NCEP Short-Range Ensemble Forecast (SREF) System: Hydrology Relevance

Jun Du, Geoff DiMego and Zoltan Toth

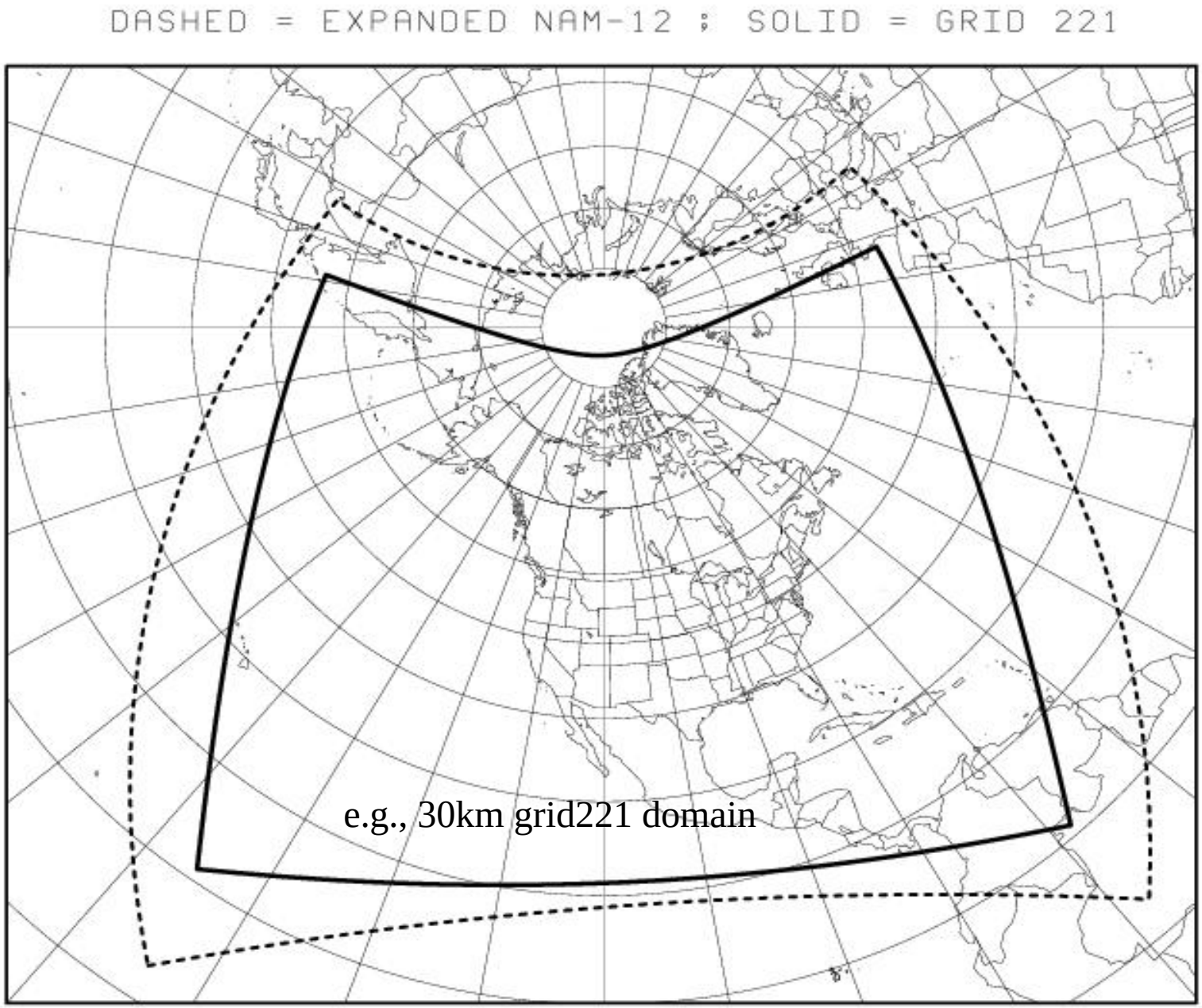
(for the DOH Hydrological Ensemble Workshop, July 16, 2008)

http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html
http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/

Acknowledgement: NCEP director, Dr. Louis Uccellini, and EMC director, Dr. Stephen Lord, for their always support to the SREF

