December 2006 NAM Changes

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Background

- **Since August, in response to poor NAM performance, EMC has run two separate parallels testing upgrades**
- **Poor performance includes**
  - **Overdevelopment of mid-latitude cyclones**
  - **Exaggerated "digging" too far south**
  - **Convection (deep & shallow) triggering issues**
- **Parallel runs are:**
  - **In data assimilation: new divergence damper with extra damping of the external mode, applied (5x) more heavily in NDAS to reduce noise**
  - **Tuning convection and microphysics**
- **Two parallel runs were combined for final testing beginning 2 November**
- **Codes (after speeding them up) turned over to NCO on 27 November**

Accelerated December 2006 NAM Changes - Summary

http://www.emc.ncep.noaa.gov/mmb/namchanges_dec2006/nam_upgrades.nov2006.html

1. The divergence damping routine, which damps all gravity-inertia and external modes, is changed to increase damping of the external mode.

2. During the NDAS, divergence damping is increased to 5x that used during the 84 hr NAM free forecast.

3a. Numerous changes are made to convective parameterization:

- Triggering of deep and shallow convection is considered only for grid points with positive cape throughout a parcel's ascent; the search for parcel instability is extended to include not only whether the most unstable (highest theta-e) parcel can support convection, but also whether parcels originating at higher levels become positively buoyant when lifted to their LCL. Convective adjustments are made with respect to the parcel associated with the greatest instability (largest CAPE).

- The search for the most unstable parcel is extended from the lowest twenty percent of the atmosphere to the lowest 40 percent of the atmosphere.

Accelerated December 2006 NAM Changes - Summary

http://www.emc.ncep.noaa.gov/mmb/namchanges_dec2006/nam_upgrades.nov2006.html

3b. Numerous changes are made to convective parameterization (continued)

- Water loading effects are now included in assessing the buoyant instability of parcels from which a revised (lower) cloud top is determined to be at the highest level of positive buoyancy.

- The latent heat of vaporization used to calculate equivalent potential temperatures during model integration is made to be consistent with the value used in generating the initial lookup tables.

- The first-guess reference temperatures in the upper-half of shallow convective clouds are limited to be no more than -1 deg C colder than the ambient temperature.

Accelerated December 2006 NAM Changes - Summary

http://www.emc.ncep.noaa.gov/mmb/namchanges_dec2006/nam_upgrades.nov2006.html

3c. Numerous changes are made to convective parameterization (continued)

- When a grid point fails the entropy check for deep convection but still has positive cape, changes in temperature and moisture by shallow convection are then considered at these so-called swap points. The first-guess estimate for the top of shallow convection is based on the highest level where the parcel remains positively buoyant (this is more restrictive than positive cape), and the vertical extent of shallow convection is not to exceed 0.2 times the atmospheric pressure depth (e.g., 200 hPa for a surface pressure of 1000 hPa). A final adjustment is made to the top of shallow convection in which it can extend to higher altitudes if the mean ambient relative humidity (RH) in the cloud layer exceeds a threshold rh while remaining positively buoyant (i.e. CAPE greater than 0). The threshold RH is based on the RH at cloud base that is consistent with a deficit saturation pressure of 25 mb (usually near 90%). The maximum cloud top height for shallow convection is limited to 450 hPa.

Accelerated December 2006 NAM Changes - Summary

http://www.emc.ncep.noaa.gov/mmb/namchanges_dec2006/nam_upgrades.nov2006.html

4. Three changes are made to the cloud microphysics:

- During melting precipitation ice particles are assumed to have the same mean diameter (1 mm) as at the freezing level.

- Two changes intended to increase the presence of supercooled liquid water and improve forecast products for use in aircraft icing algorithms:

a. The temperature at which small amounts of supercooled liquid water, if present, are assumed to be glaciated to ice was lowered from -30C to -40C.

b. The temperature at which ice nucleation is allowed to occur was lowered from -5C to -15C based on aircraft icing observations

5. allow horizontal diffusion between neighboring grid points with a slope of less than or equal to 54 m / 12 km (9x that in operational NAM).

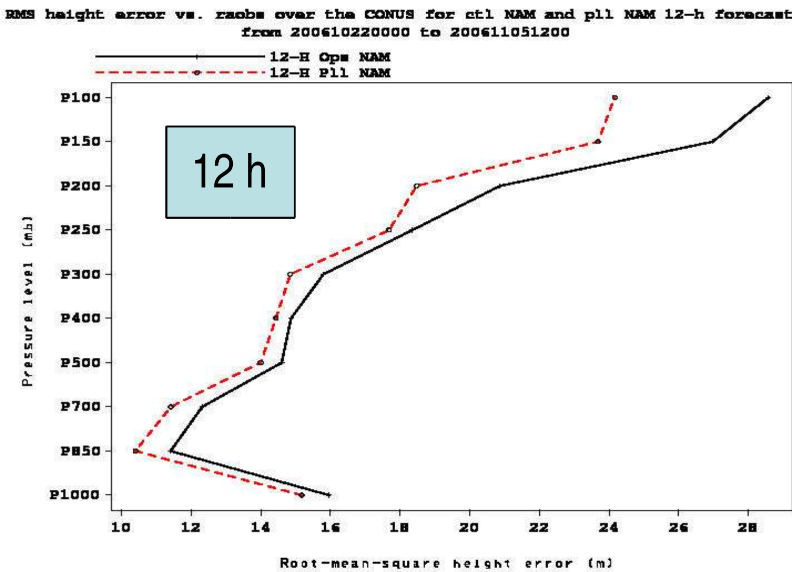
Accelerated December 2006 NAM Changes - Summary

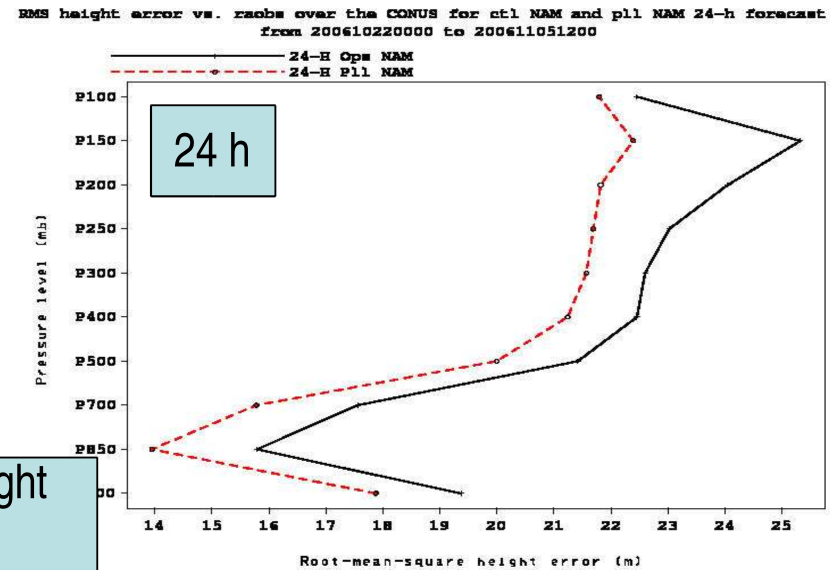
http://www.emc.ncep.noaa.gov/mmb/namchanges_dec2006/nam_upgrades.nov2006.html

The combined impact of these changes has led to:

- Slight improvement in NAM QPF scores,
- A 5-10% reduction in NAM height, temperature and vector wind root-mean-square errors compared to radiosondes; positive impacts increase with forecast range,
- A significant reduction in the false alarm rate for tropical storms.
- The numerical instability observed off Newfoundland in ops NAM runs from 1-4 December was eliminated by these changes.

Height Forecast - Divergence Damping of External Mode Change: 22 Oct – 5 Nov 06

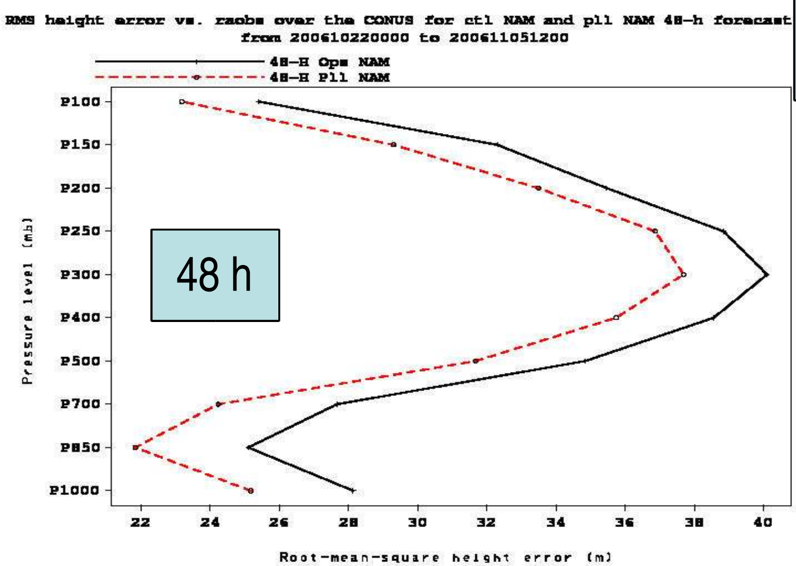


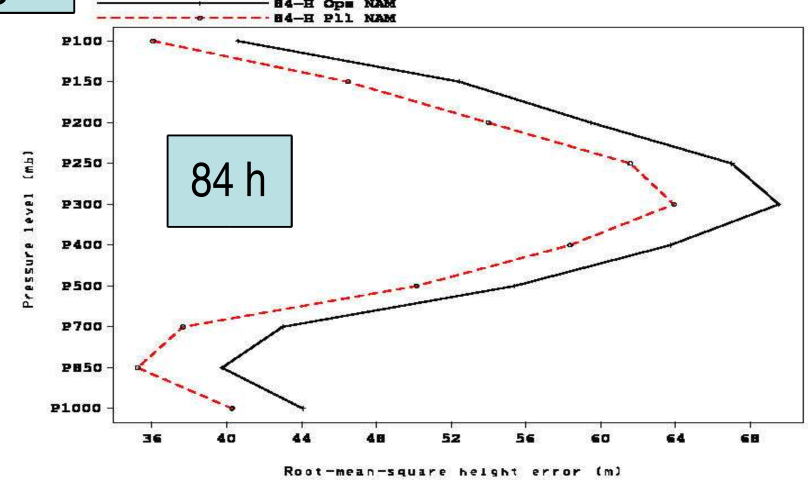


RMS Height Error

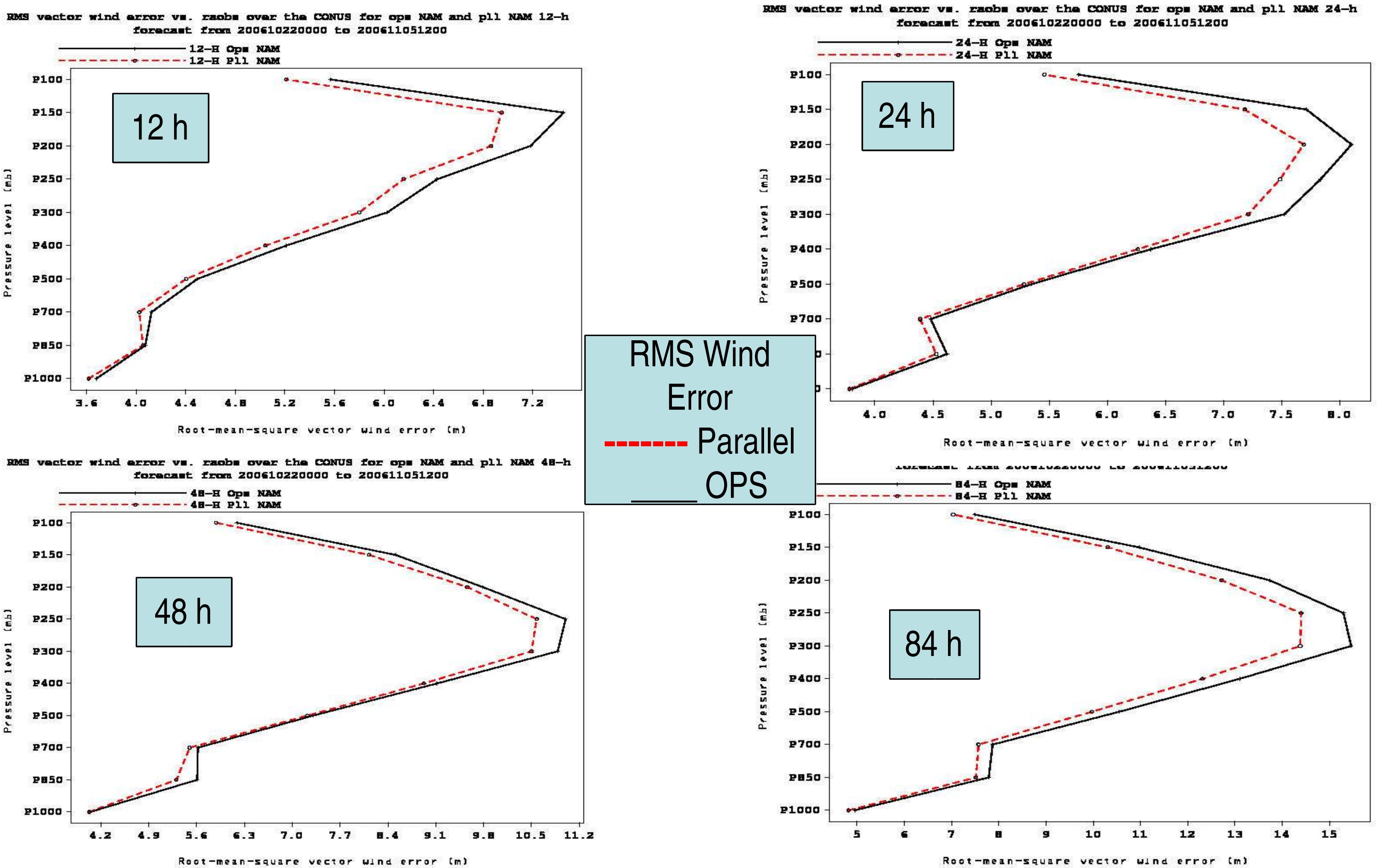
------- Parallel

_____ OPS



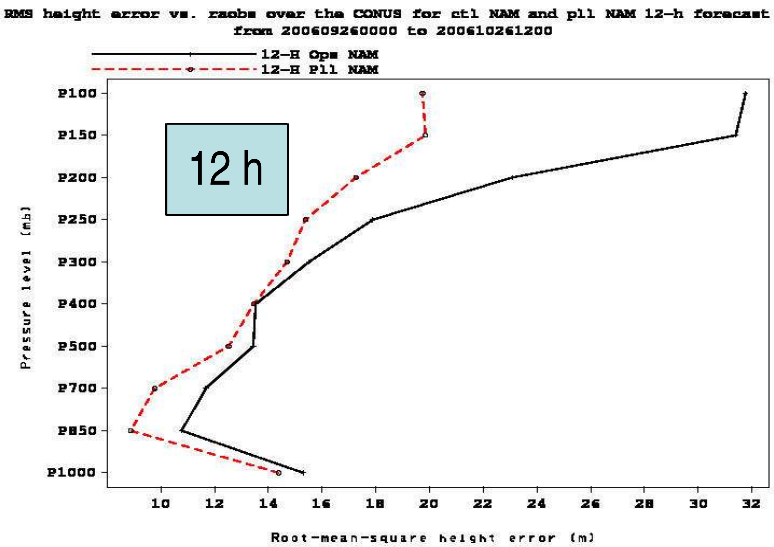


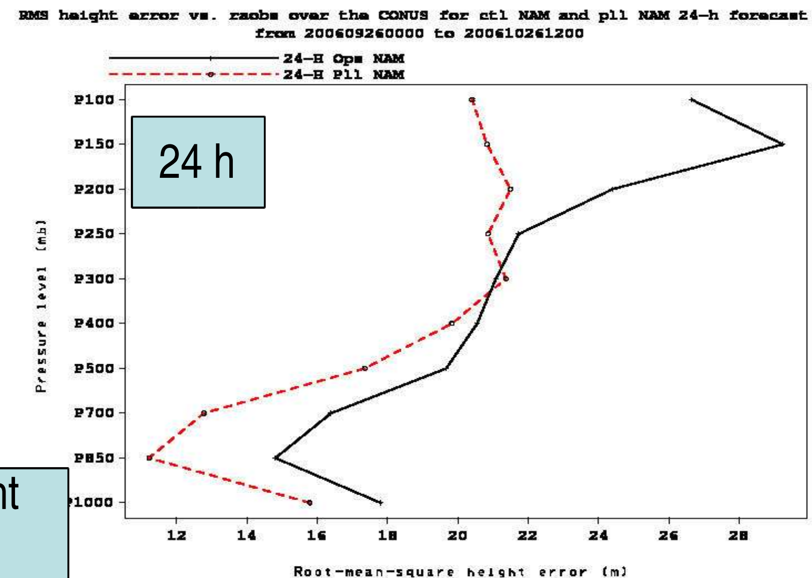
Wind Forecast - Divergence Damping of External Mode Change : 22 Oct – 5 Nov 06



Height Forecast

Physics Changes : 26 Sept – 26 Oct 06





RMS Height Error
------- Parallel
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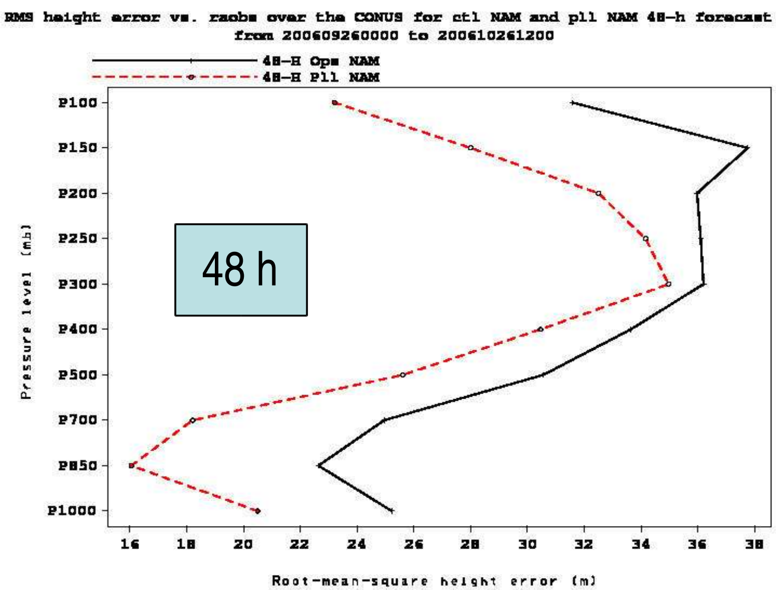
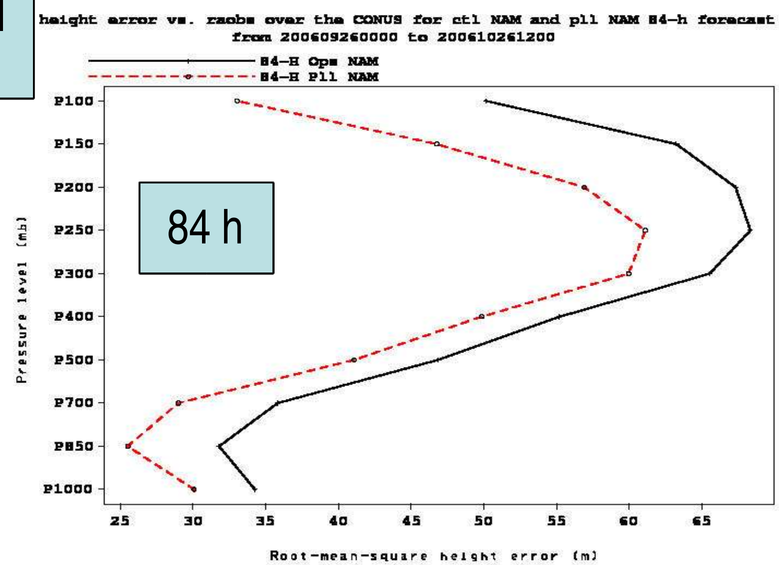
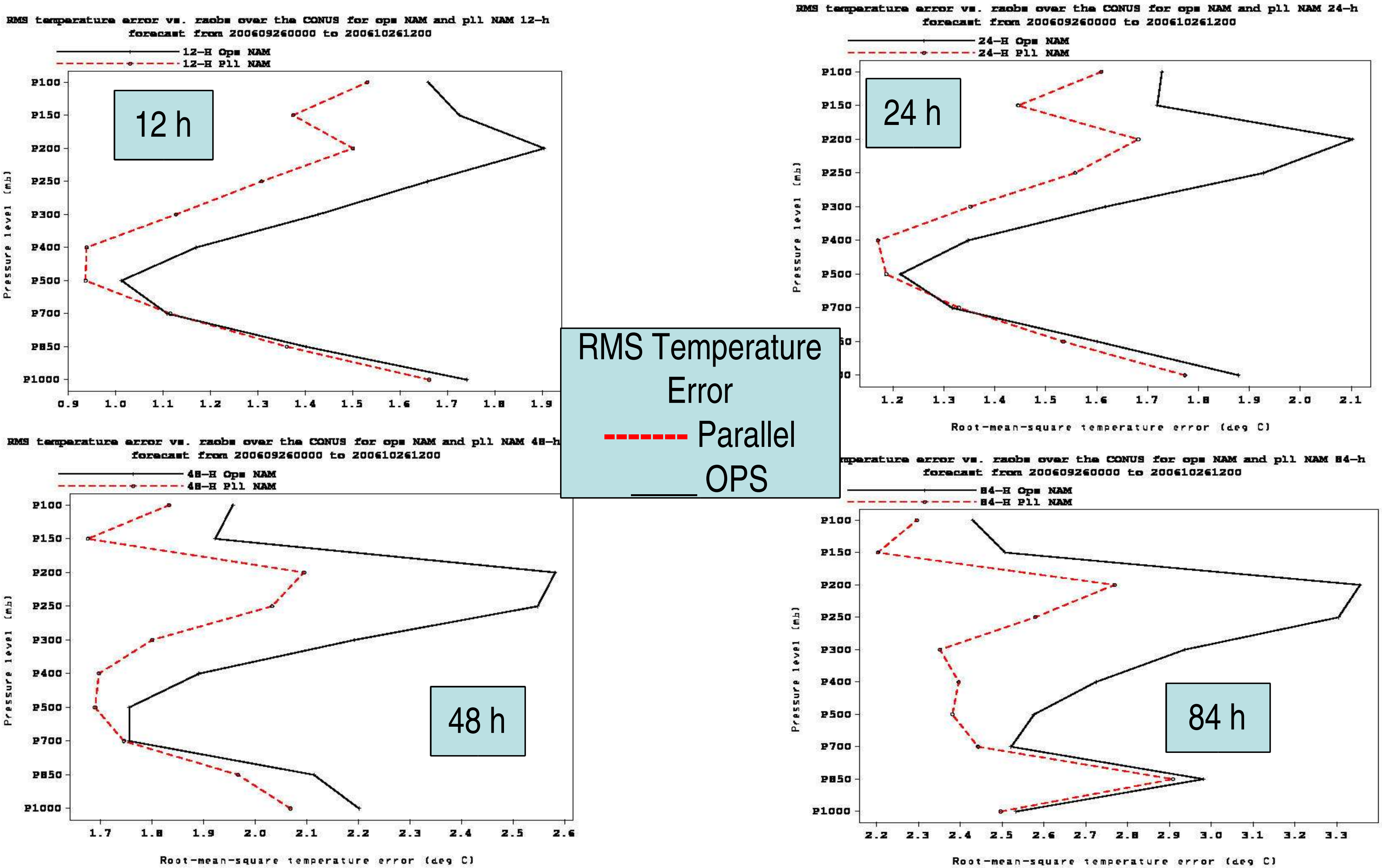


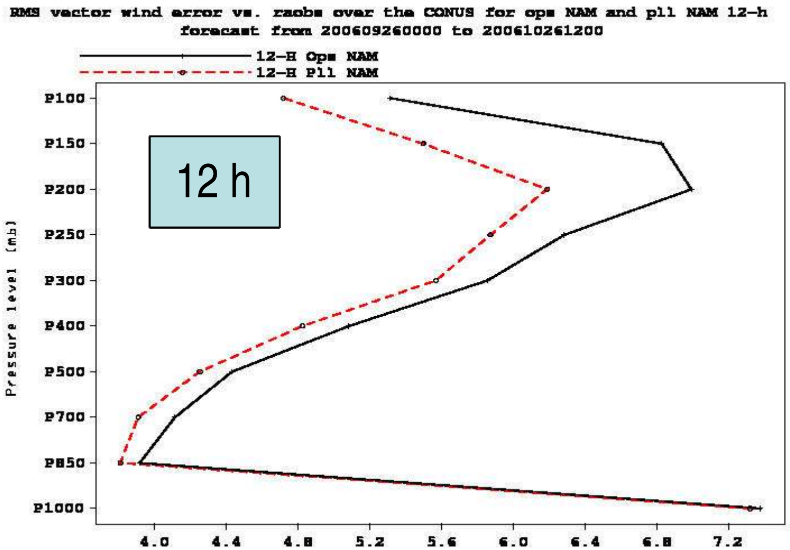


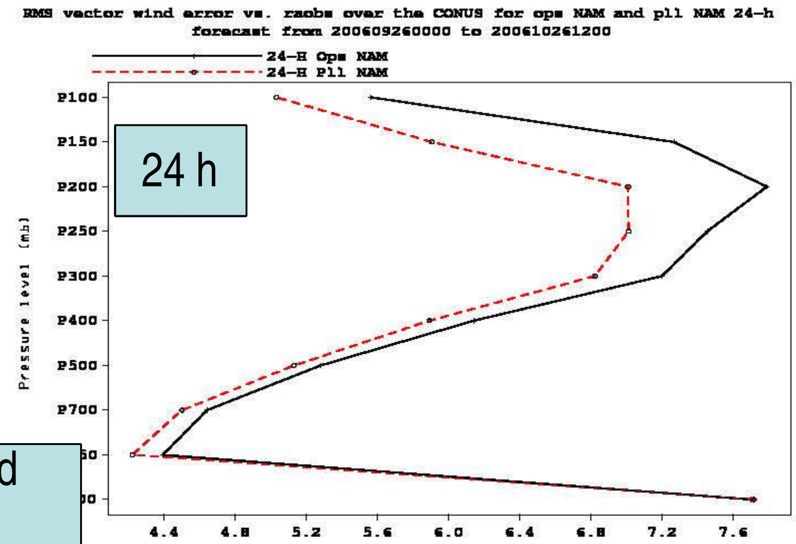
Temperature Forecast
Physics Changes 26 Sept – 26 Oct 06



Wind Forecast

Physics Changes : 26 Sept – 26 Oct 06





RMS Wind Error

------- Parallel

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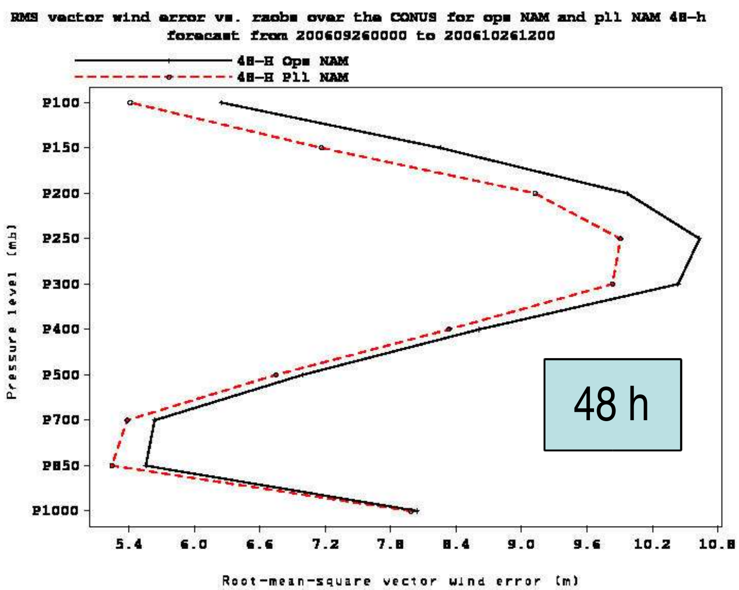
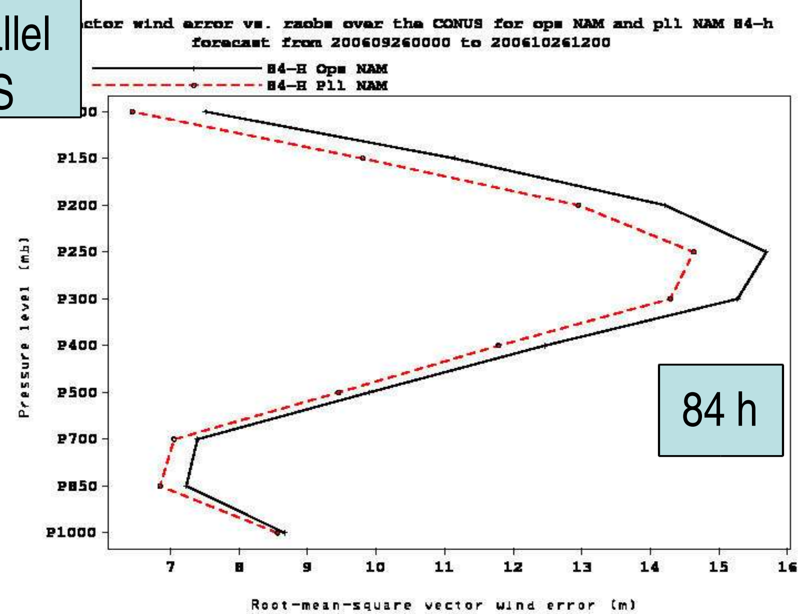
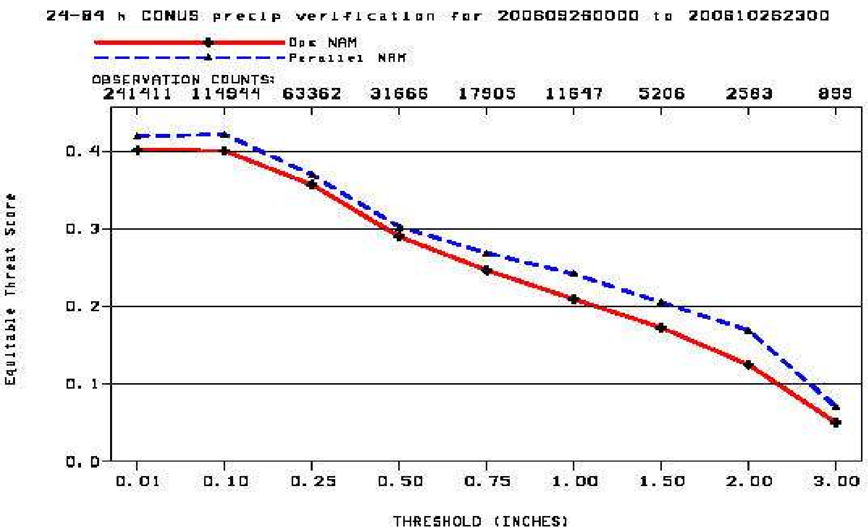
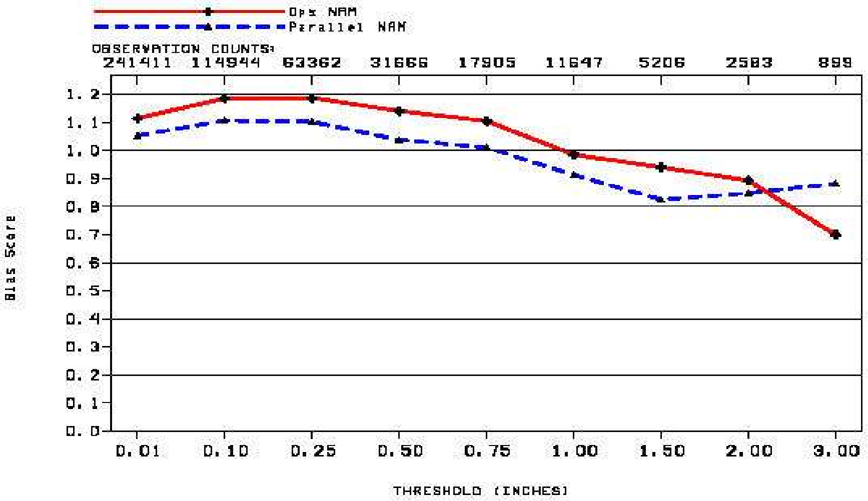




