N
C
E
P

Decision Brief: Upgrade to NAM/DGEX

Mesoscale Modeling Branch

Eric Rogers, Geoff DiMego, Tom Black, Mike Ek,

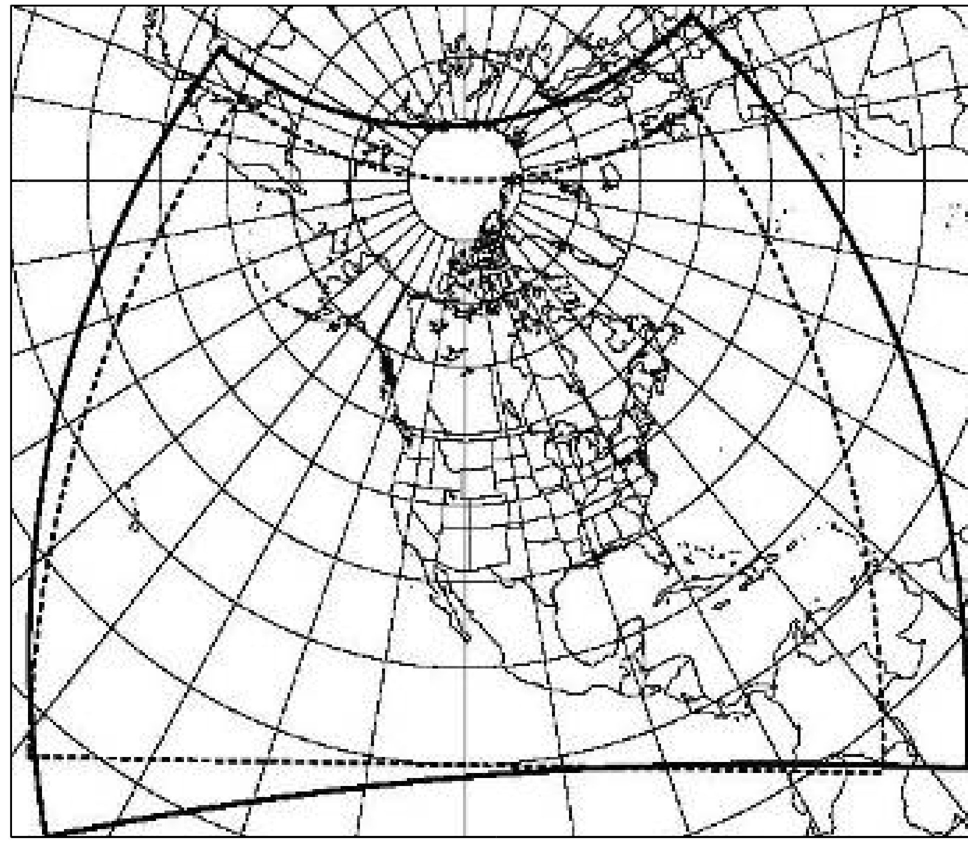
Brad Ferrier, George Gayno, Zavisa Janjic, Dennis Keyser,

Ying Lin, Matthew Pyle, Wan-Shu Wu

14 March 2008

Proposed Changes

- Expand computational domain by 18%
  - Requested by NWS Alaska Region to move lateral boundary further north/west
  - Requested by AWC to extend lateral boundary further east over Atlantic
  - More efficient obs pre-processing for NDAS/NAM (only dumped over new NAM domain instead of western hemisphere)



Proposed Changes to WRF-NMM Model

- Gravity Wave Drag / Mountain Blocking
- Unified (with NCAR) land-surface physics
- Modified passive advection (relax requirement for exact conservation of q, TKE, cloud water in advection step due to open inflow/outflow at the lateral boundary)

Proposed Changes to WRF-NMM Model

- Improved computation of surface longwave radiation
  - remove averaging of tendencies from two lowest layers
  - upward LW at sfc computed based on skin temp instead of average of skin T and lowest model layer T
- Bug fix for climatological values of stratospheric O_3
- August 2007 version of WRF-NMM repository code with modified array indexing (~5% speedup vs current ops code); compiled with higher optimization for further speedup (Thanks to J. Abeles and C. Pasti of IBM)

Proposed Changes to NAM GSI analysis / data assimilation

- Newer (Aug 2007) version of the GSI
- Recomputed NMM-based background error covariances
- Assimilation of new/better observation types (AIRS radiances, MODIS wind, Mesonet wind observations, Single field-of-view GOES radiances)

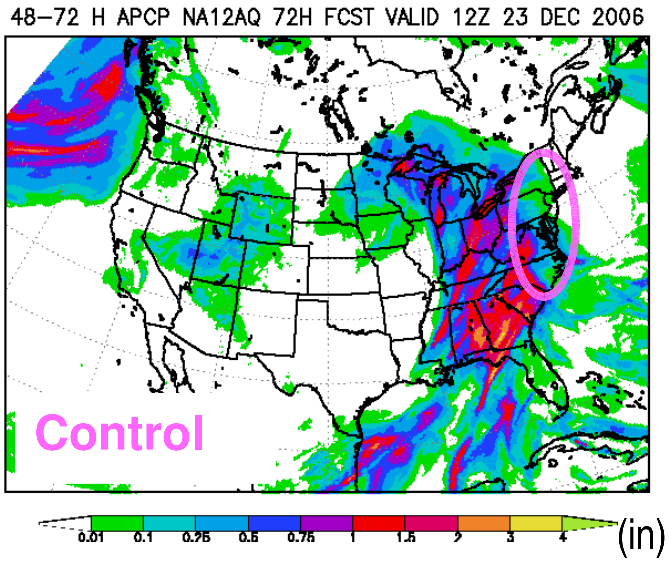
Other Proposed Changes

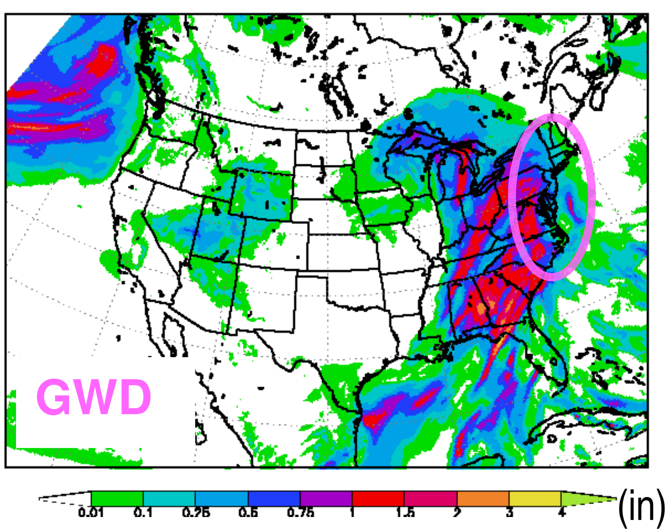
- Use 12-36 h forecast precipitation from the 00z NAM as driver for NDAS soil moisture in regions outside of CONUS rather than 3-h NDAS forecast
- New surface terrain w/modified smoothing
- Fix oversized Great Salt Lake, remove elevated water points, use climatological water temperatures for Lake Champlain

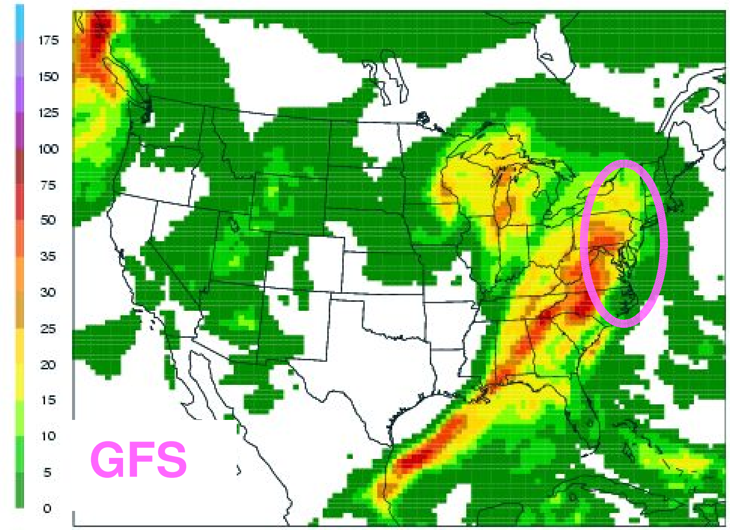
Gravity Wave Drag (GWD) & Mountain Blocking (MB)

- “Mountain blocking” (Lott & Miller, 1997)
  - Wind flow around subgrid orography
  - Low-level flow is blocked below a dividing streamline (air flows around, not over barrier)
- Gravity wave drag (Alpert et al., 1988, 1996; Kim & Arakawa,1995)
  - Mountain wave stress, pressure drag
  - Vertical distribution of the wave stress, changes winds aloft (momentum deposition)
- Effect/influence of subgrid scale orography controlled by tuning parameter SIGFAC, via:
  - SIGFAC * Standard_deviation_of_terrain
  - Set SIGFAC=0 in 12-km NAM after extensive tuning experiments

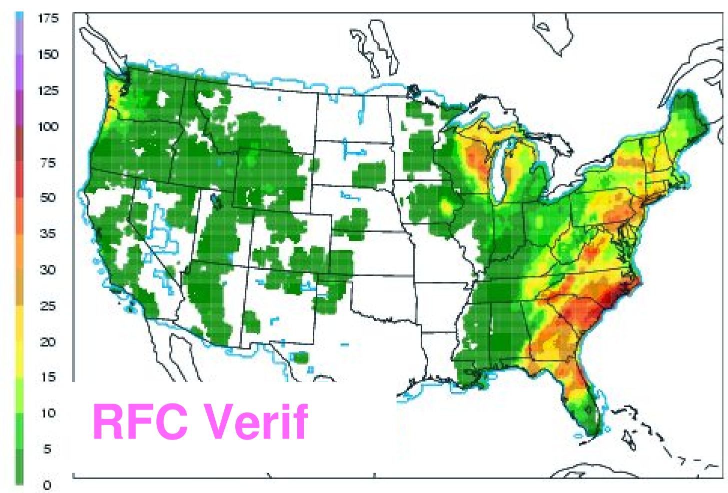
Example of GWD impact : 12z 12/20/06 NMM test
48-72 h QPF valid 12Z 23 Dec 2006



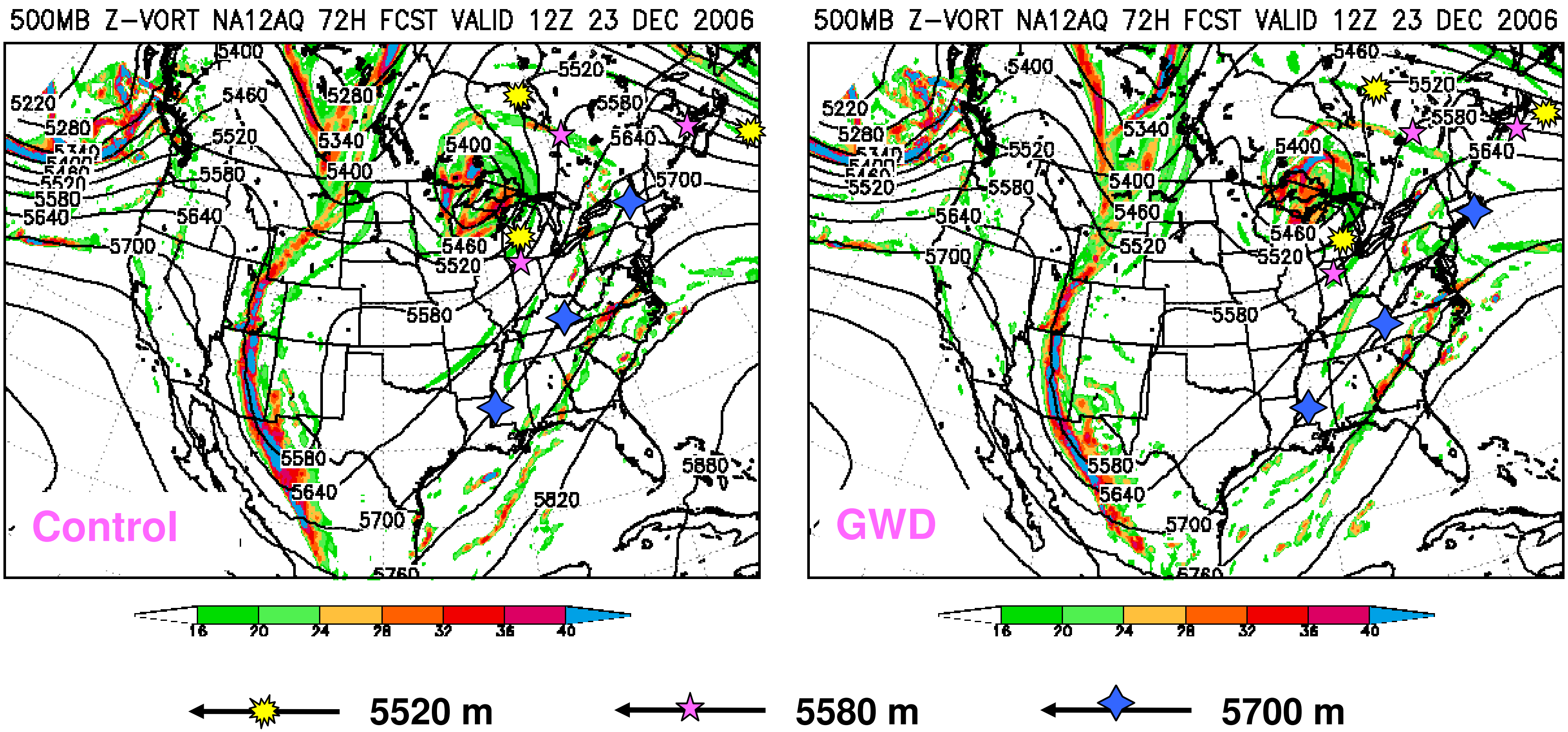




(mm)



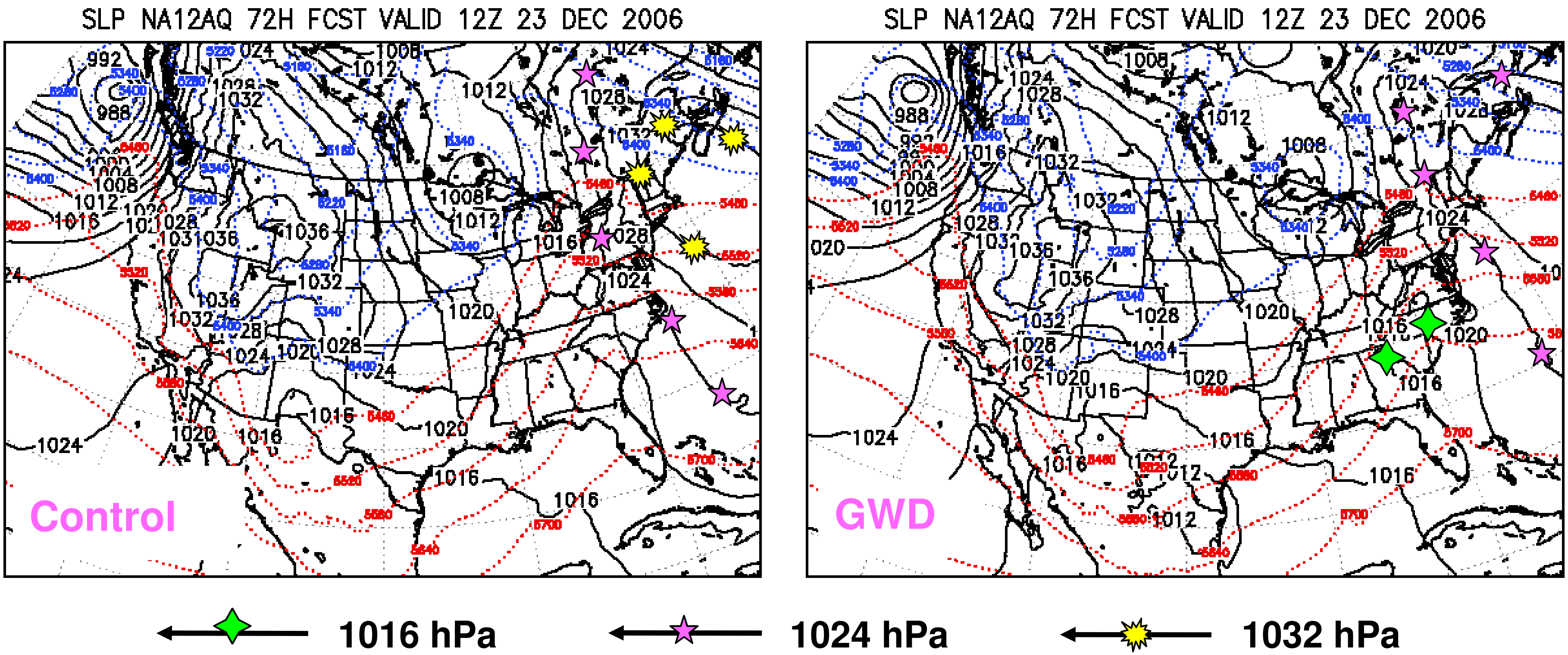
12Z 20 Dec 2006 Runs, 72-h 500-hPa Z + Vort



In GWD run:

- **Lower heights over eastern Canada and most of eastern US**
- **Flatter, more progressive ridge over mid Atlantic & New England**

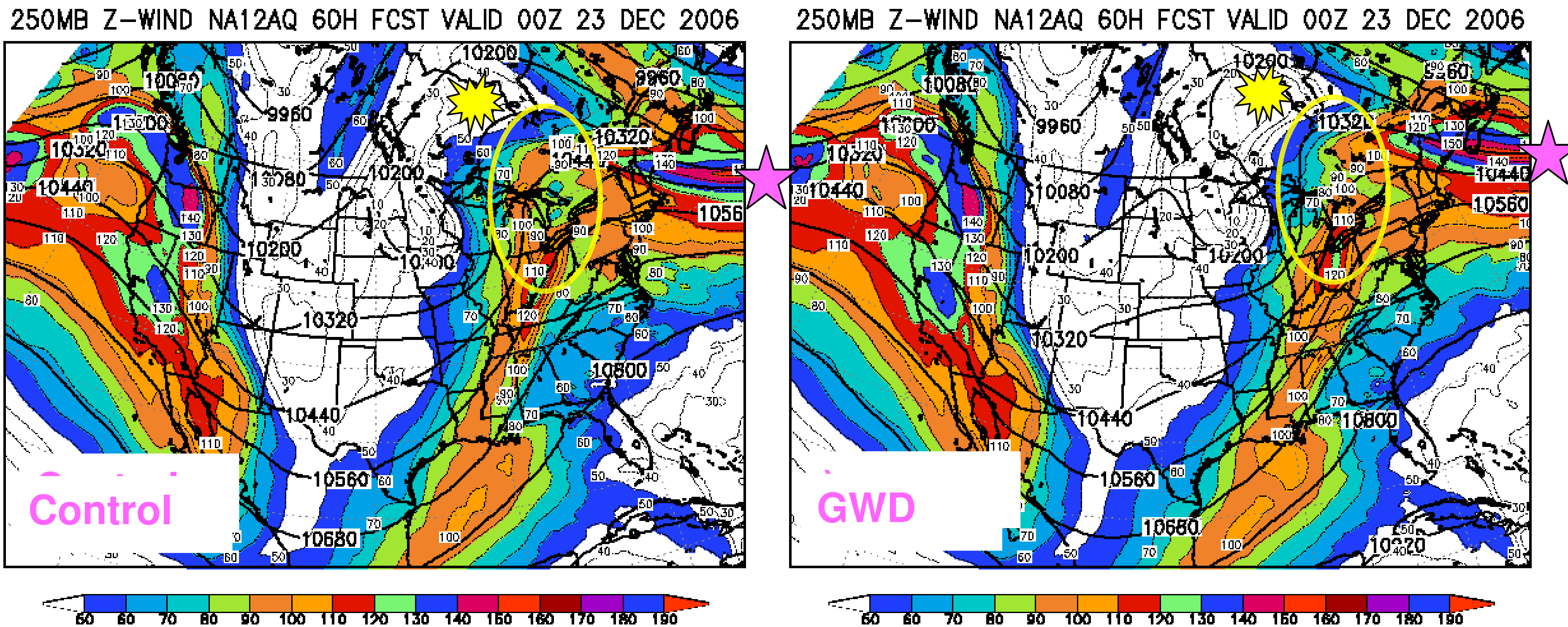
12Z 20 Dec 2006 Runs,
72-h SLP + 1000-500 hPa thickness



In GWD run:

- **High pressure breaks down over Canada & New England**
- **Low pressure forms over western NC and SC**

12z 20 Dec 2006 Runs,
60-h 250-hPa winds + vorticity

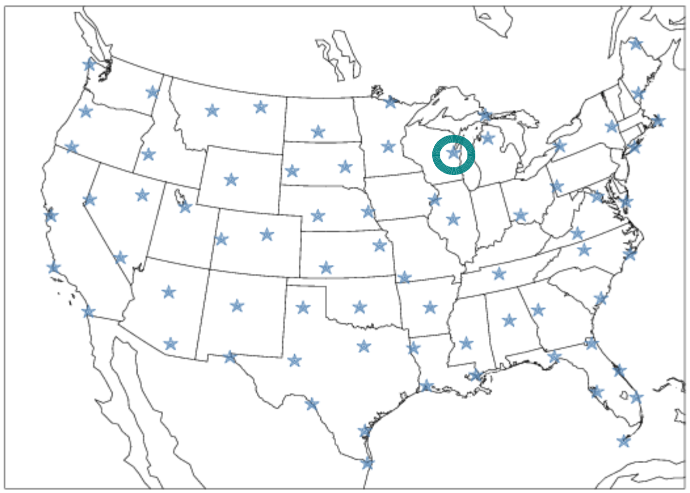


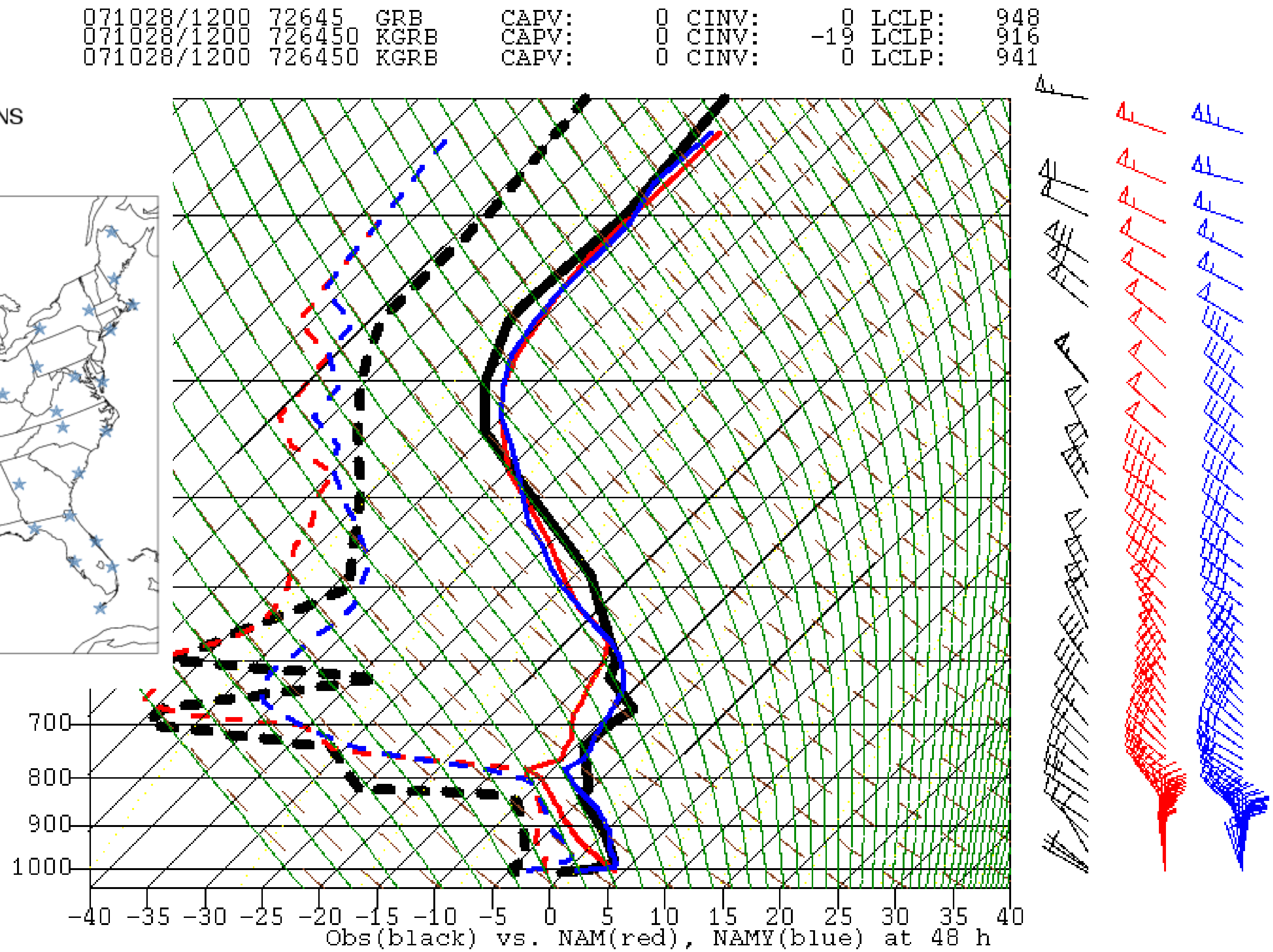
In GWD run vs. control:

- **Jet streak displaced to the NE**
- **Stronger flow through weaker ridge**

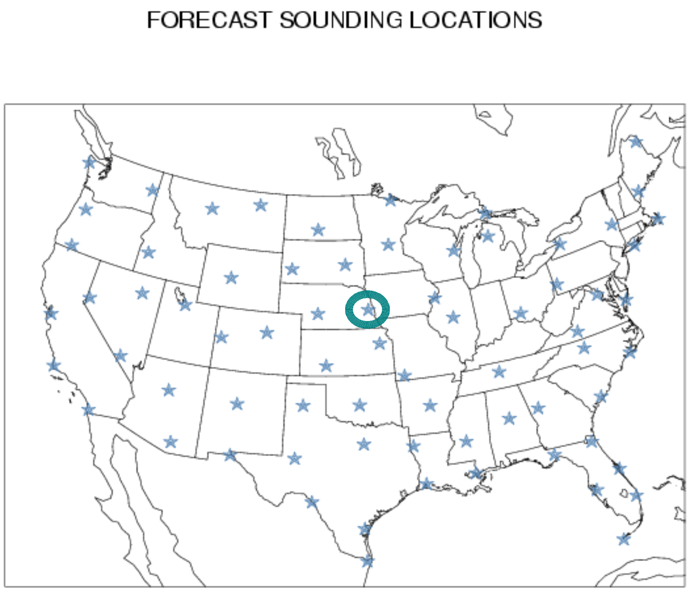
Example of impact of GWD on lower tropospheric vertical profiles : Obs=black, Ops NAM=Red, New NAM=blue

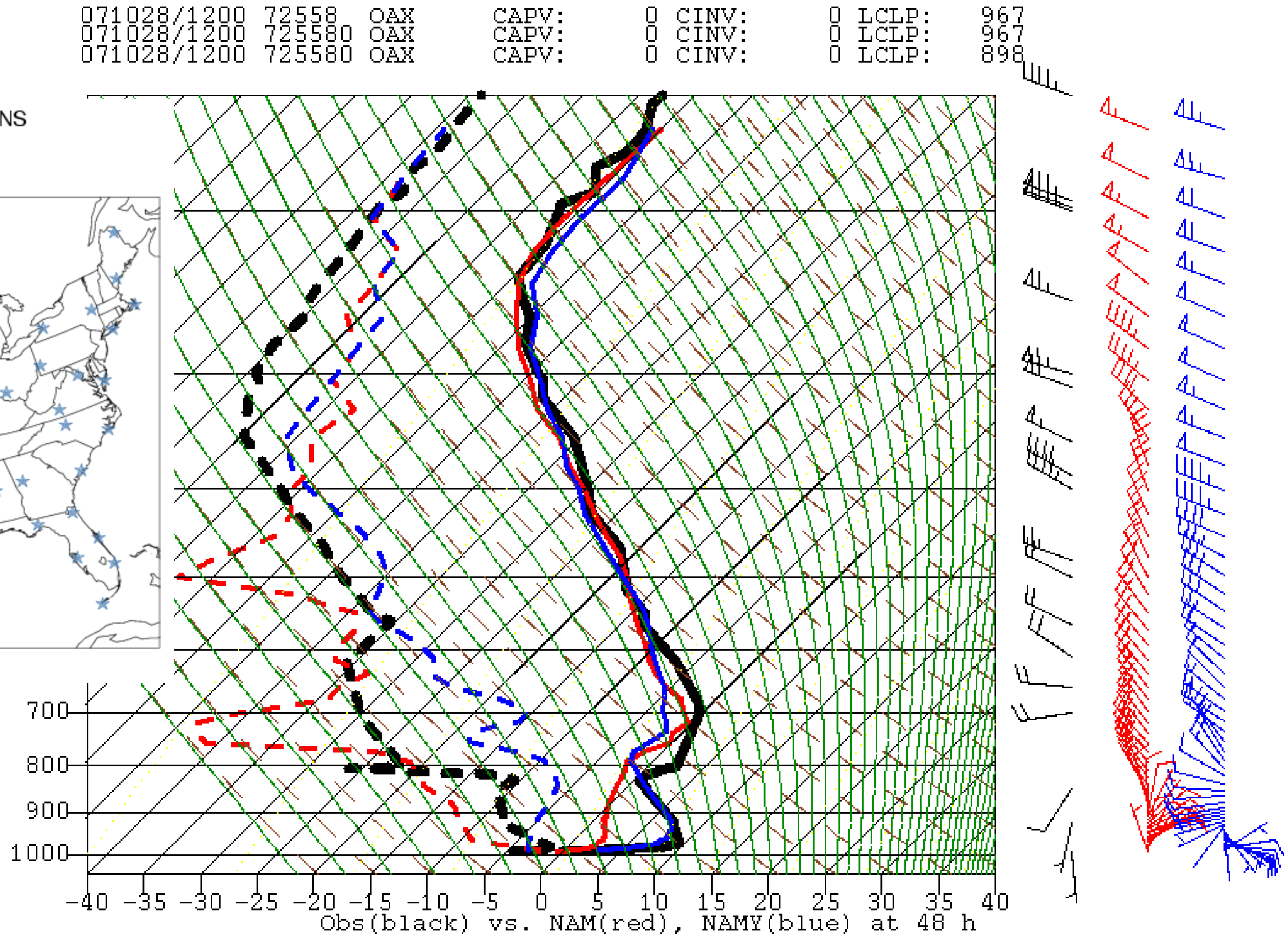
FORECAST SOUNDING LOCATIONS





Example of impact of GWD on lower tropospheric vertical profiles : Obs=black, Ops NAM=Red, New NAM=blue



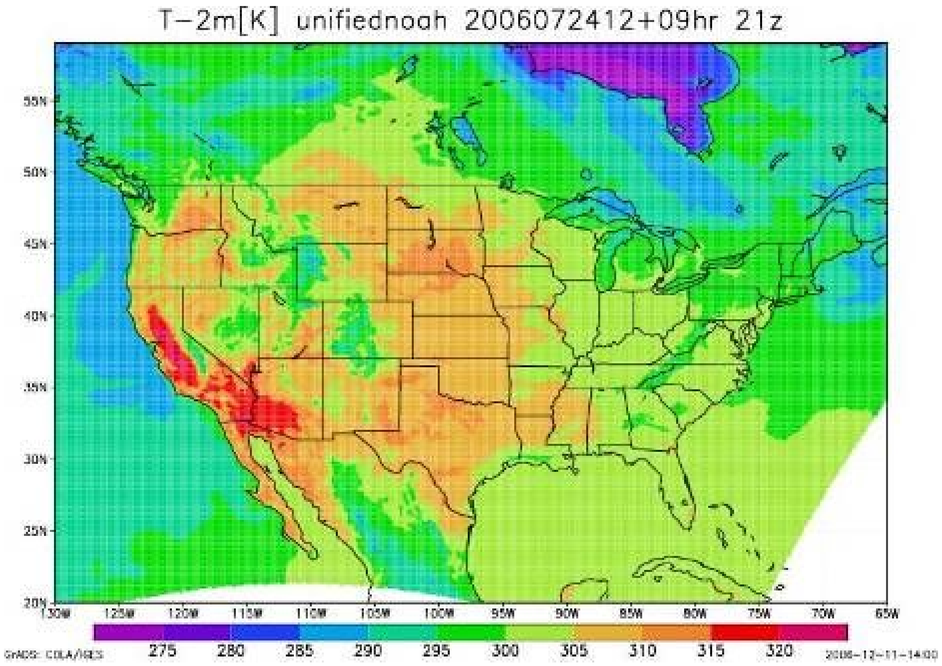


WRF-NMM unification of land-surface physics with NCAR

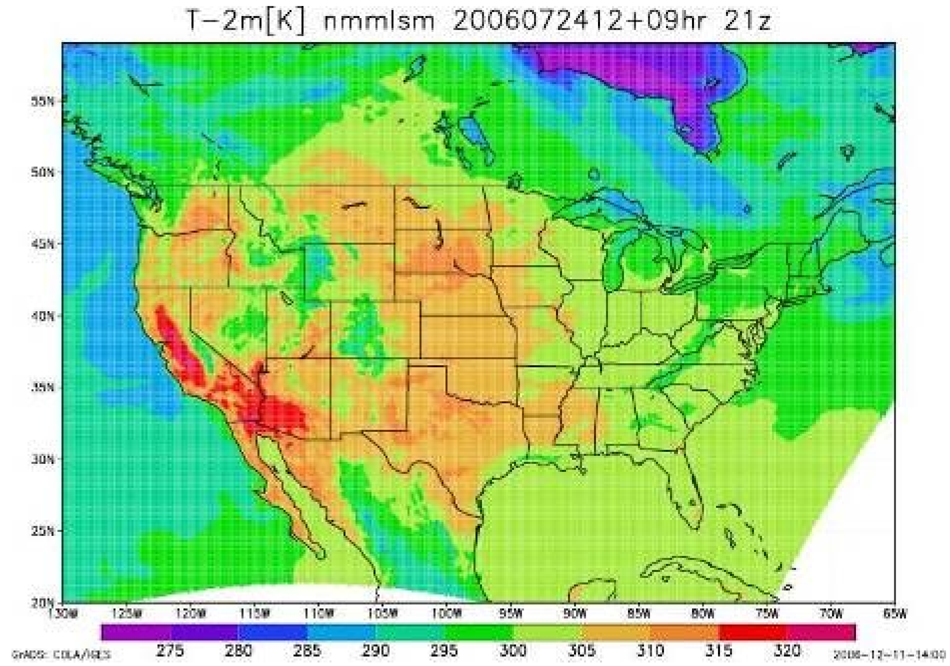
- New module intended to have - minor impact: some changes to cold season physics, minor changes to other parameters, and passing total incoming/net radiation
- Primary cold season change: use total soil moisture instead of frozen soil moisture to determine bare soil evaporation

*- mid-day 2-m air temperatures **nearly identical** for test case: 24-JULY-2006/21z (+09-hour forecast from 12z init)*

"Old module"



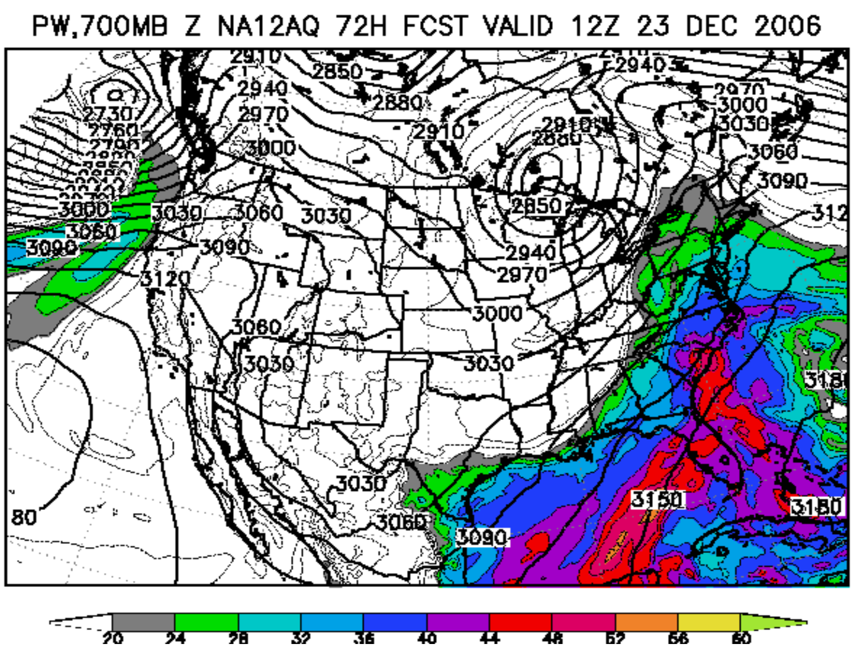
"New unified module"



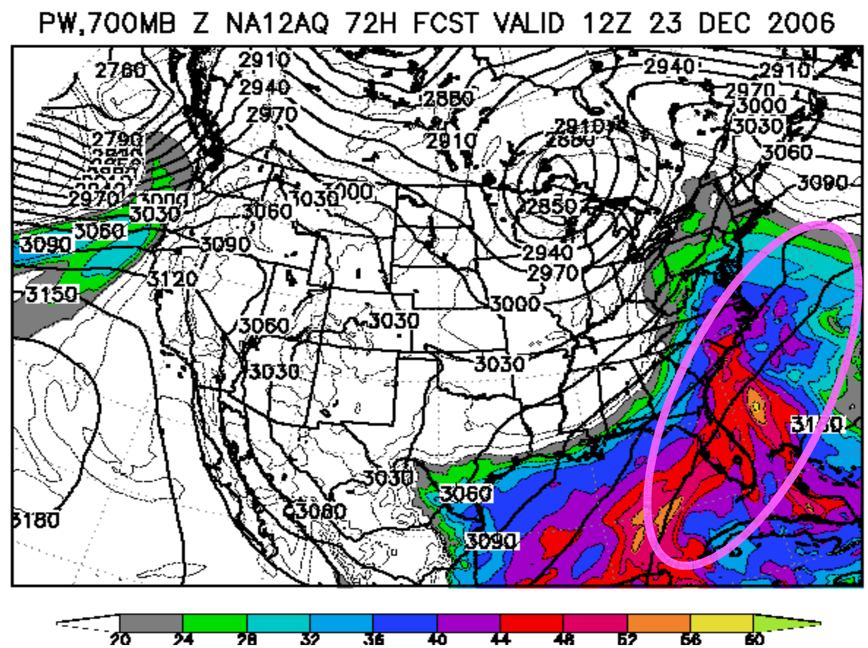
Impact of Modified Advection: 12z 20 Dec 2006 case: 72-h PW

example of higher PWs in the ADV runs

CTL



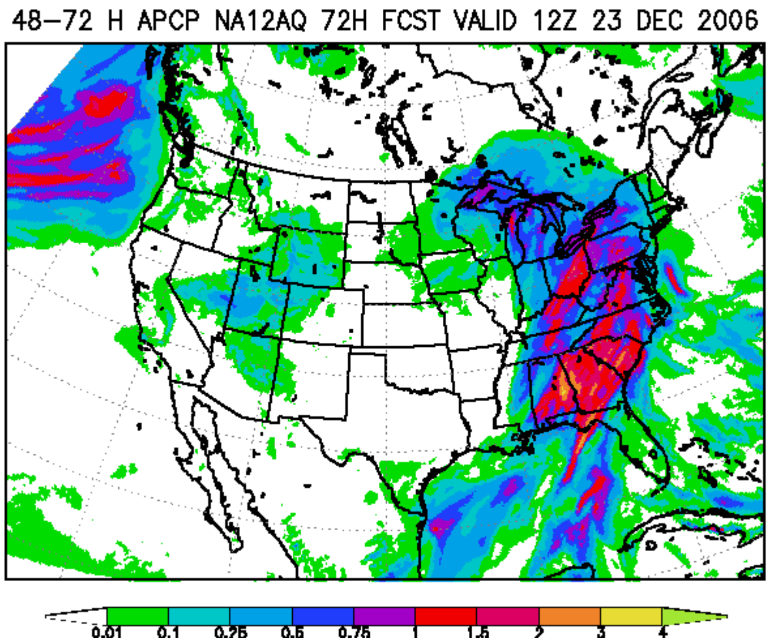
ADV



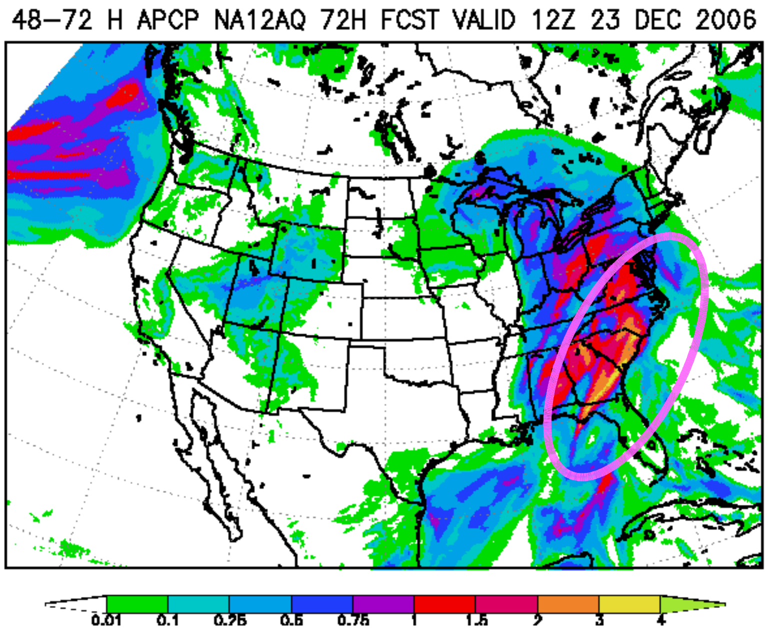
Impact of Modified Advection : 12Z 20 December 2006 : Day 3 Precipitation

Note heavier precip in the ADV run along SE coast

CTL



ADV



Go here for precipitation scores **and scroll towards the bottom.**

ADV run improved scores for *>1"* amounts.

