Mesoscale Modeling Branch: Where We Are and Where We're Going
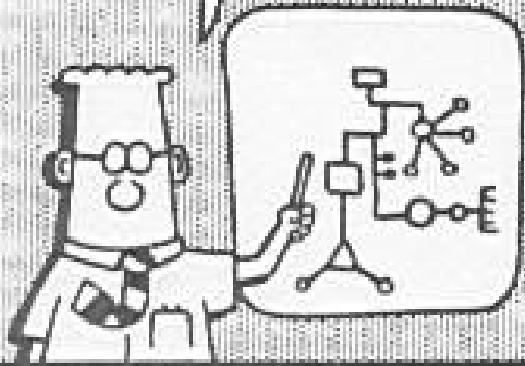
N
C
E
P

Geoff DiMego et al.

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301-763-8000 ext7221

6 December 2005

Where the Nation's climate and weather services begin

- I've tried my very best to avoid this result again this year … 76 vs 152!

Who We Are

One Less Than Last Year - BINB

- Government Scientists
  - Tom Black
  - Dennis Keyser
  - Ying Lin
  - Geoff Manikin
  - Jeff McQueen
  - Dave Parrish
  - Eric Rogers
  - Wan-Shu Wu

- Visiting Scientists
  - Mike Ek
  - Zavisa Janjic
  - Fedor Mesinger

- Contractor Scientists
  - Sajal Kar

- Contractor Scientists
  - Mike Baker
  - Stacie Bender
  - Hui-Ya Chuang
  - Jun Du
  - Brad Ferrier
  - S. Gopalakrishnan
  - Dusan Jovic
  - Pius Lee
  - Curtis Marshall
  - Manuel Pondeca
  - Jim Purser
  - Matt Pyle
  - Perry Shafran
  - Marina Tsidulko
  - Binbin Zhou

T O P I C S

- Recent Changes in Operations
  - 25 January, 2005 – NAM is "born"
  - Observation Processing in 2005
  - FINAL Eta Upgrade package – 3 May
  - Explicit WRF in HiResWindow – 28 June
  - SREF Upgrade + Add 6 WRF members - 31Aug + 6 Dec
  - Air Quality Forecast System & Interim Smoke Product-June & Oct

- Development Efforts & Other Projects
  - WRF-NMM progress towards Eta replacement
  - RTMA = Real-Time Mesoscale Analysis (OSIP is a 4-letter word!)
  - Dominant Precipitation Type

- Plans for the Future [liberally interspersed above]

# January 25, 2005
BIG Day for NCO

- NCEP's Operational Production Suite moved to new computer system (White in Fairmont, WV Blue in Gaithersburg, MD)

- NAM is born: Operational Eta forecast system officially renamed North American Mesoscale (NAM) forecast system; Eta Data Assimilation System (EDAS) renamed NAM Data Assimilation System (NDAS)

Observation Processing in 2005

Data require constant attention – this is a fraction of the year's activities

- January 25: Aircraft qc inc AMDAR + new European AMDAR=E-ADAS; mobile sfc syn land & E-ADAS

- January 25: Mesonets, GPS-IPW, RASS Tv, CAP winds, JMA profiler and sensible weather for verif

- January 25: Aqua/Terra MODIS sat-winds

- January 25: new job AIRNOW O_3 from EPA; Profiler CQC upgrade;

- January 25: new BUFRLIB release

- February 22: qc for inc drifting buoys, NAVY + NESDIS SST from AVHRR

- April 19: tide gauge data

- April 26, 2005: HIRS-3 from NOAA-15-17

- May 03, 2005: 88D Level 2.5 radial winds

- May 03, 2005: Add 3 Mesonets

- May 31, 2005: The GFS and GDAS analyses were modified to assimilate Aqua AIRS IR and AMSU-A brightness temperatures.

- June 7: Hi-res EUMETSAT vis+cld-top wtr vpr sat-winds; Japanese IR, vis+wtr vpr sat-winds; and GOES IR, vis+wtr vpr winds

- June 21: AMSU-A from NOAA-15-17 + NCO's web-based Real Time Data Monitoring System

- June 28, 2005: RUC13 analysis of Mesonets (not wind), RASS Tv and GPS-IPW

- July 12: add Alaska DOT Mesonet &AIRNOW O_3

- July 13, 2005: elim'd drops near trop cyc & adj'd GOES layer prcp water retrvls SSM/I TCPW.

- July 21: JMA's MTSAT-1R sat-drvd winds.

- August 17: LDM-to-LDM & add 4 new Mesonets & soil moist tension and soil temp

- August 10+23+31:raob radiation correction & RSS

- August 23+26:NOAA-18 HIRS-4,MHS+AMSU-A

- August 23, 2005: Hi-res EUMETSAT clr sky (deep layer) water vapor satellite-derived winds

- September 27: USGS River and Stream flow NESDIS POES sst, AVHRR brtns temp and albedo; NAVY POES hi-res sst, AVHRR brtns temp+albedo; NAVY POES phys sst retrvl; and NESDIS POES phys sst retrvl (GSI analysis)

- October 11: GOES clr sky (imager) brtns temp, 1hr & 8hr AIRNOW O_3, NOAA-18 ATOVS SBUV O_3

- October 18 & 26: ATOVS retrvls and AVHRR 1B, AIRS + AMSR-E radiances, NOAA-15-17 HIRS-3 and NOAA-18 HIRS-4

- November 29: NOAA-17 SBUV layer+tot O_3, NOAA-18 AMSU-A brt temps & Aqua/Terra MODIS sat-derived IR and water vapor winds

- December 6: GOES clear sky (imager) brightness temps; trop cyclone vitals + AIRNOW O_3

- December 13: WSR-88D Levl II wind & reflctvty

ACARS Observation Density
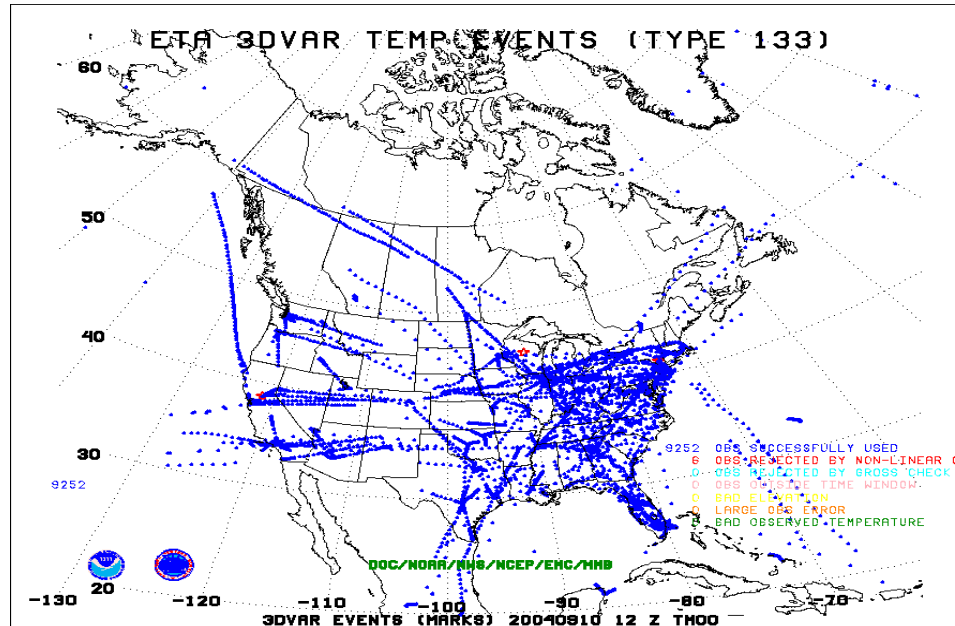
- **New aircraft QC package ready this year**

- **Stacie Bender adapted from NRL package**

- **Includes an improved track-check**

- **Ascent/descent reports output as profiles**
  - **For use in validating boundary layer etc**
  - **For use in grid-to-obs verification**
  - **Much more continuous in time than 00z/12z RAOBs**

NCEP

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

Mesoscale Modeling Branch

Geoff DiMego and Eric Rogers

28 April 2005

http://www.emc.ncep.noaa.gov/mmb/briefings/

http://www.emc.ncep.noaa.gov/mmb/mmbpll/Spring2005.NAMUpgrade_newweb/Spring2005.NAMUpgrade.html

8

where the nation's climate and weather services begin

Spring NAM Upgrade Package

1. ## 3DVar Analysis

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

2. ## Precip Assimilation - Ying Lin

3. ## NAM Prediction Model (Eta Model)

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

4. ## NAM Output Products

   Brad Ferrier, Geoff Manikin, Mike Ek, Ying Lin
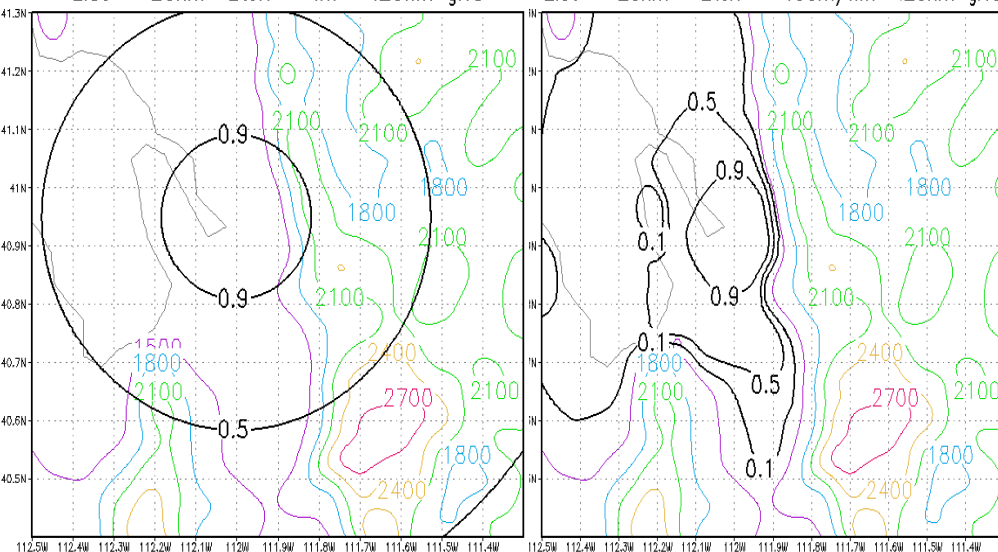
Spring NAM Upgrade Package: 1. 3DVar

- Use of on-time overland <u>surface temperature</u> observations turned back on
  - Using 2DVar with anisotropic covariance tied to terrain
  - All off-time sfc data & all on-time overland sfc temps were turned off in September 2003
- Use of <u>Level 2.5</u> (on-site derived superobs) of WSR-88D radial velocity

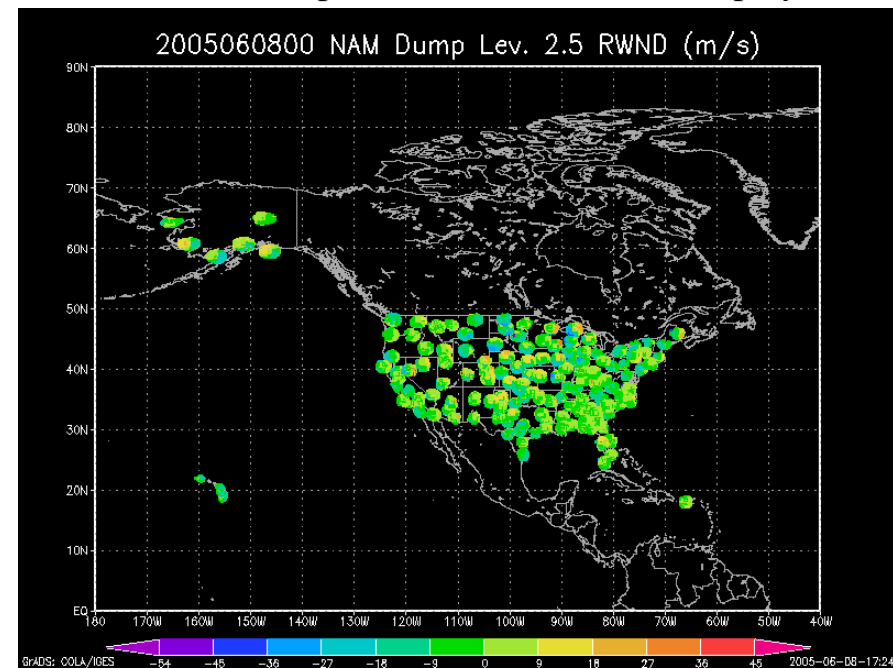<u>Isotropic</u> Correlation: ob's influence extends up mountain slope

<u>Anisotropic</u> Correlation: ob's influence restricted to areas of similar elevation

<u>Over 1M reports after Build 6.1 Fix Deployed</u>

Liso = 25km   Lterr = inf   .25km grid

Liso = 25km   Lterr = 400m/km   .25km grid

2005060800 NAM Dump Lev. 2.5 RWND (m/s)

Spring NAM Upgrade Package:
2. Simplified Precipitation Assimilation

- Use observed precipitation directly in driving the land surface model

- No attempt to create precipitation when model is less than observed

- Continue to reduce latent heat and moisture fields when model precipitation is greater than observed

- Continue bias correction of observed precipitation

Impact of Simplified Precipitation Assimilation

<u>Neutral to slightly positive</u> impact on QPF precipitation scores and near surface & upper air forecast fit to observations

<u>More-moist soil</u> – old method tends to have a dry bias during assimilation because model precipitation did not exactly reproduce the observed QPF
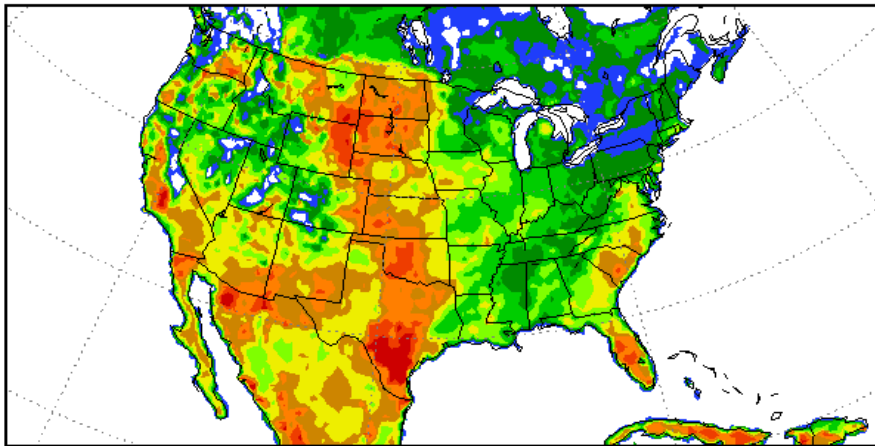
<u>More robust</u> - some previous EDAS failures linked to attempts to create precipitation not forecast by Eta

NAM

0-100cm MOISI AVAIL NAM 00H FCSI VALID 00Z 20 APR 2005
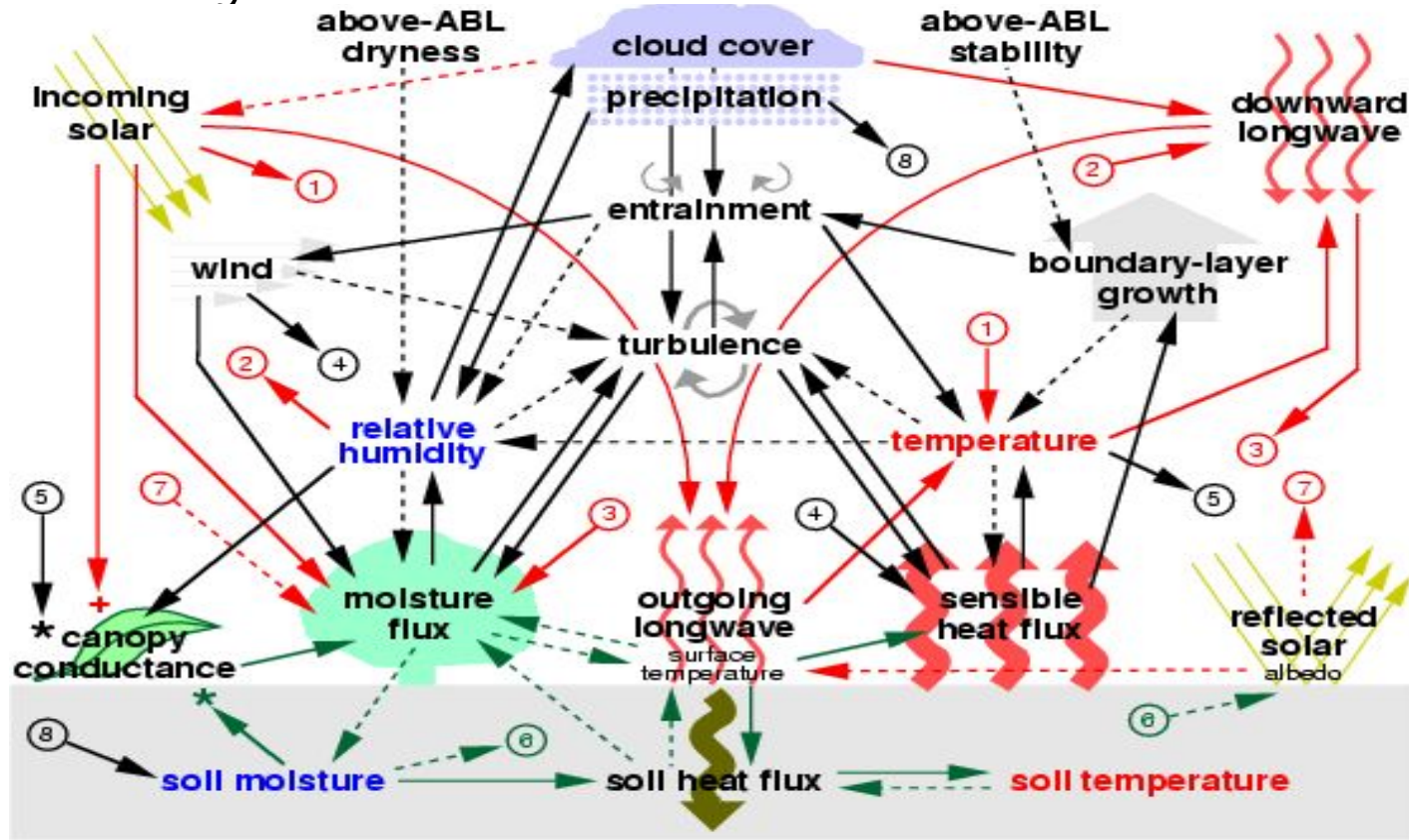
NAMX – wetter

