GEFS (v11) reforecast

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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 (34km) 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:
  - Jan. 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
    - Ensemble transform - un-necessary if there is no significant difference
    - Rescaling – un-necessary if we confirm EnKF parallels have the similar characteristics for different seasons
- Stochastic perturbations
  - Tune STTP 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

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Preliminary results for period of May 22nd – October 31st 2013

Extended Summer Season

General stats: http://www.emc.ncep.noaa.gov/gc_wmb/xzhou/EnKF_prhs13_10.HTML

Surface against observations:
http://www.emc.ncep.noaa.gov/gmb/wx20cb/vsdb/geavg.20130601.20130831/g2o/

Precipitation:
http://www.emc.ncep.noaa.gov/gmb/yluo/tmp_dir/GEFS_PQPFvrfy_summer_test.html

TC tracks (one slide)

Note: model version may be slightly (minor) different during integration period.

Preliminary results for period of January 2nd – May 14 2014

Extended Winter Season

General stats:
http://www.emc.ncep.noaa.gov/gmb/wd20dh/STTP2014/PROB_OoFa.HTML

Precipitation:
http://www.emc.ncep.noaa.gov/gmb/yluo/GEFS_VRFY/GEFS_PQPFvrfy_spring_test
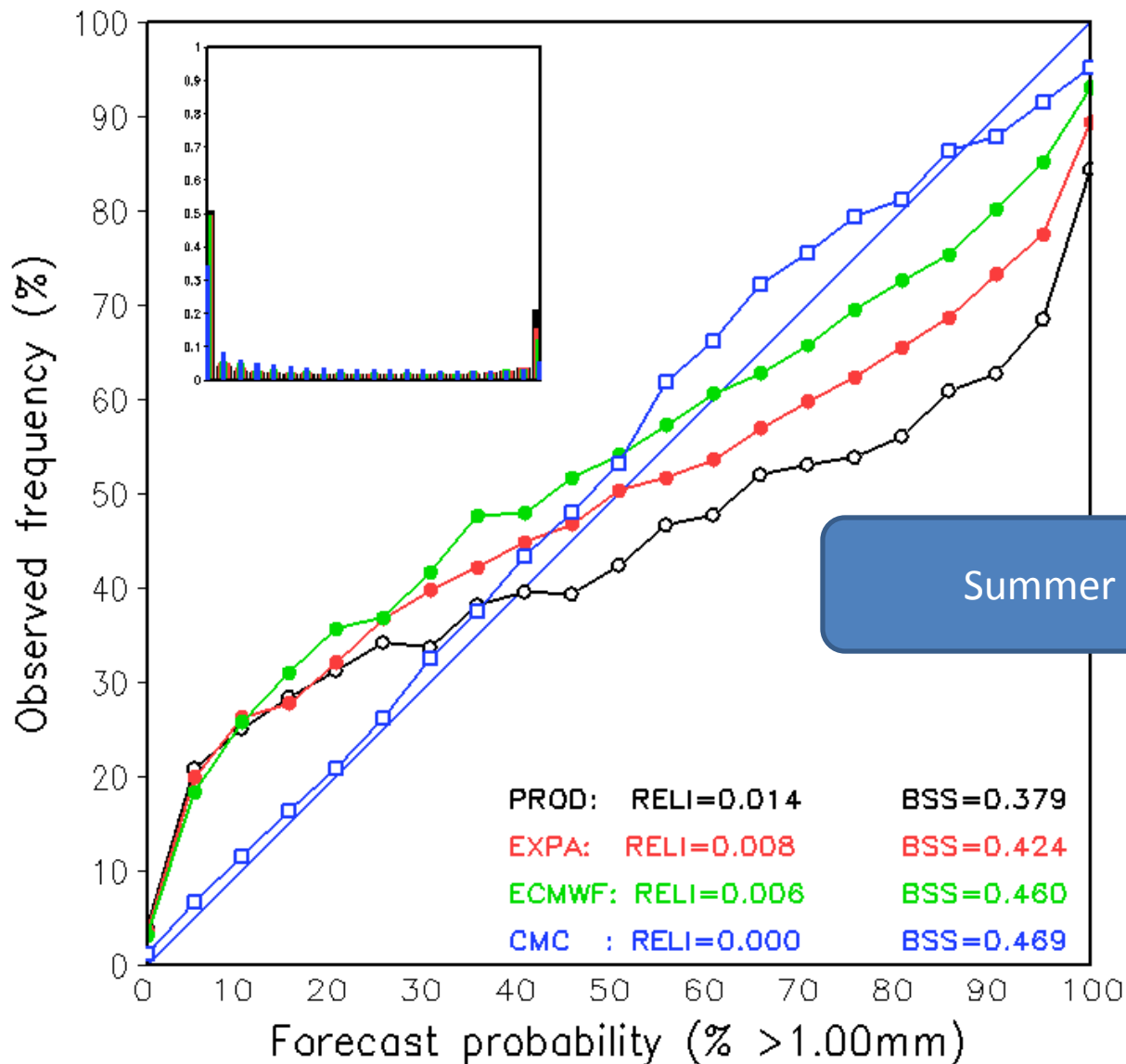.html

Note: model version may be slightly (minor) different during integration period.

Northern Hemisphere 500hPa Height
Ensemble Mean Anomaly Correlation
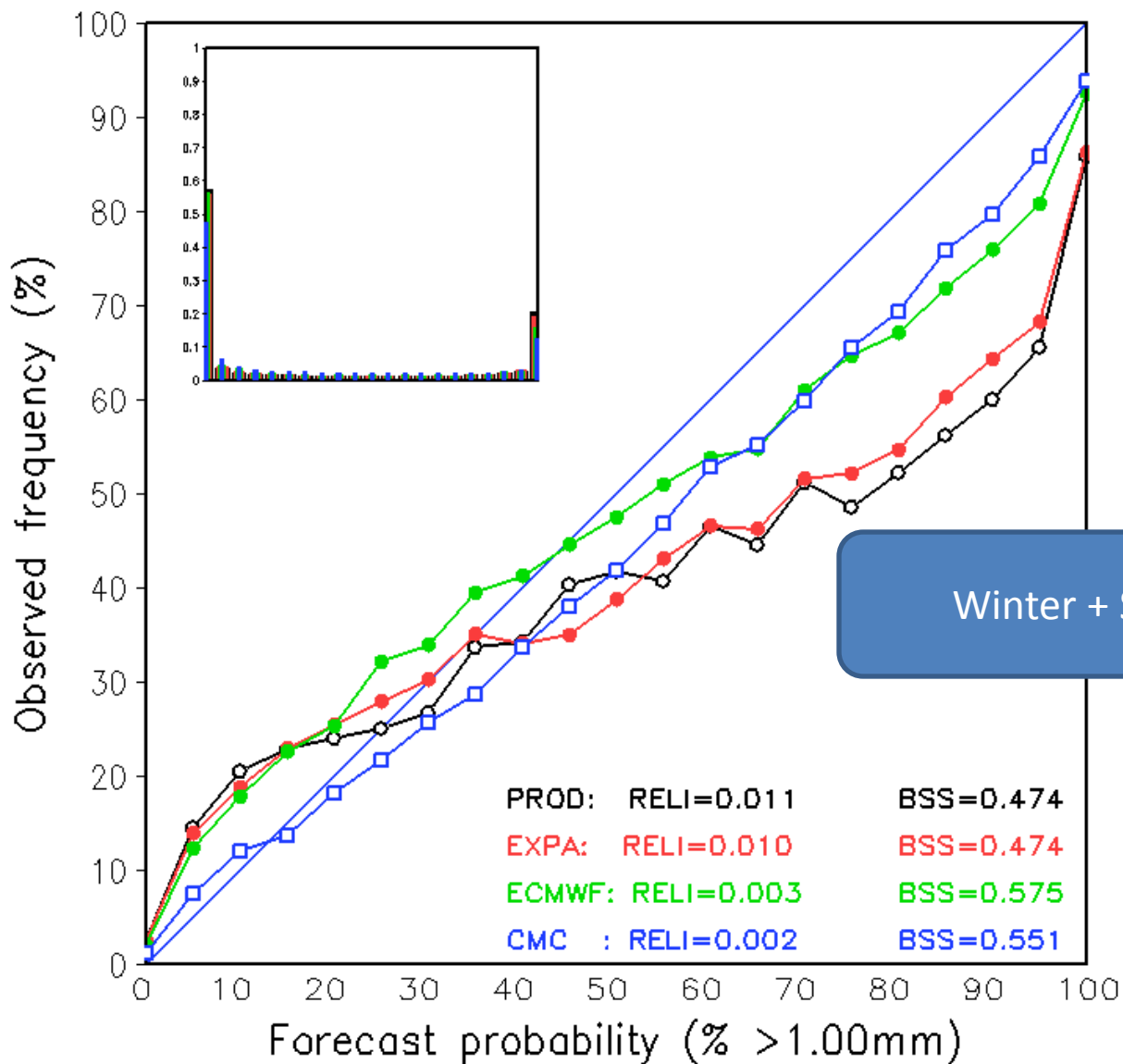Average For 20130516 – 20140630
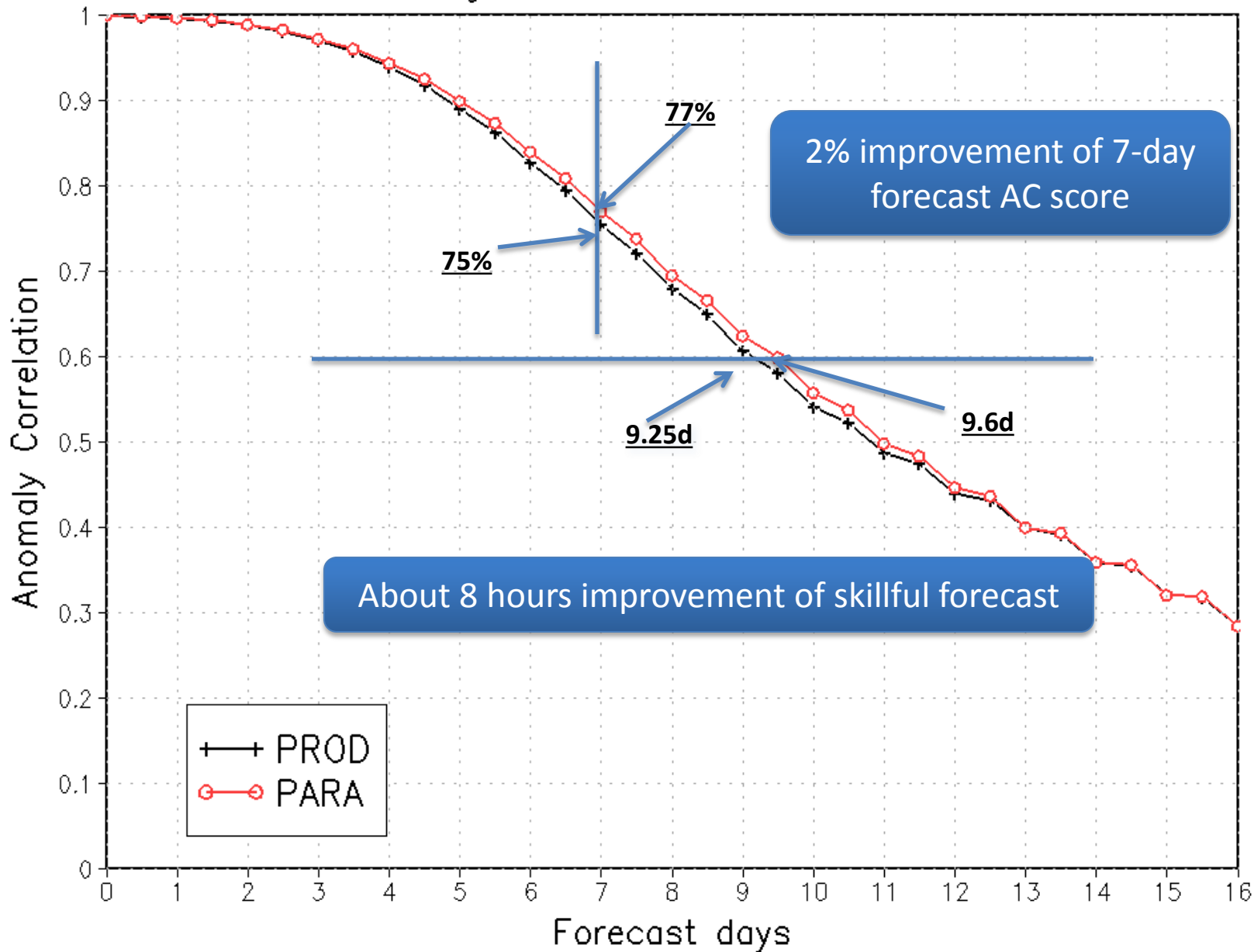
Reliability Diagram
fhr 12–36 For 20130516 – 20131031

Observed frequency (%)

Summer 2013

PROD: RELI=0.014   BSS=0.379
EXPA: RELI=0.008   BSS=0.424
ECMWF: RELI=0.006   BSS=0.460
CMC : RELI=0.000   BSS=0.469

Forecast probability (% >1.00mm)

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

Reliability Diagram
fhr 12-36 For 20140102 – 20140507

Winter + Spring 2014

PROD: RELI=0.011   BSS=0.474
EXPA: RELI=0.010   BSS=0.474
ECMWF: RELI=0.003   BSS=0.575
CMC : RELI=0.002   BSS=0.551

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

May 15 – Oct. 31 2013 AL/EP/WP TC Track Verifications

Retrospective runs – once per day at 00UTC

Legend:
- AVNO ---- GFS prod
- PRHS ---- GFS para
- AEMN ----GEFS prod
- T574 ---- GEFS para