New GSI analysis

- Recomputed NMM background errors
- Code changes:
  - Data reported with height use height, not pressure in the forward model
  - Change of analysis variable from Ln(ps) to ps
  - Use sensible temperature directly if no valid q obs
  - Extend mpi-io capability to more data input
  - Ability (not yet turned on) to utilize multiple guess files

GSI Changes : Impact of AIRS radiance assimilation

Penalty function for conventional data at end of each NDAS cycle: assimilation of AIRS leads to better 1st guess fit to conventional obs

U-wind

2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3

cntl u
airs u

V-wind

2.4
2.3
2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3

cntl v
airsv

Temp

1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1

cntl t
airs t

q

1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95

cntl q
airs q

Sfc P

9.8
9.3
8.8
8.3
7.8
7.3
6.8
6.3
5.8
5.3
4.8
4.3

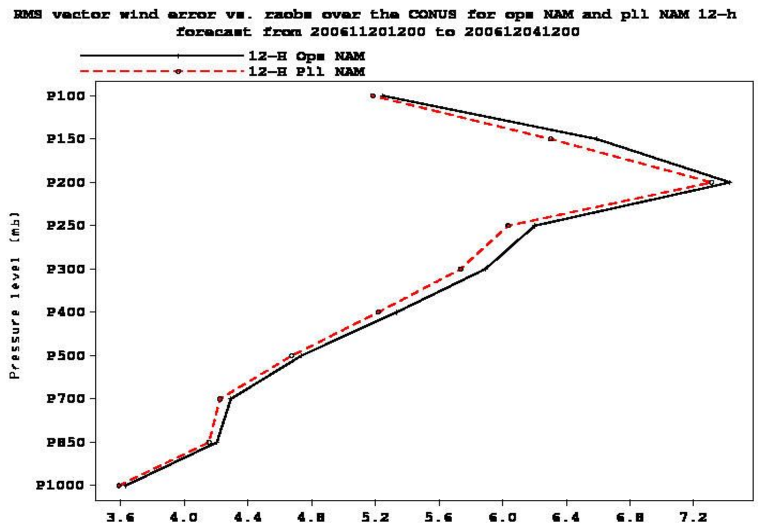
cntl P
airs P

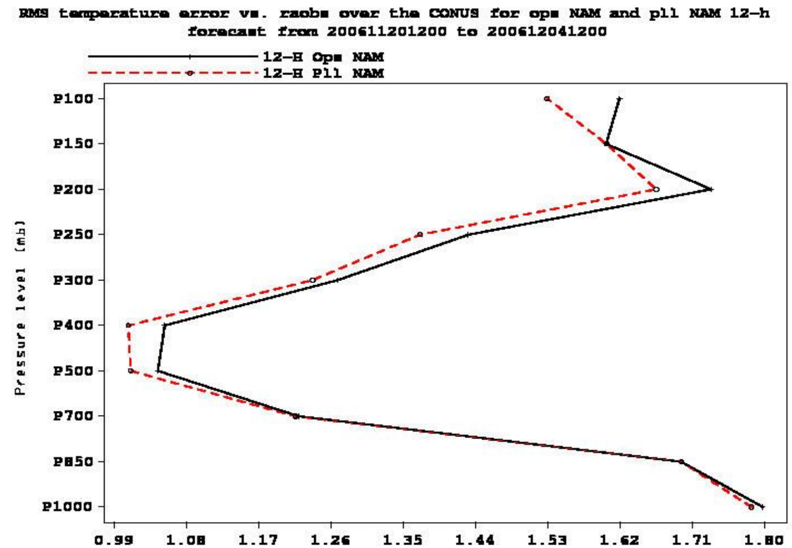
Impact of AIRS data on forecast

RMS Vector Wind error vs CONUS RAOBS

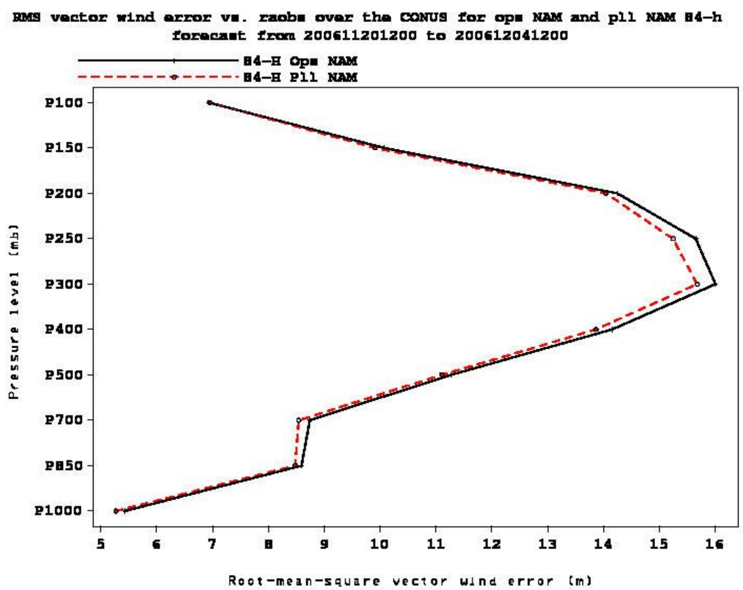
RMS Temperature error vs CONUS RAOBS

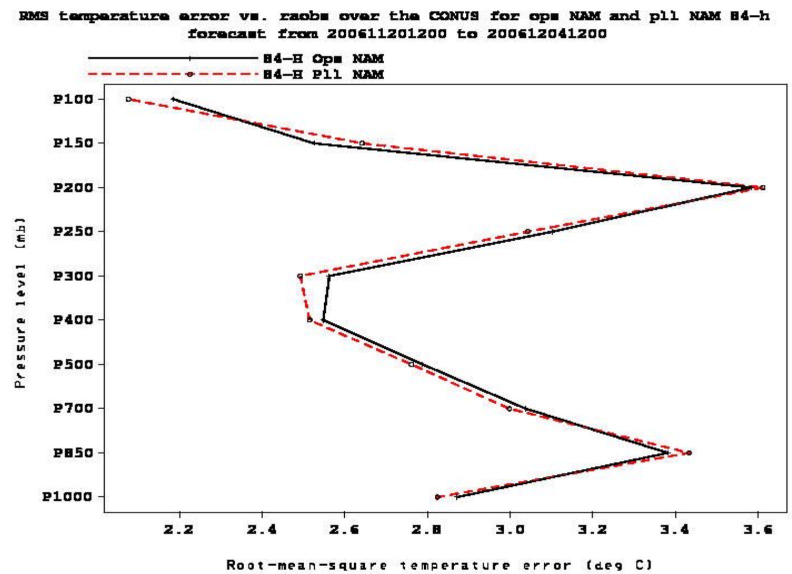
12h FORECAST





84h FORECAST





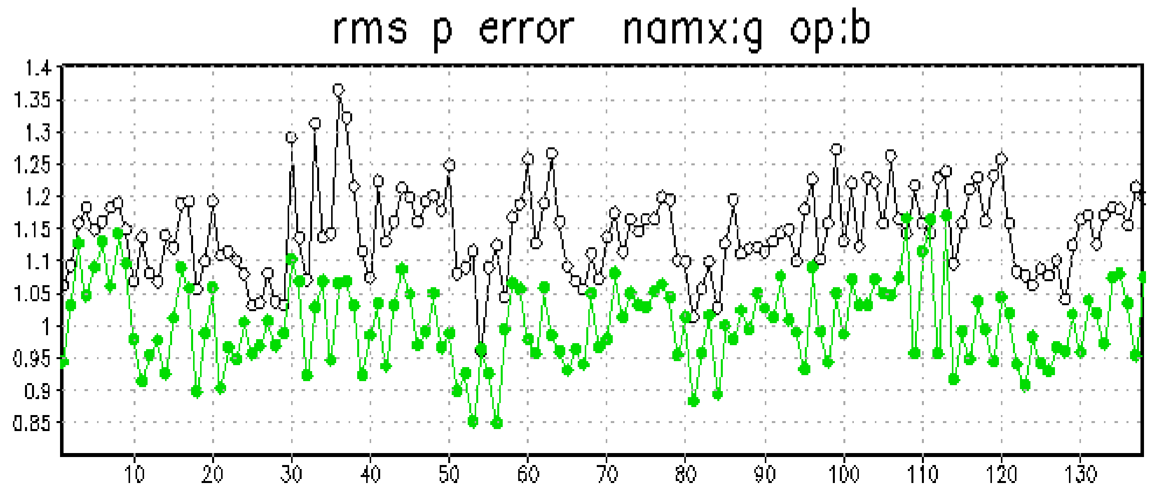
GSI Changes : Tuning of Background Error

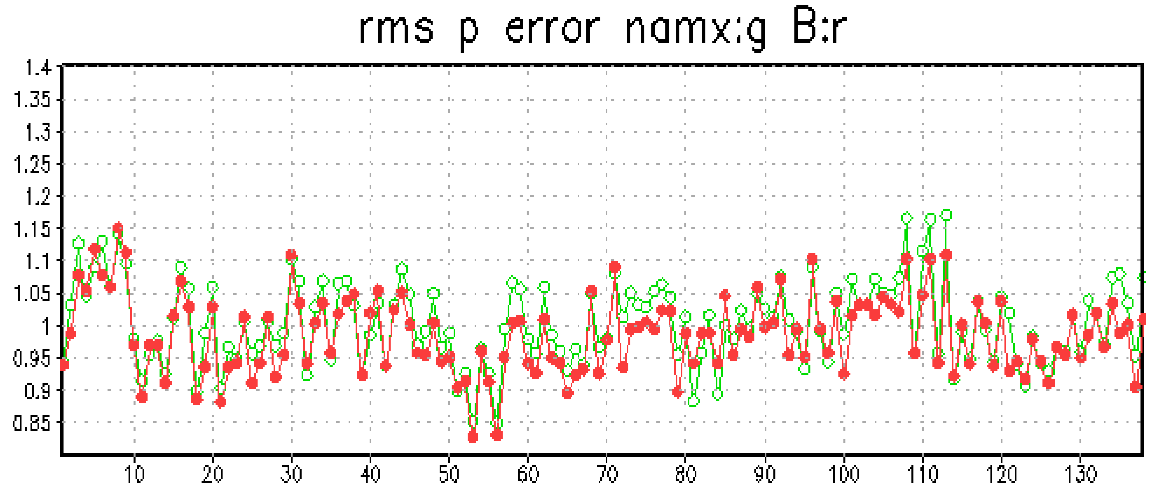
- Model/analysis changes/fixes since background error last estimated
- Adaptive tuning of ob error for the new data
- Change variance of Temp and stream function, velocity potential (wind)

GSI Changes: Tuning of Background Error

· Shown: time series of surface pressure obs RMS fit to 1st guess (3-h WRF-NMM forecast)

Black = Ops NDAS
Green = Parallel NDAS with current ops background error covariances
Red = Parallel NDAS with retuned background error covariances

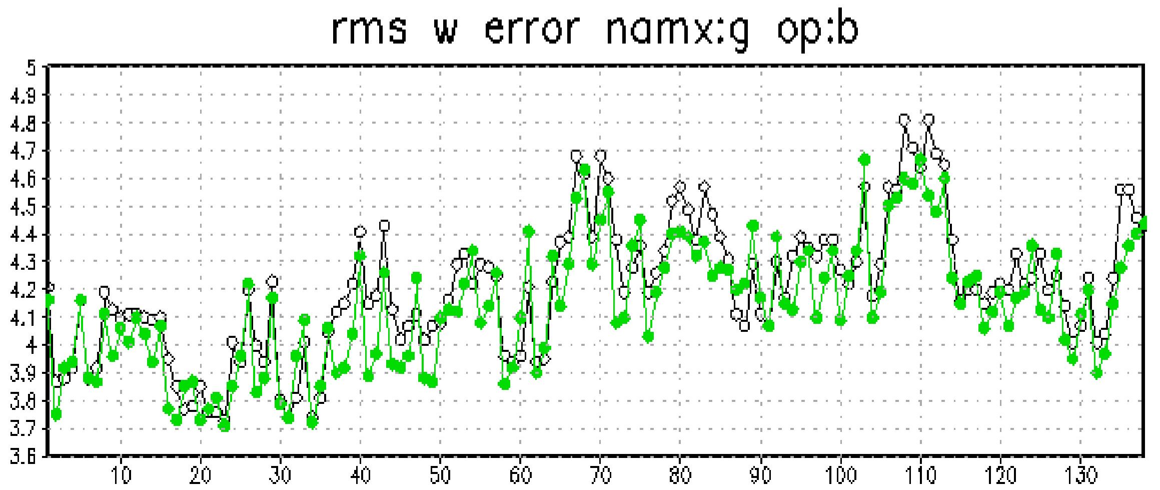


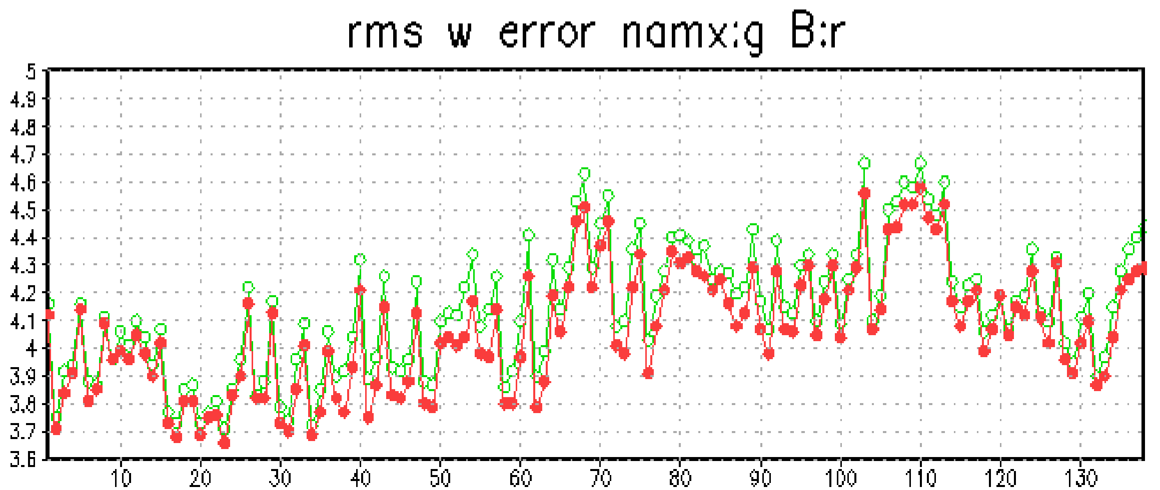


GSI Changes : Tuning of Background Error

- Shown: time series of wind obs RMS fit to 1st guess (3-h WRF-NMM forecast)

Black = Ops NDAS
Green = Parallel NDAS with current ops background error covariances
Red = Parallel NDAS with retuned background error covariances





GSI analysis test results: Offline NDAS tests of individual analysis changes

Test Period	GSI analysis or Observation Component Being Tested	Impact on Psfc	Impact on Temp	Impact on Wind	Impact on Moisture
2007020300-2007020912	Mesonet winds with use_list	-	o	+	o
200703????-200703????	MODIS winds	o	o	+	o
2007041800-2007042012	GOES 1X1 radiances	-	+	+	+
200705????-200705????	EUMETSAT winds	o	o	+	o
2007072000-2007073012	New background error covariances	+	+	++	++
2007081600-2007082412	New GSI	+	o	o	-

+++ large positive impact
++ moderate positive impact
+ slight positive impact
o neutral impact
- slight negative impact
-- moderate negative impact
--- large negative impact

OCONUS Precipitation Driver for Soil Moisture

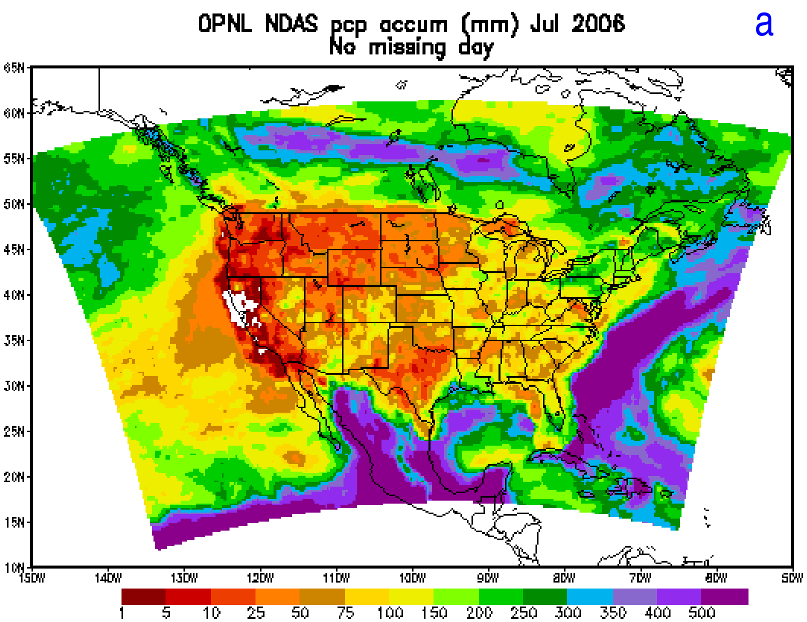
In OPNL NAM, hourly precipitation analysis (a merged Stage II/Stage IV hourly product, after adjusting for bias using long-term budget history array) is used as driver for soil moisture.

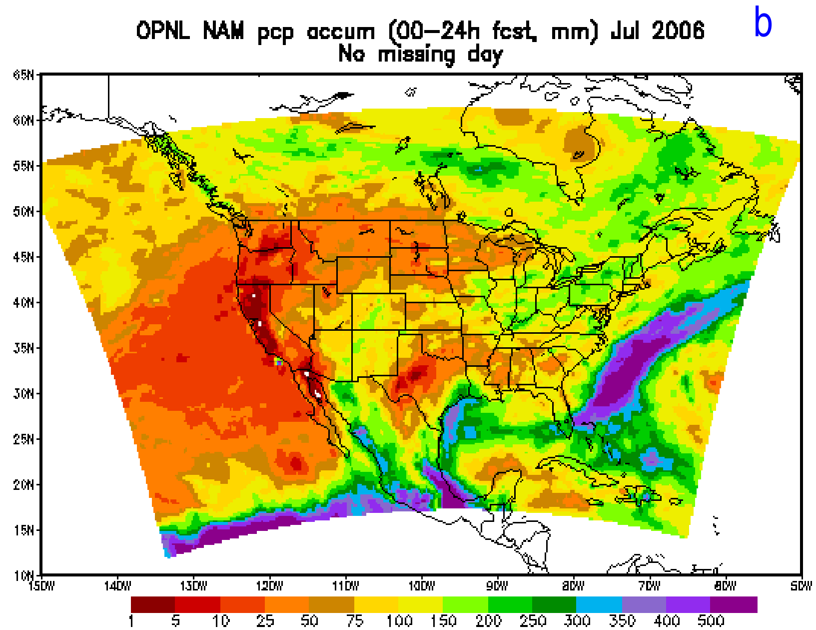
When/where hourly precipitation analysis is not available, or when it is snowing (large low bias in hourly obs), model precip during NDAS is used as driver for soil moisture.

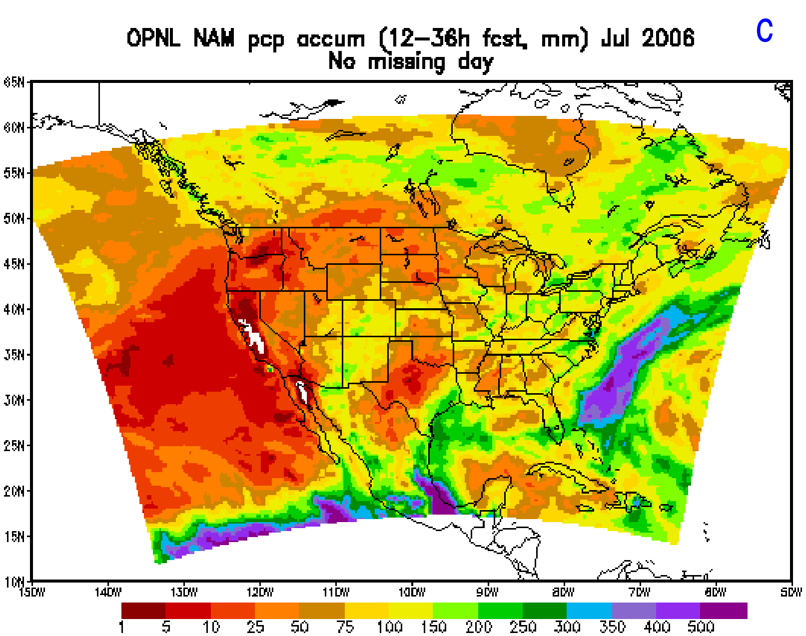
This might lead to excessive OCONUS soil moisture when there is a model spin-down problem.

Solution: use 00Z cycle's NAM hourly model precip (from the 12-36h fcst) to fill in outside of Stage II/IV coverage.

Why the proposed solution would work







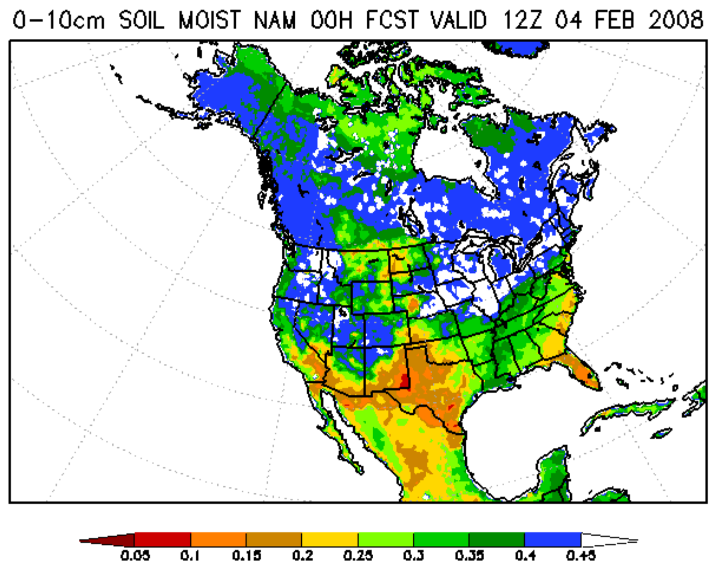
Monthly precip for Jul 2006
Fig. a: from NDAS (shows precip input to soil)
Fig. b: from NAM 00-24h fcst
Fig. c: from NAM 12-36h fcst

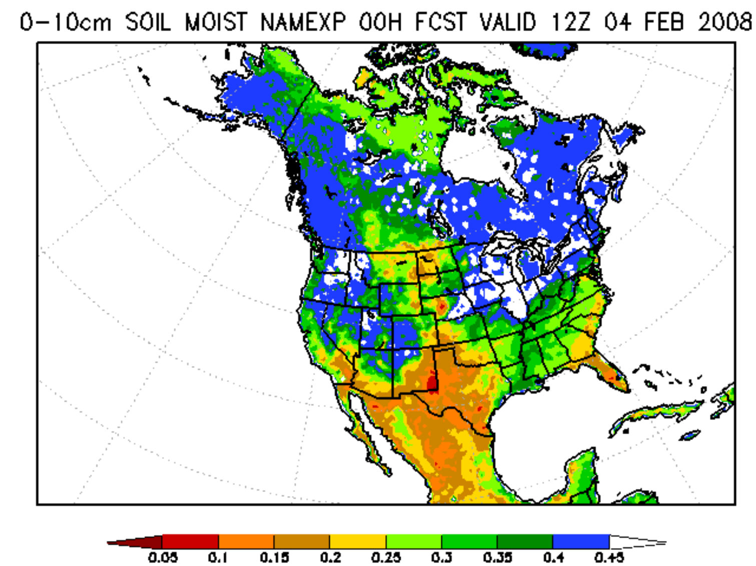
In OPNL NAM, NDAS precip is used as OCONUS soil moisture driver. Using the NAM 12-36h forecast would have alleviated much of the problem caused by the precip spin-down.

Volumetric soil moisture after one year

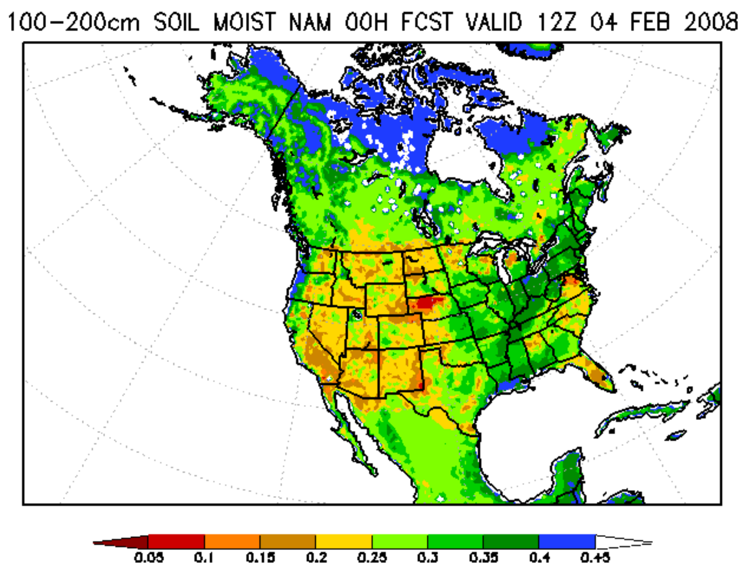
Ops NAM | Parallel NAM

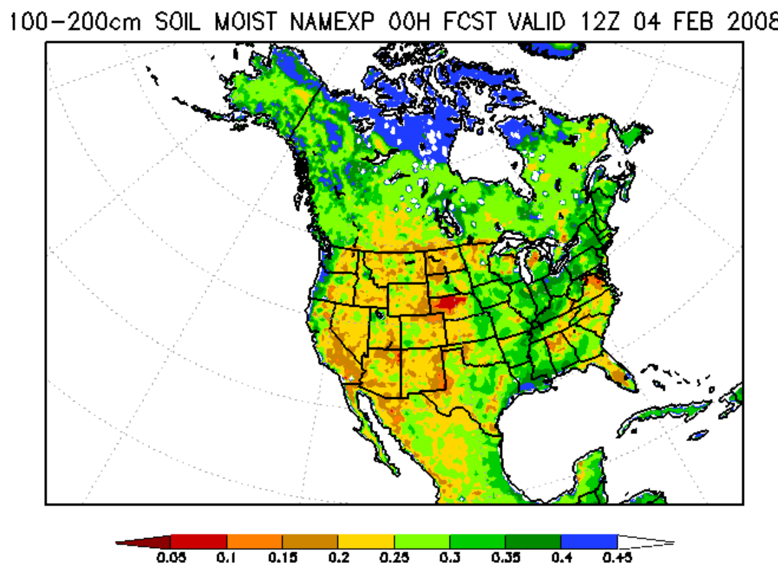
0-10 cm layer





100-200 cm layer

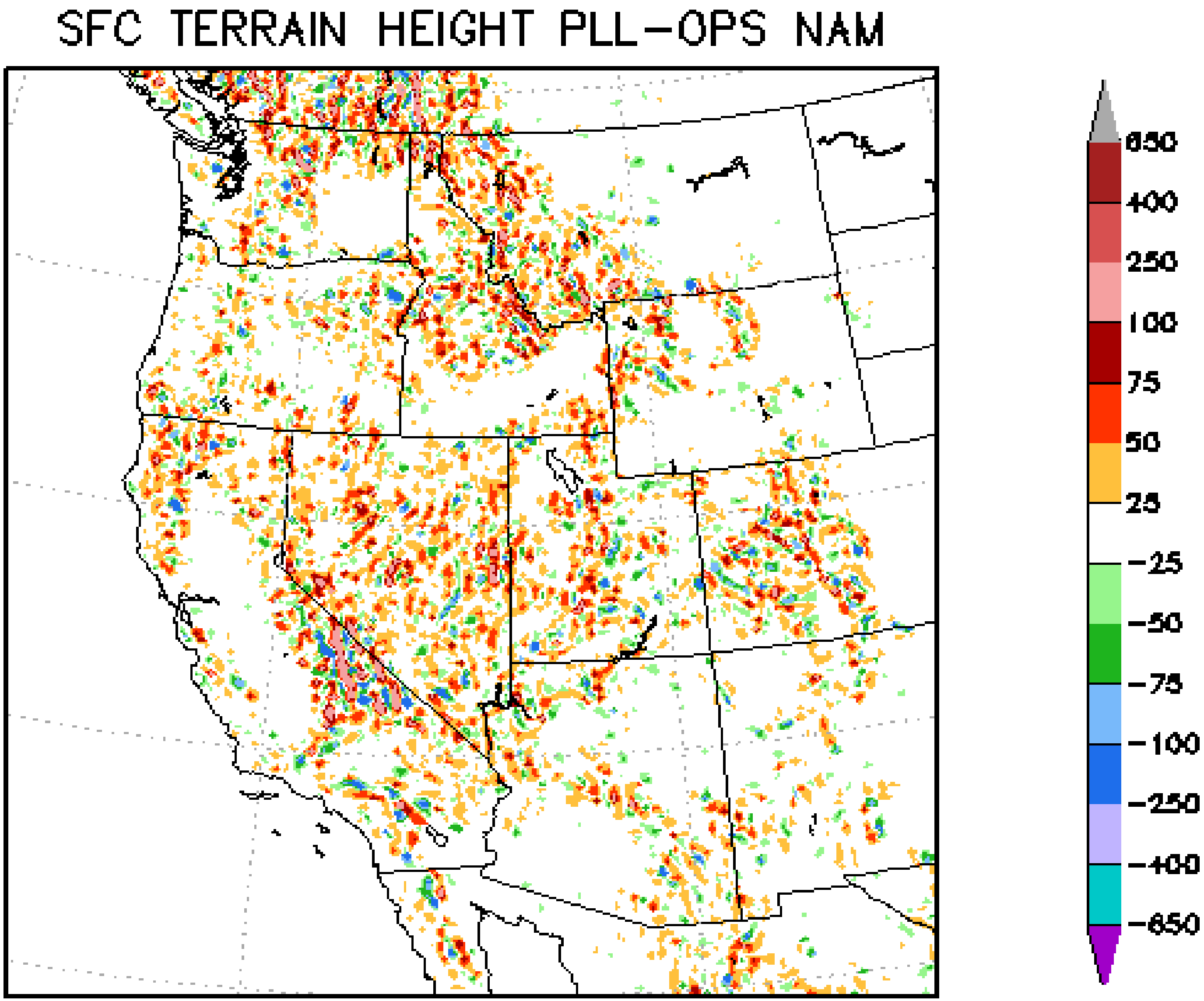




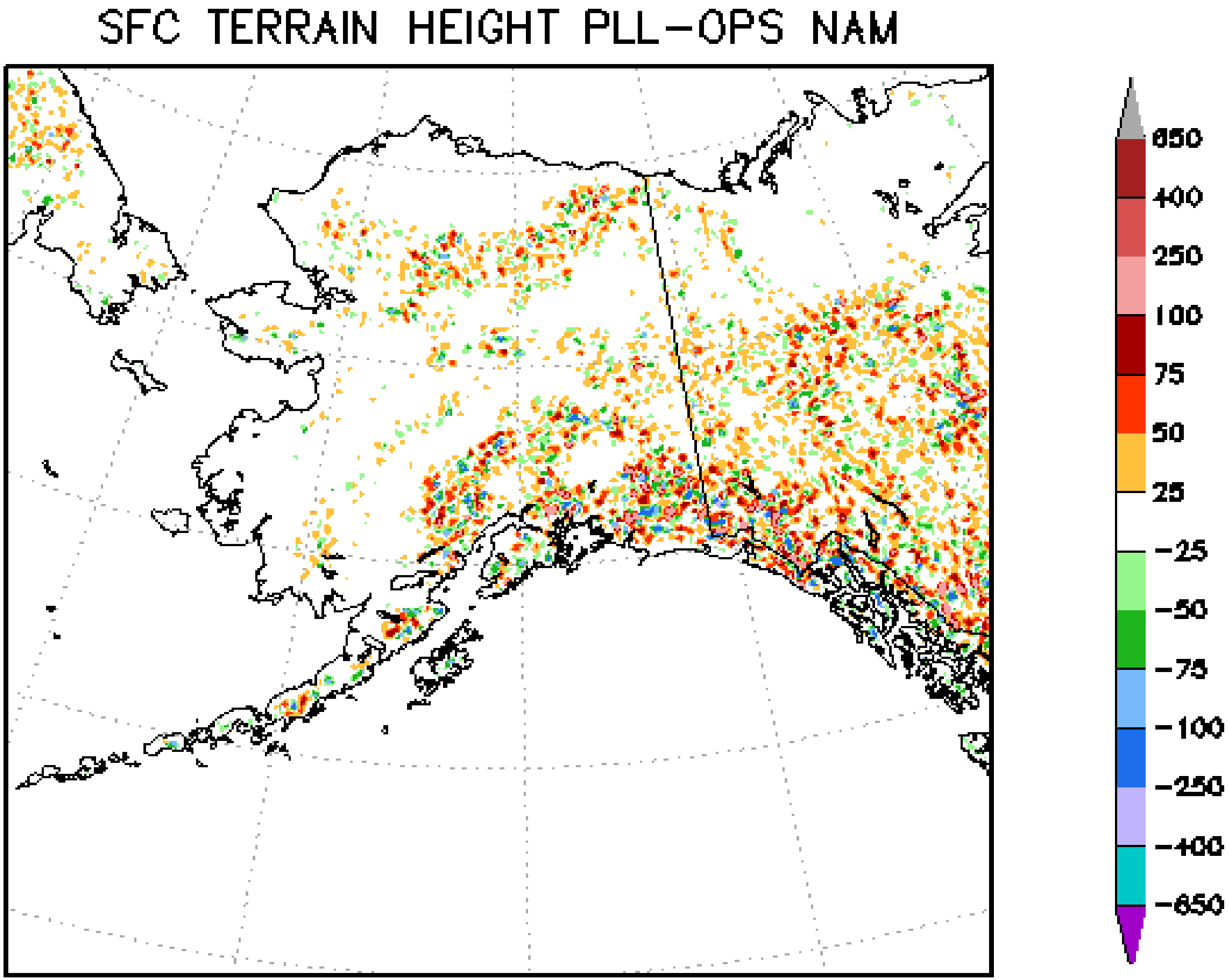
New surface terrain

- Rationale : Model “too noisy” during assimilation
- Two smoothing steps
  - 1-2-1 filter at every point (eliminates 2-delta-x noise but reduces amplitude of large-scale features
  - “Desmooth” step to restore some detail lost in step 1 at scales > 2-delta x
- For new NAM 3 passes of filters applied

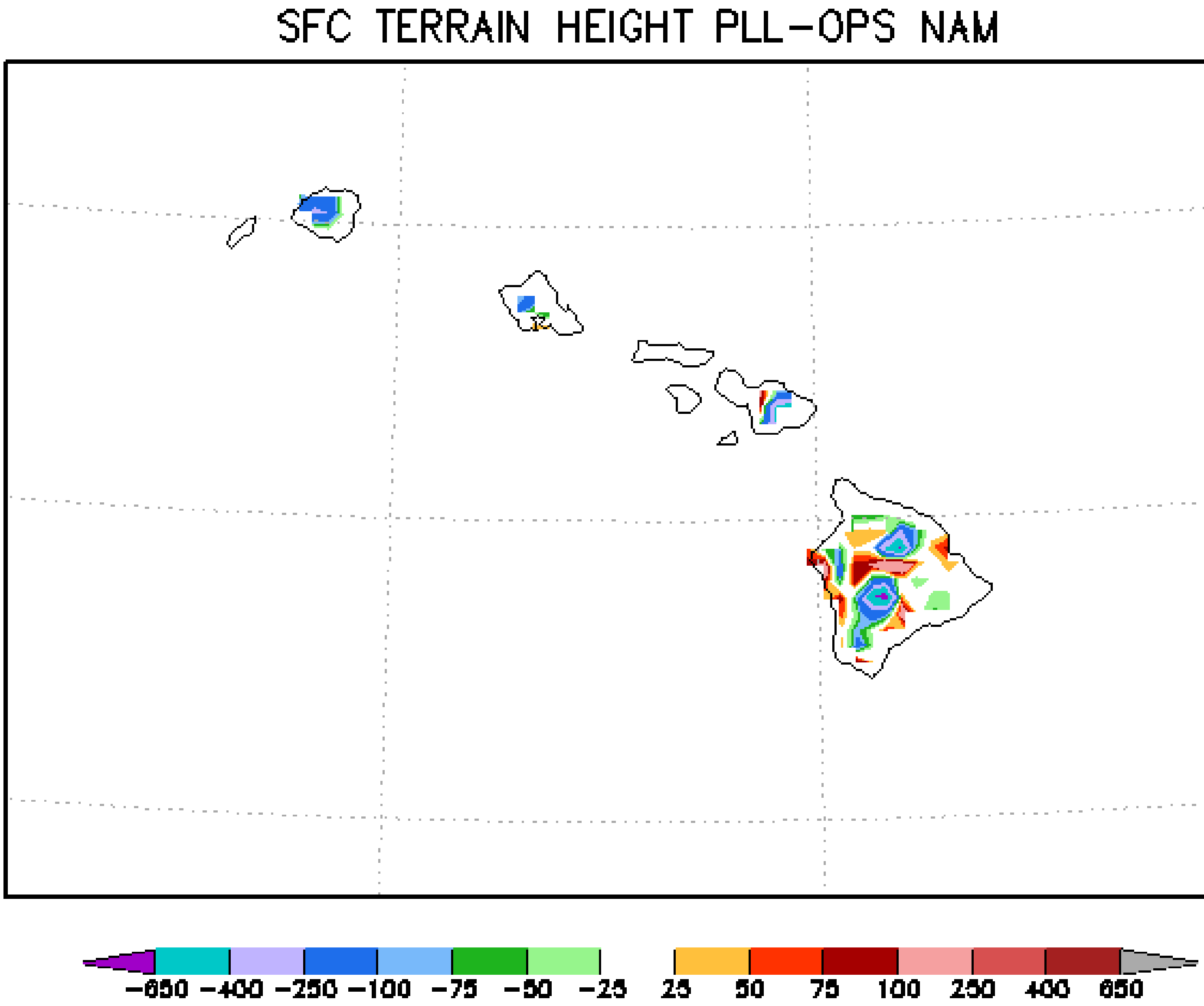
New surface terrain: difference vs ops NAM



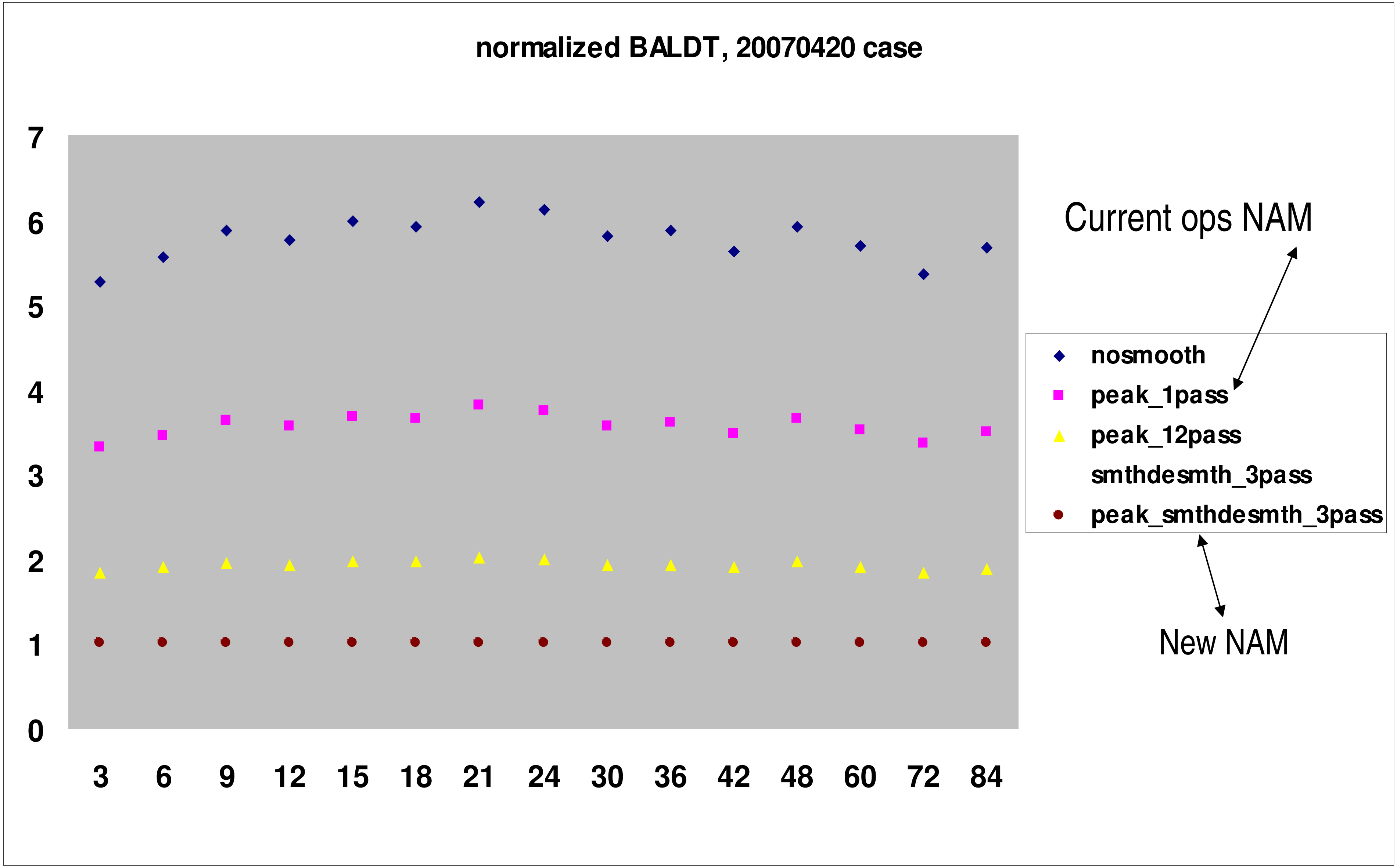
New surface terrain: difference vs ops NAM



New surface terrain: difference vs ops NAM



Noise Reduction with New Terrain



Case studies tested with components of NAM change package

Case Date	Description of Issues
20 Jul 2006 12z	High dew point temperatures over Pac NW (esp coastal mountains)
21 Oct 2006 00z	Misplaced storm track, spurious snow storm over IA/WI/IL
7 Dec 2006 12z	Very warm (>10C) surface temperatures over inner-mountain west
20 Dec 2006 12z	Subsidence along upwind side of Black Hills, winter storm over east
29 Mar 2007 12z	Failed to predict heavy, convective precipitation over OK/KS/TX
29 Apr 2007 12z	High dew point temperatures over ID, western MT
29 Jun 2007 00z	Missed a light precipitation event over SE TX
3 Jul 2007 12z	Case of interest to AQ, under-prediction of ozone over Los Angeles
9 Jul 2007 00z	1st of 2 cases to look at convective momentum mixing by J. Carley
16 Jul 2007 00z	2nd case studied by Jacob Carley to look at Cu momentum mixing

Each experimental set of 10 runs consisted of running the NAM prediction model (WRF-NMM) out to 84 hours using the same initial conditions as a NAM control forecast. Verification was performed by comparing both the control and experimental forecasts against observations. The complete set of statistics for the last **26** sets of experiments can be viewed at http://www.emc.ncep.noaa.gov/mmb/bf/launcher/ .

- Experiment 1 - **Test gravity wave drag (GWD), 1-pass (1X) vs. 3-pass (3X) terrain**
- Experiment 2 - **Test modified advection and diffusion (All runs use GWD with SIGFAC=0, 3X terrain, *original* advection)**
- Experiment 3 - **Test different diffusion coefficients (COAC) (GWD with SIGFAC=0, 3X terrain, *modified* advection)**
- Experiment 4 - **Test convective momentum mixing (GWD, SIGFAC=0, 3X terrain, *original* advection)**
- Experiment 5 - **Test changes to cloud-radiation parameters to reduce upper-level warm biases (GWD, SIGFAC=0, 3X terrain, *modified* advection)**
- Experiment 6 - **Test changes to microphysics, convection to reduce upper-level warm, moist biases (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 7- **Test No GWD vs. GWD with SIGFAC=0 and SIGFAC=3 (3X terrain, modified advection)**
- Experiment 8 - **Test momentum mixing + reduced water loading in convection (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 9 - **Test No GWD vs. GWD with SIGFAC=0 to SIGFAC=6 (3X terrain, modified advection)**
- Experiment 10 - **Test following changes to BMJ convection:**
  (1) EPSPR=10 (was 1.E-7)
  (2) EPSPR=1000, increase depth of shallow convection to 400 mb at swap points
  (3) Crude parameterization of downdrafts
  (GWD, SIGFAC=3, 3X terrain, modified advection)
- Experiment 11 - **Test GWD with SIGFAC=0**
  vs. GWD with SIGFAC=0 and RIC=0.505 (in MYJSFC + PBL) rather than RIC=0.25
  vs. Mountain blocking only (no GWD) with SIGFAC=0
  (3X terrain, modified advection)
- Experiment 12 - **Test No CWM in MYJ SFC (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 13 - **Test GFS PBL + SAS (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 14 - **Numerous radiation tests involving RRTM LW, GSFC SW, Dudhia SW, and GFDL LW+SW (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Part of Experiment 14 - **Reduced cloud emissivities for GFDL LW (in the Eta) (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 15 - **Test Thompson Microphysics (GWD, SIGFAC=0, 3X terrain, modified advection)**
  => 48-h runs made only for 2006122012, 2007032912, and 2007070312
- Experiment 16 - **Test countergradient term (CT) in MYJ SFC & PBL (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 17 - **Test changes to ETANEW microphysics and GFDL radiation (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 18 - **Further tests of convective momentum mixing using smaller values of "fwind" (GWD with SIGFAC=0, 3X terrain, modified advection)**
- Experiment 19 - **Test calling physics more frequently (NPHS=2 rather than 6, GWD with SIGFAC=0, 3X terrain, modified advection)**
- Experiment 20 - **Test WSM5 and WSM6 microphysics, plus changes to ETANEW microphysics (GWD with SIGFAC=0, 3X terrain, modified advection)**
- Experiment 21 - **Test change in diagnosing 10-m winds from MYJ surface layer, compare against the CONTROL and the GFS PBL + SAS (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 22 - **Test modified horizontal diffusion provided by Wan-Shu (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 23 - **Test new NAMEXP code comparing LSM option 99, 2, and 2 with revised DQSDT (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 24 - **Another round of GWD testing using new NAMEXP code for old NMM LSM option 99 and new Noah LSM option (3X terrain, modified advection)**
- Experiment 25 - **Test SIGFAC=-1 and TADJ=900 in GWD, 10-19-07 version of ETANEW microphysics (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Experiment 26 - **Test background horizontal diffusion (Zavisa's "Fback" code) (GWD, SIGFAC=0, 3X terrain, modified advection)**
- Final comparison - **Before changes vs. After changes**
- Experiment 27 - **Test p_top_requested=200 vs. 5000 in namelist.input file ("NAMEXP" code, 3X terrain, SIGFAC=0 in GWD, modified advection, etc.)**

NAM Model Experiments Most Relevant to 2008Q2 Change Package

Exp.	Description
1	**Test** GWD and 1X vs. 3X terrain; **Result**: use GWD, 3X terrain.
2	**Test** modified advection and horizontal diffusion; **Result**: use only modified advection.
7	**Test** SIGFAC=0 vs. 3 in GWD; **Result**: SIGFAC=0 produced better surface T, RH, SIGFAC=3 produced slightly better QPF and surface winds (mixed upper air results).
9	**Test** no GWD vs. with GWD with SIGFAC=0, 1, 2, 3, 4, 5, and 6; **Result**: GWD still showed improvements, small SIGFAC had better surface verification. This set of experiments was prompted by problems seen in the NAM parallels in late Sep – early Oct, which were due to issues unrelated to GWD.
11	**Test** GWD vs. MB only; **Result**: Gravity wave breaking in GWD accounted for much of the improvement in upper-air scores and in QPF.
24	**Test** different LSM configurations; **Result**: A corrected version of the unified Noah LSM produced slightly better forecasts than the current LSM running in the NAM.
25	**Test** further reductions in the amplitude of GWD, such as SIGFAC=-1 and slowing the time scale for adjusting momentum from 160 s (currently NAM physics time step) to 900 s. Also includes a small test to the microphysics in order to reduce tiny amounts of small hail from reaching the surface in warm-season conditions, which caused some difficulty in earlier version of the unified Noah LSM (note these were corrected). **Result**: Both GWD-related changes eliminated the effectiveness of GWD, and the microphysics changes were found to have a no perceptible impact.
Net Result	**Use 3X terrain, modified advection, GWD with SIGFAC=0, and the corrected unified Noah LSM**

Summary of overall results of NAM case study tests

Case Date	Near Surface Impact	Precipitation Impact	Upper Air Impact
20 Jul 2006 12z	-	+++	o
21 Oct 2006 00z	+	++	++
7 Dec 2006 12z	--	-	+
20 Dec 2006 12z	++	+++	++
29 Mar 2007 12z	+	+	+
29 Apr 2007 12z	+	+	+
29 Jun 2007 00z	+	+	+
3 Jul 2007 12z	o	o	+
9 Jul 2007 00z	+	+	o
16 Jul 2007 00z	o	-	-

+++ large positive impact : ++ moderate positive impact : + slight positive impact
o neutral impact
- slight negative impact : -- moderate negative impact : --- large negative impact

• Precipitation impact is based on 3-day cumulative scores
(00-72 h for 00Z cycles, 12-84h for 12Z cycles)

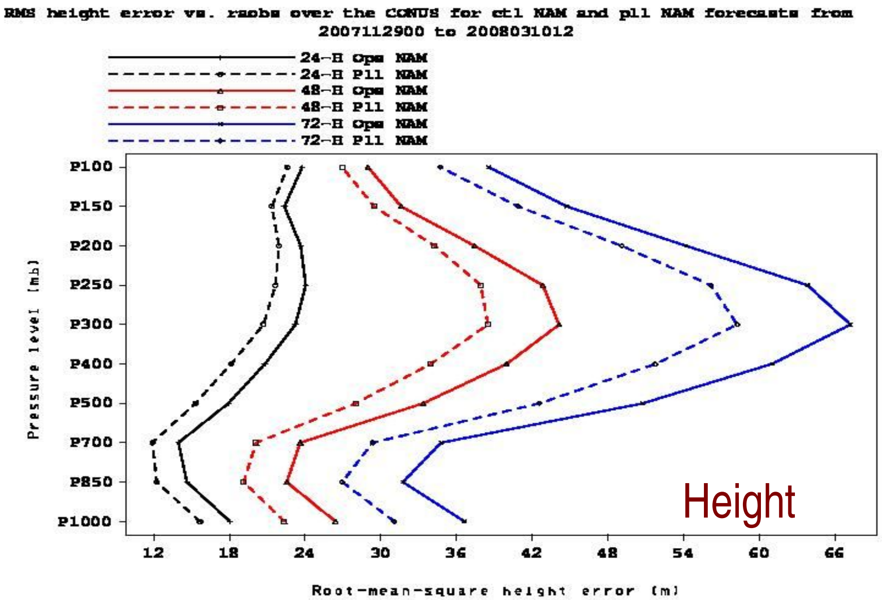
Summary of NAM/DGEX Test Results

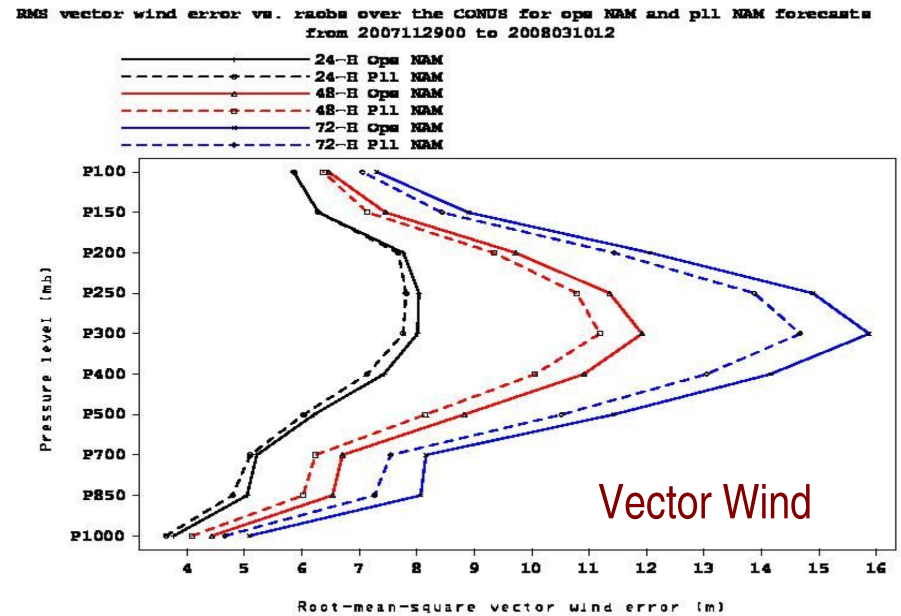
Component	Dates Summarized	Surface Impact (T/Td/V)	Precipitation Impact	Upper Air Impact
All Changes	29 Nov 07–10 Mar 08	o / - / +	o	++
All Changes	25 Oct -25 Nov 07	- / - / ++	o	+
All Changes	1-31 August 2007	o / o / o	o	+
All Changes	27 Feb – 31 Mar 07	- / - / o	+	+
Domain expansion	24 Oct – 13 Dec 07	o / o / o	o	o
Unified LSM	8 – 23 Sep 07	o / - / o	o	o
GWD	19 Oct – 5 Dec 07	o / - / ++	+	++
DGEX (all changes)	14 Jan – 12 Mar 08	o / X / -	N/A	++

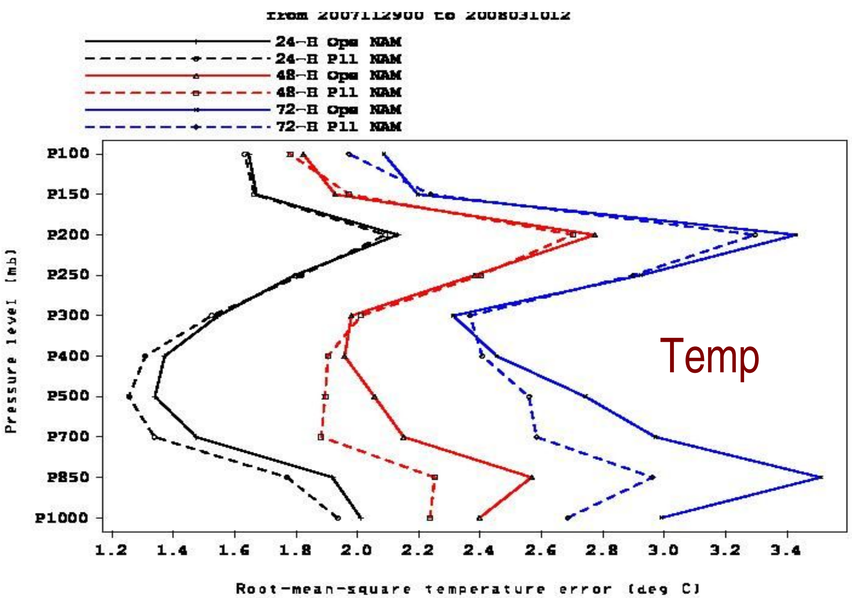
Some cumulative verification stats for the full change package

