# EMC FY15 Upgrade Review

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# GEFS Upgrade (V11)

**Presented by:**

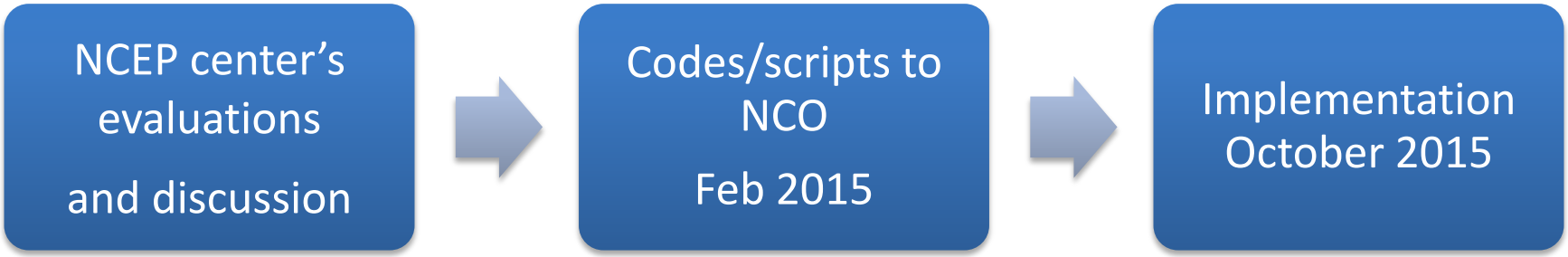
**Yuejian Zhu**
**Environmental Model Center**

**Update: 10/6/2015**

# 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_L$574 (34km) L64 (hybrid) |
| Resolution 192-384 h | T190 (70km) L42 (hybrid) | $T_L$382 (52km) L64 (hybrid) |
| Computational Cost | 105 nodes (in peak) | 300 nodes 1st segment<br>150 nodes 2nd segment |
| Execution time | ~ 60 min | 35 min 1st segment<br>25 min 2nd segment |
| Output resolution | $1^O$ x $1^O$ | $0.5^O$ x $0.5^O$ and $1^O$ x $1^O$ |
| 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 of DA and Ensemble Generation
  - Direct link to the hybrid 3D-Var EnKF DA system
- Perturbations are 6h EnKF forecasts 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 tropics
    - to reduce the spread growing of geopotential height

# Expected improvements

- Hurricane track forecast
  - Main reason: DA/model and spatial resolutions
- Probabilistic forecast guidance
  - Main reason: DA/model and spatial resolution, EnKF initial perturbations, 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 (Q4FY15)
  - NCO will continue to run current operational GEFS (with BV-ETR cycling every 6 hours, but 00UTC forecast only) for one year (or longer?)
    - Current: 21 members, 00, 06, 12, 18UTC
    - Future: 21 members, 00UTC, initially on WCOSS Phase I (eventually move to Phase II)
  - 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 this implementation.

- Based on communications with WPC, CPC, SPC, NWC, 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
    - Forecasts have been done, NCO was helping to run part of retrospective cases
  - 18 years ensemble control only reforecast
    - Year 1995-2012
    - 00UTC and every other day
    - Forecasts has been finished, OHD has received the data
  - 18 years ensemble reforecast for CPC (on going)
    - Year 1995-2012
    - 00UTC and every 4 days
    - NCO will run them in production machine
    - Starting from mid-July
  - All data will be saved in HPSS tapes
    - NCO to publish part of data: pgrba data at 1.0 degree, every 6 hours, out to 16 days for public access (2-year retrospective runs).
  - Note: EMC and NWC will continue to discuss a configuration of GEFS reforecast
    - Half day meeting will be scheduled in later July
    - One full day workshop will plan in September

# 2-year (plus) GEFS (V11.0) retrospective data posted (3/12/15)

## Short description of the data

In late August/early September 2015, the NCEP Global Ensemble Forecast System (GEFS) will be updated. In preparation for this upgrade, NCEP has rerun nearly two years GEFS retrospective forecast data, and is offering a sample dataset for our customers' evaluation.

A summary of the scientific details of the GEFS upgrade are listed in Table 1. More details of the upgrade are available at:
http://www.emc.ncep.noaa.gov/gmb/yzhu/html/imp/201412_imp.html

Below are highlights of the retrospective dataset:

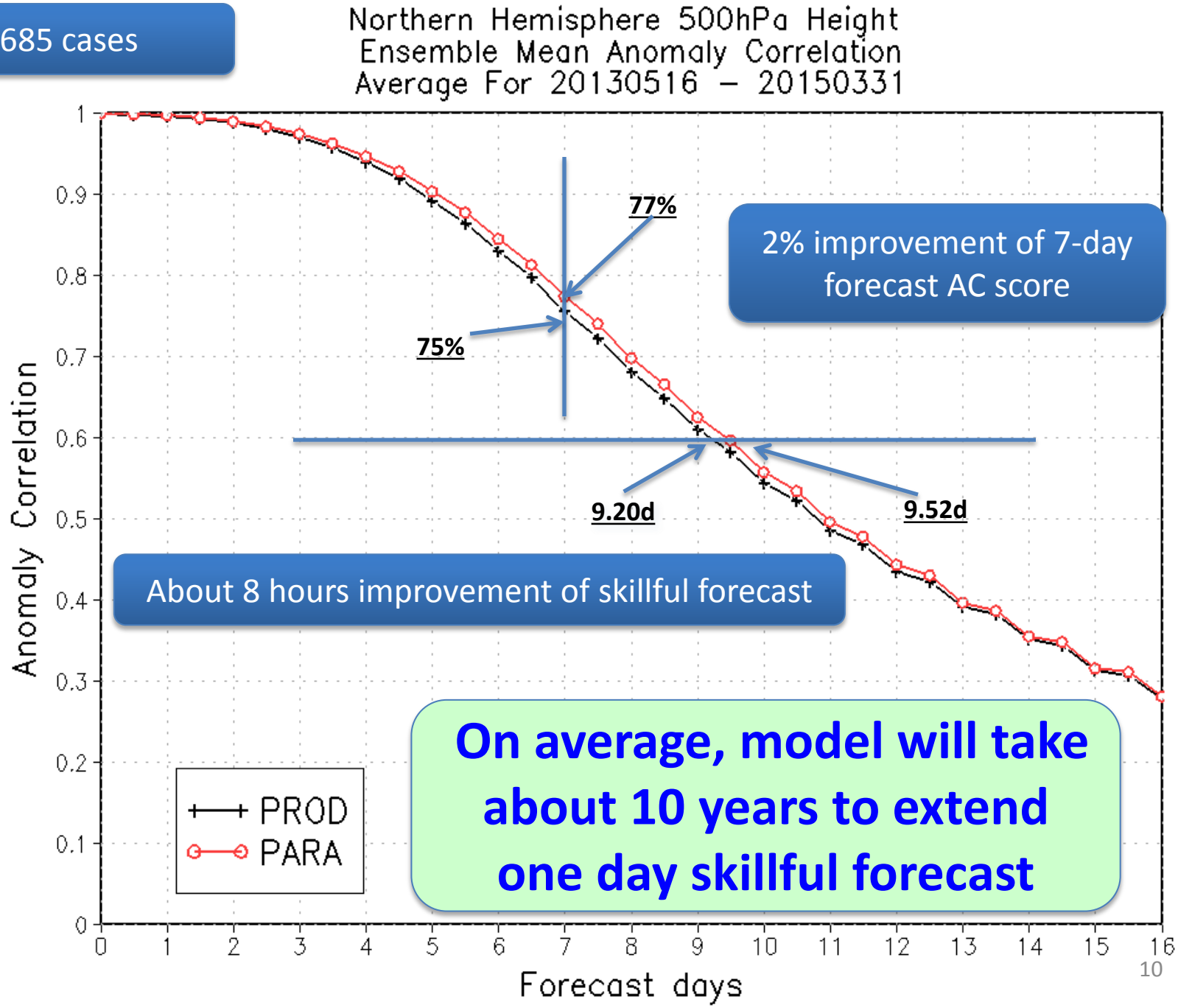
- Data is available at:
  http://para.nomads.ncep.noaa.gov/pub/data/nccf/retrospective/gefs/
- Directory and file:
  - Retrospective runs will be available for May 15, 2013 through the present. There is also the potential to provide data from Summer 2012 if there is interest.
    - *note that the data is being actively sent to the server now, we expect the full dataset to be available by late April*
  - For each day, only the 00Z forecast is available
  - There are about 1495 files in each directory - only the "pgrb2a" files
    - 20 perturbed forecasts (gep01.*, gep02.*, ..., gep20.*)
    - 1 un-perturbed forecast (gec00.*)
    - Ensemble mean (geavg.*)
    - Ensemble spread (gespr.*)
    - 65 lead times (*f00, *f06, *f12, ... , *f384; every 6 hours)
  - Each file contains 80 variables (see table 1)
- Data format: GRIB II
- Data resolution: 1*1 degree global

As this is the first time we are offering retrospective data in this manner, we ask that our users contact NCEP Central Operations and let us know your intended use of this data. This will help us determine the level of interest in providing future retrospective data. Please send an email to Rebecca.Cosgrove@noaa.gov indicating your interest in and intended use of the data.

# EMC evaluations of two-year (+) retrospective runs

**June 1st 2013 – May 31st 2015**
**and**
**Summer of 2011 and 2012**

685 cases

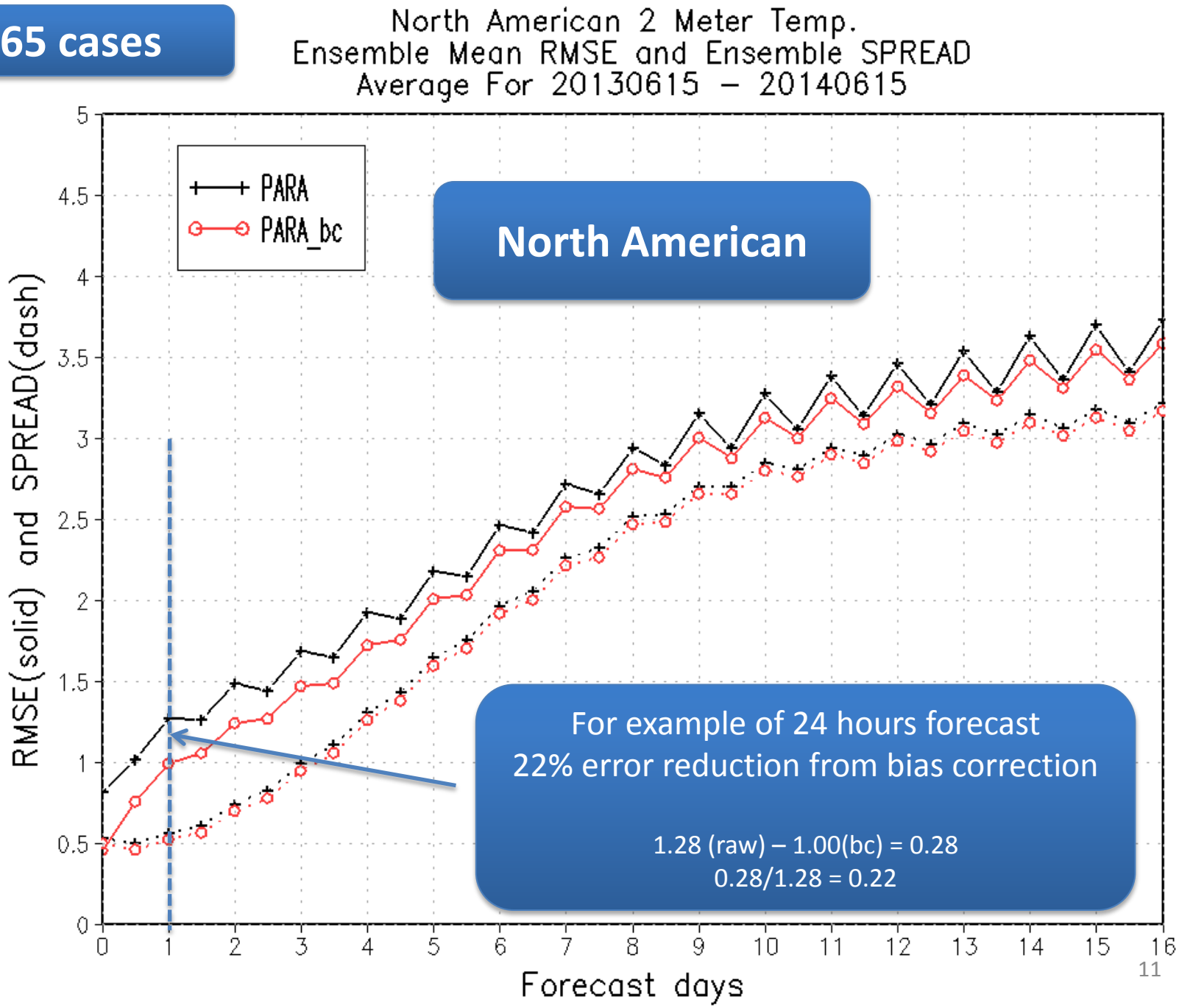



2% improvement of 7-day forecast AC score

About 8 hours improvement of skillful forecast

**On average, model will take about 10 years to extend one day skillful forecast**

**365 cases**

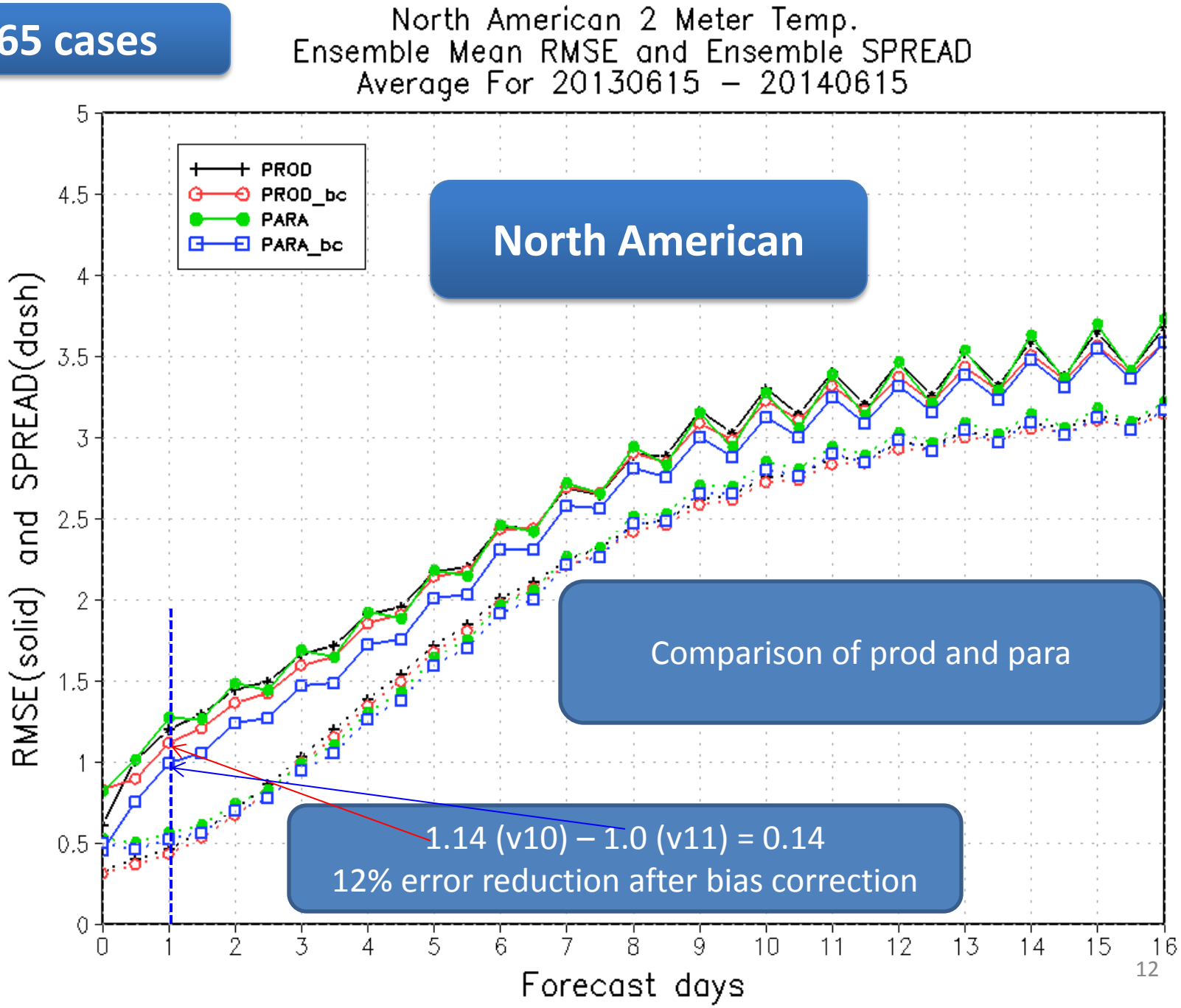



**North American**

For example of 24 hours forecast
22% error reduction from bias correction

1.28 (raw) – 1.00(bc) = 0.28
0.28/1.28 = 0.22

365 cases

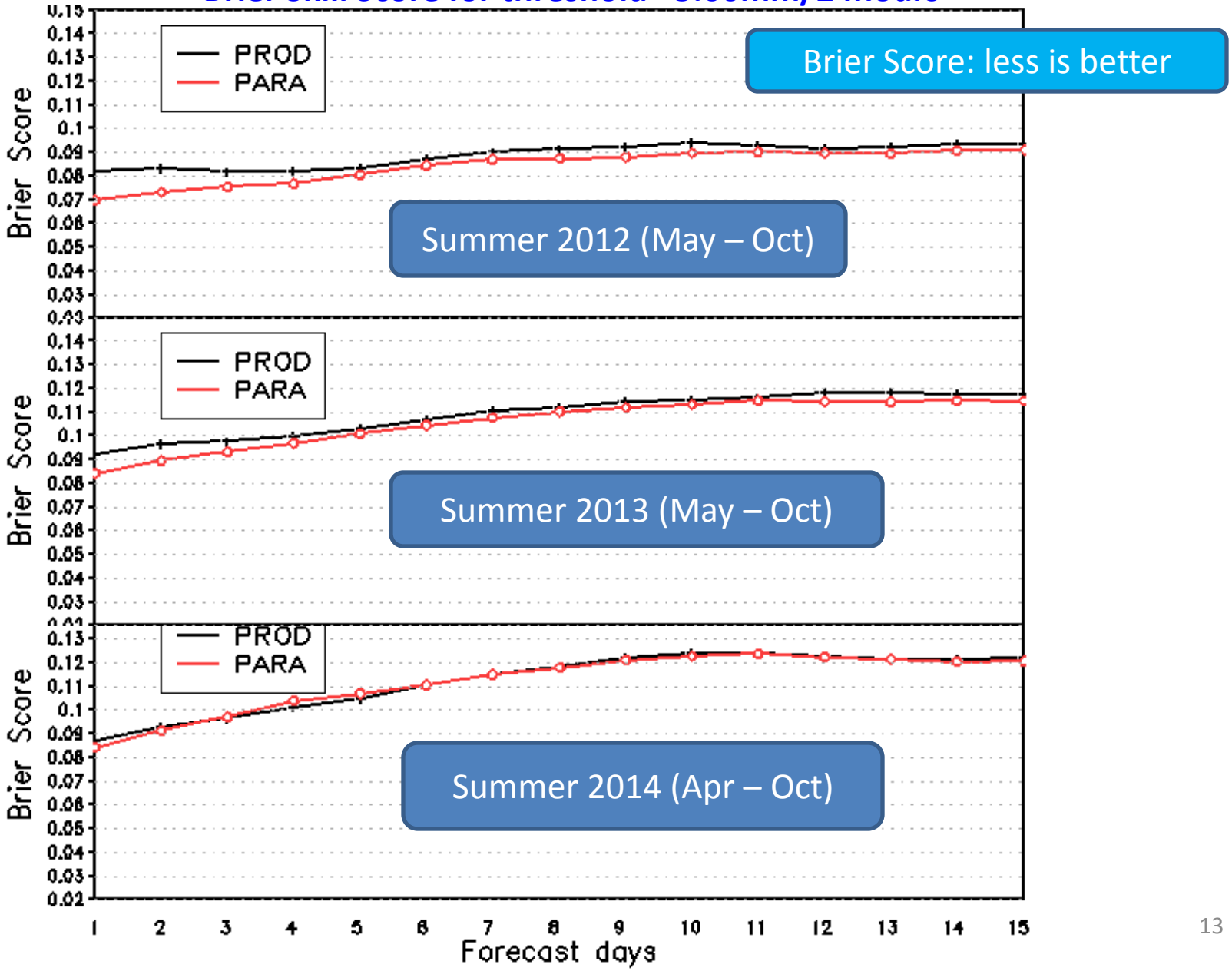



North American

Comparison of prod and para

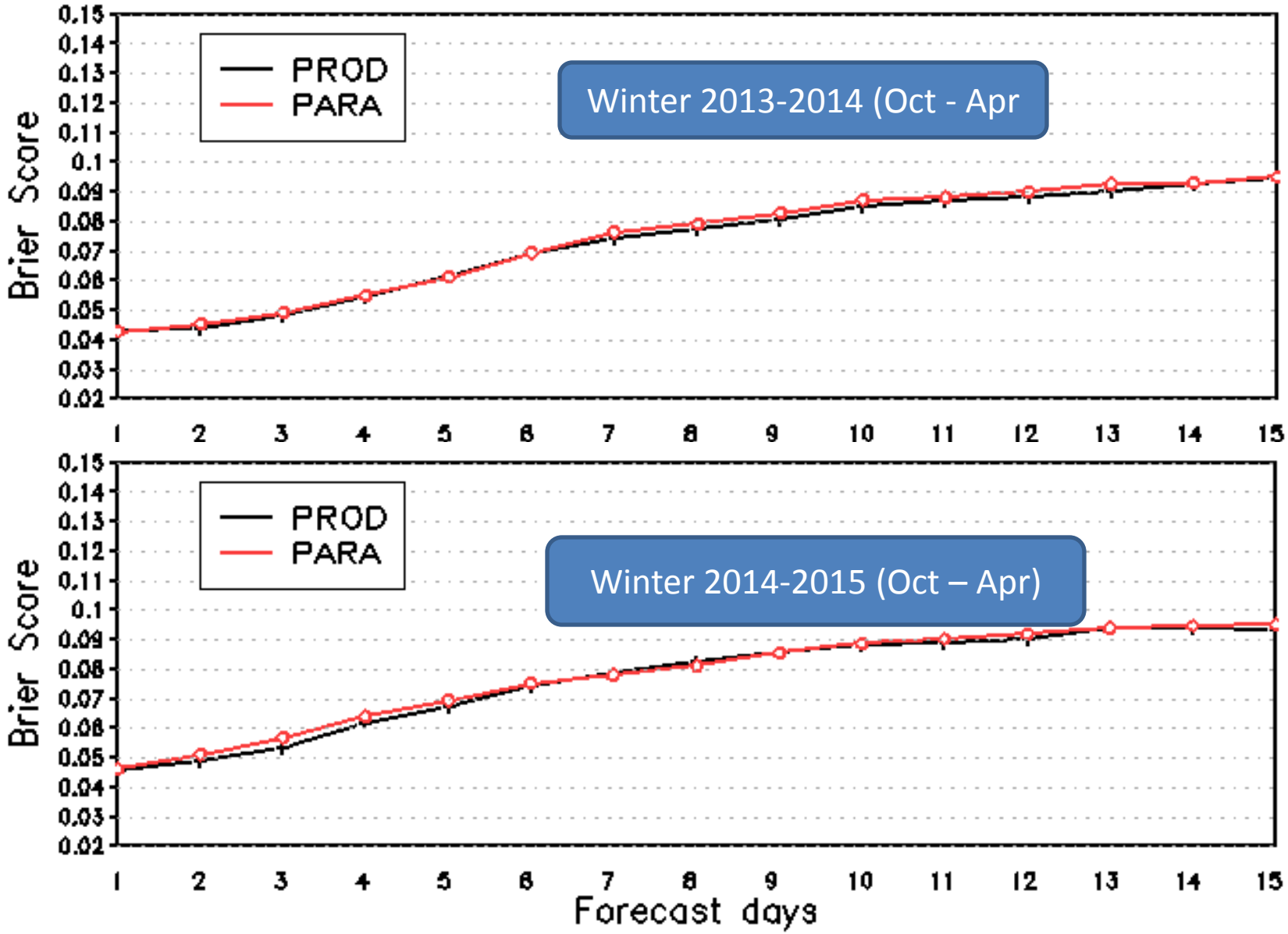
1.14 (v10) – 1.0 (v11) = 0.14
12% error reduction after bias correction