CASEs: 236, 207, 185, 158, 133, 93, 61, 39
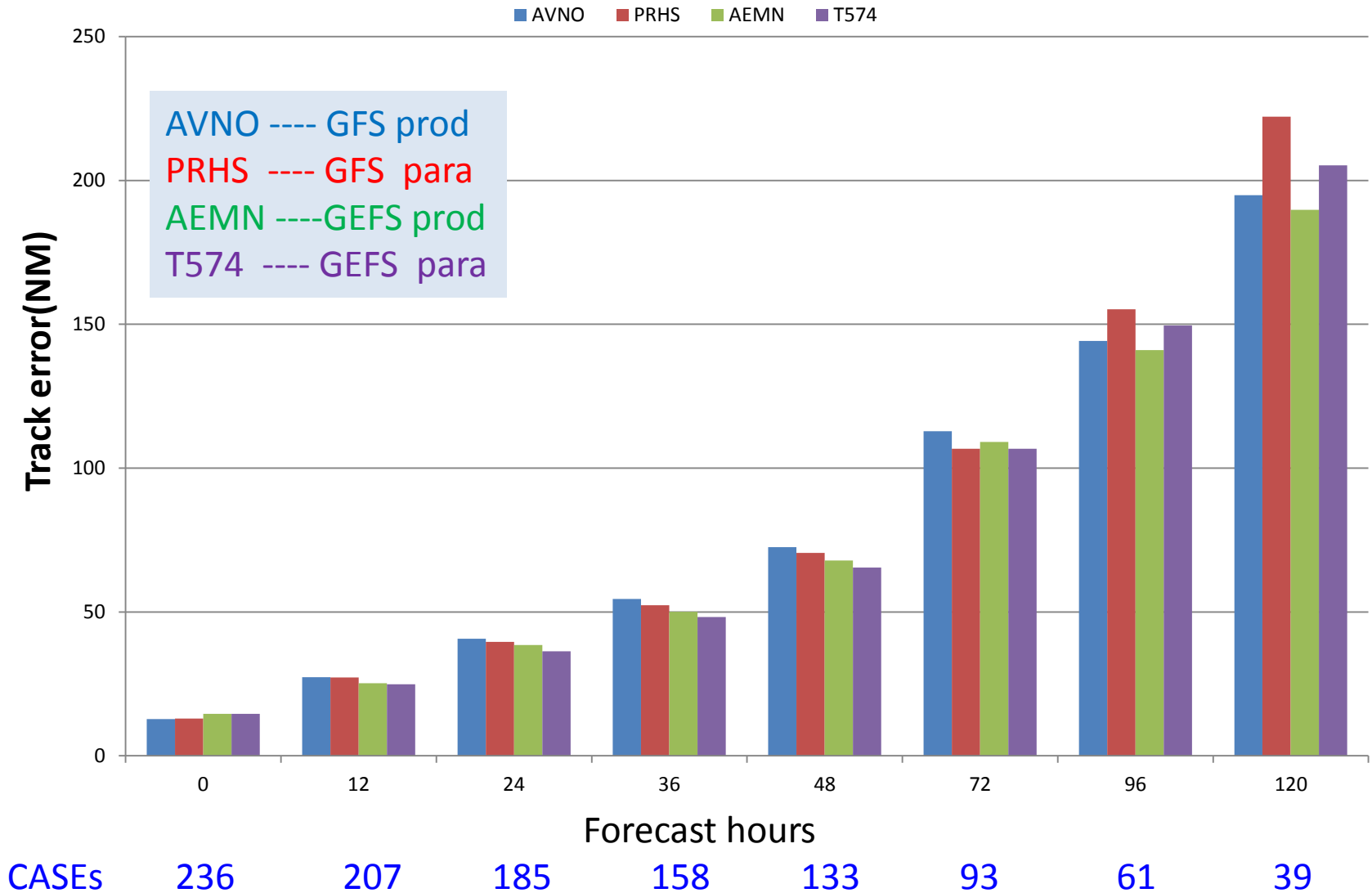
Summary

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

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)
    - May 2013 – the time of implementation
    - Expect to be available: Mid of March 2015
  - 18 years ensemble control only reforecast
    - Year 1995-2012
    - 00UTC and every other day
    - Expect to be available: end of Jan. 2015
  - All data will be saved in HPSS tapes
    - No public ftp access
- Computation resource
  - EMC will look for resource of development of WCOSS and research machine "zeus"
- Still in the discussion with CPC to have 18 years ensemble retrospective runs

NH 500 mb Height (wave 1-20 AC)

Anomaly correlation

GEFSc-v10
GEFSc-v11

NH 500 mb Height (F-A rms))

RMS error

GEFSc-v10
GEFSc-v11

NH 500 mb Height (F-A mean))

Mean error (bias)
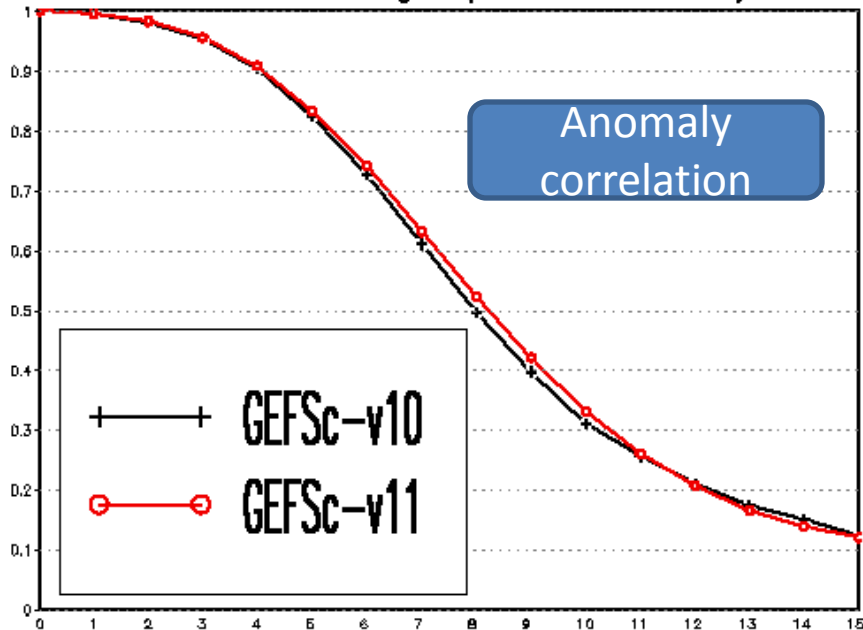
Forecast days

Statistical period: 01/18/1999 – 12/31/1999 (178 cases)

Old one

Ensemble control only
T574L64 (0-192h)
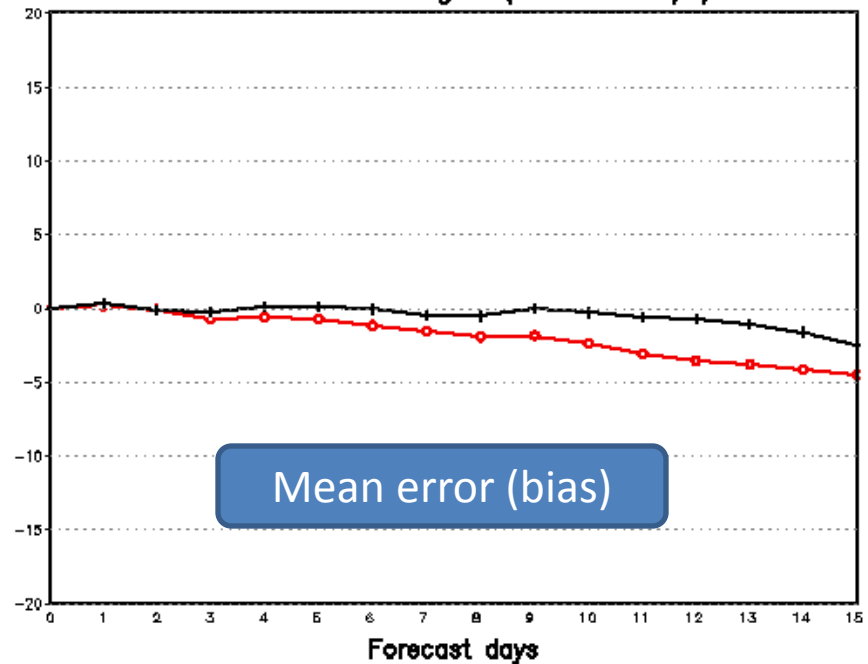T382L64 (192-384h)

Forecast days
NH 500 mb Height (wave 1–20 AC)

Anomaly correlation
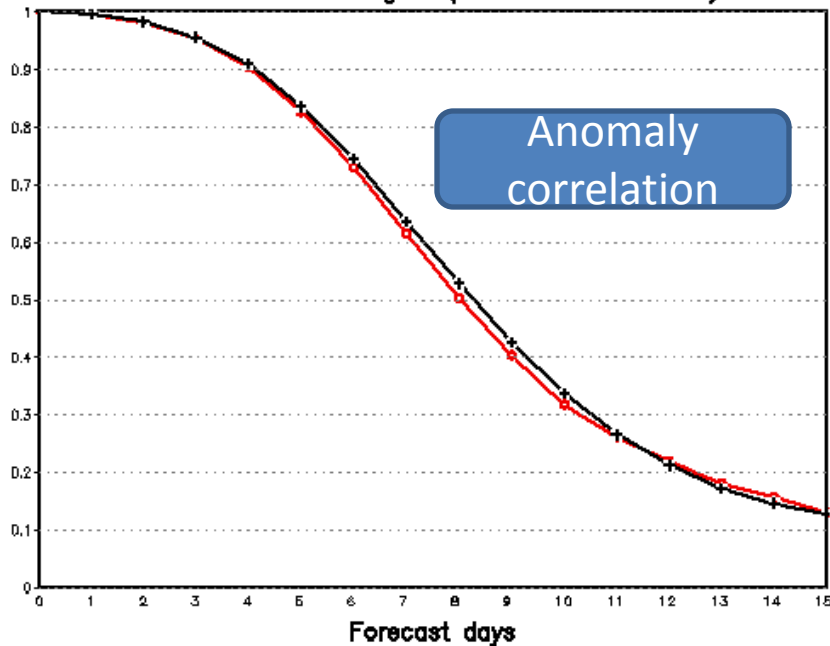
Statistical period: 01/18/1999 – 12/31/1999 (178 cases)

Ensemble control only
T574L64 (0-192h)
T382L64 (192-384h)

NH 500 mb Height (F–A rms))

V11
V10

RMS error

NH 500 mb Height (F–A mean))

Mean error (bias)

Forecast days
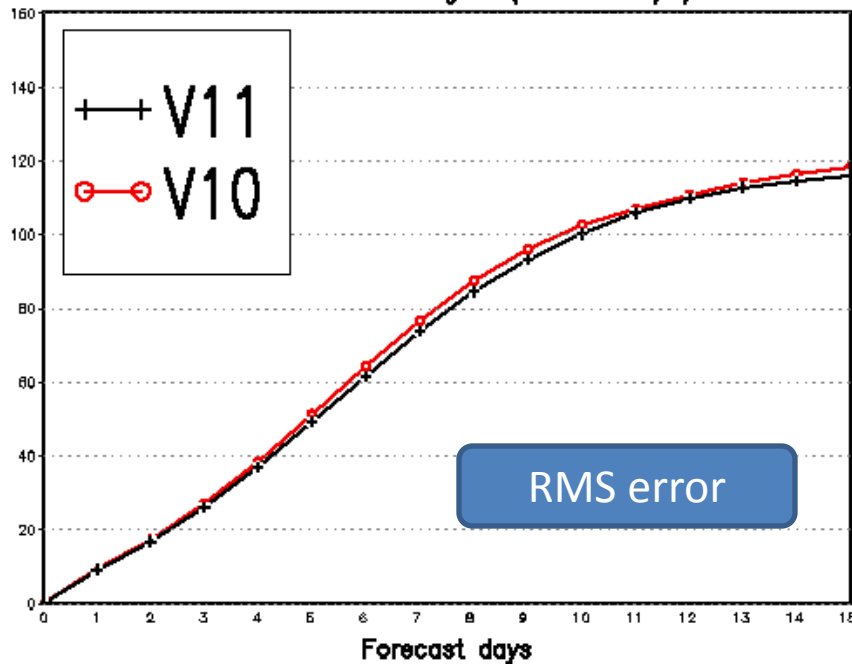
NH 500 hPa Geopotential Height at day 8 for 00Z18JAN1999 − 00Z30DEC1999

GEFSc−v10=0.495
GEFSc−v11=0.522

Increase AC: 2.7%
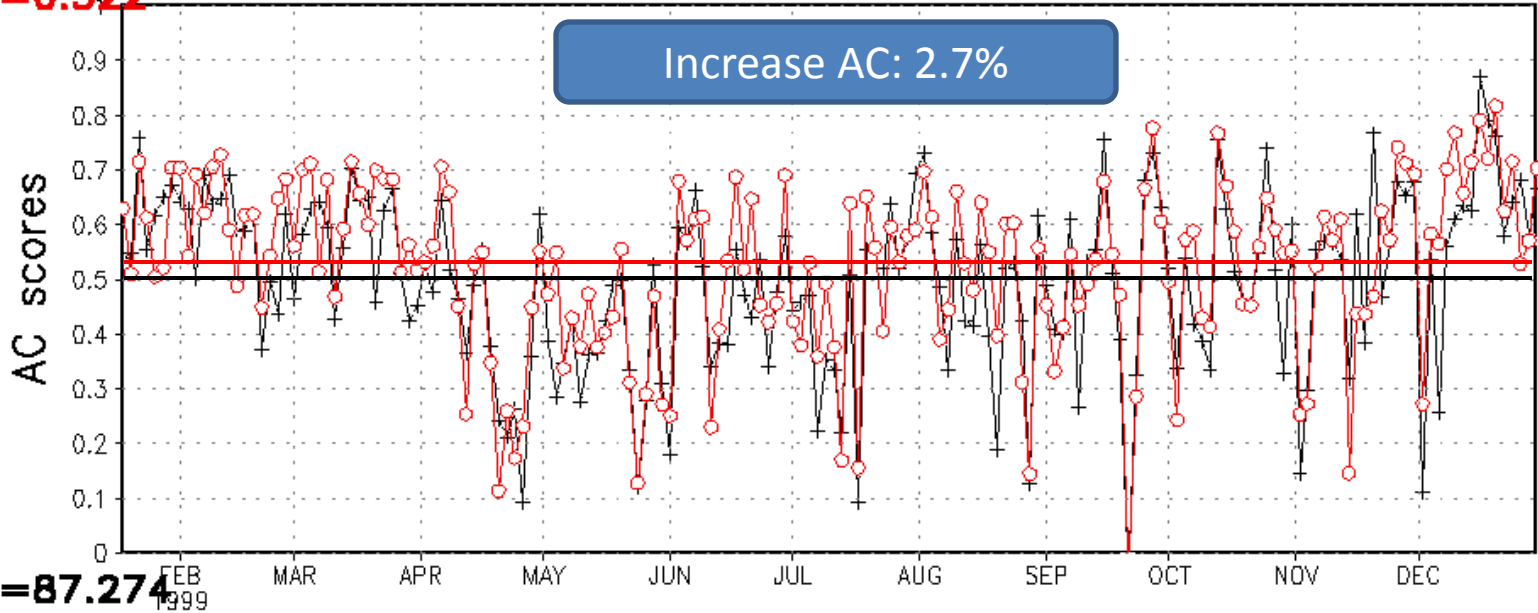
GEFSc−v10=87.274
GEFSc−v11=83.998