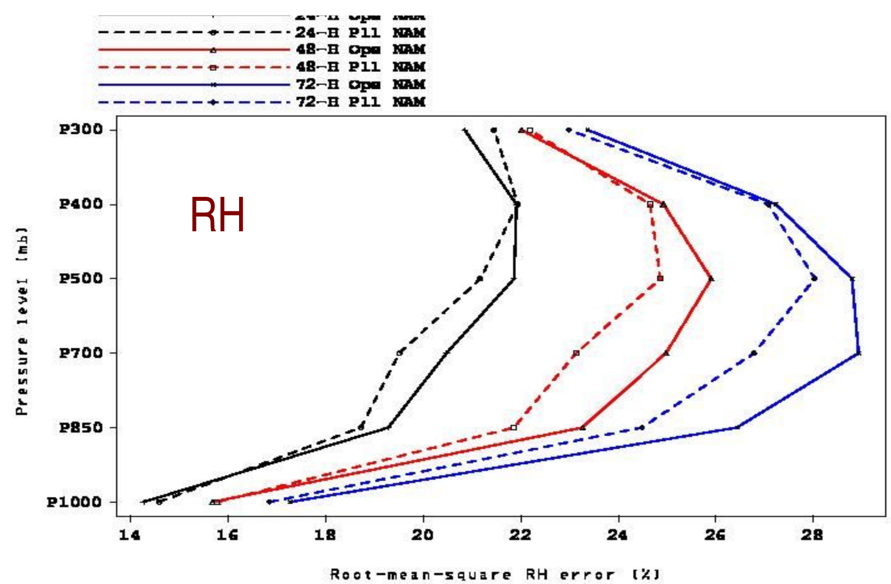
- On all plots, ops=solid line, parallel=dashed line
- NAM Time Periods
  - 29 November 2007 – present
  - August 2007
  - March 2007
  - Shown : stats for days 1,2,3
- DGEX Time Period
  - 14 January 2008 – present
  - Shown : stats for days 4,5,6,7,8

CONUS RMS errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

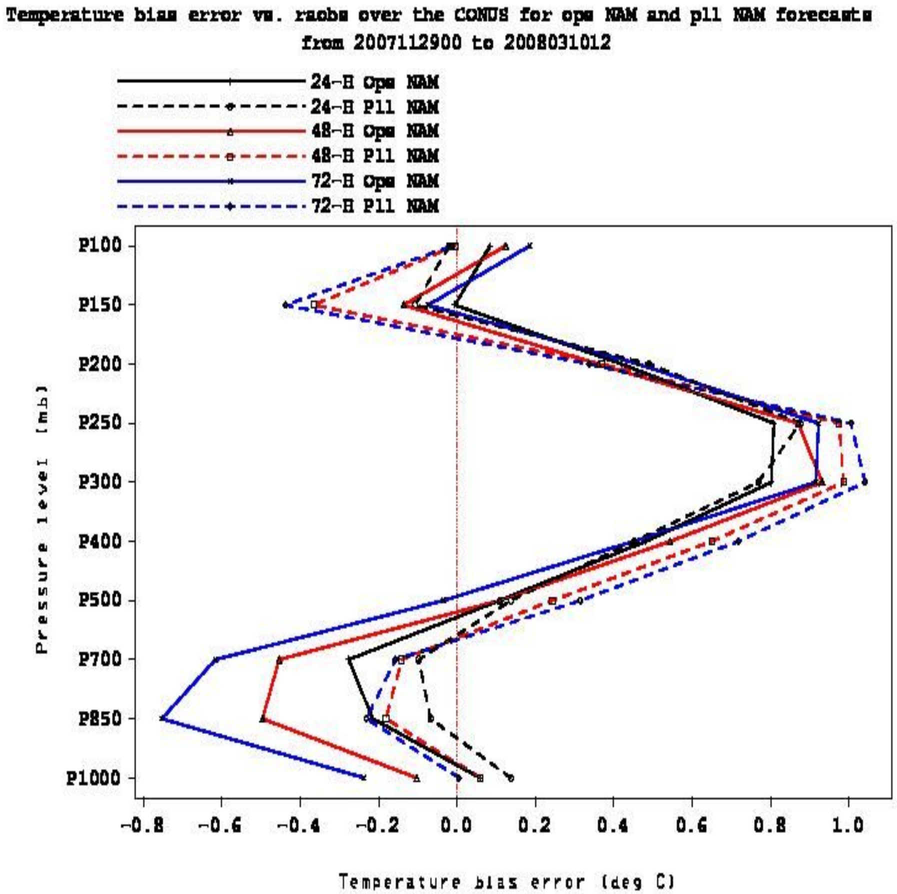




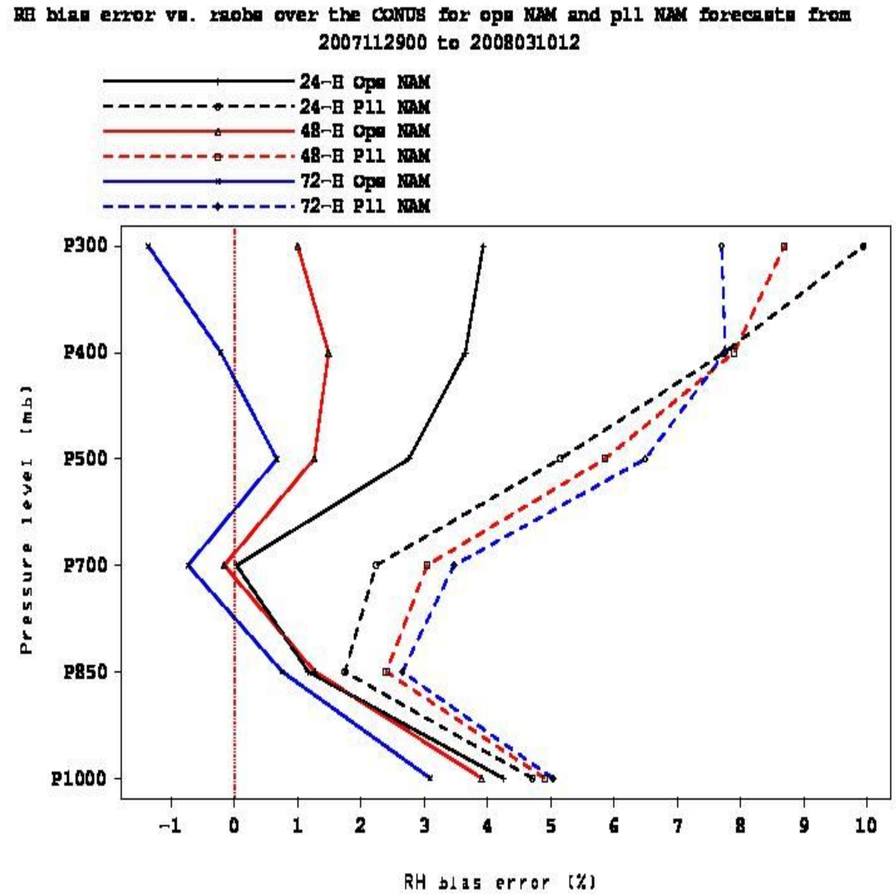




CONUS Bias errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

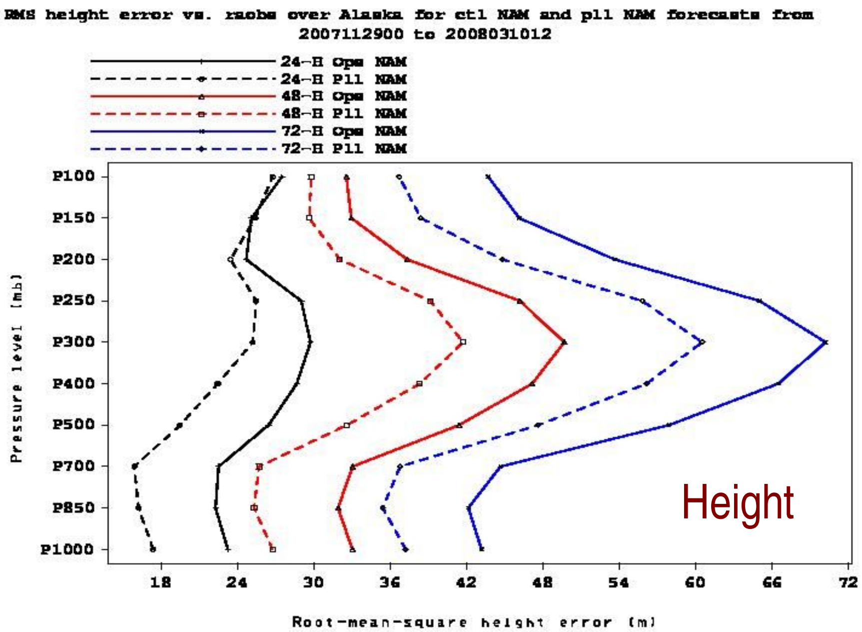


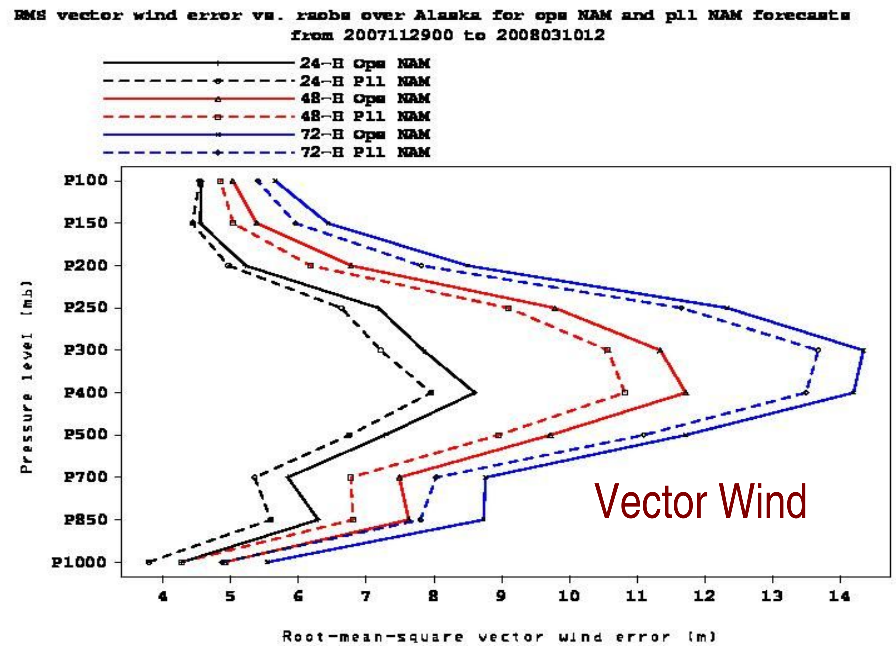
Temp

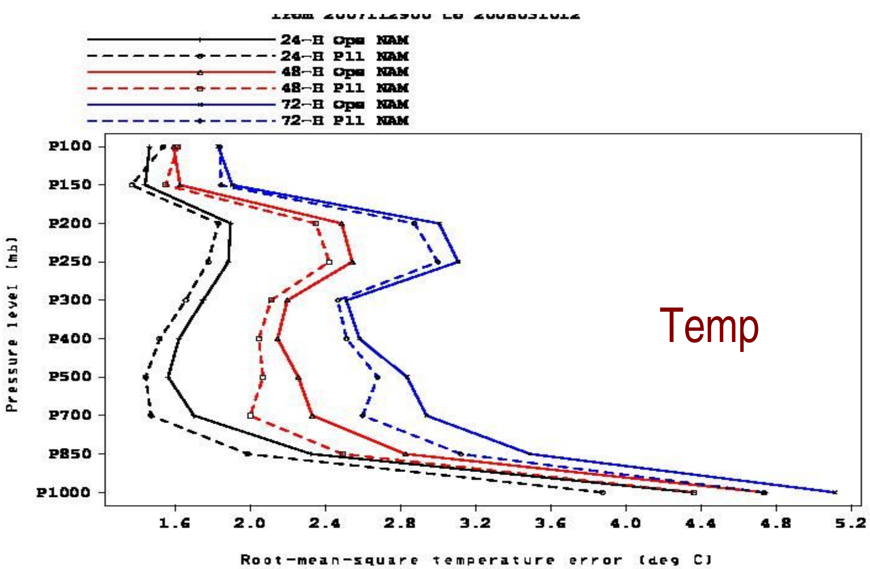


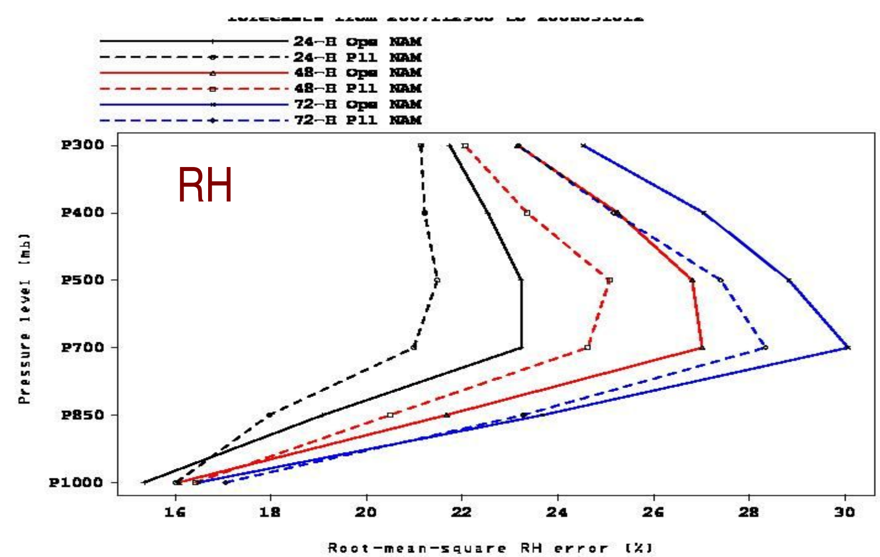
RH

Alaska RMS errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

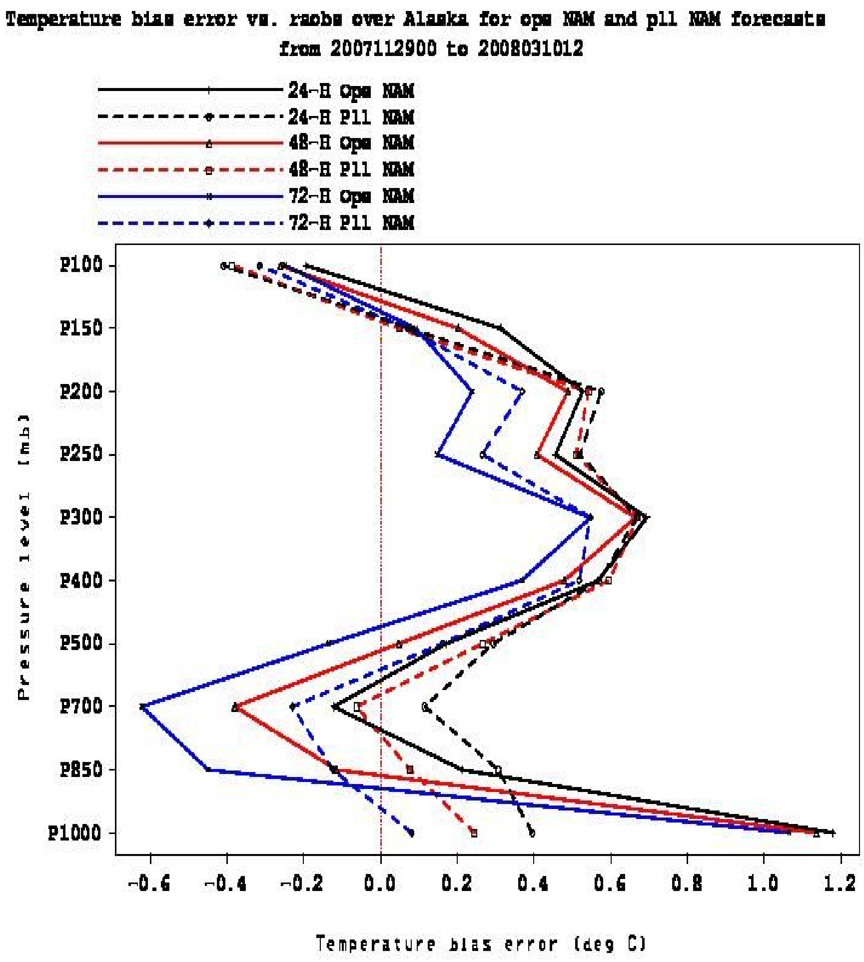




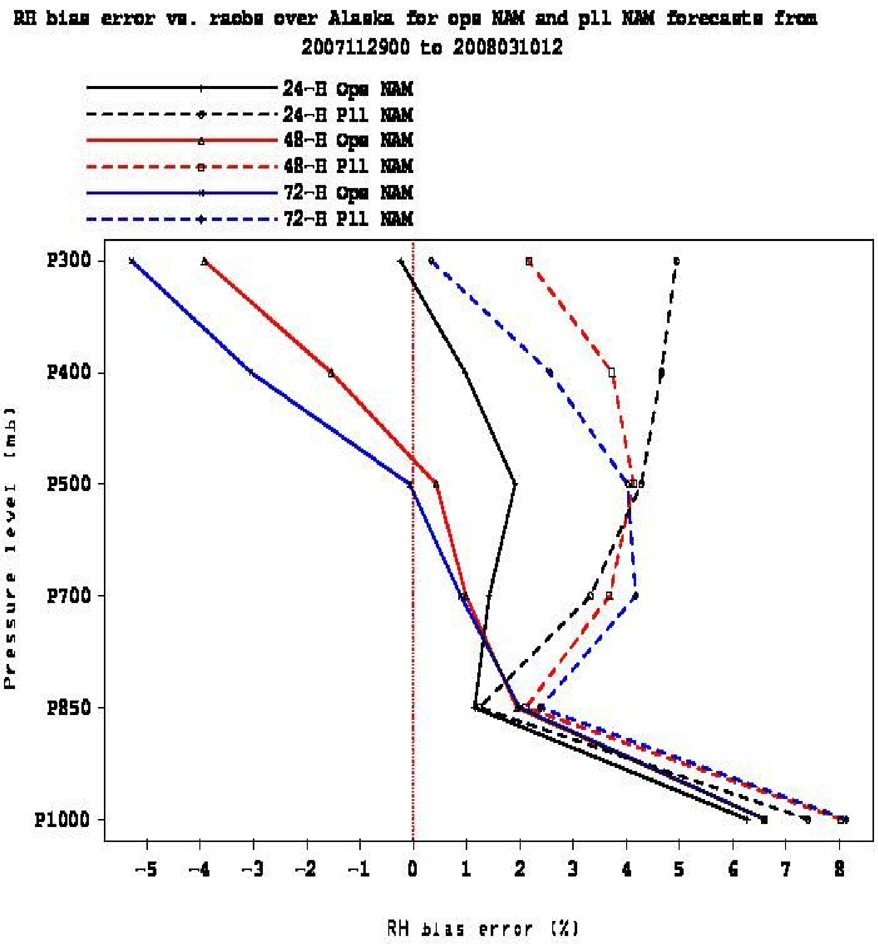




Alaska Bias errors vs raobs: 29 Nov 07 – 10 Mar 08
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

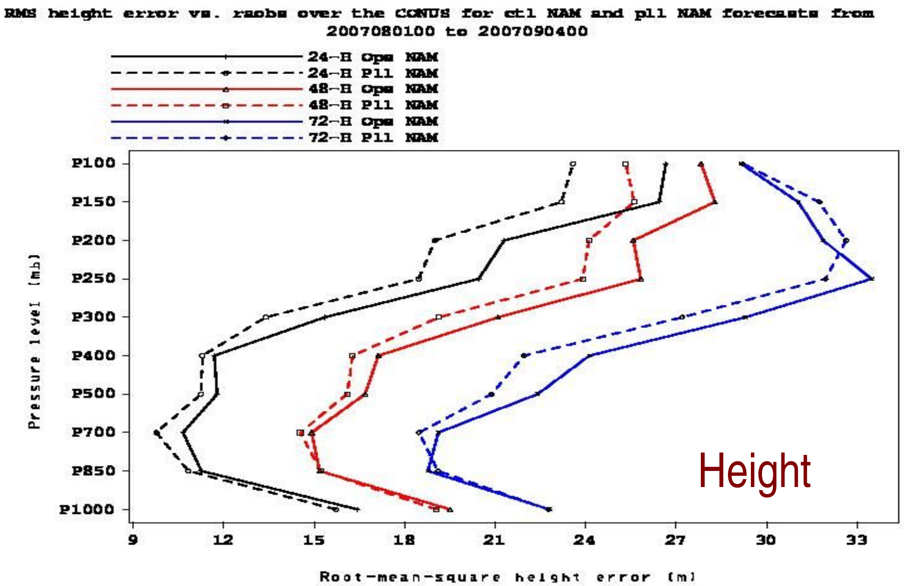


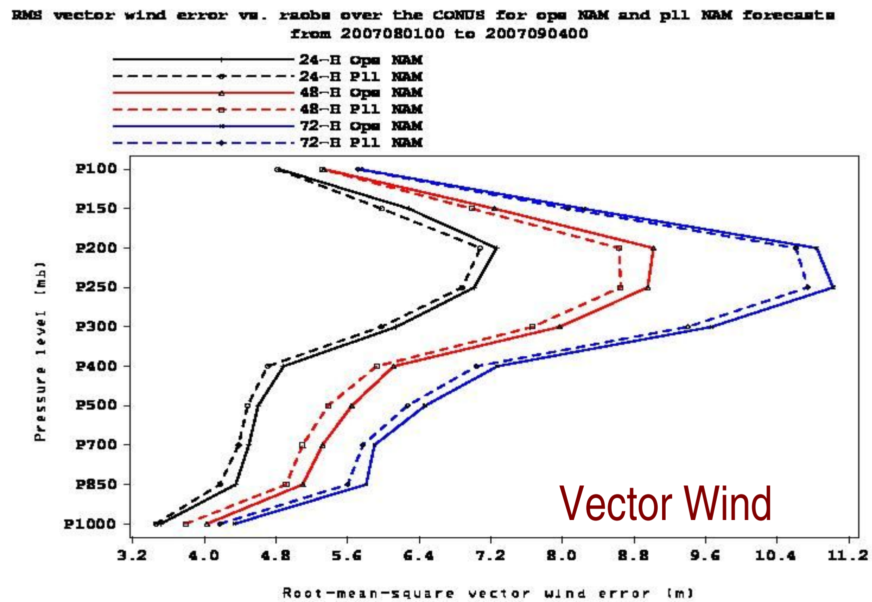
Temp

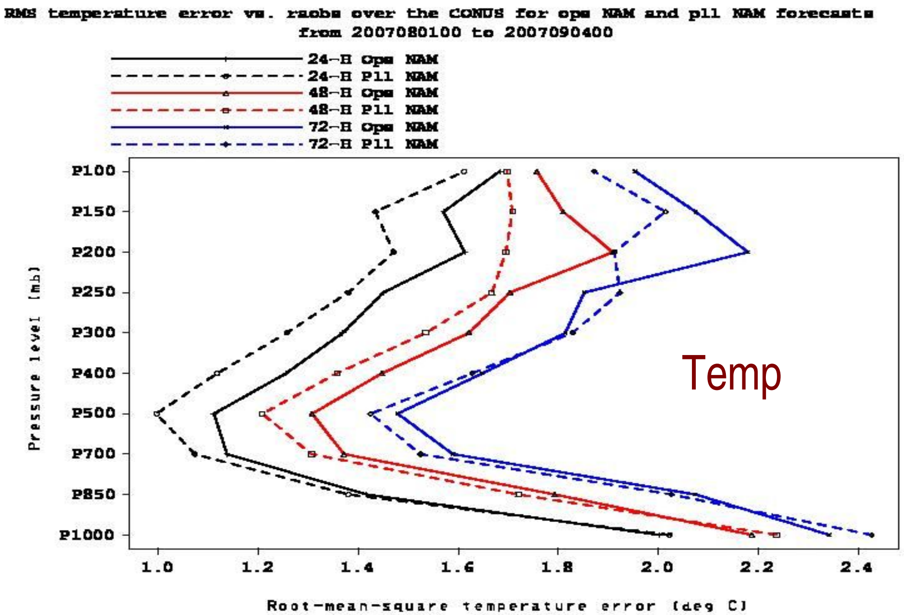


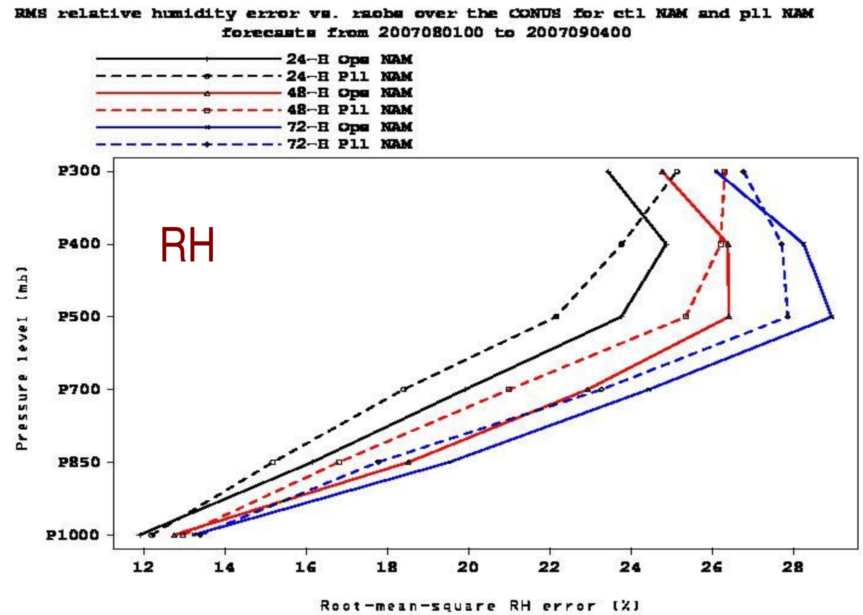
RH

CONUS RMS errors vs raobs: August 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

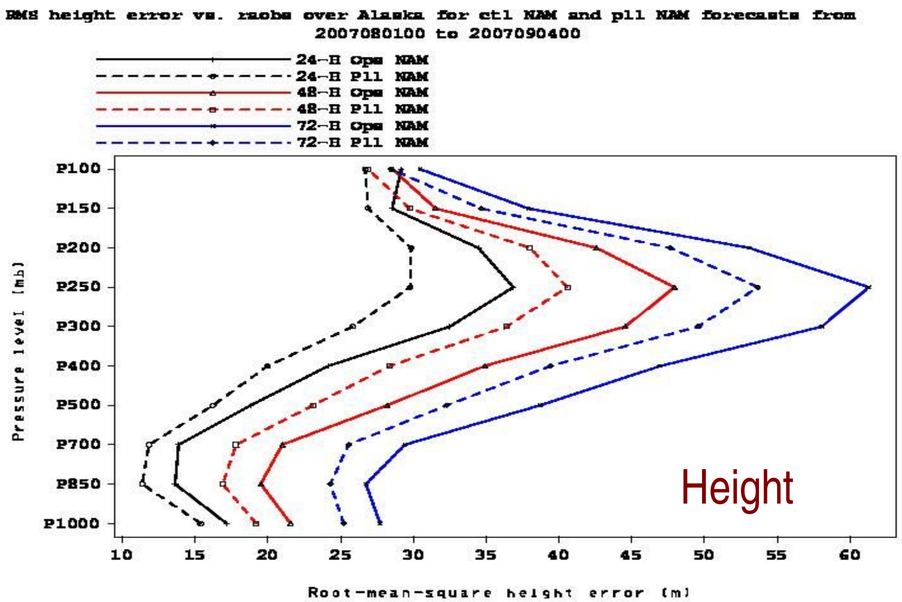


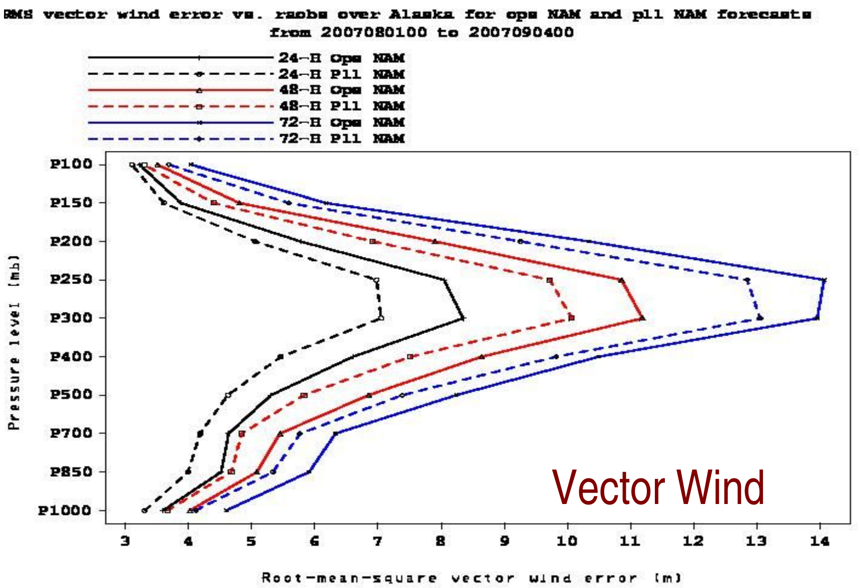


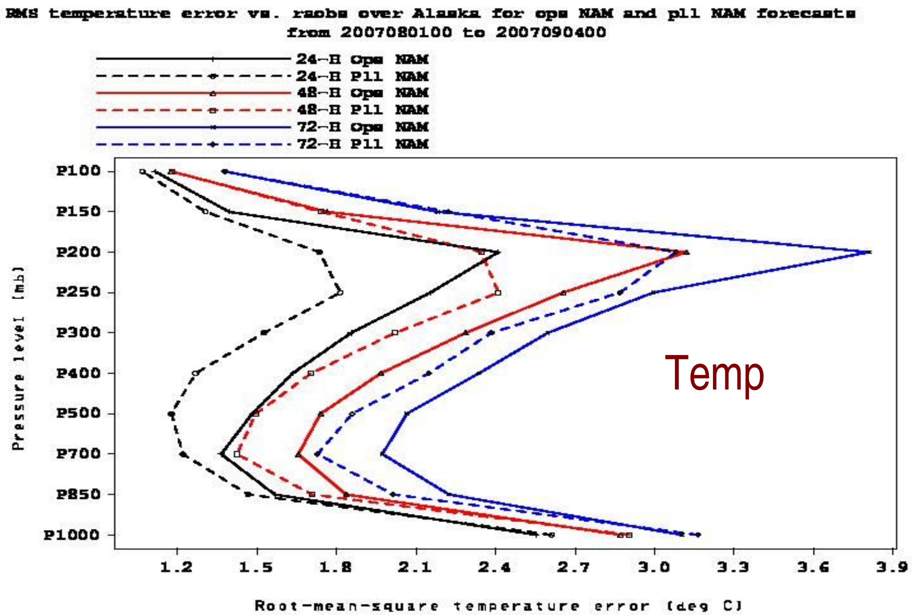


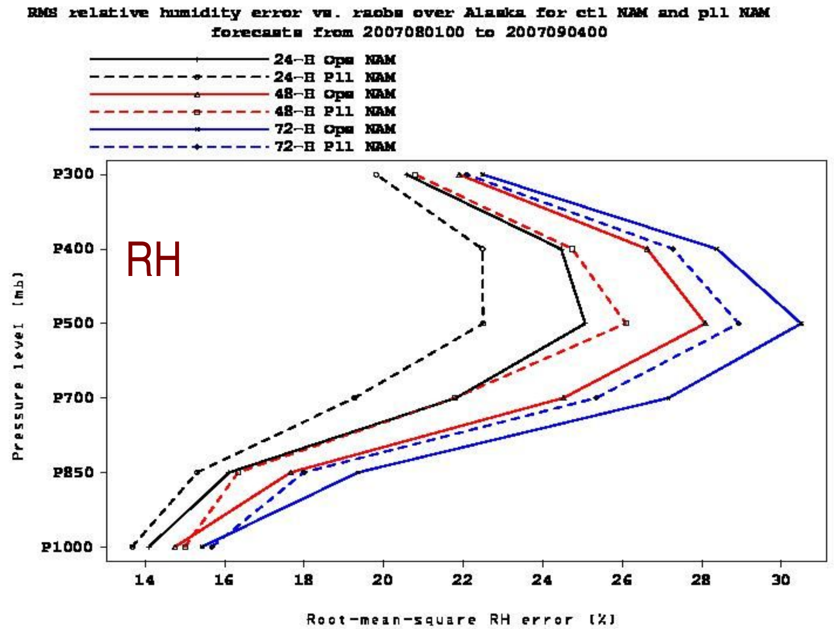


# Alaska RMS errors vs raobs: August 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

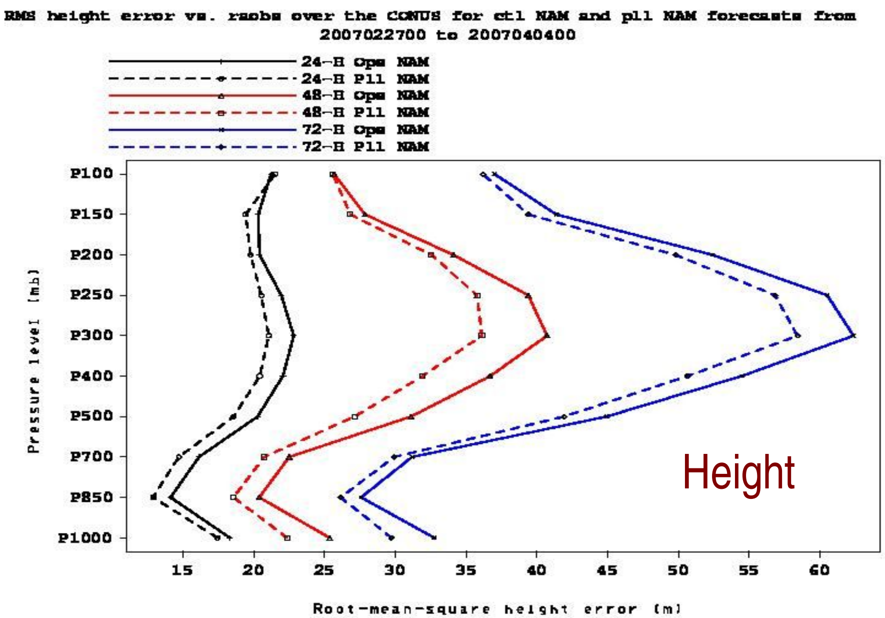


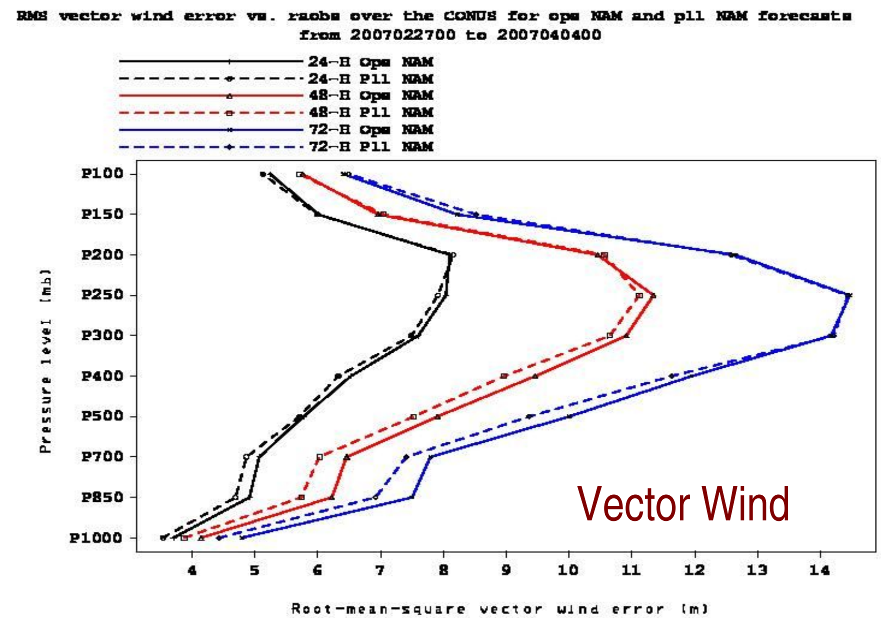


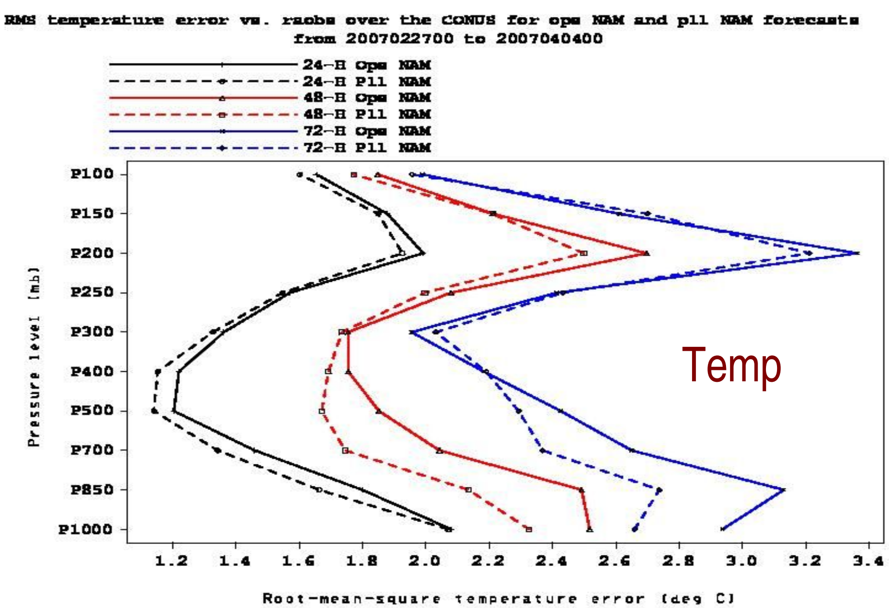


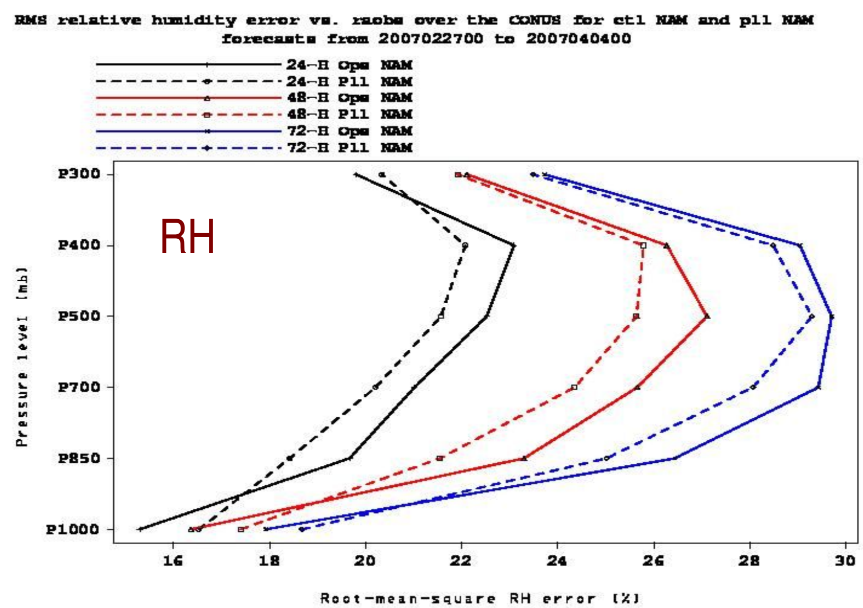


CONUS RMS errors vs raobs: March 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

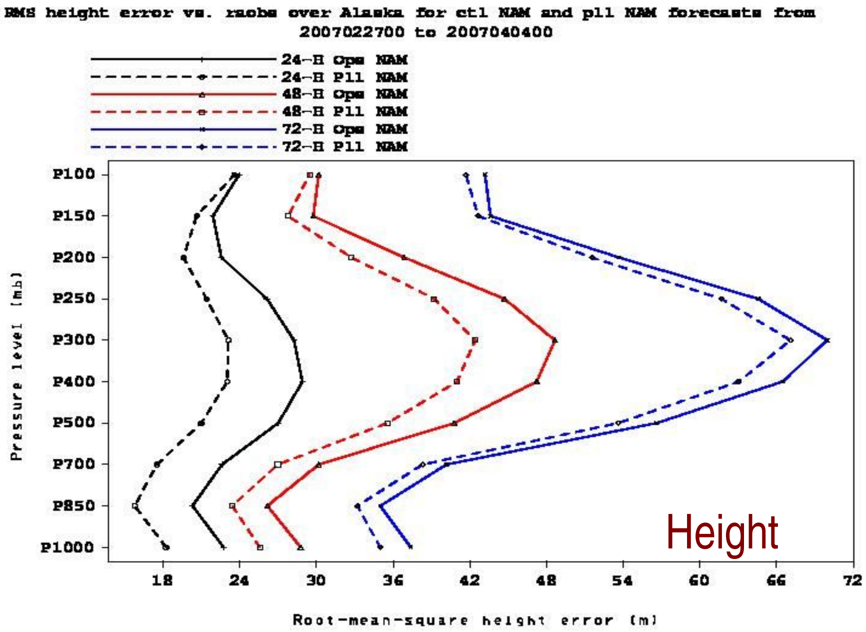


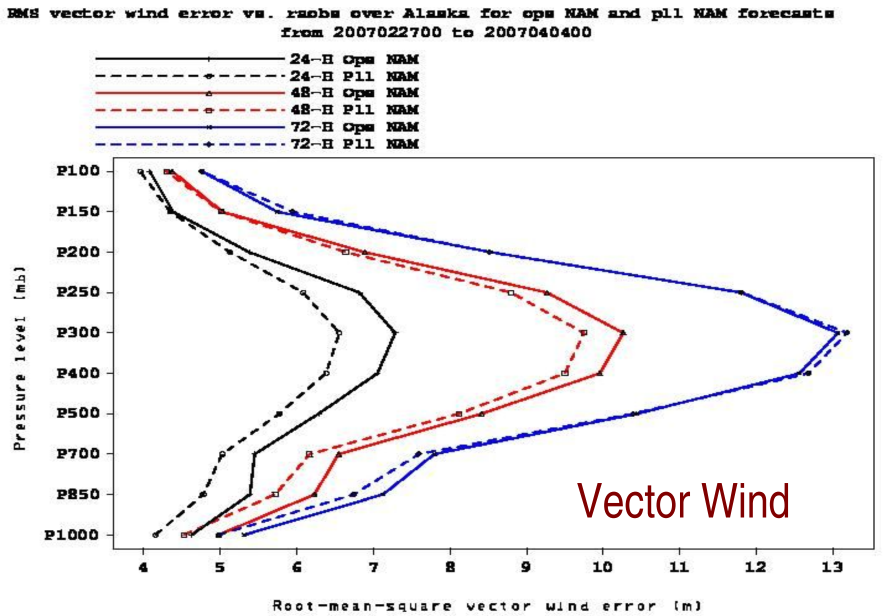


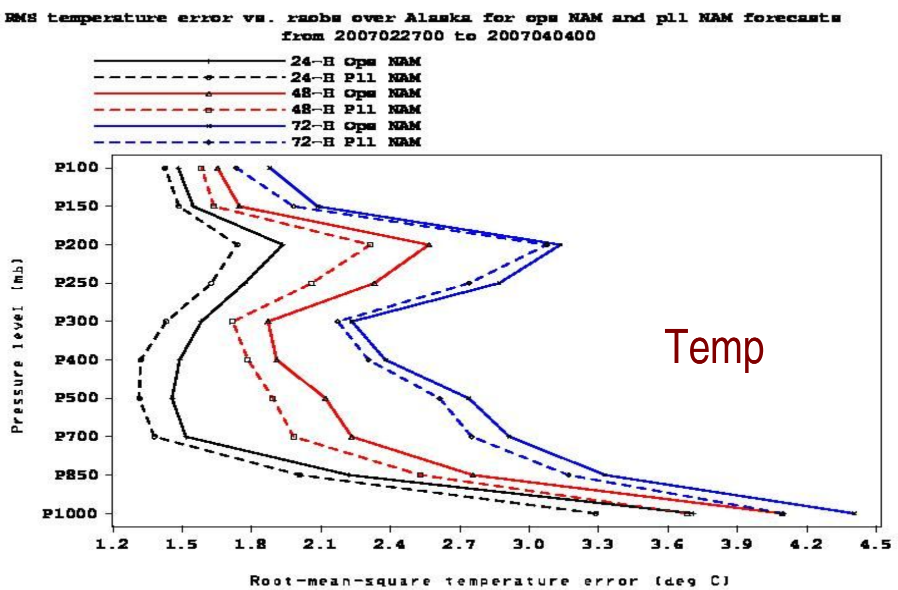


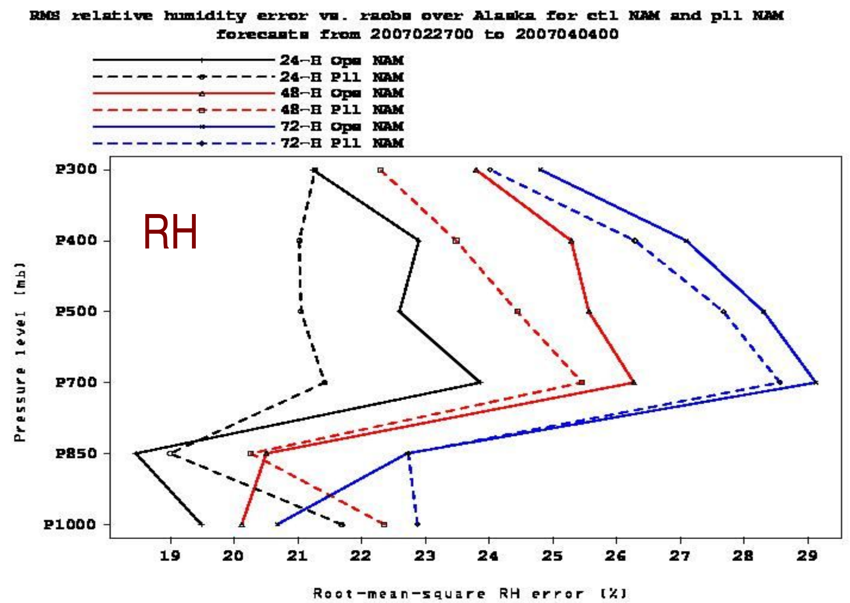


Alaska RMS errors vs raobs: March 2007 retrospective
Black=24-h fcst, Red=48-h fcst, Blue=72-h fcst