# Ensemble Precipitation Verification for CONUS

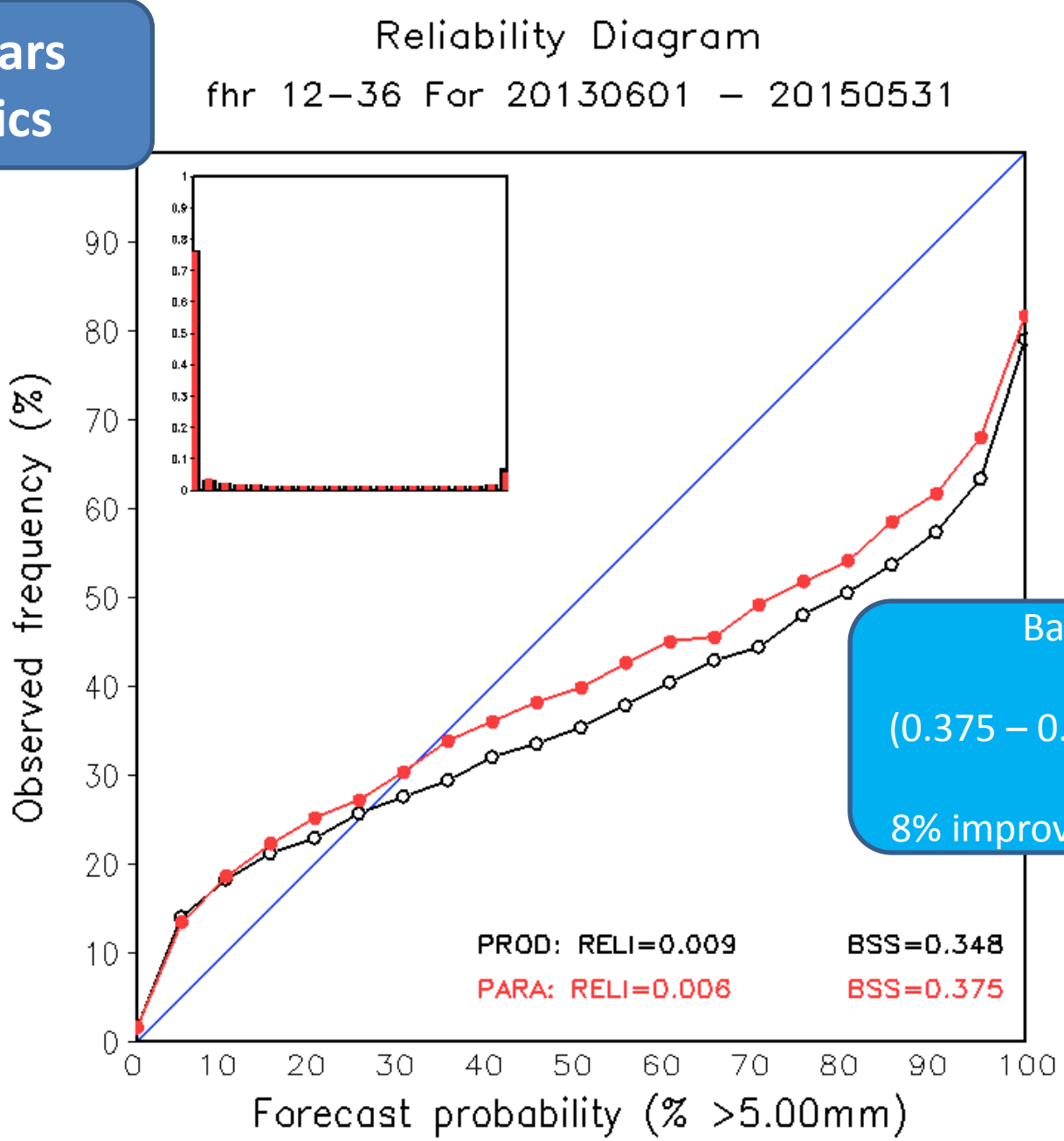


# Ensemble Precipitation Verification for CONUS

**Brier Skill Score for threshold >5.00mm/24hours**



# Two years Statistics

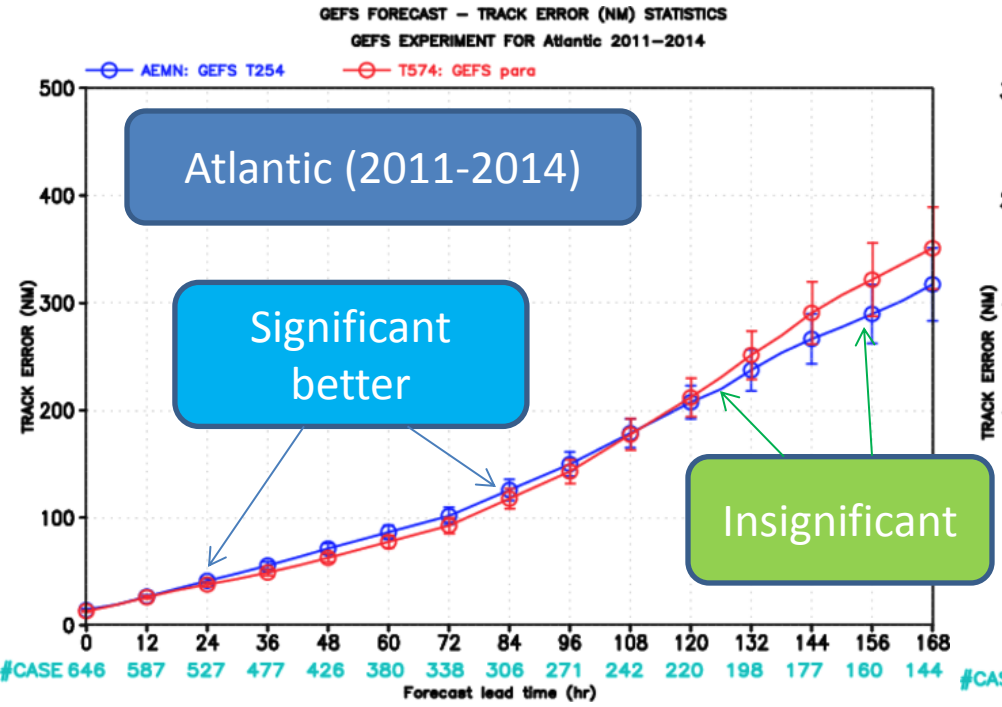


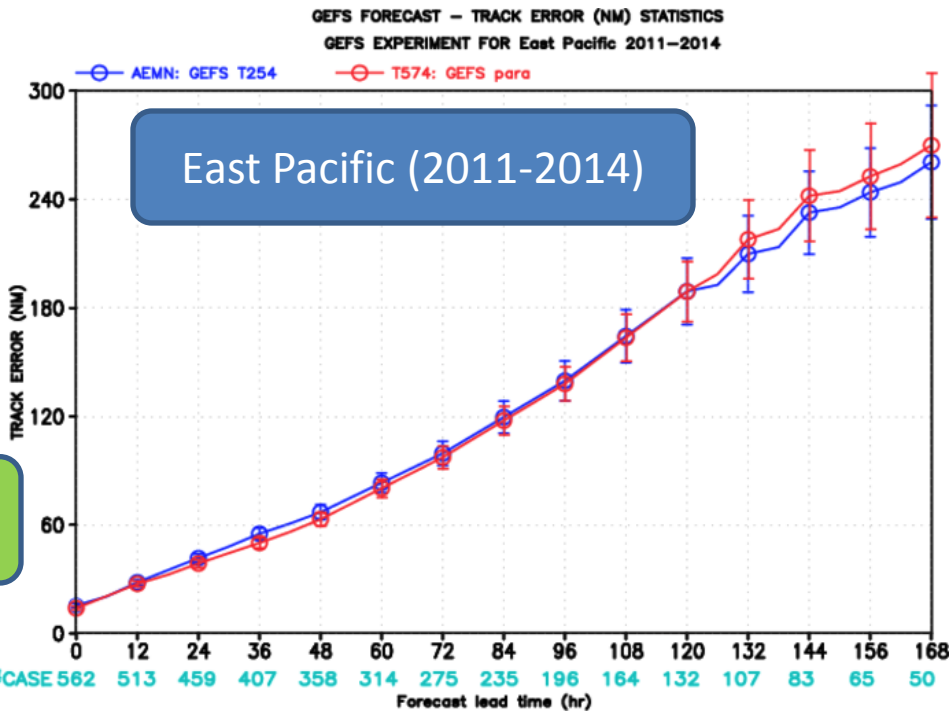

Based BSS

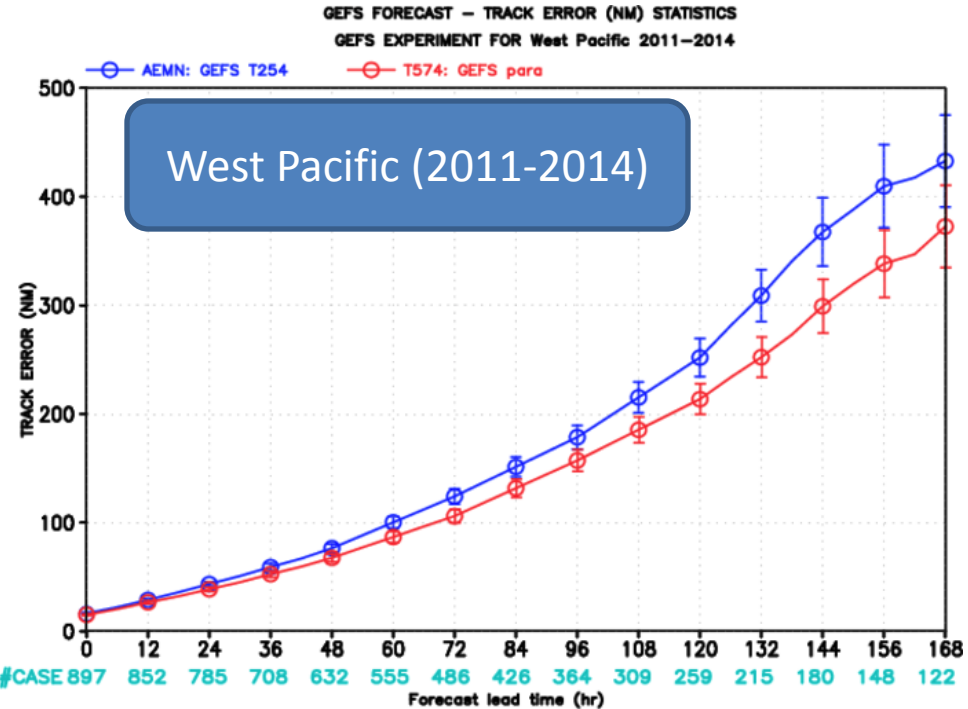
(0.375 – 0.348)/0.348=8%

8% improvement of PQPF

Precipitation reliability for 12-36hr and greater than 5mm/day



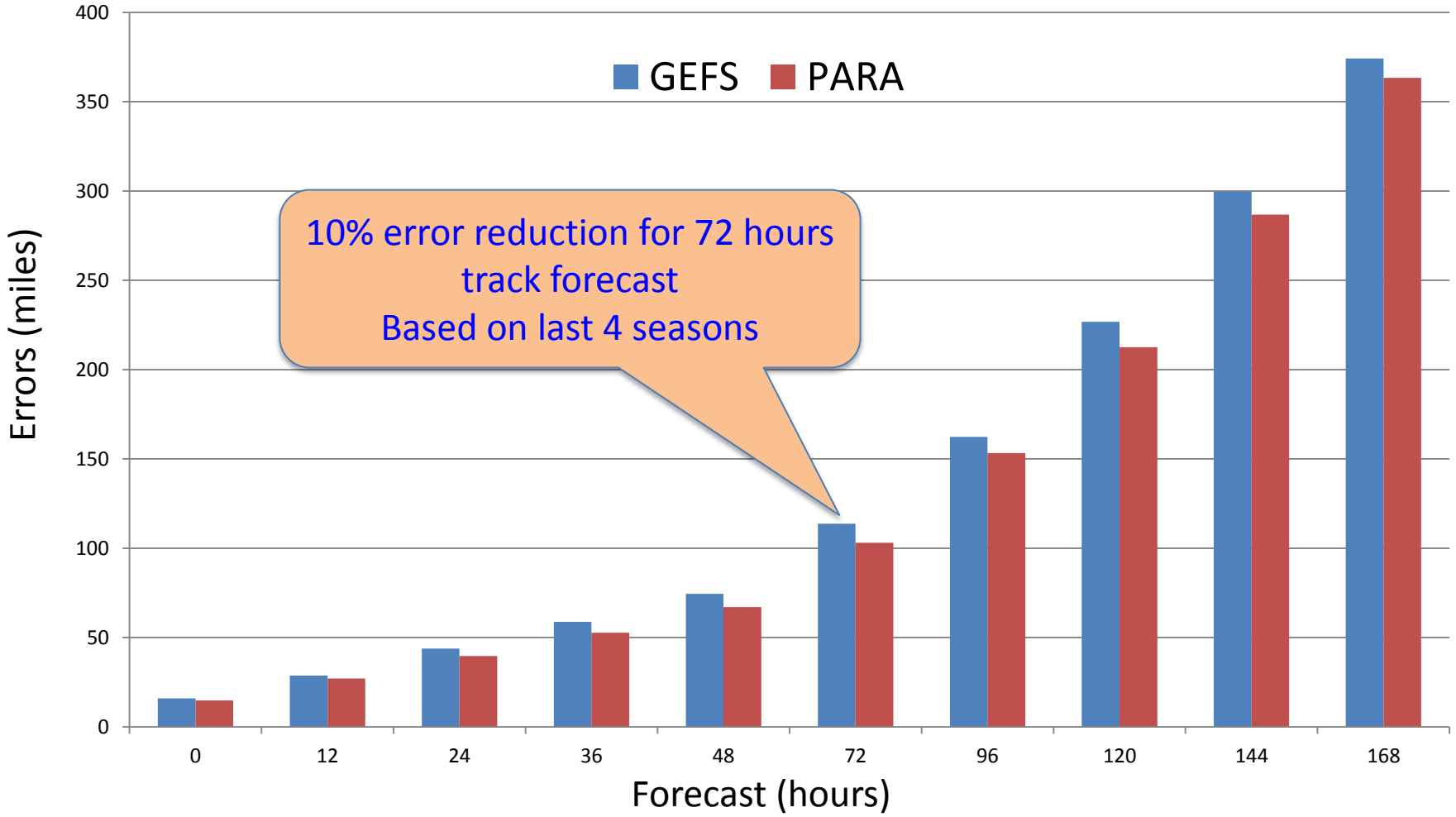




# TS track verification

1. For 2011 season, there are selected Atlantic/East Pacific cases only
2. For 2011 season, we use GEFSv10 parallel to compare, instead of operational GEFSv09
3. Samples included tropical low pressure and extra tropical lows in order to compare to NHC
4. Track forecast are all improved, except for a slight degradation of AL beyond d-5, but it is insignificant

# TS track errors for 2011-2014 seasons

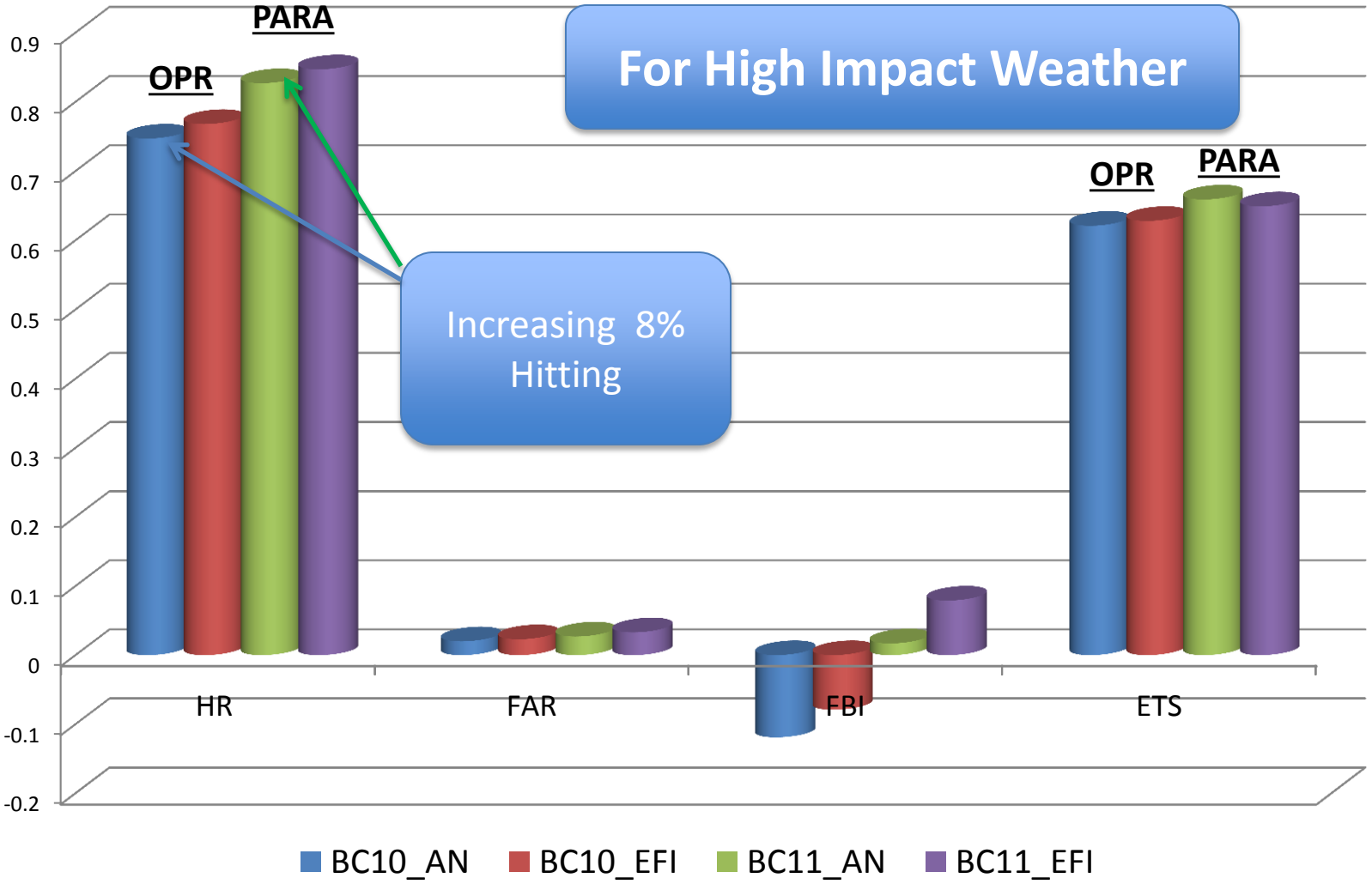
## Statistics for all basins




| Cases | 2201 | 2101 | 1972 | 1817 | 1672 | 1375 | 1090 | 834 | 632 | 458 |
|---|---|---|---|---|---|---|---|---|---|---|

# Statistics for extreme cold weather event (11 cases)

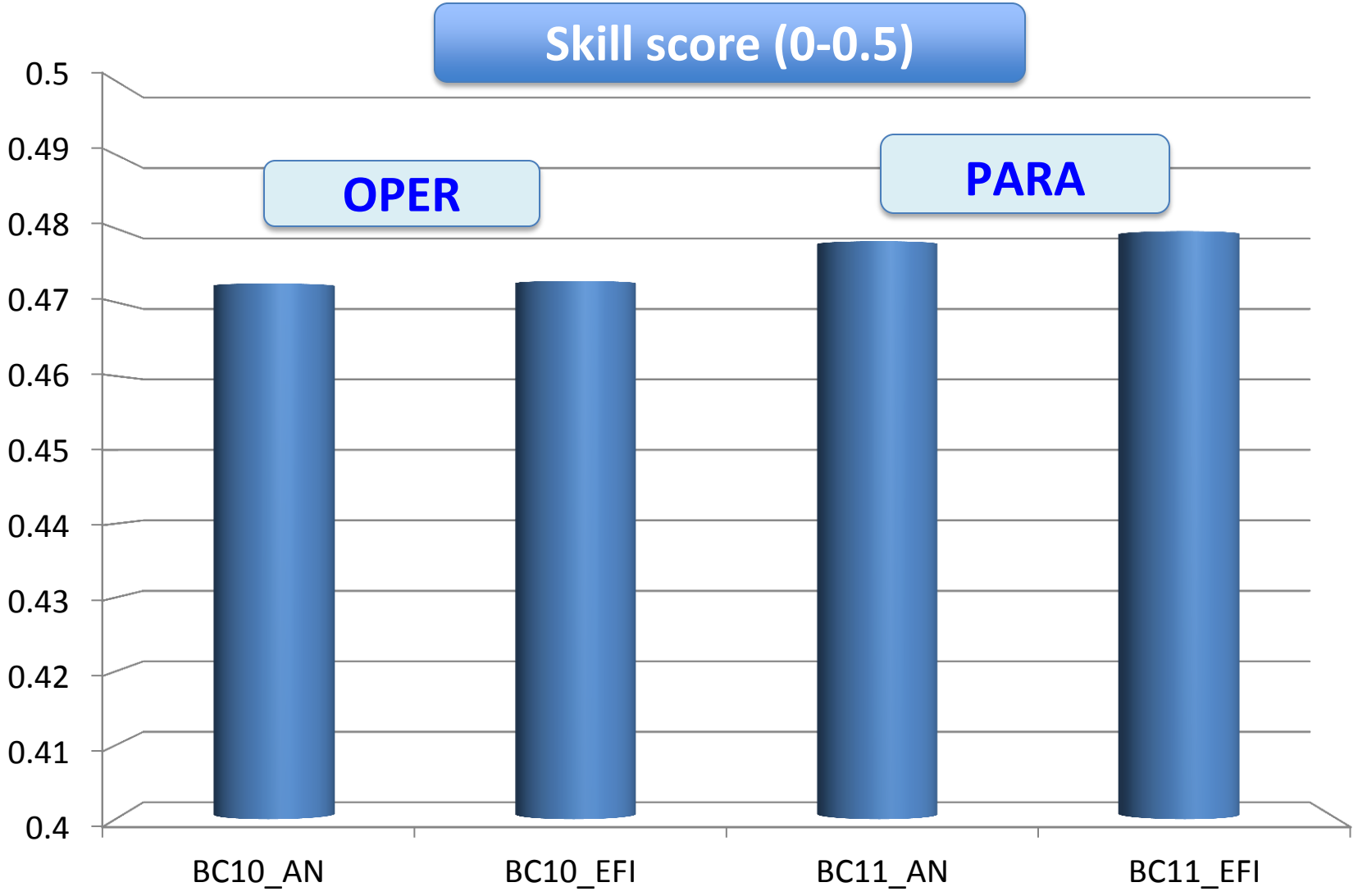
## – V10 and V11 bias-corrected forecast (96hrs)




HR – Hitting rate; FAR – False alarm rate; FBI – Frequency bias; ETS – Equitable threat score)

# ROC area for extreme cold weather event (11 cases)

## – V10 and V11 bias-corrected forecast (96hrs)



# Cost and benefit of GEFS upgrade

- Implementation cycling – 2 years (actually 3+ years now from last implementation)

- Computation cost (example)
  - GEFSv10 – ~105 nodes for 1 hour (one cycle) - 52km (day 1-8)
  - GEFSv11 - ~150-300 nodes for 1 hour (one cycle) – 34km (day 1-8)
  - Nearly 2-3 times resource increasing for upgrade (higher resolution)

- Benefit and improvement (based on 2-year + retrospective runs)
  - Approximate 8-hr useful forecast skill (60%) improvement based on NH 500hPa height AC score
  - Approximate 10% error reduction over all for 72 hours Tropical Storm track forecast from last 4 summer season statistics
  - Approximate 12% error reduction for NA 24 hours surface temperature forecast after bias correction (final products)
  - Approximate 8% BS skill improvement for CONUS PQPF 36-72 hours forecast great than 5mm/24 hours
  - Approximate 8% increasing “hits” for extreme cold weather events for 96 hours forecast with the same “false alarms”
  - **Benefit – social and economic impact?**

# Summary

- Extended summer
  - Improvement:
    - Over-all large scale circulation in terms of AC, RMS error, CRPS and other measures
    - Surface temperature skills – improved for east of CONUS slightly (from cold bias to warm bias)
    - Surface wind
    - Precipitation – improved reliability and skill
    - Hurricane tracks out to 5 days, out to 7 days for West Pacific
  - Neutral:
  - Degrade or concern:
    - Summer warm bias for CONUS T2m and dry bias for heavy precipitation
    - Slight degradation of hurricane tracks forecast for AL basin beyond day-5, but it is insignificant

- Extended winter
  - Improvement:
    - Over-all for many atmospheric variables
    - Surface wind
    - Surface temperature after bias correction
    - Extreme weather events (cold events)
  - Neutral:
    - Surface temperature errors and bias for CONUS (against obs)
    - Precipitation
  - Degrade:

# Users recommendations

- CPC's recommendation – implement
- WPC's recommendation – implement
- WFO (ER)'s recommendation – implement
- SPC's recommendation – not implement
  - Weaker CAPE for summer due to warm bias
- NHC's recommendation – neutral (early communication) – not implement (later)
  - Degradation (insignificant) for TC track forecast beyond d-5 for Atlantic Basin.