0-100cm MOISI AVAIL NAMX 00H FCSI VALID 00Z 20 APR 2005
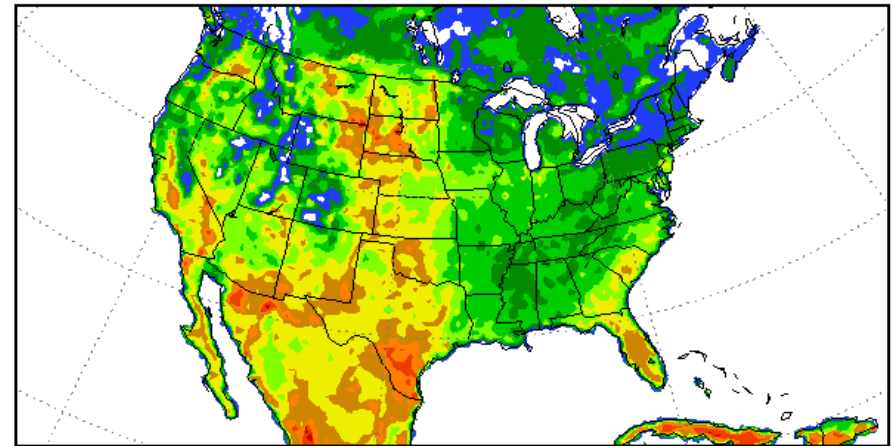
Spring NAM Upgrade Package:
3. Prediction Model (Eta Model)

- Changes to Eta Model involved clouds & cloud-radiation interactions AND land-surface physics - thus invoking the Physics Wheel of Pain

+ positive feedback for C3, C4 plants, negative feedback for CAM plants
★ negative feedback above optimal values

surface layer/ABL processes → positive feedback
land-surface → radiation → negative feedback

Spring NAM Upgrade Package: 3a. Land-Surface Model

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

LSM changes mostly relevant to warm season

- <u>High-resolution</u> vegetation & soils data bases with <u>more</u> classes - Unifies with WRF
- Retuned canopy conductance & other vegetation parameters
- Lowered roughness length for heat to reduce skin temperature + diagnosed 2-m air temp

  Result in:

- Reduced temperature biases in East & West
- Moistened - fine in West, too moist in East
- Eliminated PW drift

LSM changes mostly relevant to cold season

- For patchy snow cover, changes to parameters:
  - snow cover fraction (less snow depth for 100% cover)
  - snow albedo (yields higher)
  - surface skin temperature (higher via non-snow cover)
  - snow sublimation (reduced)
- Surface emissivity (for snow only):
  - Lup = εs σ T^4, εs = 1.0, 0.95, 0.90.
- PBL: in very stable conditions when PBL depth diagnosed as lowest Eta model level, impose lower limit on eddy diffusivity up to (+ one level above) inversion lvl

Result in:

- Slightly reduced night time cold bias

Spring NAM Upgrade Package: 3b. Gridscale Cloud

- Modified radiation scheme to "see" <u>thicker clouds</u> by removing upper limit for cloud water mixing ratio when computing optical depths
- Modified cloud cover fraction formulation to allow for <u>more partial cloudiness</u> (had been too binary)
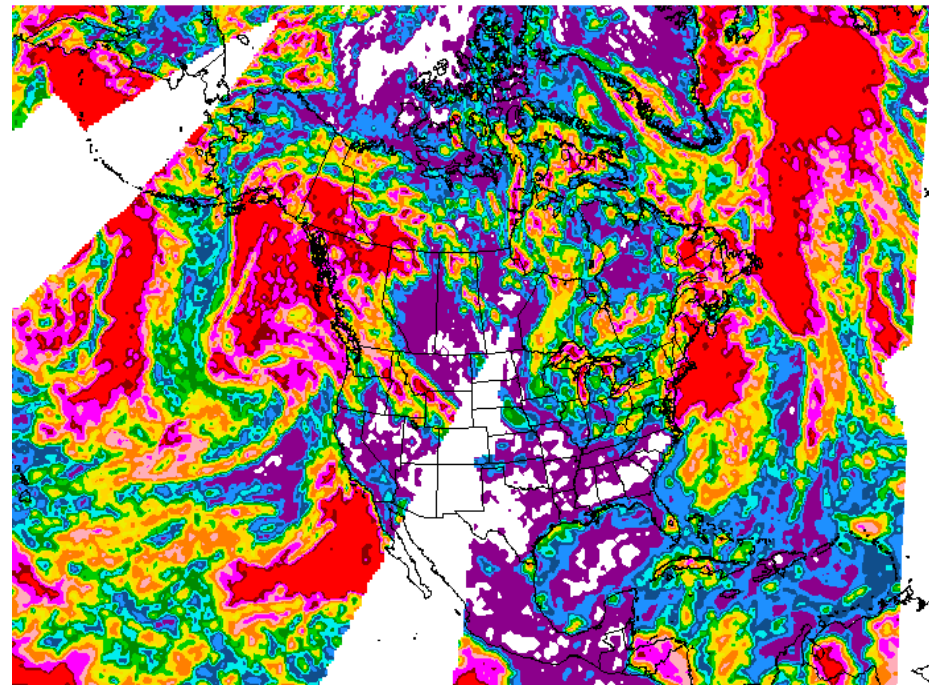- Tuning aided by comparisons with <u>AFWA and CLAVR</u> total cloud

AFWA
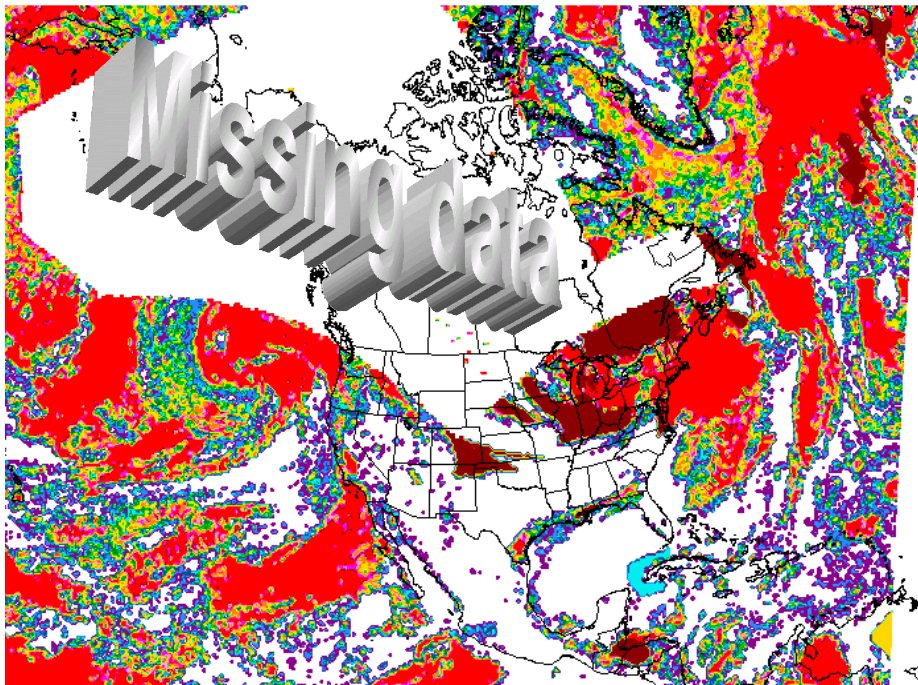
CLAVRx

Spring NAM Upgrade Package: 4. Output Products

- **Improved <u>surface visibility</u> by including conv. precip rate**
- **Added clear-sky radiation fluxes for use by the AOF System**
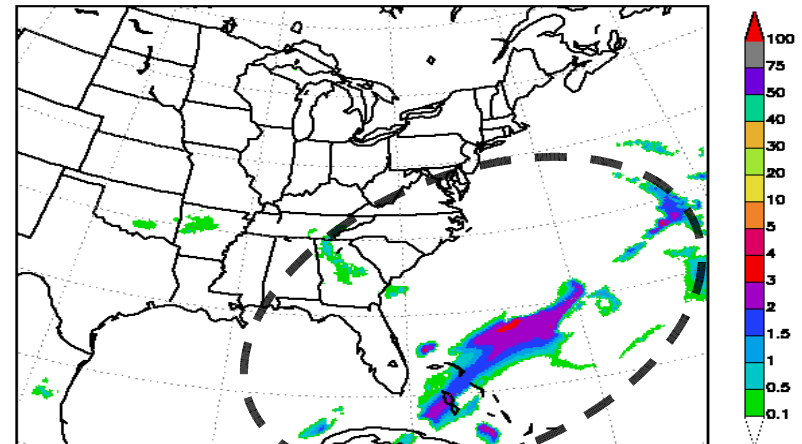

VISIBILITY (KM) NAM 24H FCST VALID 00Z 01 MAR 2005
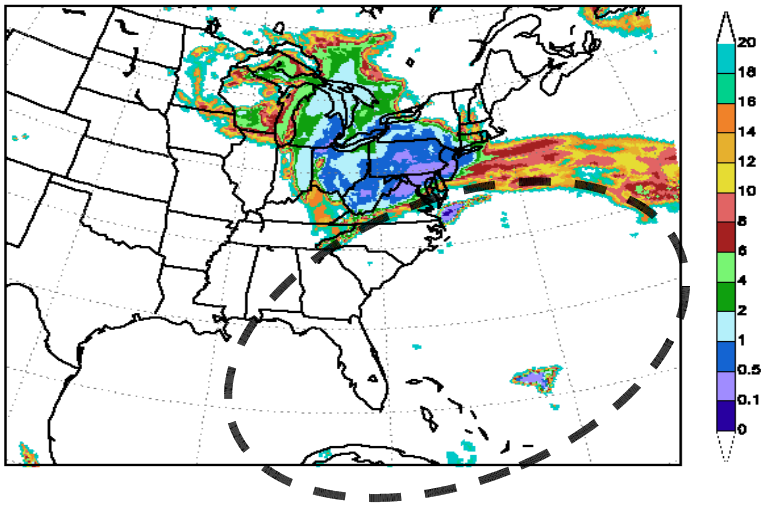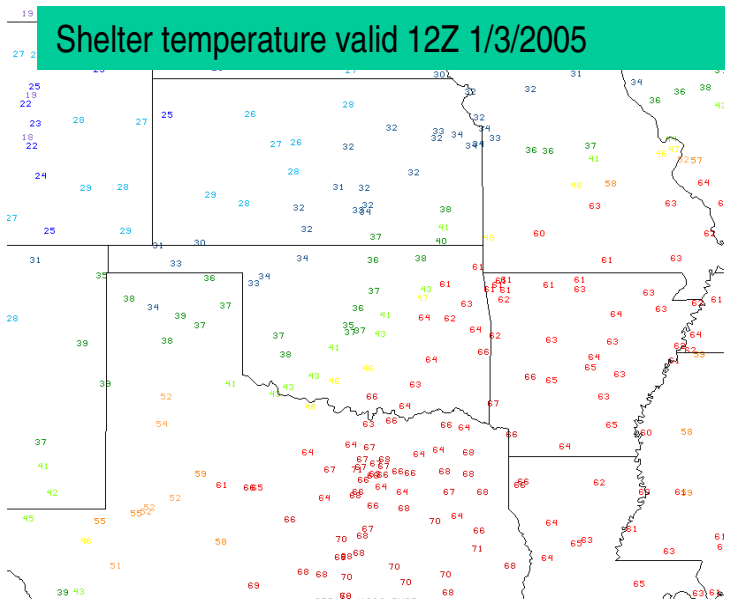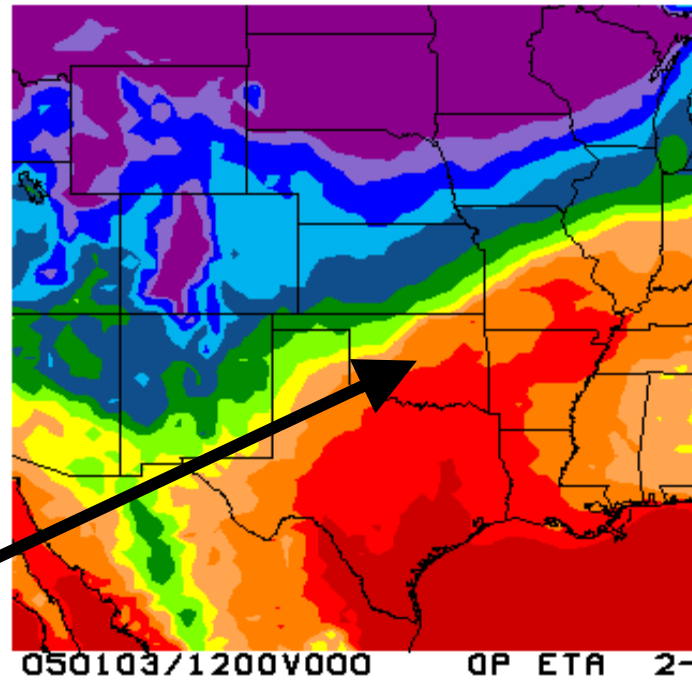

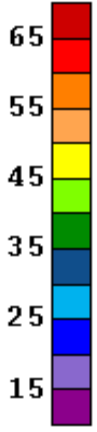VISIBILITY (KM) NAMX 24H FCST VALID 00Z 01 MAR 2005
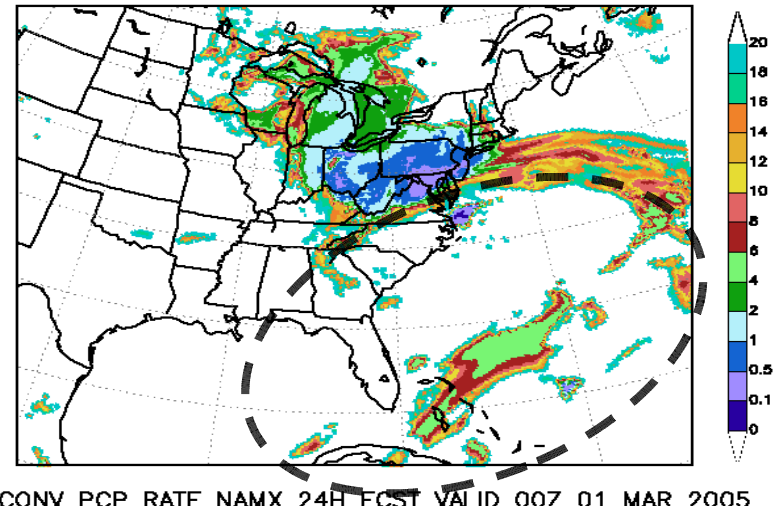
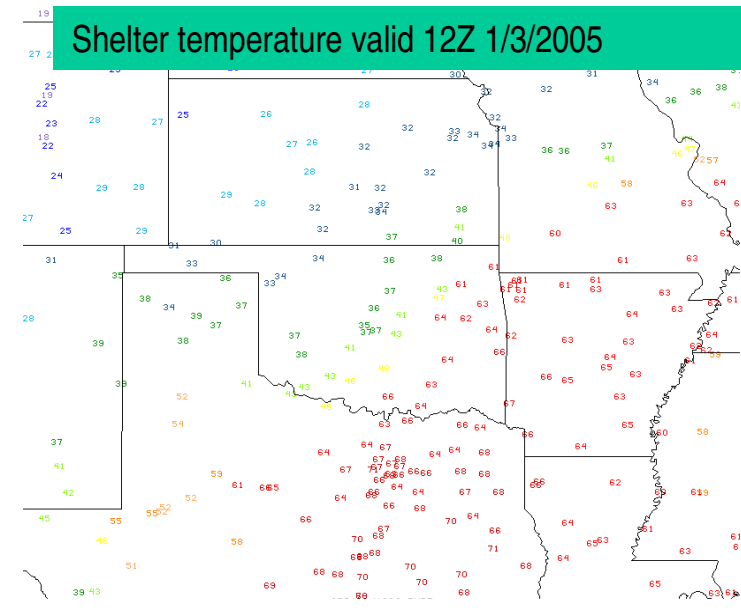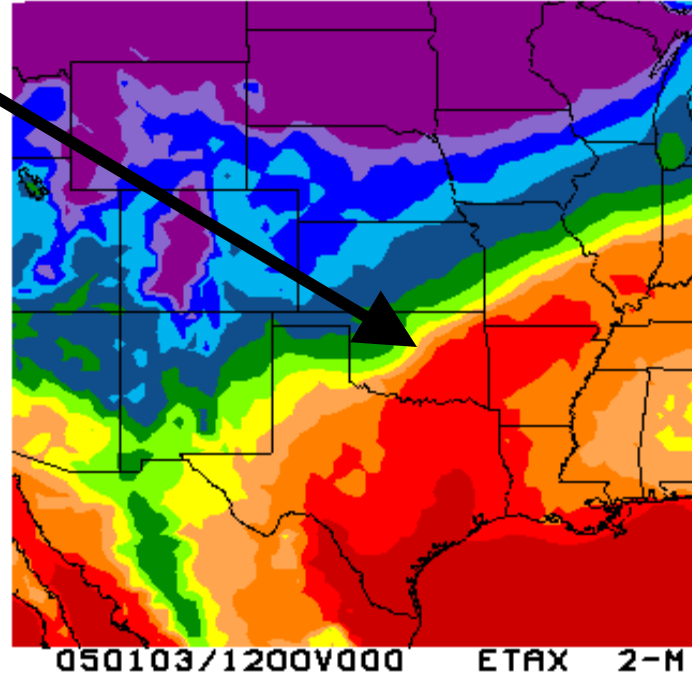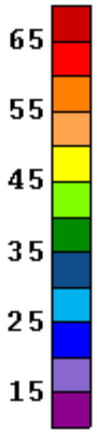CONV PCP RATE NAMX 24H FCST VALID 00Z 01 MAR 2005

