N
C
E
P

Spring 2005 Upgrade Package for North American Mesoscale (NAM) Decision Brief

Mesoscale Modeling Branch
Geoff DiMego and Eric Rogers

28 April 2005

where the nation's climate and weather services begin

Spring Upgrade Package

- 3DVar Analysis

  Manuel Pondeca, Dave Parrish, Jordan Alpert, Krishna Kumar, Dennis Keyser, Stacie Bender, Rogers

- Precip Assimilation - Ying Lin
- Prediction Model (Eta Model)

  Brad Ferrier, Ken Mitchell, Mike Ek, VinceWong, Yu-Tai Hou, Mary Hart, Rogers

- Output Products

  Brad Ferrier, Geoff Manikin, Mike Ek, Ying Lin

Spring Upgrade Package: 3DVar

- Improved use of on-time overland surface temperature observations using 2DVar with anisotropic covariance tied to terrain

- Use of Level II.5 (on-site derived superobs) of 88D radial velocity

Improved Surface Temperature Analysis Within the Eta 3DVar System

- **Background:**

  - Eta forecasts initialized with the GFS 3DVar analysis were found to be superior to Eta forecasts initialized with the Eta 3DVar analysis

  - Assimilation of surface temperature in the Eta 3DVar shown to account for nearly all of the forecast degradation

  - It appears that the Eta 3DVar is handicapped by being cast in the step-mountain framework, because Eta is not terrain following, it is difficult to cleanly limit the vertical influence of surface data

  - Surface temperatures overland were turned off as a temporary fix since September 2003

  - Anisotropic covariances with vertical stability dependence cast in a terrain following coordinate (at least near the surface) is been the long-term goal

Spring Upgrade Solution to Allow Surface Temperatures To Be Turned Back On

- Limit the vertical influence of the surface temperature obs by analyzing these data independently with a 2DVar module
- Advantage: relatively easy to implement the 2DVar module without compromising 3DVar code etc

Implementation:

1) use original 3dvar code to analyze all the observations except for surface temperature

2) at the end of the 3dvar, invoke the 2dvar module to analyze surface temperature

3) resulting 2dvar increments replace those from the 3dvar analysis at the appropriate vertical levels

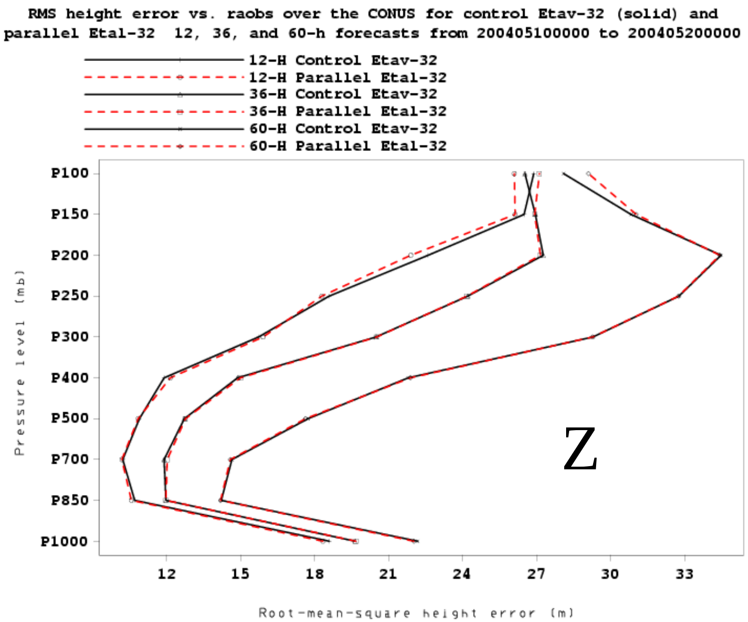
Specifics of 2DVar Module

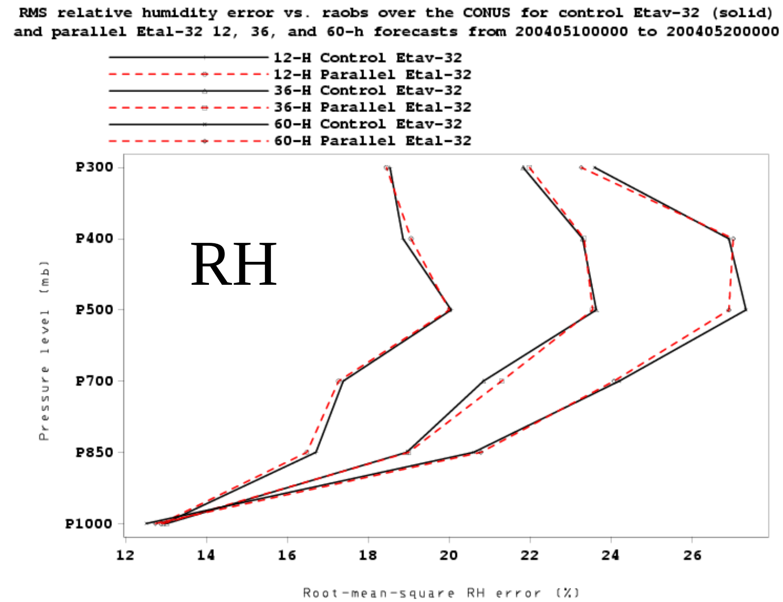
- Univariate analysis
- Background error structures prescribed to stretch along contour lines of topography to some extent
- First guess field is the original first guess for the 3DVar taken locally at the first vertical level above the Eta steps
- 2DVar analysis increments replace those from the original 3DVar at the vertical level used to construct the 2DVar first guess field

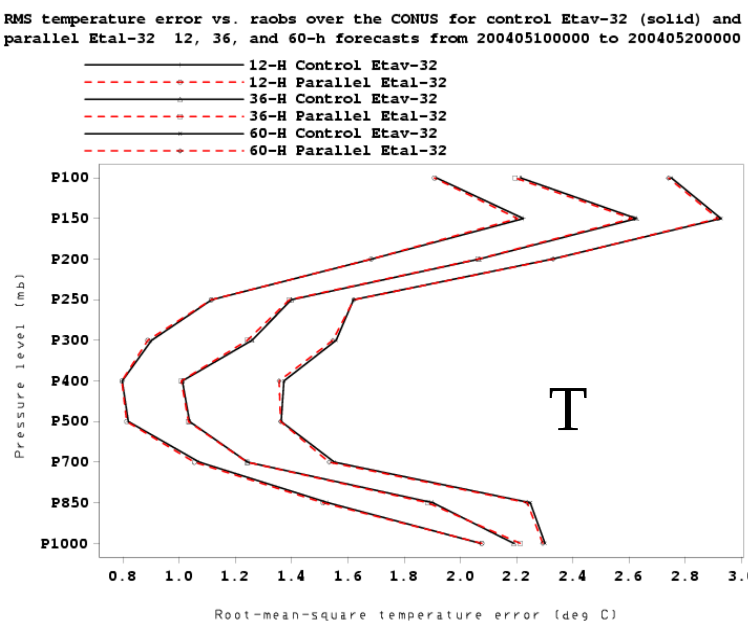
Main result

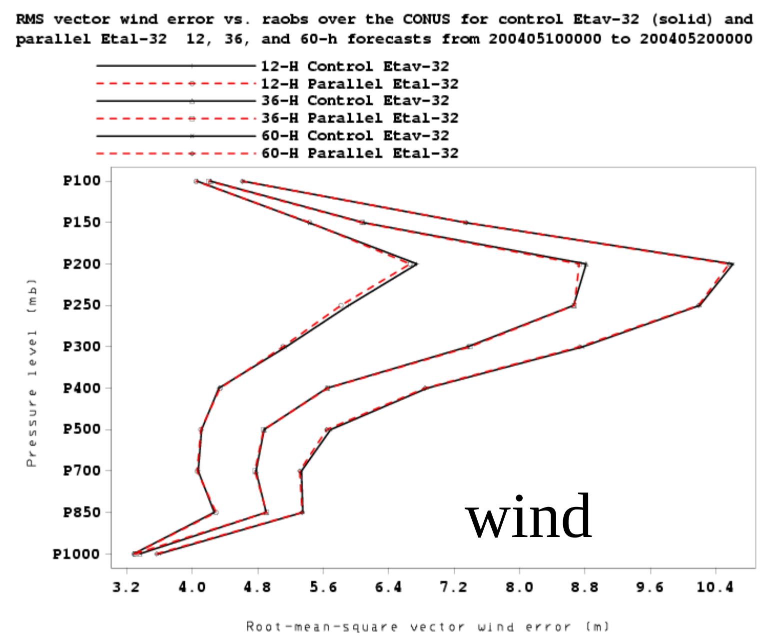
- With the modified assimilation system, surface temperature data have a non-negative impact on the model forecast.

12hr/36hr/60hr Fits to Obs from a 5-day 2DVar Test





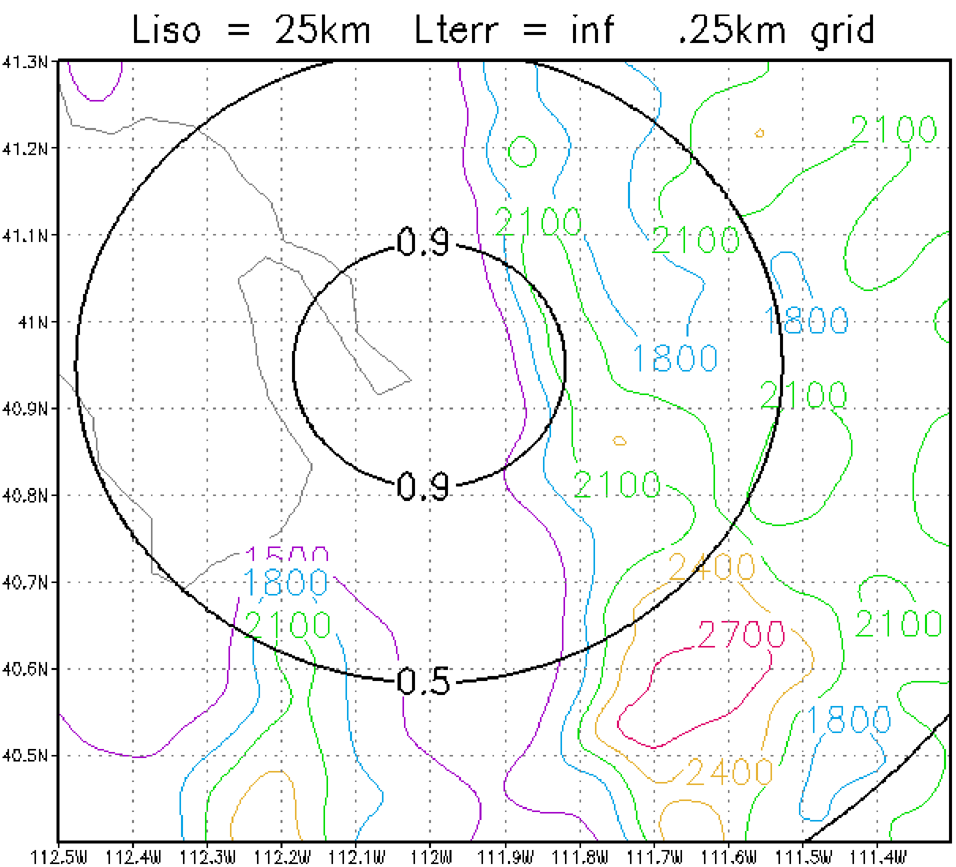


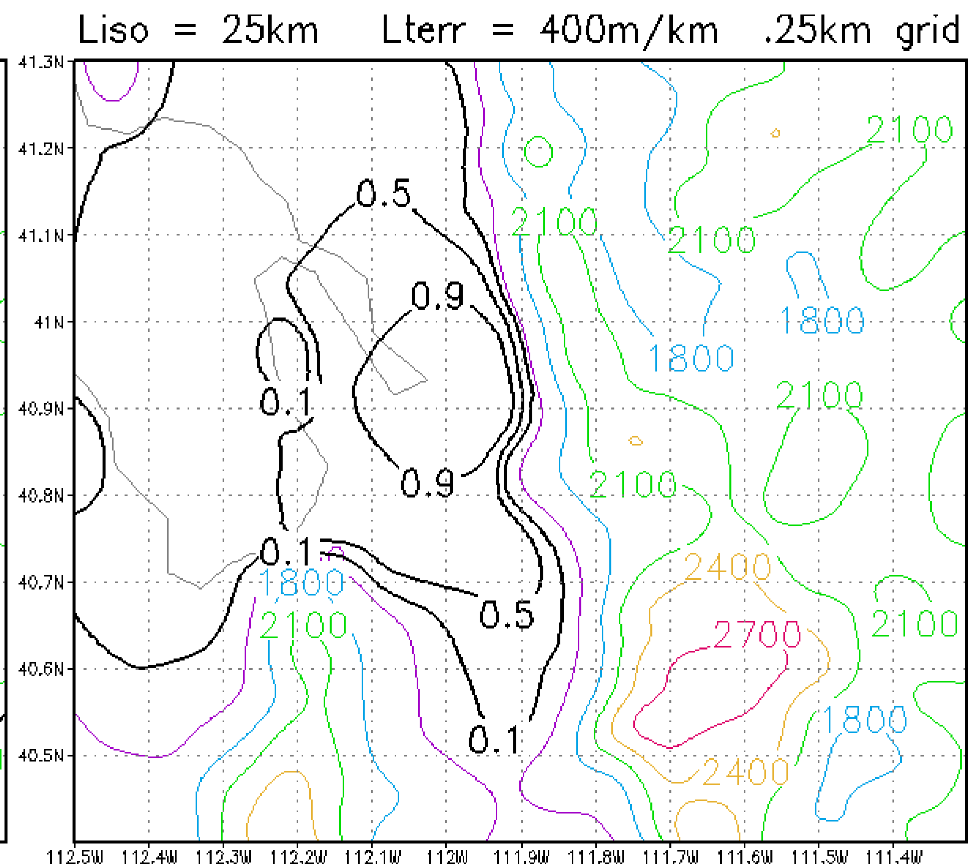


Error Correlations for Valley Ob Location Plotted Over Utah Topography

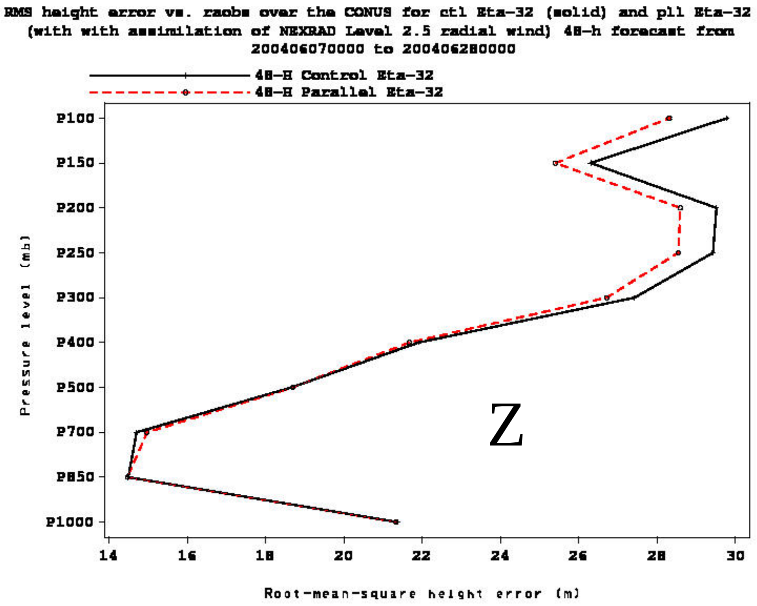
Isotropic Correlation: obs' influence extends up mountain slope

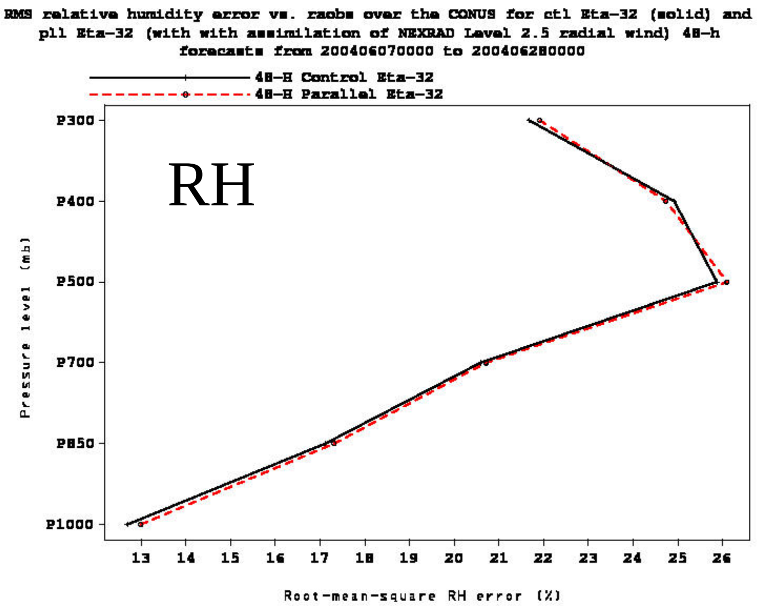
Anisotropic Correlation: obs' influence restricted to areas of similar elevation

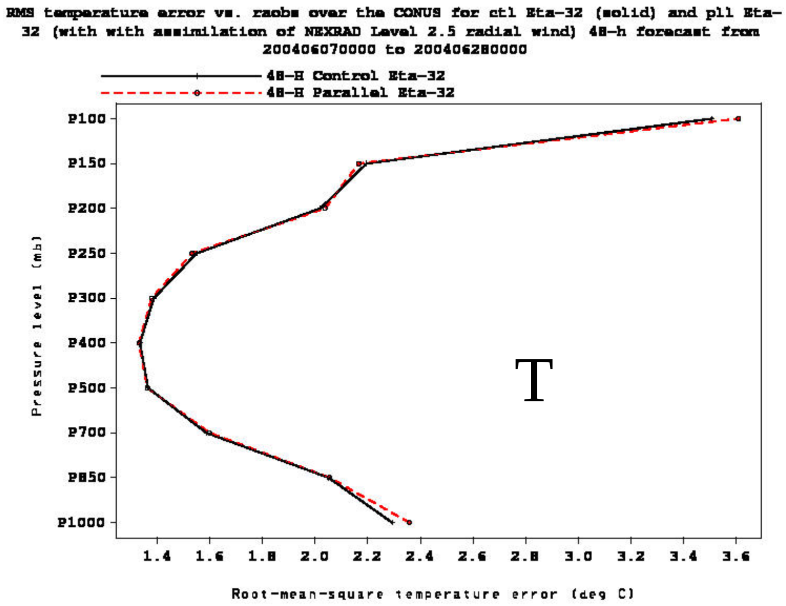


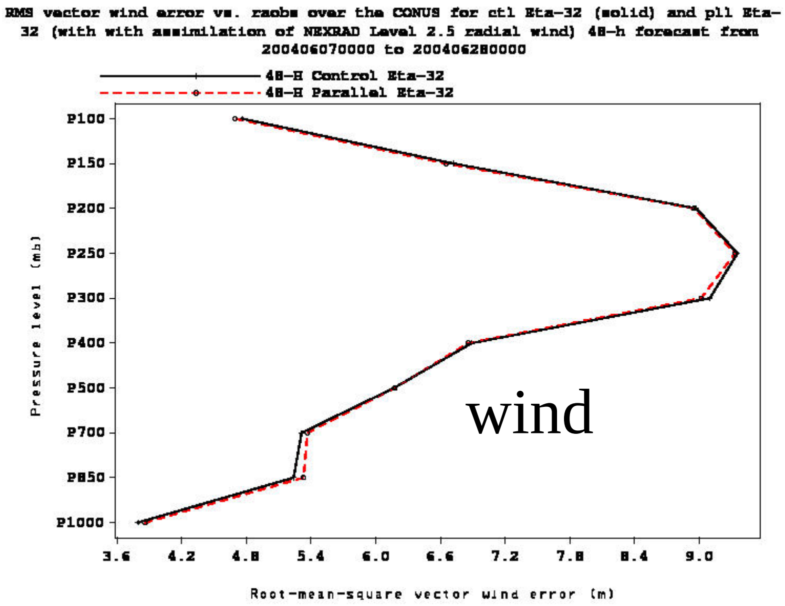


Level II.5 Wind Test June 2004 48hr







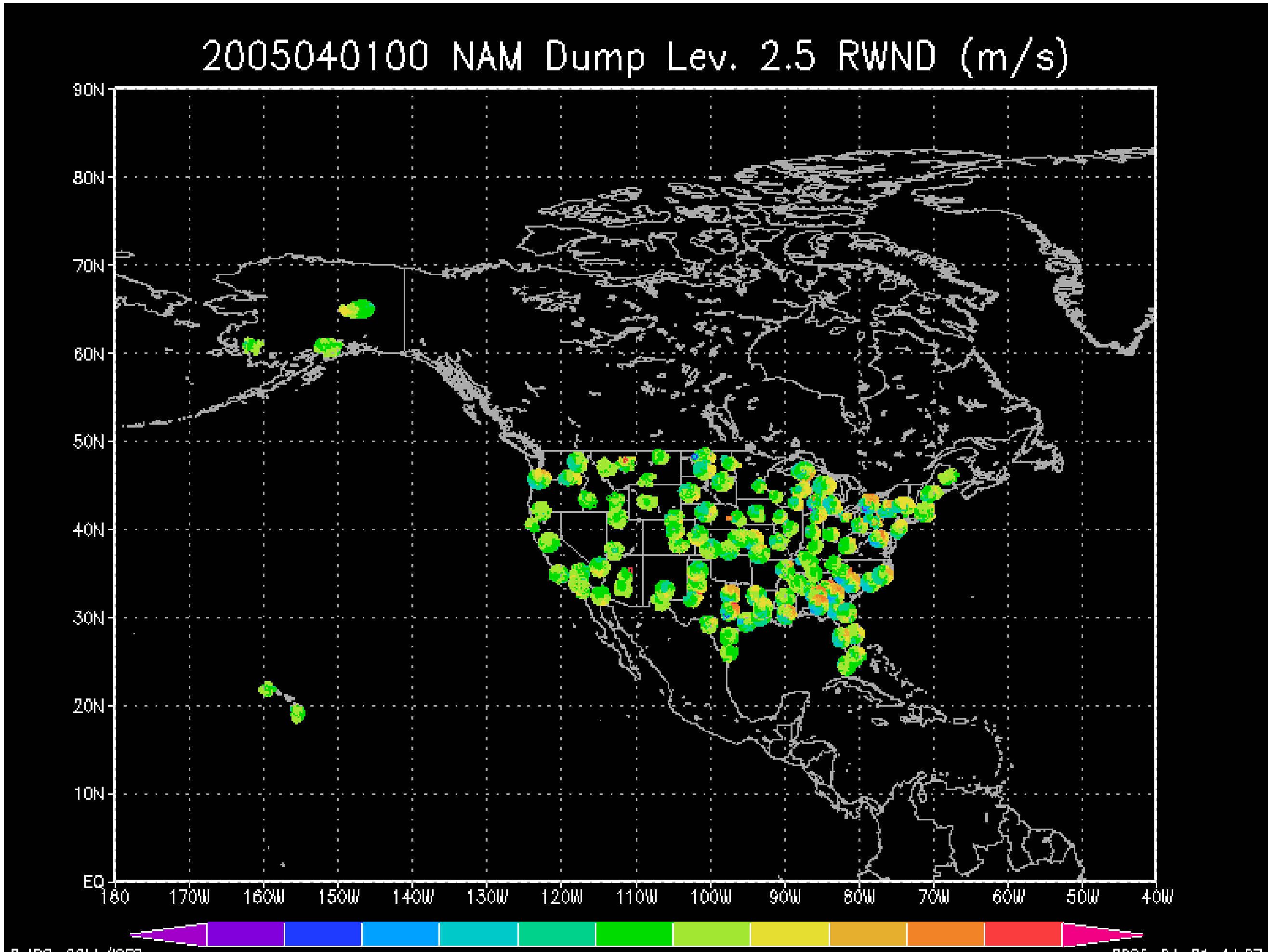


Sample Distribution (not yet complete) of Level II.5 Radial Wind Superobs Sites with Build 6.1

879055 wind obs at 110 radar sites as of 1 April

1112881 wind obs at 131 radar sites as of 26 April

Build 6.1 fixes problem with superobs lat-long



Spring Upgrade Package: Precipitation Assimilation

Simplified / streamlined precipitation assimilation procedures in NAM Data Assimilation System (NDAS). Reasons:

- Original method evolved in step over the years with increasingly more sophisticated microphysics; had become too contrived/cumbersome
- Streamlining makes method more forward-compatible with future modeling systems (WRF or ESMF)
- Streamlining makes precipitation assimilation more robust - some previous EDAS failures linked to attempts to create precipitation not forecast by Eta

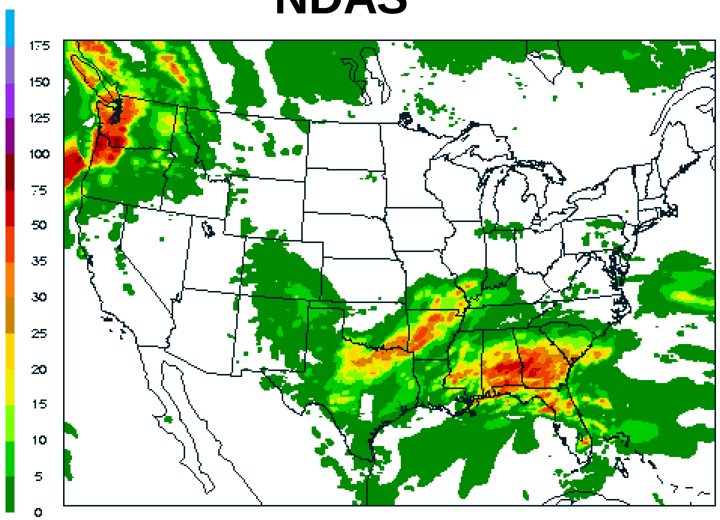
Precipitation Assimilation Changes

1. Cease attempts to create precipitation when model precipitation is less than observed
2. Continue to reduce latent heat and moisture fields when model precipitation is greater than observed
3. Use observed precipitation directly in driving the land surface physics

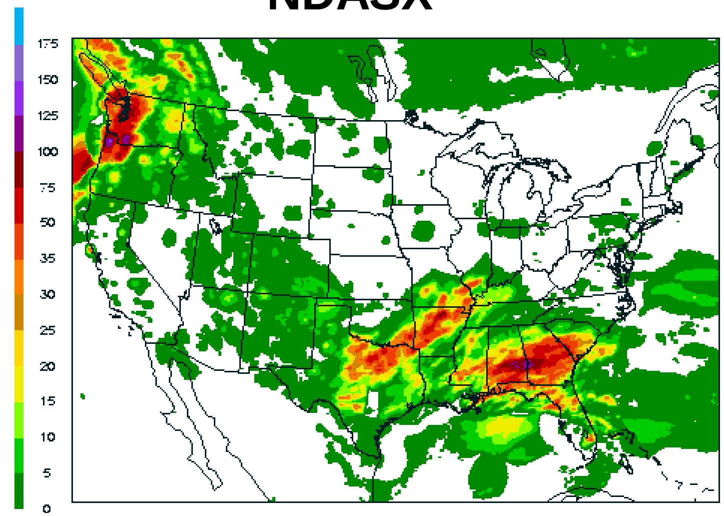
Impact of Simplifying Precipitation Assimilation

- Neutral to slightly positive impact on QPF precipitation scores and near surface & upper air forecast fit to observations
- More-moist soil – old method tends to have a dry bias during assimilation because model precipitation did not exactly replicate observed QPF

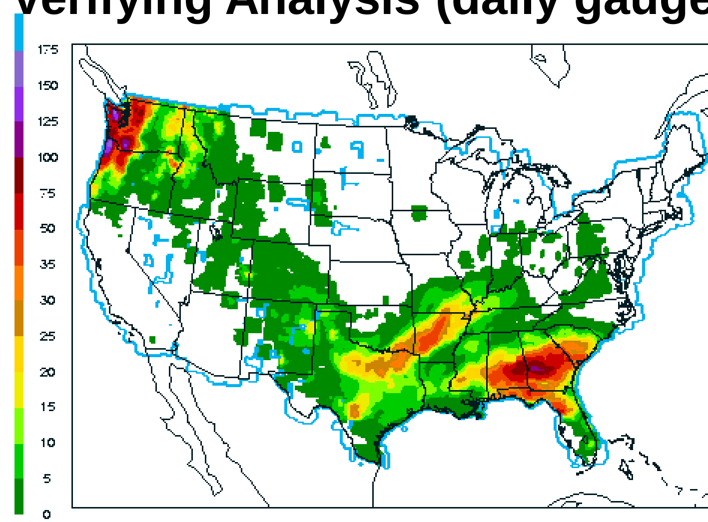
NDAS



NDASX



Verifying Analysis (daily gauges)

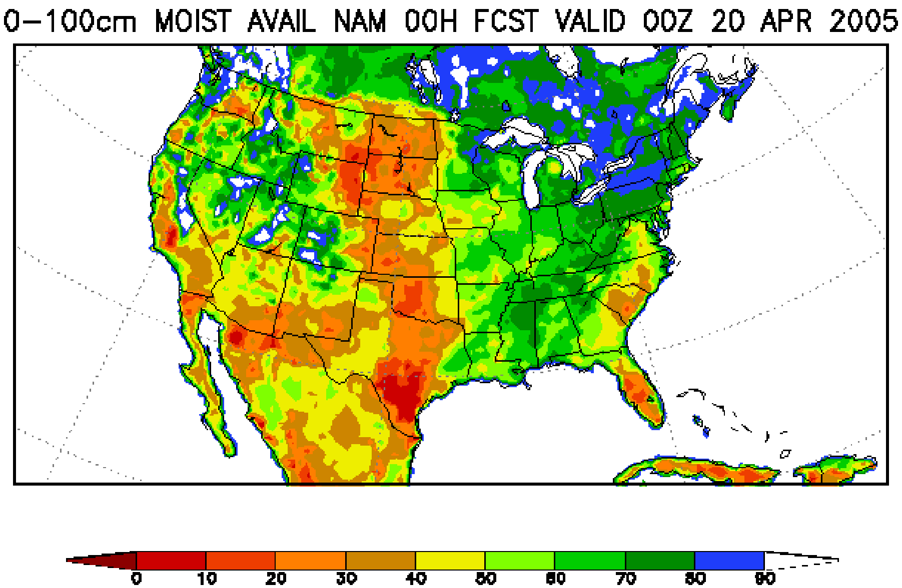


24 hour NDAS precip falling onto soil ending 12Z 27 Mar 2005

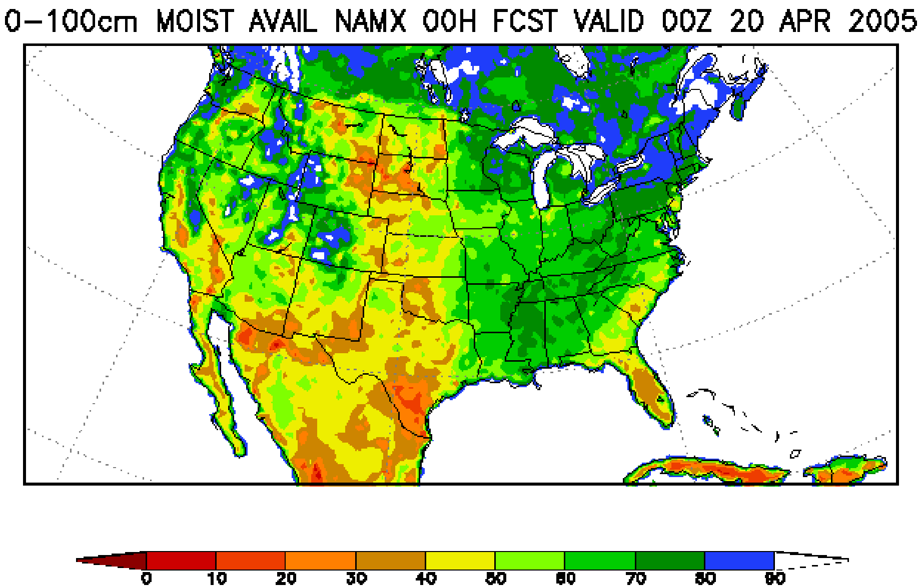
Long-term Impact on Soil Moisture Fields:

snapshot of top 1-m soil moisture availability

NAM



NAMX – wetter



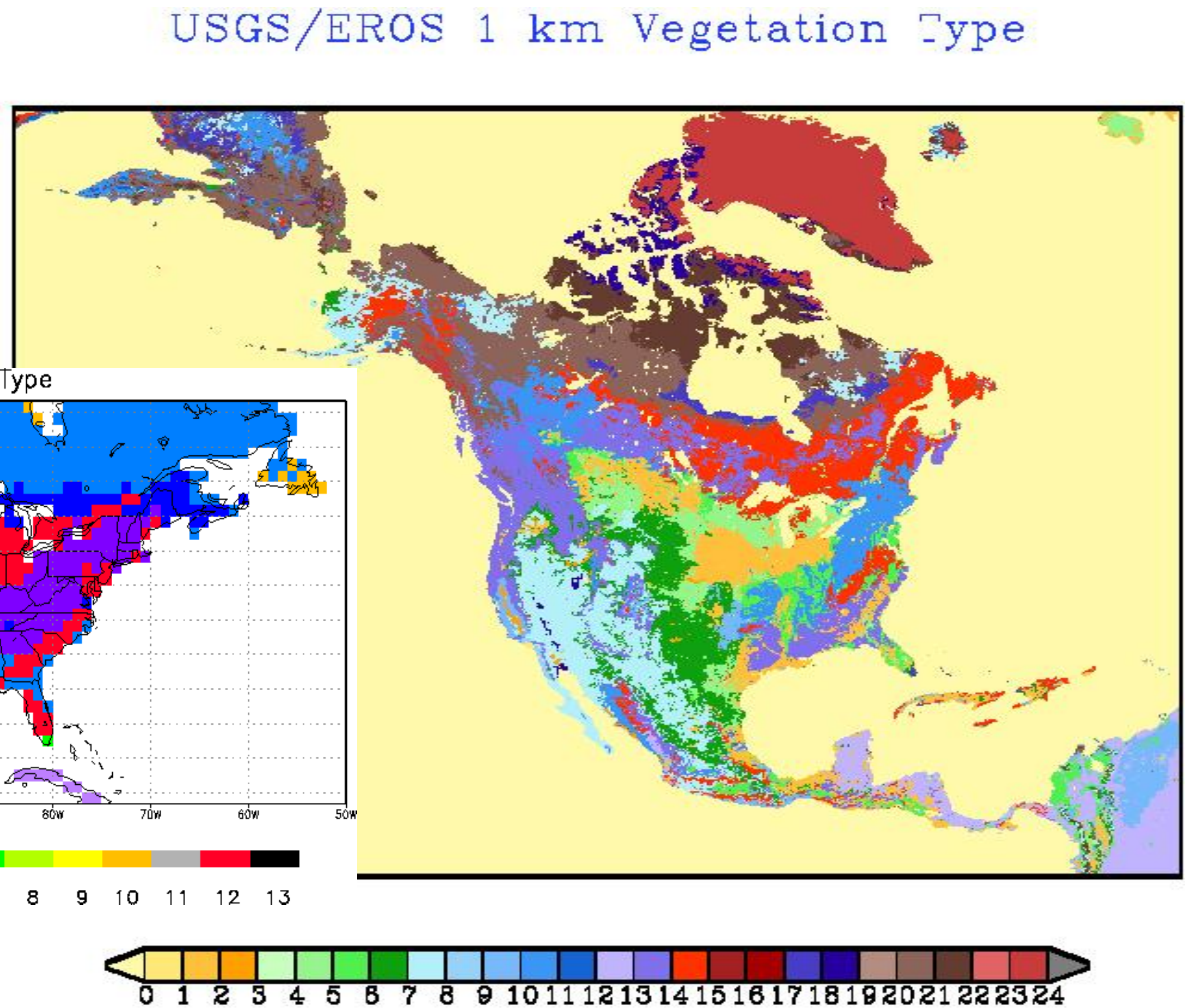
Spring Upgrade Package: Prediction Model (Eta)

- Noah LSM upgrades in the NAM prediction model (Eta)
- To address low-level temperature and humidity biases & drift during different seasons
  - Summer: warm/dry bias during day, typically over areas with larger greenness fractions
  - Summer: drying trend in PW and low level moisture with forecast range
  - Winter: cold bias during night, typically under calm/clear conditions especially over snowpack, and during day over shallow/melting snowpack

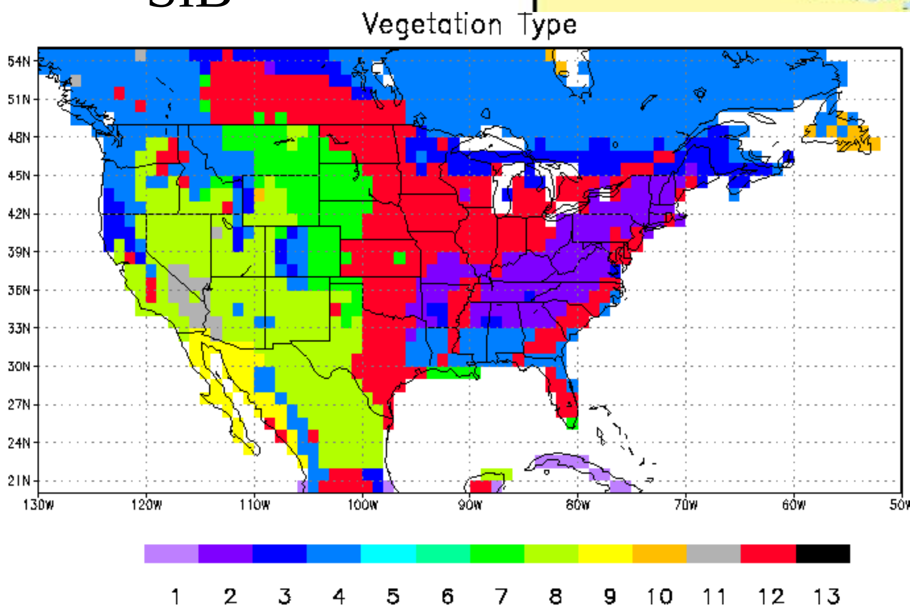
LSM changes (more) relevant to warm season

- Use high-resolution (1-km vs 1 deg) vegetation and soils data bases with more classes - Unifies with WRF-Noah LSM and responds to EPA / CMAQ request
- Retuned canopy conductance and other vegetation parameters - ops had been tuned to higher values to maintain reasonable evaporation rates given low soil moisture bias which is removed by Ying Lin’s new precipitation assimilation procedures
- Lowered roughness length for heat to reduce skin temperature, and hence lower diagnosed 2-m air temp
  - But no significant change to sensible heat flux
    - due to compensating effects on exchange coefficient and near-surface temperature gradient
  - No significant change to latent heat flux
    - primarily because LE largely affected by canopy conductance, which is much larger than aerodynamic conductance (especially in regions with large greenness fraction)

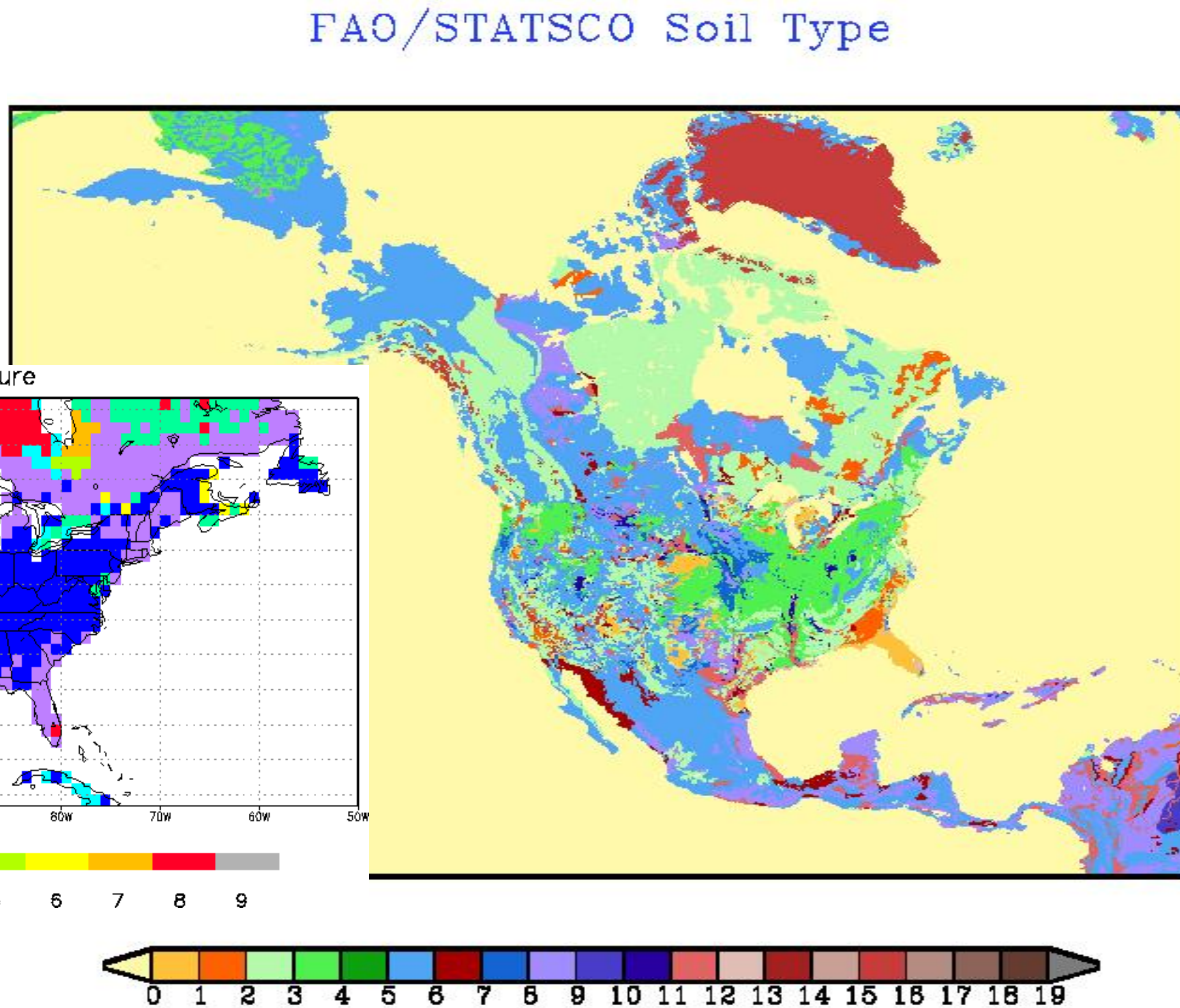
USGS 24-class high-resolution (1-km) vegetation data set replaces old SiB 13-class 1-degree data set



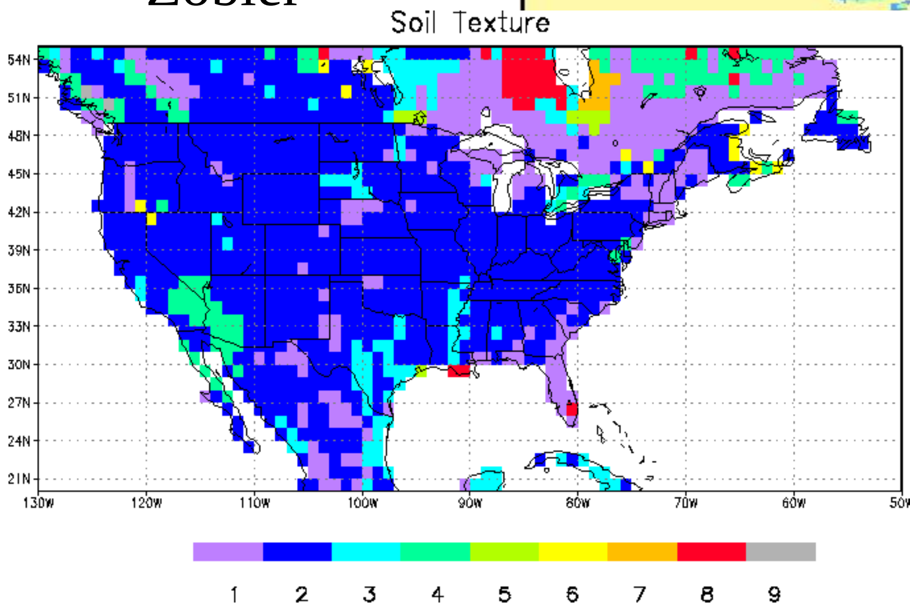
SiB



New STATSGO 16-class high-resolution (1-km) soils data base replaces old Zobler 9-class 1-degree data set

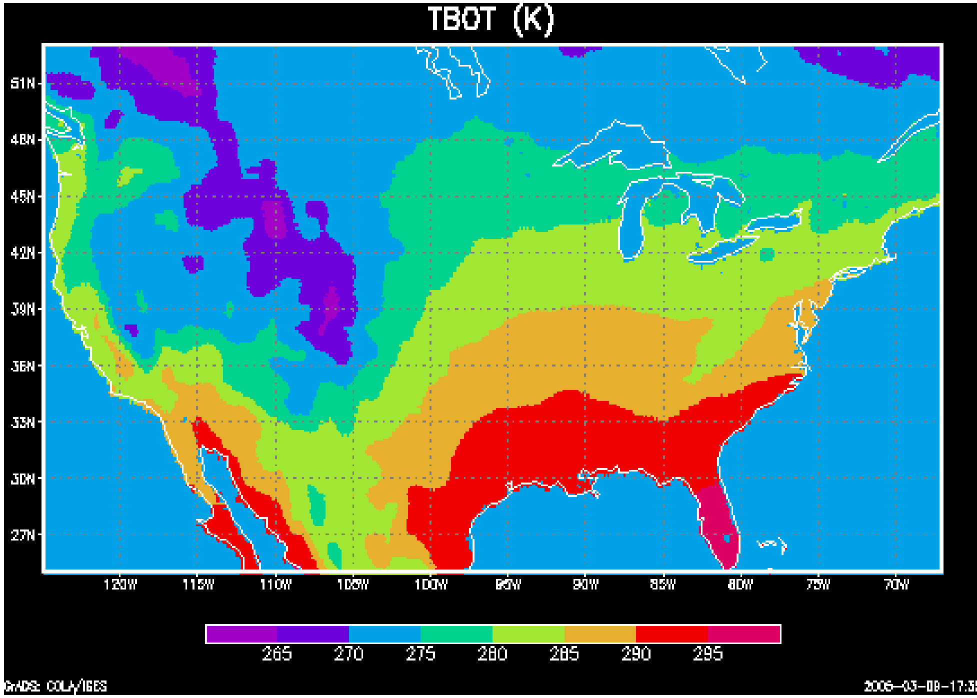


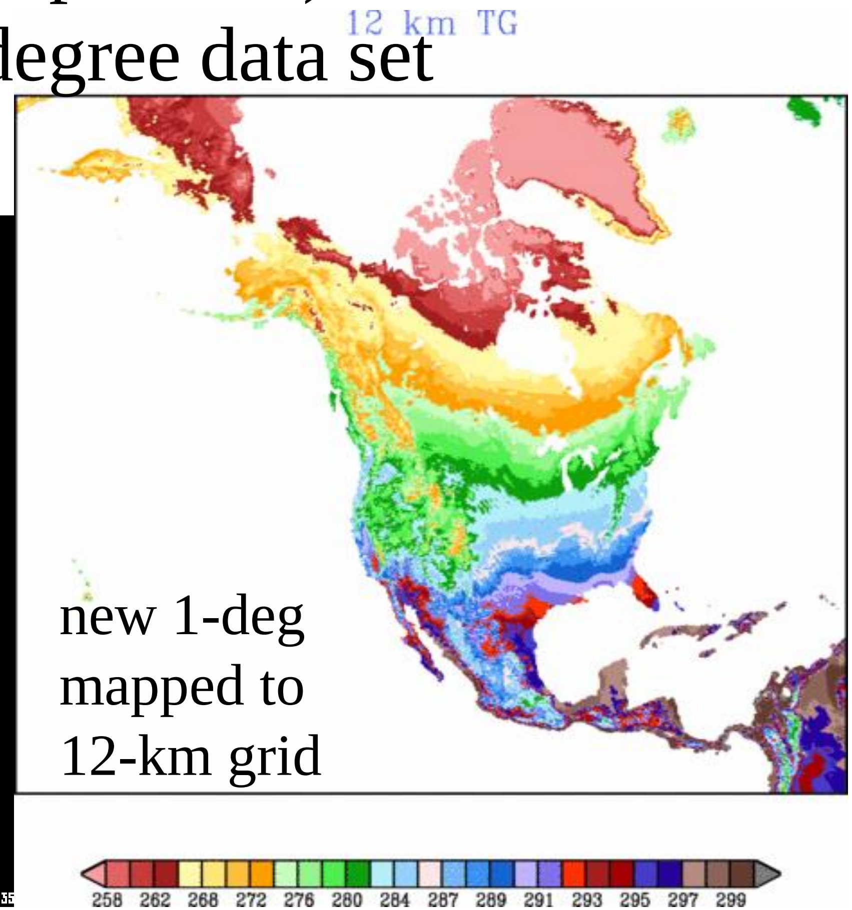
Zobler



New 1-deg TBOT (soil temperature) data base replaces old (global) 2.5-degree data set

old 2.5-deg mapped to 12-km grid





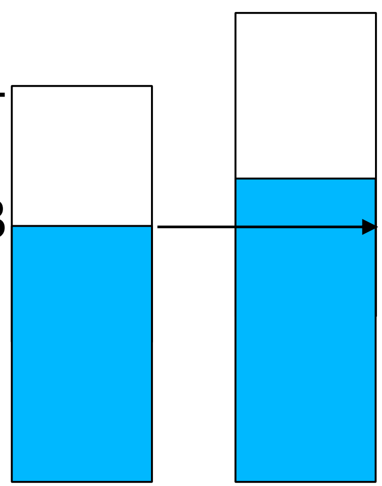
new 1-deg mapped to 12-km grid

Necessary to adjust TBOT for a given terrain elevation (standard lapse rate = 6.5C/km). For model "cold start", soil temperature states similarly adjusted for different model grid/terrain (ties in with soil moisture re-scaling).