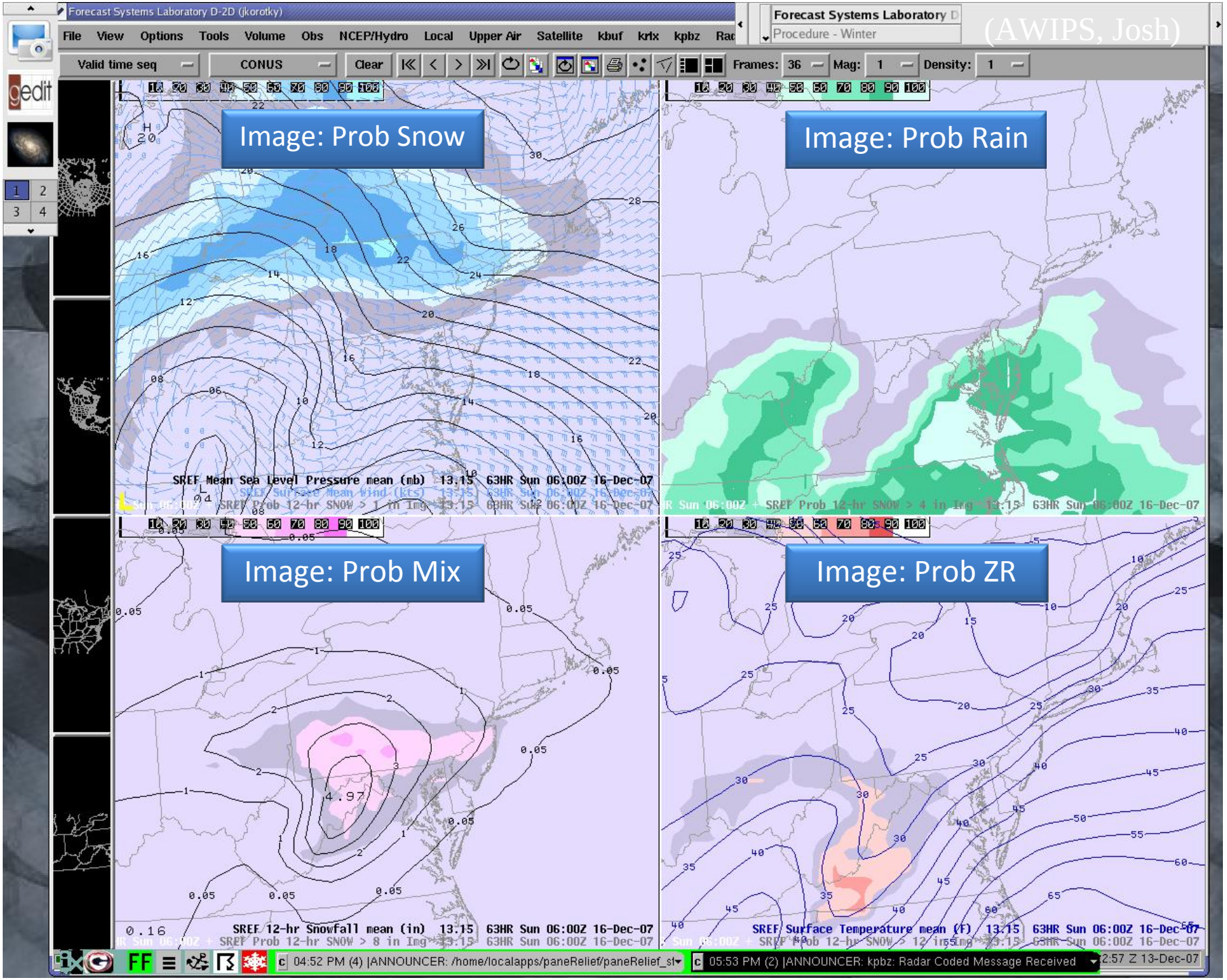
The current SREF configuration

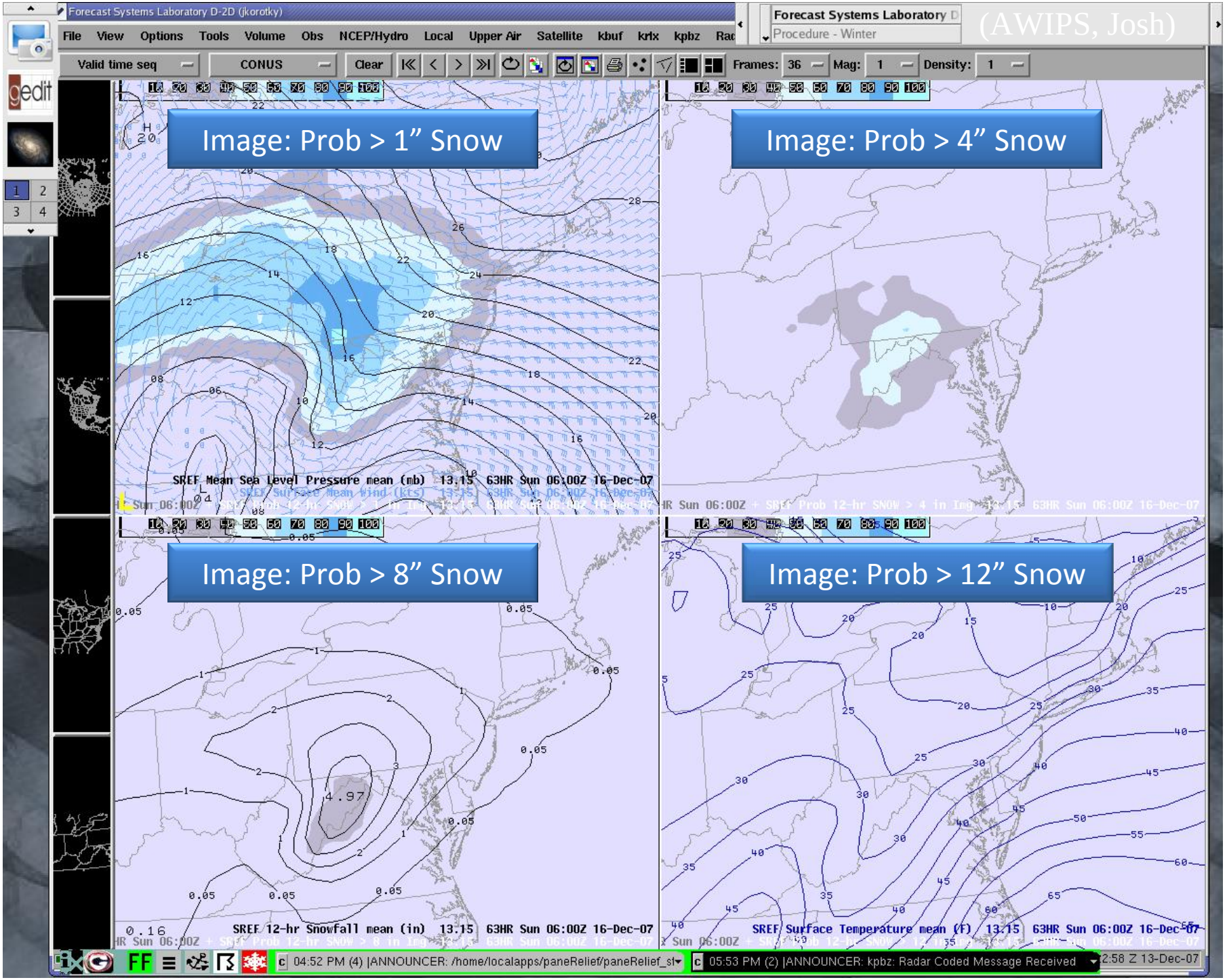
- Entire North America domain (covering U.S., Canada, Mexico, Eastern Pacific and Western Atlantic)
- 21 members (with 4 regional models)
- 32-45km depending on models
- Run 4 times per day (03, 09, 15 and 21z)
- 3hrly output to 87hr for each cycle
- 4 AWIPS output domains: NorthAmerican (221, 30km), CONUS (212, 40km), Alaska (216) and Eastern Pacific/Hawaii (243)


