 18UTC for Sandy period
  - 00UTC – summer of 2013
  - 12UTC – party of summer of 2014
  - 00UTC – summer of 2014
- Three main basins
  - Atlantic
  - East Pacific
  - West Pacific

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



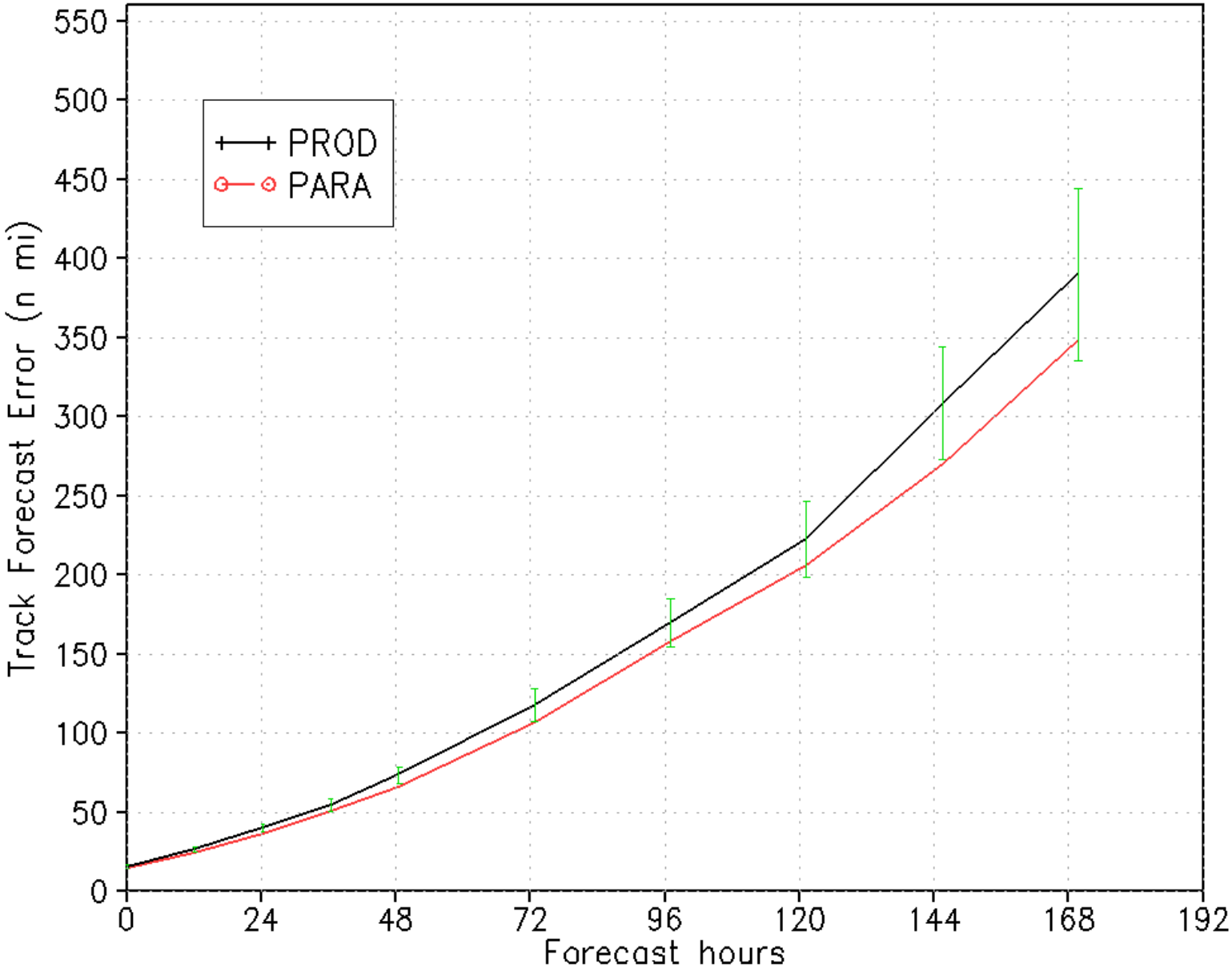
CASES	187	161	129	95	65	47	31	20

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



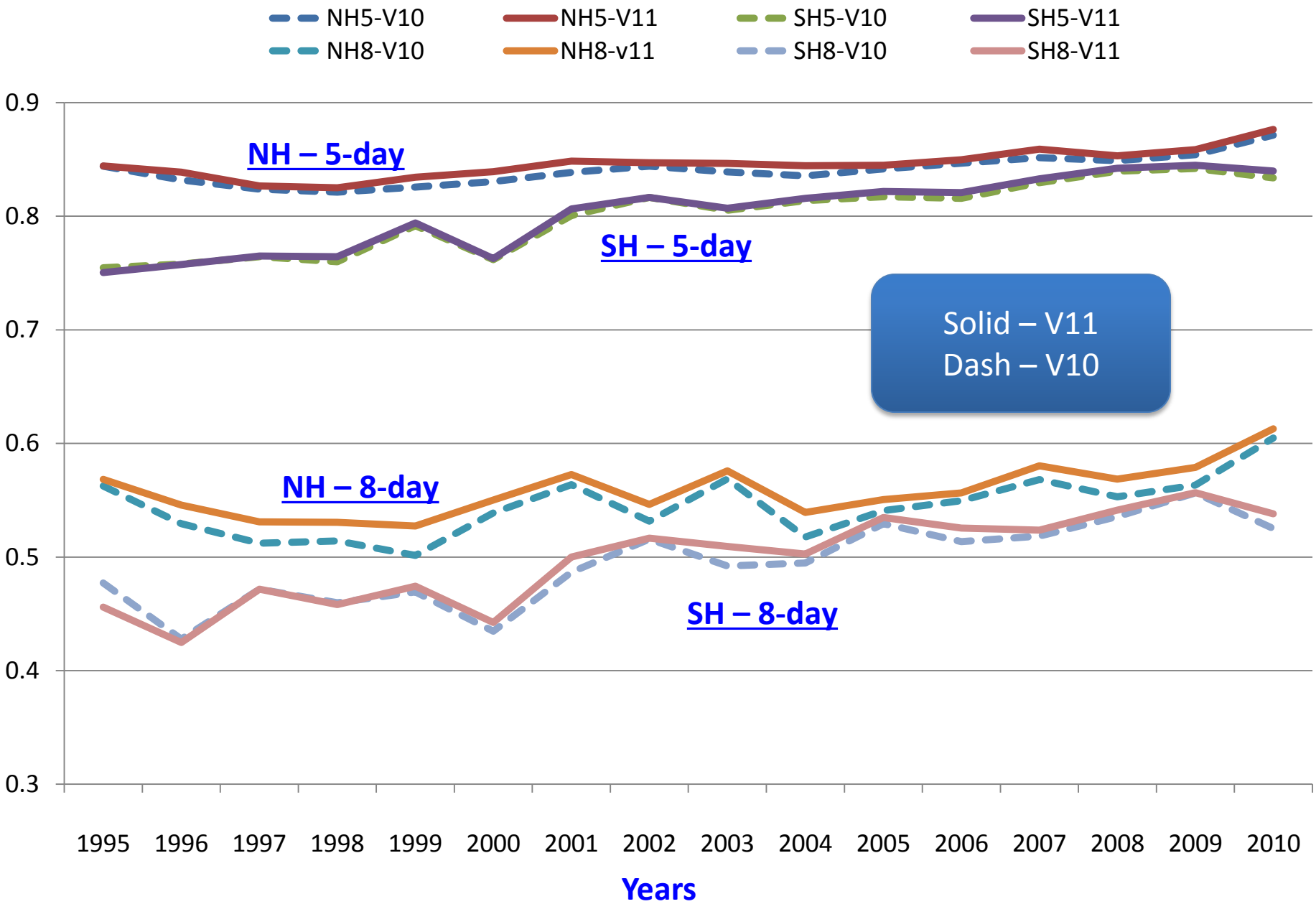