Soil Moisture Re-scaling

-Necessary to re-scale soil moisture since Eta with the old soils needed to restart Eta with the new soils.

-To preserve surface evaporation (with respect to plant stress) in going from the old (Zobler) to new (STATSGO) soils, convert soil moisture contents in order to maintain relative saturation.



BUT...

Soil Moisture Spin-up

BUT... the subsequent evolution of soil moisture will be different for one soil type versus another, so model spin-up is important.

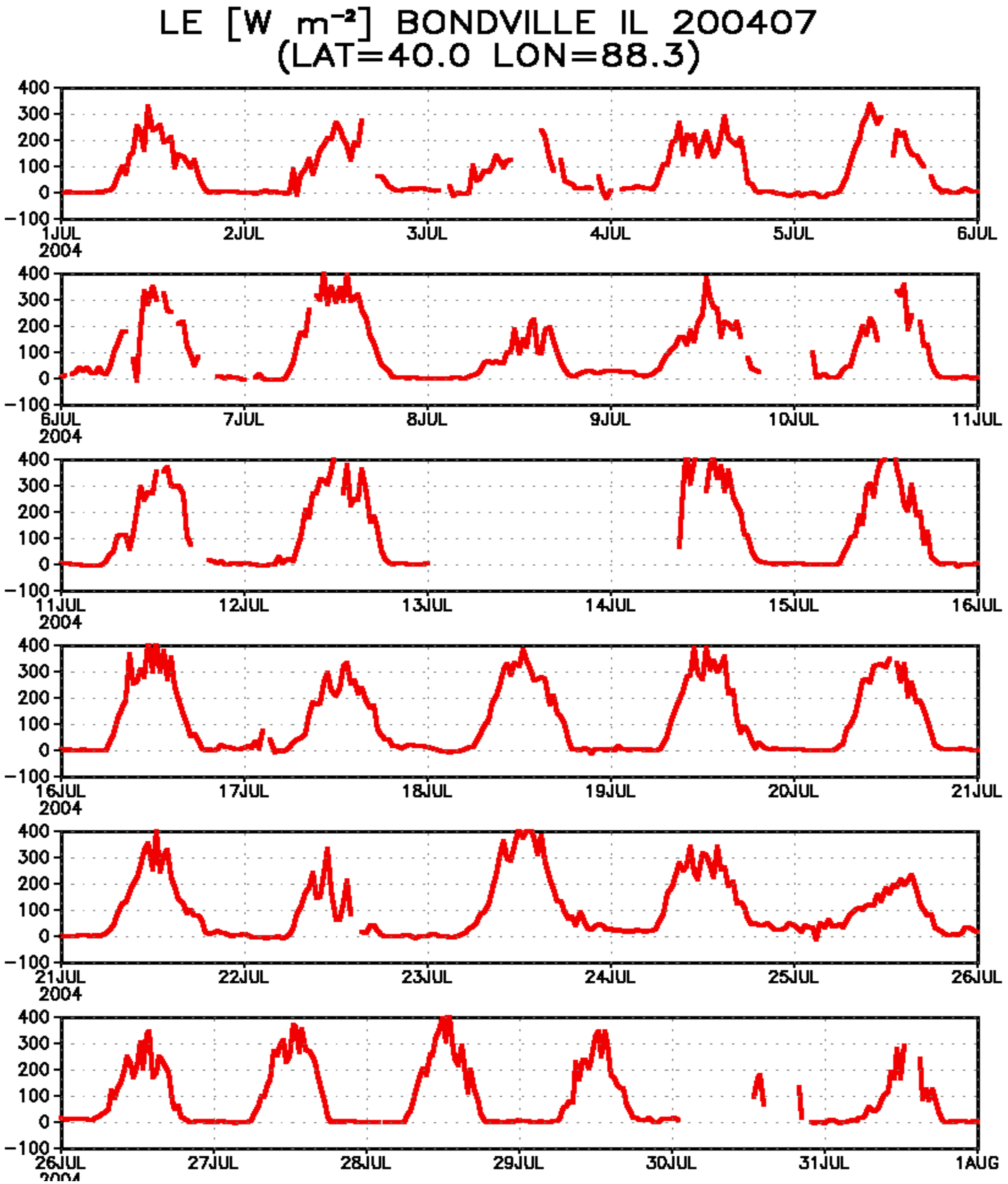
-Continuous/cycled Etax tests during July-August 2004
showed that higher latent heat fluxes (vs control Eta) over eastern CONUS die down after about 1 month of cycling,
as land states settle in with their own new vegetation and soil parameters.

-In August, Etax still had higher latent heat flux than control Eta, but difference significantly less than July.

July 2004 observed daily latent heat flux

-Comparisons with offline Noah LSM suggested lower canopy conductance

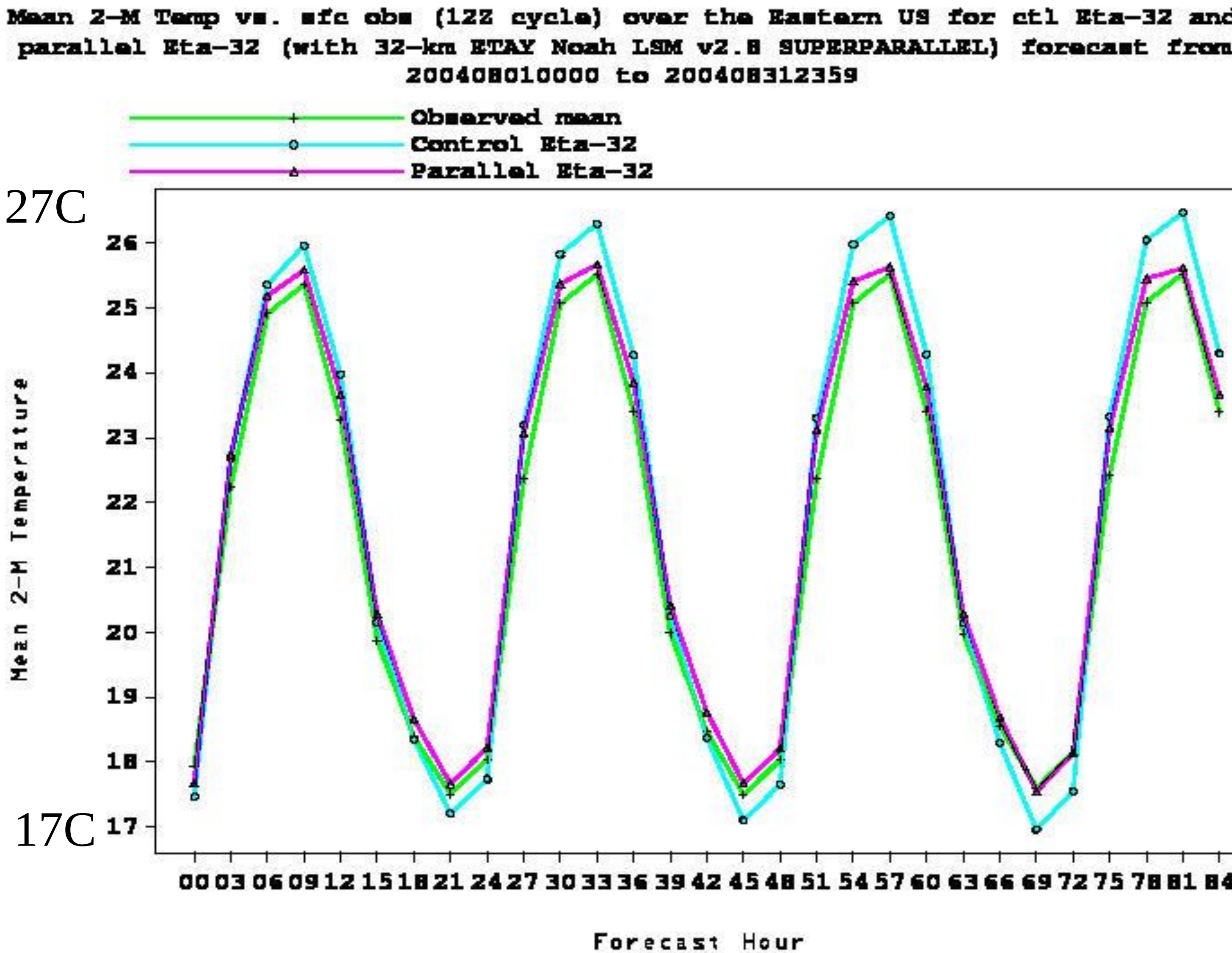
-Leaf Area Index adjusted down, Rs-min increased



Reduced Warm Bias

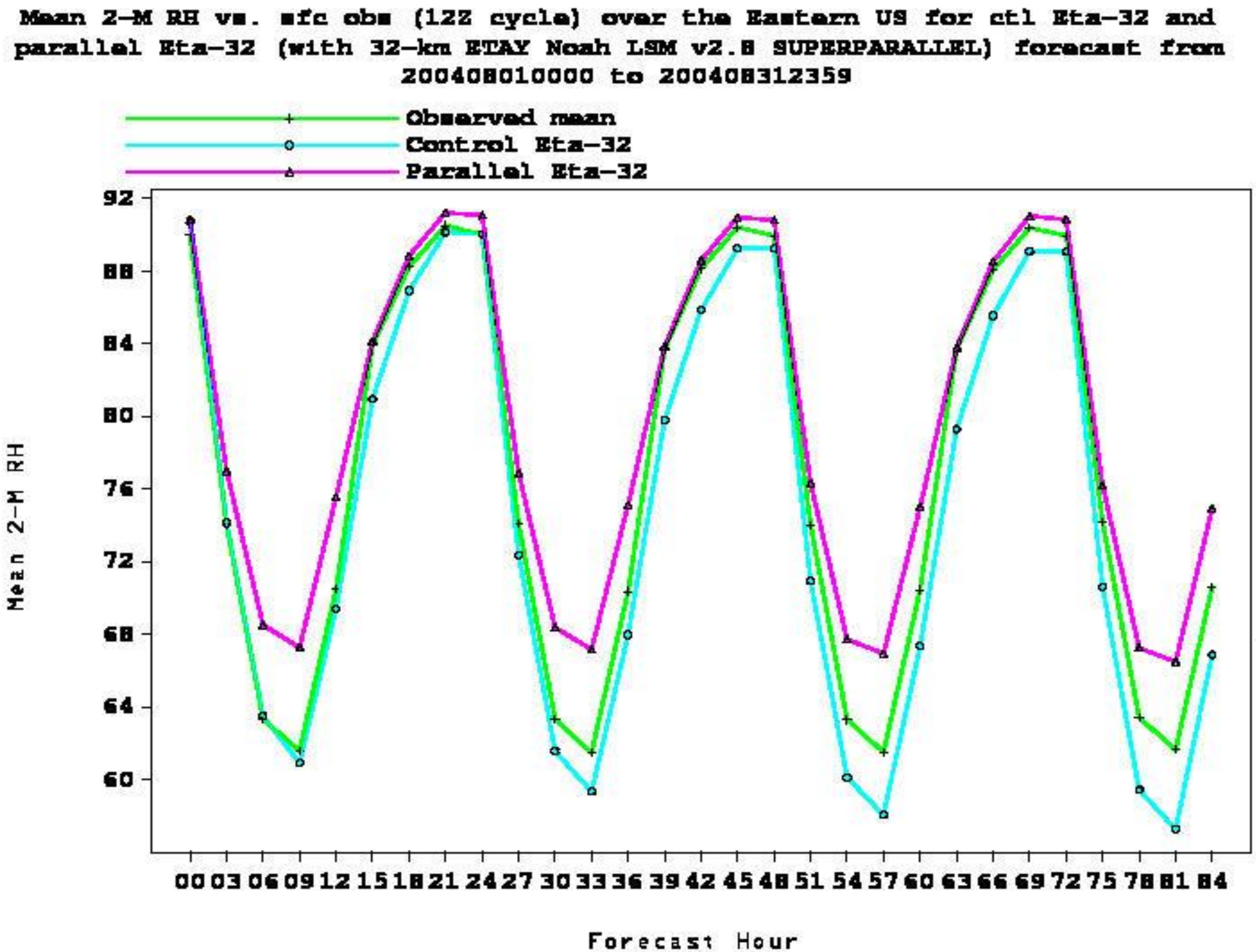
Eastern CONUS, August 2004

2-m temp



Higher Relative Humidity - Eliminated Drift

Eastern CONUS, August 2004

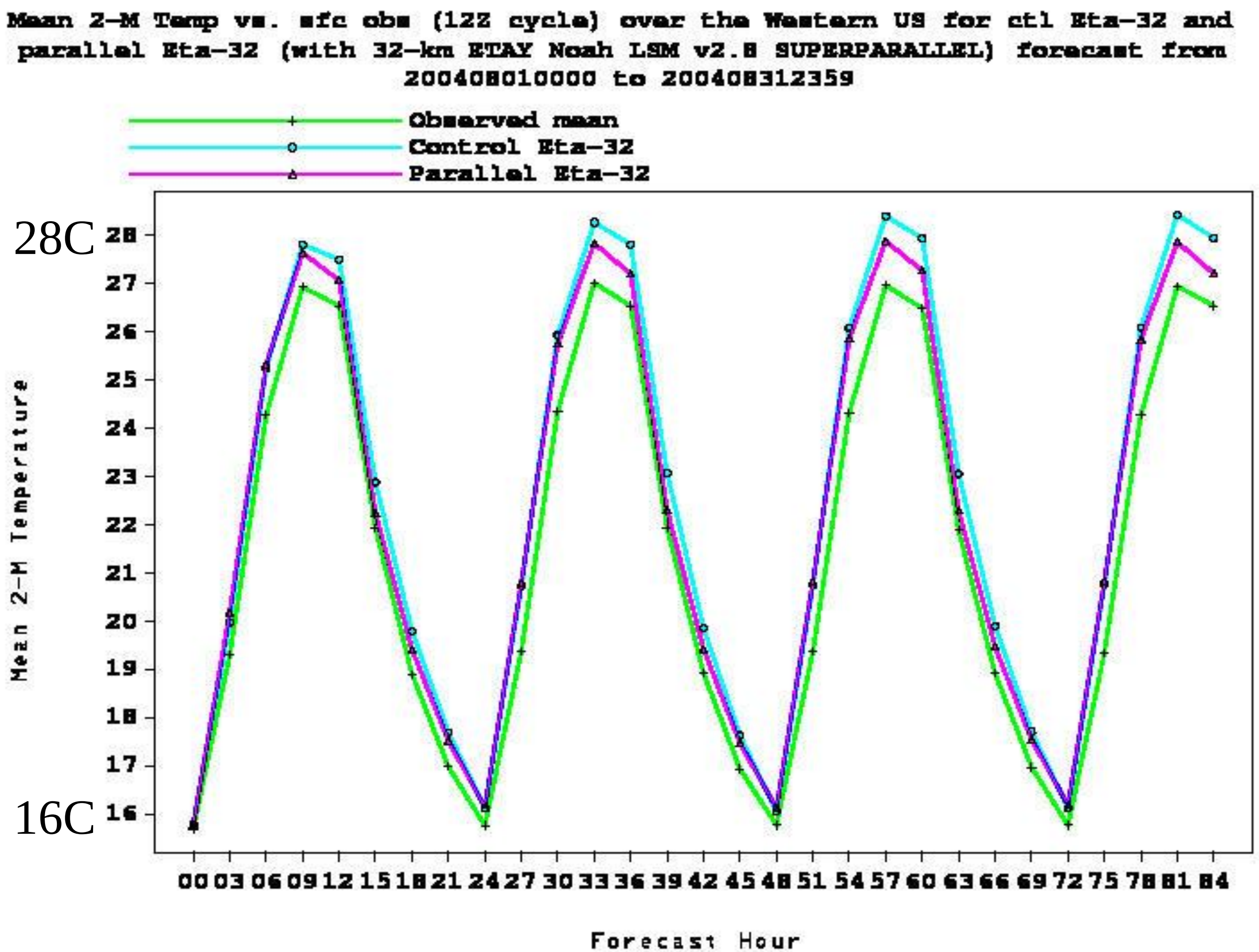


Too moist during day but no growth in bias with forecast range

Reduced Warm Bias

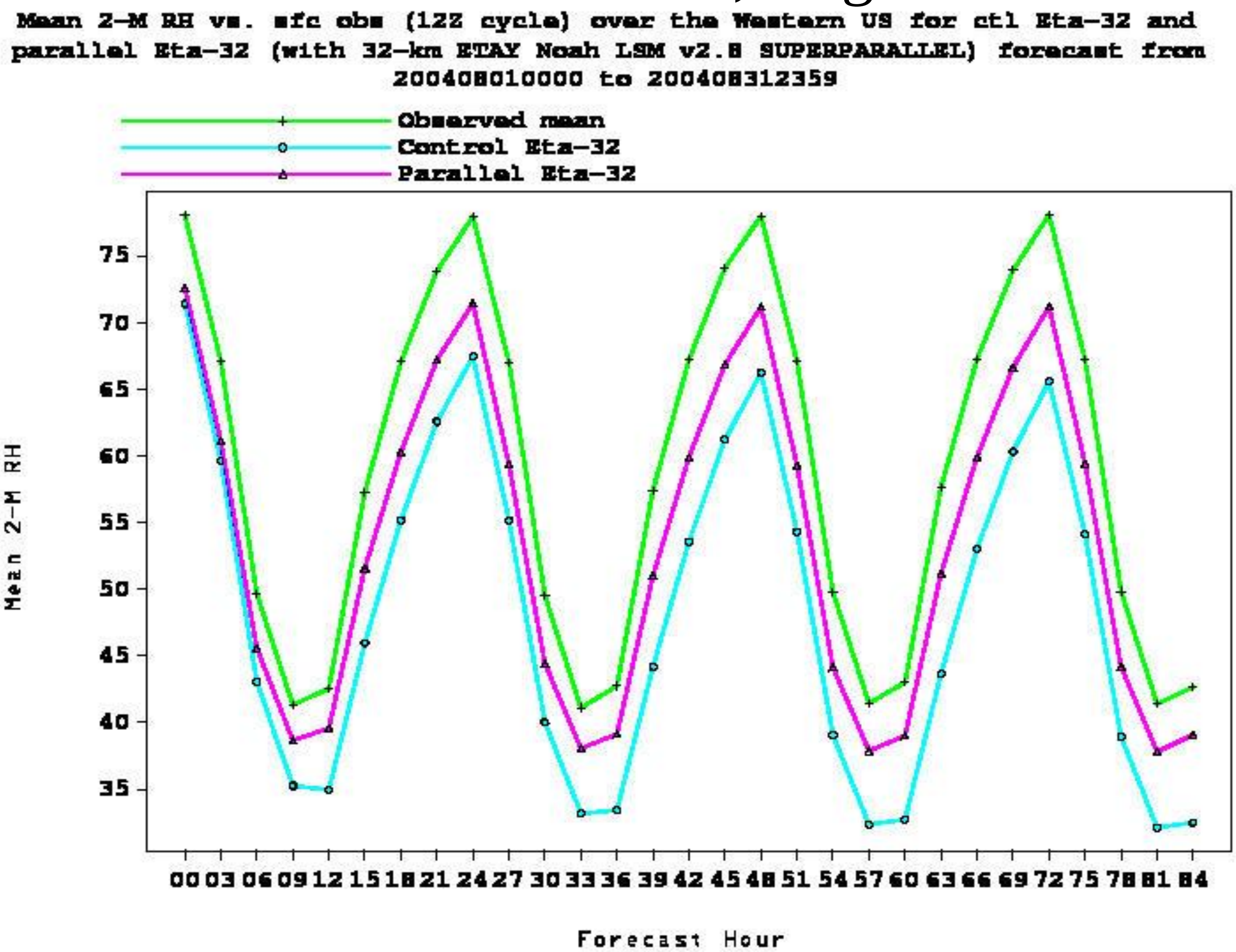
Western CONUS, August 2004

2-m temp



Relative Humidity – Reduced Dry Bias

Western CONUS, August 2004



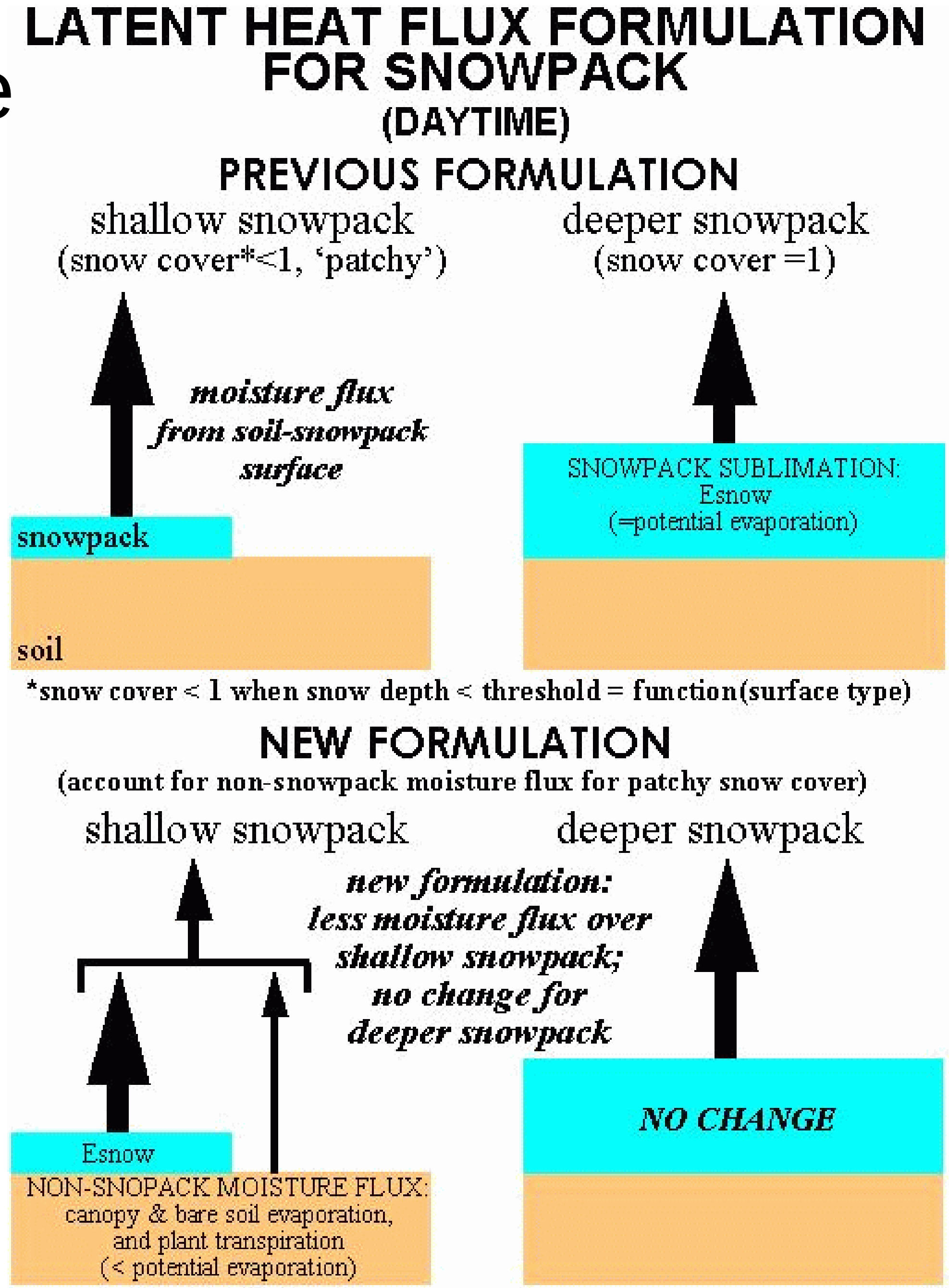
LSM changes (more) relevant to cold season

- For patchy snow cover, changes to parameters:
  - snow cover fraction (less snow depth for 100% cover)
  - snow albedo (yields higher)
  - surface skin temperature (higher via non-snow cover)
  - snow sublimation (reduced)

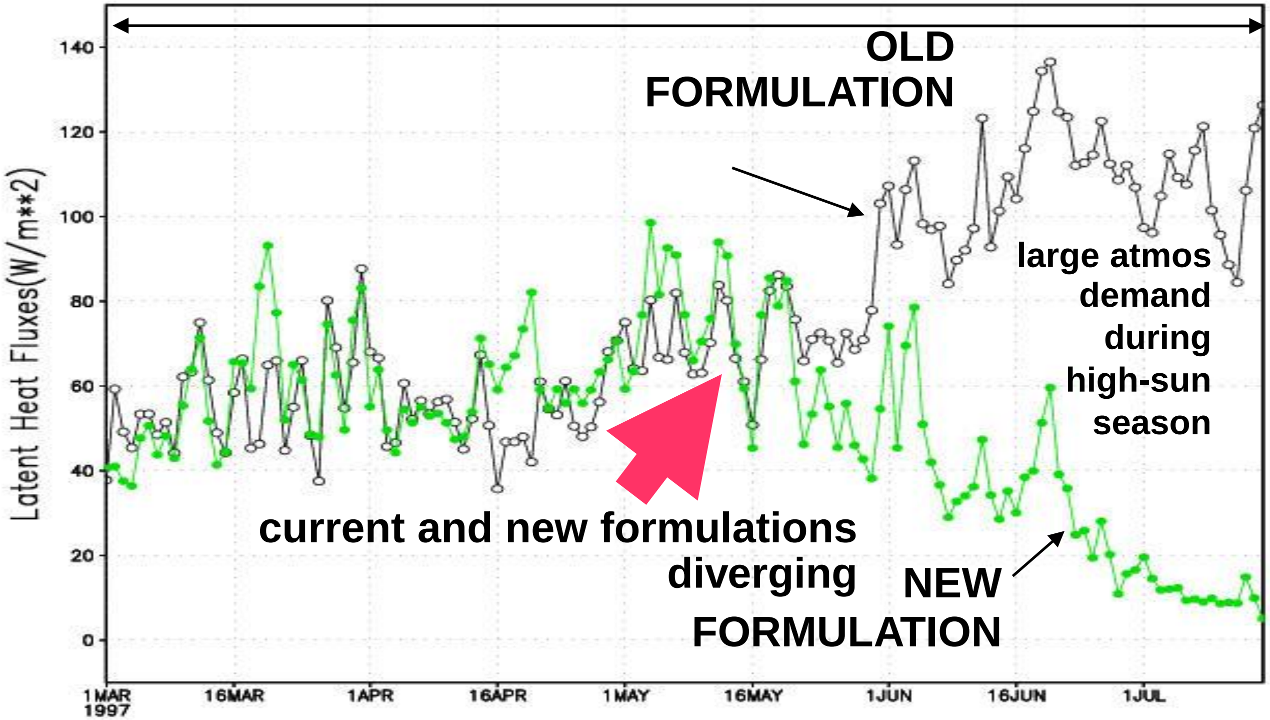
- Surface emissivity (for snow only):
  - Lup = $\varepsilon_s\ \sigma\ T^4$, ε_s = 1.0, 0.95, 0.90.

- PBL: in very stable conditions when PBL depth diagnosed as lowest Eta model level, impose lower limit on eddy diffusivity up to (and one level above) inversion height (positive impact previously shown

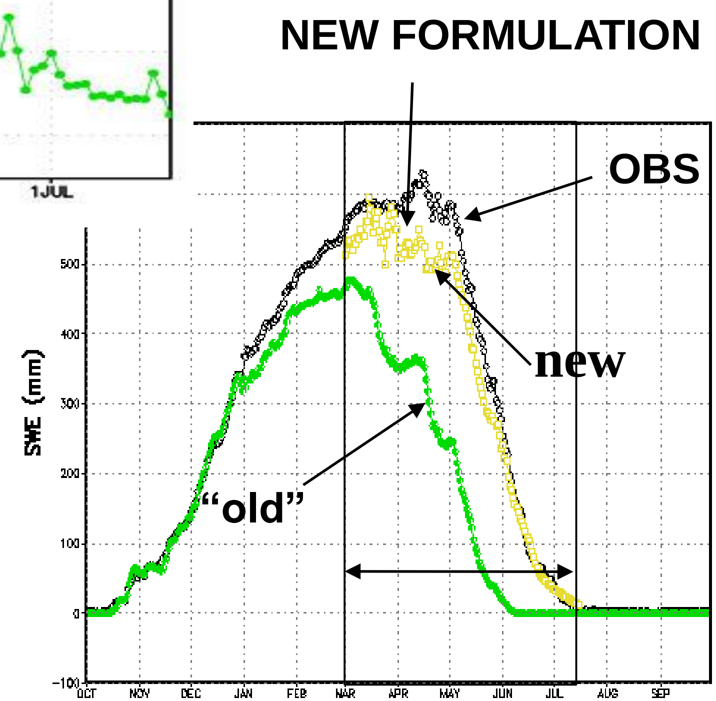
Previous Eta Bundle included ONLY the effect of patchy snow cover on surface skin temp and sensible heat flux … NOW the effect of patchy snow cover applies ALSO to latent heat flux



DAILY BASIN-AVERAGE SURFACE MOISTURE

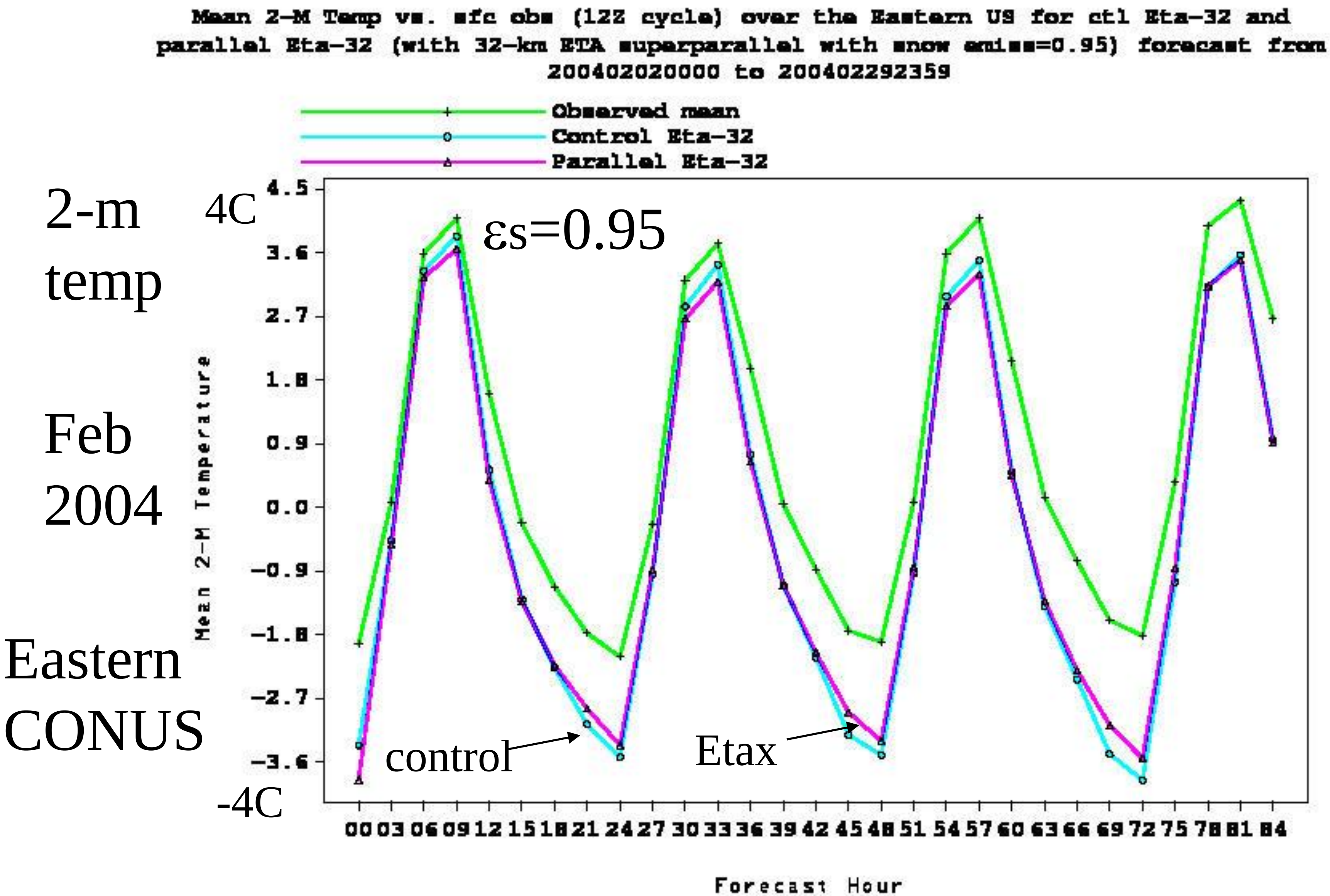


DAILY BASIN-AVERAGE SNOW DEPTH (S.W.E.)



<u>Offline</u> (uncoupled N-LDAS) results show the effect of the various cold-season changes to the Noah LSM

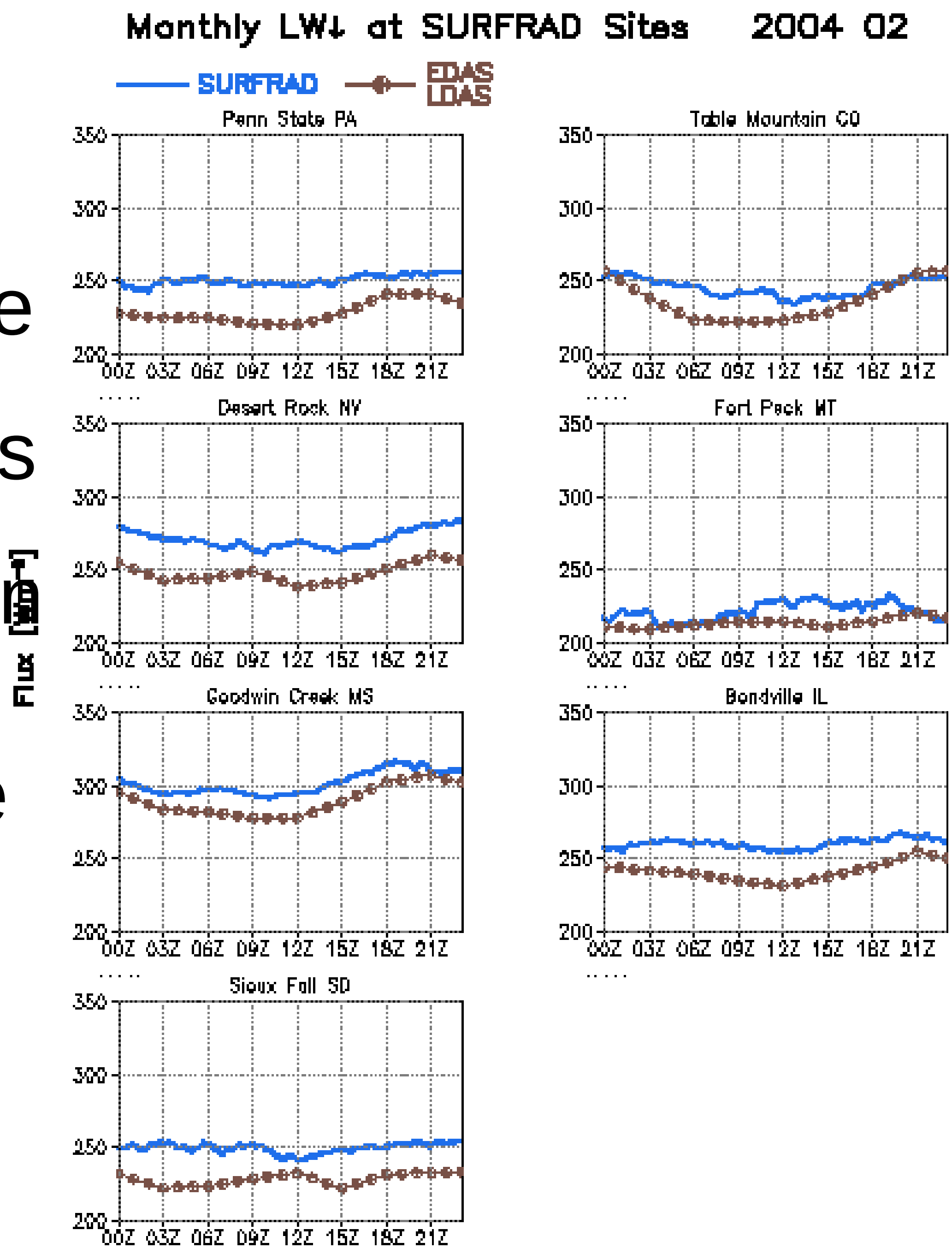
Slightly reduced night time cold bias



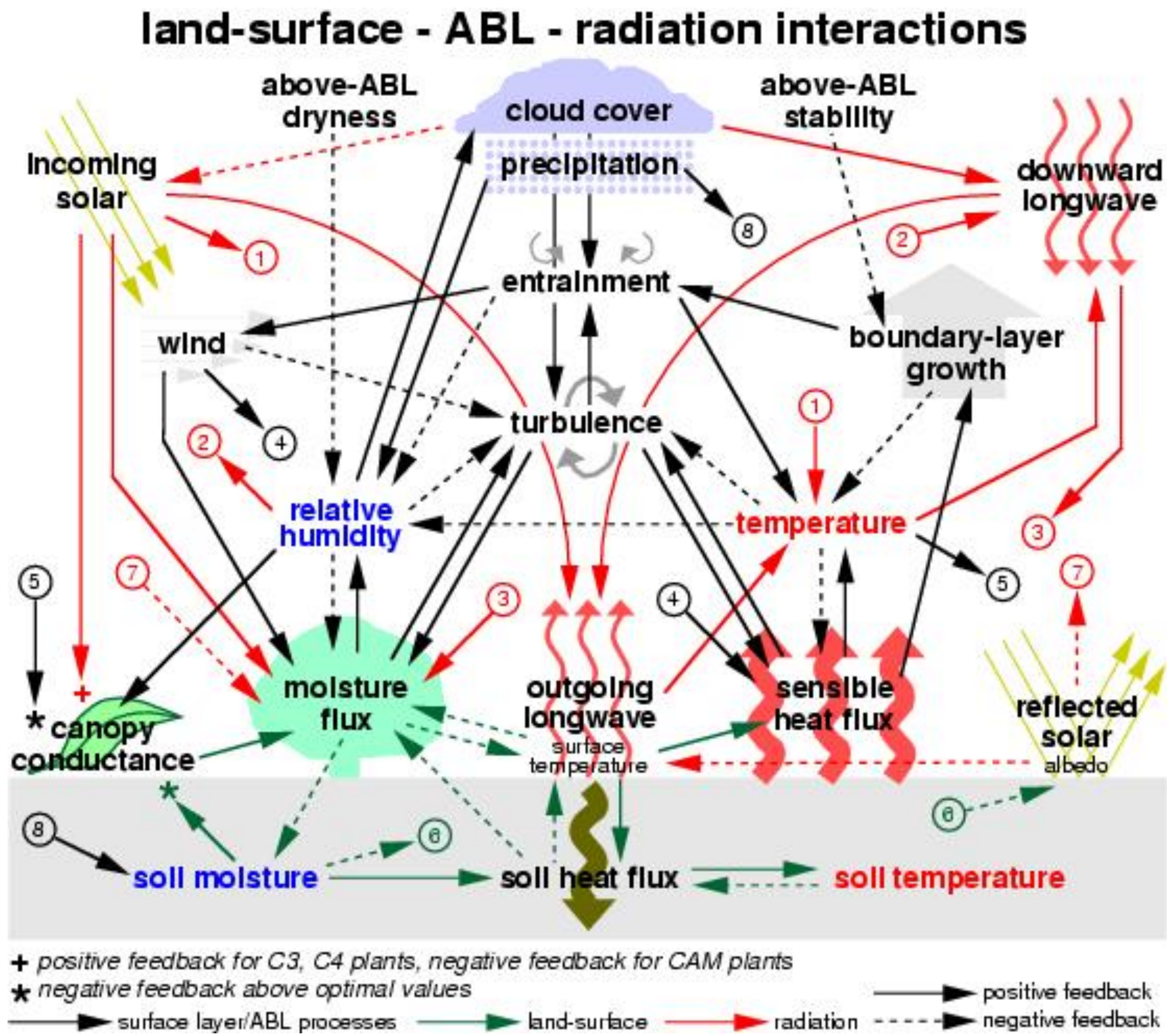
Feb 2004 monthly downward longwave

-generally a low bias

-low-level clouds can have a significant effect on night time surface cooling



PHYSICS "WHEEL OF PAIN"



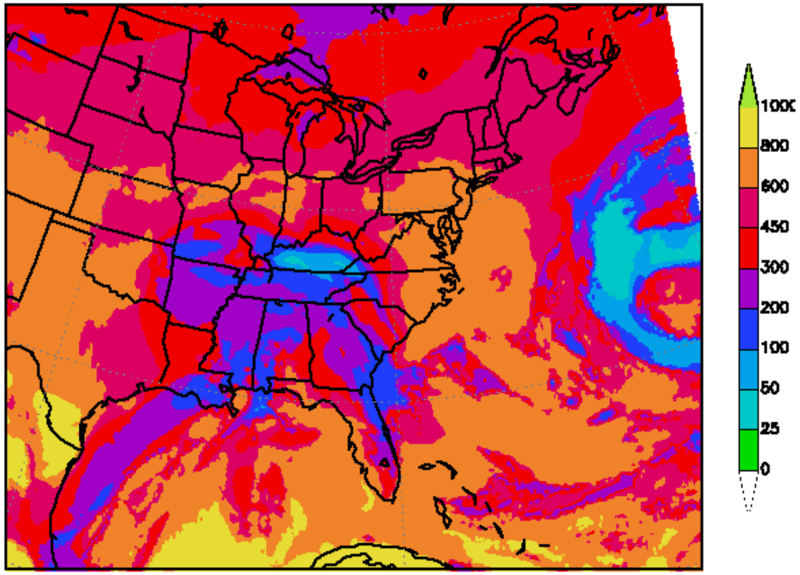
Spring Upgrade Package: Prediction Model (Eta)

- Modified radiation scheme to “see” thicker clouds by removing upper limit for cloud water mixing ratio when computing optical depths

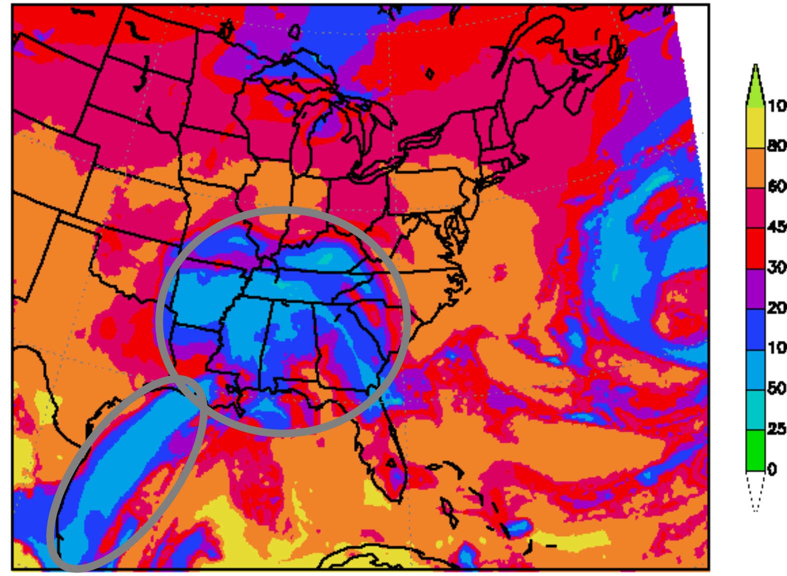
- Modified cloud cover fraction formulation to allow for more partial cloudiness (had been too binary)

Shortwave NAM vs. NAMX

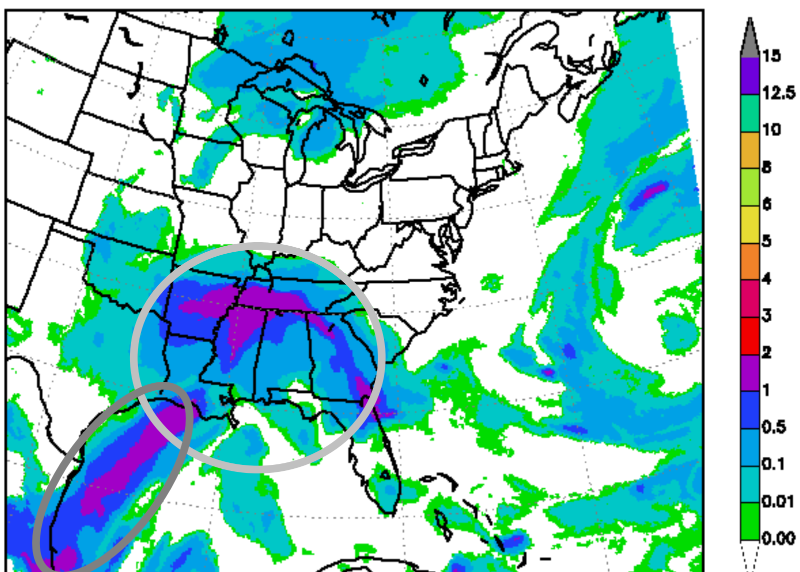
SFC DNWRD SW FLUX NAM 06H FCST VALID 18Z 02 FEB 2005



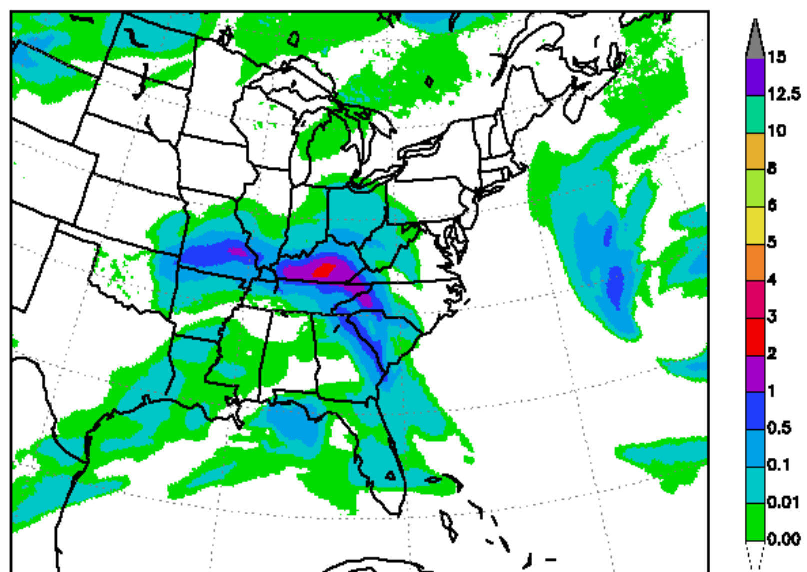
SFC DNWRD SW FLUX NAMX 06H FCST VALID 18Z 02 FEB 2005