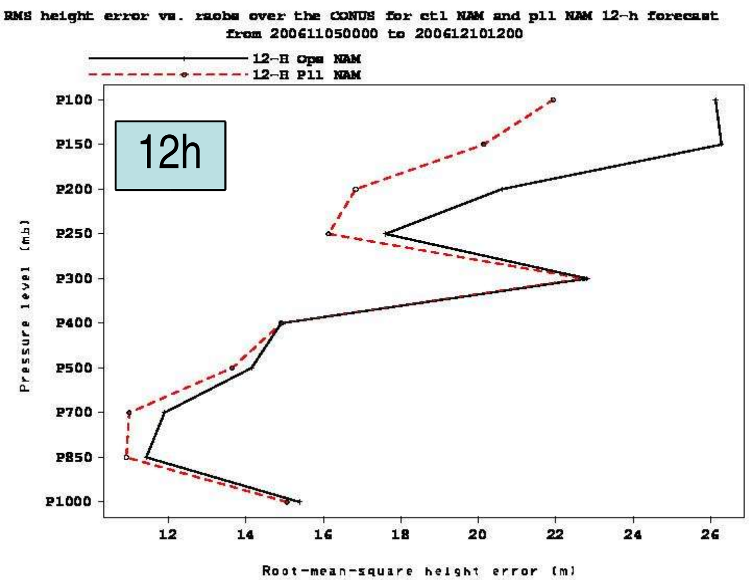
24-h Precipitation Forecast
Physics Changes : 26 Sept – 26 Oct 06

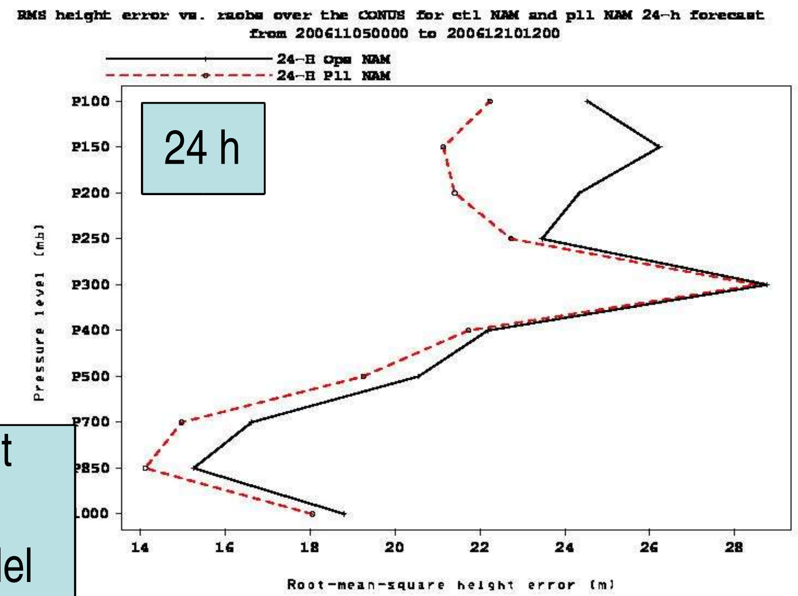


Precipitation
Threat & Bias
Parallel
OPS



Height Forecast – All Changes 5 Nov – 10 Dec 2006





RMS Height Error

------- Parallel

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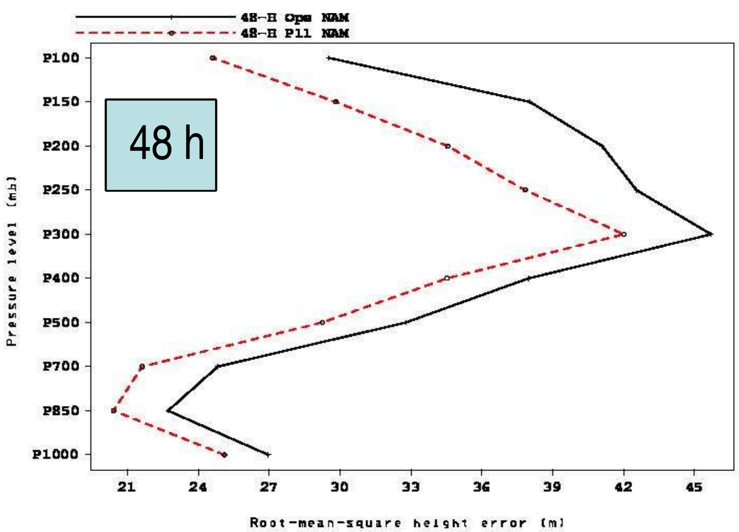
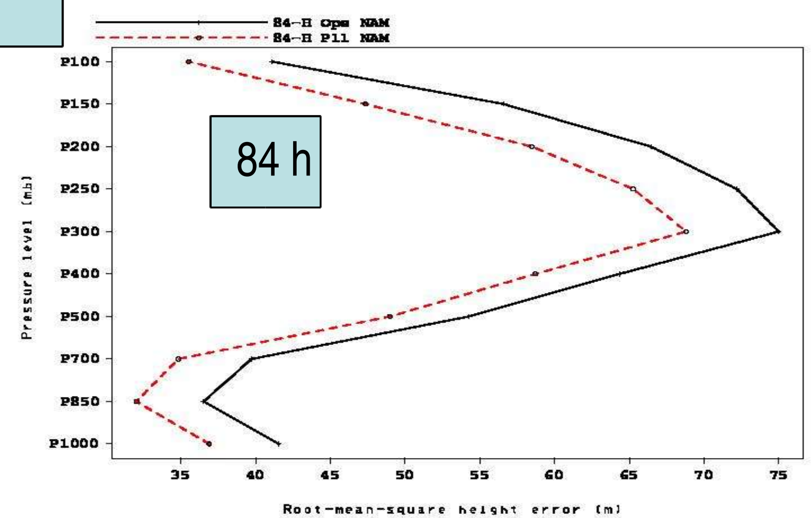
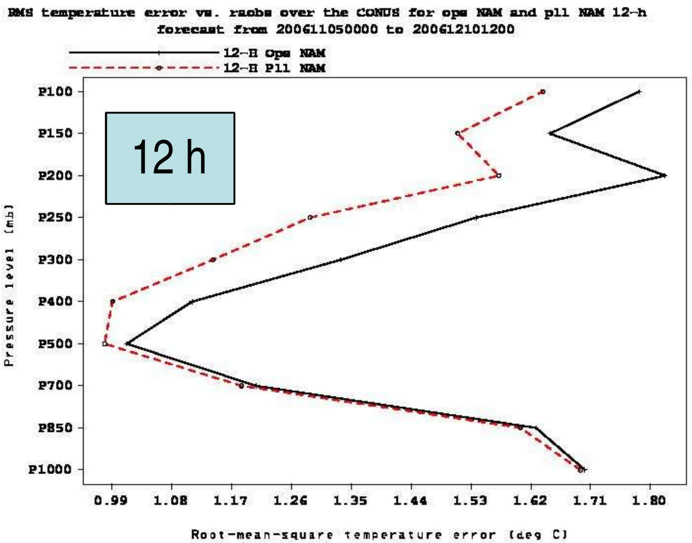
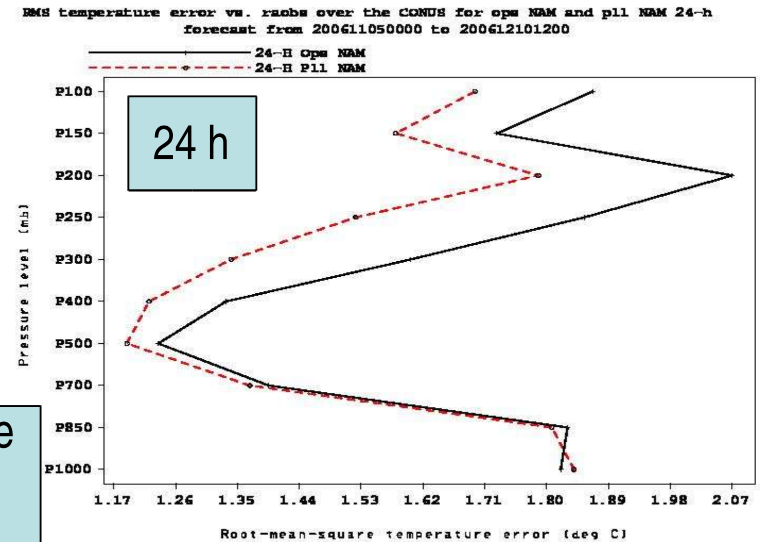




Temperature Forecast – All Changes 5 Nov – 10 Dec 2006





RMS Temperature Error

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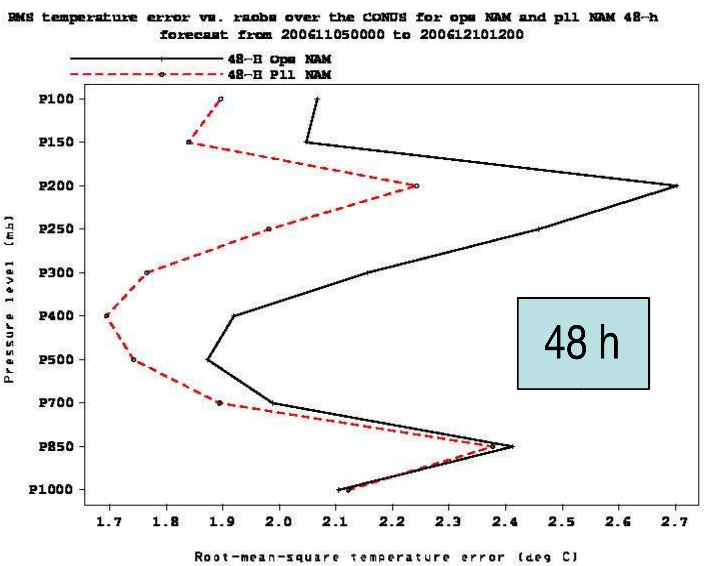
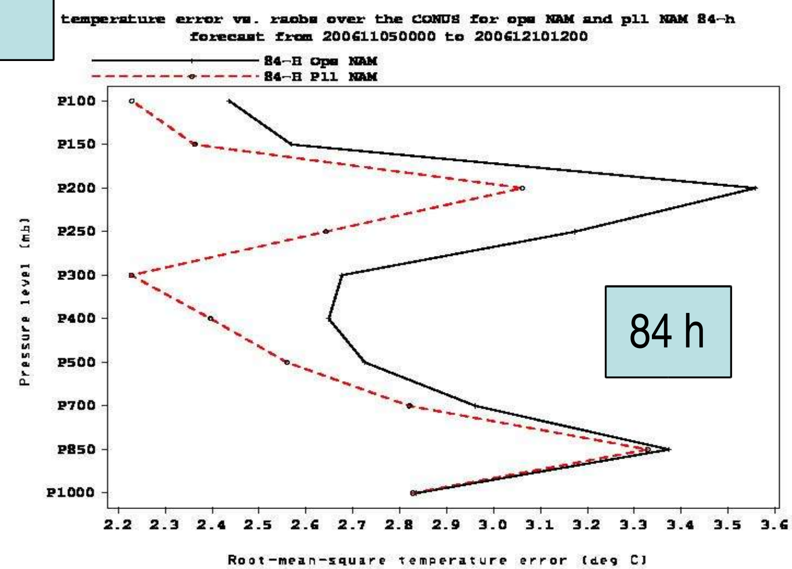
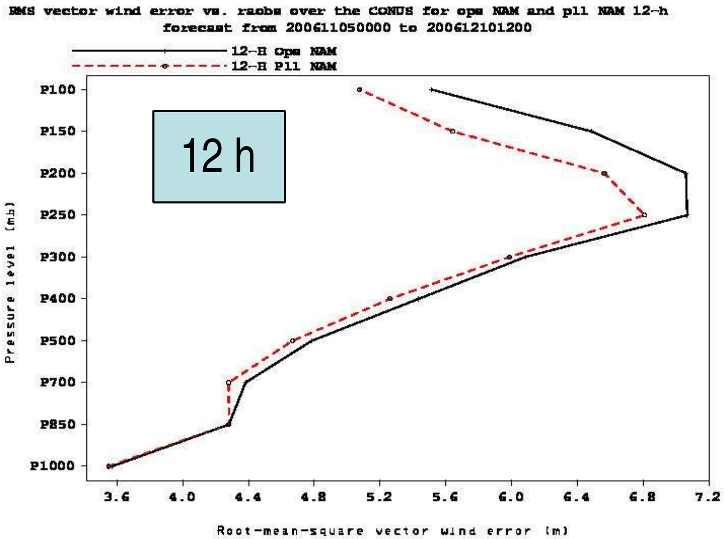
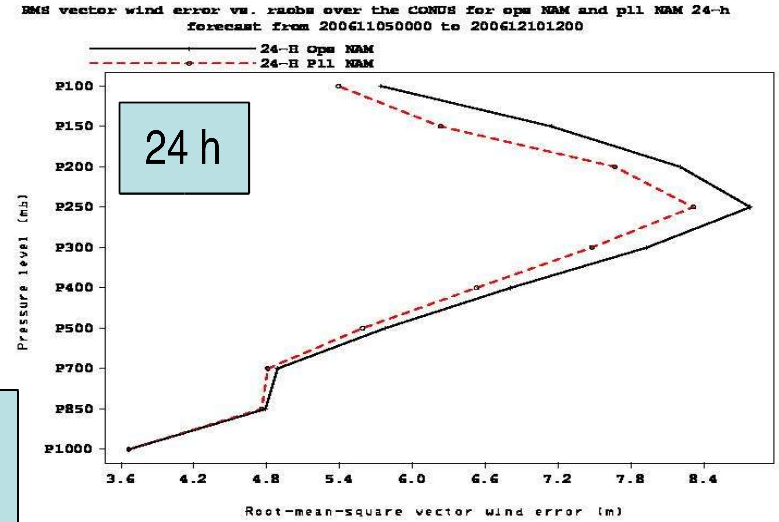




Wind Forecast – All Changes
5 Nov – 10 Dec 2006





RMS Wind Error
------- Parallel
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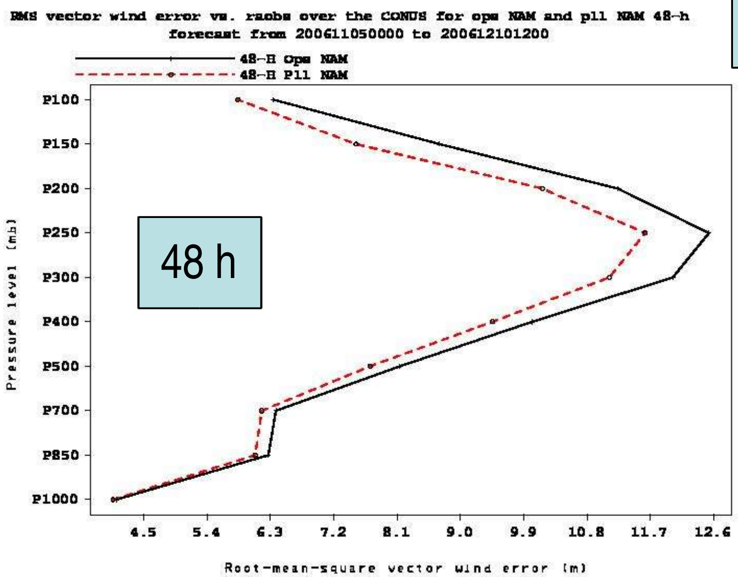
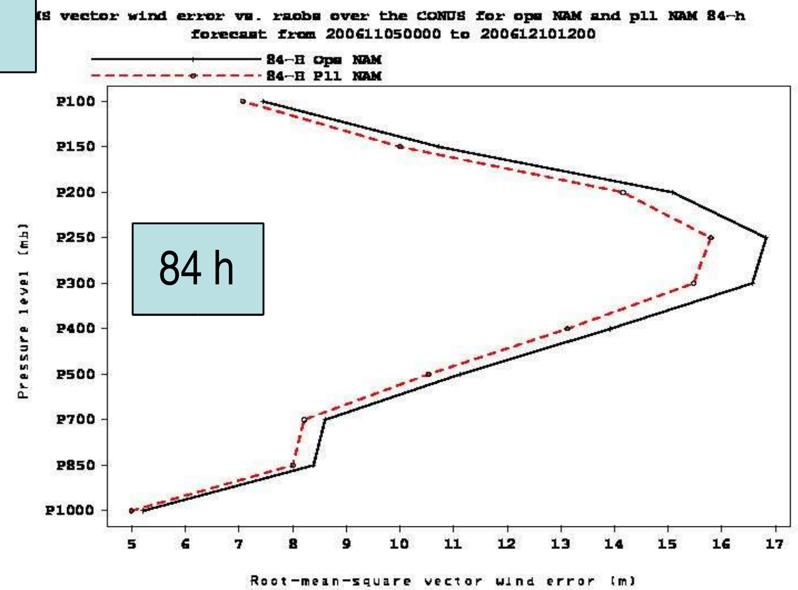
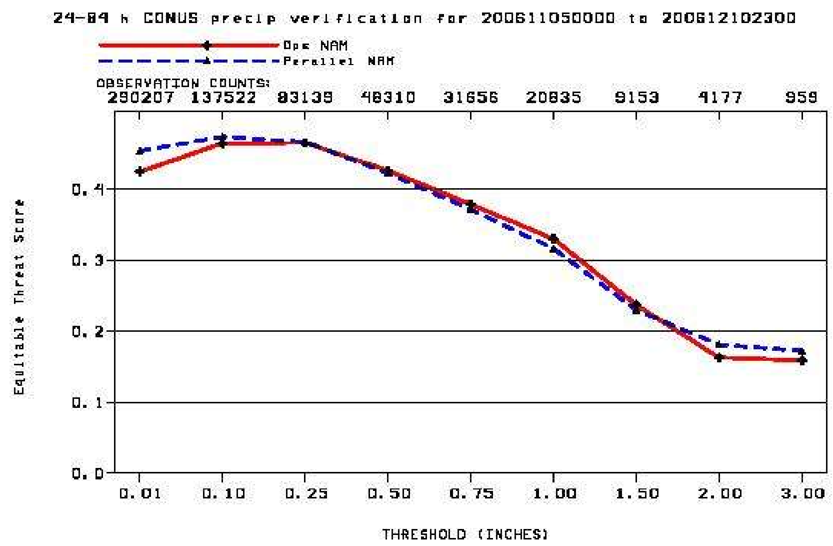
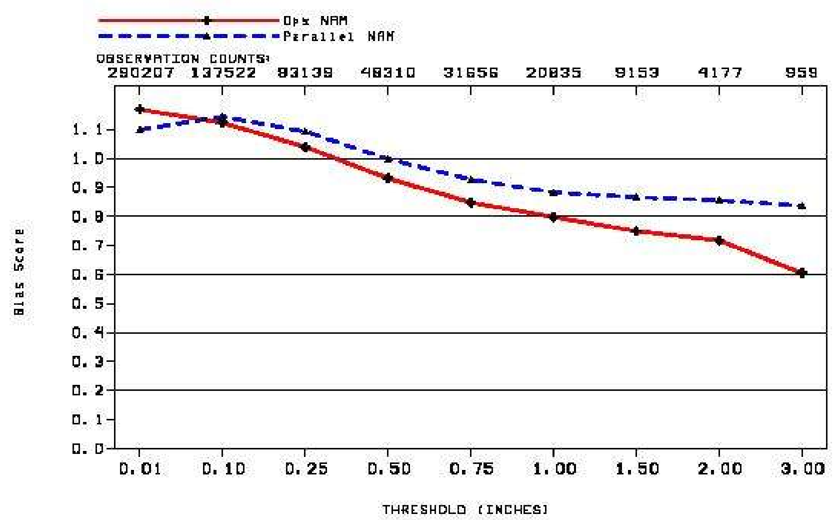




24-h Precipitation Forecast – All Changes
5 Nov – 10 Dec 2006





Precipitation Threat & Bias

------- Parallel

OPS

Divergence Damping Change Motivation

- Noisy analysis increments in NDAS
- Relatively frequent update every 3 hours
  - We want even more frequent not less
- Insufficient time for model to adjust
- Lack of Digital Filter Initialization in NDAS
  - DFI not easy to include quickly in WRF
- External mode gravity waves most likely ramification of the imbalance
  - Therefore, increase their damping during assimilation

Divergence Damping

- Dispersion of gravity-inertia waves alone can explain linear geostrophic adjustment on an infinite plane

- “In a finite domain, unless viscosity is introduced, gravity waves will forever ‘slosh’ without dissipating.” (e.g., Vallis, 1992, JAS)

- Numerical experiments by Farge and Sadourny (1989, J.Fluid.Mech) strongly support the idea of dissipative geostrophic adjustment

Divergence Damping

Finite volume mass divergence in the NMM

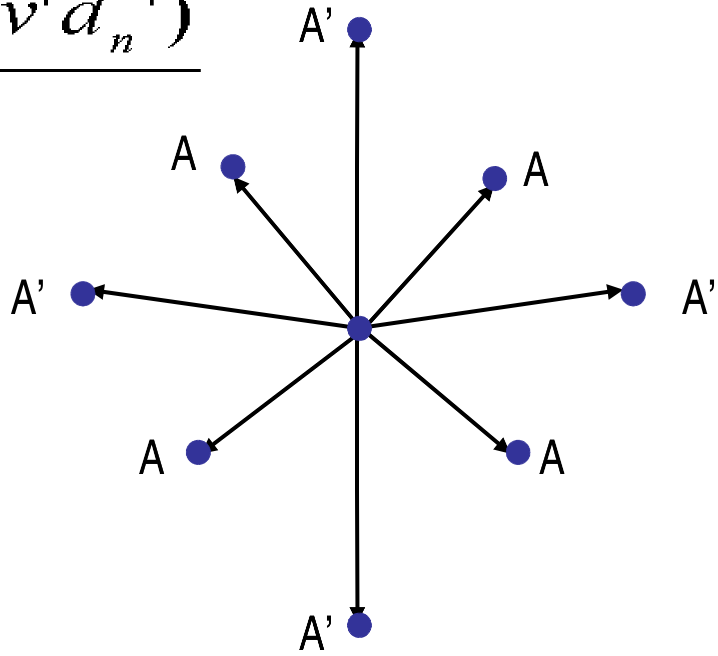
$$D_l = \frac{1}{3}\frac{\delta_x(\Delta\pi\, u\, \Delta y) + \delta_y(\Delta\pi\, v\, \Delta x)}{\Delta A} + \frac{2}{3}\frac{\delta_{x'}(\Delta\pi\, u' d_n') + \delta_{y'}(\Delta\pi\, v' d_n')}{\Delta A'}$$

$$u' d_n' = u\,\Delta y + v\,\Delta x$$

$$v' d_n' = -u\,\Delta y + v\,\Delta x$$

$$\pi - hydrostatic\ pressure$$

$$A, A' - grid\ box\ areas$$



Divergence Damping

- Divergence damping

$$\Delta\pi \frac{\partial u}{\partial t} = K_1 \, \delta_x D_l$$

$$\Delta\pi \frac{\partial v}{\partial t} = K_1 \, \delta_y D_l$$

- Damps both internal and the external gravity wave modes

- Enhanced divergence damping damps spurious fast modes; *important in data assimilation*

Divergence Damping

- External mode divergence

$$D_{ext} = \sum_{bottom}^{top} D_l$$

- External mode divergence damping

$$\Delta\pi \frac{\partial u}{\partial t} = K_2 \frac{\Delta\pi}{\mu} \delta_x D_{ext}$$

$$\Delta\pi \frac{\partial v}{\partial t} = K_2 \frac{\Delta\pi}{\mu} \delta_y D_{ext}$$

$$\mu = \pi_{bottom} - \pi_{top}$$

Divergence Damping

- Affects vertically integrated wind using vertically integrated divergence

$$\sum_{bottom}^{top} \Delta\pi \frac{\partial u}{\partial t} = K_2 (\delta_x D_{ext}) \frac{1}{\mu} \sum_{bottom}^{top} \Delta\pi$$

$$\sum_{bottom}^{top} \Delta\pi \frac{\partial v}{\partial t} = K_2 (\delta_y D_{ext}) \frac{1}{\mu} \sum_{bottom}^{top} \Delta\pi$$

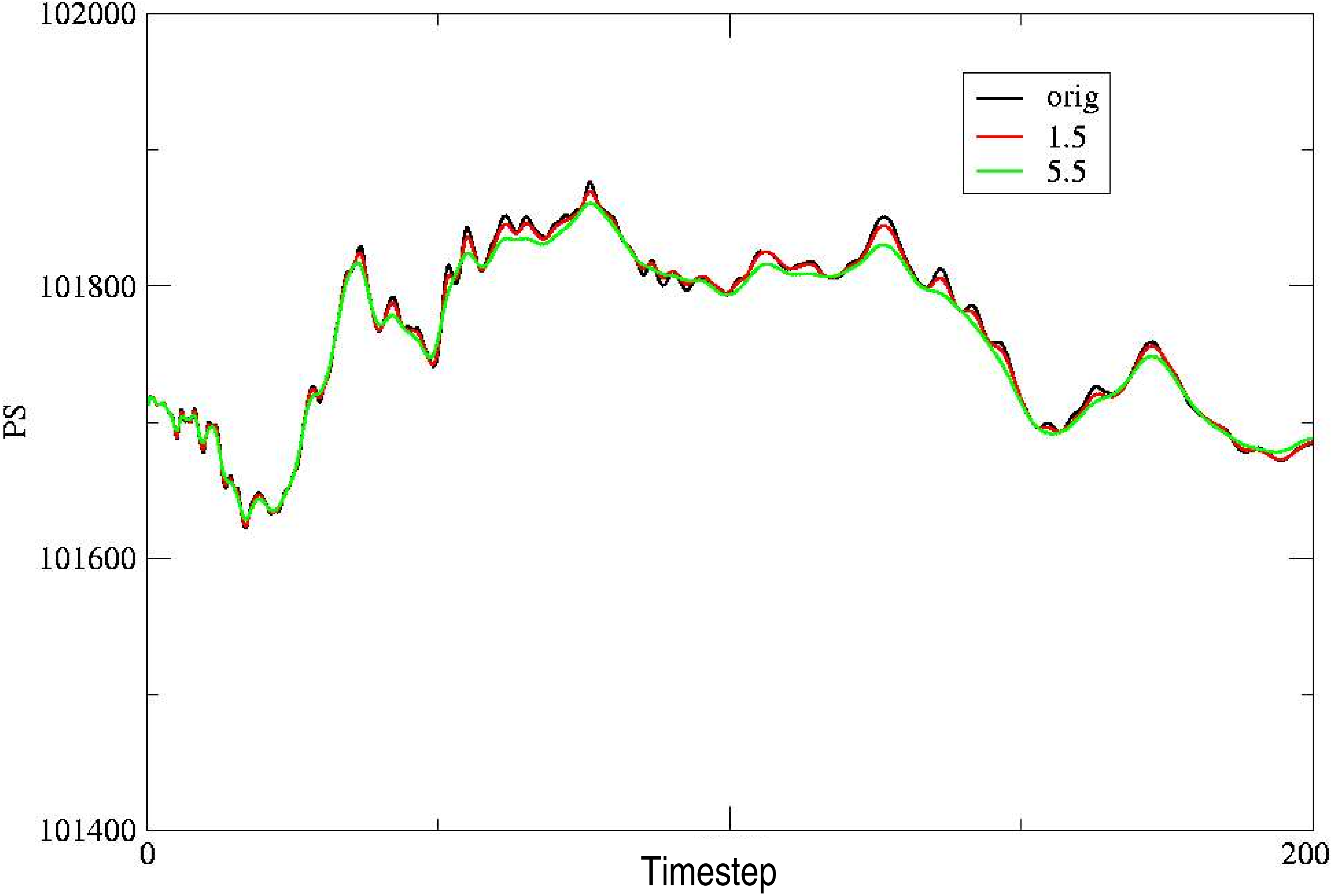
Divergence Damping

- External mode damping combined with divergence damping, enhanced damping of the external mode

$$\frac{\partial u}{\partial t} = \frac{K_1}{\Delta\pi}\delta_x D_l + \frac{K_2}{\mu}\delta_x D_{ext}$$

$$\frac{\partial v}{\partial t} = \frac{K_1}{\Delta\pi}\delta_y D_l + \frac{K_2}{\mu}\delta_y D_{ext}$$

Impact of change to divergence damping on surface pressure trace



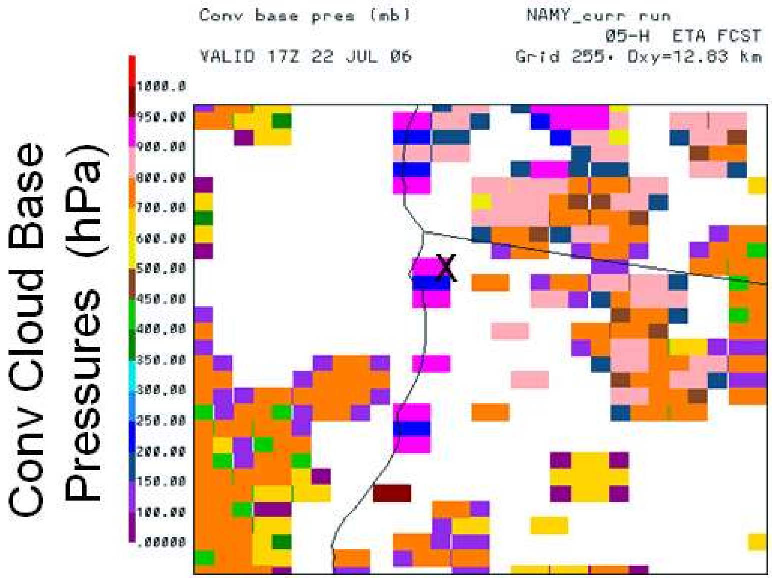
Physics Tuning - Original Motivation

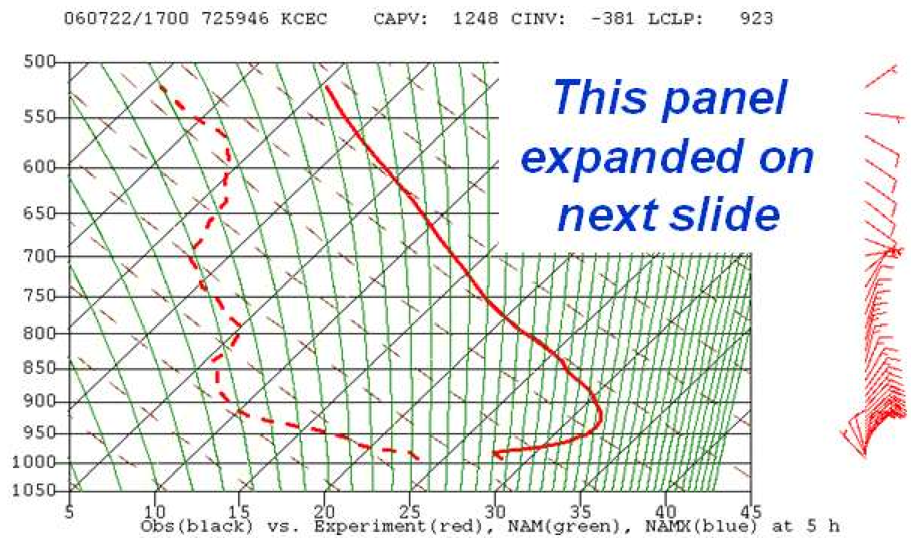
- Began as an investigation of NAM forecasts over NW California during the July 2006 heat wave of
  - Unusually high dewpoint temperatures;
  - Localized grid-point storms
- Found spurious triggering of shallow convection:
  - Crescent City, CA
  - 5h – 7h into forecast from 2006072212 cycle
  - 10 am to noon local time