# Plan for future

- Evaluation metrics – broader topic
  - Unify (consensus) model evaluation metrics between model developers and users
    - EMC will lead a 1-day workshop to discuss this in next 6 months with NCEP service centers, NWS/regions and other users
- Sciences
  - Improve model physics
    - To reduce/eliminate model bias
      - Warm bias of summer CONUS temperature
      - Dry bias of summer CONUS precipitation
      - Enhance/improve forecast skills (CAPE and others) for severe weather, fire weather
    - To improve TC track forecast for longer lead-time
  - Improve stochastic perturbation for ensemble
    - To implement SPPT (Stochastic Perturbed Physics Tendencies) scheme – increase precipitation spread and reliability

# 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:
  - Shrinivas Moorthi, Hui-ya Chuang, Dana Carlis, Fanglin Yang, Kate Howard, Diane Strokes, Mike Young, Suranjana Saha, Vijay Tallapragada, Mark Iredell, John Derber.
- NCO staffs:
  - Steven Earle, Jianbin Yang, Xiaoxue Wang, Simon Hsiao, Jistin Cooke, Carissa Klemmer, Luke Lin, Rebecca Cosgrove

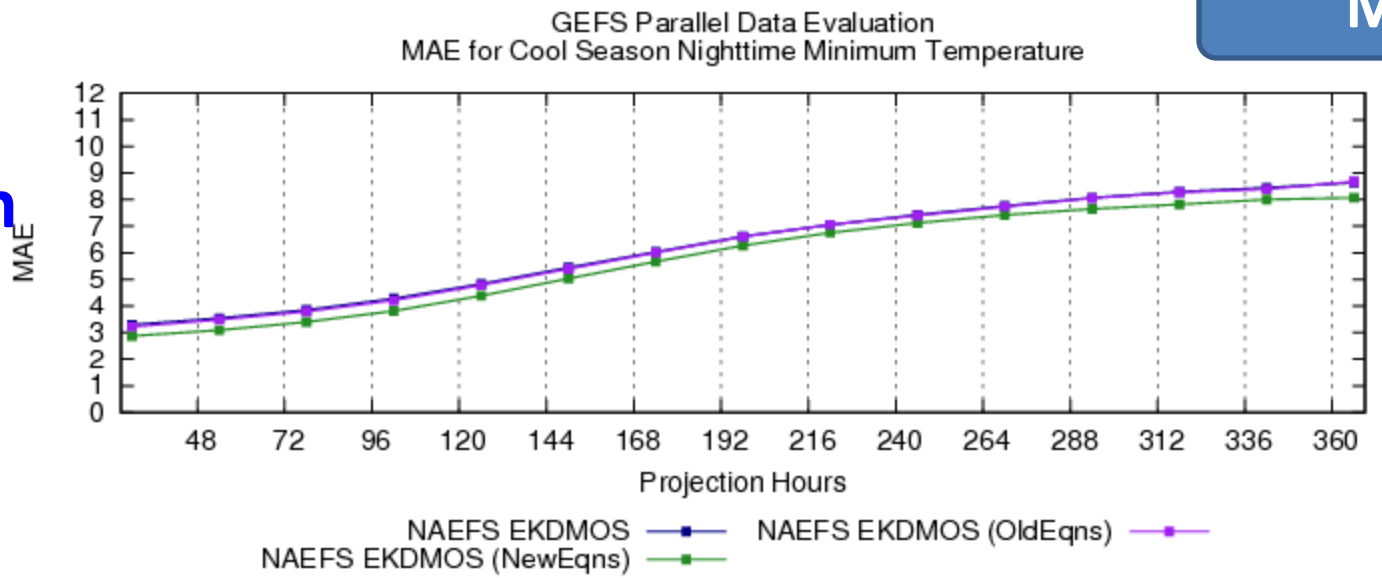
# Users evaluations of two-year (+) retrospective runs

**June 1st 2013 – May 31st 2015**
**and**
**Summer of 2011 and 2012**

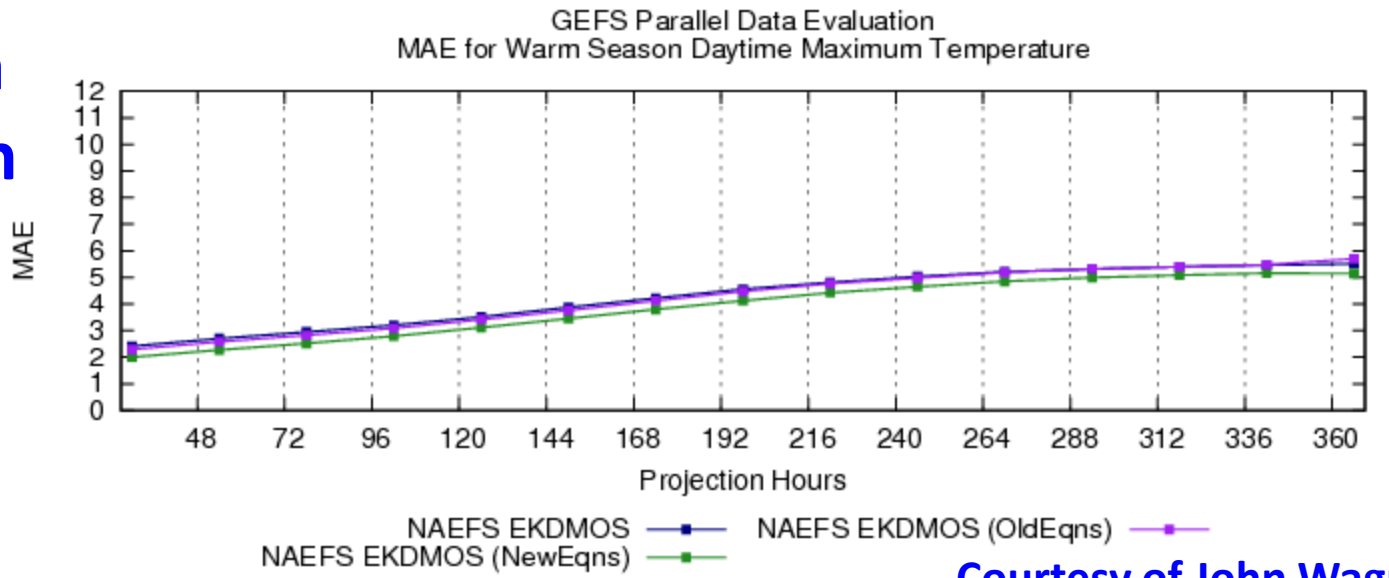
# Evaluation of GEFS retrospective runs (2013-2014) for EKDMOS

MDL

## Cold season



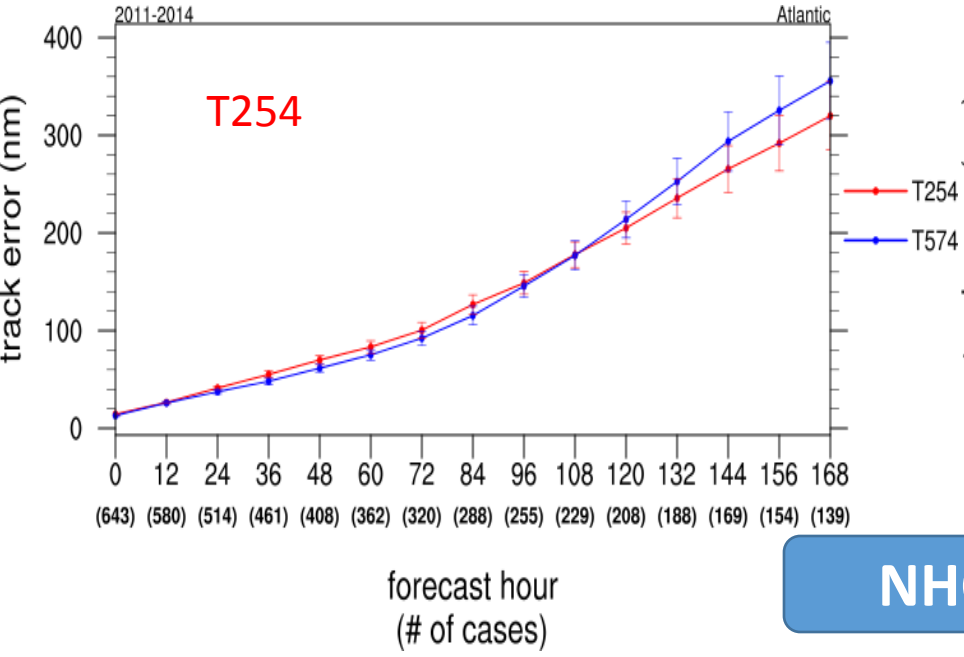

## Warm season



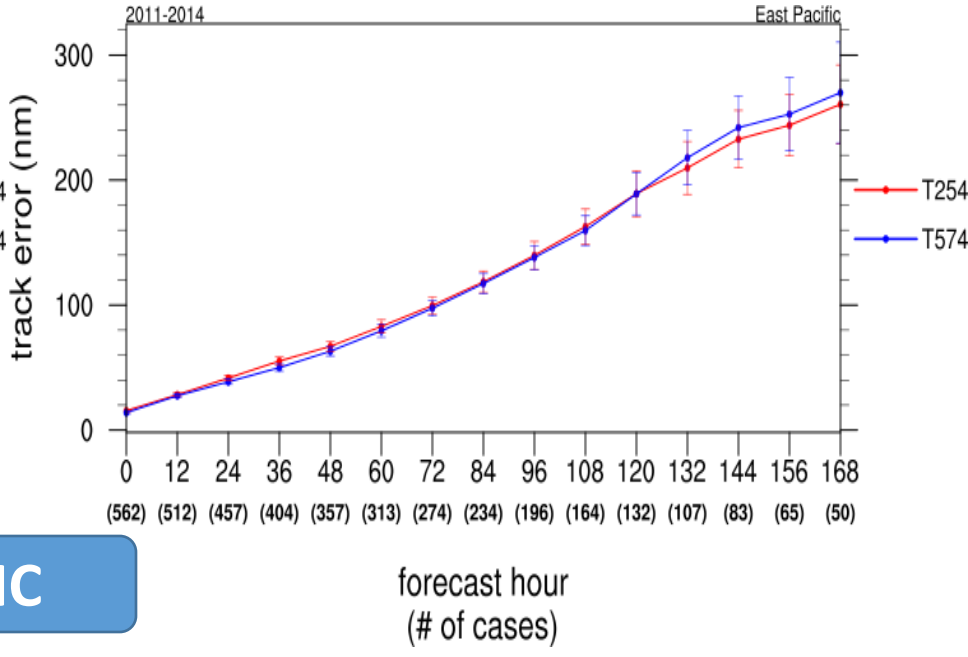

Courtesy of John Wagner (MDL)

# 2011-2014

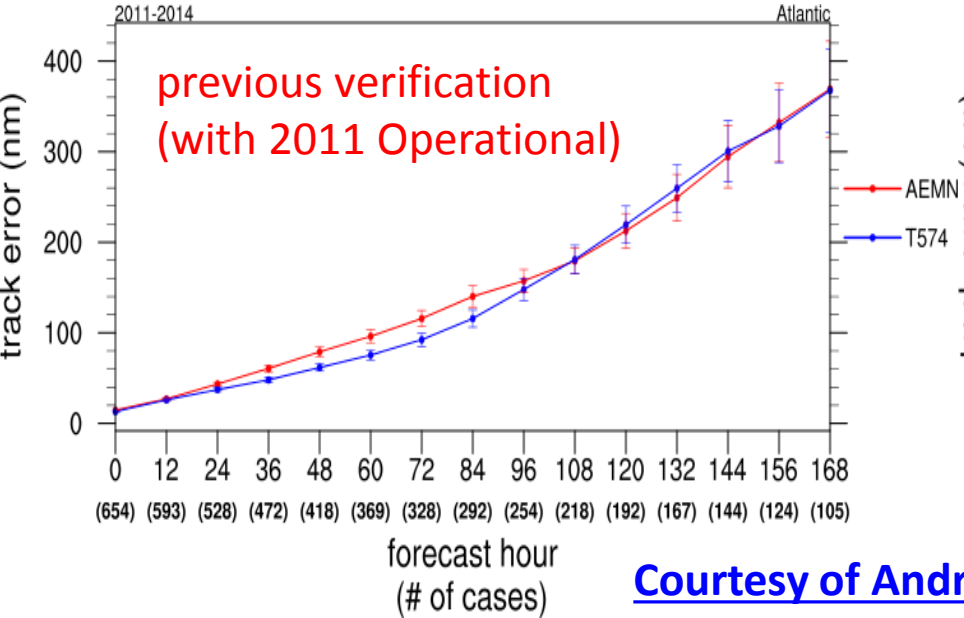
## Atlantic

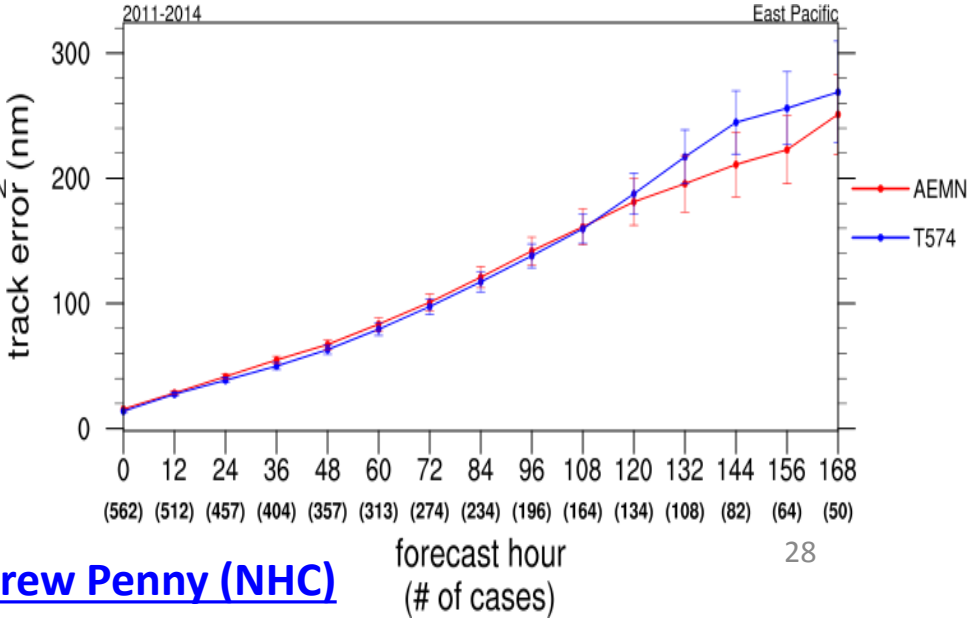



## East Pacific



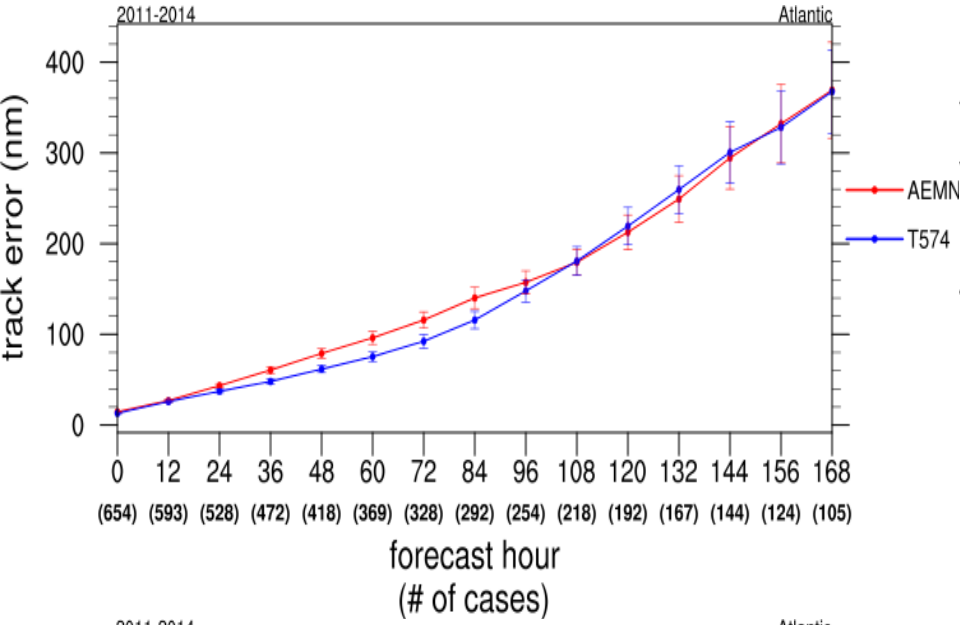

**NHC**



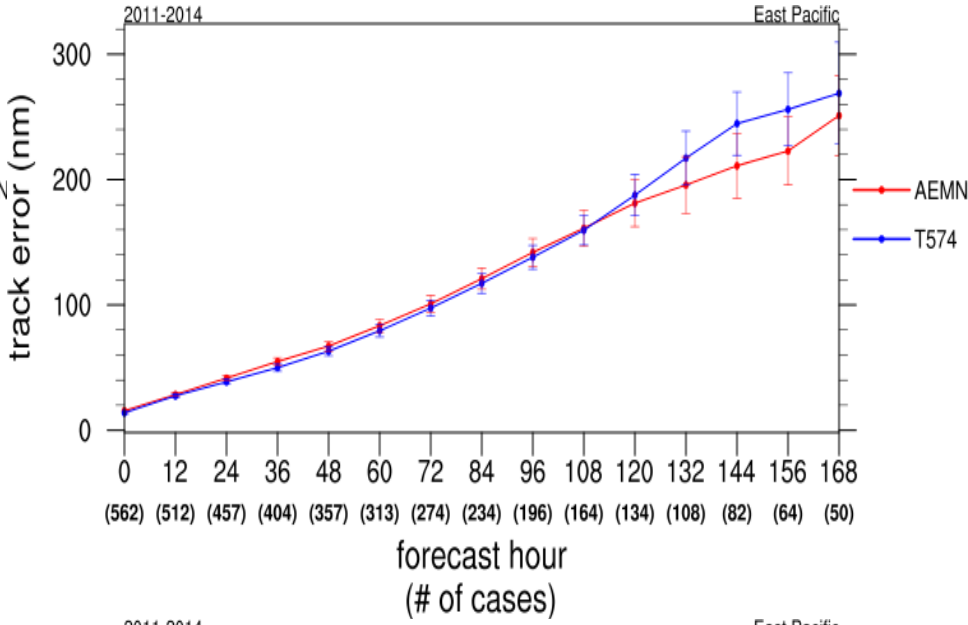



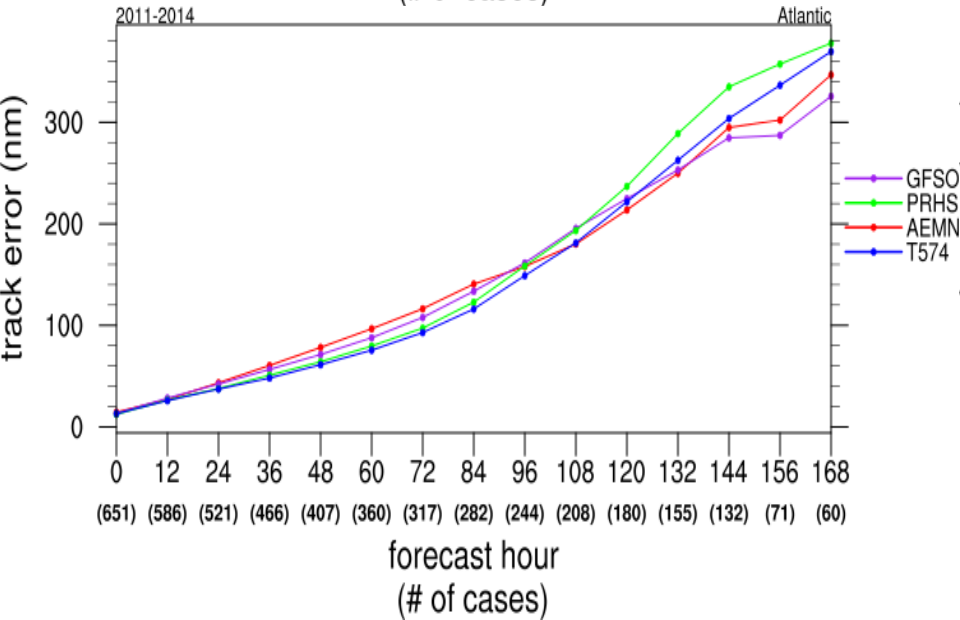

Courtesy of Andrew Penny (NHC)