DASHED = EXPANDED NAM-12 ; SOLID = GRID 221
e.g., 30km grid221 domain

SREF Data

- AWIPS (mean, prob and spgt in grid212)
- NOMADS (same as above plus individual members)
- Public ftp site (same as AWIPS plus individual members of selected fields)
- NCEP CCS (NCEP internal)
- 2-year archive of all grib outputs (NCEP internal).
- Personal help (temporally and limited efforts, such as data to RFC)


Forecast Systems Laboratory D-2D (jkorotky)
File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kbuf krlx kpbz
Forecast Systems Laboratory
Procedure - Winter
(AWIPS, Josh)
Valid time seq
CONUS
Clear
Frames: 36
Mag: 1
Density: 1
Image: Prob Snow
Image: Prob Rain
Image: Prob Mix
Image: Prob ZR
SREF Mean Sea Level Pressure mean (mb) 13.15 63HR Sun 06:00Z 16-Dec-07
SREF Prob 12-hr SNOW > 1 in Img 13.15 63HR Sun 06:00Z 16-Dec-07
SREF Prob 12-hr SNOW > 4 in Img 13.15 63HR Sun 06:00Z 16-Dec-07
SREF 12-hr Snowfall mean (in) 13.15 63HR Sun 06:00Z 16-Dec-07
SREF Prob 12-hr SNOW > 8 in Img 13.15 63HR Sun 06:00Z 16-Dec-07
SREF Surface Temperature mean (F) 13.15 63HR Sun 06:00Z 16-Dec-07
SREF Prob 12-hr SNOW > 12 in Img 13.15 63HR Sun 06:00Z 16-Dec-07
04:52 PM (4) |ANNOUNCER: /home/localapps/paneRelief/paneRelief_st
05:53 PM (2) |ANNOUNCER: kpbz: Radar Coded Message Received
2:57 Z 13-Dec-07


Forecast Systems Laboratory D-2D (jkorotky)
File View Options Tools Volume Obs NCEP/Hydro Local Upper Air Satellite kbuf krlx kpbz
Forecast Systems Laboratory
Procedure - Winter
(AWIPS, Josh)
Valid time seq
CONUS
Clear
Frames: 36
Mag: 1
Density: 1
Image: Prob > 1” Snow
Image: Prob > 4” Snow
Image: Prob > 8” Snow
Image: Prob > 12” Snow
SREF Mean Sea Level Pressure mean (mb) 13.15 63HR Sun 06:00Z 16-Dec-07
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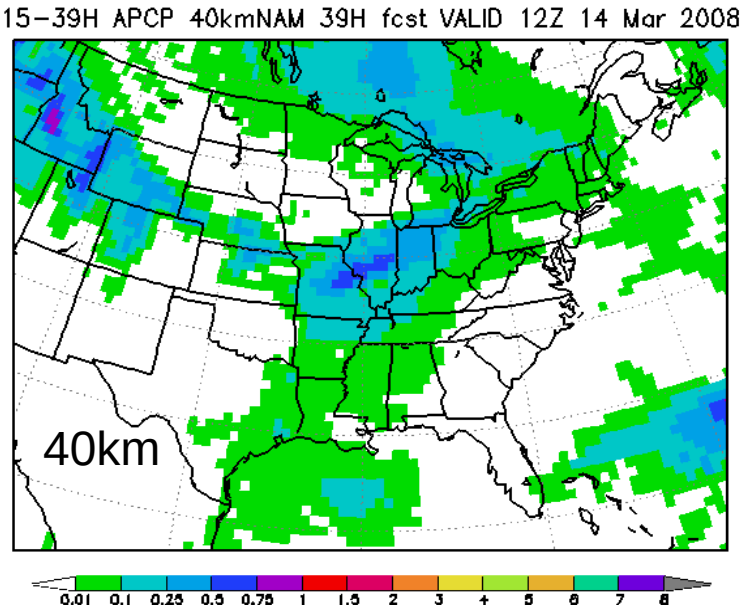
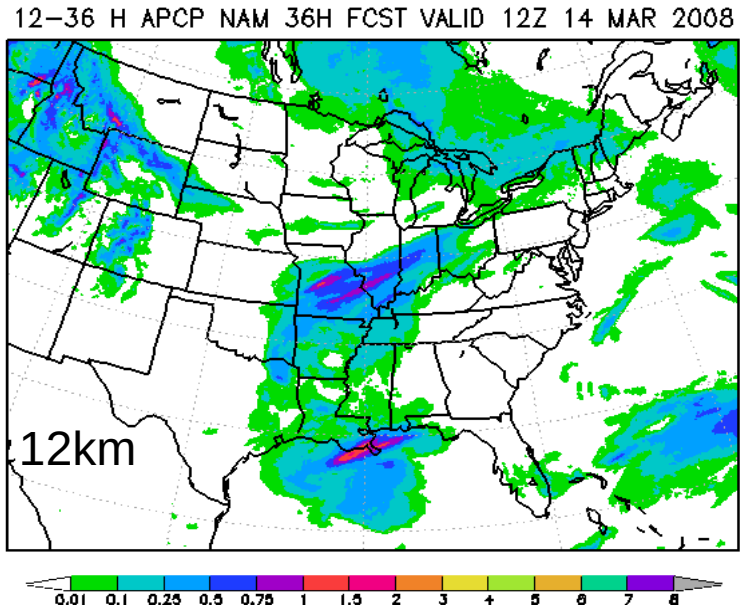
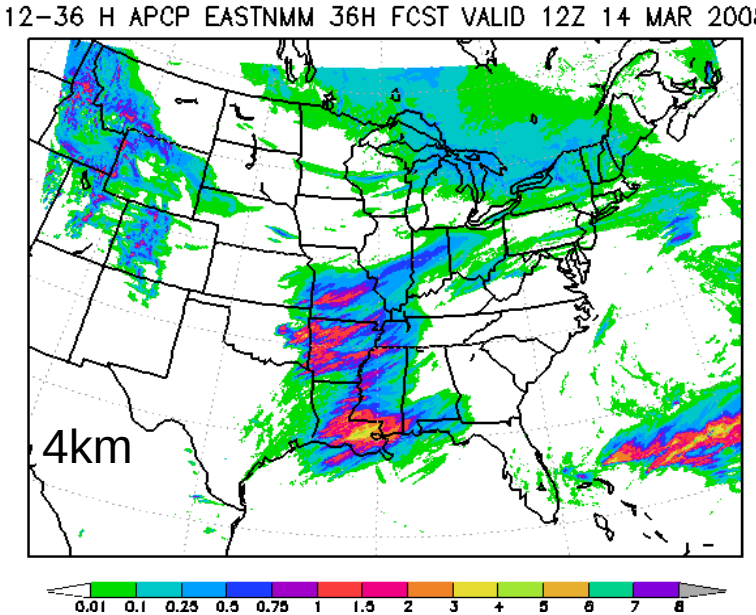
SREF Surface Temperature mean (F) 13.15 63HR Sun 06:00Z 16-Dec-07
04:52 PM (4) |ANNOUNCER: /home/localapps/paneRelief/paneRelief_st
05:53 PM (2) |ANNOUNCER: kpbz: Radar Coded Message Received