TCOL CLDWTR+RAIN NAMX 06H FCST VALID 18Z 02 FEB 2005



TCOL CLDICE+SNOW NAMX 06H FCST VALID 18Z 02 FEB 2005

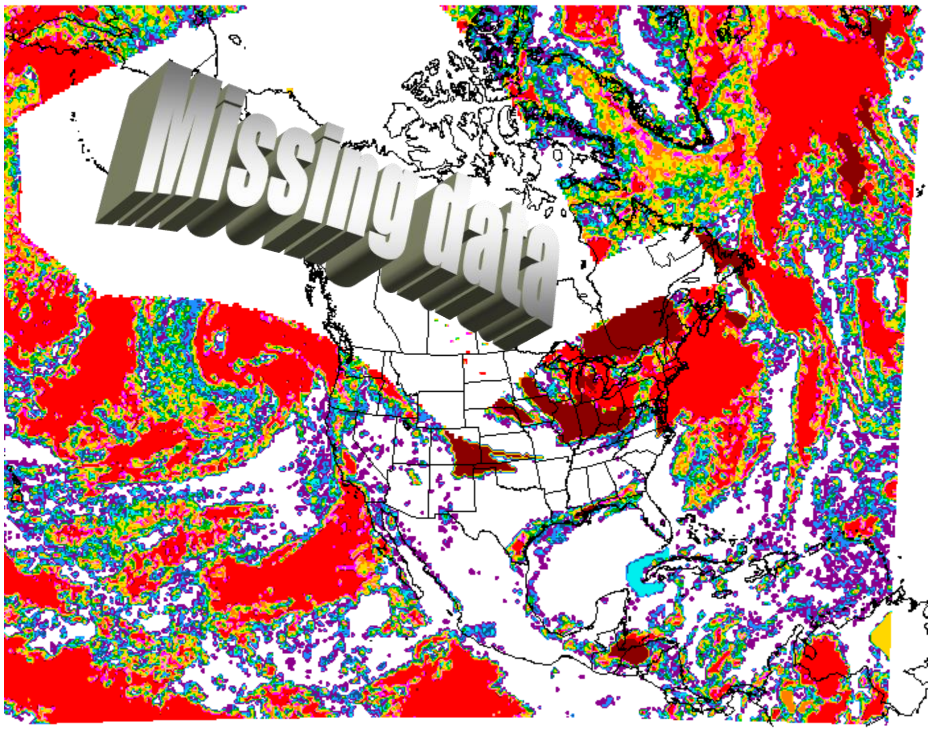


AFWA, CLAVRX total cloudiness (%)

(12Z 13 December 2004)

0 1 10 20 30 40 50 60 70 80 90 95 99 100 101

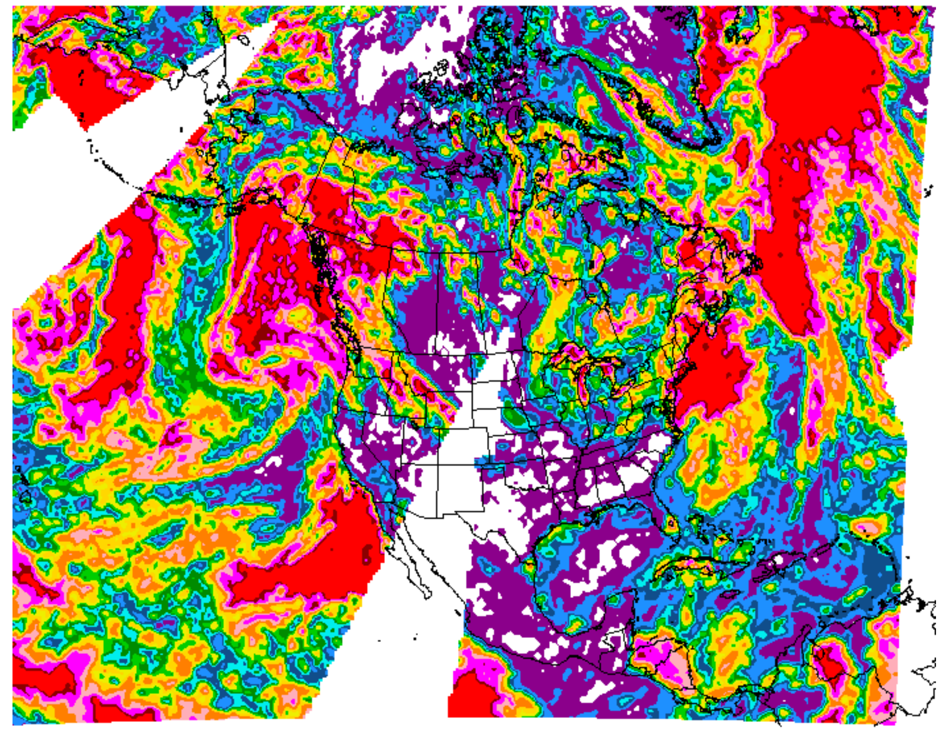
AFWA



041213/1200V000 AFWA CLOUD COVER

0 1 10 20 30 40 50 60 70 80 90 95 99 100 101

CLAVRx

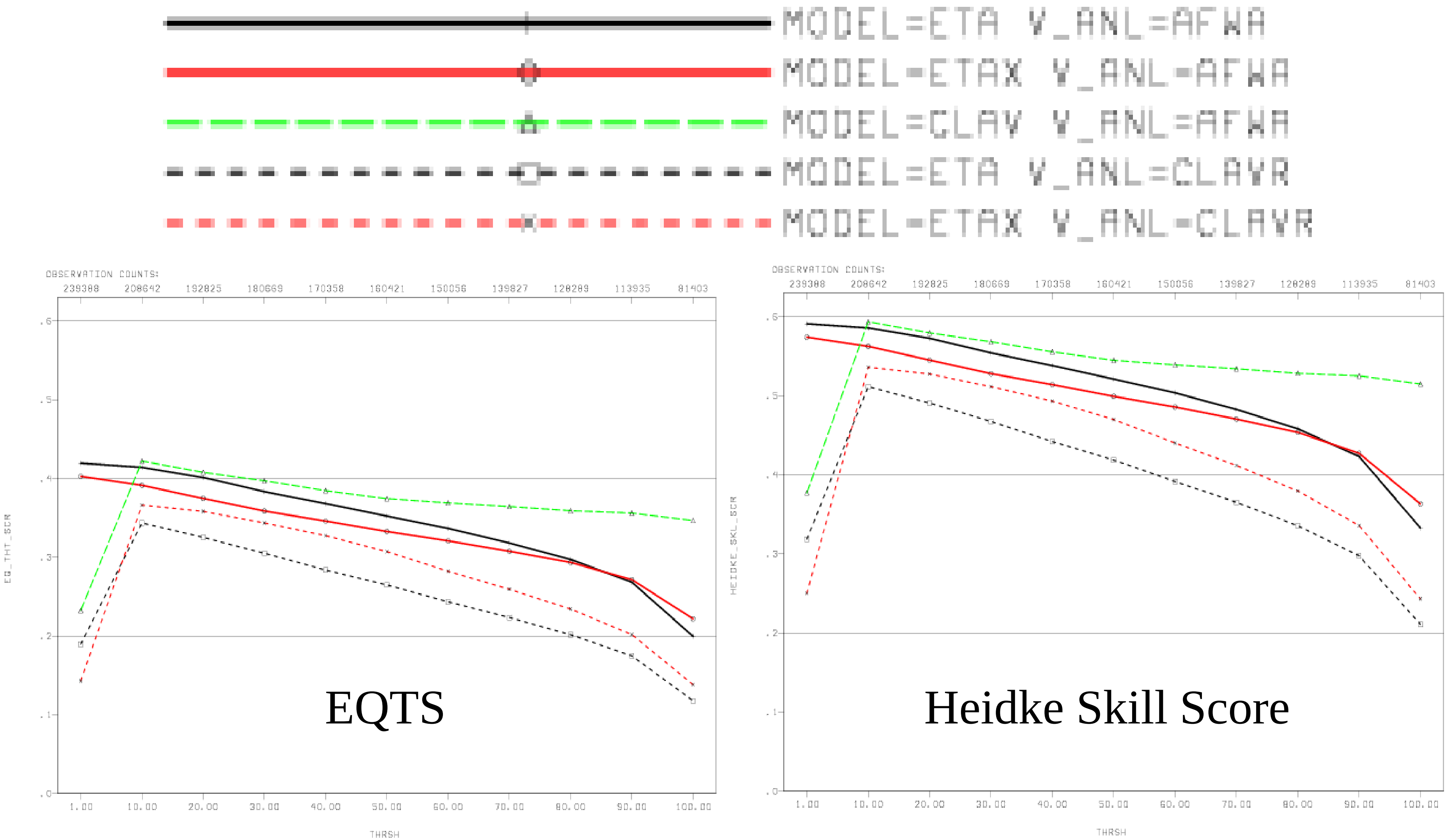


041213/1200V000 CLAVR CLOUD COVER

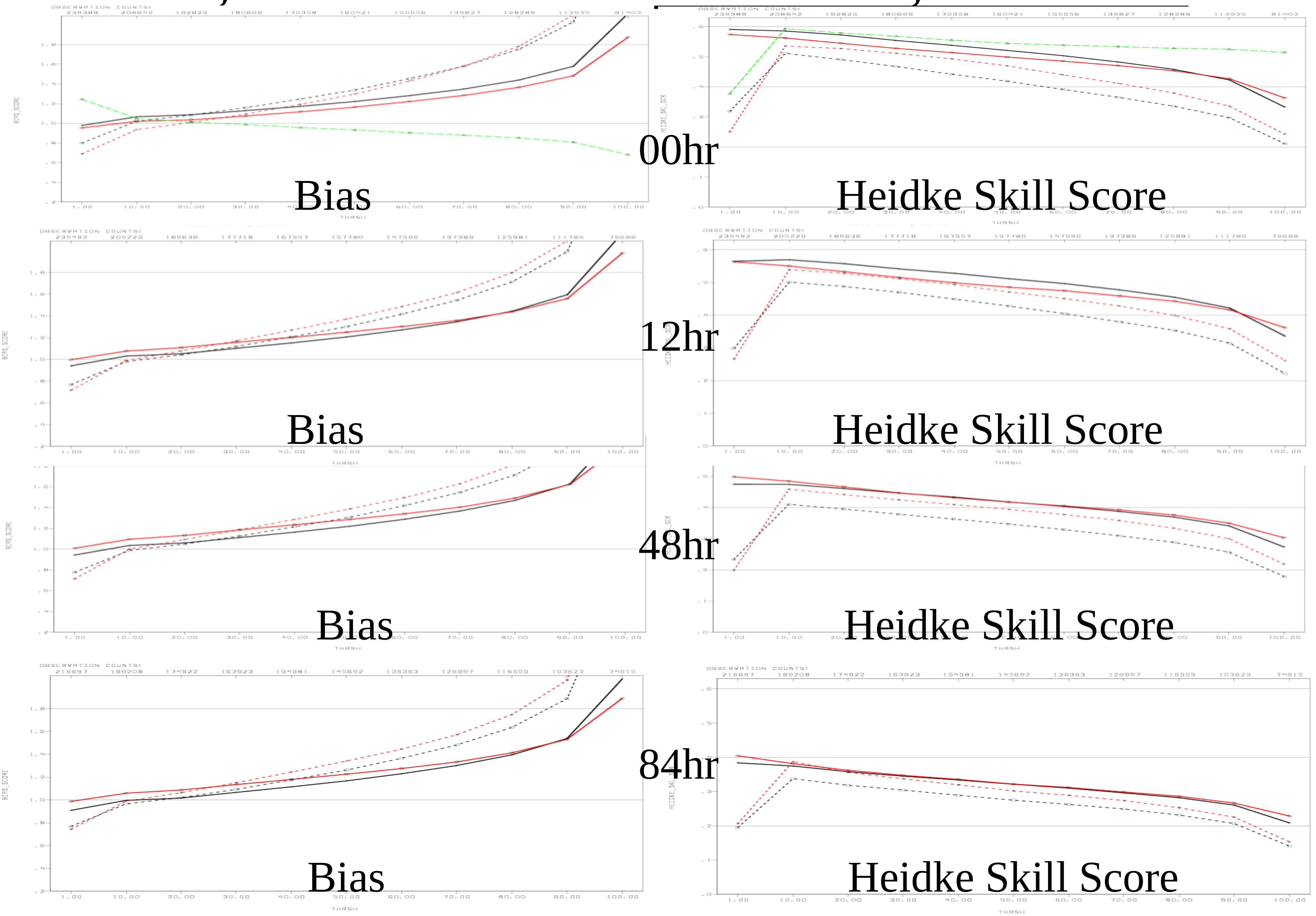
Many thanks to Mary Hart – First cloud verifications

Eta, EtaX scores from AFWA, CLAVRx

00&12Z Cloud Fraction (%) analyses from 20041212 – 20050110 verified from 32-km Grid 221 over CONUS



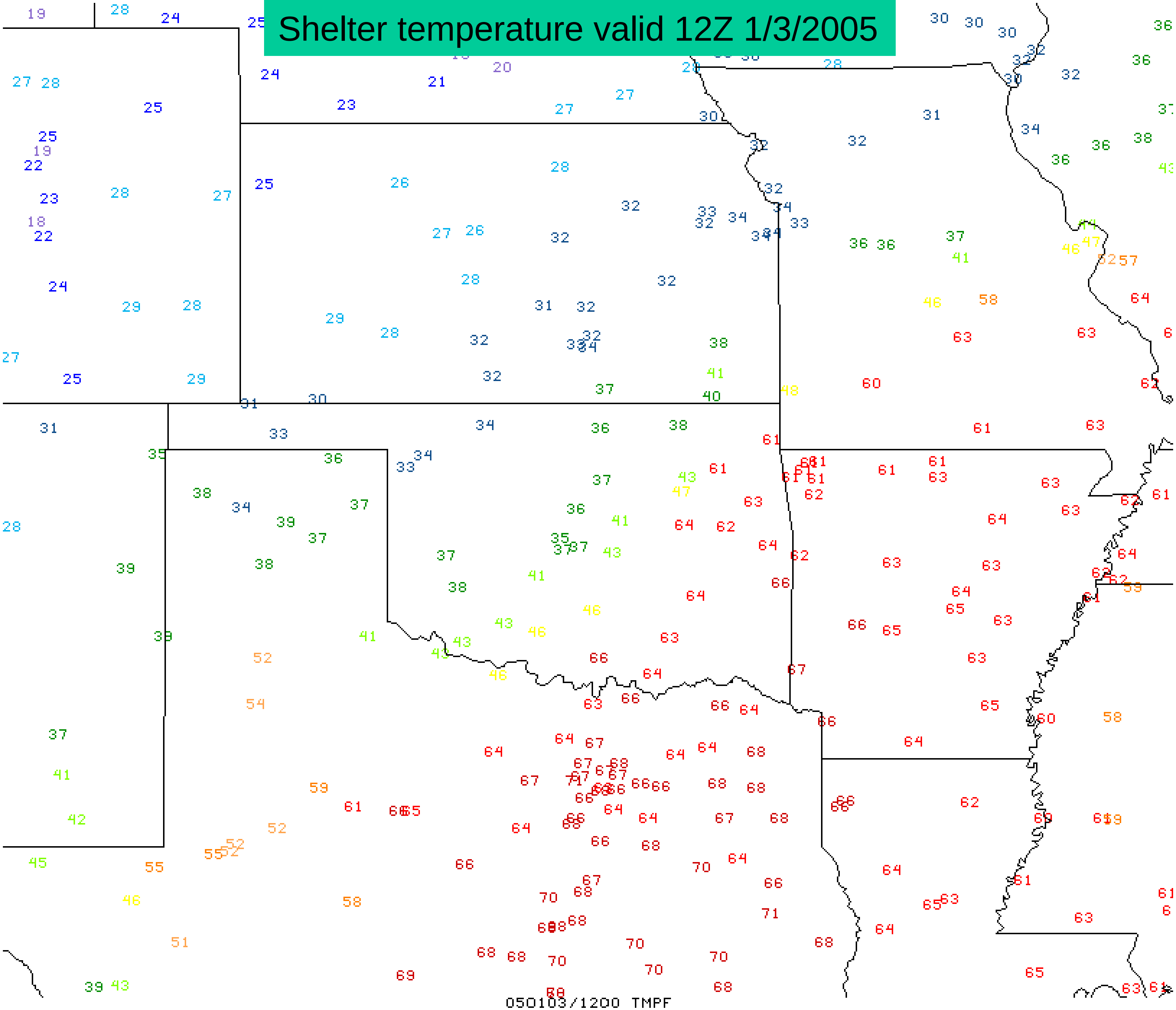
Eta, EtaX scores from AFWA, CLAVRx

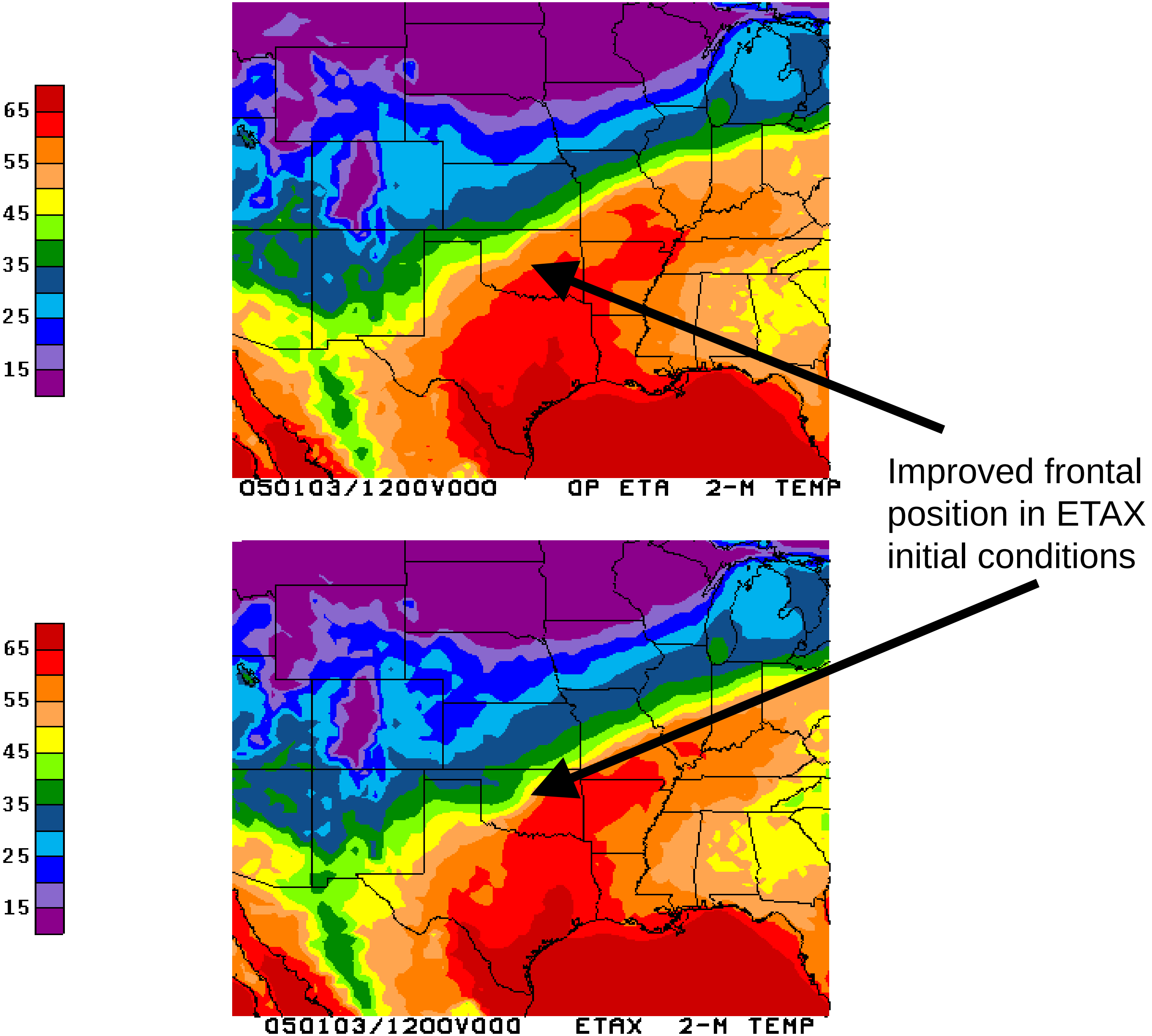


January Frontal Case

Rogers & Manikin

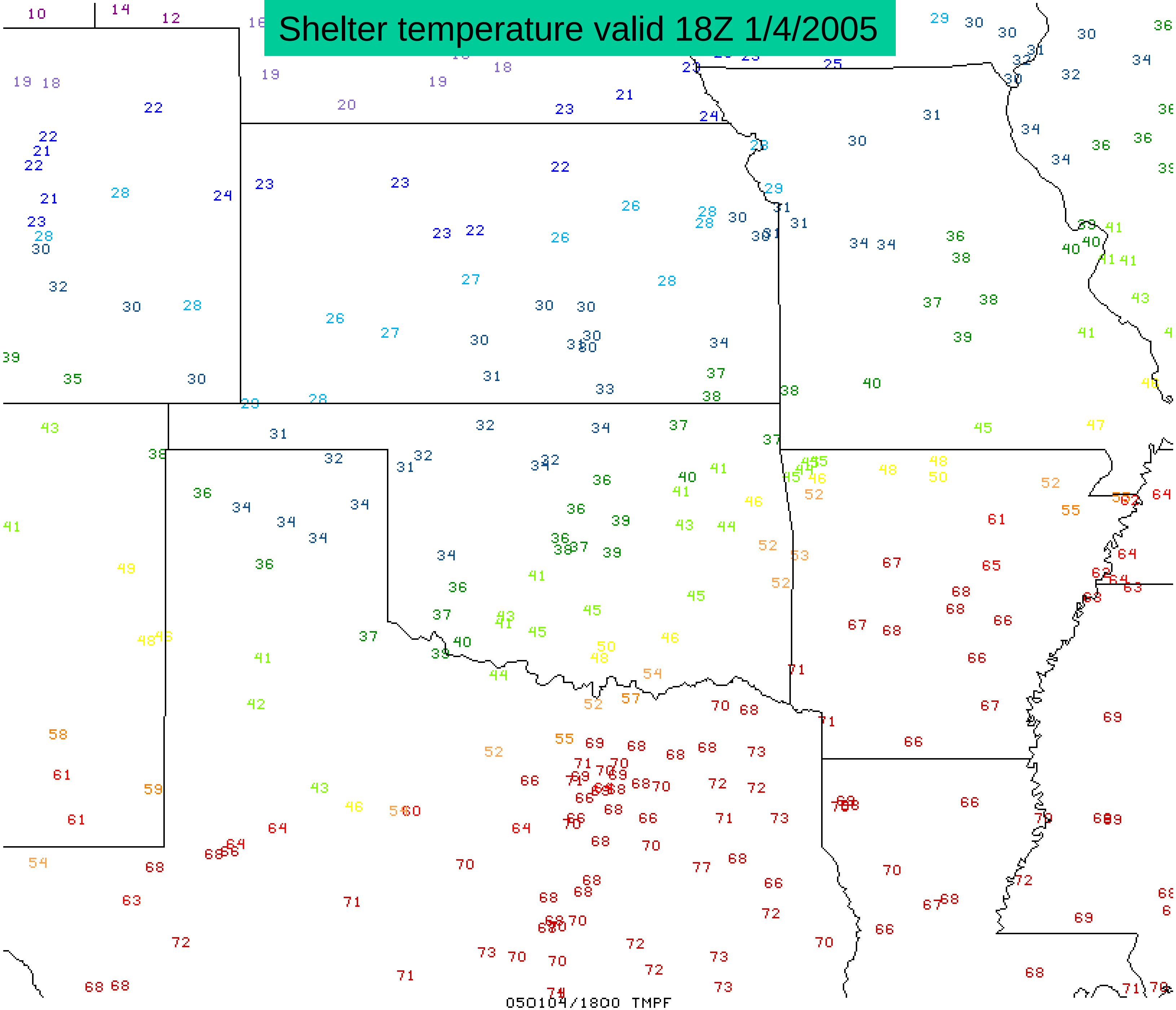
Shelter temperature valid 12Z 1/3/2005



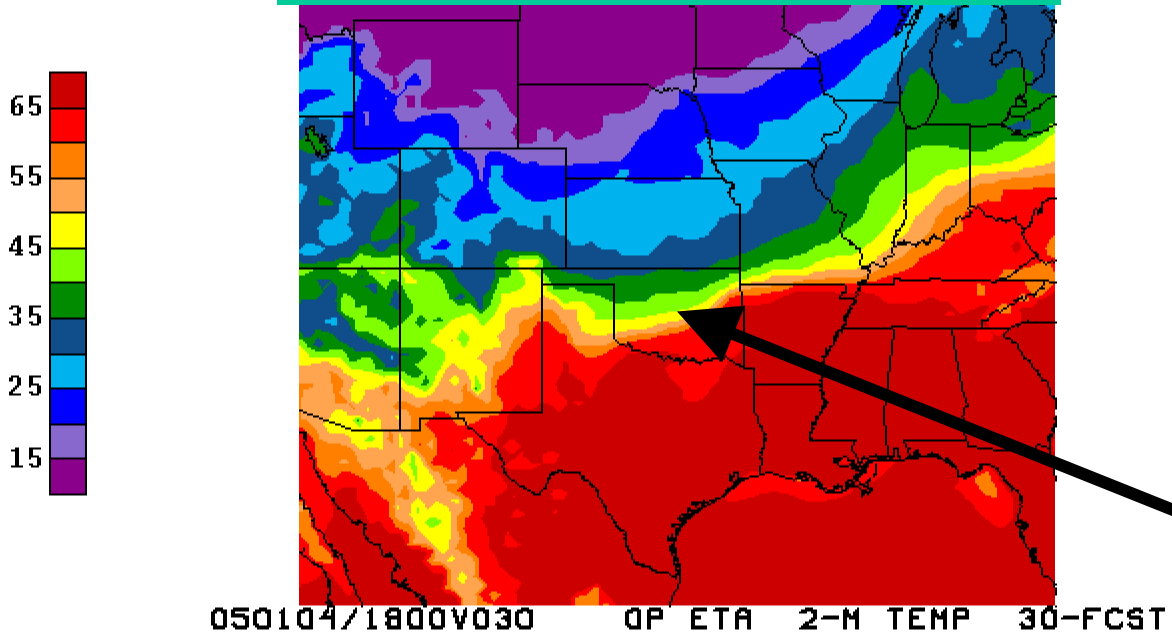


65
55
45
35
25
15
050103/1200V000 OP ETA 2-M TEMP
Improved frontal position in ETAX initial conditions
65
55
45
35
25
15
050103/1200V000 ETAX 2-M TEMP

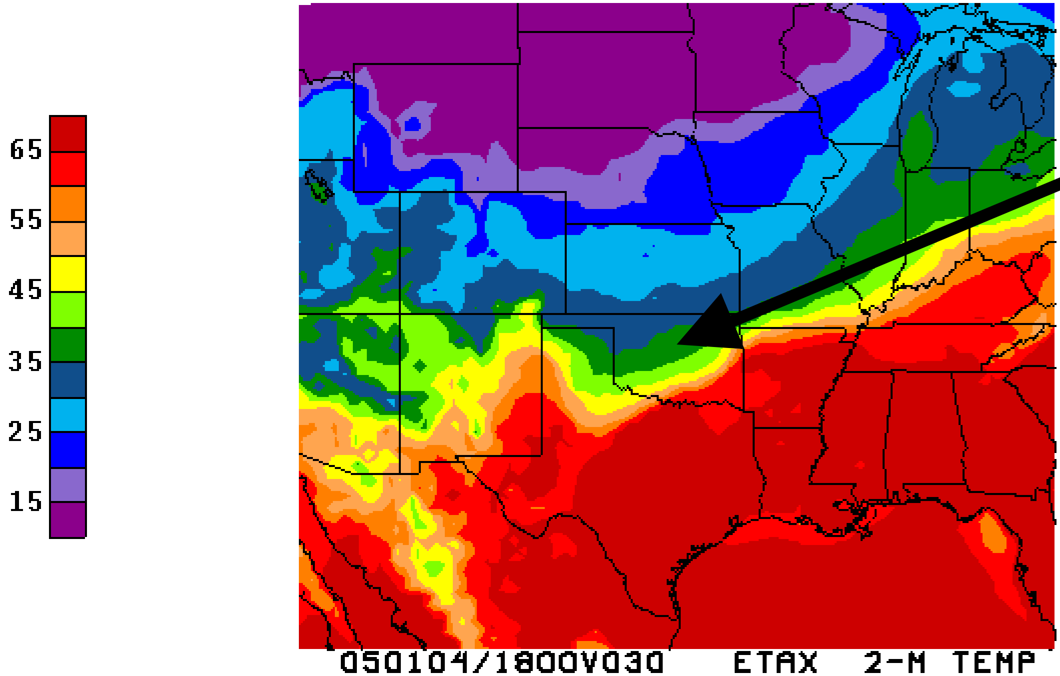
Shelter temperature valid 18Z 1/4/2005



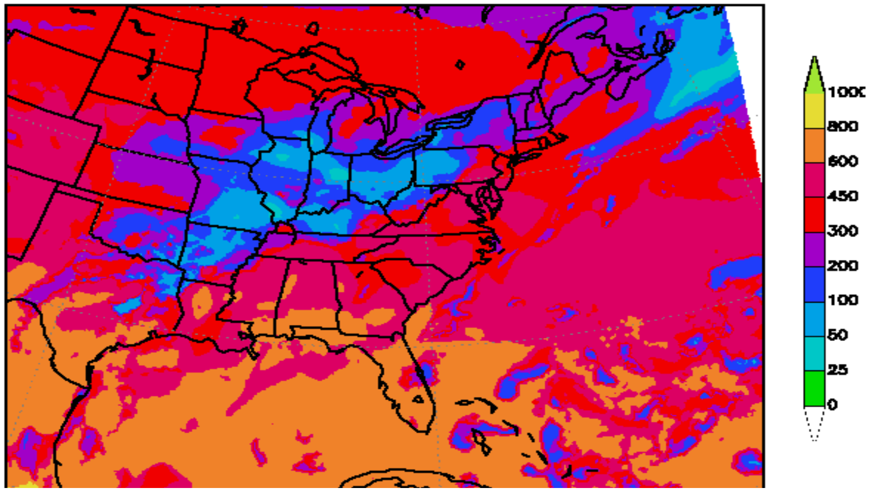
30-h Forecasts valid 18Z 1/4/2005



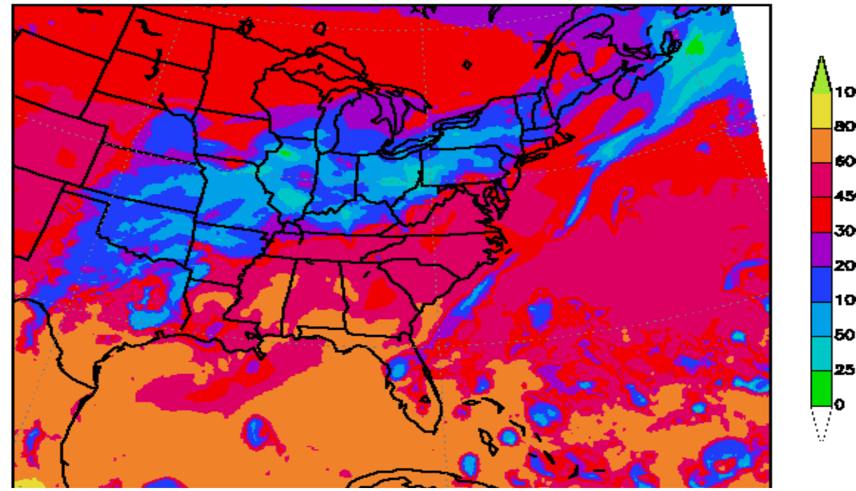
Improved frontal position in ETAX forecast



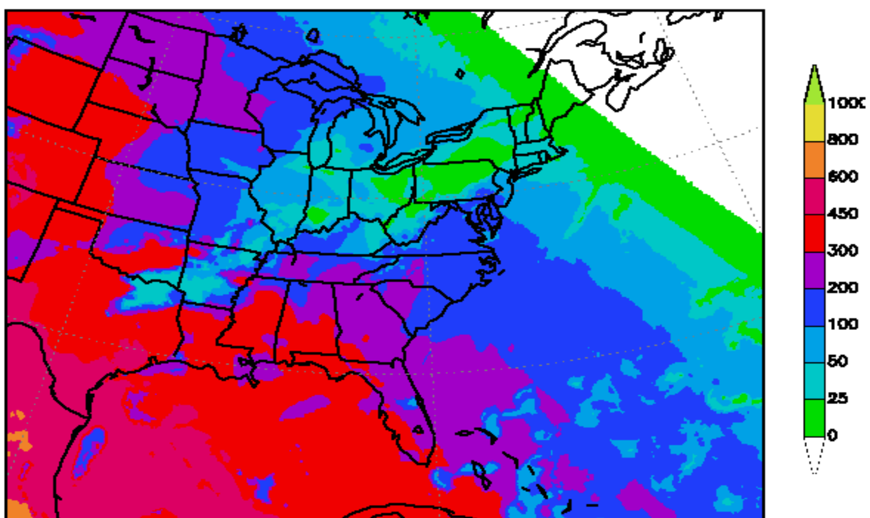
SFC DNWRD SW FLUX ETA 06H FCST VALID 18Z 03 JAN 2005



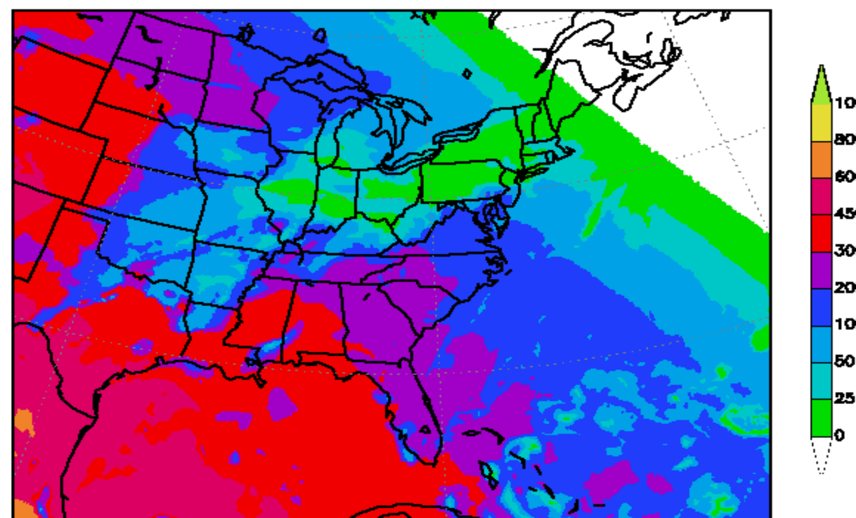
SFC DNWRD SW FLUX ETAX 06H FCST VALID 18Z 03 JAN 2005



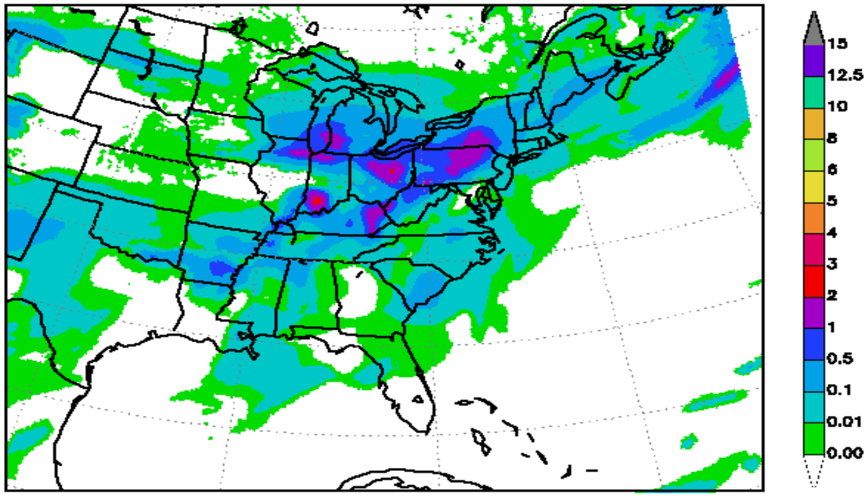
SFC DNWRD SW FLUX ETA 09H FCST VALID 21Z 03 JAN 2005



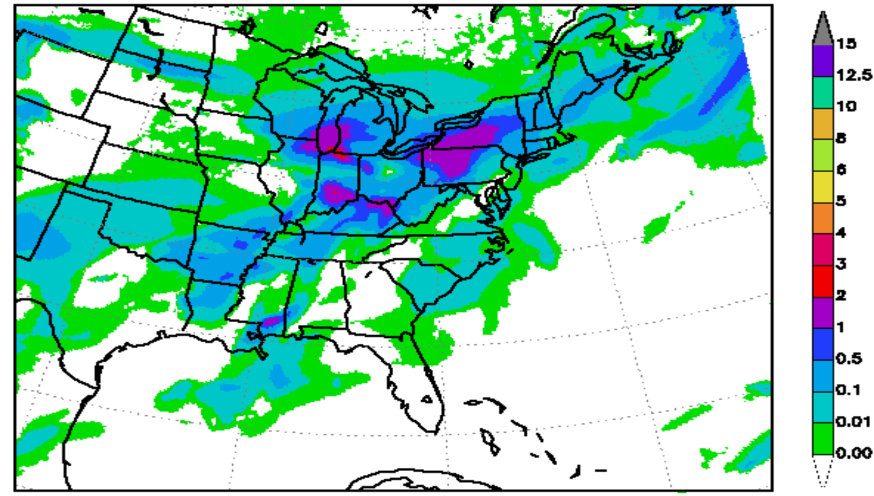
SFC DNWRD SW FLUX ETAX 09H FCST VALID 21Z 03 JAN 2005



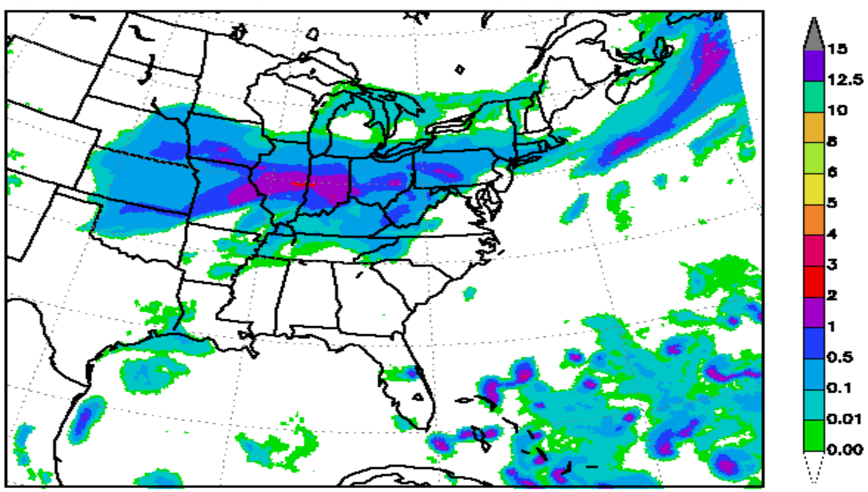
TCOL CLDICE+SNOW ETA 09H FCST VALID 21Z 03 JAN 2005



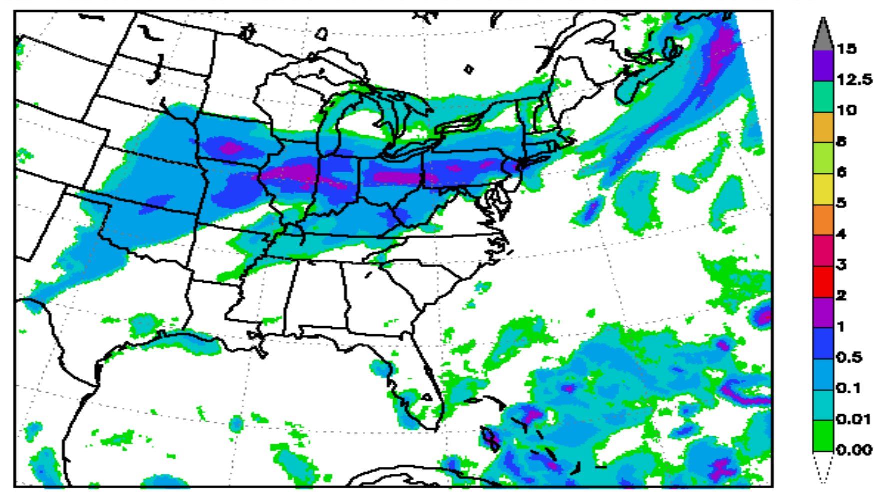
TCOL CLDICE+SNOW ETAX 09H FCST VALID 21Z 03 JAN 2005



TCOL CLDWTR+RAIN ETA 09H FCST VALID 21Z 03 JAN 2005



TCOL CLDWTR+RAIN ETAX 09H FCST VALID 21Z 03 JAN 2005



Real-Time Parallel Stats Pages

http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll/pll12stats.etx_14dec04-20mar05/

1. PRECIPITATION THREAT AND BIAS SCORES

CONUS, 24-84 hour forecasts	Eastern US, 24-84 hour forecasts	Western US, 24-84 hour forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel

CONUS, 24-h forecasts	CONUS, 36-h forecasts	CONUS, 48-h forecasts	CONUS, 60-h forecasts	CONUS, 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel
Eastern U.S., 24-h forecasts	Eastern U.S., 36-h forecasts	Eastern U.S., 48-h forecasts	Eastern U.S., 60-h forecasts	Eastern U.S., 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel
Western U.S., 24-h forecasts	Western U.S., 36-h forecasts	Western U.S., 48-h forecasts	Western U.S., 60-h forecasts	Western U.S., 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel

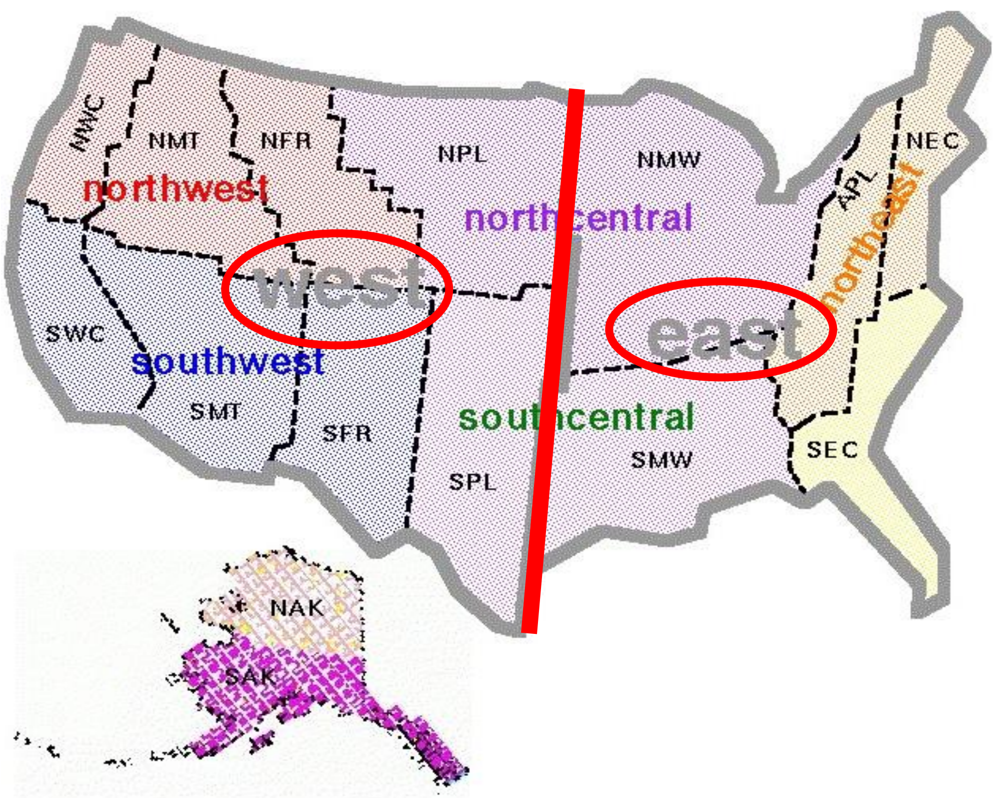
2. UPPER AIR RMS STATISTICS (12, 24, 48, 60, and 84-h forecasts)

CONUS vector wind	CONUS temperature	CONUS relative humidity	CONUS height
RMS error	RMS error	RMS error	RMS error
	Bias	Bias	Bias

Alaska vector wind	Alaska temperature	Alaska relative humidity	Alaska height
RMS error	RMS error	RMS error	RMS error
	Bias	Bias	Bias

3. NEAR-SURFACE STATISTICS

Verification Regions:



2-M Temperature 00Z CYCLE	2-M Temperature 12Z CYCLE	2-M Relative Humidity 00Z CYCLE	2-M Relative Humidity 12Z CYCLE	10-M Wind Speed (squared) 00Z CYCLE	10-M Wind Speed (squared) 12Z CYCLE
Eastern US	Eastern US	Eastern US	Eastern US	Eastern US	Eastern US
Western US	Western US	Western US	Western US	Western US	Western US
Alaska	Alaska	Alaska	Alaska	Alaska	Alaska

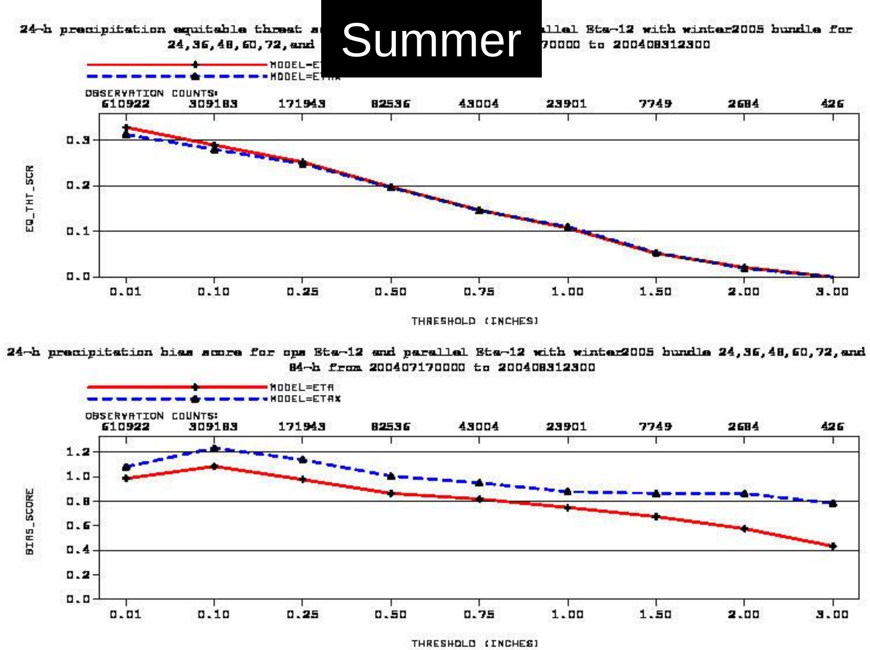
NAM vs NAMX Quantitative Verification Statistics

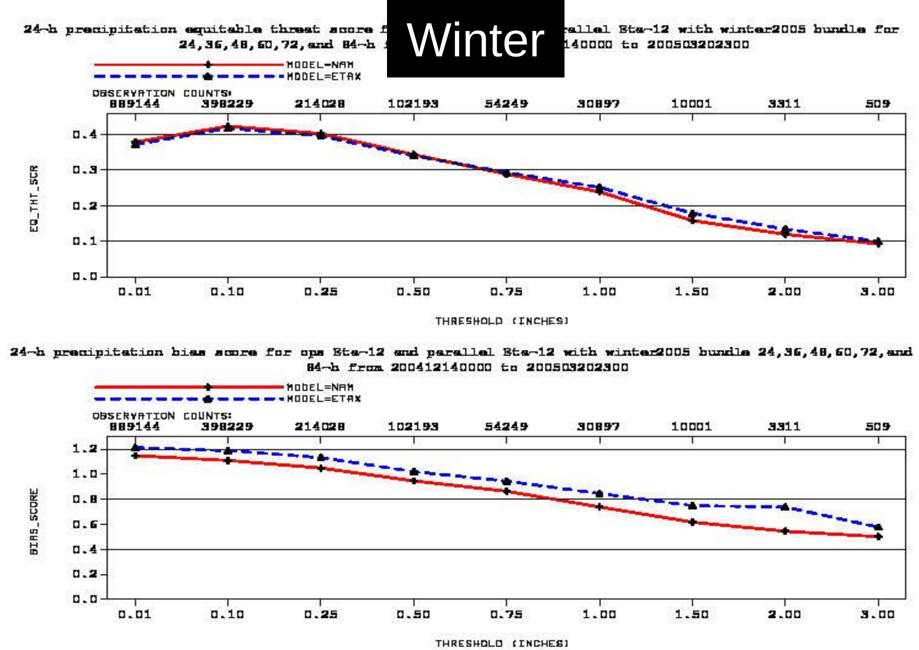
Summer : 17 July – 31 August 2004

(NDAS-only spin-up run started 15 June 2004)