Convective precip accounted for in NAMX, but not in NAM in the Stoelinga-Warner visibility computation

January Frontal Case
Rogers & Manikin

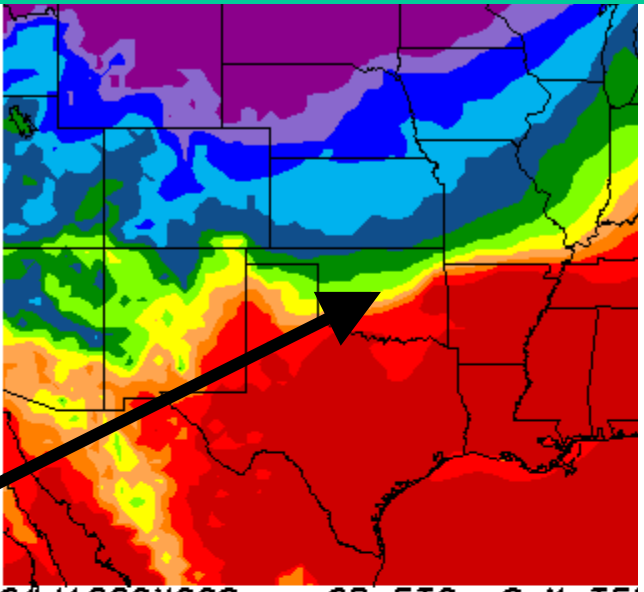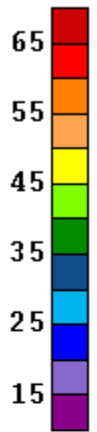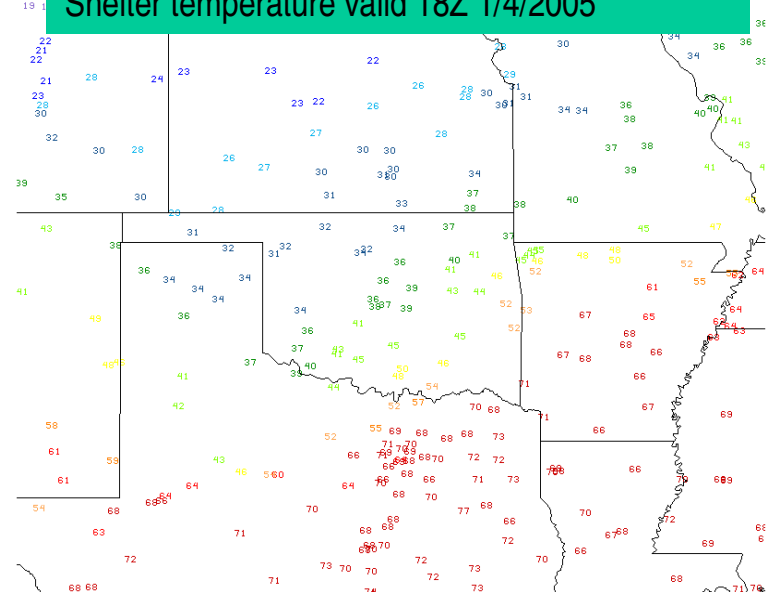Improved frontal position in ETAX initial conditions
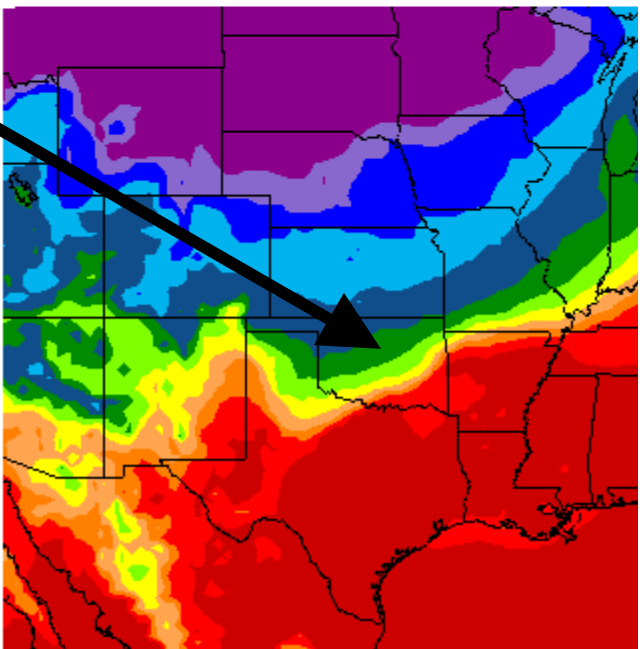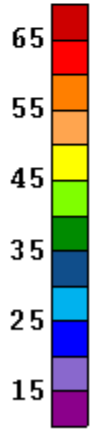
January Frontal Case
Rogers & Manikin

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

Shelter temperature valid 18Z 1/4/2005

Improved frontal position in ETAX 30 hr forecast
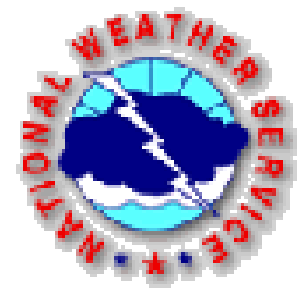
Shelter temperature valid 18Z 1/4/2005
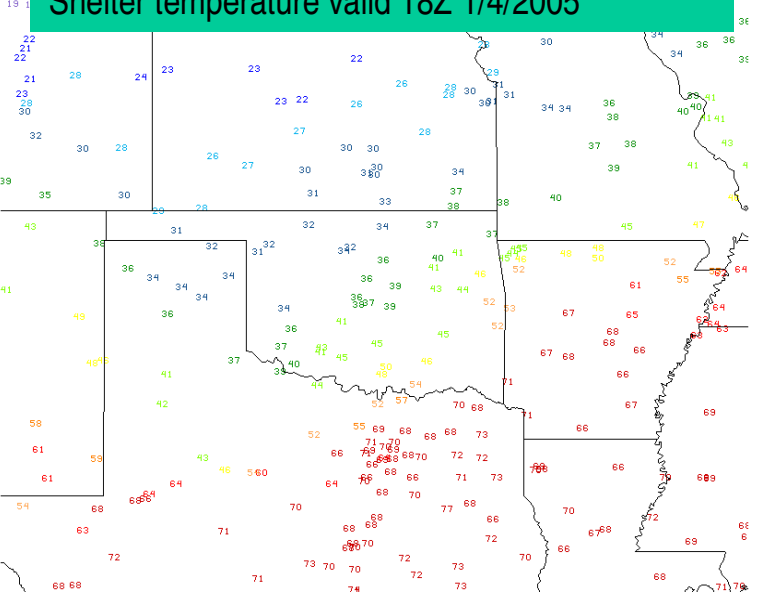
Testing,Verification & Evaluation

- NAM vs NAMX Verification
  - Summer :
    - 17 July – 31 August 2004
    - NDAS-only spin-up started 15 June 2004
  - Winter :
    - 14 Dec 2004 – 20 March 2005
  - Spring :
    - 21 March - 24 April 2005
- DGEX vs DGEXX Verification
  - Two parallel cycles/day
    - 00z Alaska
    - 06Z CONUS
  - Winter :
    - 1 January – 20 March 2005
  - Spring :
    - 21 March -24 April 2005

- 3DVar changes
  - Sfc Temps: no negative impact, safe to turn back on
  - L2.5 88D winds: minimal impact on performance statistics
- Precip Assimilation
  - More robust, more accurate & more soil moisture
- Prediction Model changes
  - Cloud and radiation: more partial cloudiness and better absorption
  - LSM changes: soil & veg better defined, reduced 2-m temperature biases, less drying trend with more low level moisture overall
- Impacts to DGEX minor but generally positive
- Three NCEP Service Centers (HPC, SPC, AWC) recommend implementation as proposed

Real-Time Parallel Stats Pages

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

1. PRECIPITATION THREAT AND BIAS SCORES

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

CONUS, 24-h forecasts	CONUS, 36-h forecasts	CONUS, 48-h forecasts	CONUS, 60-h forecasts	CONUS, 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel

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

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

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

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

※

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

3. NEAR-SURFACE STATISTICS

Verification Regions:

Alaska →

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

June 2005 Upgrade Package for High Resolution Window (HRW) Decision Brief

N C E P

Mesoscale Modeling Branch

Geoff DiMego, Eric Rogers and Matt Pyle

24 June 2005

http://www.emc.ncep.noaa.gov/mmb/mmbpll/June2005.HRWUpgrade/June2005.HRWupgrade.html

where the nation's climate and weather services begin

June 2005 Upgrade Package Background – What Changed

- Original Milestone: add 4 more WRF runs to the HiResWindow slot in early FY2005 …
  - Abrupt loss of critical scientist working on the WRF ensemble breeding cycle

- Success of three recent experiments using explicit (4-5 km) configurations of the WRF model with no convective parameterizations
  - BAMEX 2003
  - SPC/NSSL Spring Program 2004 & 2005
  - DTC Winter Forecast Experiment 2005

June 2005 Upgrade Package The New Plan

- Push limits of computer to maximum resolution

- WRF-ARW: from 10km/50lev to 5.8km/35lev

- WRF-NMM: from 8km/60lev to 5.1km/35lev

- Not ideal but sufficient to <u>turn-off</u> calls to convective parameterizations

- WRF Ensemble was still promised - 6 WRF members to be added to SREF by Q4 FY2005

June 2005 Upgrade Package Validation of New Plan

- NCEP Director was briefed 27 May and a "vetting of the plan" was requested

- EMC polled NWS Regions & NCEP Service Centers concerning new plan

- Responses received were all positive:
    - NCEP: AWC, HPC, SPC
        - TPC, CPC don't really use but had no objections
    - NWS: CR, WR, SR (ER & CR were evaluators)

Original WRF H~i~R~es~W~indow~ Nested Runs

21 Sept 2004 Became WRF Runs of **Two** Control Configurations
WRF-ARW at 10km/50levels **and** WRF-NMM at 8km/60levels

- <u>FOUR</u> routine runs made at the same time every day

- 00Z : Alaska & Hawaii

- 06Z : Western & Puerto Rico

- 12Z : Central & Hawaii

- 18Z : Eastern & Puerto Rico

- Everyone gets daily high resolution runs of **both** WRF controls **_if & only if_** GFDL hurricane runs are <u>not</u> needed

http://www.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/
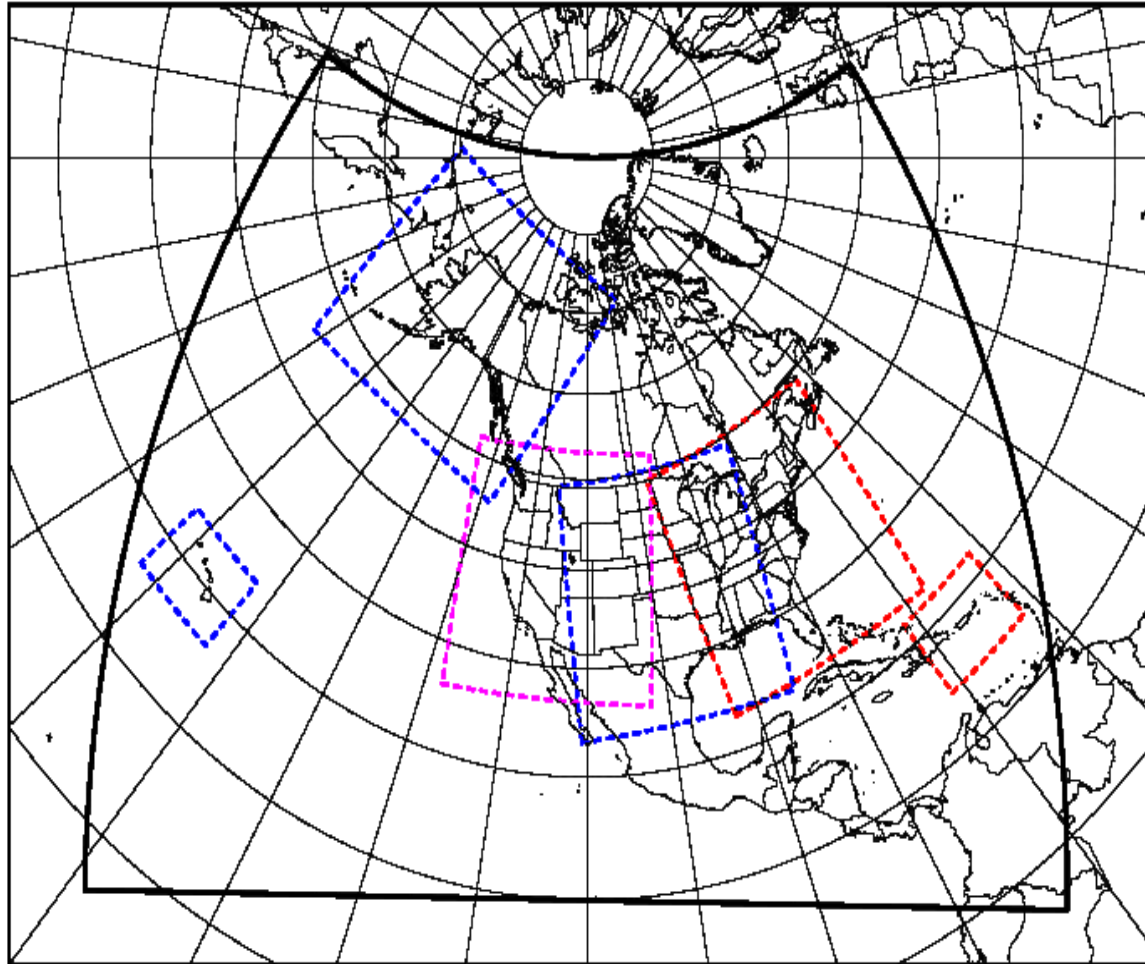
Alaska domain is smaller than depicted

New WRF H_iR_{es}W_{indow} Nested Runs

28 June 2005 Become **Explicit** WRF Runs of Two Control Configs
WRF-ARW at **5.8km**/35levels and WRF-NMM at **5.1km**/35levels

- <u>FOUR</u> routine runs made at the same time every day

- 00Z : Alaska & Hawaii

- 06Z : Western & Puerto Rico

- 12Z : Central & Hawaii

- 18Z : Eastern & Puerto Rico

- Everyone gets daily high resolution runs of **both** WRF controls ***if & only if*** GFDL hurricane runs are <u>not</u> needed

http://www.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/
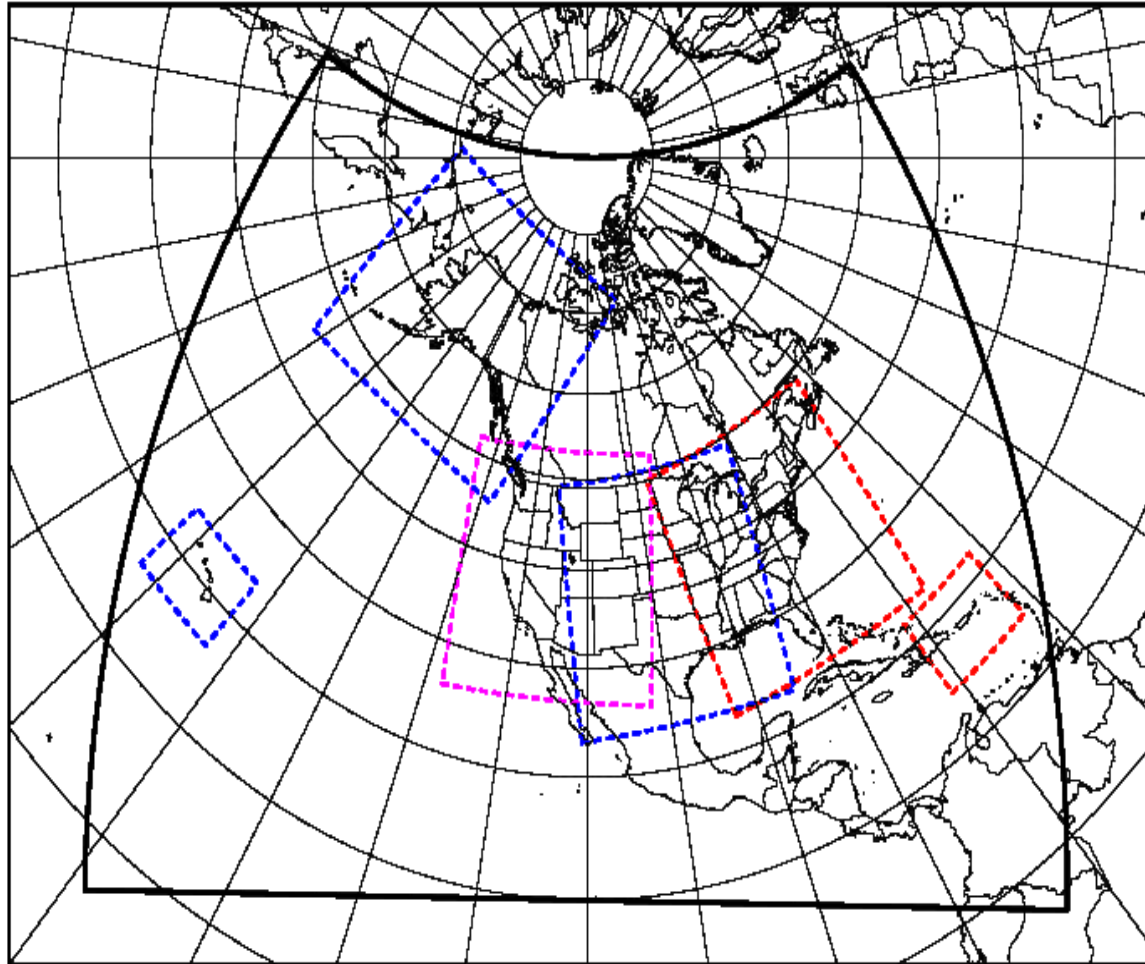
Alaska domain is smaller than depicted

Prior Experience: BAMEX

Bow-Echo

And

MCV Experiment

WRF-ARW only

BAMEX Success:

Mode of Convection

Project Location: MidAmerica Airport, Illinois
Project Dates: 20 May to 6 July 2003

This catalog is in POST FIELD SEASON MODE

Please see the Data Archive Master list for available datasets.