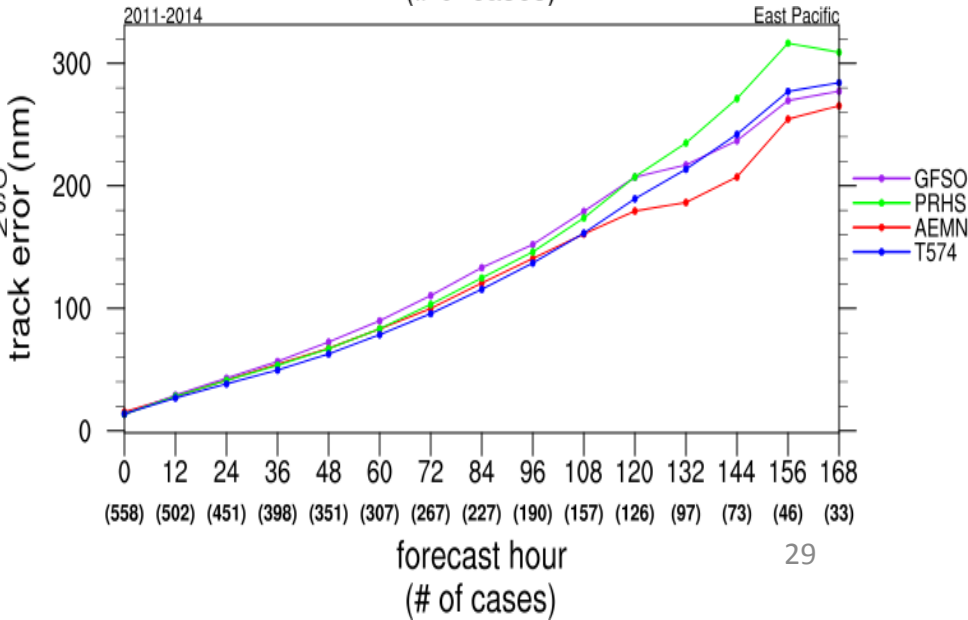
# 2011-2014 Atlantic



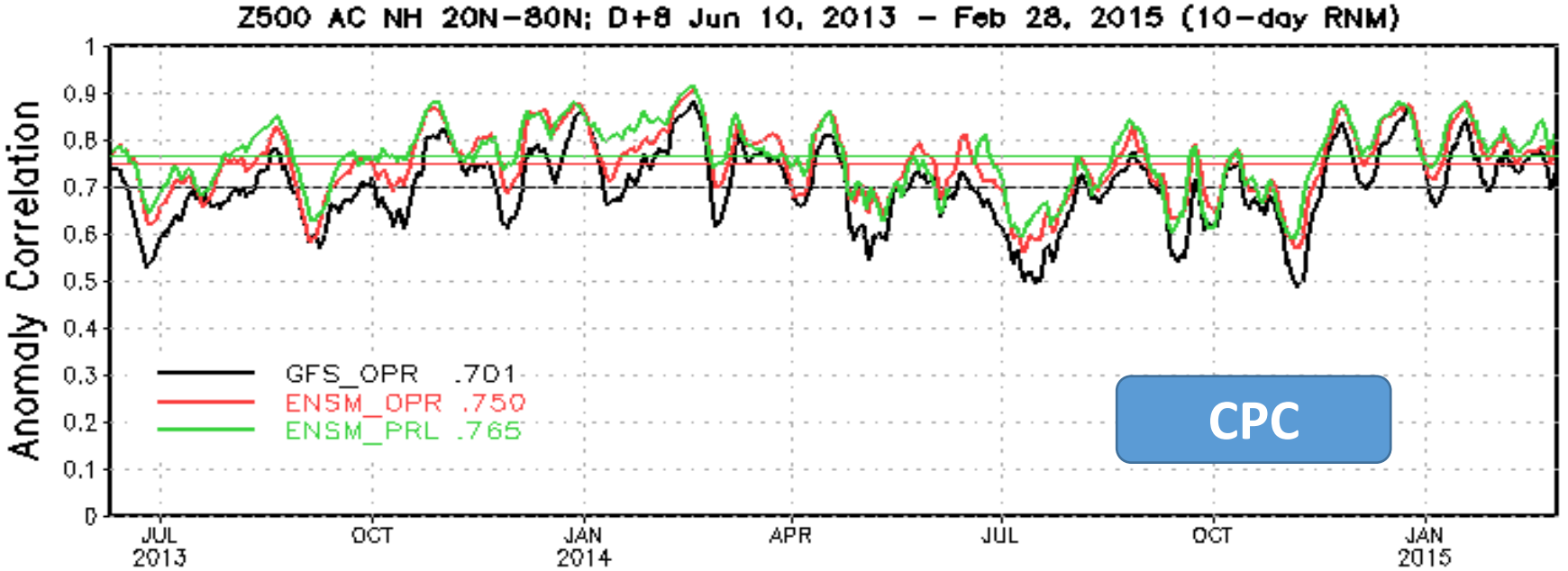

# East Pacific

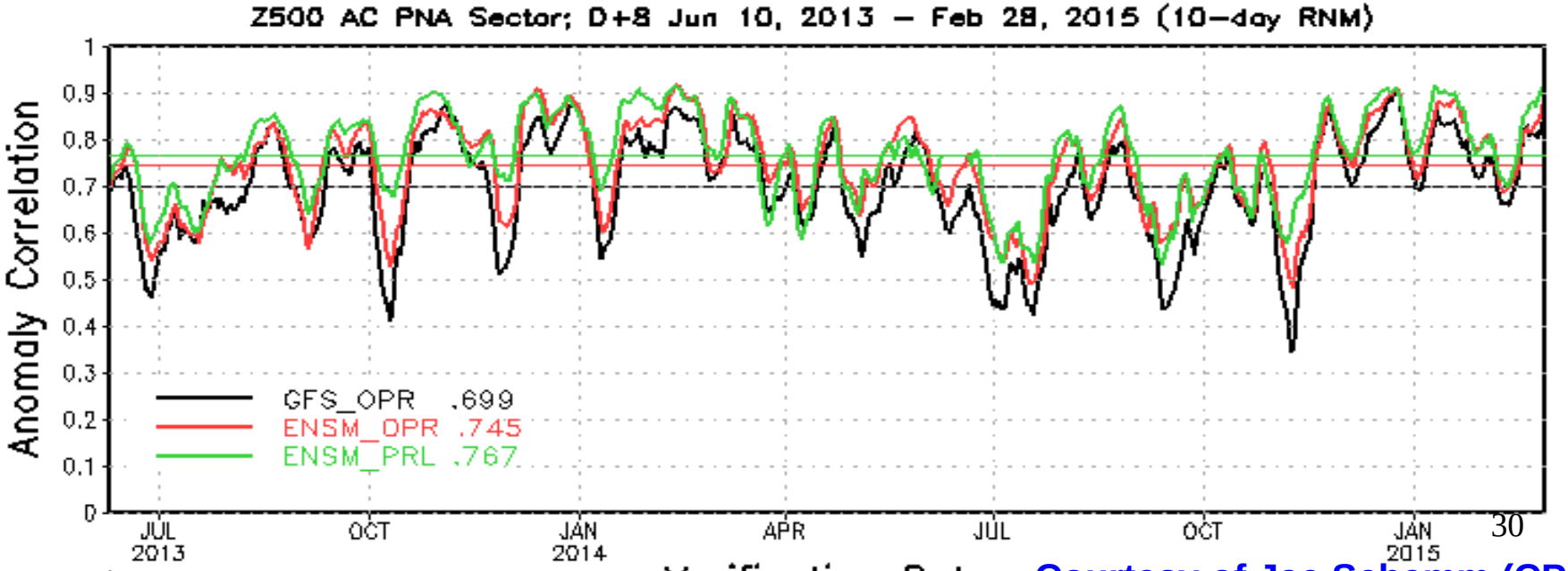


# Z500 Anomaly Correlation Scores for D+8 Forecast

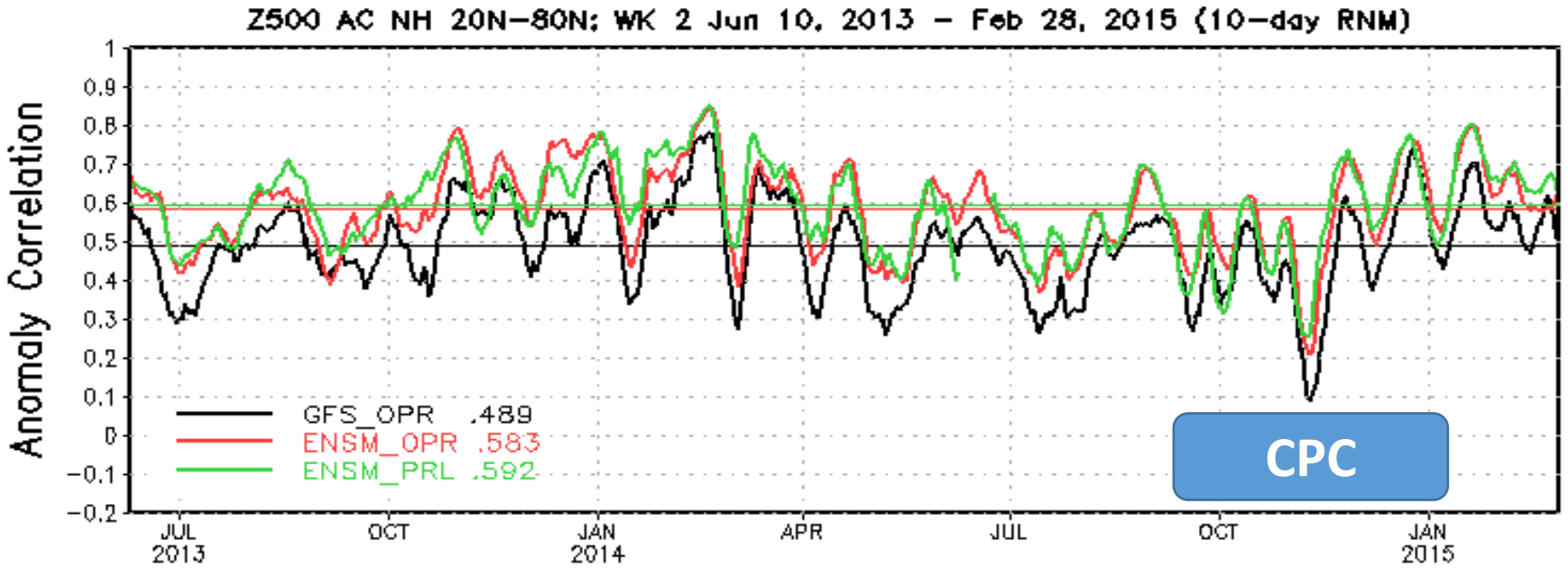


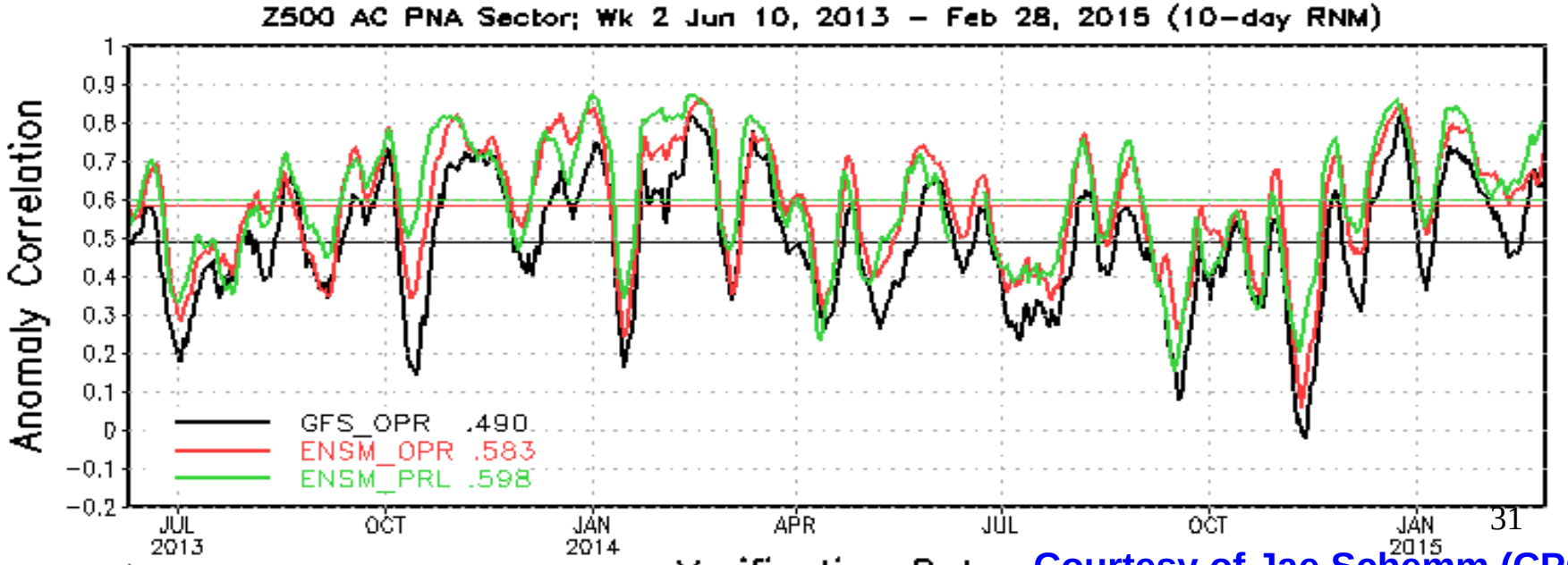






Courtesy of Jae Schemm (CPC)

# Z500 Anomaly Correlation Scores for Week 2






Courtesy of Jae Schemm (CPC)

# Active Users Feedback

- WPC – EMC has presented for WPC in May and later September
- NHC – Jessica Schauer and Andy Penny
- CPC – Dan Collins and Jae Schemm,
- WFOs and regions:
  - ER: Richard Grumm and Brian Miretzky
  - WR: Trevor Alcott
  - CR: Jeff Halblaub
- MDL – John Wagner
- JTWC – Matthew Kucas
- Private sectors and University researchers:
  - Violeta Toma (vt25@mail.gatech.edu)
  - Nickitas Georgas (ngeorgas@stevens.edu )
  - Michael Pass ( wxman11@wxman11.onmicrosoft.com )
  - Eric Wertz (Manager, Weather Data Solutions)
  - Alfonso Mejia ( Assisst Prof, amejia@engr.psu.edu )
  - Ryan Fulton ( ryan.fulton@wilkensweather.com )
  - Chris Brandolino ( Chris.Brandolino@niwa.co.nz )
  - Joe Koval ( joe.koval@weather.com )
  - ……

Hello Dingchen and Justin,

We are beginning to modify our test system to point at the parallel data on "http://para.nomads.ncep.noaa.gov".

However, there are **no index (.idx) files** for the .5 degree files we intend to use. Specifically, I am referring to these files in the screen shot below.

We use the index files to determine which fields to download.

Will you be adding the index files soon for these specific files?

Thanks
Joe

Joe Koval
Director, Weather Systems Development
The Weather Company
Atlanta, GA 30339

User request

Hi Dingchen,

By way of introduction, my name is Chris Brandolino. I am a Principal Scientist (Forecasting) with the National Institute of Water and Atmospheric Research in Auckland, New Zealand.

I am writing to get a clear understanding about the operational impacts of the soon-to-be made available GEFS T574. With regards to the anticipated GEFS upgrade, could you please advise as to how long you expect the "old" GEFS will be operational/available once the "new" GEFS is operational in mid-October?

In other words, will the **"new" and "old" GEFS** continue in parallel, and if so, how long do you expect to run or make available the "old" GEFS once the upgrade is implemented?

Also, could you please advise me as to if hindcasts and/or re-forecasts will be made available for the upgraded GEFS products (T574)? If so, when and where might they be located?

I'd be most grateful for any help you can provide.

Thank you.

Kind regards,

Chris

User request

Andrew,

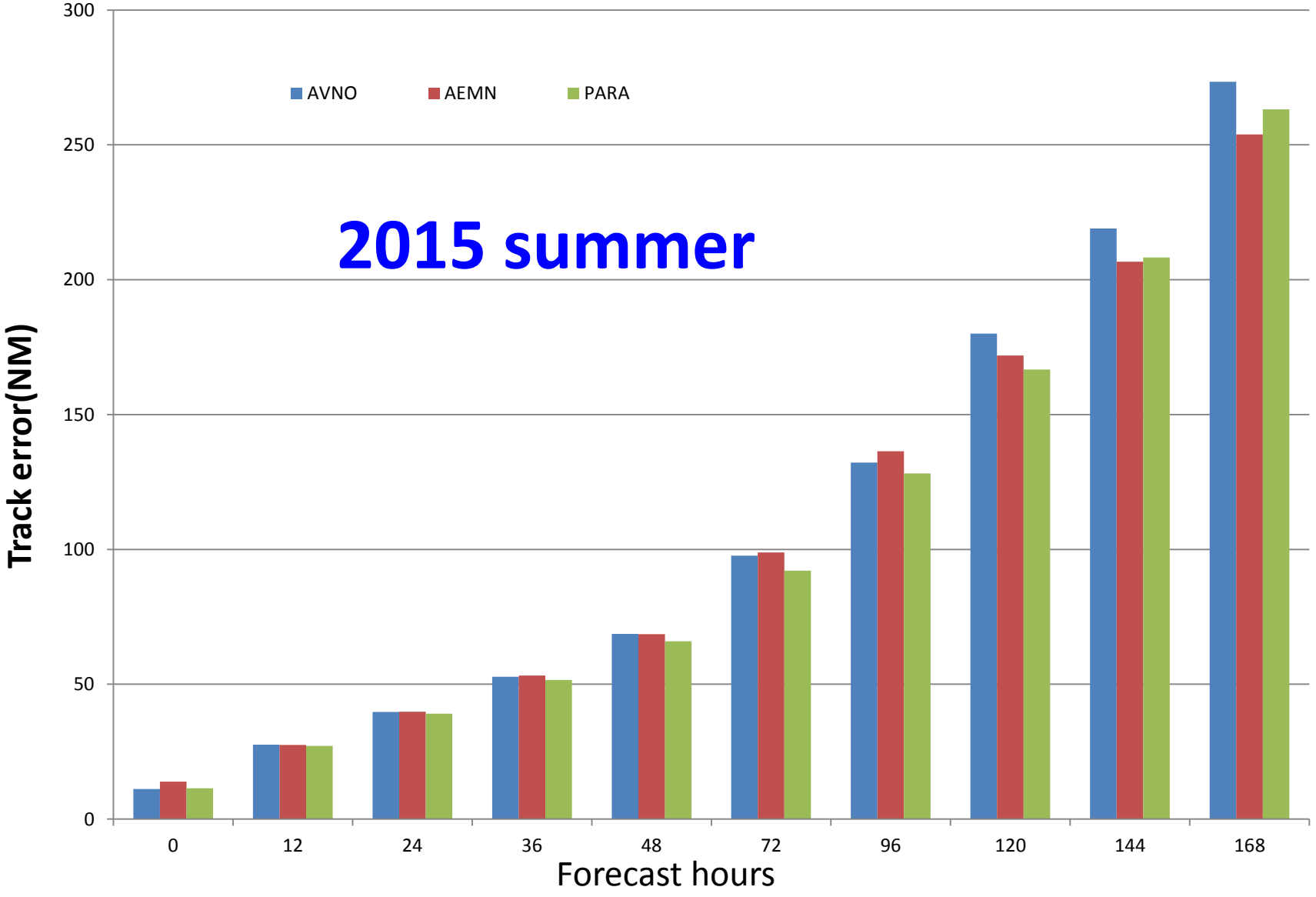
Picked up your email from the NOMADS website. I'm interested in acquiring the **GEFS cyclone model tracks** to use in a similar way that Mr. Cowan has done below, and having a really tough time understanding if there is a dedicated source we can connect with or if its something we have to derive from the overall GEFS model. Appreciate any assistance you can provide.

Regards,

Ryan Fulton - Sr. Program Manager | Weather Applications, Aviation & Marine
Wilkens Weather Technologies, LP, A Rockwell Collins Company
2925 Briarpark Drive, Suite 710, Houston, TX 77042 USA
Office: +1.713.430.7228 | Mobile: +1.281.908.9031
ryan.fulton@wilkensweather.com

User request

# AL03-11, CP01-08, EP04-17, WP09-23, 07/08-10/06, 2015




CASES 1006 931 837 748 663 517 405 310 232 168

# Hurricane Sandy Study for GEFS

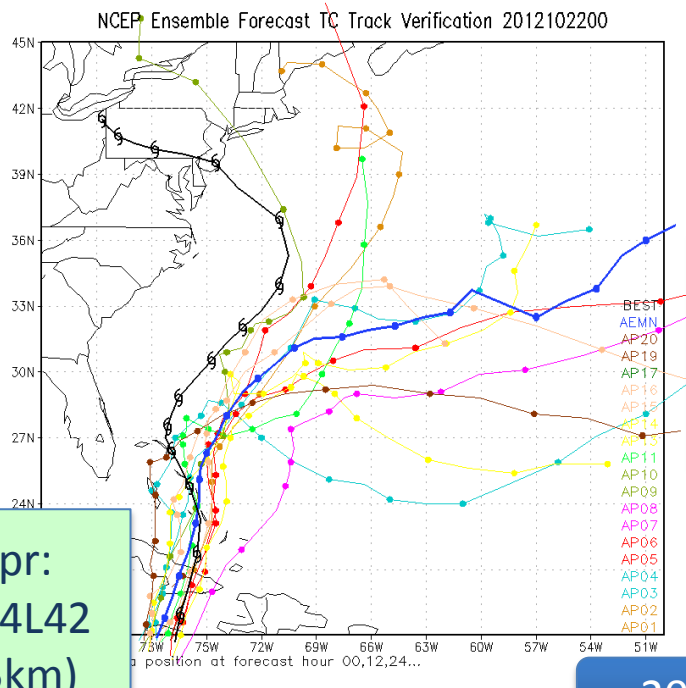
Period: 10/22 – 10/28/2012

Named: 10/23/2012

Yuejian Zhu
EMC/NCEP

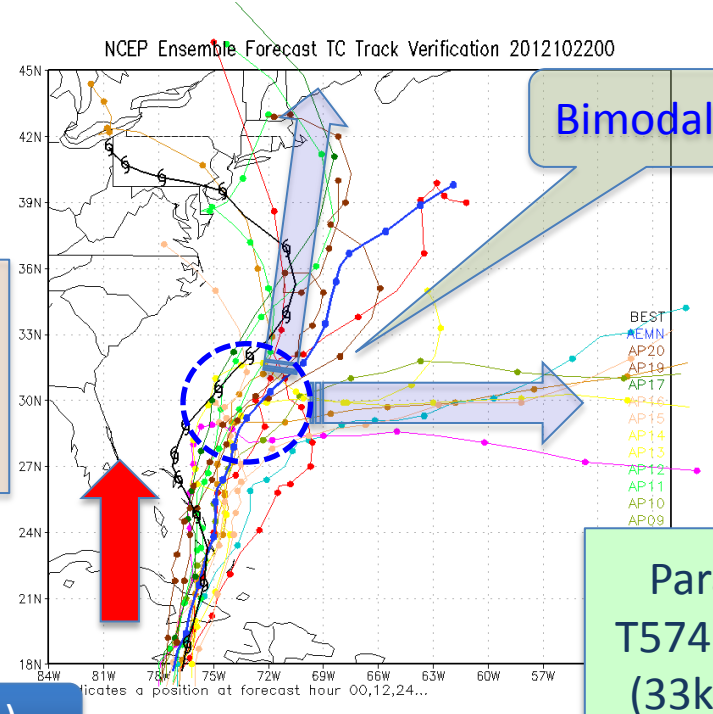
September 15 2014

Acknolegements:
Dingchen Hou, Xiaqiong Zhou and Jiayi Peng




00UTC

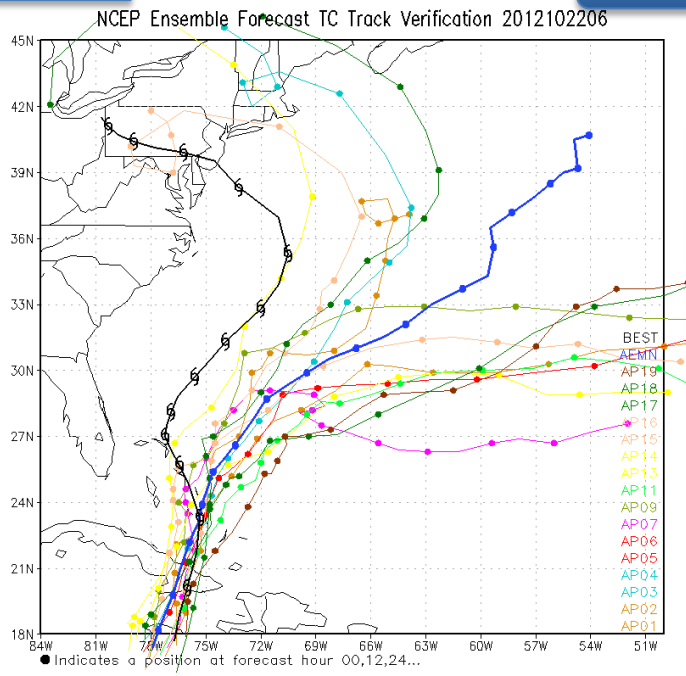
Thick blue: ensemble mean




Opr: T254L42 (55km)

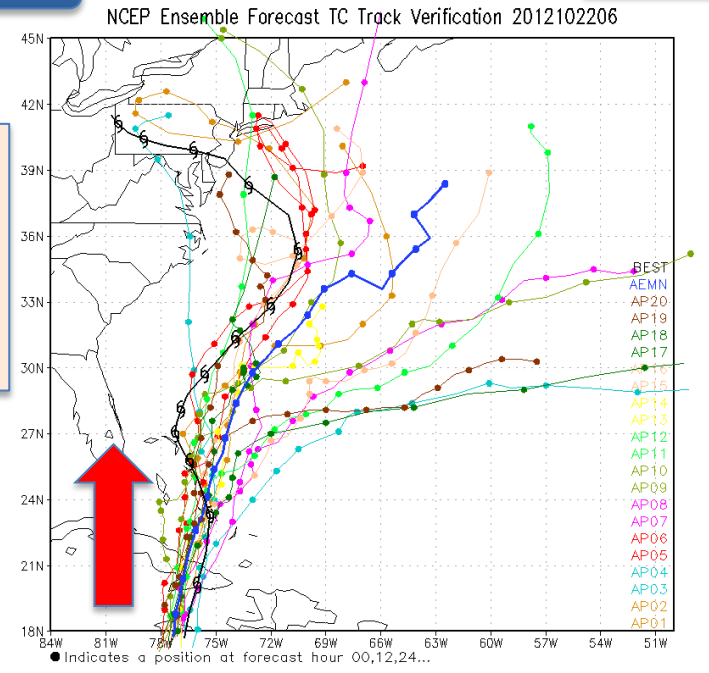
Para: T574L64 (33km)