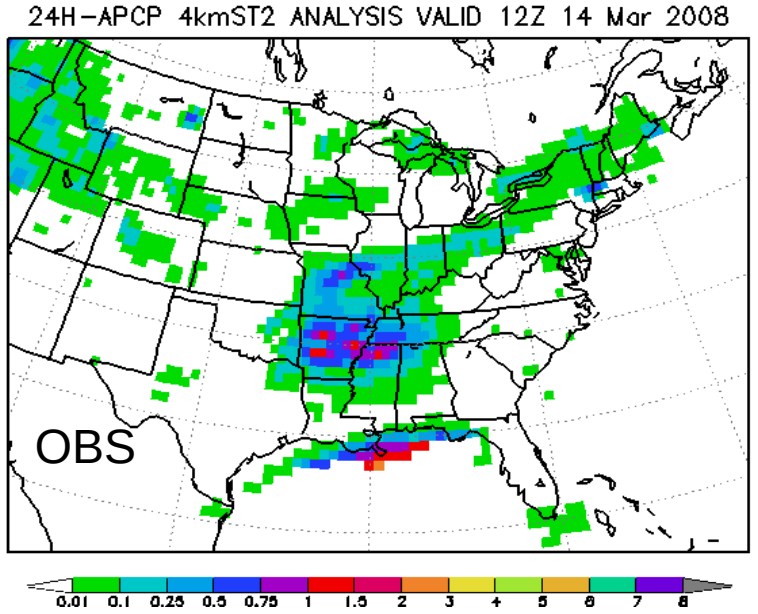
(1) Dynamical Downscaling of Precipitation