Decrease error: 3.28m
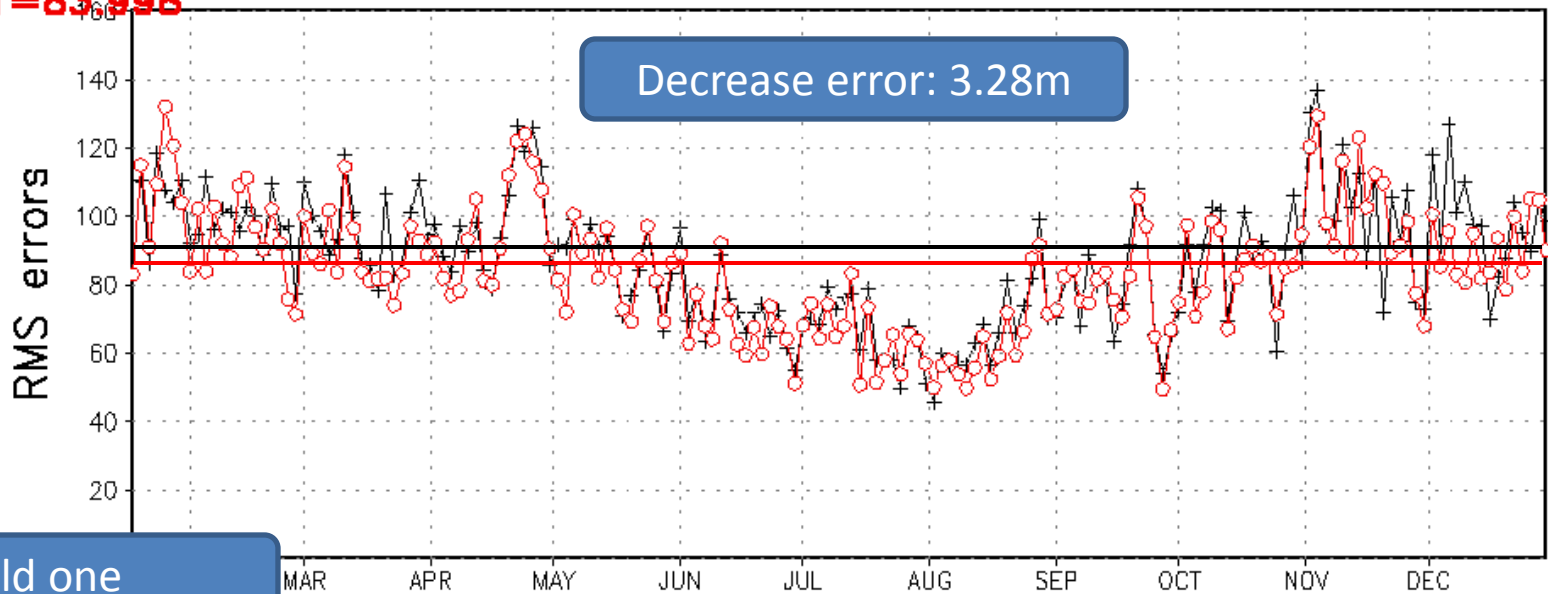
Old one

NH 500 hPa Geopotential Height at day 8
for 00Z02JAN1999 – 00Z30DEC1999

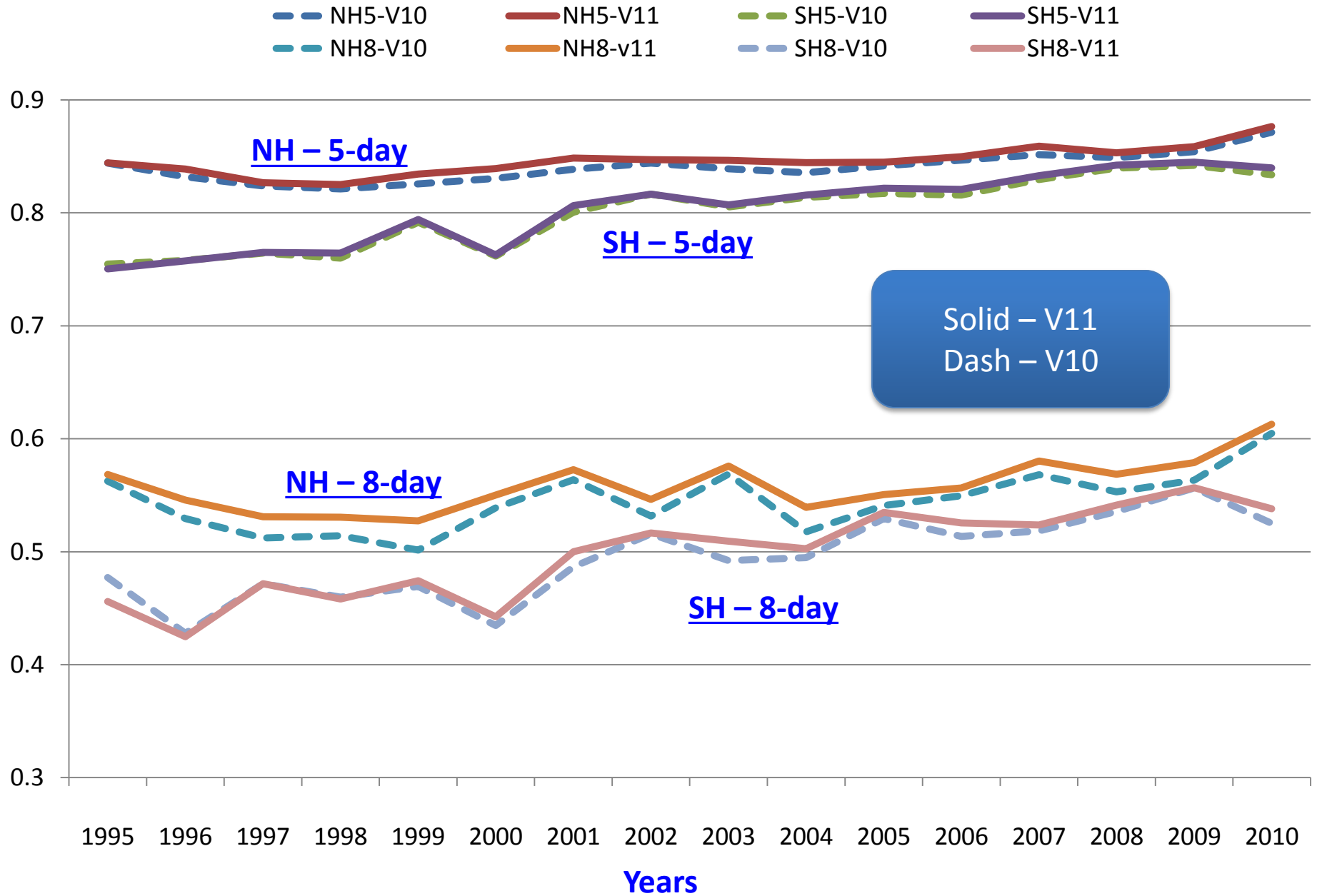V11=0.527
V10=0.501

Increase AC: 2.6%
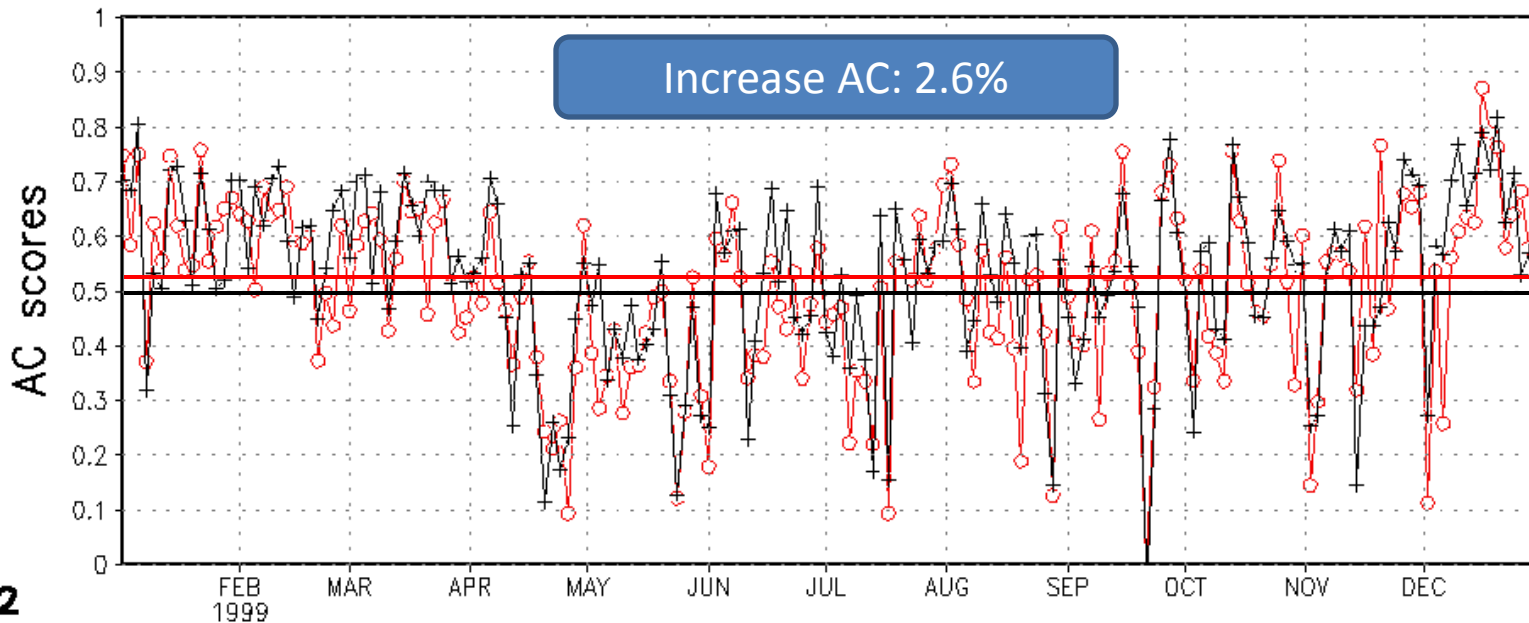
V11=84.312
V10=87.464

Decrease error: 3.15m
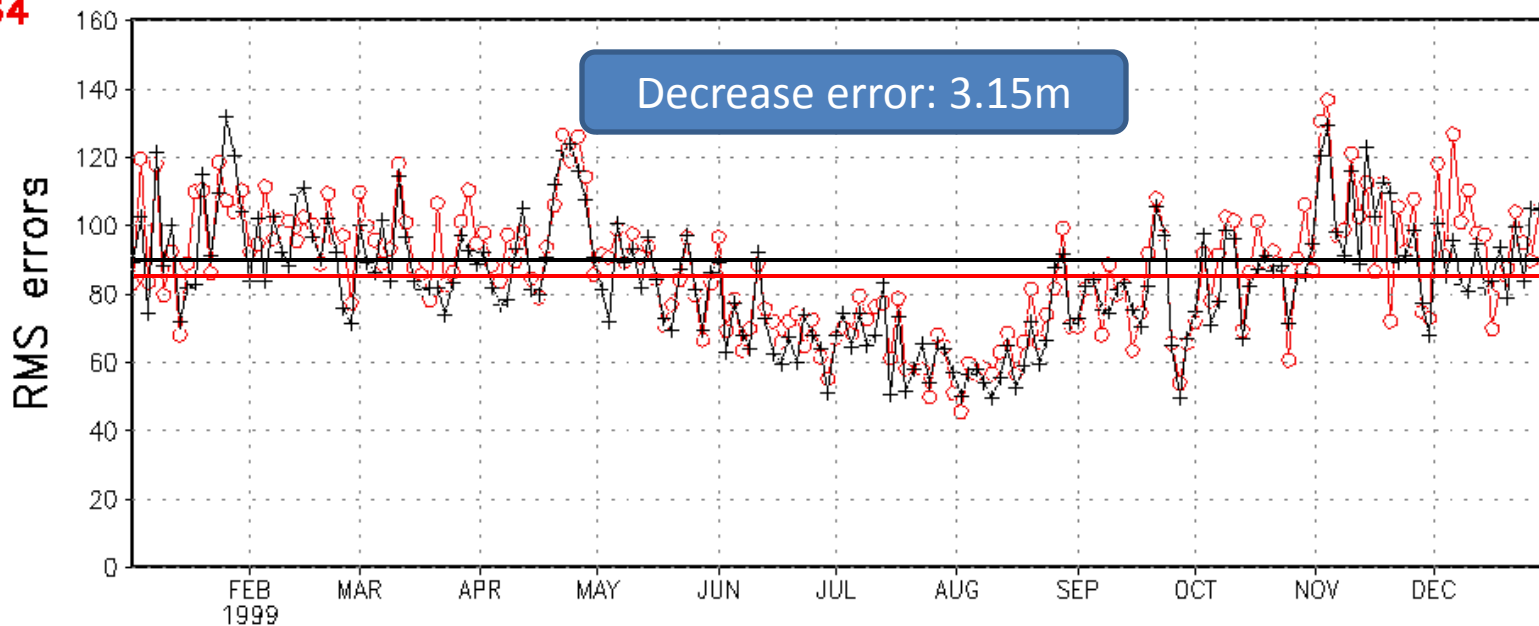
500hPa Anomaly Correlation for Control Only Reforecast (V10 .vs V11)

Bias evaluation

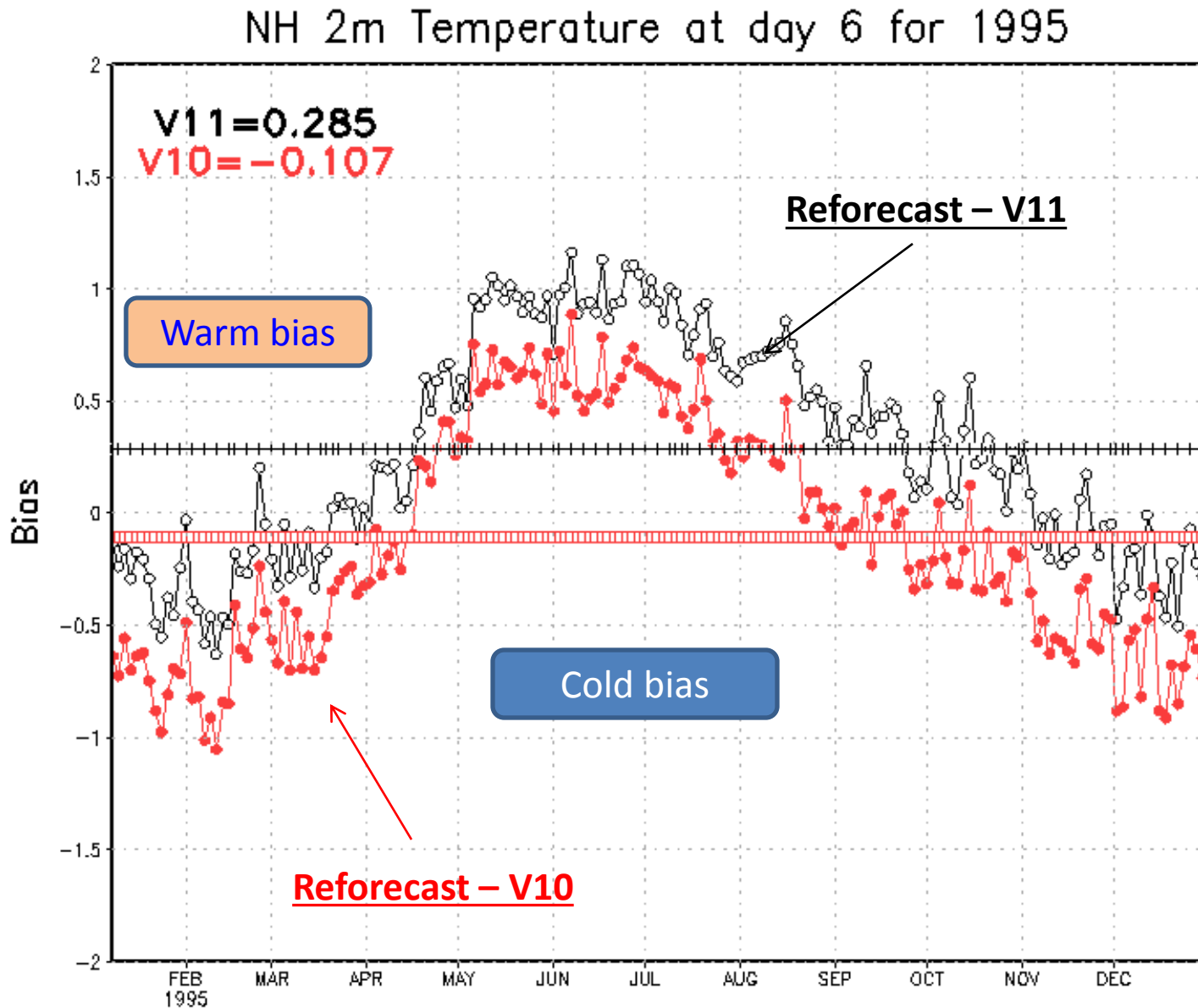- 2-meter temperature
  - In-consistent of analyses
    - Prior to May 2011 – CFS reanalysis
      - Small US domain – cold bias ~ 0.4degree (against obs)
    - After May 2011 – hybrid analysis
      - Small US domain – cold bias ~ 0.8degree (against obs)
  - Comparison of v10 and v11 forecasts
    - Against analysis
      - Cold bias (NH) for v10
      - Warm bias (NH) for v11
    - Against observation – only available for short period
      - Summer (2014) three months
        - » Cold bias (CONUS) for v10
        - » Warm bias (CONUS) for v11
      - Winter (2013-2014) – short period
        - » Both forecasts have cold bias, even parallel is a little warm

