N
C
E
P

Decision Brief:
Q1 2008 SREF Upgrade

Mesoscale Modeling Branch

Geoff DiMego

Jun Du, Binbin Zhou, Jeff McQueen and Xiaoxue Wang

29 November 2007

where the nation's climate and weather services begin

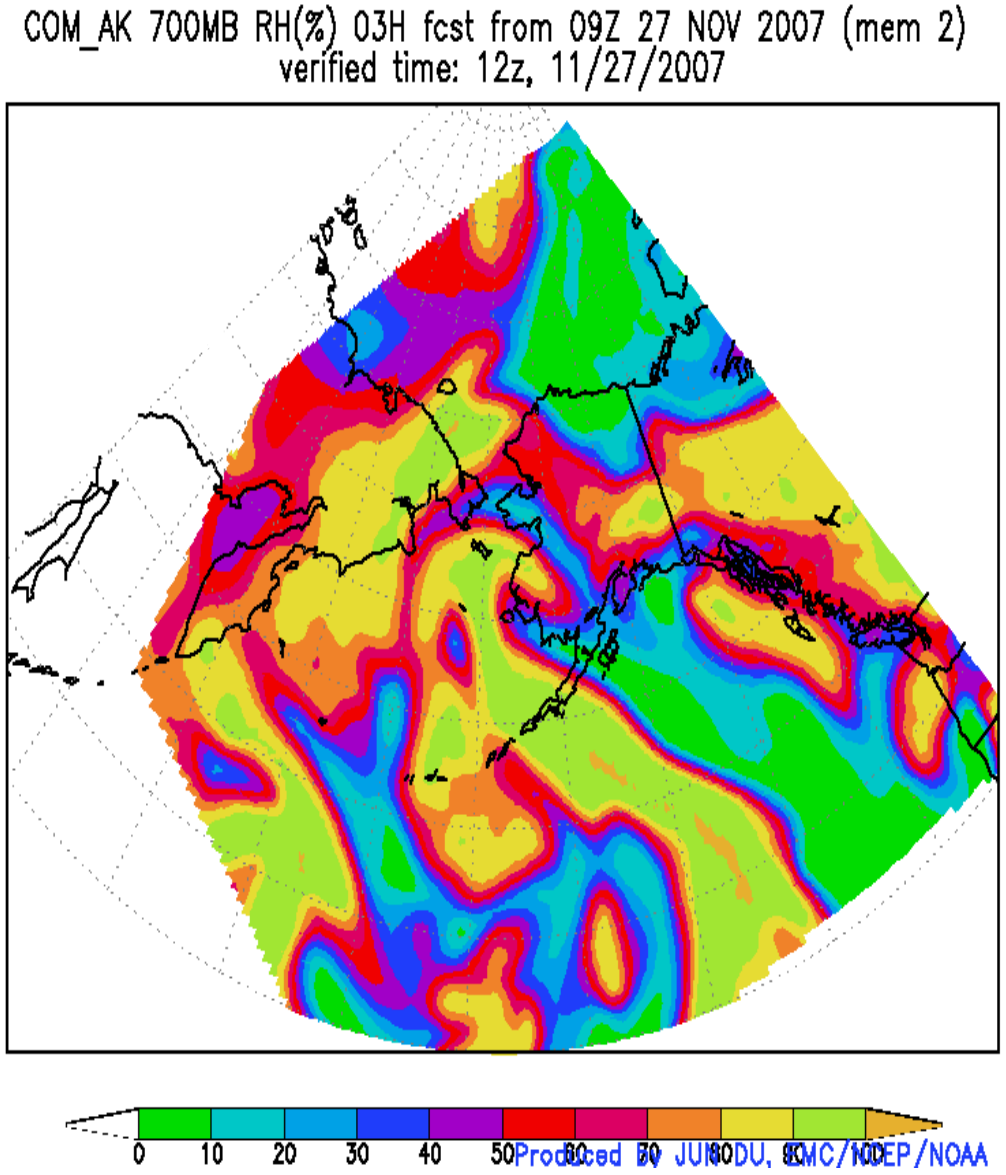
Scope

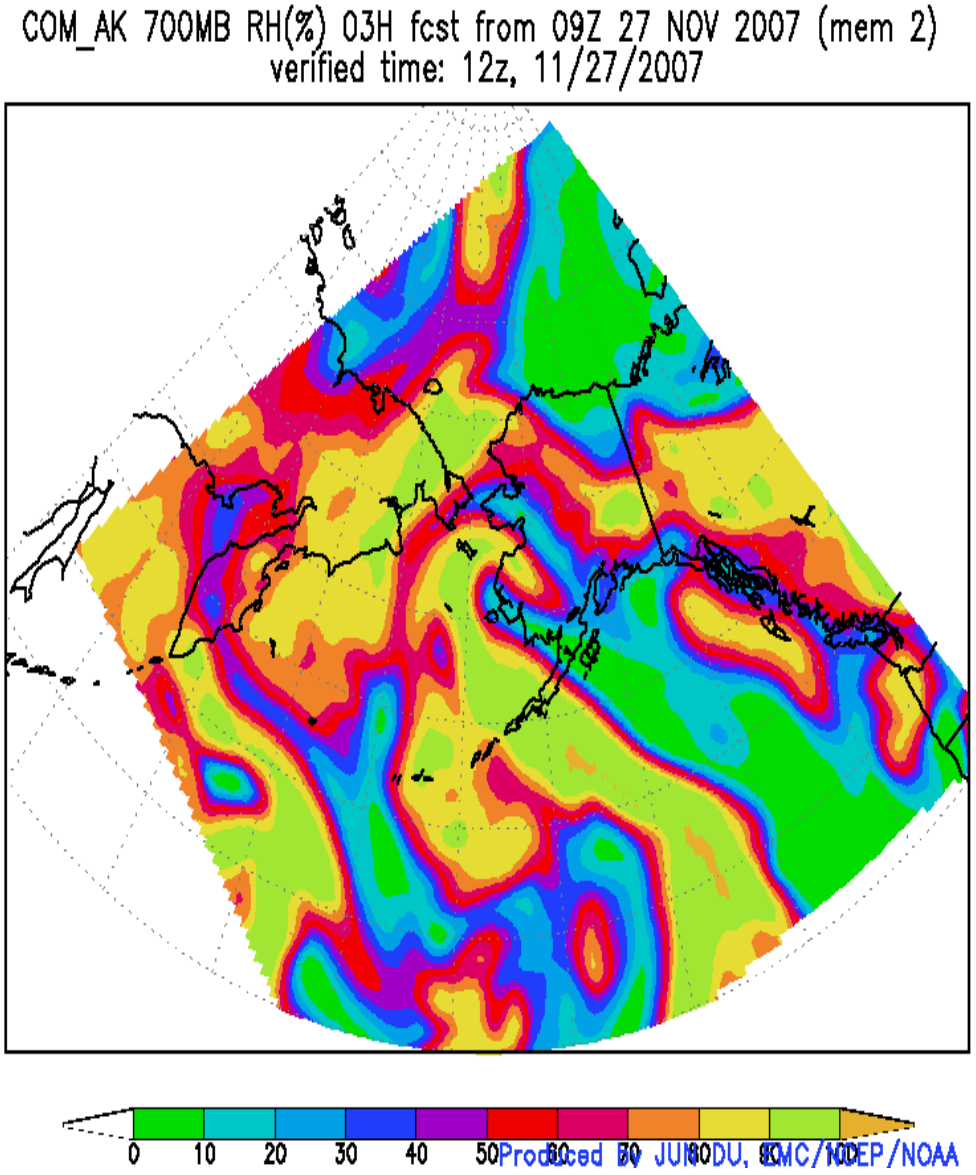
- Introduce a bias correction scheme to basic meteorological fields (excluding QPF).
  - Completed as planned
- Expand RSM Domain to fully cover Alaska.
  - Completed as planned
- Add aviation-related ensemble products (icing, clear air turbulence, flight restriction, ceiling).
  - Completed as planned
- Add BUFR sounding output to six (6) WRF members
  - Completed as planned

Expected Benefits

- Address known SREF weaknesses and biases observed since the Dec 2005 implementation
  - Achieved expectation
- Provide SREF output for Alaska
  - Achieved expectation

RSM Domain Expansion Covers Missing Part of Alaskan Grid (#216)





Acknowledgement: Henry Juang & Jun Wang

Alaskan Aviation Guidance Added to SREF Web Page

http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html

SHORT-RANGE ENSEMBLE FORECASTING (SREF)

Take free "Ensemble Forecasting" online course by clicking here

General Weather Forecasting for CONUS, Alaska, and Hawaii regions
A subset of selected fields for Winter Weather (CONUS, Alaska, and Hawaii)
Specific Applications (Aviation(CONUS), Aviation(Alaska), Convection, and Energy)
SREF-based other products: .Bright's plumes (under testing), Manikin's Meteograms, Marchok's Cyclone Tracks
Beijing 2008 Olympic Mesoscale Ensemble Project Testing Page
NCEP/NCO's SREF Guidance Page, Manousos's Winter Weather Impact
online available SREF datasets:NOMADSand NCEP ftp server

Sample Icing Product

NCEP SREF Aviation Products (Experimental)

Fcst-cycle
CONUS

Mean/spread or prob

NEW Flight Restriction Prob

NEW Visbility&Ceiling

Cloud amount

10m Wind

Lower level wind shear

Convection cloud

Jet stream probability

NEW Icing probability

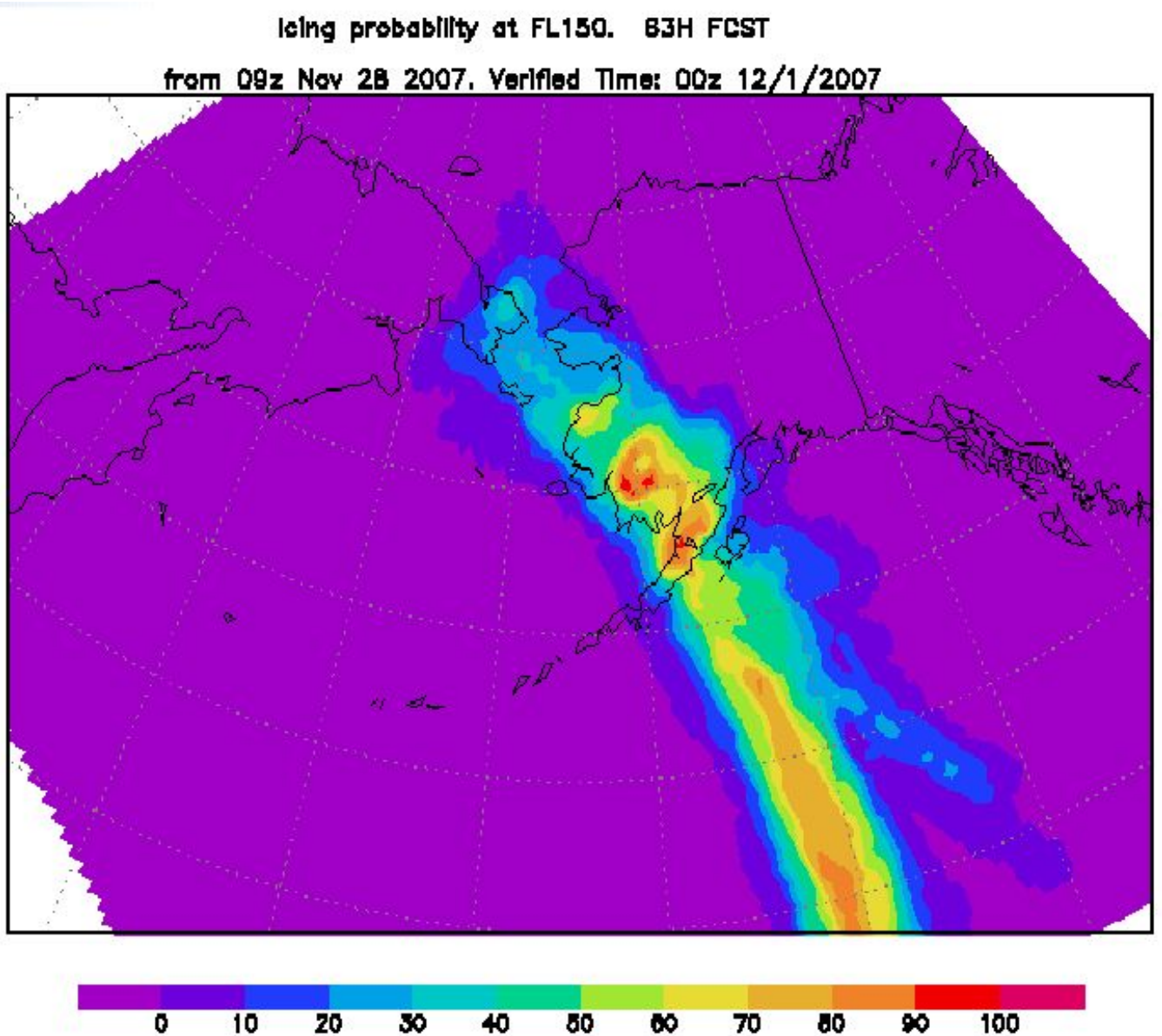
Turbulence probability

NEW Tropopause

Frozen height

Precipitation type prob

Fog (new)

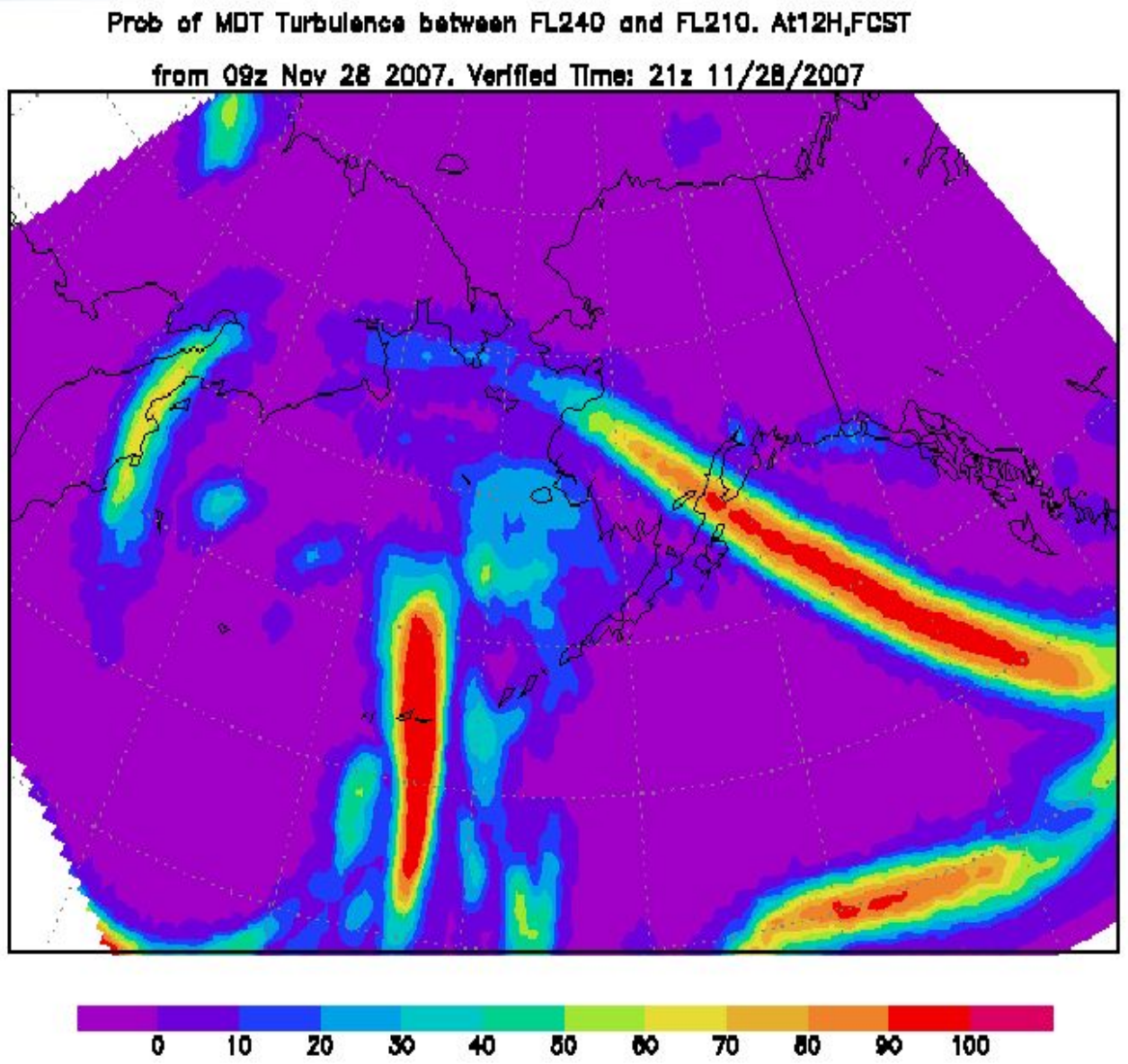


Sample Turbulence Product

NCEP SREF Aviation Products (Experimental)