CASES	294	266	225	188	145	104	69	43

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



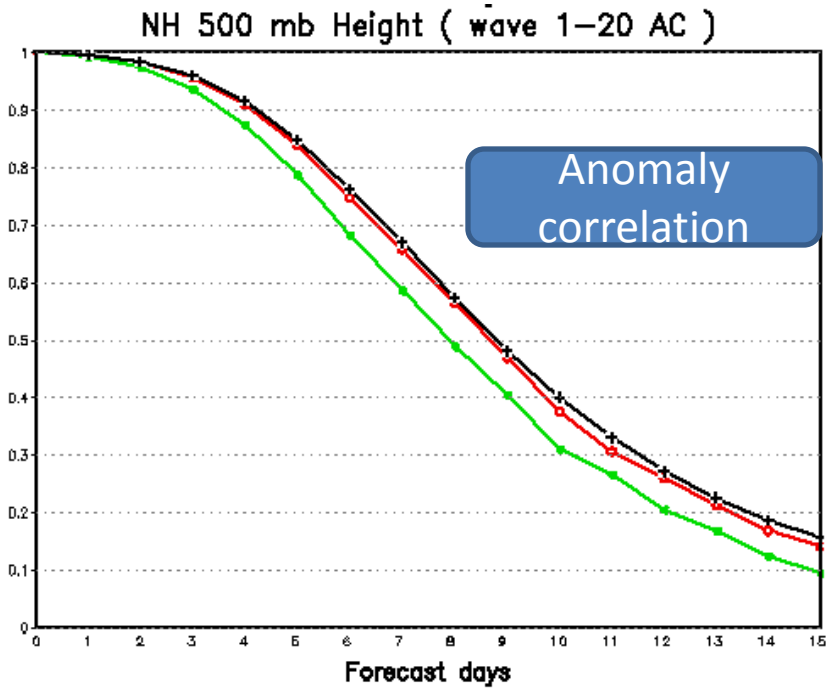
CASES	326	292	238	178	127	86	57	36

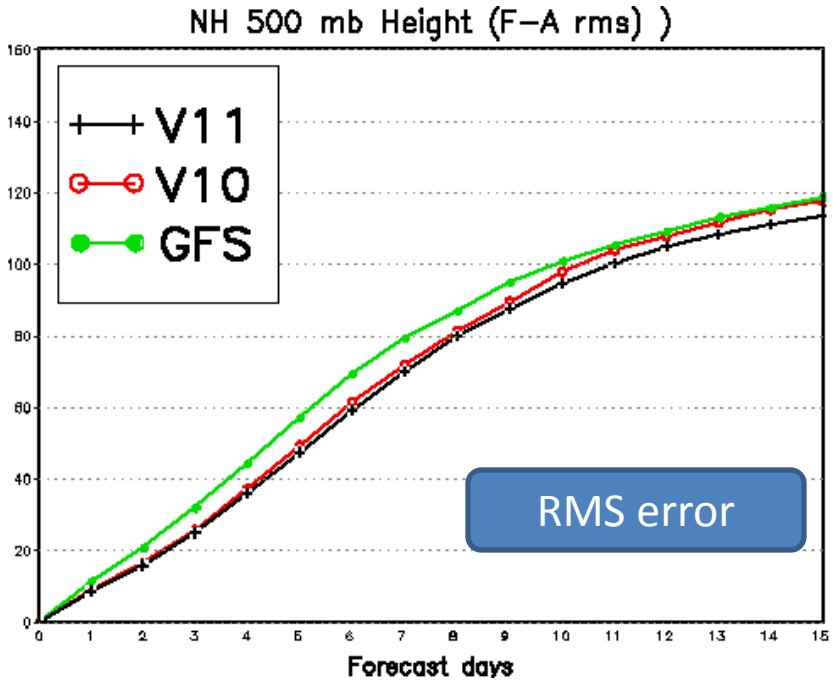
500hPa Anomaly Correlation for Control Only Reforecast (V10 .vs V11)

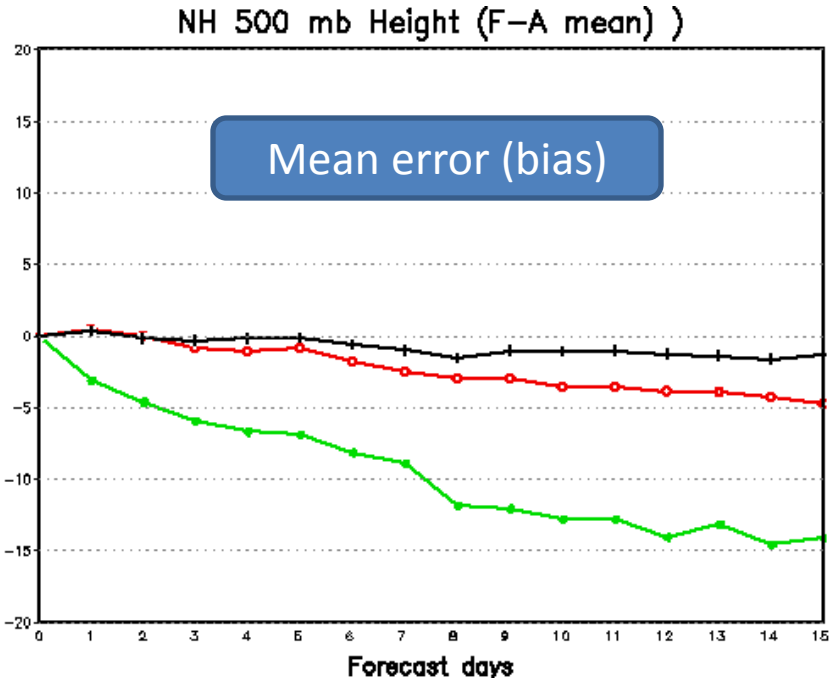


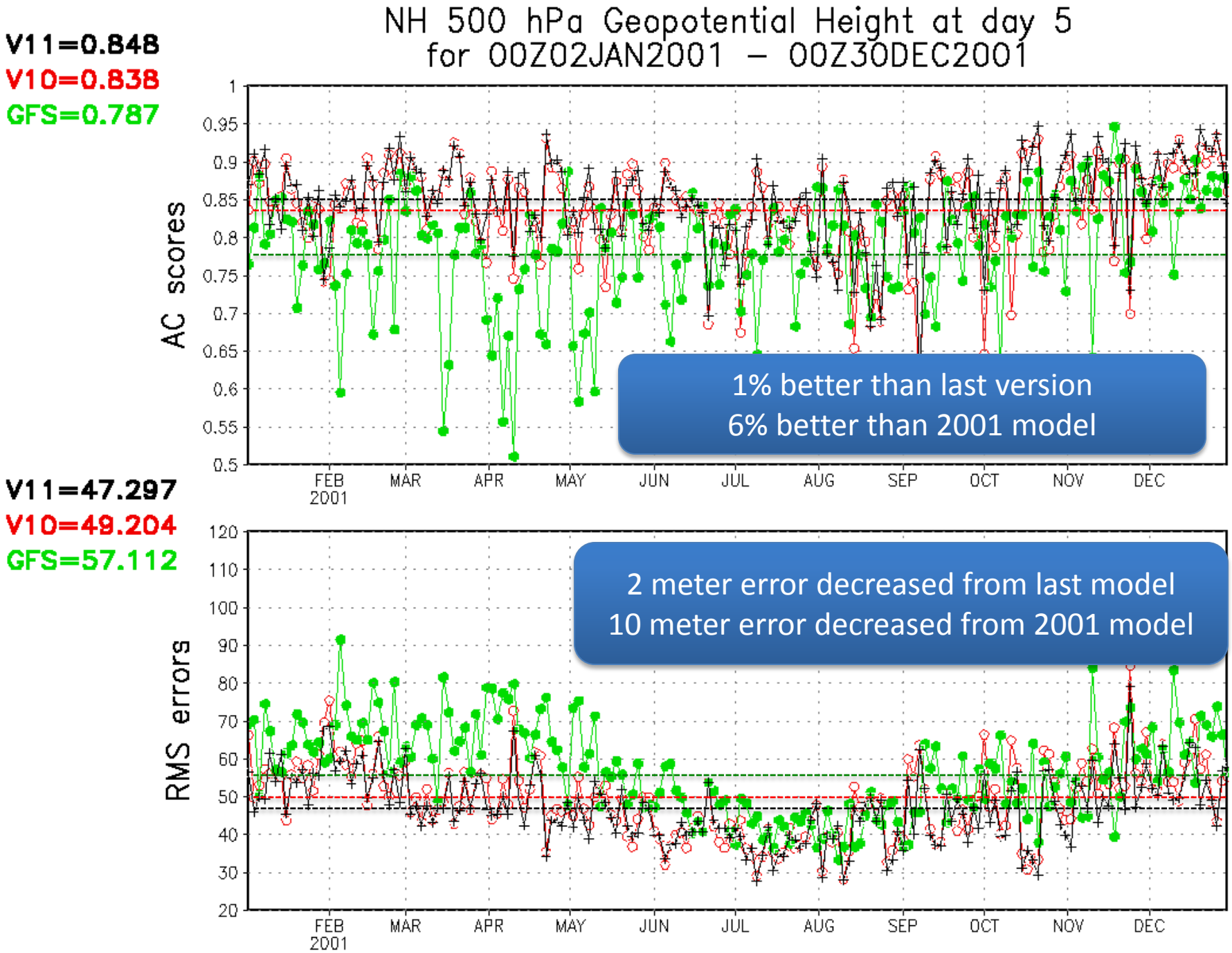
Statistical period: 01/01/2001 – 12/31/2001 (183 cases)