Changing short-term forecast bias due to changes in data assimilation system

GEFS Day 1 (F006-F024) Temperature Bias (GEFS - Obs)

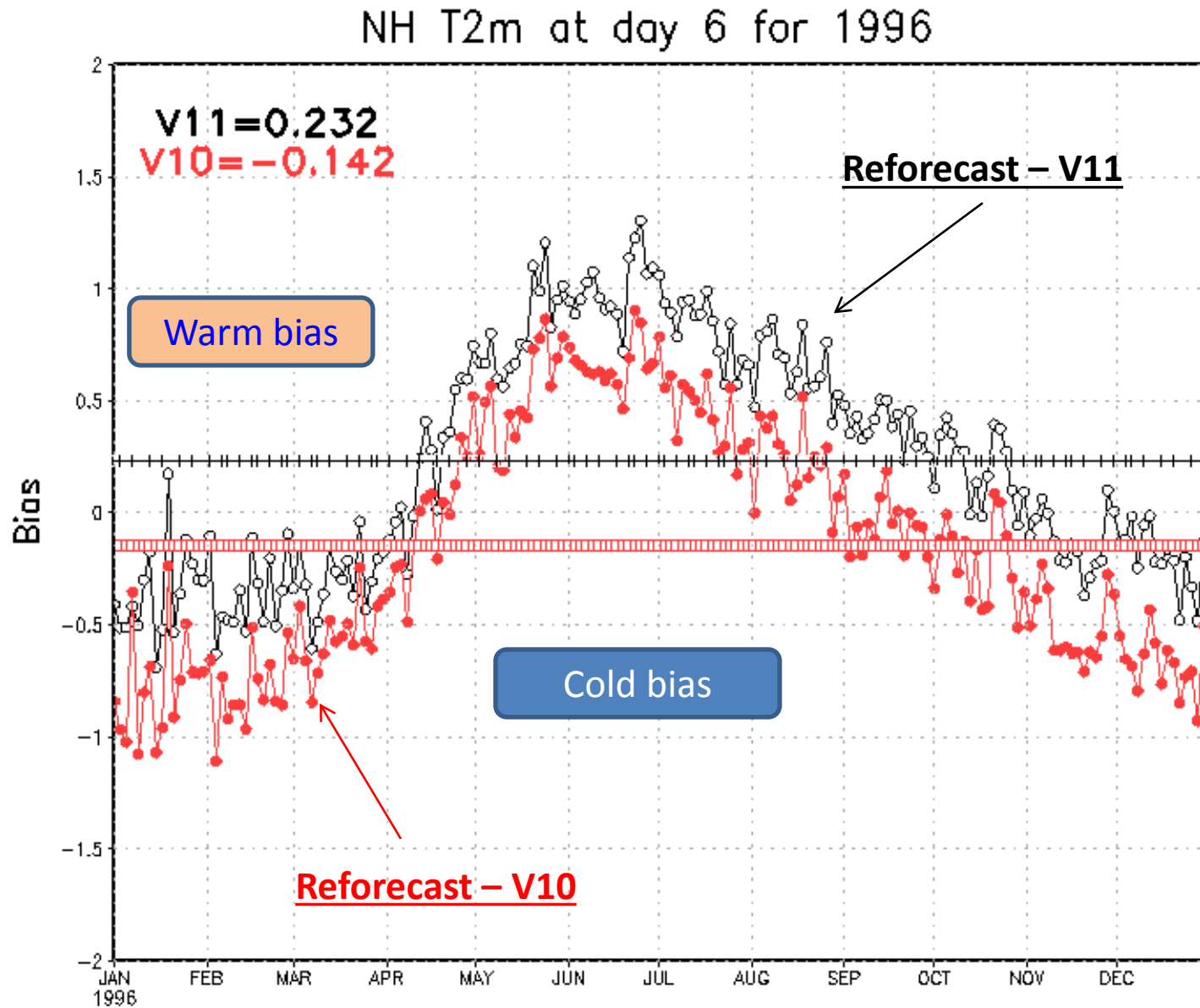Domain:

103° W - 90° W

30° N – 37° N
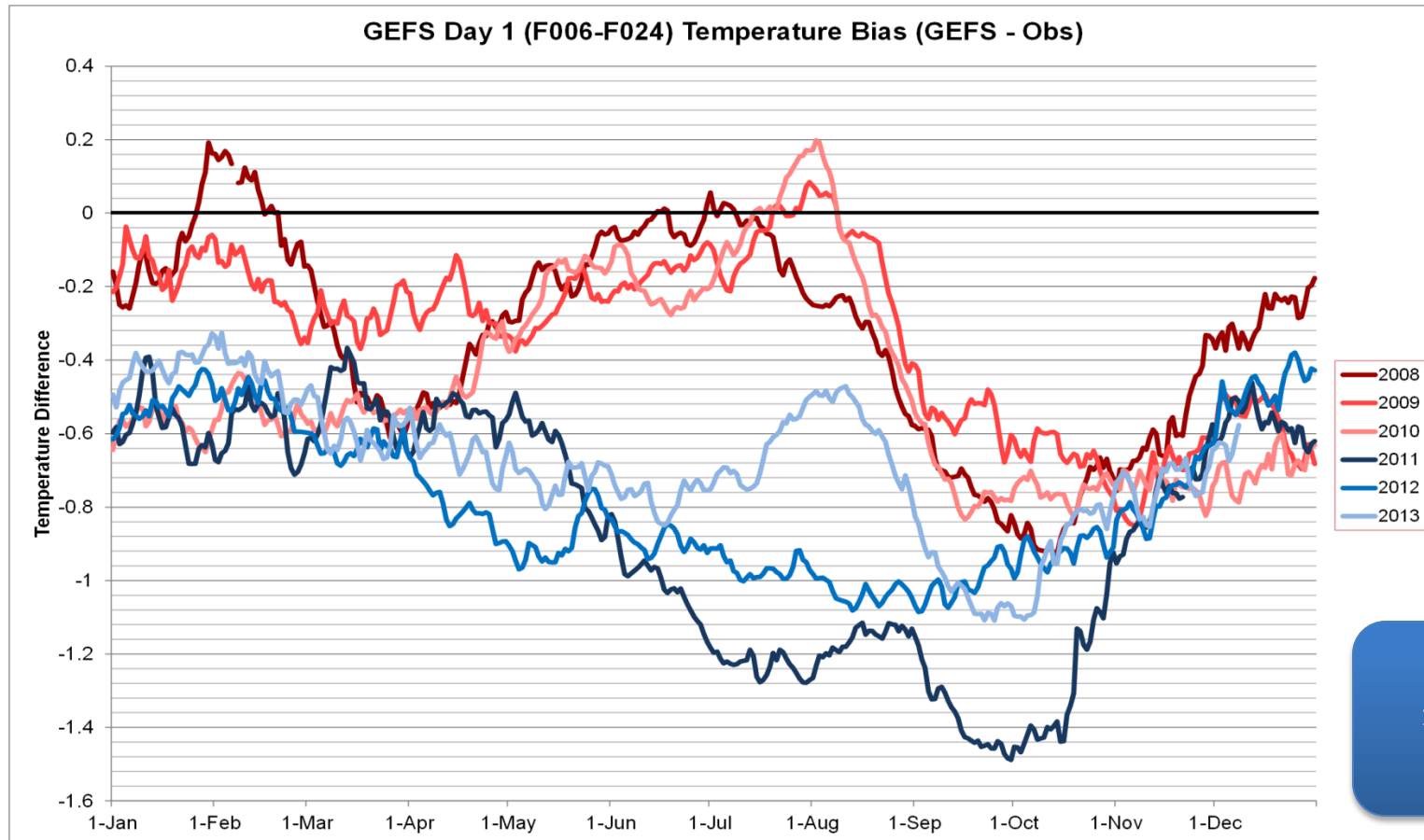
c/o CPC. In 2011, the reforecasts changed from CFSR initialization to GSI initialization, which used a slightly different version of the forecast model.
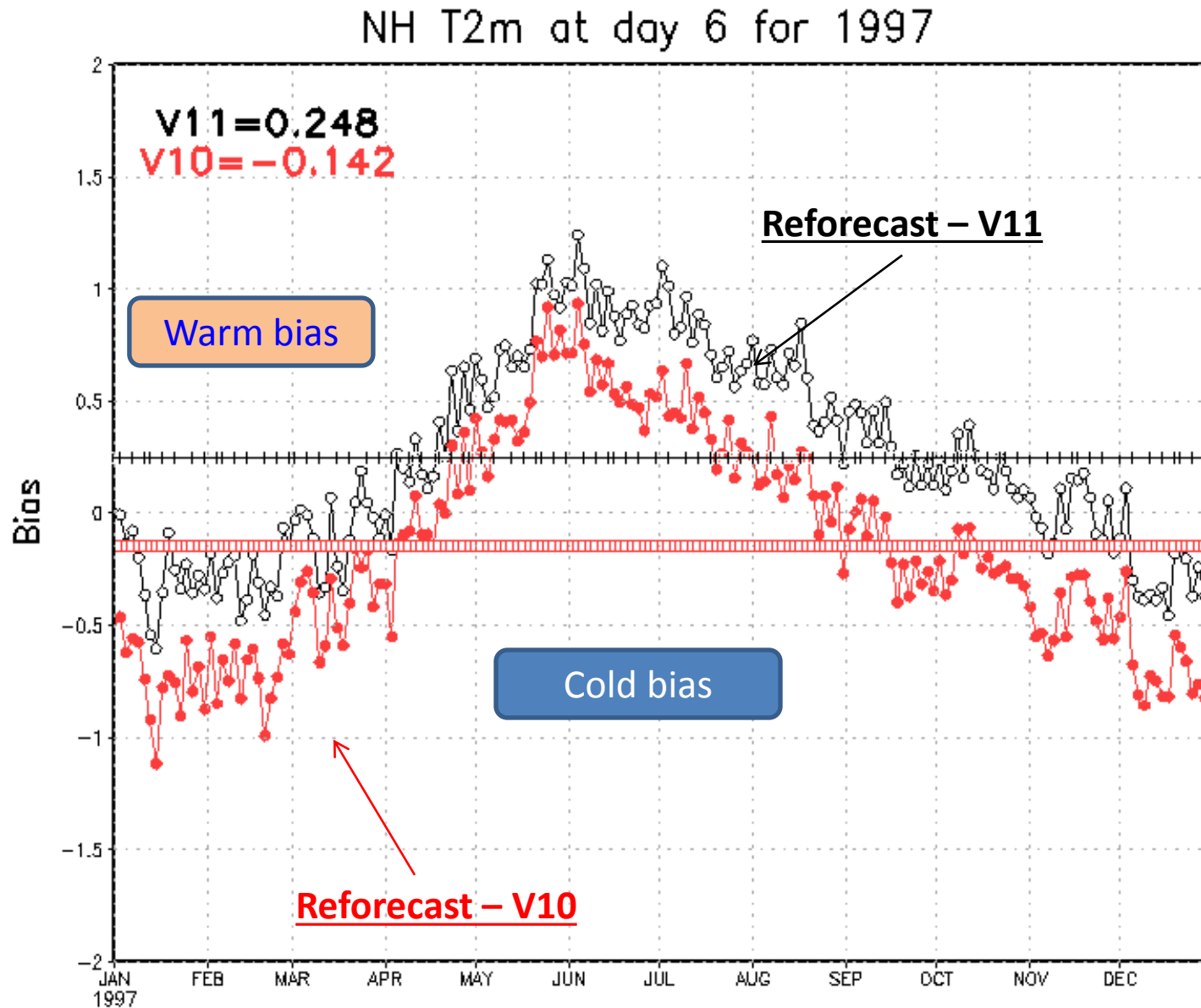
19

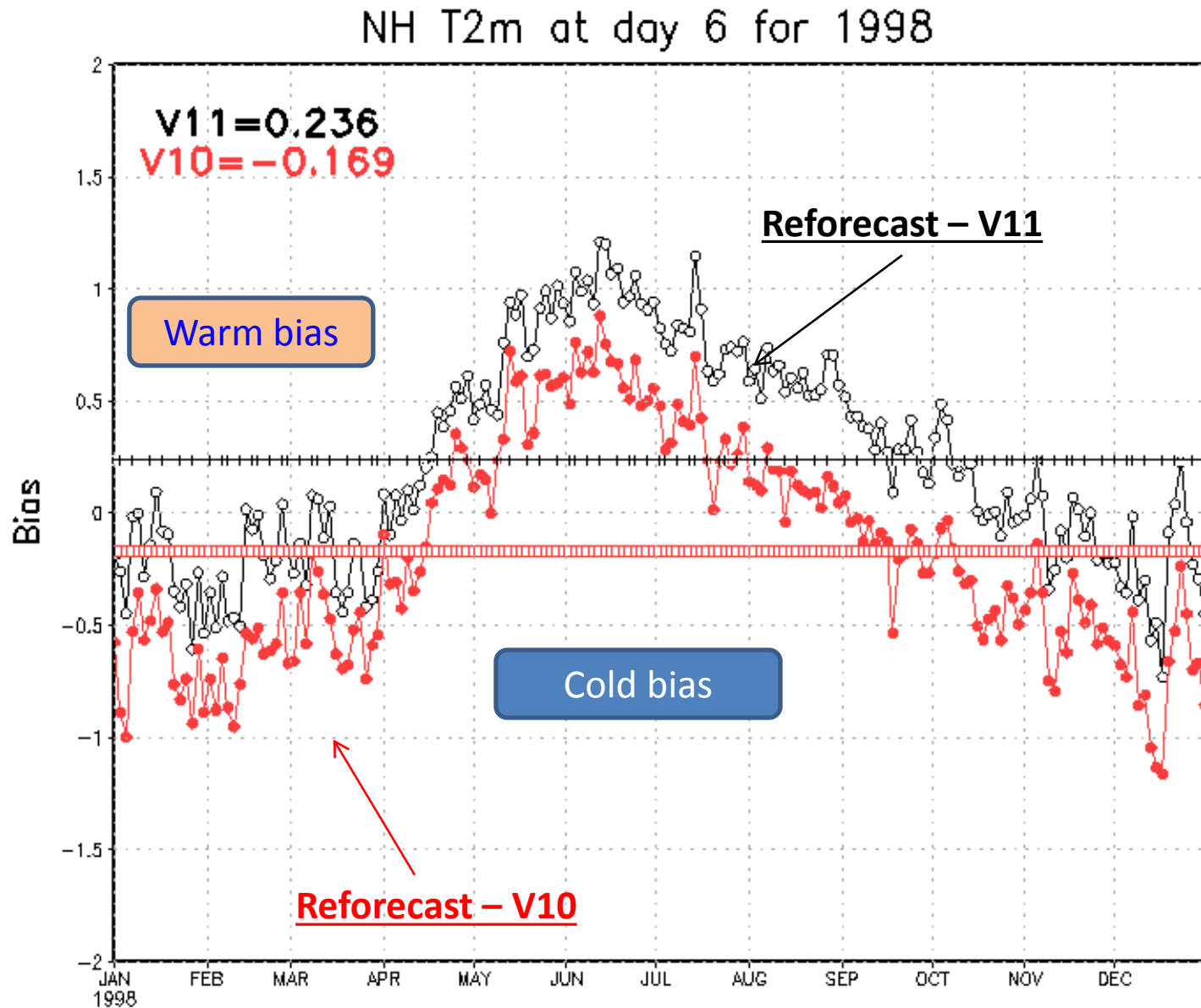# 2-meter temp. bias of 1995 (fcst: 144 hours)