Post-cycle
CONUS

Mean/spread or prob
Flight Restriction Prob
Visbility&Ceiling
Cloud amount
10m Wind
Lower level wind shear
Convection cloud
Jet stream probability
Icing probability
Turbulence probability
Tropopause
Frozen height
Precipitation type prob
Fog (new)

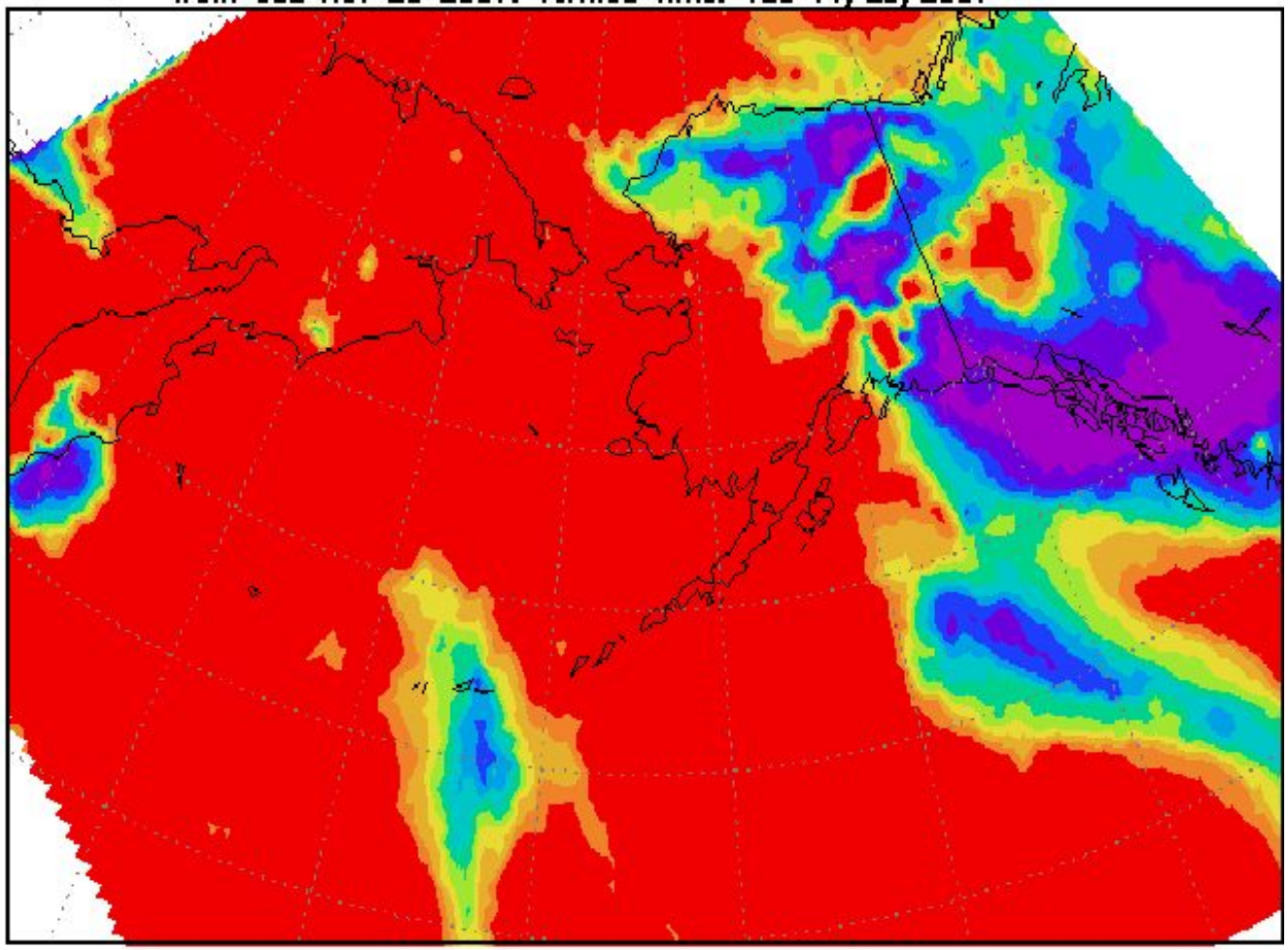


Sample Flight Restriction Product

NCEP SREF Aviation Products (Experimental)

Fcst-cycle
CONUS

Mean/spread or prob
Flight Restriction Prob
Visbility&Ceiling
Cloud amount
10m Wind
Lower level wind shear
Convection cloud
Jet stream probability
Icing probability
Turbulence probability
Tropopause
Frozen height
Precipitation type prob
Fog (new)



Sample Ceiling Height Product

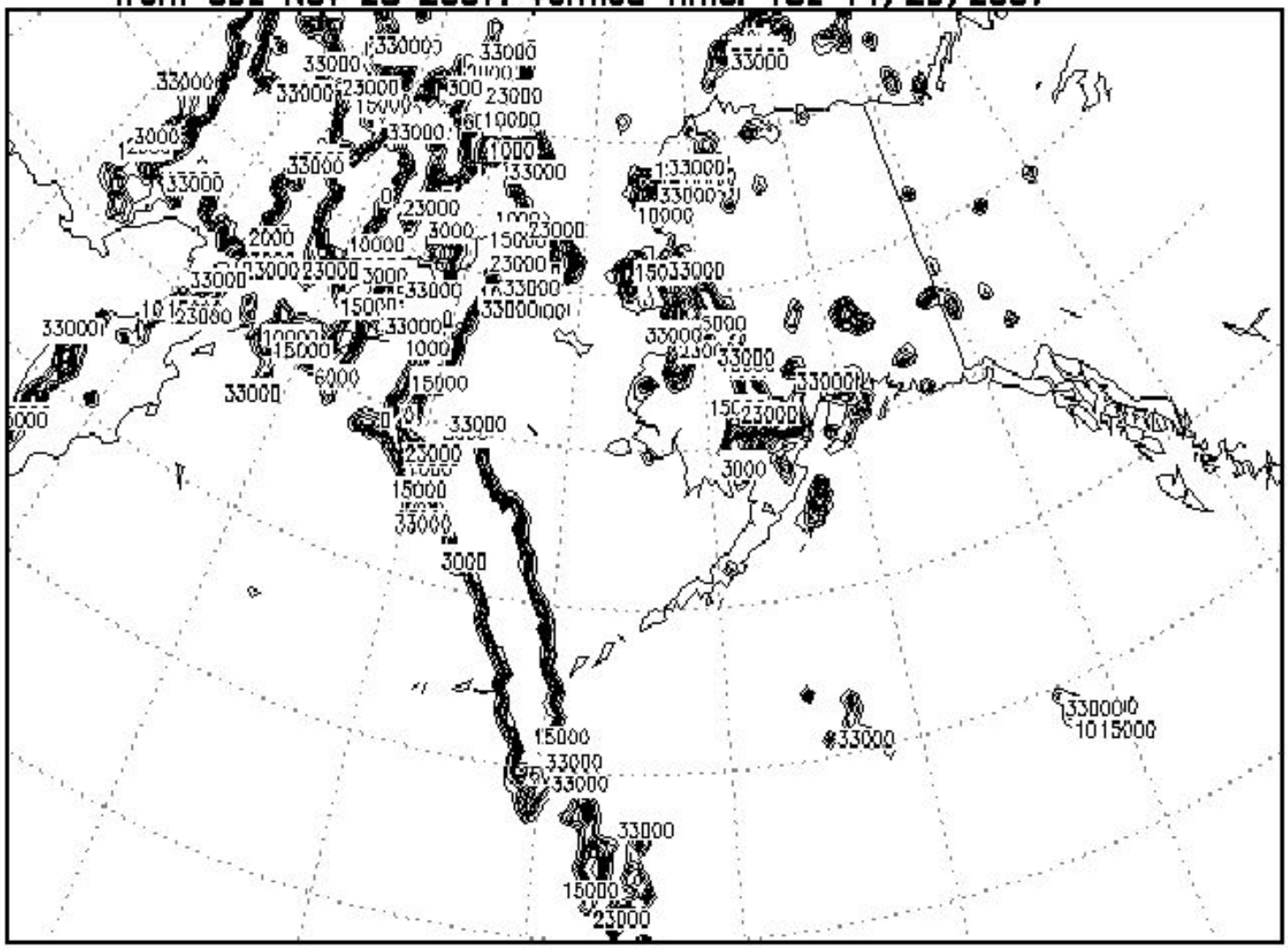
NCEP SREF Aviation Products (Experimental)

Fcst-cycle
CONUS

Mean/spread or prob
Flight Restriction Prob
Visbility&Ceiling
Cloud amount
10m Wind
Lower level wind shear
Convection cloud
Jet stream probability
Icing probability
Turbulence probability
Tropopause
Frozen height
Precipitation type prob
Fog (new)

Cloud Base Height Mean (ft) and Spread(color shade) 33H FCST

from 09z Nov 28 2007. Verified Time: 18z 11/29/2007



Sample BUFR Guidance Web Page

http://www.t.emc.ncep.noaa.gov/mmb/srefmeteograms/sref.html

EXPERIMENTAL SREF FORECAST METEOGRAMS

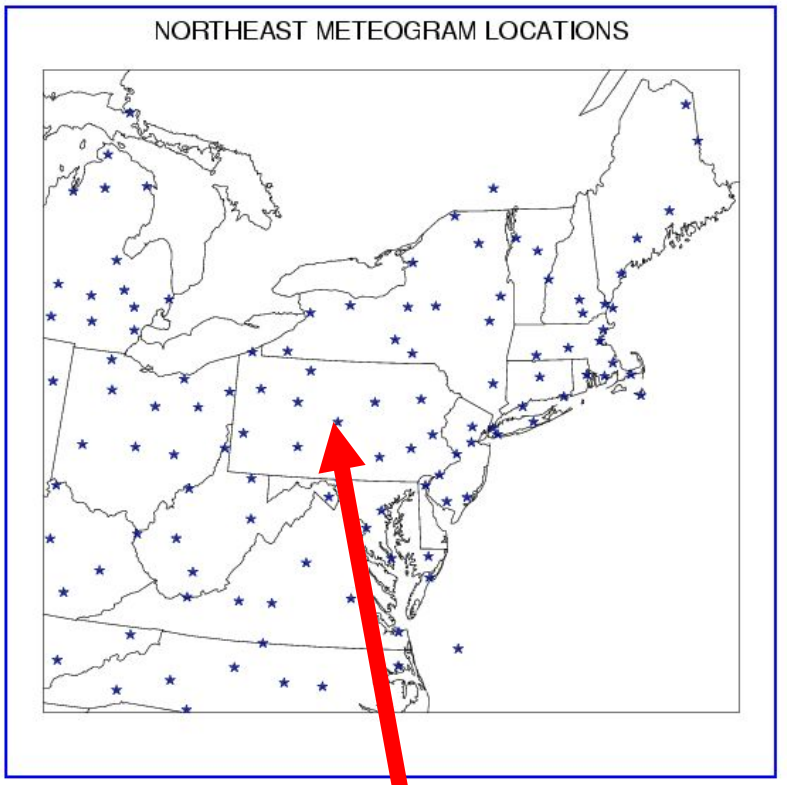
Forecasts of surface variables and vertical profiles of cloud and wind are available for over 600 stations within the Eta domain. A complete list of the available stations can be found here . Select a region below, and you will be sent to a local map where you can click on the star representing the location you want. Check out the main SREF forecasting page for more information on the system. Documentation o SREF system can be found here.

If you want to bypass the stars, please enter a 6-digit ID from the table linked above. Get data

CLICK ON THE DESIRED REGION

1st click here

Click on a site



2nd click here for State College, PA

BUFR Sounding Product

- Added BUFR sounding output from 6 WRF members
- All 21 members now have BUFR sounding output
- Next package will include an ensemble BUFR sounding product

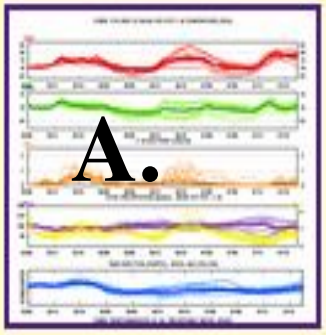
Sample BUFR Guidance Web Page

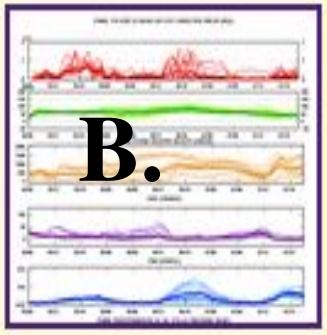
http://wwwt.emc.ncep.noaa.gov/mmb/srefmeteograms/stations

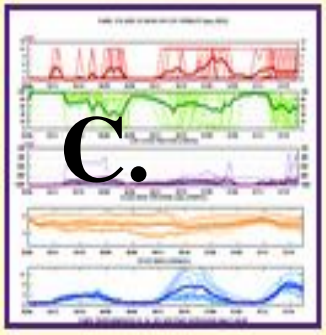
Three sets of Eta forecast surface meteograms are available for this station. Click on the far left **SAMPLE** meteogram plot below to get the basic weather meteogram, the middle plot for the convective forecasting meteogram, and the far right plot for the aviation forecasting meteogram.