Case 1: Mar. 14, 2008

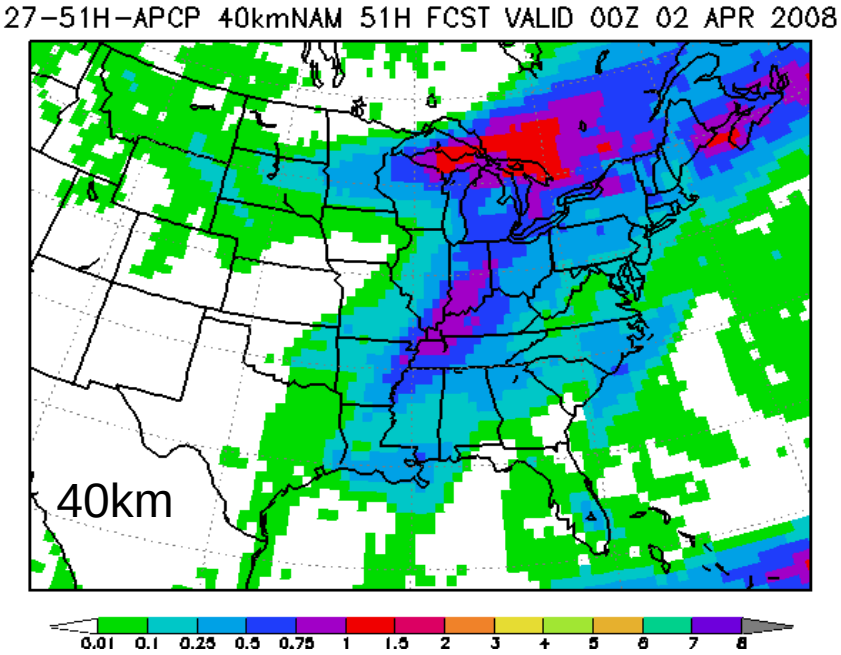


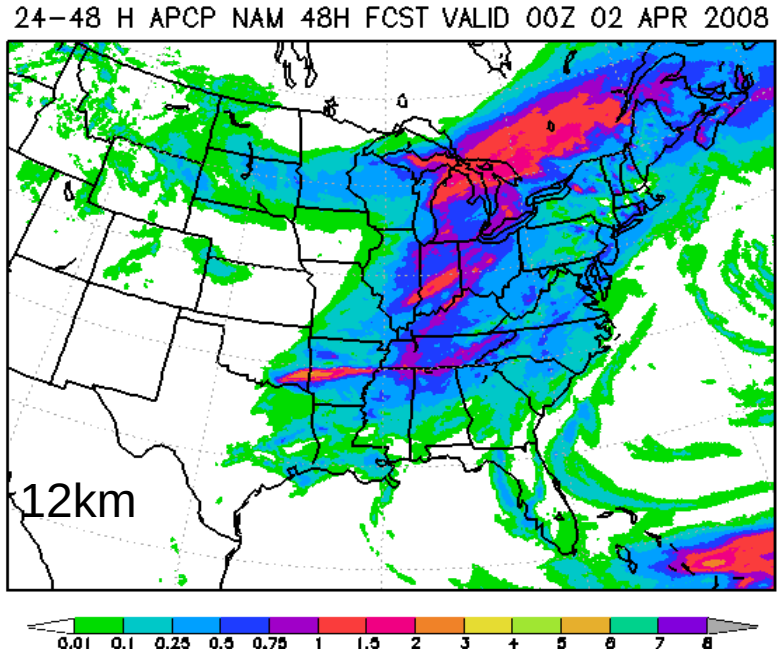


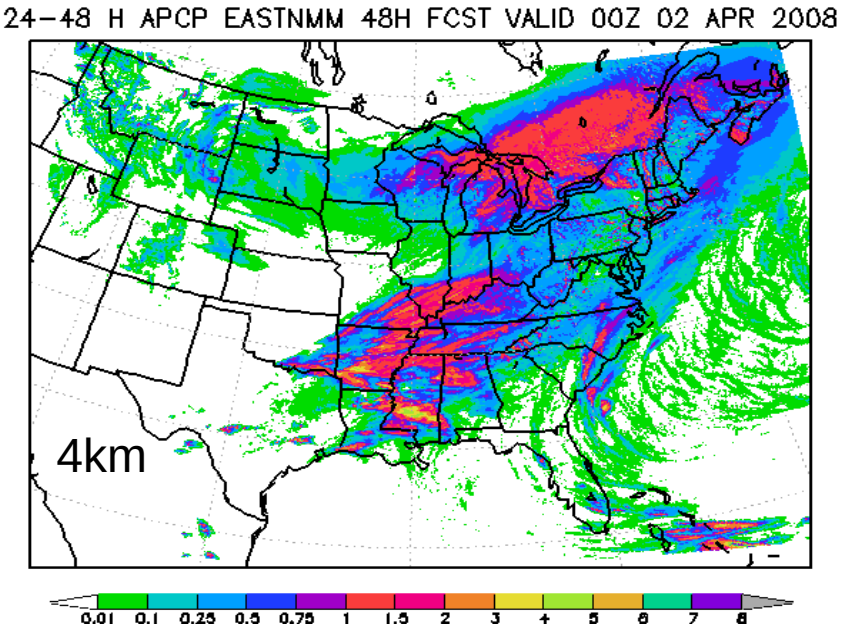


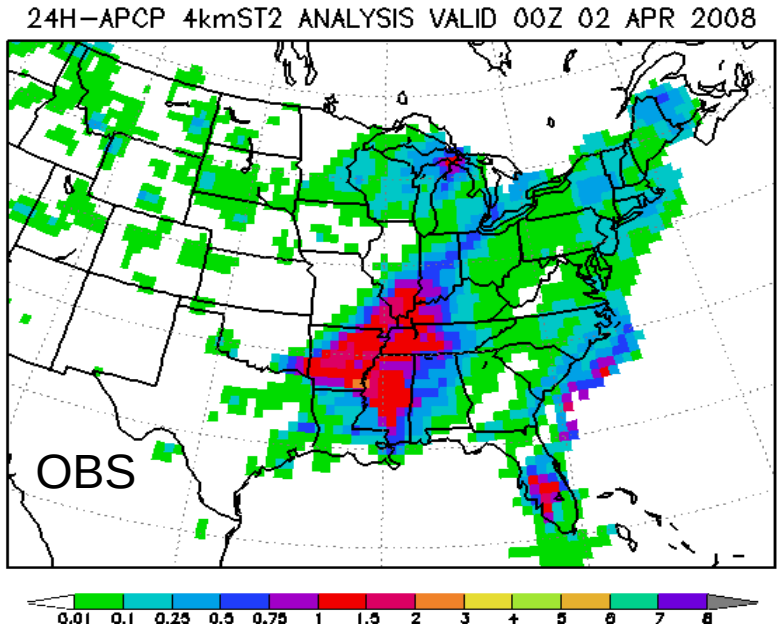


Case 2: Apr. 2, 2008

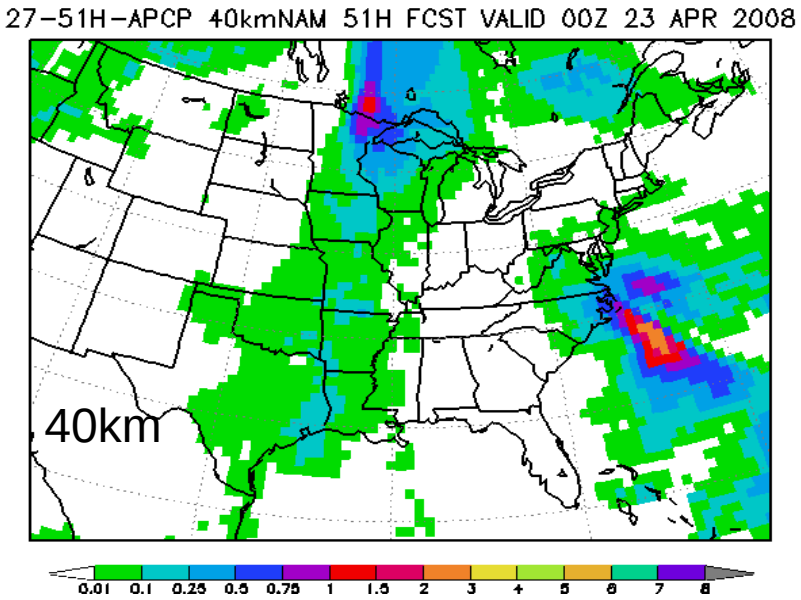


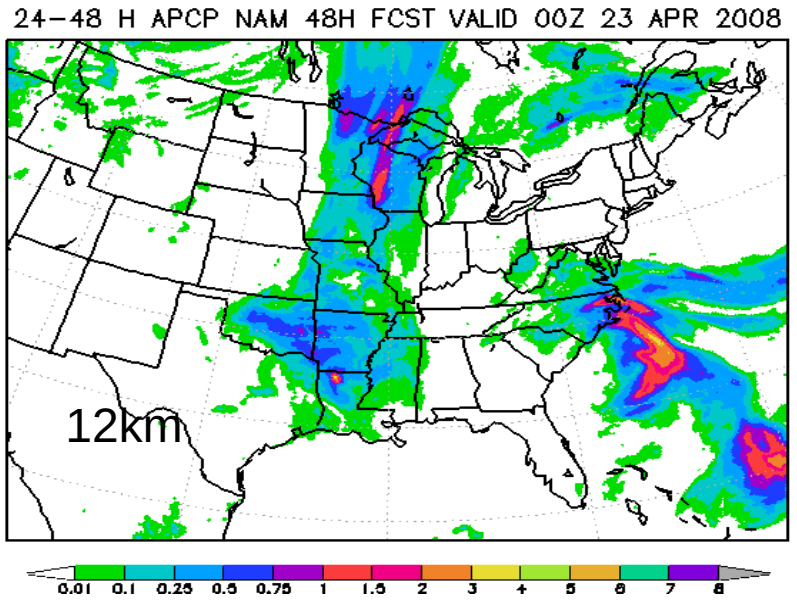