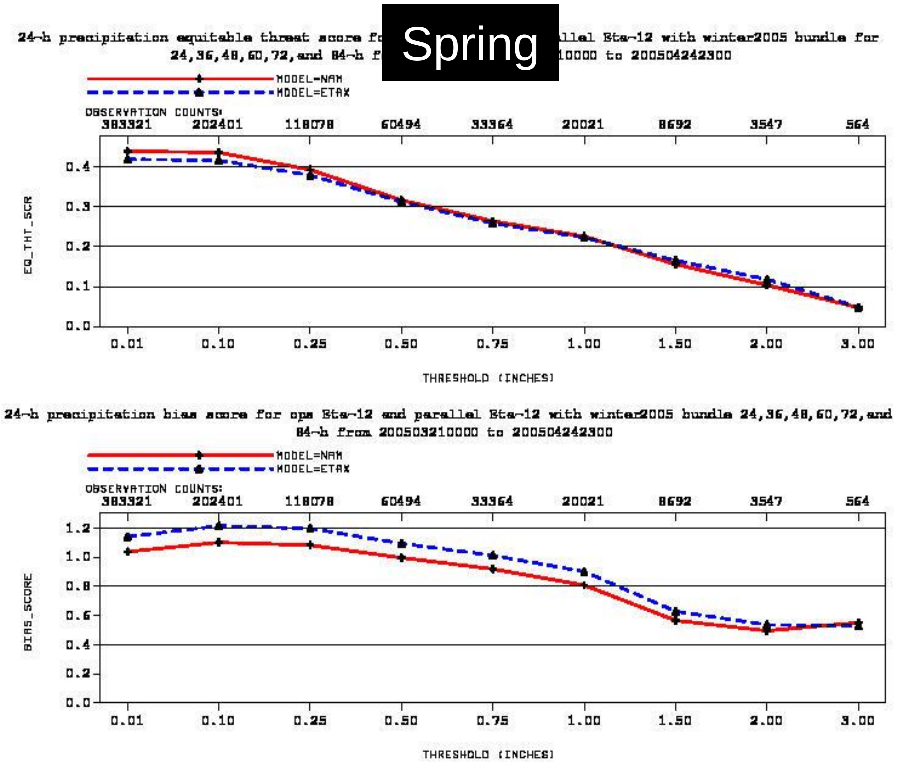
Winter : 14 December 2004 – 20 March 2005

Spring : 21 March -24 April 2005



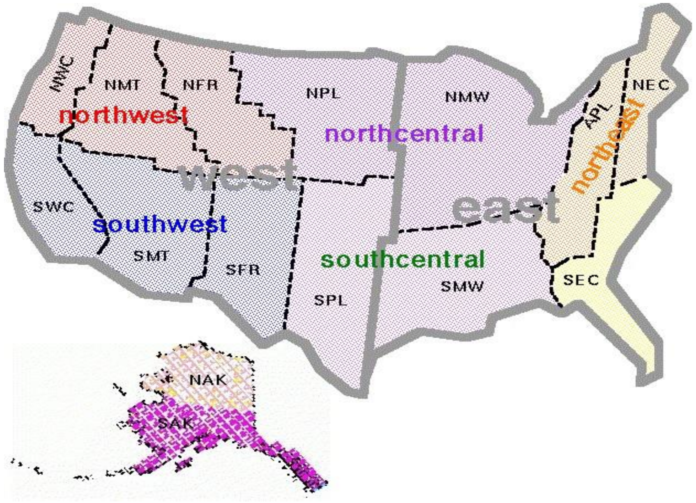


24-h QPF
Bias (bottom),
Equitable Threat (top)
NAM = Red solid
NAMX = Blue dashed



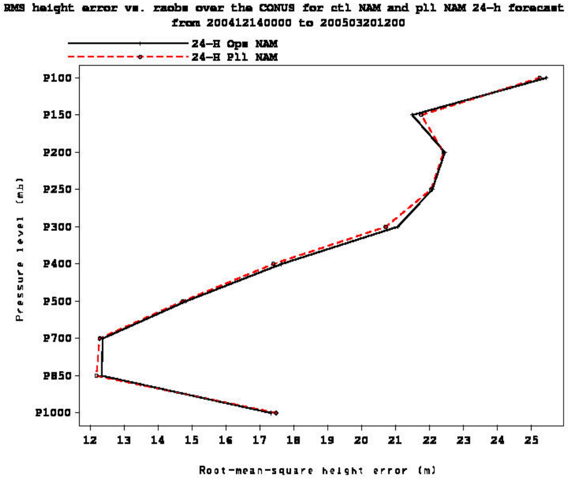
Winter : Forecast vs observations

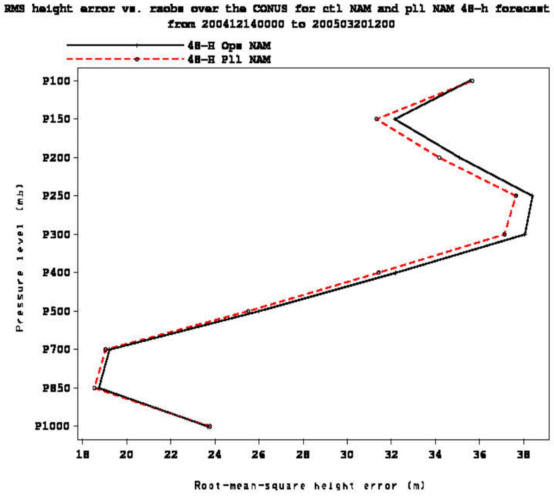
- Height and wind RMS vs raobs : CONUS and Alaska
- Temperature and RH bias vs raobs : CONUS and Alaska
- 2-m Temperature / RH vs surface obs : East CONUS, West CONUS, Alaska

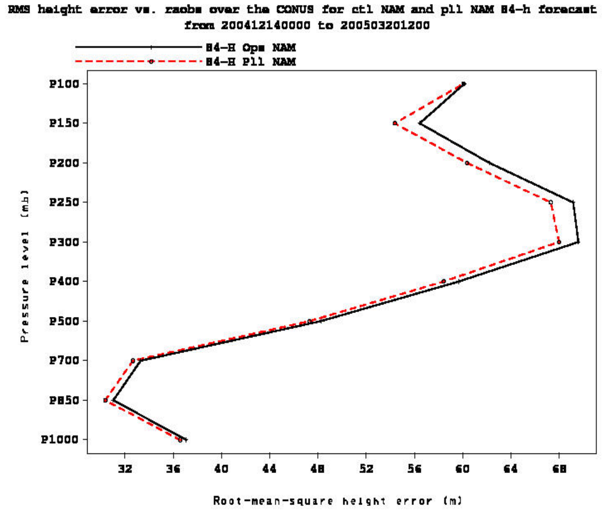


CONUS Winter : Height and Vector Wind RMS Error ; NAM = Solid black, NAMX = Dashed Red

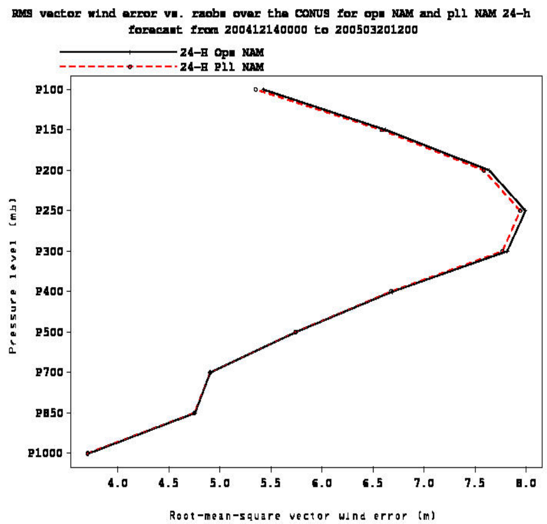
Z

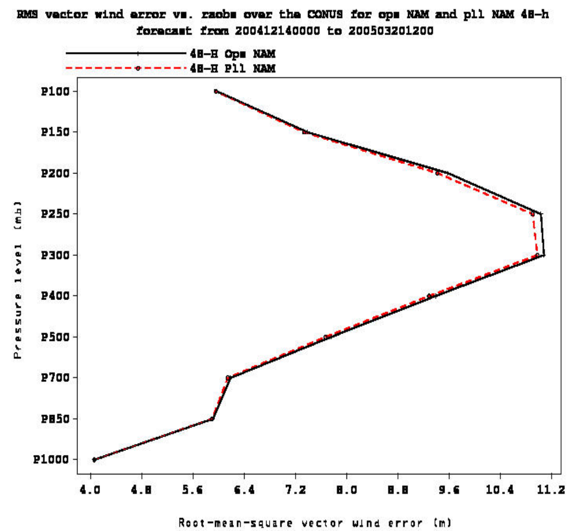


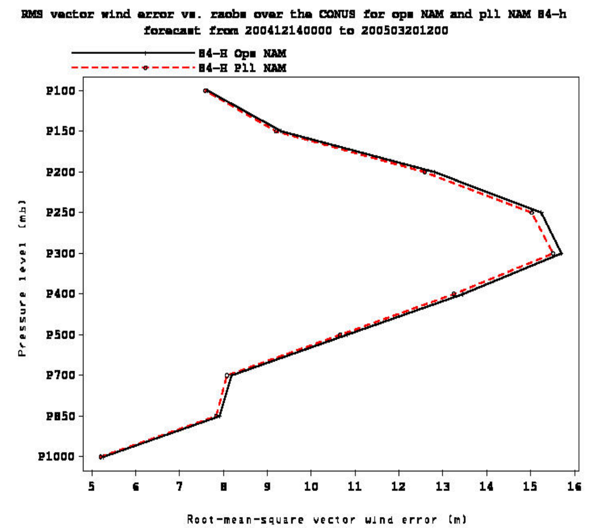




V



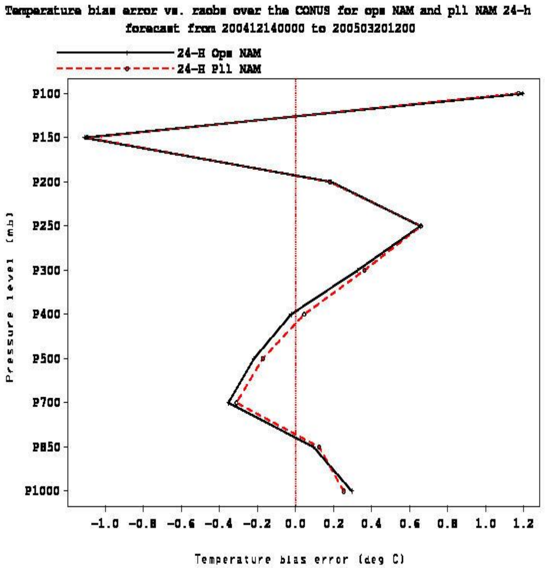


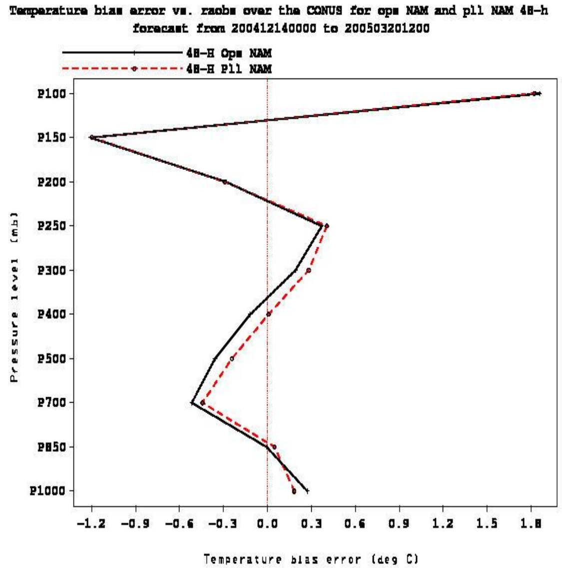


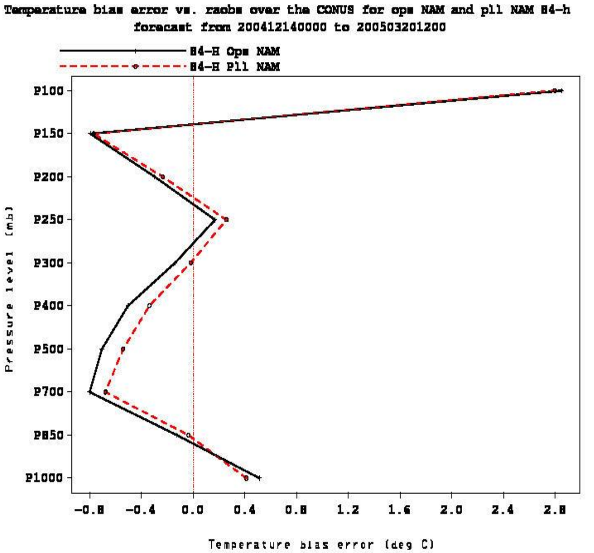
24-h 48-h 84-h

CONUS Winter : Temperature and RH Bias Error ; NAM = Solid black, NAMX = Dashed Red

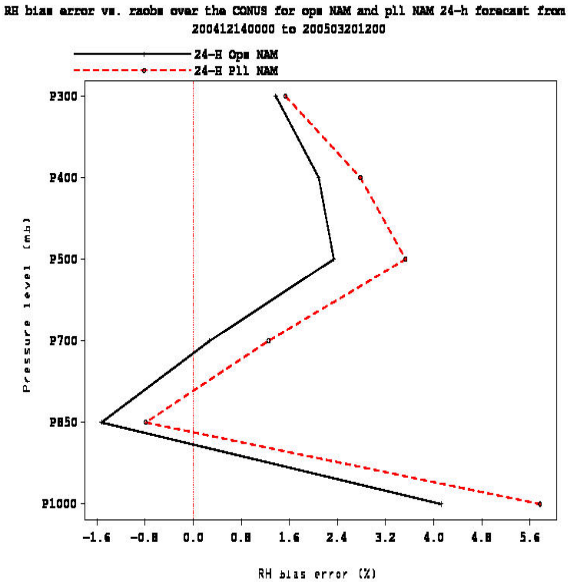
T

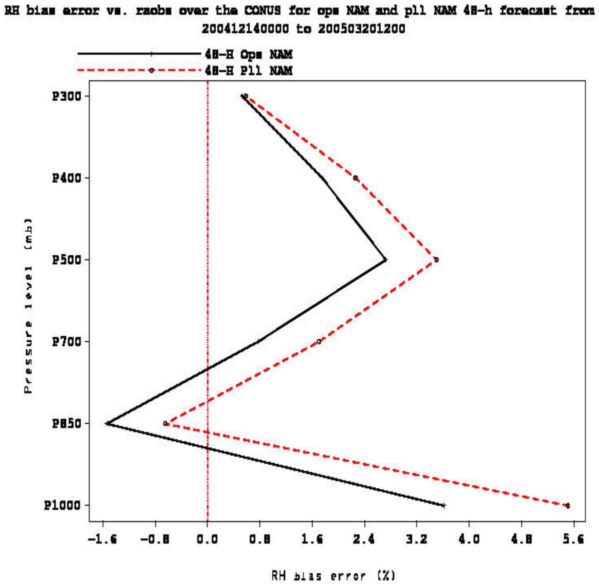


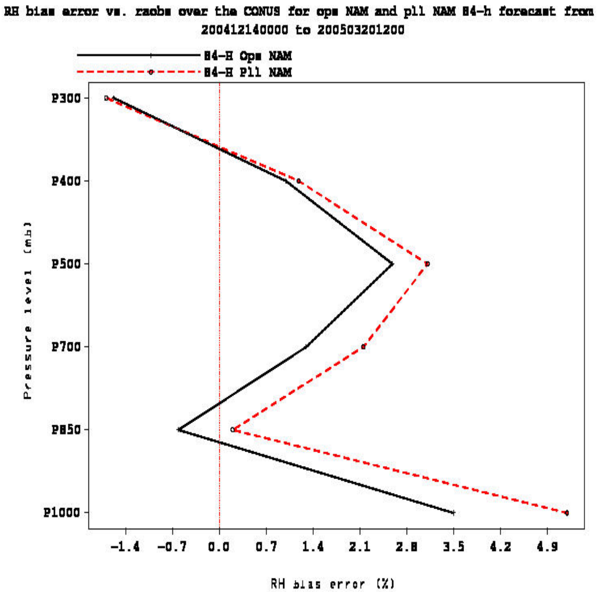




R
H



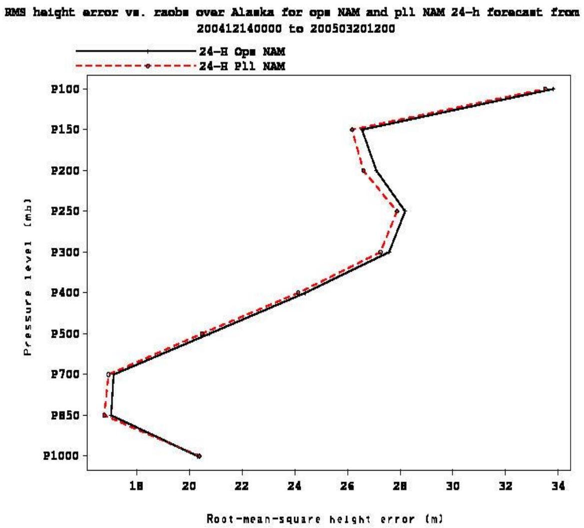


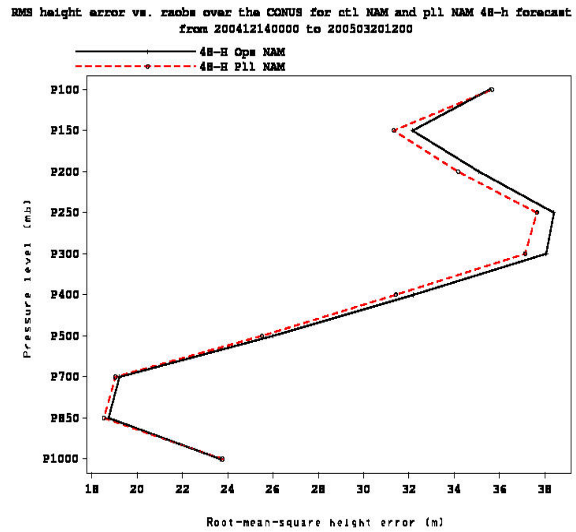


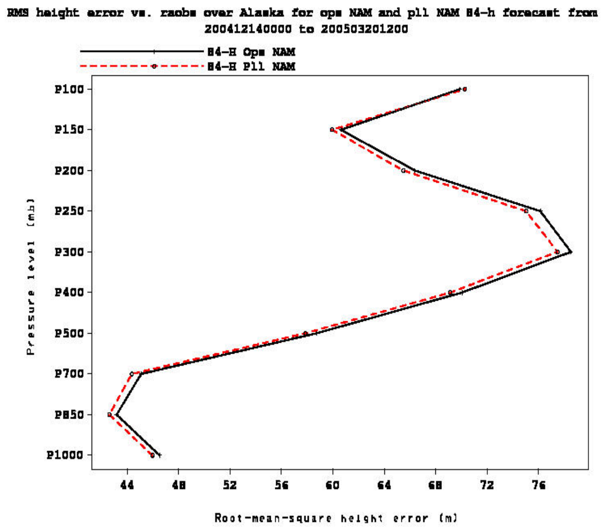
24-h 48-h 84-h

Alaska Winter: Height and Vector Wind RMS Error ;
NAM = Solid black, NAMX = Dashed Red

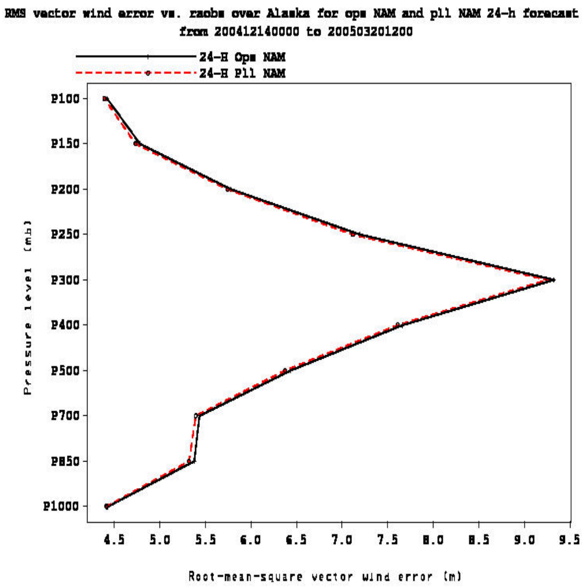
Z

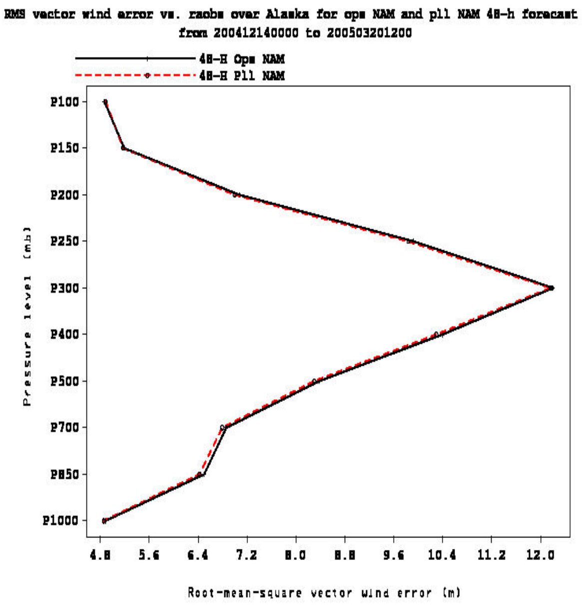


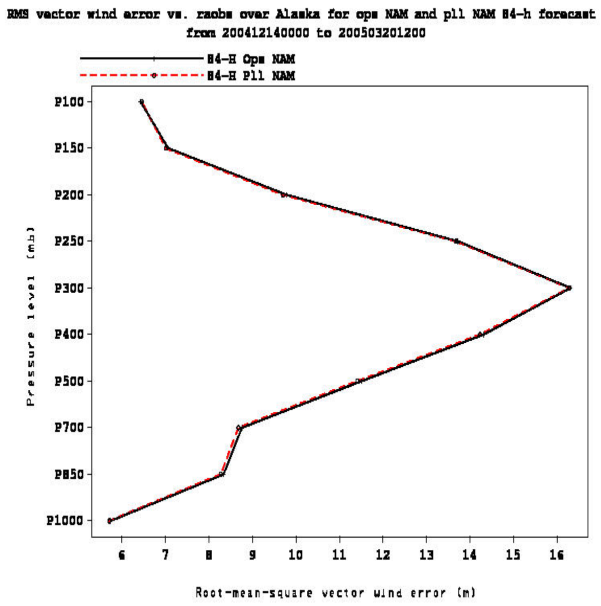




V



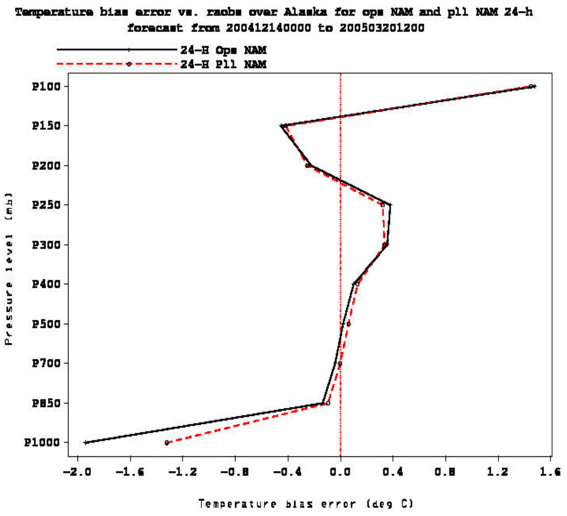


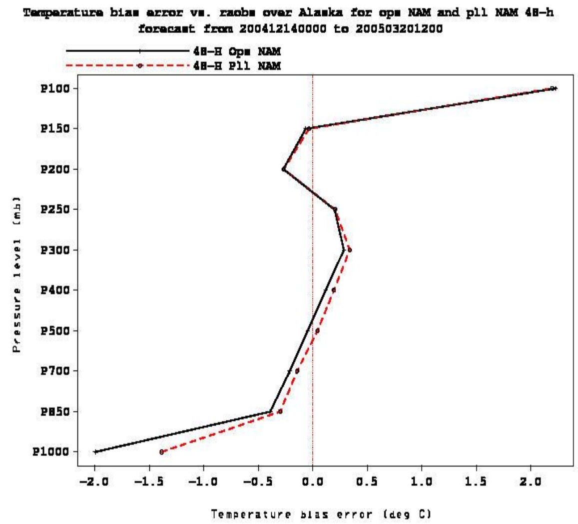


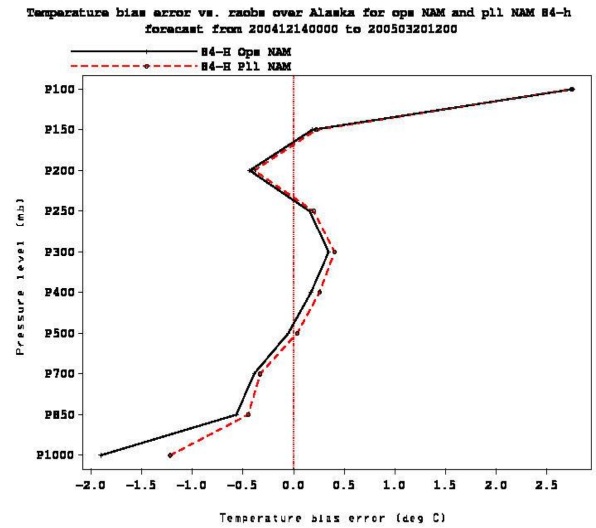
24-h 48-h 84-h

Alaska Winter: Temperature and RH Bias Error ;
NAM = Solid black, NAMX = Dashed Red

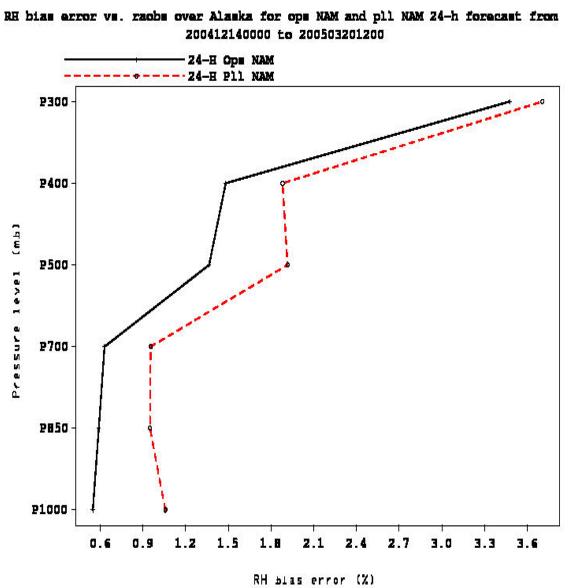
T

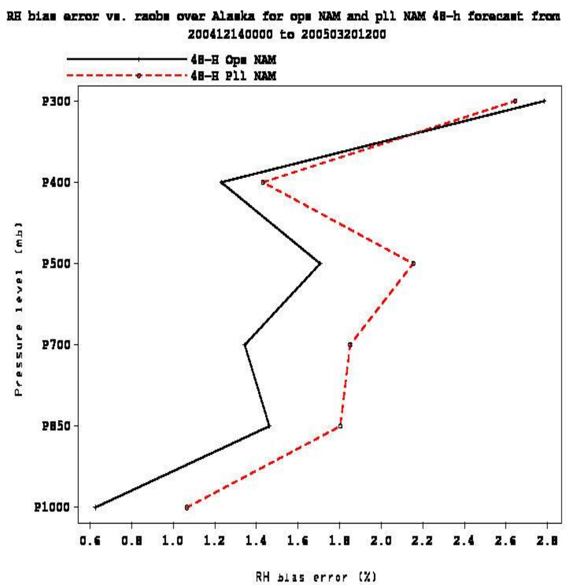


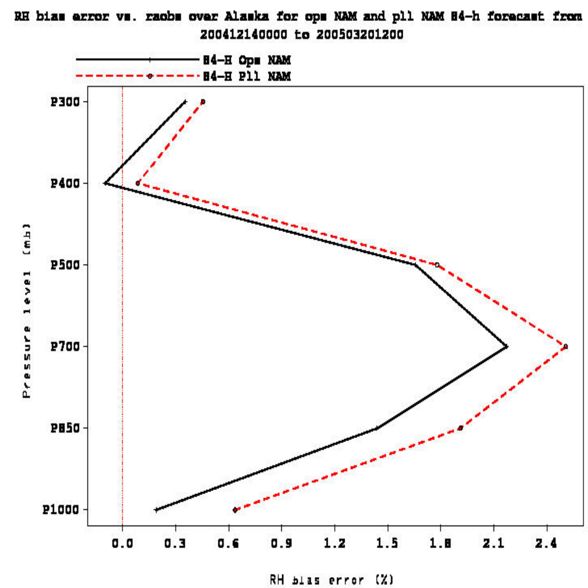




R
H







24-h

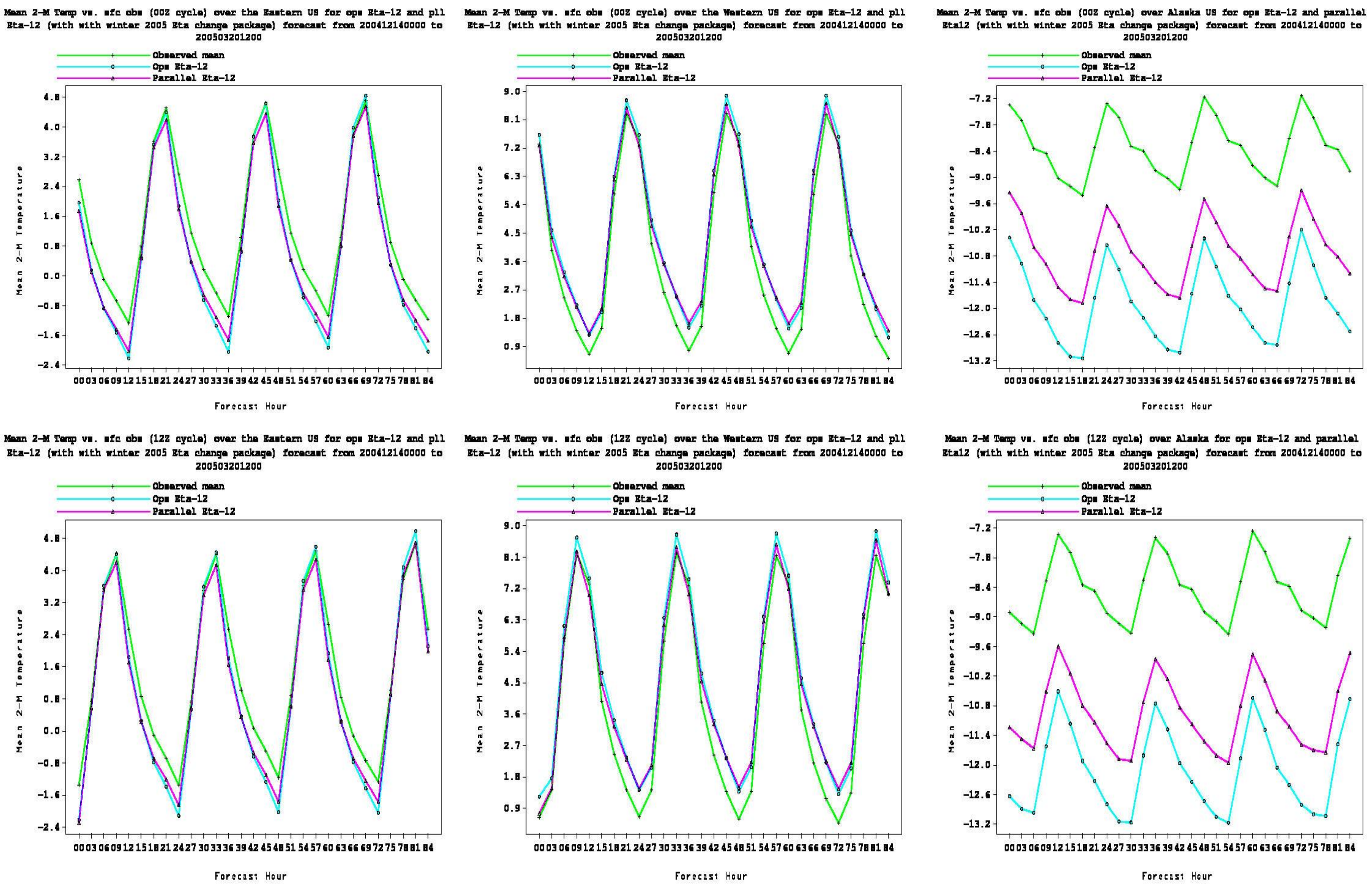
48-h

84-h

Winter Mean 2-m Temperature vs Obs ;
Obs=Green ; NAM = Cyan ; NAMX = Magenta

00Z

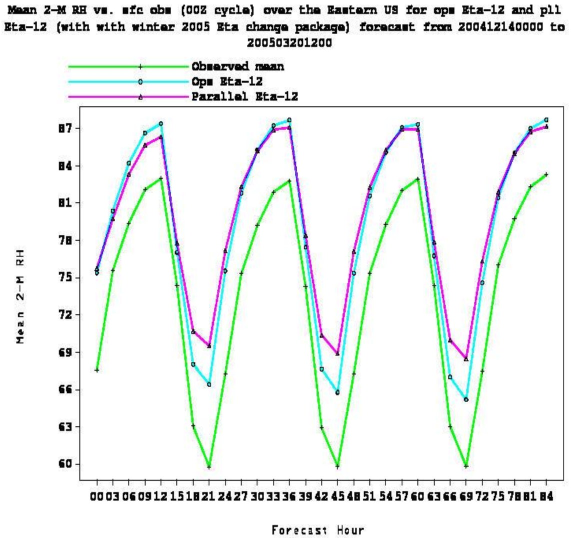
12Z

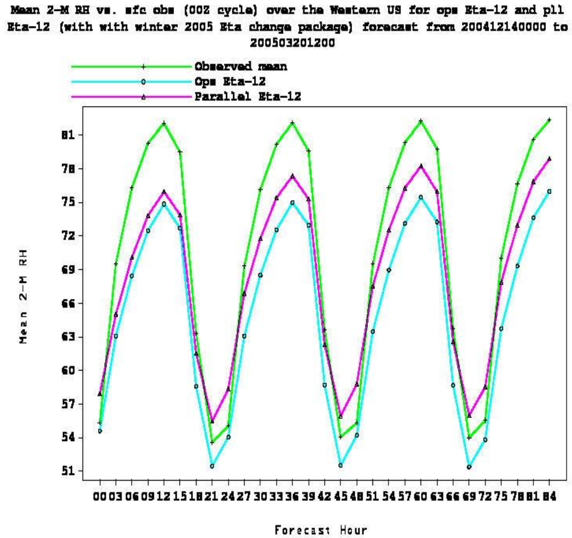


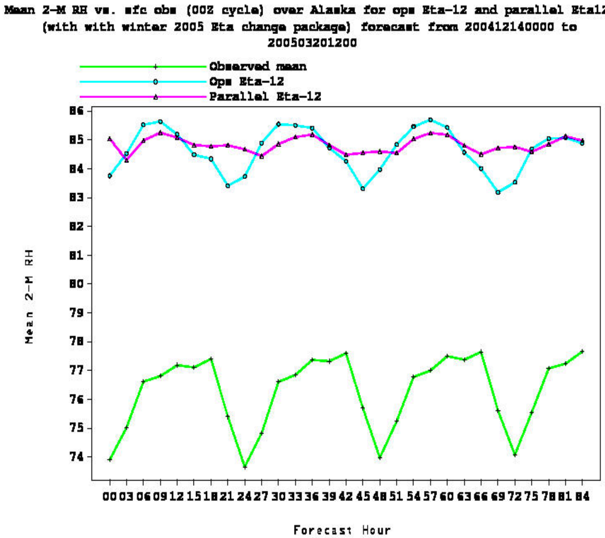
East CONUS West CONUS Alaska

Winter Mean 2-m RH vs Obs ; Obs=Green ;
NAM = Cyan ; NAMX = Magenta

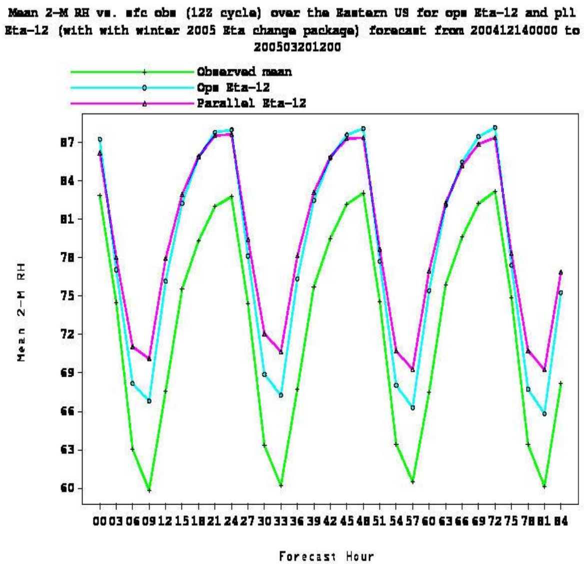
00Z

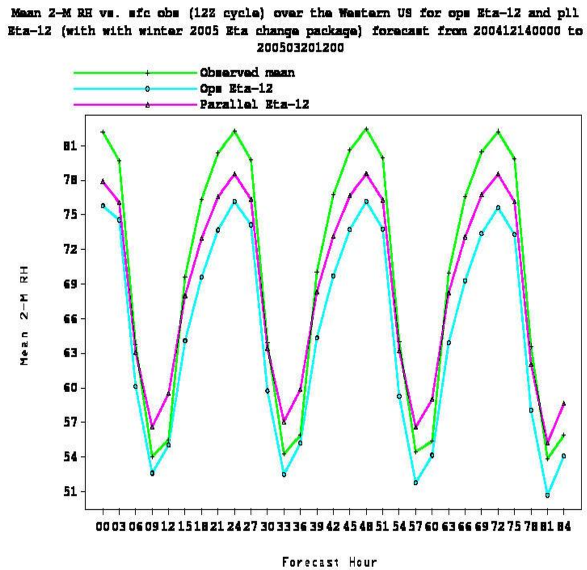


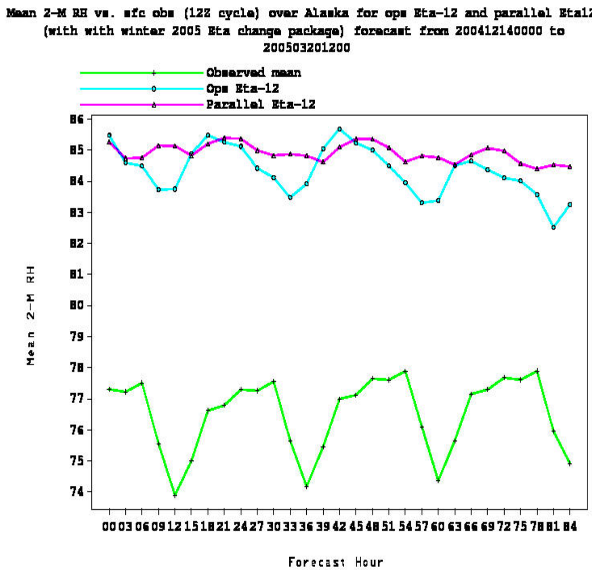




12Z



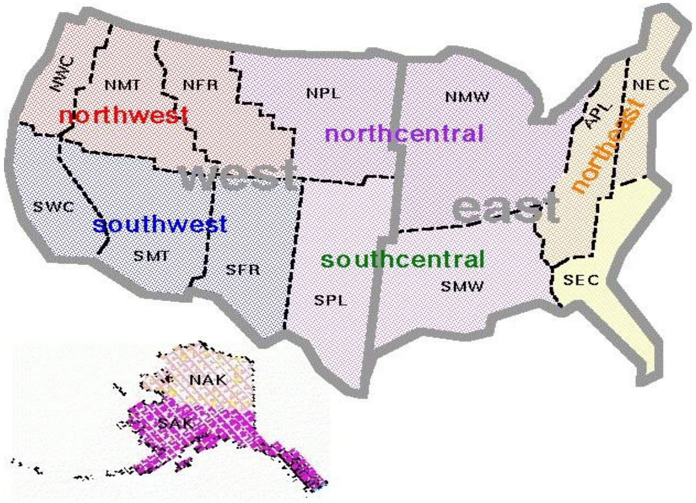




East CONUS | West CONUS | Alaska

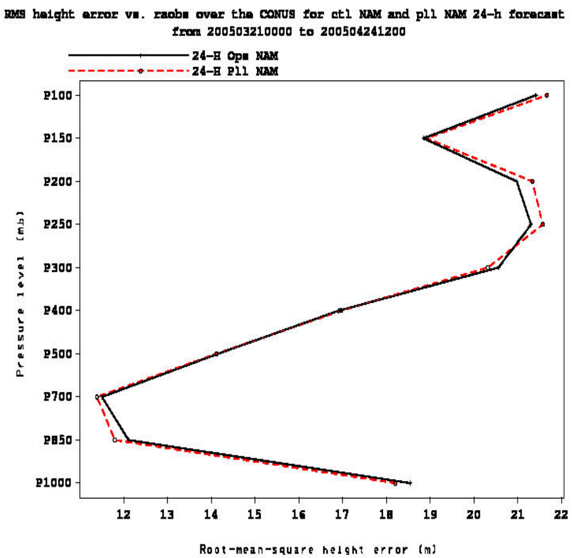
Spring : Forecast vs observations

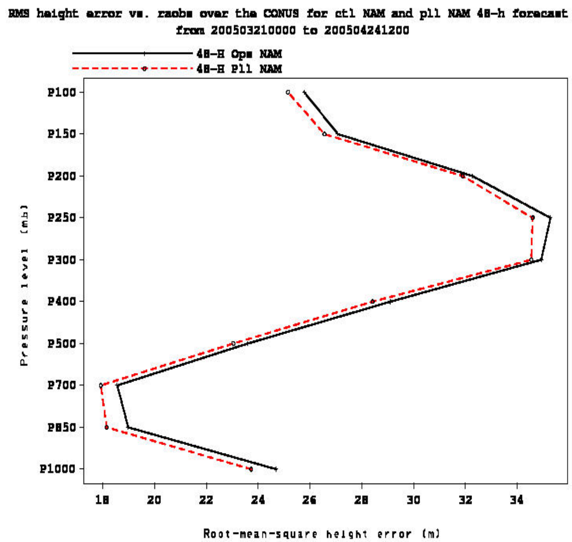
- Height and wind RMS vs raobs : CONUS and Alaska
- Temperature and RH bias vs raobs : CONUS and Alaska
- 2-m Temperature / RH vs surface obs : East CONUS, West CONUS, Alaska

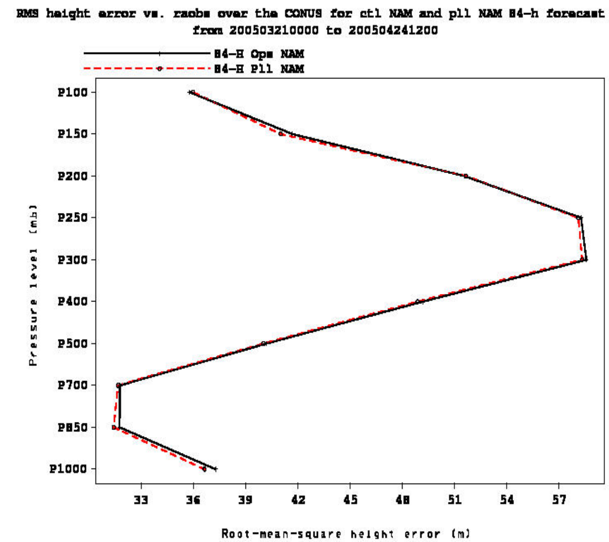


CONUS Spring : Height and Vector Wind RMS Error ;
NAM = Solid black, NAMX = Dashed Red

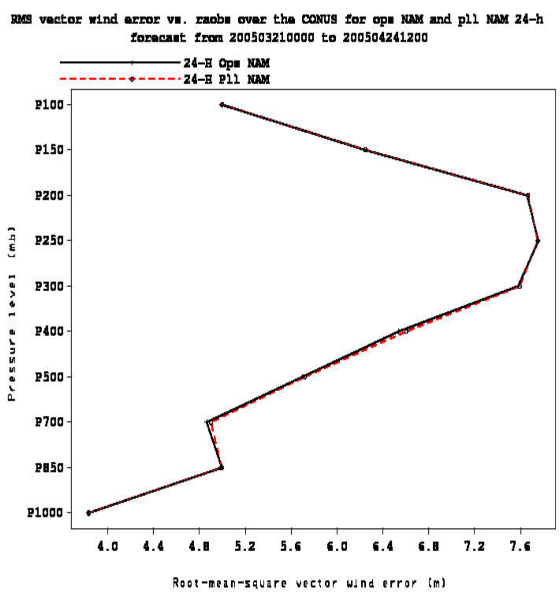
Z

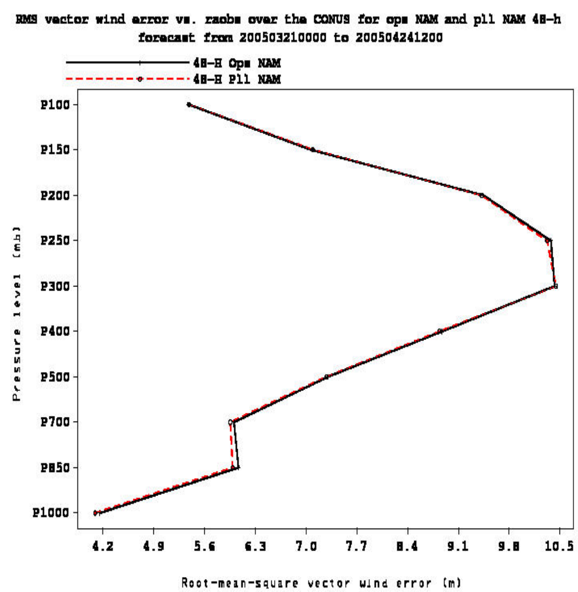


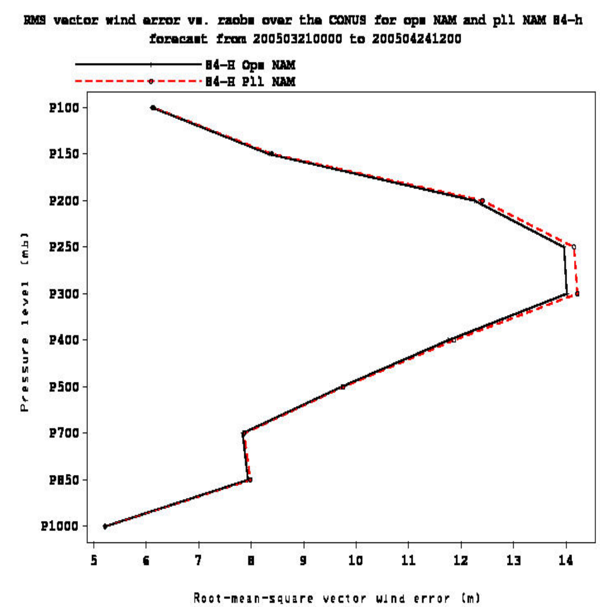




V



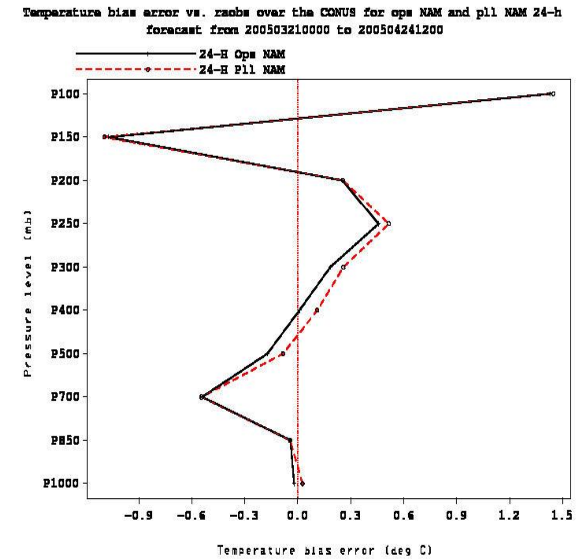


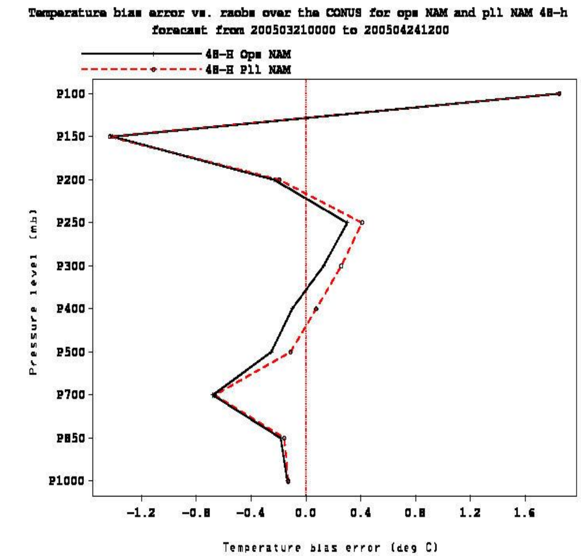


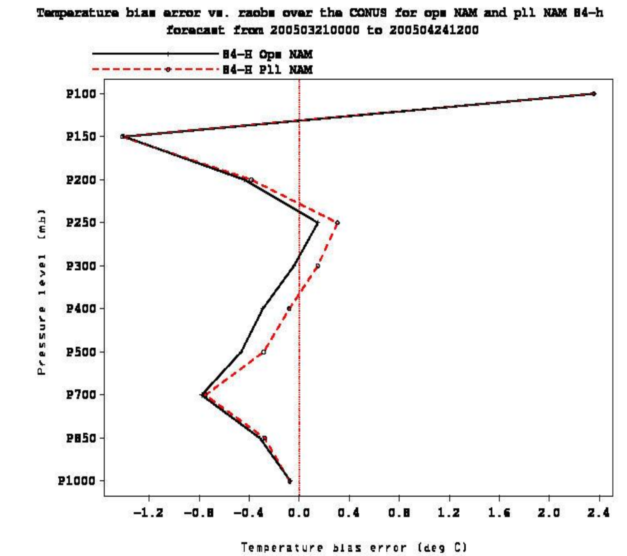
24-h 48-h 84-h

CONUS Spring : Temperature and RH Bias Error ; NAM = Solid black, NAMX = Dashed Red