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

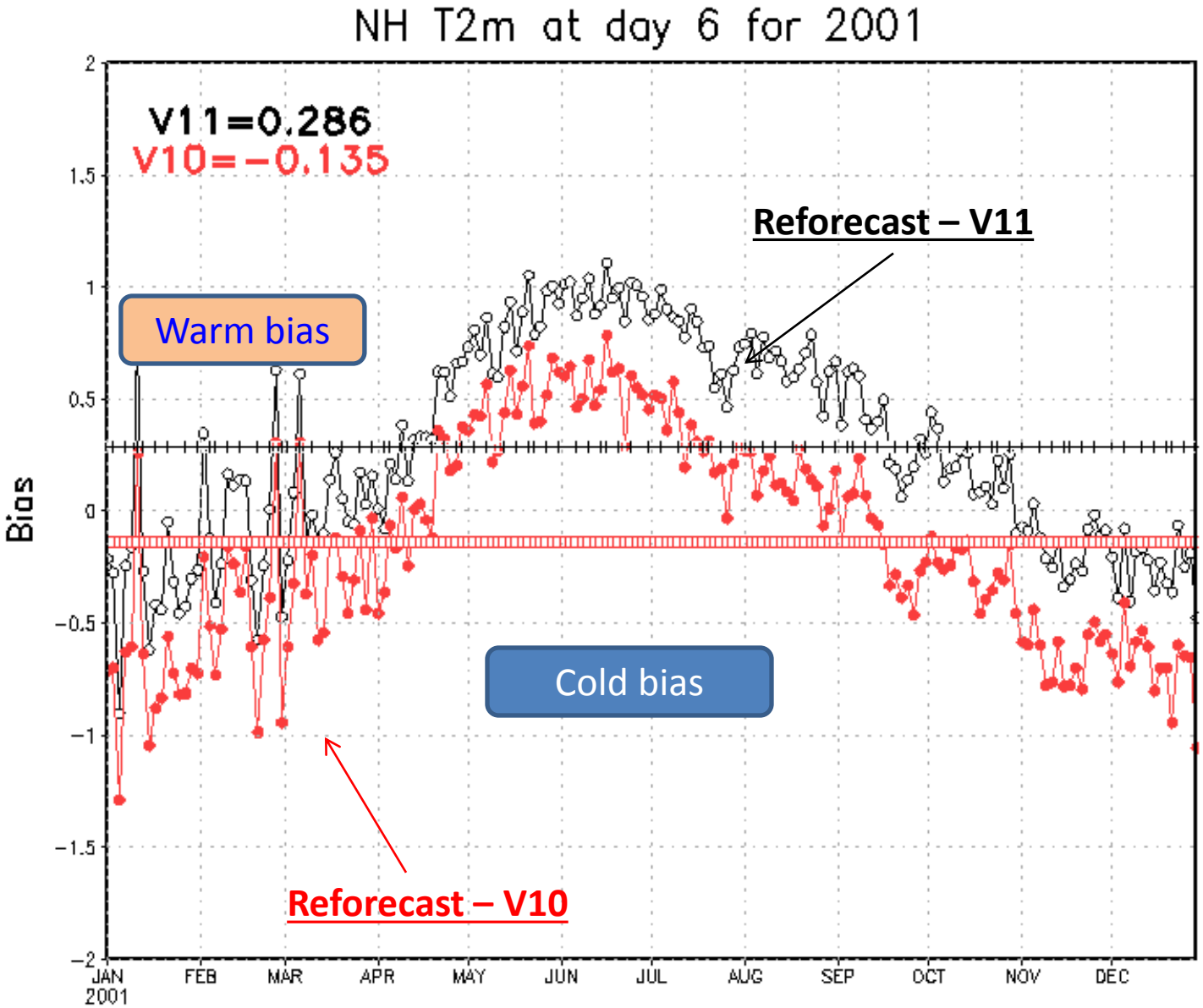







NH 500 hPa Geopotential Height at day 5
for 00Z02JAN2001 – 00Z30DEC2001
V11=0.848
V10=0.838
GFS=0.787
AC scores
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
FEB 2001
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1% better than last version
6% better than 2001 model
V11=47.297
V10=49.204
GFS=57.112
RMS errors
120
110
100
90
80
70
60
50
40
30
20
FEB 2001
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
2 meter error decreased from last model
10 meter error decreased from 2001 model

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



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 west of 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:

Sandy Case Study for NEXT GEFS

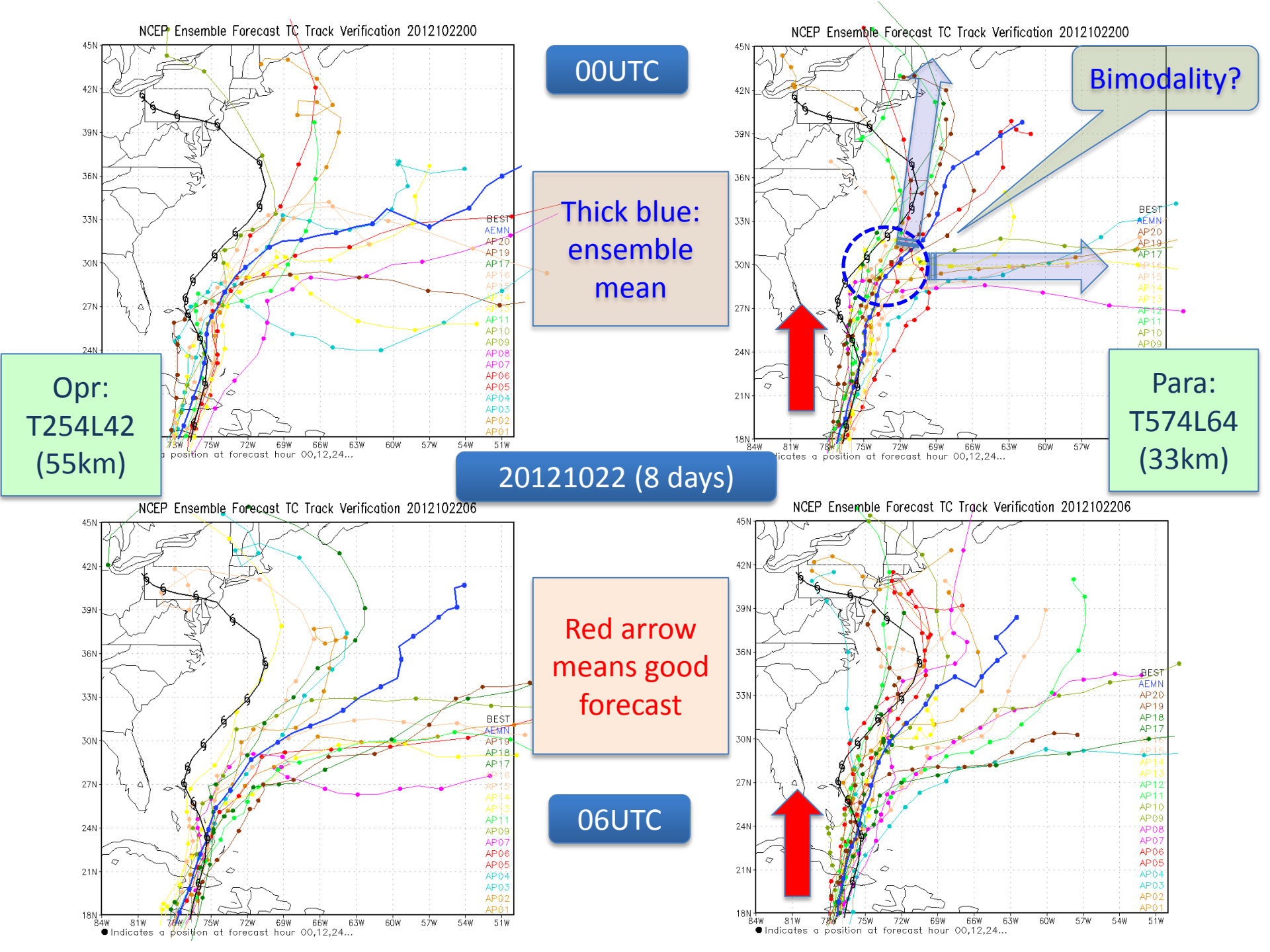
Period: 10/22 – 10/28/2012

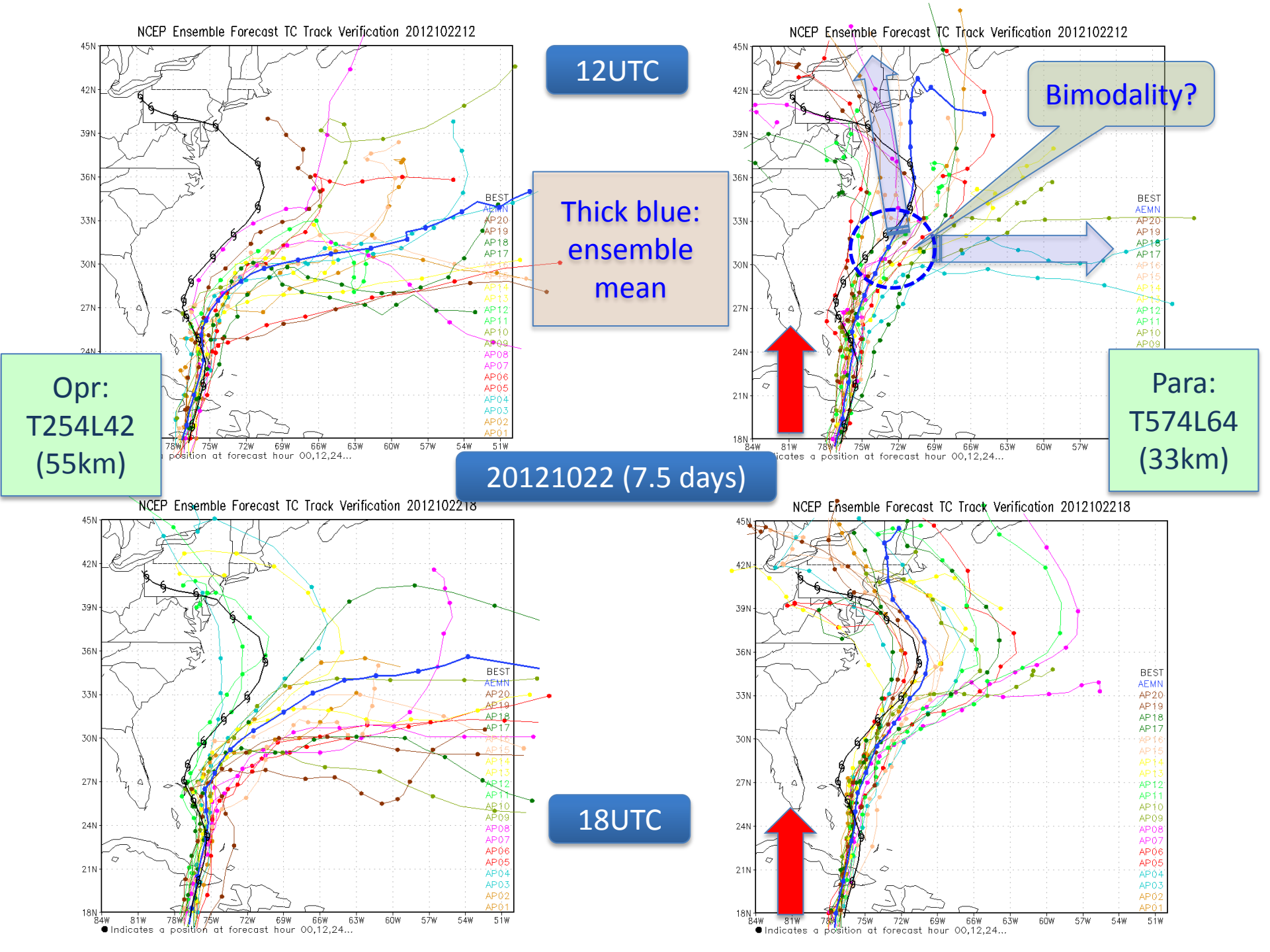
Named: 10/23/2012

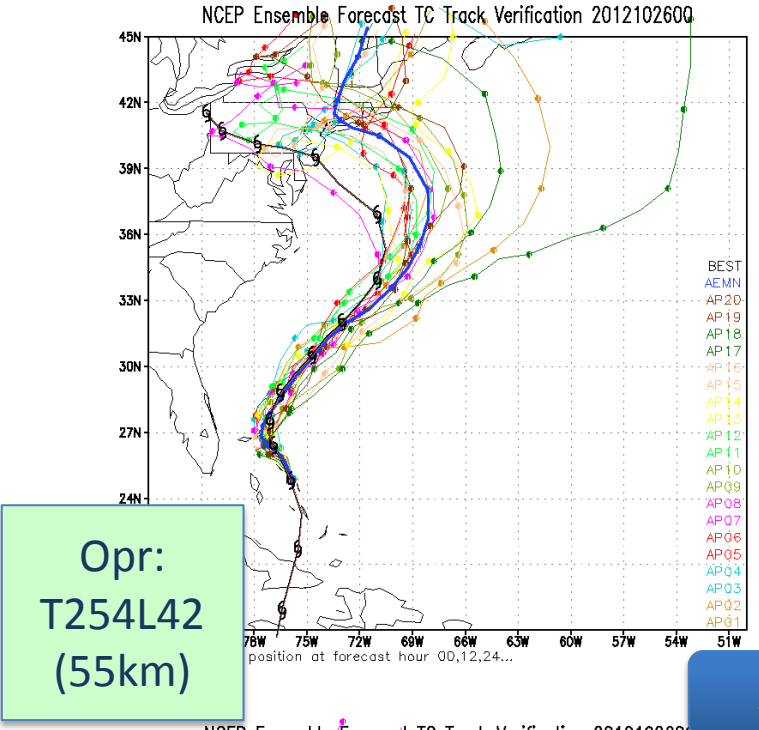
Yuejian Zhu
EMC/NCEP

September 15 2014

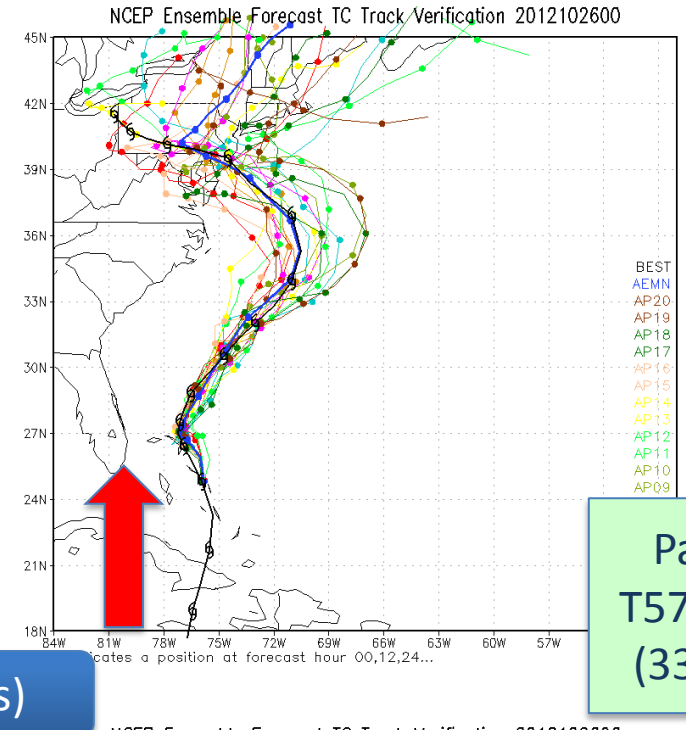
Acknolegements:
Dingchen Hou, Xiaqiong Zhou and Jiayi Peng


NCEP Ensemble Forecast TC Track Verification 2012102200
00UTC
Thick blue: ensemble mean
Bimodality?
Opr: T254L42 (55km)
Para: T574L64 (33km)
20121022 (8 days)
NCEP Ensemble Forecast TC Track Verification 2012102206
Red arrow means good forecast
06UTC
BEST
AEMN
AP20
AP19
AP18
AP17
AP16
AP15
AP14
AP13
AP12
AP11
AP10
AP09
AP08
AP07
AP06
AP05
AP04
AP03
AP02
AP01
● Indicates a position at forecast hour 00,12,24...


NCEP Ensemble Forecast TC Track Verification 2012102212
12UTC
Thick blue: ensemble mean
Opr: T254L42 (55km)
NCEP Ensemble Forecast TC Track Verification 2012102212
Bimodality?
Para: T574L64 (33km)
20121022 (7.5 days)
NCEP Ensemble Forecast TC Track Verification 2012102218
18UTC
NCEP Ensemble Forecast TC Track Verification 2012102218
BEST
AEMN
AP20
AP19
AP18
AP17
AP16
AP15
AP14
AP13
AP12
AP11
AP10
AP09
AP08
AP07
AP06
AP05
AP04
AP03
AP02
AP01
● Indicates a position at forecast hour 00,12,24...