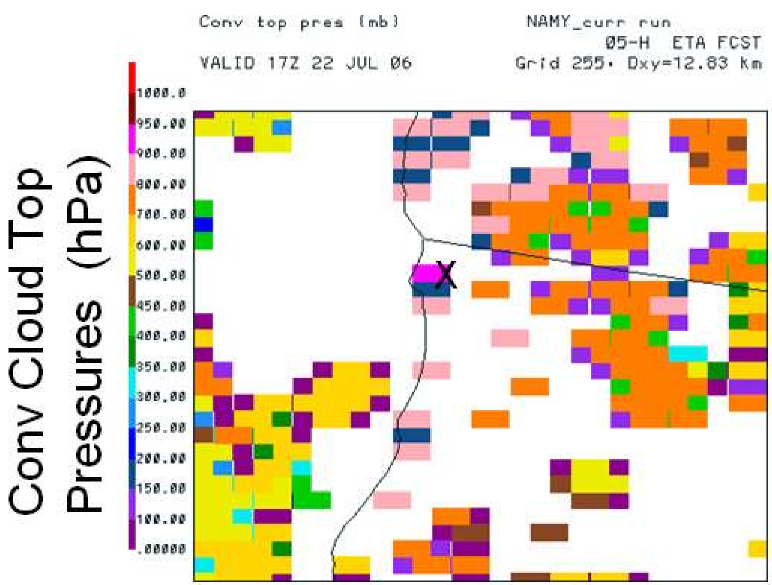
Physics Tuning - Original Motivation (continued)

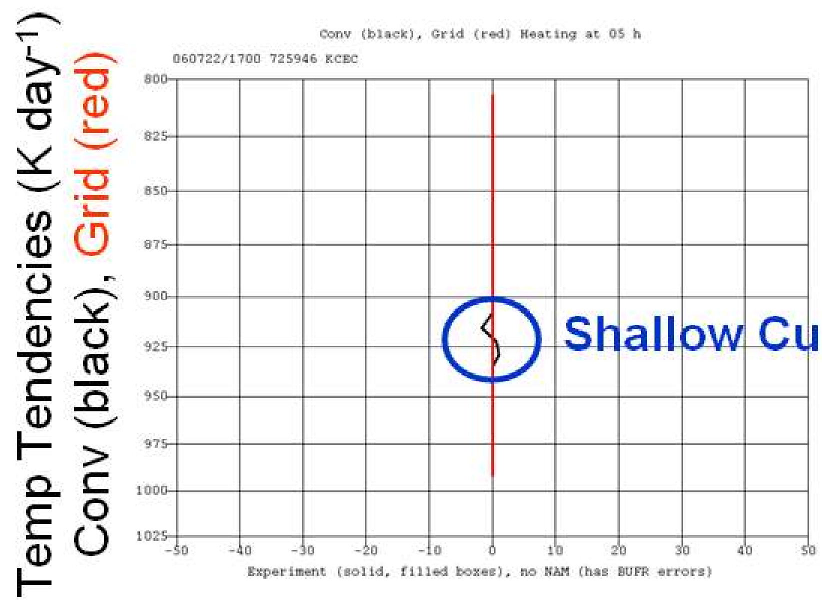
- Next slide shows the following fields at 5h into the forecast:
  - UL: Horizontal map of convective (CU) cloud-base pressures (hPa)
    - Crescent City is located at the X
    - CU base pressure is 950-900 hPa at Crescent City
  - LL: Map of CU cloud-top pressures (hPa)
    - CU top pressure also between 950-900 hPa
  - UR: NAM forecast sounding at Crescent City
  - LR: Temperature tendencies from convection (black), grid-scale (red) processes at C-City

5h valid 17Z (10 am) July 22 '06 (x - Crescent City)



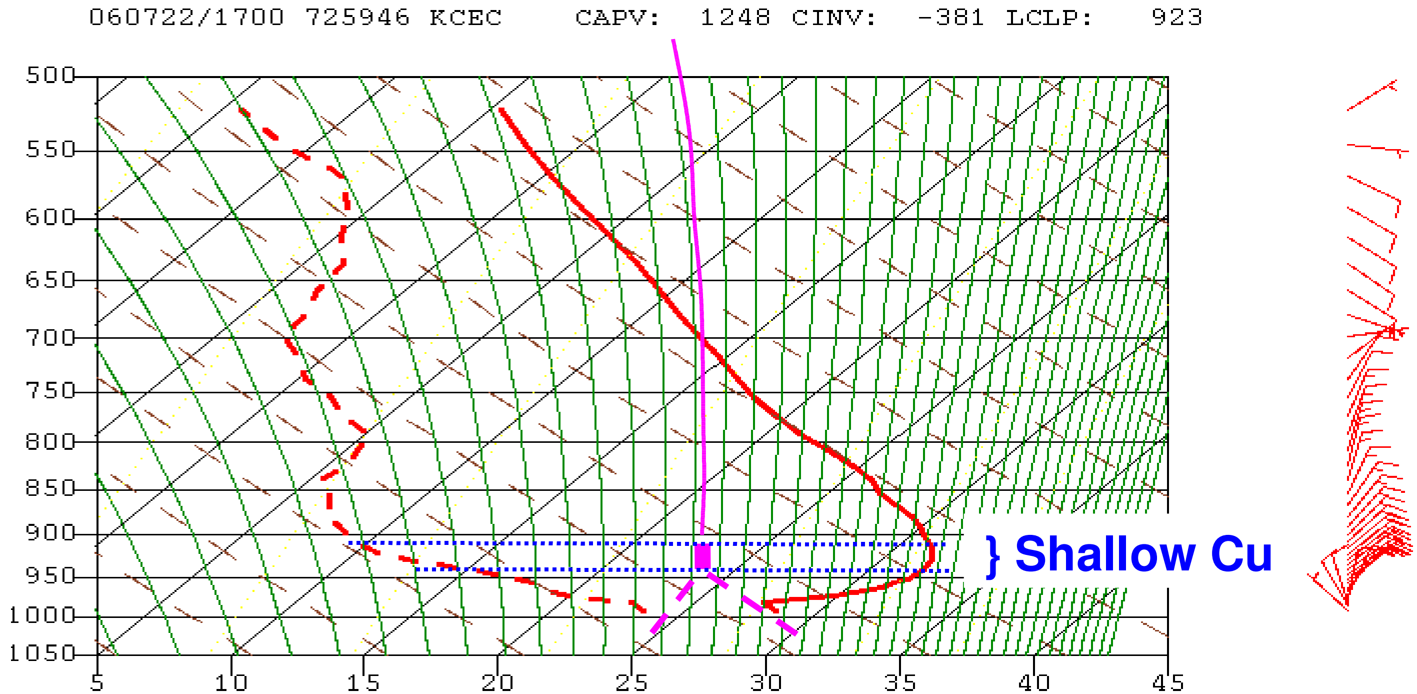






5h valid 17Z (10 am) July 22

Undiluted lift of *MAP* is much colder than the environment throughout the cloud layer



Moist adiabat extended above cloud base (*most unstable parcel; MAP*)

Moist adiabat of *MAP* within shallow convective cloud

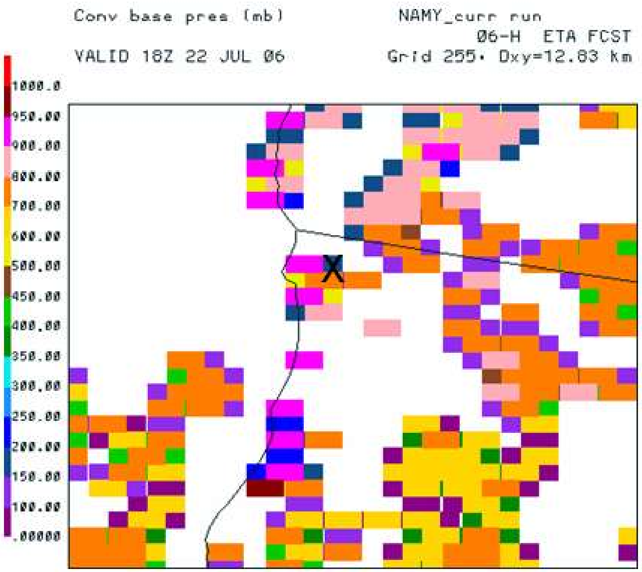
Dry adiabat & mixing ratio lines from *MAP* source (sfc) to cloud base

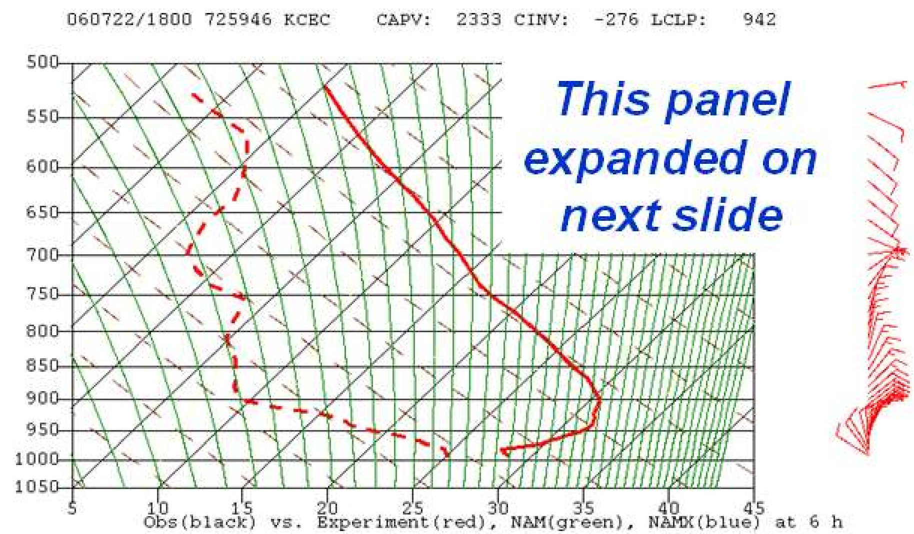
What did the previous slide show?

- Shallow convection (CU) was active in the model, despite:
  - Temperatures throughout parameterized cloud almost 10°C colder than environment
  - Unrealistic triggering of convection, even when considering virtual temperature effects (i.e., parcel much moister than environment)
- Next 4 slides show spurious convective triggering over the next two hours of the forecast

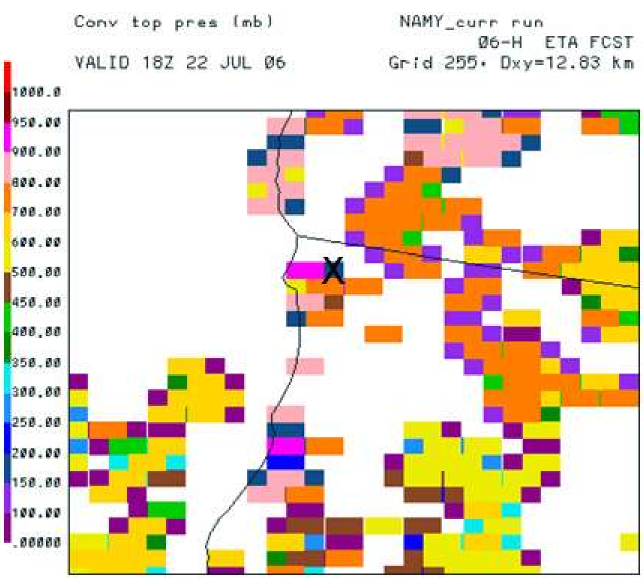
6h val 18Z (11 am) July 22 (x - Crescent City)

Conv Cloud Base (hPa)





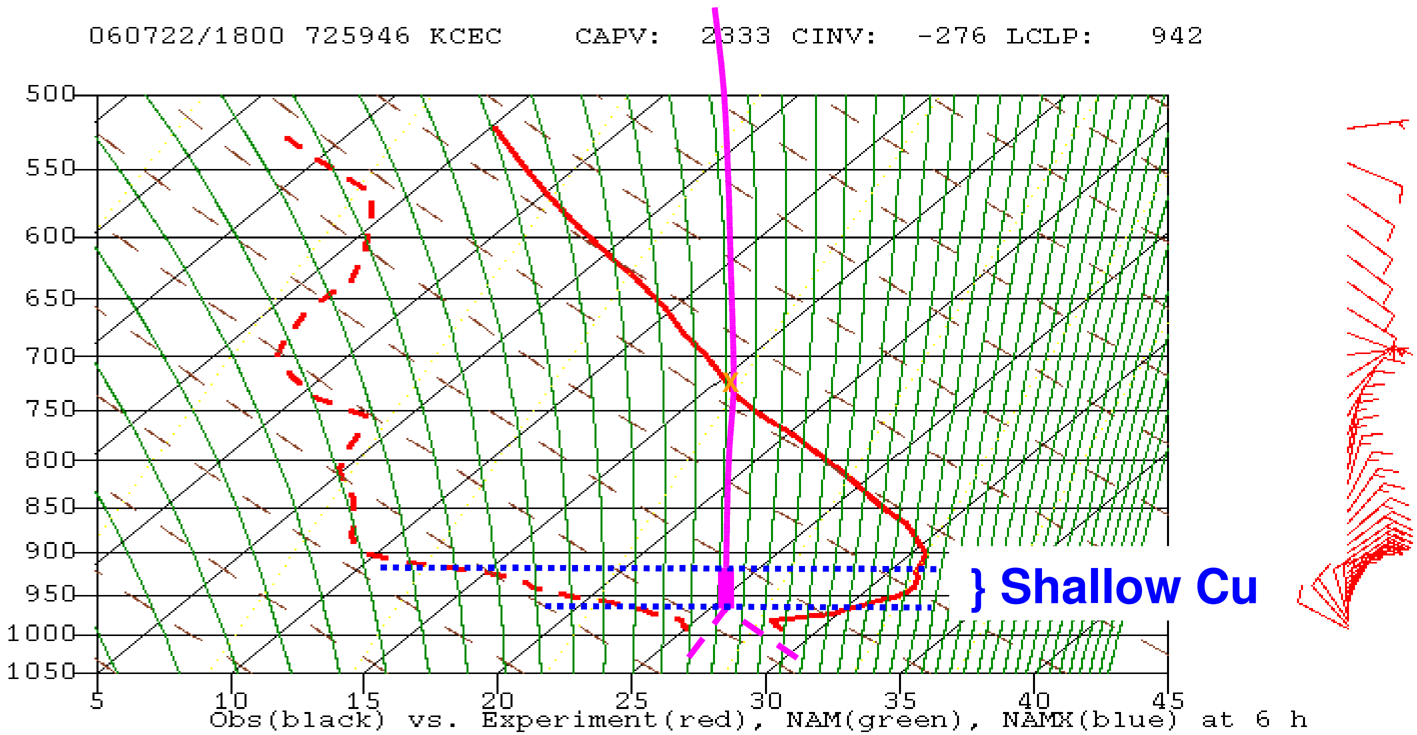
Conv Cloud Top (hPa)



Temp Tendencies (K day^{-1})
Conv (black), Grid (red)

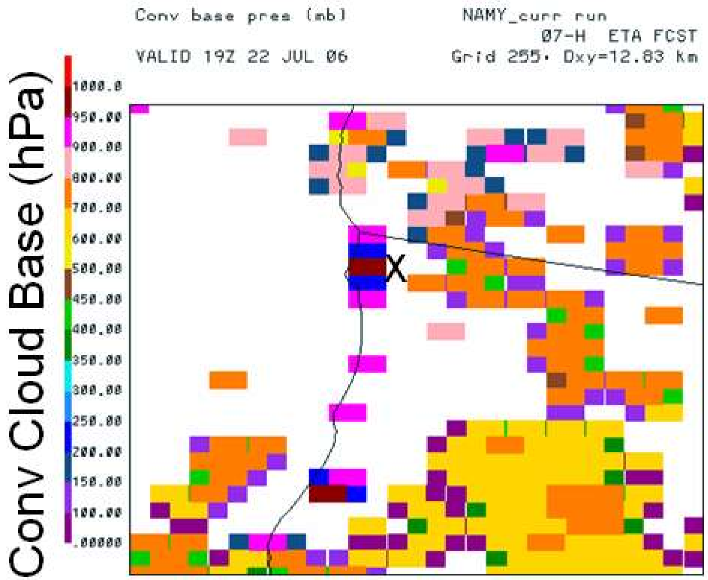
6h valid 18Z (11 am) July 22

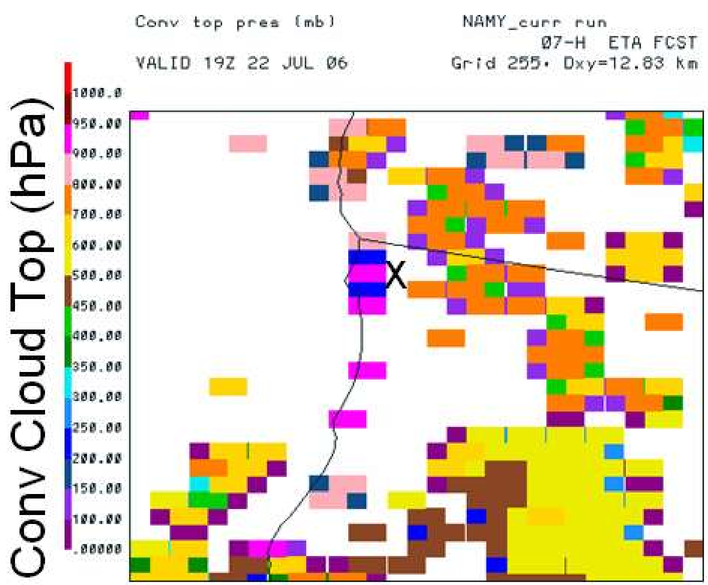
(expanded from upper right of previous slide)

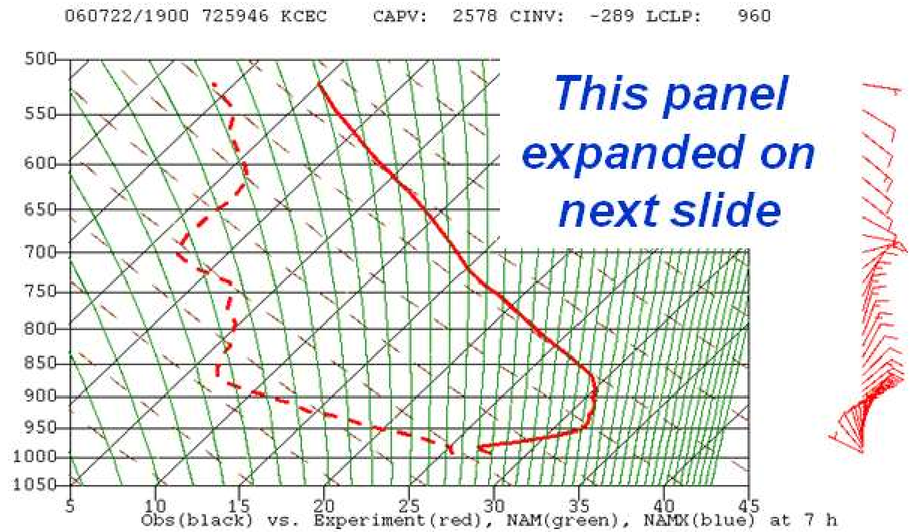


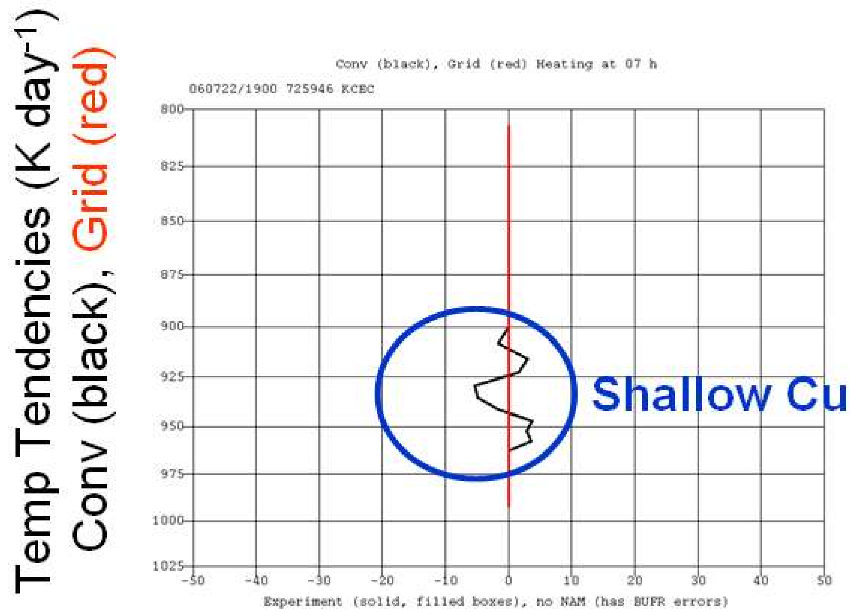
- Moist adiabat extended above cloud base (most unstable parcel)
- Moist adiabat within shallow convective cloud (most unstable parcel)
- Dry adiabat & mixing ratio lines from most unstable parcel to cloud base

7h val 19Z (12 pm) July 22 (x - Crescent City)



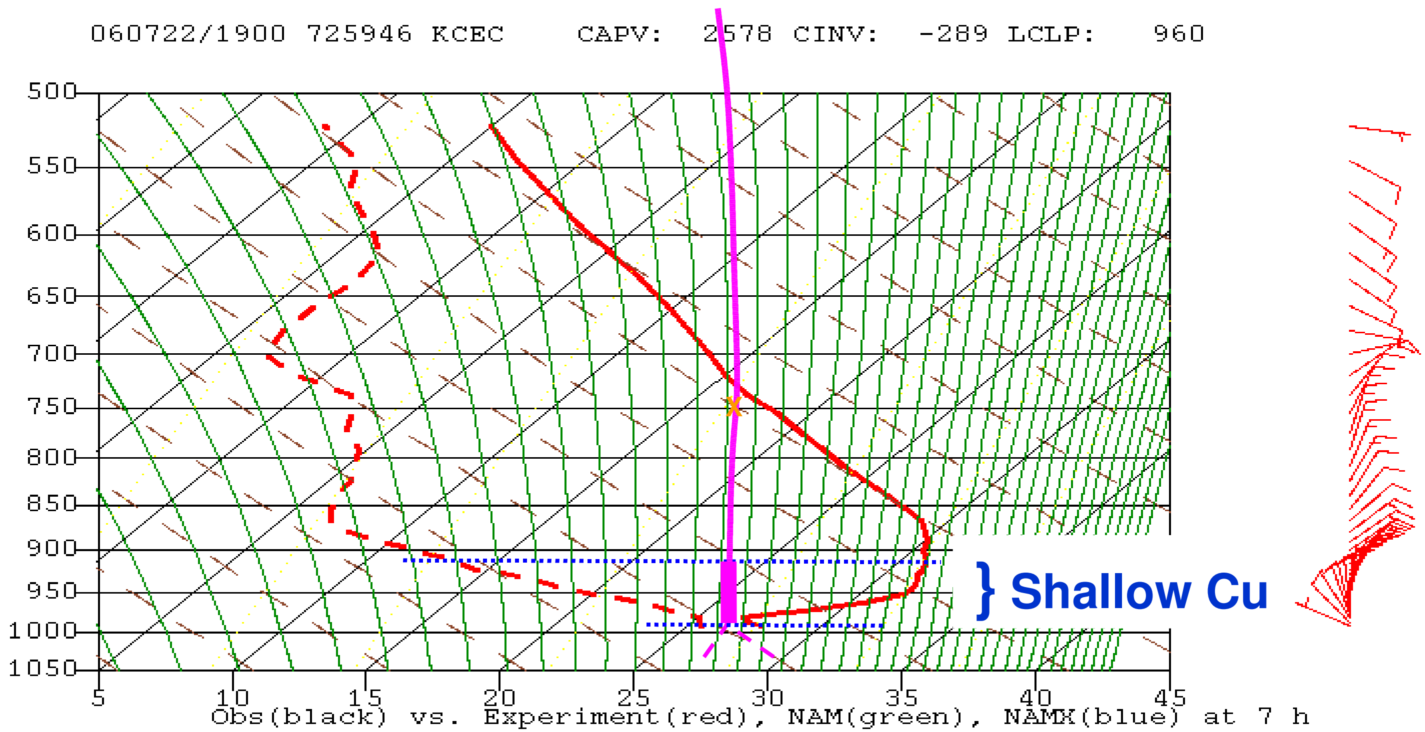






7h valid 19Z (12 pm) July 22

(expanded from upper right of previous slide)



Moist adiabat extended above cloud base (most unstable parcel)

Moist adiabat within shallow convective cloud (most unstable parcel)

Dry adiabat & mixing ratio lines from most unstable parcel to cloud base

Conclusions from initial study

- For this case ΔT & ΔQ due to convection are small, but …
  - presence of shallow Cu is unrealistic, as the undilute lifting of the *MAP* is colder than the environment (negatively buoyant) over the full depth of the cloud;
  - larger impacts documented by SPC forecasters, Baldwin *et al.* (2002, WAF), and in COMET training modules

FYI: Deep ⇔ precipitating convection (≥200-hPa thick);
Shallow ⇔ non-precipitating convection (<200-hPa thick)

Why was convection triggering?

- Conditions associated with "swap points"
  - Consider shallow Cu after failing deep Cu test (involves cloud-avg thermodynamics)
  - Deep Cu top at the highest level of positive parcel buoyancy (based only on temperature)
- Shallow convection
  - Limited checks on parcel instability within the cloud layer
  - Cloud top determined by vertical relative humidity (RH) gradients (more difficult when there are no well-defined dry, stable layers)

Why was convection triggering (cont)?

- Large CAPE values in soundings
- Instability could be released, but only after parcels are lifted more than 225 hPa above their LFC (near ~725 hPa)
- Operational BMJ scheme does not *explicitly* consider convective inhibition (CIN) in triggering convection

Why hasn't EMC done something about this?

THE CHALLENGE has been to change the convective scheme without degrading QPF

General changes to BMJ convection (1 of 2)

- Triggering of deep and shallow convection
  - Integrated buoyancy ("CAPE") >0 throughout parcel ascent, including below cloud base
    - "CAPE" $\equiv \int B\, dp$ (B = parcel buoyancy)
    - $B = (T+0.61q_v-q_t)_{parcel}/(T+0.61q_v)_{env} - 1$

      (T = temperature, q_v = vapor, q_t = condensate)
  - Above criterion applied to all levels in the lowest 40% (was 20%) of atmosphere ($p \geq 0.6p_{sfc}$; was $\geq 0.8p_{sfc}$)
  - Most unstable parcel (*MAP*) => largest CAPE;
    MAP was the $(\theta_e)_{max}$, but intervening dry, stable layers could shift greatest parcel instability to higher levels (e.g., elevated CU decoupled from PBL)

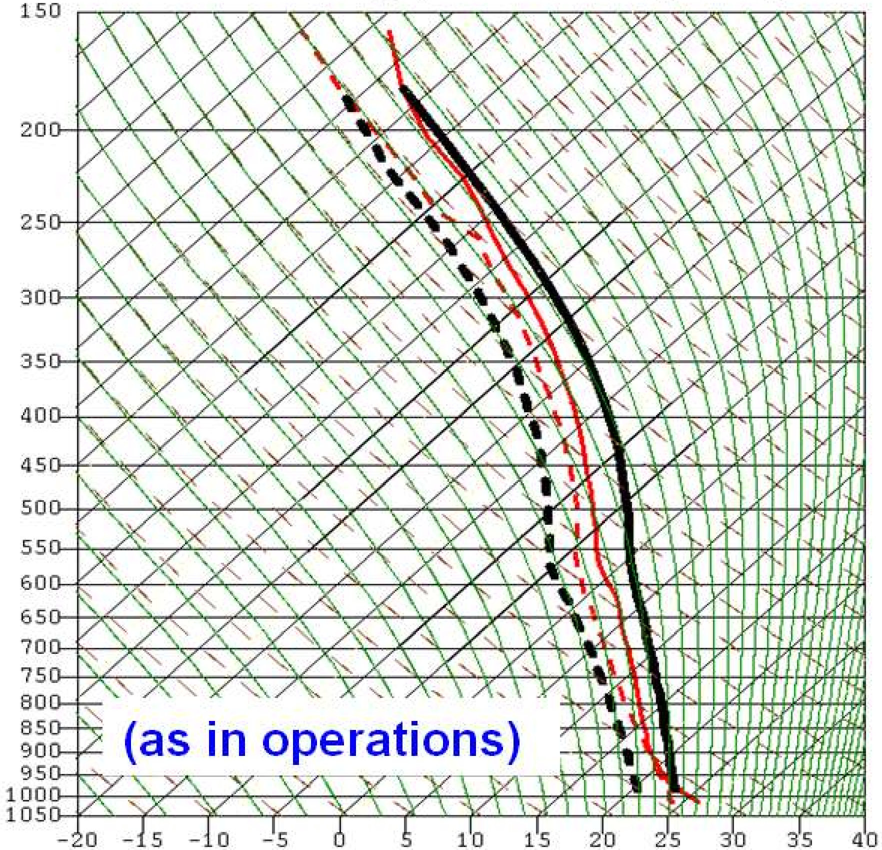
General changes to BMJ convection (1 of 2)

- Same value for L_v (latent heat of vaporizaton, in exponent) used to calculate equivalent potential temperature (θ_e) throughout BMJ convection code
  - Generating θ_e vs. T lookup tables at start of forecast
  - θ_e calculated during forecast

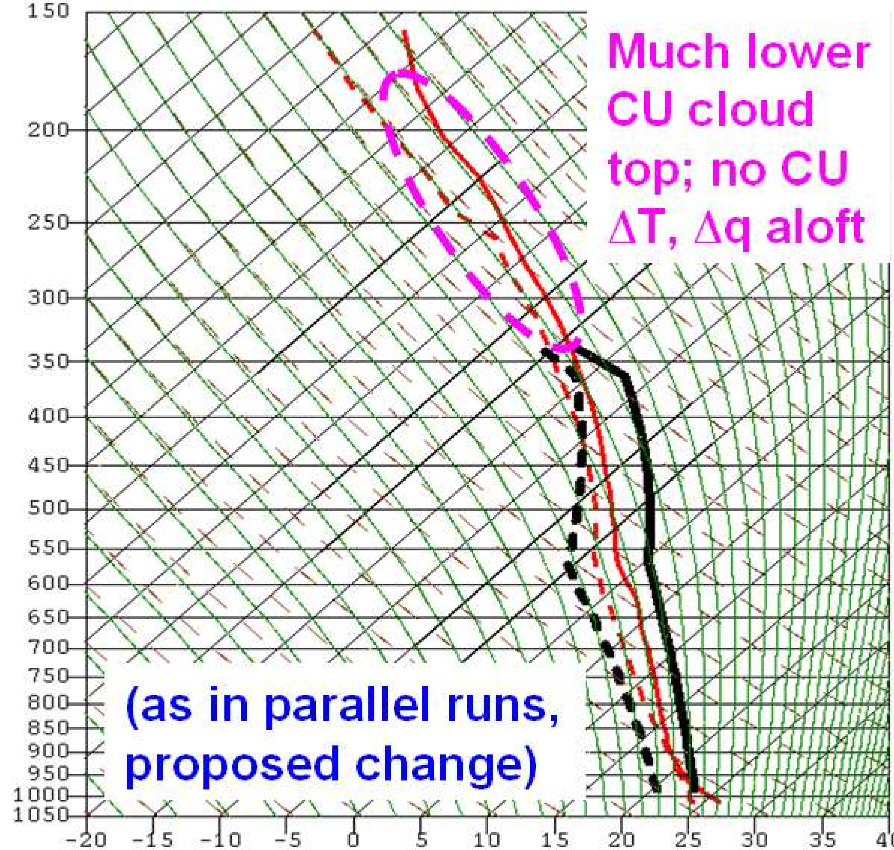
► Next 3 slides elaborate on water loading effects (q_t)

Impact of water loading in parcel (1 of 3)

Excluding water loading when calculating parcel buoyancy



Including water loading when calculating parcel buoyancy



- Red lines: input sounding 48-h fcst off Hatteras[1]
- Black lines: convectively adjusted profiles

[1] Input sounding from a model run with suppressed CU triggering

Impact of water loading in parcel (2 of 3)

- No condensate is assumed to fall out of parcel, *so water loading is exaggerated*
- Assumes a reversible process; implies total condensate mixing ratios in parcel approach
  20 g kg^{-1}! (not realistic)
- Theories:
  1. Partly compensates for lack of entrainment?
  2. Reduces "double counting" of heating aloft by grid-scale heating from ice processes?
  3. Mean properties of convection where most stabilization occurs is not the most intense?