Please note that the 3000 gif giles available on this site must be processed and then ftp'ed. As a result, glitches can occur making some of the files unavailable for a certain run. **ALWAYS CHECK THE TIME AXIS ON THE BOTTOM OF THE PLOT TO BE CERTAIN YOU ARE VIEWING THE MODEL CYCLE YOU WANT!**

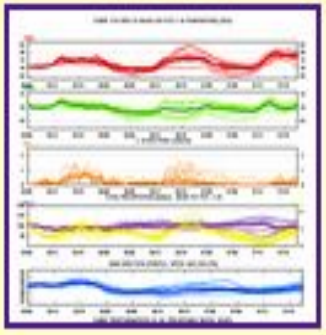
MOST RECENT 09Z CYCLE

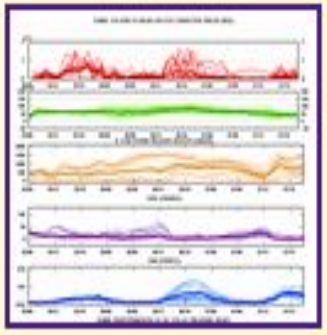


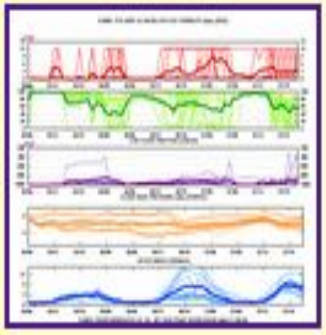




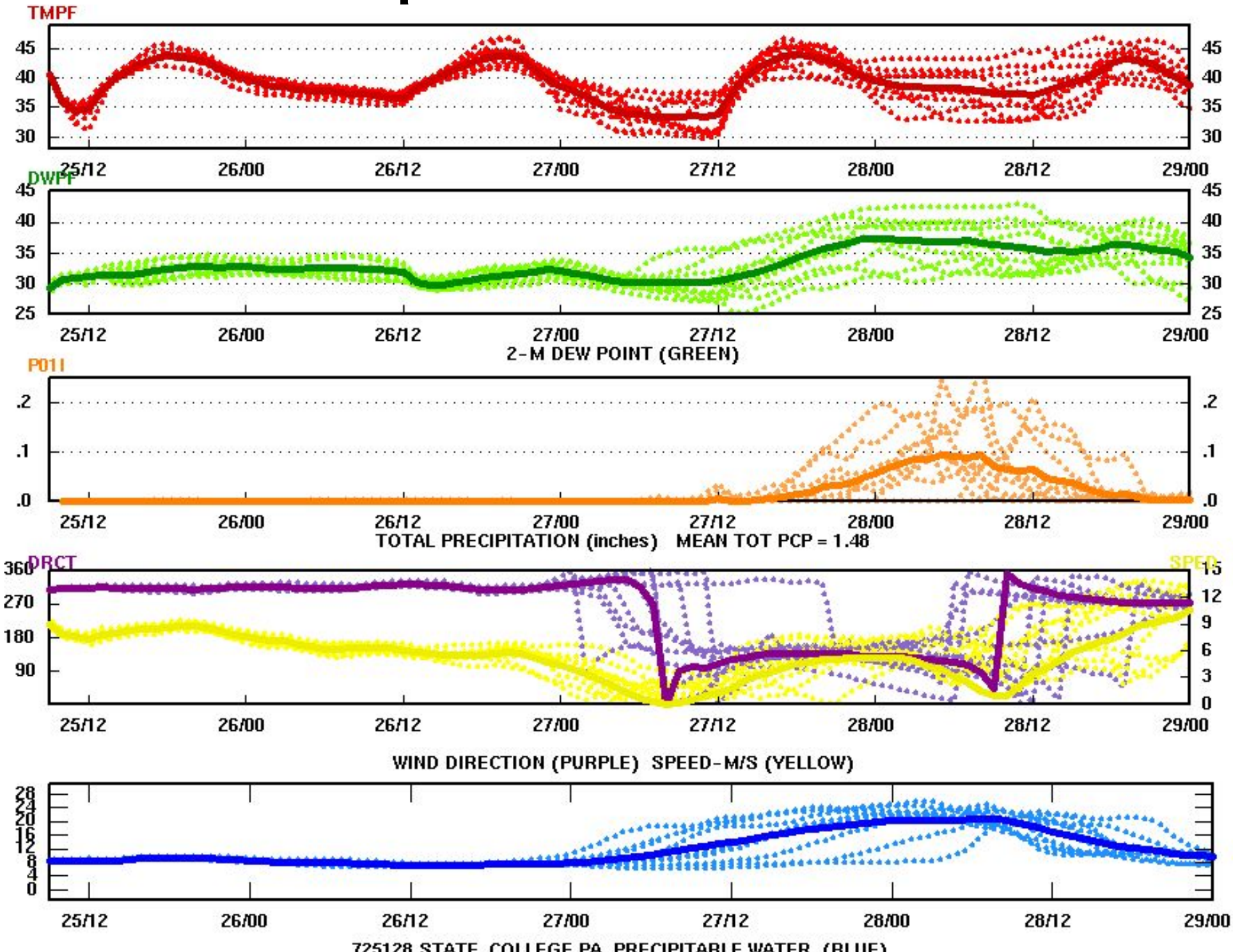
MOST RECENT 21Z CYCLE



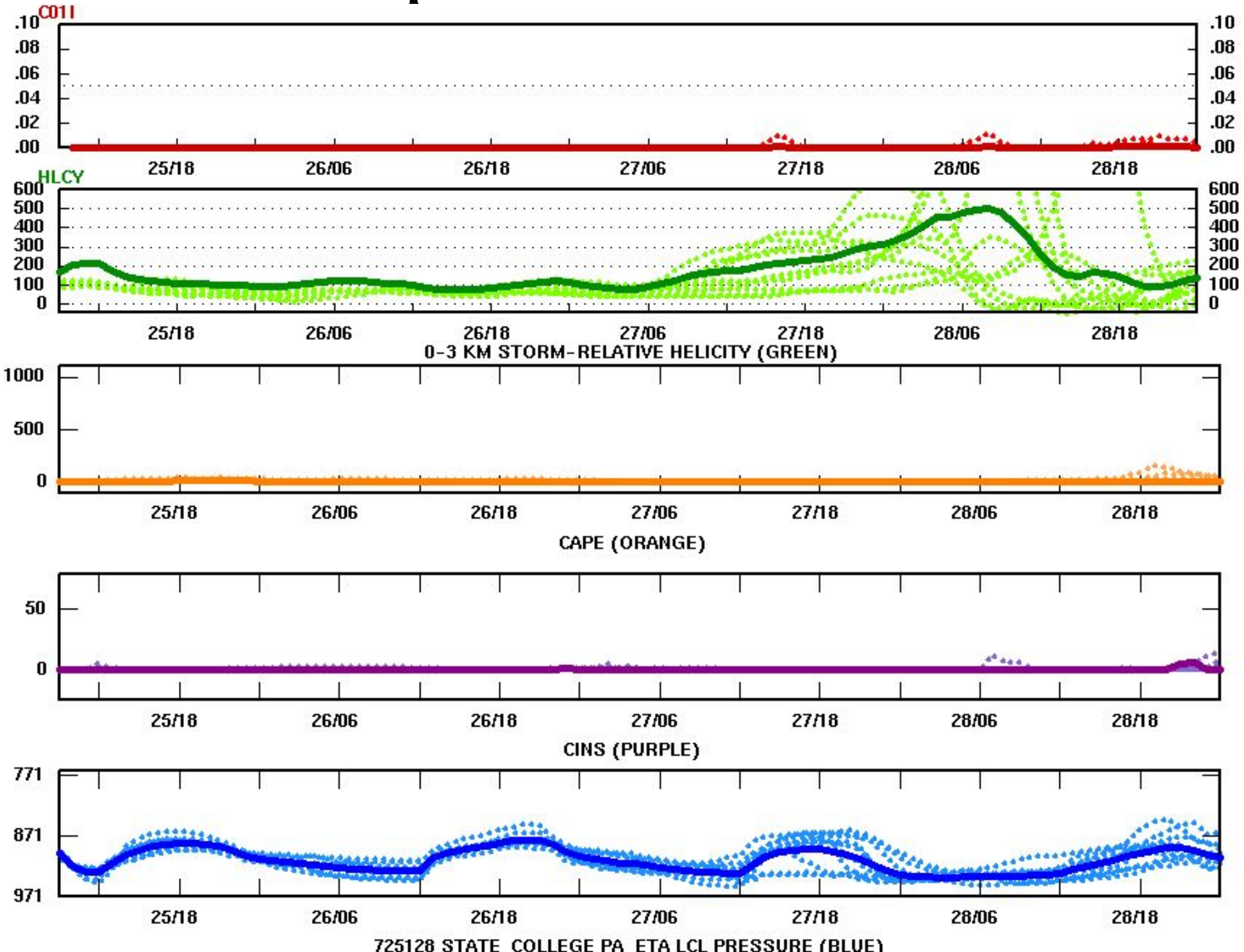




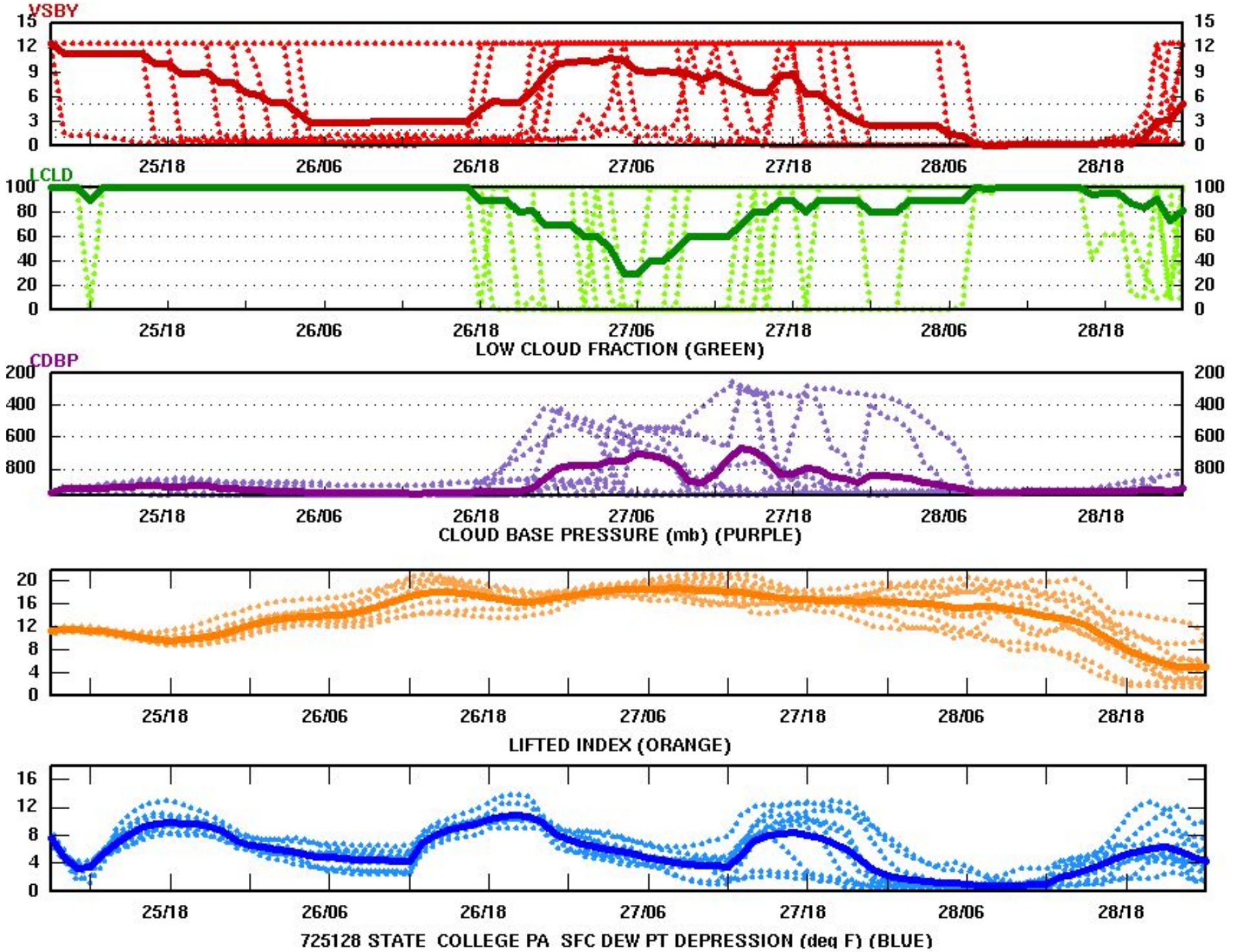
Sample BUFR Guidance A.



Sample BUFR Guidance B.



Sample BUFR Guidance C.



Bias Correction Method

- Idea: Decaying average method which "weights" more the most recent past data.
- Technique: Bias = (1-a)*(accumulated bias from past) + a*(most recent past error), where a=5% or 0.05 for this implementation (note: 0.02 for GEFS).
- Each model has its own bias estimation based on the corresponding sub-ensemble mean: Eta, RSM, NMM and ARW yielding 4 independent components.
- Each cycle (03z, 09z, 15z, 21z) is bias corrected separately.
- Each forecast hour is bias corrected separately within the same cycle.