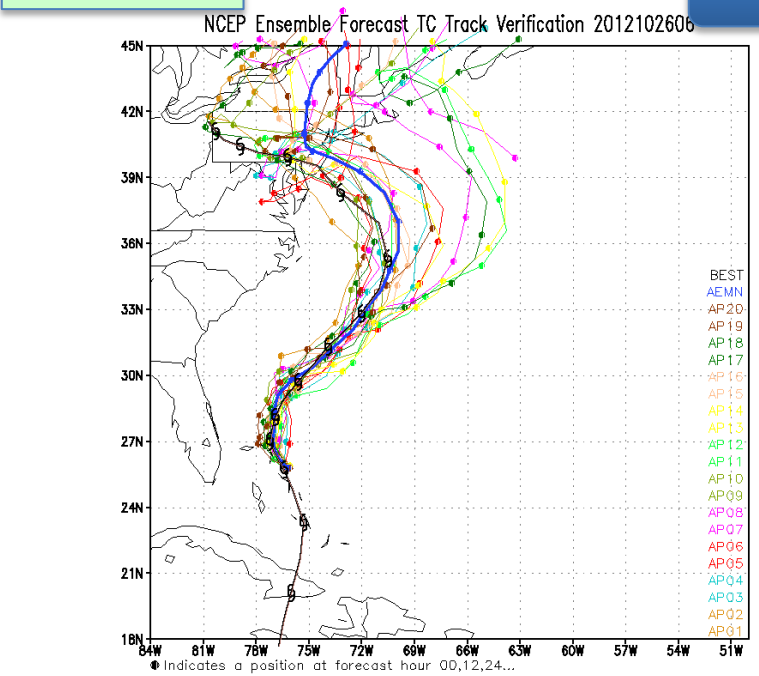
00UTC



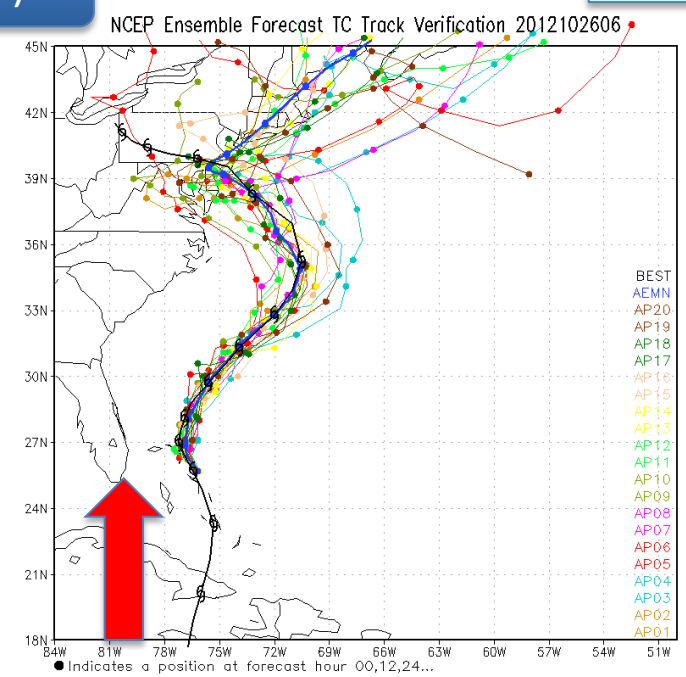
Opr:
T254L42
(55km)

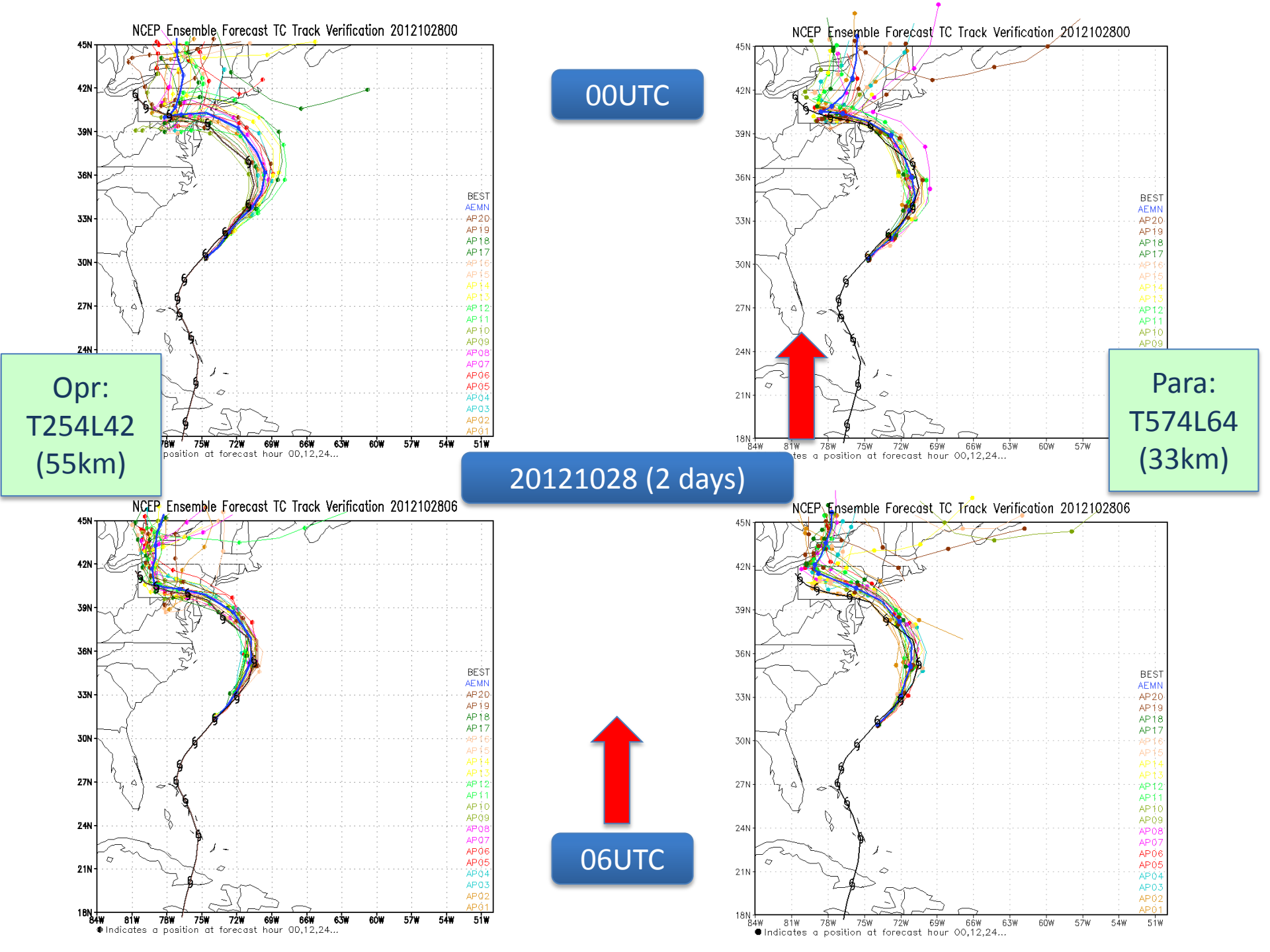
Para:
T574L64
(33km)

20121026 (4 days)