Impact of water loading in parcel (3 of 3)

- In almost all sensitivity experiments, reducing the vertical depth of convection resulted in improved upper-air forecasts of all fields (esp. winds, heights, temps)
- Crudely mimics effects of randomized cloud top (depth) in GFS' SAS scheme
- *Including full water loading effects in triggering led to improved performance*

> *THIS DEVELOPMENT IS STILL A WORK IN PROGRESS !!!*

Changes to BMJ shallow convection (1 of 4)

- Cloud top at swap points (failed deep CU)
  - Current NAM.
    - Top is located at $(\partial RH / \partial p)_{max}$ if >0 (where RH decreases most rapidly with height)
    - Cloud thickness is limited to $0.2 * p_{sfc}$ (nominally 200-hPa for 1000 hPa sfc pressure) and cannot extend above 450-hPa level++
  - Changes.
    - Parcel is buoyant (B>0) at all levels, so cloud top is at the highest level where B>0 (more restrictive than CAPE = $\int B\, dp > 0$)
    - ++Same limits as in 2nd bullet above

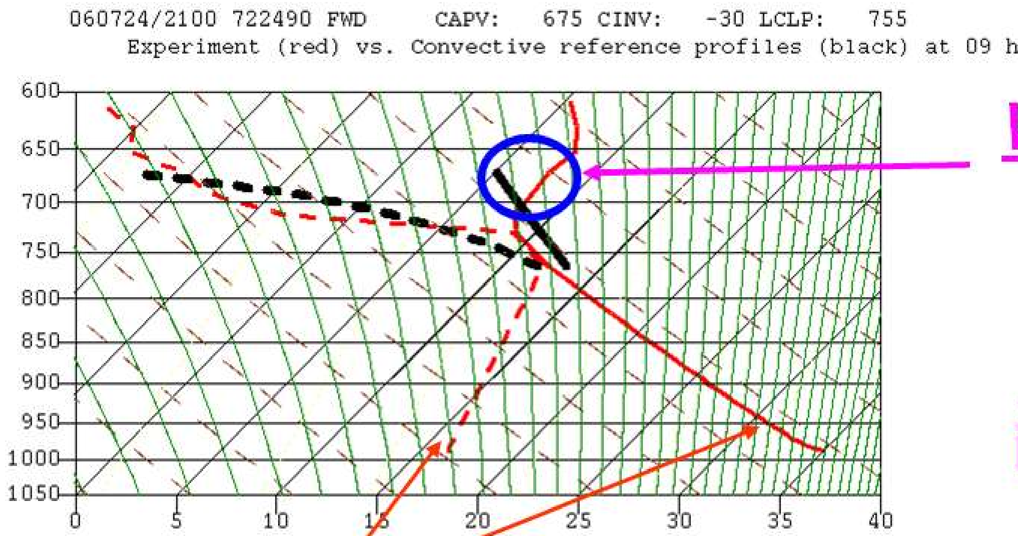
Changes to BMJ shallow convection (2 of 4)

- Raise shallow cloud top in moist conditions (all points) if:
  - Mean in-cloud relative humidity (RH) > RH_{crit}
    - RH_{crit} => lifting the ambient temperature and pressure at cloud base 25 mb to reach saturation
    - RH_{crit} ~ 90% in typical conditions (e.g., 88.8% @ 900 hPa, 20°C)
  - CAPE > 0 (relax more stringent criterion of positive buoyancy [B>0] at all levels)
  - As before, tops cannot extend above 450 hPa

Changes to BMJ shallow convection (3 of 4)

- Reference temperature profiles (next slide)
  - Limit cooling to ≤1°C colder than ambient environment in upper half of cloud
  - Why? To reduce temperature sensitivities in NDAS forecasts *over oceans*
    - Before change: >5°C variations at L27 (~ 750 hPa)
    - After change: <2.5°C but still present
    - 750 hPa ≈ 950 hPa (cloud base) – 200 hPa (max depth)
  - Shallow CU forms in response to analysis changes in low-level temperature and/or moisture from ship and/or buoy observations

Limit cooling in upper half of shallow CU (4 of 4)



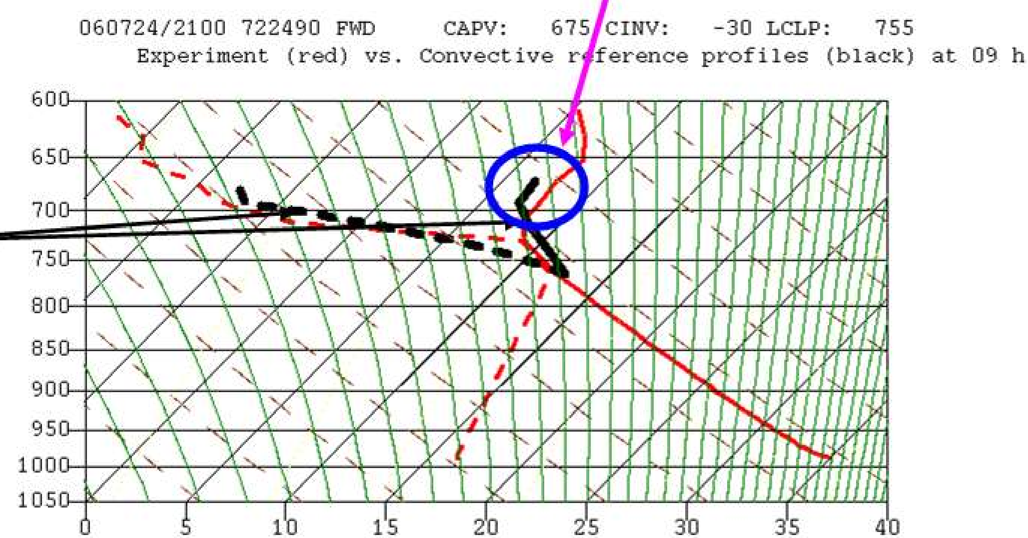
Without **limit to cooling in upper half of cloud**

With **limit to cooling in upper half of cloud**

Red lines: forecast sounding input to single column model

Black lines: final convective reference profiles

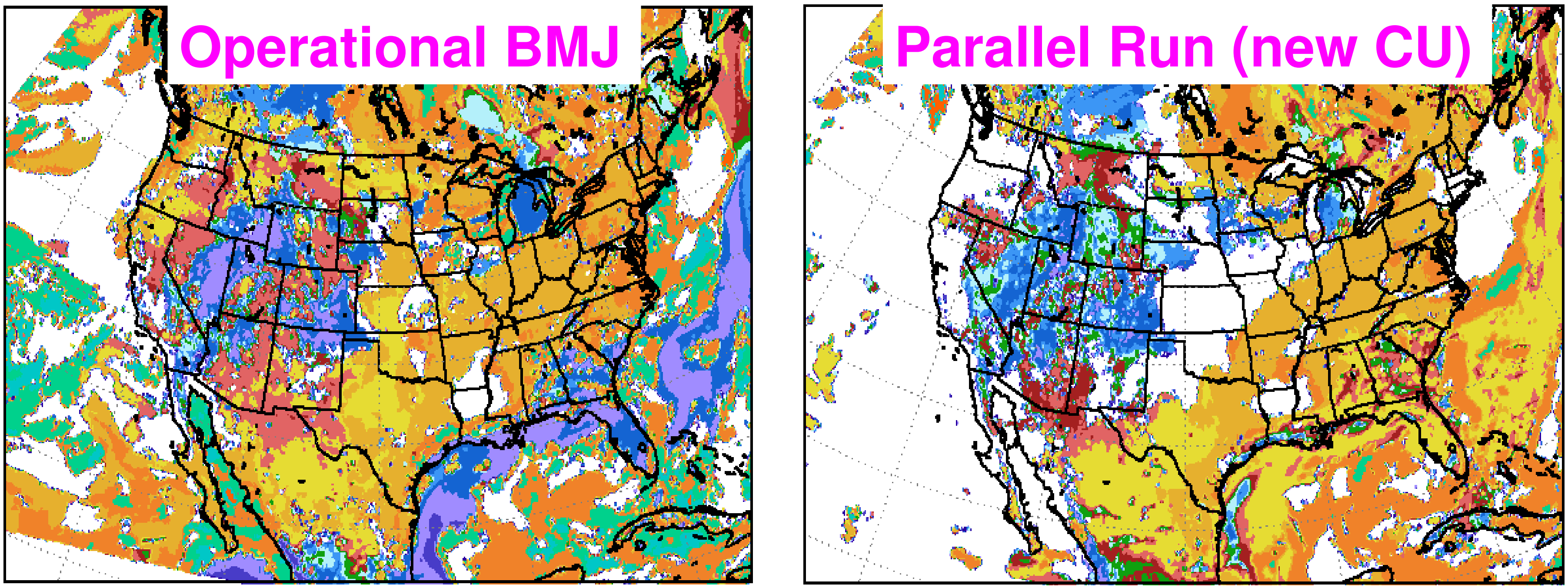
(Convective adjustments applied over 40-min period; rates updated every 160s)



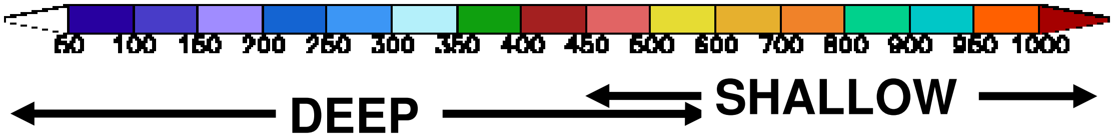
Examples showing direct impact of changes in convective triggering (1 of 7)

9-h FCST valid 21Z 24 July 2006

(near mid-afternoon maximum temperatures – day 1)



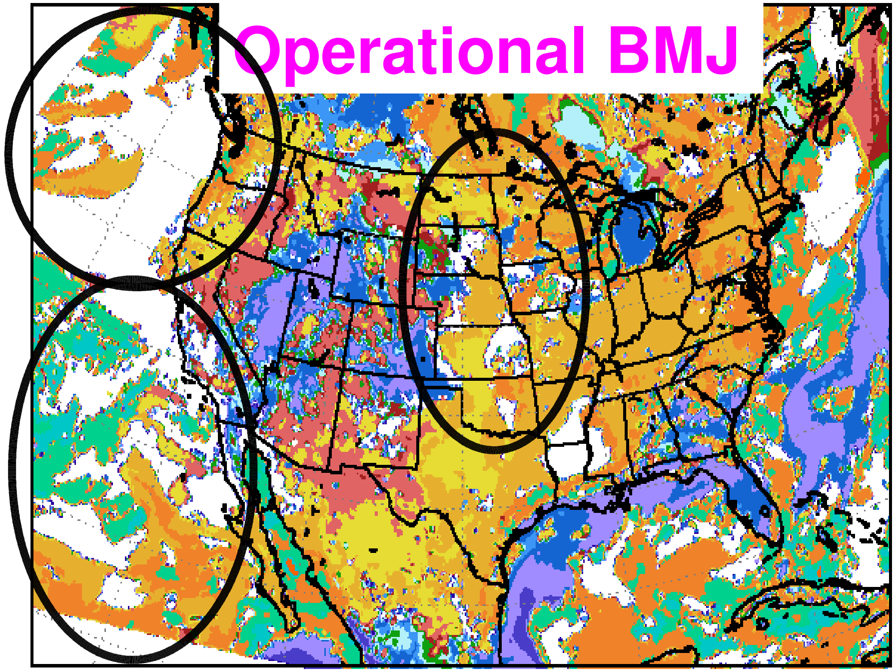
Total (shallow + deep) convective cloud-top pressures (hPa)

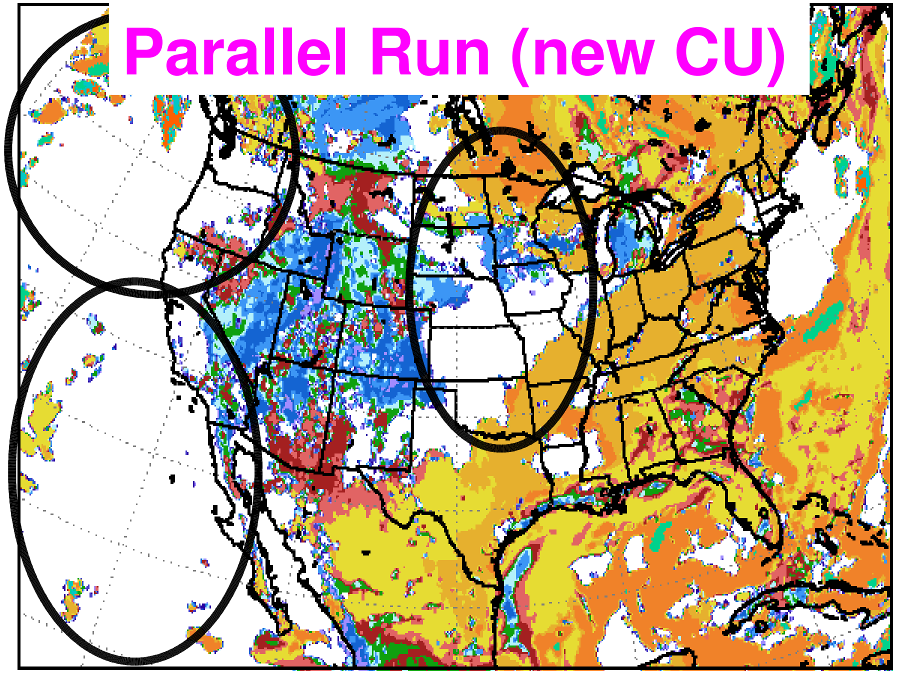


Examples showing direct impact of changes in convective triggering (2 of 7)

9-h FCST valid 21Z 24 July 2006

(near mid-afternoon maximum temperatures – day 1)





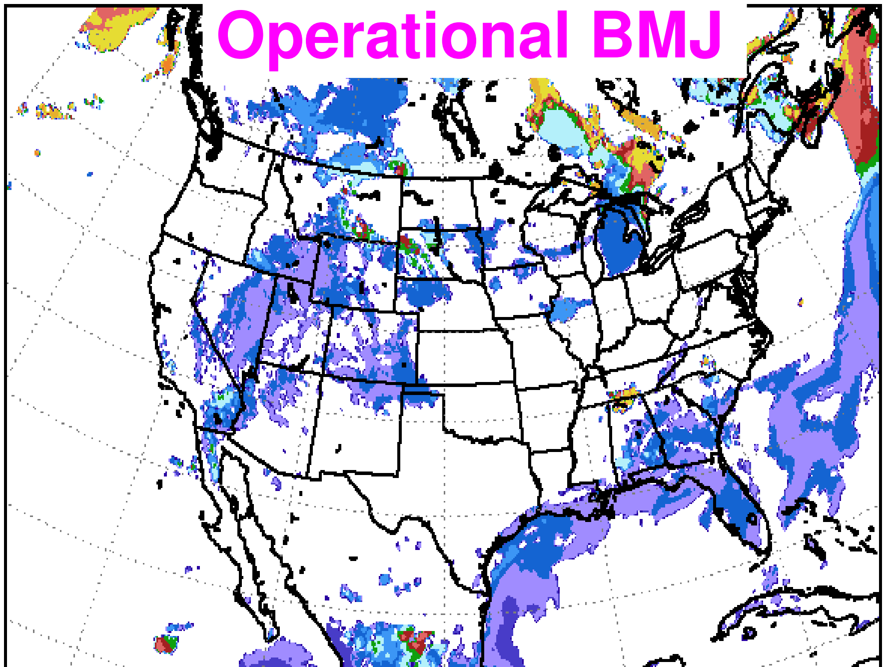
Total (shallow + deep) convective cloud-top pressures (hPa)

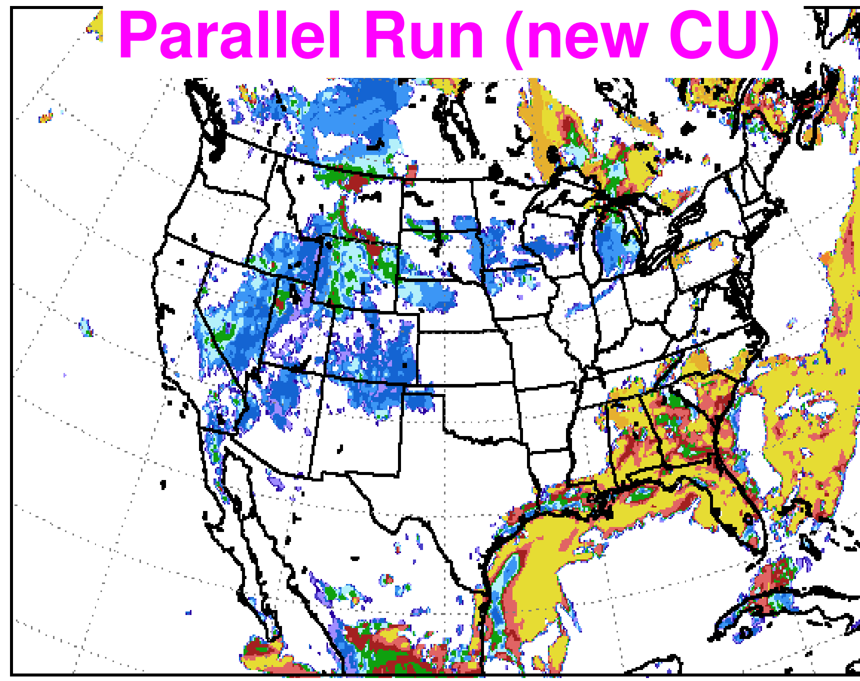
- **Smaller area of shallow convection in new CU scheme (e.g., over central plains, west coast, Pacific)**

Examples showing direct impact of changes in convective triggering (3 of 7)

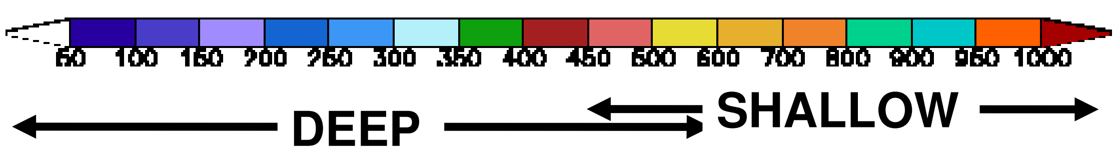
9-h FCST valid 21Z 24 July 2006

(near mid-afternoon maximum temperatures – day 1)



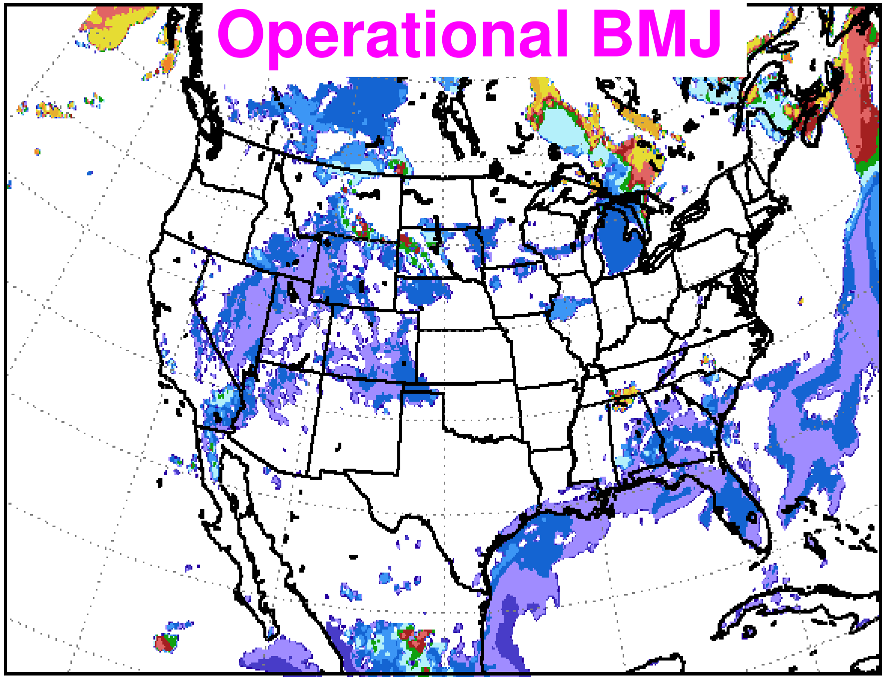


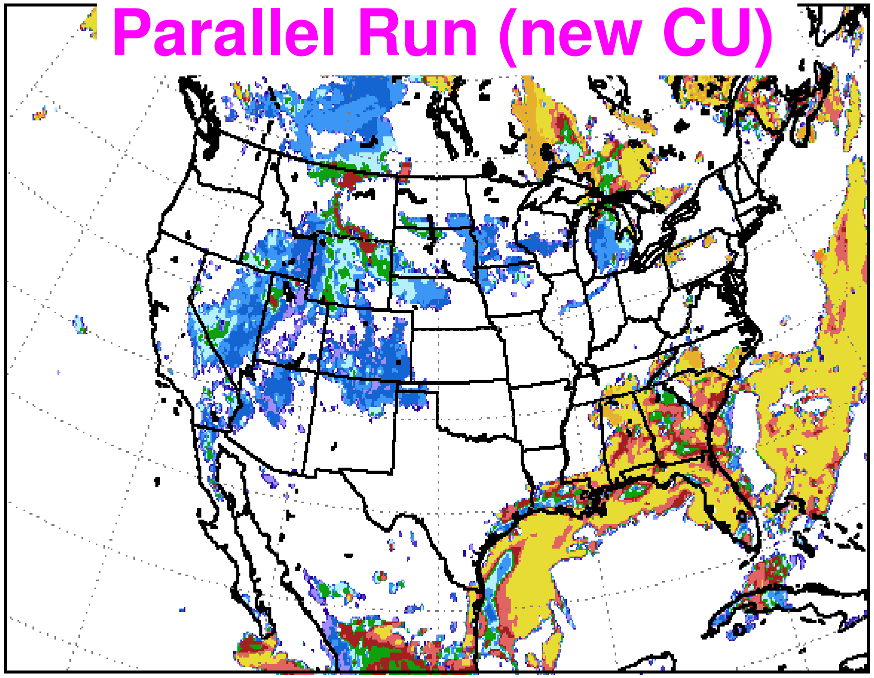
Deep convective cloud-top pressures (hPa)



Examples showing direct impact of changes in convective triggering (4 of 7)

9-h FCST valid 21Z 24 July 2006
(near mid-afternoon maximum temperatures – day 1)



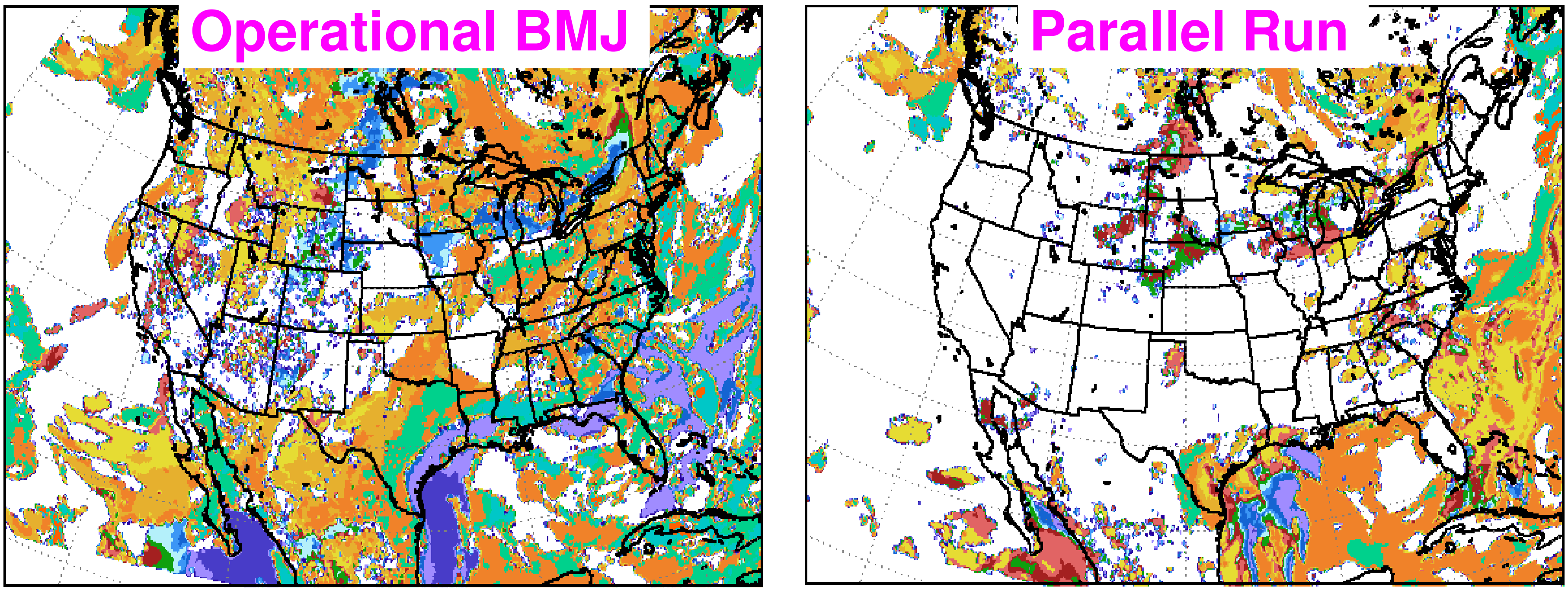


- **Much lower deep convection in new CU scheme (e.g., over SE US, GoM, Atlantic; somewhat lower over mountain west and southern Canada)**

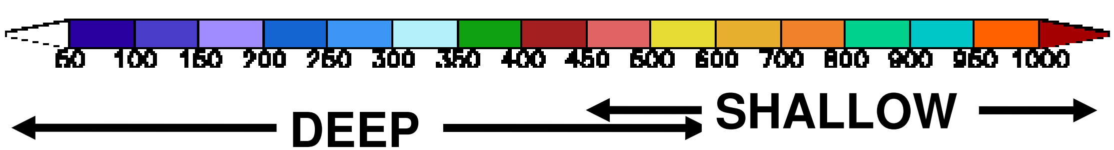
Examples showing direct impact of changes in convective triggering (5 of 7)

24-h FCST valid 12Z 25 July 2006

(near early morning minimum temperatures – day 1)



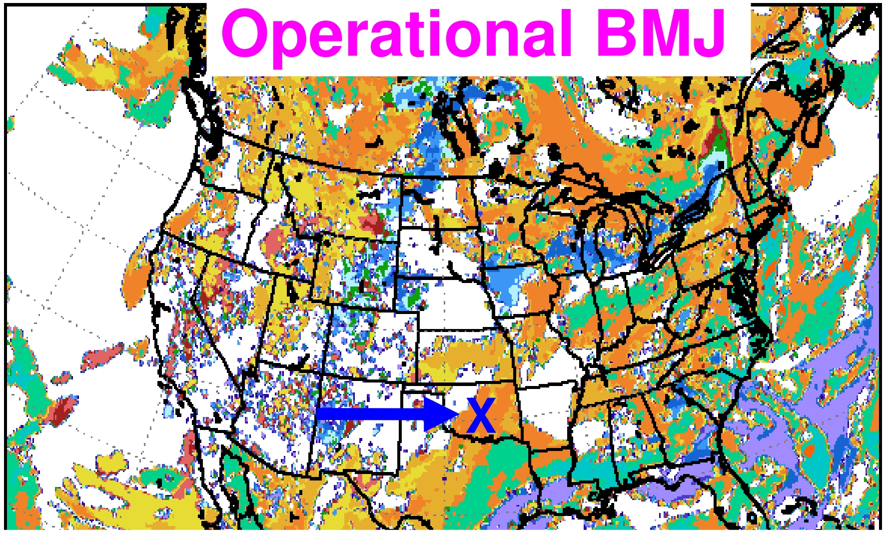
Total (shallow + deep) convective cloud-top pressures (hPa)

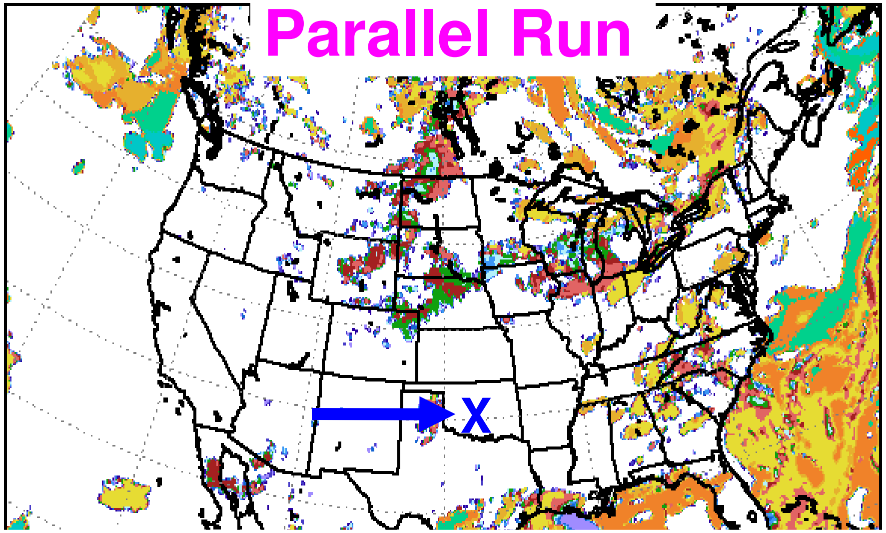


Examples showing direct impact of changes in convective triggering (6 of 7)

24-h FCST valid 12Z 25 July 2006

(near early morning minimum temperatures – day 1)

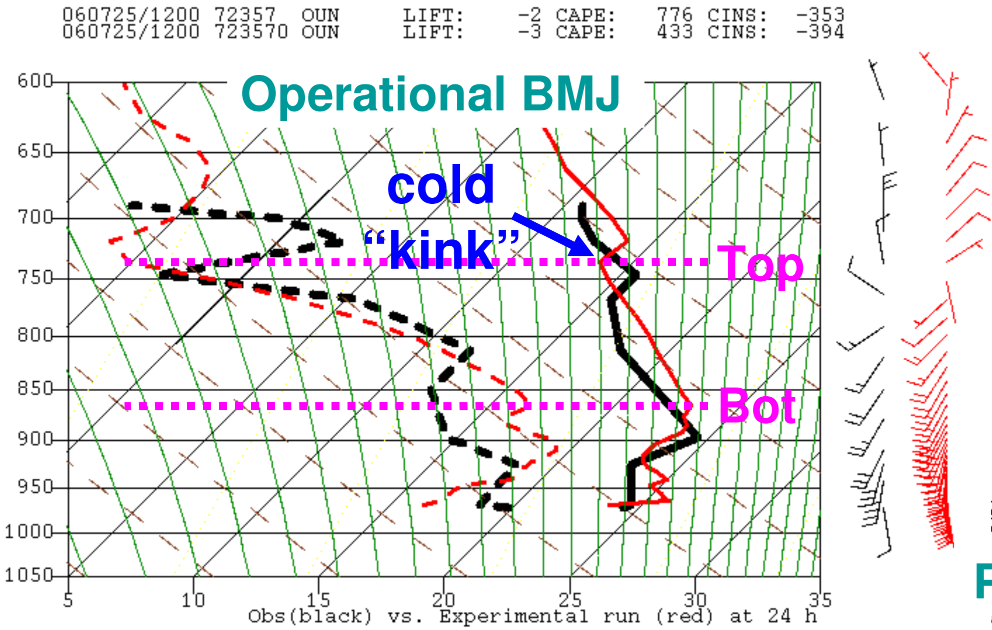




- **Much less shallow convection in new CU scheme in the late evening and early morning hours (mostly deep CU)**
- **Much stronger diurnal variation in convective triggering over land in new scheme**

(Next slide compares forecast soundings at X)

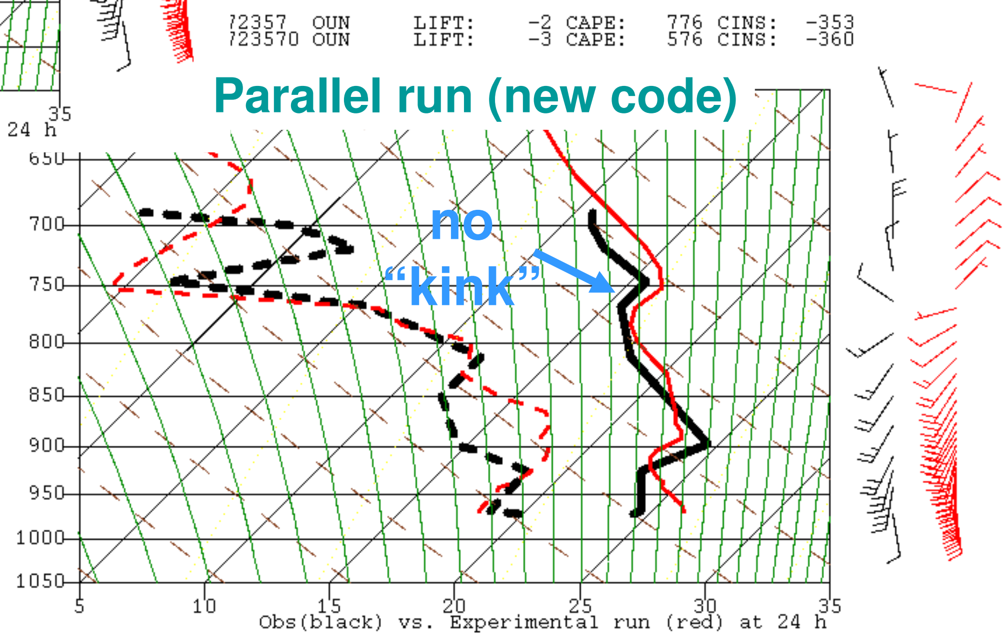
FCST vs. OBS soundings (7 of 7)