NH 2m Temperature at day 6 for 1995

2-meter temp. bias of 1996 (fcst: 144 hours)

NH T2m at day 6 for 1996

V11=0.232
V10=−0.142

Reforecast – V11

Warm bias

Bias

Cold bias

Reforecast – V10

2-meter temp. bias of 1997 (fcst: 144 hours)

NH T2m at day 6 for 1997

V11=0.248
V10=-0.142

Reforecast – V11

Warm bias

Cold bias

Reforecast – V10

2-meter temp. bias of 1998 (fcst: 144 hours)

NH T2m at day 6 for 1998

V11=0.236
V10=−0.169

Warm bias

Reforecast − V11

Cold bias

Reforecast − V10

2-meter temp. bias of 1999 (fcst: 144 hours)

NH T2m at day 6 for 1999

V11=0.267
V10=−0.140

Warm bias

Reforecast − V11

Cold bias

Reforecast − V10
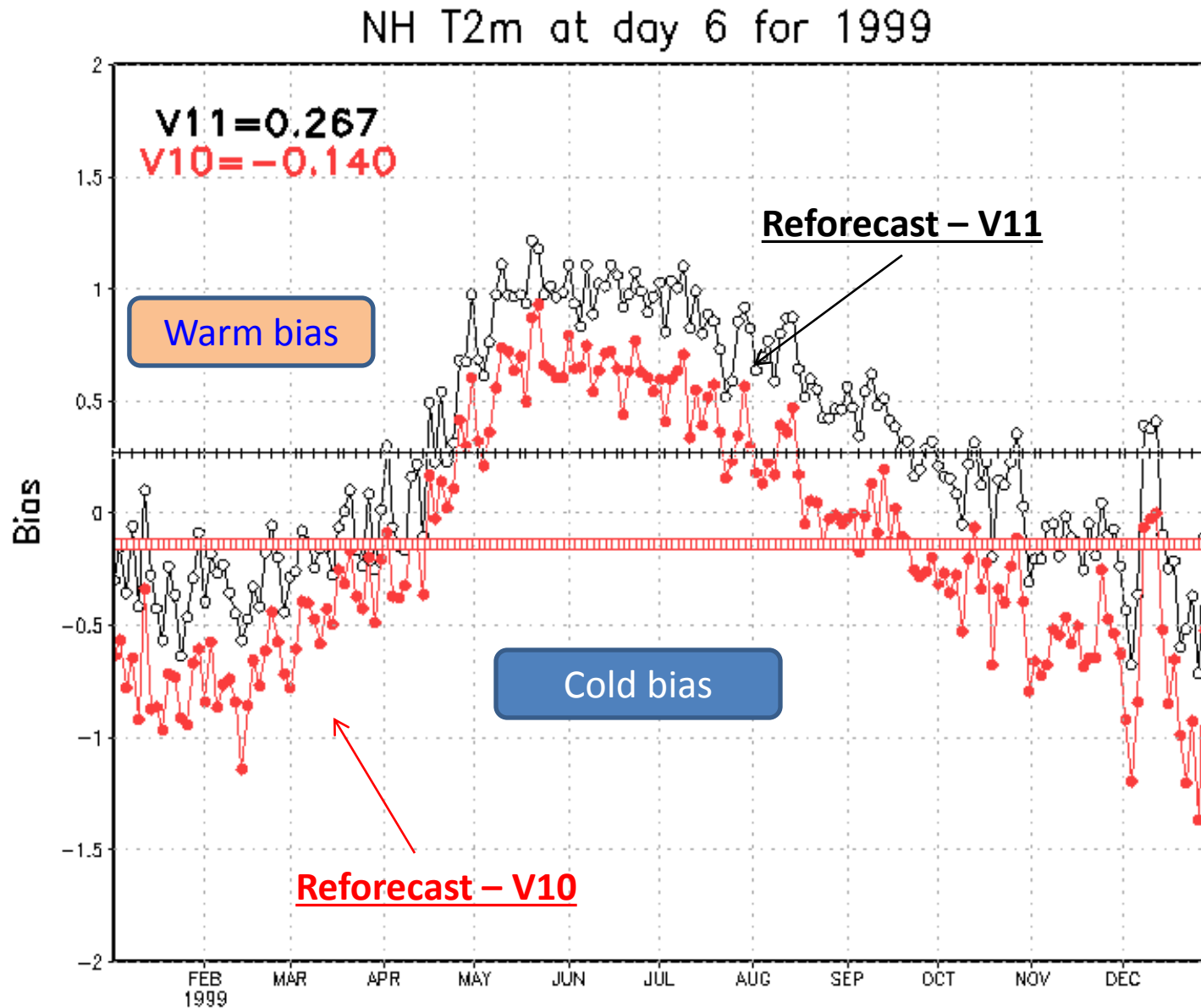
2-meter temp. bias of 2000 (fcst: 144 hours)

NH T2m at day 6 for 2000

V11=0.284
V10=−0.128

Warm bias

Reforecast − V11

Cold bias

Reforecast − V10
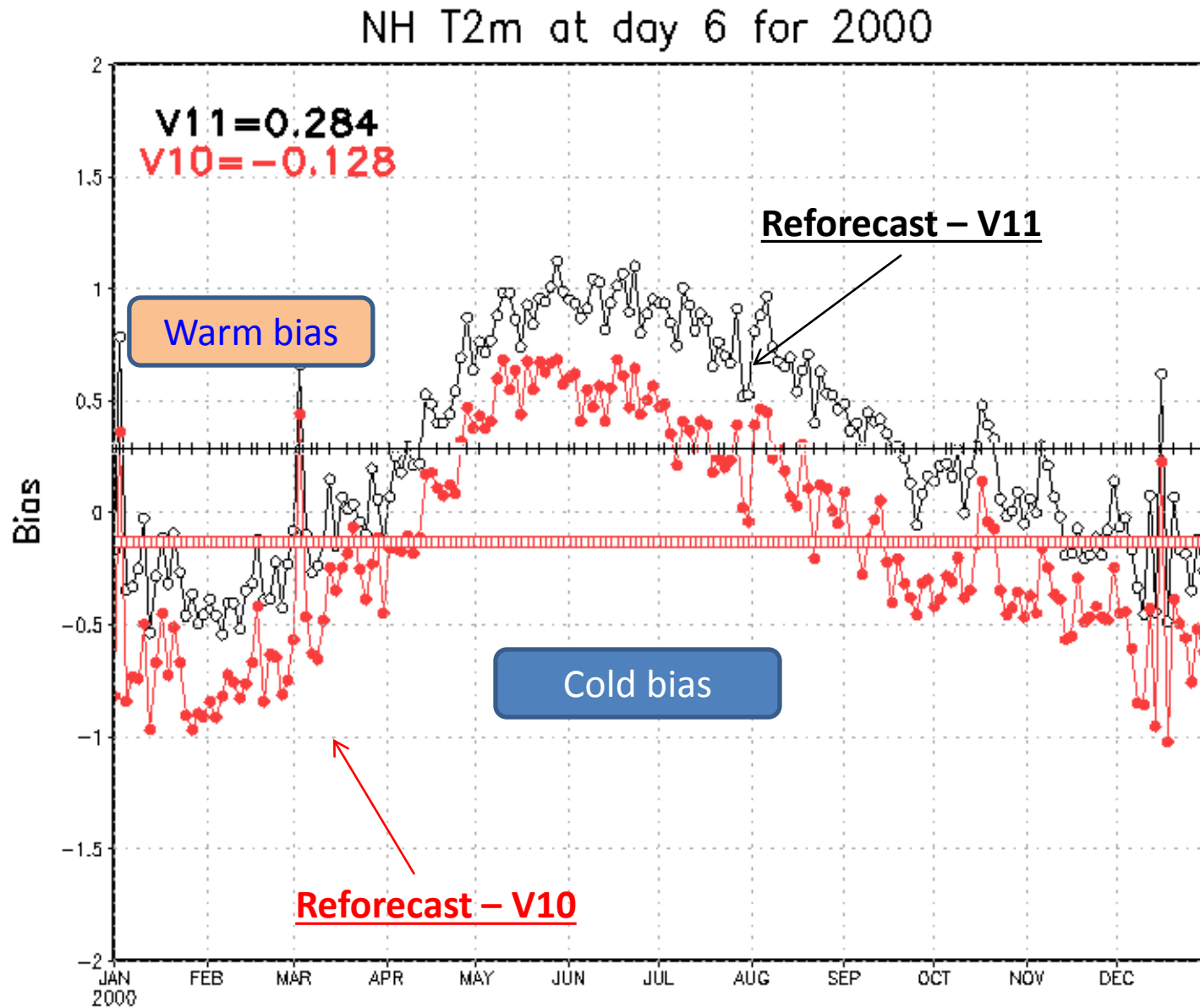
2-meter temp. bias of 2001 (fcst: 144 hours)

NH T2m at day 6 for 2001

V11=0.286
V10=−0.135

Reforecast − V11

Warm bias

Cold bias

Reforecast − V10
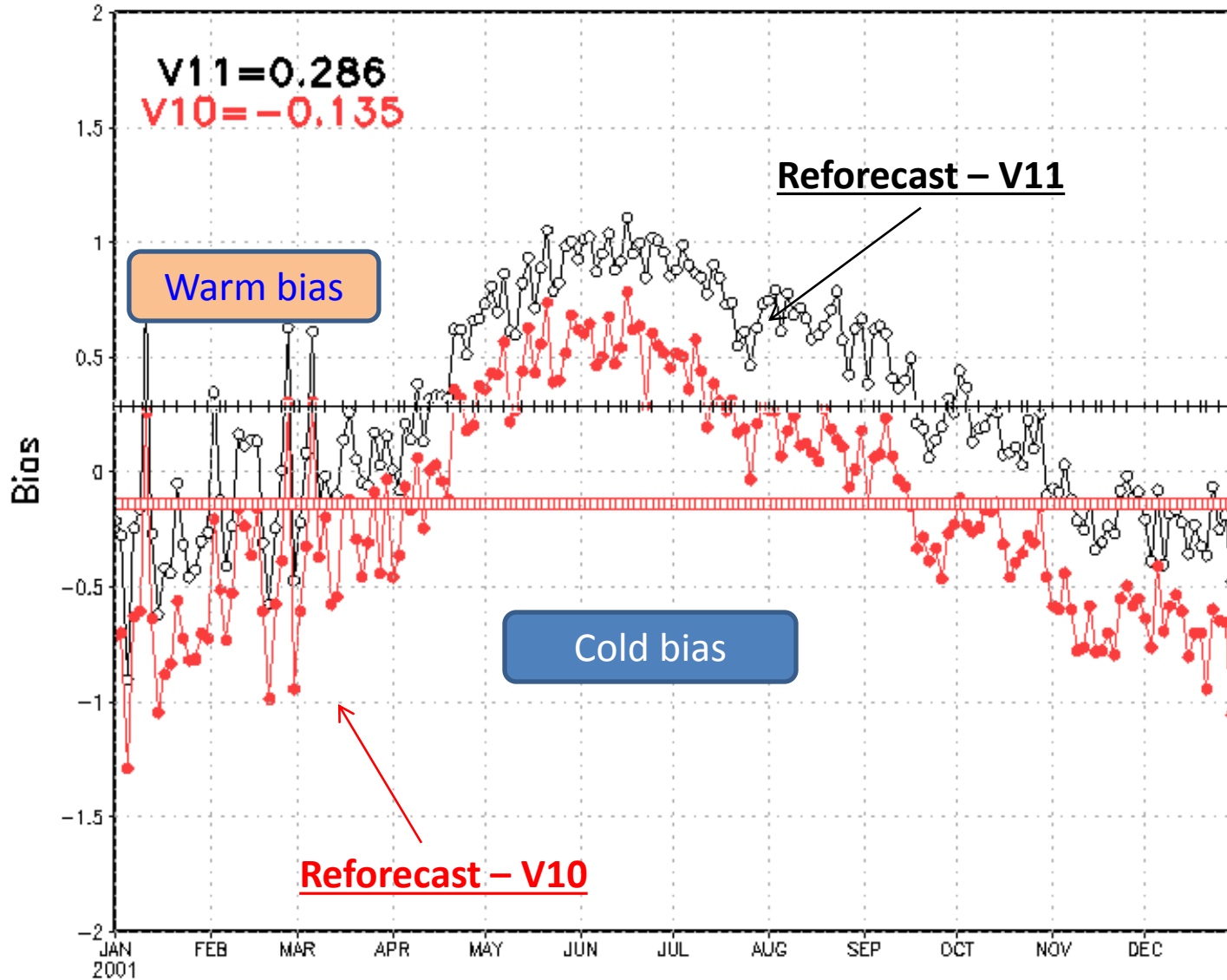
2-meter temp. bias of 2002 (fcst: 144 hours)