Acknowledgement: Bo Cui & Zoltan Toth

Bias Corrected Variables (32)

Near Surface:

t2m, rh2m, q2m, u10m, v10m, mslp

Upper Level Temperature & RH:

t300, t500, t700, t850

rh300, rh500, rh700, rh850

Upper Level Height

z250, z300, z500, z700, z850, z1000

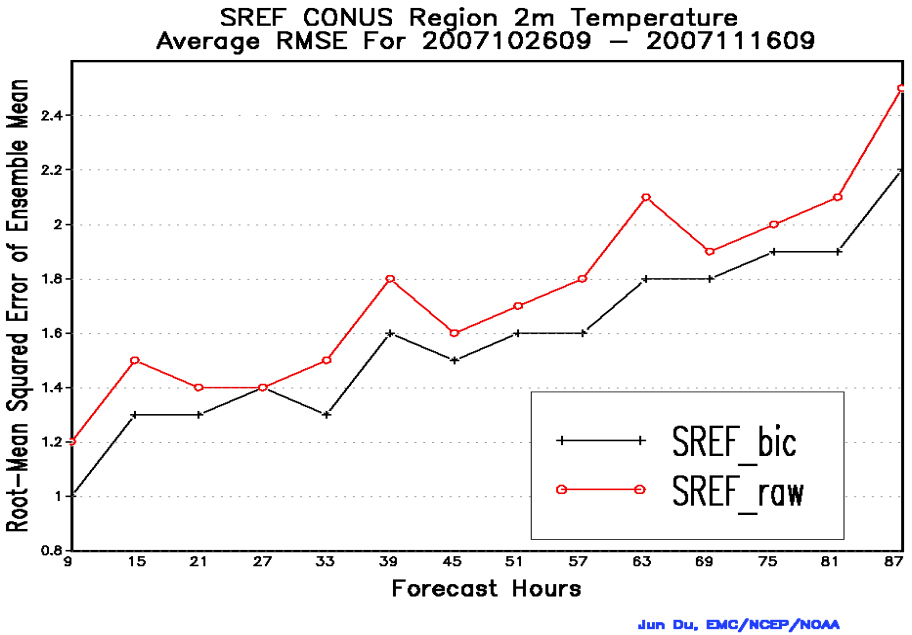
Upper Level Winds

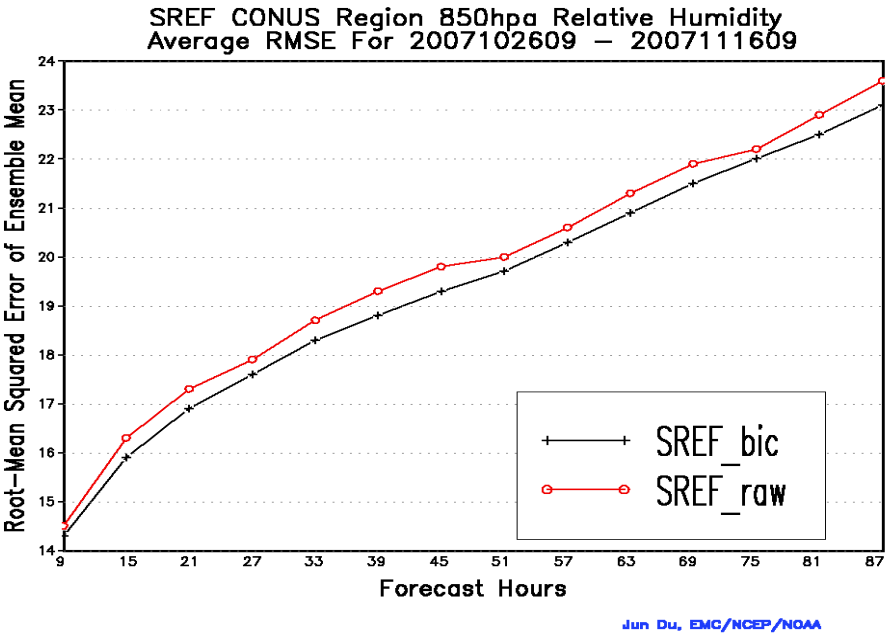
u250, u300, u500, u700, u850, u1000

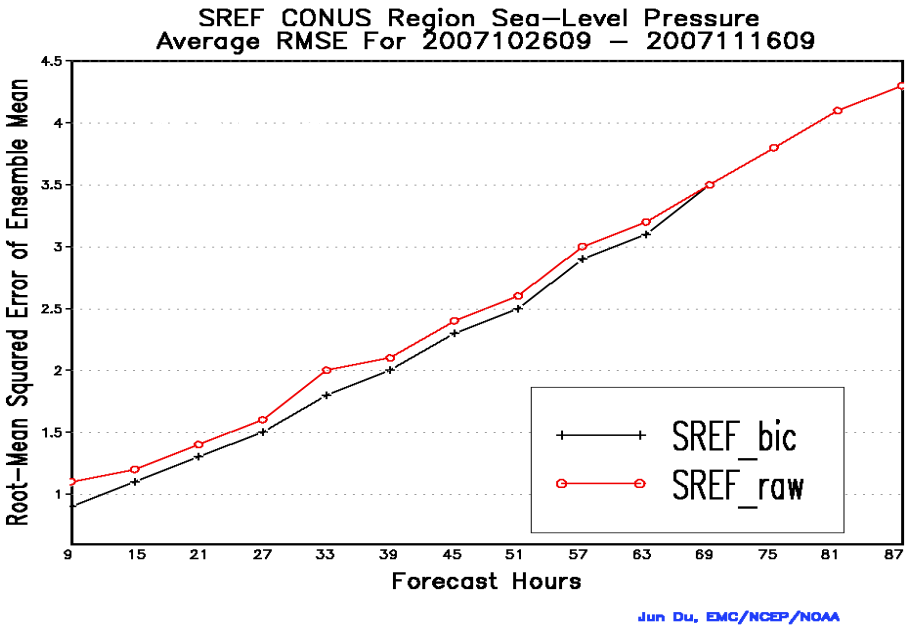
v250, v300, u500, v700, v850, v1000

RMSE of Ensemble-Mean Forecast

Near Sfc Fields Improved

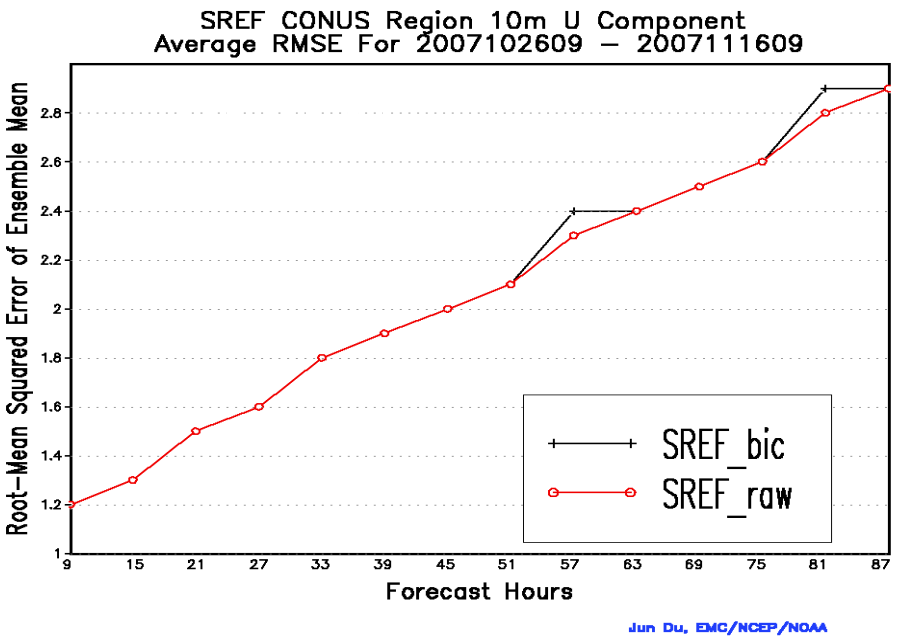


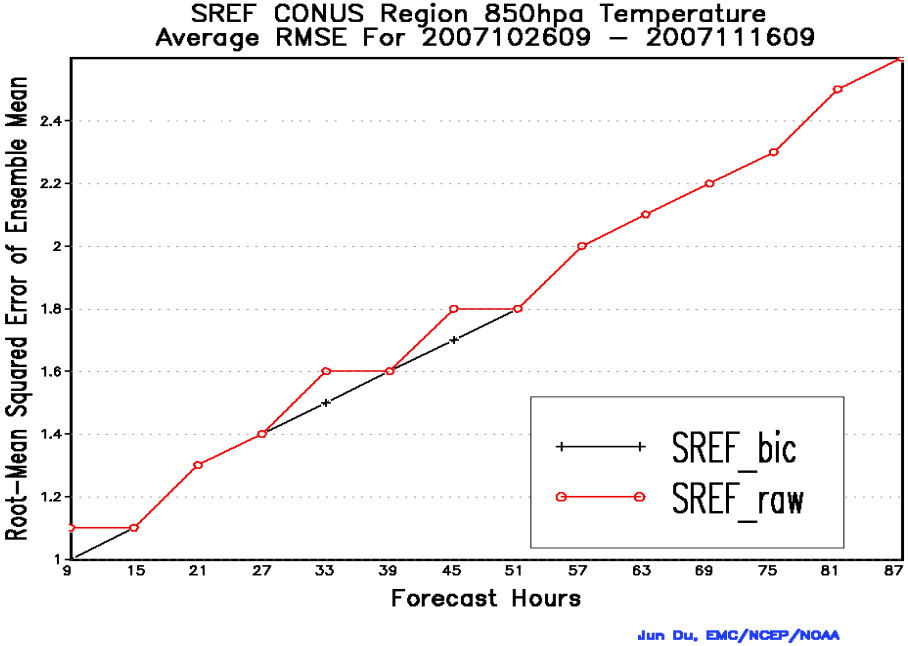


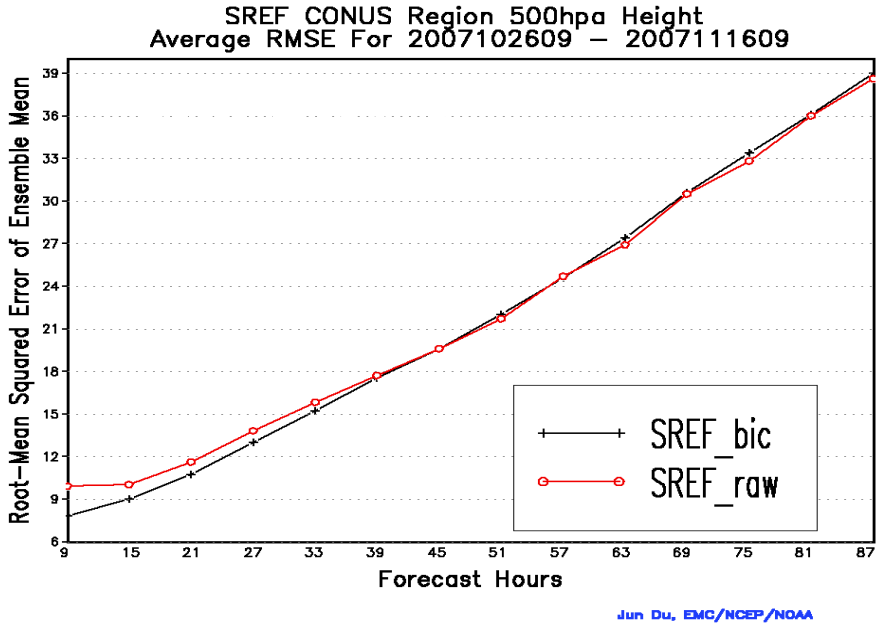


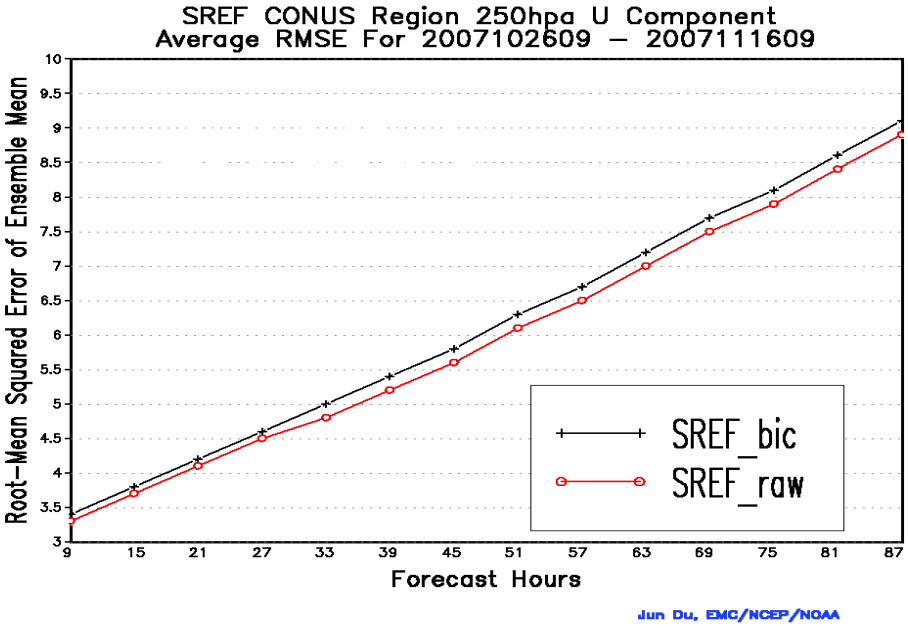
RMSE of Ensemble-Mean Forecast:

Other fields not much improved or slightly worse

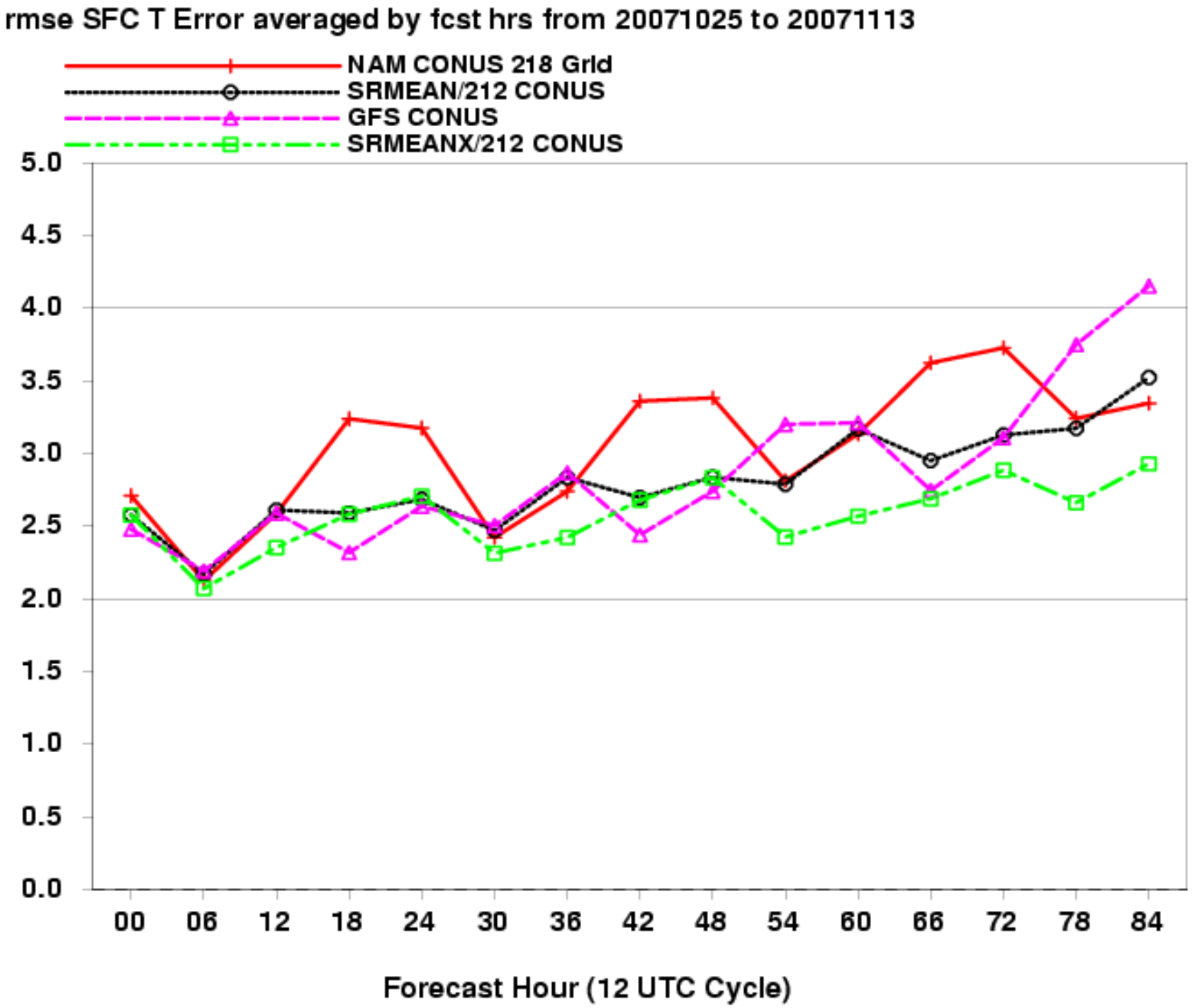






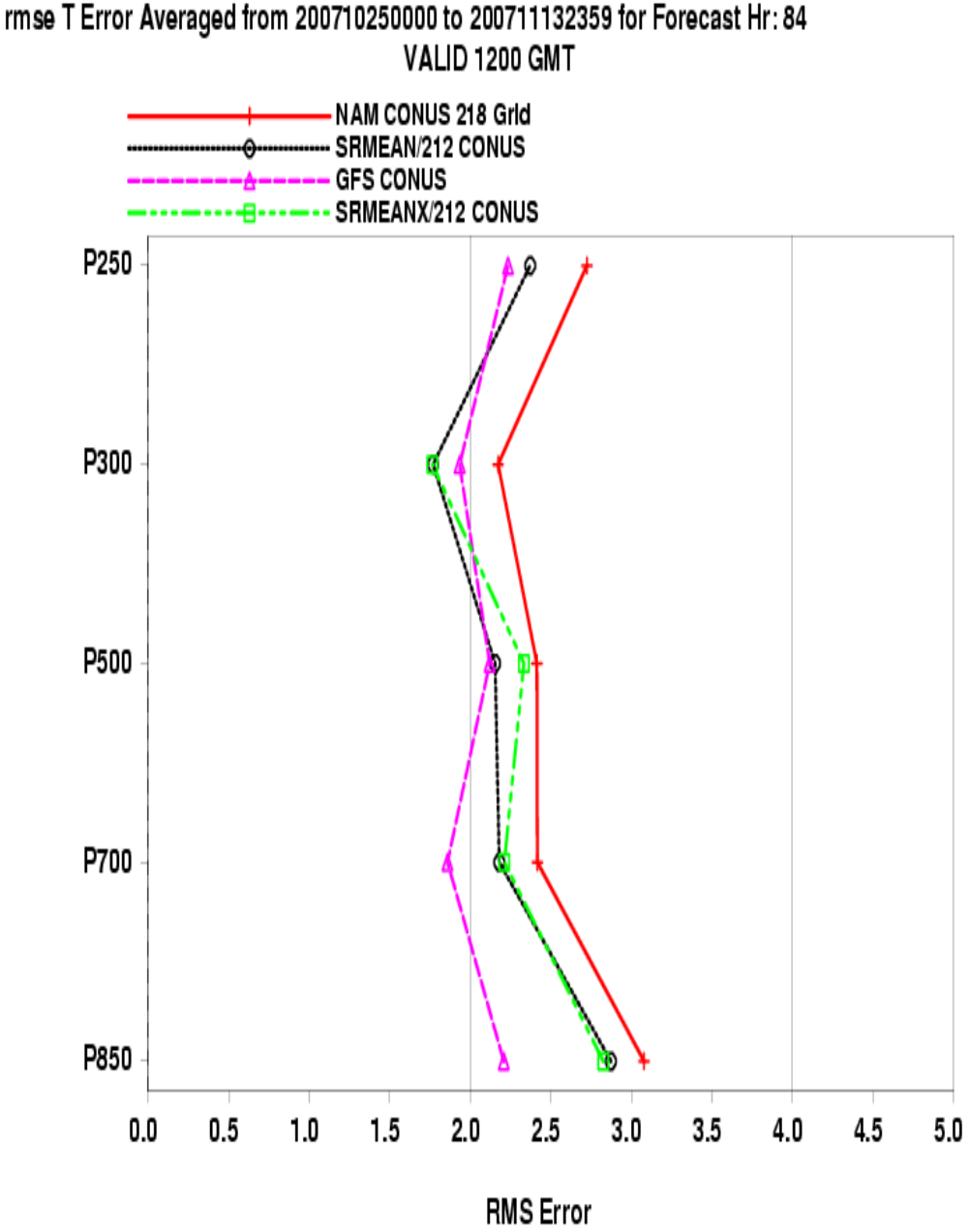


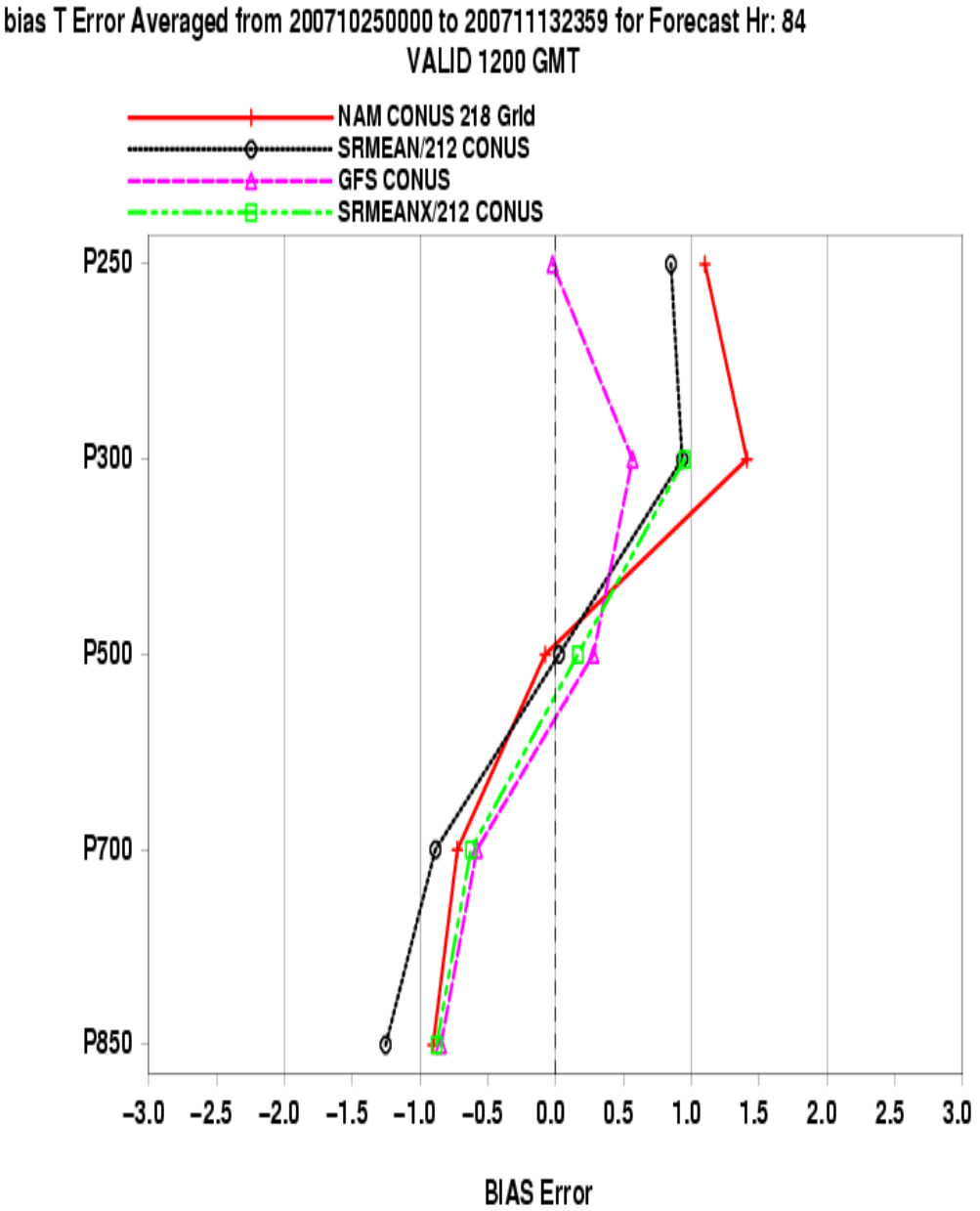
Large Sfc T Impact



Small Upper Level Impact: Temp vs Obs

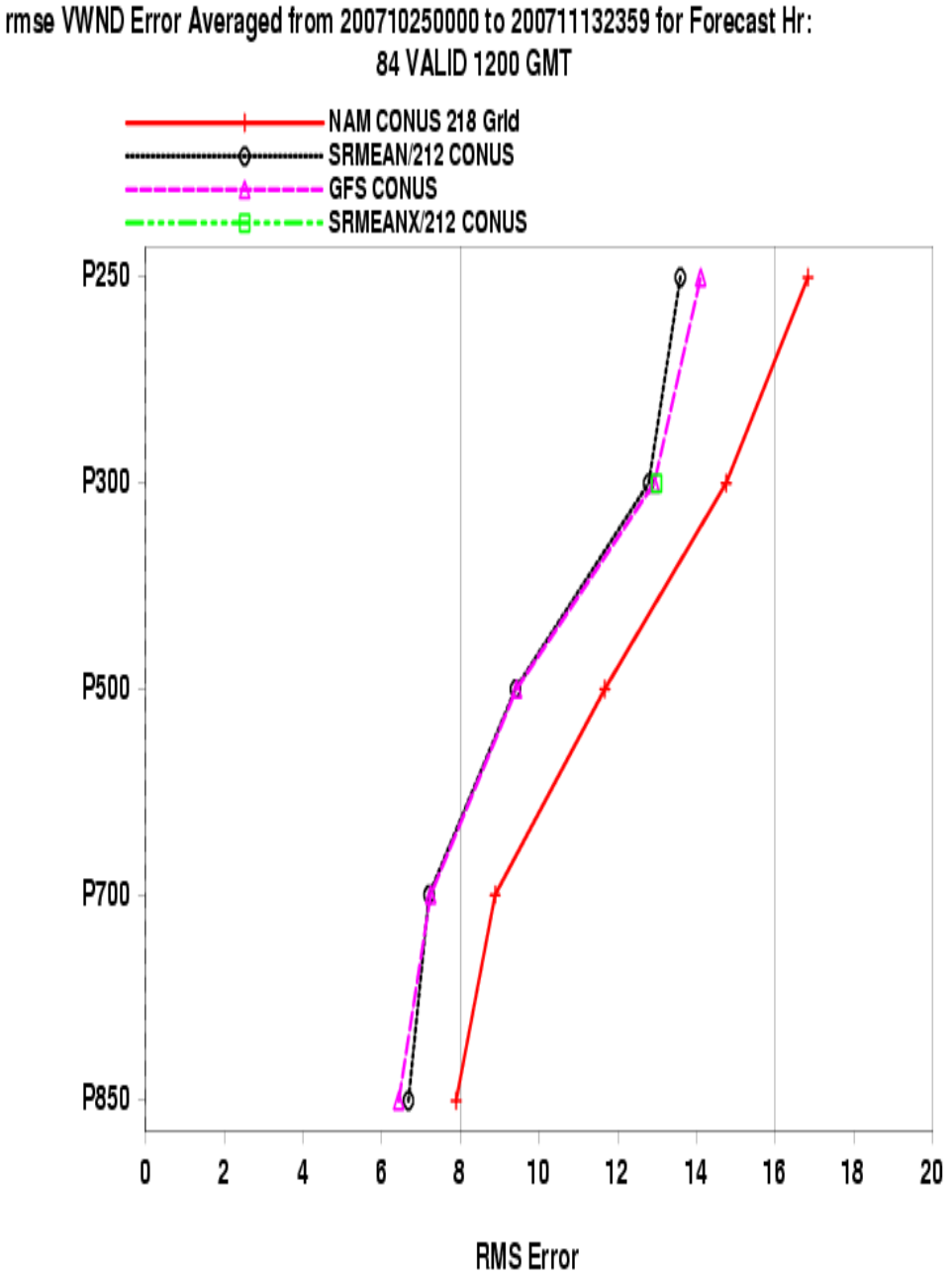
(BIC=green; RAW=black)

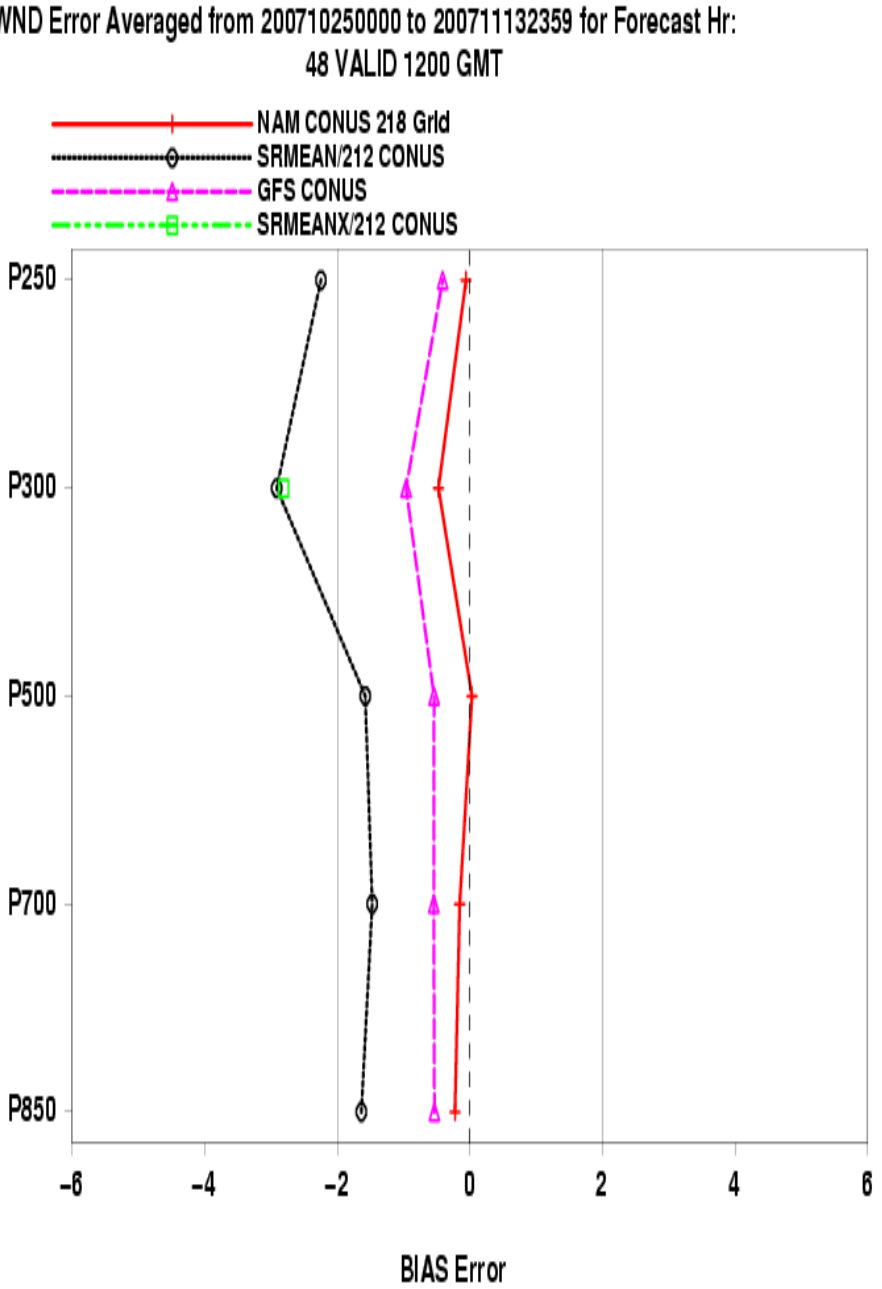




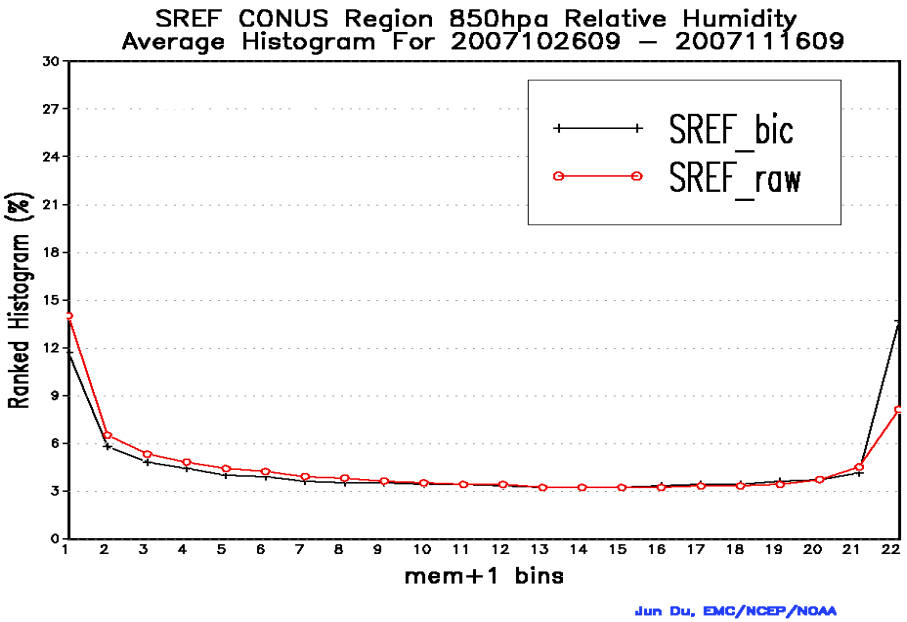
Small Upper Level Impact: Wind Speed vs Obs