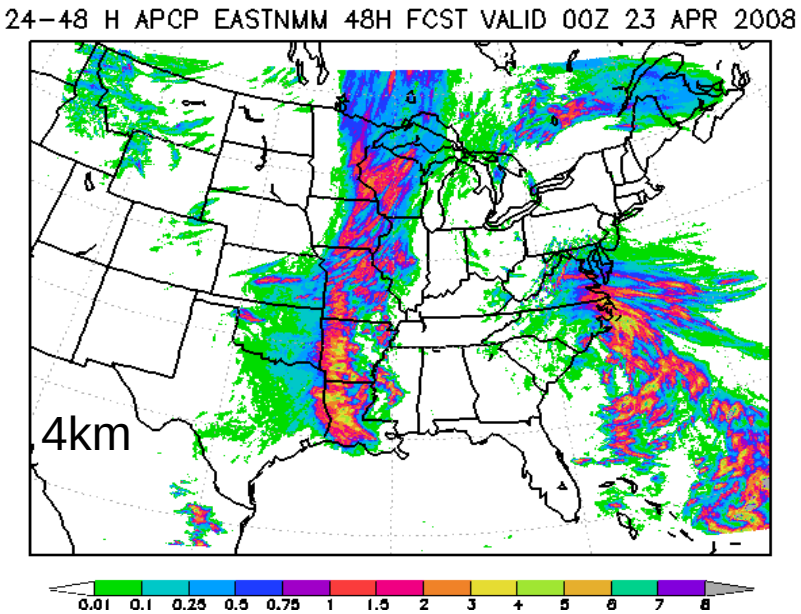


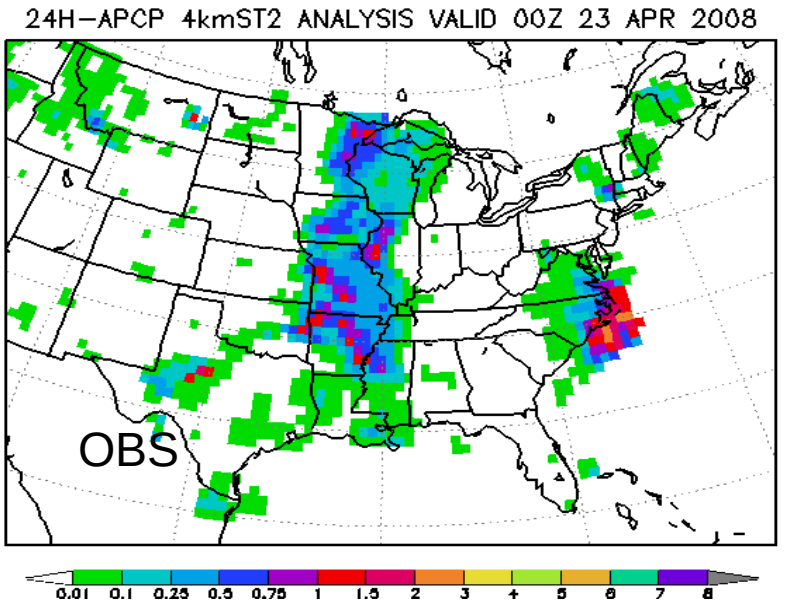


Case 3: Apr. 21, 2008

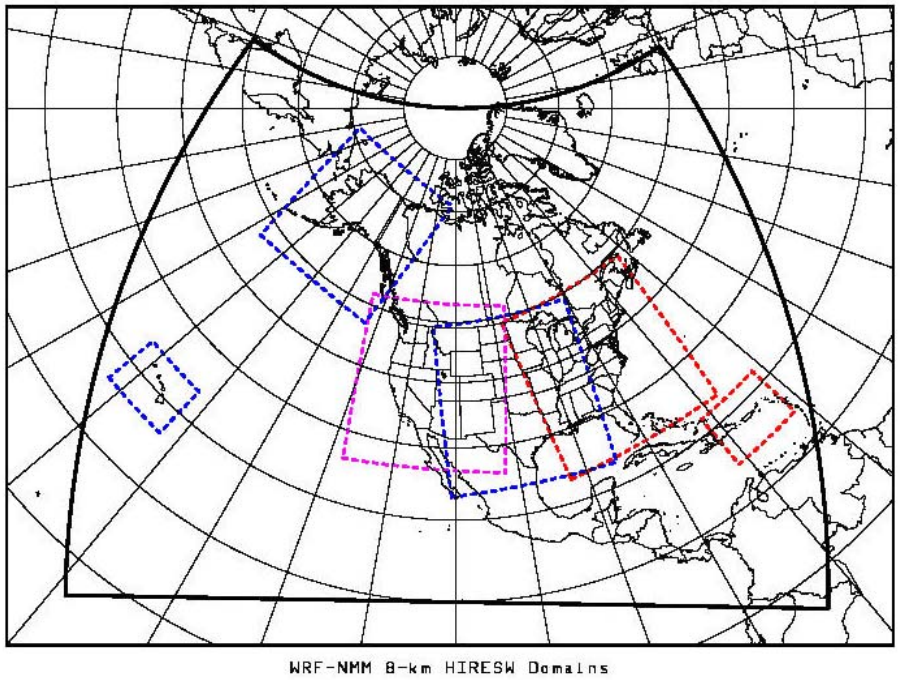








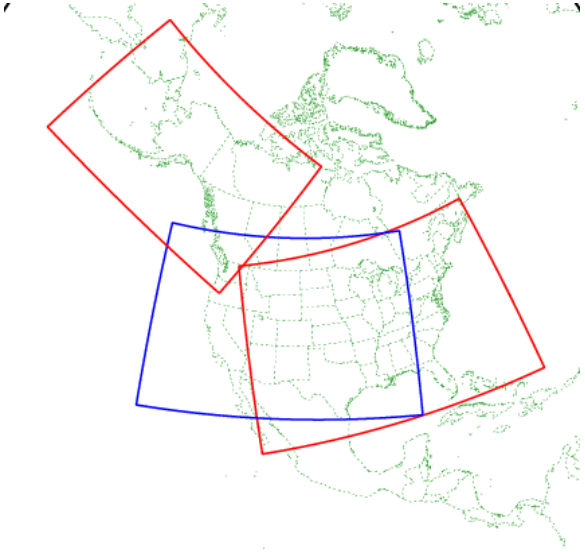
Hi-Res Window (HRW) runs



Before the 2007 change: Large & Small Domains