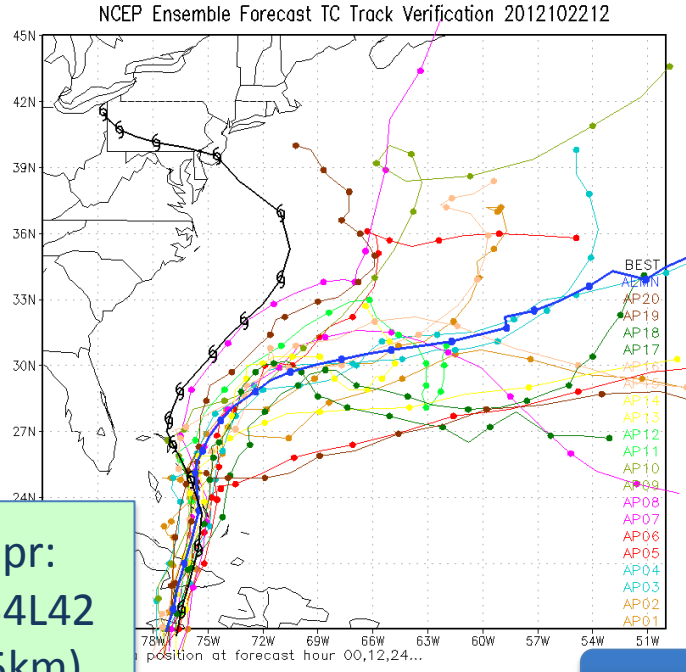
20121022 (8 days)




Red arrow means good forecast

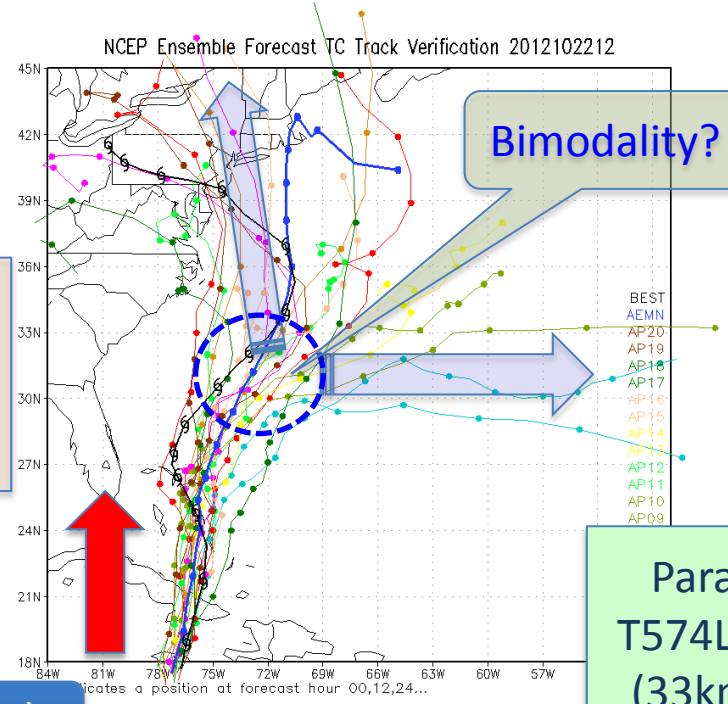
06UTC






12UTC

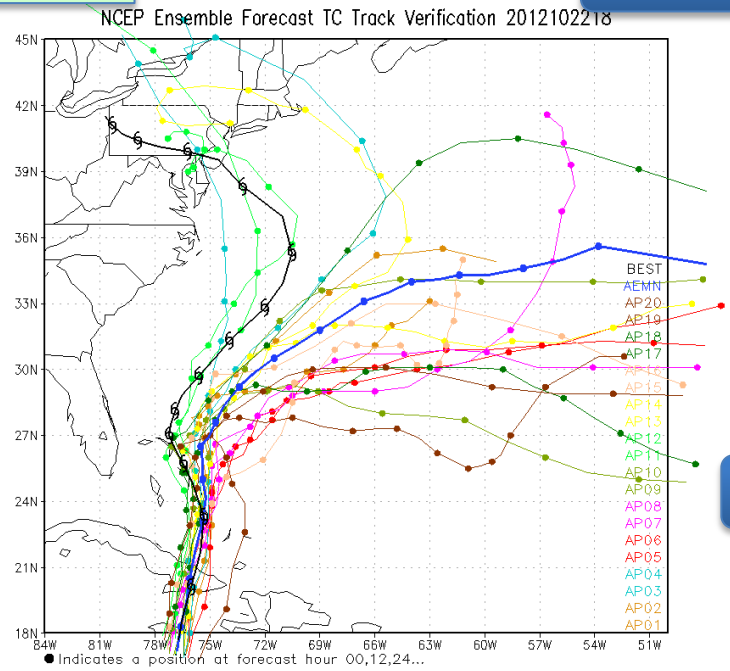
Thick blue: ensemble mean



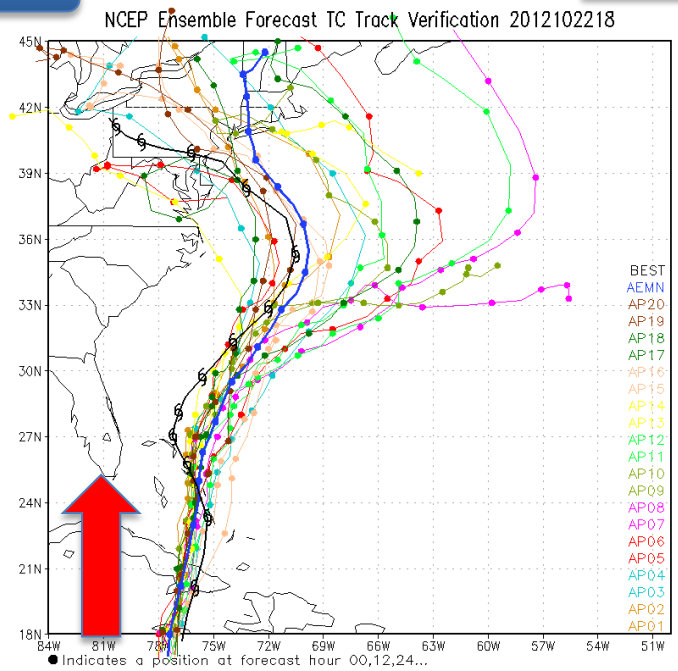

Opr: T254L42 (55km)

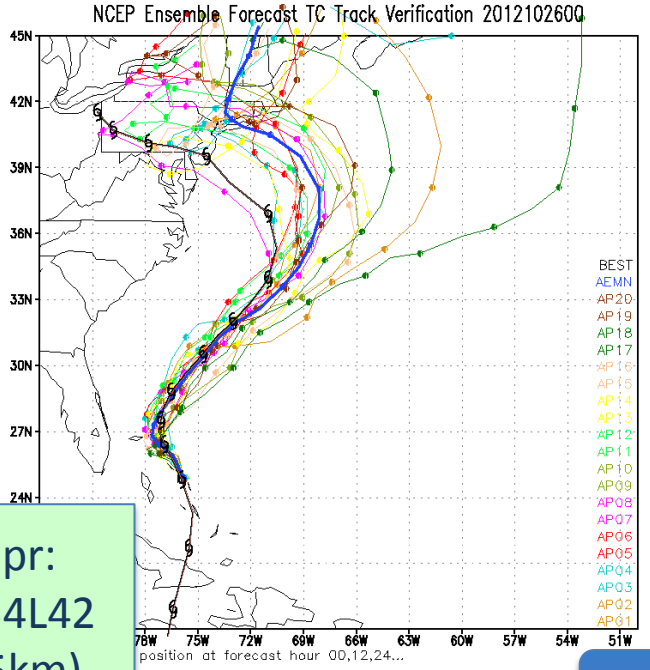
Para: T574L64 (33km)

20121022 (7.5 days)

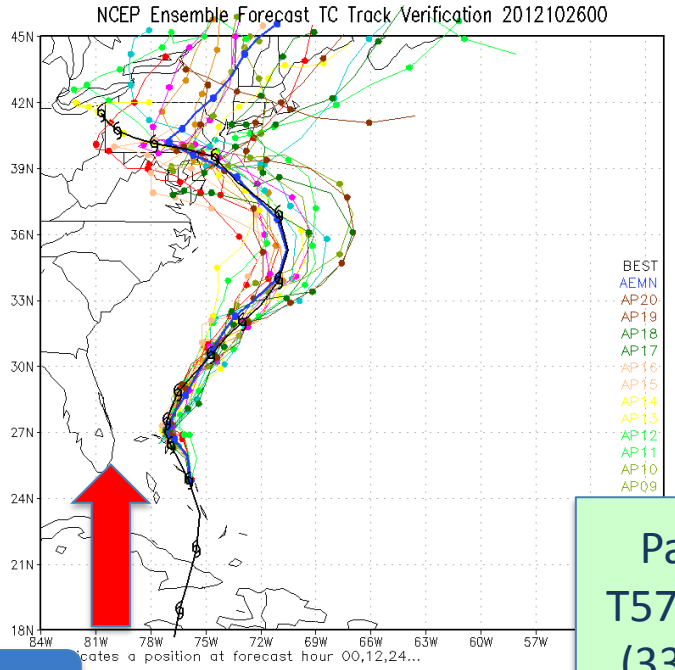



18UTC





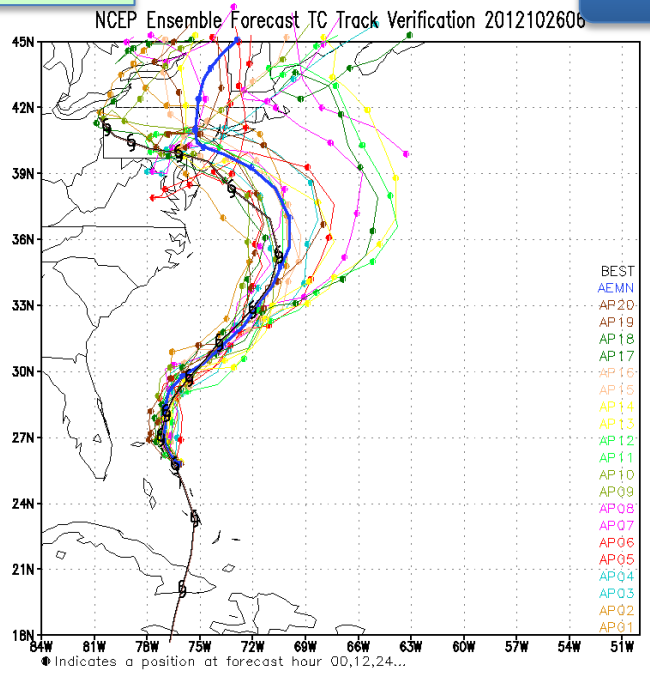

00UTC



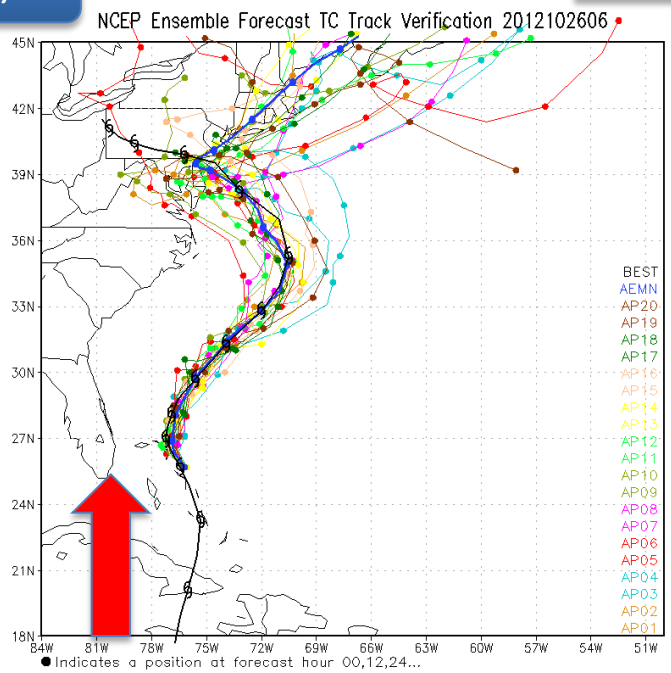

Opr:
T254L42
(55km)

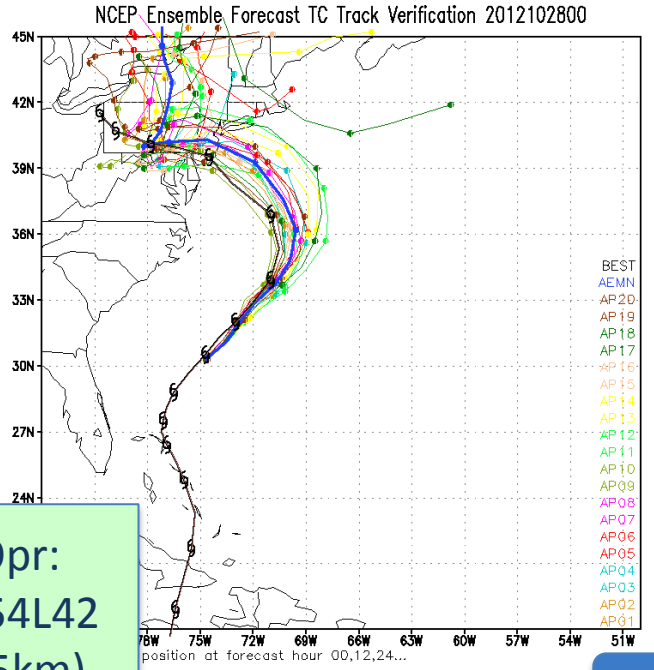
Para:
T574L64
(33km)

20121026 (4 days)

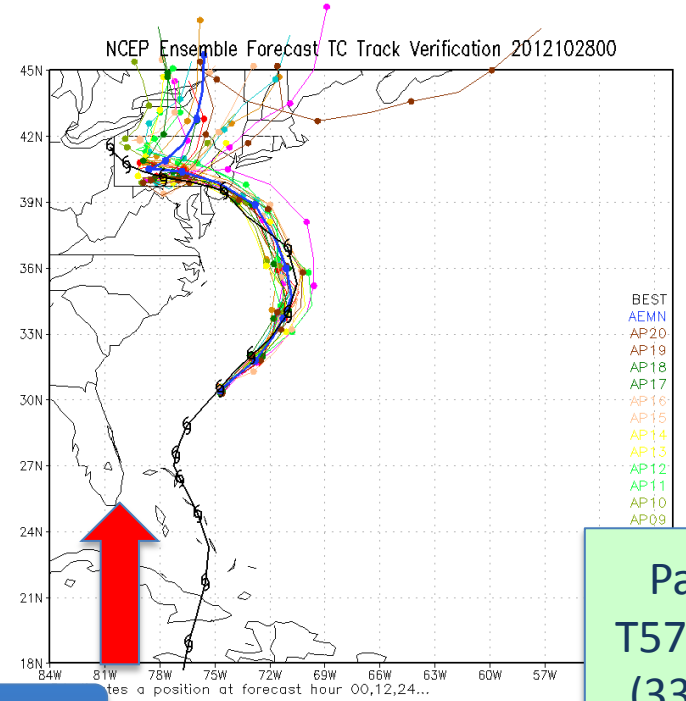



06UTC





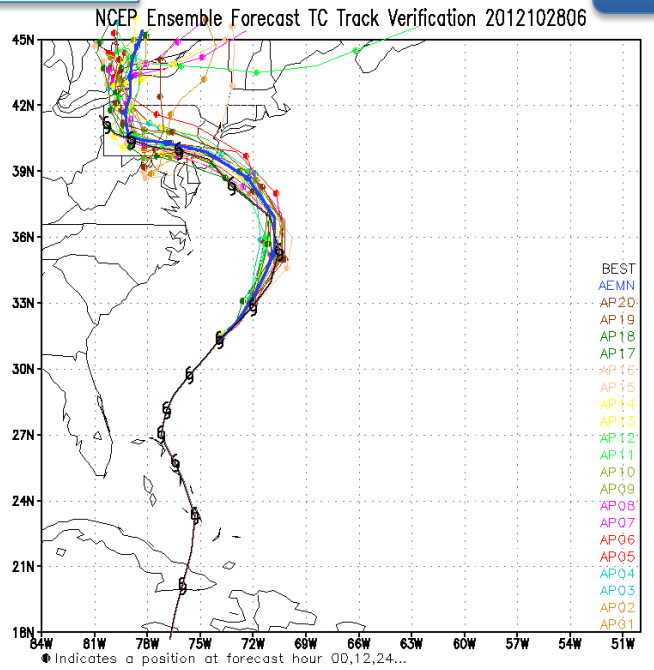

00UTC



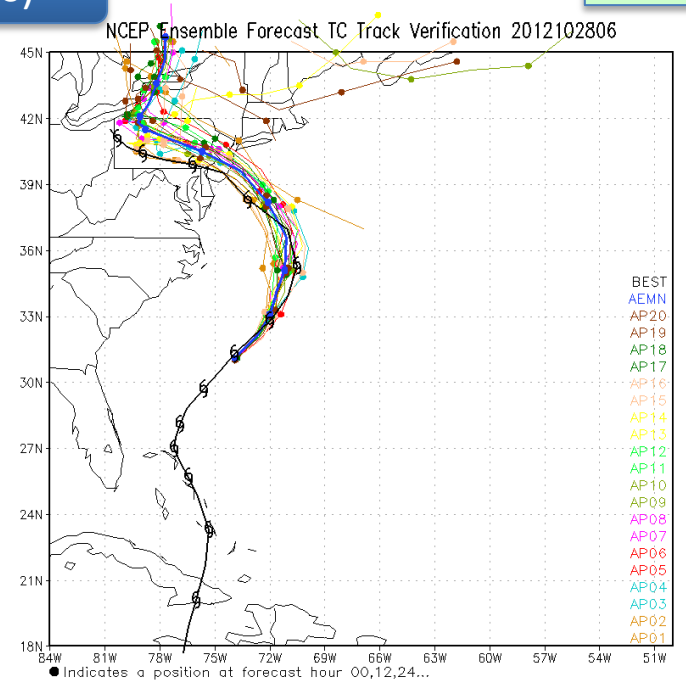

Opr:
T254L42
(55km)

20121028 (2 days)

Para:
T574L64
(33km)