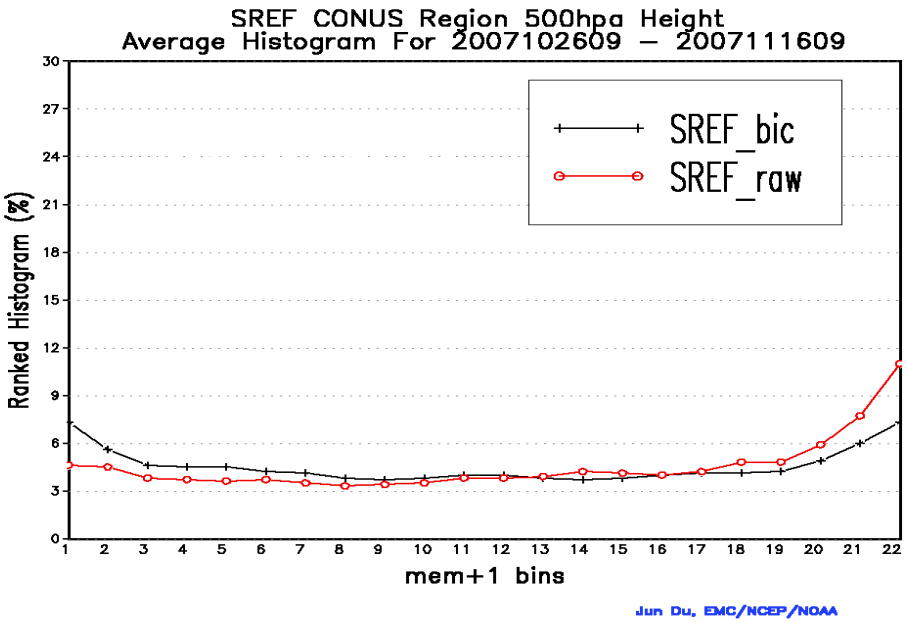
(BIC=green; RAW=black)

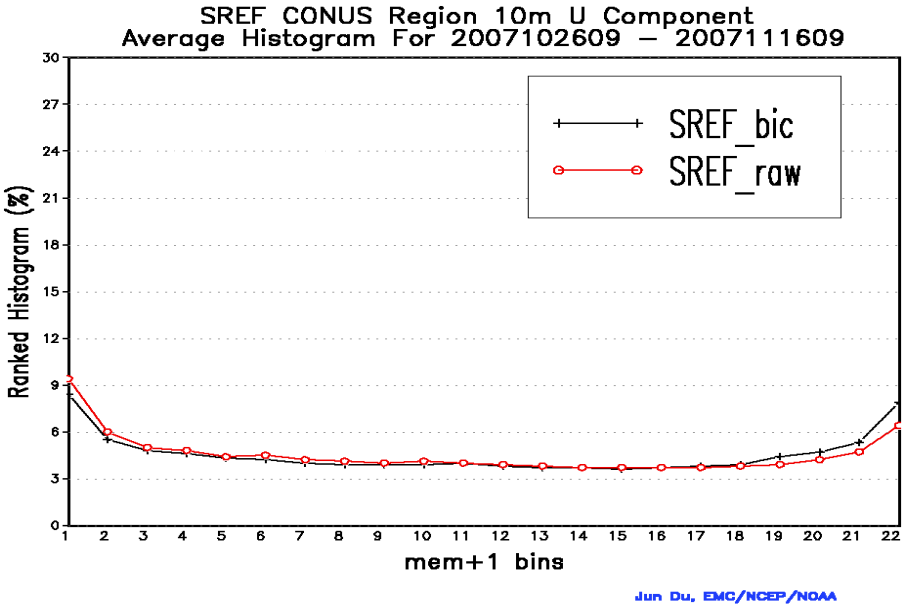


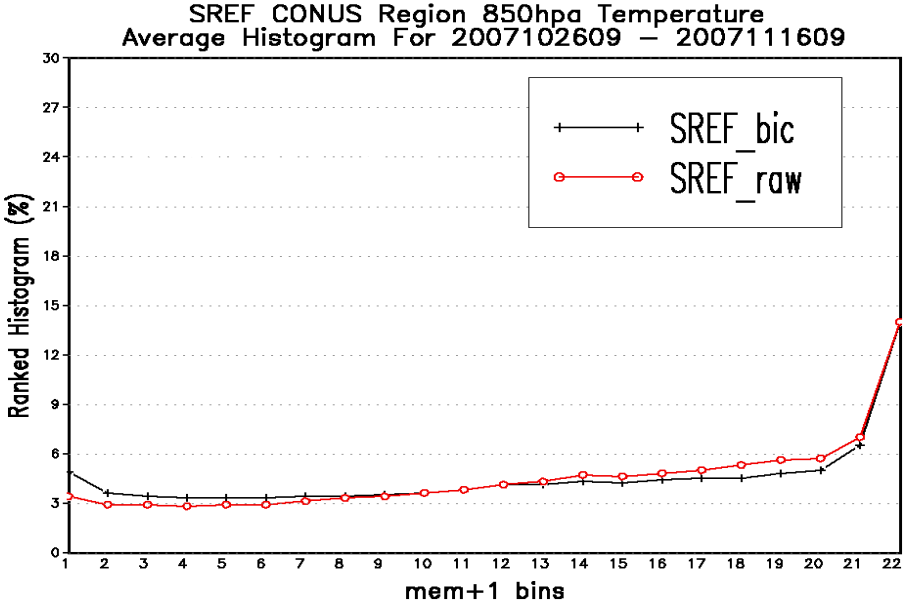


Talagrand Distribution = Ensemble Spread: Fields Improved

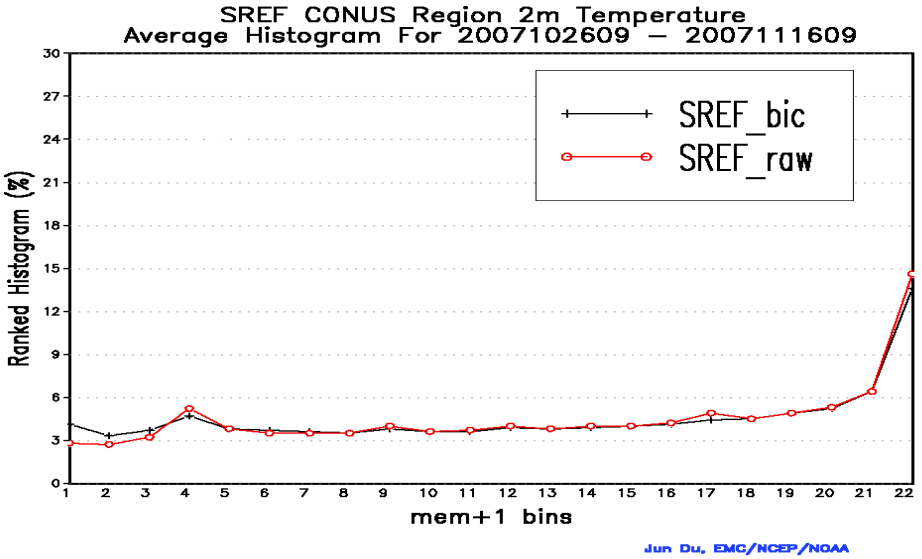


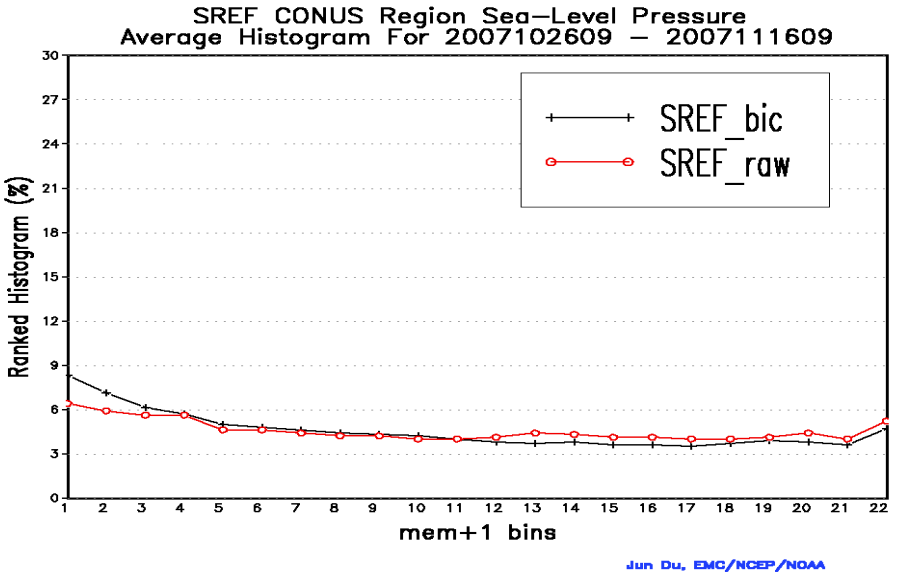


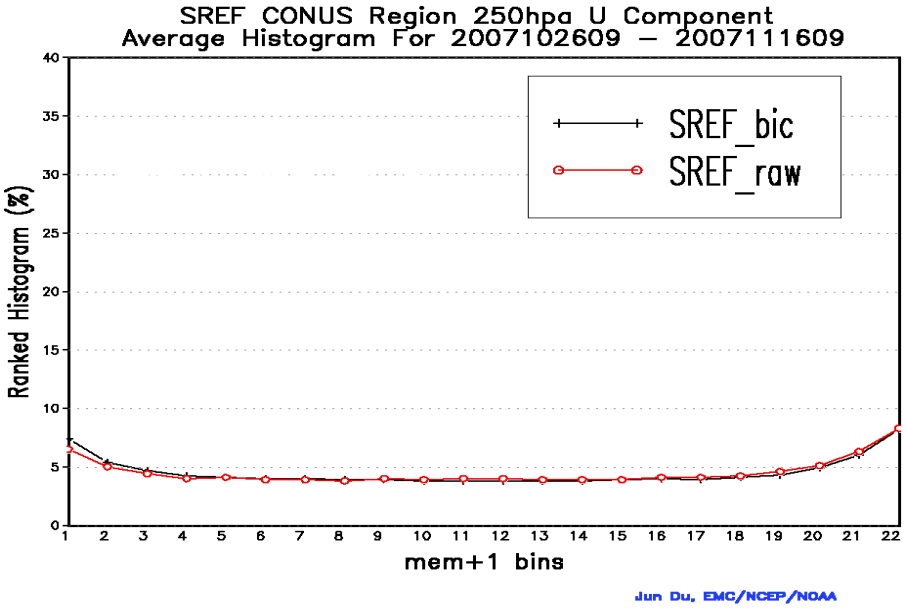




Talagrand Distribution = Ensemble Spread:
Fields not much improved or slightly worse