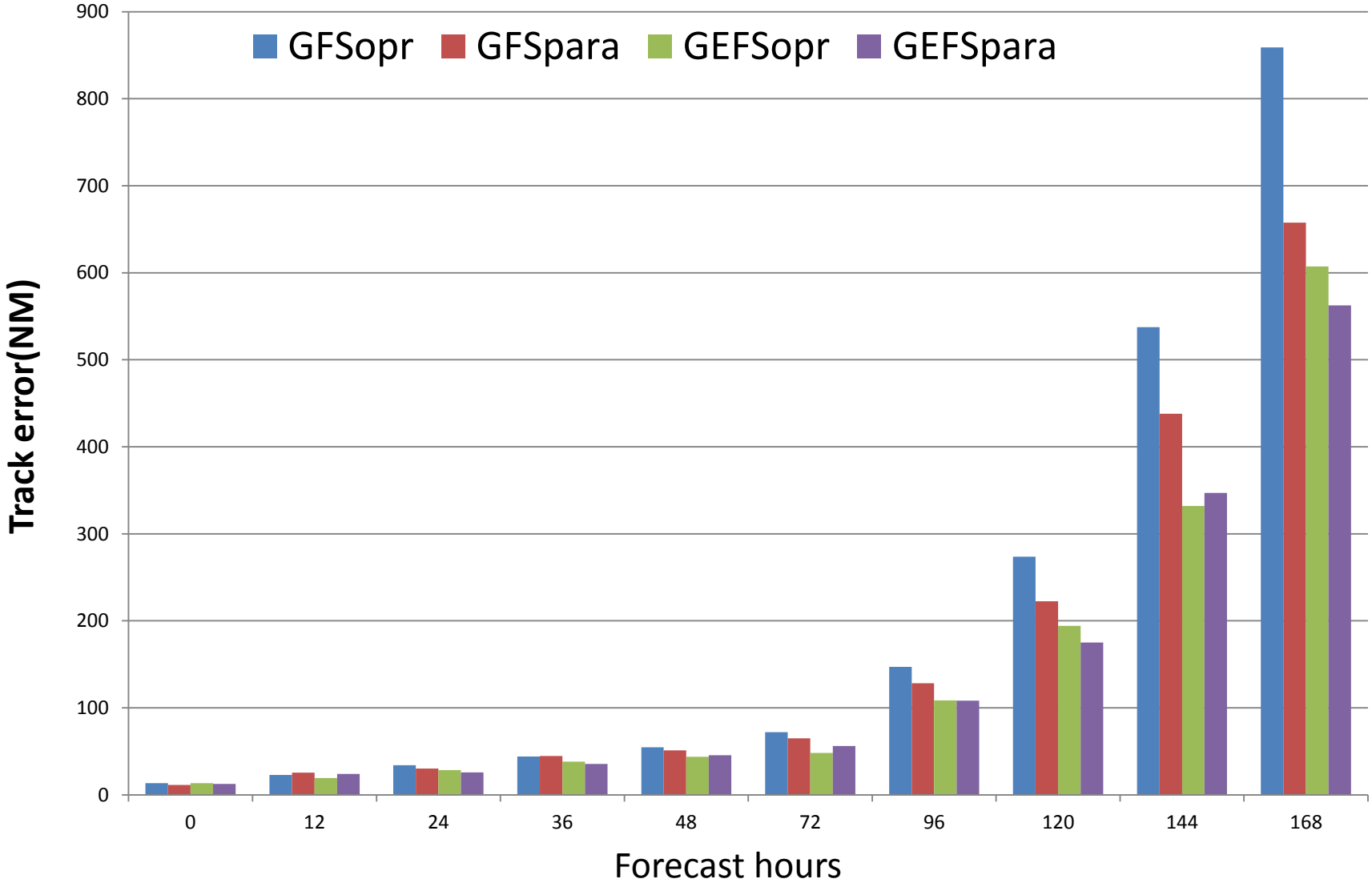


06UTC




NCEP Ensemble Forecast TC Track Verification 2012102800
00UTC
Opr:
T254L42
(55km)
Para:
T574L64
(33km)
20121028 (2 days)
NCEP Ensemble Forecast TC Track Verification 2012102806
06UTC
BEST
AEMN
AP20
AP19
AP18
AP17
AP16
AP15
AP14
AP13
AP12
AP11
AP10
AP09
AP08
AP07
AP06
AP05
AP04
AP03
AP02
AP01
Indicates a position at forecast hour 00,12,24...

2012 Sandy Track Verifications (7-days)



CASEs	32	32	32	31	29	25	21	17	13	9

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

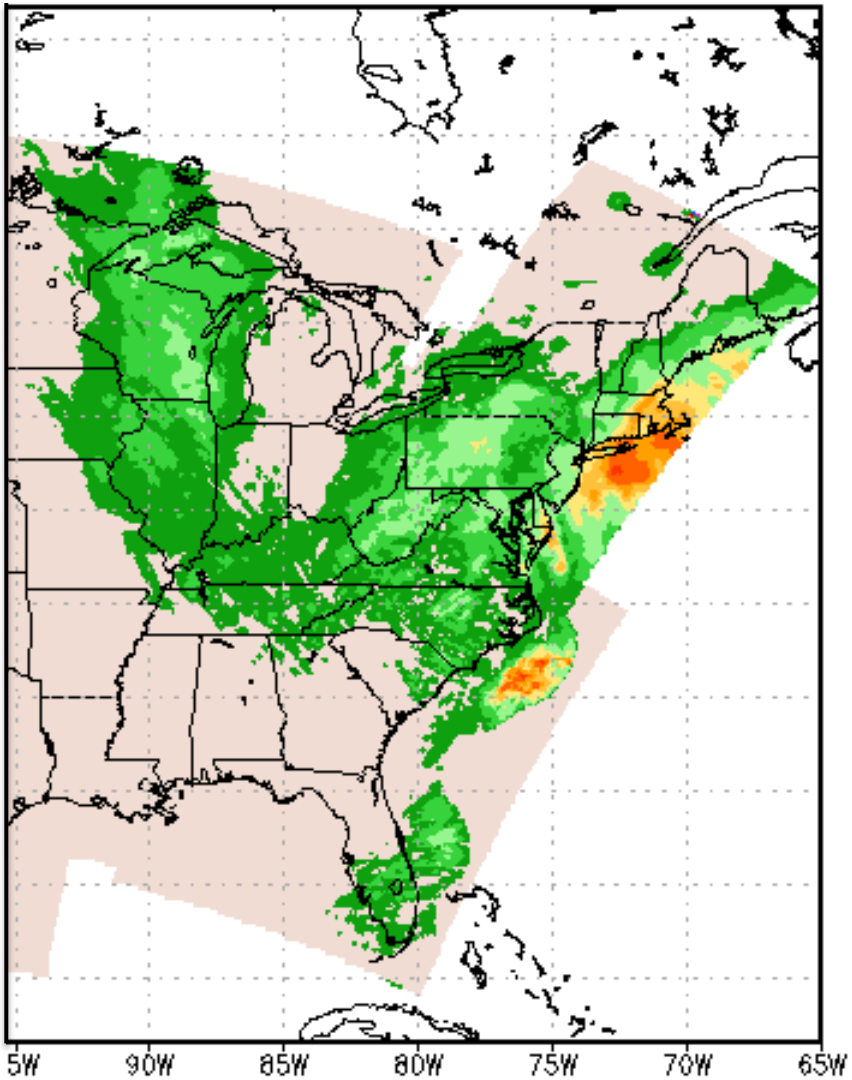
01/26 12UTC – 01/28 12UTC 2015

Yuejian Zhu
EMC/NCEP/NWS
Jan. 30 2015

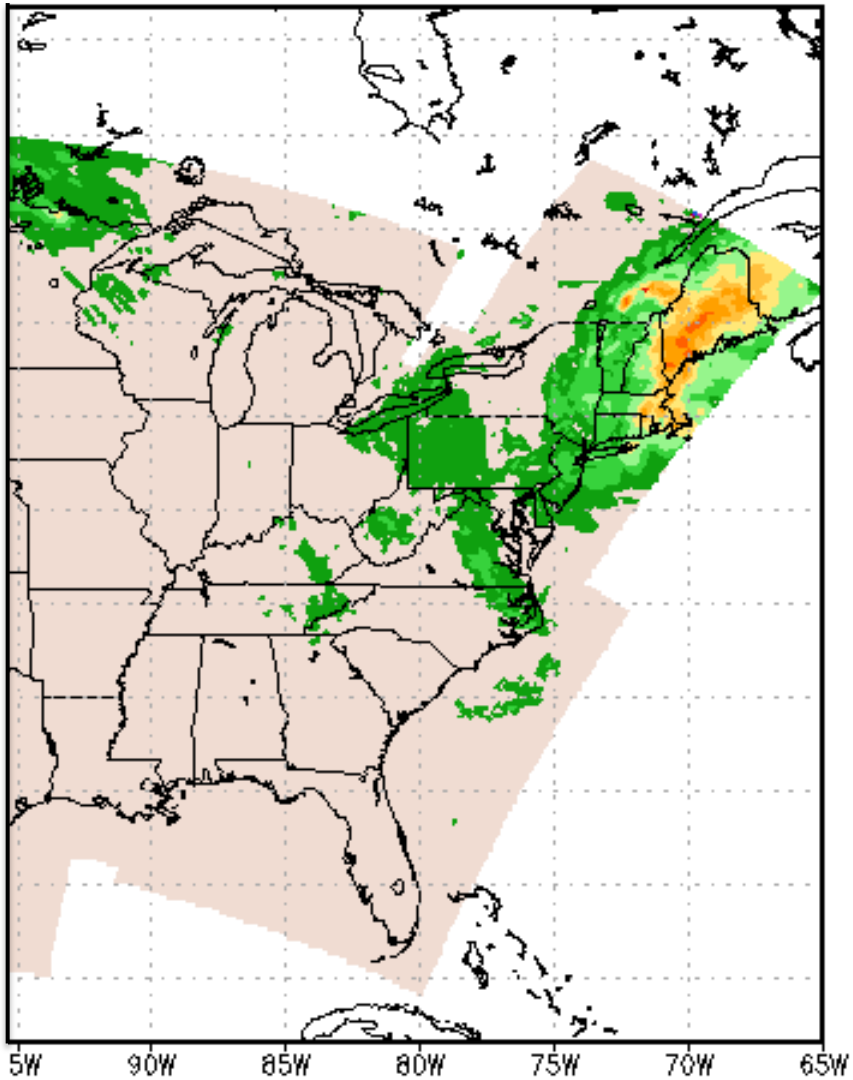
Acknowledgements:
Hong Guan, Yan Luo and Xiaxiong Zhou