06UTC



# Review of 2015 NE Blizzard

01/26 12UTC – 01/28 12UTC 2015

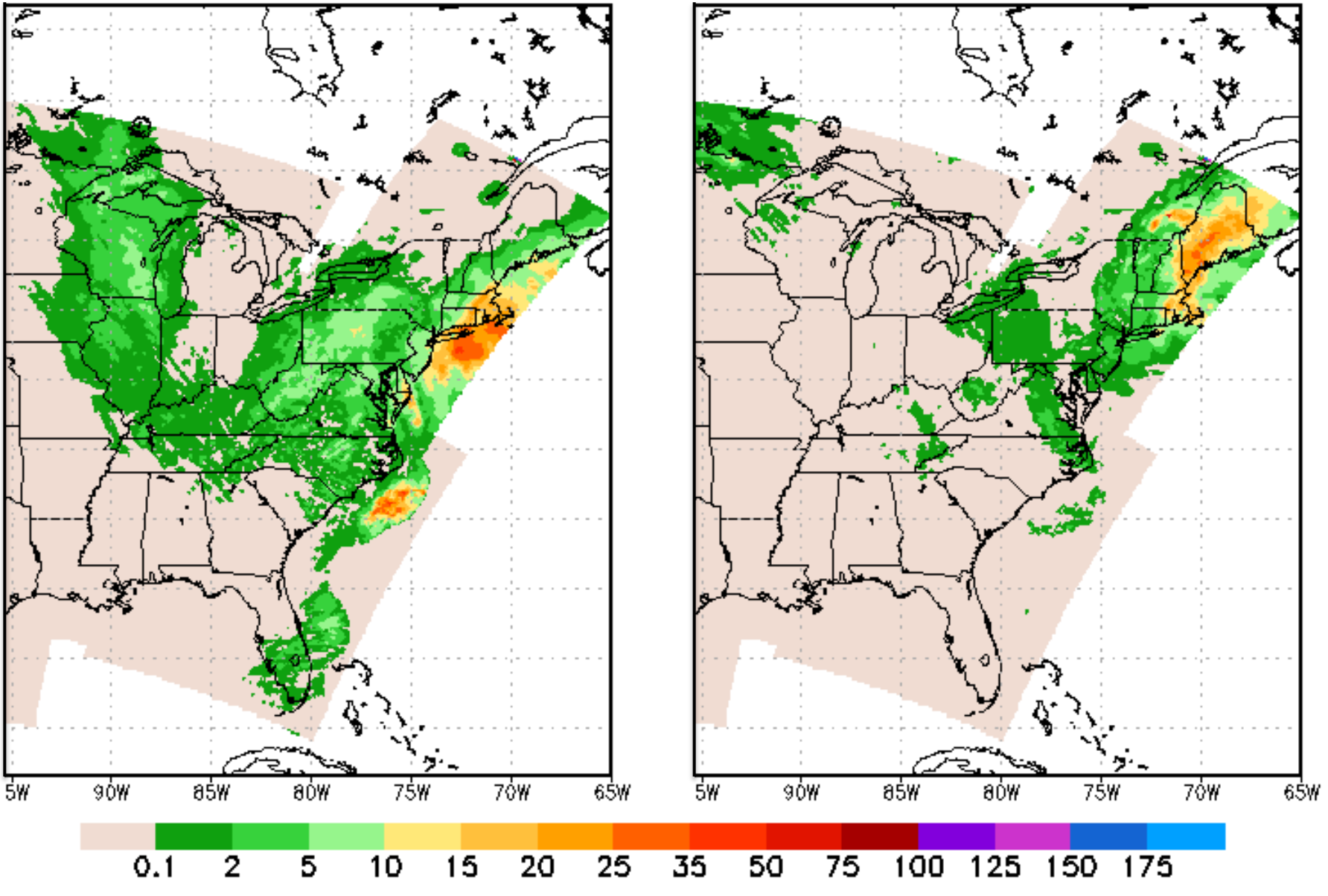
Yuejian Zhu
EMC/NCEP/NWS
Jan. 30 2015

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**

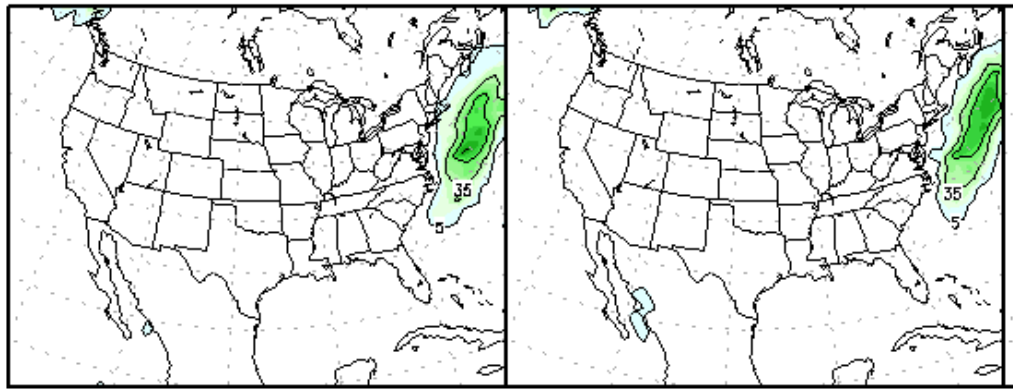
**2015012500**

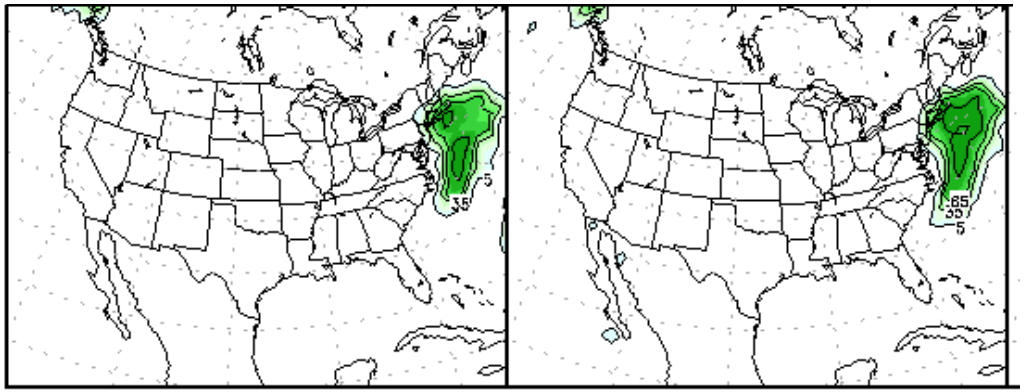
**2015012600**

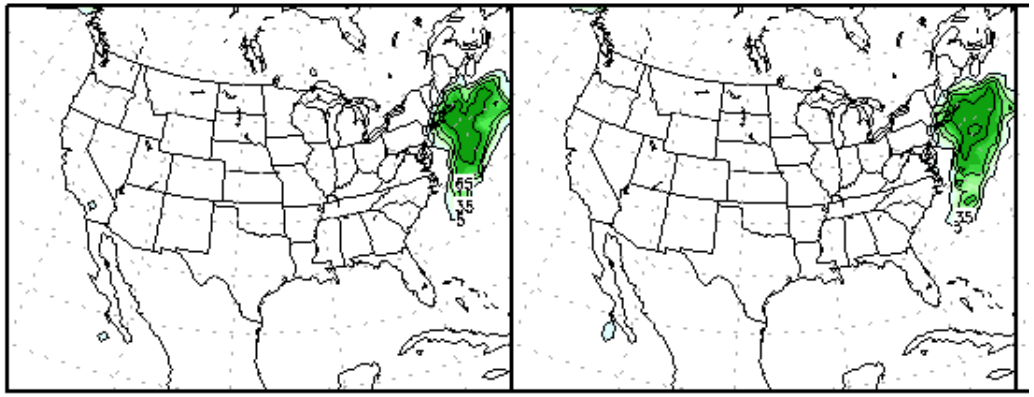
60–84 hr fcst

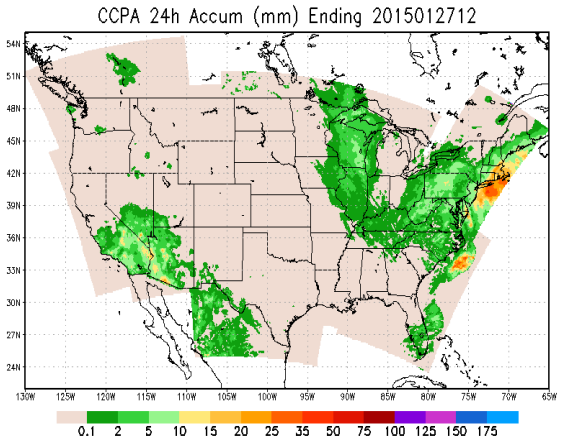
36–60 hr fcst

12–36 hr fcst










NCEP GEFS
PROD/PARA
Forecast difference

**PROD** **PARA**

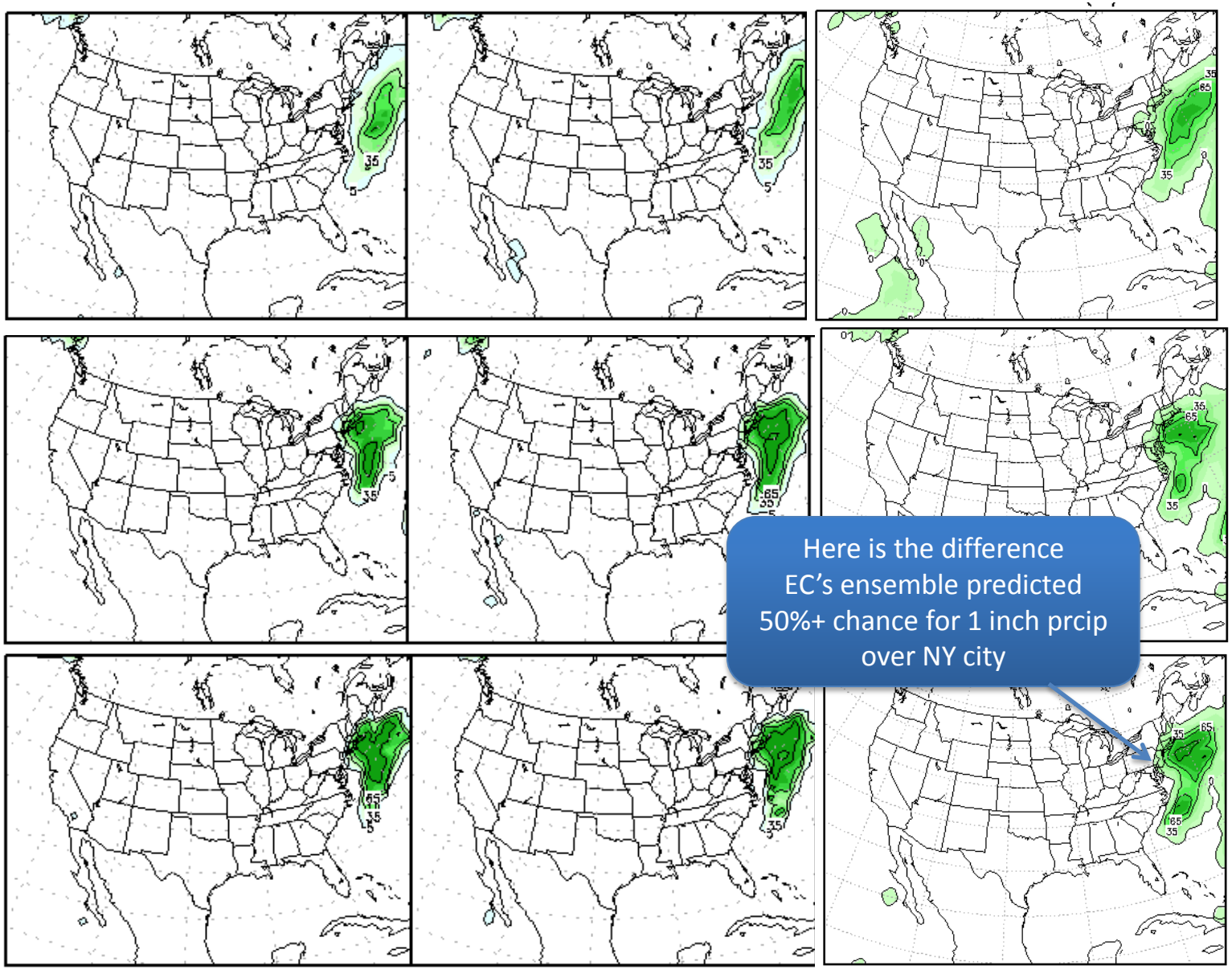
# Ensemble Based Probabilistic Quantitative Precipitation Forecast (PQPF)
## Valid: 2015012612 – 2015012712 Amount 24hr >25.4mm (1 inch)

Initial Time

**2015012400** — 60–84 hr fcst

**2015012500** — 36–60 hr fcst

**2015012600** — 12–36 hr fcst

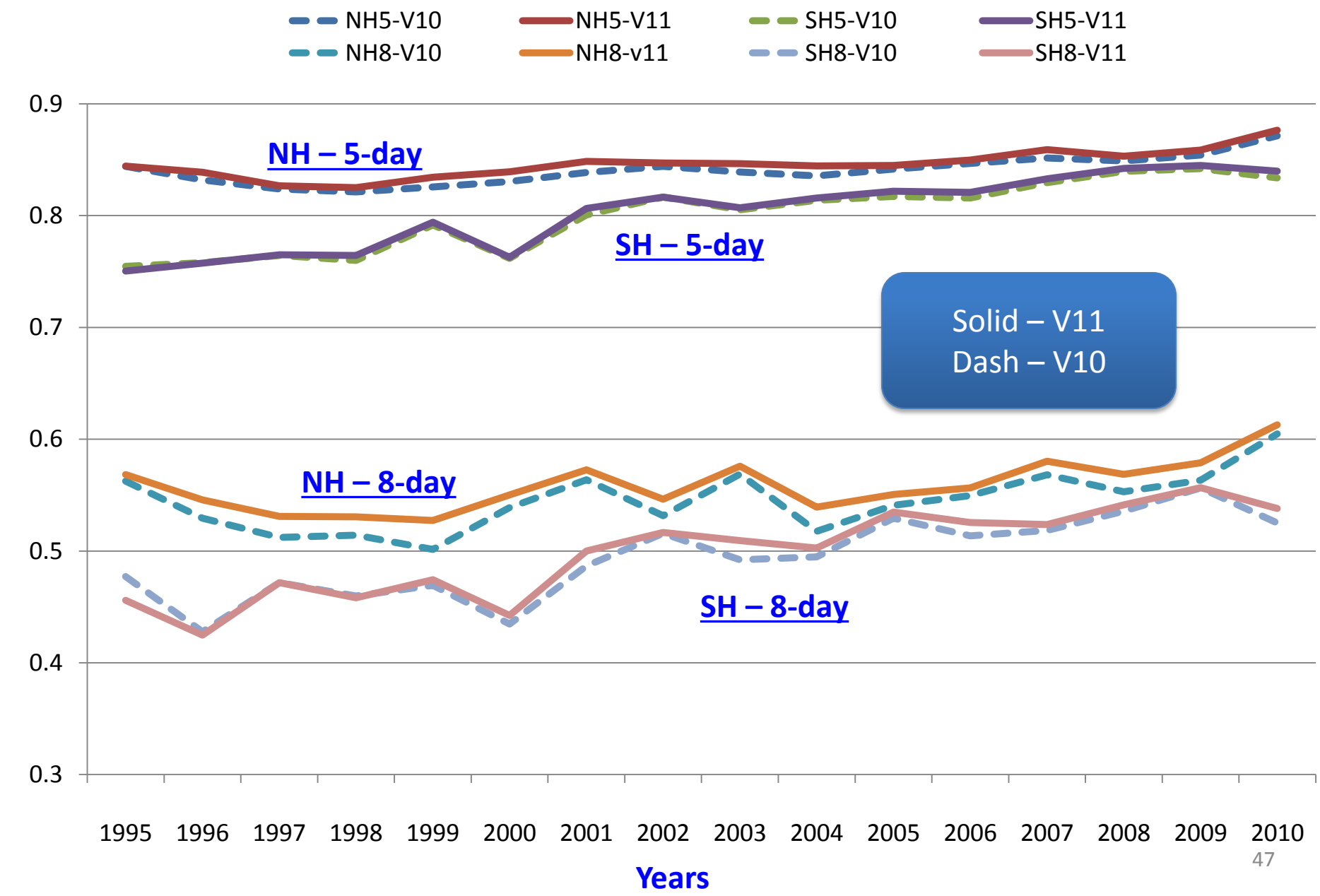


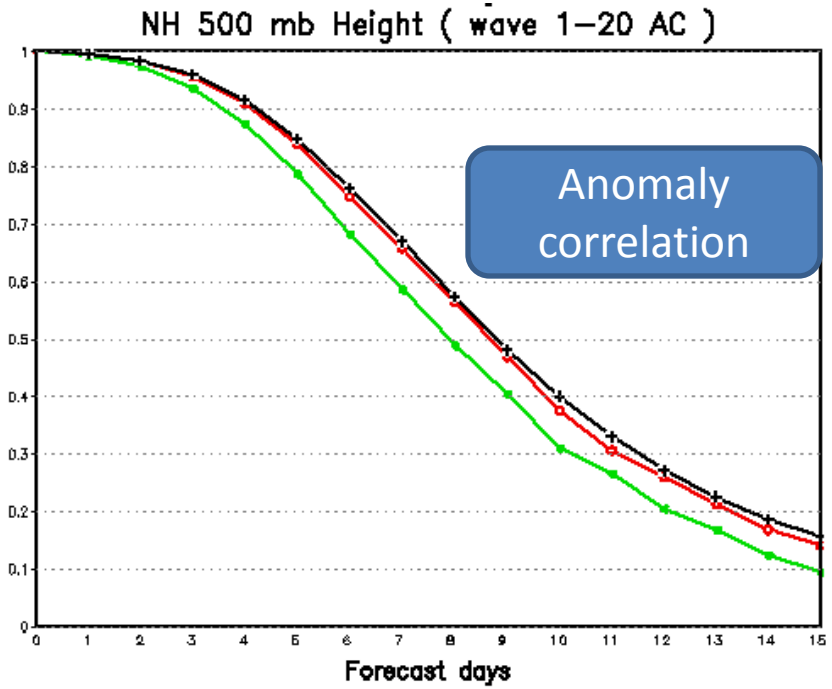

**PROD** **PARA** **ECMWF**

Extra slides for

GEFS control only reforecast (18 years)

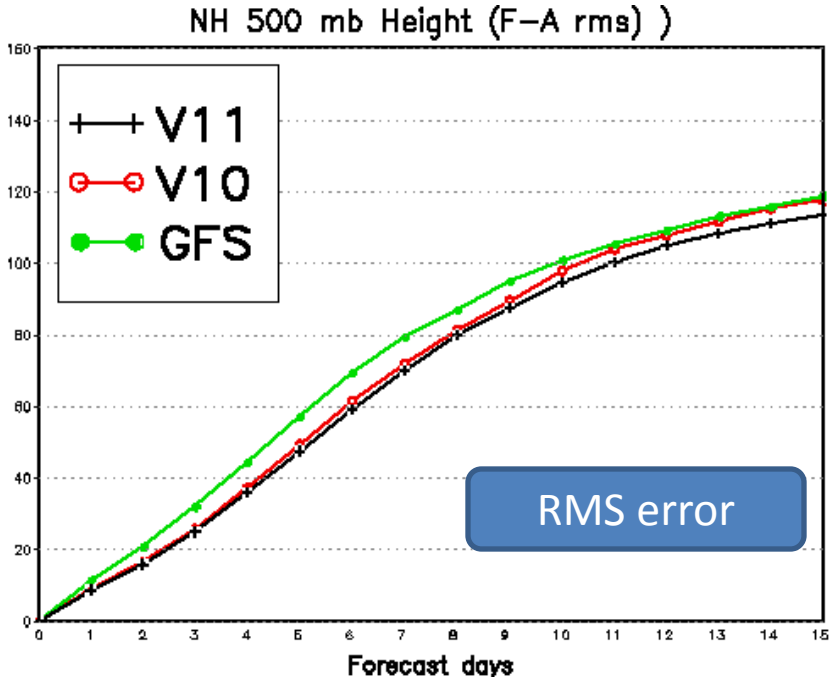
# 500hPa Anomaly Correlation for Control Only Reforecast (V10 .vs V11)

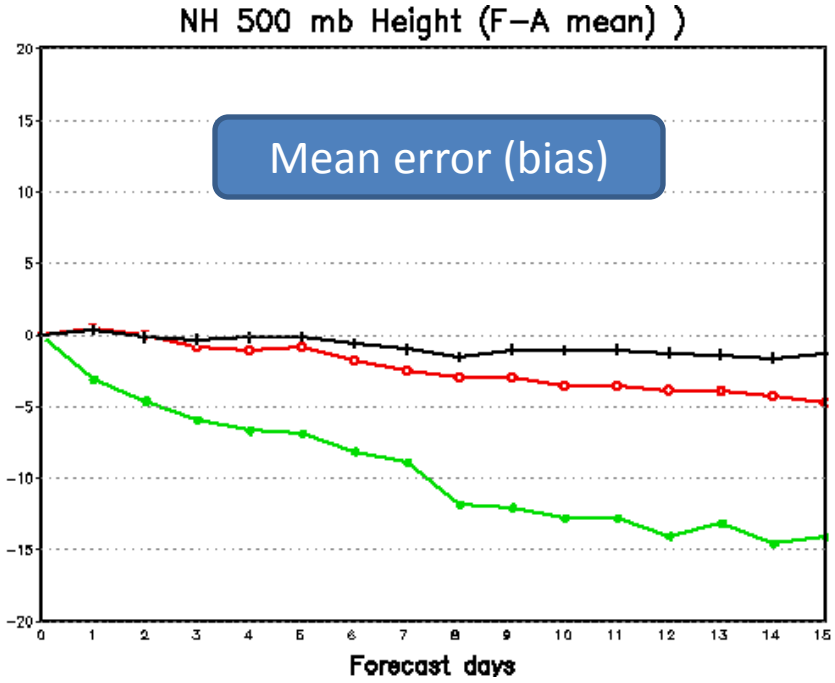




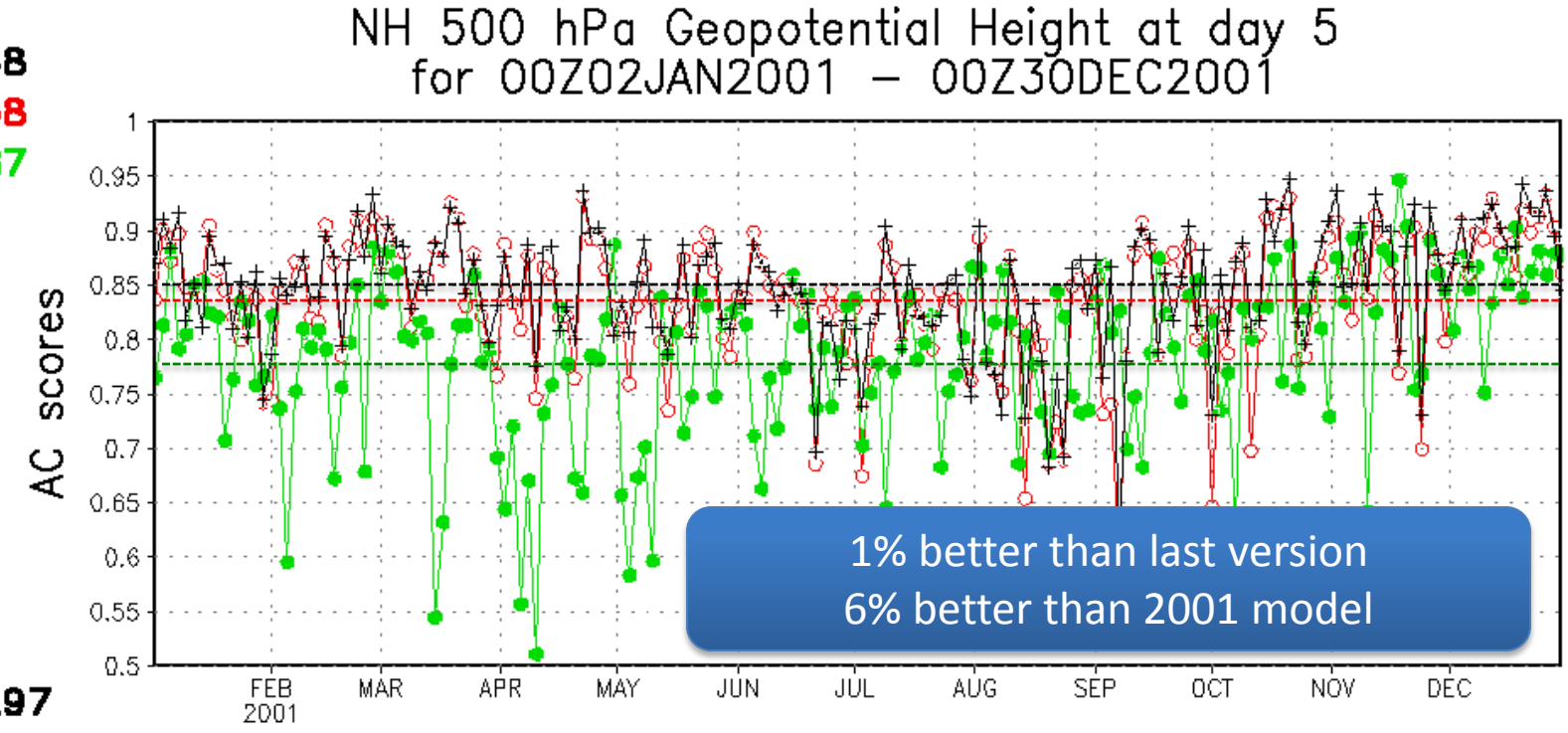

# Statistical period: 01/01/2001 – 12/31/2001 (183 cases)

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

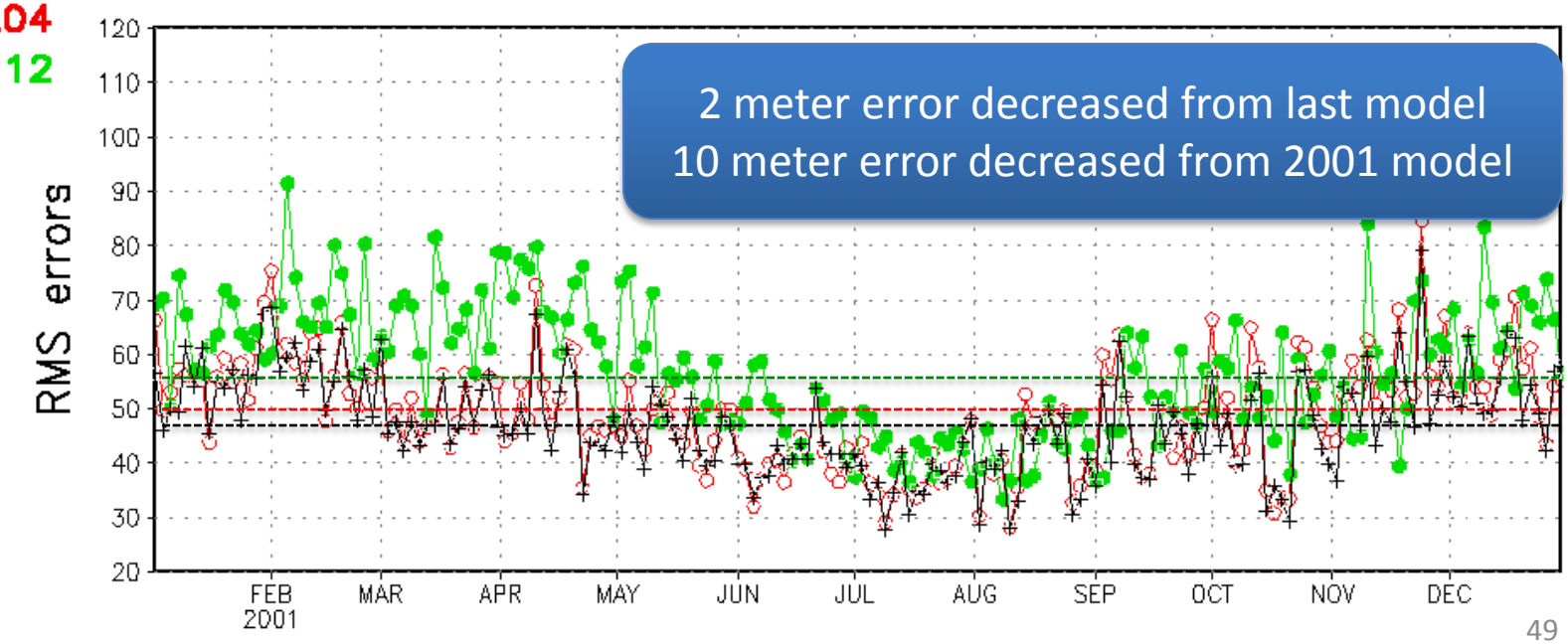


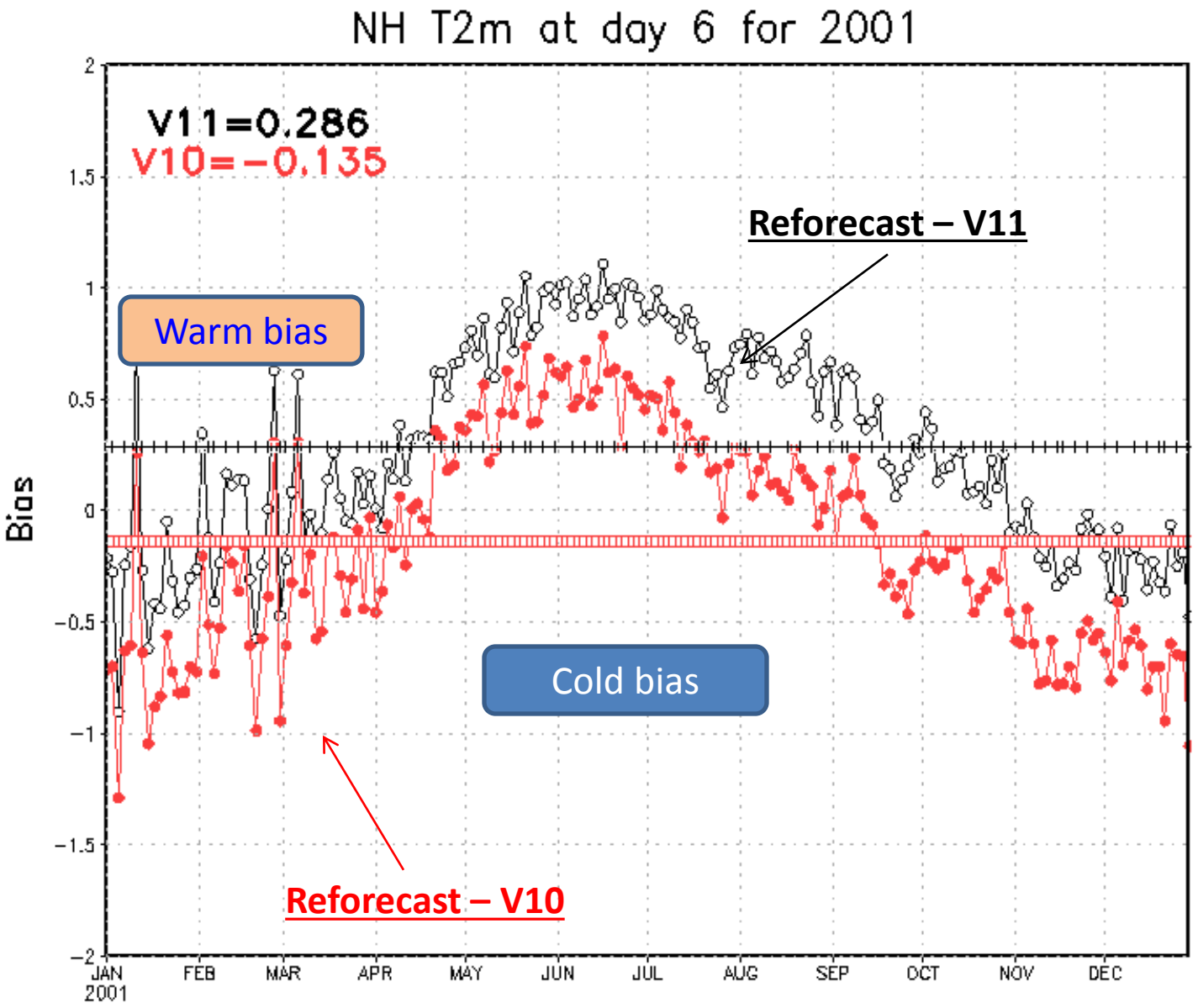
V11=0.848
V10=0.838
GFS=0.787




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 has run real time parallel in May 2015
  - Real time data access through NCEP ftp (soon)
  - 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),<br>WEASD(water equiv. of accum. Snow depth), SNOD(surface) | 4 |
| **Other** | 850 hPa vertical velocity | 1 |
| **Notes** | Current NAEFS grids at 1*1 degree | |

Background !!!