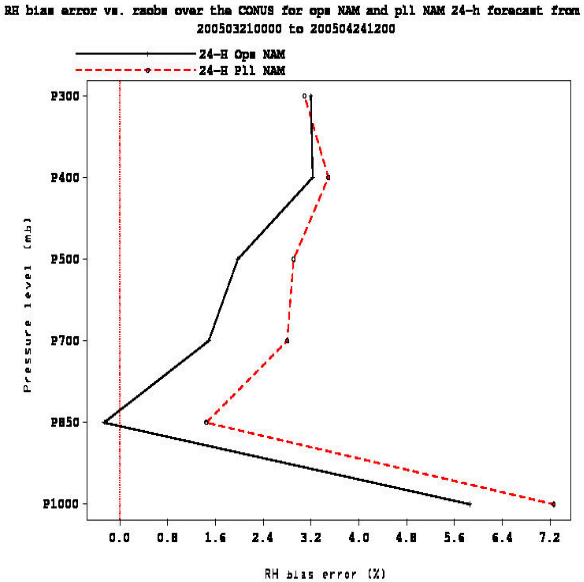
T

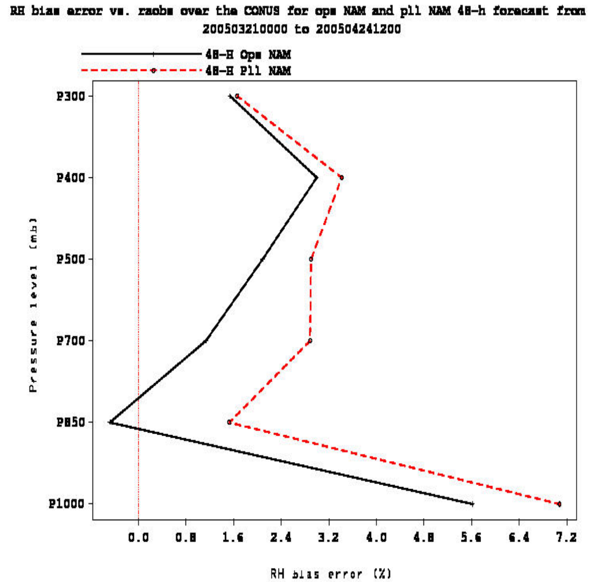


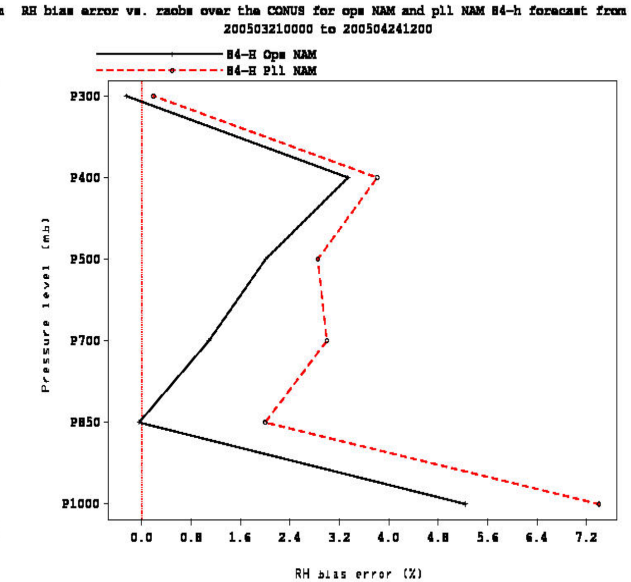




RH





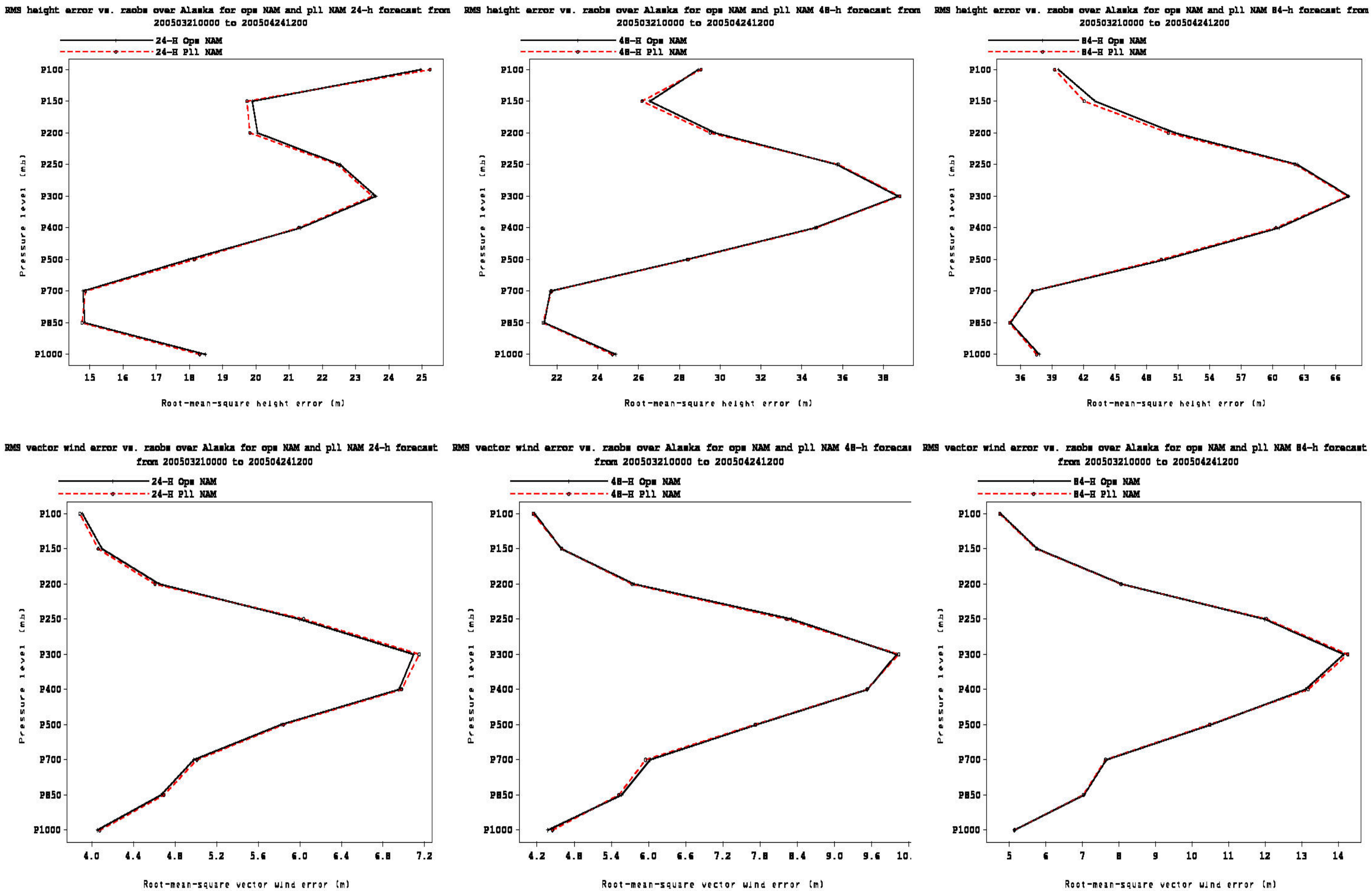


24-h 48-h 84-h

Alaska Spring : Height and Vector Wind RMS Error ;
NAM = Solid black, NAMX = Dashed Red

Z

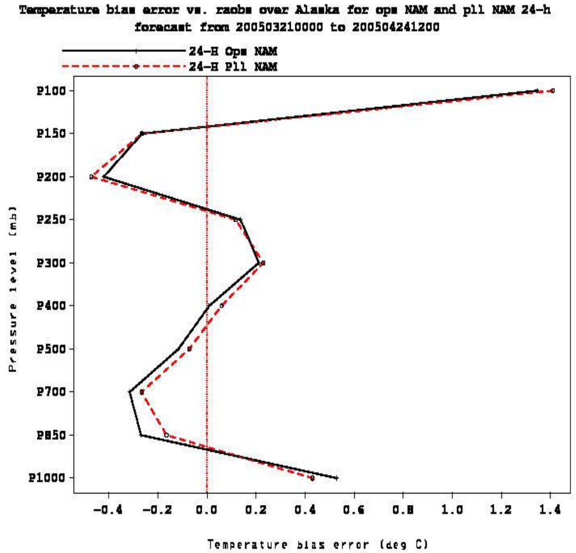
V

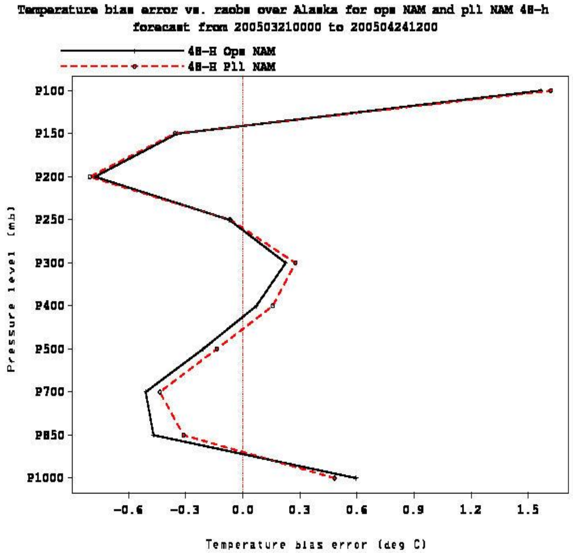


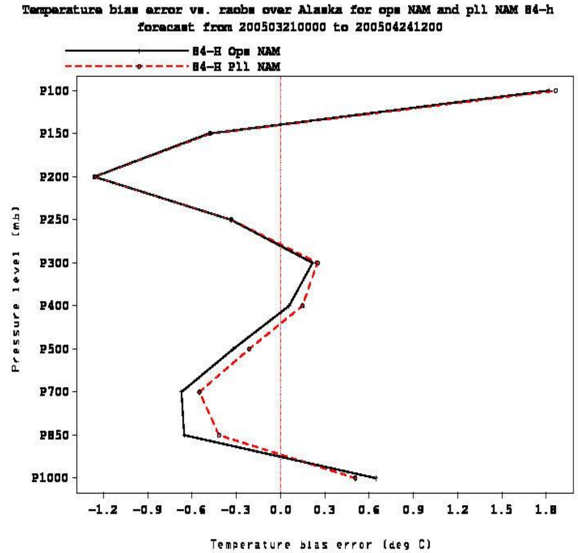
24-h 48-h 84-h

Alaska Spring : Temperature and RH Bias Error ;
NAM = Solid black, NAMX = Dashed Red

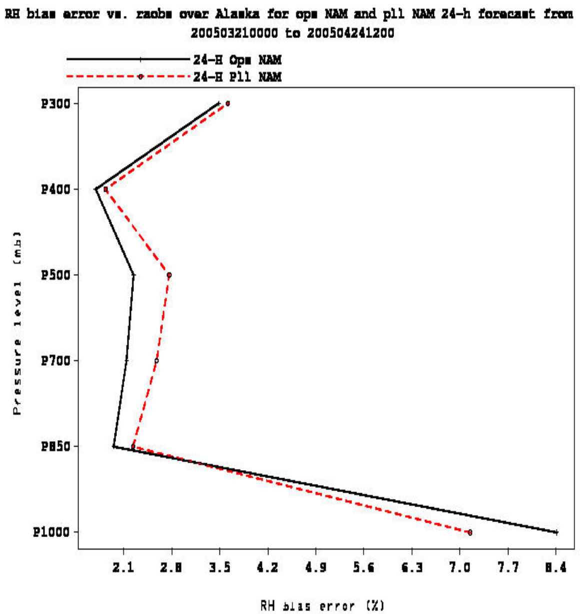
T

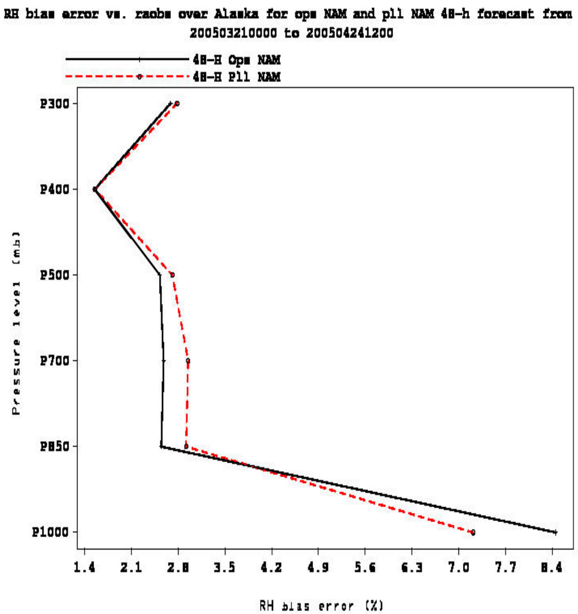


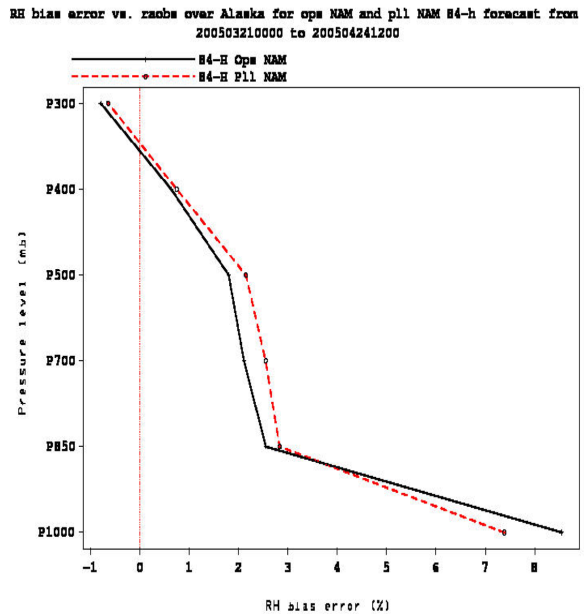




R
H





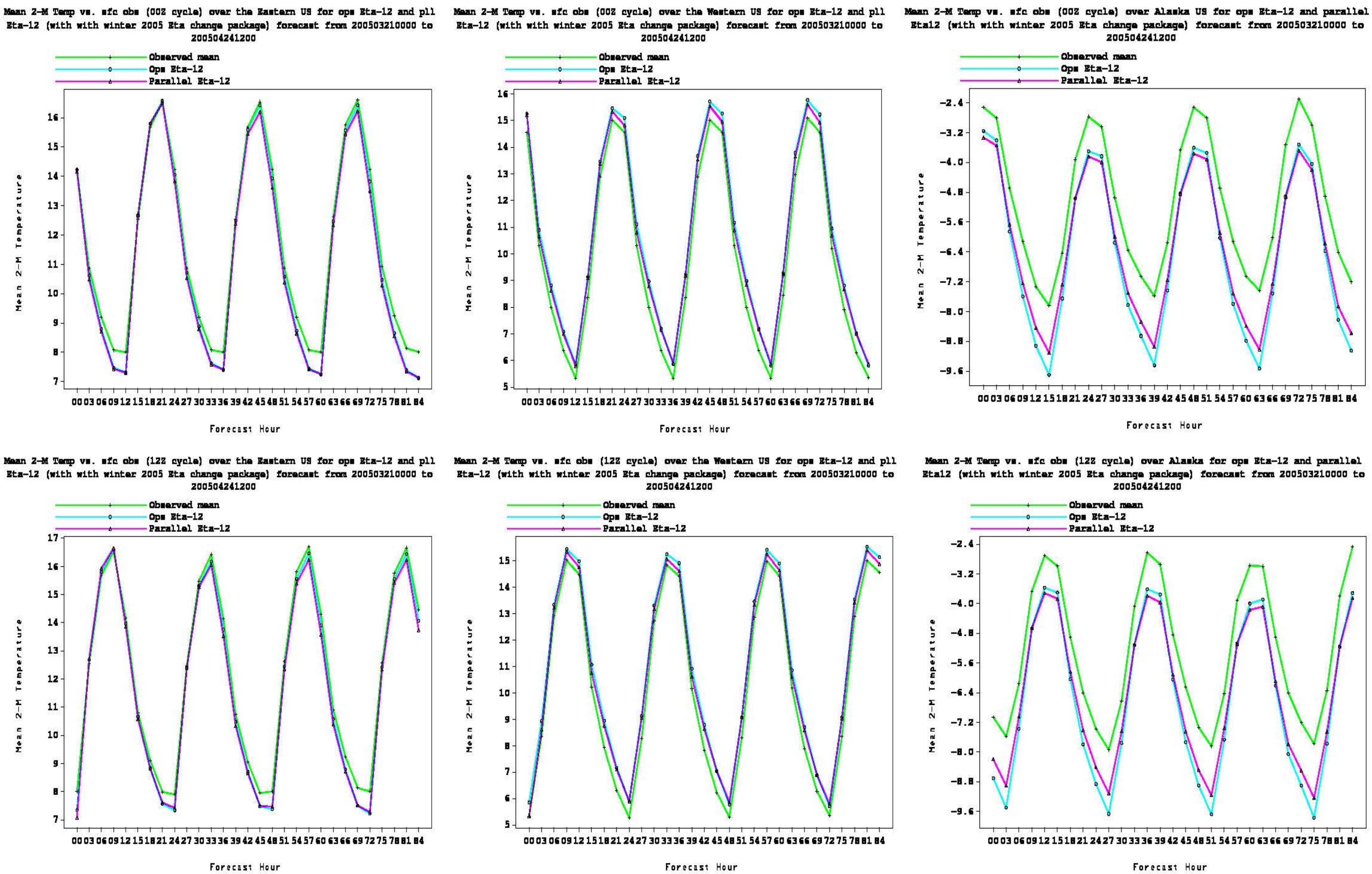


24-h 48-h 84-h

Spring Mean 2-m Temperature vs Obs ;
Obs=Green ; NAM = Cyan ; NAMX = Magenta

00Z

12Z



East CONUS

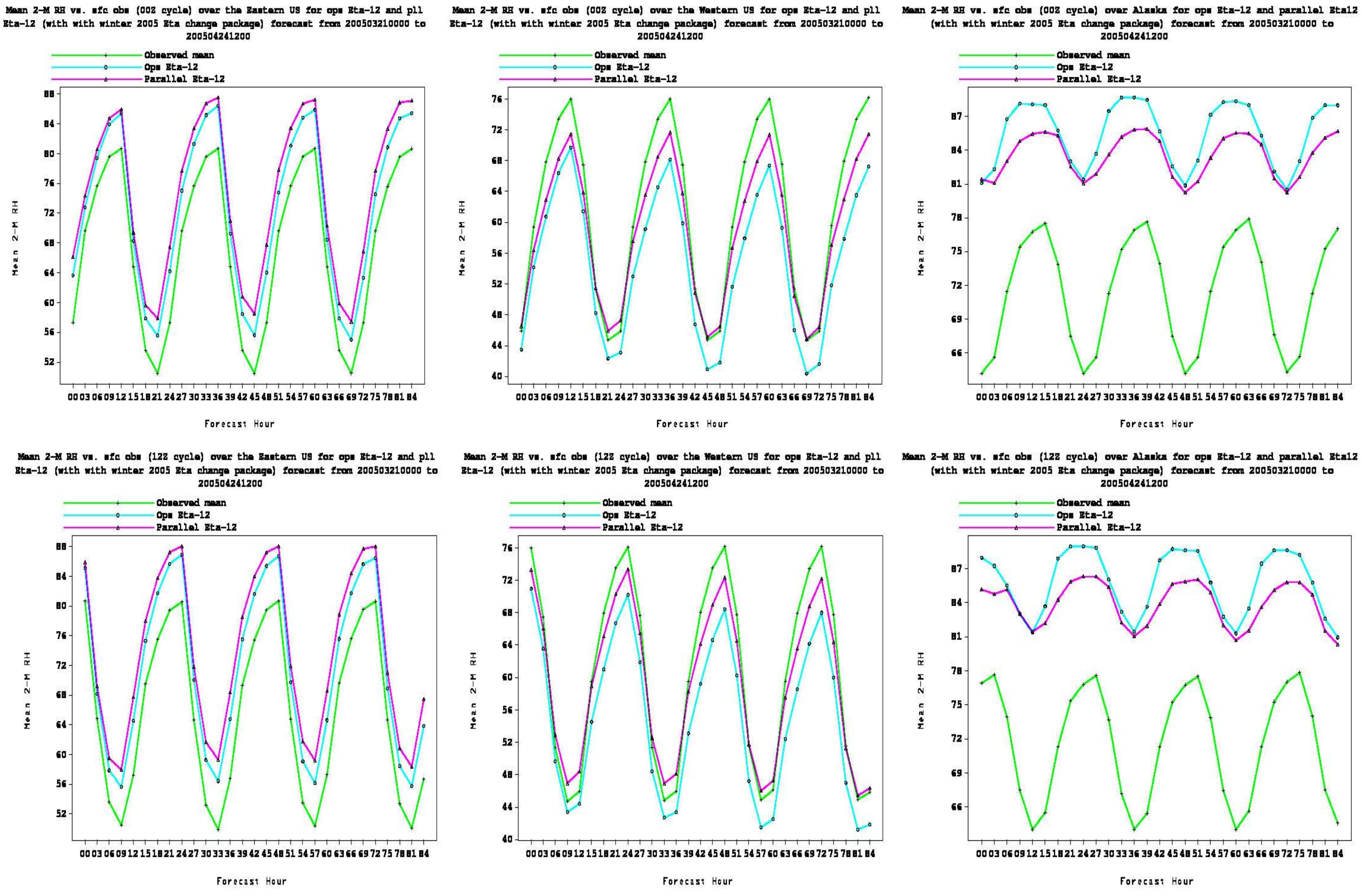
West CONUS

Alaska

Spring Mean 2-m RH vs Obs ; Obs=Green ; NAM = Cyan ; NAMX = Magenta

0
0
Z

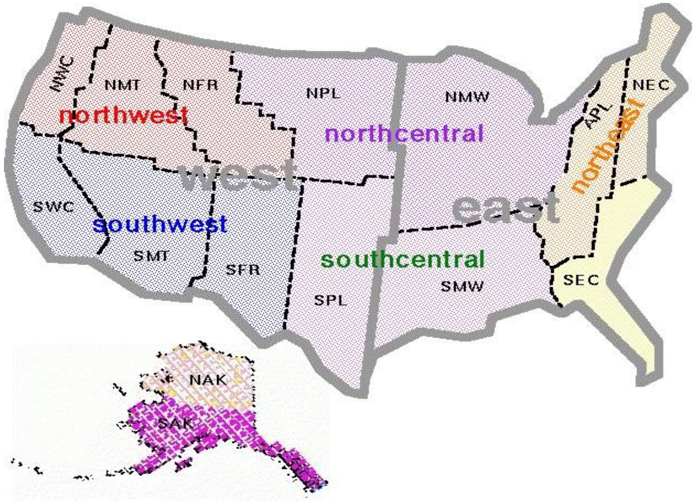
1
2
Z



East CONUS West CONUS Alaska

Summer : Forecast vs observations

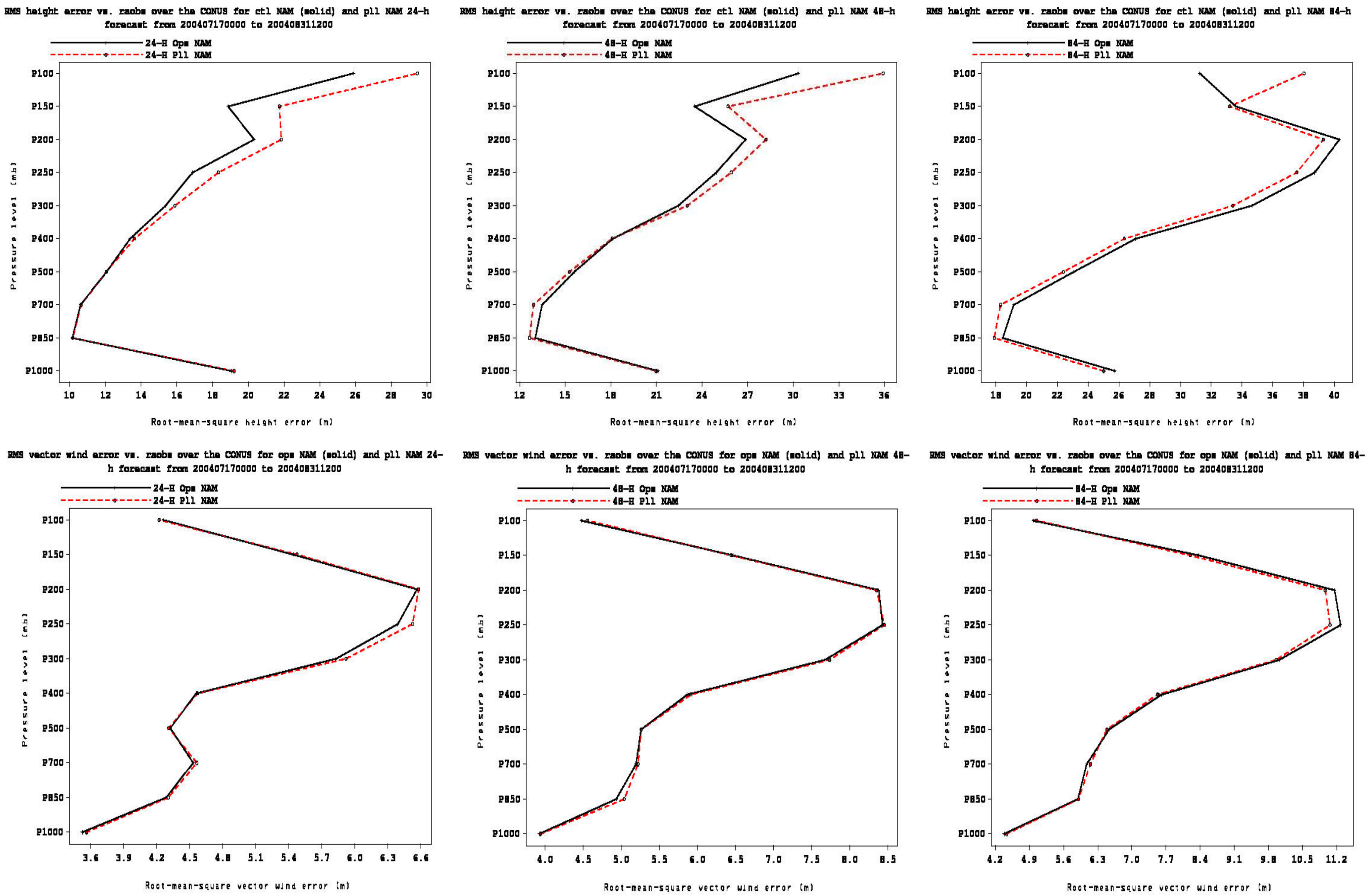
- Height and wind RMS vs raobs : CONUS and Alaska
- Temperature and RH bias vs raobs : CONUS and Alaska
- 2-m Temperature / RH vs surface obs : East CONUS, West CONUS, Alaska



CONUS Summer : Height and Vector Wind RMS Error ;
NAM = Solid black, NAMX = Dashed Red

Z

V

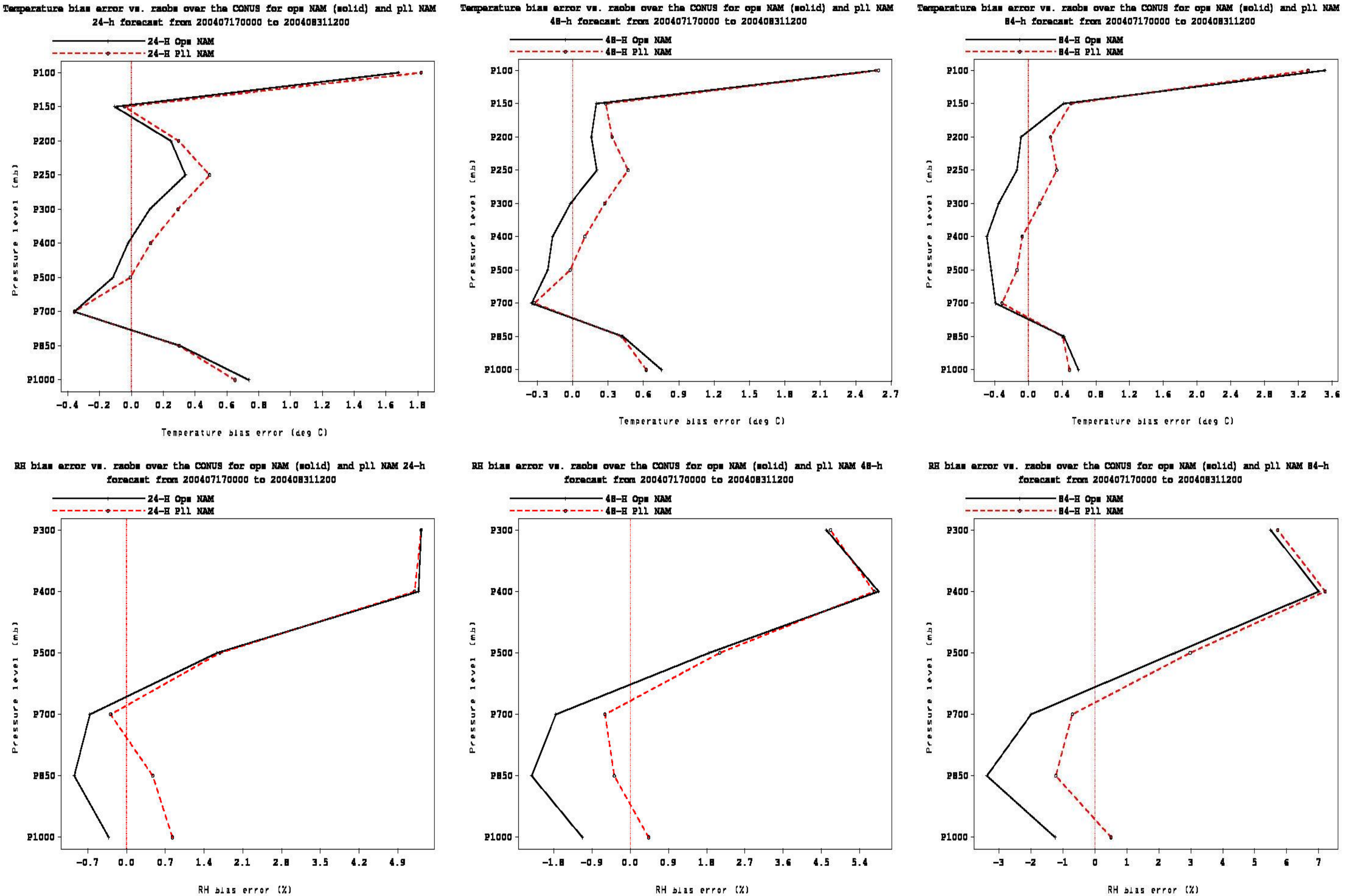


24-h 48-h 84-h

CONUS Summer : Temperature and RH Bias Error ;
NAM = Solid black, NAMX = Dashed Red

T

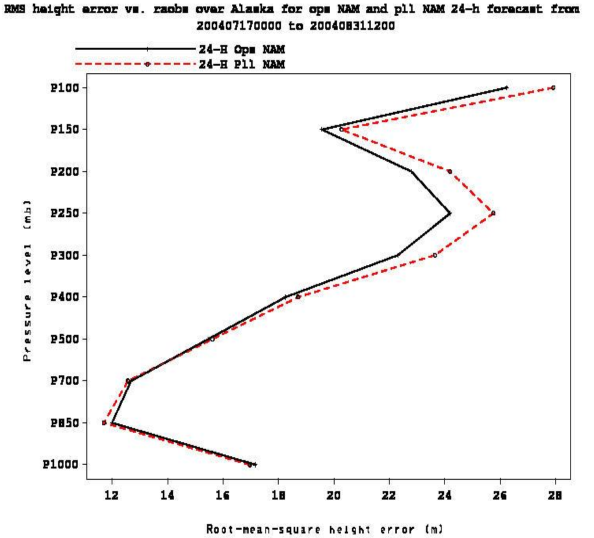
R
H

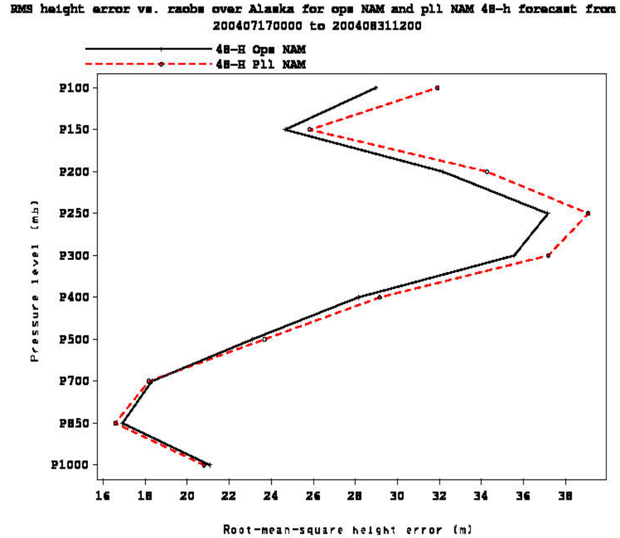


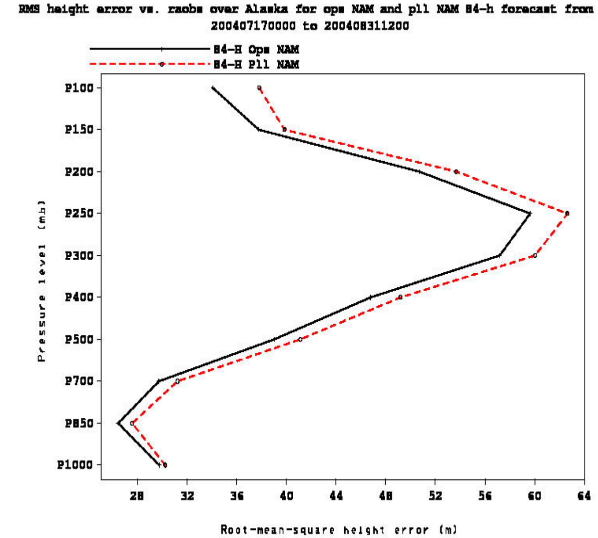
24-h 48-h 84-h

Alaska Summer : Height and Vector Wind RMS Error ;
NAM = Solid black, NAMX = Dashed Red

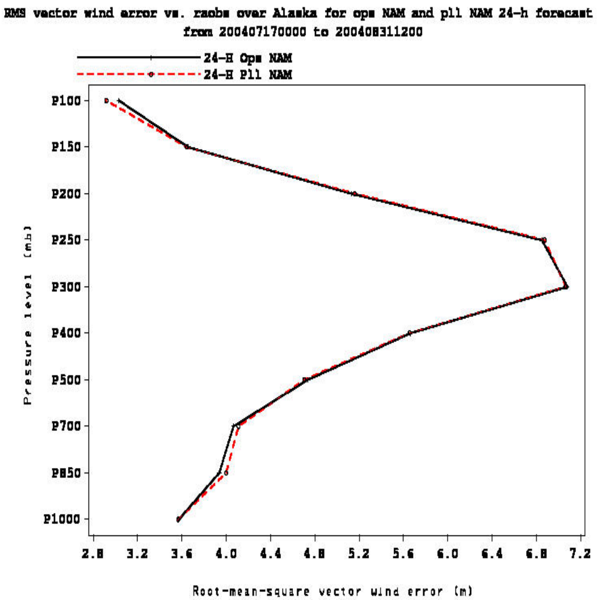
Z

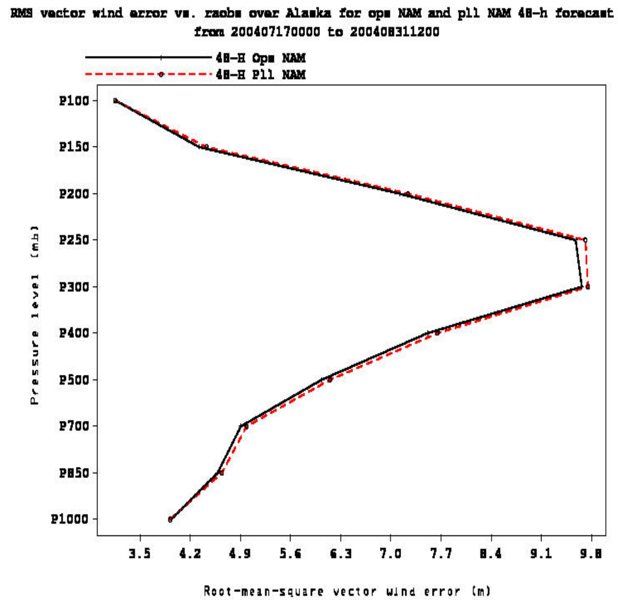


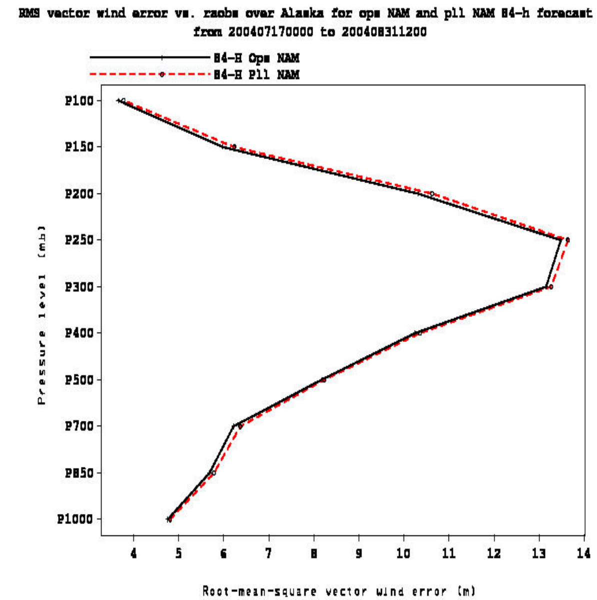




V







24-h

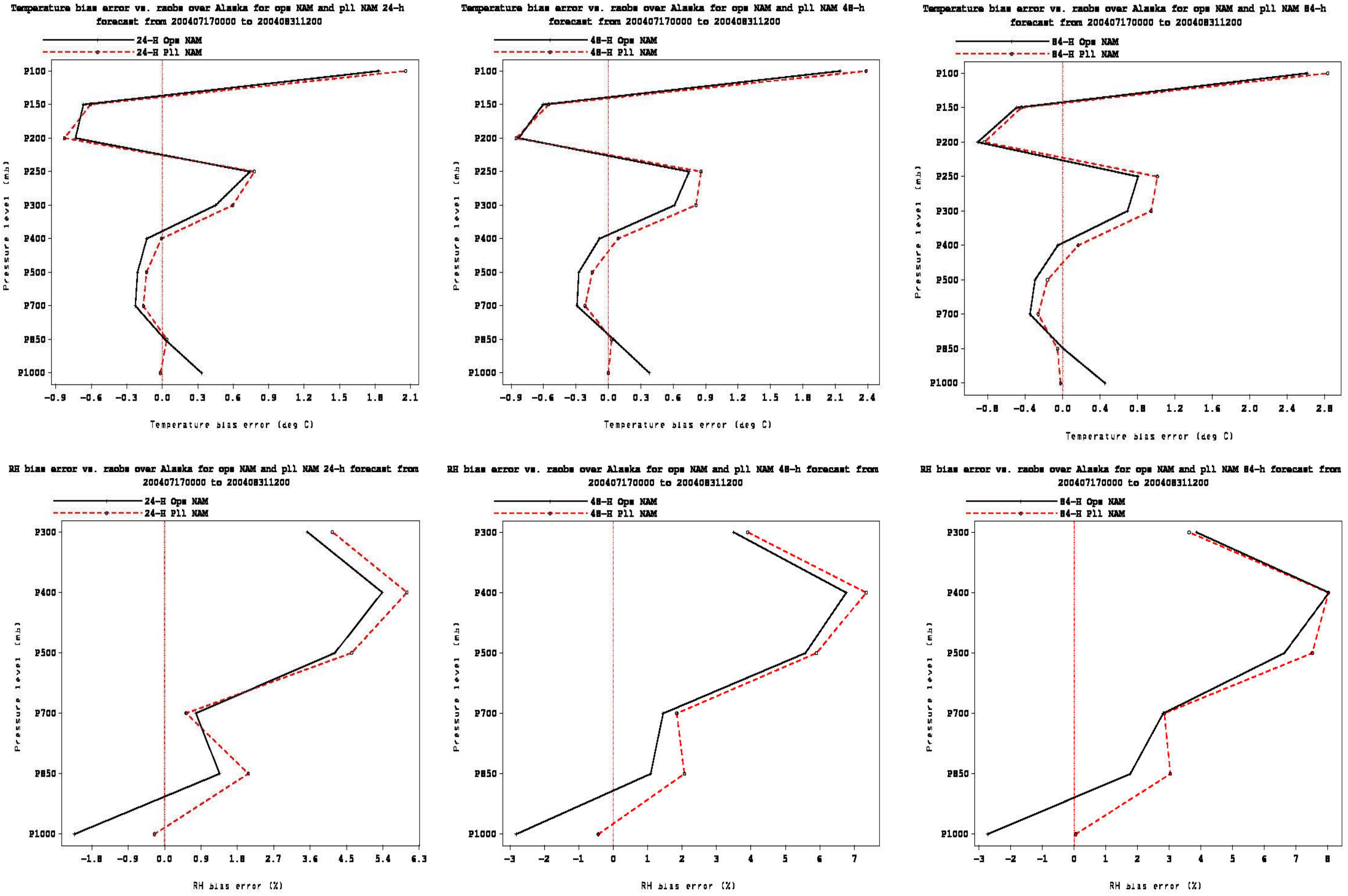
48-h

84-h

Alaska Summer : Temperature and RH Bias Error ; NAM = Solid black, NAMX = Dashed Red