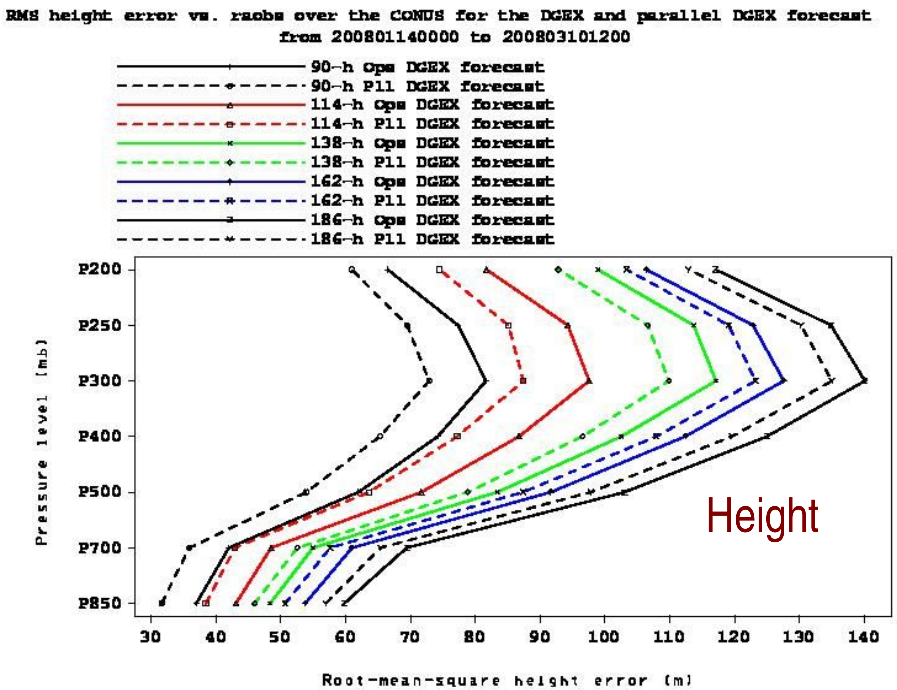


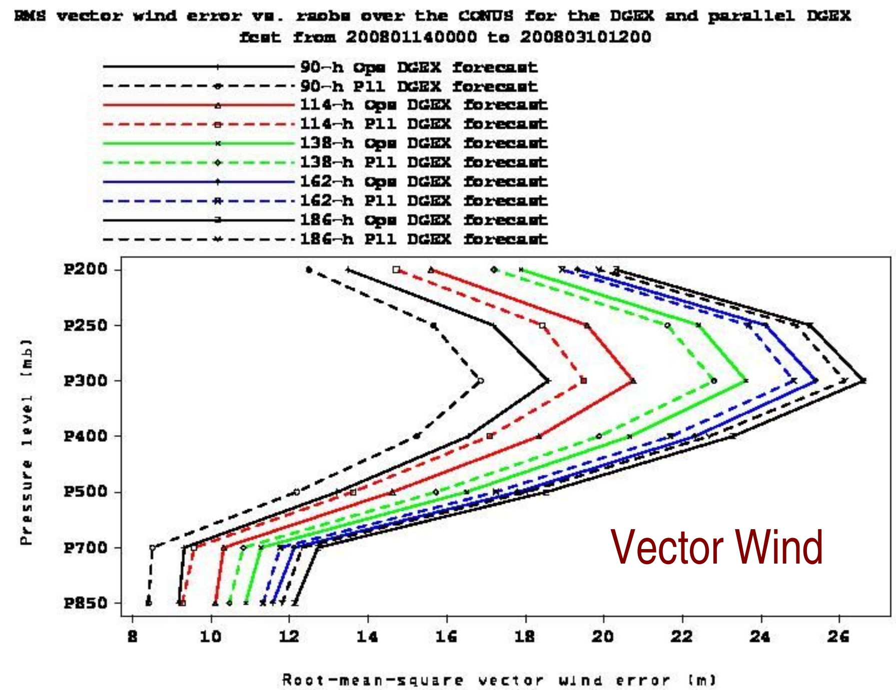


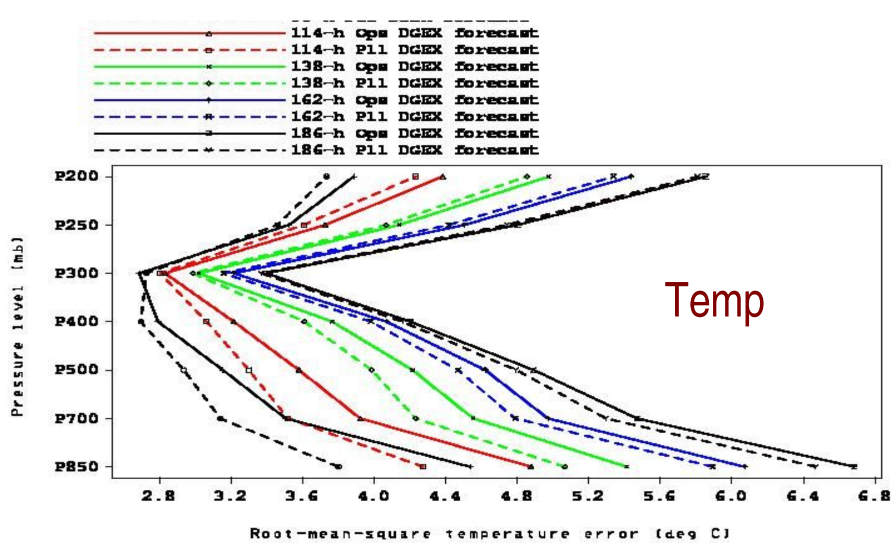


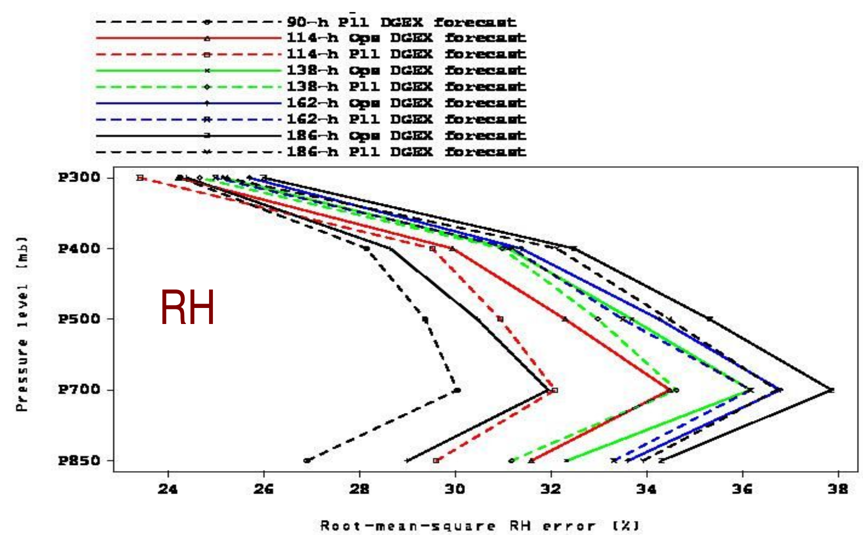


CONUS DGEX RMS errors vs raobs: 14 Jan – 10 Mar 08
Black=90h, Red=114h, Green=138h, Blue=162h, Brown=186h

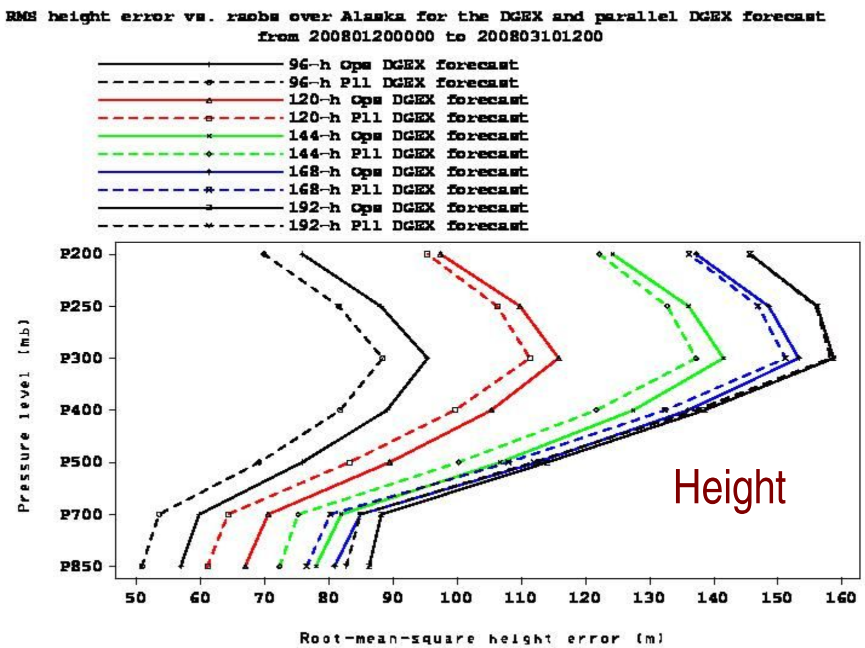


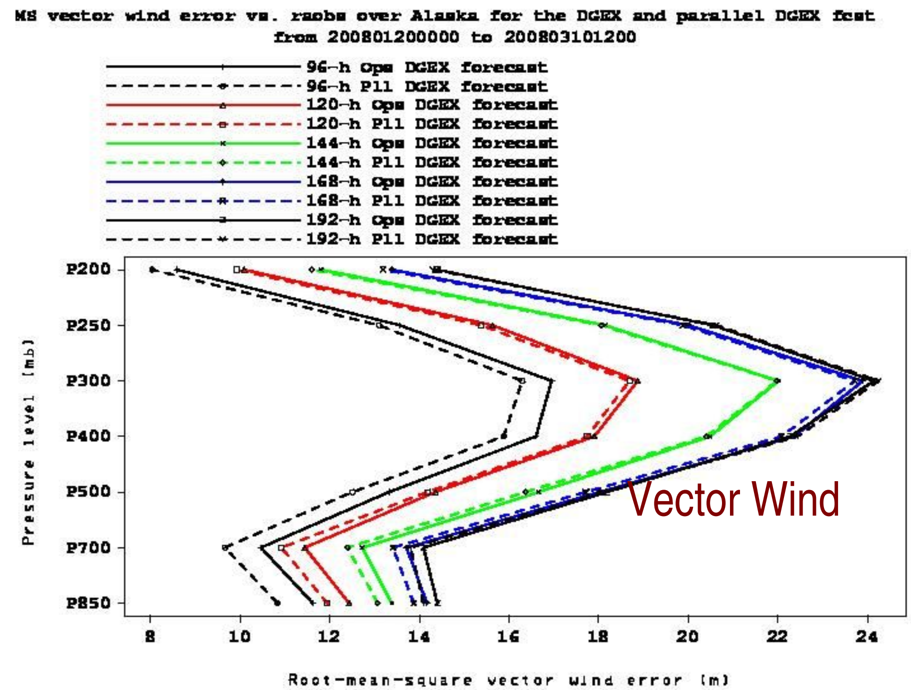


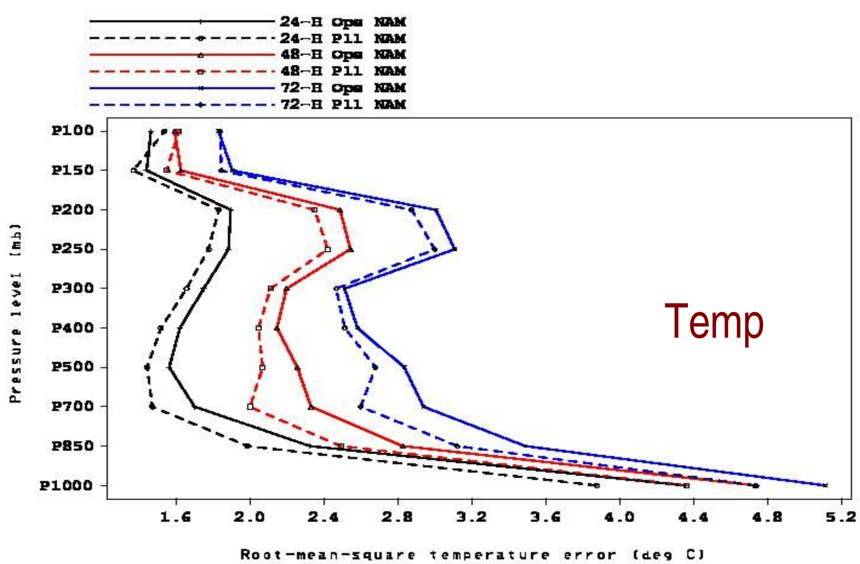


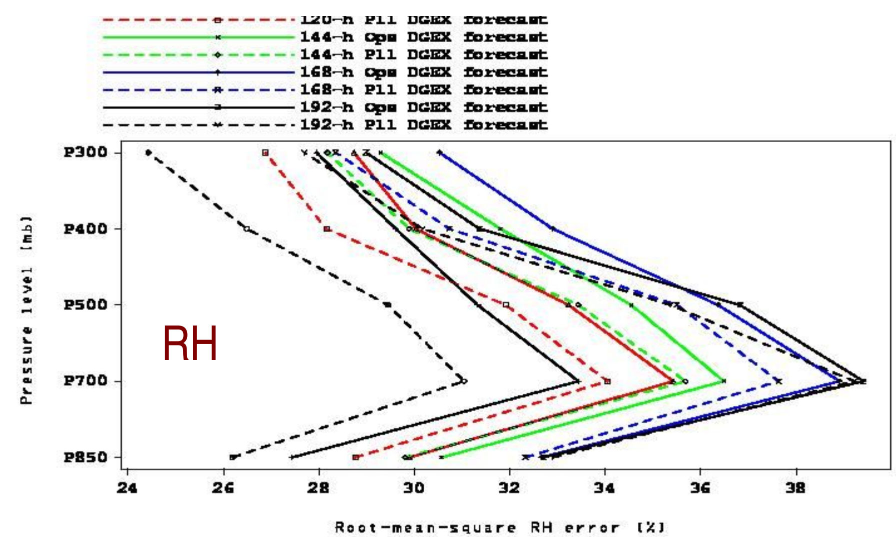


Alaska DGEX RMS errors vs raobs: 14 Jan – 10 Mar 08
Black=96h, Red=120h, Green=144h, Blue=168h, Brown=192h

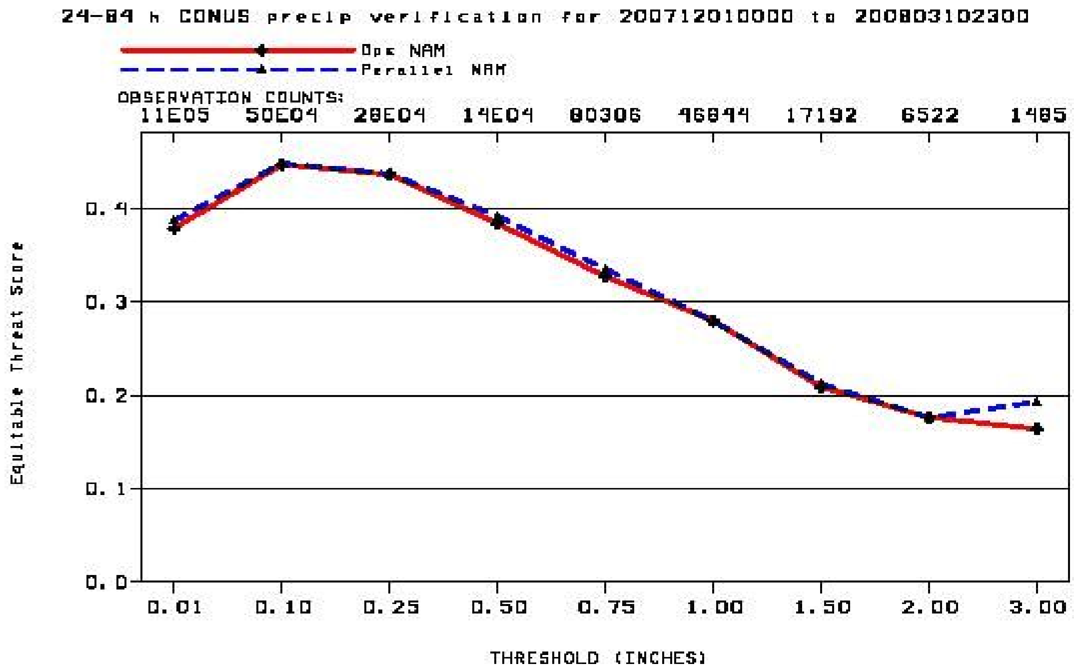


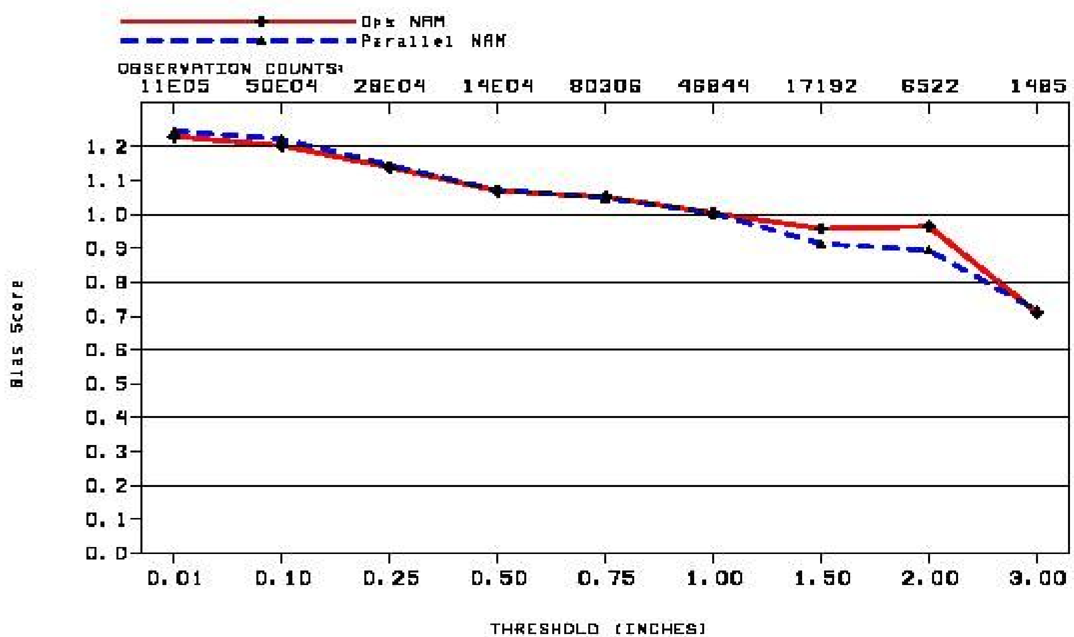




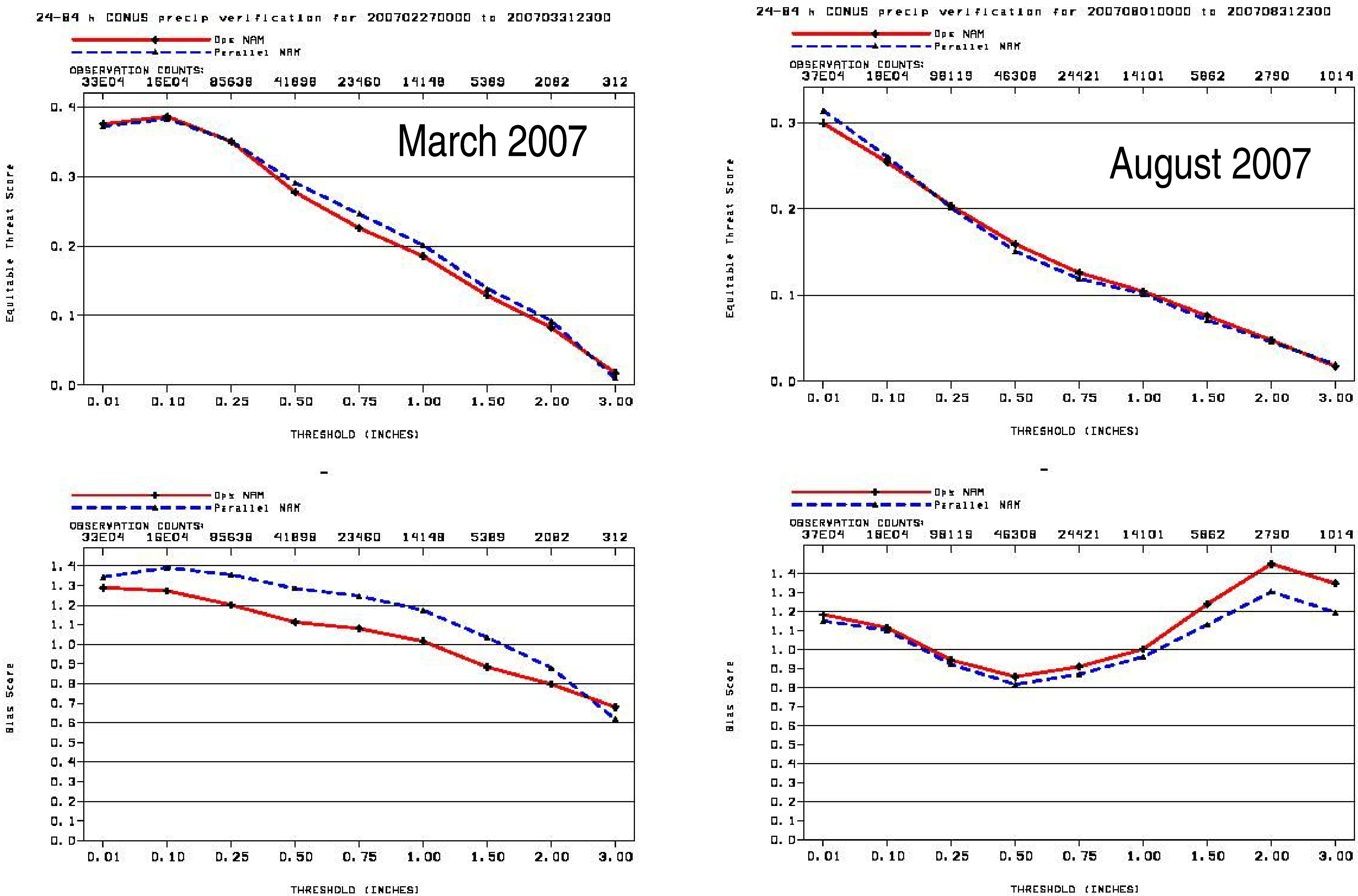


Cumulative QPF scores:
Equitable Threat (top) and bias (bottom) for Ops NAM (soild red) and parallel NAM
(dashed blue) for 1 Dec 07 - 10 March 08





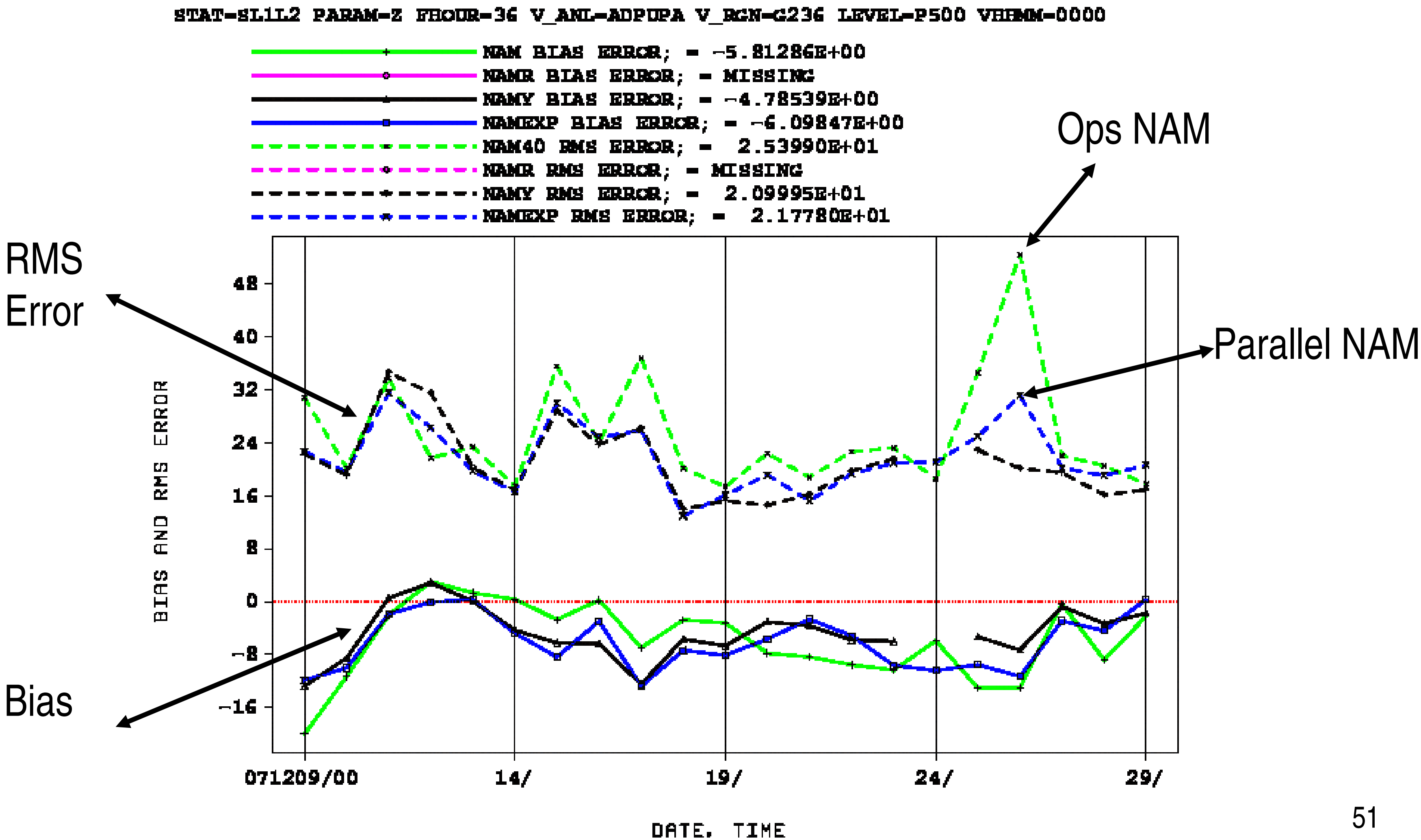
Cumulative QPF scores: Equitable Threat (top) and bias (bottom) for ops NAM (solid red) and parallel NAM (dashed blue)

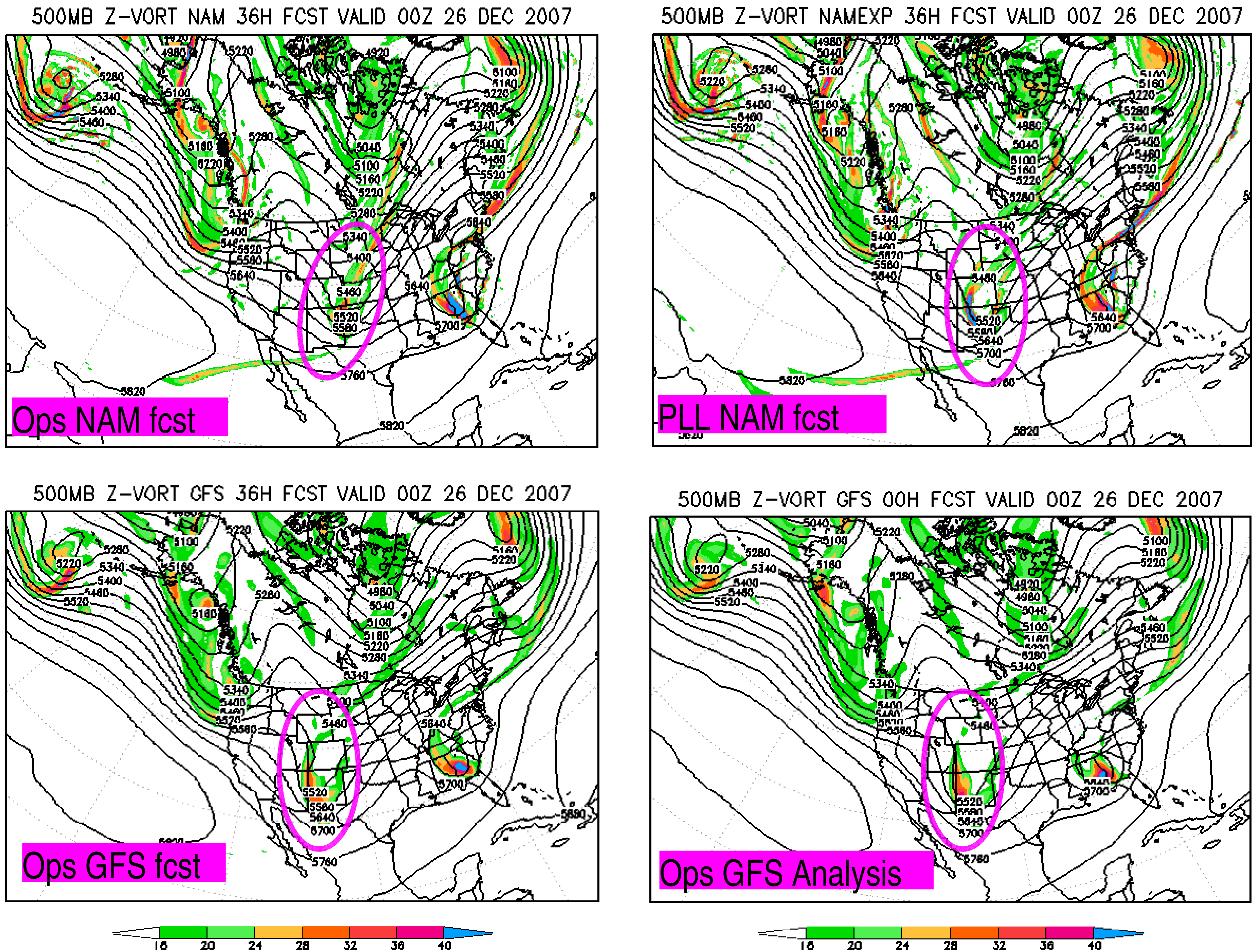


NAM vs Parallel NAM Forecast Examples

- Examples of NAM "dropout" cases where parallel did better
- Hurricane Dean
- Ex-Hurricane Noel
- 22 February 2008 East Coast Winter Storm
- SLP forecast example from Mike Brennan

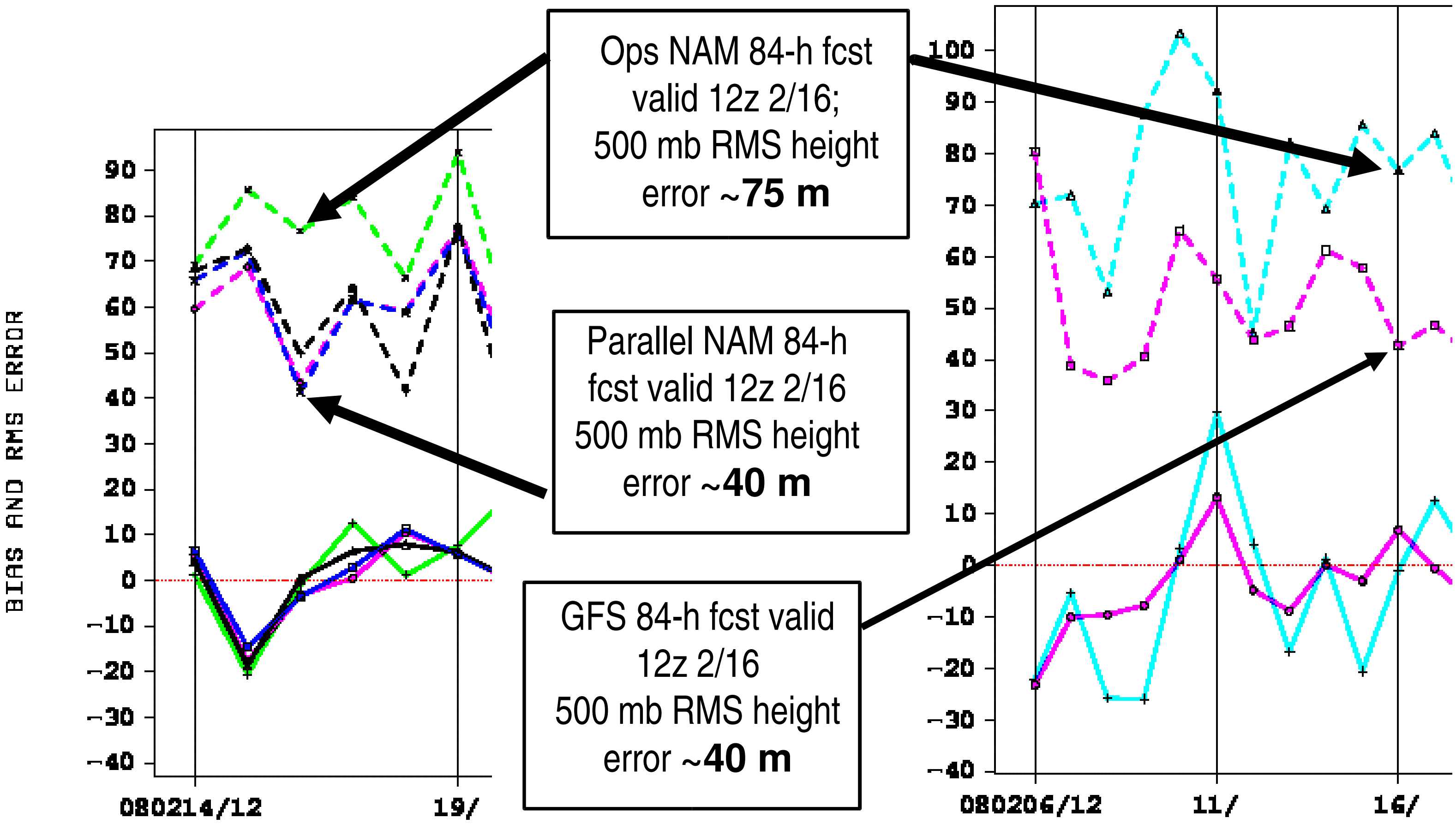
Time series of 36-h forecast 500 mb Height errors: NAM vs Parallel NAM

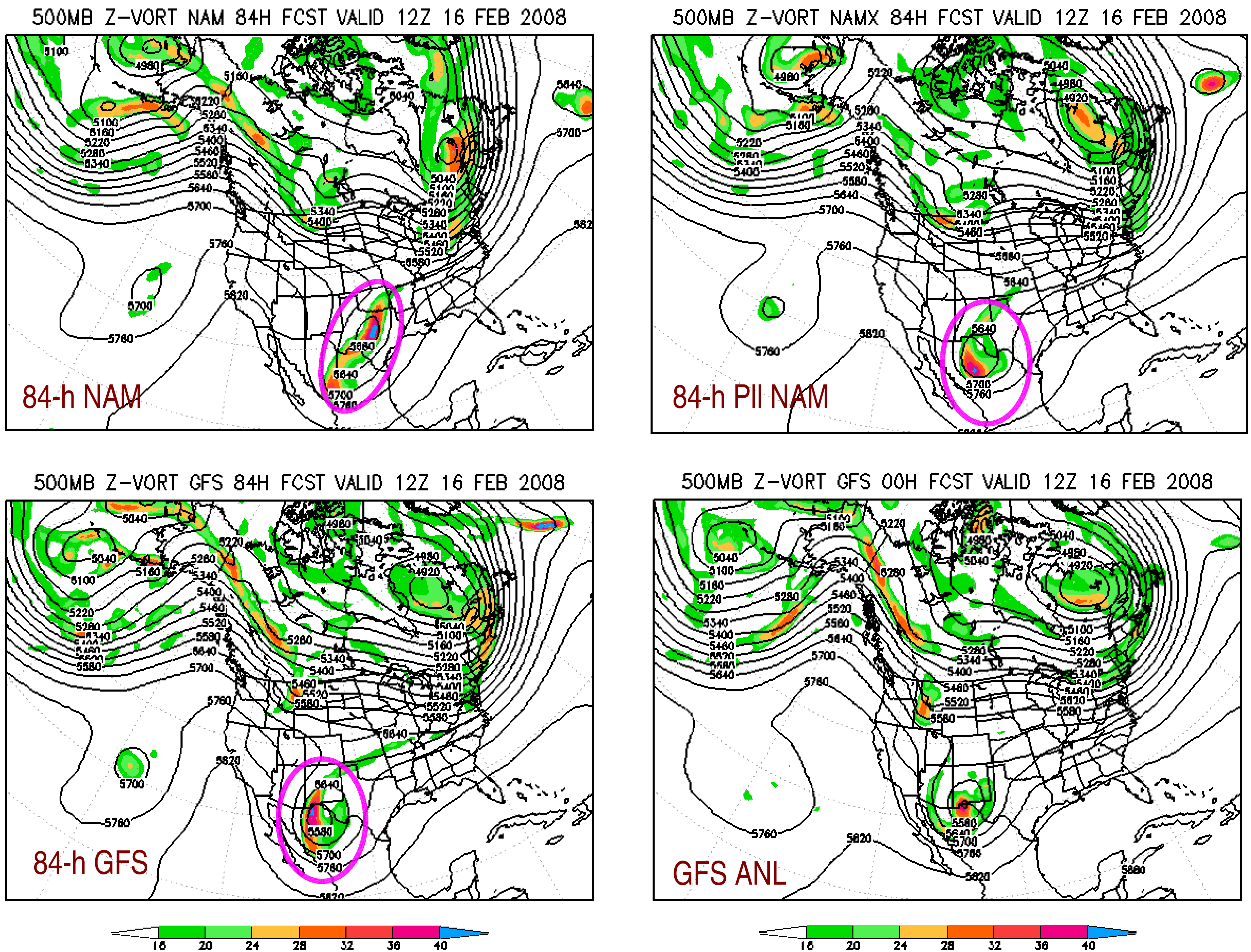


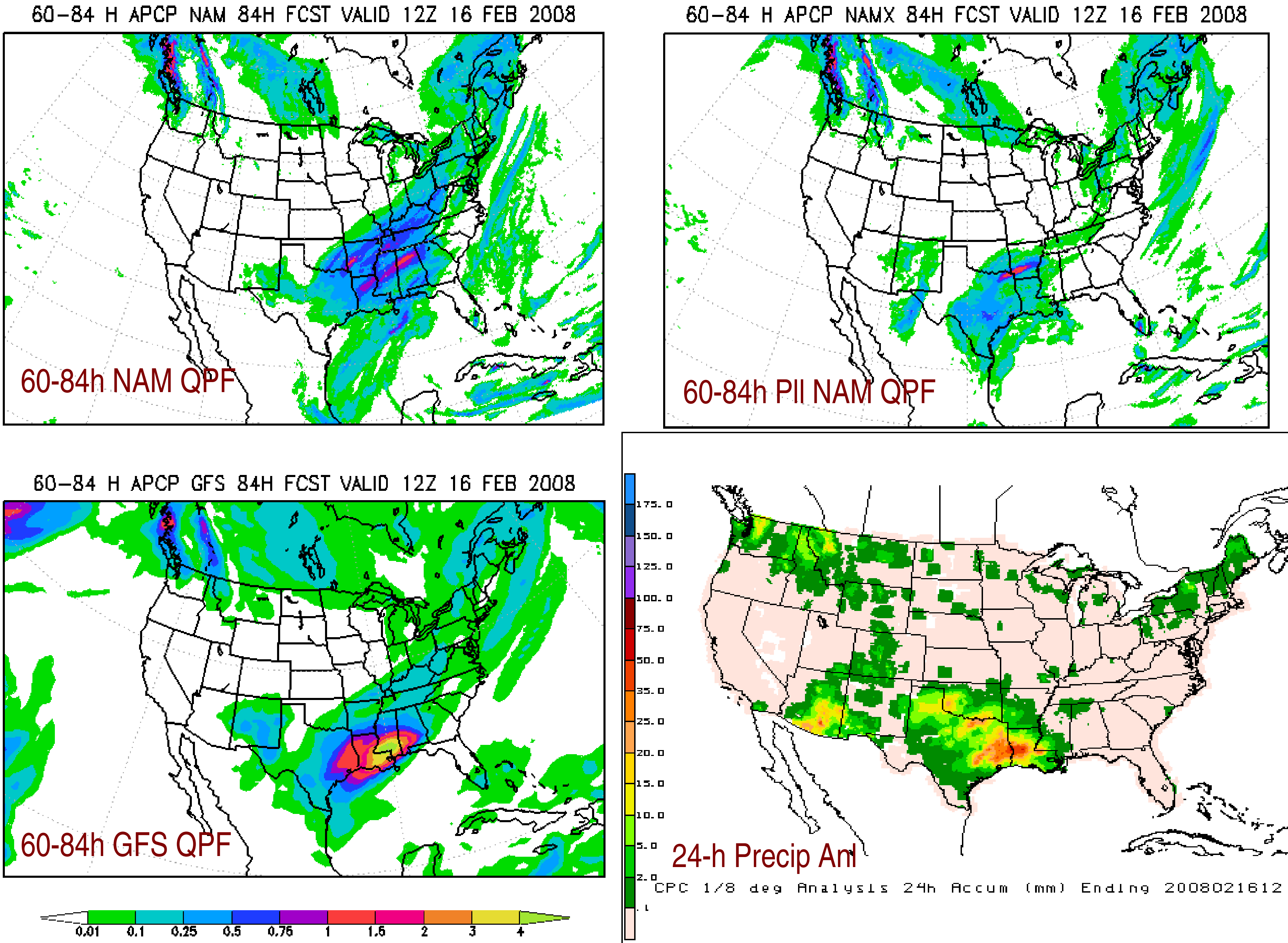


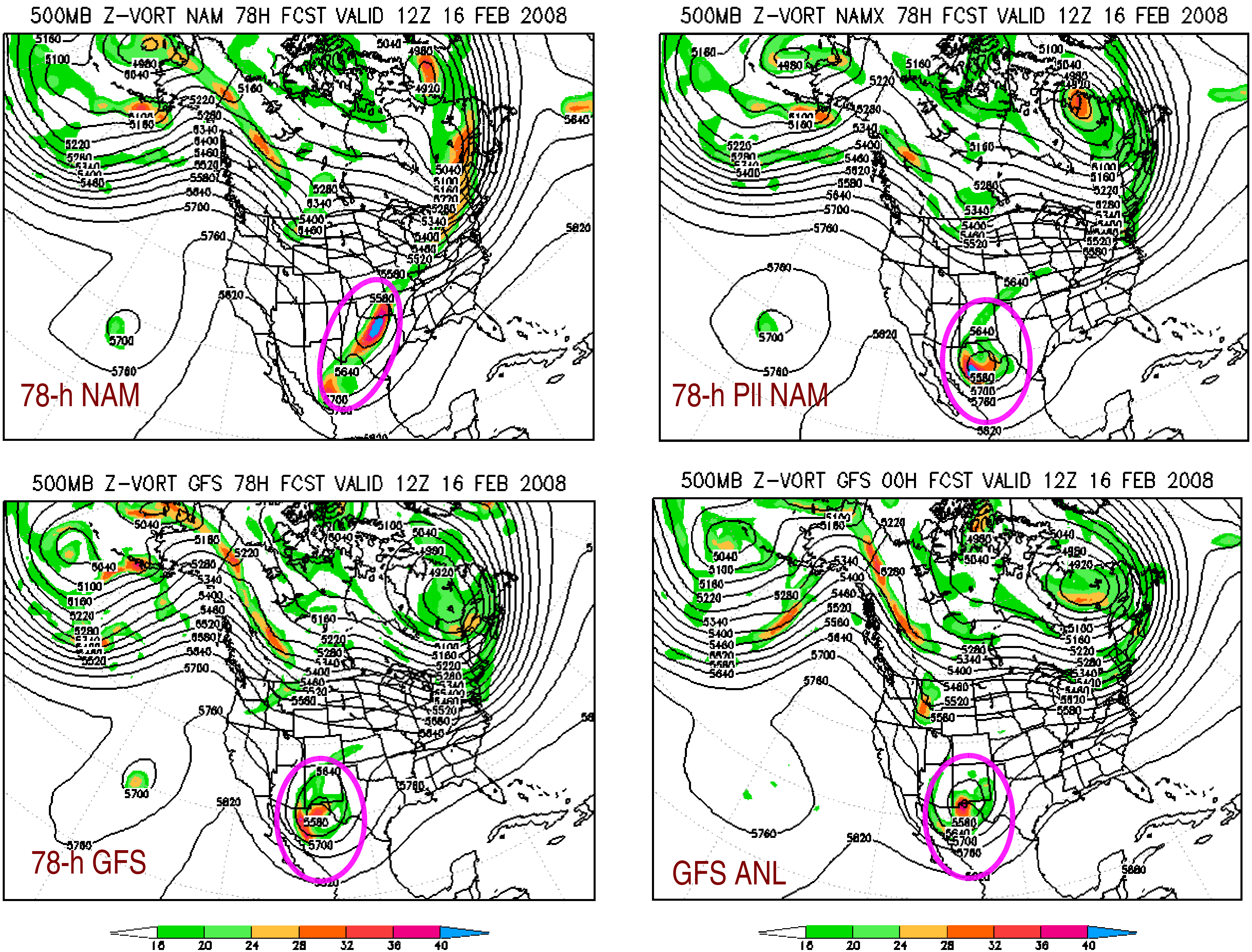
500MB Z-VORT NAM 36H FCST VALID 00Z 26 DEC 2007
Ops NAM fcst
500MB Z-VORT NAMEXP 36H FCST VALID 00Z 26 DEC 2007
PLL NAM fcst
500MB Z-VORT GFS 36H FCST VALID 00Z 26 DEC 2007
Ops GFS fcst
500MB Z-VORT GFS 00H FCST VALID 00Z 26 DEC 2007
Ops GFS Analysis
16 20 24 28 32 36 40
16 20 24 28 32 36 40

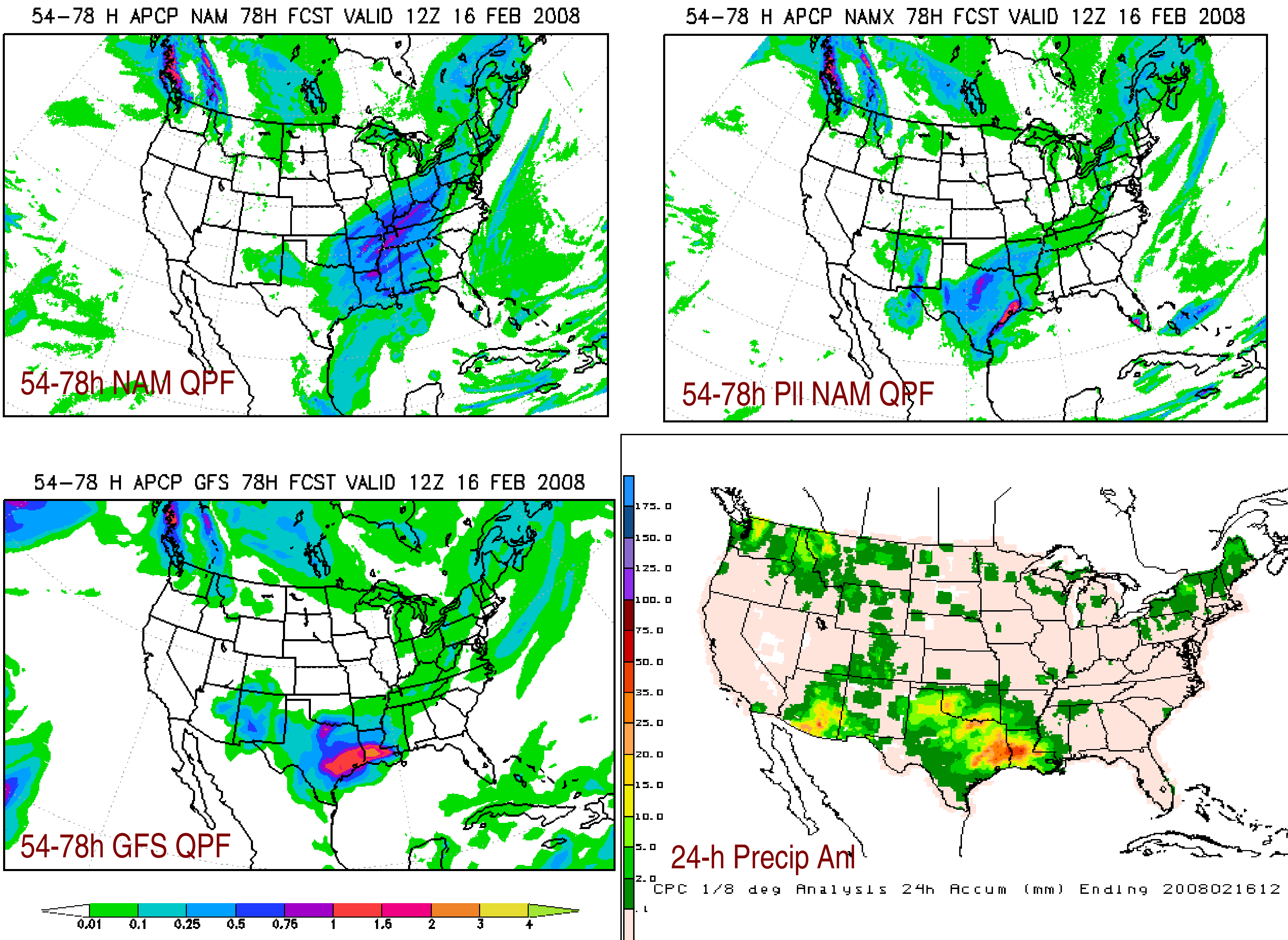
Ops NAM vs Parallel NAM vs GFS 500 mb height / 24-h QPF forecasts valid 12z 2/16/2008



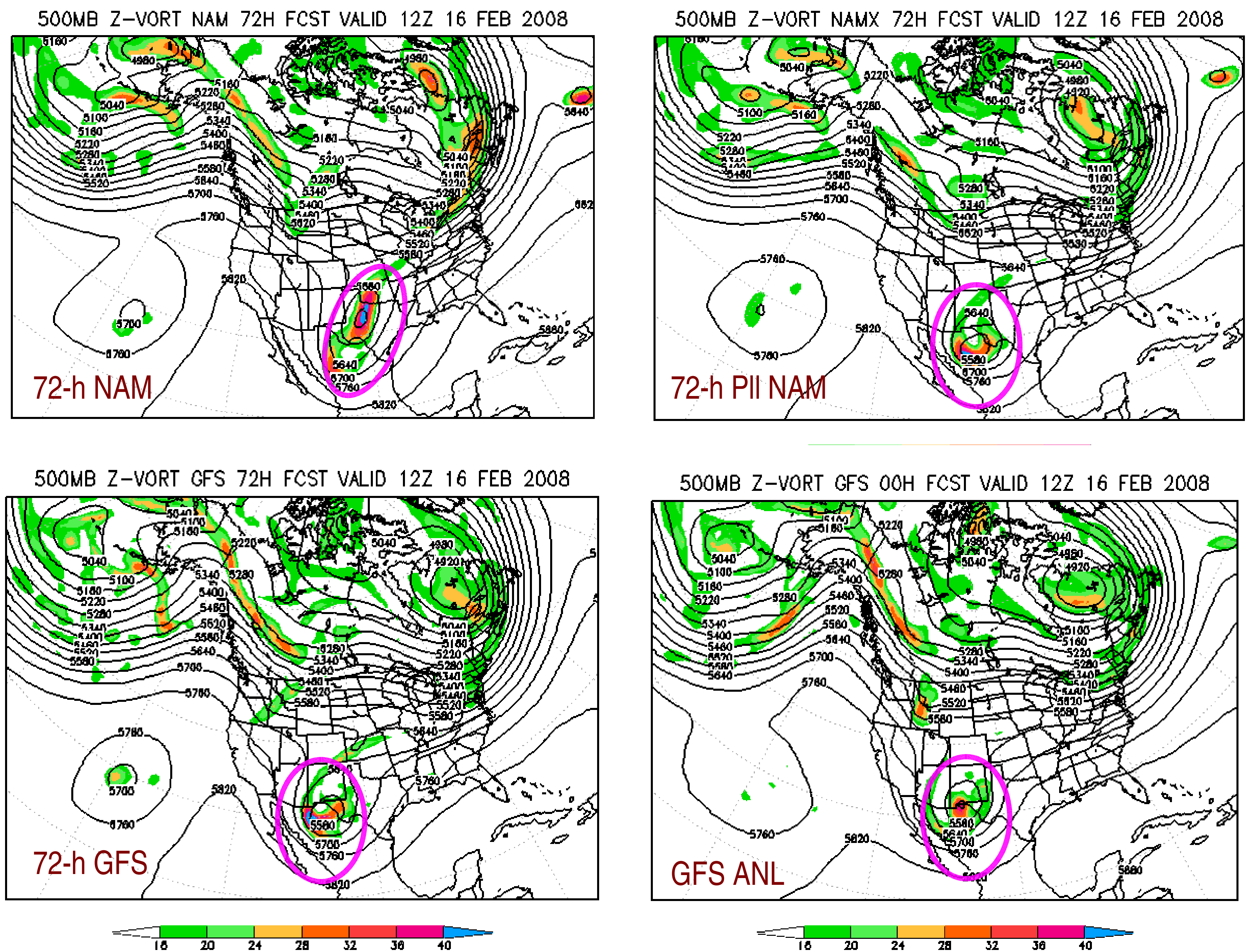

500MB Z-VORT NAM 84H FCST VALID 12Z 16 FEB 2008
84-h NAM
500MB Z-VORT NAMX 84H FCST VALID 12Z 16 FEB 2008
84-h PII NAM
500MB Z-VORT GFS 84H FCST VALID 12Z 16 FEB 2008
84-h GFS
500MB Z-VORT GFS 00H FCST VALID 12Z 16 FEB 2008
GFS ANL
16 20 24 28 32 36 40
16 20 24 28 32 36 40