5.2 km for WRF-NMM

5.8 km for WRF-ARW



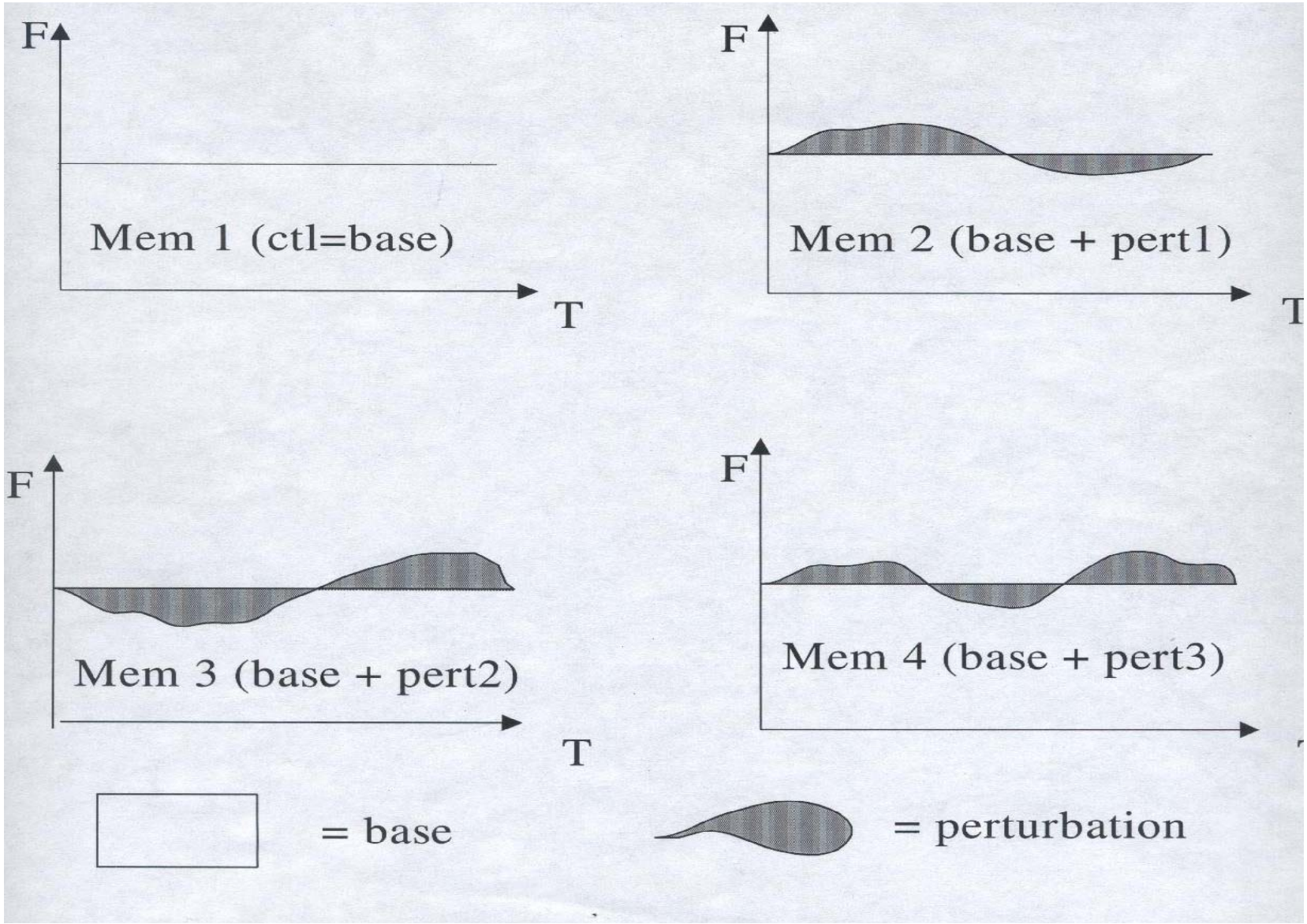
Current: new Large Domains

4.0 km for WRF-NMM

5.1 km for WRF-ARW

Small domain size is unchanged

Dynamically Downscaled Ensemble via. Hybrid Ensembling approach (Du, 2004): Combining the forecast variance from 40km-SREF