Prior Experience: SPC/NSSL Spring Programs 2004 & 2005

- EMC made special WRF-NMM Runs Beginning in April 2004, EMC ran:
  - 4.5 km version of its WRF-NMM
  - Without calls to parameterized convection
  - Initialized off 12 km Eta (at 40 km resolution)
  - Daily runs to 30 hours from 00z
  - Central & Eastern US domain
- SPC requested that this run be continued as long as possible – and it is ***still*** running!

Domains of Integration for Spring Program

NCEP NMM (red/orange), NCAR (blue), CAPS (cyan)

2005

2004
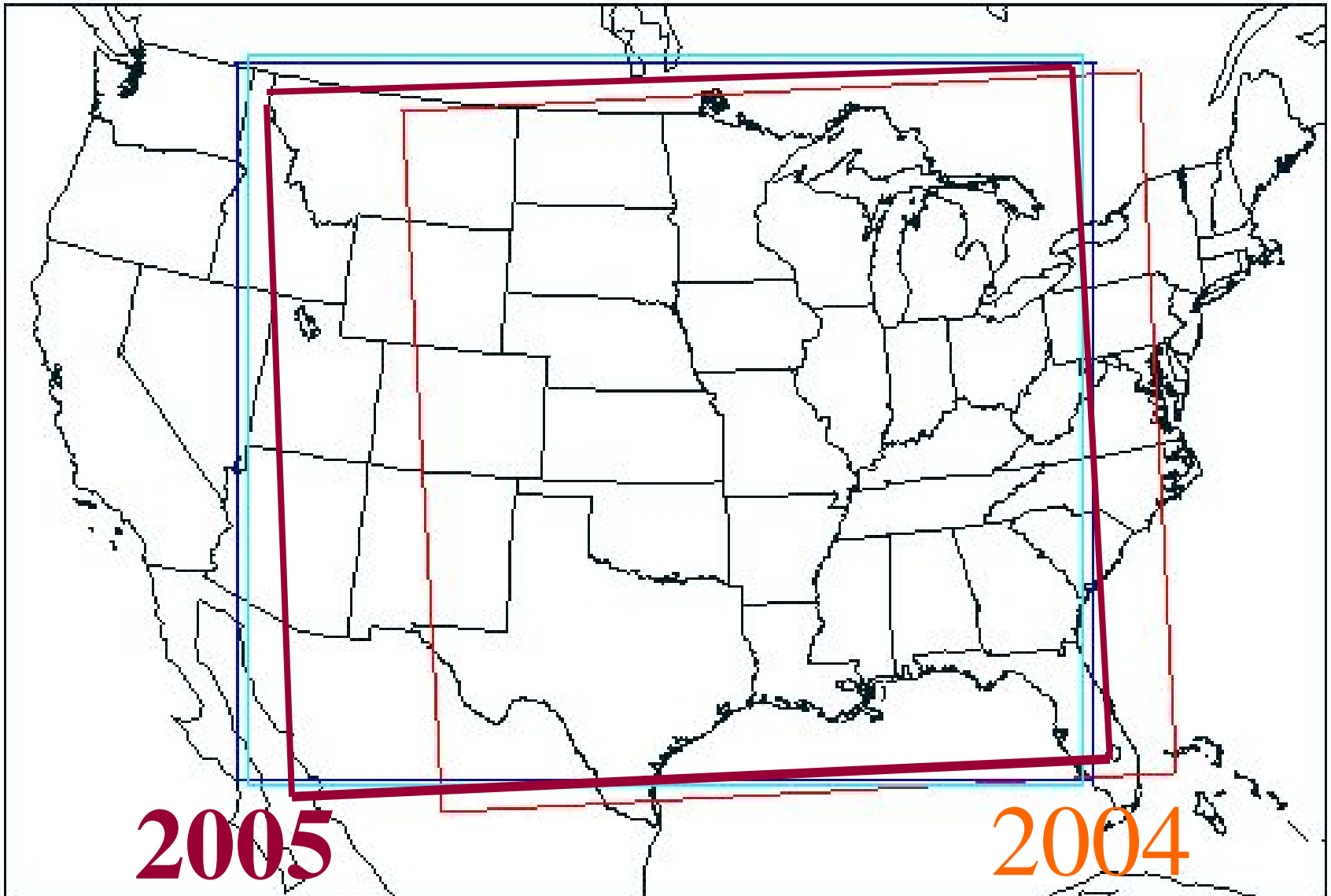
Matt Pyle Webpage Now Displaying Simulated Reflectivity
http://www.emc.ncep.noaa.gov/mmb/mmbpll/cent4km/v2/

1 h Precipitation totals (in.)

01h	02h	03h	04h
05h	06h	07h	08h
09h	10h	11h	12h
13h	14h	15h	16h
17h	18h	19h	20h
21h	22h	23h	24h
25h	26h	27h	28h
29h	30h	31h	32h
33h	34h	35h	36h
0-36h	NMM WRF Loop		

Simulated radar reflectivity, lowest model level (dBZ)

00h	01h	02h	03h
04h	05h	06h	07h
08h	09h	10h	11h
12h	13h	14h	15h
16h	17h	18h	19h
20h	21h	22h	23h
24h	25h	26h	27h
28h	29h	30h	31h
32h	33h	34h	35h
36h	NMM WRF Loop		

Simulated composite radar reflectivity (dBZ)

30 hour forecast valid 06z 6 December, 2005

051206/0600V030   35   HYBL   REFD
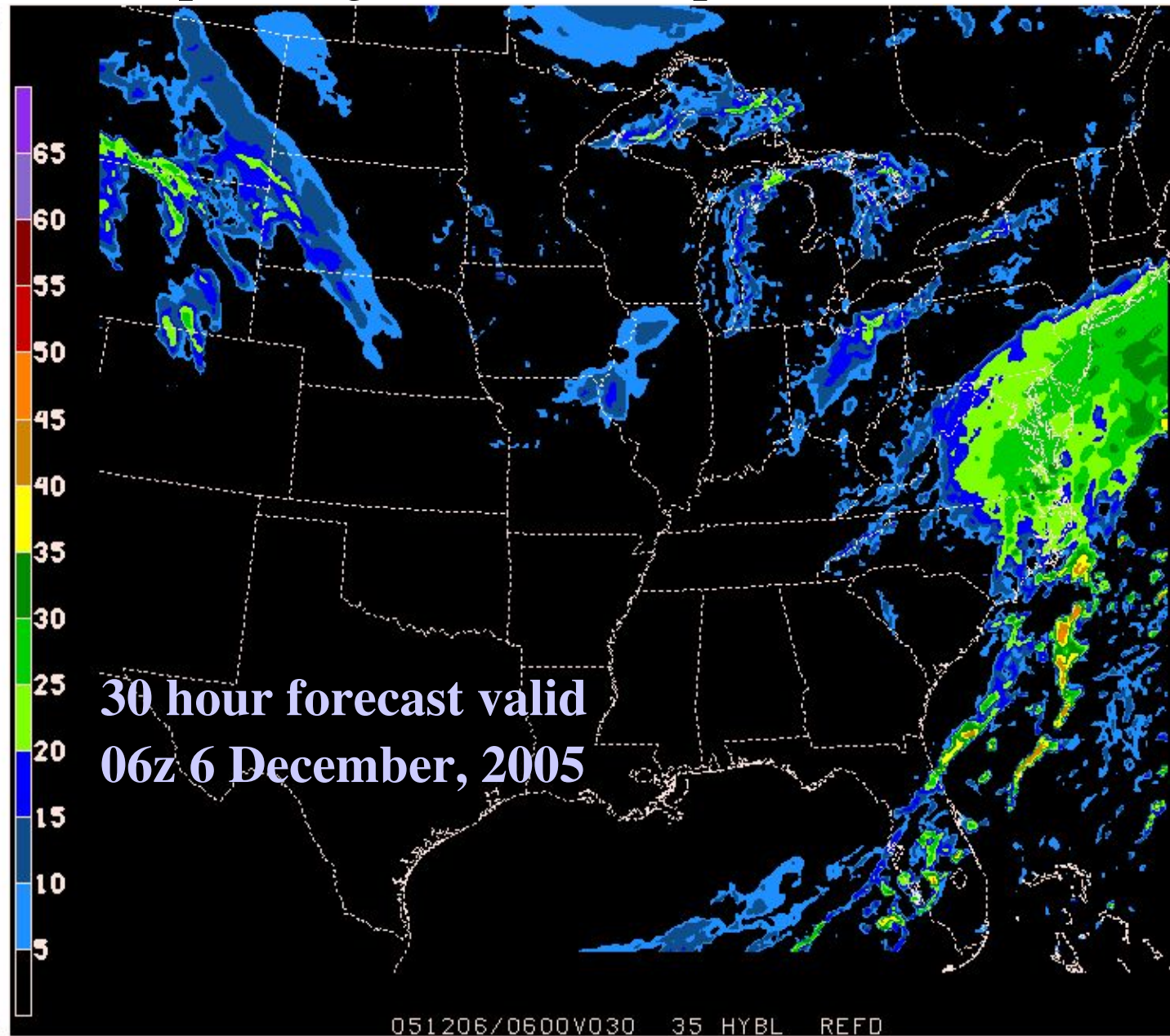
Prior Experience: DTC Winter Forecast Experiment (DWFE)

- Cold season (Jan-Mar 2005) runs
  - Both cores/controls run between NCAR & FSL
  - 5 km resolution over full CONUS domain
  - Explicit configuration with no parameterized convection
  - Forecast fields distributed to NWS offices via FXNet
  - Full verification against observations & gages

Phenomena Simulated/Forecast by DWFE WRF Model Runs

- Narrow <u>Reflectivity</u> Bands
  - Lake Effect snowbands
  - Cold frontal band

- Topographically forced Pressure Waves and Snowbands

- <u>Reflectivity</u> Structures in Marine Boundary Layer
  - **Pacific Marine Stratus**
  - **Atlantic Cloud Streets**
  - **Gulf Mesoscale Cellular Convection**

- Mesoscale vortex over Lake Erie

Composite Reflectivity (dBZ)

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
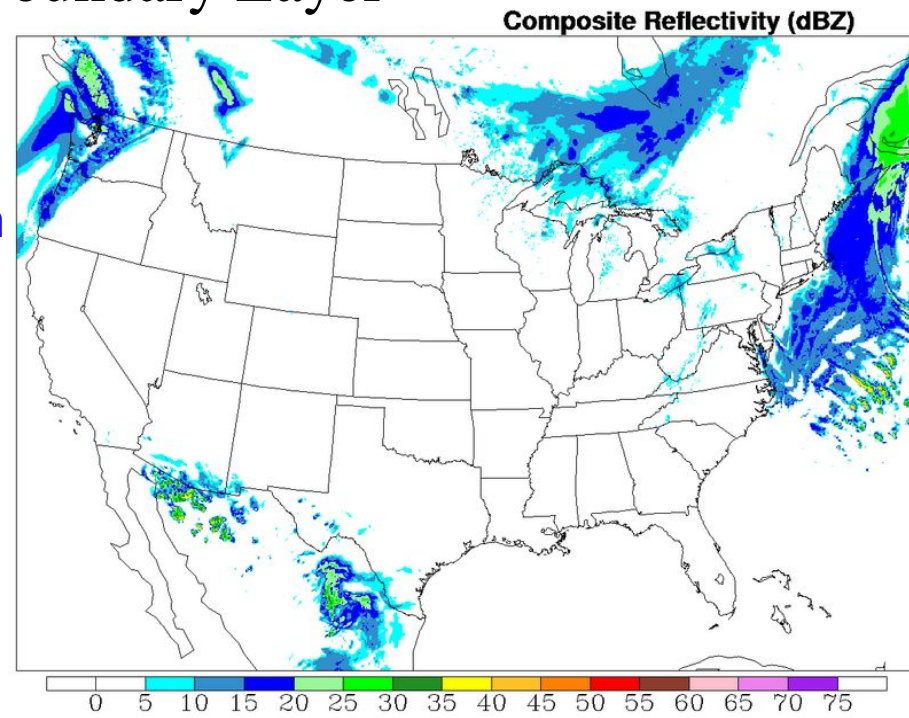
DWFE Forecaster Feedback

Pluses

- Allowed forecasters to gain experience using high-resolution WRF model output over a large domain in an operational fashion
- AWIPS and FX-Net display capabilities
- Novel radar reflectivity product
  - First time presented for winter weather
  - Useful for real-time verification against radar data
  - Made visualization of mesoscale features easier
- The ability to forecast mesoscale structures
  - Lake effect snow bands and other bands
  - Interaction of winter systems with terrain
  - Details offered HPC "tremendous advantage" over operational QPF
  - Predicted timing and placement of snowbands

Minuses

- Conflicts with IFPS during active weather
- Only one run per day and 48h forecast too short a duration (limiting factors at HPC and for populating 5-km NDFD grids)
- Overprediction of orographic snowfall and in regions of instability (e.g., cold air outbreaks over Gulf Stream)
- WRF models tend to forecast features similar in appearance to (but with much greater detail than) the Eta model, to which they are slaved
- Global model forecast errors feed directly into errors in forecasts of fine-scale details in WRF models after a few hours
- Multi-scale display of upper-level fields?

35

http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll /hiresw5km.east08/index.html

SLP, 1000-500 mb Thickness

NMM Loop	EM Loop	NMM5 Loop
EM5 Loop	NMM/EM Loop	NMM5/EM5 Loop
NMM/NMM5 Loop	EM/EM5 Loop	

Total Precipitation (in)

NMM Loop	EM Loop	NMM5 Loop
EM5 Loop	NMM/EM Loop	NMM5/EM5 Loop
NMM/NMM5 Loop	EM/EM5 Loop	

Total Precipitation (in) Regional Loops

NMM North Loop	NMM Lakes Loop	NMM South Loop
EM North Loop	EM Lakes Loop	EM South Loop
NMM5 North Loop	NMM5 Lakes Loop	NMM5 South Loop
EM5 North Loop	EM5 Lakes Loop	EM5 South Loop
NMM/EM North Loop	NMM/EM Lakes Loop	NMM/EM South Loop
NMM/NMM5 North Loop	NMM/NMM5 Lakes Loop	NMM/NMM5 South Loop
NMM5/EM5 North Loop	NMM5/EM5 Lakes Loop	NMM5/EM5 South Loop
EM/EM5 North Loop	EM/EM5 Lakes Loop	EM/EM5 South Loop

24-H Accumulated Precipitation (in)

06-30h	18-42h

NCEP Parallel HiResWindow (HIRESW) Runs - Eastern U.S. Domain

The current forecast cycle is 18Z 10 JUN 2005 ; graphics finished at Sat Jun 11 06:06:10 GMT 2005

Loops of the following WRF HIRESW runs are displayed on this page:

- Ops 8 km Non-hydrostatic Meso Model (EASTNMM)

- Ops 10 km WRF Eulerian Mass (EM) dynamic core (EASTEM)

- Parallel 5 km NMM (EASTNMM5)

- Parallel 5 km EM (EASTEM5)

THESE GRAPHICS ARE FOR THE Eastern U.S. DOMAIN

DISCLAIMER : This web page is not "operational" and therefore not subject to 24-h monitoring by NCEP's Central Operation

For more info on the HiResWindow runs, email Eric Rogers at *eric.rogers@noaa.gov* or Geoff DiMego at *geoff.dimego@n...*

Get the HIRESW forecasts for the previous 7 days here (link opens a new v...

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
X	X	X	X	X	X	X

Disclaimer

NWS' ER & CR plus NCEP's SPC and HPC Recommend Implement as proposed

Original 8 km operational WRF-NMM
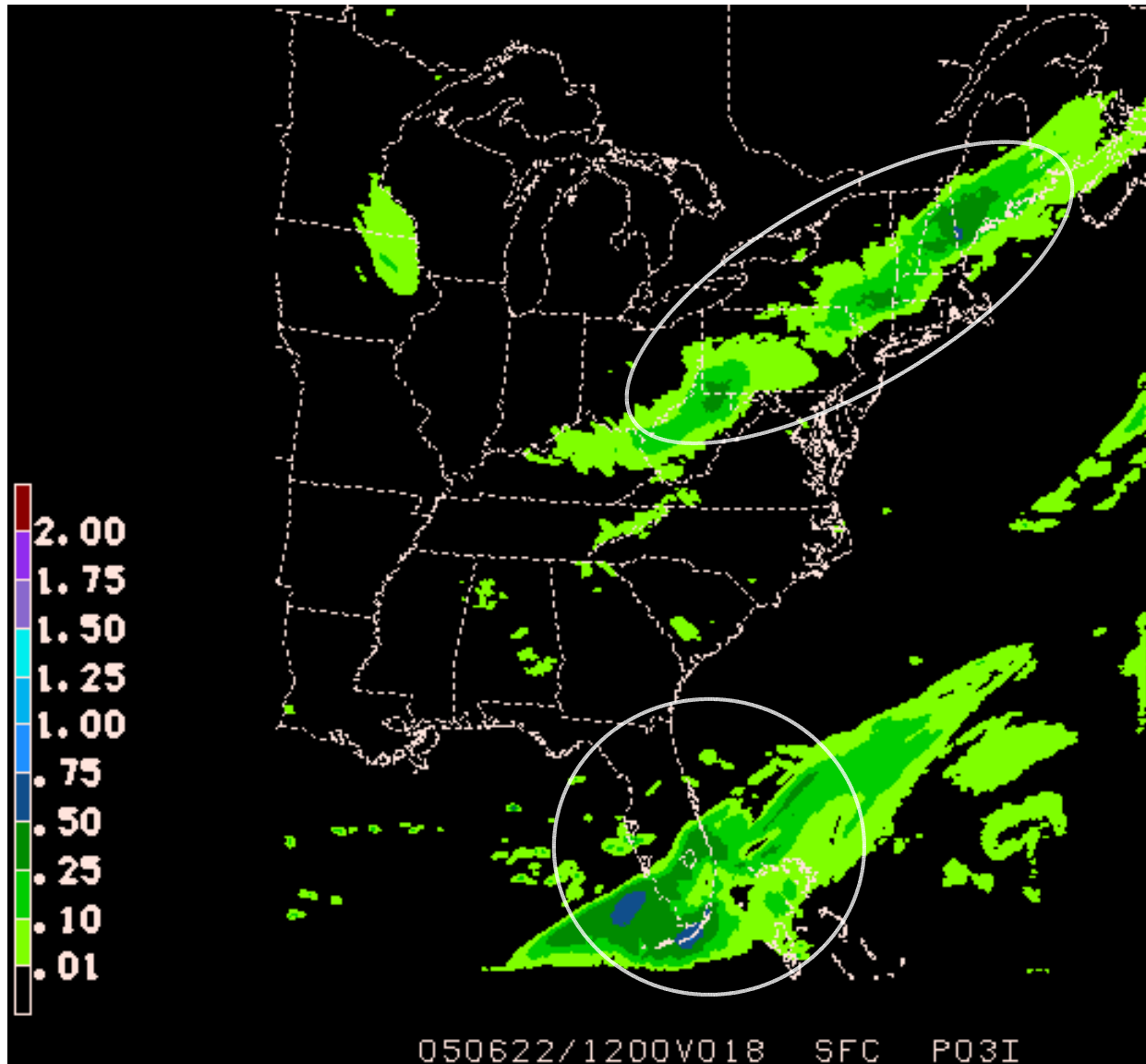
BMJ produces broad, smooth precipitation patterns in the current HRW

050622/1200V018   SFC   P03I

3 h precipitation total (in.)