(X in LL panel in previous slide)

Norman, OK
12Z 25 July 2006

- 24-h FCST soundings (red)
- Observed soundings (black)



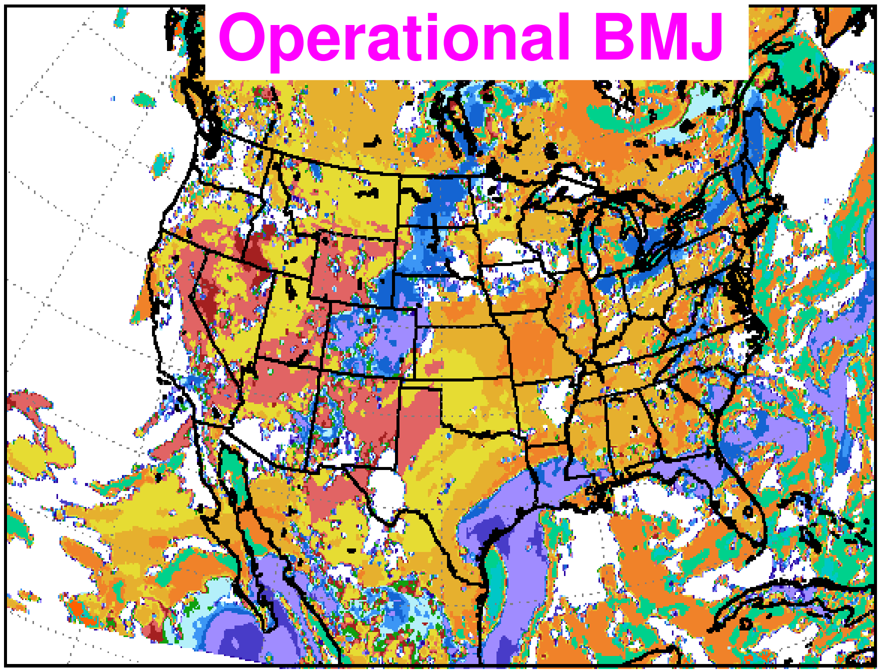
(X in LR panel in previous slide)

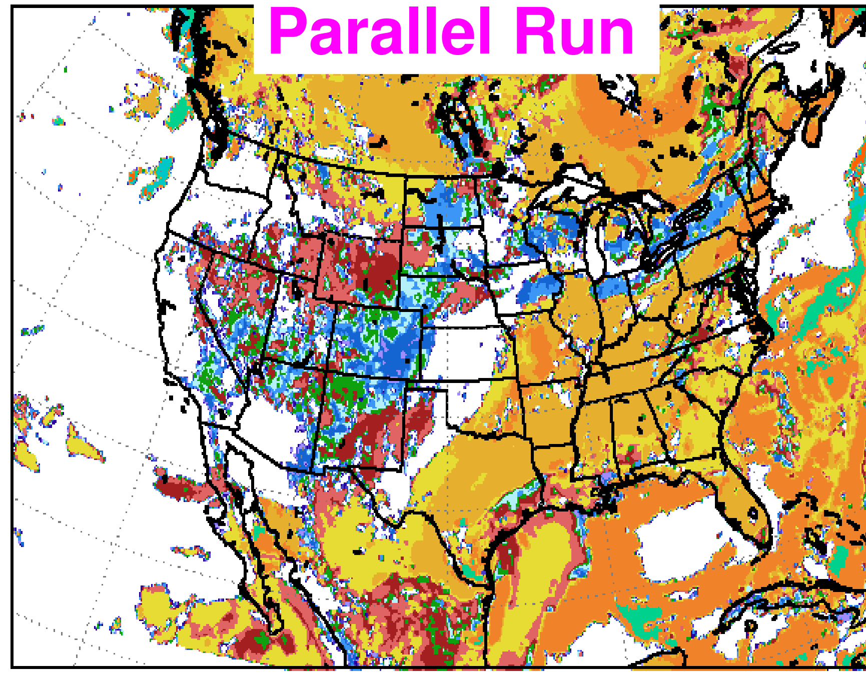
- Shallow CU triggered in control (cold "kink", above)
- Shallow CU did not trigger in parallel, better agreement with observations (no "kink", right)

Day 2 examples showing direct impact of changes in convective triggering (1 of 4)

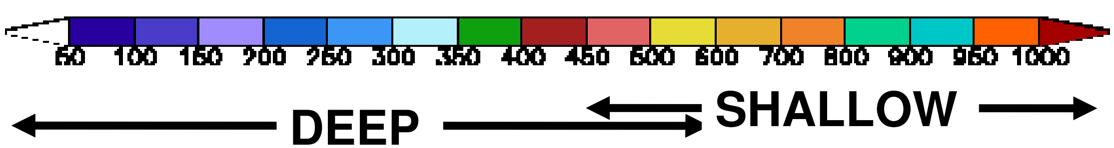
33-h FCST valid 21Z 25 July 2006

(near mid-afternoon maximum temperatures – day 2)





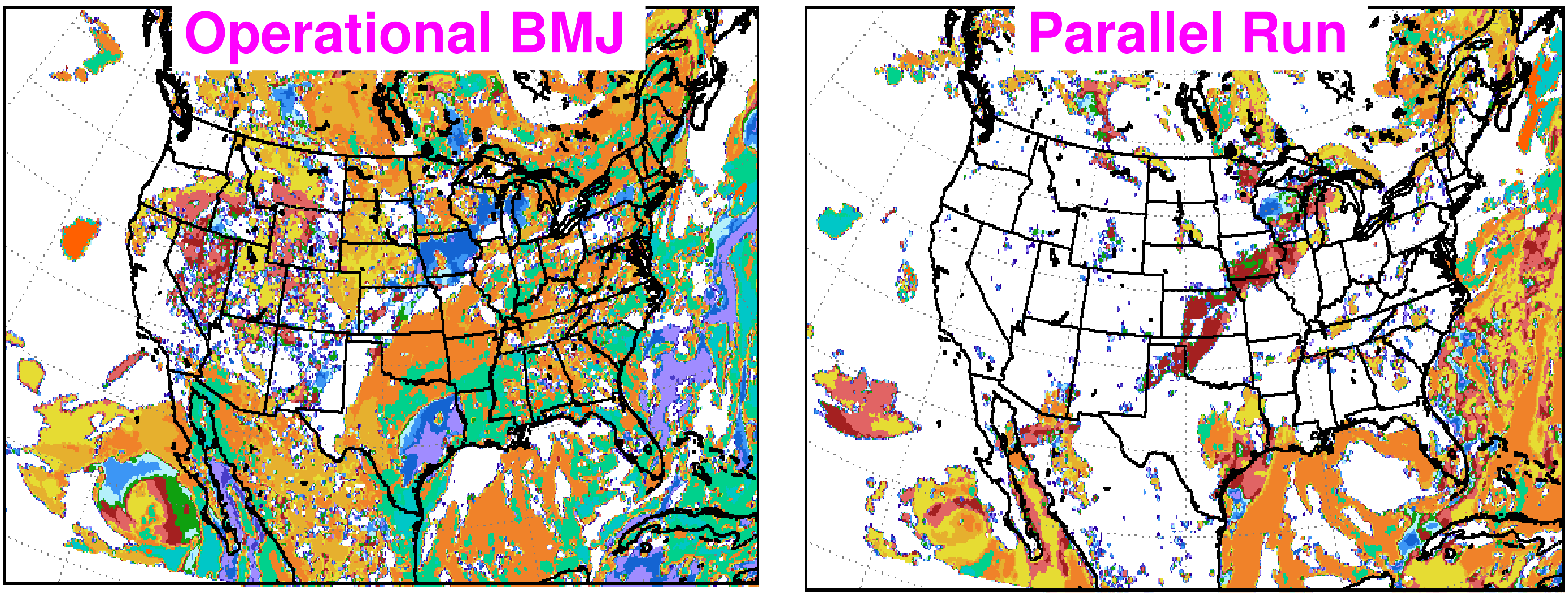
Total (shallow + deep) convective cloud-top pressures (hPa)



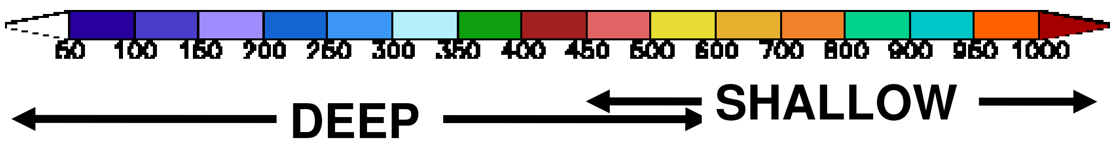
Day 2 examples showing direct impact of changes in convective triggering (2 of 4)

48-h FCST valid 12Z 26 July 2006

(near early morning minimum temperatures – day 2)



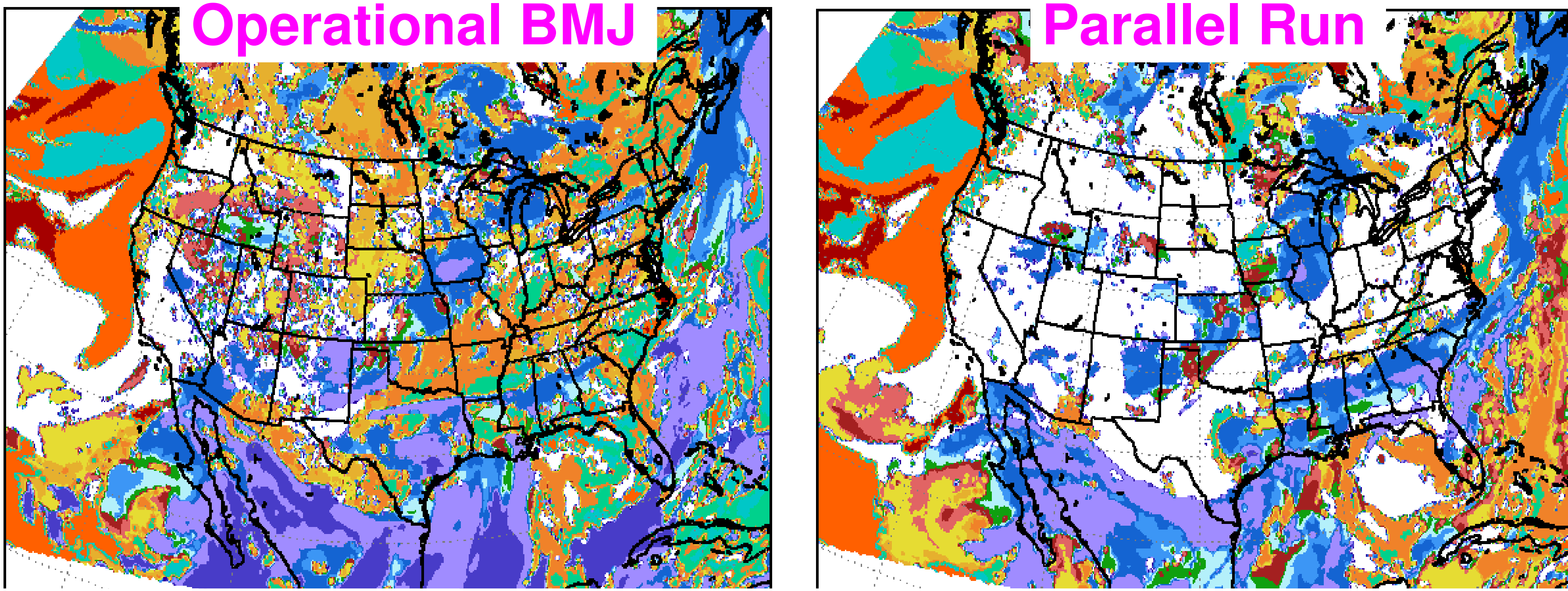
Total (shallow + deep) convective cloud-top pressures (hPa)



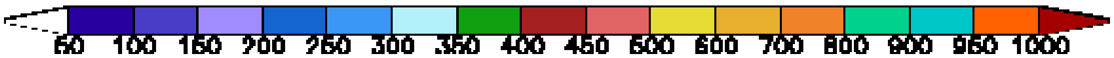
Day 2 examples showing direct impact of changes in convective triggering (3 of 4)

48-h FCST valid 12Z 26 July 2006

(near early morning minimum temperatures – day 2)



Total **(CU *+ grid-scale*) cloud-top pressures (hPa)**

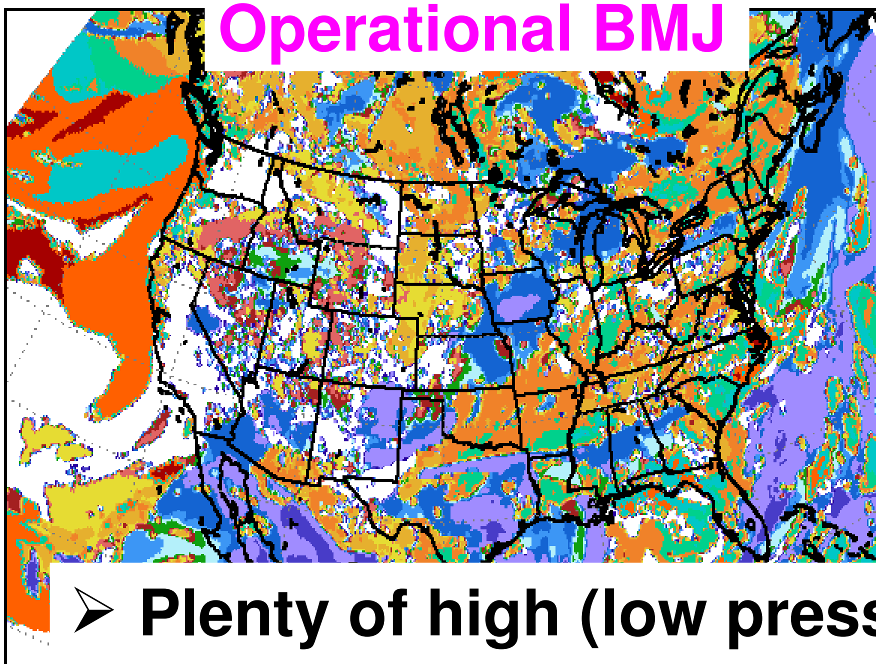


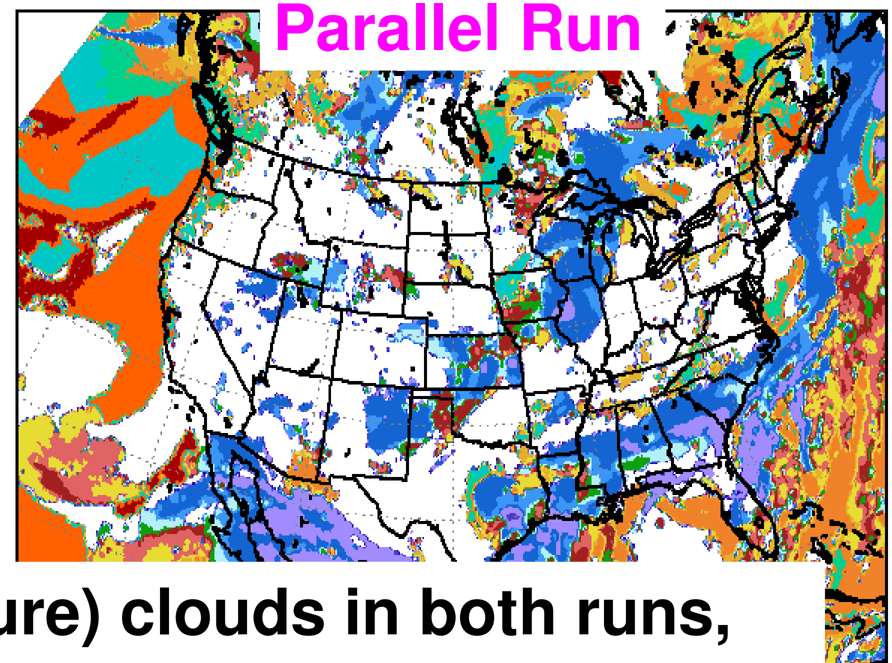
← DEEP → ← SHALLOW →

Day 2 examples showing direct impact of changes in convective triggering (4 of 4)

48-h FCST valid 12Z 26 July 2006

(near early morning minimum temperatures – day 2)





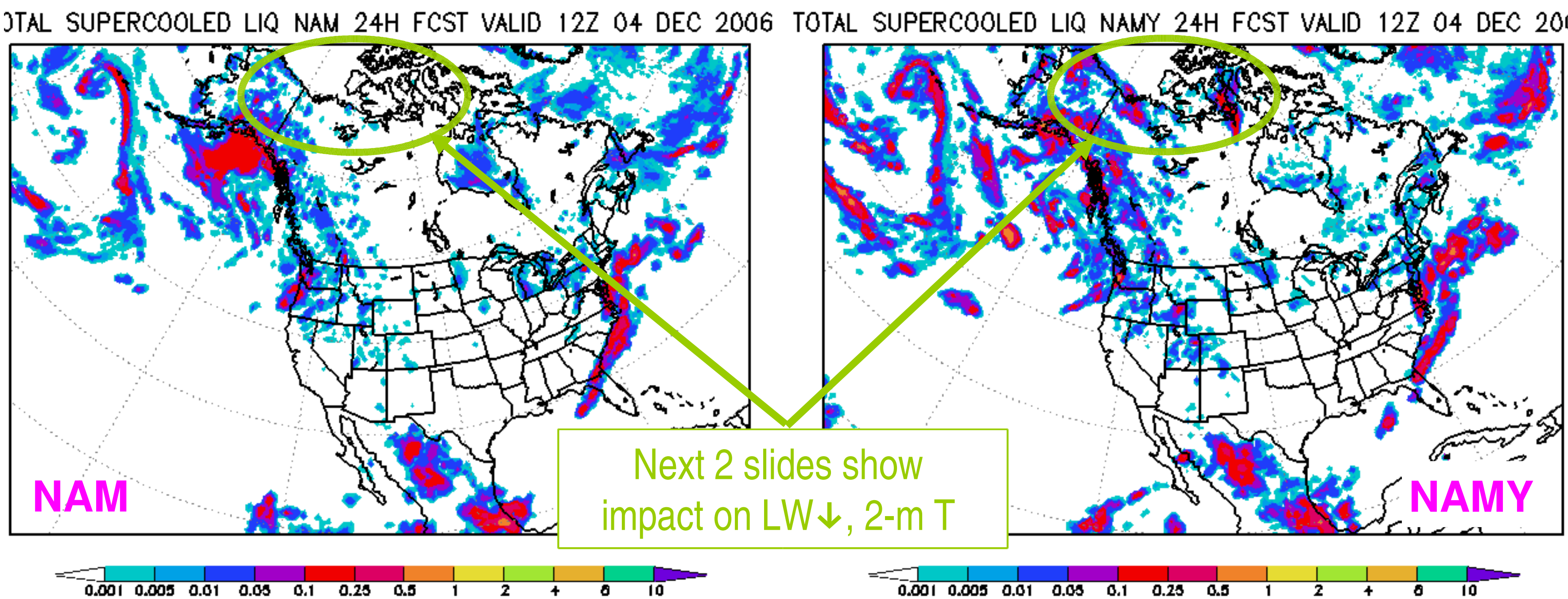
- **Plenty of high (low pressure) clouds in both runs, mostly in the form of grid-scale (ice) clouds**
- **Noticeable shifts in cloud patterns in parallel run**
- **Much less total cloudiness in parallel at 12Z; reduce high bias in model cloudiness out west**

<u>Microphysics changes</u>

- **Precipitation ice particles are assumed to have a fixed mean diameter (1 mm) during melting. Should reduce rates of melting (and cooling).**

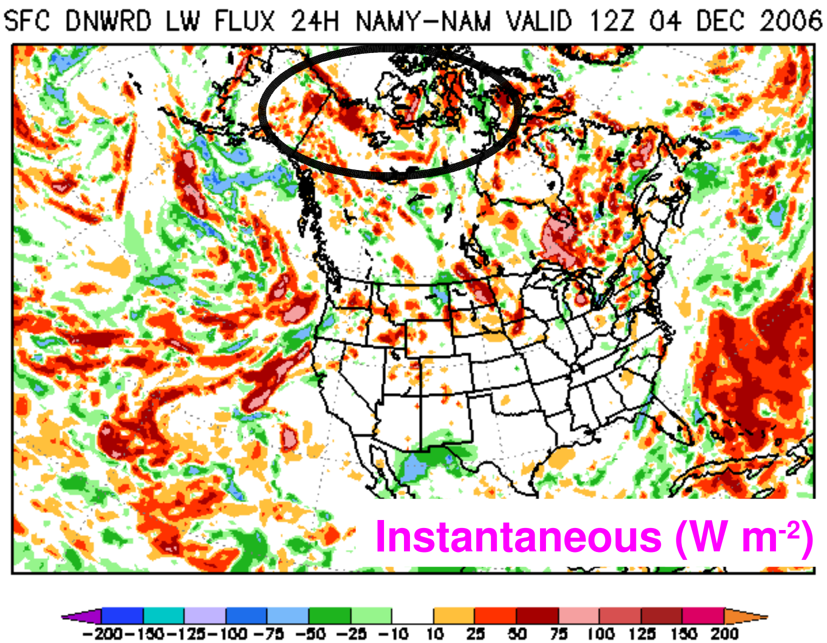
- **Changes to produce more supercooled liquid water:**
  1) complete glaciation at -40°C (was -30°C);
  2) <u>onset of ice nucleation at -15°C</u> (was -5°C) based on aircraft observations

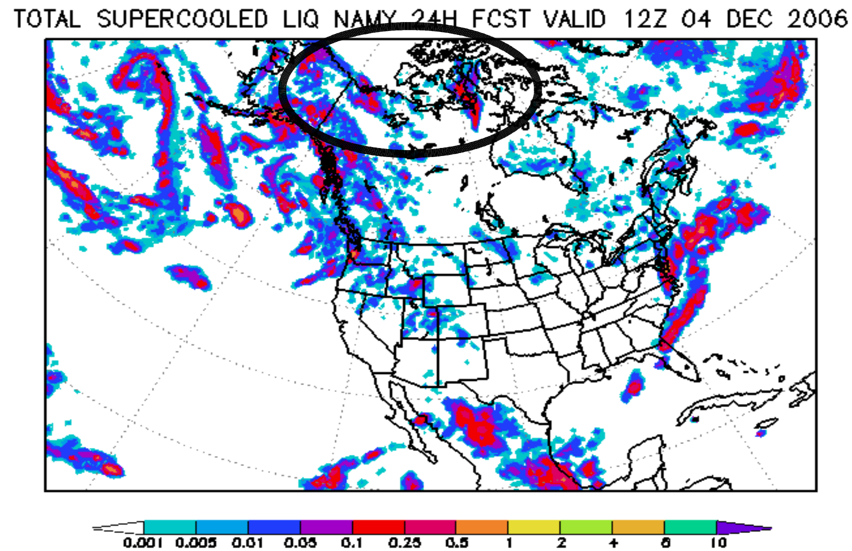
24-h column-integrated supercooled (T<0°C) liquid water (mm)



Impact of liquid water on LW↓

- Liquid water now present in some arctic clouds in NAMY, almost completely absent in NAM (previous slide)
- Higher (NAMY – NAM) incoming surface longwave (LW↓, left) below clouds with supercooled liquid water in NAMY (right)

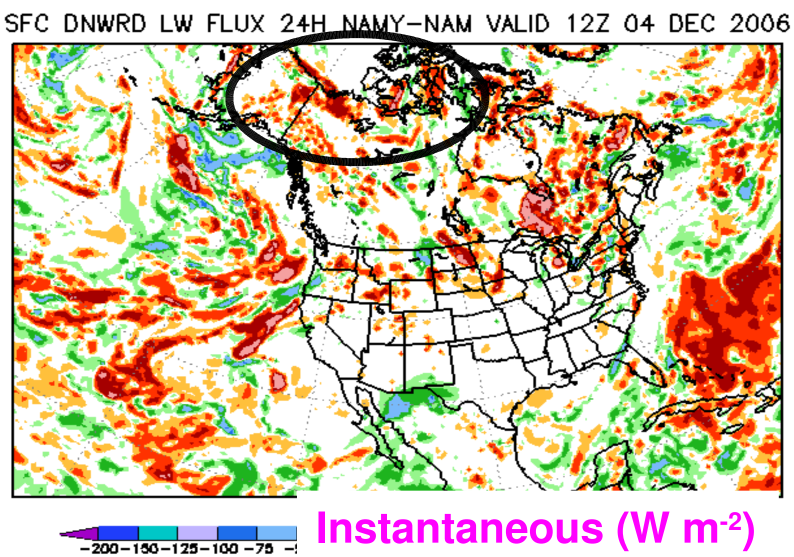


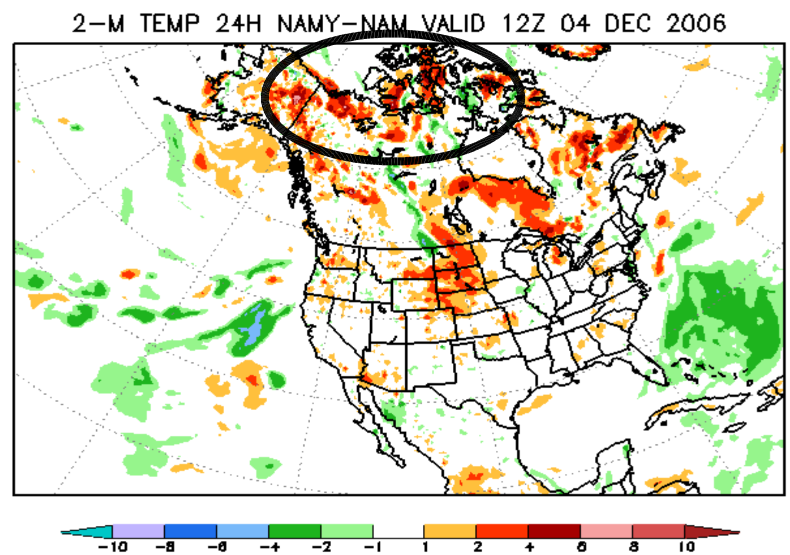


Impact of higher LW↓ on 2-m T

- Higher incoming surface longwave (LW↓, left) correlated with warmer 2-m temperatures in NAMY (right)

- Real-time verification over Arctic Canada (00Z) and N Alaska (00Z) now show NAMY is slightly warm (used to have a cold bias); to be addressed in next change package





Liquid Water in Arctic Clouds

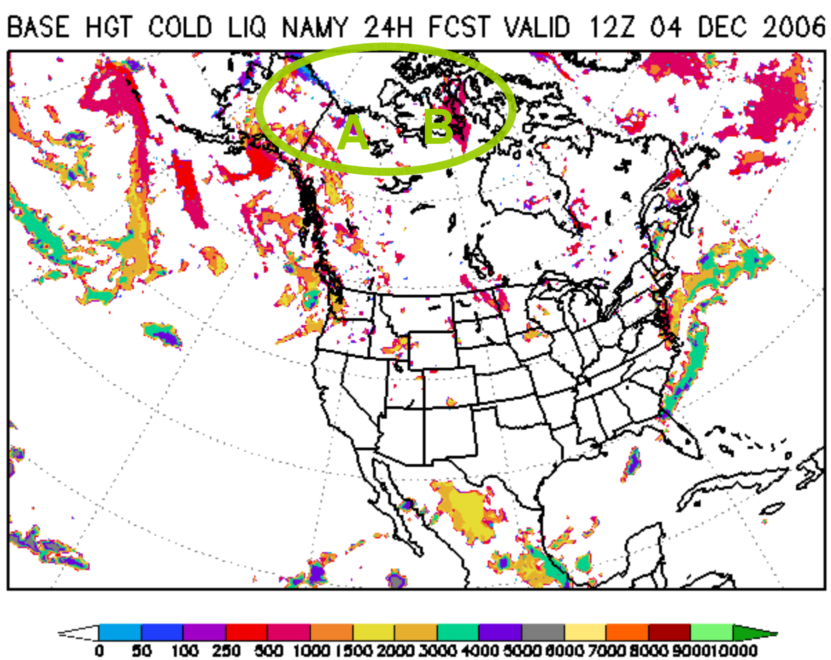
- **Edited from Nov 26 Baltimore.Examiner.com:**

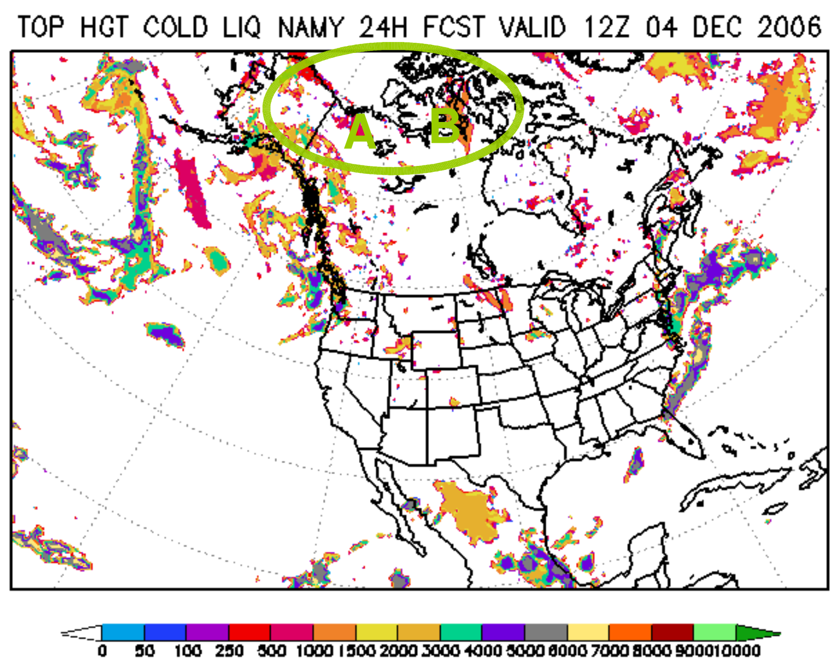
EUREKA, Nunavut Territory - ... "Much to our surprise, we found that Arctic clouds have got lots of super-cooled liquid water in them. Liquid water has even been detected in clouds at temperatures as low as minus 30 degrees Celsius (minus 22 F)," said Taneil Uttal, chief of the Clouds and Arctic Research Group at the Earth Systems Research Laboratory of the U.S. National Oceanic and Atmospheric Administration (NOAA)."If a cloud is composed of liquid water droplets in the Arctic, instead of ice crystals, then that changes how they will interact with the earth's surface and the atmosphere to reflect, absorb and transmit radiation," …..