T

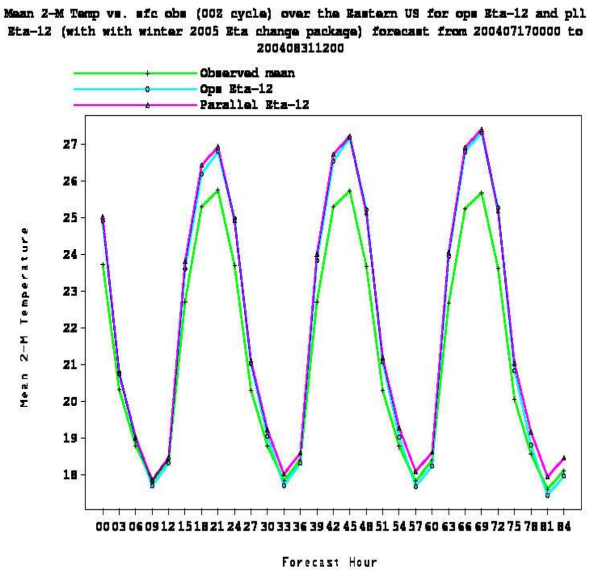
R
H

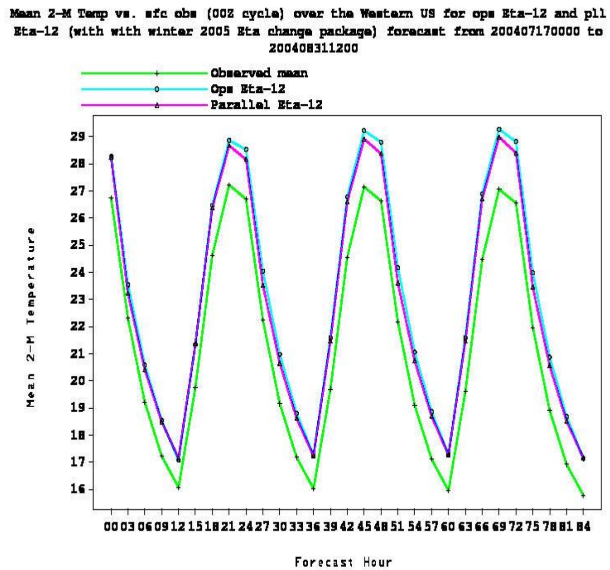


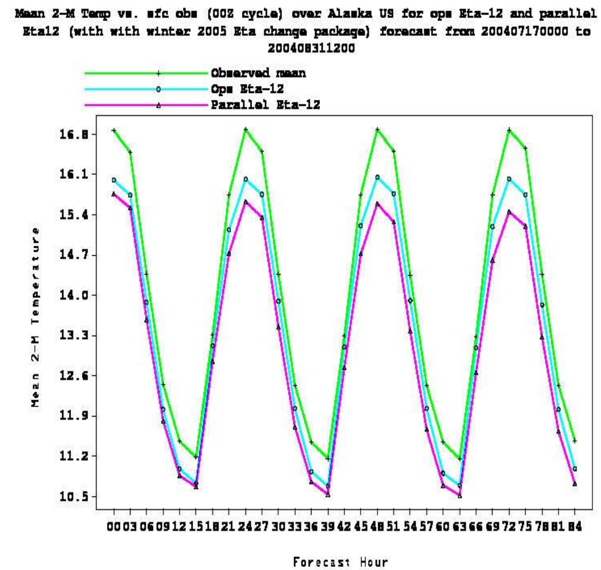
24-h 48-h 84-h

Summer Mean 2-m Temperature vs Obs ;
Obs=Green ; NAM = Cyan ; NAMX = Magenta

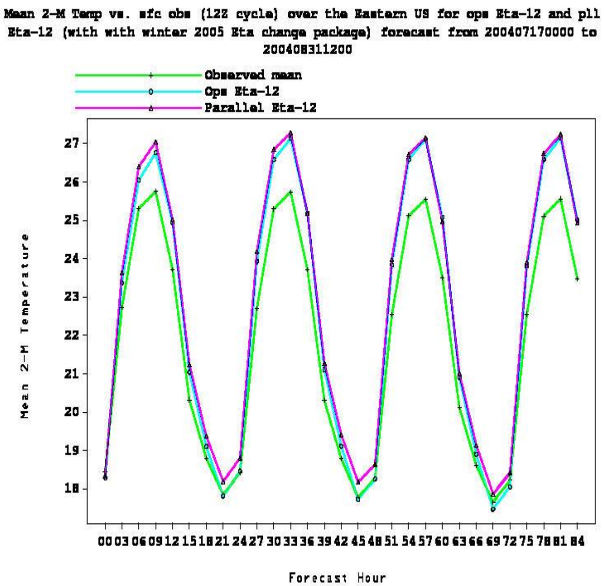
00Z

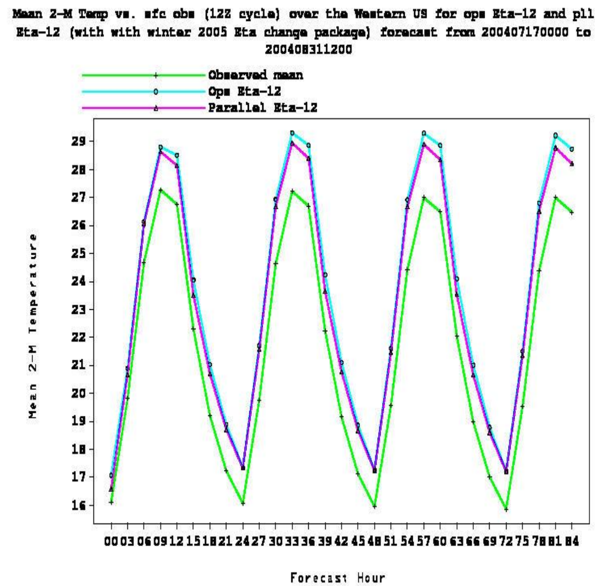


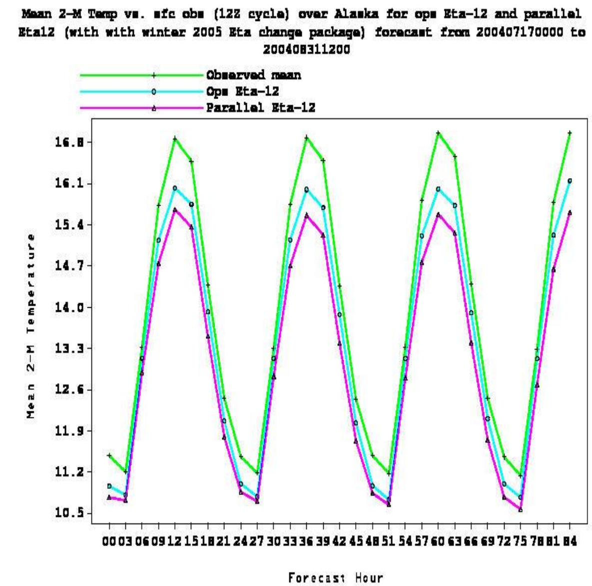




12Z



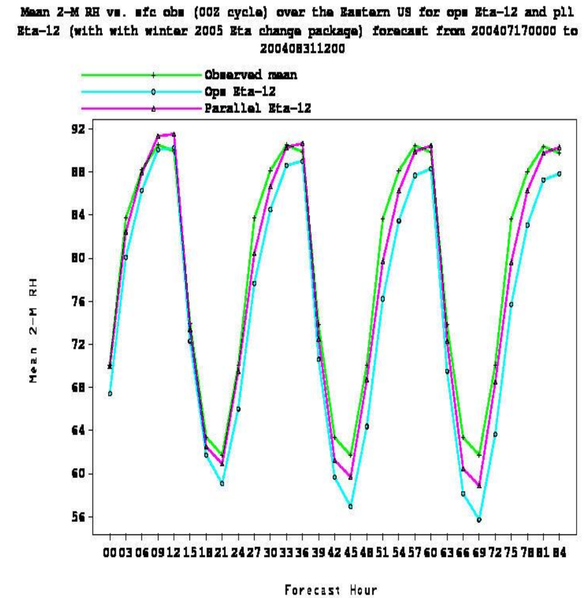


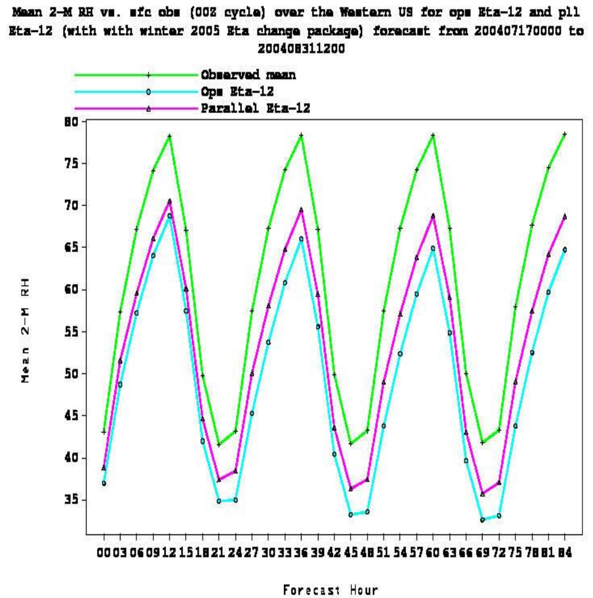


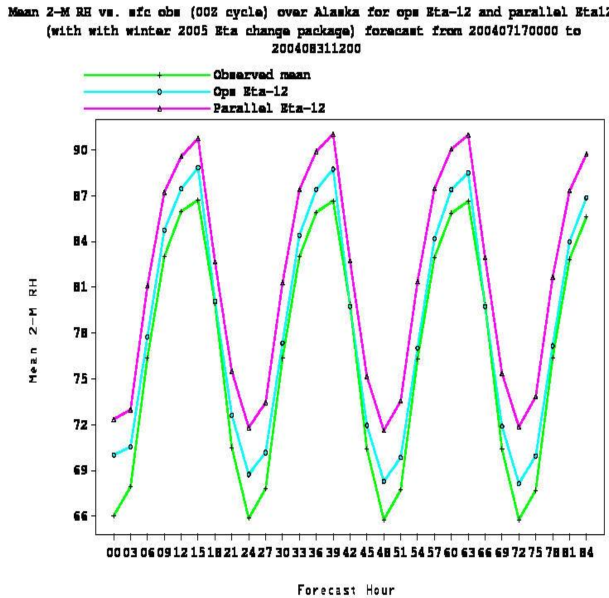
East CONUS West CONUS Alaska

Summer Mean 2-m RH vs Obs ; Obs=Green ; NAM = Cyan ; NAMX = Magenta

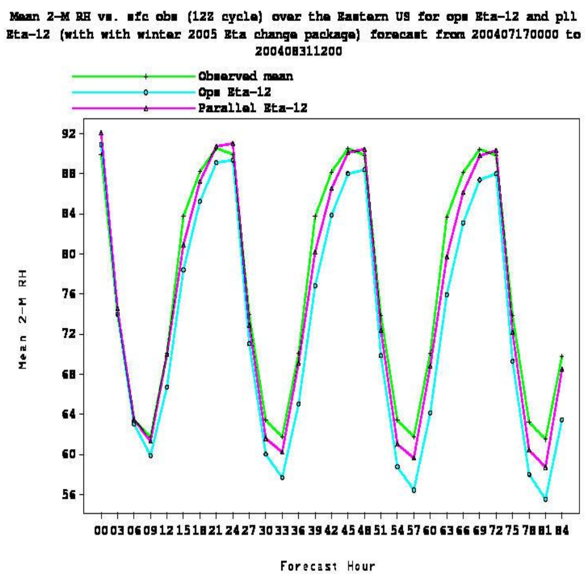
00Z

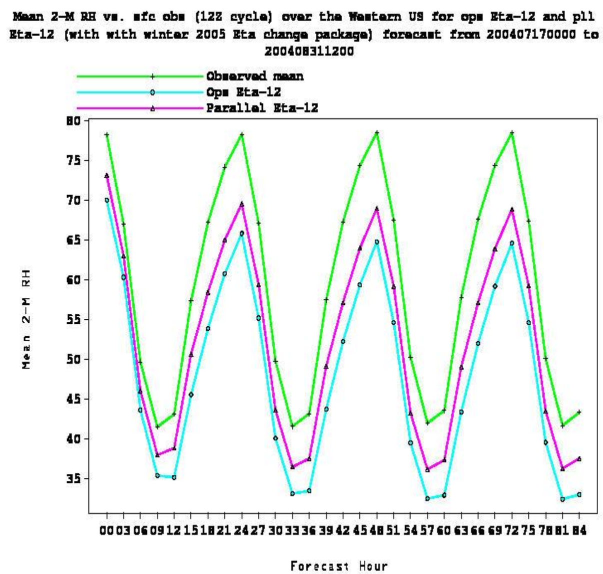


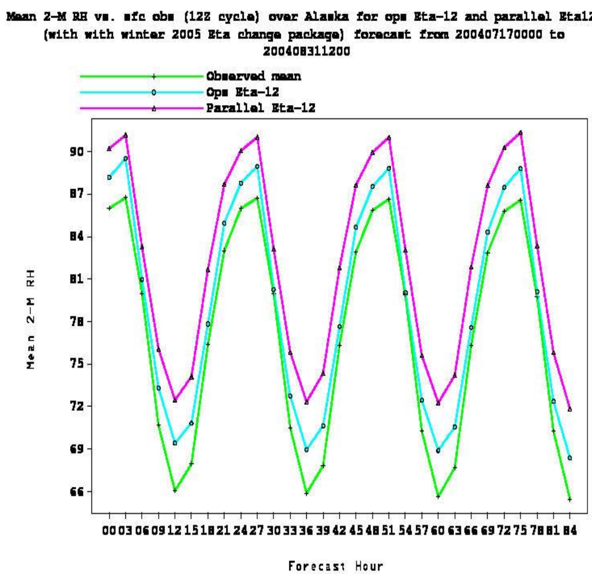




12Z







East CONUS | West CONUS | Alaska

DGEX vs DGEXX Quantitative Verification Statistics

Winter : 1 January – 20 March 2005

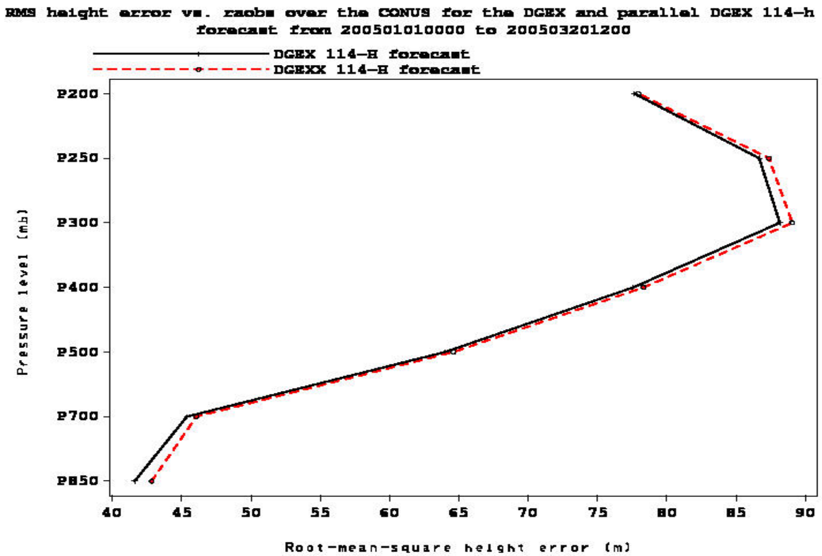
Spring : 21 March -24 April 2005

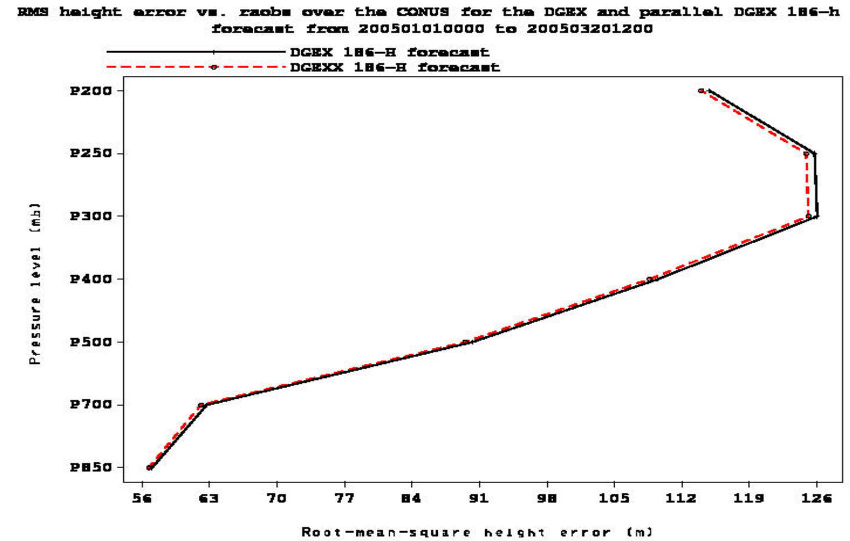
Two parallel cycles / day

(00z Alaska and 06Z CONUS)

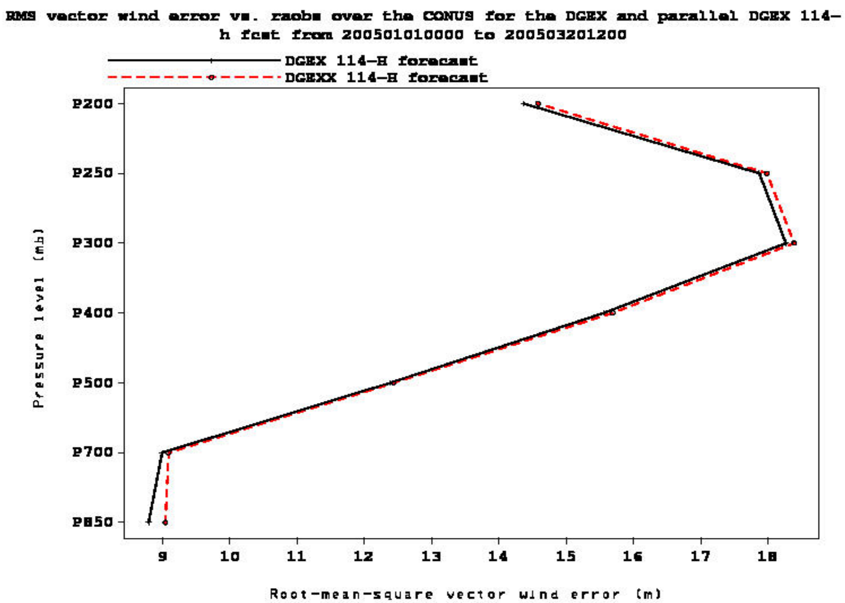
CONUS Winter : Height and Vector Wind RMS Error ;
DGEX = Solid black, DGEXX = Dashed Red

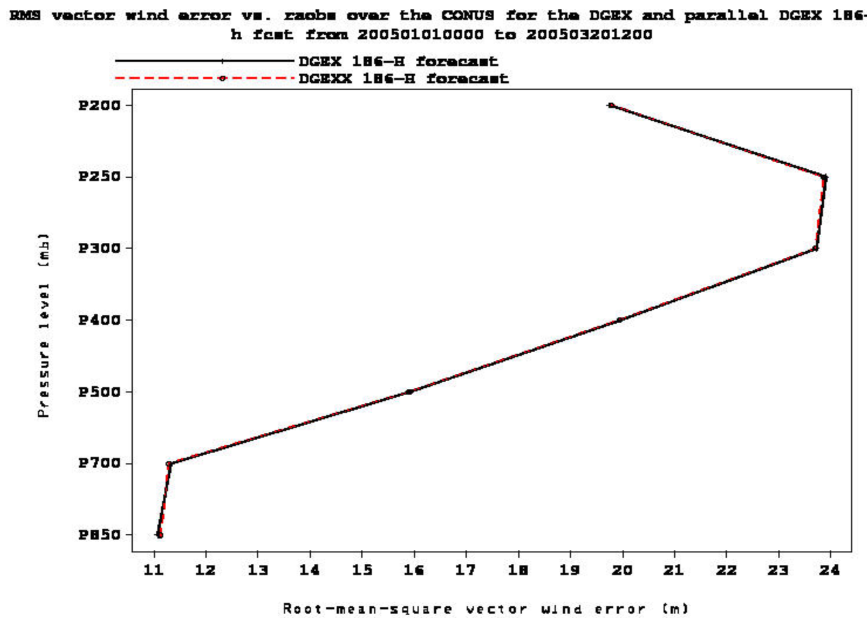
Z





V



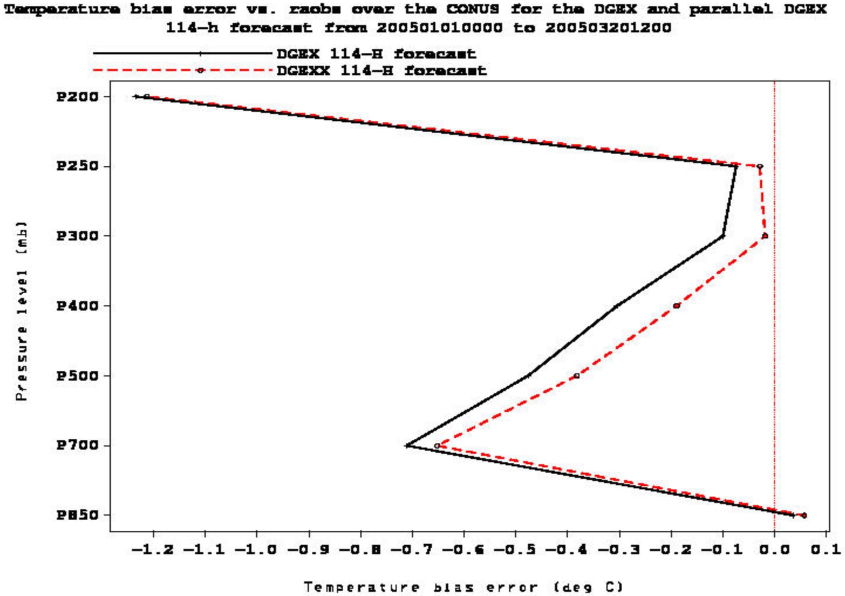


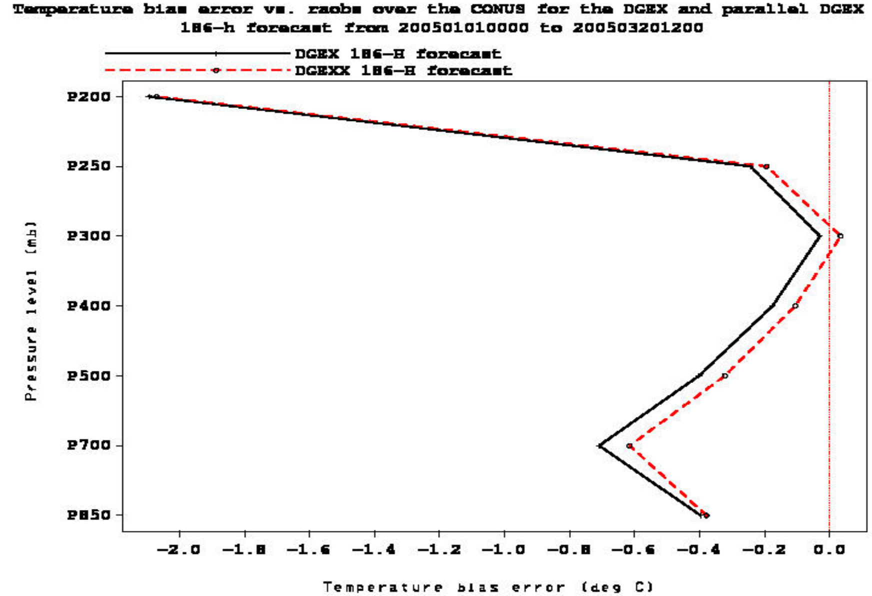
114-h Forecast

186-h Forecast

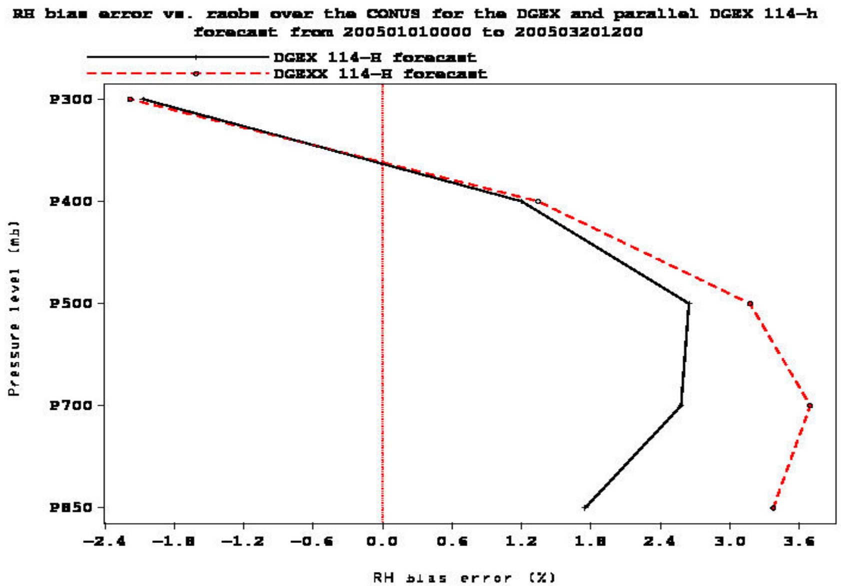
CONUS Winter : Temperature / RH Bias Error ;
DGEX = Solid black, DGEXX = Dashed Red

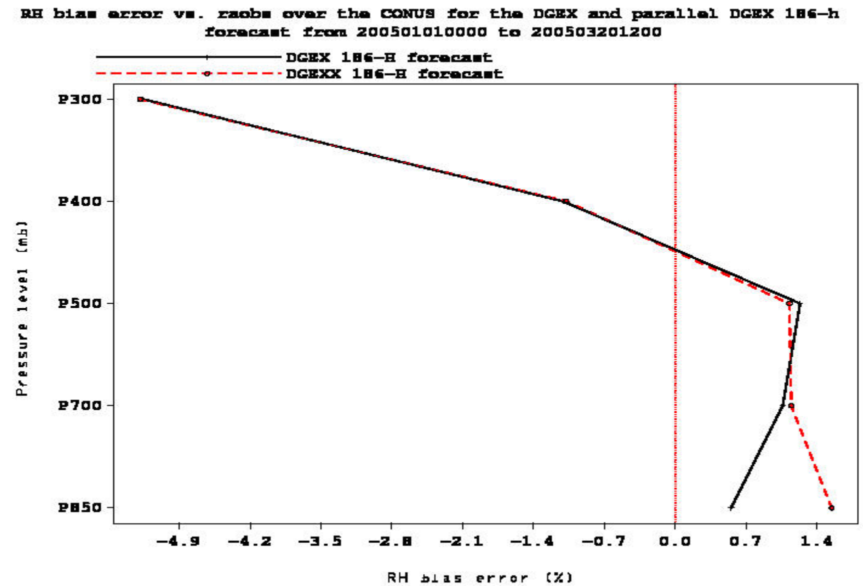
T





R
H



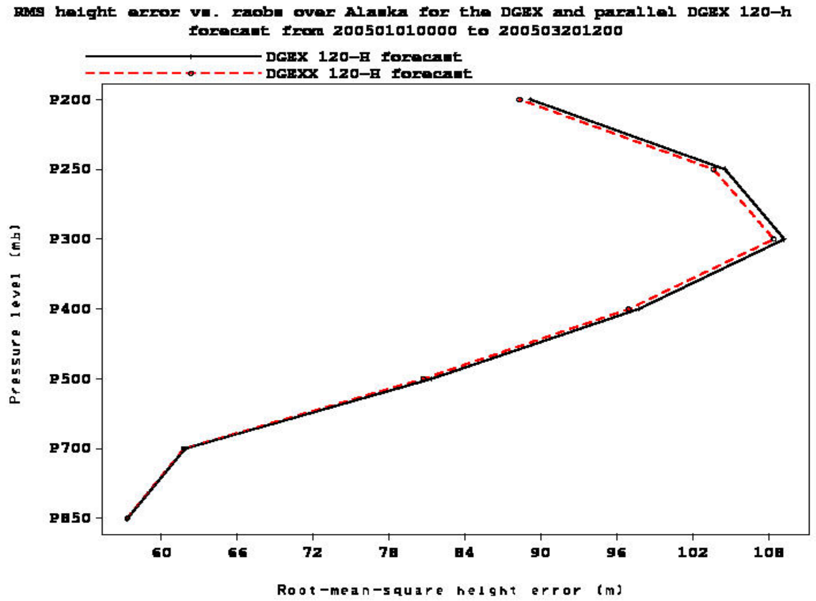


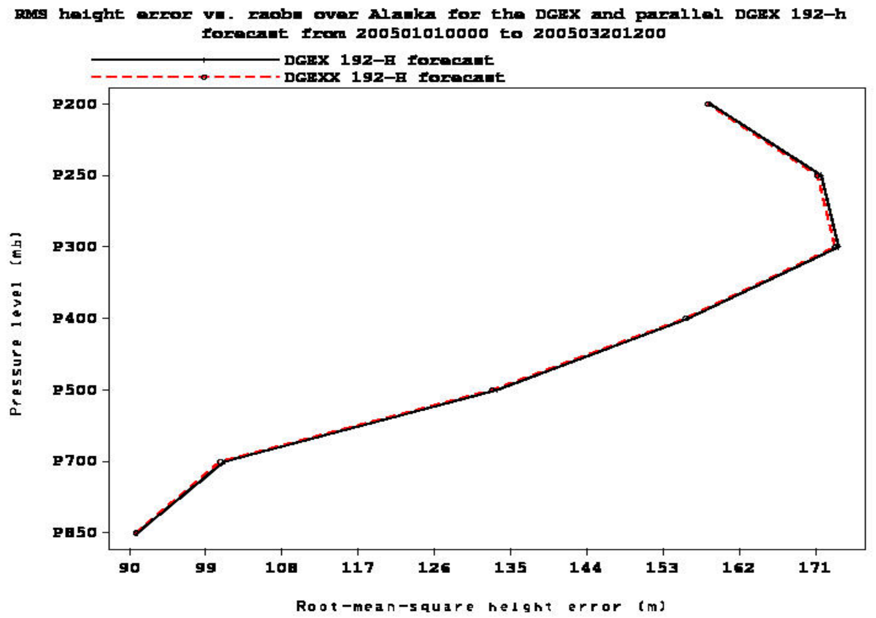
114-h Forecast

186-h Forecast

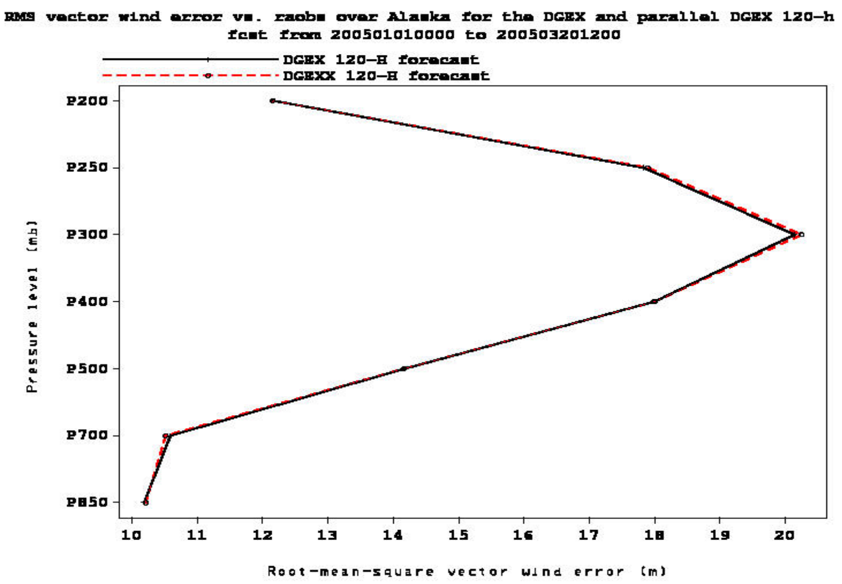
Alaska Winter : Height and Vector Wind RMS Error ;
DGEX = Solid black, DGEXX = Dashed Red

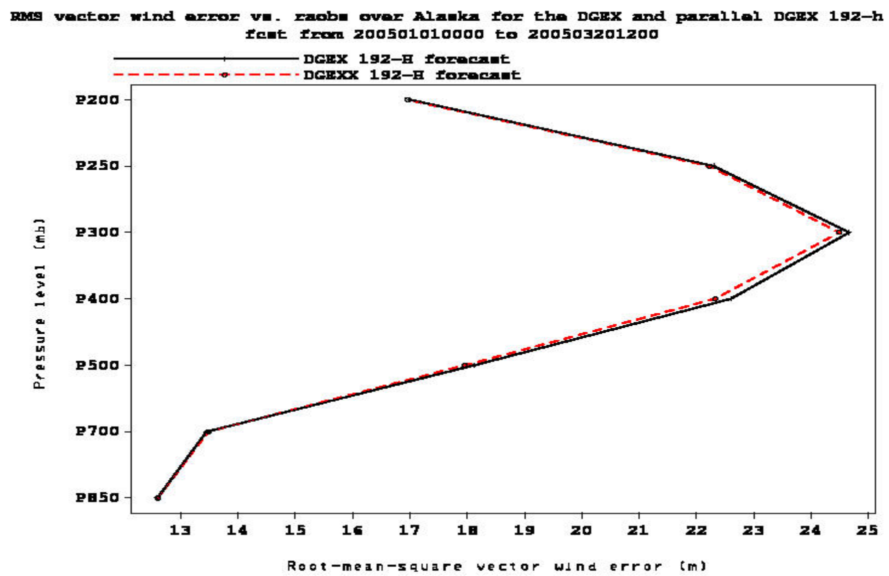
Z





V



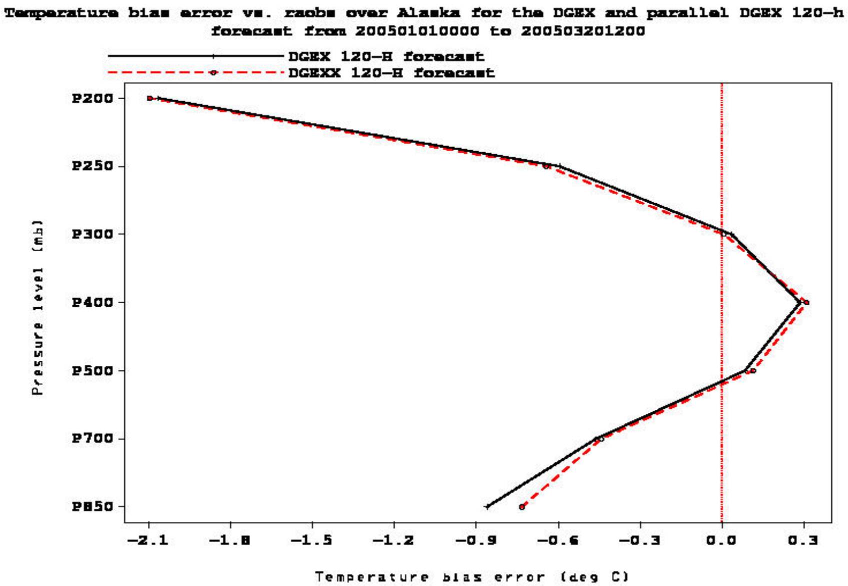


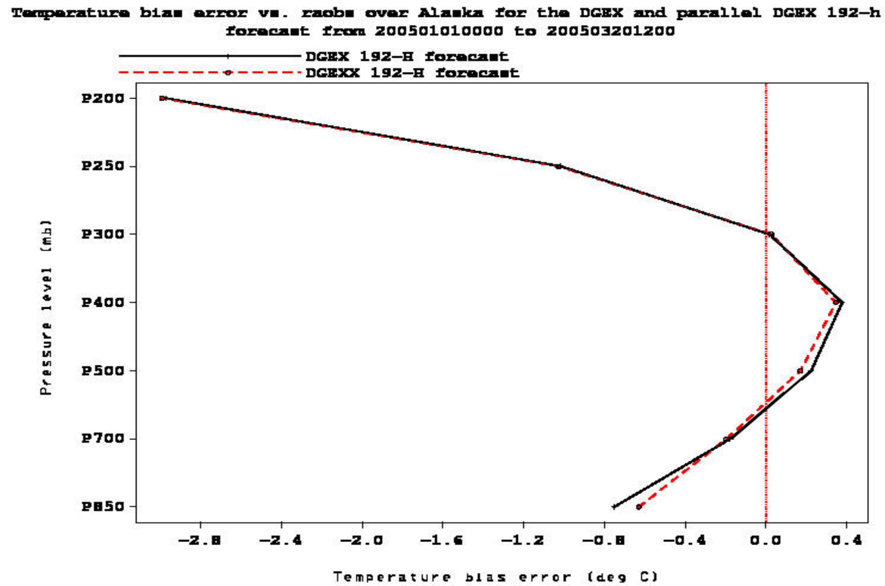
120-h Forecast

192-h Forecast

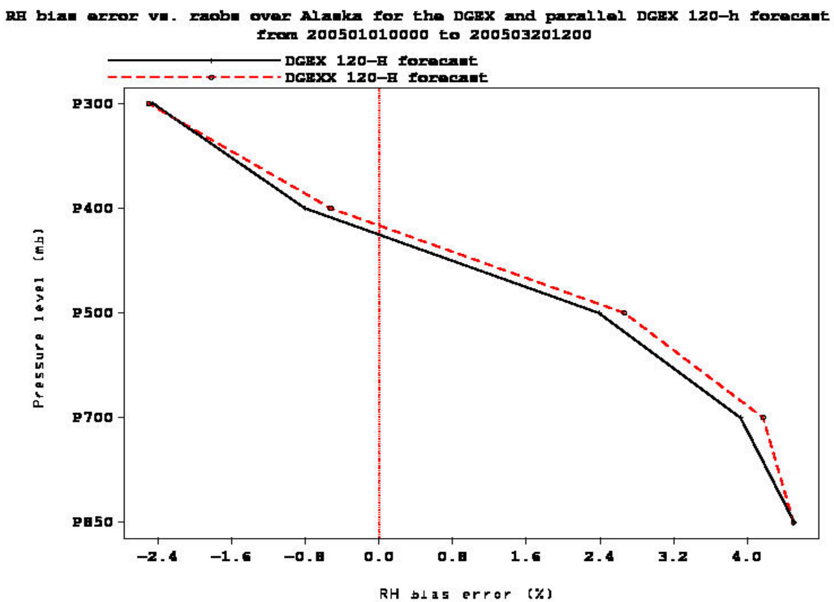
Alaska Winter : Temperature / RH Bias Error ;
DGEX = Solid black, DGEXX = Dashed Red

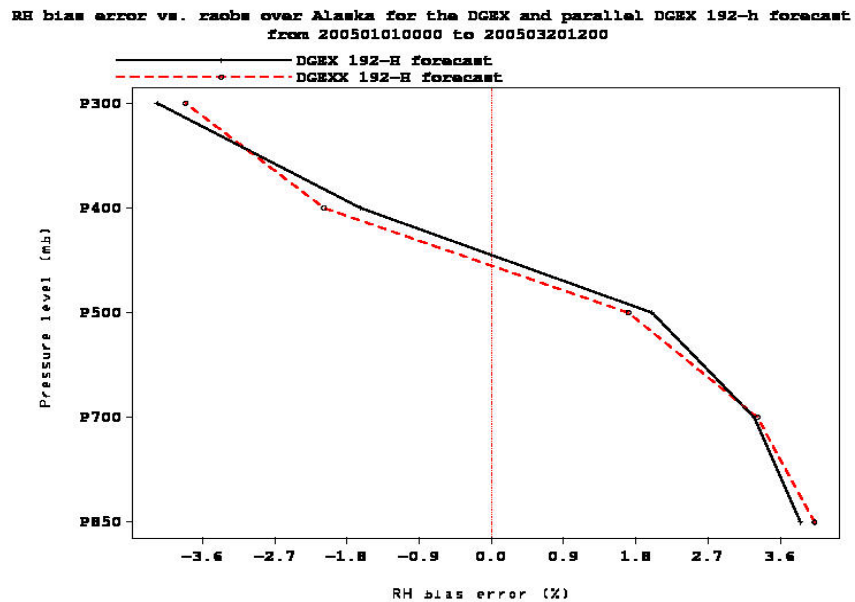
T





R
H

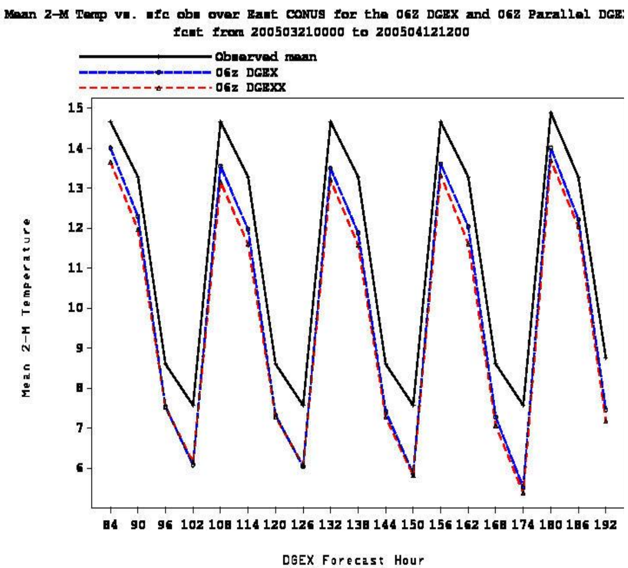




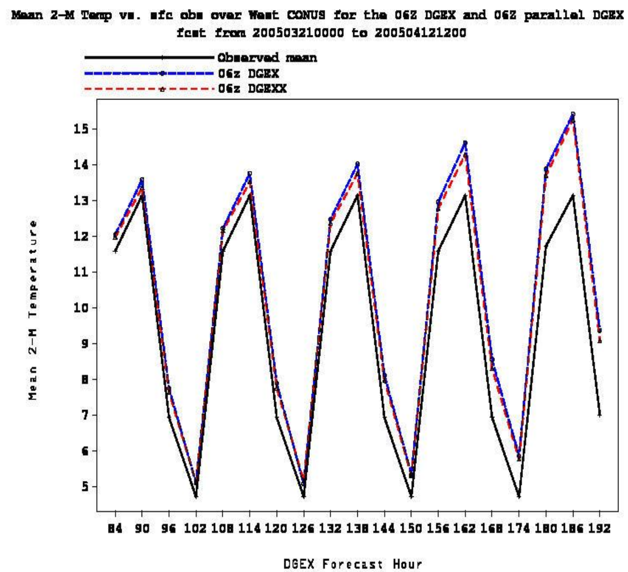
120-h Forecast

192-h Forecast

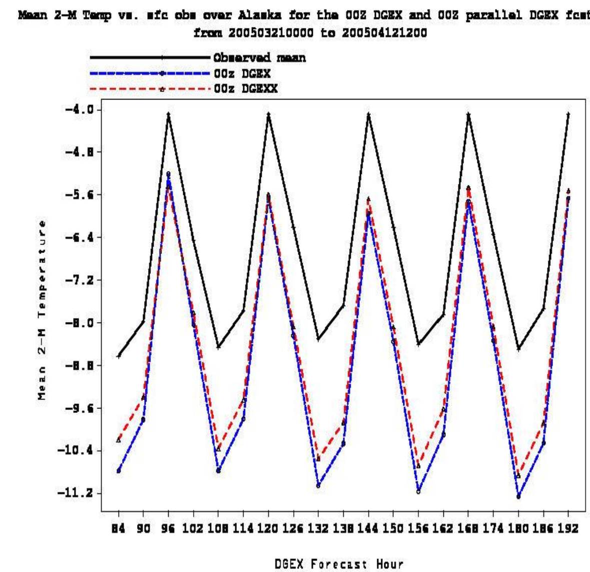
Winter Mean 2-m Temperature vs Obs ;
Obs=Black ; DGEX = Blue ; DGEXX = Red



East CONUS



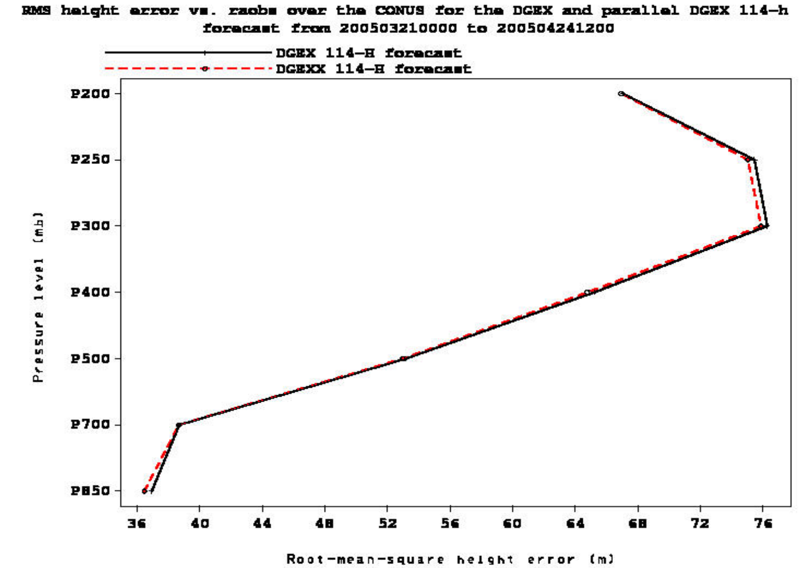
West CONUS

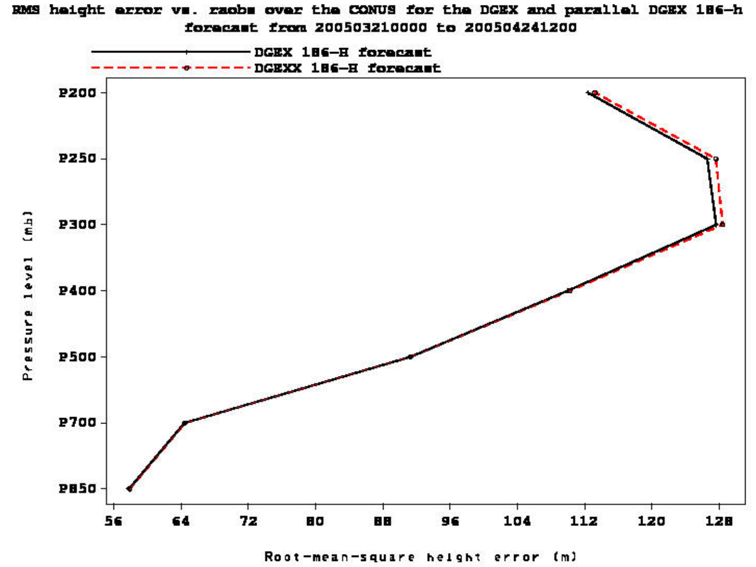


Alaska

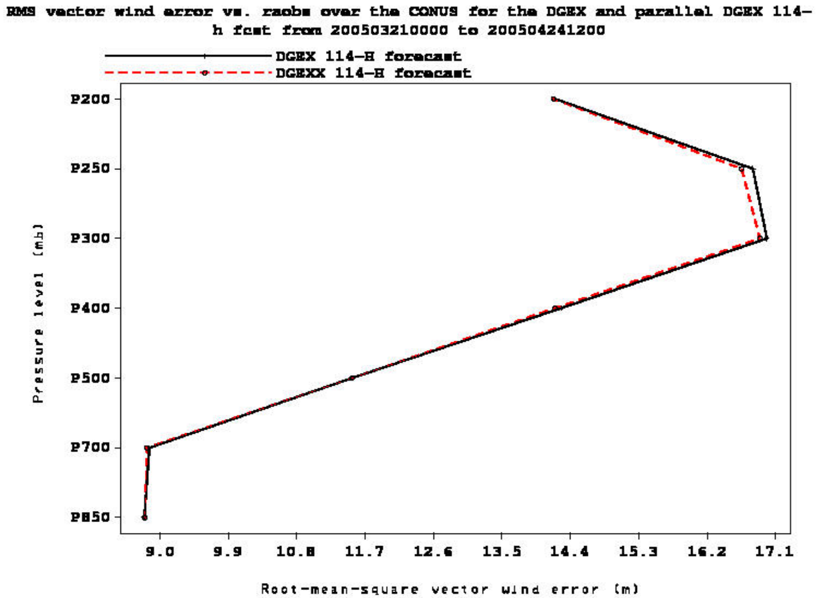
CONUS Spring : Height and Vector Wind RMS Error ;
DGEX = Solid black, DGEXX = Dashed Red

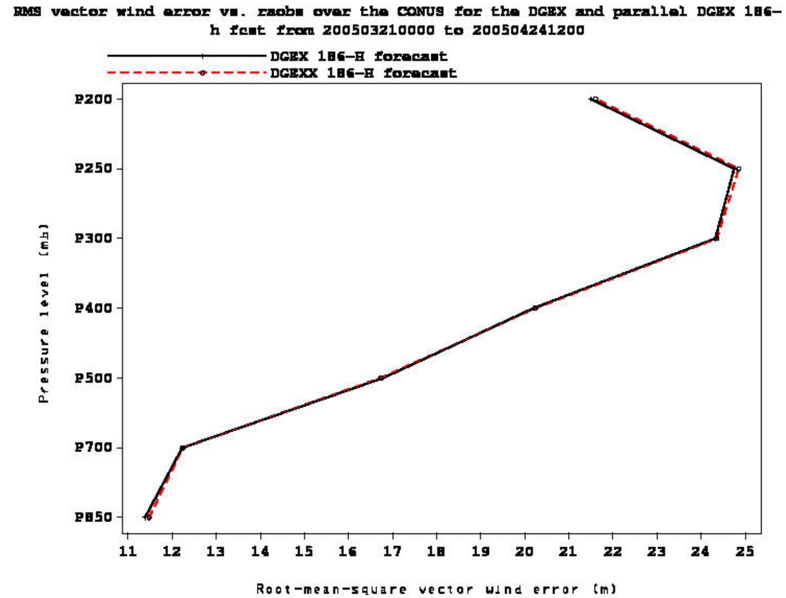
Z





V



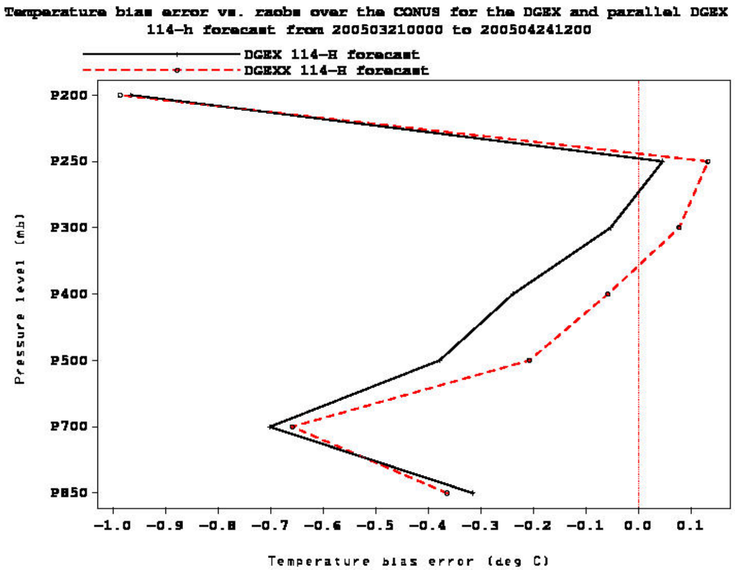


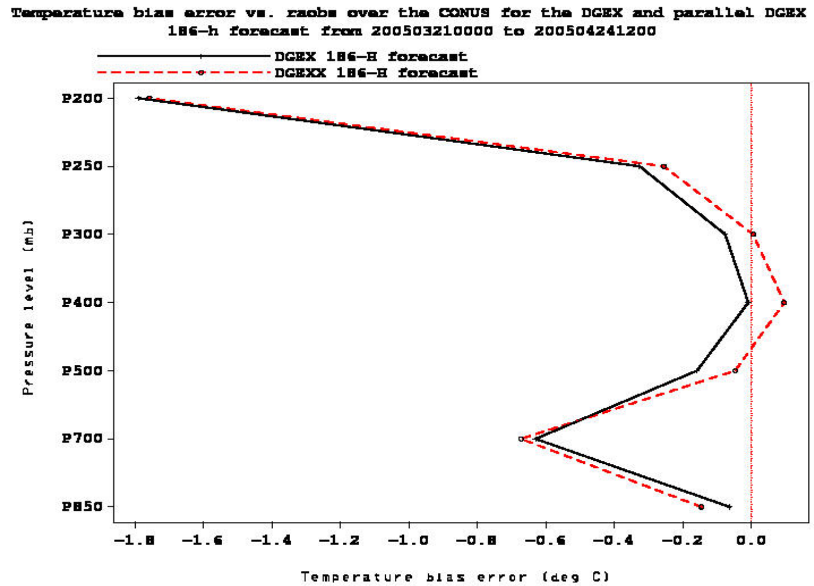
114-h Forecast

186-h Forecast

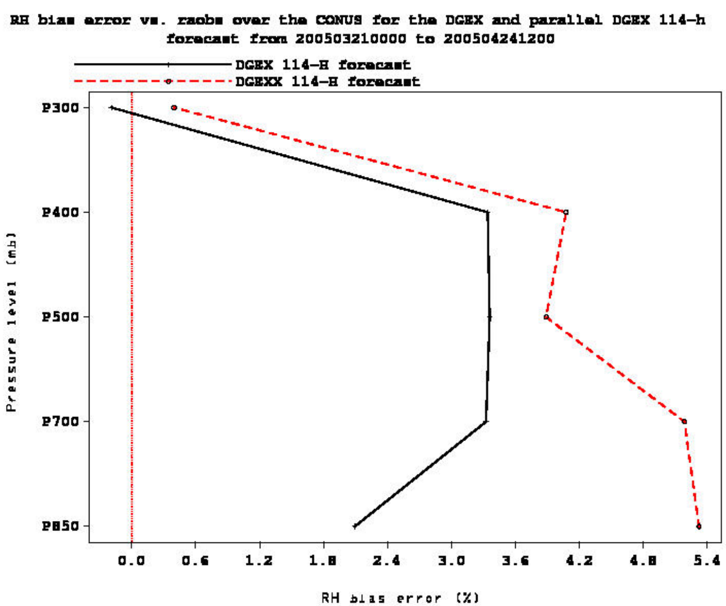
CONUS Spring : Temperature / RH Bias Error ;
DGEX = Solid black, DGEXX = Dashed Red