37

New 5.1 km parallel WRF-NMM
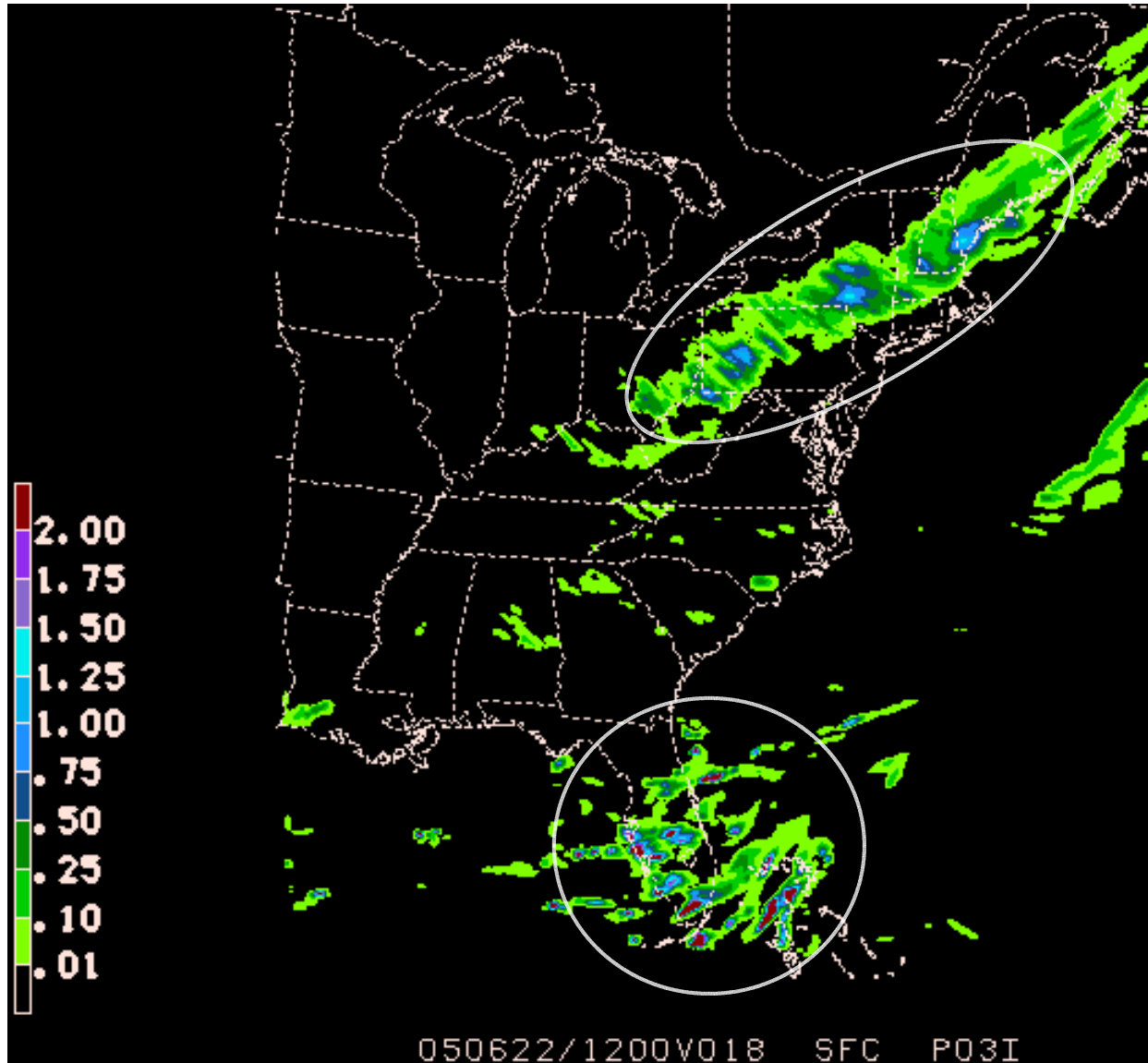
localized, more intense maxima

generally less spatial coverage

3 h precipitation total (in.)

August Upgrade Package for Short-Range Ensemble Forecast (SREF) System

Mesoscale Modeling Branch
Jeff McQueen, Jun Du, Binbin Zhou,
Brad Ferrier, Hui-Ya Chuang,
Jongil Han, Henry Juang, Luke Lin

http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs/

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P

where the nation's climate and weather services begin

SREF Phase-I Upgrade
Implemented at 21z on 31 August 2005

- **Extended forecast range from 63 hr to 87 hr**
- **All members now start & end at ~same time**
- **Domain, products & webpages expanded to include**
  - **<u>Alaska</u> on grid #216 (45 km polar stereo)**
  - **Eastern Pacific (<u>Hawaii</u>) on grid #243 grid (.4 deg lat-long))**
  - **Everything identical to CONUS on grid #212 (40 km Lambert)**
- **RSM changes**
  - Updated and optimized version
  - RSM resolution decreased from 40 to 45 km to include
  - Expanded domain covering Alaska and Hawaii
  - BUFR output added (now all 15 SREF members have BUFR output)
  - RSM post is replaced by WRF post
- **3hr-old global ensemble members used as LBCs instead of 9hr-old ones plus more global ensemble members used for added diversity**

40

Newly Enhanced SREF Webpage

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

SHORT-RANGE ENSEMBLE FORECASTING (SREF)

Take free "Ensemble Forecasting" online course by clicking here
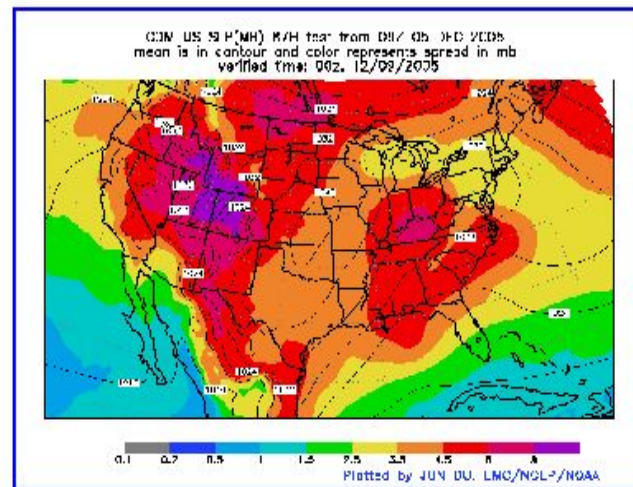
General Weather Forecasting (for CONUS, Alaska and Hawaii three subregions)

Specific Applications (Aviation, Winter Weather, Convection, and Energy)

SREF-based other products: Meteograms, Cyclone Tracks, and Precip Types (12km Eta based)

NCEP/NCO's SREF Guidance Page

online available SREF datasets: NOMADS and NCEP ftp server

Example of Alaska SREF Webpage

Example of Hawaii SREF Webpage

NCEP

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December Package for Short-Range Ensemble Forecast (SREF) System

Mesoscale Modeling Branch

Jeff McQueen, Jun Du, Binbin Zhou, Nashat Ahmad,
Dusan Jovic, Matt Pyle, Brad Ferrier,Zavisa Janjic,
Hui-Ya Chuang, George Gayno and Xiaoxue Wang

http://wwwt.emc.ncep.noaa.gov/mmb/SREF-Docs/

where the nation's climate and weather services begin

SREF Phase-II Upgrade:

21 Members with 6 WRF Members

Model Name	Res (km)	Levels	Members	Init	Cloud/ Physics	Convective Scheme
RSM-SAS	45	28	Ctl,n,p	GFS	Zhao/GFS	Simplified Arak-Schubert
RSM-RAS	45	28	n,p	GFS	Zhao/GFS	Relaxed Arak-Schubert
Eta-BMJ	32	60	Ctl,n,p	NAM	Ferrier/Eta	Betts-Miller-Janjic (BMJ)
Eta-SAT	32	60	n,p	NAM	Ferrier/Eta	BMJ-moist profiles
Eta-KF	32	60	Ctl,n,p	NAM	Ferrier/Eta	Kain-Fritsch (KF)
Eta-KFD	32	60	n,p	NAM	Ferrier/Eta	KF-with full detrainment
WRF-NMM	40	50	Ctl,n,p	GFS	Ferrier/NMM	Betts-Miller-Janjic (BMJ)
WRF-ARW	45	35	Ctl,n,p	GFS	Ferrier/NCAR	Kain-Fritsch (KF)

Impact of 6 WRF Members

- Ensemble Mean RMSE reduced across the board
- Increased Spread
  - Spread roughly equal to forecast error
  - Lower Likelihood of Outliers
  - Higher Consistency
- Flatter Tallegrand Diagrams
- Flatter Ranked Histograms
- Better ETS and RPSS for QPF

SREF Planned Upgrades(By FY07)

System

- Run SREF 4 times per day at 03, 09, 15 and 21 UTC
- Increase resolution to ~25 km
- Use Higher resolution GFS w/ MREF anomolies for SREF LBCs
- Test Ensemble Transform initial condition perturbations
- **Upgrade WRF member codes to final NAM WRF V2.1**
- Replace Eta-BMJ members with e.g. WRF-ARW using BMJ/NCEP physics
- Replace Eta-KF members with e.g. WRF-NMM using KF/NCAR physics
- Replace RSM-SAS members with e.g. WRF-ARW using SAS/GFS physics
- Replace RSM-RAS members with e.g. WRF-NMM using RAS/GFS physics

Products

- Improved and new products
- **Mean, spread, prob. products in AWIPS OB7**

Post Processing

- Implement **Grid Based Bias Correction** → test Du regime dependent system
- Develop Confidence Factors for forecasts
- Improve Probabilistic NCEP Forecast Verification System (FVS)

Additional SREF Outputs for AWIPS-OB7

Means/Spreads
- Heights at 1000, 850, 700, 500, 250 mb
- U+V at 1000, 850, 700, 500, 250 mb & 10 m
- Temperature 850, 700, 500 mb & 2 m
- Dew Point (RH) 850, 700, 500 mb & 2 m
- QPF at 3, 6, 12 and 24 hour totals
- 12-hr Snowfall
- Sea Level Pressure
- Precipitable Water

Probabilistic Fields
- 3-hr/6-hr QPF   GE .01", .25", .50", 1.0"
- 12-hr/24-hr QPF   GE 01", .25", .50", 1.0", 2.0"
- 12-hr Snowfall   GE 1", 4", 8", 12" (have 2.5, 5, 10, 20")
- Temperature at 2 m & 850 mb   LE 0°C
- 10 m Wind   GE 25 kt, 34 kt, 50 kt
- CAPE   GE 500, 1000, 2000, 3000, 4000
- Lifted Index   LE 0, -4, -8
- Surface Visibility   LE 1 mi, 3 mi
- Cloud Ceiling*   LE 500 ft, 1000 ft, 3000 ft
- Probability of precipitation types (have rain, frozen, & freezing)
- 6-hr/12-hr/24-hr QPF Best Category

High-Resolution Applications of WRF-Based Ensemble

- DTRA project
  - Torino Olympics in 2006
  - Washington, DC area
  - Use with 1-way nesting from S. Gopalakrishnan and HWRF
- Beijing Olympics 2008

Improvements for the NOAA Air Quality Forecast System
Implemented June 2005

**Jeff McQueen, Pius Lee, Marina Tsildulko, Geoff DiMego
Bert Katz, Geoff Manikin, Sarah Lu and Dave Michaud**

http://www.emc.ncep.noaa.gov/mmb/mmbpll/CMAQ-NWP05conf/CMAQ-NWP05conf.html

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June 2005 Surface Ozone Forecast Guidance
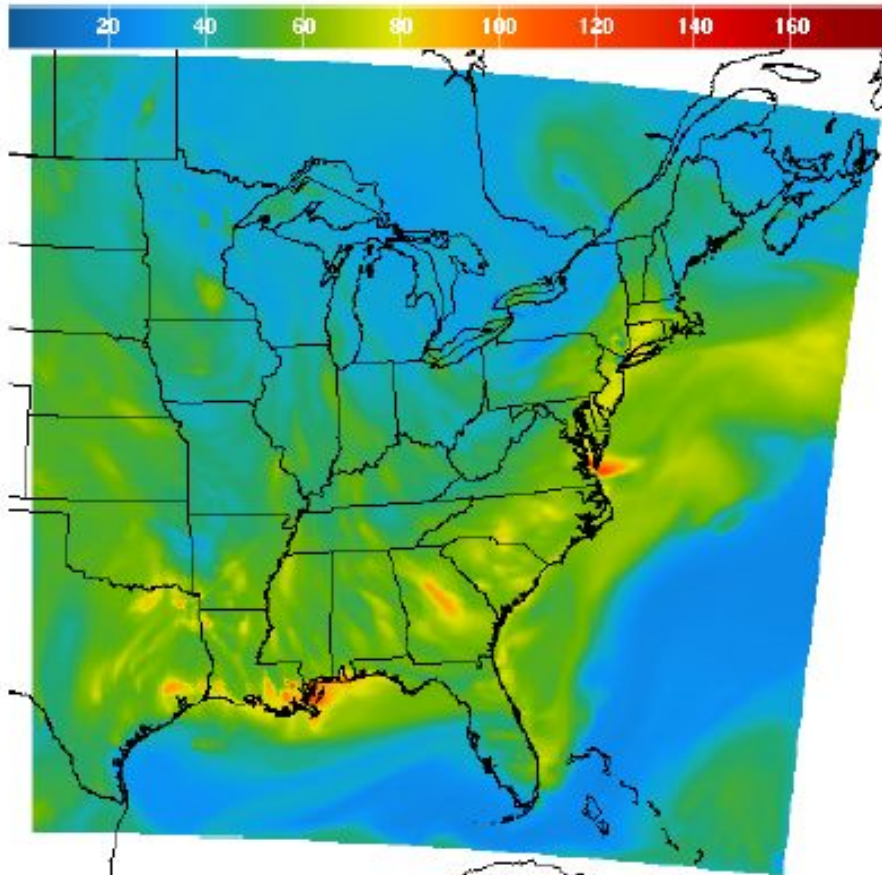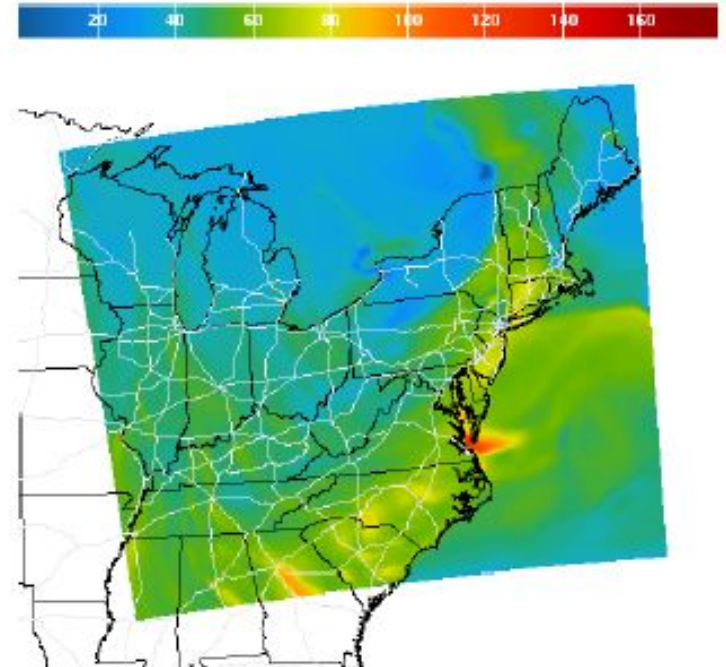
Interim Smoke Guidance Product
Implemented 14 October 2005

- Fire locations from NESDIS

- HYSPLIT (ARL Lagrangian model) uses NAM winds to transport smoke (Draxler)

- Interim Smoke System creates National Product
  – Historical smoke distribution
  – Smoke from new fires
  – GIS shape-file output