Supercooled Water in Arctic Clouds

- Liquid water confined to fairly thin, shallow layers
- Soundings at points A and B on next slide

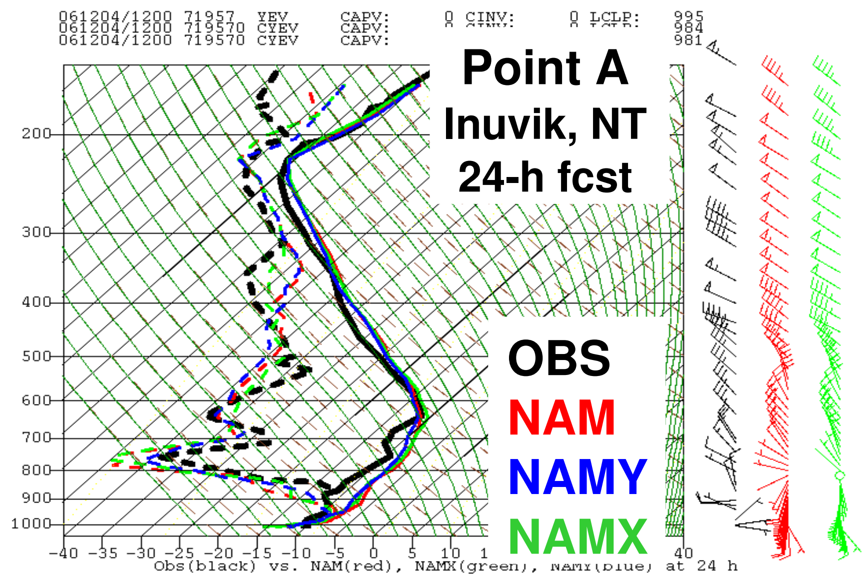
24-h height (m) of base (left) and top (right) of supercooled water layer

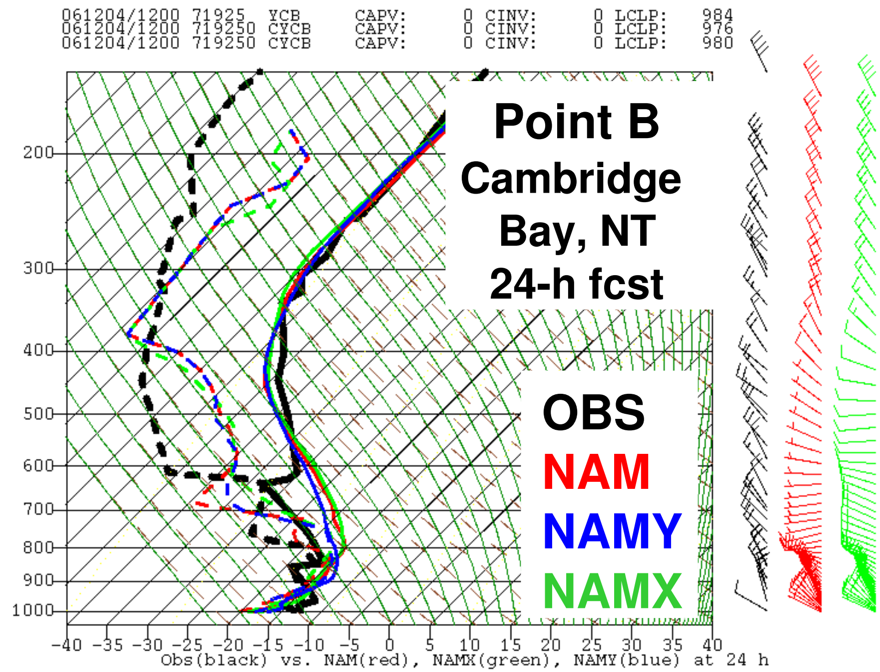




Forecast soundings at A, B

- Similar sounding structure between runs
- Impacts confined to shallow layer (in model)



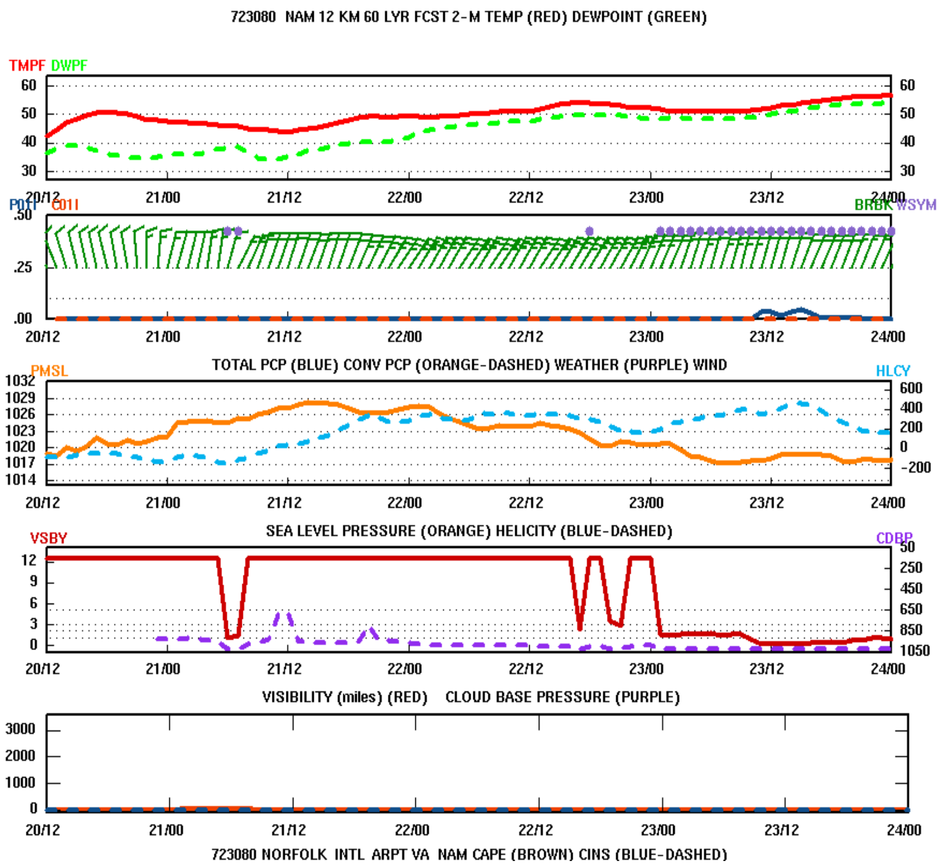


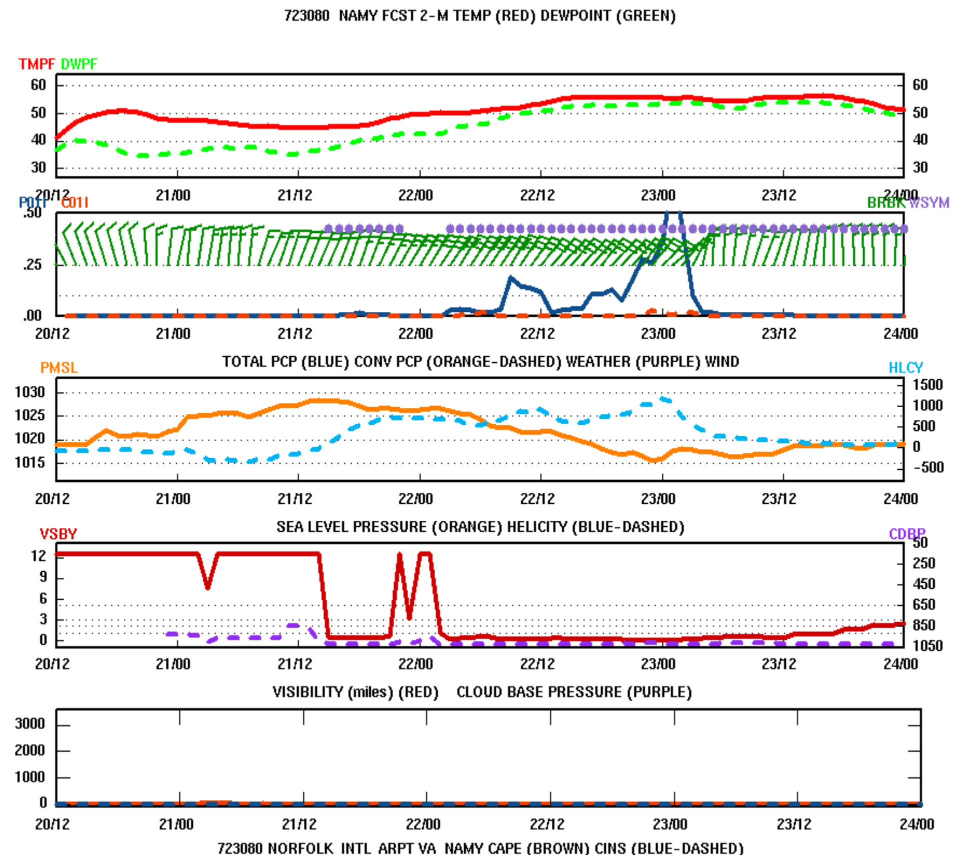
NAMY => **NAM** + cloud changes + div damp + hor diff

NAMX => **NAM** + AIRS in NDAS

NAM vs parallel NAM : 12z 20 November cycle

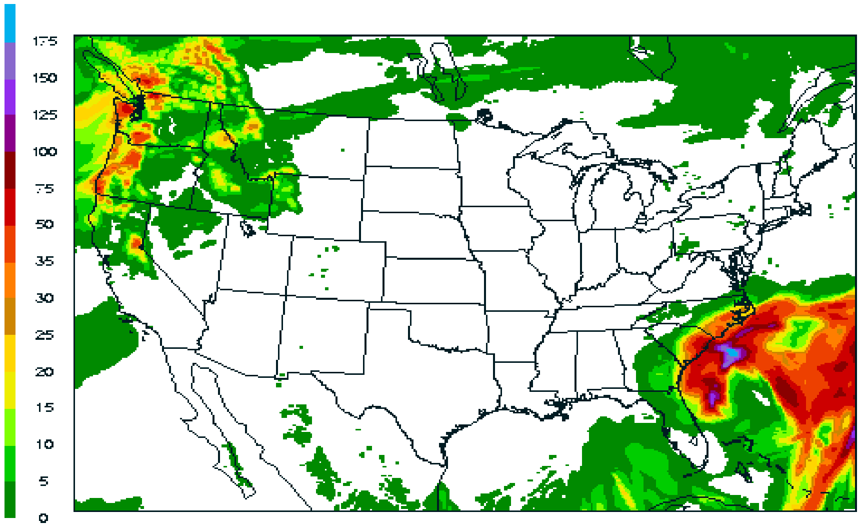
Norfolk, VA NAM, NAMY forecast meteogram from 12z 11/20





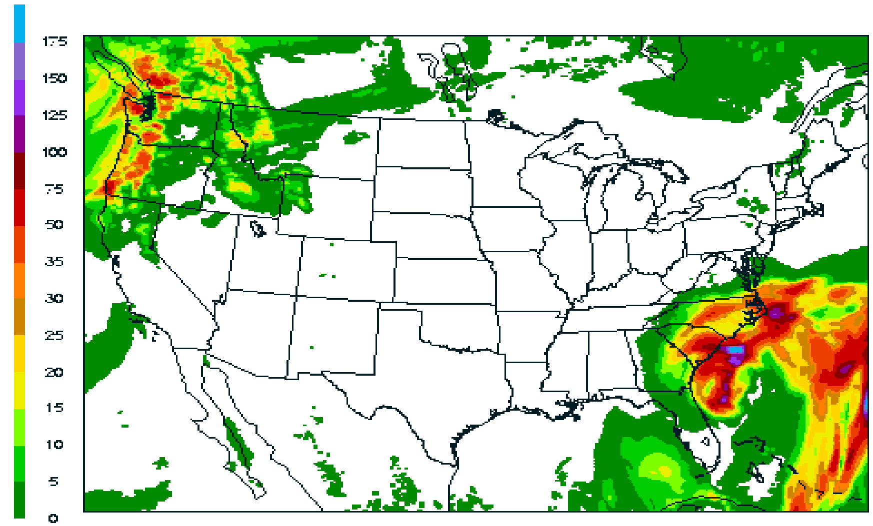
PRECIP (mm)
24h accum
VALID 12Z 22 NOV 2006

NAM
48-H FCST
12.2 KM LMB CON GRD



PRECIP (mm)
24h accum
VALID 12Z 22 NOV 2006

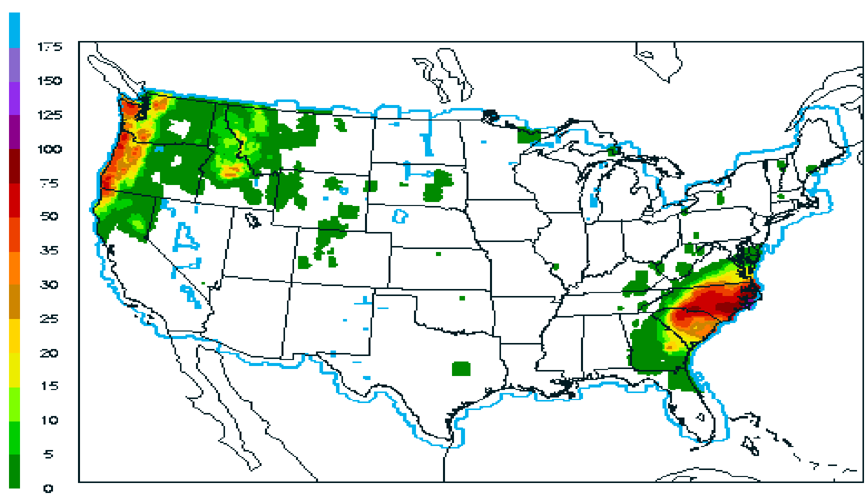
NAMY
48-H FCST
12.2 KM LMB CON GRD



PRECIP (mm)
24h accum
VALID 12Z 22 NOV 2006

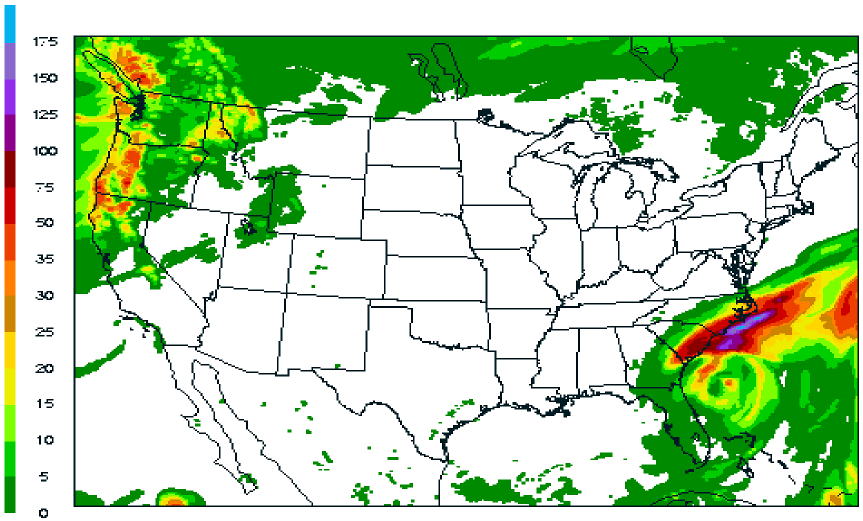
CPC RFC 1/8 Deg

12.2 KM LMB CON GRD



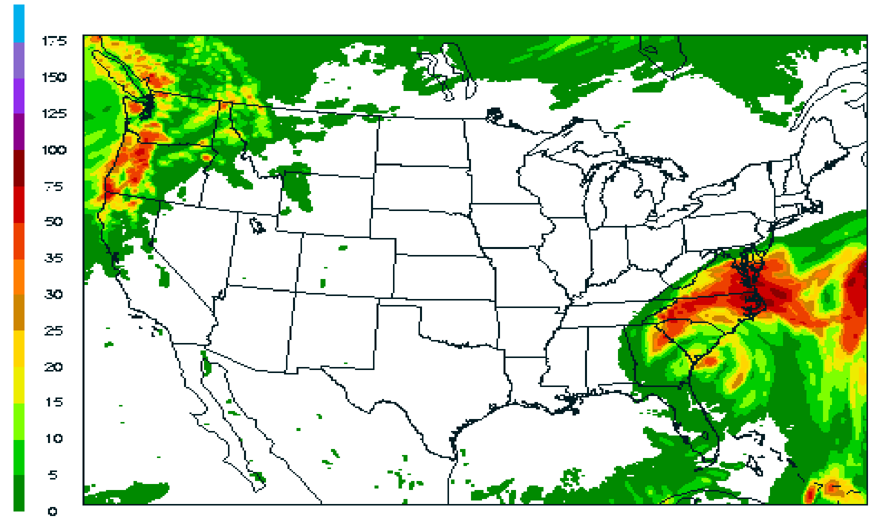
PRECIP (mm)
24h accum
VALID 12Z 23 NOV 2006

NAM
72-H FCST
12.2 KM LMB CON GRD



PRECIP (mm)
24h accum
VALID 12Z 23 NOV 2006

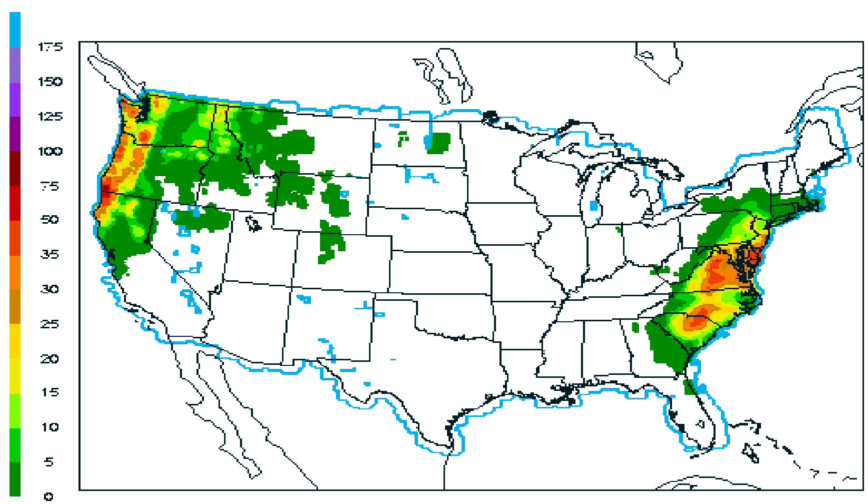
NAMY
72-H FCST
12.2 KM LMB CON GRD



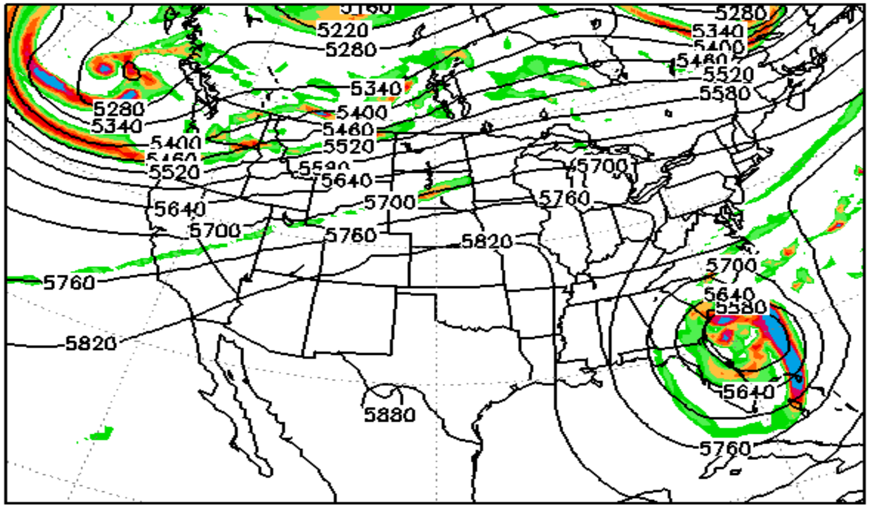
PRECIP (mm)
24h accum
VALID 12Z 23 NOV 2006

CPC RFC 1/8 Deg

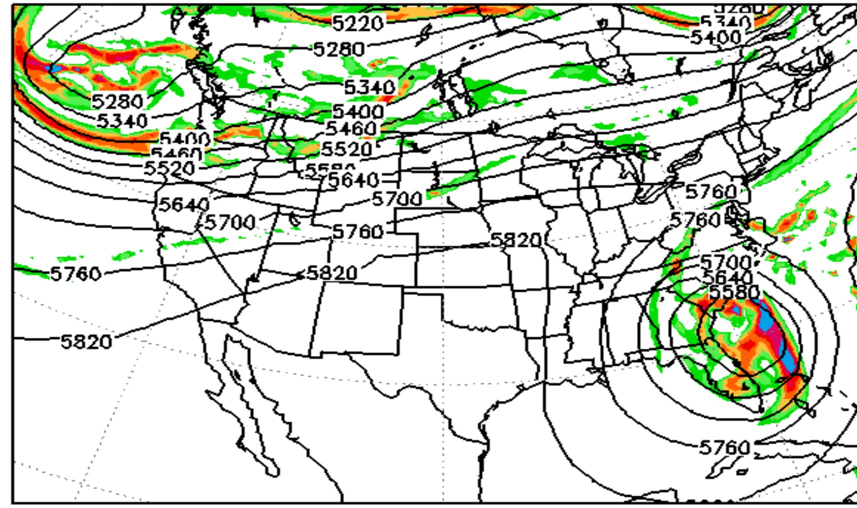
12.2 KM LMB CON GRD



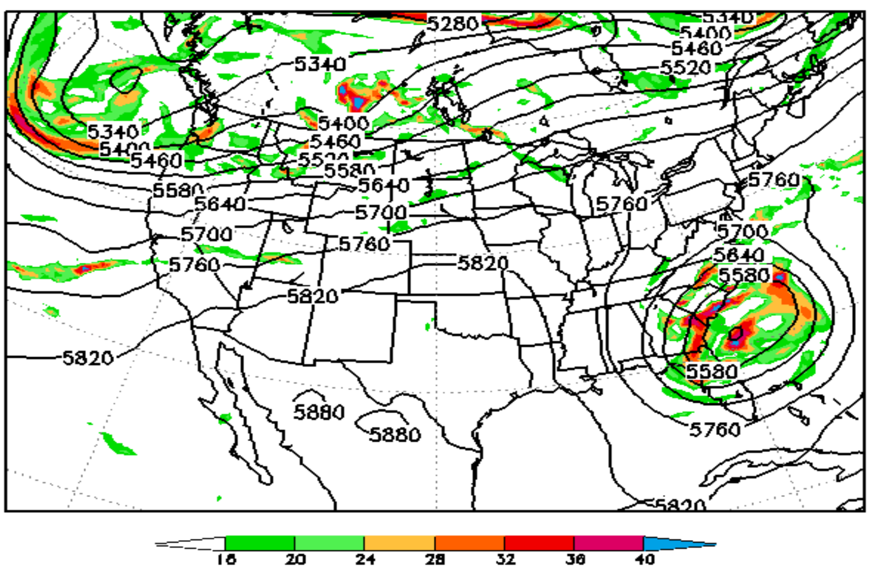
500MB Z-VORT NAM 48H FCST VALID 12Z 22 NOV 2006



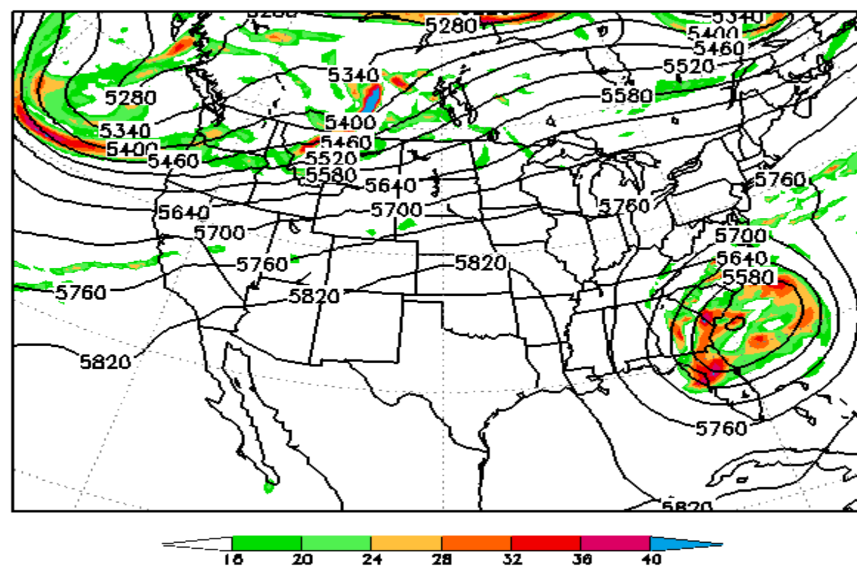
500MB Z-VORT NAMY 48H FCST VALID 12Z 22 NOV 2006



500MB Z-VORT NAM 00H FCST VALID 12Z 22 NOV 2006



500MB Z-VORT NAMY 00H FCST VALID 12Z 22 NOV 2006



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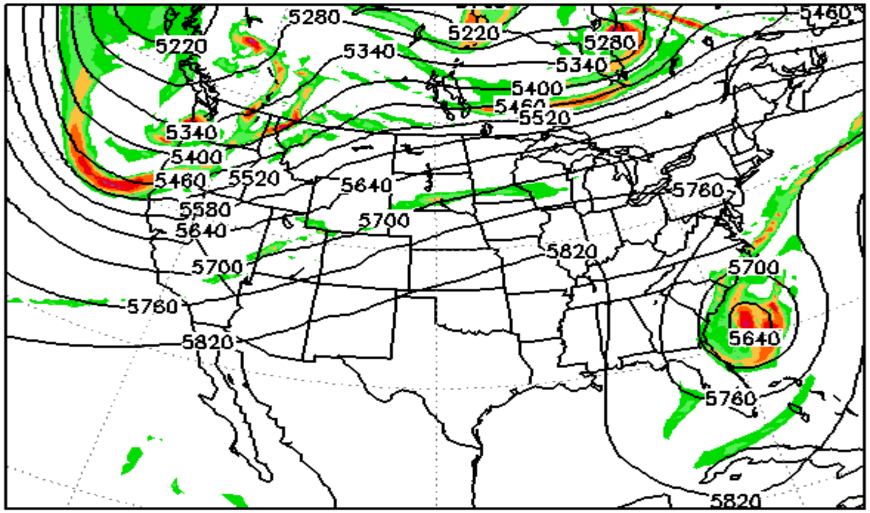

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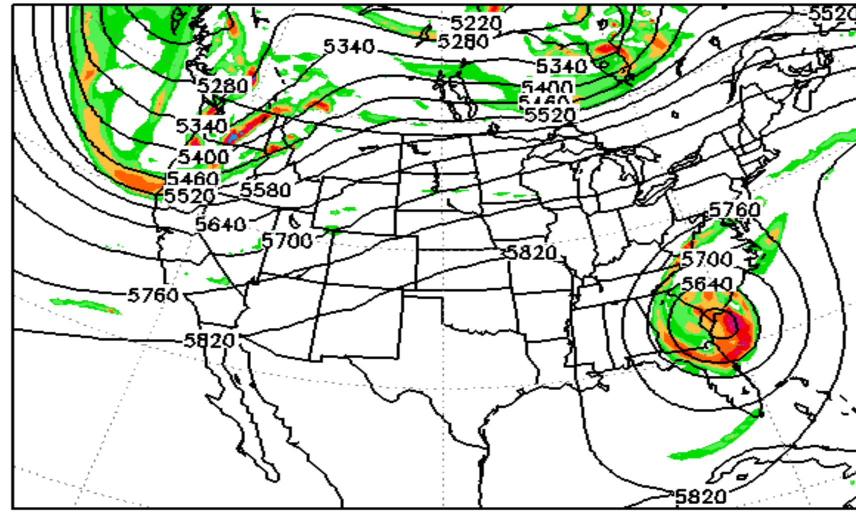

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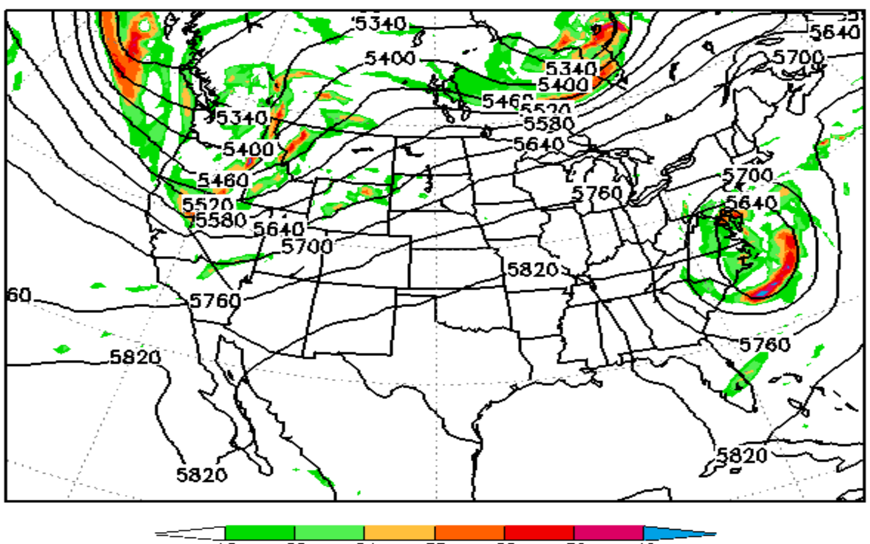

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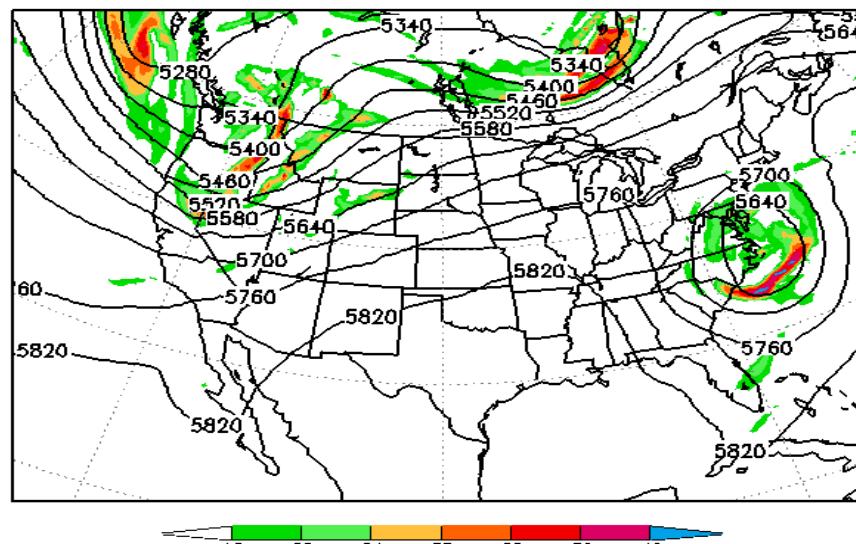
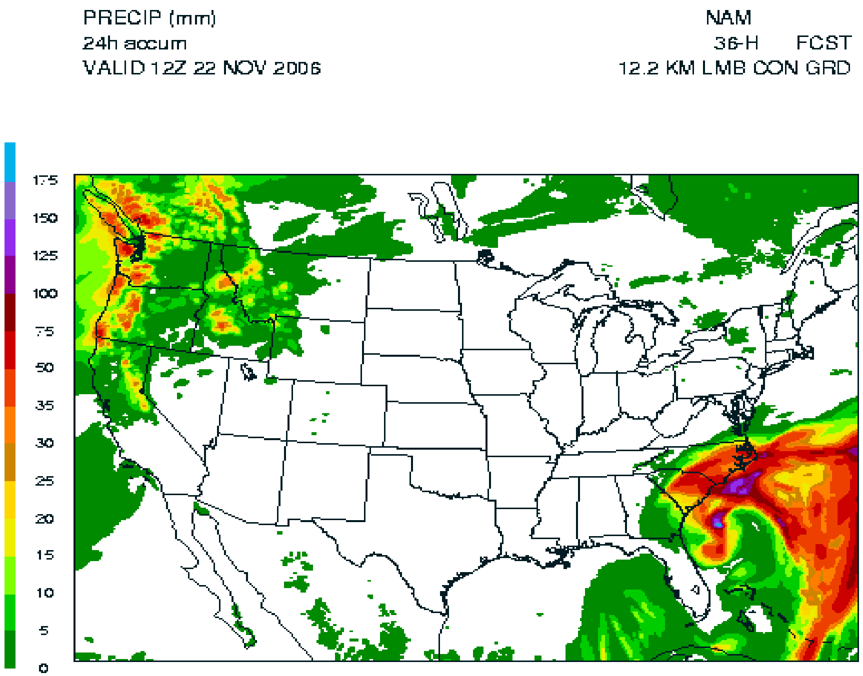
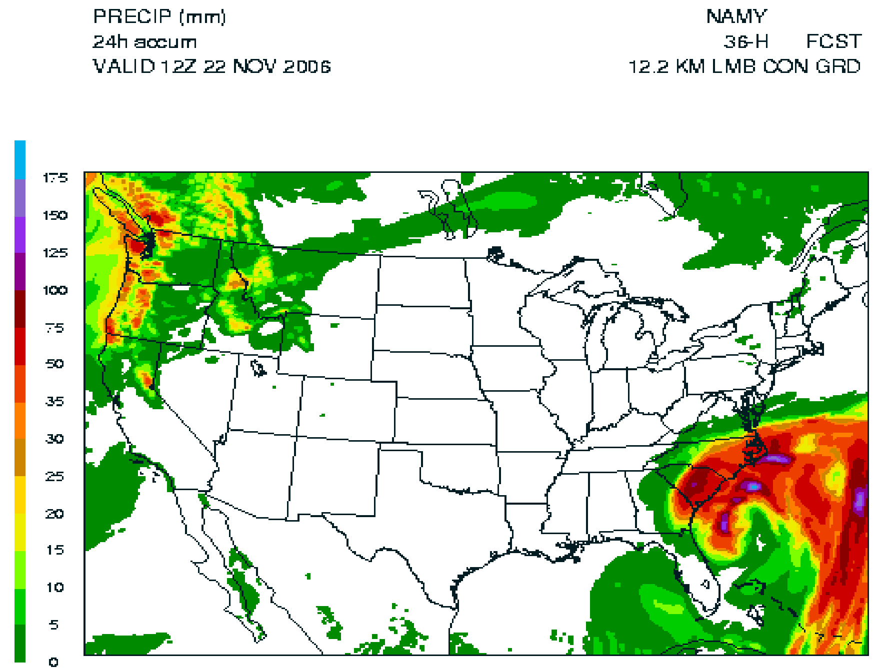