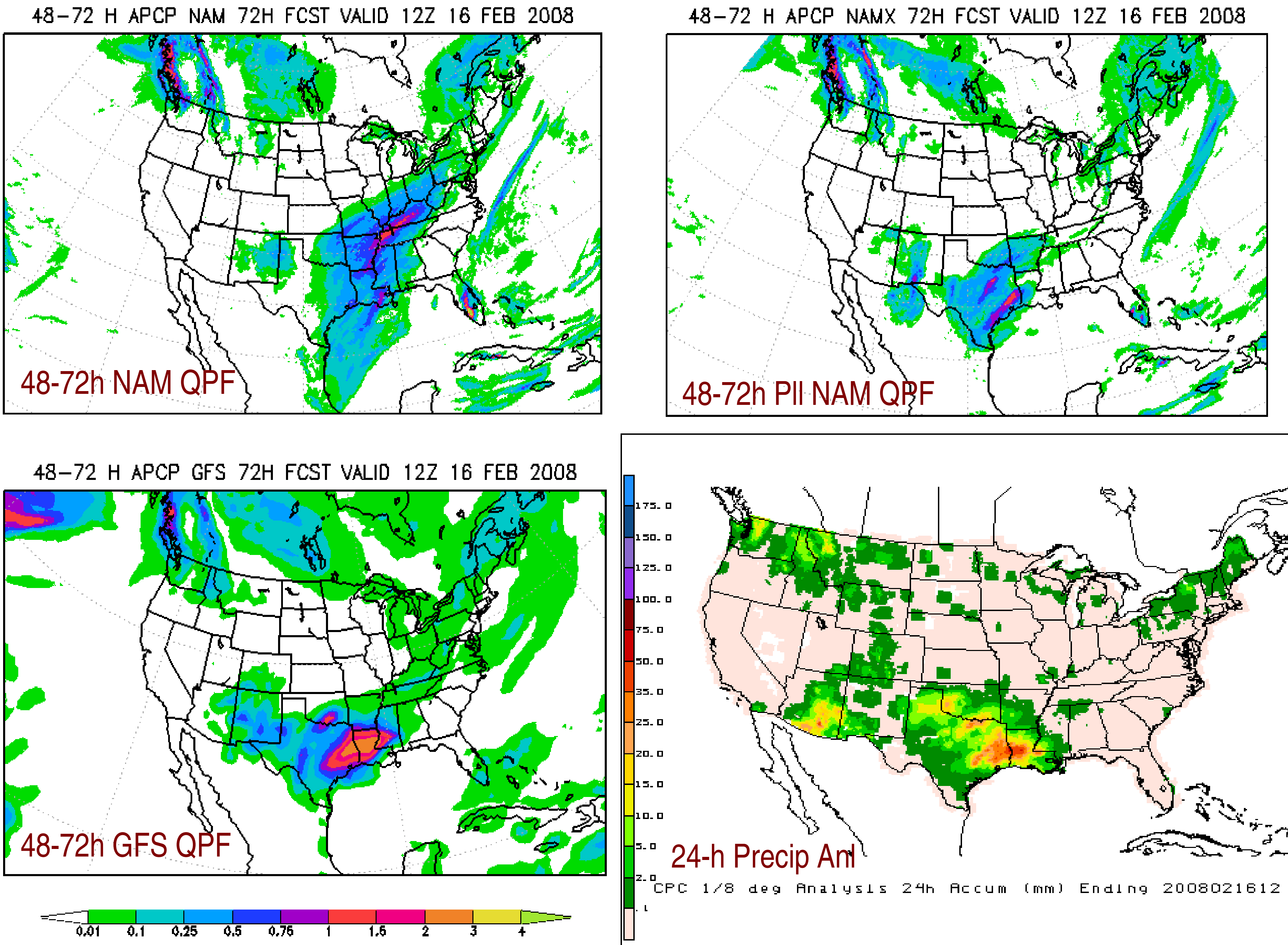

60-84 H APCP NAM 84H FCST VALID 12Z 16 FEB 2008
60-84h NAM QPF
60-84 H APCP NAMX 84H FCST VALID 12Z 16 FEB 2008
60-84h PII NAM QPF
60-84 H APCP GFS 84H FCST VALID 12Z 16 FEB 2008
60-84h GFS QPF
0.01 0.1 0.25 0.5 0.75 1 1.5 2 3 4
175.0
150.0
125.0
100.0
75.0
50.0
35.0
25.0
20.0
15.0
10.0
5.0
2.0
.1
24-h Precip Anl
CPC 1/8 deg Analysis 24h Accum (mm) Ending 2008021612


500MB Z-VORT NAM 78H FCST VALID 12Z 16 FEB 2008
78-h NAM
500MB Z-VORT NAMX 78H FCST VALID 12Z 16 FEB 2008
78-h PII NAM
500MB Z-VORT GFS 78H FCST VALID 12Z 16 FEB 2008
78-h GFS
500MB Z-VORT GFS 00H FCST VALID 12Z 16 FEB 2008
GFS ANL
16 20 24 28 32 36 40
16 20 24 28 32 36 40



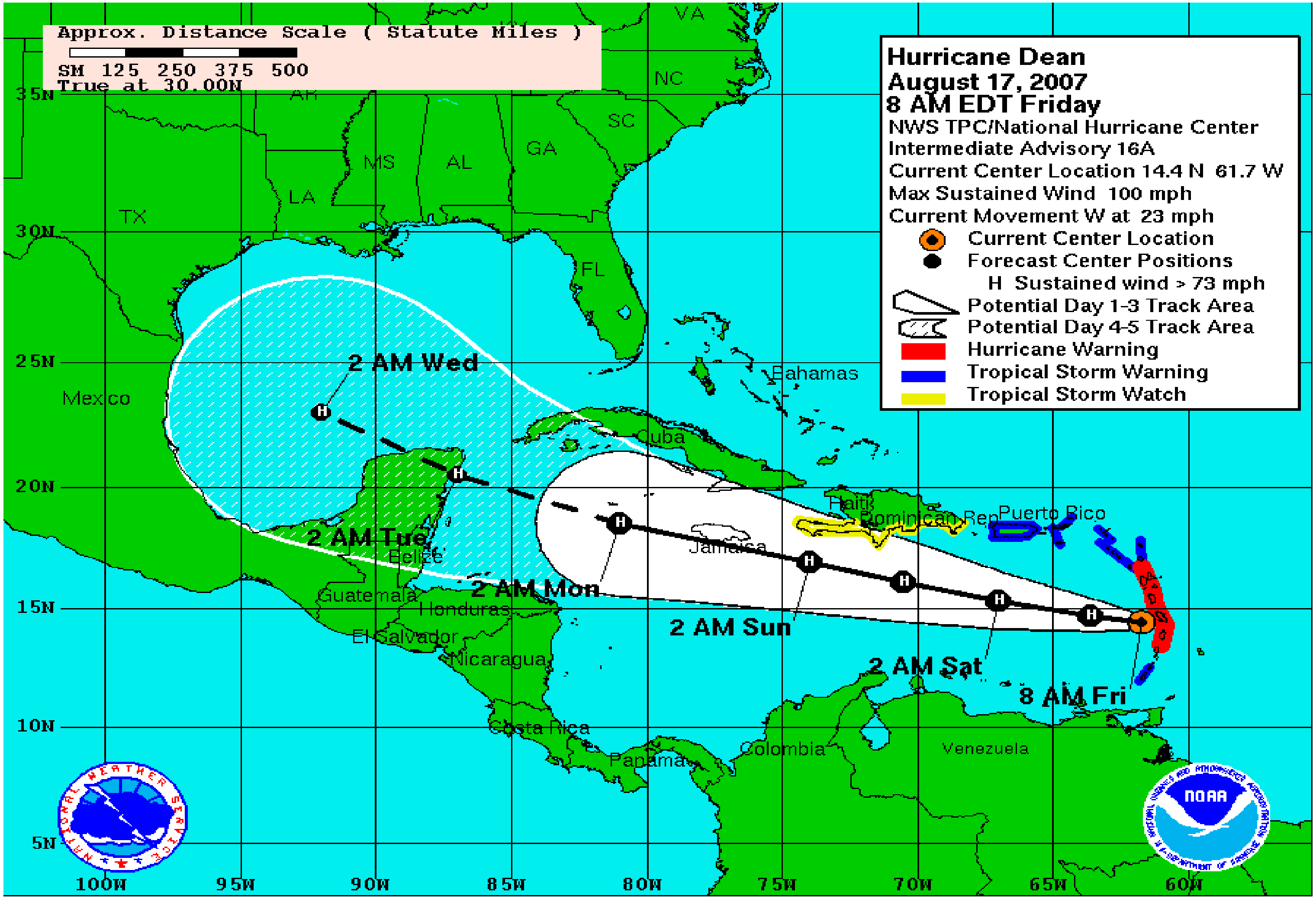
54-78 H APCP NAM 78H FCST VALID 12Z 16 FEB 2008
54-78h NAM QPF
54-78 H APCP NAMX 78H FCST VALID 12Z 16 FEB 2008
54-78h Pll NAM QPF
54-78 H APCP GFS 78H FCST VALID 12Z 16 FEB 2008
54-78h GFS QPF
0.01
0.1
0.25
0.5
0.76
1
1.6
2
3
4
175.0
150.0
125.0
100.0
75.0
50.0
35.0
25.0
20.0
15.0
10.0
5.0
2.0
.1
24-h Precip Anl
CPC 1/8 deg Analysis 24h Accum (mm) Ending 2008021612


500MB Z-VORT NAM 72H FCST VALID 12Z 16 FEB 2008
72-h NAM
500MB Z-VORT NAMX 72H FCST VALID 12Z 16 FEB 2008
72-h PII NAM
500MB Z-VORT GFS 72H FCST VALID 12Z 16 FEB 2008
72-h GFS
500MB Z-VORT GFS 00H FCST VALID 12Z 16 FEB 2008
GFS ANL
16 20 24 28 32 36 40
16 20 24 28 32 36 40

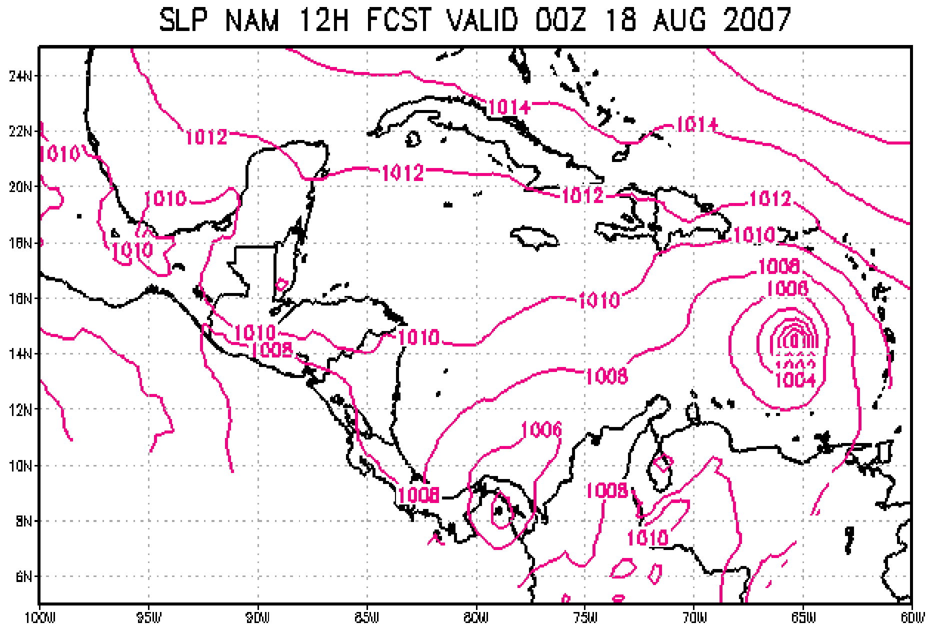


48-72 H APCP NAM 72H FCST VALID 12Z 16 FEB 2008
48-72h NAM QPF
48-72 H APCP NAMX 72H FCST VALID 12Z 16 FEB 2008
48-72h Pll NAM QPF
48-72 H APCP GFS 72H FCST VALID 12Z 16 FEB 2008
48-72h GFS QPF
0.01
0.1
0.25
0.5
0.75
1
1.5
2
3
4
175.0
150.0
125.0
100.0
75.0
50.0
35.0
25.0
20.0
15.0
10.0
5.0
2.0
.1
24-h Precip Anl
CPC 1/8 deg Analysis 24h Accum (mm) Ending 2008021612

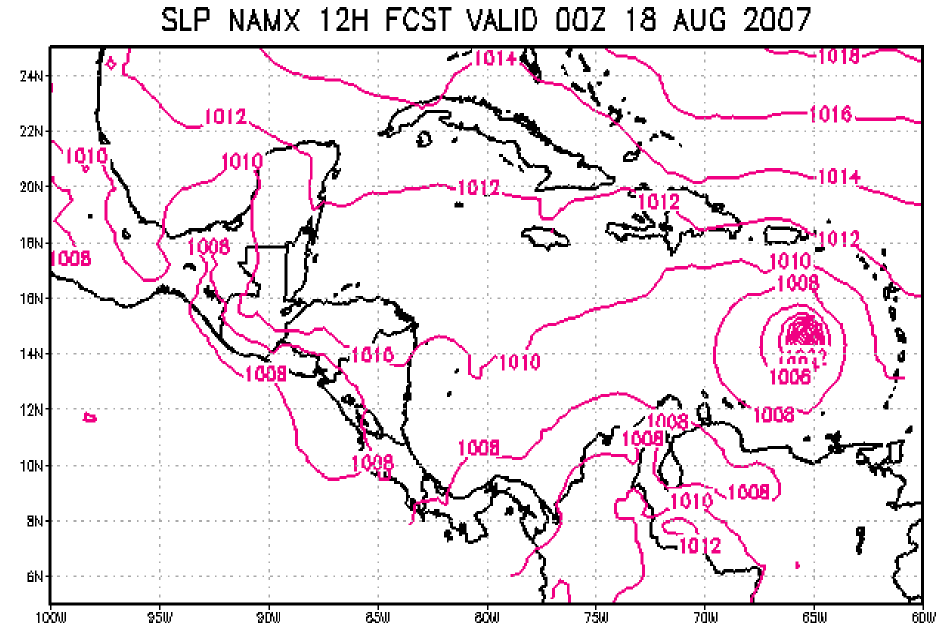
Hurricane Dean : 12z 17 August 2007 cycle