# GEFS (V11.0.0) Upgrade (Q4FY15)

**Project Status as of 5/29/2015**

## 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) (Q4FY15)

**Project Status as of 05/29/2015**

## 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:**

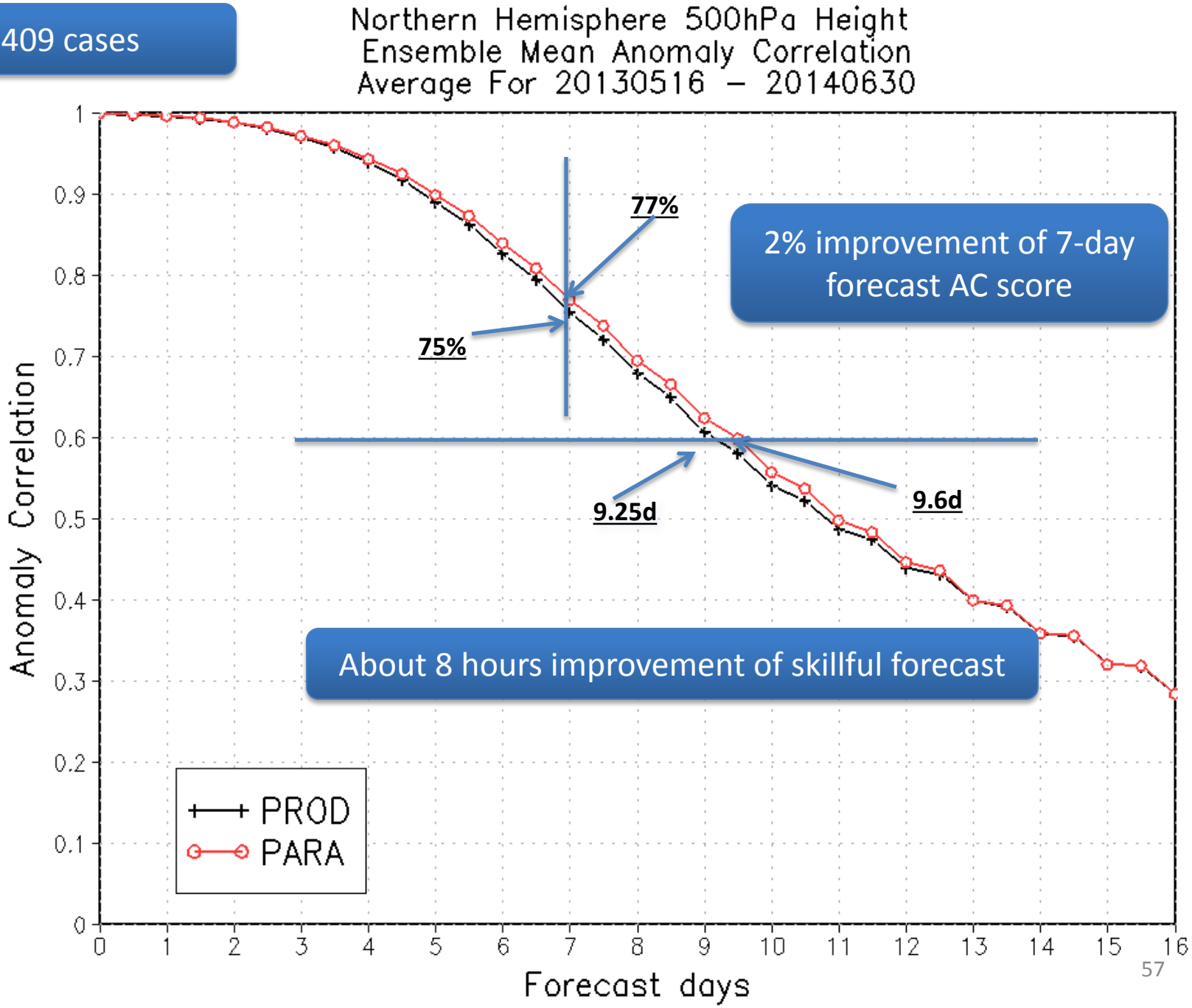
**Funding Sources**: EMC Base: NCO Base:

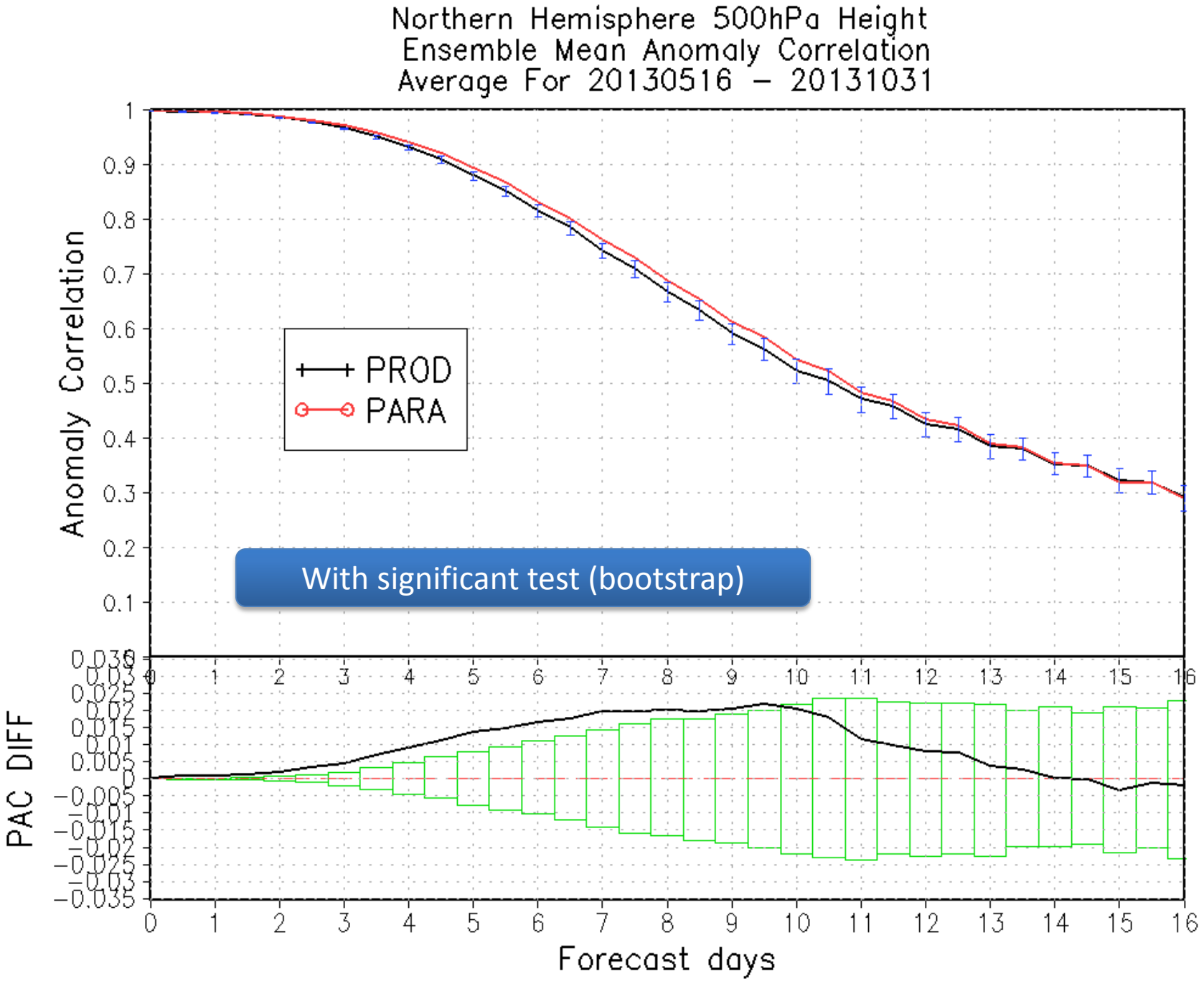
| R | Management Attention Required | Y | Potential Management Attention Needed | G | On Target |
|---|---|---|---|---|---|

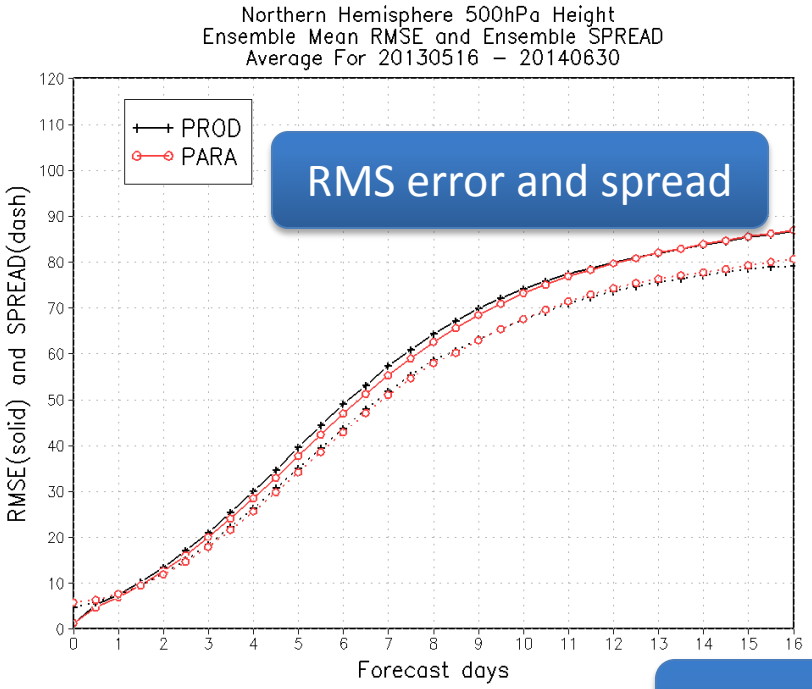
# Evolution of NCEP GEFS configuration (versions)

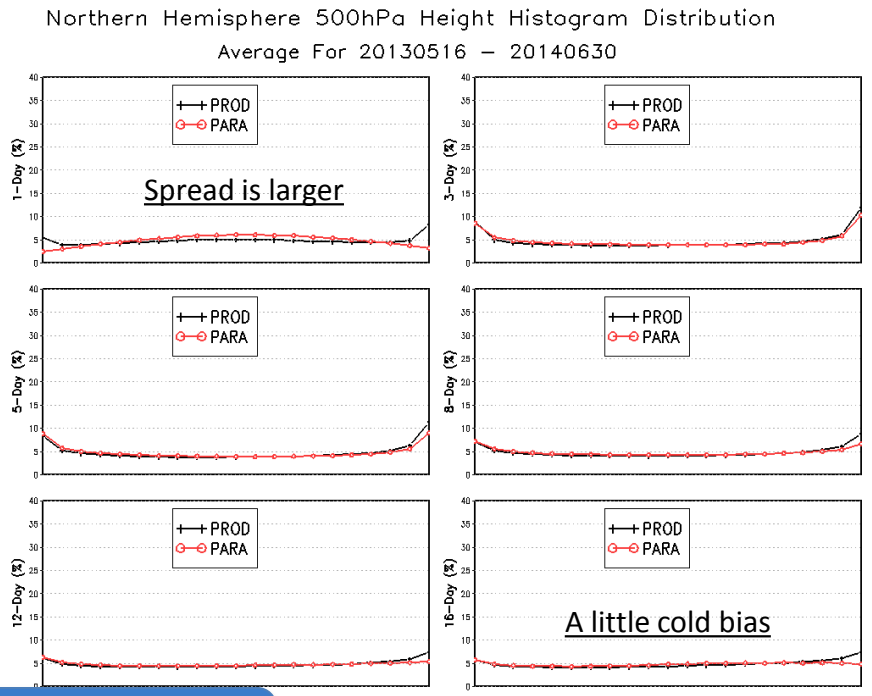
| Version | Implementation | Initial uncertainty | TS relocation | Model uncertainty | Resolution | Forecast length | Ensemble members | Daily frequency |
|---|---|---|---|---|---|---|---|---|
| V1.0 | 1992.12 | BV | None | None | T62L18 | 12 | 2 | 00UTC |
| V2.0 | 1994.3 | | | | T62L18 | 16 | 10(00UTC)<br>4(12UTC) | 00,12UTC |
| V3.0 | 2000.6 | | | | T126L28(0-2.5)<br>T62L28(2.5-16) | | 10 | |
| V4.0 | 2001.1 | | | | T126(0-3.5)<br>T62L28(3.5-16) | | | |
| V5.0 | 2004.3 | | | | T126L28(0-7.5)<br>T62L28(7.5-16) | | | 00,06,12,<br>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)<br>T190L42 (8-16) | | | |
| V11.0 | 2015.04 | EnKF (f06) | | | TL574L64 (0-8)<br>TL382L64 (8-16) | | | |

409 cases

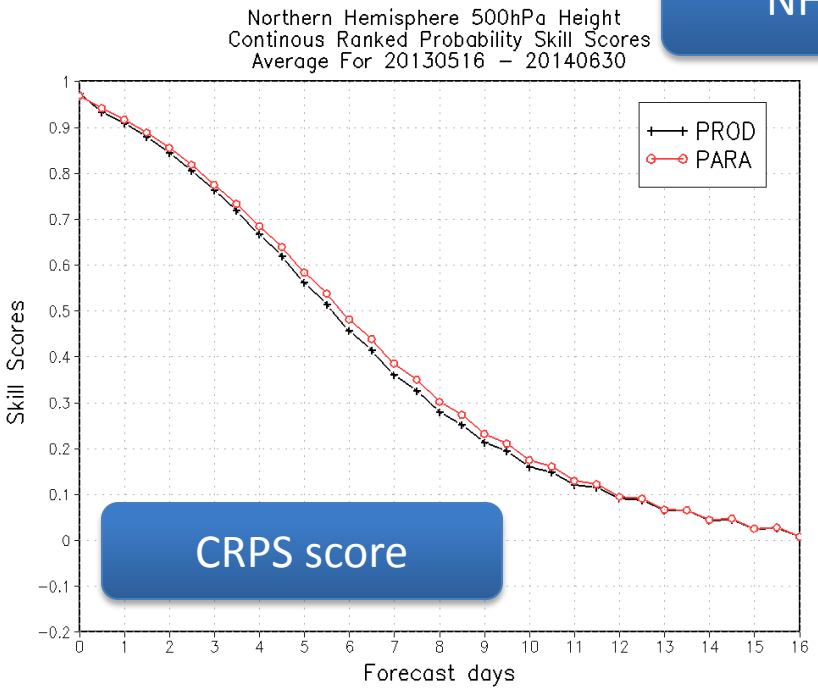

Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20130516 – 20140630
Anomaly Correlation
Forecast days
PROD
PARA
77%
75%
9.25d
9.6d
2% improvement of 7-day forecast AC score
About 8 hours improvement of skillful forecast

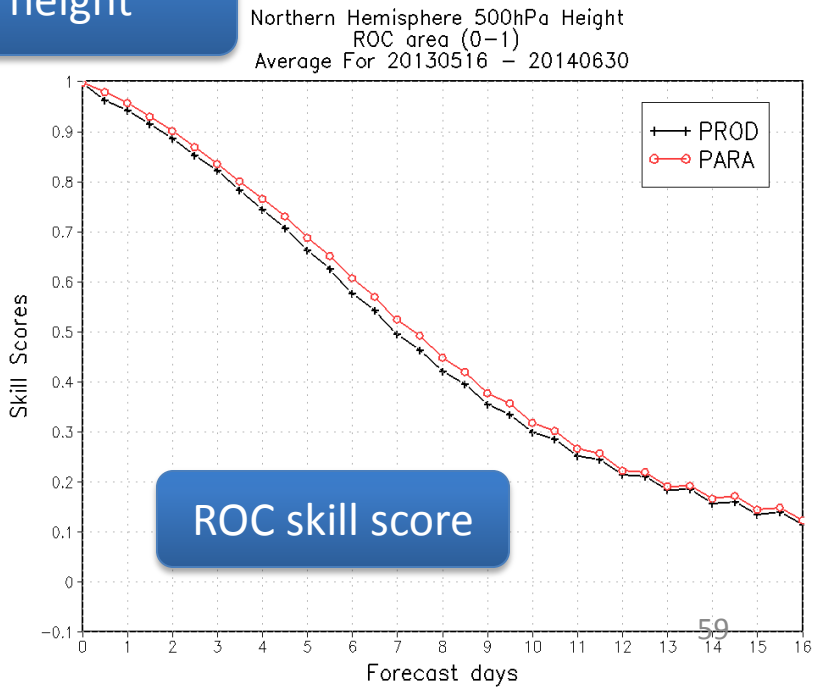

Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
Average For 20130516 – 20131031
Anomaly Correlation
PROD
PARA
With significant test (bootstrap)
PAC DIFF
Forecast days