NAM vs parallel NAM : 00z 21 November cycle


PRECIP (mm)
24h accum
VALID 12Z 22 NOV 2006
NAM
36-H FCST
12.2 KM LMB CON GRD
175
150
125
100
75
50
35
30
25
20
15
10
5
0


PRECIP (mm)
24h accum
VALID 12Z 22 NOV 2006
NAMY
36-H FCST
12.2 KM LMB CON GRD
175
150
125
100
75
50
35
30
25
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5
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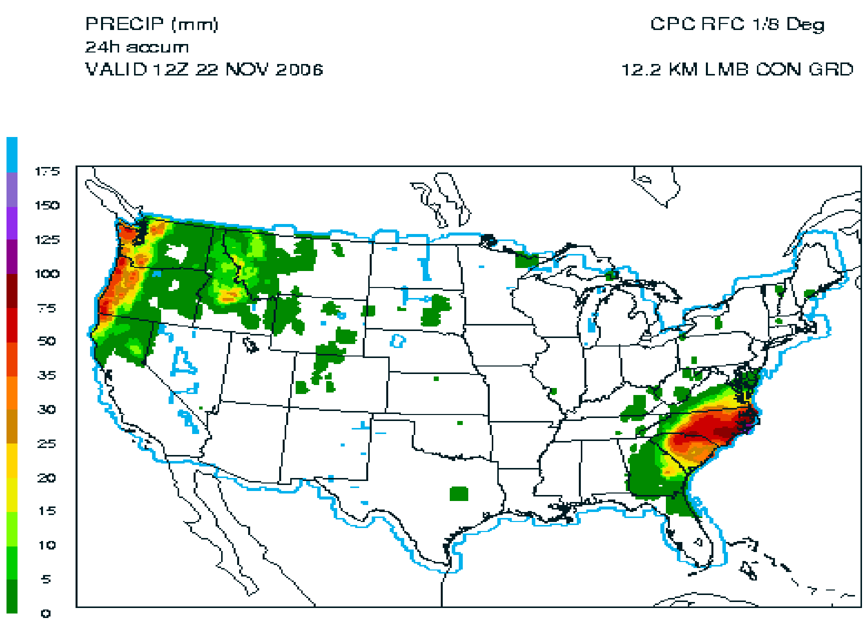
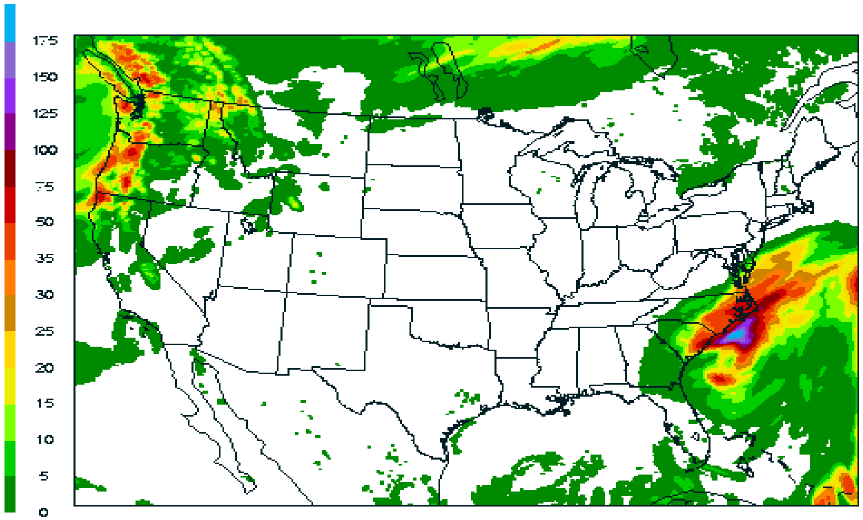

PRECIP (mm)
24h accum
VALID 12Z 22 NOV 2006
CPC RFC 1/8 Deg
12.2 KM LMB CON GRD
175
150
125
100
75
50
35
30
25
20
15
10
5
0

PRECIP (mm)
24h accum
VALID 12Z 23 NOV 2006

NAM
60-H FCST
12.2 KM LMB CON GRD



PRECIP (mm)
24h accum
VALID 12Z 23 NOV 2006

NAMY
60-H FCST
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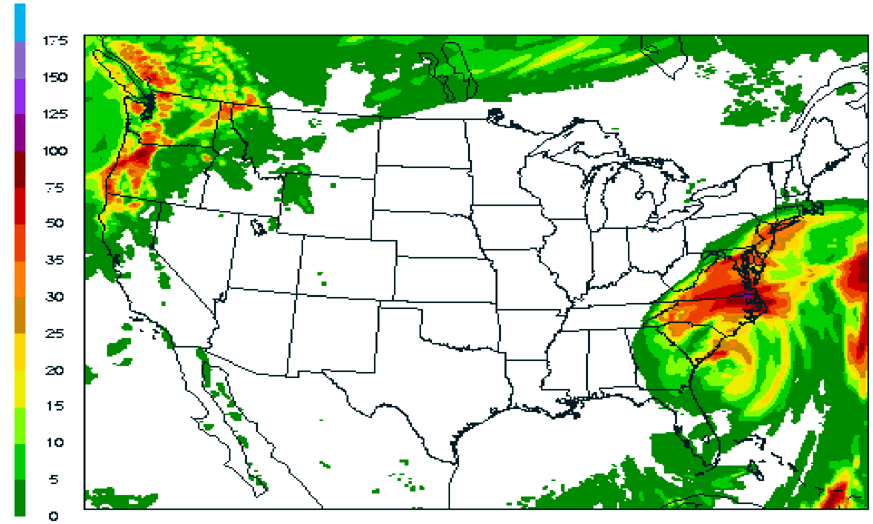
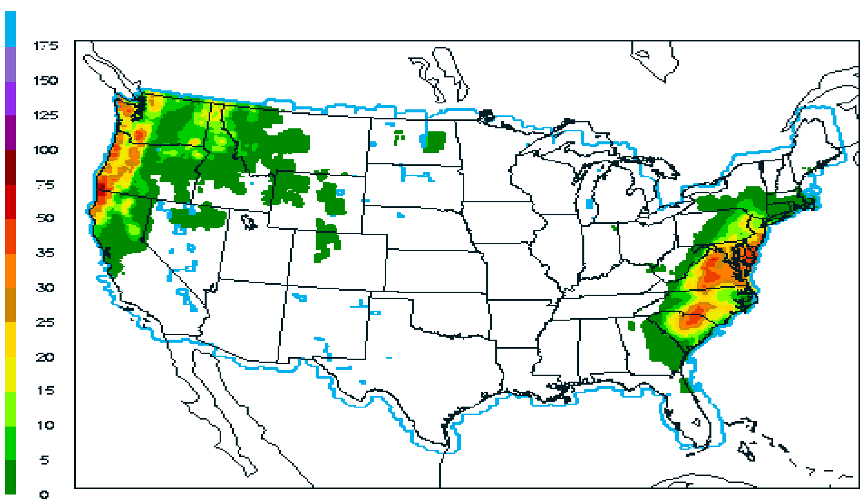


PRECIP (mm)
24h accum
VALID 12Z 23 NOV 2006

CPC RFC 1/8 Deg

12.2 KM LMB CON GRD



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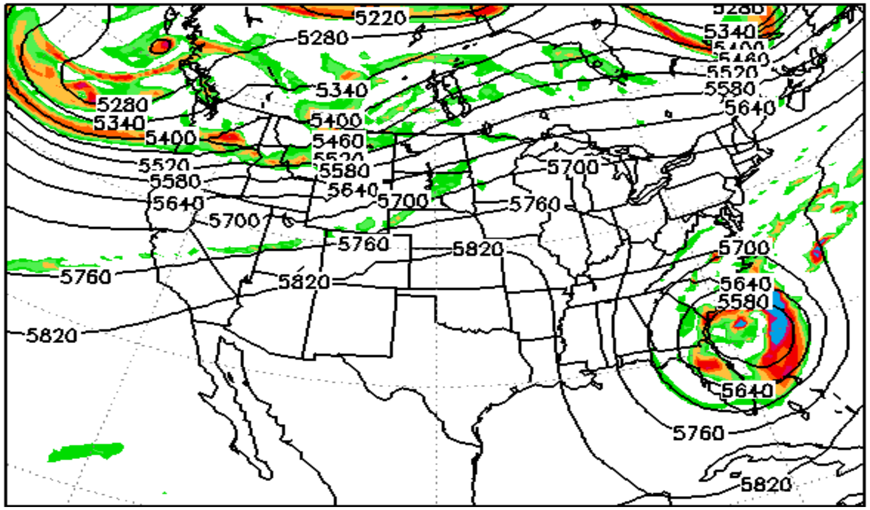

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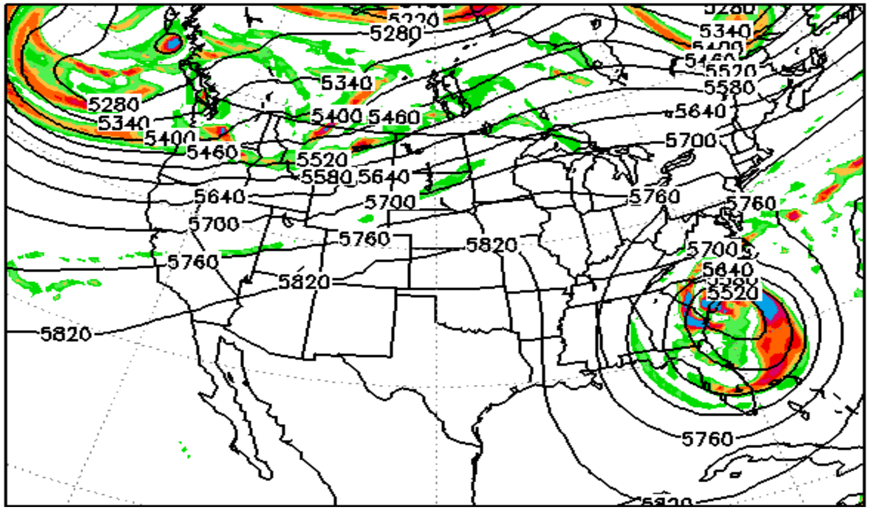

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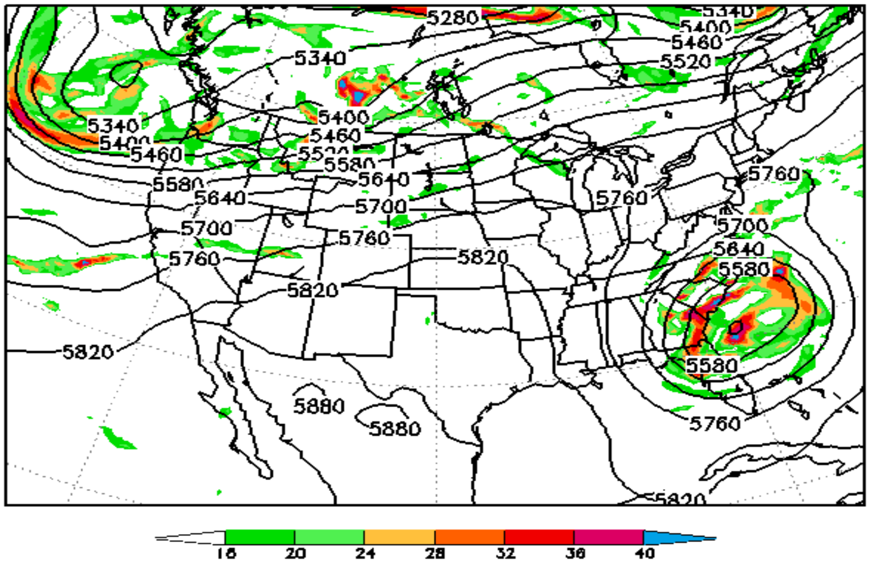

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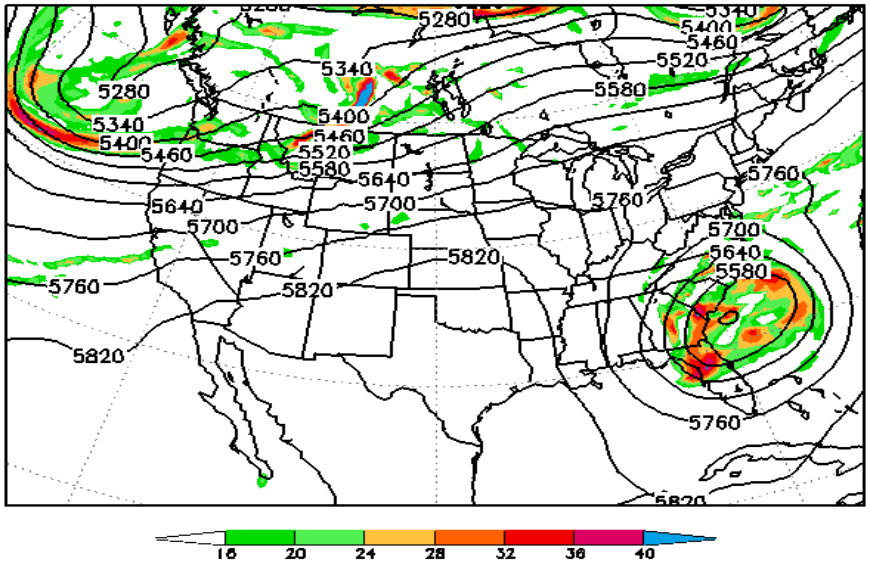

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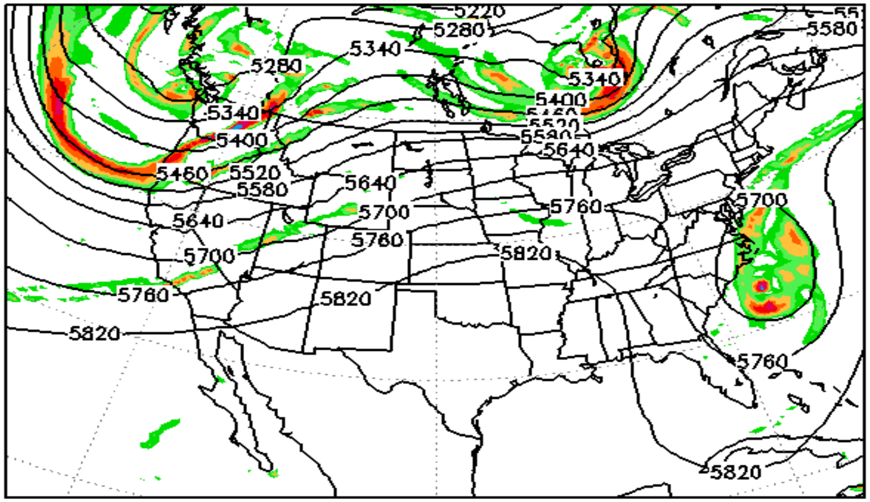

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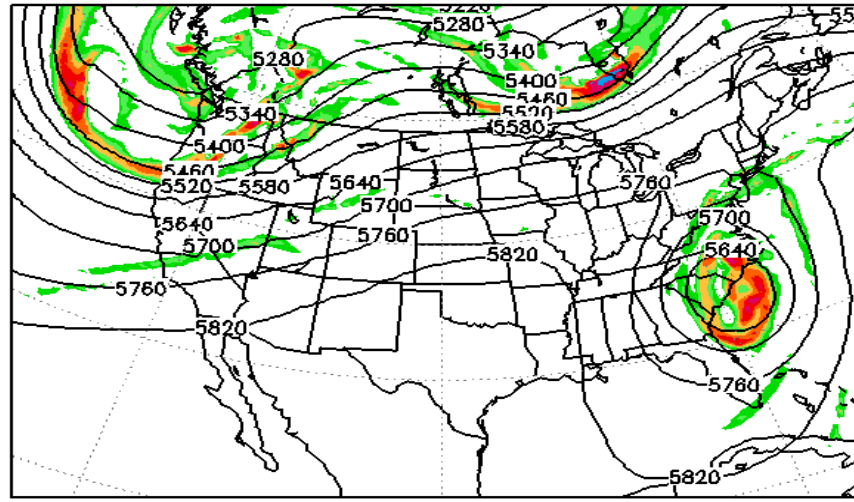

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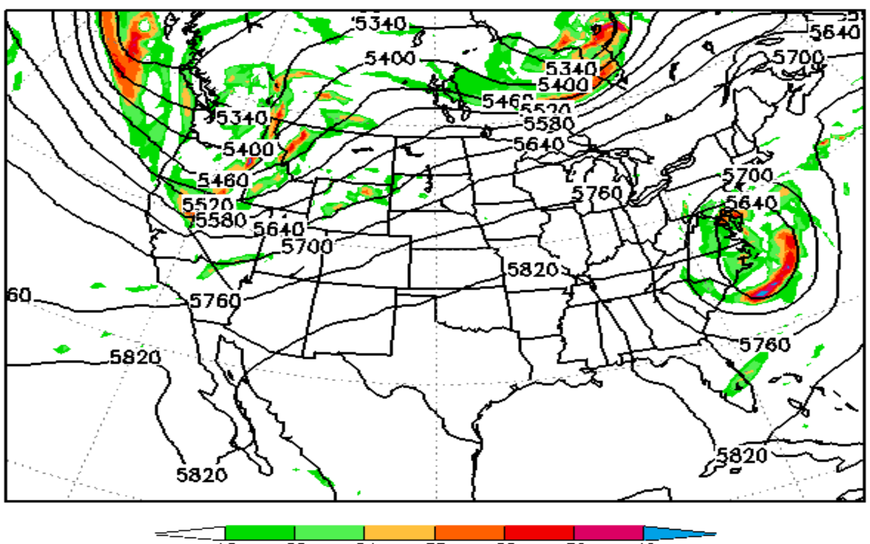

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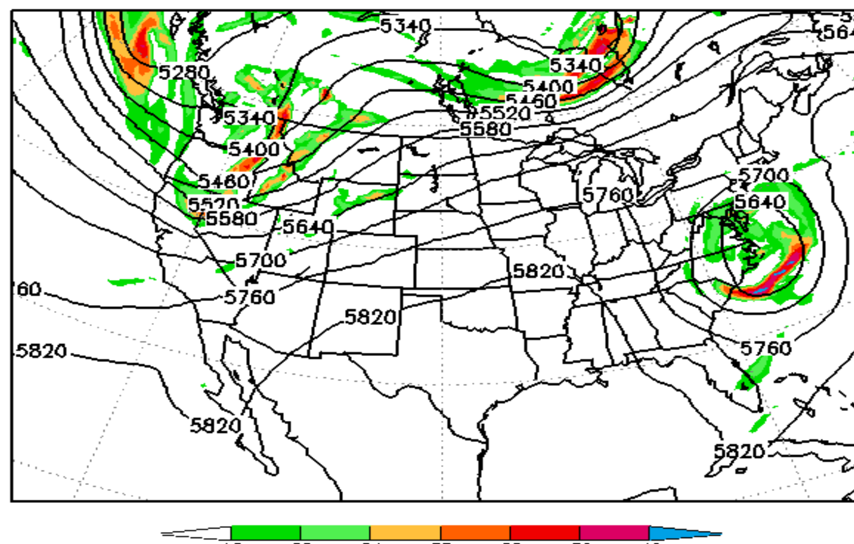
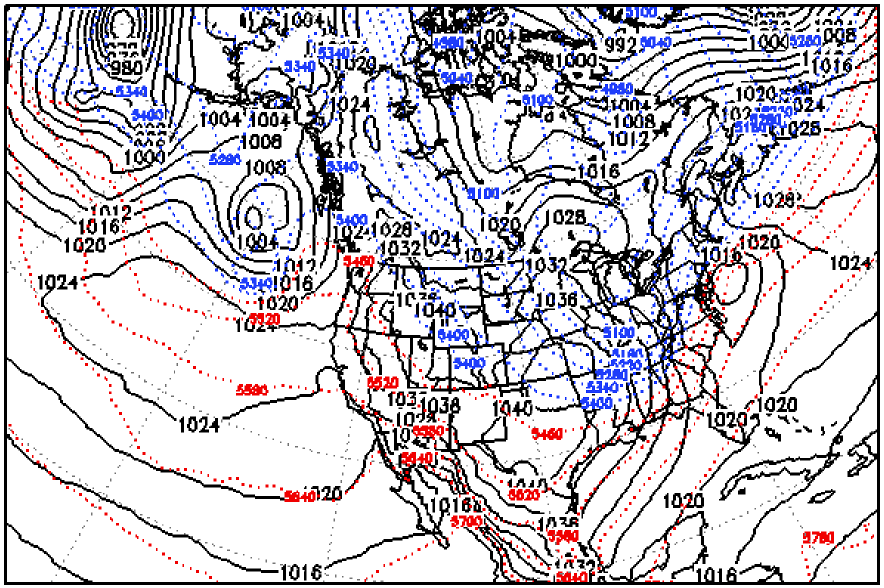


NAM vs parallel NAM : 1-4 December 2006 linear instability problem in ops NAM : Forecasts valid 12z 12/4

SLP NAM 72H FCST VALID 12Z 04 DEC 2006



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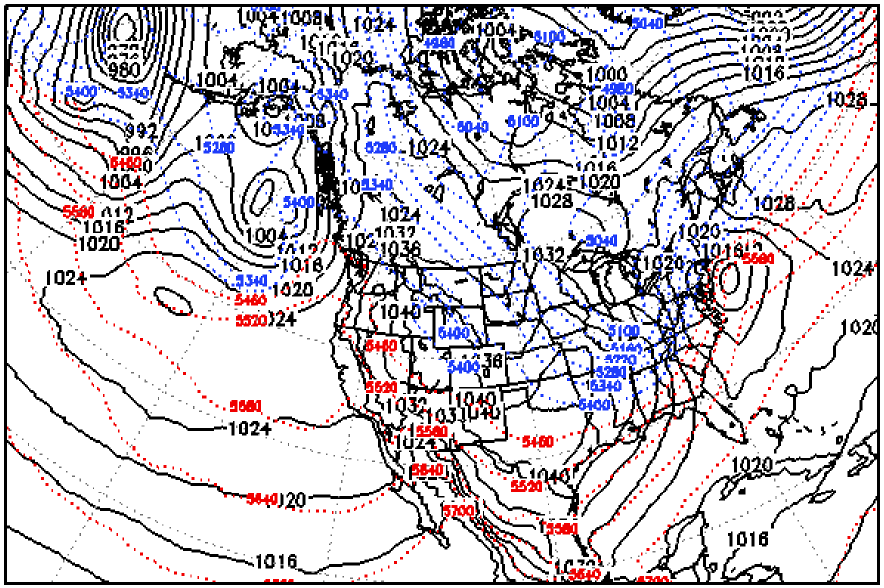

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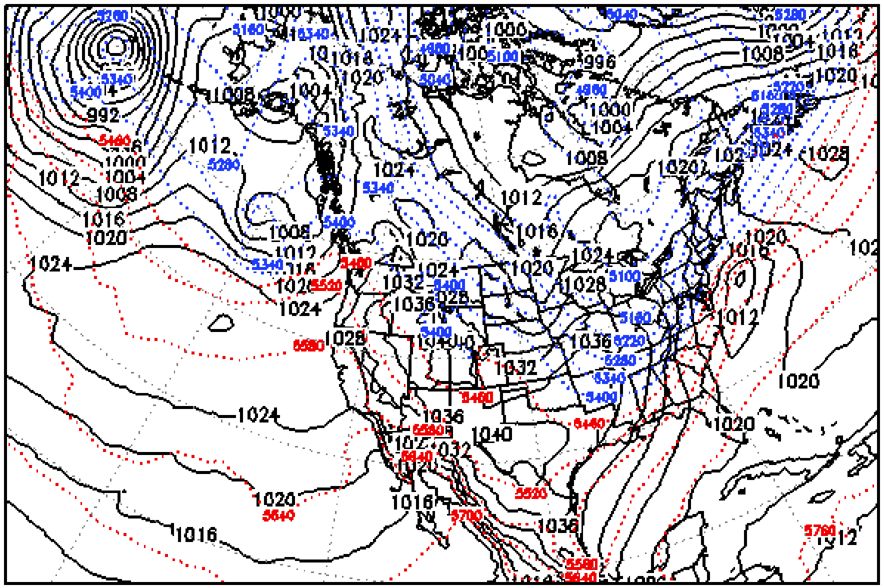

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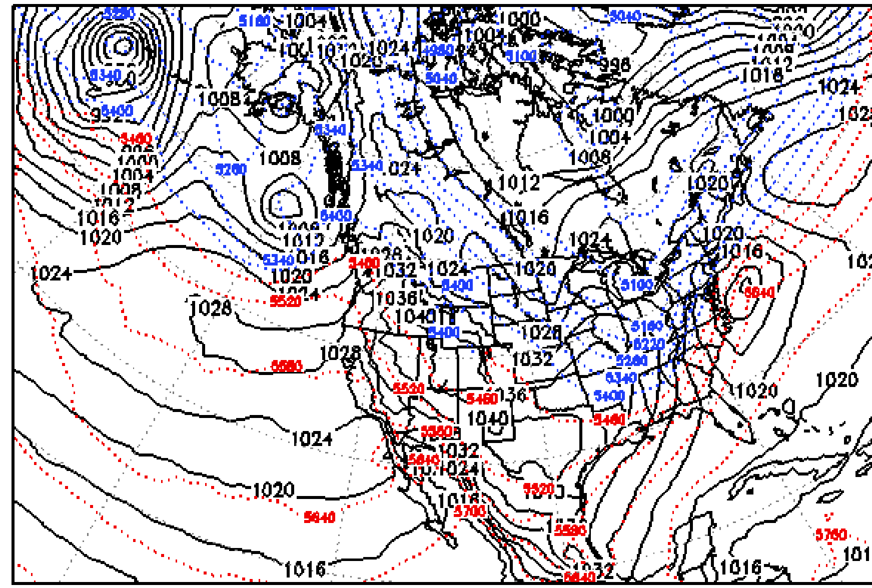

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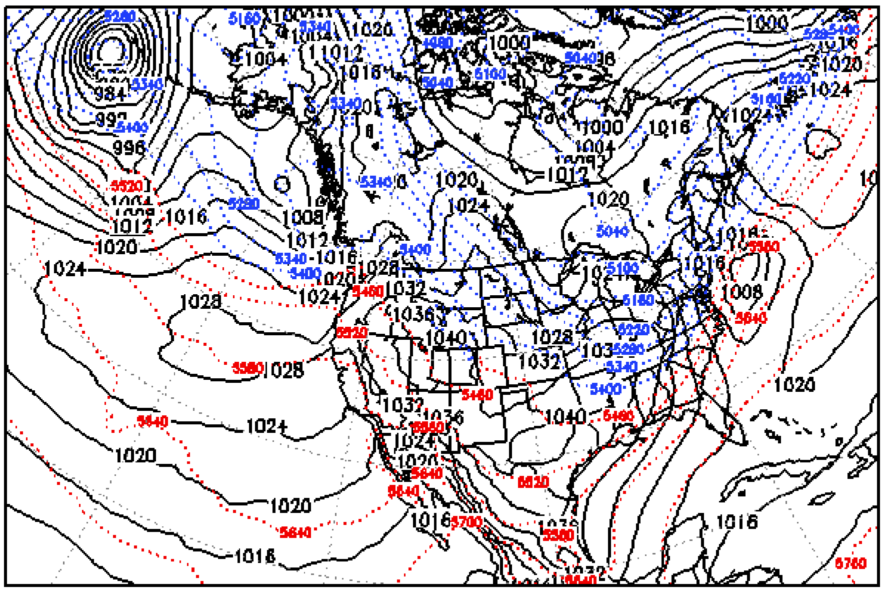

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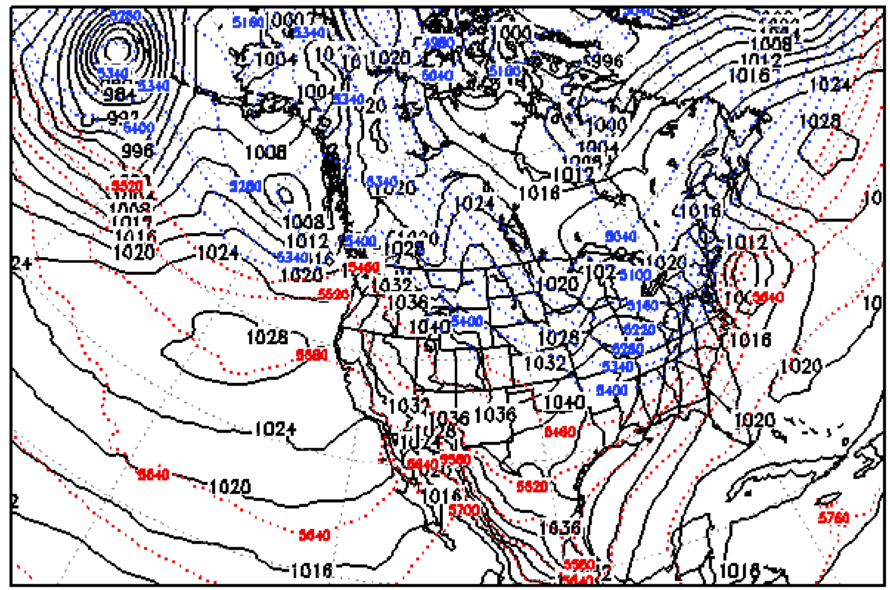

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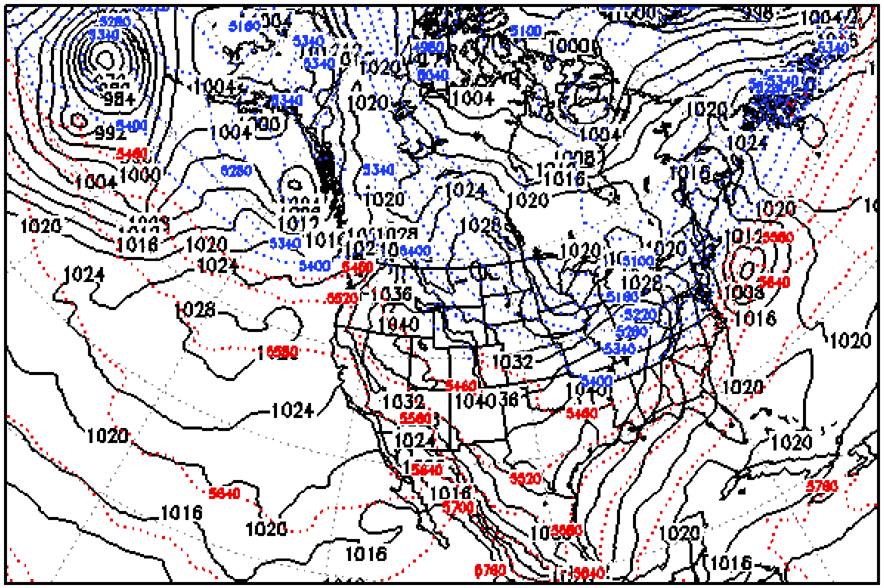