NOAA ARL/NESDIS FIRE SMOKE FORECAST
Air Concentration (ug/m3) Surface Layer Average   0 m and   100 m
Integrated from 1500 12 Oct to 1800 12 Oct 05 (UTC)
PM25 Release started at 0000 12 Oct 05 (UTC)

from   100 m

Source ☆   at multiple locations

NAM METEOROLOGICAL DATA

1.0E+02	2.0E+01	5.0E+00	1.0E+00	1.8E+02 Maximum at square
				4.6E-03 Minimum
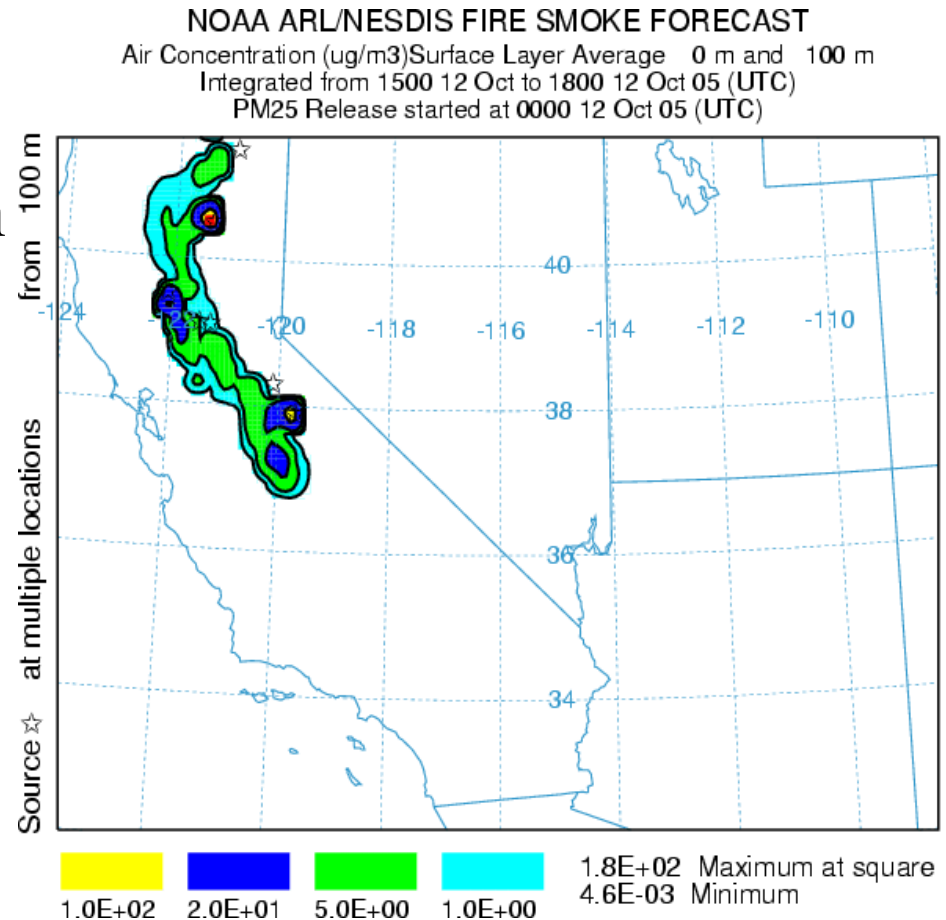
DGEX = <u>D</u>ownscaled <u>G</u>FS by <u>E</u>ta E<u>x</u>tension

• Cycle times – run twice per day per domain
  – 06z & 18z (using 00z&12z GFS LBC) for CONUS
  – 00z & 12z (using 06z&18z GFS LBC) for OCONUS

• Must convert to WRF-NMM when Eta is replaced in the NAM

• Adding rest of OCONUS runs must wait for next CCS upgrade
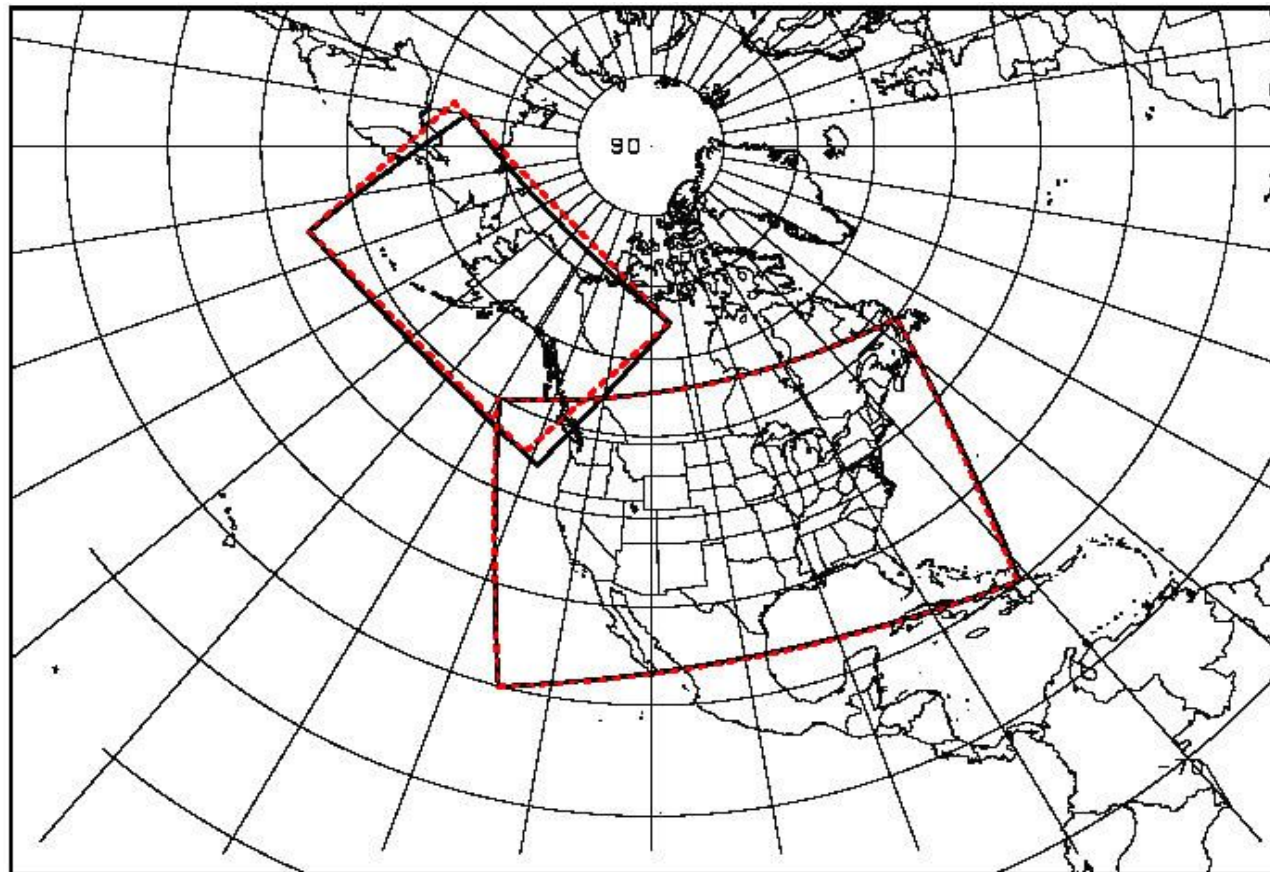
Solid black = DGEX integration grid; Dashed red = DGEX output grid

FireWx/IMET Support runs

- 8 km nested run of Nonhydrostatic Mesoscale Model (NMM)

- Run to 48 hr <u>over the top</u> of NAM at 00z, 06z, 12z & 18z

- IMETS view on laptops w/satellite comms & FXNET

- Boise Fire Center and/or SPC choose daily domains to run

- **(IMET or OPC+etal.** wher **MUST convert to**
WRF-NMM when Eta
is replaced in the
NAM

• Upgrade to 5 km
and output on NDFD
grid must wait for
next CCS upgrade

26 Pre-Defined Fixed-Domain Nests

Progress Towards NAM Upgrade to WRF-NMM and GSI

- Real-time parallel data assimilation cycle and 84 hr forecast system up and running in June 2005
  - Used "most recent" WRF Version 2.1 (NOTE: HiResWindow uses v1.3, SREF uses v2.0)
  - Limited to 12 km, two runs per day, on half NAM domain due to longer WRF-NMM runtime than equivalent Eta system
  - Would have been MUCH WORSE had not NCEP's cycle been made independent of WRF-SI & real codes via Matt Pyle's lateral boundary condition code and George Gayno's external dataset provider
  - First regional application of Gayno and GSI codes

Progress Towards NAM Upgrade to WRF-NMM and GSI

- Physics Wheel-of-Pain is Fully Engaged!
  - Some low-level WRF-NMM biases greater than Eta
  - Comparisons complicated by differing vertical coordinate and layer depths as well as differing codes
  - Attempts to isolate causes have involved making pbl, surface layer and land-surface model codes and terrain and land states as identical as possible with the current NAM
  - Improvements have been made with nightime 2 m cold bias and with 10 m wind
  - Surface latent-heat fluxes are the biggest current target
  - Tuning of cloud and radiation are underway

Progress Towards NAM Upgrade to WRF-NMM and GSI

- GSI is evolving rapidly
  - Warm season performance indicates GSI already much better than Eta 3DVar
  - New moisture variable coupling RH and temperature is promising (used by ECMWF)
  - Top of model moved to 2 mb to assist the direct assimilation of satellite radiances
  - New NMM based forecast error correlations will replace smoother broader GFS values used now
  - Use of WSR-88D Level II radial winds is imminent
  - Long list of new data sources waits in the wings

Progress Towards NAM Upgrade to WRF-NMM and GSI

- Field evaluation should be possible ~January
  - Tom Black, IBM and NCAR have made great progress in finding ways to reduce runtime of WRF
  - ~100% certain the 12 km will fit comfortably
  - Eric Rogers in process of building full domain parallel for testing and eventual submission to NCO

  http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll/nampll12_fullcyc_2mbtop/

  - NCO plans to run WRF-NMM in near-real-time depending on actual computer demands of WRF-based NAM parallel

Recent comparison: NAM, NMM, GFS

500MB Z-VORT NAM 72H FCST VALID 00Z 05 DEC 2005

72hr
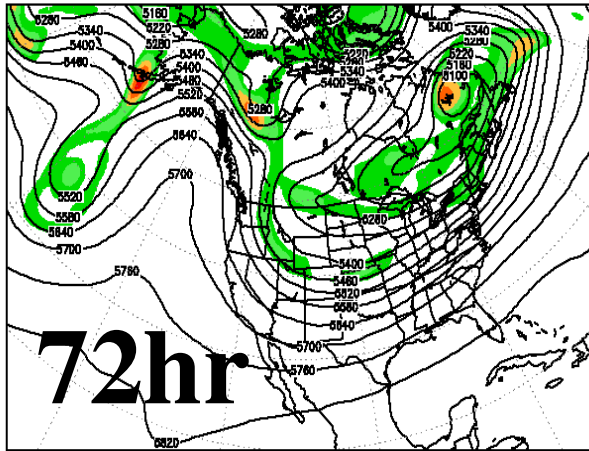
500MB Z-VORT NAMX 72H FCST VALID 00Z 05 DEC 2005

72hr
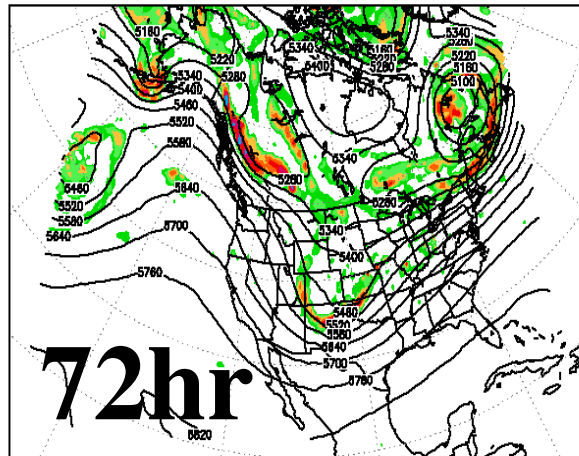
500MB Z-VORT GFS 72H FCST VALID 00Z 05 DEC 2005

72hr

NAM

NMM
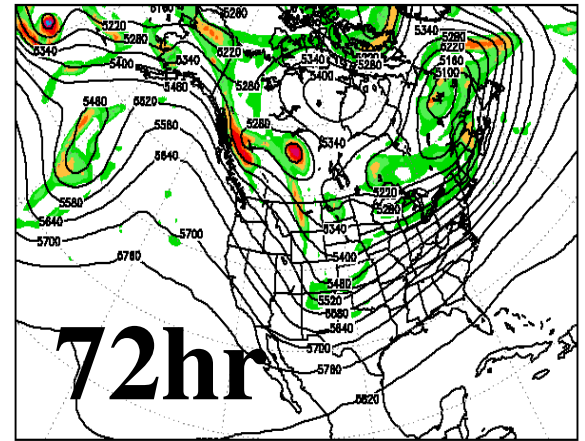
GFS

500MB Z-VORT NAM 84H FCST VALID 00Z 05 DEC 2005

84hr
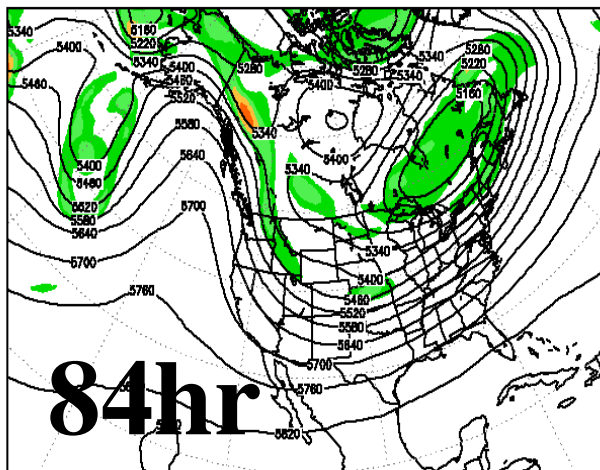
500MB Z-VORT NAMX 84H FCST VALID 00Z 05 DEC 2005

84hr
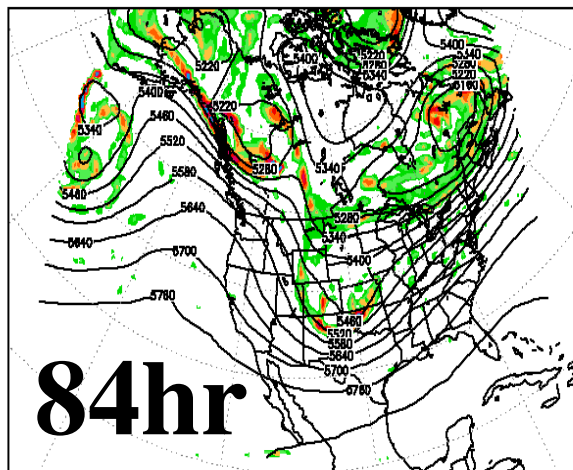
500MB Z-VORT GFS 84H FCST VALID 00Z 05 DEC 2005

84hr
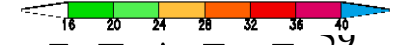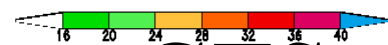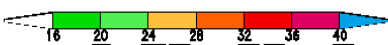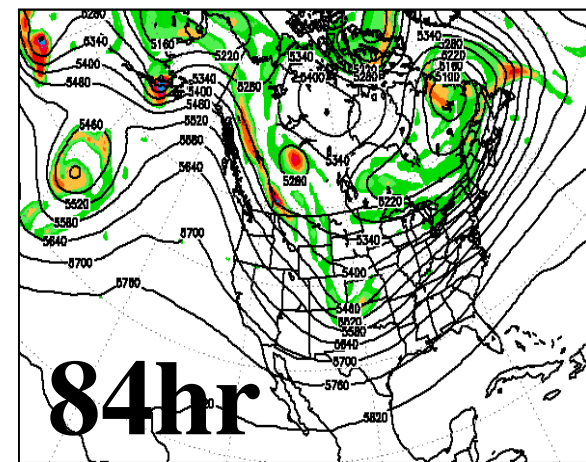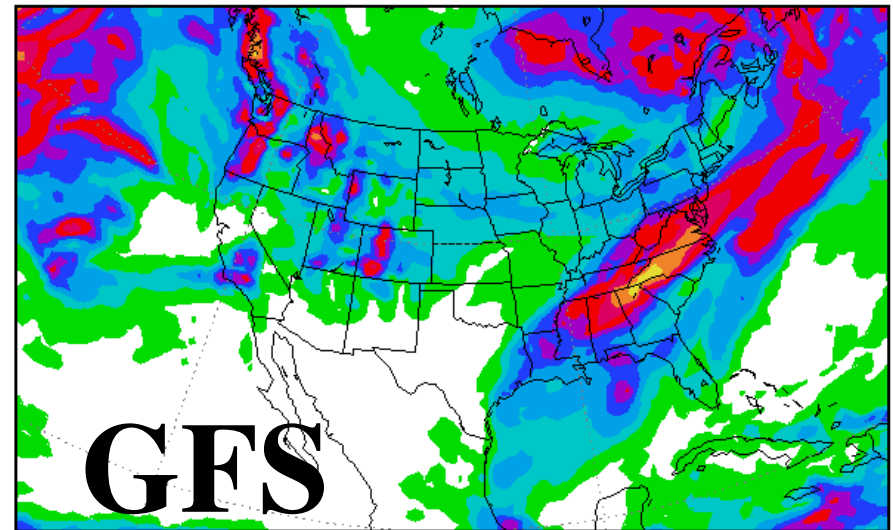
NMM closer to GFS than to NAM

84-H APCP NAM 84H FCST VALID 00Z 06 DEC 2005

NAM
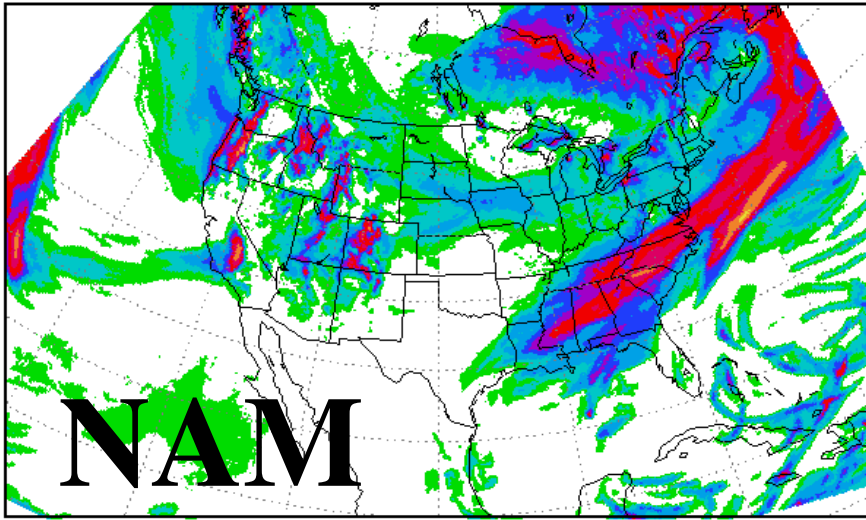
84-H APCP NAMX 84H FCST VALID 00Z 06 DEC 2005