NH T2m at day 6 for 2002

V11=0.251
V10=-0.155

Reforecast – V11

Warm bias

Cold bias

Reforecast – V10
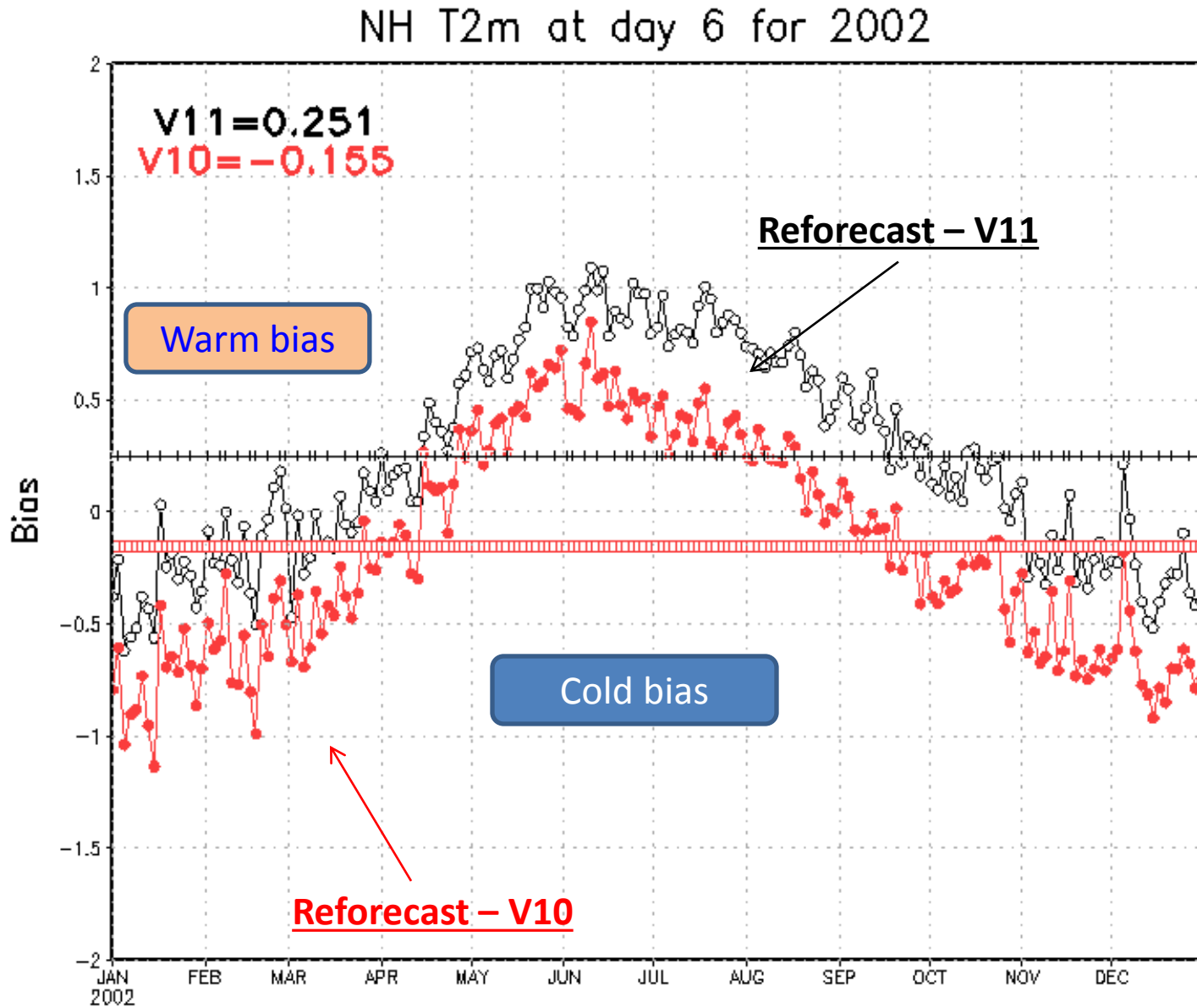
2-meter temp. bias of 2003 (fcst: 144 hours)

NH T2m at day 6 for 2003

V11=0.225
V10=−0.176

Reforecast − V11

Warm bias

Cold bias

Reforecast − V10
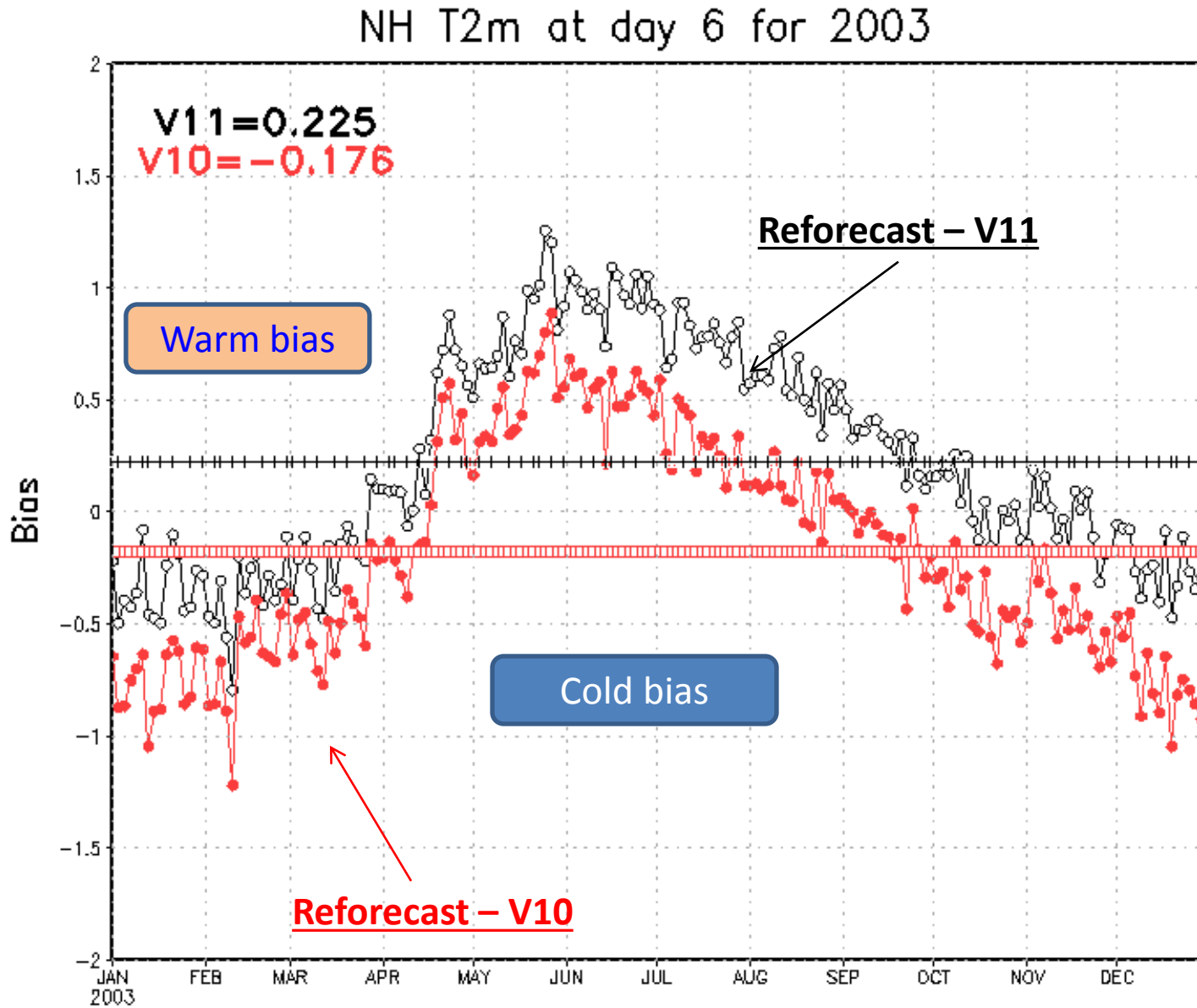
2-meter temp. bias of 2004 (fcst: 144 hours)

NH T2m at day 6 for 2004

V11=0.281
V10=−0.110

Warm bias

Reforecast − V11

Cold bias

Reforecast − V10
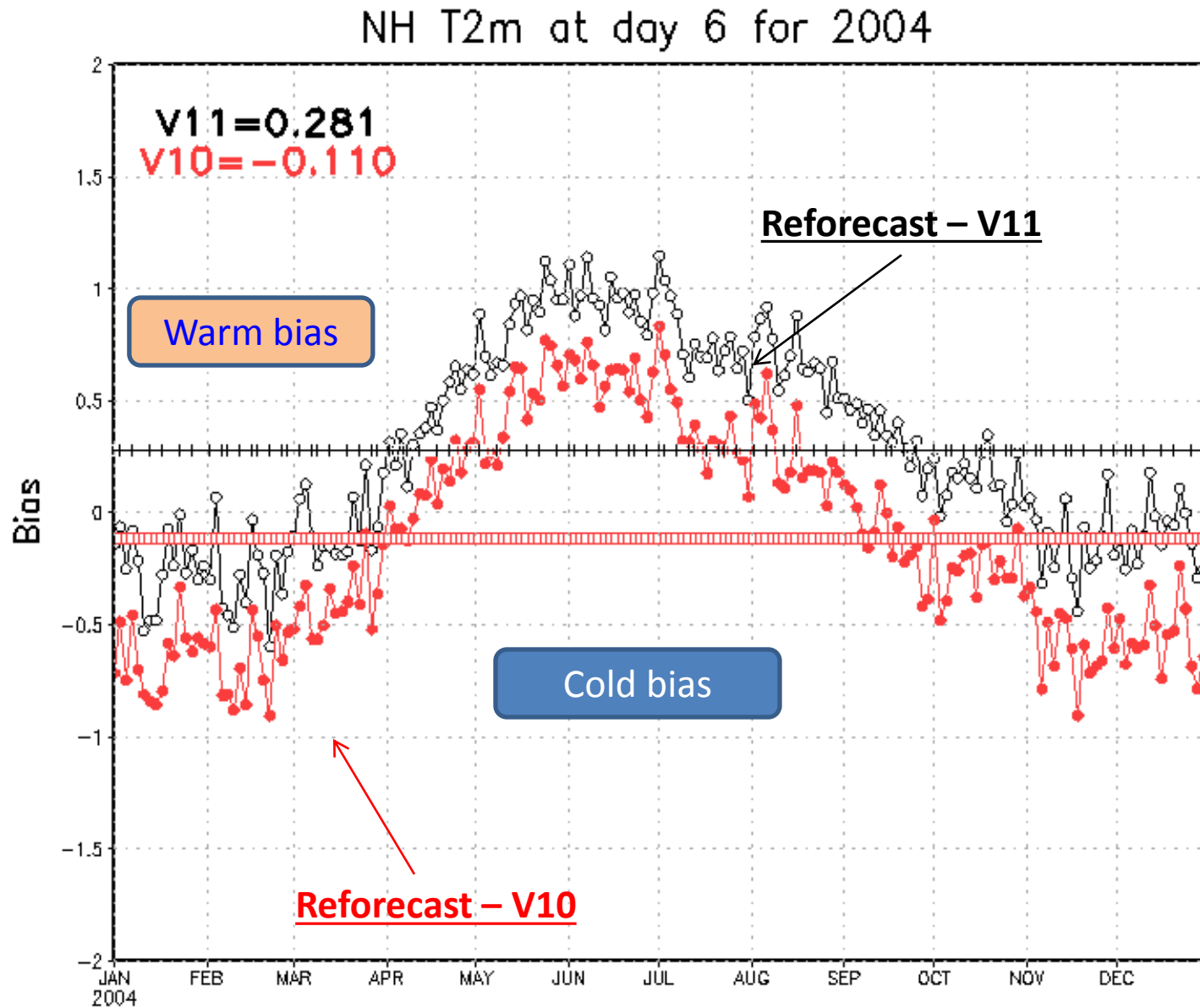
2-meter temp. bias of 2005 (fcst: 144 hours)