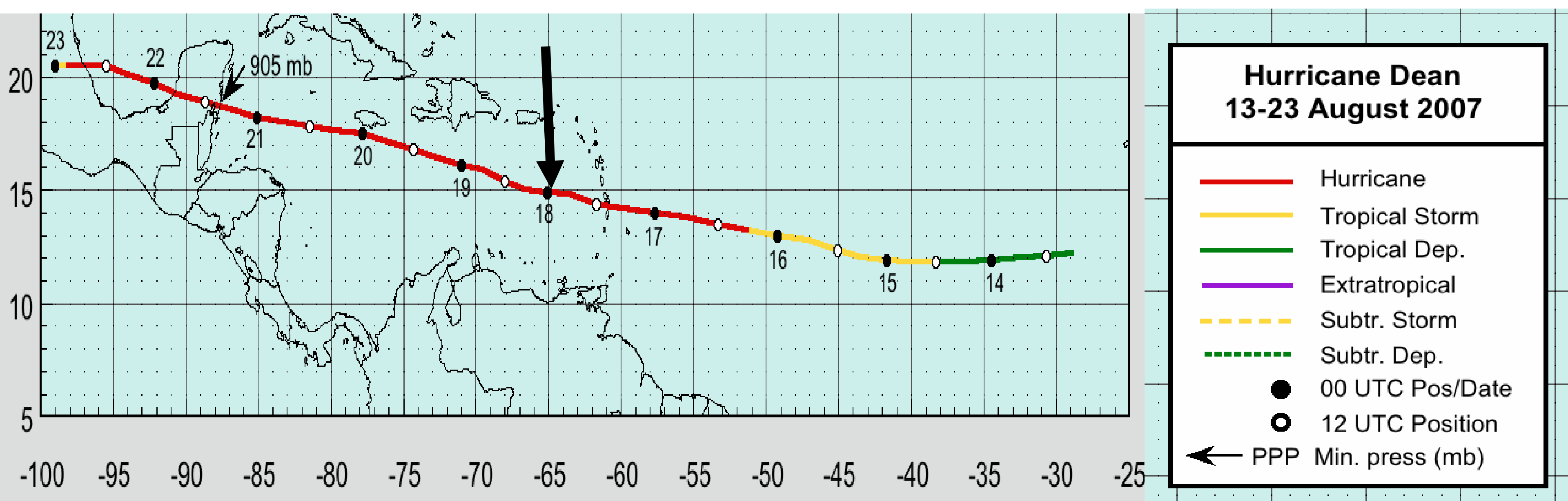


Ops NAM

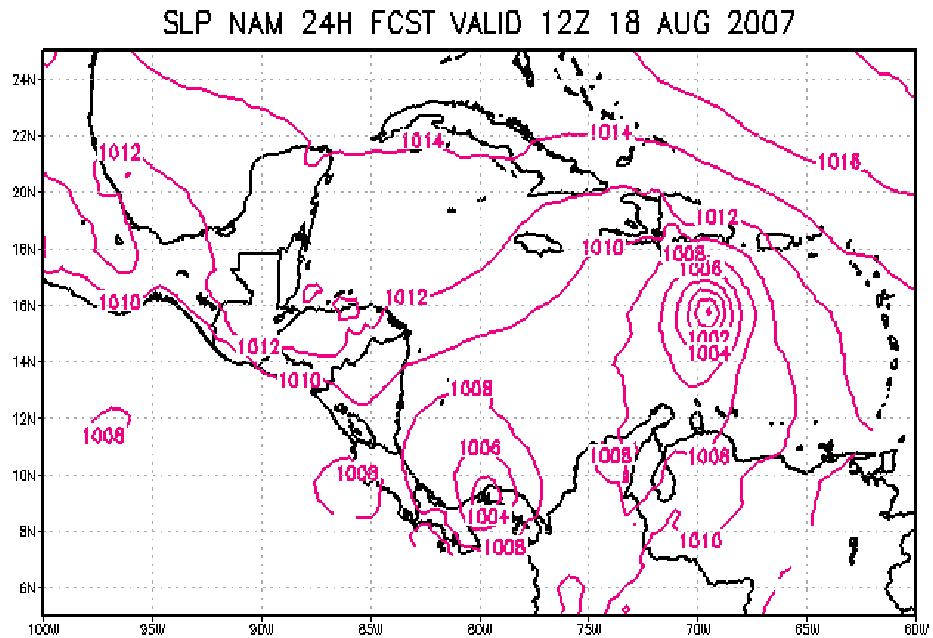


Parallel NAM

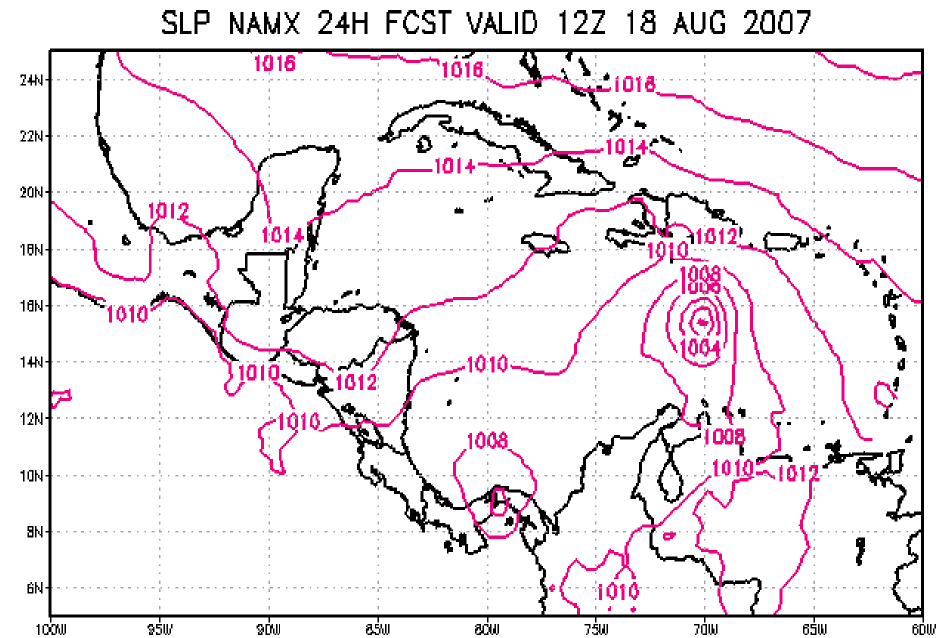


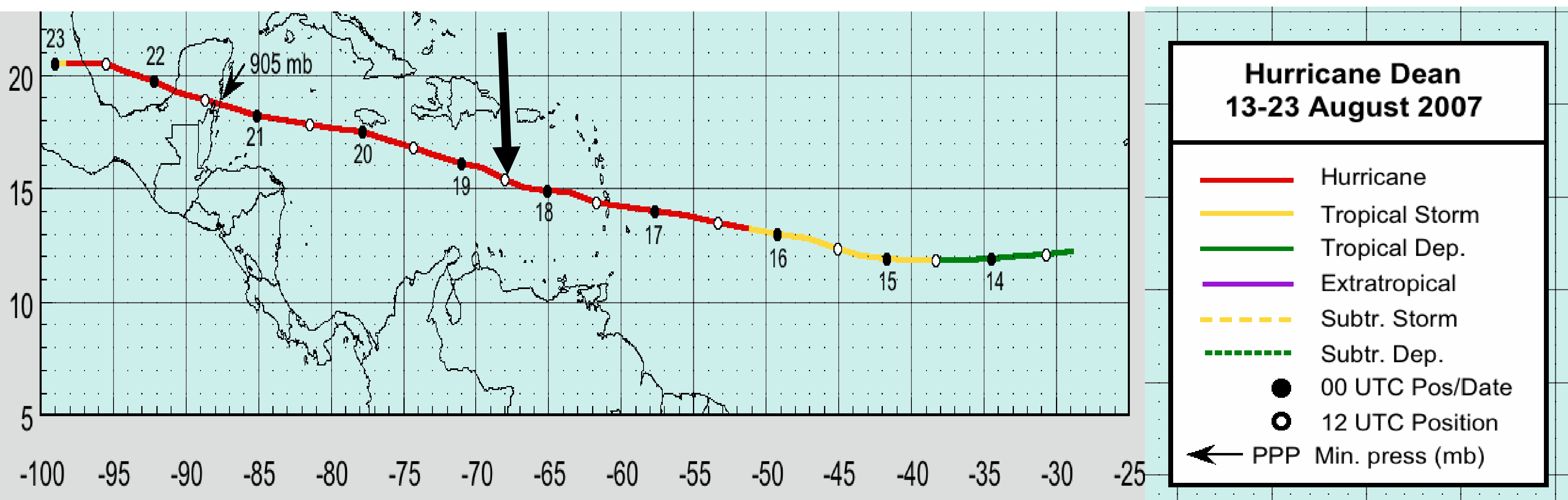


Ops NAM



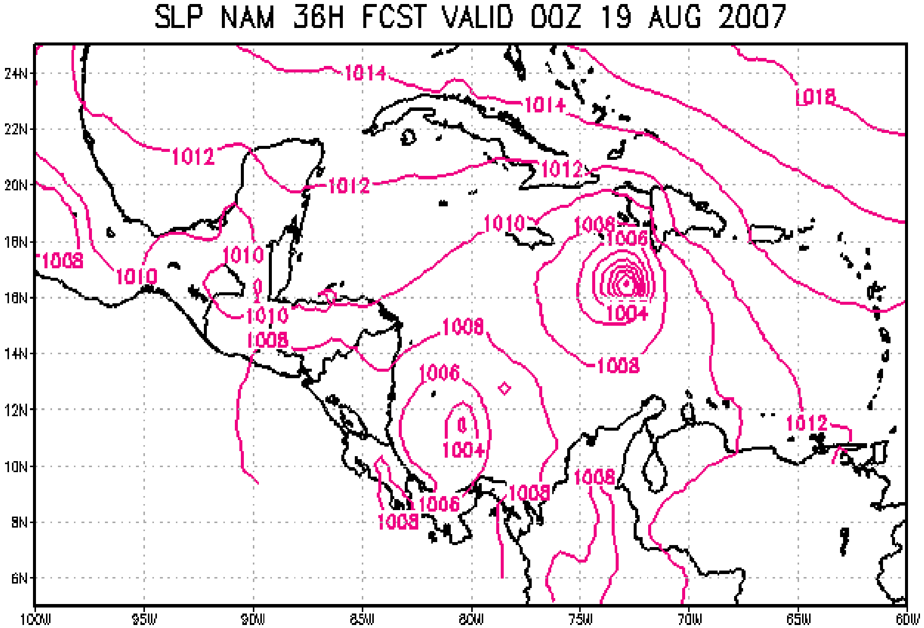
Parallel NAM

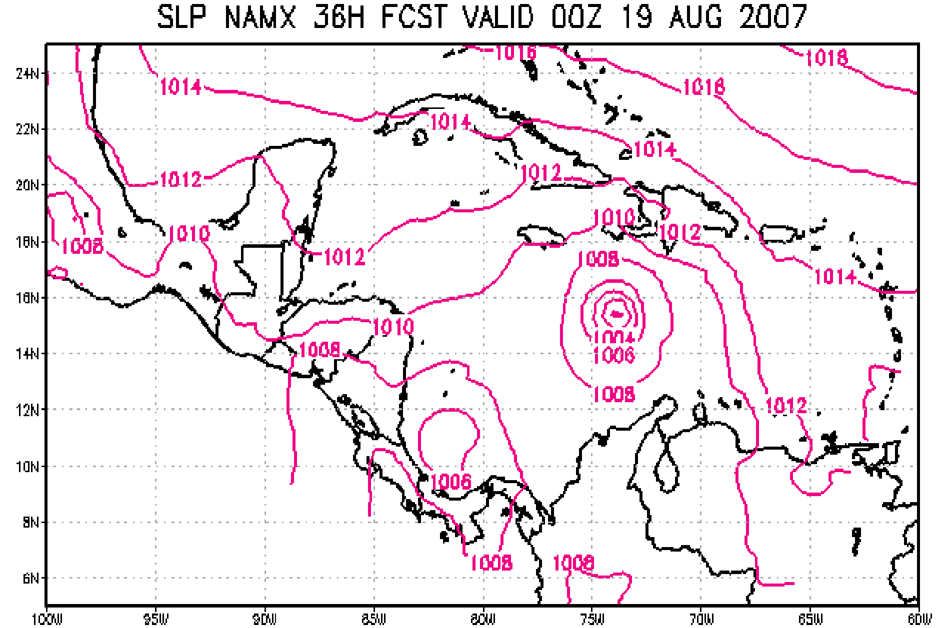


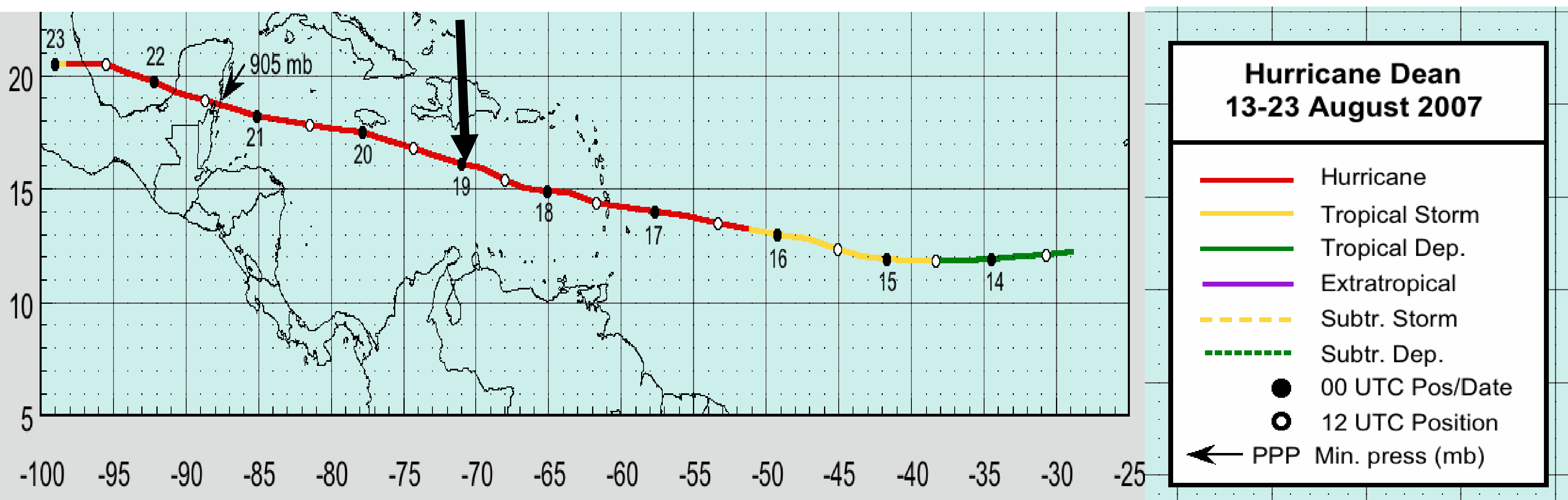


Ops NAM

Parallel NAM

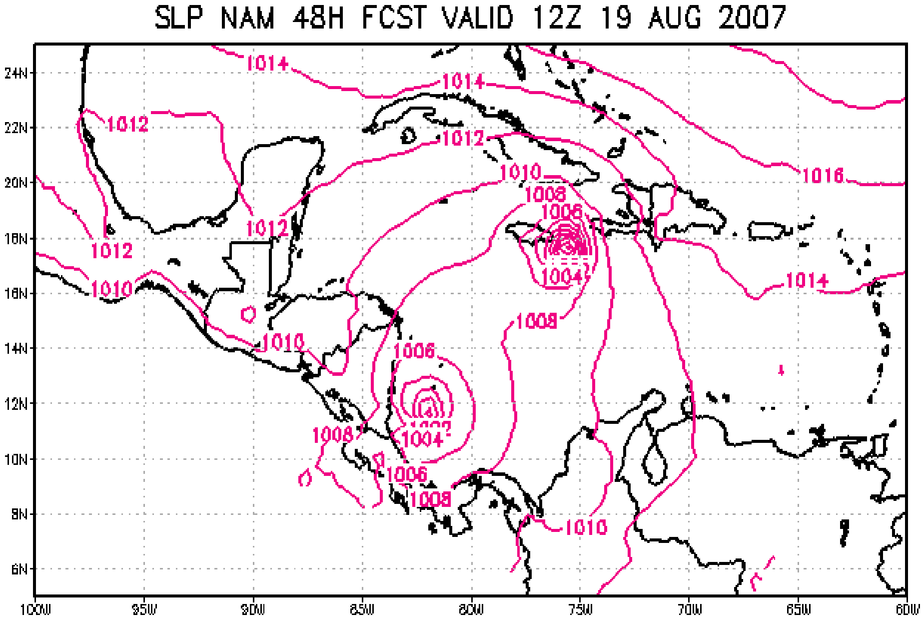


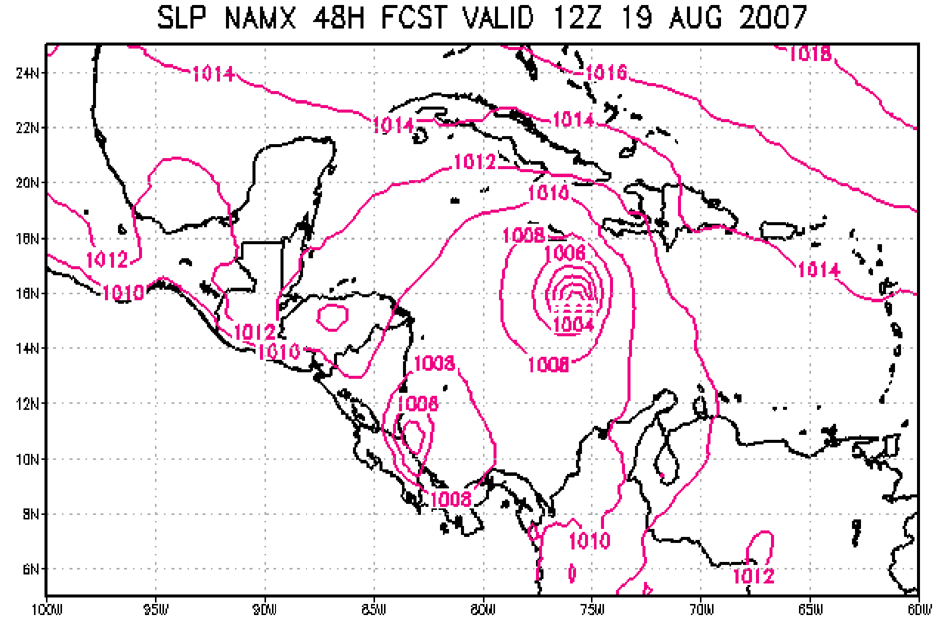


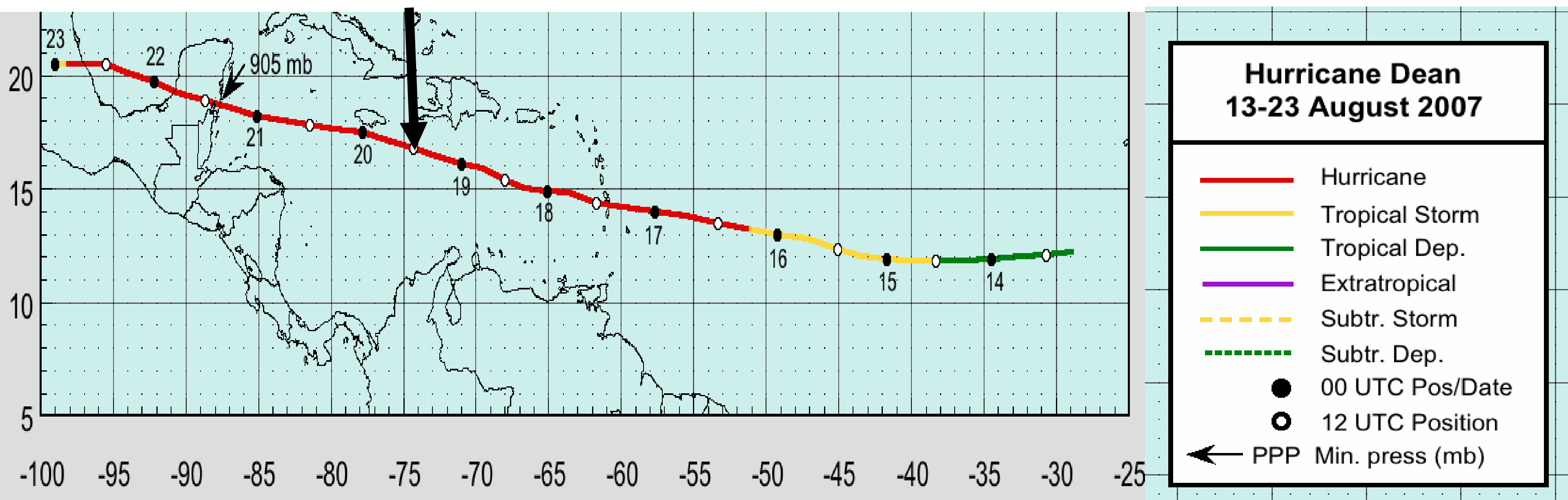


Ops NAM

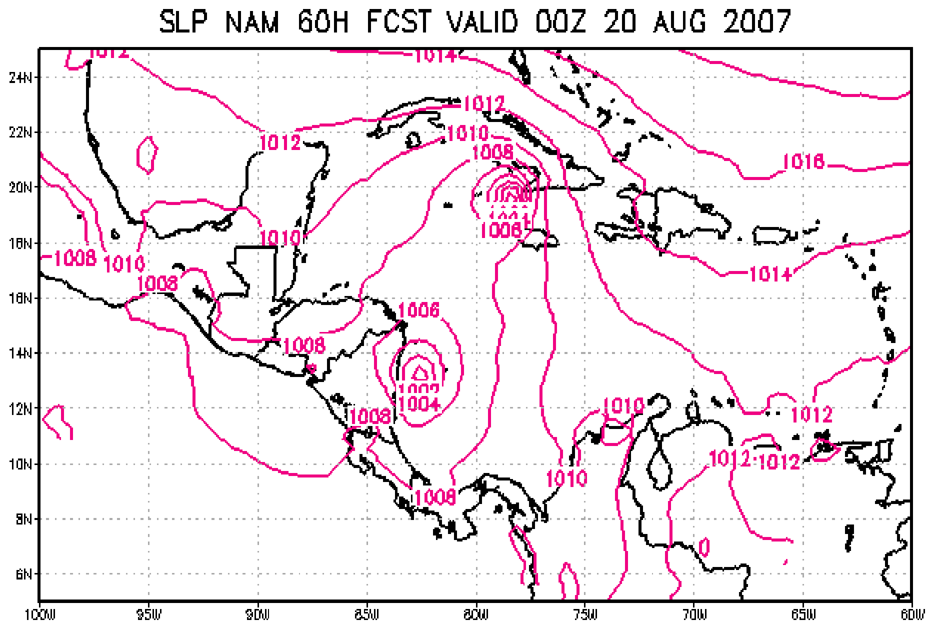
Parallel NAM



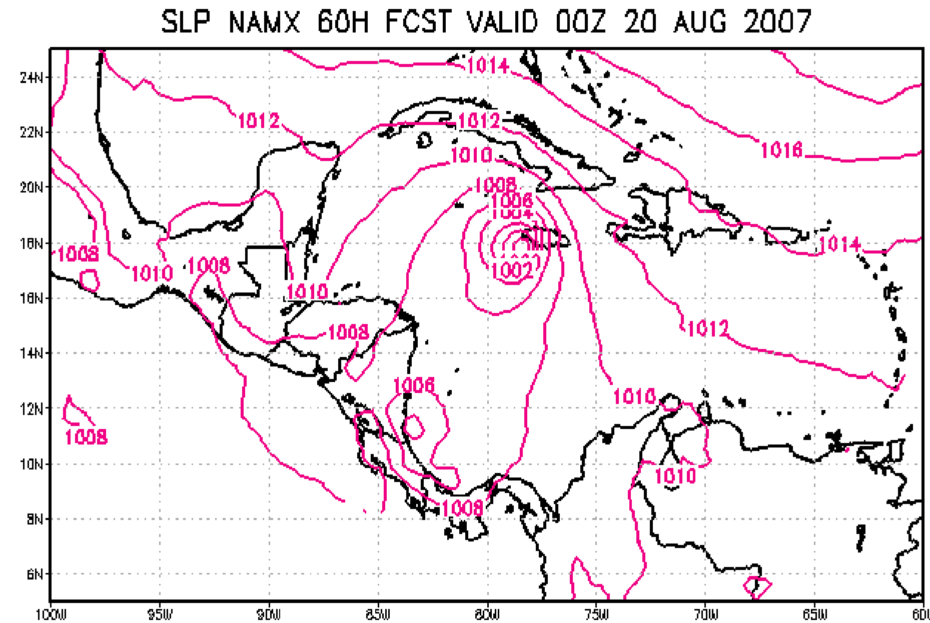


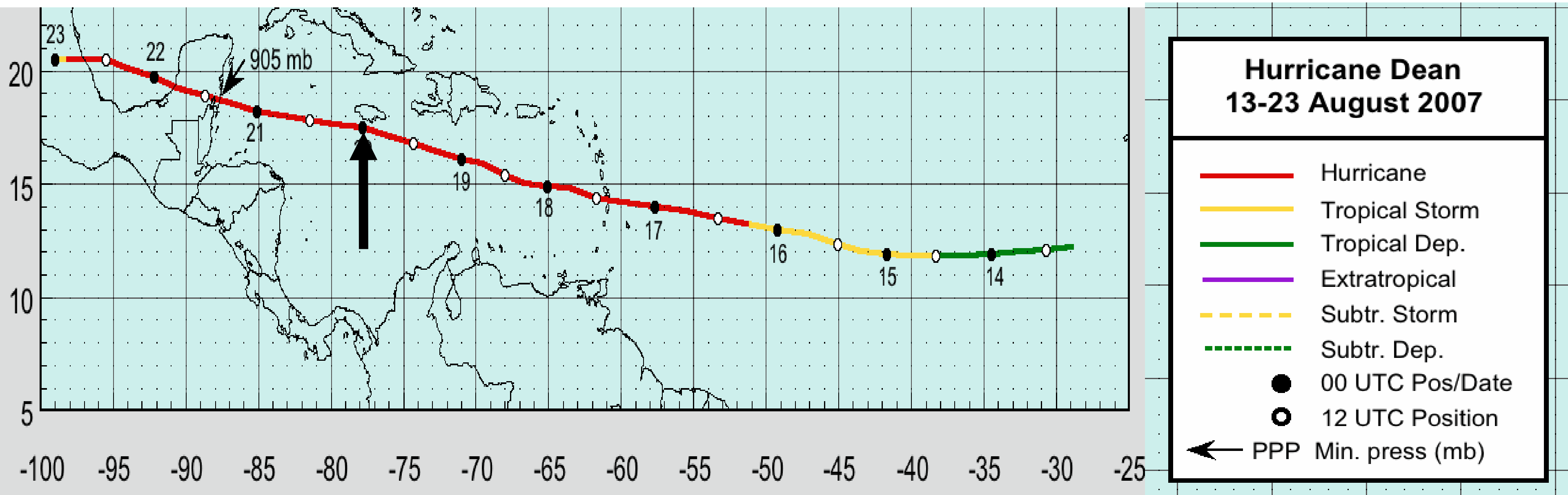


Ops NAM

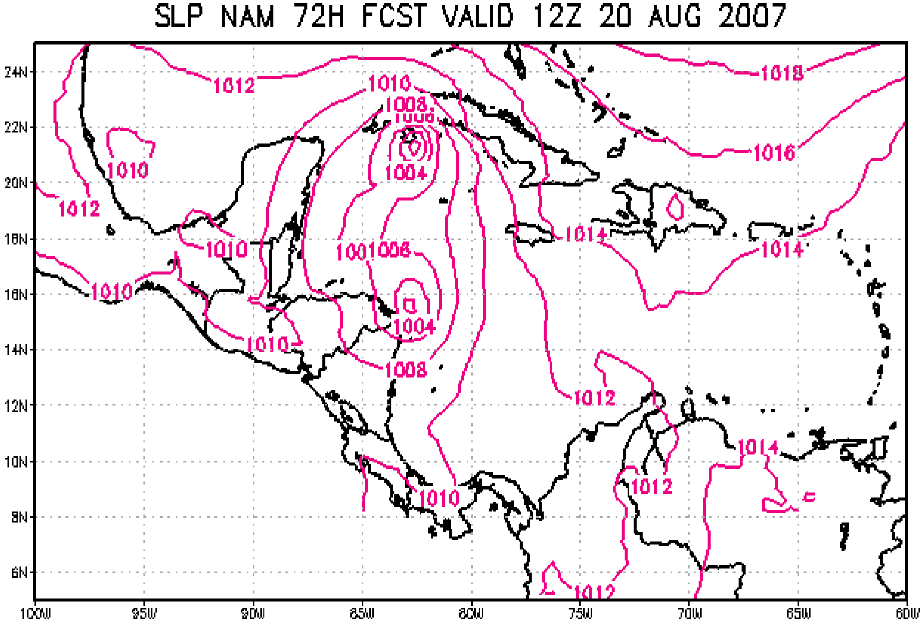


Parallel NAM

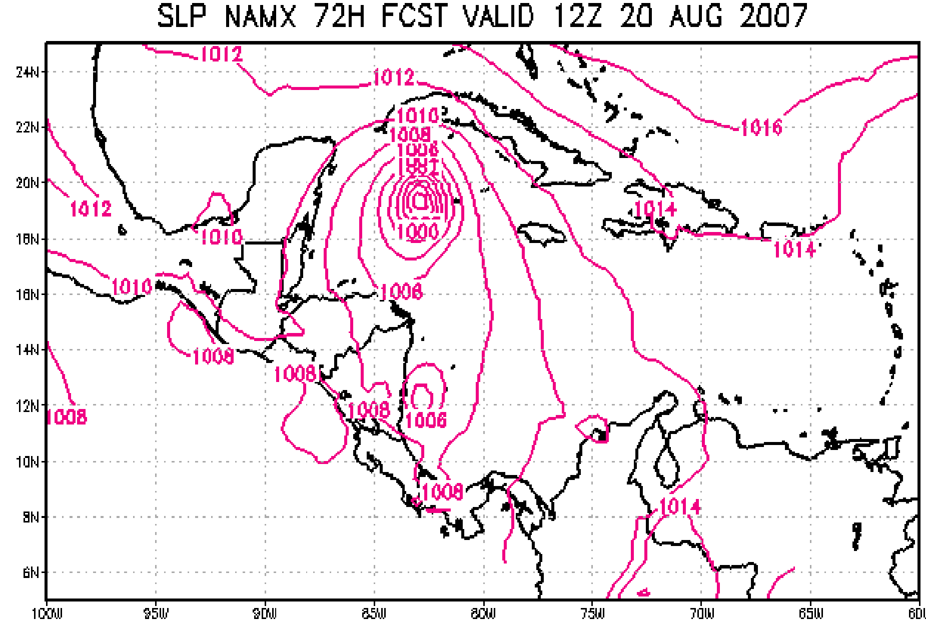


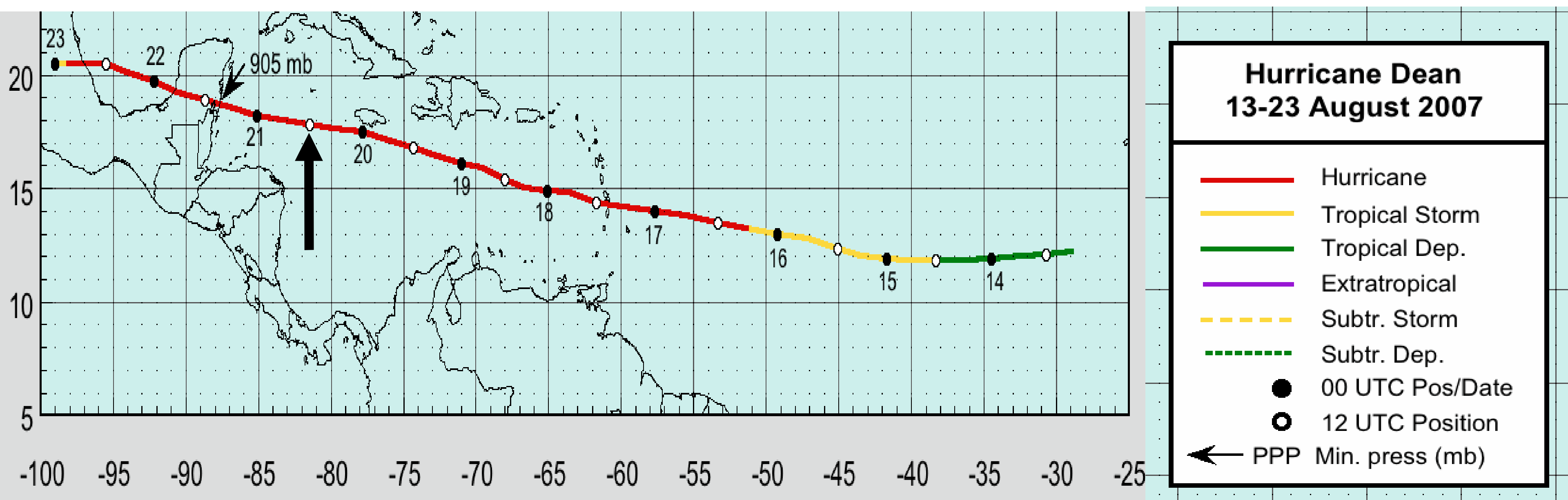


Ops NAM

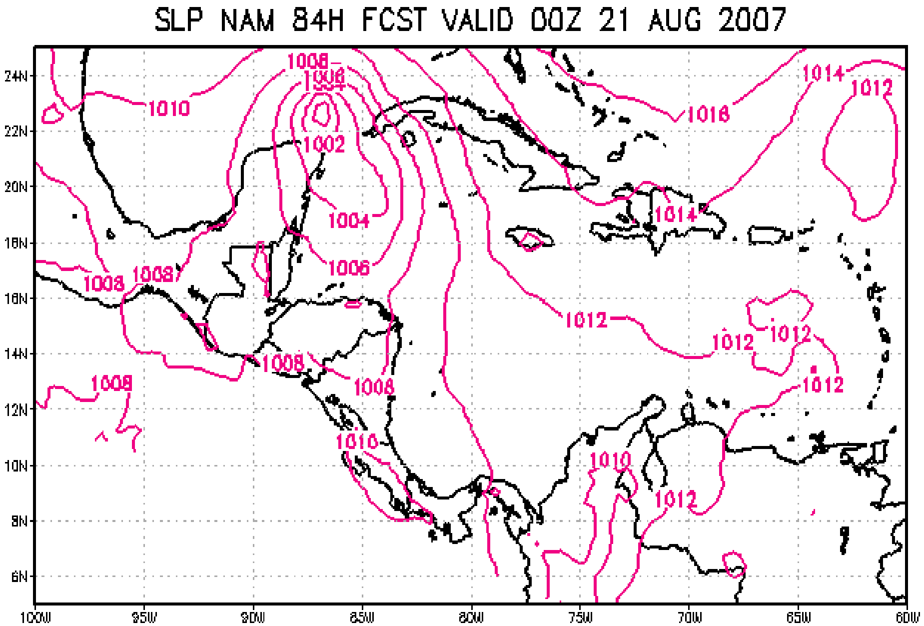


Parallel NAM

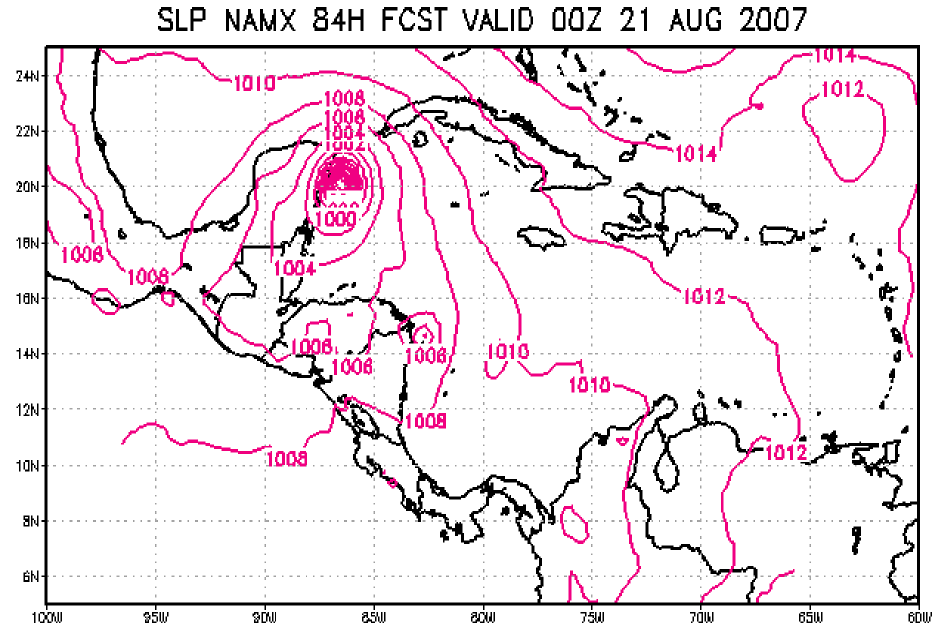


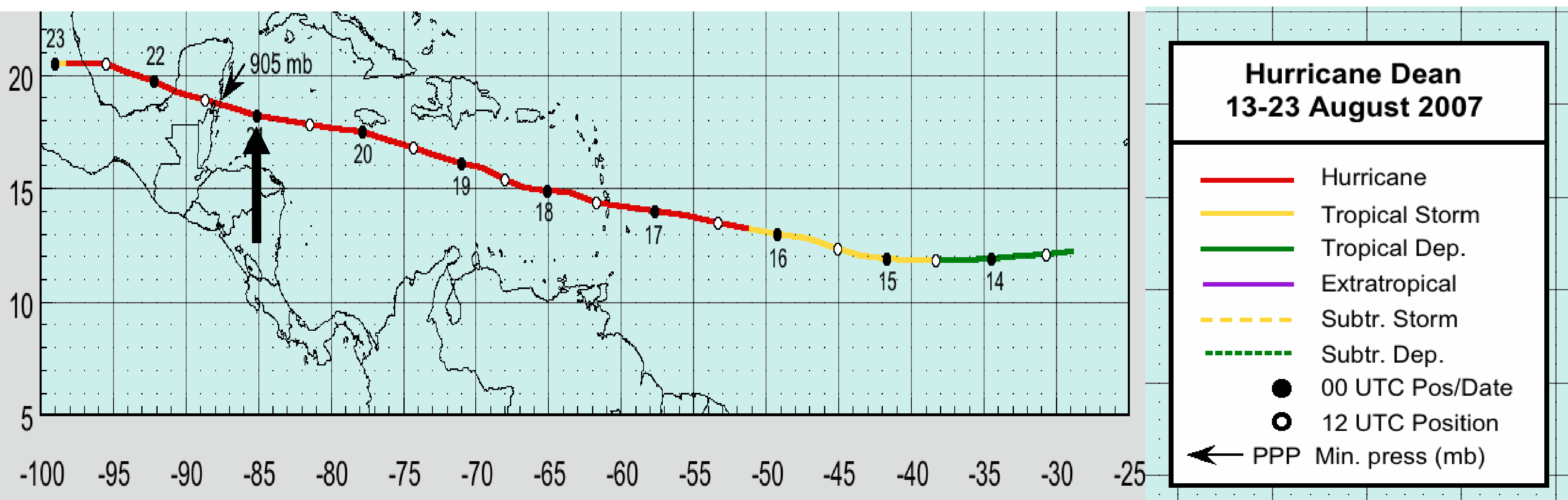


Ops NAM

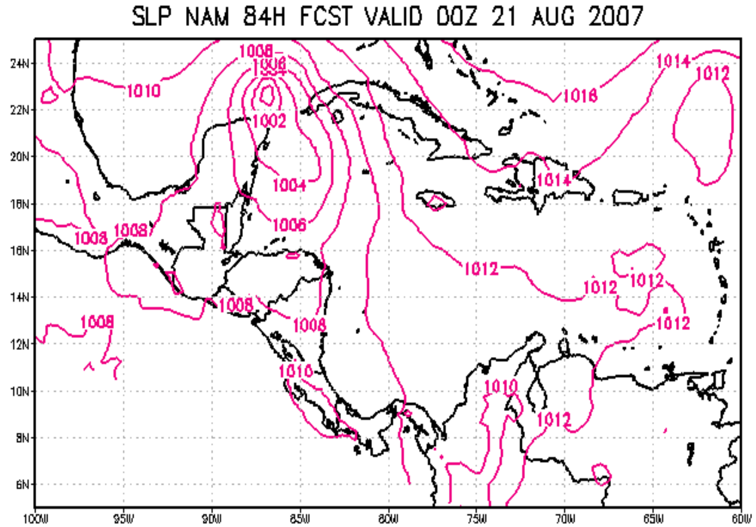


Parallel NAM

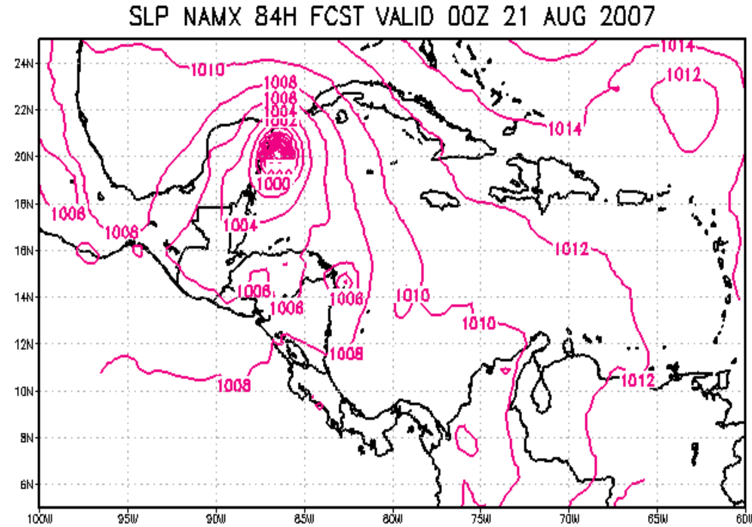




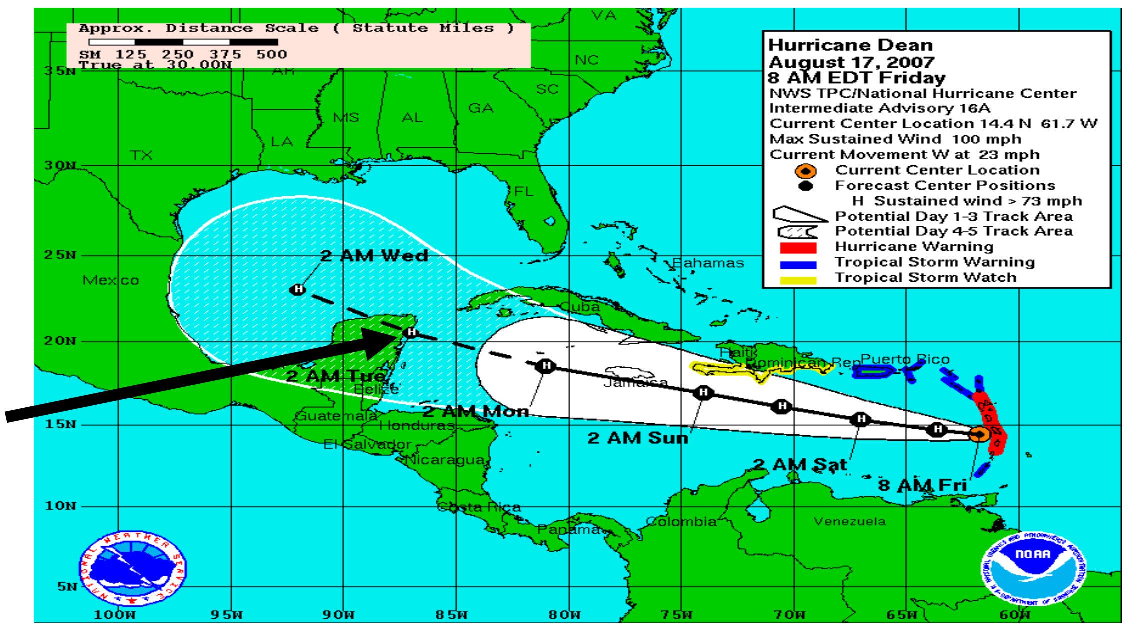
Ops NAM



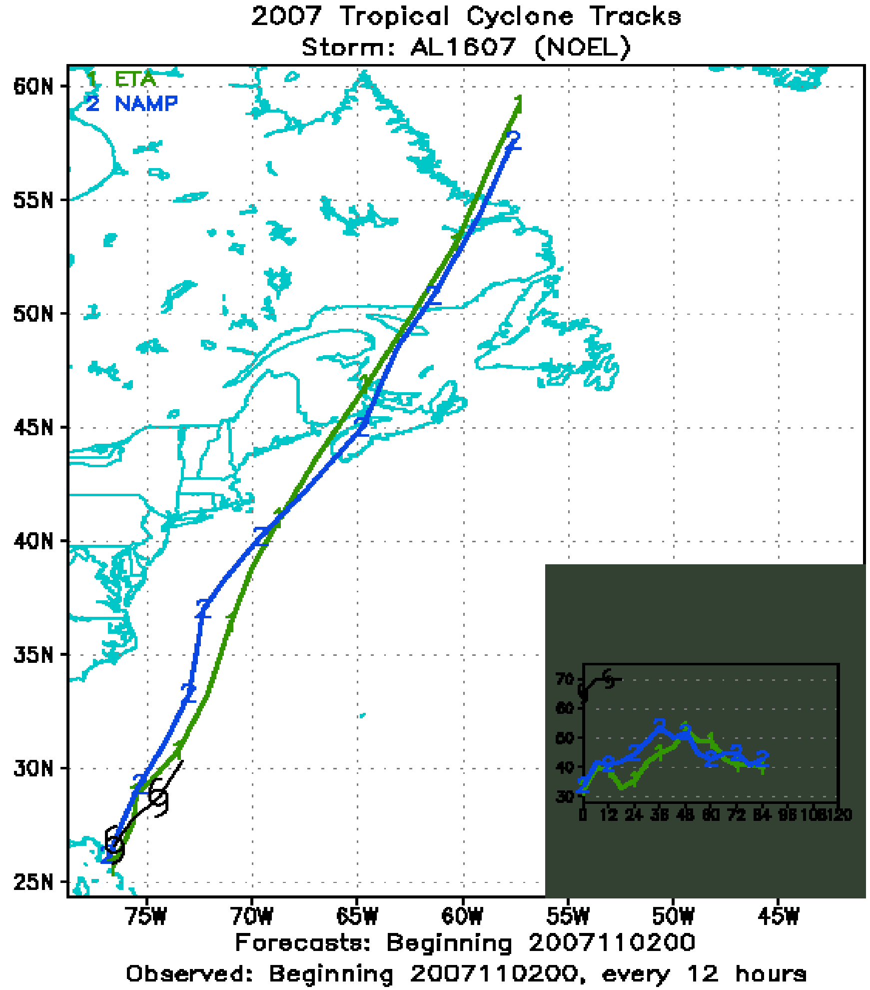
Parallel NAM



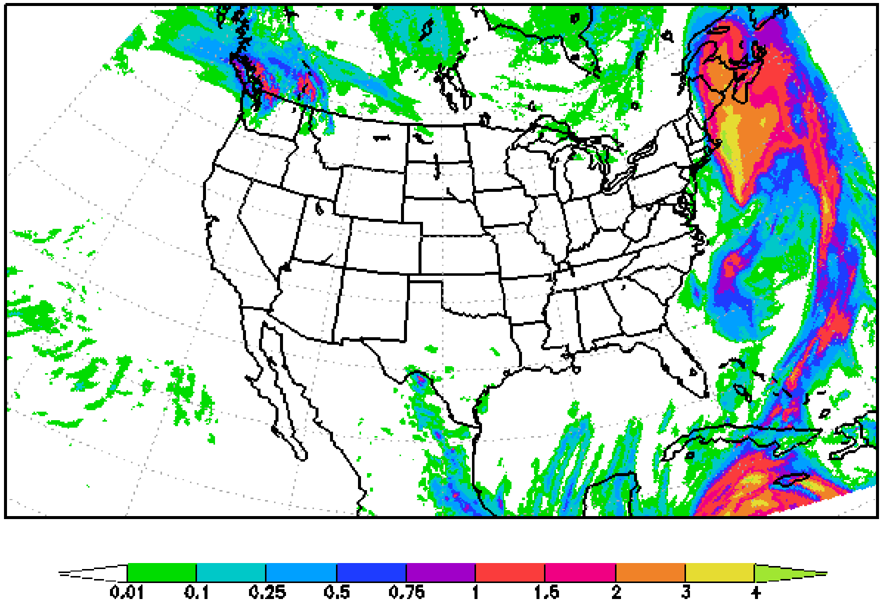
TPC predicted position (issued 12z 8/17) valid 06z 8/21



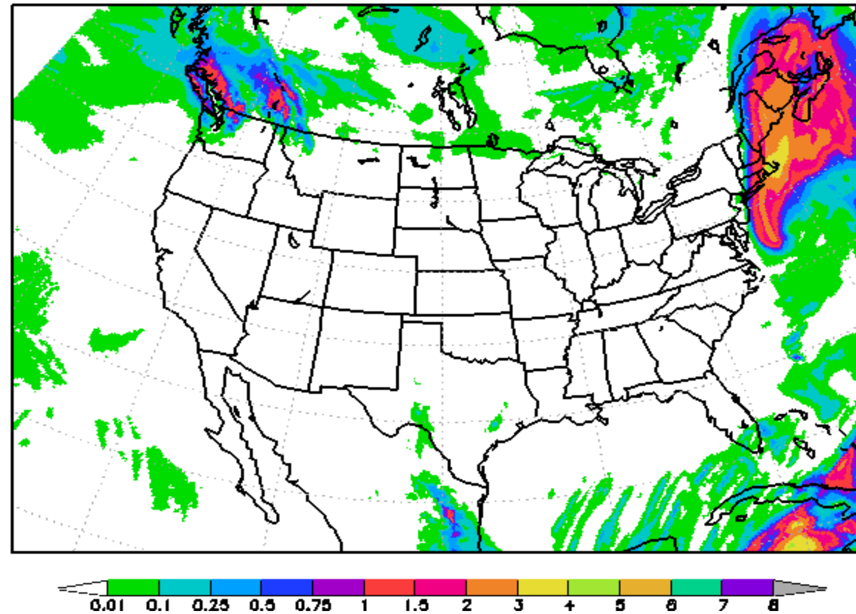
Ex-Hurricane Noel : Better Model QPF by Parallel NAM in New England



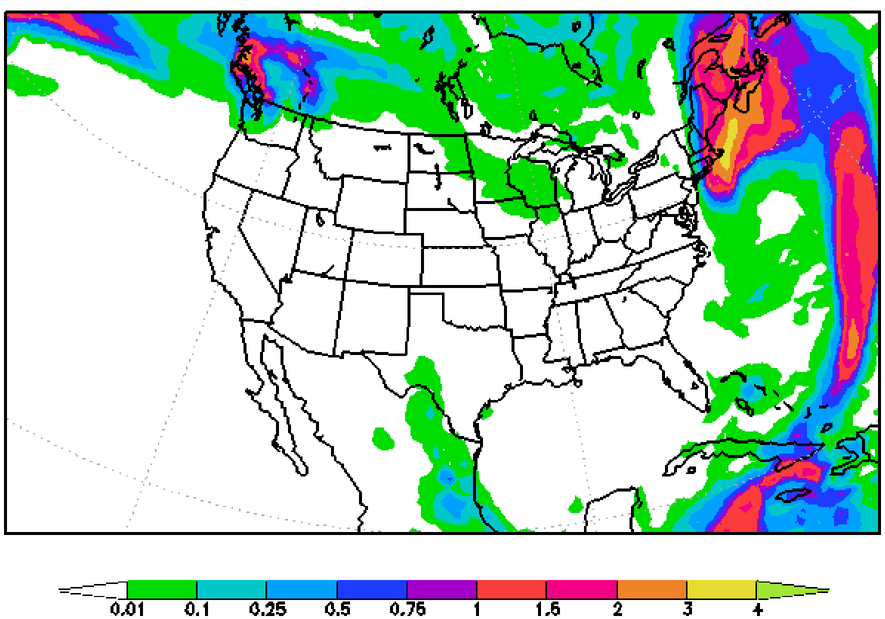
36-60 H APCP NAM 60H FCST VALID 12Z 04 NOV 2007

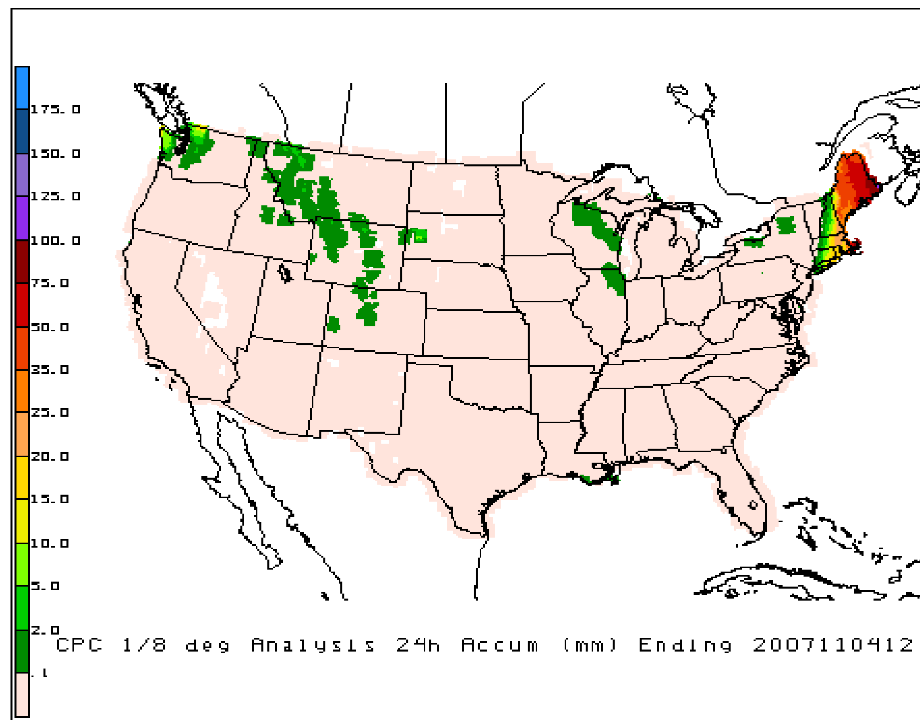


36-60 H APCP NAMEXP 60H FCST VALID 12Z 04 NOV 2007

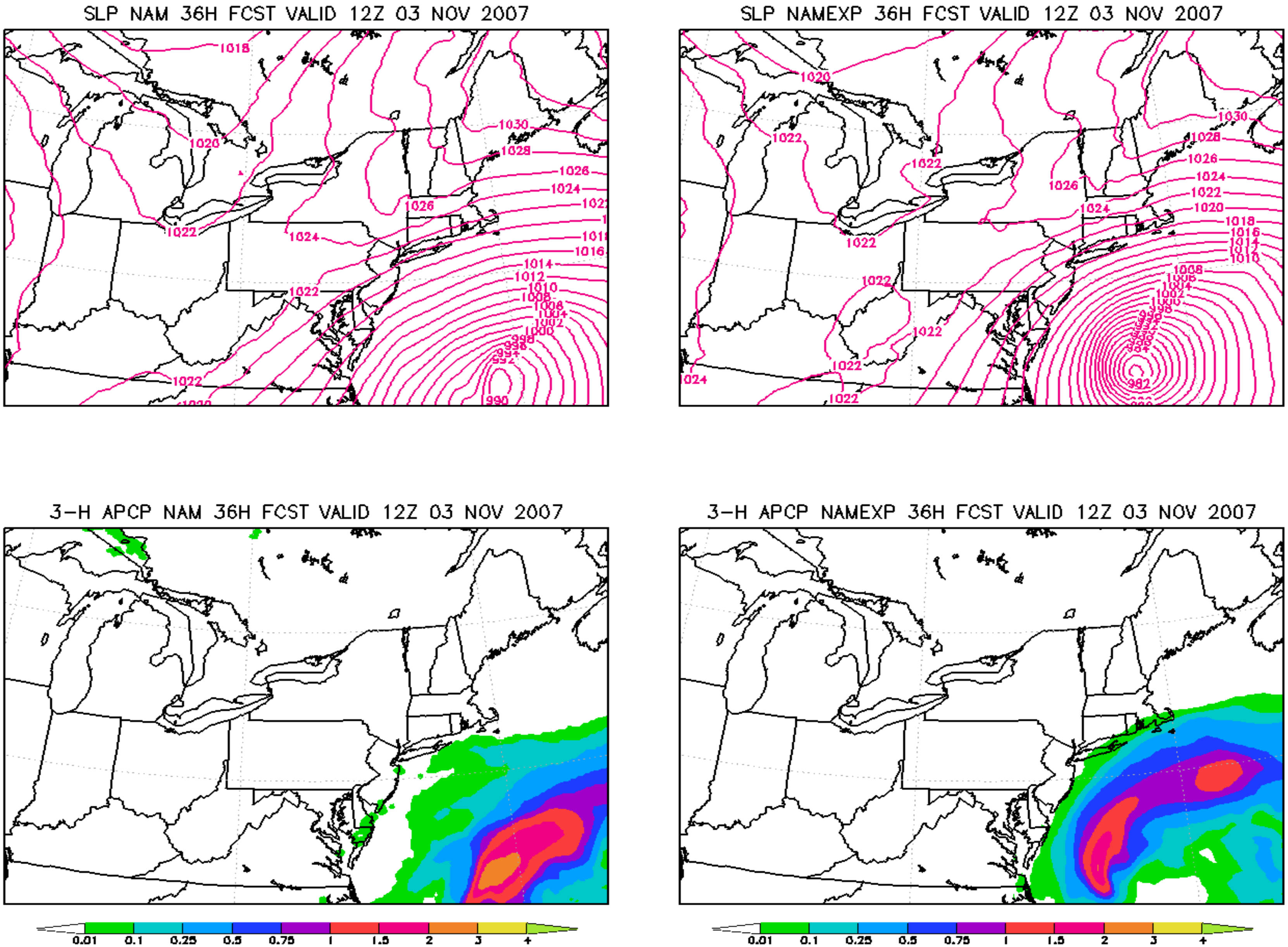


36-60 H APCP GFS 60H FCST VALID 12Z 04 NOV 2007





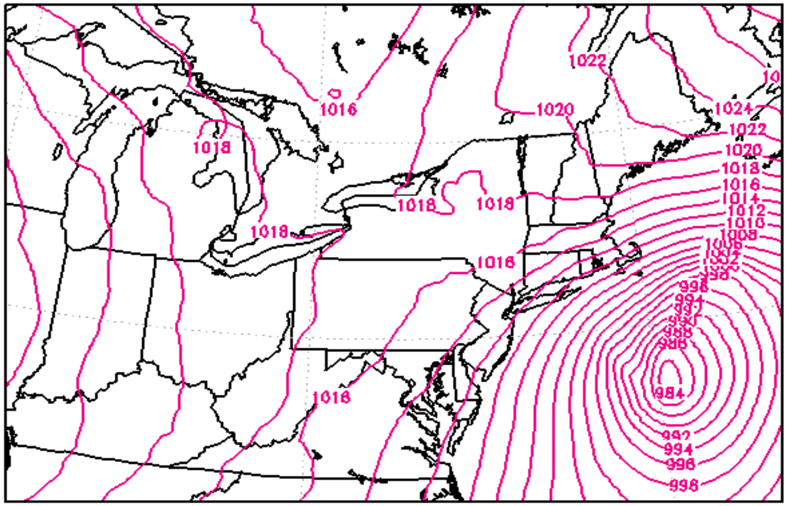
Ops NAM　　Parallel NAM



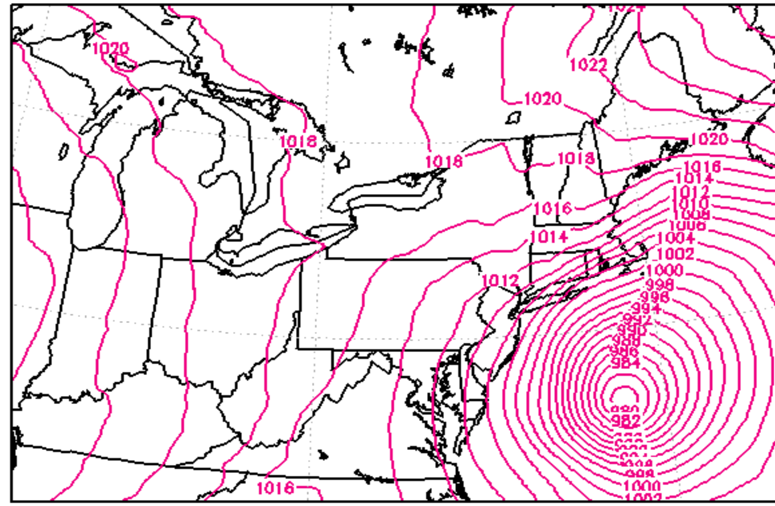
Ops NAM

Parallel NAM

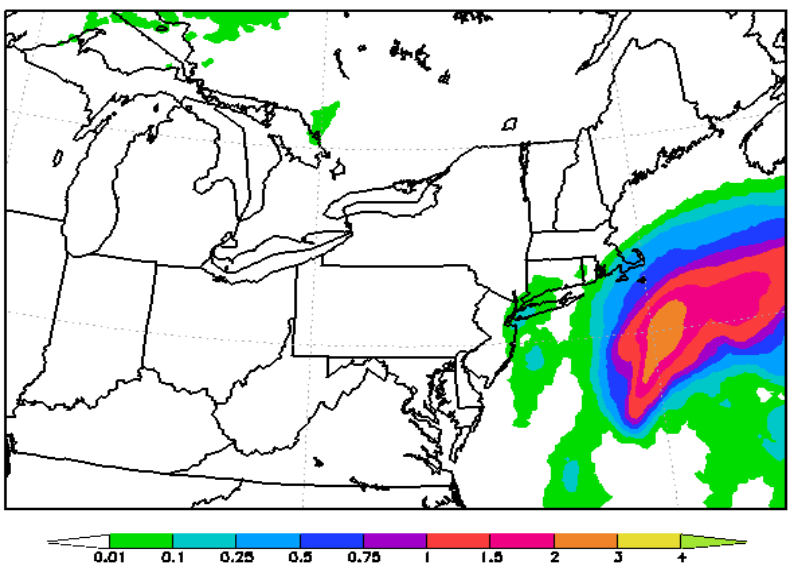
SLP NAM 42H FCST VALID 18Z 03 NOV 2007



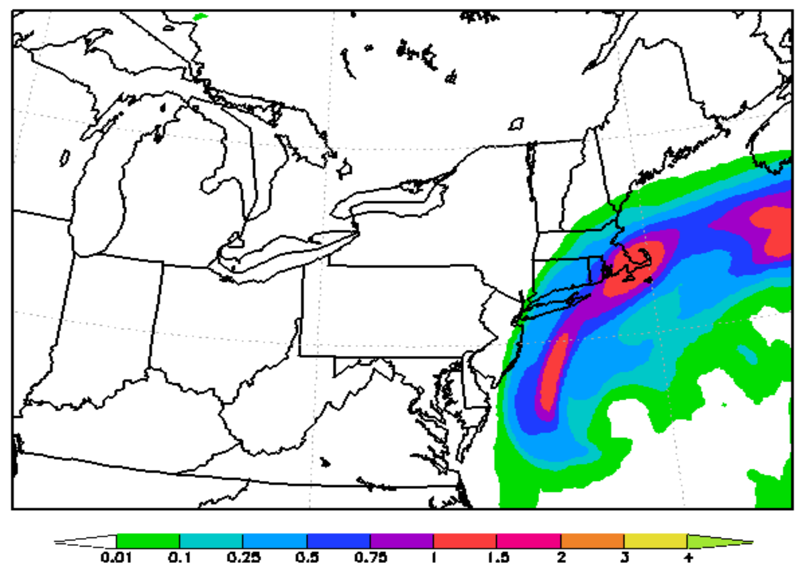
SLP NAMEXP 42H FCST VALID 18Z 03 NOV 2007



3-H APCP NAM 42H FCST VALID 18Z 03 NOV 2007

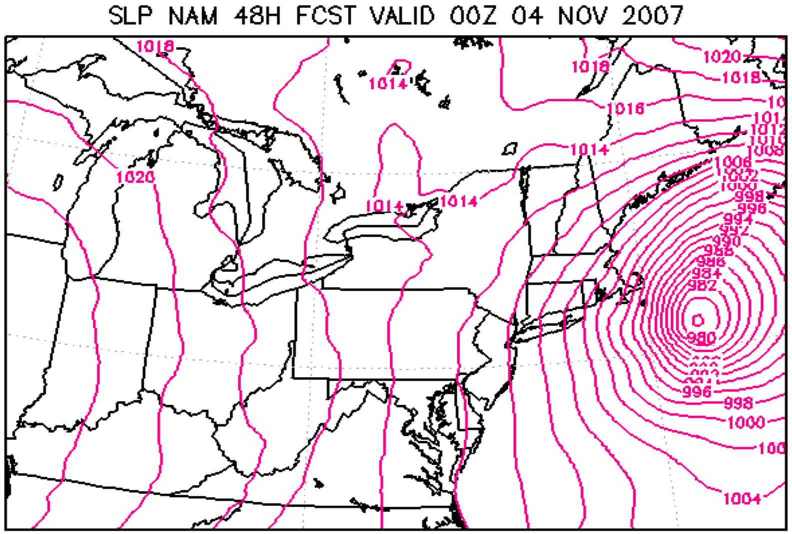


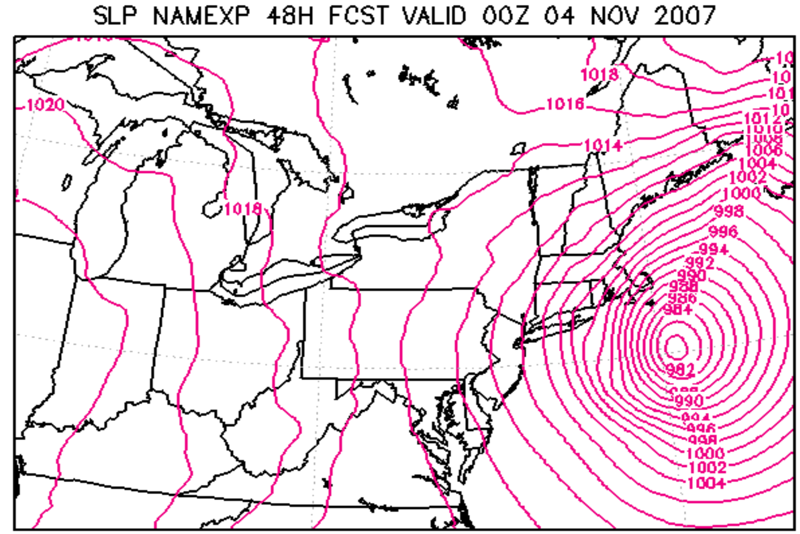
3-H APCP NAMEXP 42H FCST VALID 18Z 03 NOV 2007

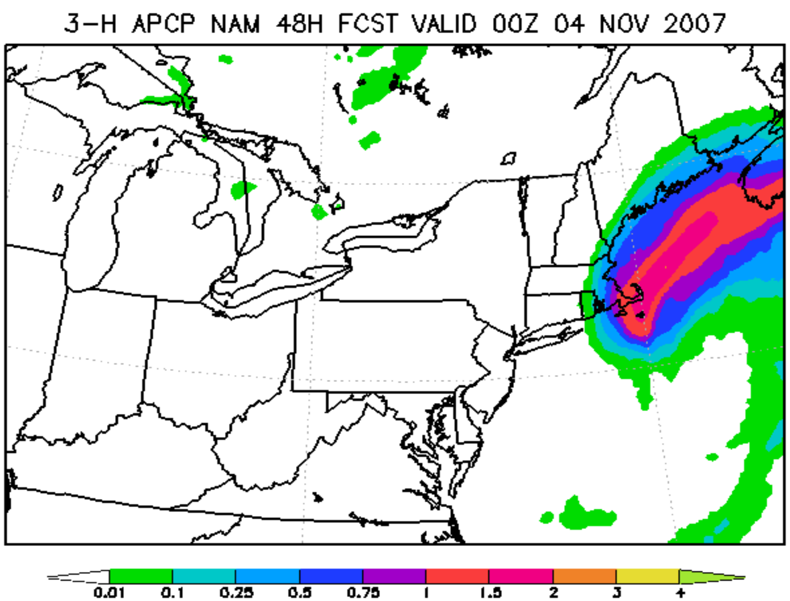


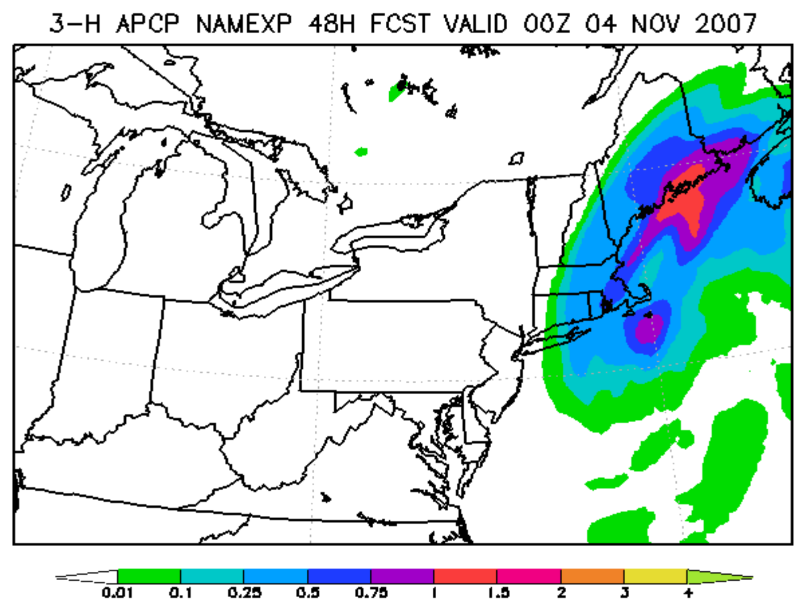
Ops NAM

Parallel NAM





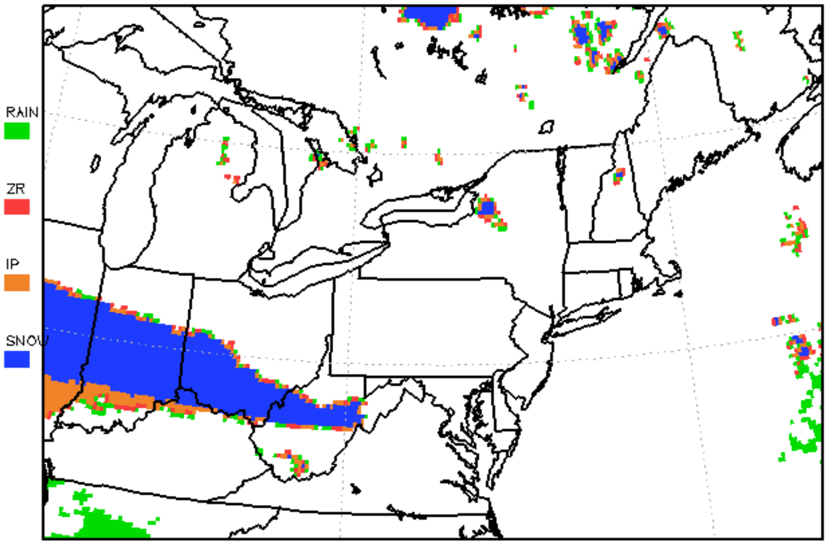




Ops NAM vs Parallel NAM : 00z 2/20/2008 cycle

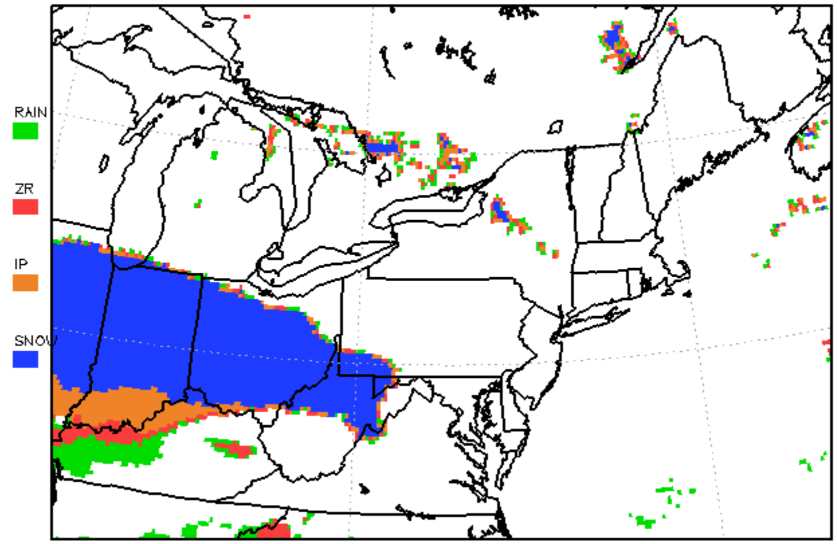
Ops NAM

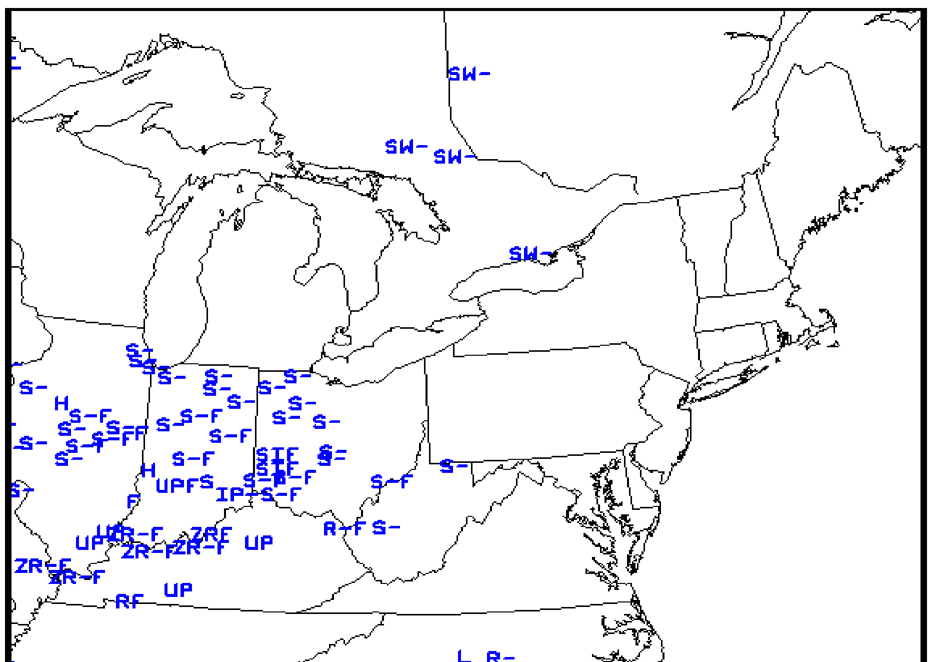
PRECIP TYPE NAM 48H FCST VALID 00Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 48H FCST VALID 00Z 22 FEB 2008

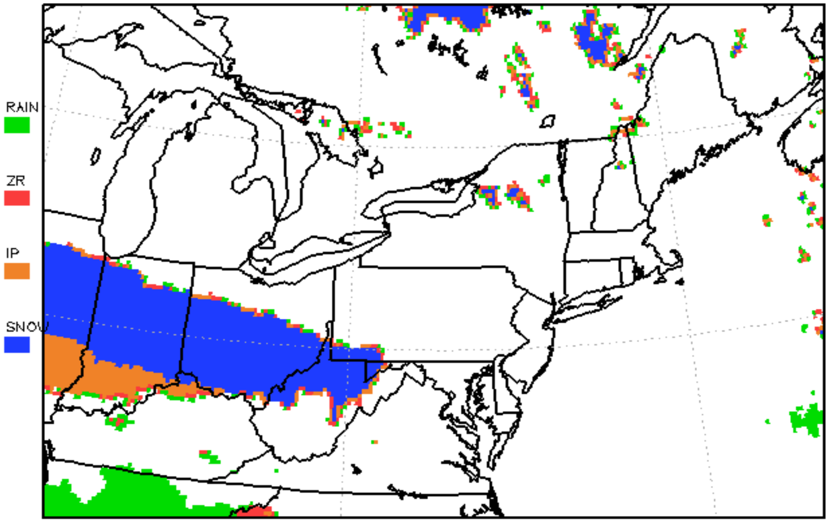




OBSERVED WX TEMP VALID 00Z 22 FEB 2008

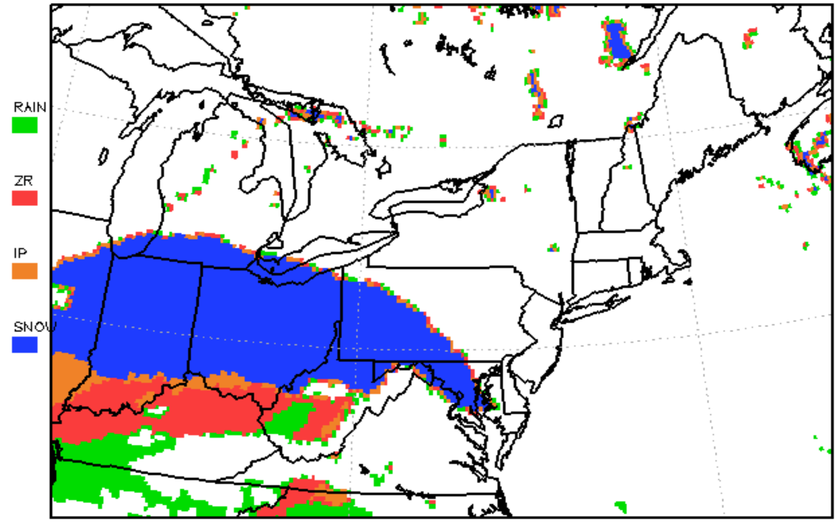
Ops NAM

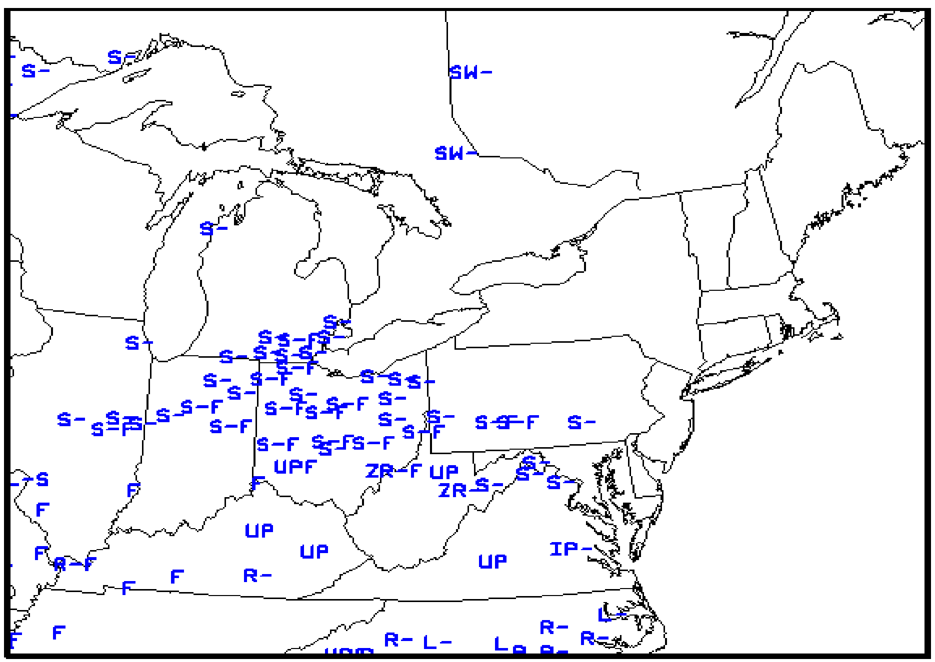
PRECIP TYPE NAM 51H FCST VALID 03Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 51H FCST VALID 03Z 22 FEB 2008