NMM

84-H APCP GFS 84H FCST VALID 00Z 06 DEC 2005

GFS
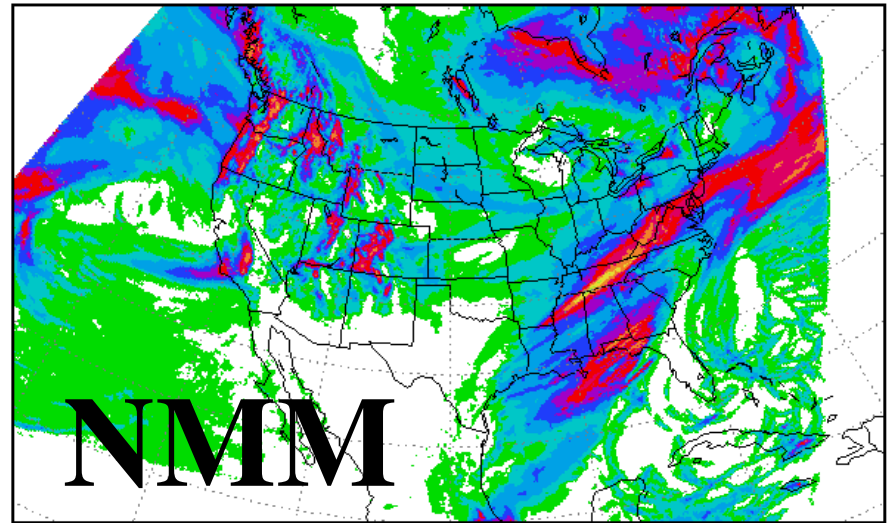
NMM resembles GFS more than NAM but looks to have axis of heaviest snow too far north – Louis loved it until it didn't verify
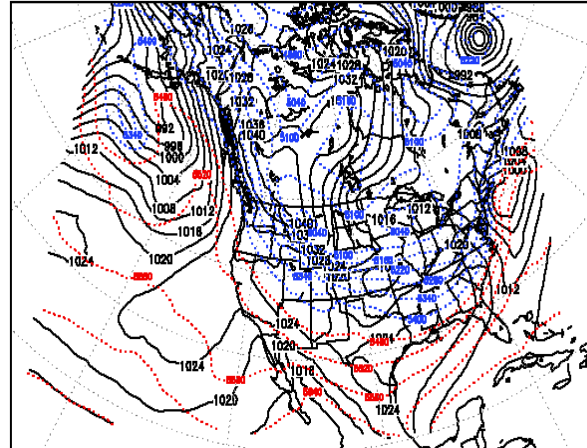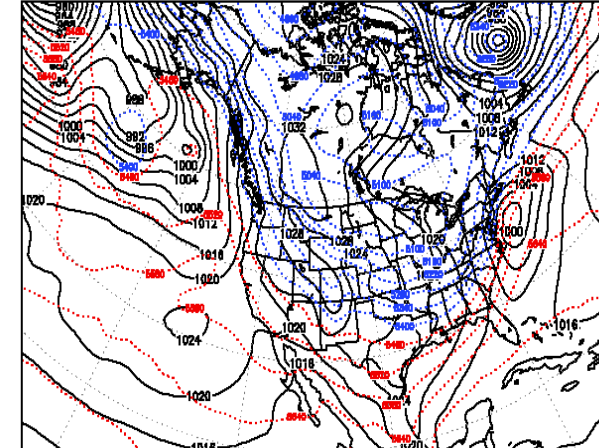
72 hr NMM too much snow in DC
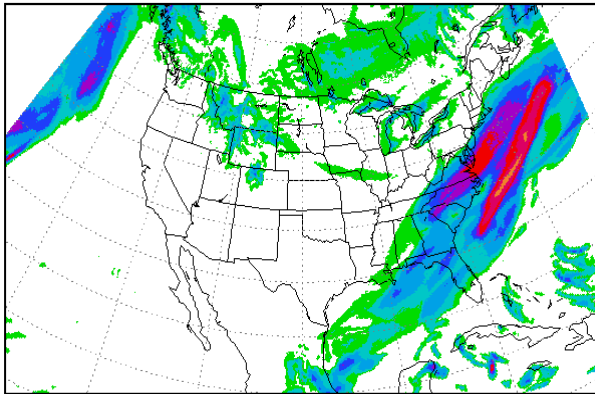
SLP NAM 72H FCST VALID 12Z 06 DEC 2005
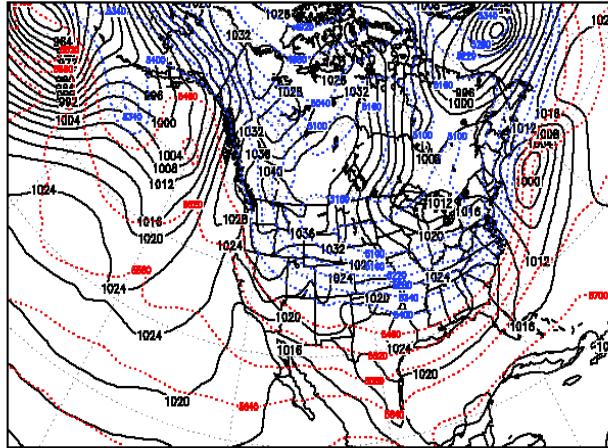
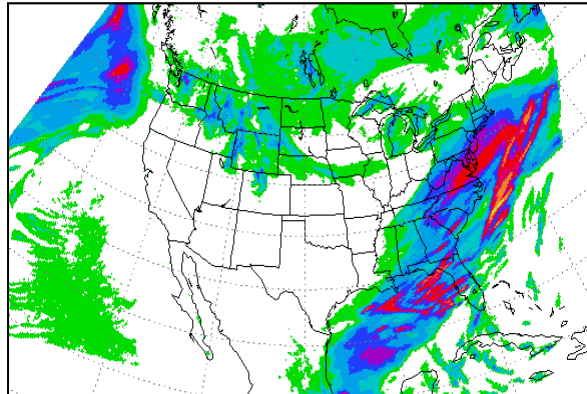SLP NAMX 72H FCST VALID 12Z 06 DEC 2005
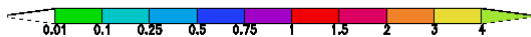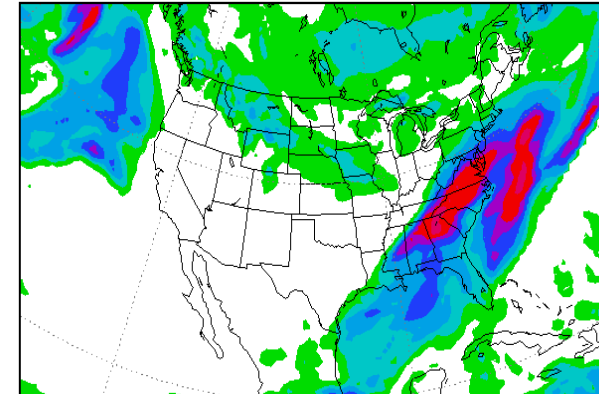
SLP GFS 72H FCST VALID 12Z 06 DEC 2005

48-72 H APCP NAM 72H FCST VALID 12Z 06 DEC 2005

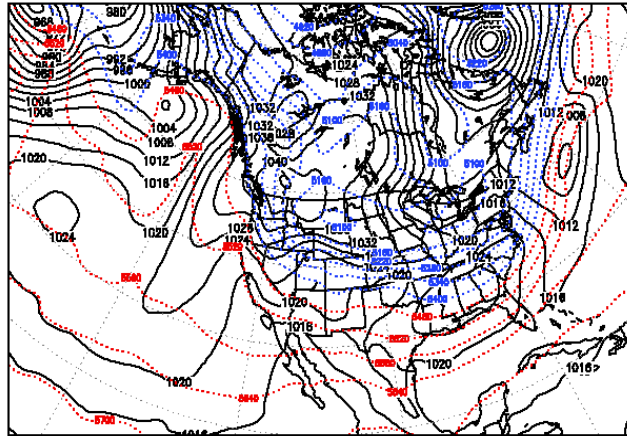48-72 H APCP NAMX 72H FCST VALID 12Z 06 DEC 2005

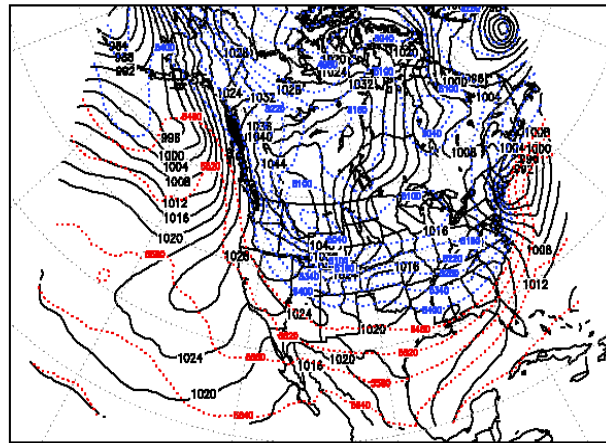48-72 H APCP GFS 72H FCST VALID 12Z 06 DEC 2005
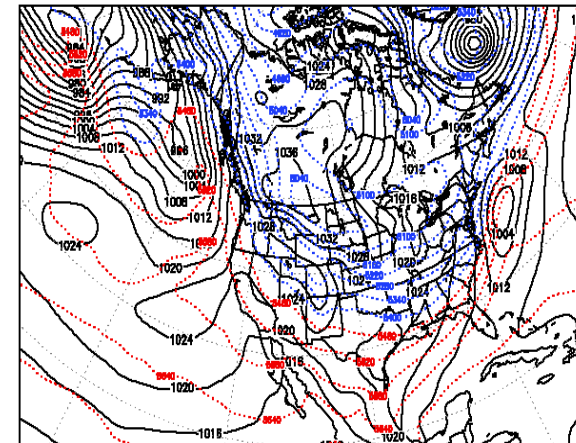
84 hr NMM too much snow in DC

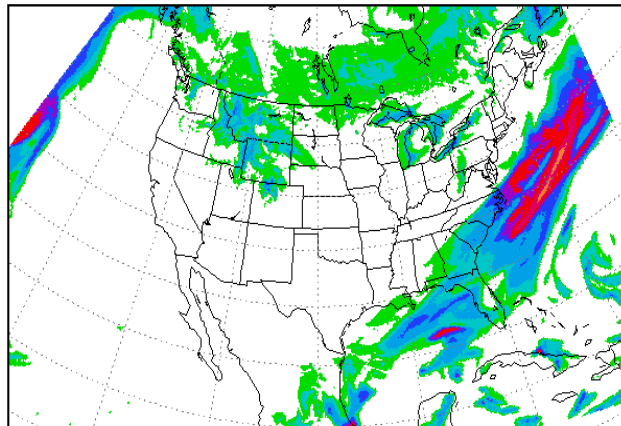SLP NAM 84H FCST VALID 12Z 06 DEC 2005
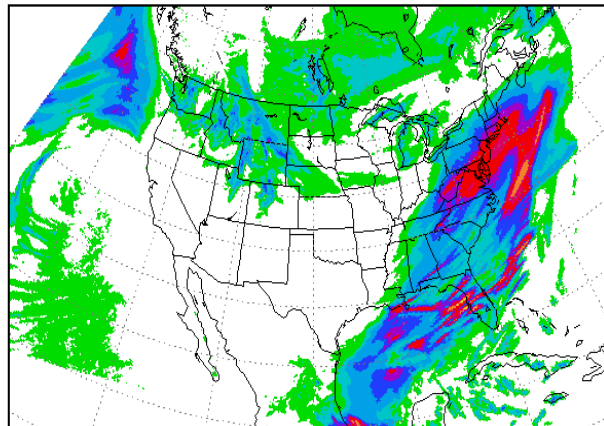
SLP NAMX 84H FCST VALID 12Z 06 DEC 2005

SLP GFS 84H FCST VALID 12Z 06 DEC 2005

60-84 H APCP NAM 84H FCST VALID 12Z 06 DEC 2005

60-84 H APCP NAMX 84H FCST VALID 12Z 06 DEC 2005

60-84 H APCP GFS 84H FCST VALID 12Z 06 DEC 2005

0.01 0.1 0.25 0.5 0.75 1 1.5 2 3 4
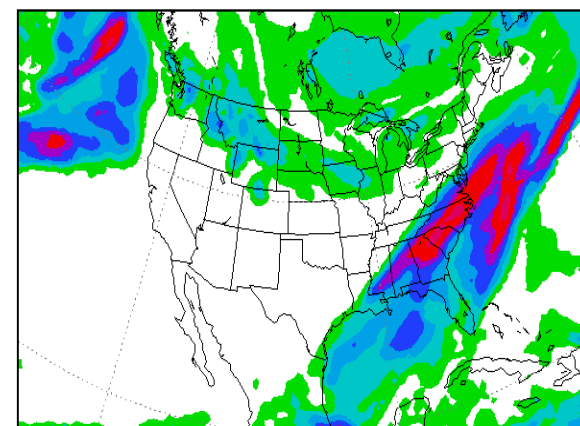
OST Seminar 5 October 2005

Real-Time Mesoscale Analysis (RTMA) - A First Step Towards an Analysis of Record

Geoff DiMego, Ying Lin, Manuel Pondeca, Seung-Jae Lee,
Wan-Shu Wu, David Parrish, and Stacie Bender

Mesoscale Modeling Branch
National Centers for Environmental Prediction

http://www.nws.noaa.gov/ost/ifps_sst/presentations/AOR-RTMA_SeminarDiMego100505.ppt

Geoff.DiMego@noaa.gov
301-763-8000 ext 7221

NOAA Science Center - Room 205
5200 Auth Road
Camp Springs, MD 20746-4304

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First Steps Toward an AOR

- **June 2004 Community Meeting on Real-time and Retrospective Mesoscale Objective Analysis**
 - **AOR program should develop and implement suite of consistent sensible weather analysis products using current and future technologies.**
- **Mesoscale Analysis Committee (MAC) established August 2004 by Jack Hayes Director, NWS OST**
- **MAC Committee meeting in Silver Spring in October 2004 to define needs and development strategy for AOR**
- **Three Distinct requirements / phases emerge:**
  - **Real-time analysis for forecasters**
    - **Phase I – RTMA = Real-Time Mesoscale Analysis**
    - Hourly within 30 minutes
    - Prototype for AOR
    - **NCEP and FSL volunteer to build first phase**
  - **Best analysis for verification**
    - **Phase II – Analysis of Record**
    - Best analysis possible
    - Time is no object
  - **Long-term history for local climatology**
    - **Phase III – Reanalysis**
    - Apply mature AOR retrospectively
    - 30 year time history of AORs

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RTMA Procedure

- Temperature & dew point at 2 m & wind at 10 m
  - RUC forecast/analysis (13 km) is downscaled by FSL to 5 km NDFD grid – Sta Benjamin
  - Downscaled RUC used as first-guess in NCEP's 2DVar analysis of ALL surface observations – Manuel Pondeca
  - Estimate of analysis uncertainty & C-V – Wan-Shu Wu
- Precipitation – NCEP Stage II analysis - Ying Lin
- Sky cover – NESDIS GOES sounder effective cloud amount - Bob Aune

RTMA Logistics

- Hourly within ~30 minutes

- On the 5 km NDFD grid in GRIB2

- Operational at NCEP Q3 FY2006

- Distribution of analyses and estimate of analysis uncertainty via AWIPS SBN as part of AWIPS-OB7 upgrade – end of FY2006

- Archived at NCDC
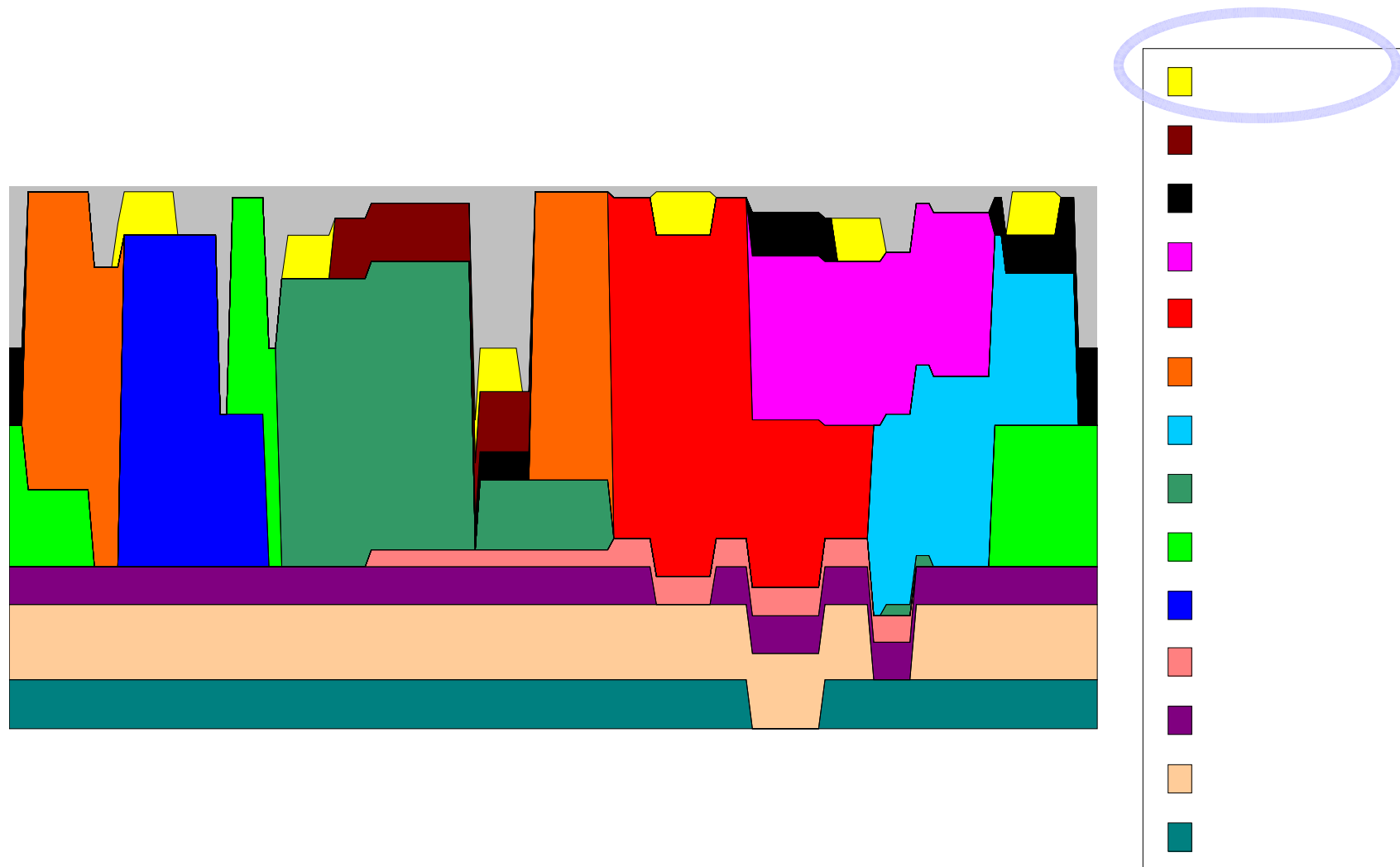
1% of CCS set aside for RTMA [67]

Mesonet Issues

- Mesonets comprise majority of obs but they are not as "good" as other conventional sfc ob sources

- Winds not used in current RUC due to biases

- FSL has constructed a "Uselist" of acceptable networks based on overall siting strategies etc.