NH T2m at day 6 for 2005

V11=0.281
V10=−0.089

Warm bias

Reforecast – V11

Cold bias

Reforecast – V10
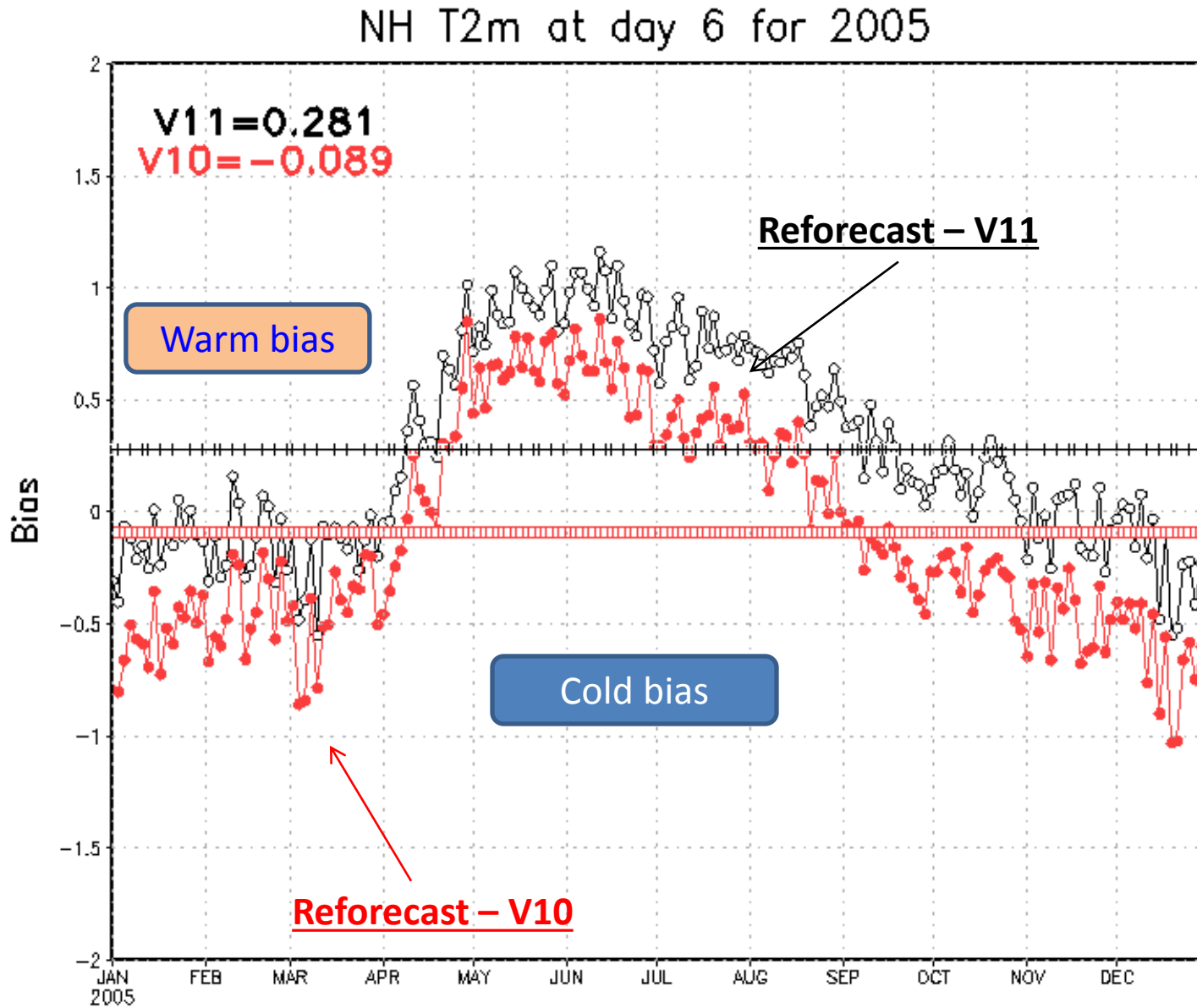
2-meter temp. bias of 2006 (fcst: 144 hours)
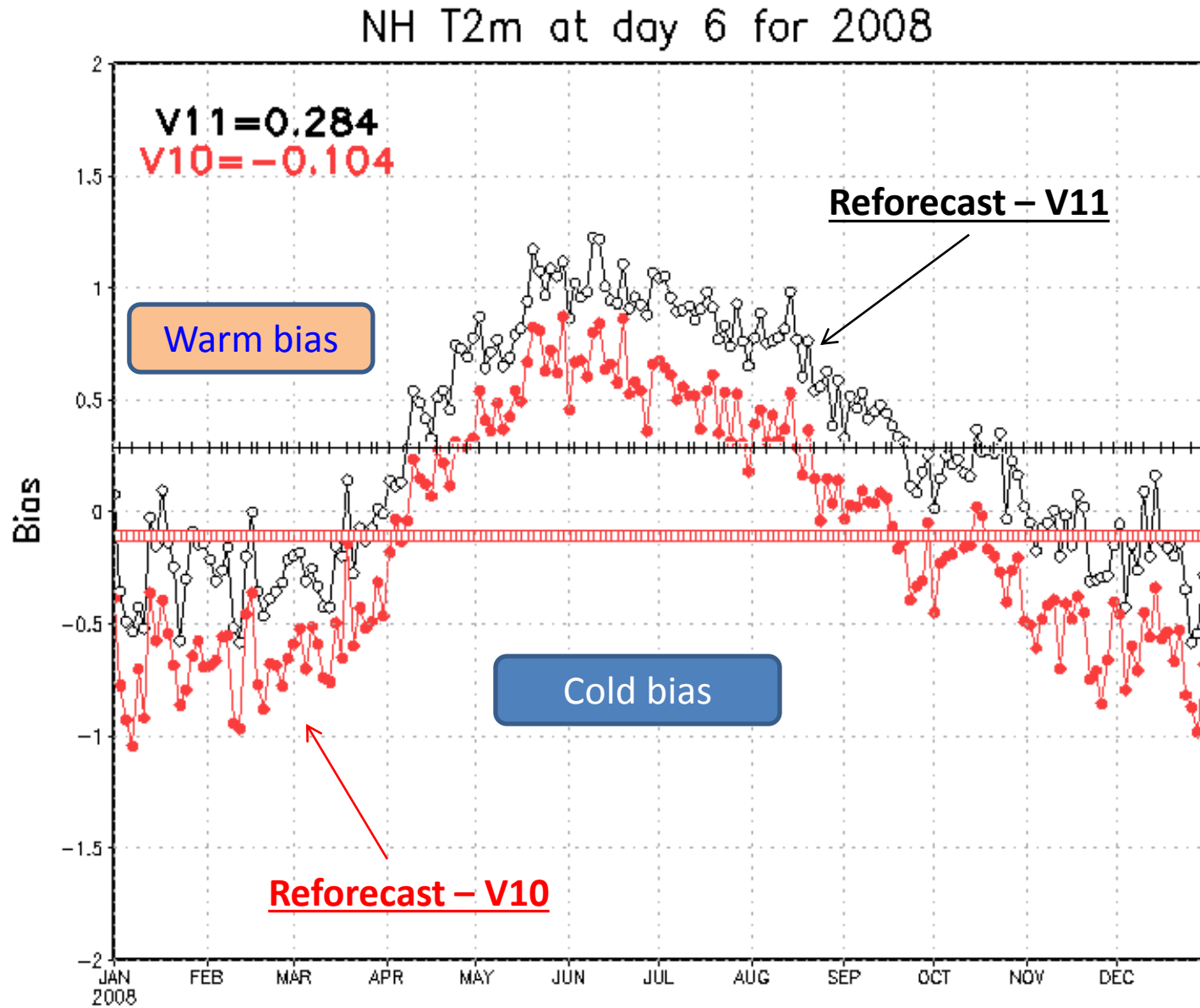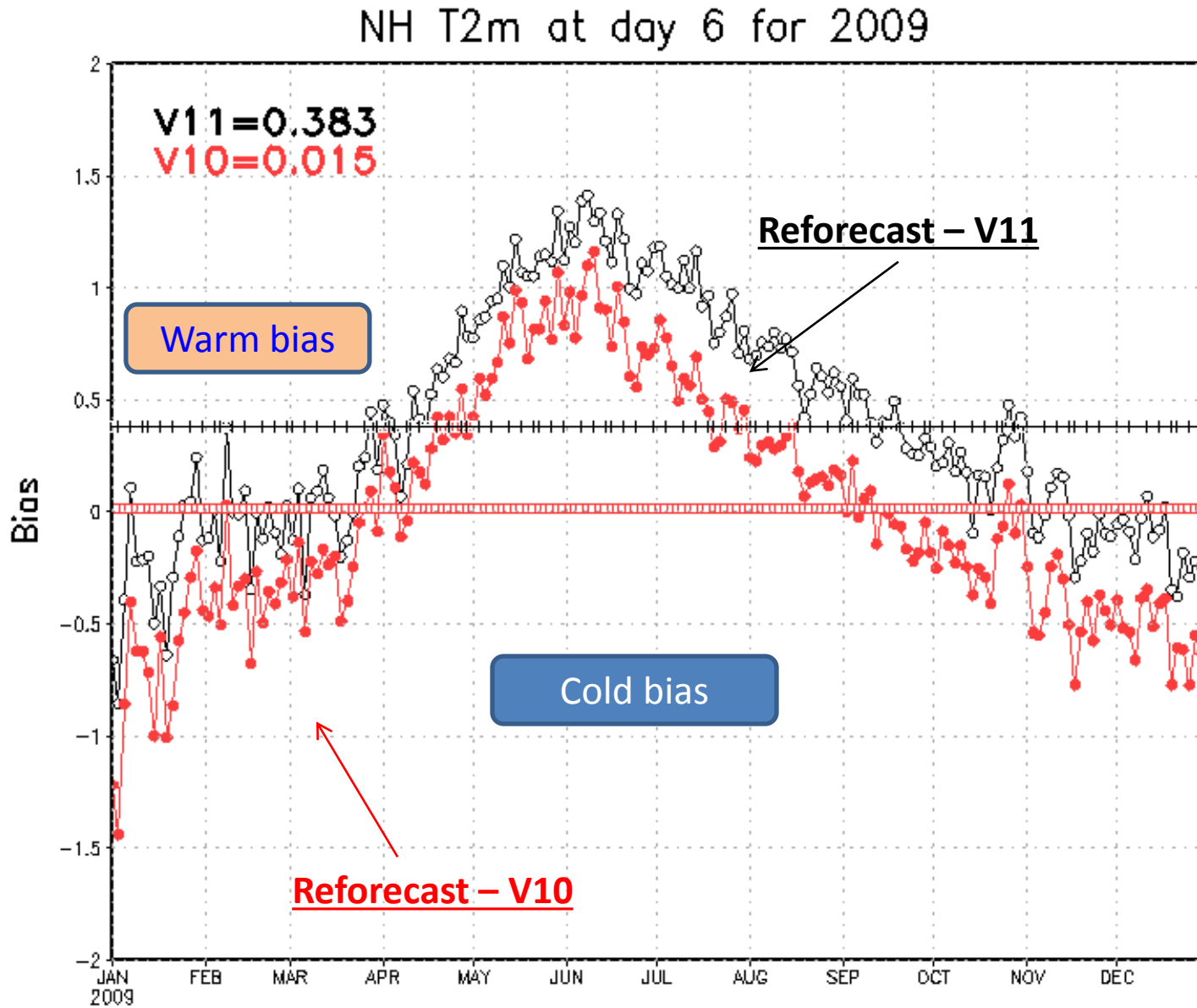

NH T2m at day 6 for 2006
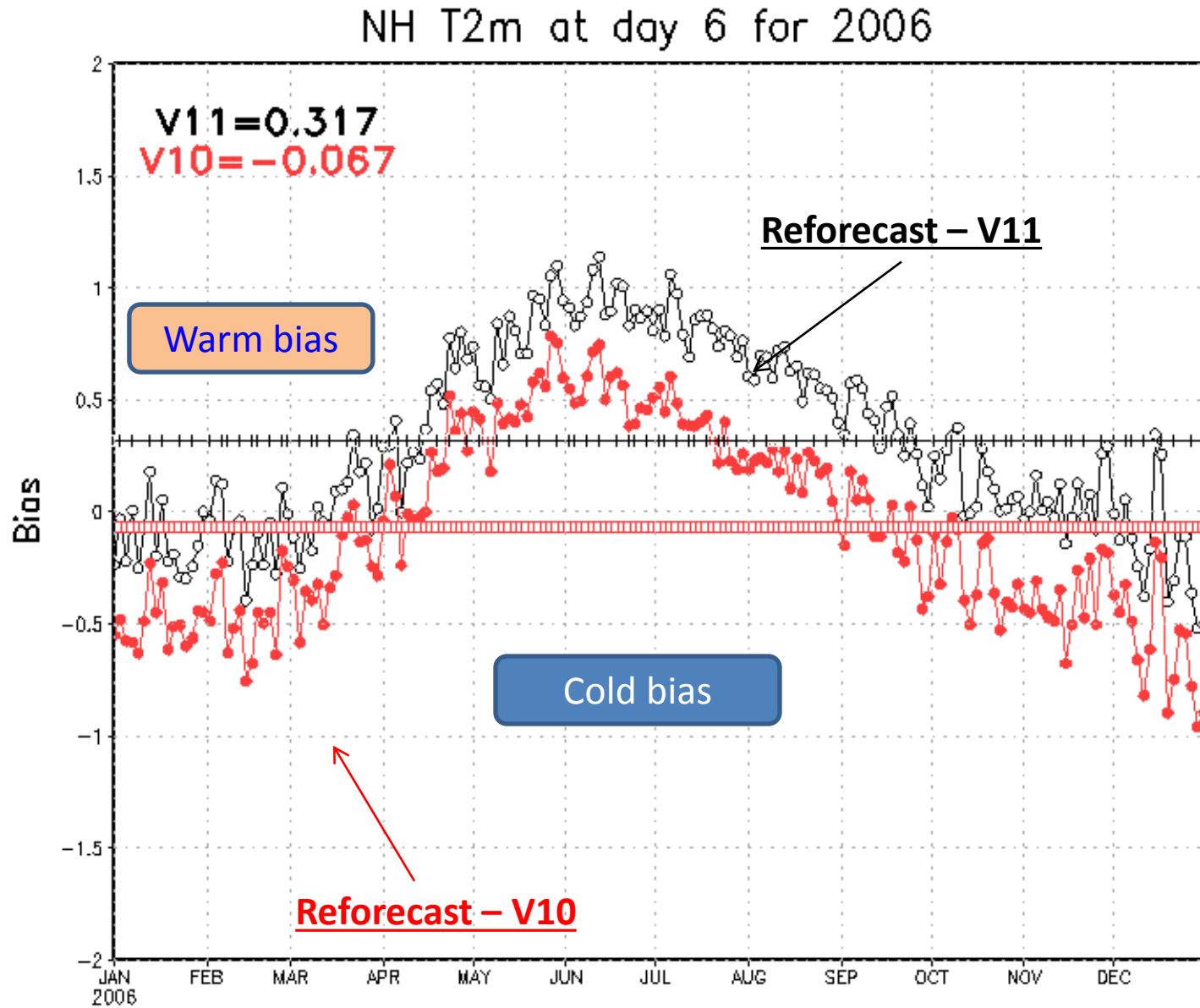
2-meter temp. bias of 2007 (fcst: 144 hours)
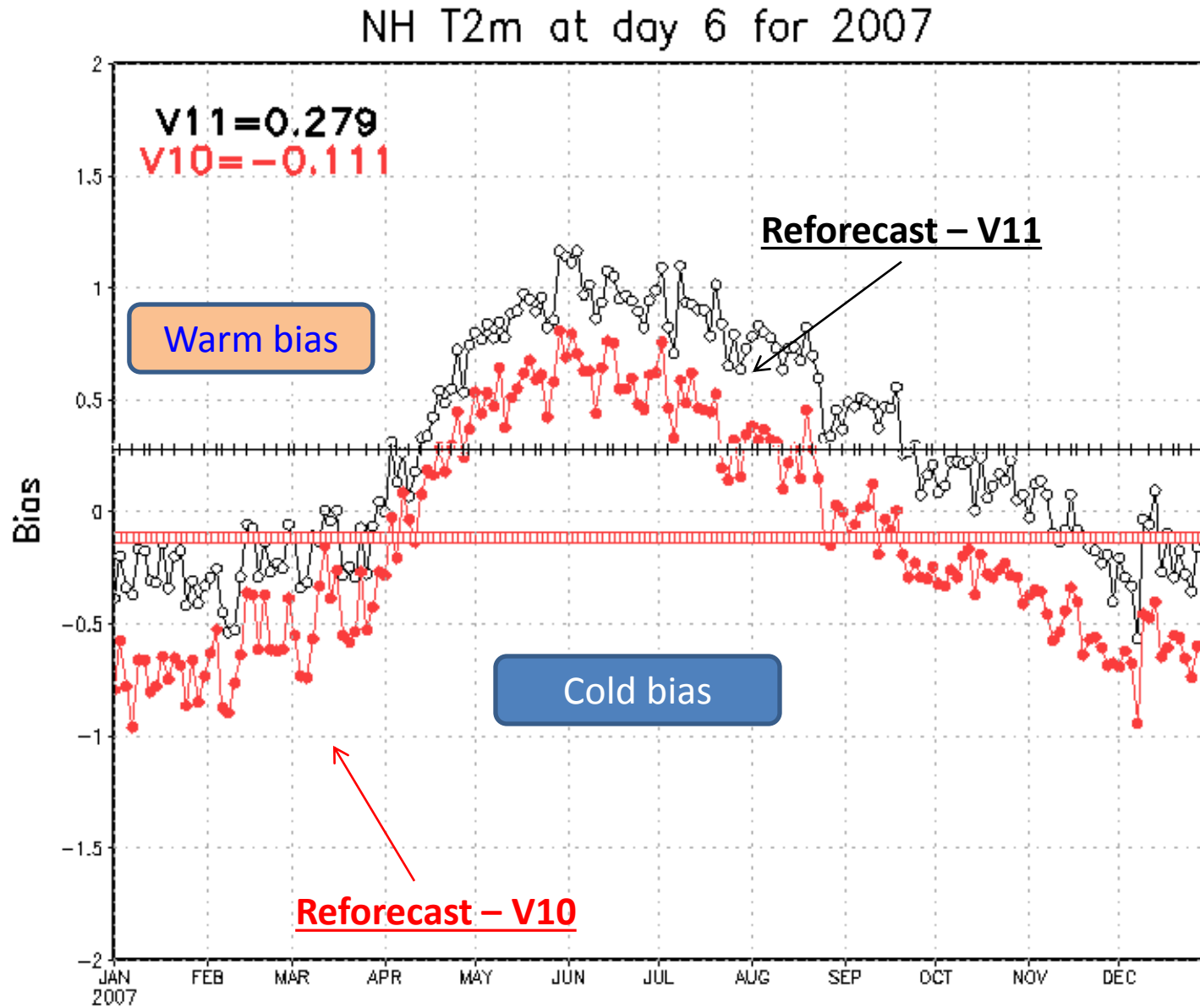
2-meter temp. bias of 2008 (fcst: 144 hours)
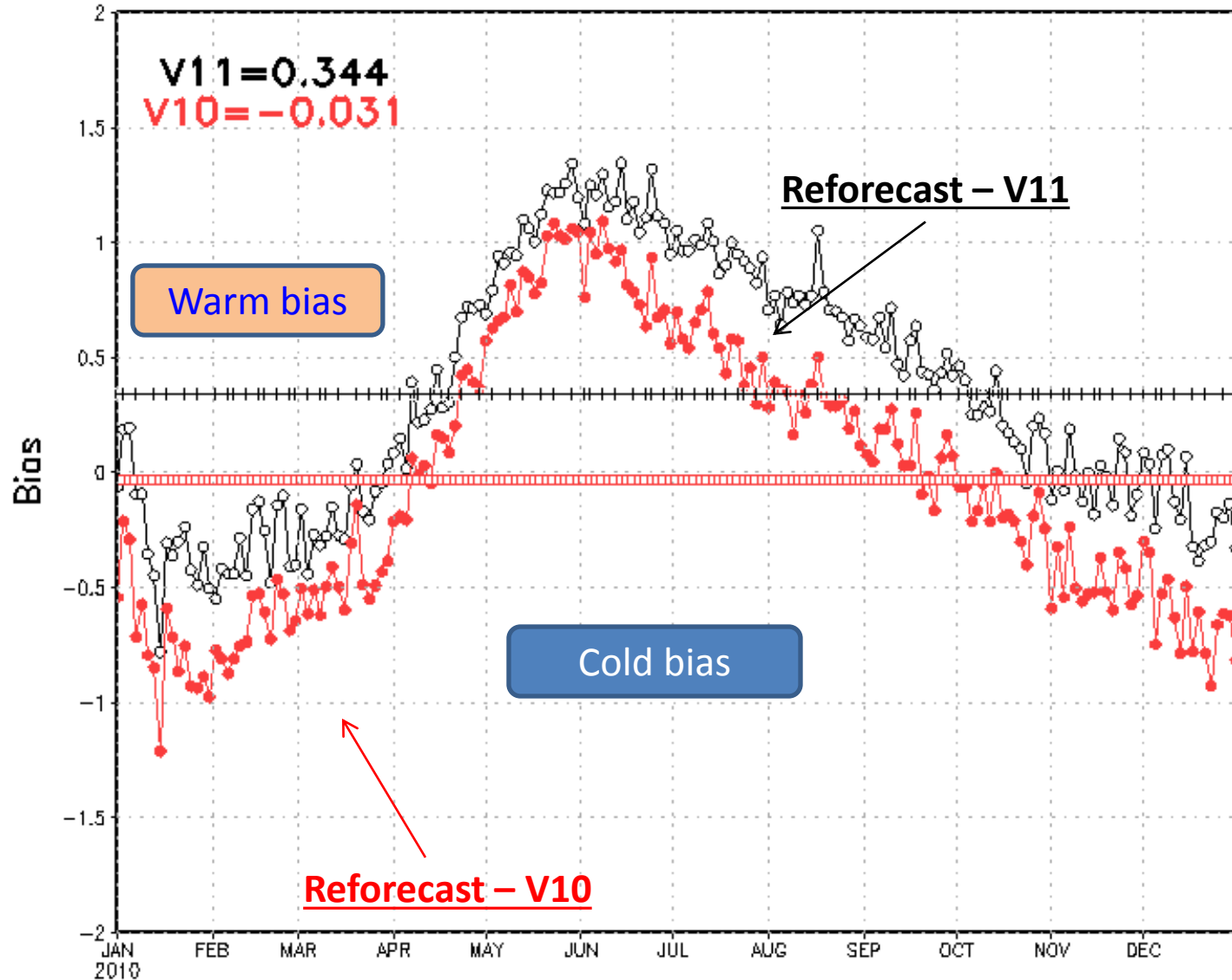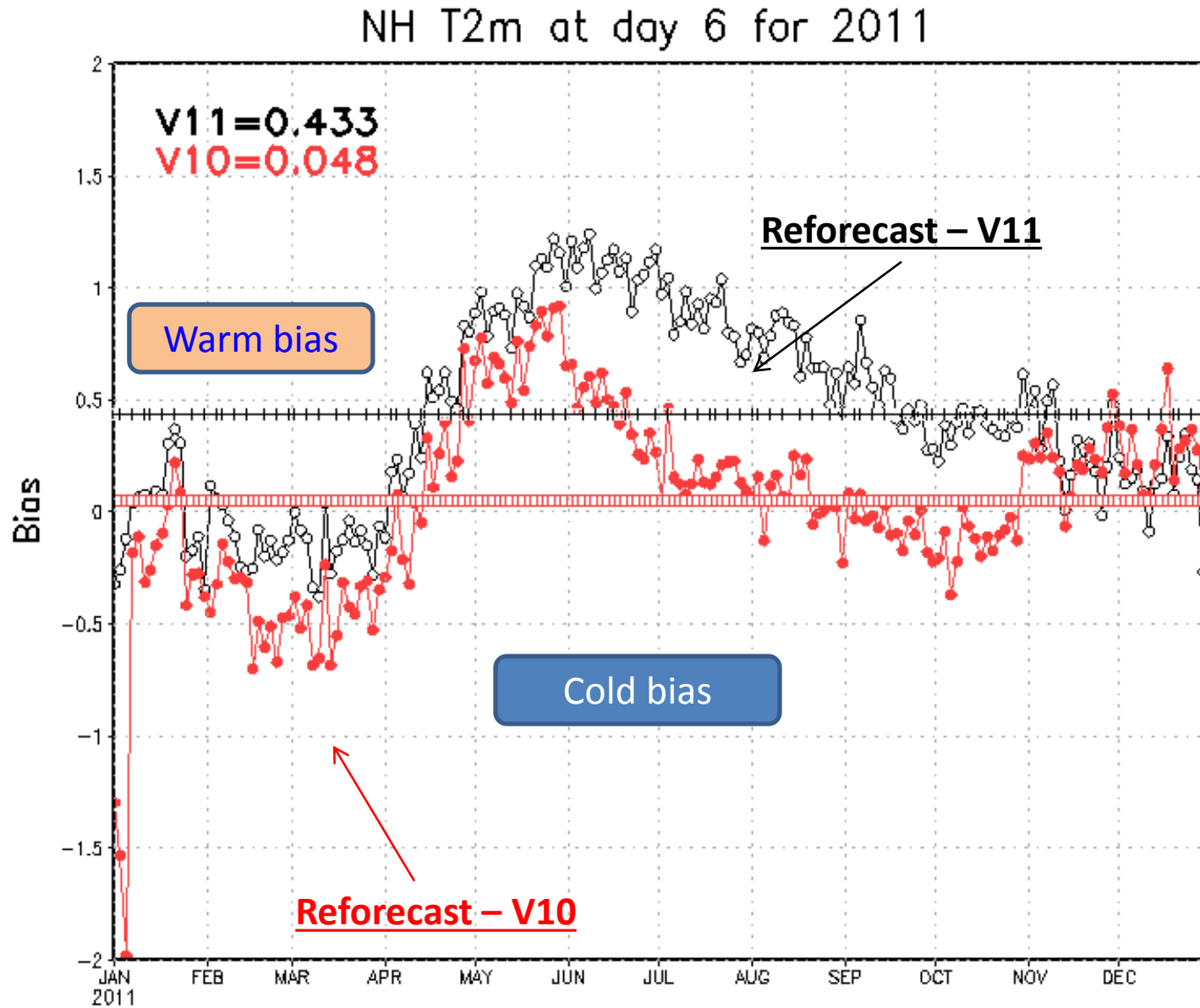
2-meter temp. bias of 2009 (fcst: 144 hours)