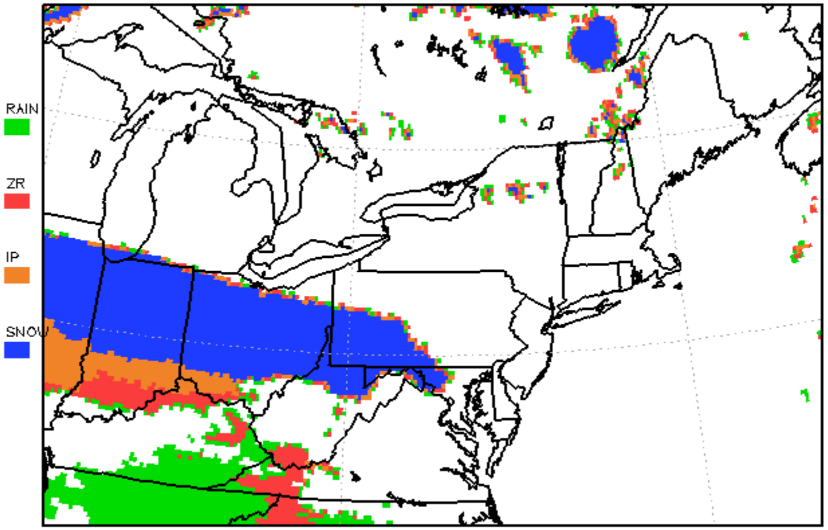


OBSERVED WX TEMP VALID 03Z 22 FEB 2008

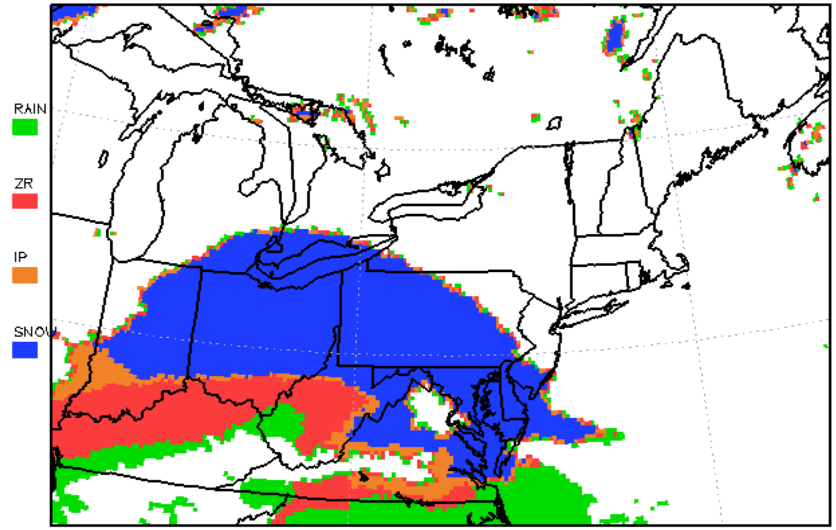
Ops NAM

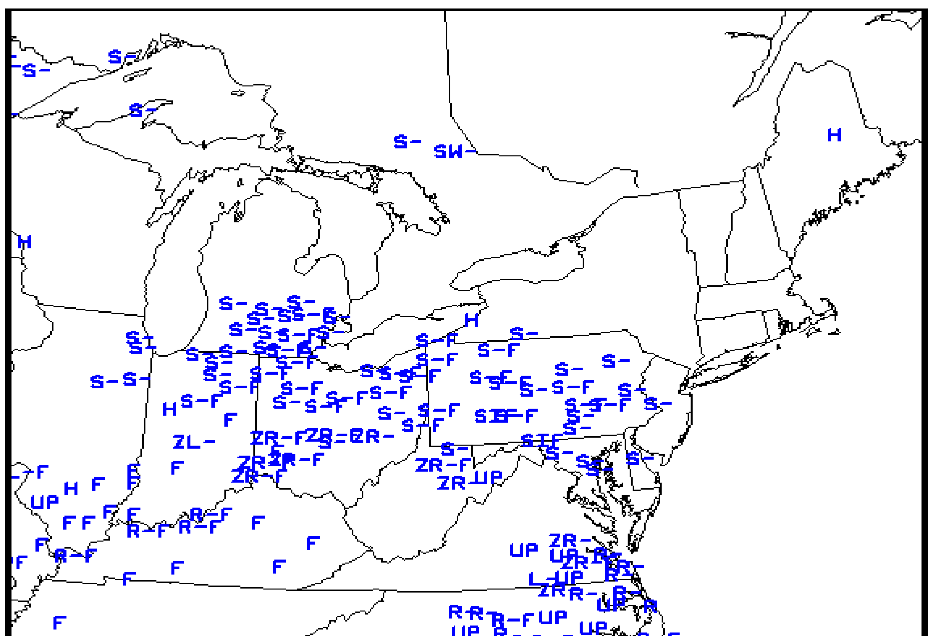
Parallel NAM

PRECIP TYPE NAM 54H FCST VALID 06Z 22 FEB 2008



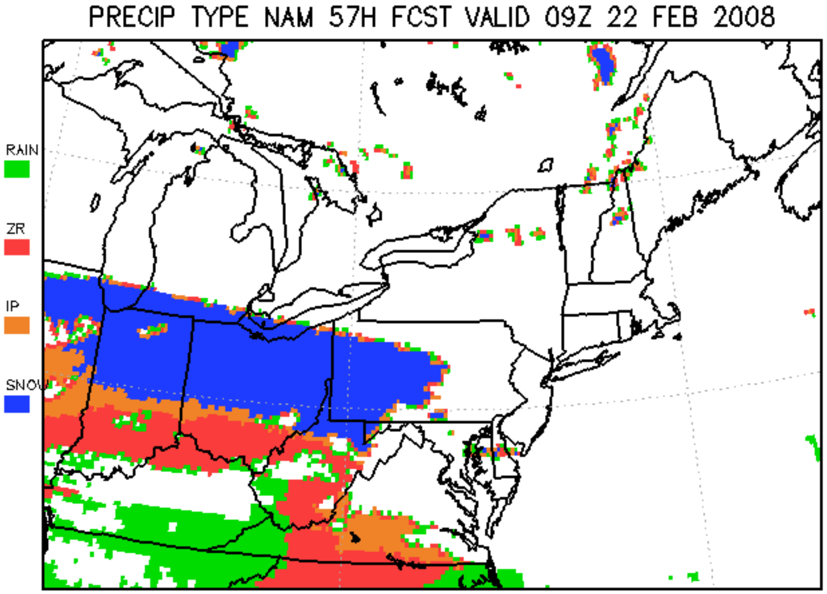
PRECIP TYPE NAMX 54H FCST VALID 06Z 22 FEB 2008



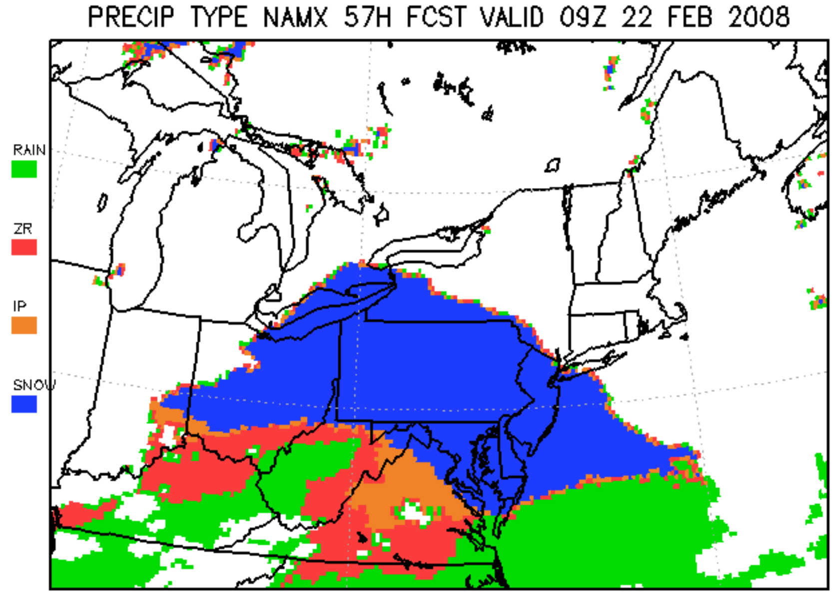


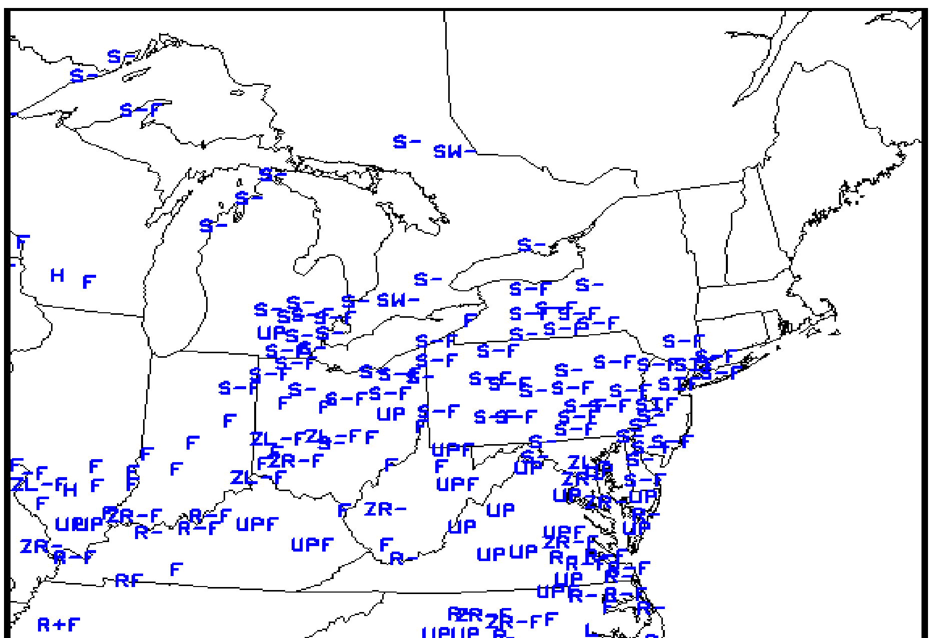
OBSERVED WX TEMP VALID 06Z 22 FEB 2008

Ops NAM



Parallel NAM

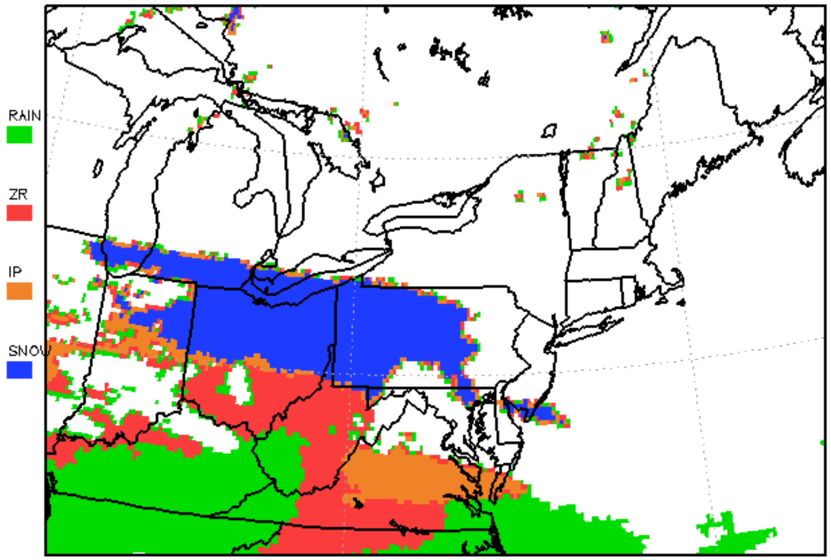




OBSERVED WX TEMP VALID 09Z 22 FEB 2008

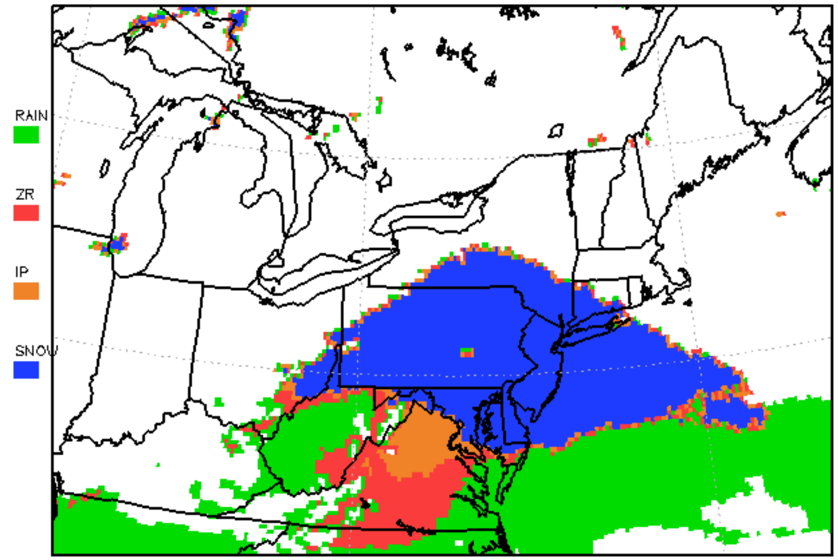
Ops NAM

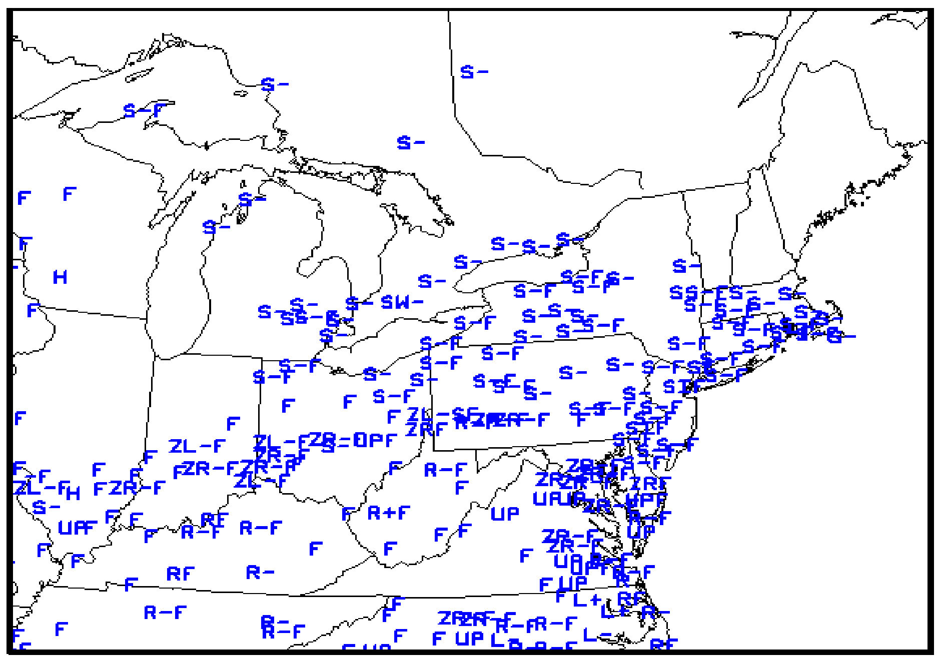
PRECIP TYPE NAM 60H FCST VALID 12Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 60H FCST VALID 12Z 22 FEB 2008

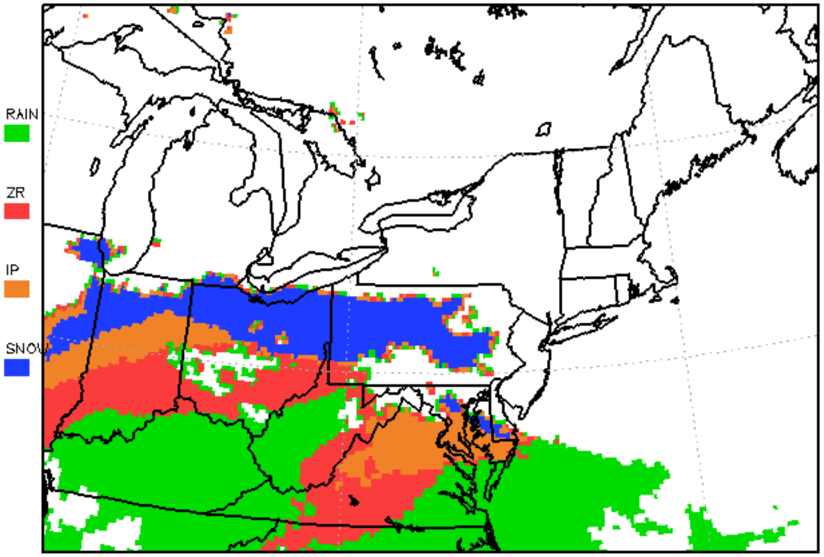




OBSERVED WX TEMP VALID 12Z 22 FEB 2008

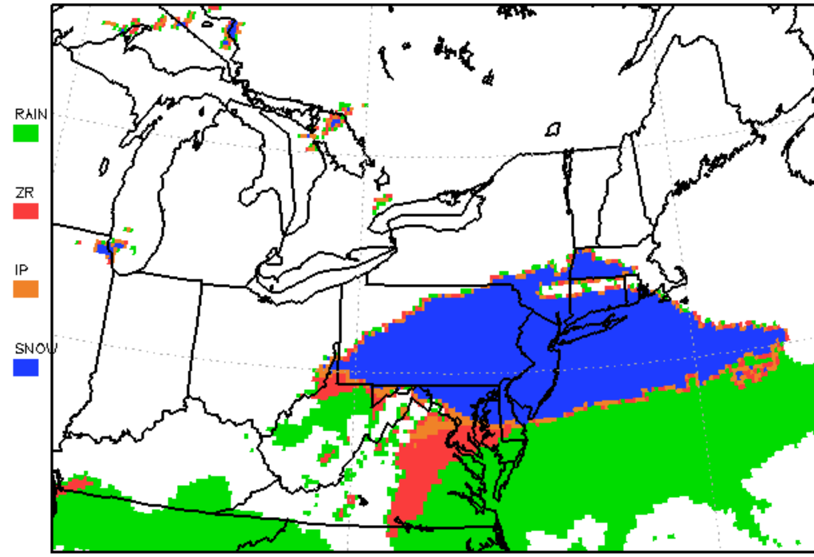
Ops NAM

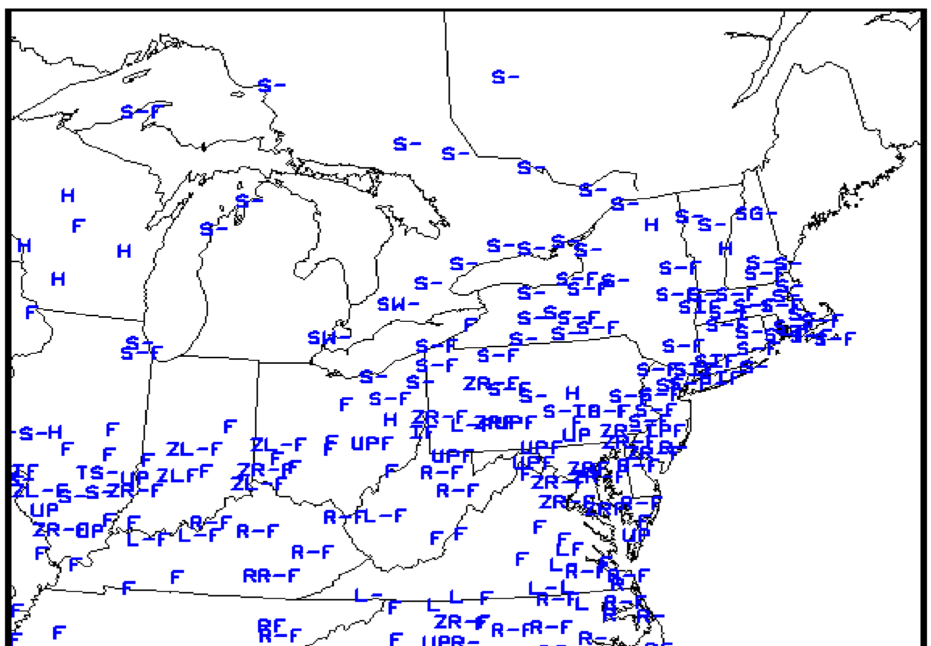
PRECIP TYPE NAM 63H FCST VALID 15Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 63H FCST VALID 15Z 22 FEB 2008

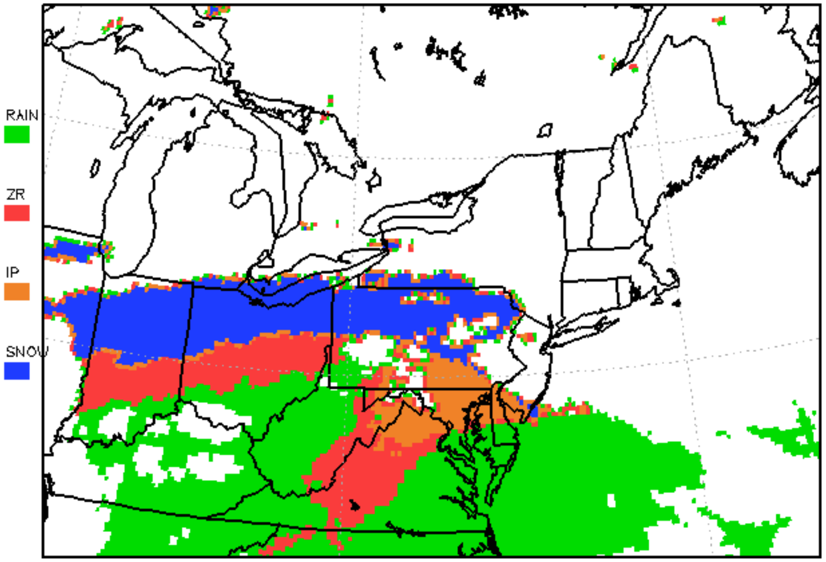




OBSERVED WX TEMP VALID 15Z 22 FEB 2008

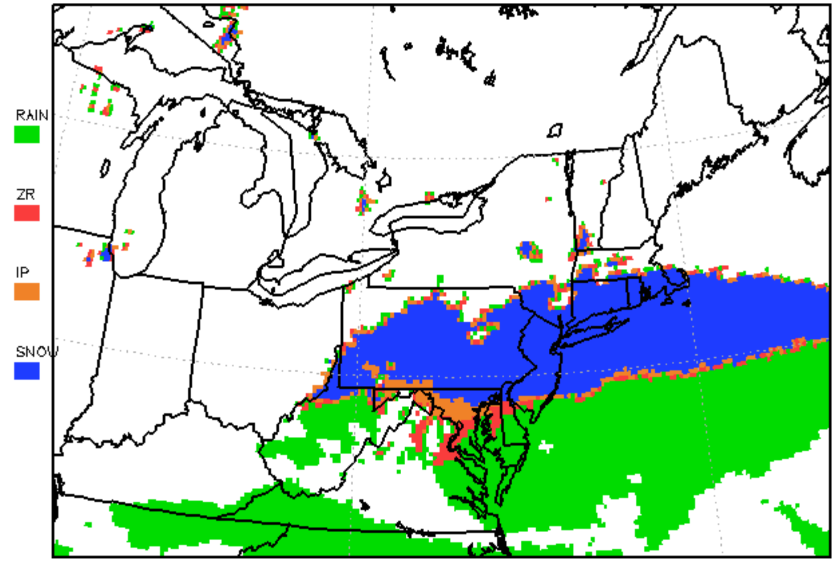
Ops NAM

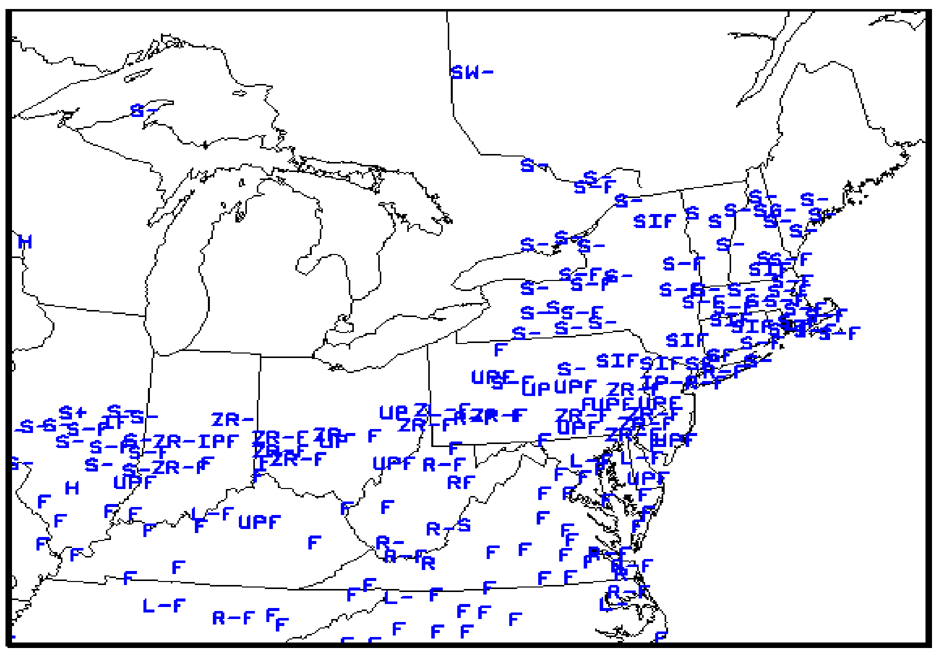
PRECIP TYPE NAM 66H FCST VALID 18Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 66H FCST VALID 18Z 22 FEB 2008

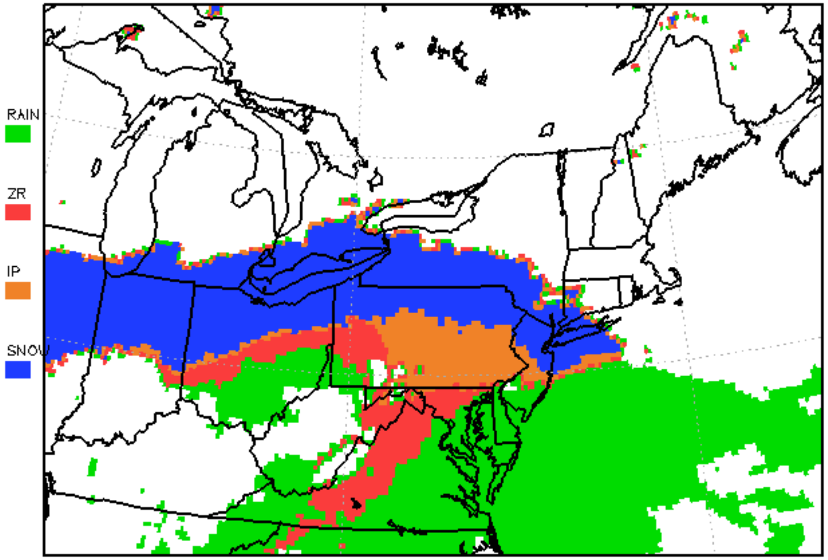




OBSERVED WX TEMP VALID 18Z 22 FEB 2008

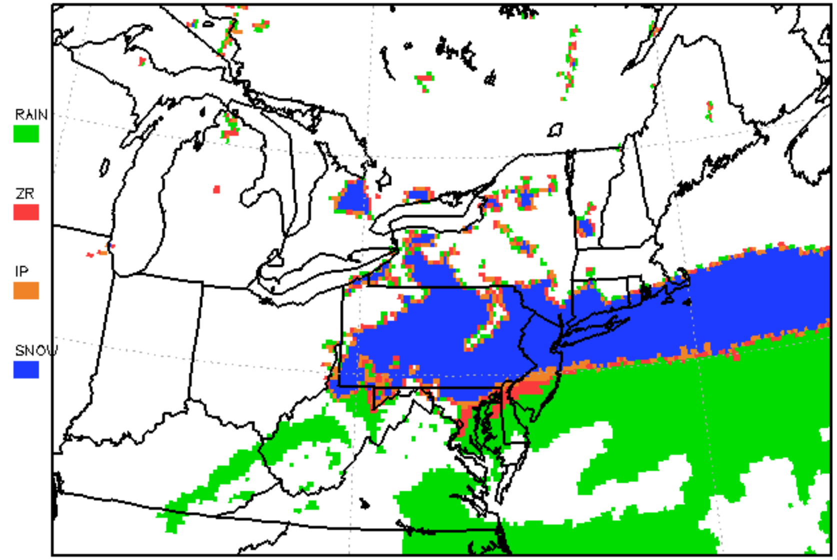
Ops NAM

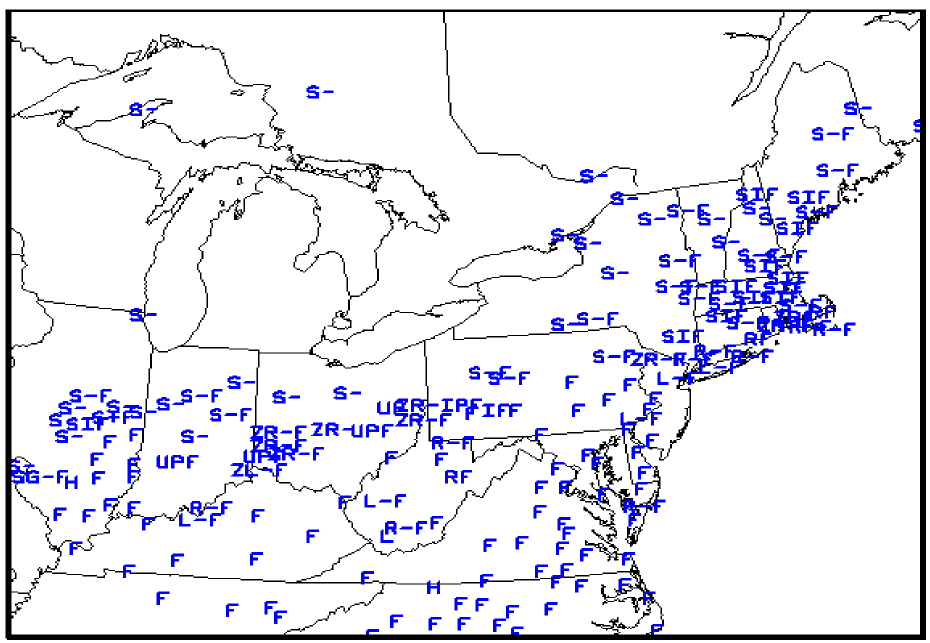
PRECIP TYPE NAM 69H FCST VALID 21Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 69H FCST VALID 21Z 22 FEB 2008

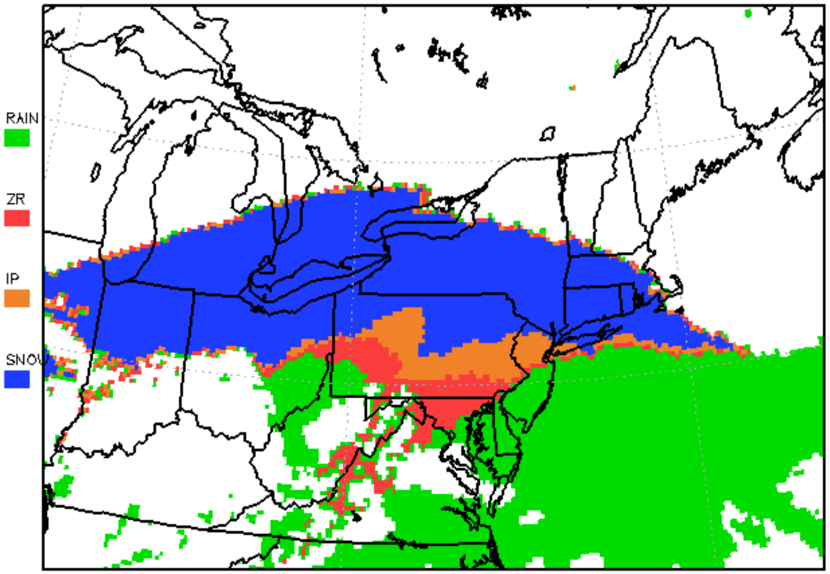




OBSERVED WX TEMP VALID 21Z 22 FEB 2008

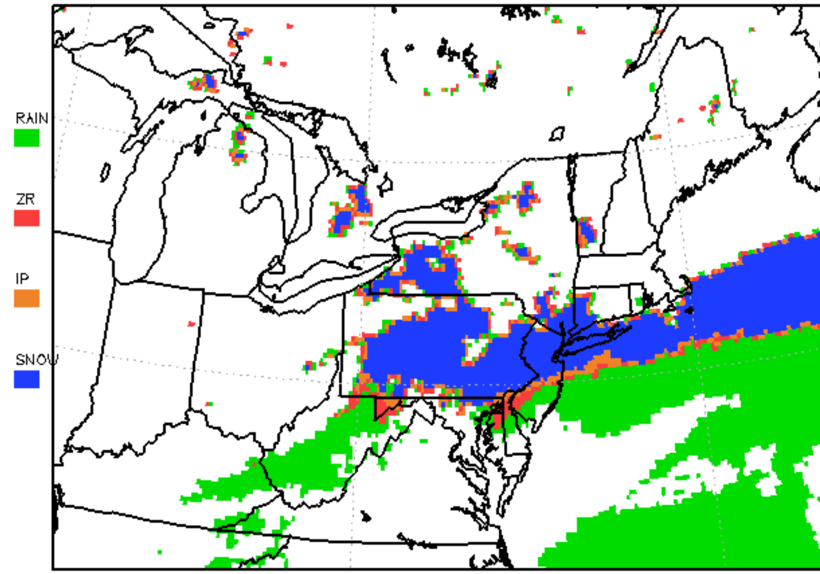
Ops NAM

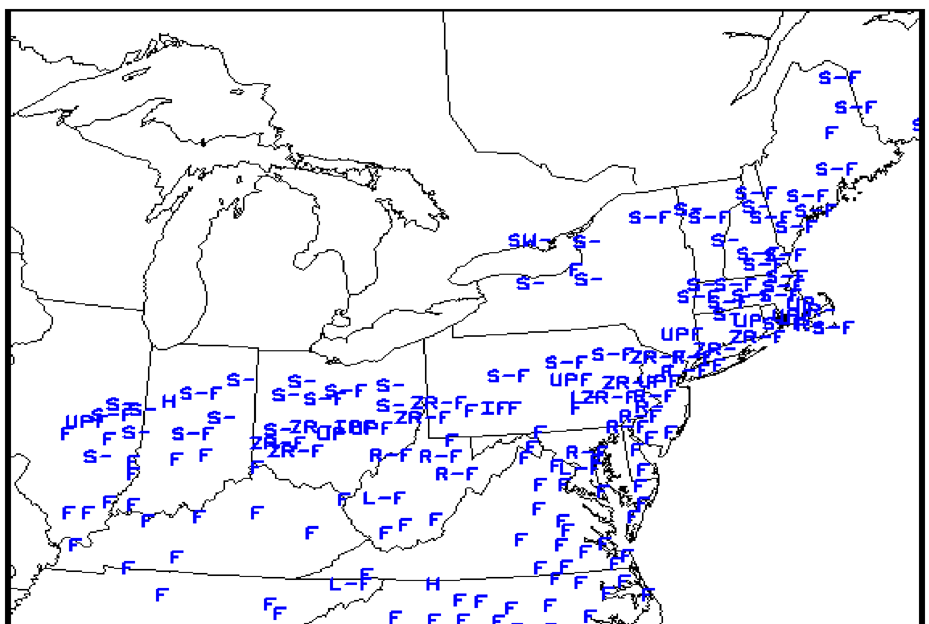
PRECIP TYPE NAM 72H FCST VALID 00Z 23 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 72H FCST VALID 00Z 23 FEB 2008



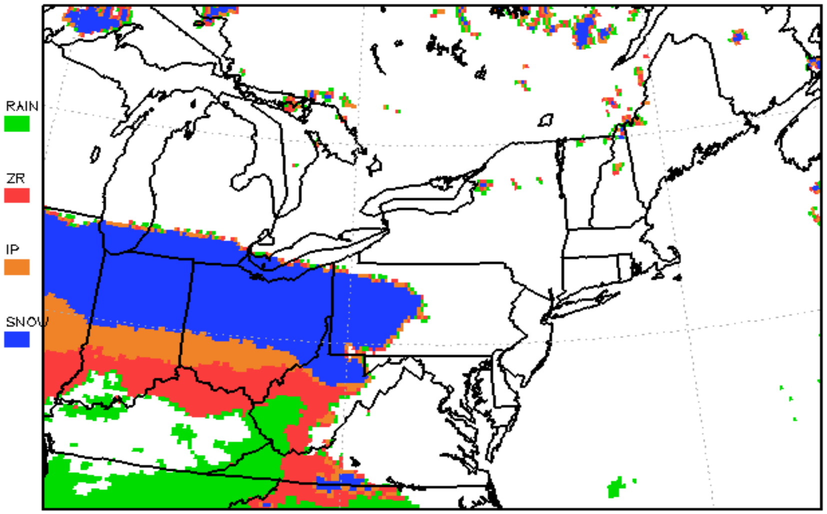


OBSERVED WX TEMP VALID 00Z 23 FEB 2008

Ops NAM vs Parallel NAM : 12z 2/20/2008 cycle

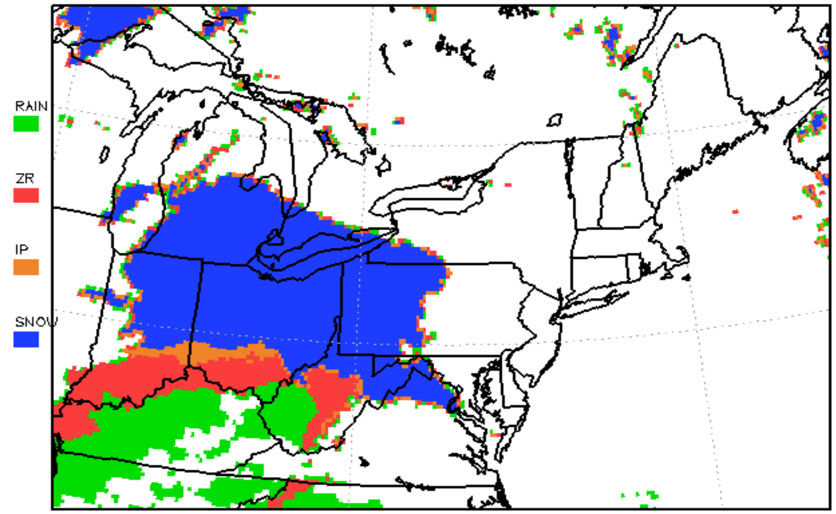
Ops NAM

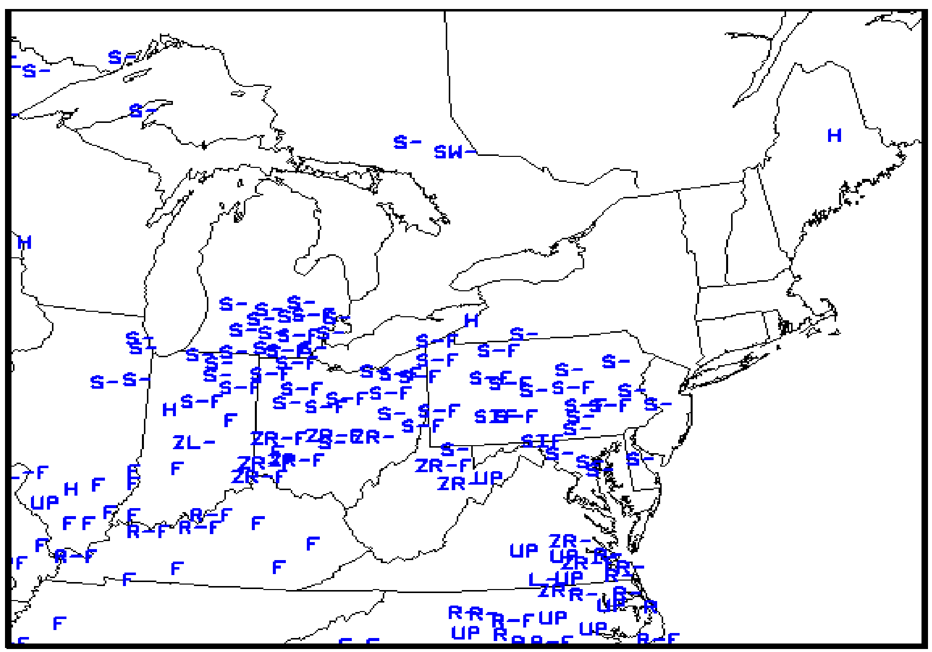
PRECIP TYPE NAM 42H FCST VALID 06Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 42H FCST VALID 06Z 22 FEB 2008

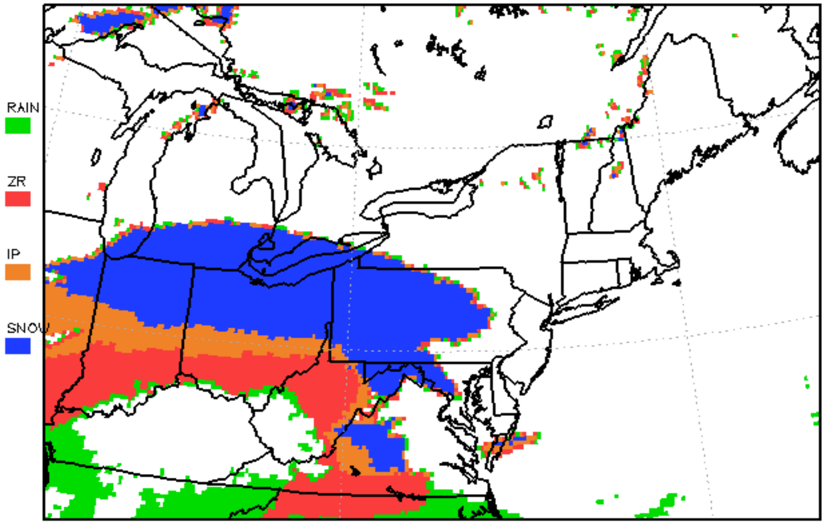




OBSERVED WX TEMP VALID 06Z 22 FEB 2008

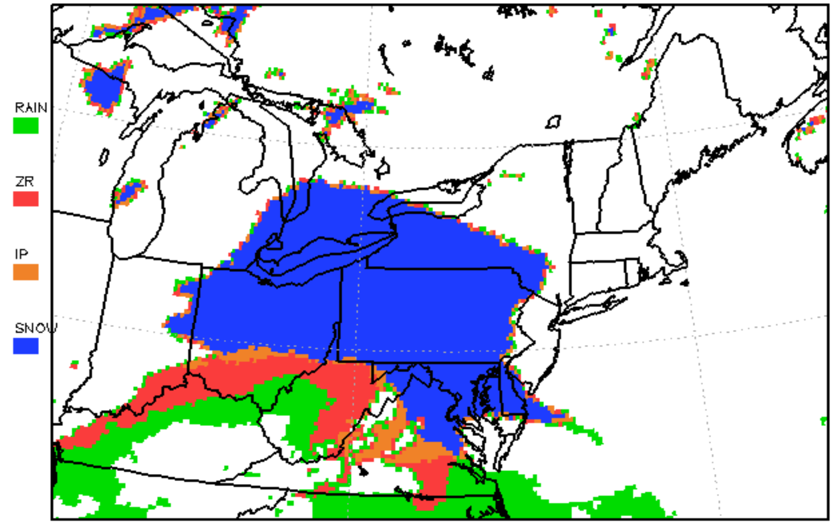
Ops NAM

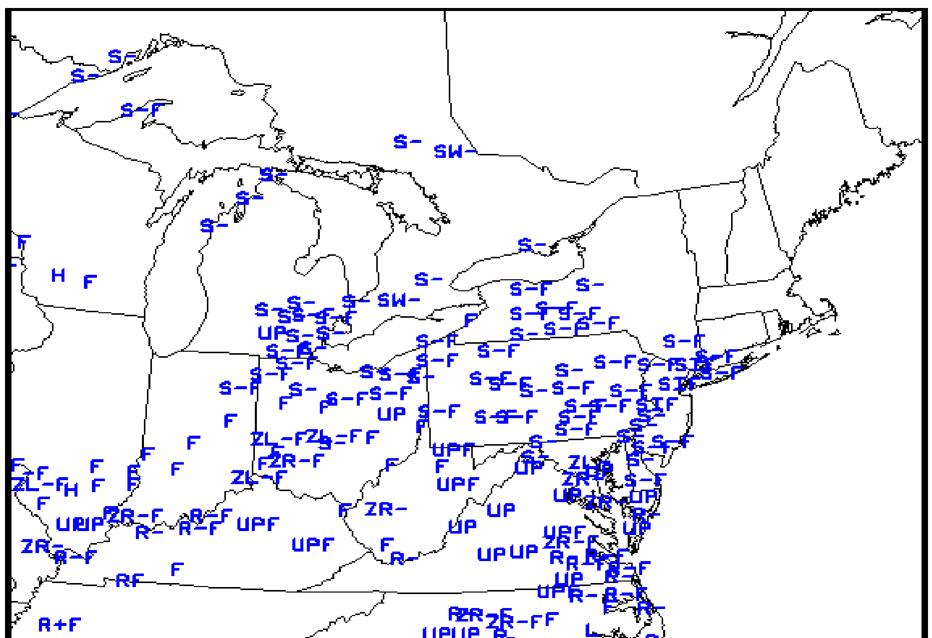
PRECIP TYPE NAM 45H FCST VALID 09Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 45H FCST VALID 09Z 22 FEB 2008