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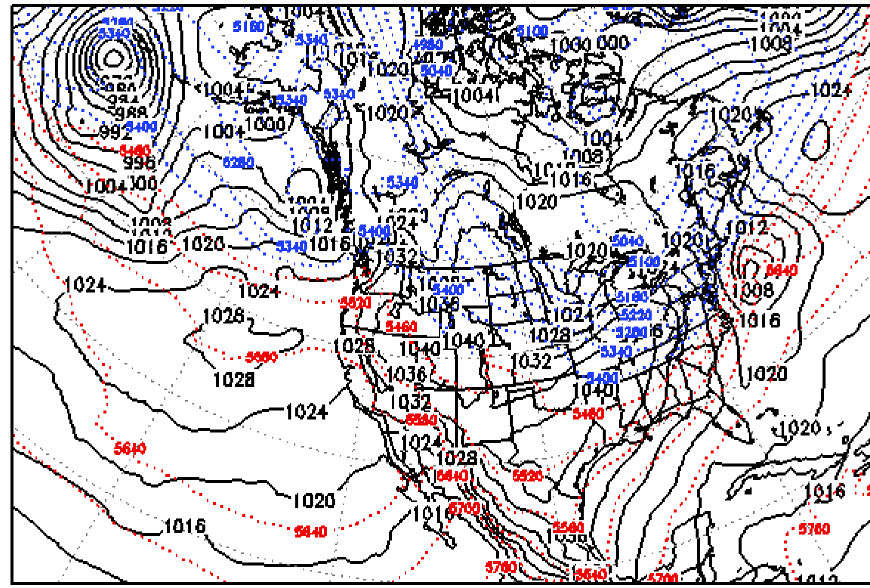

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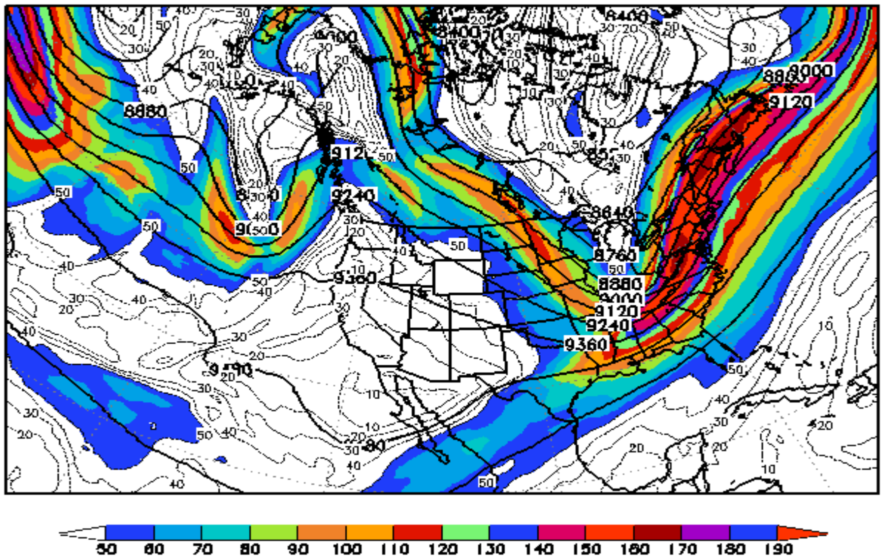

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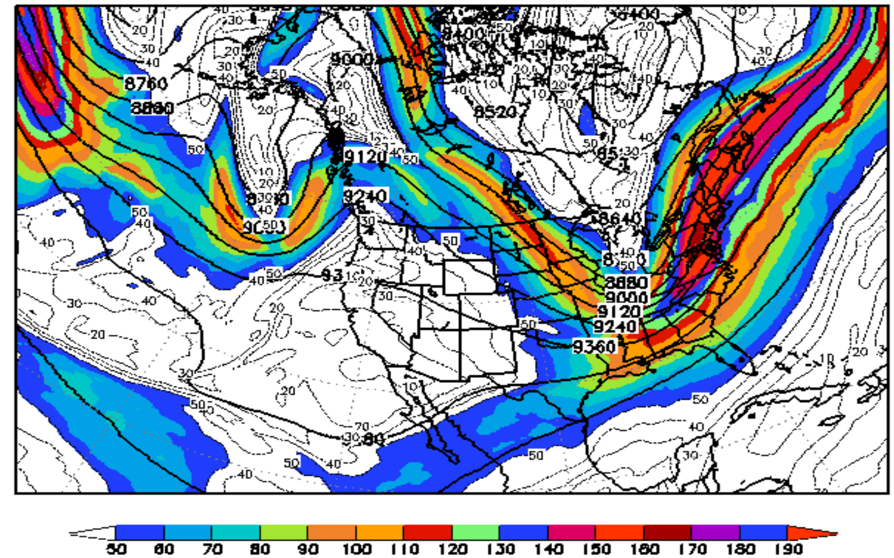

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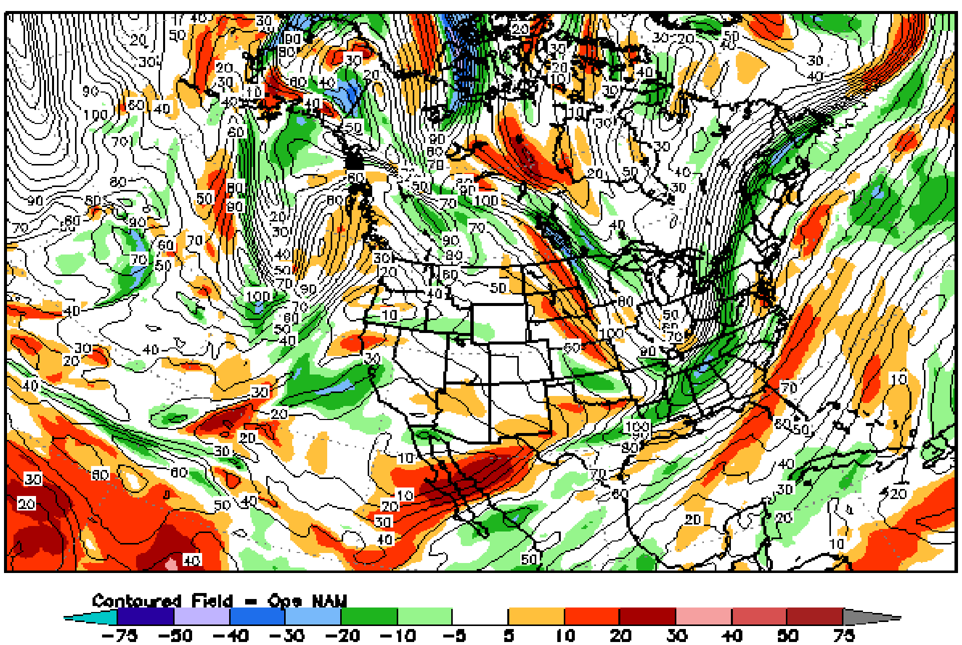

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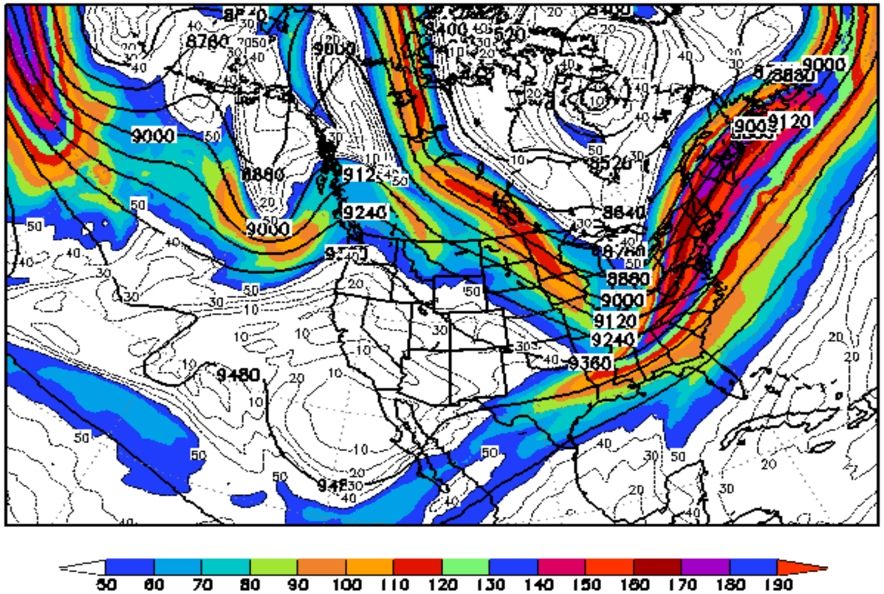

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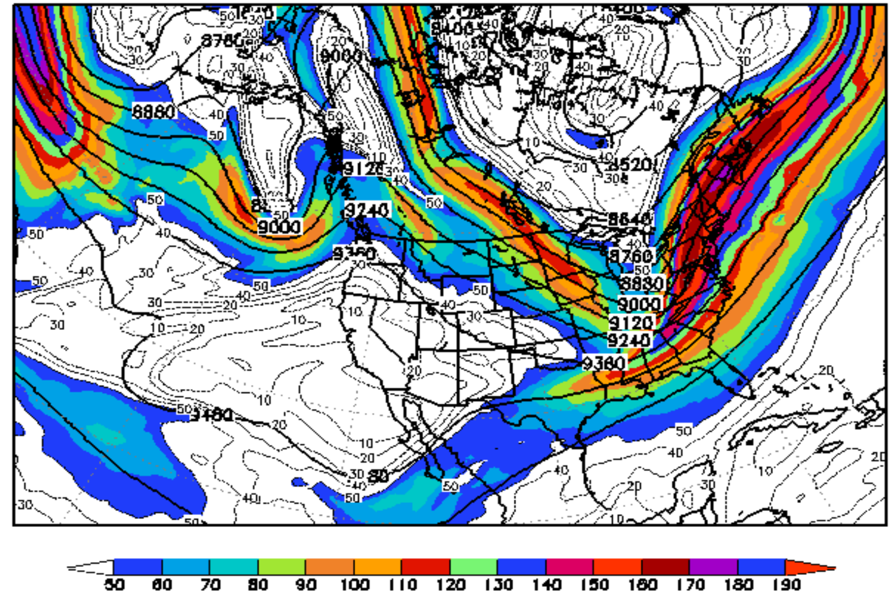

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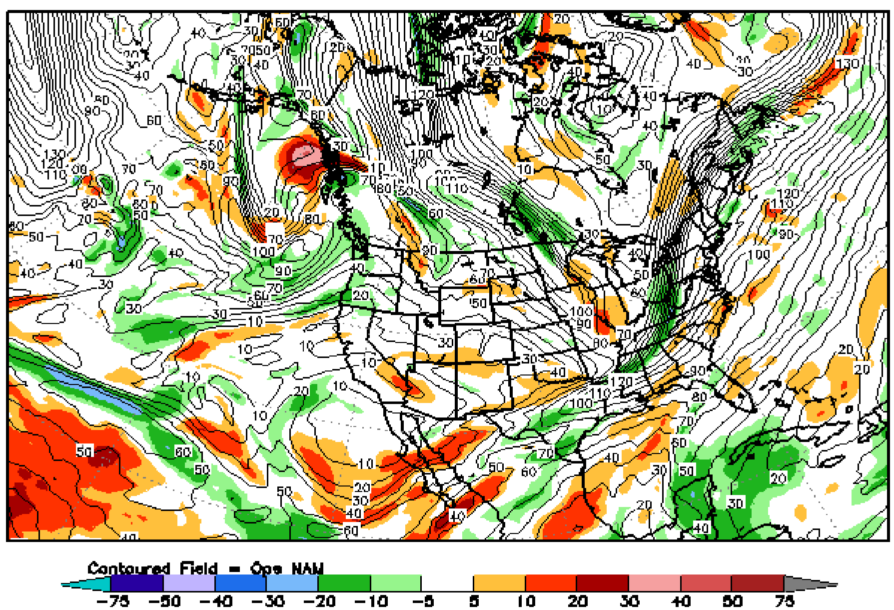

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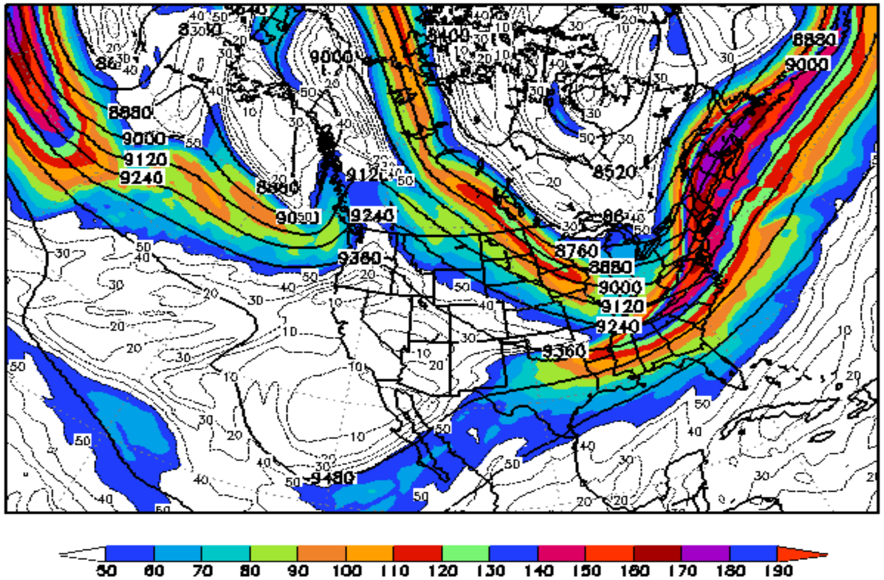

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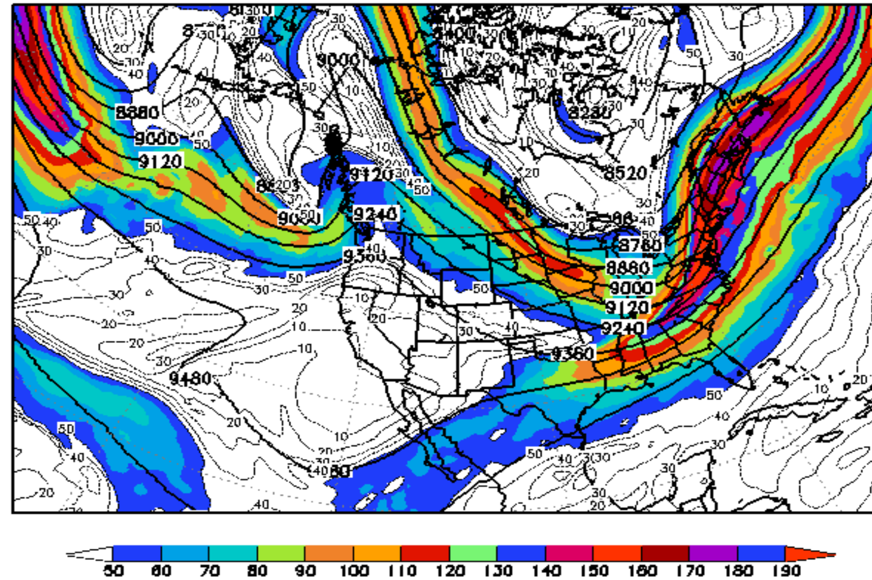

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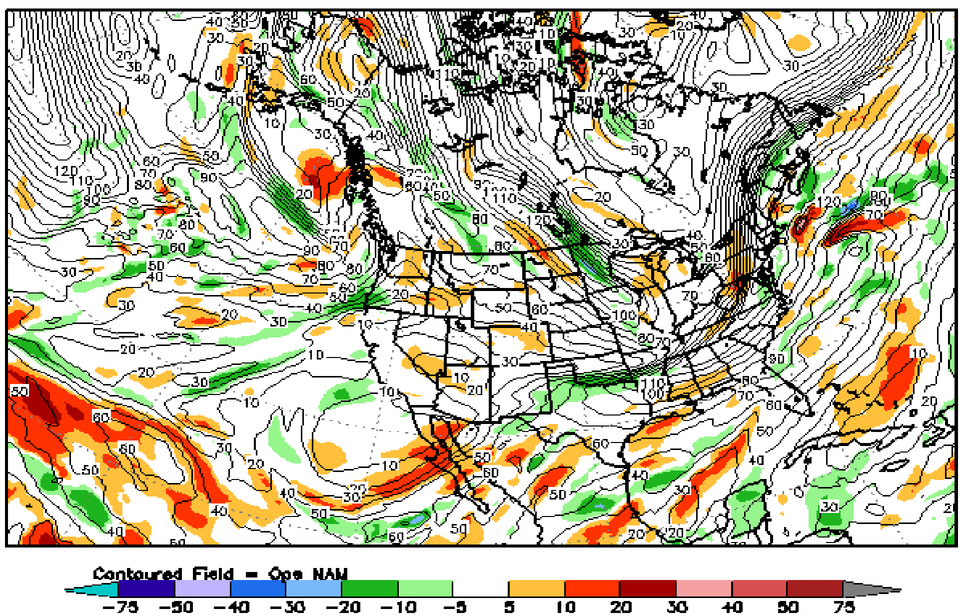

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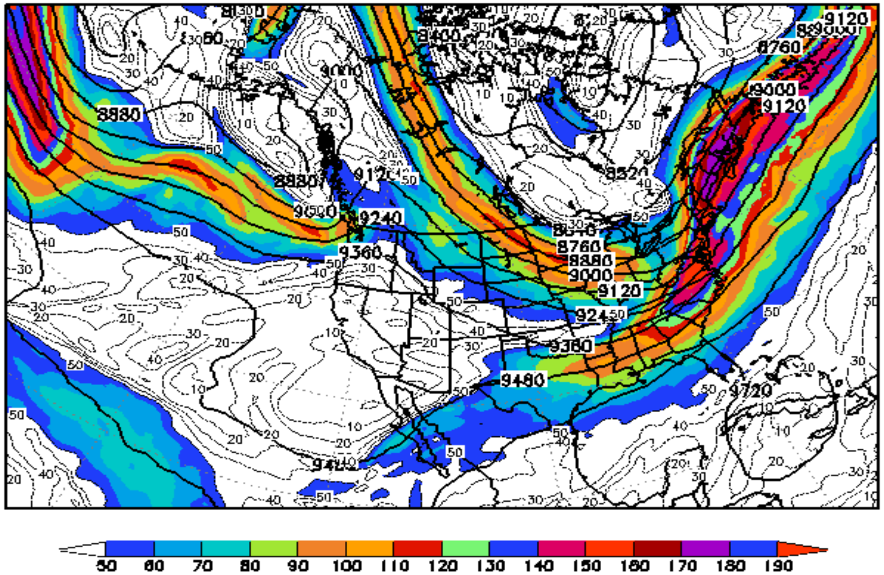

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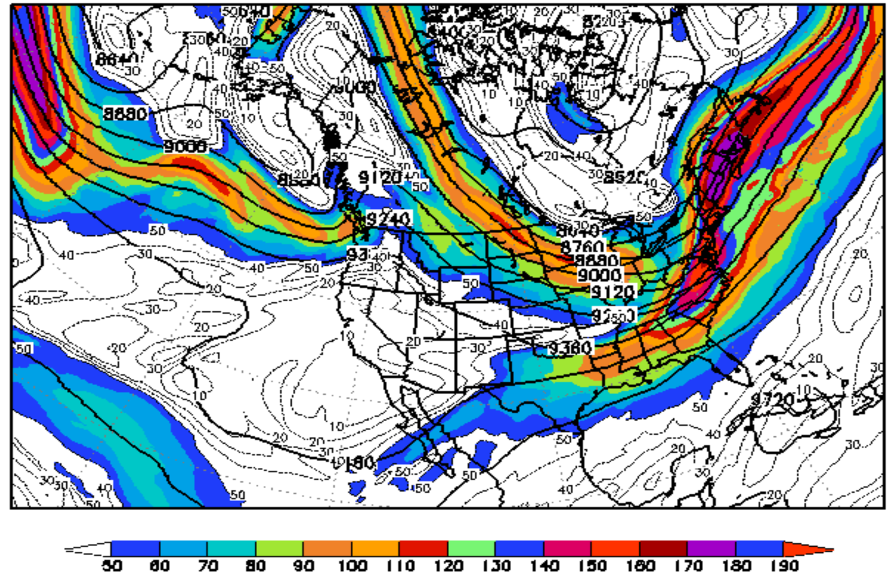

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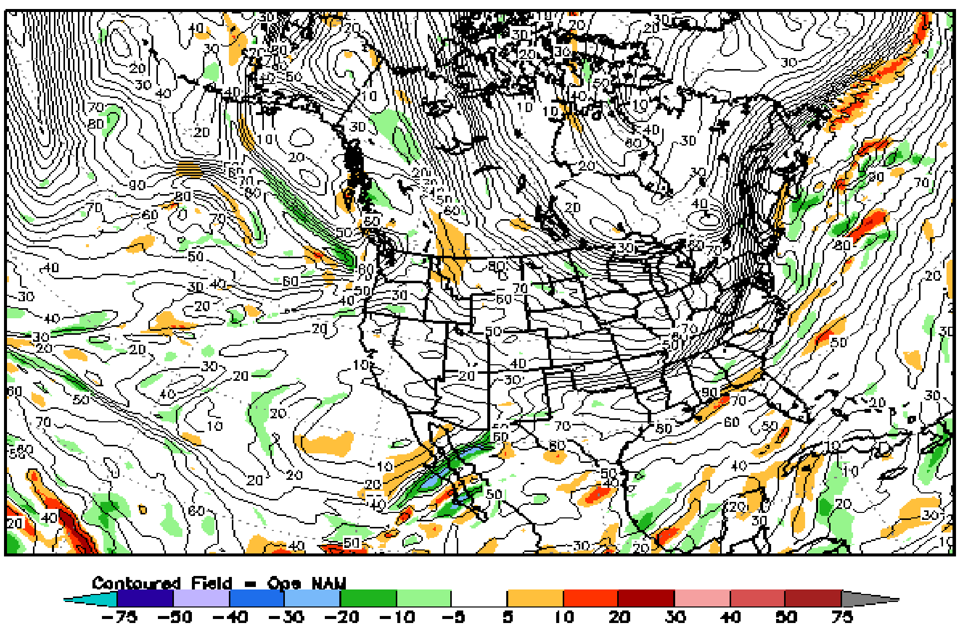
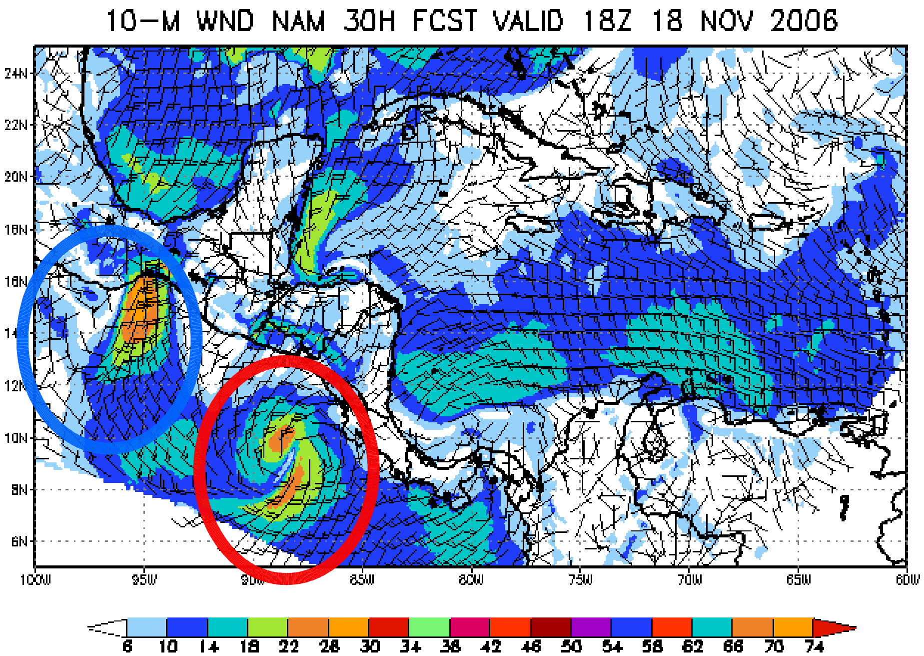
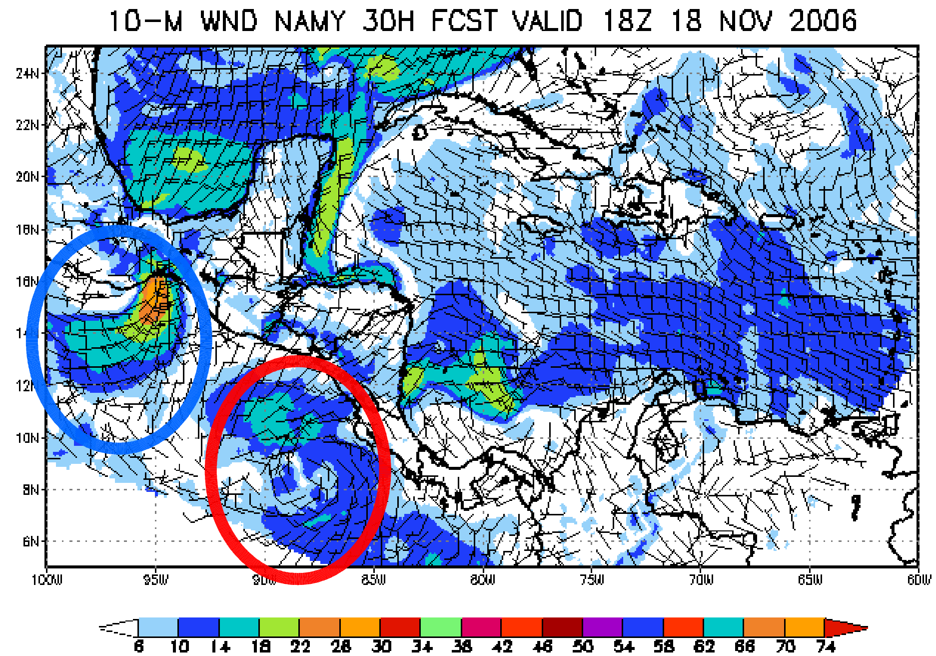


Tehuantepecer Case
NAMY Has No Tropical Circulation in Eastern Pacific (None Observed)



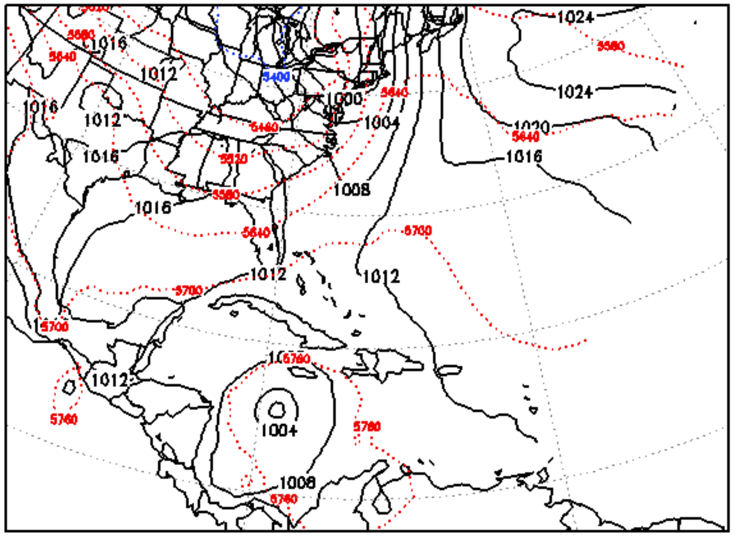


Comment from Lance Bosart, 11/20/06:

In the NAMY 30 h forecast the winds curl anticyclonically westward **over the eastern Pacific along the west side of the cold surge** as is typically seen in the observations (because of the strong gap flow the Coriolis force exceeds the PGF and the winds turn anticyclonically as a result). In the same forecast from the NAM, however, this anticyclonic turning of the winds is missing in favor of a straight shot to the SSW. Is the **boguscane** near 9 N and 88 W in the NAM creating an isallobaric field that is pulling the gap flow more southward?

Unobserved TC eliminated while Observed storm (Sergio) retained

SLP NAM 84H FCST VALID 12Z 17 NOV 2006



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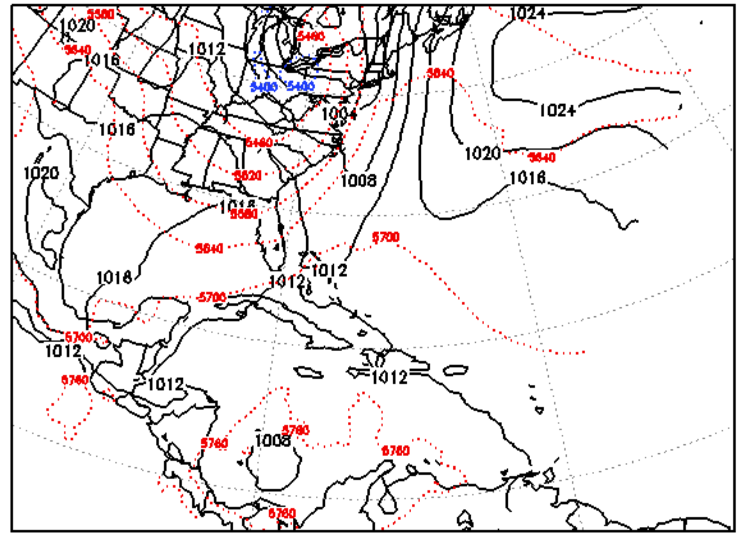

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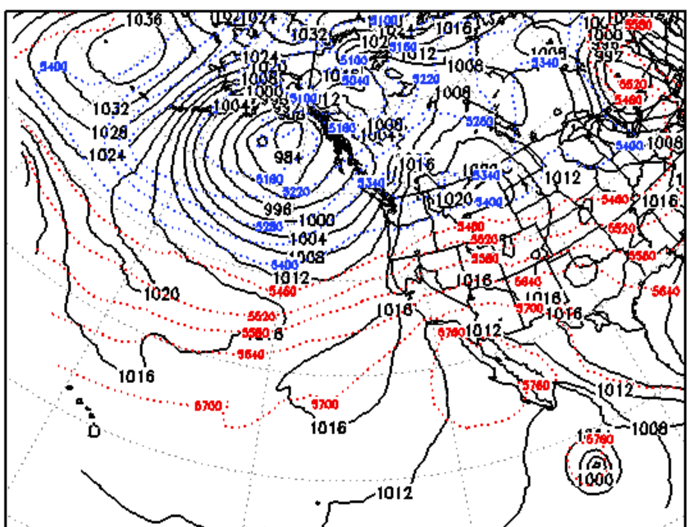

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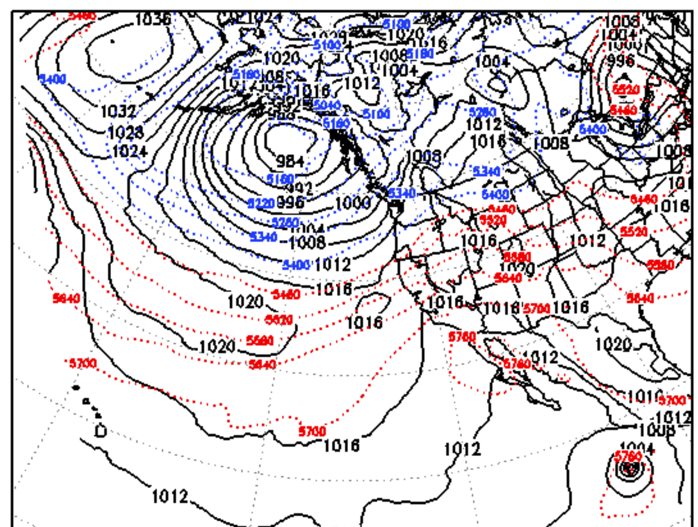

SPC Concurrence

The Storm Prediction Center endorses the proposed EMC-NAM crisis change scheduled for implementation in production on 19 December 2006. The errors EMC have isolated and attempted to address with this change are significant and if not addressed have the potential to adversely effect forecast operations during critical weather events. Results from your parallel testing suggest the changes will significantly mitigate the problems and improve the overall NAM forecasts with no degradation in QPF scores. Modifications to the current convective scheme contained in this crisis change are also welcomed by the SPC.

The SPC supports prompt implementation of the proposed changes.

HPC Concurrence

- Hi, Ed,

  I have reviewed the attachments (not included here) and recommend endorsing these changes.

  Keith Brill

- Geoff - It looks good.   HPC approves. Ed Danaher

AWC Concurrence

Hello Brad, Eric, and Geoff,

Thanks for sending me this information on the upcoming changes to the WRF-NMM running in NAM. I've reviewed the web site verification statistics and they are impressive - the proposed changes will improve the NAM…

The proposed changes to the NAM's BMJ and shallow convection are scientifically sound and it is great to see that the "physics wheel of pain" agrees with you.

AWC is thankful for your effort to improve the NAM.

Steve Silberberg