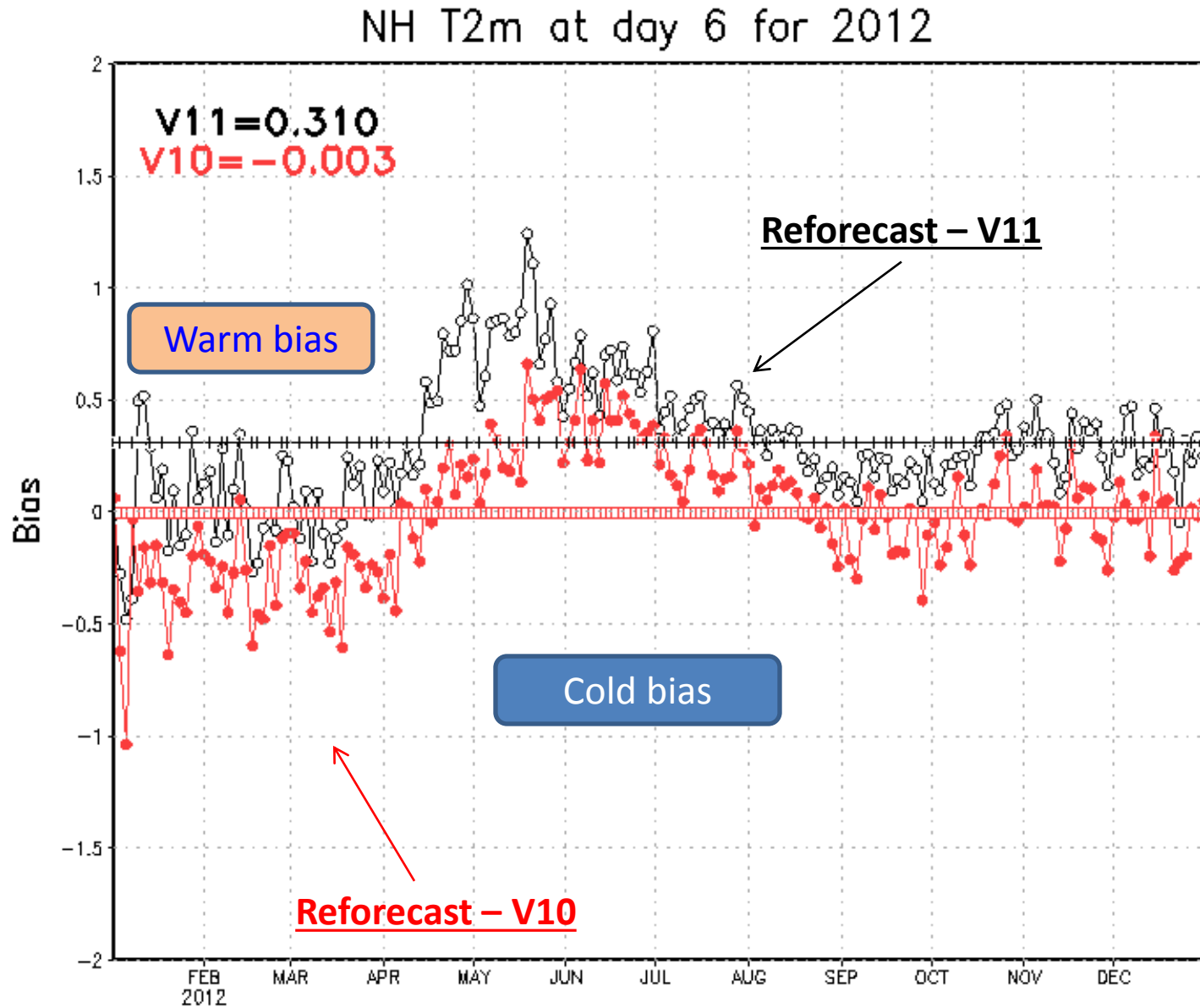

NH T2m at day 6 for 2009

V11=0.383
V10=0.015

Warm bias

Reforecast – V11

Cold bias

Reforecast – V10

2-meter temp. bias of 2010 (fcst: 144 hours)

NH T2m at day 6 for 2010

V11=0.344
V10=−0.031

Warm bias

Reforecast − V11

Cold bias

Reforecast − V10

2-meter temp. bias of 2011 (fcst: 144 hours)

2-meter temp. bias of 2012 (fcst: 144 hours)

NH T2m at day 6 for 2012

2-meter temperature evaluation against observation
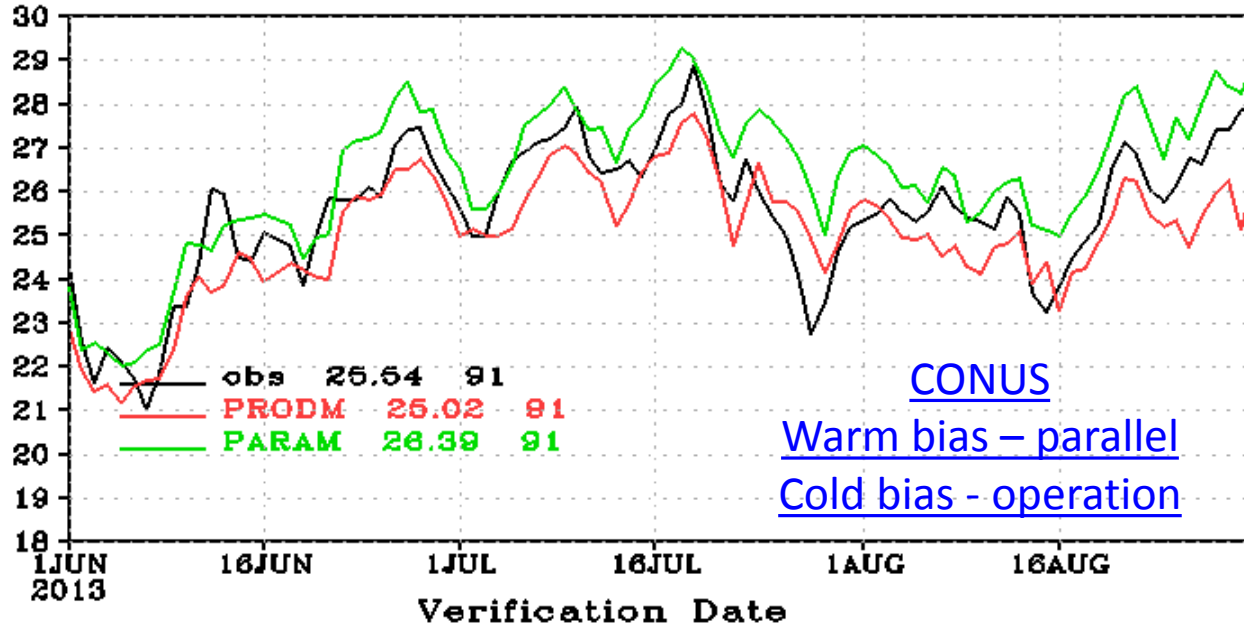## (6 days – 144 hrs forecast)

Ensemble mean

Summer 2013

3 months

T SFC, CONUS, 00Z cycle, fh144

obs   25.54   91
PRODM 25.02   91
PARAM 26.39   91

CONUS
Warm bias – parallel
Cold bias - operation

T SFC, CONUS East, 00Z cycle, fh144

obs   24.93   91
PRODM 24.24   91
PARAM 25.58   91

East of CONUS

T SFC, CONUS West, 00Z cycle, fh144

obs   27.42   91
PRODM 27.40   91
PARAM 28.89   91

West of CONUS

2-meter temperature evaluation against observation

(6 days – 144 hrs forecast)

Ensemble mean

Winter-Spring 2014

4 months

T SFC, CONUS, 00Z cycle, fh144

obs 8.524 118
PRODM 6.785 118
PARAM 6.741 118

CONUS
Cold bias for both
But para is colder

T SFC, CONUS East, 00Z cycle, fh144

obs 7.476 118
PRODM 5.567 118
PARAM 5.553 118

East of CONUS

T SFC, CONUS West, 00Z cycle, fh144

obs 11.07 118
PRODM 10.52 118
PARAM 10.37 118

West of CONUS