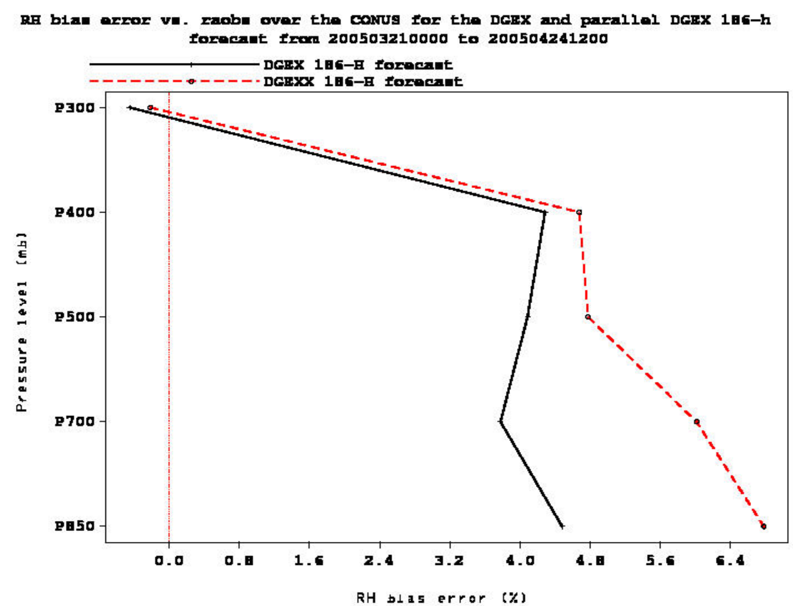
T





R
H



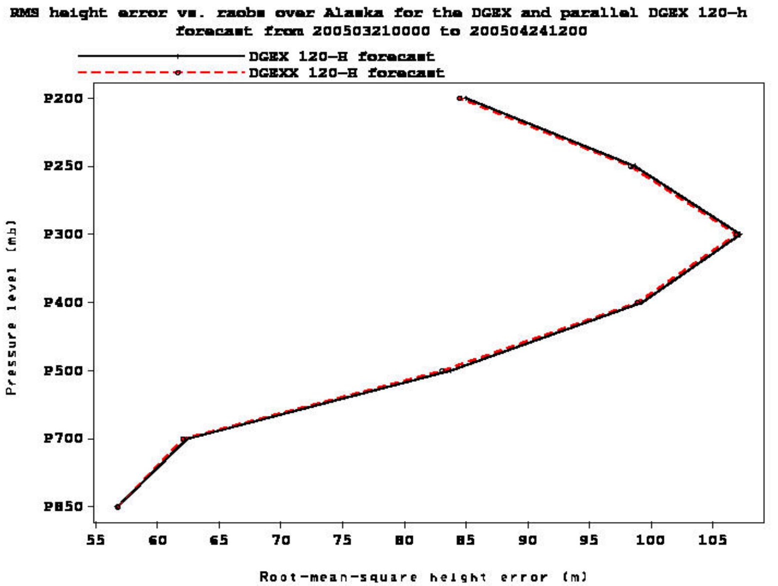


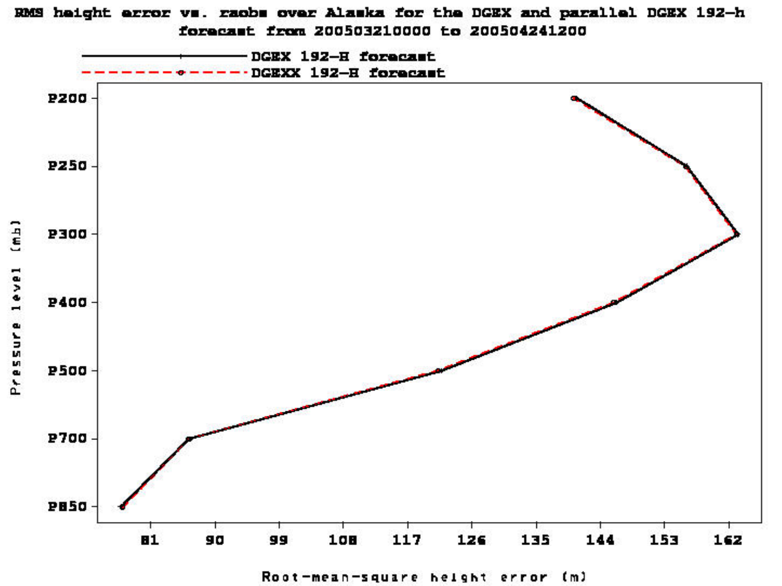
114-h Forecast

186-h Forecast

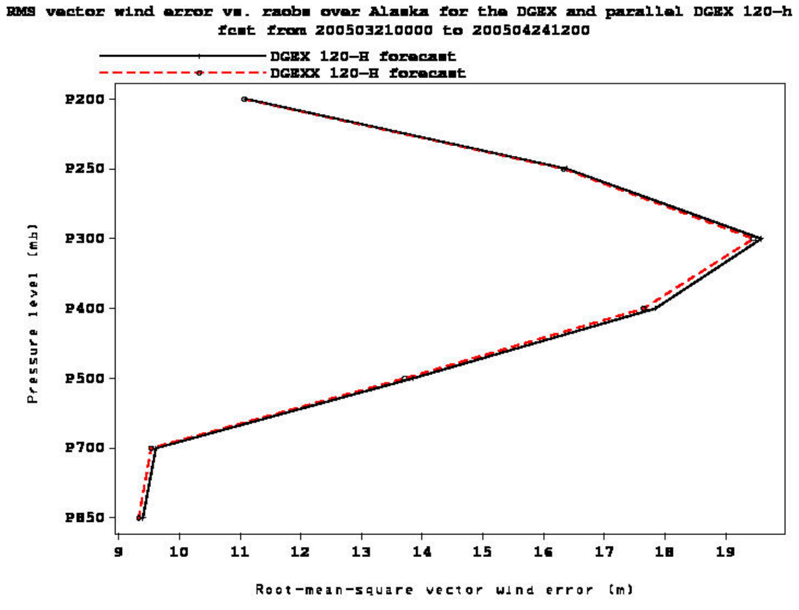
Alaska Spring : Height and Vector Wind RMS Error ;
DGEX = Solid black, DGEXX = Dashed Red

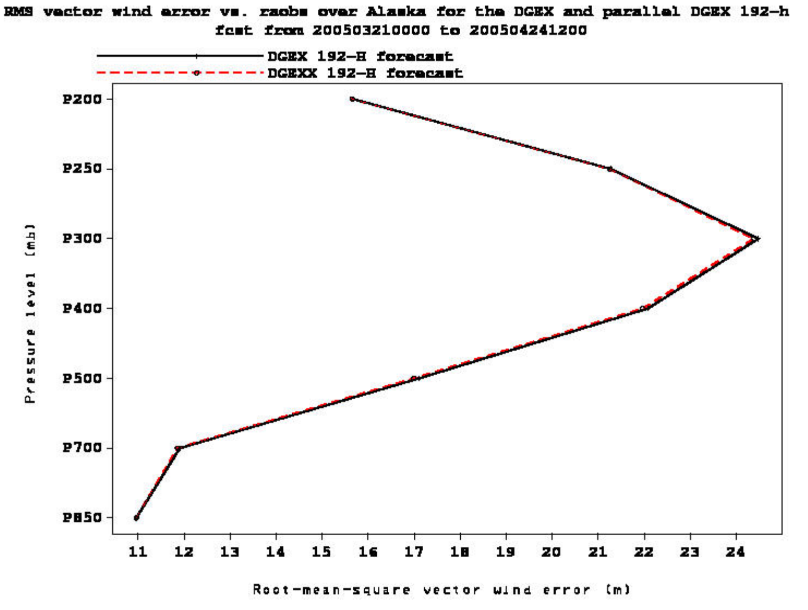
Z





V



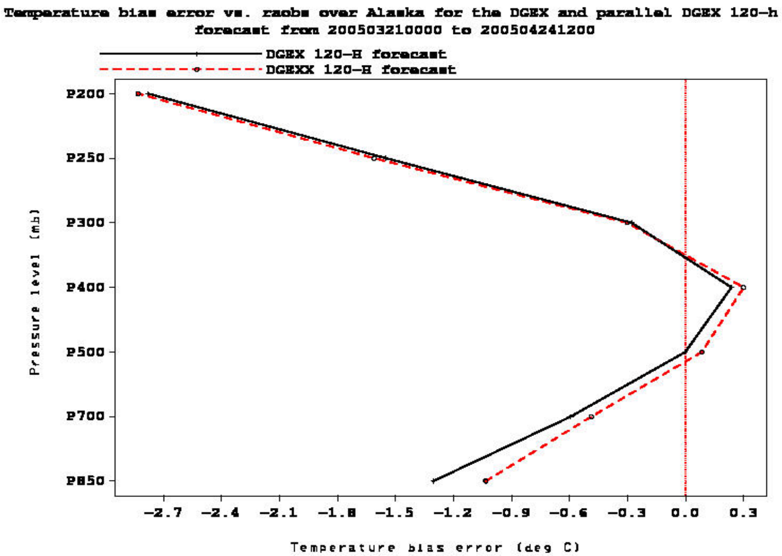


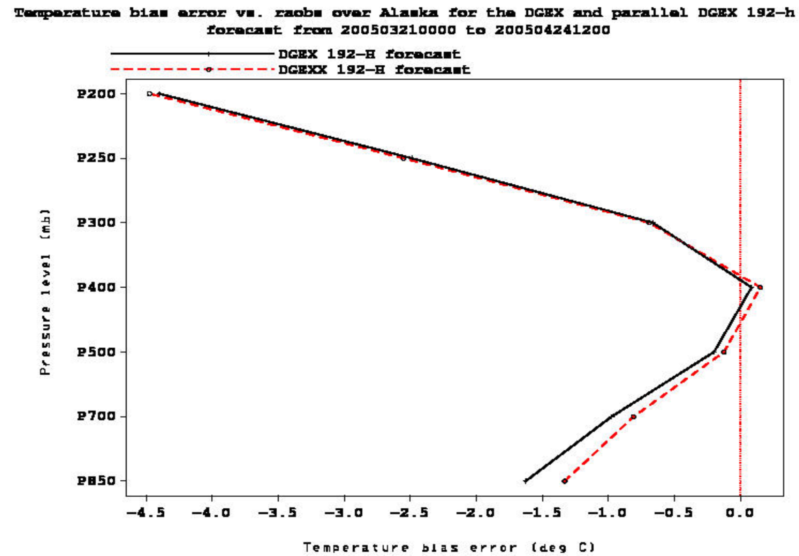
120-h Forecast

192-h Forecast

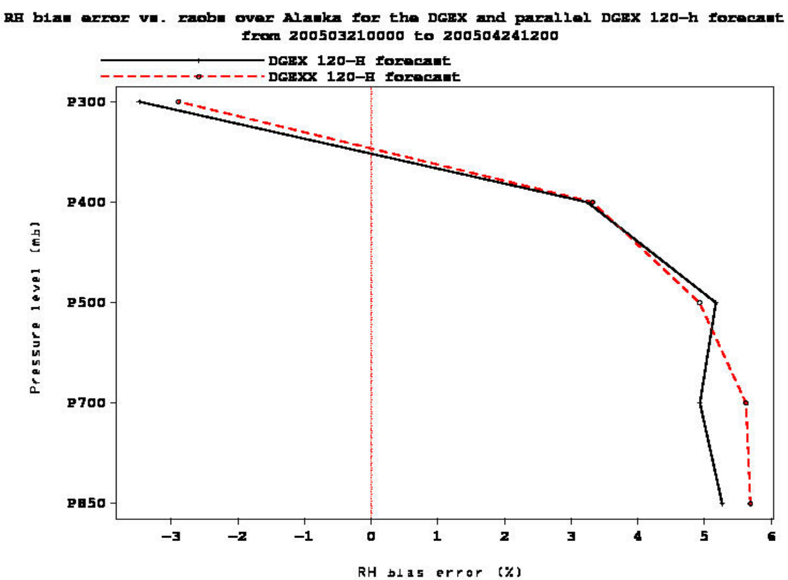
Alaska Spring : Temperature / RH Bias Error ; DGEX = Solid black, DGEXX = Dashed Red

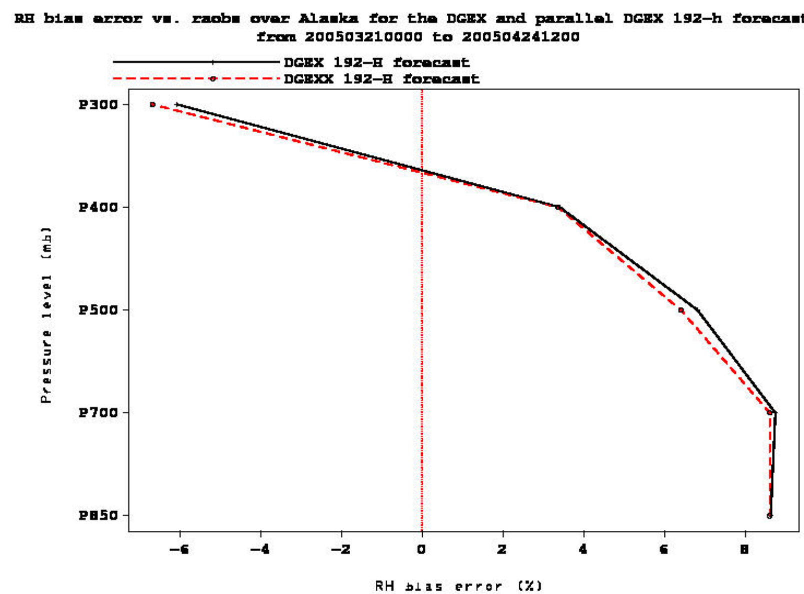
T





R
H

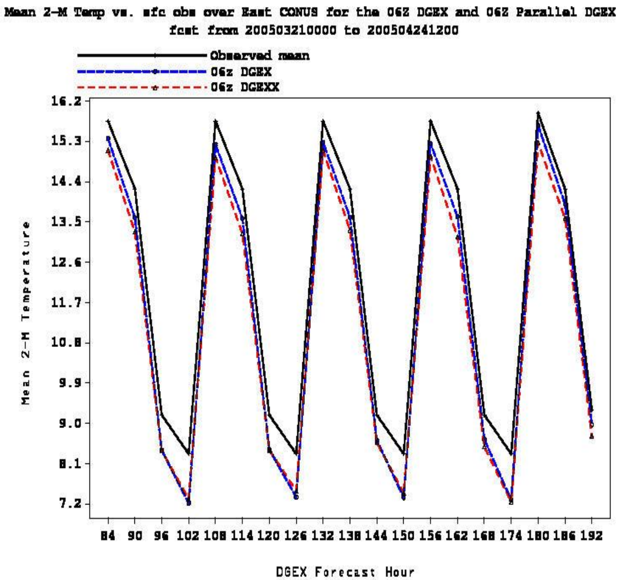




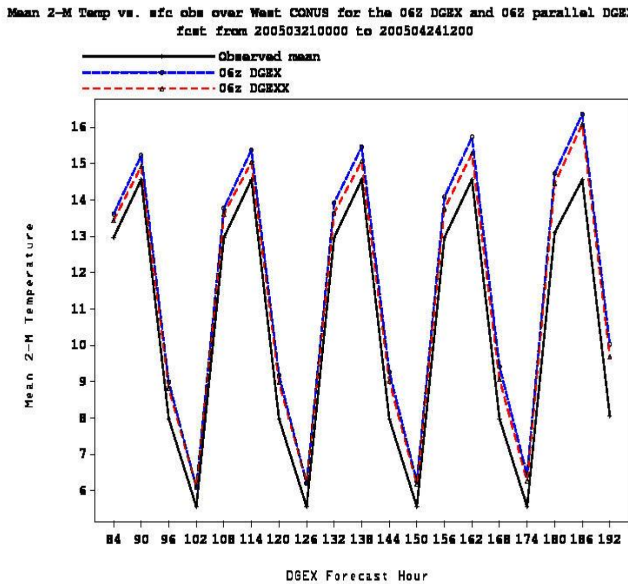
120-h Forecast

192-h Forecast

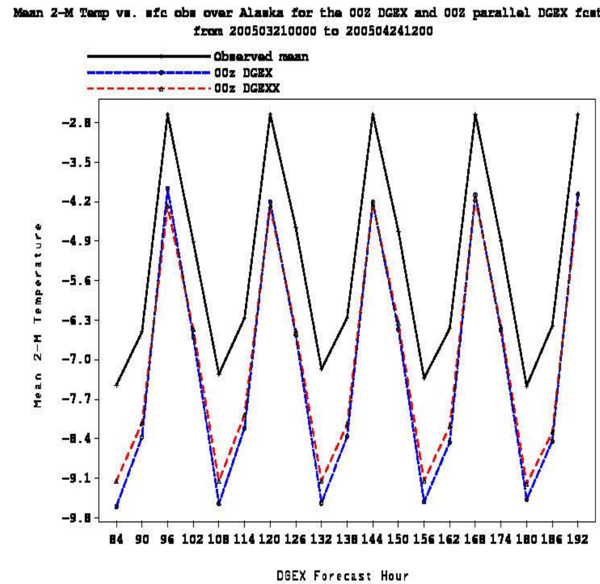
Spring Mean 2-m Temperature vs Obs ; Obs=Black ; DGEX = Blue ; DGEXX = Red



East CONUS



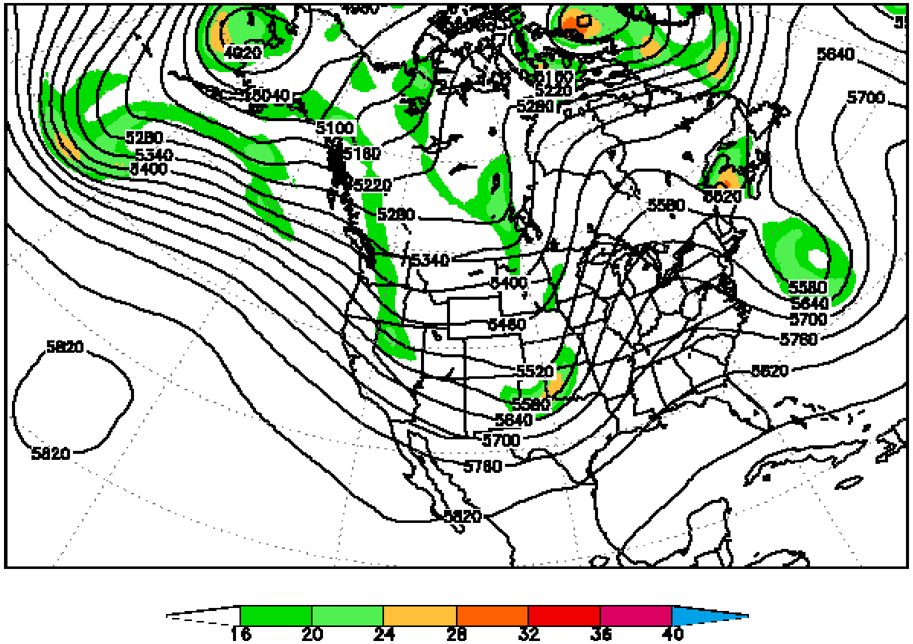
West CONUS



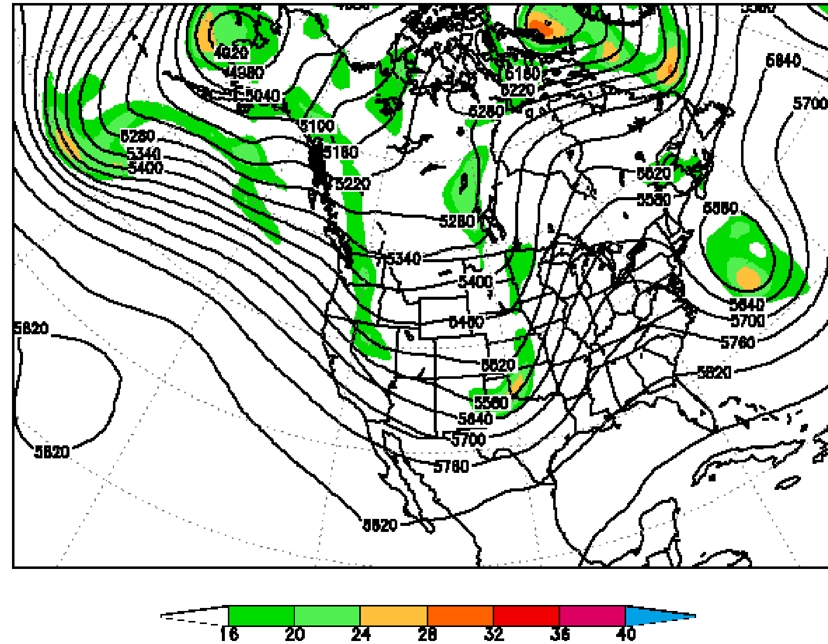
Alaska

Example of 500mb Height Differences

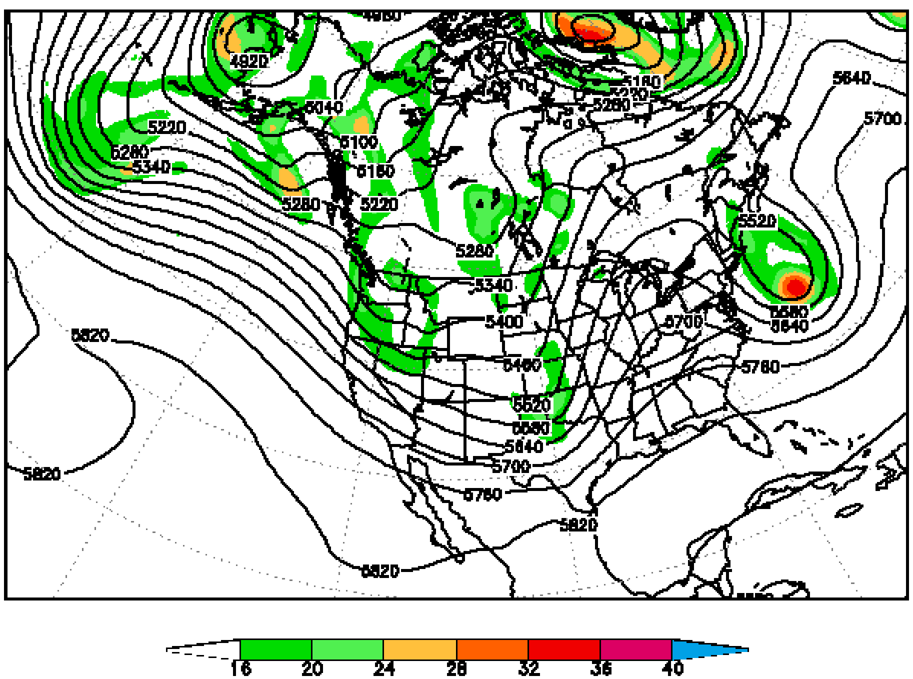
500MB Z-VORT NAM 48H FCST VALID 00Z 30 MAR 2005



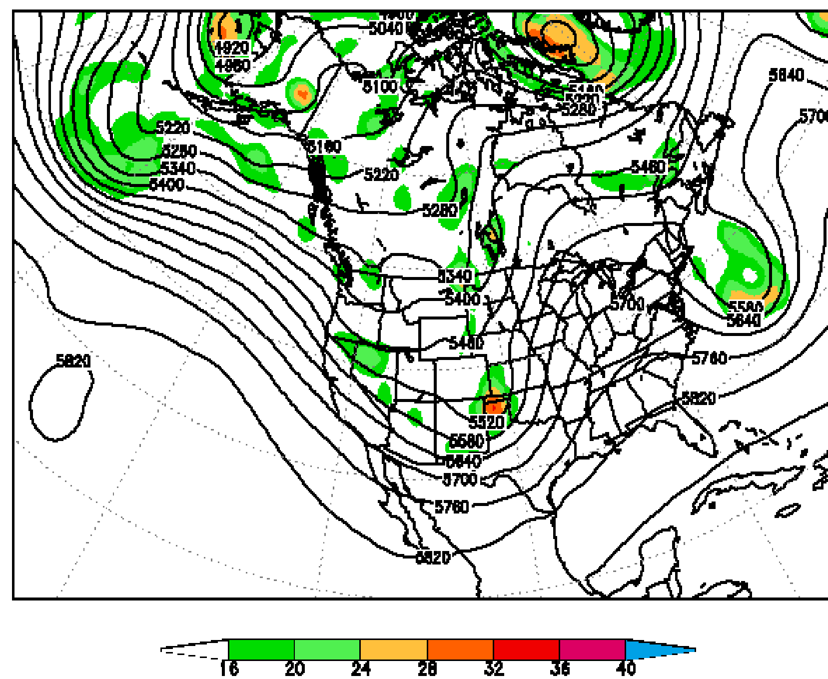
500MB Z-VORT NAMX 48H FCST VALID 00Z 30 MAR 2005



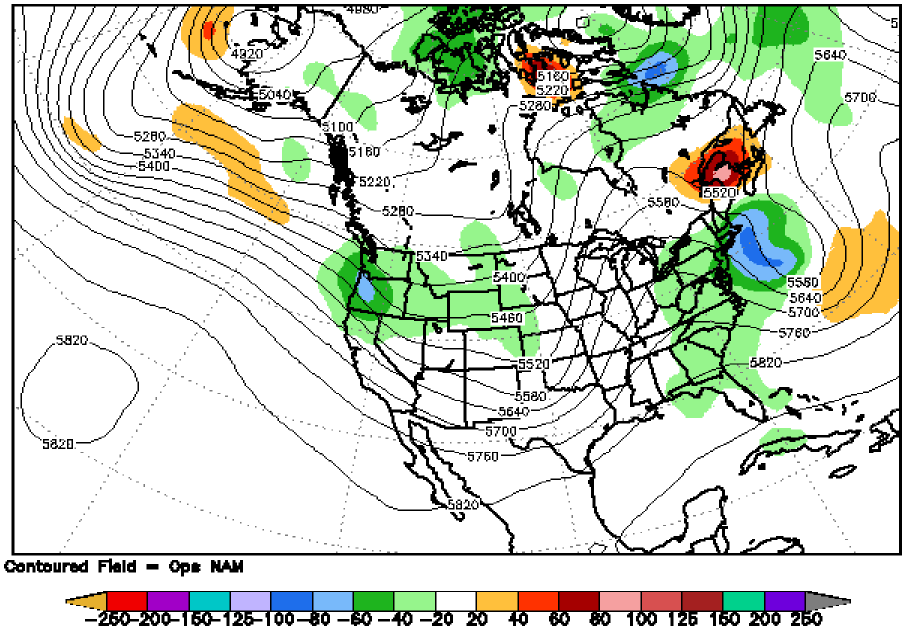
500MB Z-VORT GFS 48H FCST VALID 00Z 30 MAR 2005



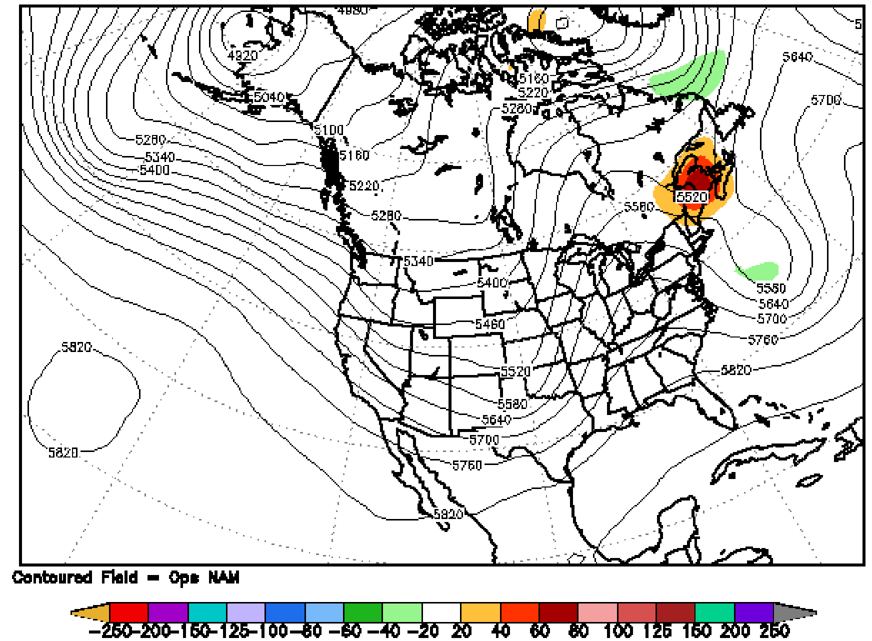
500MB Z-VORT GFS 00H FCST VALID 00Z 30 MAR 2005



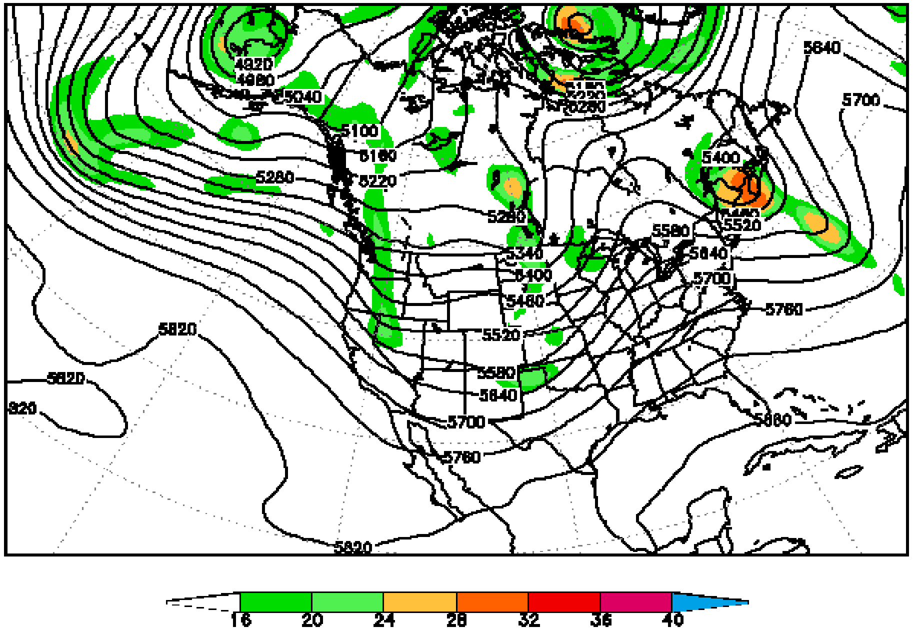
500MB Z 48H GFS–NAM VALID 00Z 30 MAR 2005



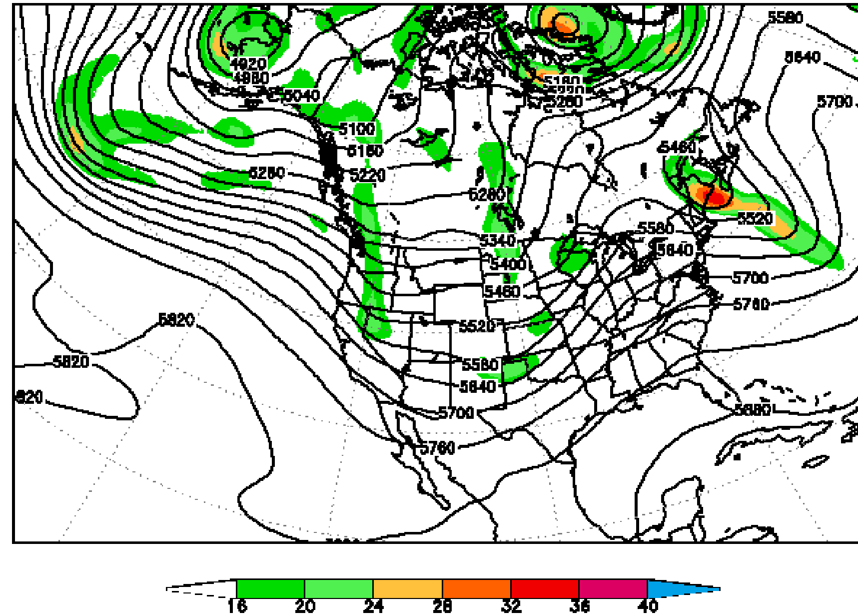
500MB Z 48H NAMX–NAM VALID 00Z 30 MAR 2005



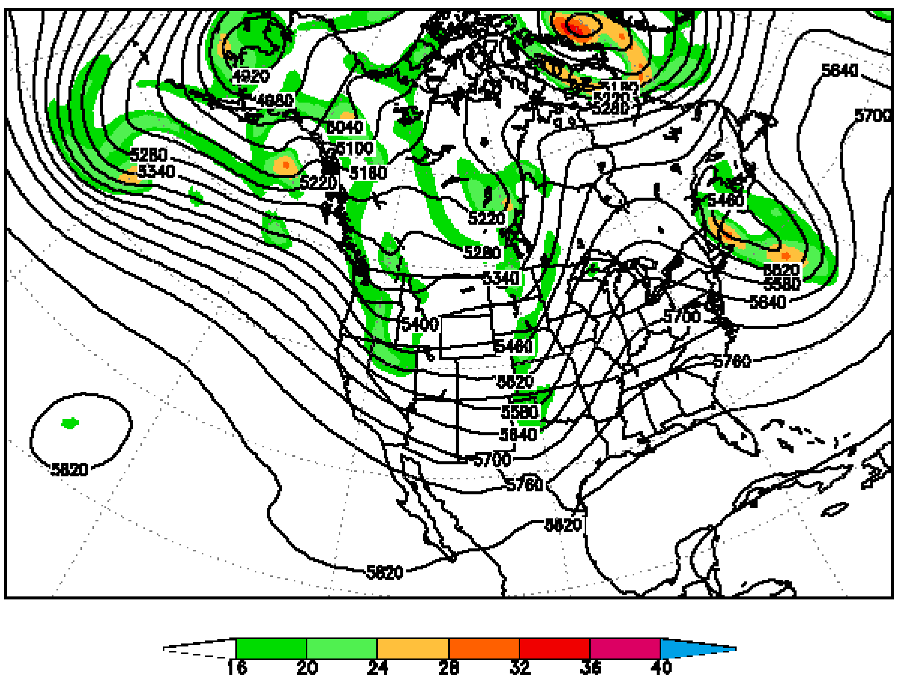
500MB Z-VORT NAM 60H FCST VALID 00Z 30 MAR 2005



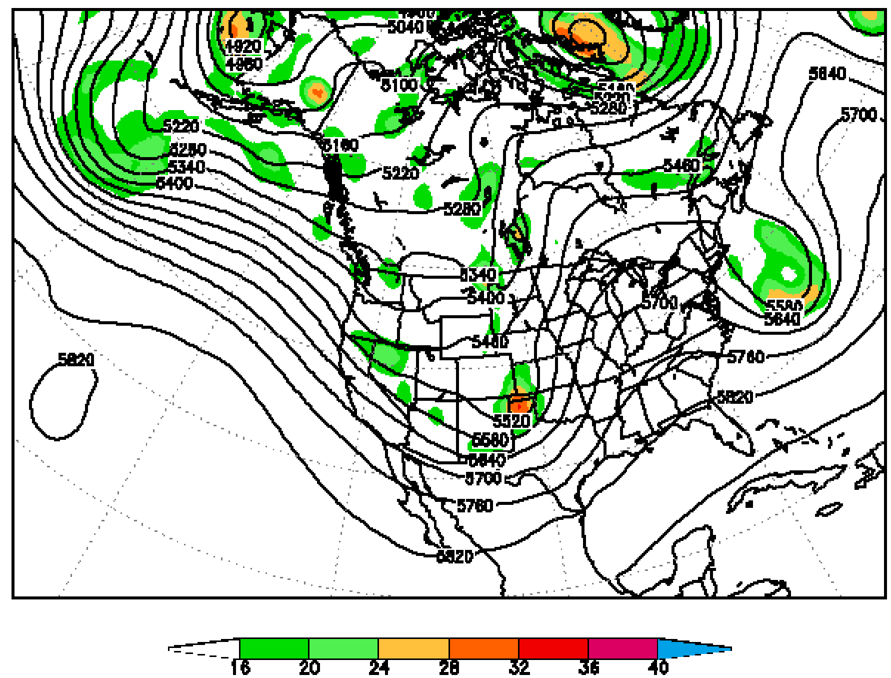
500MB Z-VORT NAMX 60H FCST VALID 00Z 30 MAR 2005



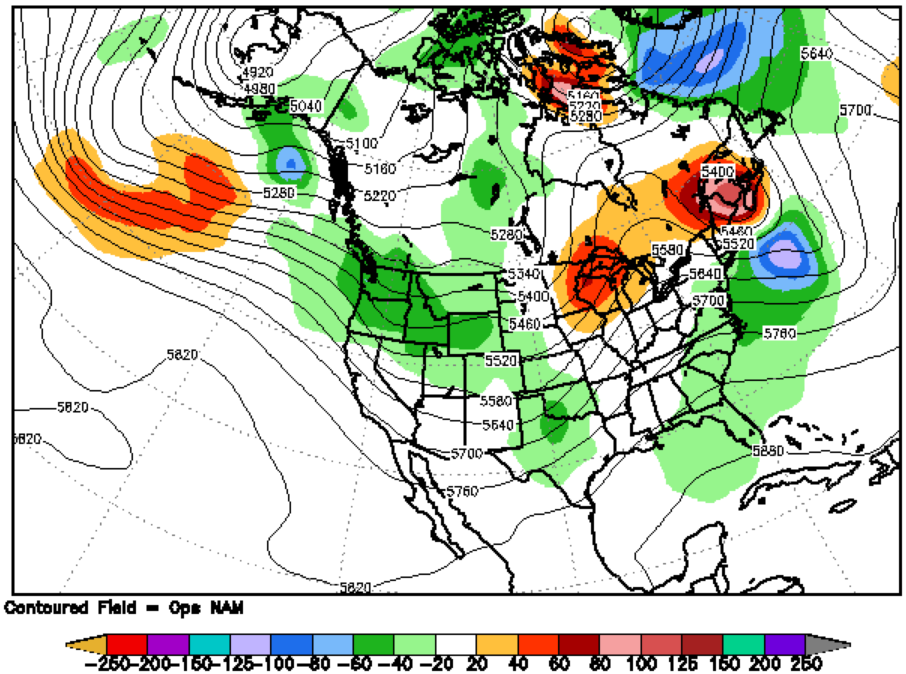
500MB Z-VORT GFS 60H FCST VALID 00Z 30 MAR 2005



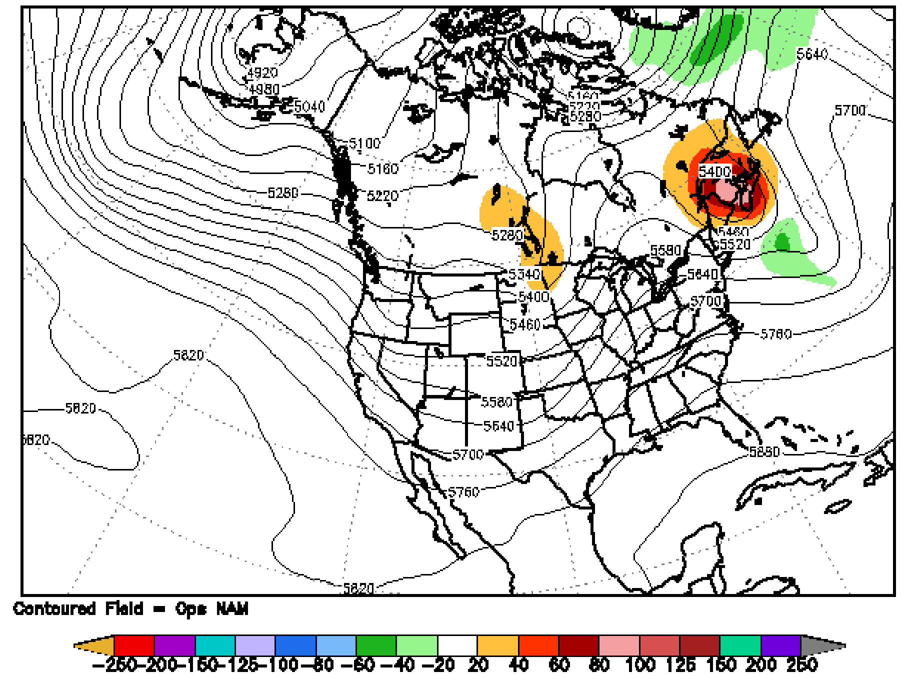
500MB Z-VORT GFS 00H FCST VALID 00Z 30 MAR 2005



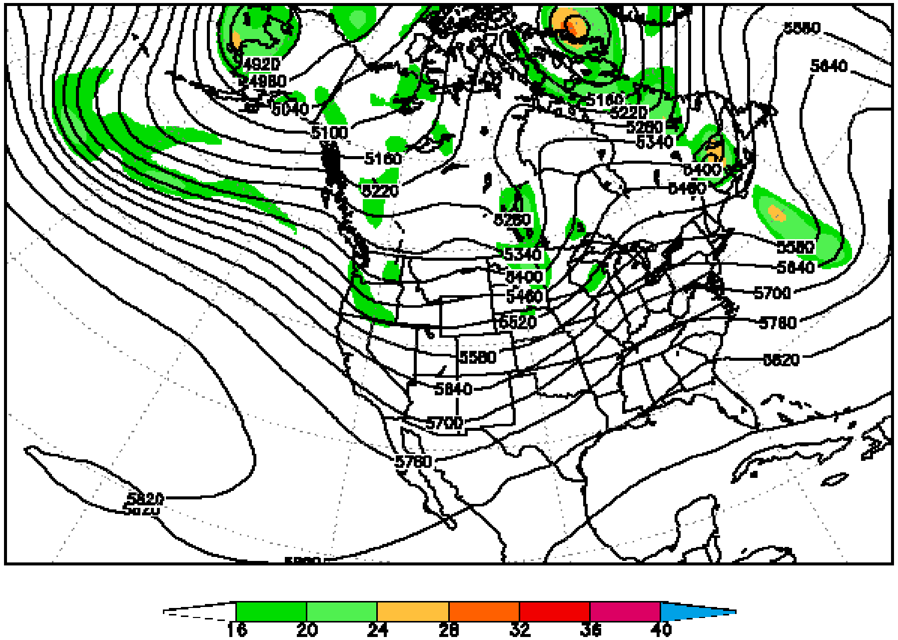
500MB Z 60H GFS-NAM VALID 00Z 30 MAR 2005



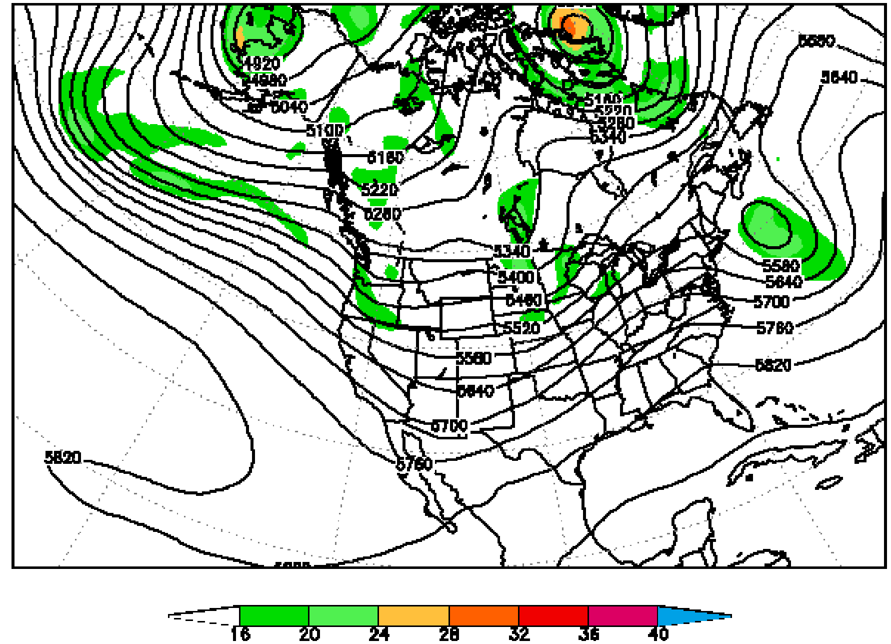
500MB Z 60H NAMX-NAM VALID 00Z 30 MAR 2005



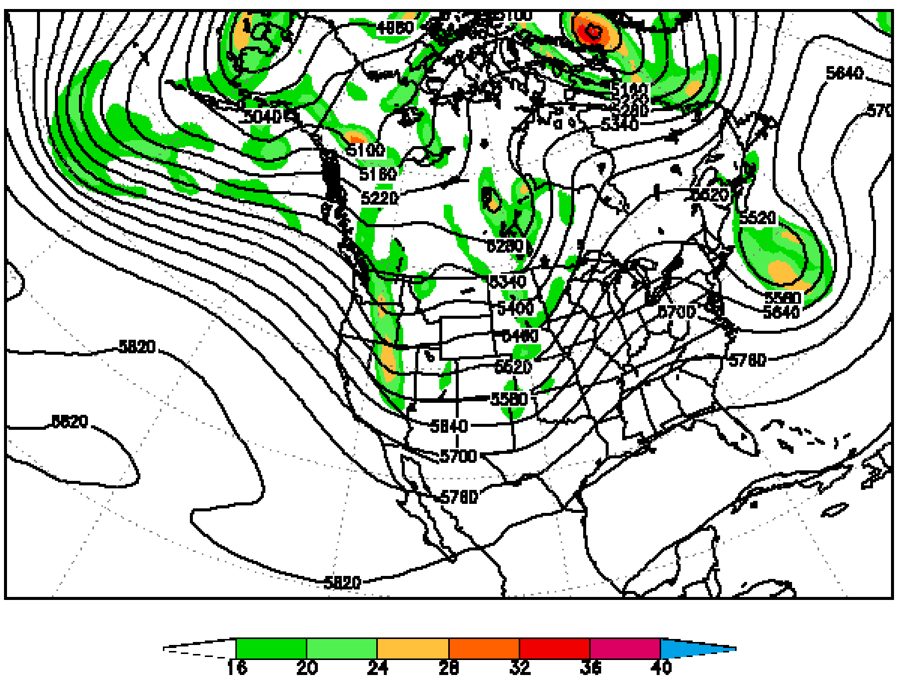
500MB Z-VORT NAM 72H FCST VALID 00Z 30 MAR 2005



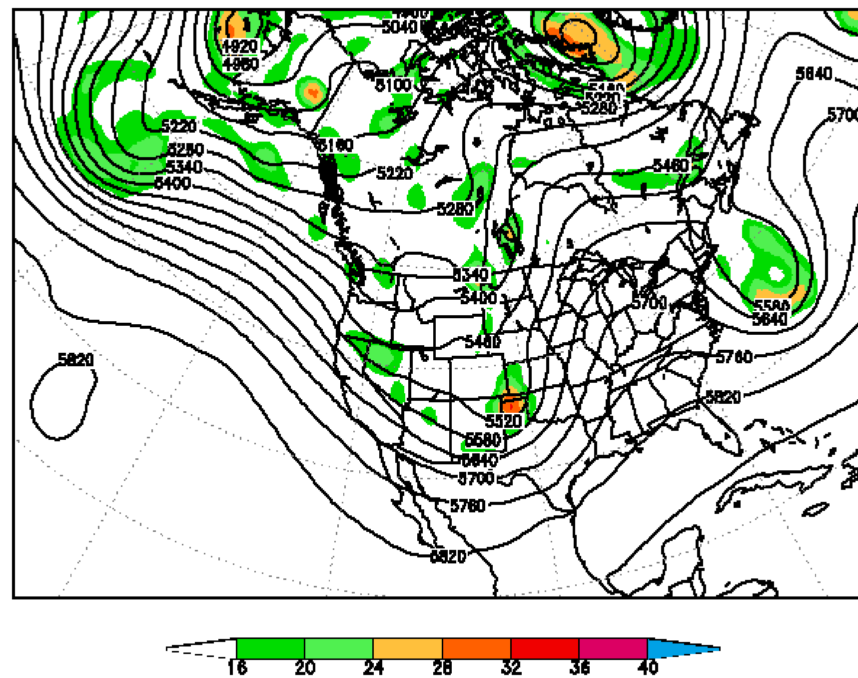
500MB Z-VORT NAMX 72H FCST VALID 00Z 30 MAR 2005