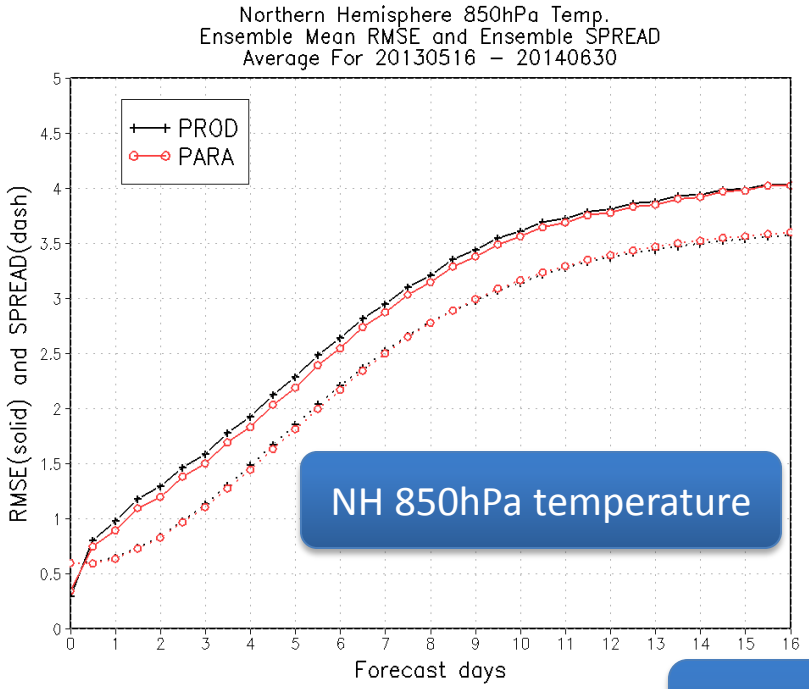


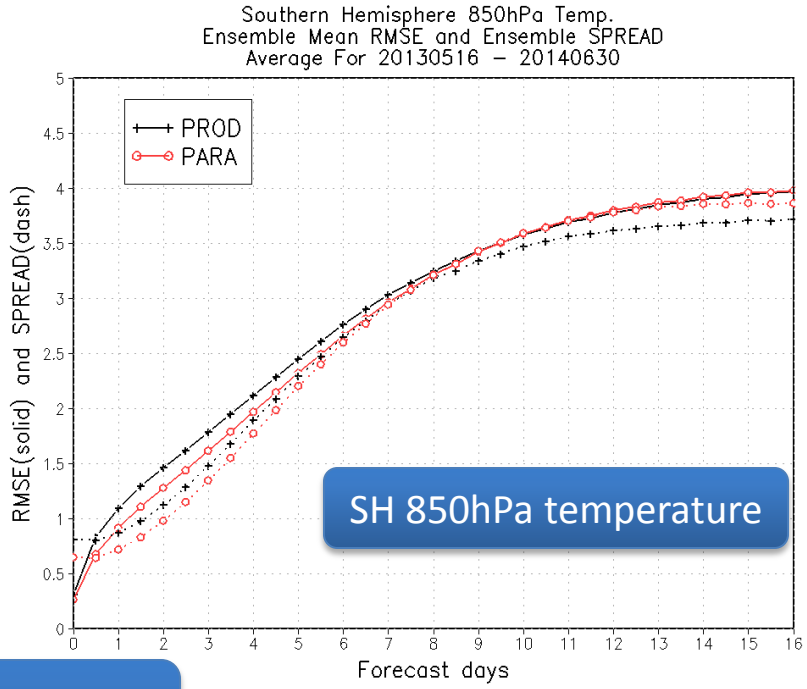




NH 500hPa height

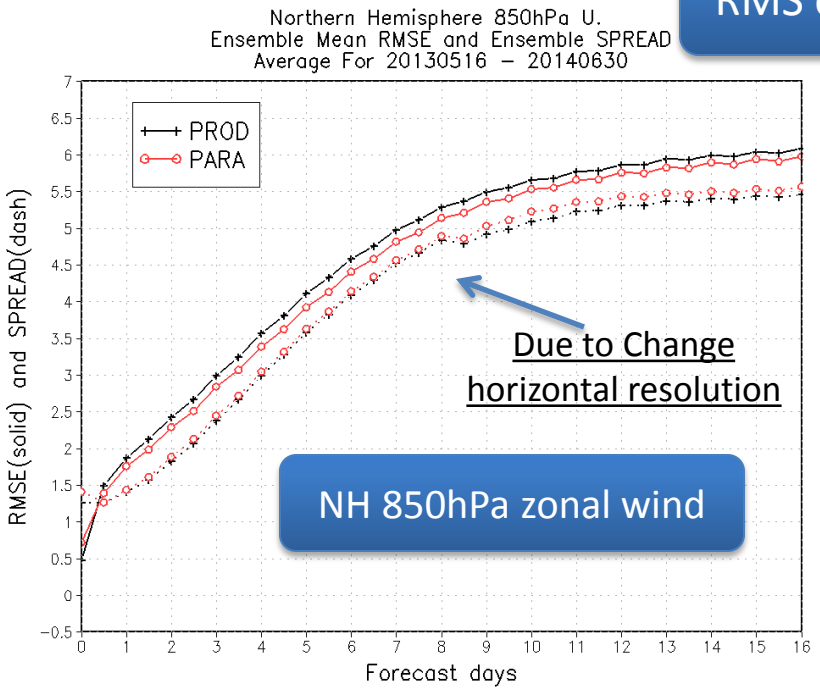


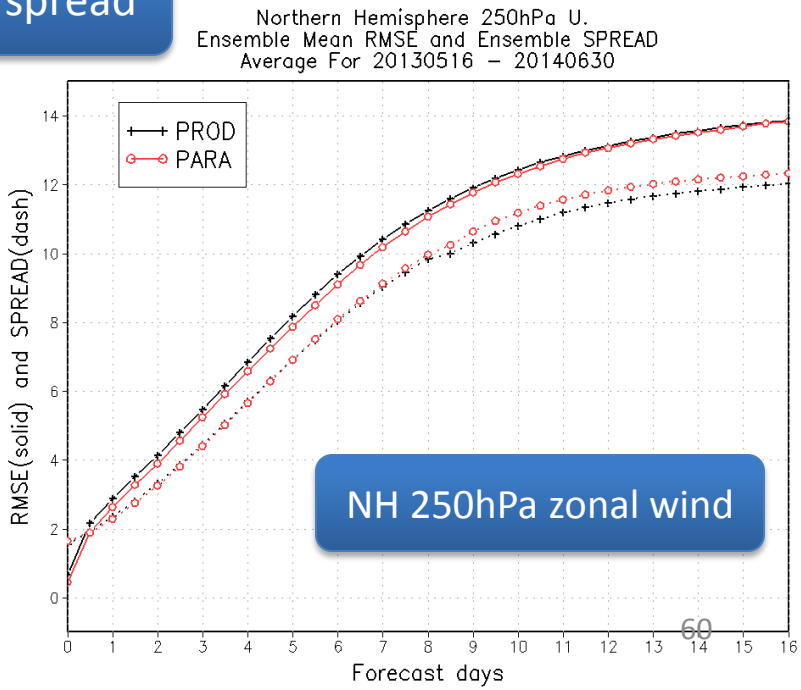



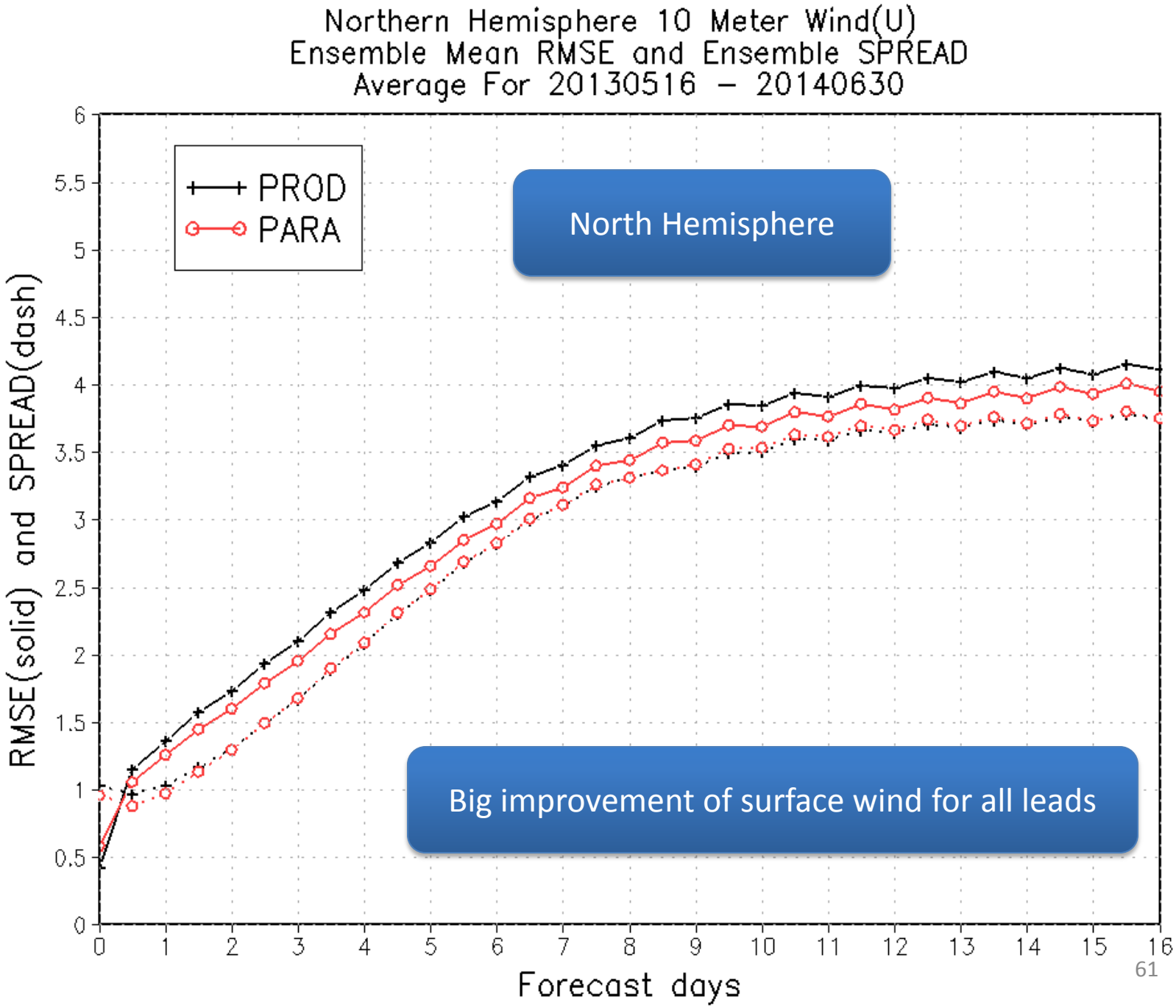



RMS error and spread




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
North Hemisphere
Big improvement of surface wind for all leads

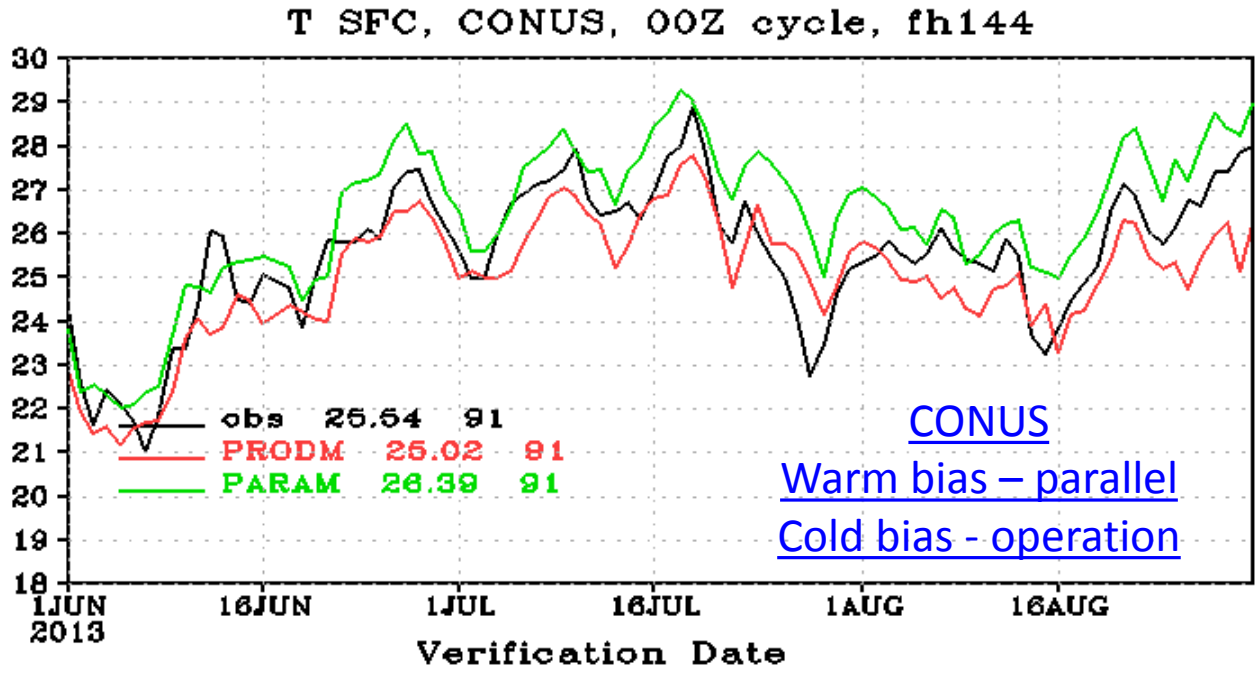
# 2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Summer 2013

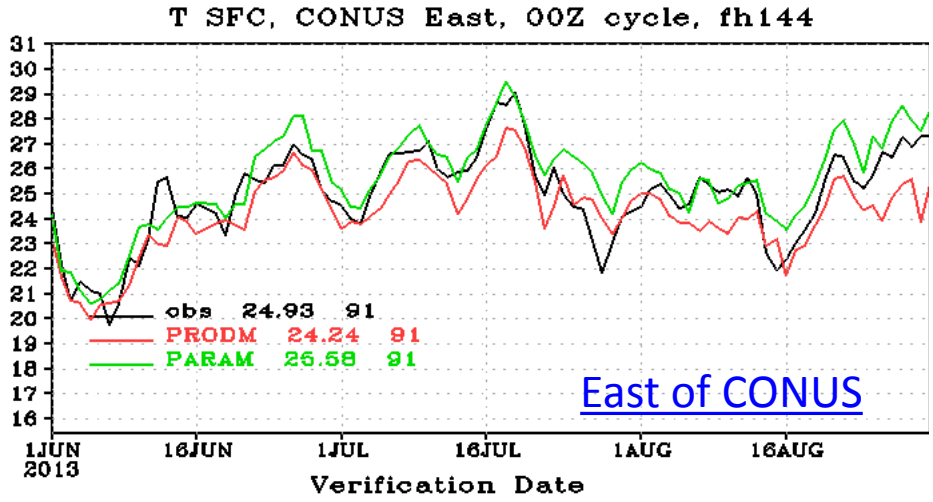
3 months



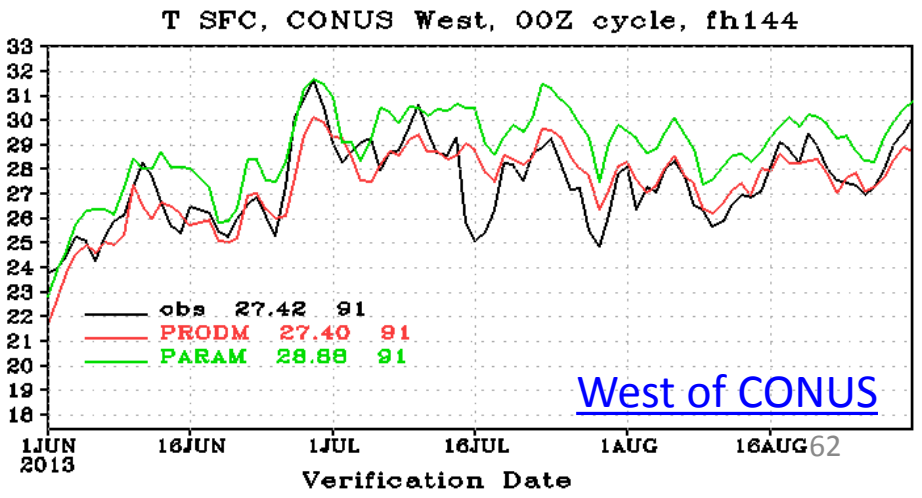

CONUS

Warm bias – parallel

Cold bias - operation




East of CONUS




West of CONUS

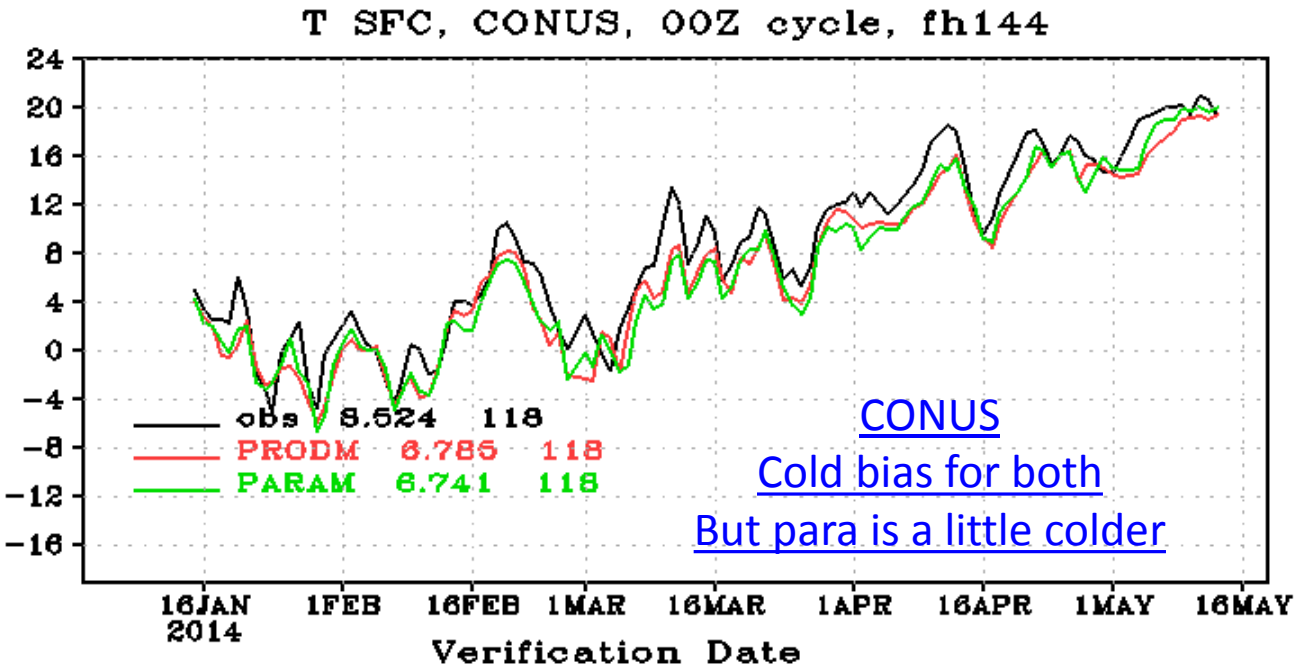
# 2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Winter-Spring 2014

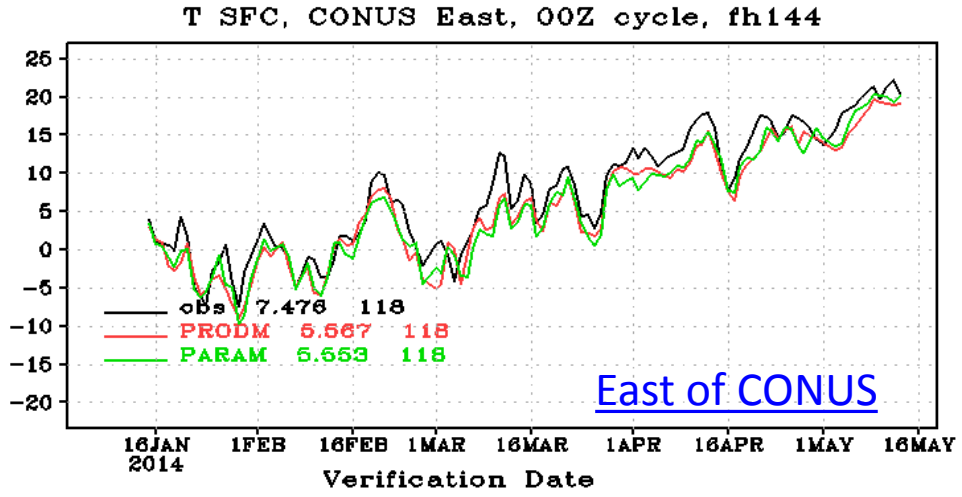
4 months



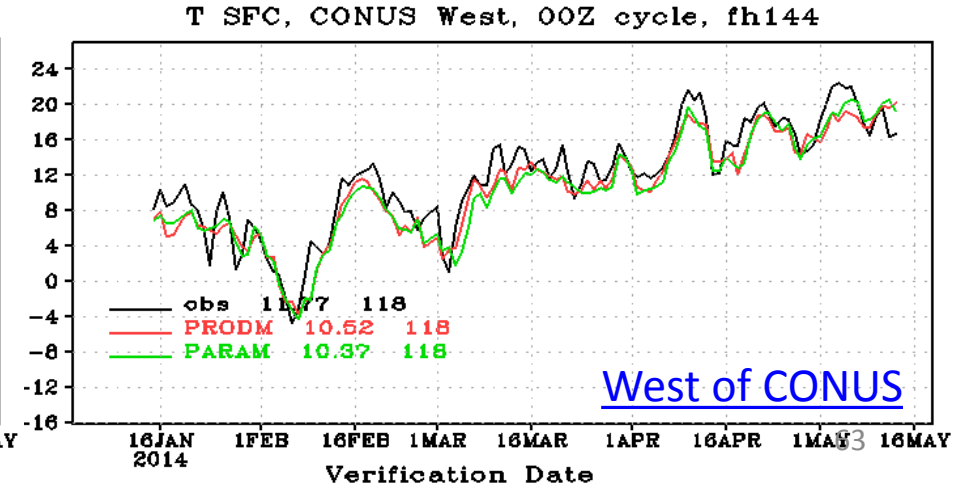

CONUS

Cold bias for both

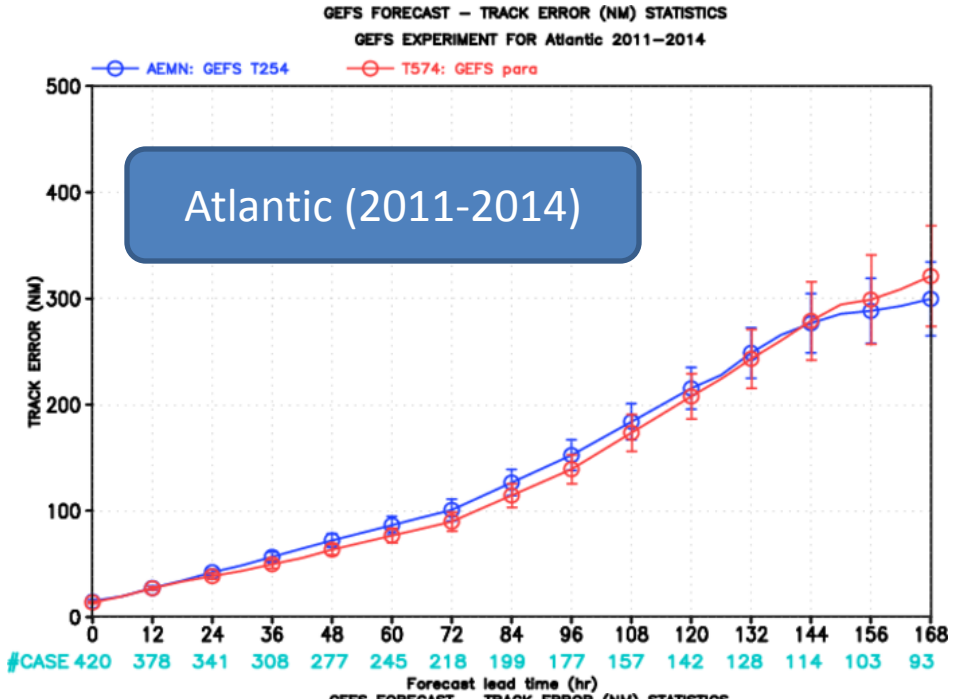
But para is a little colder

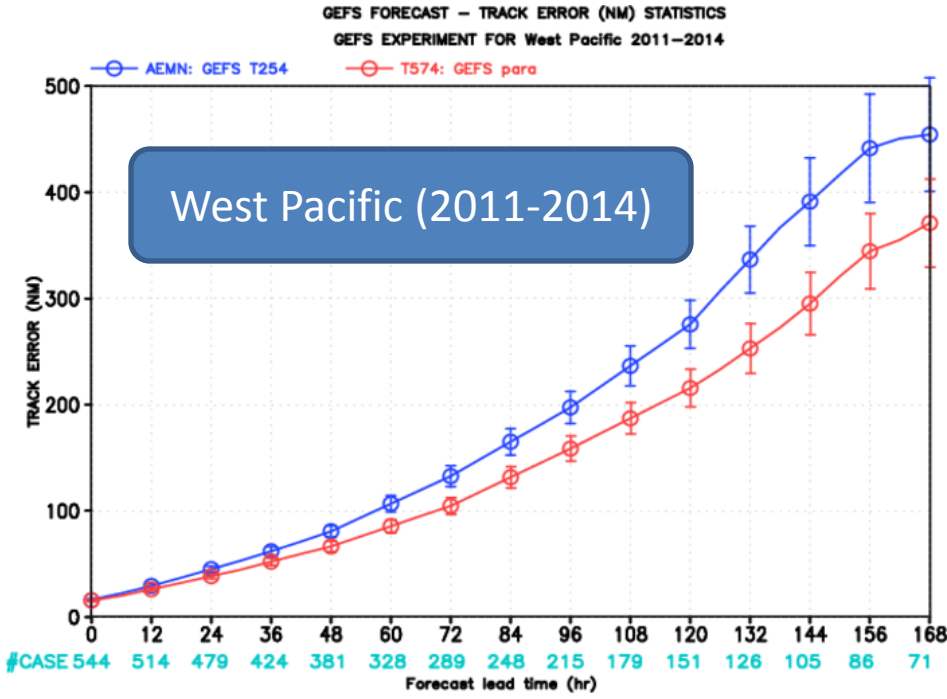


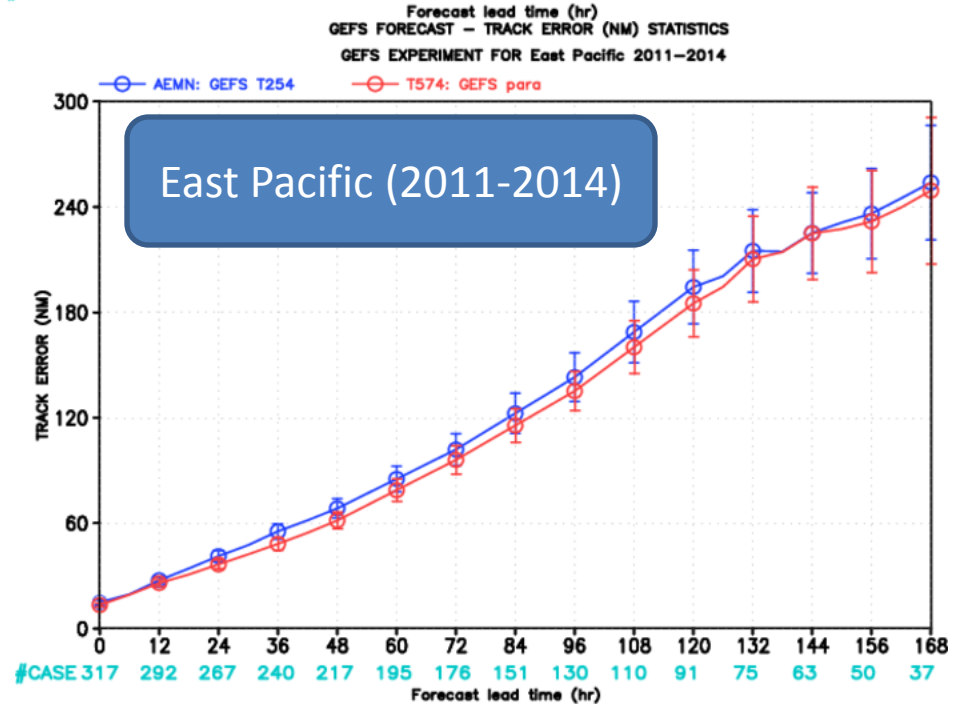

East of CONUS




West of CONUS




# TS track verification

1. For 2011 season, there are selected Atlantic/East Pacific cases only
2. For 2011 season, we use GEFSv10 parallel to compare, instead of operational GEFSv09
3. Samples are for named TC only (less samples)