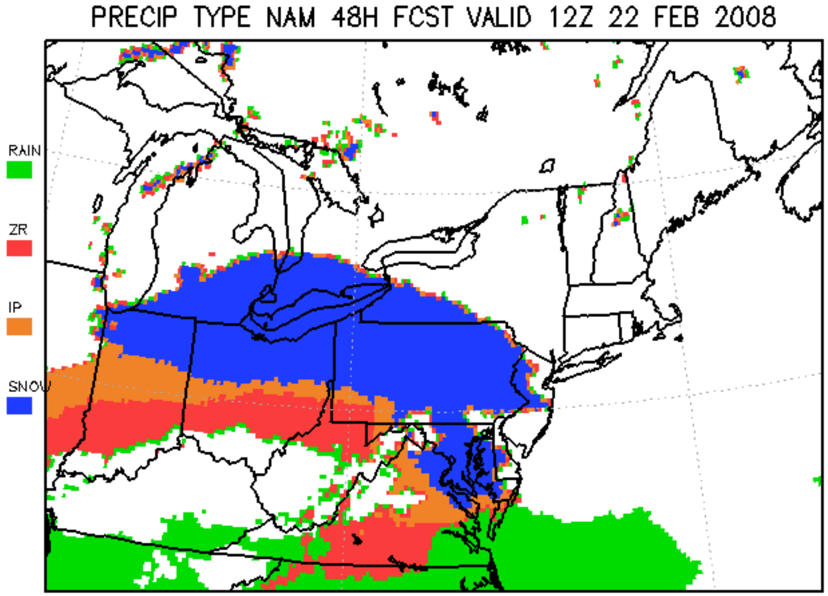


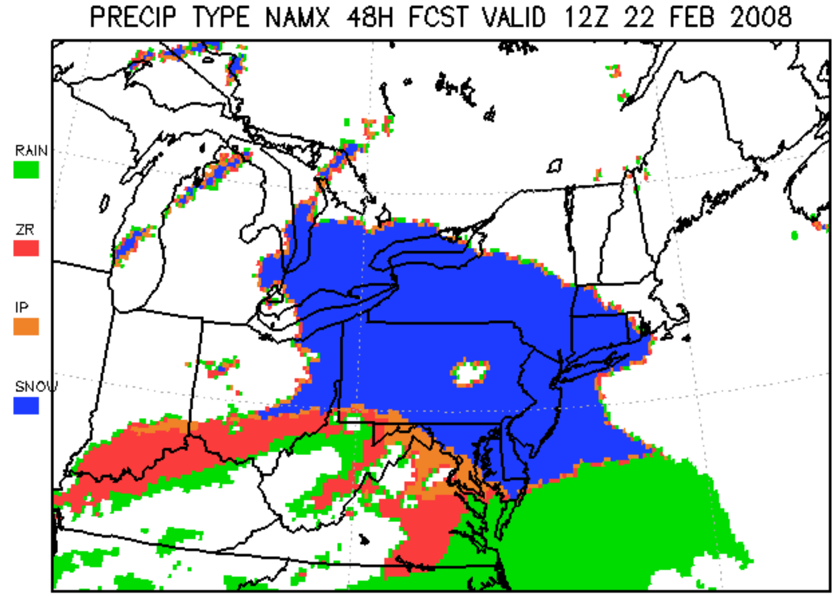


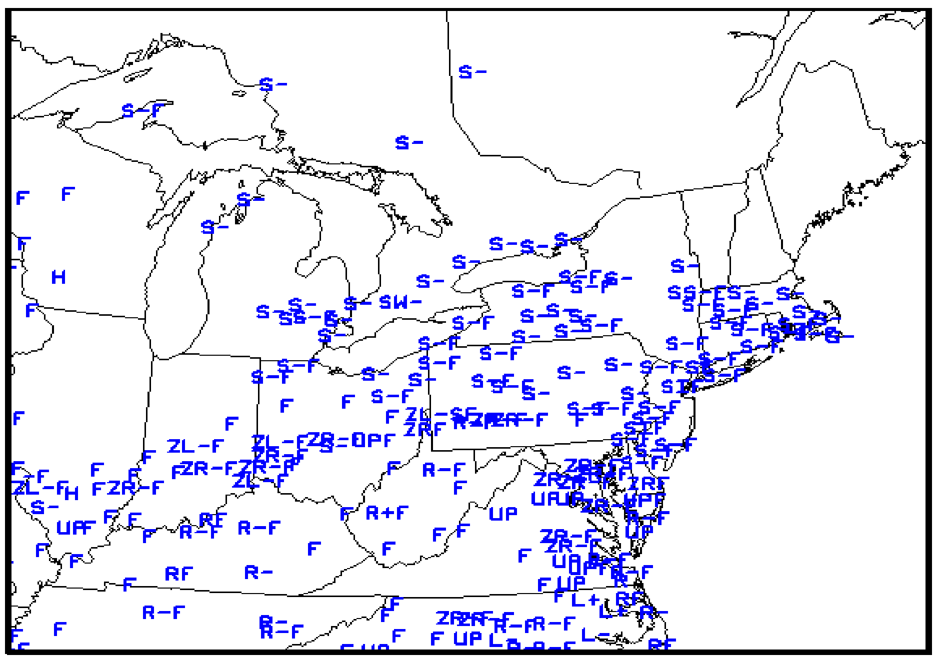
OBSERVED WX TEMP VALID 09Z 22 FEB 2008

Ops NAM

Parallel NAM

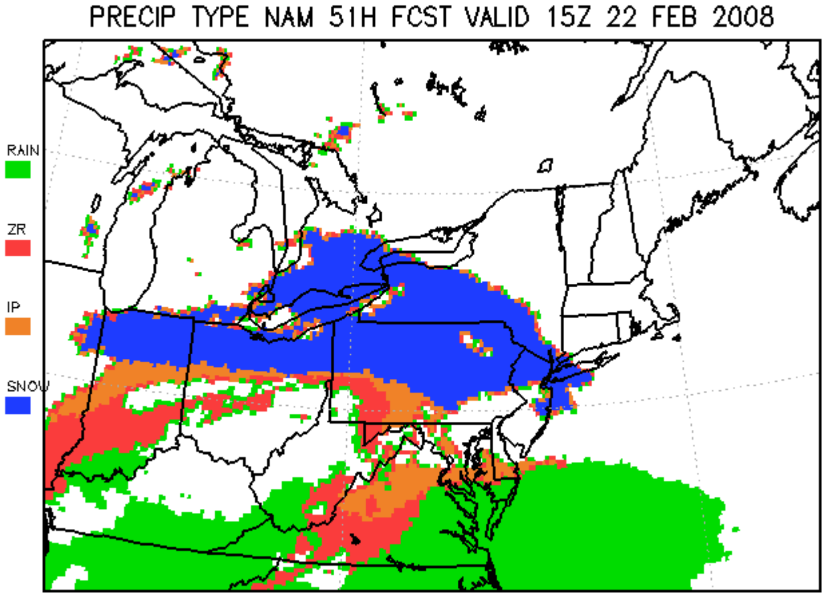




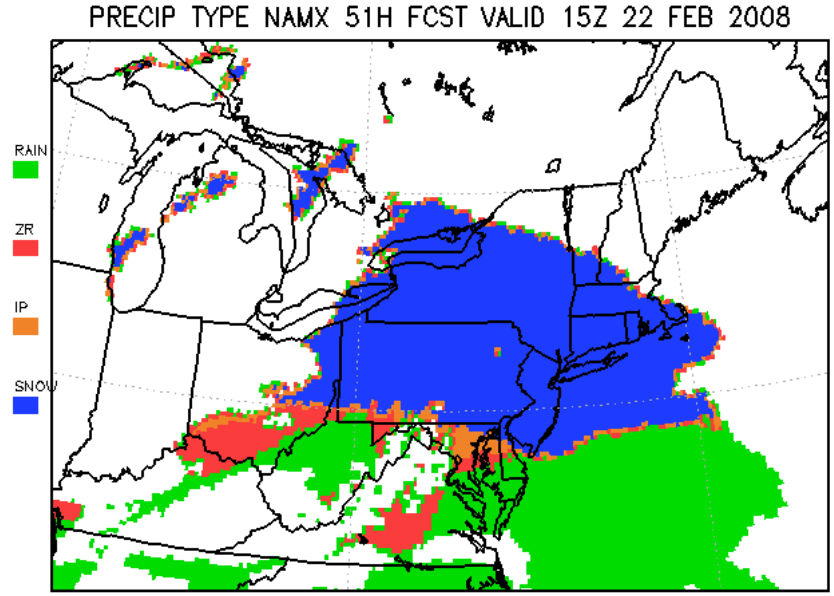


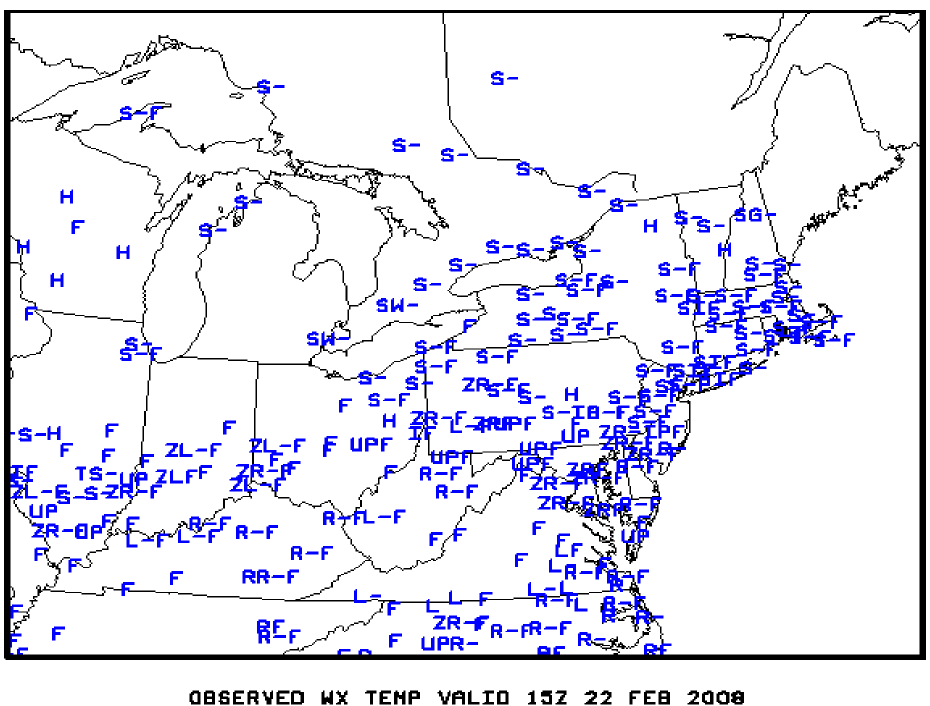
OBSERVED WX TEMP VALID 12Z 22 FEB 2008

Ops NAM



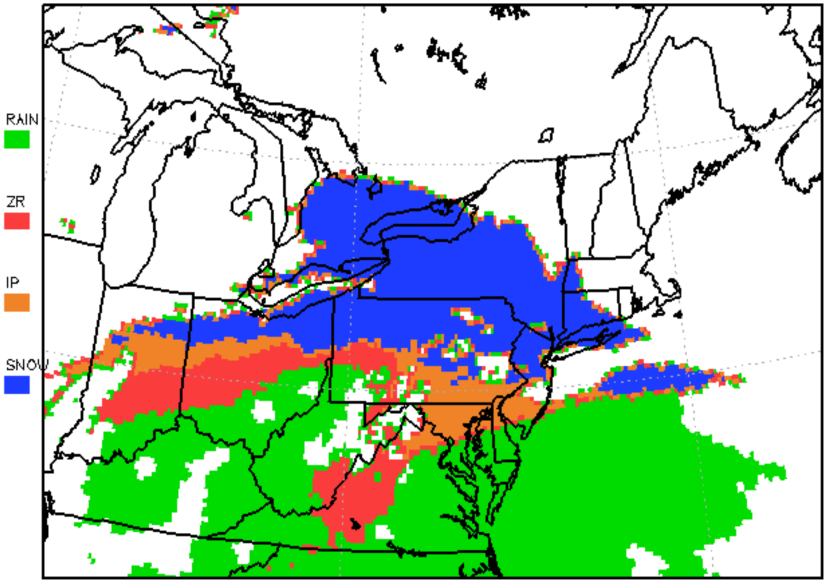
Parallel NAM





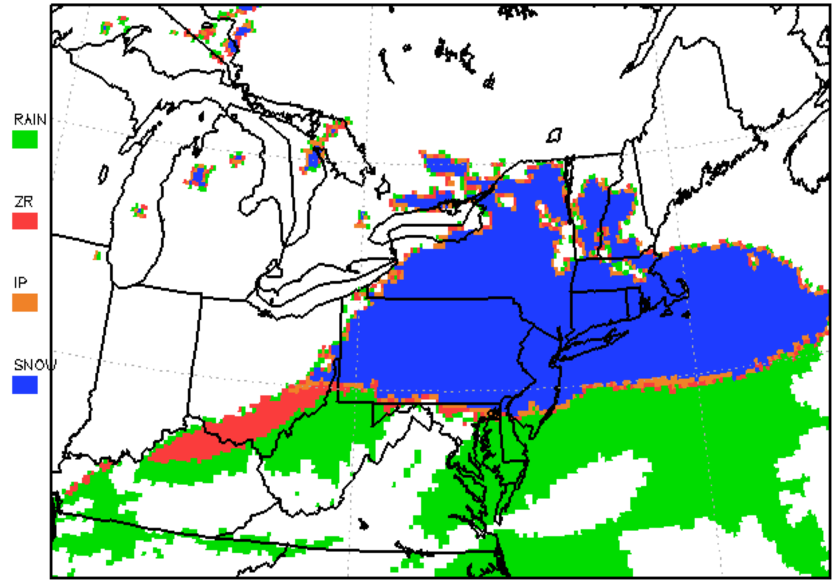
Ops NAM

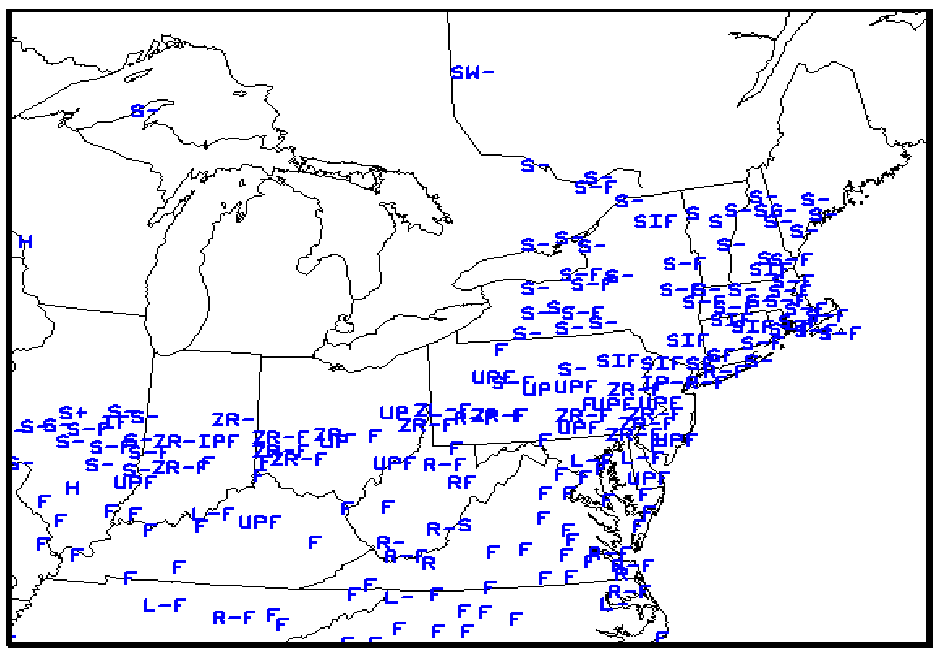
PRECIP TYPE NAM 54H FCST VALID 18Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 54H FCST VALID 18Z 22 FEB 2008

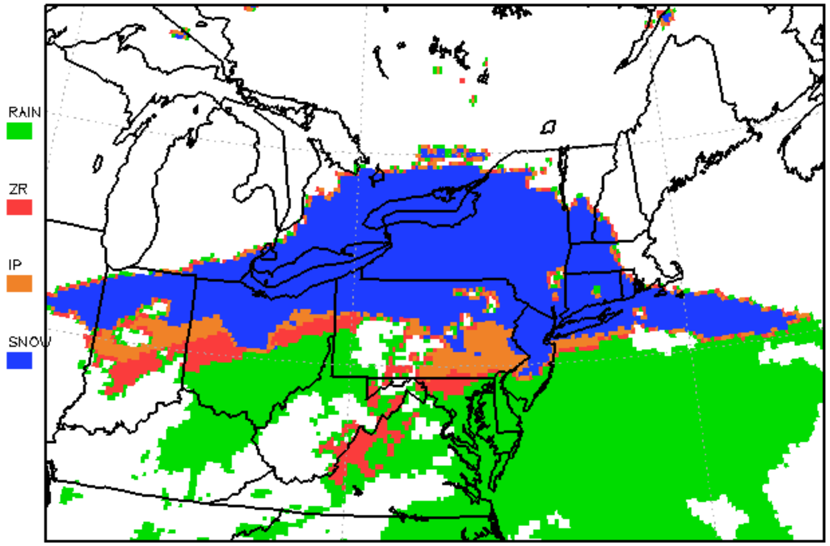




OBSERVED WX TEMP VALID 18Z 22 FEB 2008

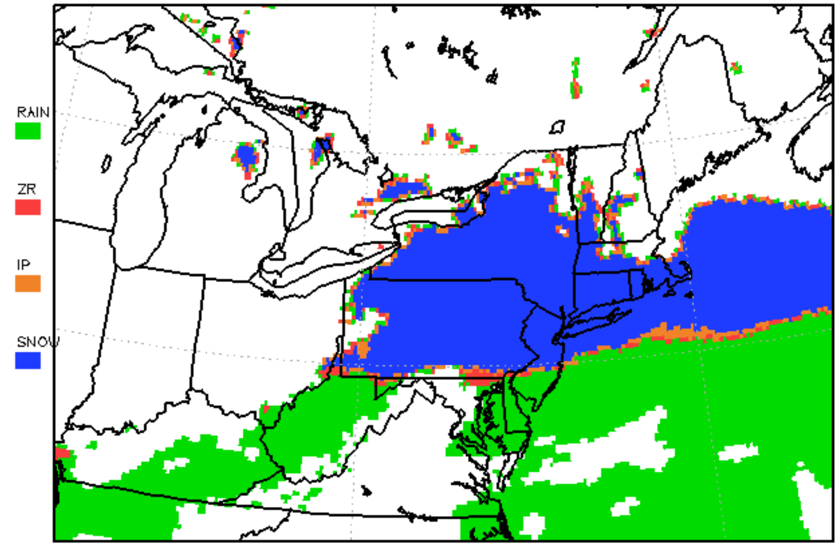
Ops NAM

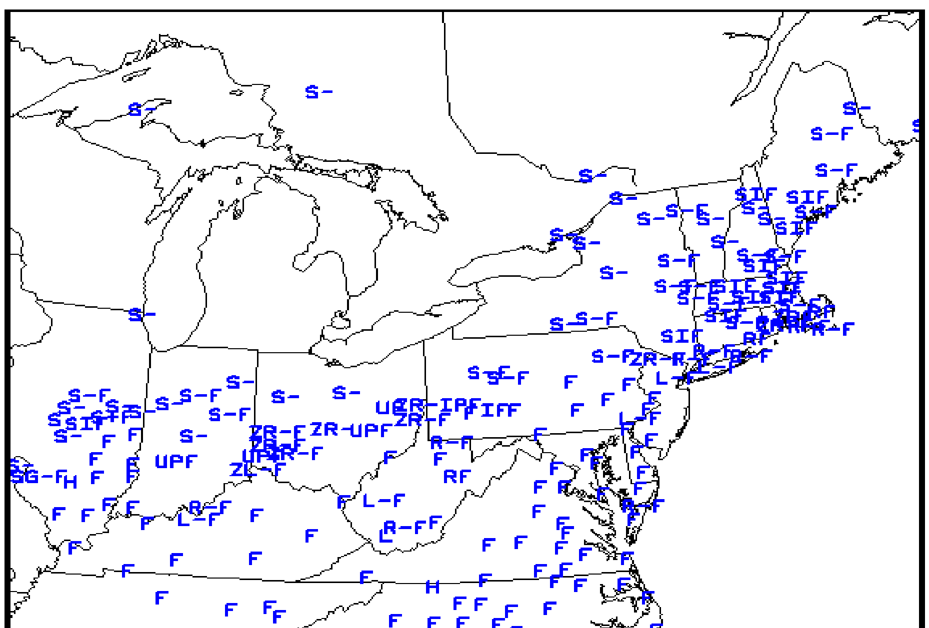
PRECIP TYPE NAM 57H FCST VALID 21Z 22 FEB 2008



Parallel NAM

PRECIP TYPE NAMX 57H FCST VALID 21Z 22 FEB 2008

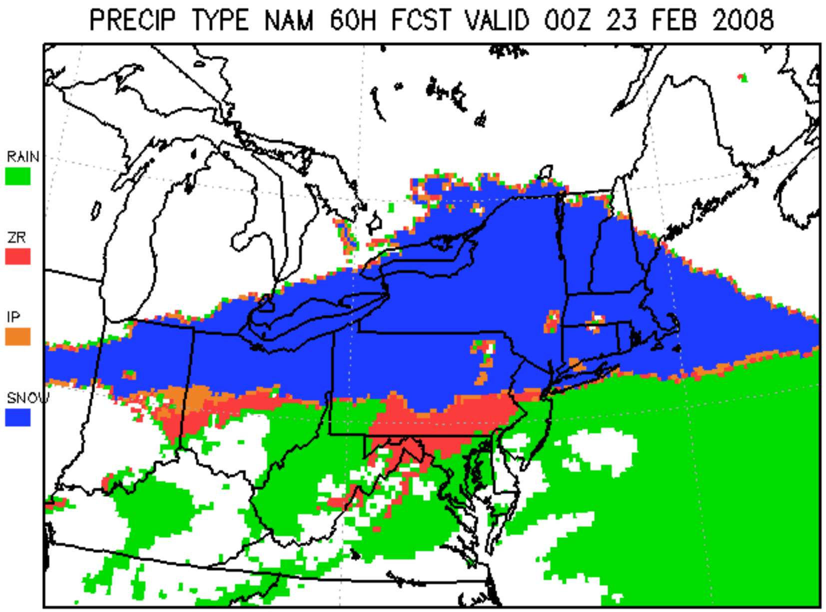


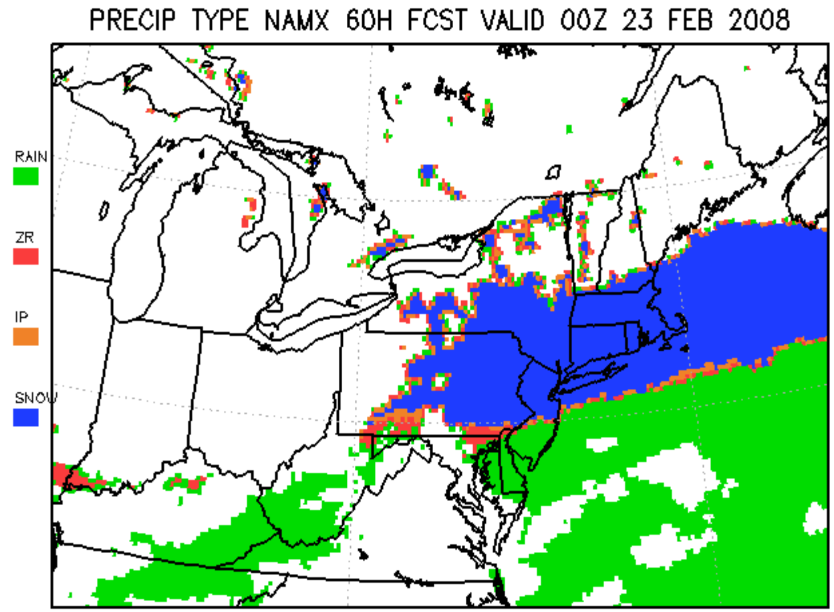


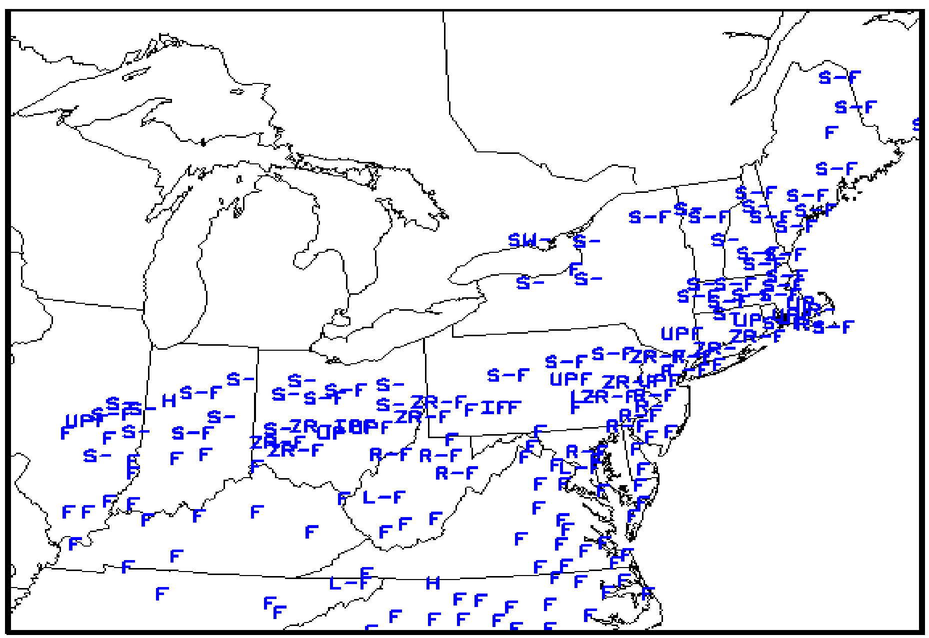
OBSERVED WX TEMP VALID 21Z 22 FEB 2008

Ops NAM

Parallel NAM







OBSERVED WX TEMP VALID 00Z 23 FEB 2008

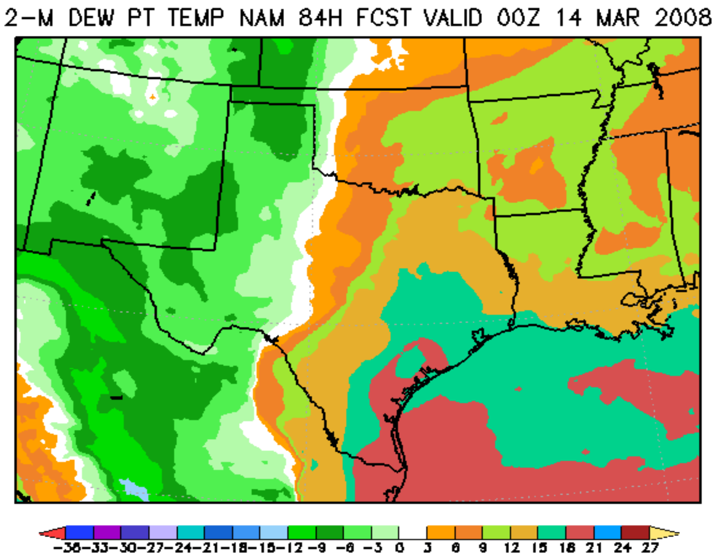
SPC Evalutaion from Steve Weiss

Recommendation: Implement as proposed

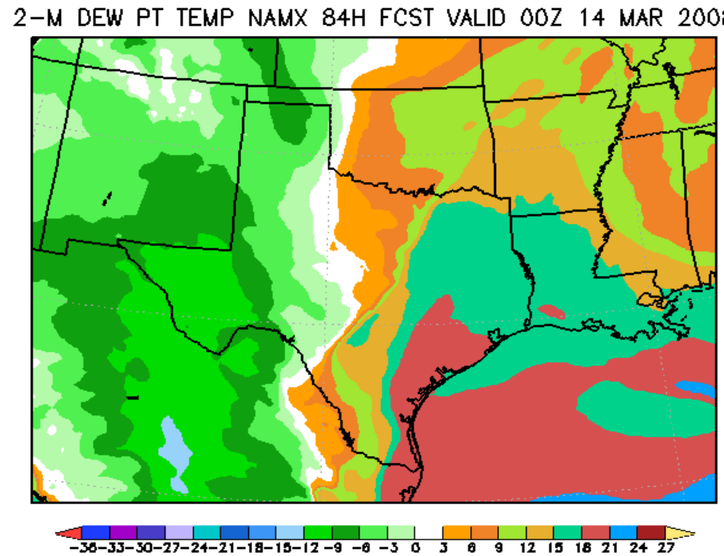
SPC has concerns about initial observations of excessive return flow moisture and instability in the NAM parallel performance. This characteristic may not be a show stopper in an overall NWS sense, especially given other improvements in the parallel version. Thus, SPC cautiously supports the NAM upgrade implementation. If the early indications of a high bias in the 2-m dew point field are confirmed over a longer period of time, we ask that EMC take a closer look at this aspect of model performance.

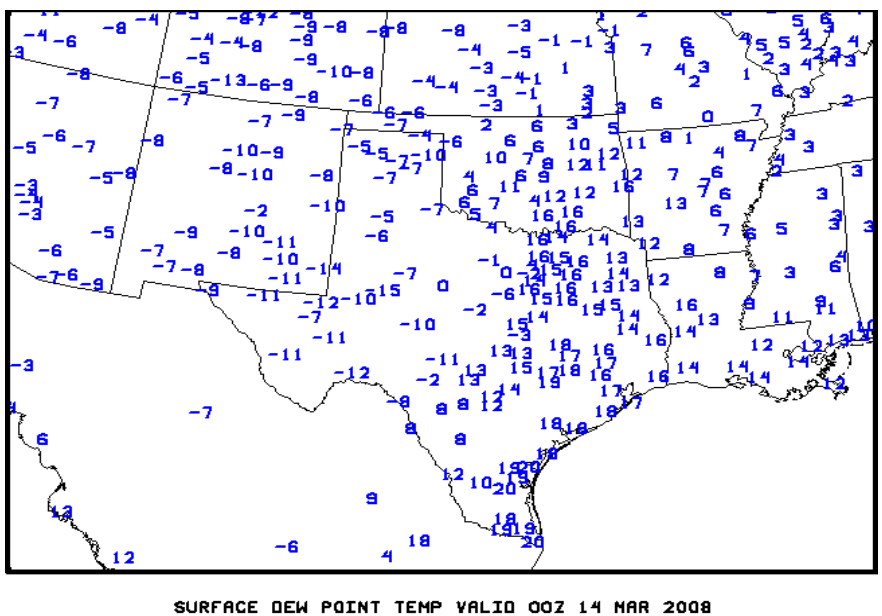
84-h 2-m Td Forecast example from SPC valid 00z 14 March

Ops NAM

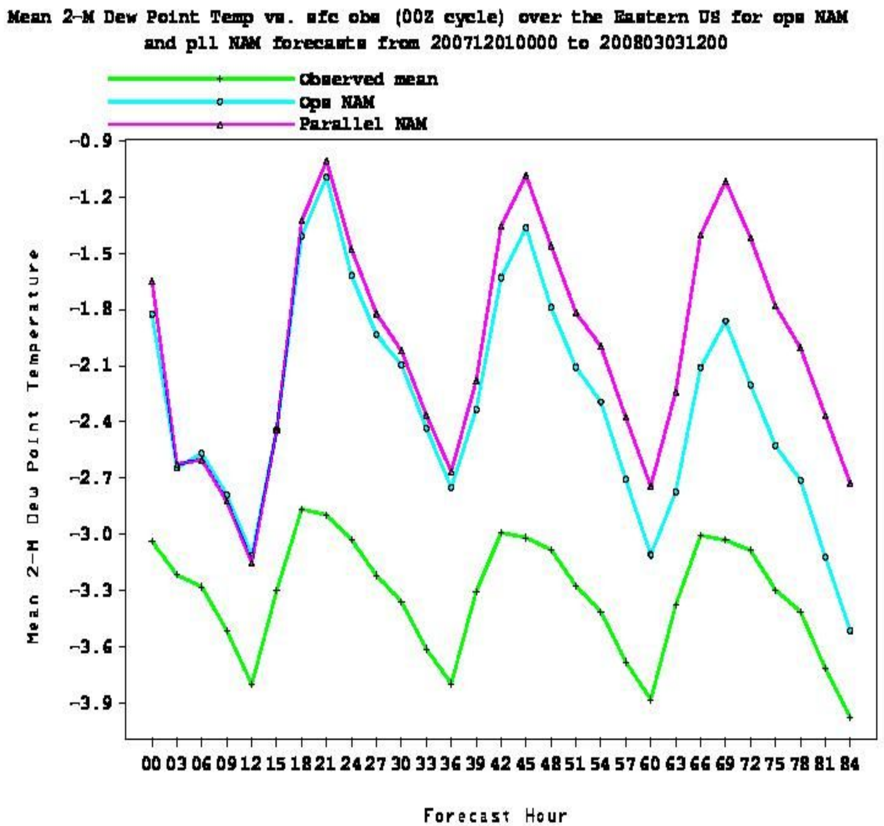


Parallel NAM

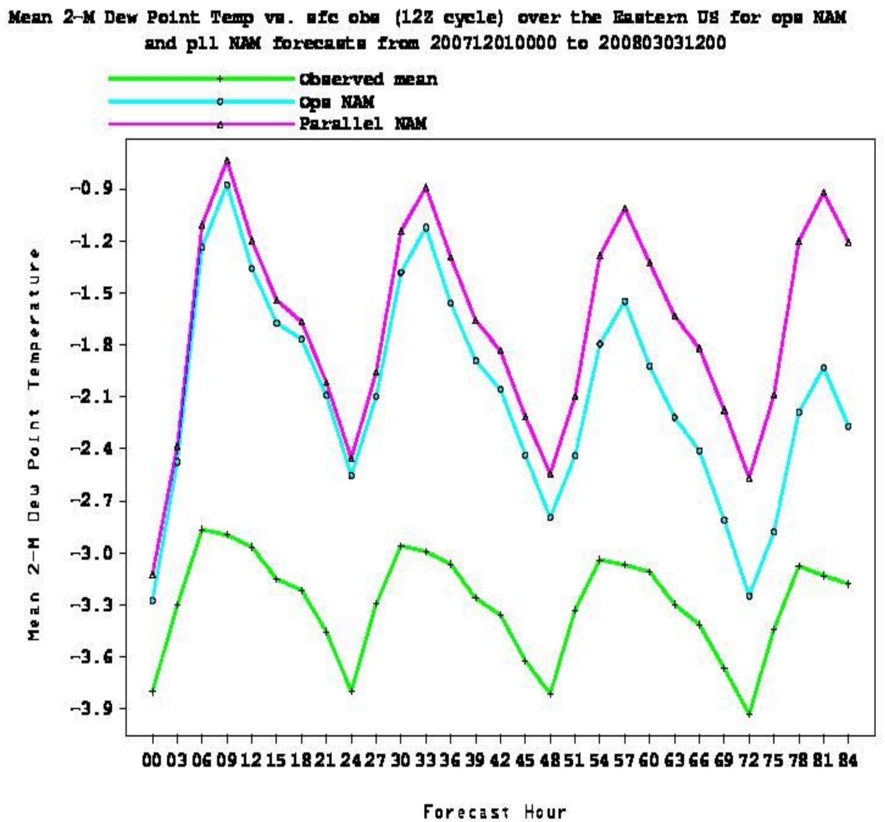




Mean diurnal trace of 2-m dewpoint for 1 Dec 07- 3 Mar 08 over Eastern CONUS : Blue=ops NAM, Magenta=parallel NAM, green=obs



All 00z cycles



All 12z cycles

AWC Evaluation from Steve Silberberg

- 250 hPa jet streams, vert wind shear, & Ellrod stronger in NAM-Parallel → improved turbulence guidance
- NAM-Parallel moisture and icing guidance equivalent to NAM-Operational
- NAM-Parallel Stability equivalent to NAM-Operational
- NAM-Parallel visibility equivalent to NAM-Operational
- NAM-Parallel surface friction velocity more realistic around topography and coastline than NAM-Operational
- NAM-Parallel composite reflectivity not as good as NAM-Operational
- AWC recommends operational implementation of NAM-Parallel
- Thank you
  - EMC for development
  - and NCO for dataflow

Suggestions to Improve Evaluation Process

- Please notify AWC 2 weeks before parallel dataflow begins
  - AWC Configuration Control Board Approval
  - AWC configuration changes to acquire and configure NAWIPS to view AWC-specific diagnostics

HPC Evaluation from Mike Brennan

- Subjective evaluation of the parallel NAM at HPC has shown a positive impact from the proposed changes to the model
  - Largest differences in mass fields seen in 2 to 3 day forecast period, but smaller differences seen in analysis and short-term forecasts
- HPC's recommendation is to implement parallel NAM as scheduled

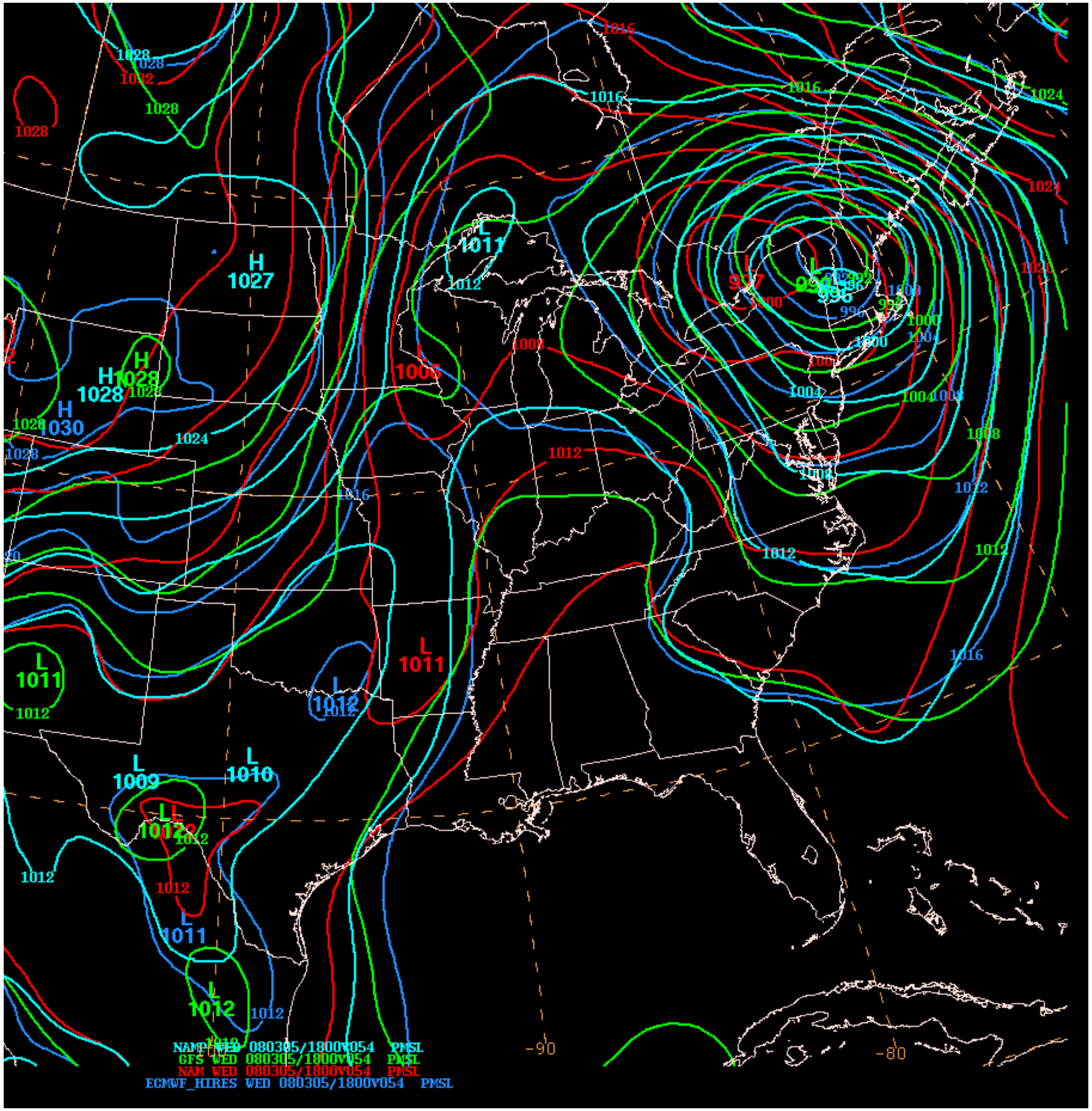
Case Example

Eastern U.S. Cyclone 5-6 March 2008

- Model forecast cycle from 12Z 3 March 2008 showed significant disagreement with the track of a cyclone moving north from the southeast into the Mid-Atlantic and Northeast in the day 2-3 time period
- Operational NAM appeared to be a western outlier with the cyclone track compared to the balance of the other deterministic guidance (GFS, ECMWF)

54-h SLP Forecast valid 18Z 5 March

12Z 3 March model cycle



Parallel NAM

Operational NAM

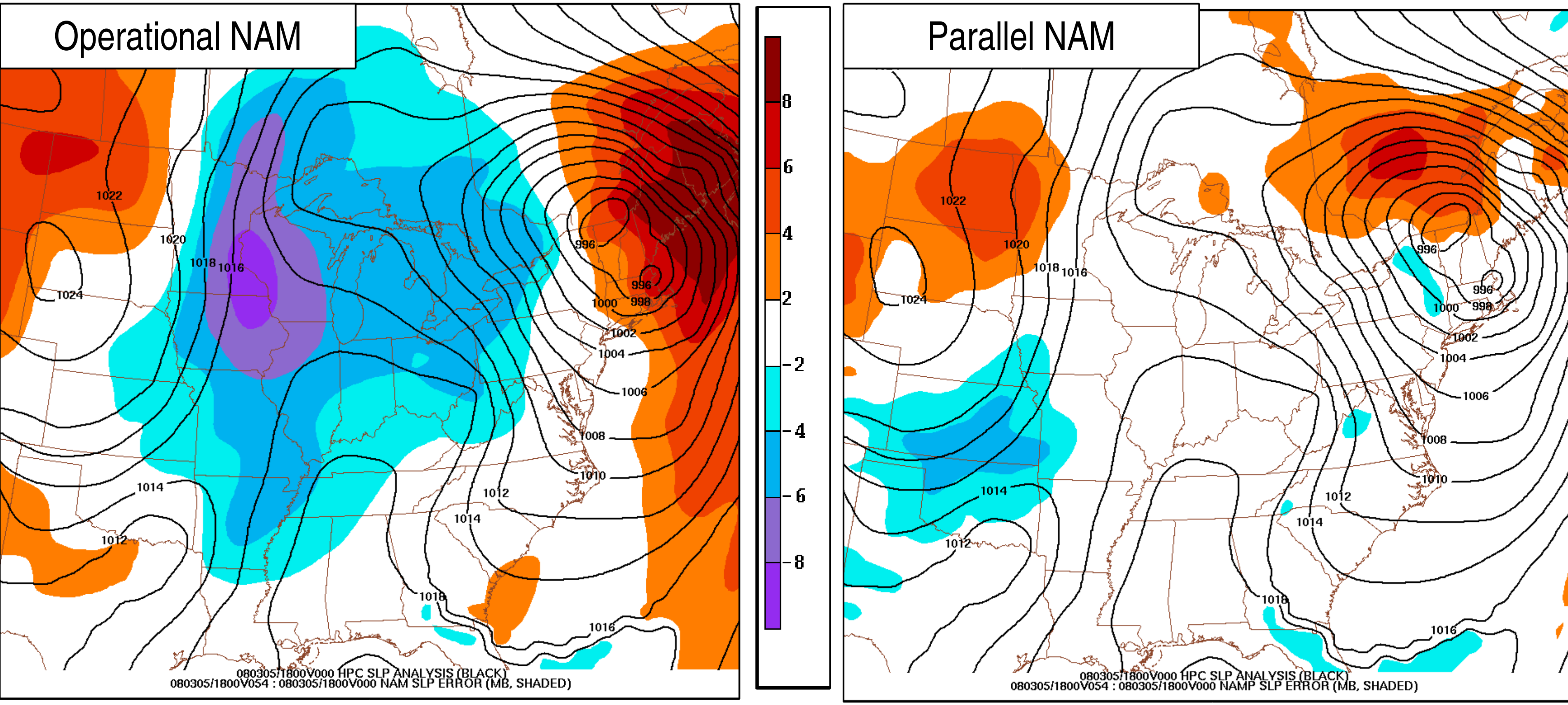
GFS

ECMWF

Operational NAM tracked cyclone much farther west through western NY compared to other operational models and parallel NAM with track through eastern NY and western NE

SLP Forecast Validation

HPC analysis – NAM/NAMP Forecast

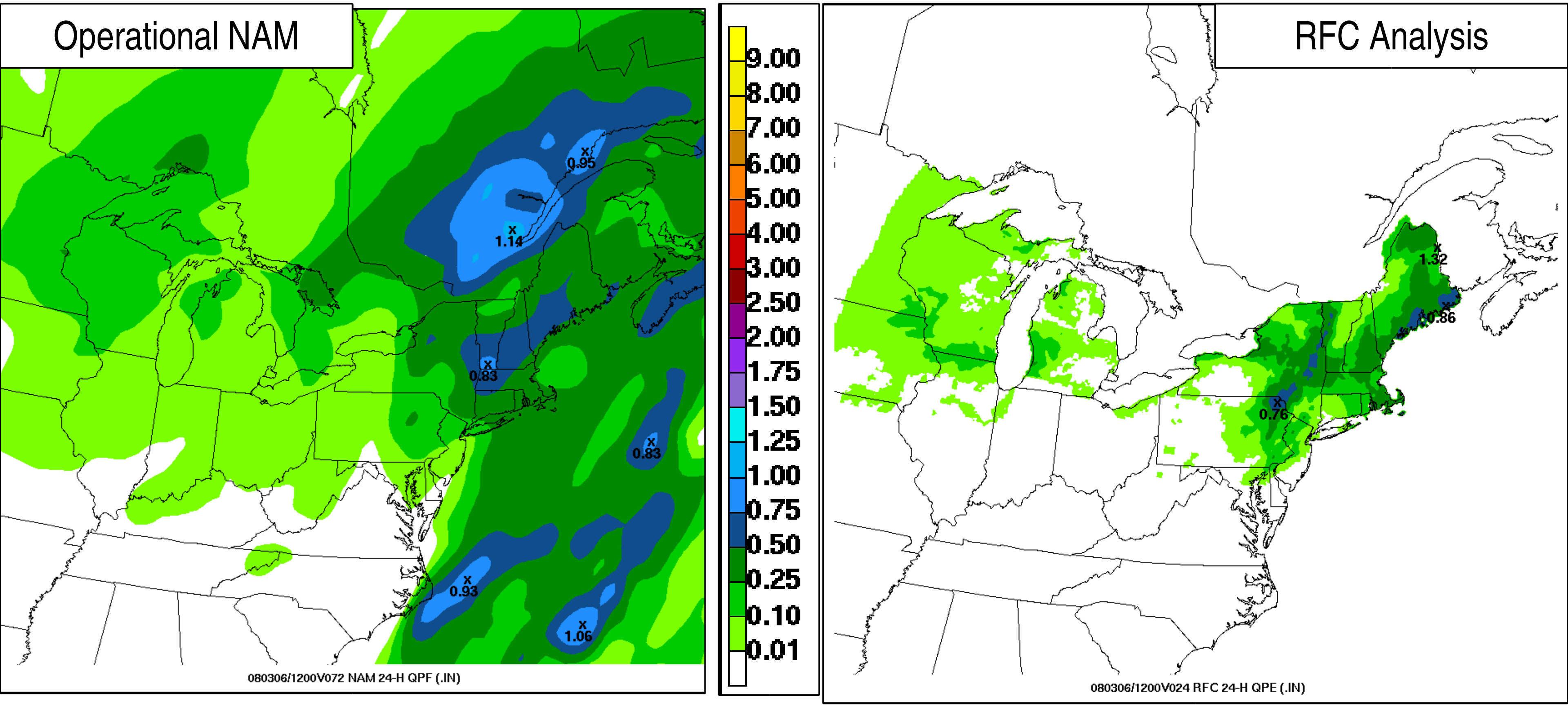


Warm (Cool) colors indicate positive (negative) SLP forecast error

- Operational NAM forecast shows much larger errors (6–8 mb) in vicinity of northeast cyclone compared to 2–4 mb errors in parallel NAM
- NAMP SLP forecast more accurate elsewhere over central/eastern CONUS

QPF Validation

NAM Forecast vs. QPE

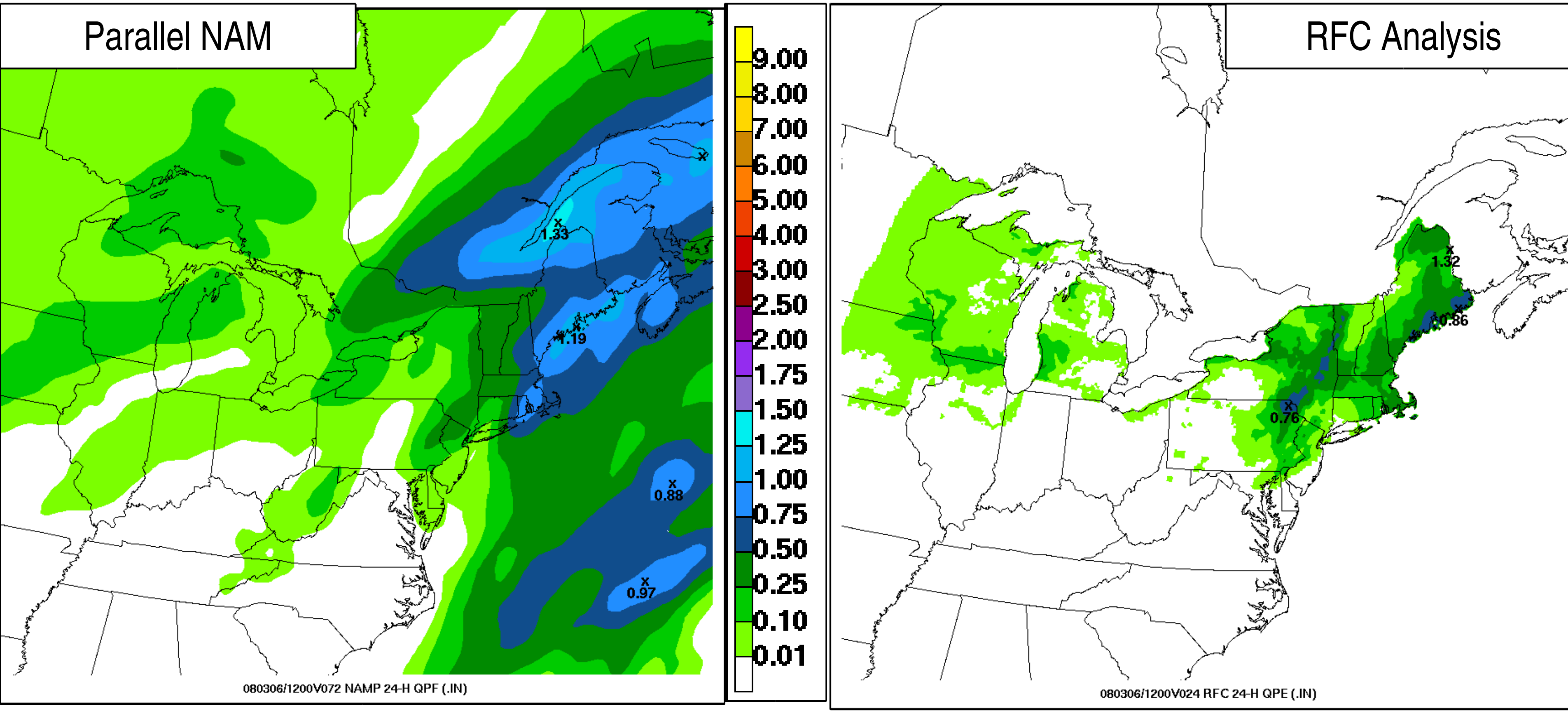


24-h QPF/QPE ending 12Z 6 March 2008

- Operational NAM shows too much QPF over interior New England and not enough QPF extending south into NE PA

QPF Validation

NAMP Forecast vs. QPE



24-h QPF/QPE ending 12Z 6 March 2008

- Parallel NAM does better job of capturing relative min of precip across NYC, LI and wrn CT
- Better depicts axis of maximum precip in eastern NY and higher amoutns along coast of Maine

Other HPC Comments

- NAMP verifies better than NAM for "significant" events
- Improved forecasts of 850-700 mb low strength at 72-84 hours
  - Operational NAM tend to be too strong with closed lows at 850-700 mb
  - NAMP has shown a net improvement in not forecasting 850-700 mb lows to be as intense over multiple runs/days
  - NAMP from the 5 March 00Z run had better forecast for the 850-700 mb cyclone track for big Ohio Valley heavy snow event than the operational NAM
- Consider the parallel NAM to be a net improvement, although propensity for NAM to have a high bias in cold-sector QPF of closed cyclones and low bias in the warm sector continues

TPC Evaluation

- We endorse the operational implementation of the experimental NAM (NAMEXP).

  Specific comments-

  1) In an example of a rerun of the NAM from last year's hurricane season, the NAMEXP exhibited less of a tendency for spurious tropical cyclone-like spinup over the Caribbean, which has been a chronic problem with the operational NAM.

  2) A limited sample of tropical cyclone (Noel and Olga 2007) track forecasts from the NAMEXP showed mostly a slight degradation in comparison to the operational NAM. However it should be noted that the NAM has historically performed much worse than models such as the GFDL, HWRF, the GFS, etc. for track.

  3) The NAMEXP forecasts seem to depict a slightly faster and more accurate progression of frontal systems in the Gulf of Mexico region.

  4) NAMEXP appears to make slightly more realistic forecasts of gap wind events, in particular Gulf of Tehuantepec gale events. Forecast maximum winds are slightly higher that the operational run of the NAM and closer to the observed winds.