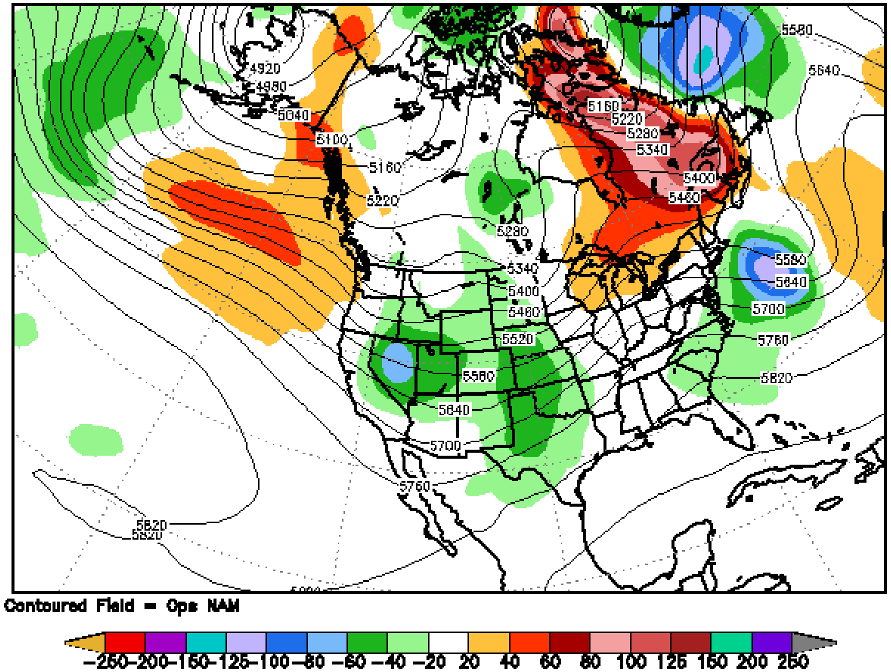
500MB Z-VORT GFS 72H FCST VALID 00Z 30 MAR 2005



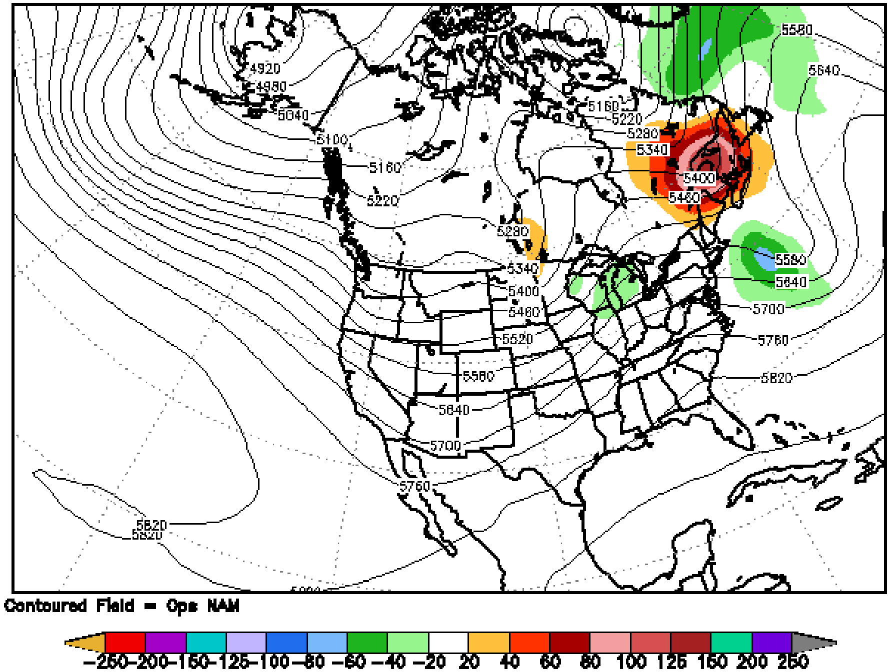
500MB Z-VORT GFS 00H FCST VALID 00Z 30 MAR 2005

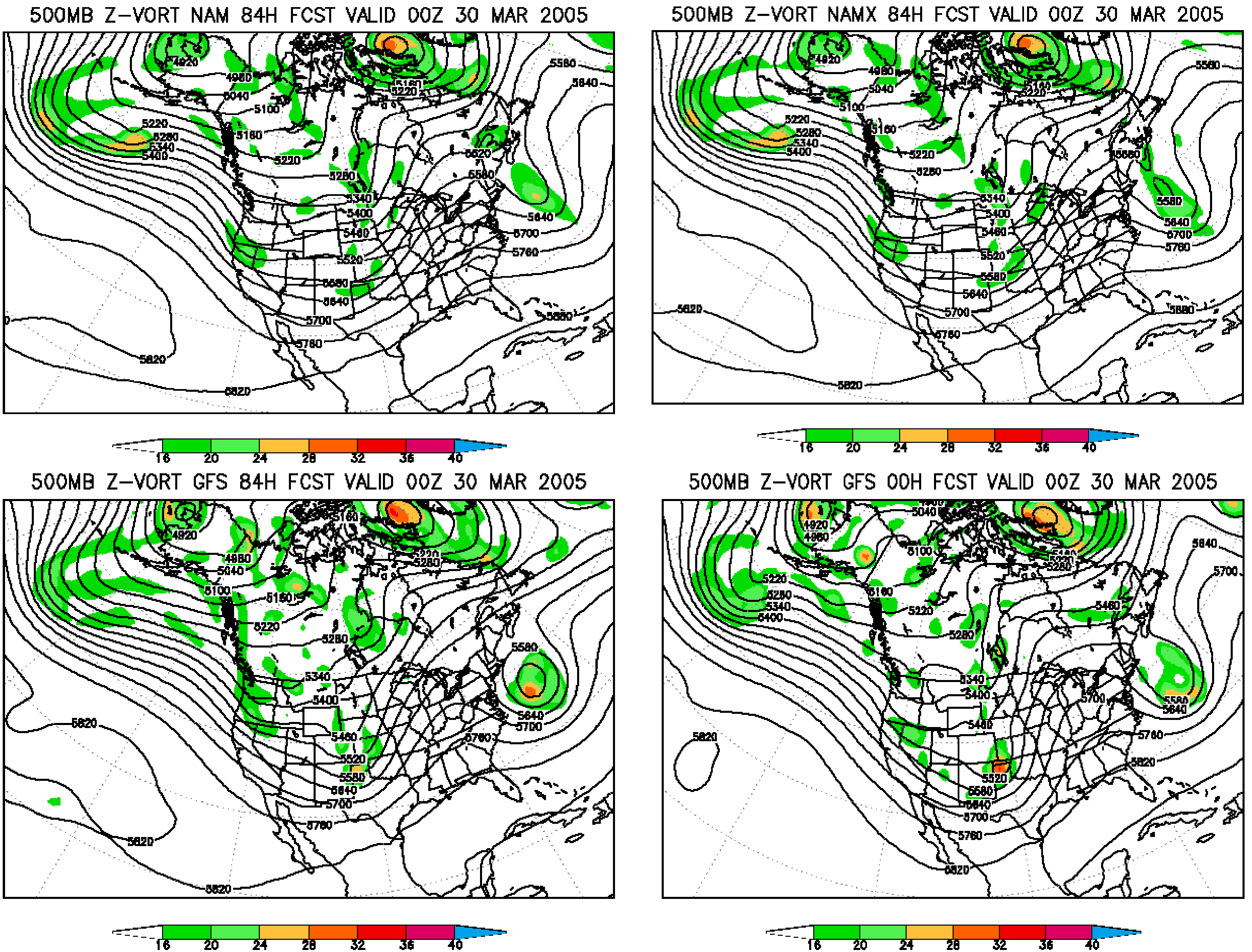


500MB Z 72H GFS-NAM VALID 00Z 30 MAR 2005

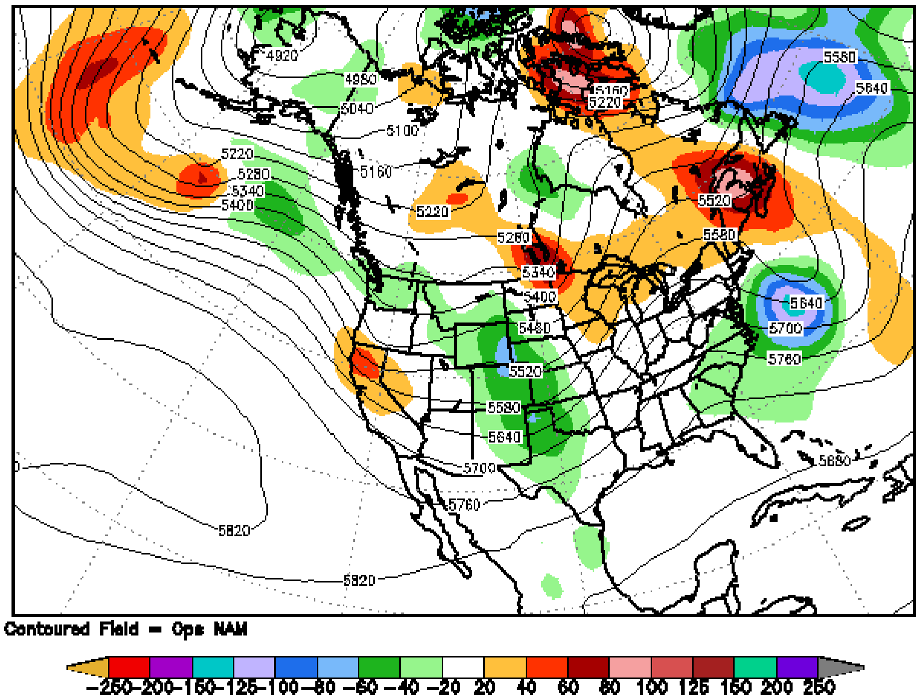


500MB Z 72H NAMX-NAM VALID 00Z 30 MAR 2005

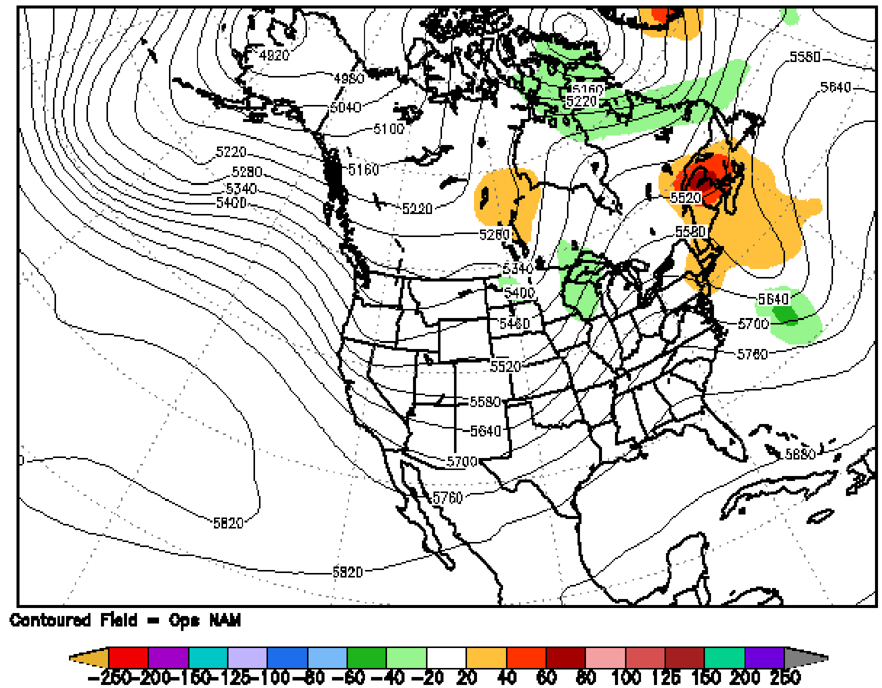



500MB Z-VORT NAM 84H FCST VALID 00Z 30 MAR 2005
500MB Z-VORT NAMX 84H FCST VALID 00Z 30 MAR 2005
500MB Z-VORT GFS 84H FCST VALID 00Z 30 MAR 2005
500MB Z-VORT GFS 00H FCST VALID 00Z 30 MAR 2005
16 20 24 28 32 36 40

500MB Z 84H GFS-NAM VALID 00Z 30 MAR 2005

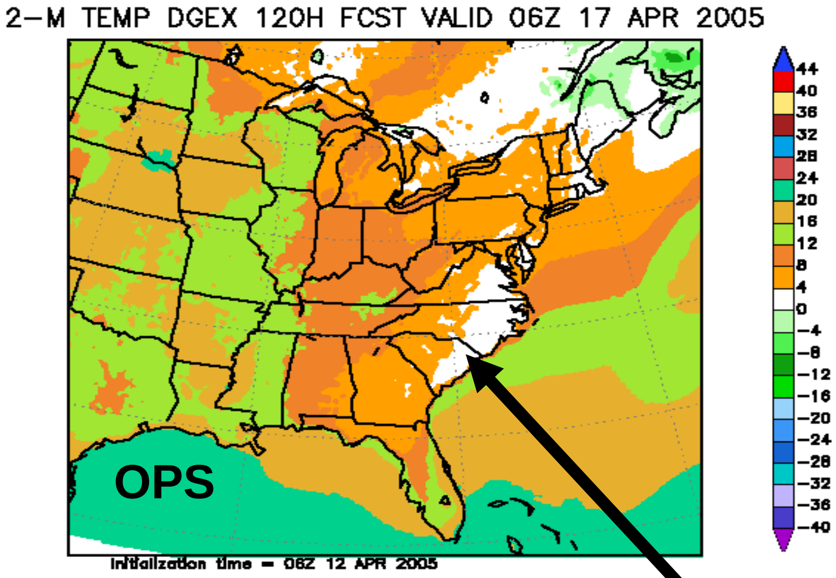


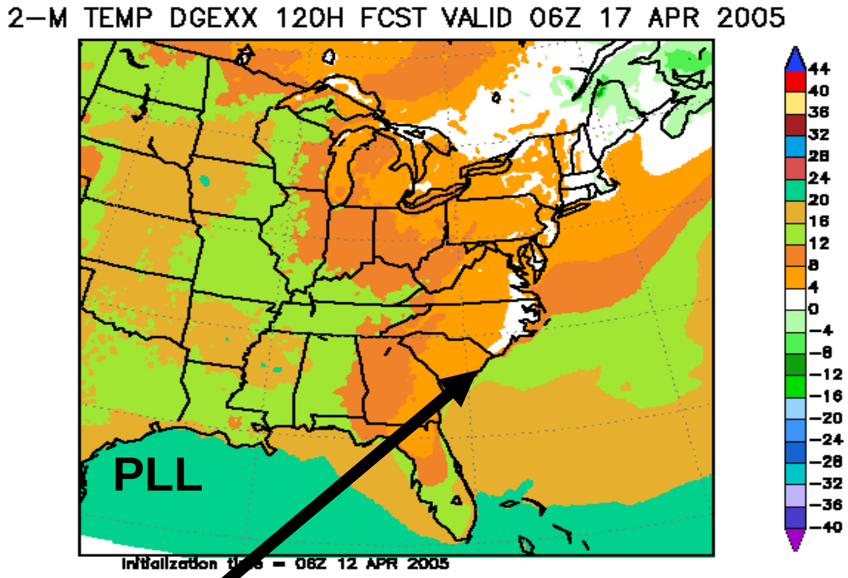
500MB Z 84H NAMX-NAM VALID 00Z 30 MAR 2005



Impact of Upgrades on DGEX

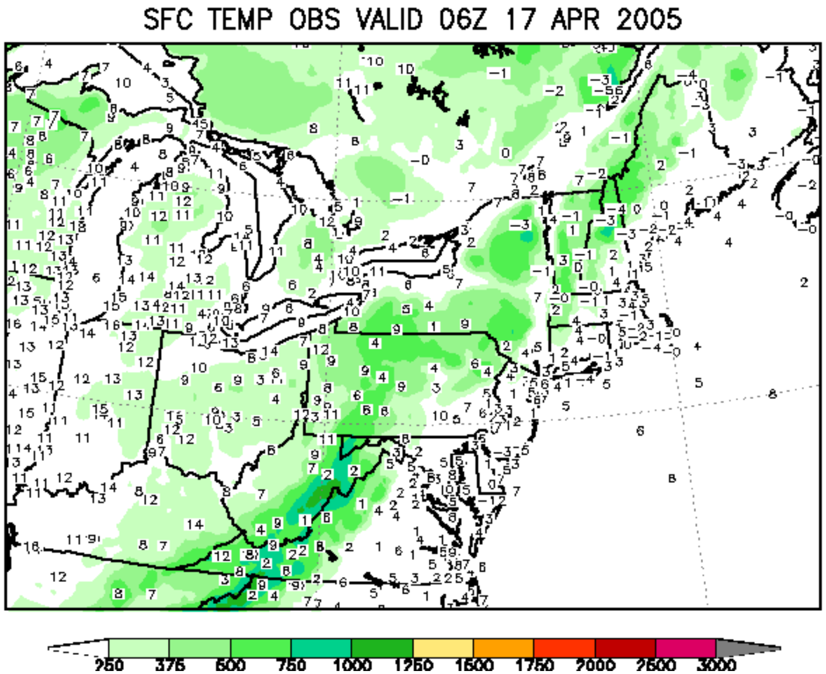
Ops and parallel DGEX 120-h forecast valid 06Z 4/17/05

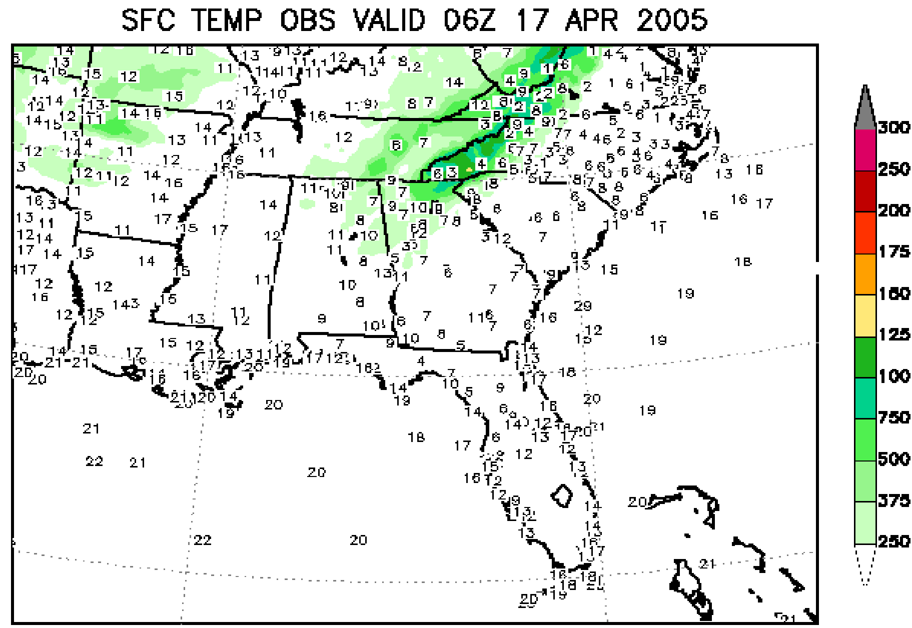


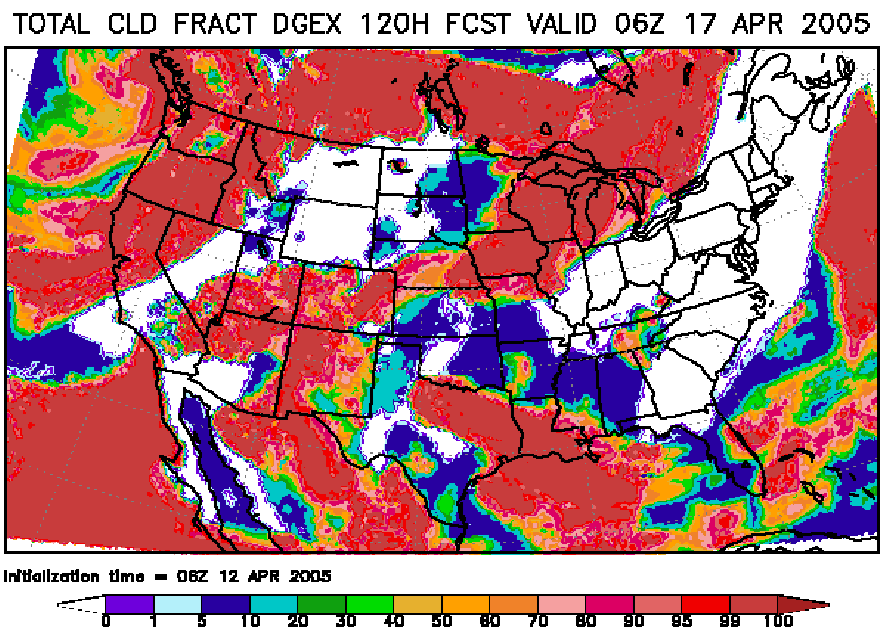


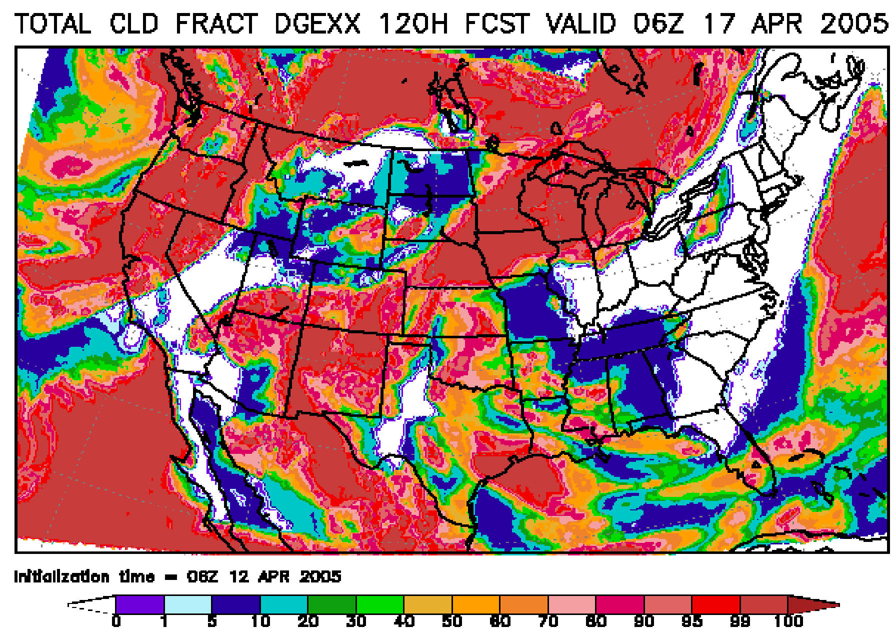
too cold

Parallel DGEX warmer along SE coast



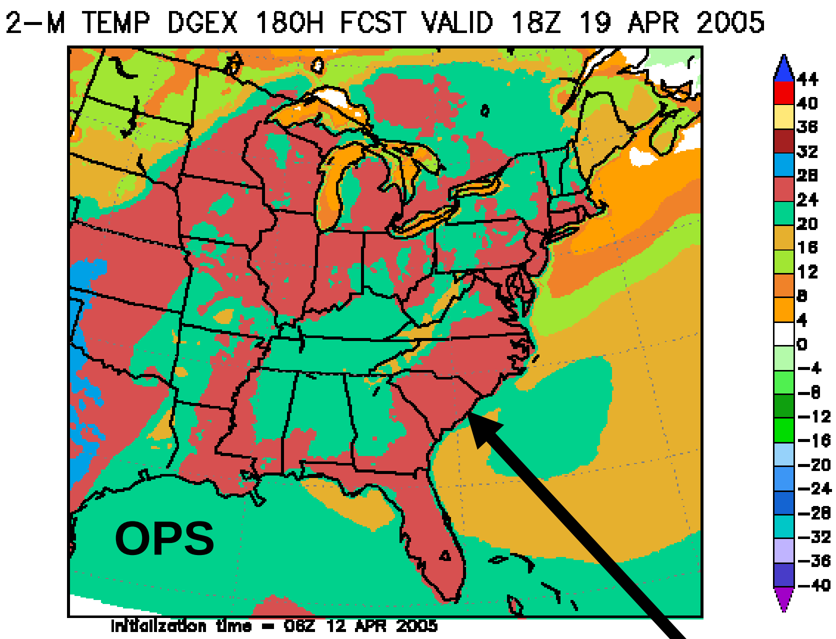


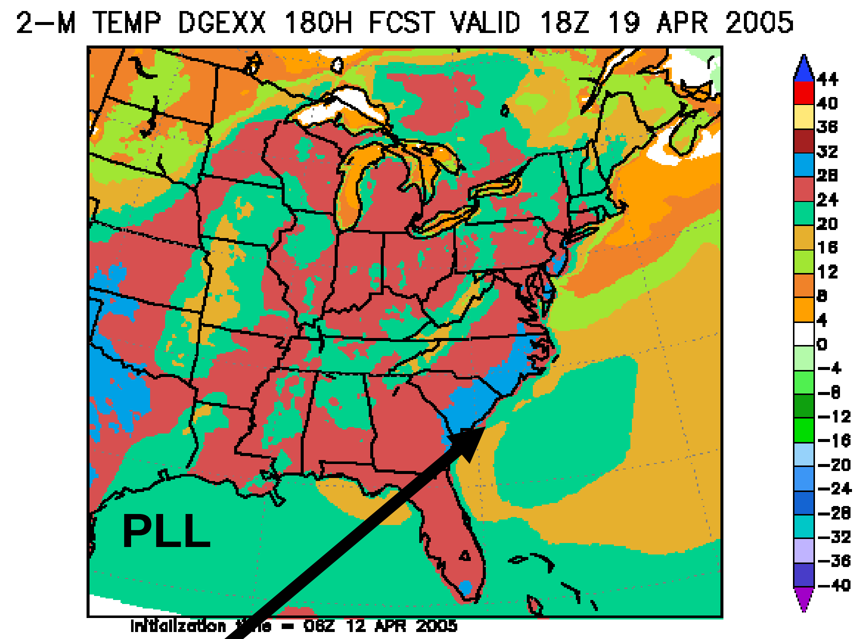




No clouds to associate with the warmer temps, so LSM related

Ops and parallel DGEX 180-h forecast valid 18Z 4/17/05

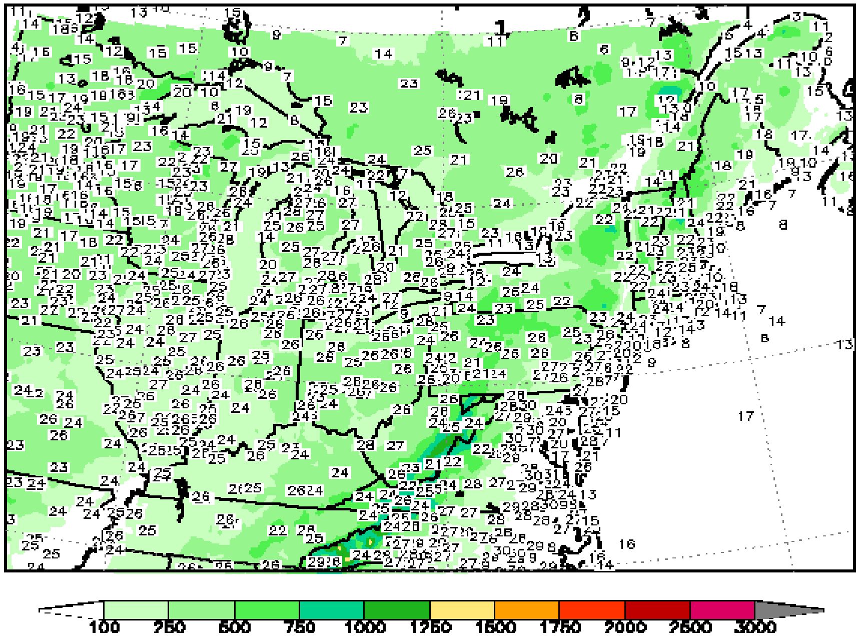




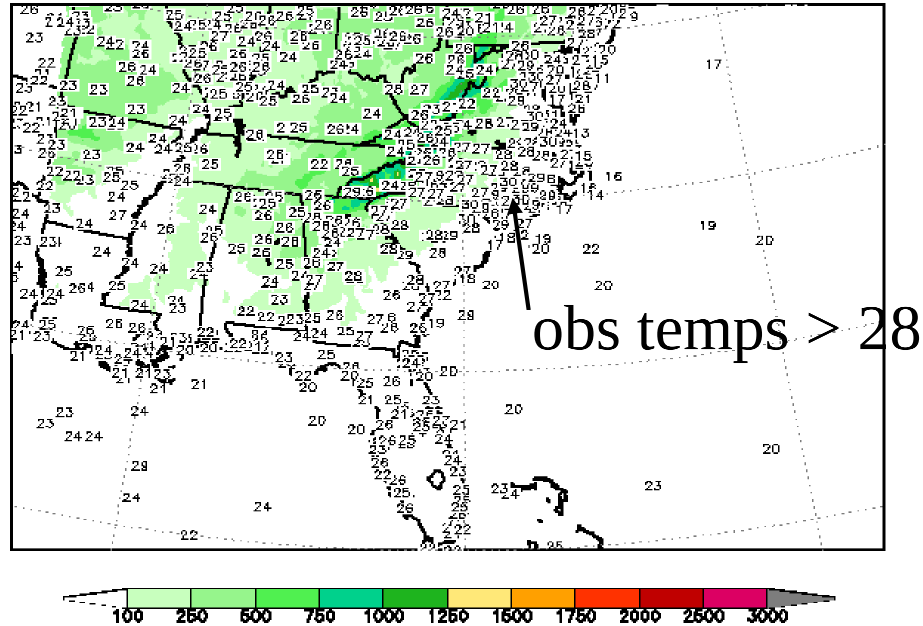
too cold > 28

Parallel DGEX warmer along SE coast

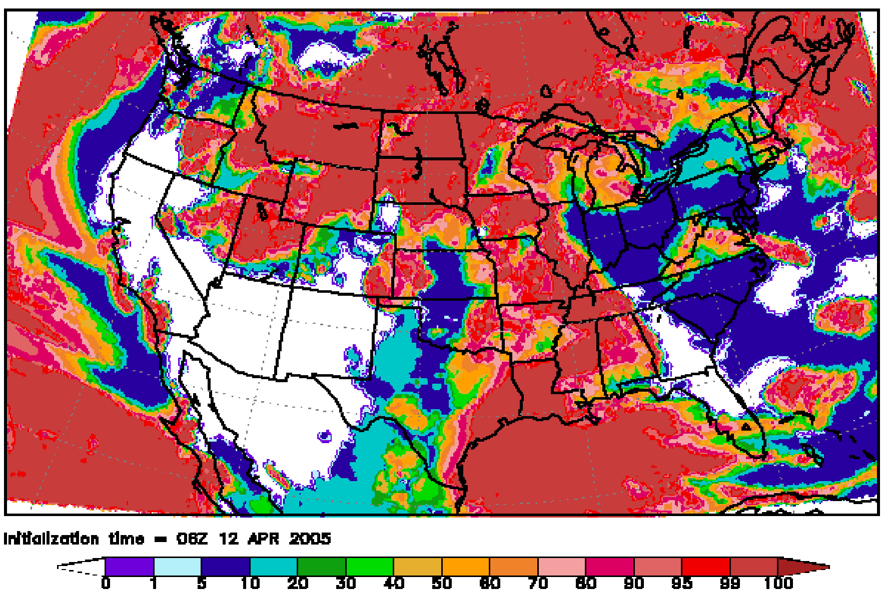
SFC TEMP OBS VALID 18Z 19 APR 2005



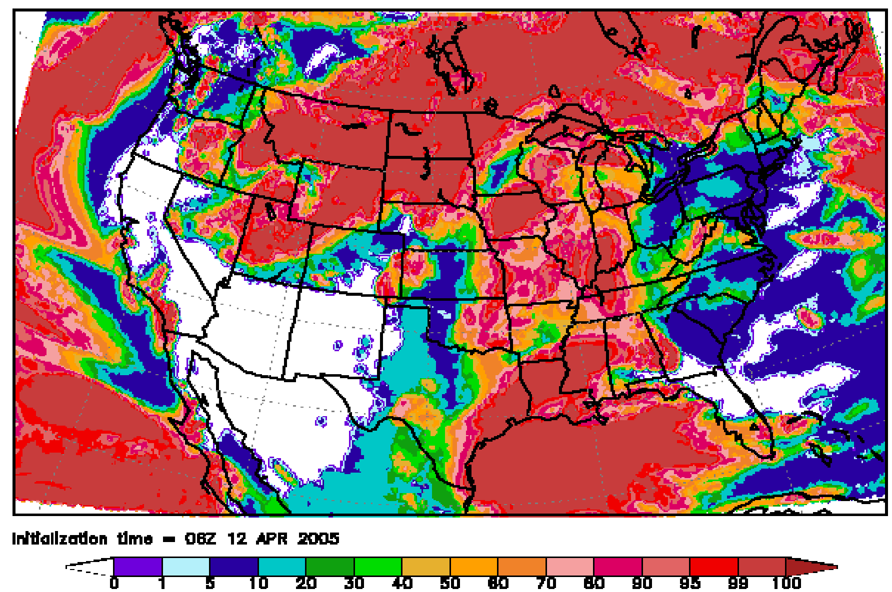
SFC TEMP OBS VALID 18Z 19 APR 2005



TOTAL CLD FRACT DGEX 180H FCST VALID 18Z 19 APR 2005



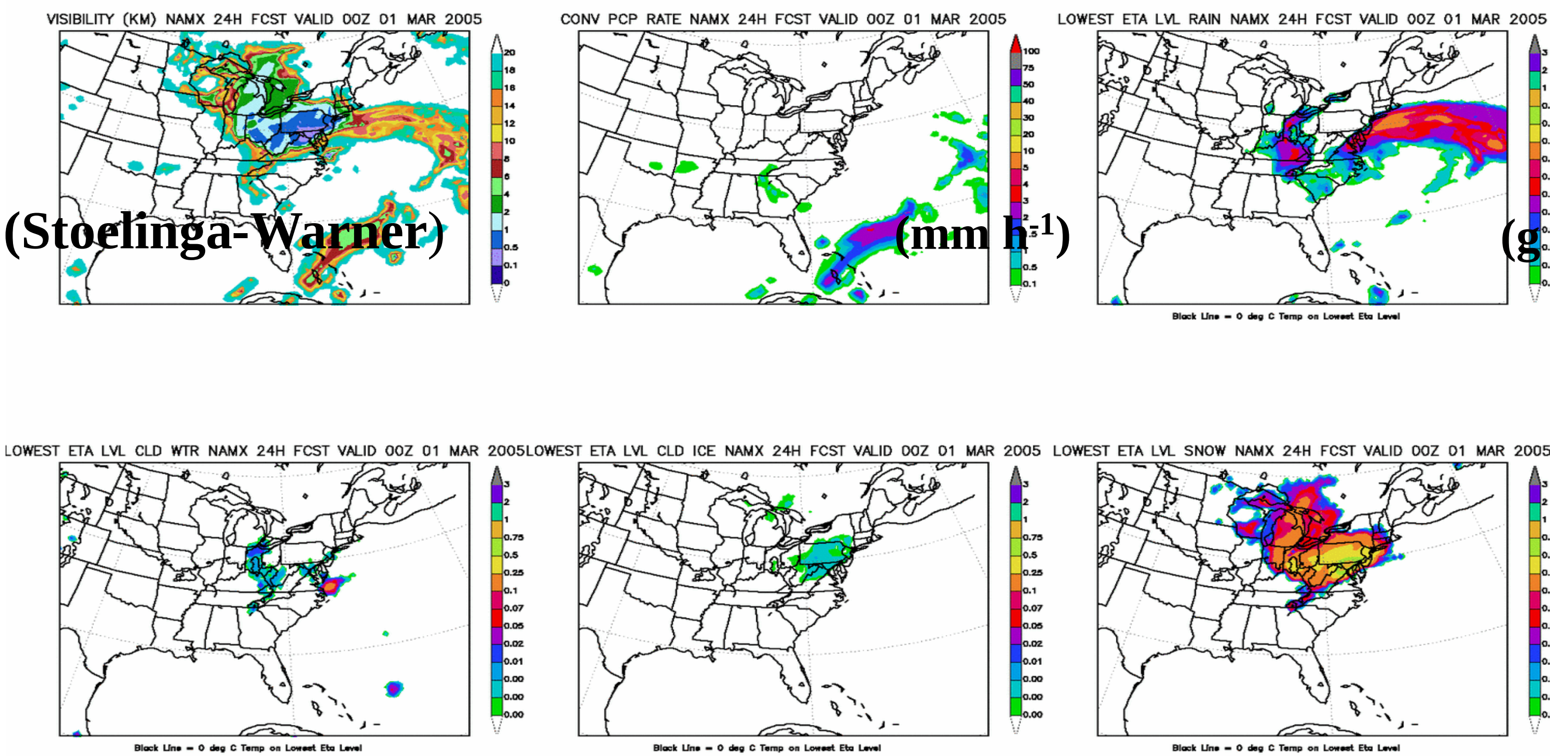
TOTAL CLD FRACT DGEXX 180H FCST VALID 18Z 19 APR 2005



Spring Upgrade Package: Products

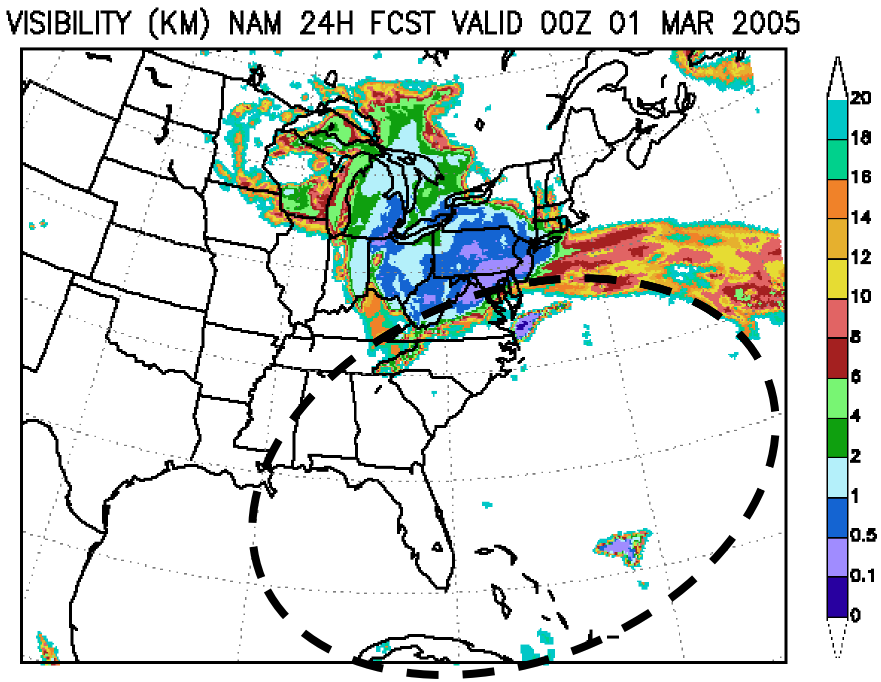
- Changes to output products coming from NAM
  - Improved surface visibility computation by including convective precipitation rate
  - Precip going into LSM
  - Added clear-sky radiation fluxes to output for use by Air Quality Forecast System

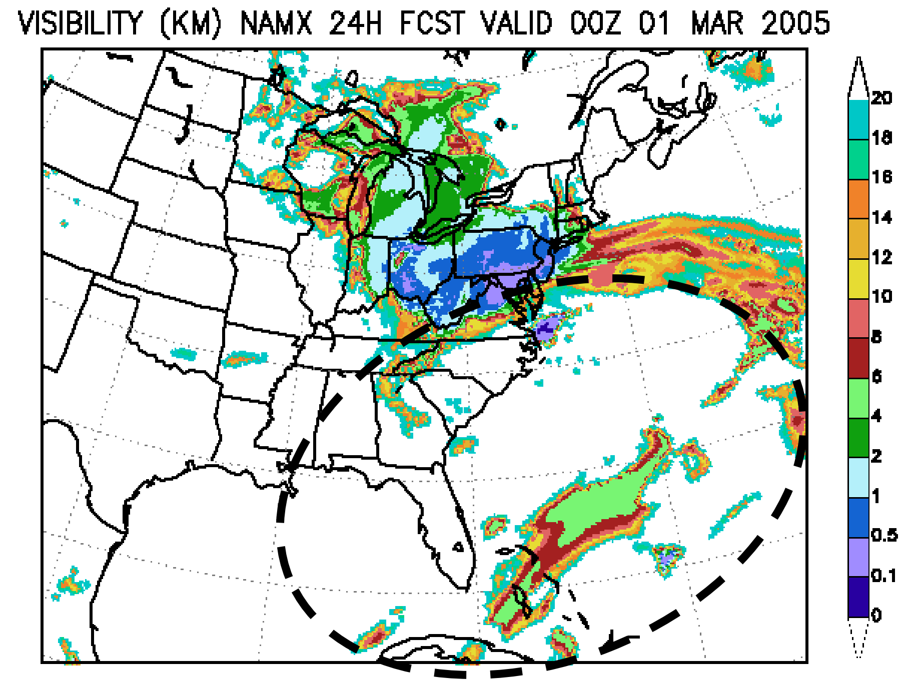
24-h Visibility and Surface Hydrometeors (NAMX)



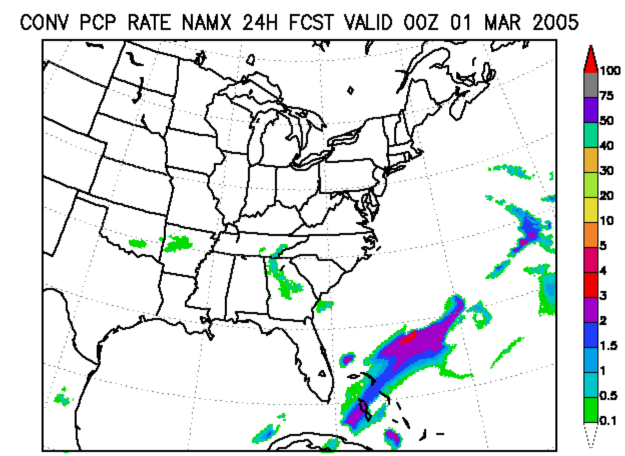
(Stoelinga-Warner) **(mm h^{-1})** **(g kg^{-1})**

(g kg^{-1}) **(g kg^{-1})** **(g kg^{-1})**





Inadvertently failed to account for convective precip in NAM, but is accounted for in NAMX



NCEP Service Center Evaluations

SPC Steve Weiss

- **No Evaluation of Retrospective Runs**
- **Real-Time Parallel Runs - SPC compared to operational NAM during period March 21 through April 15**
  - **SPC focused on fundamental fields used by SPC forecasters during the preparation of severe weather outlooks, although the short-range fields in the 6-12 hour time frame can impact convective watch decisions as well. In addition to basic synoptic pattern evolution of 500 mb heights, vorticity, temperature, surface pressure and 10m winds, SPC focused on kinematic fields related to vertical shear (jet streaks/axes of maximum wind at 500 and 850 mb, bulk vertical shear in lowest 6 km, and storm-relative helicity in lowest 3 km) and thermodynamic parameters associated with instability (lowest 30 mb BL dew point, MUCAPE and MLCAPE). On most occasions, the synoptic pattern forecasts and jet structures were comparable between the operational and parallel runs, and differences between the two runs were minor from an SPC perspective.**

NCEP Service Center Evaluations

SPC Steve Weiss

- **The largest differences were associated with low level moisture, as the parallel run consistently exhibited a more rapid northward progression of moisture inland from the Gulf of Mexico during the return flow phase over the plains in the wake of retreating surface ridges across the southeastern states. As a result, the NAM parallel BL dewpoint values were often 3-8 degrees F higher than the operational values, and this effect typically extended well inland on the leading edge of the moisture return. Comparison of the NAM parallel forecasts with verifying 2m dewpoints from METAR sites usually indicated the predicted dewpoints were too high. Within the zones of increased low level moisture in the parallel runs, larger values of MUCAPE and MLCAPE were often found when compared with CAPE forecasts from the operational run. The differences were typically on the order of 500 J/kg. General precipitation areas in the two runs were often rather similar, although when differences were observed they usually showed earlier and somewhat heavier convective precip in the parallel runs. We did note that the parallel run occasionally exhibited more structure and organization in the 3-hour accumulated precipitation field compared to the operational run, although we did not focus on specific QPF issues.**

NCEP Service Center Evaluations
SPC Steve Weiss

- **Since no access to PFC soundings from the parallel runs, SPC cannot comment on the vertical profile of low level moisture. However, there was a noticeable enough difference between the BL dewpoint values in the two runs coupled with the apparent increased moisture bias of the parallel run to raise questions about possible causes of the enhanced moisture return (advection, land-surface processes, etc.). We hope EMC will explore this aspect of NAM performance and identify processes contributing to the forecasts of increased low level moisture.**

- **There is a chance that in operational return flow situations the higher values of moisture/instability in the parallel version could lead to an erroneous early introduction of severe potential if forecasters are unaware of the possible bias in the NAM model forecasts. However, SPC forecasters will continue to consult the SREF and GFS guidance in their decision-making process, and pay close attention to evolving NAM model characteristics through the warm season and convey any new observations to EMC.**

NCEP Service Center Evaluations - SPC

- **Recommendation: Implement as proposed**

- **Although SPC has concerns about the recent observations of excessive return flow moisture and instability in the NAM parallel performance, this characteristic is likely not a "show stopper" in an overall NWS sense, and SPC will offer cautious support to move ahead with the implementation.**

NCEP Service Center Evaluations

HPC Pete Manousos

- **Real-Time Parallel Run Evaluation Comments:**

HPC forecasters experience has subjectively indicated the parallel NAM QPF does seem to outperform (by a small margin) the operational version. Differences in mass fields between the two versions do not typically become manifest until about f60 and tend to be subtle. Precipitable water values in the parallel version seem to be about .1" higher than the operational version (which was in the noise level compared to the observations). Additionally, the parallel NAM has been a little more progressive by about a half degree lon (and slightly weaker by about 30dm) at 500mb than the operational version with cut off lows moving across the CONUS. This latter tendency met with mixed review internally at HPC.

Objective statistics generated for QPF indicated for light amounts (less than 1 inch), there are no real difference in threat scores. There is some improvement for thresholds of 1 inch or greater in the day 1 time frame. However, differences are minimal between the two versions for days 2 and 3 at the same thresholds. The parallel version did exhibit a slightly higher bias (closer to 1) than the operational version, but by day 3 differences in bias are negligible

NCEP Service Center Evaluations - HPC

- **Recommendation: Implement as proposed**
- **Thank you very much (NCO & EMC) for getting this output in NAWIPS near real time. It allowed many more forecasters to be involved in the evaluation than in recent upgrades.**

NCEP Service Center Evaluations
AWC Steve Silberberg

- Real-time AWC evaluation of NAM/NAM-Parallel
- Wind, turbulence diagnostics (Ri, Ellrod, TKE generation, etc.), RH (in most areas) and stability indices (LI, K) all slightly better for NAM-Parallel
- RH areas ≥ 90% are smaller over the California coastal waters at 0.982 sigma in the NAM-Parallel.
- RH areas ≥ 90% are smaller at all lower levels (< 850 hPa) over the upper Midwest for the NAM-Parallel. At 850 hPa this reverses with the NAM-Parallel having more areas ≥ 90%. At 700 hPa and above RH areas ≥ 90% are smaller for the NAM-Parallel. Could be case dependent.
- In upslope areas of the Rockies and during Gulf Coast return flow situations, the NAM-Parallel shows smaller areas of RH ≥ 80%. After F36, the NAM-Parallel shows areas of RH ≥ 80% that do not exist in the operational NAM.
- After F24, the NAM-Parallel stability indices were more unstable than the operational NAM.

NCEP Service Center Evaluations - AWC

- **`Recommendation: Implement as proposed`**

- AWC acknowledges EMC and NCO personnel for developing and arranging dataflow for the real-time NAM-Parallel evaluation

Summary

- 3DVar changes
  - Sfc Temps: no negative impact, safe to turn back on
  - LII.5 88D winds: minimal impact on performance statistics
- Precip Assimilation
  - More robust, more accurate & moist soil moisture
- Prediction Model changes
  - Rad & cloud: more partial cloudiness and better absorption
  - LSM changes: soil & veg better defined, reduced 2-m temperature biases, less drying trend with more low level moisture overall
- Impacts to DGEX minor but generally positive
- Thoroughly tested: 3 seasons, real-time and retrosp.
- NCEP Service Centers recommend implementation
- Request NCEP Director concurrence to implement