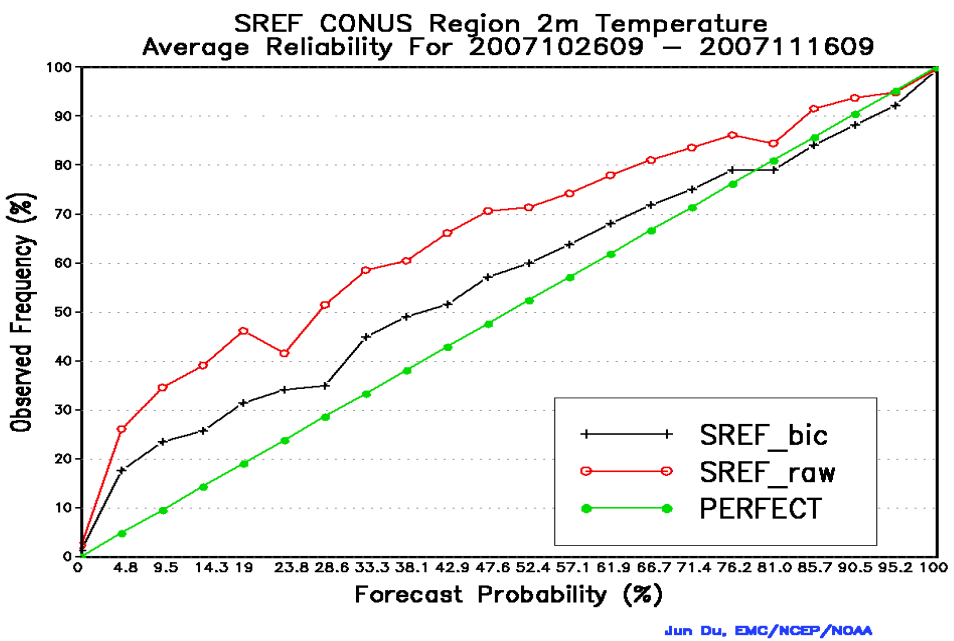


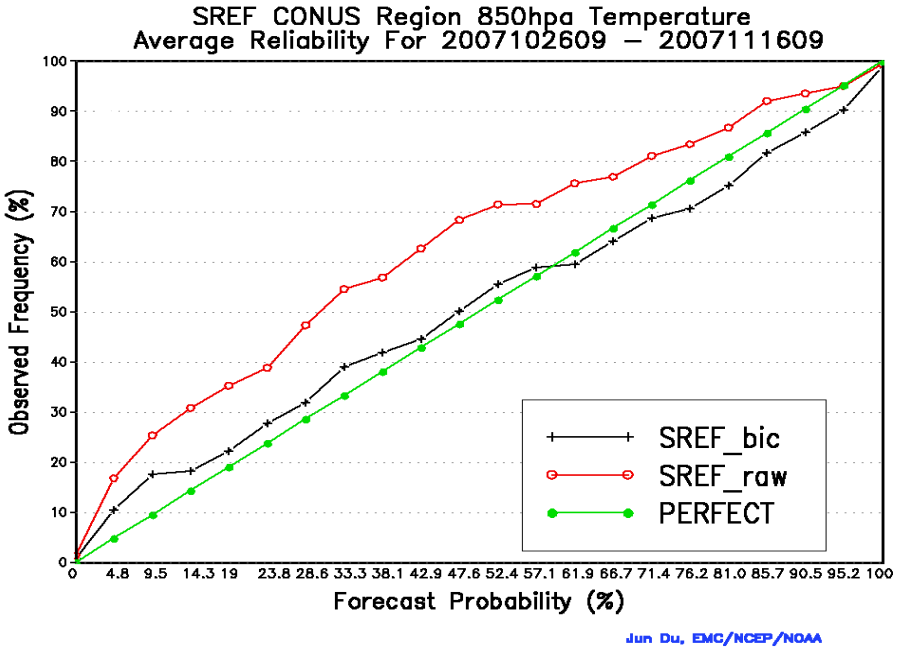


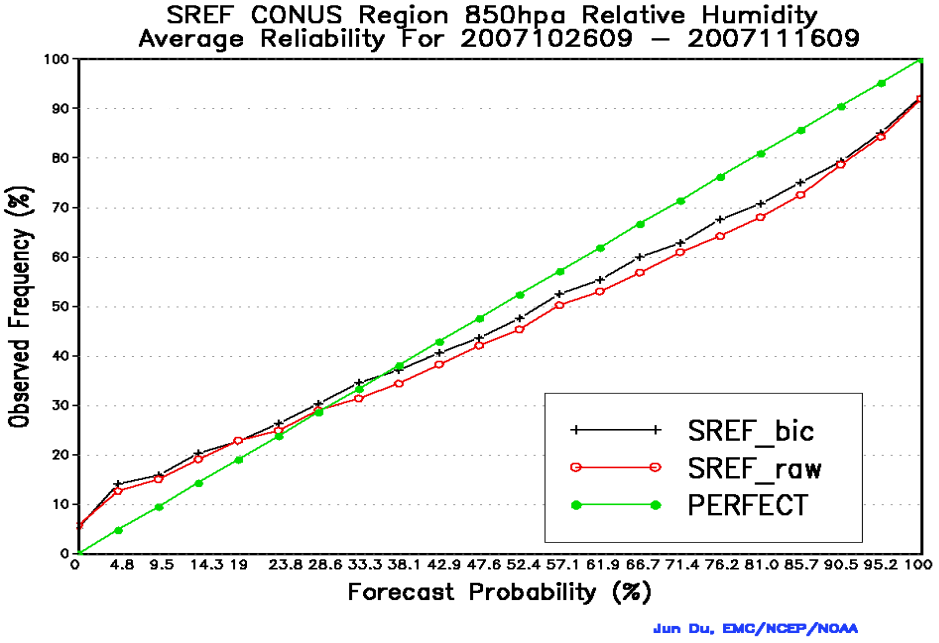


Reliability - Measures Probabilistic Forecasts:

Fields Improved

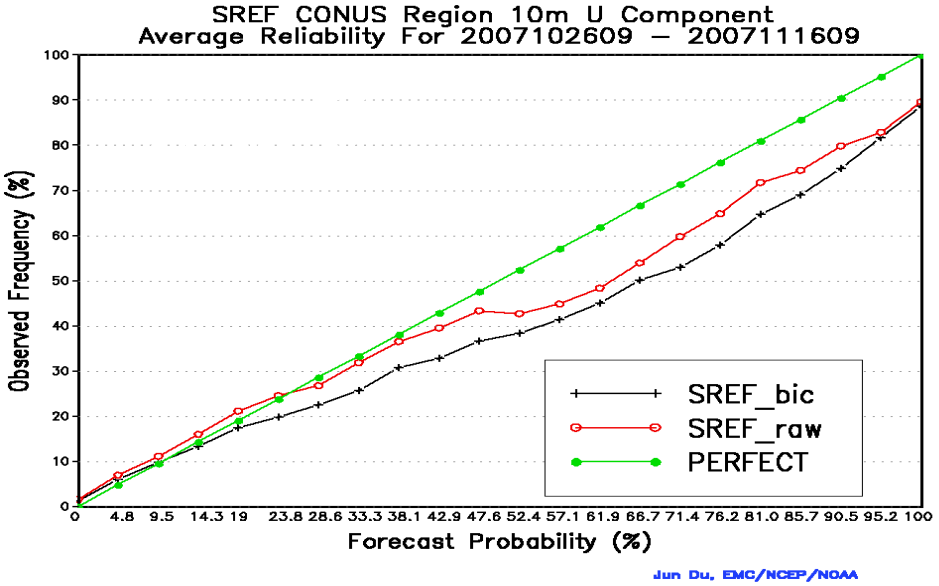


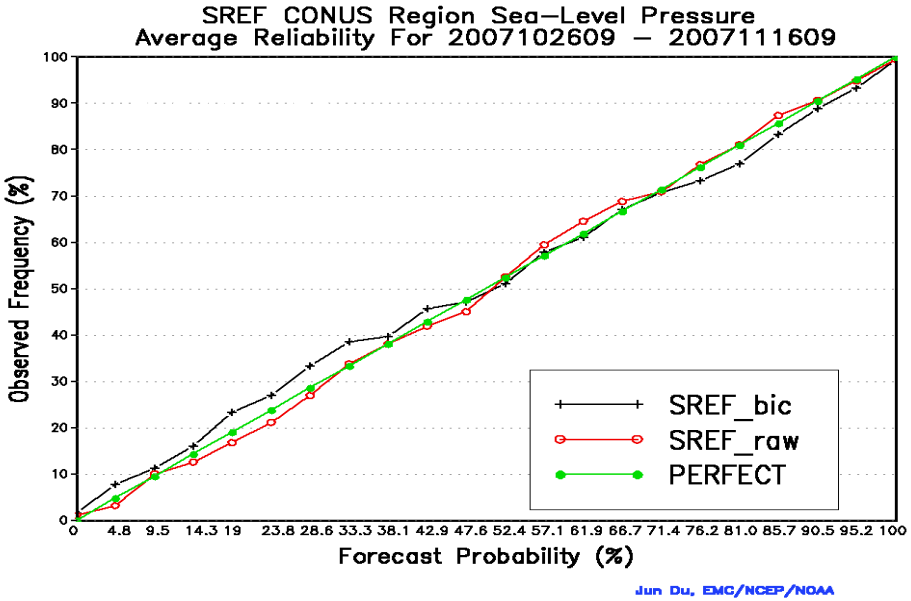


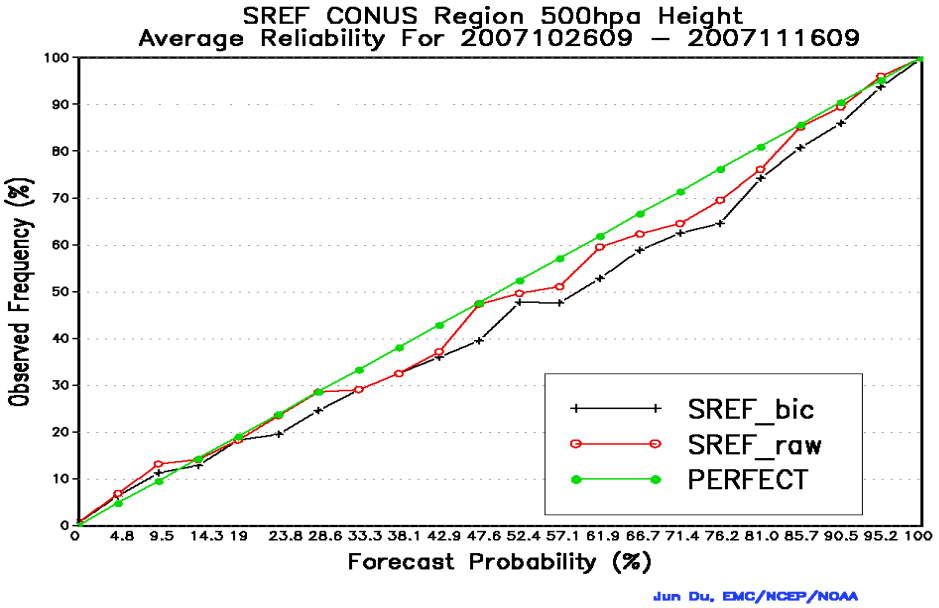


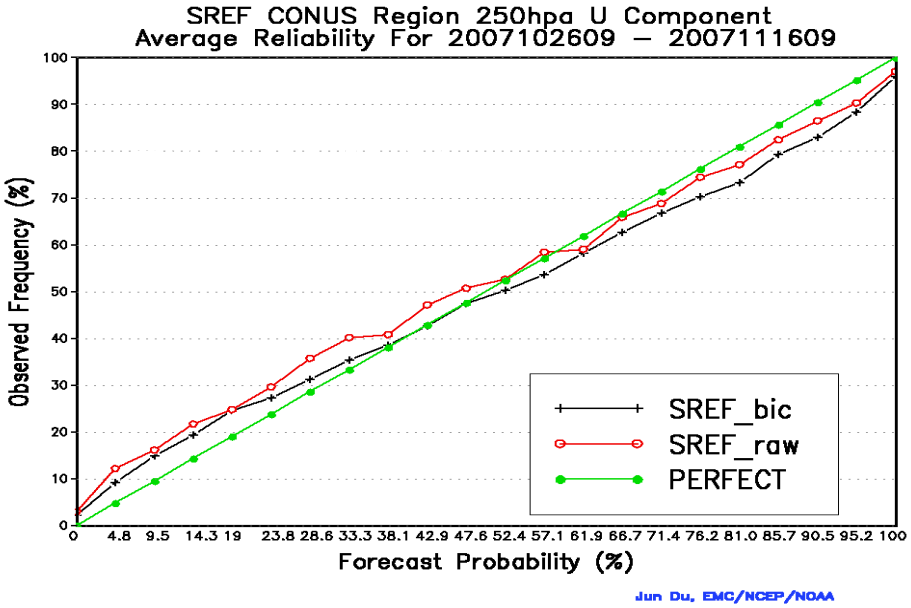
Reliability - Measures Probabilistic Forecasts:

Fields not much improved or slightly worse



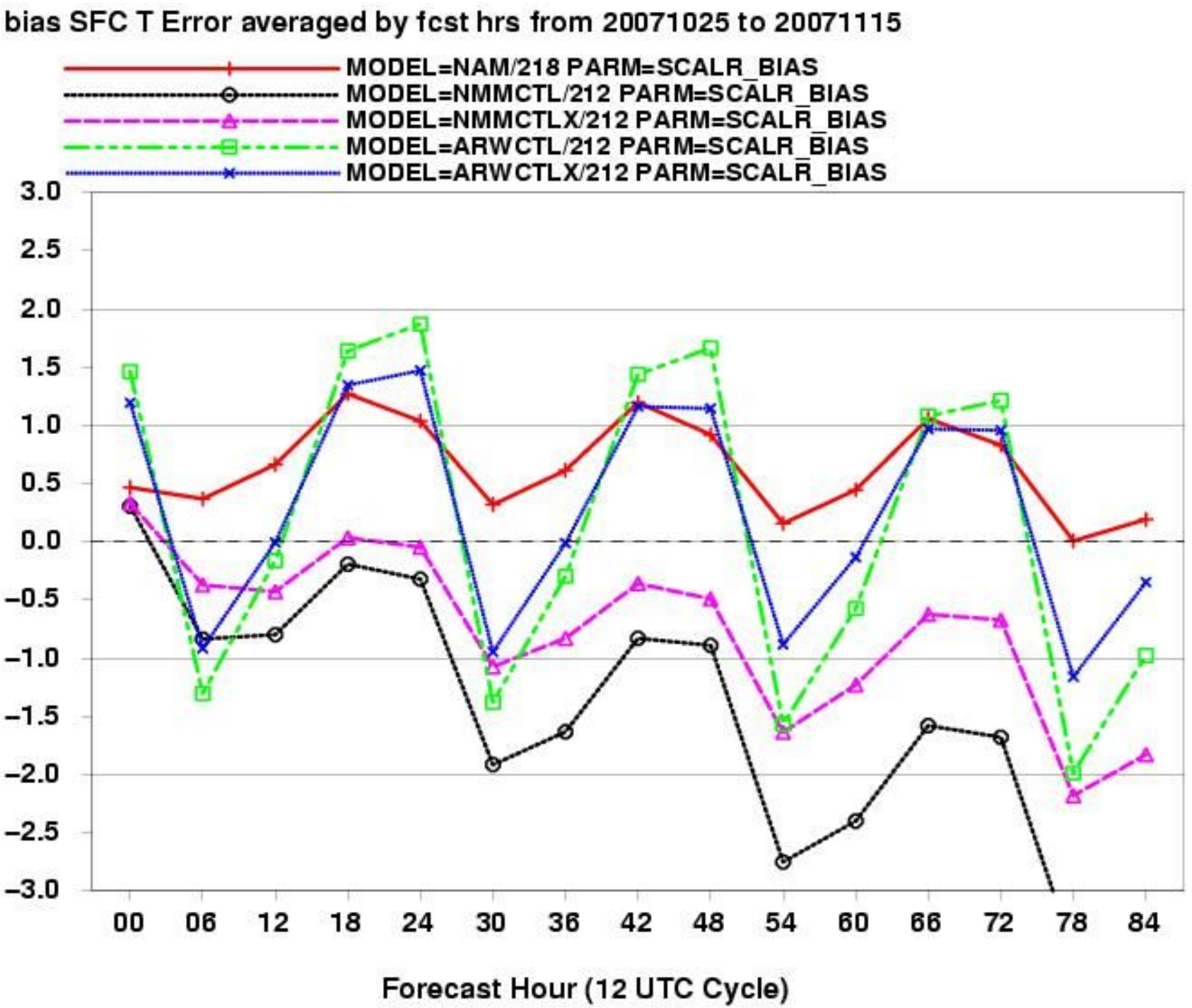


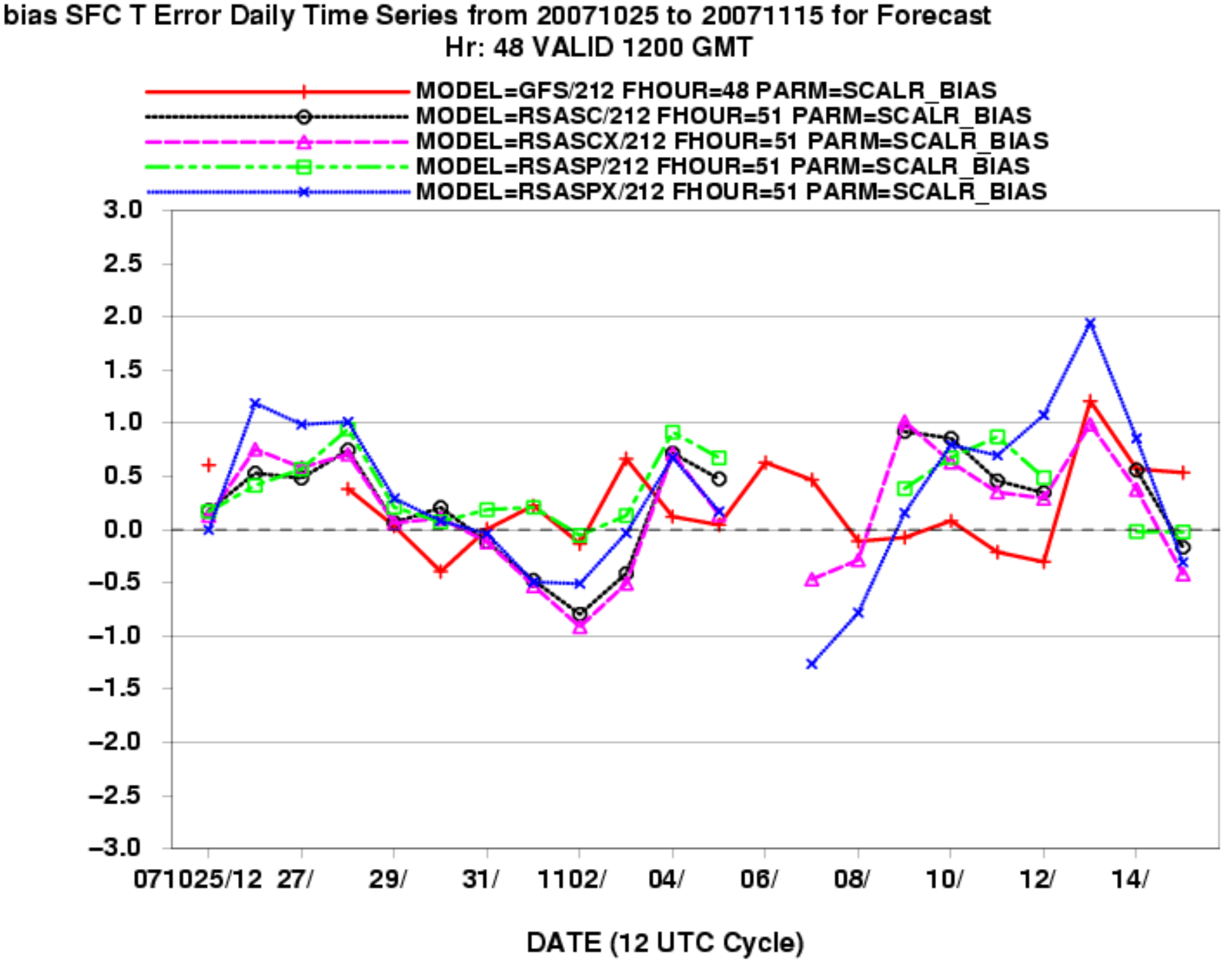




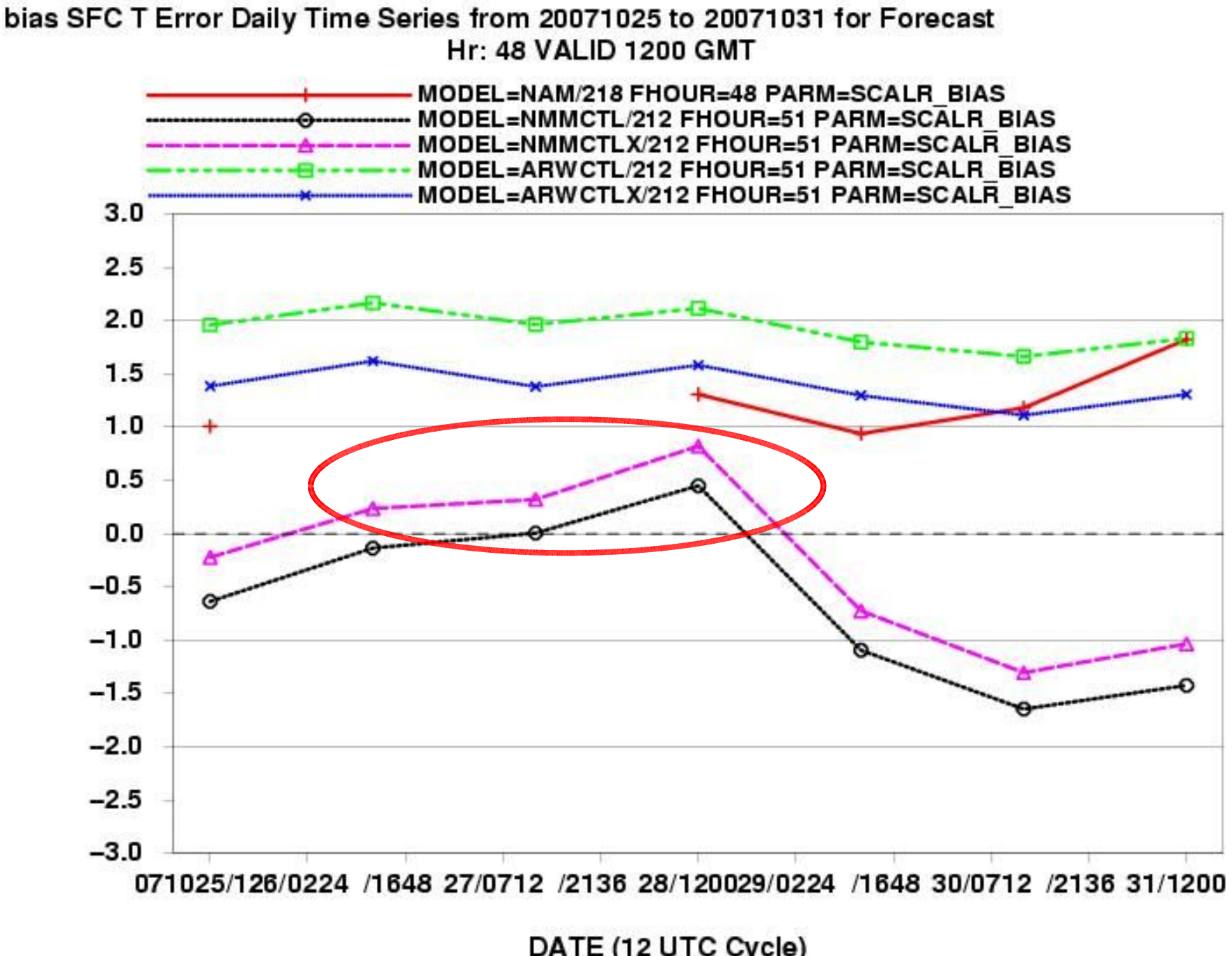
Problems Areas

- **When bias is flow-dependent** such as wind and upper levels
- **When bias is small**
- **When weather regime is changing rapidly**


bias SFC T Error averaged by fcst hrs from 20071025 to 20071115
MODEL=NAM/218 PARM=SCALR_BIAS
MODEL=NMMCTL/212 PARM=SCALR_BIAS
MODEL=NMMCTLX/212 PARM=SCALR_BIAS
MODEL=ARWCTL/212 PARM=SCALR_BIAS
MODEL=ARWCTLX/212 PARM=SCALR_BIAS
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
00
06
12
18
24
30
36
42
48
54
60
66
72
78
84
Forecast Hour (12 UTC Cycle)


bias SFC T Error Daily Time Series from 20071025 to 20071115 for Forecast
Hr: 48 VALID 1200 GMT
MODEL=GFS/212 FHOUR=48 PARM=SCALR_BIAS
MODEL=RSASC/212 FHOUR=51 PARM=SCALR_BIAS
MODEL=RSASCX/212 FHOUR=51 PARM=SCALR_BIAS
MODEL=RSASP/212 FHOUR=51 PARM=SCALR_BIAS
MODEL=RSASPX/212 FHOUR=51 PARM=SCALR_BIAS
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
071025/12
27/
29/
31/
1102/
04/
06/
08/
10/
12/
14/
DATE (12 UTC Cycle)

worse


bias SFC T Error Daily Time Series from 20071025 to 20071031 for Forecast
Hr: 48 VALID 1200 GMT
MODEL=NAM/218 FHOUR=48 PARM=SCALR_BIAS
MODEL=NMMCTL/212 FHOUR=51 PARM=SCALR_BIAS
MODEL=NMMCTLX/212 FHOUR=51 PARM=SCALR_BIAS
MODEL=ARWCTL/212 FHOUR=51 PARM=SCALR_BIAS
MODEL=ARWCTLX/212 FHOUR=51 PARM=SCALR_BIAS
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
071025/126/0224
/1648
27/0712
/2136
28/120029/0224
/1648
30/0712
/2136
31/1200
DATE (12 UTC Cycle)

Conclusions on Bias Correction

- **Bias Correction overall a positive impact**
  - **Big improvement for low-level temperature and humidity where bias is big and persistent**
  - **Small or no impact on upper-level variables (flow dependent), not good for wind (very flow dependent), not good when regime changes, and not good when bias is small**
- **A good first step but regime-dependent approach is needed such as Du (2004) which needs further testing.**
- **Bias corrected fields not to be distributed due to insufficient lead-time for advance notice.**

Feedback from HPC 1 Mike Brennan

1. A preliminary subjective evaluation of the bias corrected SREF output at HPC has shown a near **neutral impact** from these bias corrected output. Differences between the current operational SREF output and the bias-corrected SREF appear to be relatively small at most times differences in the 500-mb height fields appear to be on the order of 10 m, even at longer lead times). However, in some events, even small benefits from the bias corrected output could be beneficial to HPC for cyclone track, precipitation type, etc.

Feedback from HPC 2 Mike Brennan

2. One concern from HPC's perspective is that the precipitation type algorithm determination in the SREF is made *before* the bias correction is performed. This may result in some inconsistency between p-type from the algorithm (what is used in our winter weather blender) and what is inferred from the thermal profile based on bias corrected output. We would like to see this inconsistency rectified as soon as possible. (NOTE: Variables currently bias-corrected are insufficient to apply the precip type algorithm)
3. HPC's **recommendation is to implement** the SREF upgrade operationally on 11 December.

Feedback from SPC 1 Weiss, Bright, Schneider

The SPC input will focus on the larger domain including Alaska and the addition of bias corrected fields that are derived from a weighted decaying average statistical bias correction to base variables at the surface and mandatory pressure levels. Severe weather activity has been unusually quiet during the evaluation period.

1. Domain

The larger domain should improve the SREF.

The domain increase should benefit the system performance by reducing lateral boundary effects originating from the western edge of the domain, especially for day 2 and/or day 3 time frames. This is expected to maintain or slightly improve SREF guidance for SPC Convective Outlooks during these time frames.

Feedback from SPC 2a Weiss, Bright, Schneider

2. Bias Corrected Fields

a. Impact on SPC Operations

The effort to bias correct select SREF output is expected to have little impact on SPC operations.

SPC severe weather forecasting focuses on assessing the evolution of the environment using an ingredients-based approach over synoptic and mesoscale-sized areas, changes in model point variables are not as important to our forecasters compared to the evolution of parameter patterns and magnitudes that relate to thunderstorm development. We agree that if done properly, the bias corrections will improve statistical verification of the SREF over the longer time period (e.g., time averaged over the order of weeks and months). However, assuming that the bias corrections applied to the SREF will be generally of small magnitude since they are based on error statistics derived from the ensemble mean of the four base models (Eta, RSM, WRF-NMM, WRF-ARW), we see this as having a minor impact on SPC forecaster severe weather decision-making on a day-to-day basis.

Feedback from SPC 2b Weiss, Bright, Schneider

2. Bias Corrected Fields

b. Availability of Raw SREF Grids

It is important to continue providing the non-bias corrected (raw) SREF grids.

A key concern of the SPC is the continued operational availability of non-bias corrected (raw) SREF output grids. Over the past five years the SPC has developed numerous SREF-based guidance products focused on high impact weather events. Many of these fields are based on combined SREF parameters and have been calibrated based on the occurrence of the specific high impact weather event. To retain the documented skill of these guidance products, continued access of the raw grids is essential.

Feedback from SPC 2c Weiss, Bright, Schneider

2. Bias Corrected Fields

c. Concerns about the Bias Correction Method on Impact Weather Days

What is the effect on the bias corrections on important weather days?

The SPC has some concerns about the day-to-day performance of the weighted decaying average bias correction method, especially when applied during rapid changes in weather regimes. For example, on the synoptic scale during an extended time period characterized by a high amplitude blocking flow pattern, it is possible that the biases computed within this regime may not be appropriate when a rapid pattern shift occurs and zonal flow then predominates over the area.

As another example, onshore flow is predominant over southern California during the fall and the computed bias corrections applied to the SREF will likely reflect the occurrence of onshore flow. However, in the relatively rare instances when offshore flow develops and fire weather threats become very important, the bias correction developed from the preceding onshore flow regime could adjust critical values of temperature, RH, and wind speed in the wrong direction, and increase forecast errors on a high impact weather day that may not be reflected by the longer term statistical results.

Feedback from SPC 3 Weiss, Bright, Schneider

3. Summary and Recommendation

At this time the SPC can offer a "thumbs sideways" recommendation.

We fully support the increase to domain size and modification to the RSM initialization, but we still have questions about the bias correction method and its effect on SREF guidance for critical, high-impact forecasts. We would also like to see longer-term comparative verification results for the parallel bias corrected SREF and the current operational SREF when they are available.

Recommendation:

Implement as proposed XX

Feedback from WFO 1 Rich Grumm

1. Sorry to say we have done little with these data. We only recently began to ingest them and have focused on the mean files. We are looking at this as a training tool and the importance and value of bias corrected data. Our focus has been on examining and comparing the bias corrected data to the non-bias corrected data.

   We will have a presentation on this as we are going to Wakefield on the 5th, I will be at NCEP on the 4th for a few hours, to show the value of bias data. We are using all SREF images and data for this talk. We are trying to show people the value of bias corrected data including SREF and GEFS data, but are focusing on the SREF data as we are new to it and just developing output products.

Feedback from WFO 2 Rich Grumm

2. I will send you a copy of the talk when it is done. We are playing with images to make some points about bias correction … more at longer ranges, more significant at lower levels in the Atmosphere etc. We are hoping to be done on Friday but if not, I will get it to you on Monday or Tuesday next week when we arrive if need be. Our prototype images are at this link:

   http://eyewall.met.psu.edu/rich/srefbias/images/
   http://eyewall.met.psu.edu/rich/srefbias/ -- initial software

   We are not sure how to present these data in real-time and are considering pumping them into GFE as the bias corrected 2m temps could be helpful in short-term forecasting. …

   I think it would be prohibitive to ingest raw SREF and SREFBC data. Probably need to talk to you and explain myself on this one.

   I would like a 00-hour forecast and I would like PW (bias corrected or not) and precipitation data (probably just raw).