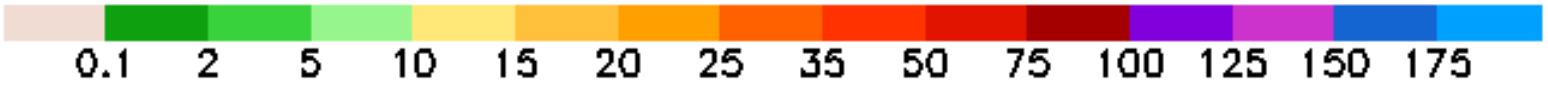
CCPA 24 hours accumulation (mm)

ENDING 12 UTC 20150127



ENDING 12 UTC 20150128





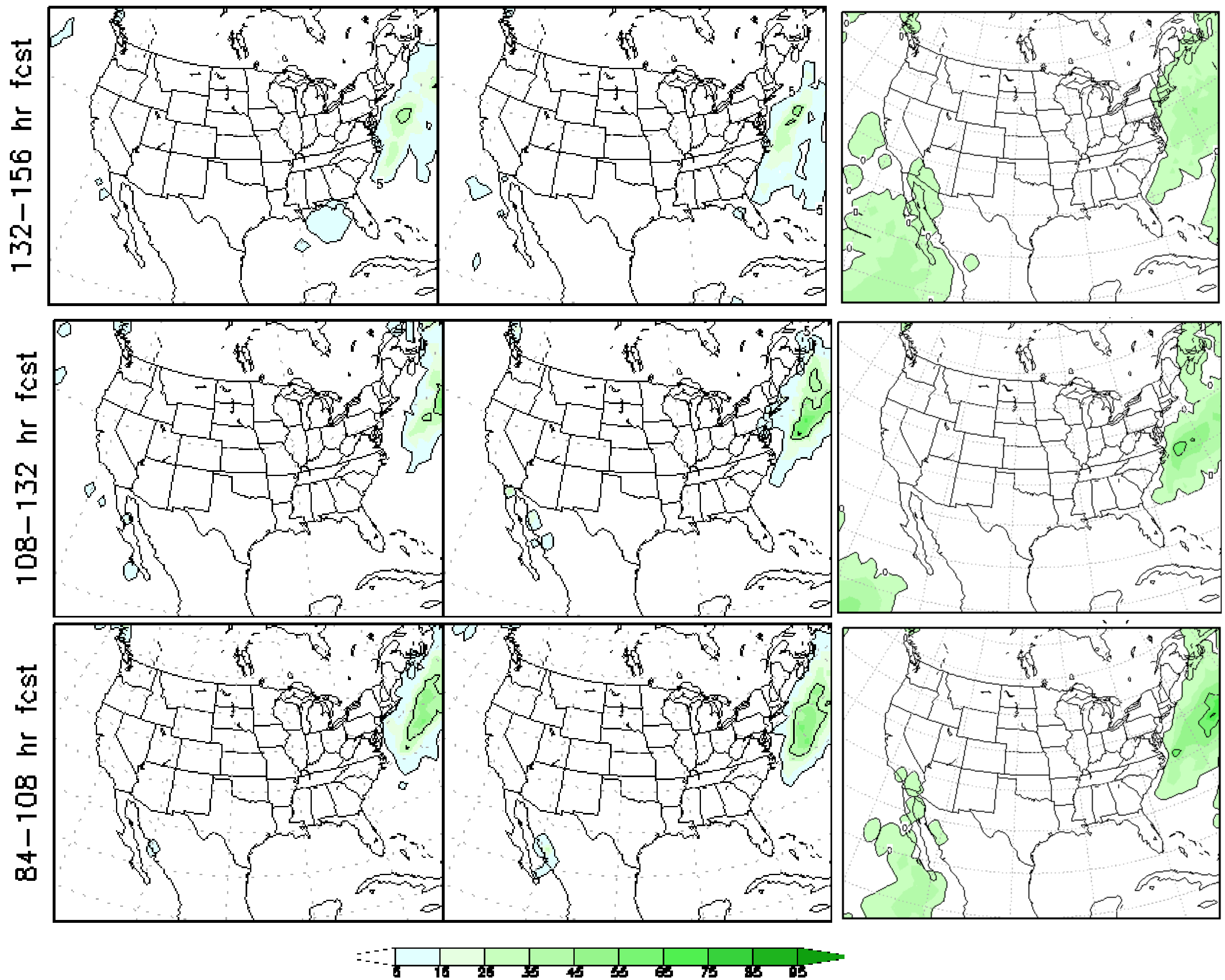
Ensemble Based Probabilistic Quantitative Precipitation Forecast (PQPF)
Valid: 2015012612 – 2015012712 Amount 24hr >25.4mm (1 inch)