- KMA visitors at NCEP working with these mesonet data in GSI context

Estimate of RTMA "Uncertainty"

- Want it to reflect obs density, obs quality and background quality
- Not direct from GSI but it will be possible to estimate it:

- Analysis error = (Hessian of cost function)$^{-1}$

  see Rabier and Courtier 1992; Fisher and Courtier 1995

- Hessian of a simplified cost function: $\nabla^2 J = \dfrac{1}{B} + \dfrac{1}{O}$

- Analysis error: $A = \dfrac{1}{\dfrac{1}{B} + \dfrac{1}{O}} = \dfrac{xO}{y}$

  since

  $$\frac{\partial J}{\partial x} = 0 \Rightarrow x\left(\frac{1}{B} + \frac{1}{O}\right) = \frac{y}{O}$$

# Estimates of RTMA Analysis "Accuracy" - Cross-validation

- Can't use quality of forecast as in 4DDA
- Cross-validation is really only way:
  - Withhold observations from analysis
  - Measure ability of analysis to reproduce withheld values
- GSI will have Cross-Validation built in
  - Withhold ~10% of each type of ob for 1st ~85% iterations
  - Measure fit of solution to withheld obs
  - Add obs back in for another ~35% iterations
  - Plan to do this periodically (not routinely)
- Also Building-in C-V score for a Baseline Successive Corrections for performance metric normalization

NCEP RTMA Precipitation Analysis

- NCEP Stage II (real-time) and Stage IV (delayed) precipitation analyses are produced on the 4-km Hydrologic Rainfall Analysis Project grid

- The existing multi-sensor (gauge and radar) Stage II precipitation analysis available 35 minutes past the hour

- RTMA is mapped to the 5 km NDFD grid and converted to GRIB2

- Upgrade plan including OHD analysis + improved gauge QC from FSL

- Primary contact: Ying Lin, NCEP/EMC

- **http://wwwt.emc.ncep.noaa.gov/mmb/ylin/pcpanl/**

Hourly Gages Available for Stage II Precipitation Analysis (courtesy FSL webpage)

Hourly Gauges (Red: Flagged) 24h Ending 12Z 20050704
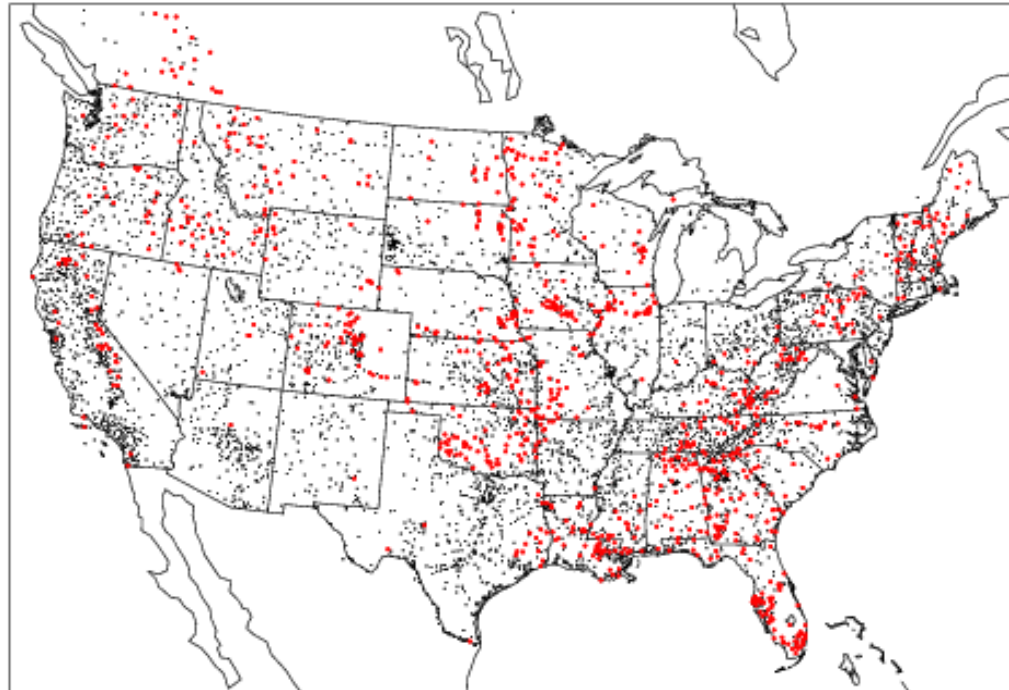
RTMA Evaluation Plan

- NCEP will establish routine hourly runs of RTMA
- **NWS ISST Field Evaluation ala DGEX**
- NCEP will establish webpage displaying RTMA
- Steve Lazarus (ADAS expert) to help NCEP's Geoff Manikin with intercomparison of 2DVar with other analyses - e.g.
  - ADAS from U of Utah / Wester Region HQ
  - STMAS from FSL Steve Koch
  - LAPS from FSL John McGinley
  - MatchOb from AWIPS – Tim Barker
  - Operational NAM, RUC & RSAS

An Overview of Precipitation Type Forecasting Using NAM and SREF Data

Geoff Manikin

Mesoscale Modeling Branch

NCEP/EMC

http://www.emc.ncep.noaa.gov/mmb/papers/manikin/3/

Thanks to:

Jun Du – SAIC/GSO @ EMC

Keith Brill – NOAA/NCEP/HPC

Brad Ferrier – SAIC/GSO @ EMC

Pete Manousos – NOAA/NCEP/HPC

http://www.emc.ncep.noaa.gov/mmb/precip_type

ETA PRECIPITATION TYPE FORECAST METEOGRAMS

- Web Page contains nine geographical regions

A mini-ensemble of Eta model precipitation type forecasts is available for 1100 stations within the Eta domain. A complete list of the available stations can be found here . Select a region below, and you will be sent to a local map where you can click on the star representing the location you want. Here is a description of the content on the plots .
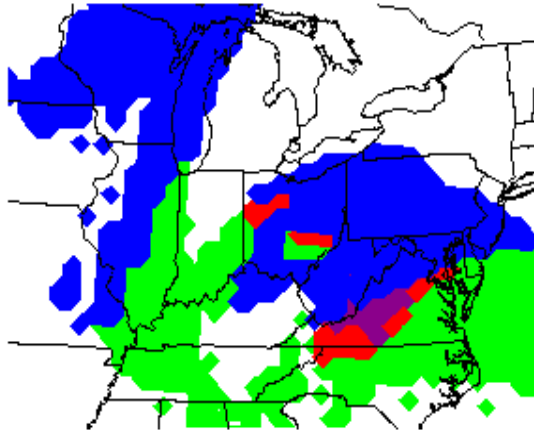
If you want to bypass the stars, please enter a 6-digit ID from the table linked above.   Get data

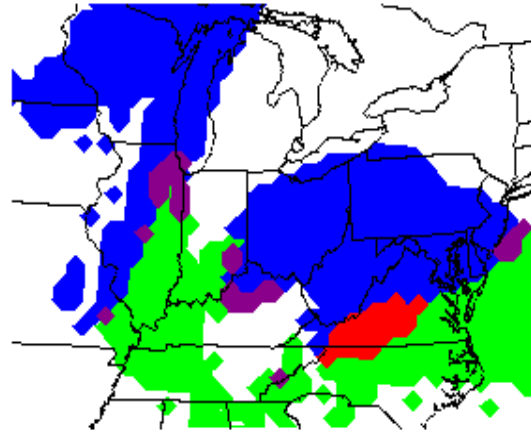**CLICK ON THE DESIRED REGION**
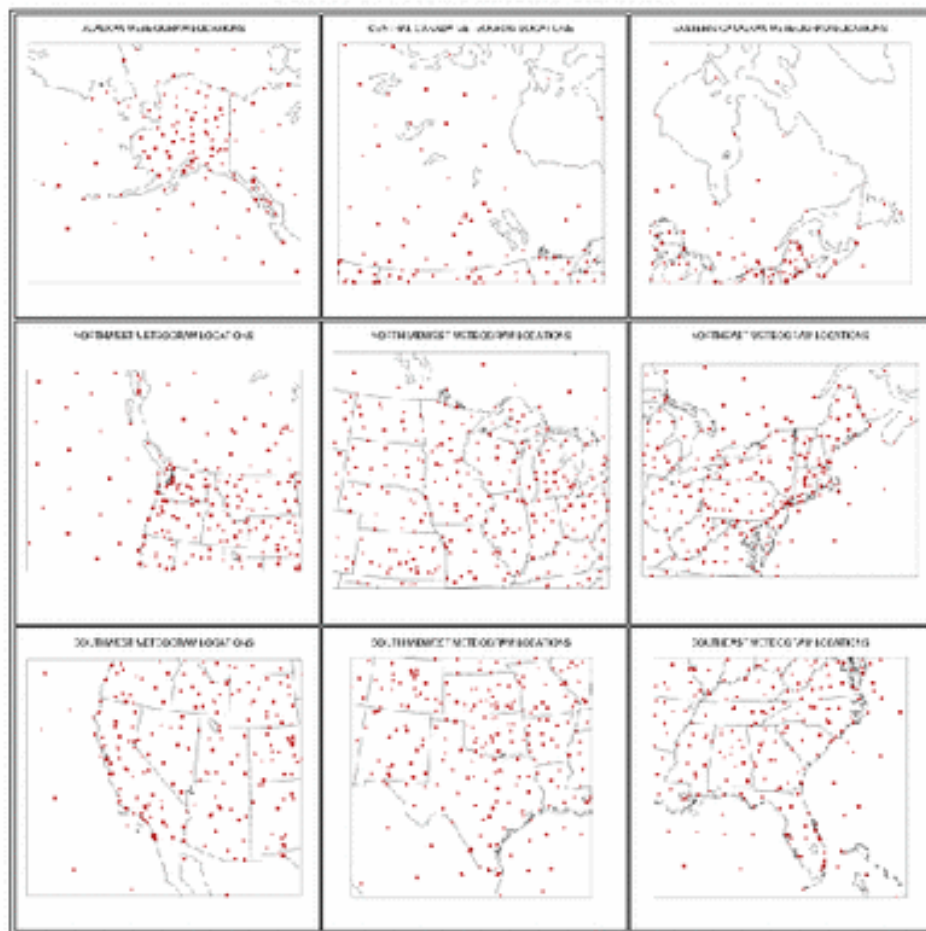
- Page is updated for 00/12z NAM cycles
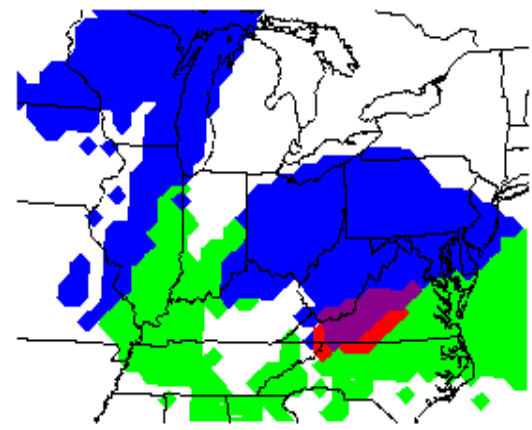
Run Multiple Algorithms on Single Run
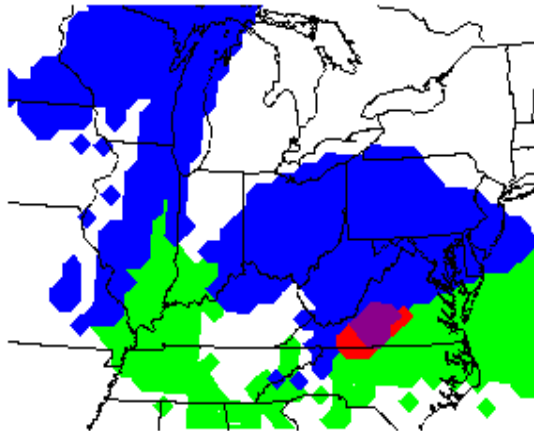

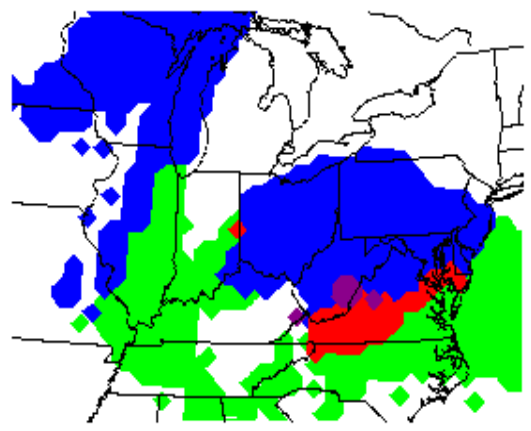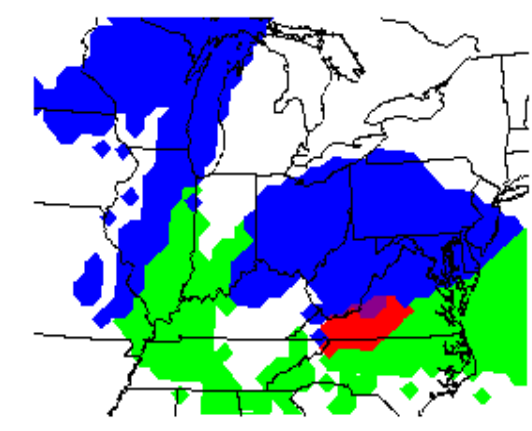150228/1500V054 54-HR   NCEP PRECIP TYPE

54-HR   RAMER TYPE

54-HR   BOURGOUIN TYPE

54-HR   REVISED NCEP TYPE

54-HR   EXPLICIT NCEP TYPE

54-HR   DOMINANT PRECIP TYPE

Manikin's Convective Forecasting Page

http://www.emc.ncep.noaa.gov/mmb/svrfcst/index.html

SLP / 2M Dew Point

00h	03h	06h	09h	12h
15h	18h	21h	24h	27h
30h	33h	36h	39h	42h
45h	48h	51h	54h	57h
60h	63h	66h	Loop	

2M Temperature

00h	03h	06h	09h	12h
15h	18h	21h	24h	27h
30h	33h	36h	39h	42h
45h	48h	51h	54h	57h
60h	63h	66h	Loop	

Sfc-Based CAPE

00h	03h	06h	09h	12h
15h	18h	21h	24h	27h
30h	33h	36h	39h	42h
45h	48h	51h	54h	57h
60h	63h	66h	Loop	

Most Unstable CAPE

00h	03h	06h	09h	12h
15h	18h	21h	24h	27h
30h	33h	36h	39h	42h
45h	48h	51h	54h	57h
60h	63h	66h	Loop	

Mixed Layer CAPE

00h	03h	06h	09h	12h
15h	18h	21h	24h	27h
30h	33h	36h	39h	42h
45h	48h	51h	54h	57h
60h	63h	66h	Loop	

NCEP ETA CONVECTIVE FORECASTING PAGE

The current forecast cycle is **00Z 06 Dec** with graphics finished at 23:54:36 EST Fri Dec 5 2003

This page displays 00/12Z Eta model forecasts of convective parameters from the operational 12-km Eta model Some of the newer fields such as 0-1km storm-relative helicity and mixed-layer CAPE are not widely available to the field, so this site offers a chance to examine more model output. Check out a complete documentation of the output from the Eta Post Processor.

NOTE: All displayed winds are in knots. Precipitation values are in inches.

GRIB files from the operational Eta-12 forecast can be found on the NCEP ftp server or at the NWS Gateway server. Descriptions of some of these output files can be found at the EMC Eta Grid Domains page.

CHECK OUT THESE OTHER EMC WEB PAGES WITH CONVECTIVE FORECASTING INFO

◉ Eta Meteograms

◉ RUC Meteograms

◉ Eta Forecast Soundings

Get the forecasts for the previous 7 days here (link opens a new window):

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
12z	12z	12z	12z	12z	12z	12z
00z	00z	00z	00z	00z	00z	00z

EMC DISCLAIMER : This web page is not "operational" and therefore not subject to 24-h monitoring by NCEP's Central Operations staff.

NWS Disclaimer