Initial Time

2015012100

2015012200

2015012300

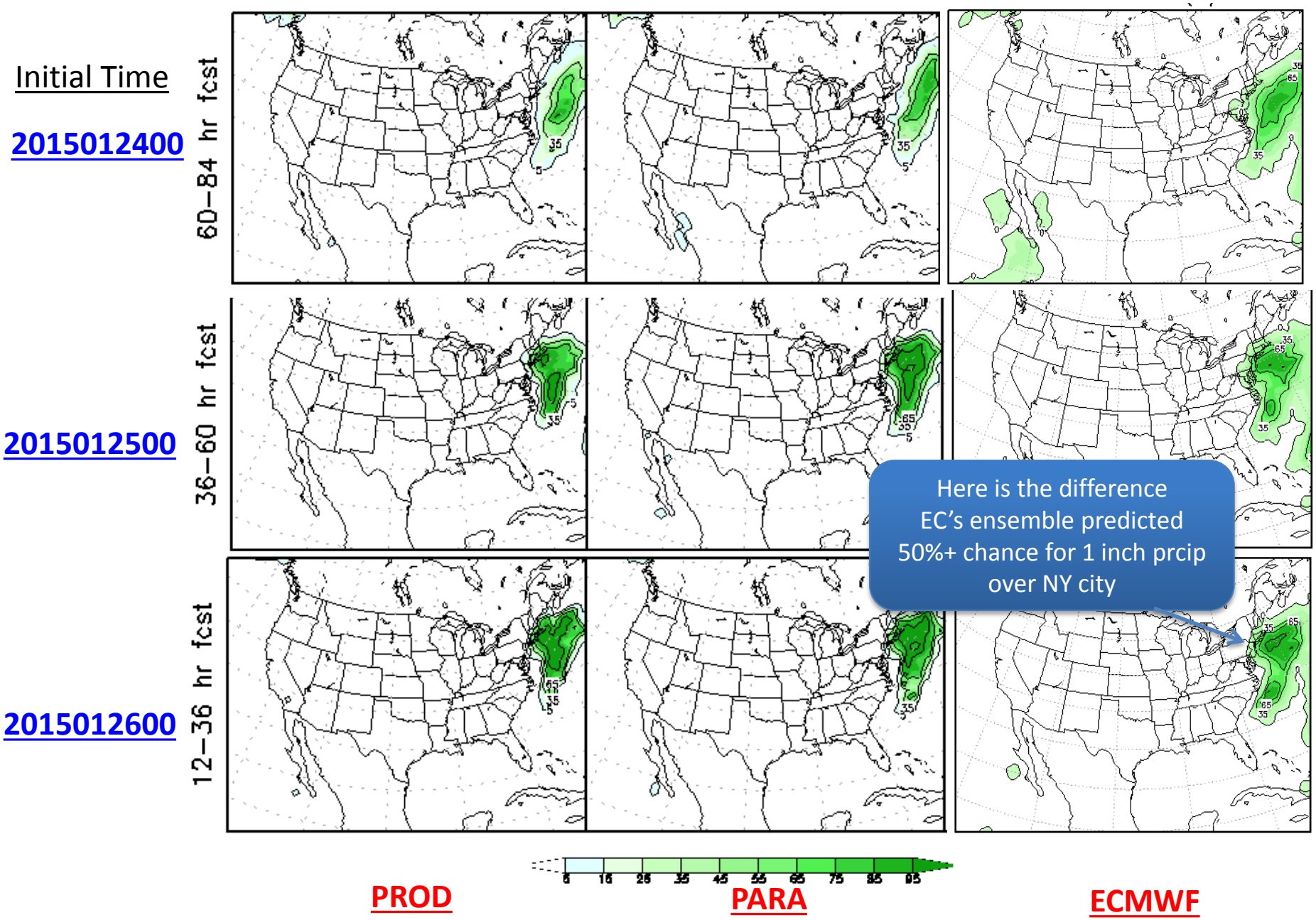


PROD

PARA

ECMWF

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



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

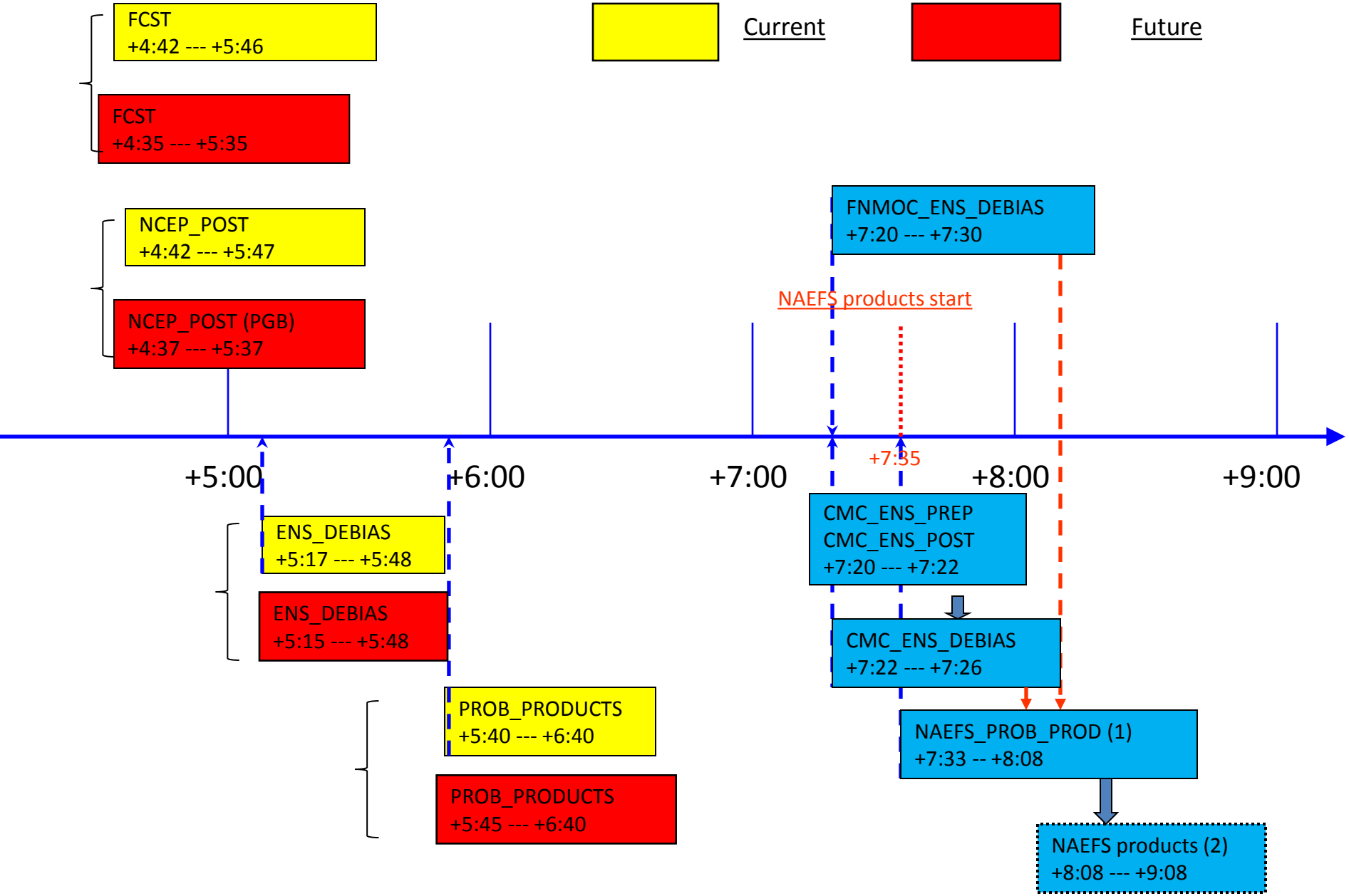
NAEFS Global Grid Exchange Variables for 1.0d

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



GEFS/NAEFS 6-hr window flow chart

Downstream Dependencies

- Sigma (hybrid) files
  - SREF
    - Yes, It uses sigma forecast
    - Noticed already
  - Wave ensemble
    - No
    - It uses bias corrected 10m winds
  - Sea ice model
    - No
    - It use pgrb files
  - Tracking
    - No
    - It uses pgrba file
  - MDL EKDMOS
    - No
    - It uses pgrba and pgrbb files
  - Public access
    - No
    - We don't post sigma files to public

- pgrb files (fcst lead time – 3 digits)
  - SREF
    - No
    - It produces pgrb file by itself
  - Wave ensemble
    - Yes
    - 10m winds – noticed already
  - Sea ice model
    - Yes
    - pgrb files – noticed already
  - Tracking
    - Yes
    - pgrb files – noticed already
  - MDL EKDMOS
    - Yes
    - pgrb (a+b) – noticed already
  - Public access (TIN)
    - Yes
    - pgrba and pgrbb

GEFS Implementation Check List

- GEFS-Q1-2012: RFCs
  - ESMF 3.1.0rp5 library
  - GEFS_INIT (3 RFCs)
    - Scripts
    - Source codes
  - GEFS_FCST (1 RFC)
    - Script
  - GEFS_CHGRES (1 RFC)
    - Script
  - GEFS_POST (1 RFC)
    - Script
  - GEFS_GFS_PRDGEN (1 RFC)
    - Script
  - GEFS_PRDGEN (1 RFC)
    - Script
  - GEFS_ENSSTAT (1 RFC)
    - Script
  - GEFS_ENSPOST (1 RFC)
    - Script
  - GEFS_TRACK (1 RFC)
    - Script
  - GEFS_POST_CLEANUP (1 RFC)
    - Script
  - GEFS_BIAS (no RFC)
  - GEFS_DEBIAS (no RFC)
  - GEFS_DNSCAL (no RFC)

- GEFS downstream dependences
  - SREF
    - POC – Jun Du
  - Wave ensemble
    - POC - Jose-Henrique Alves
  - Sea ice model
    - POC - Rrobert Grumbine
  - Hurricane tracking
    - POC - Guang Ping Lou
  - MDL EKDMOS
    - POC – John Wagner/Rebecca Cosgrove
  - Precipitation verification (sflux files)
    - POC – Yin Lin
  - GEFS probability forecast
    - POC – Bo Cui
  - GEFS down-scaling (RTMA)
    - POC – Bo Cui
  - NAEFS probability forecast
    - POC – Bo Cui
  - NAEFS down-scaling (RTMA)
    - POC – Bo Cui
  - New ensemble Bias
    - Need to copy over to prod when the time for implementation

WCOSS resources (estimated)

- Computation (Prod)
  - T254L42 out to 192 hours
    - Use 30 min
    - Average 105+12 nodes
  - T190L42 from 180 to 384 hours
    - Use 30 min
    - Average 63+8 nodes
- Computation (New)
  - T_L574L64 out to 192 hours
    - Use 32 min
    - Average 252+42 nodes
    - 155% additional resources
  - T_L254L64 from 180 to 384 hours
    - Use 23 min
    - Average 126+21 nodes
    - 155% additional resources

Disk Space (GB/day)

Current	Future	Files
	144	pgrb2a0p50 (0.5d every 3 hours – new for exchange)
54	54	pgrb2a (online for 17d – NAEFS exchange)
770	4012	sfcsig from model (x 5.0)
160	528	sflux from model (x 3.2)
1425	8400	total in /com/gens
100	216	total in /nwges

GEFS product name change

- Directory name changes (/com/gens/prod/gefs.${yyyymmdd}/${cyc}/)
  - pgrb2a → pgrb2a1p00
  - pgrb2b → pgrb2b1p00
  - pgrb2alr → pgrb2a2p50
  - pgrb2blr → pgrb2b2p50
  - pgrb2 → pgrb21p00 (don't know how to create this? pgrba+pgrbb?)
  - pgrb2a0p50 (new)
  - pgrb2b0p50 (new)
- File name changes (for above directories)
  - ge${mem}.T${cyc}Z.pgrb2af${hh} → ge${mem}.T${cyc}Z.pgrb2af${hhh} (if hh <=100)
- Notations:
  - yyyymmdd – year, month and day
  - cyc – 00, 06, 12, 18
  - mem – gfs, c00, p01, …, p20, avg, spr
  - hh – 00, 06, 12, 18, 24, 30, … , 384

Plan Schedule

- Project kick off – Jan. 2015
- EMC real time parallel – Feb. 5th 2015
- EMC CCB meeting – Feb. 13 2015
- Submit/discuss TIN – Jan. 15
- Submit RFCs – Feb. 15
- Expect NCO parallel – in March 2015
  - Service centers evaluation
- Expect implementation – Mid- April 2015

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