and the base forecast from 4km-HRW wrf runs (**44 mems**!)

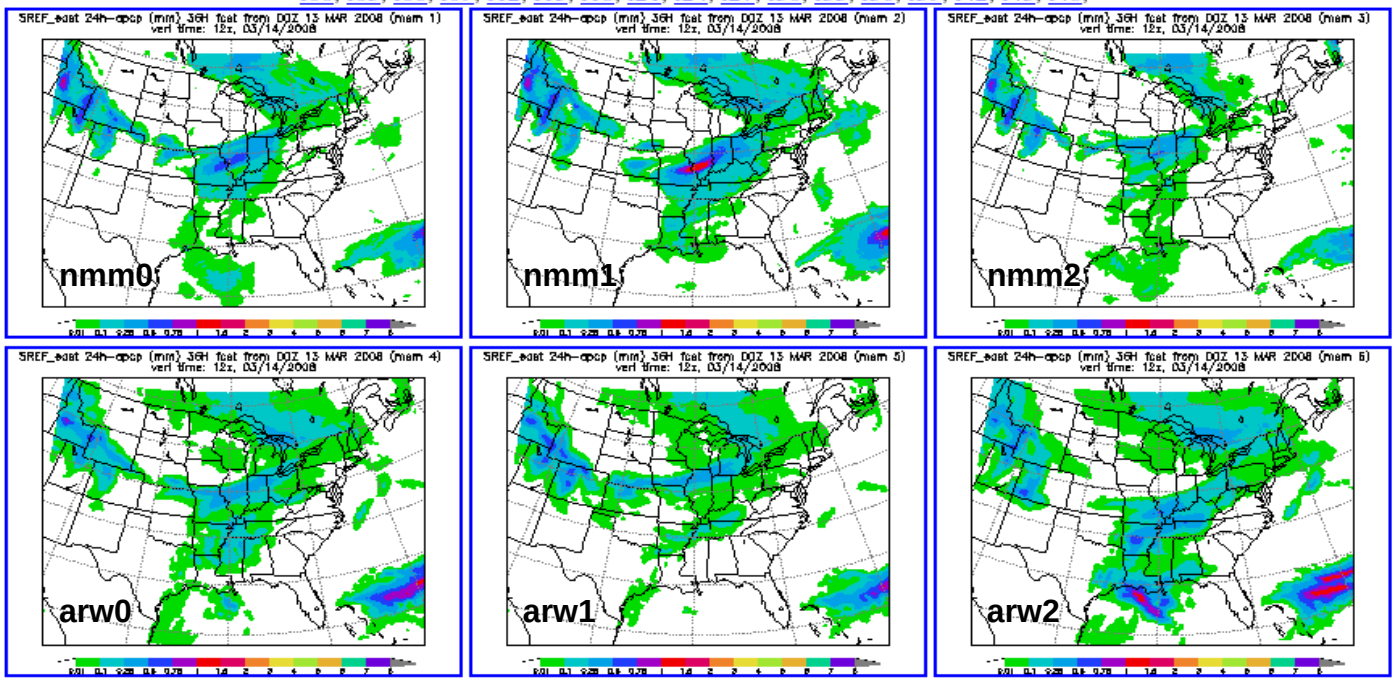


Downscaled Variables in the test (18)

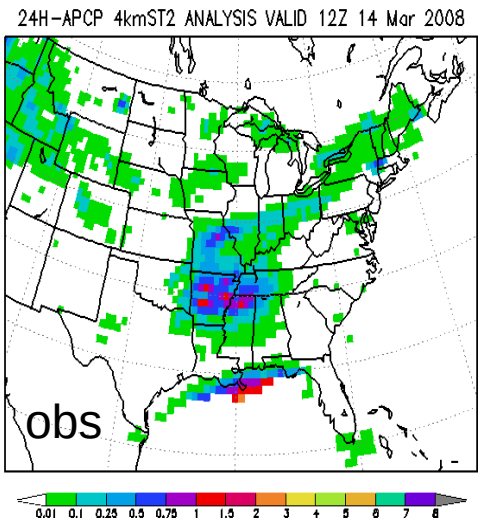
3h-apcp, **t2m, rh2m, q2m, u10m, v10m, mslp, cape, cin (9)**

t250, t500, t850, rh850, z500, u250, u850, v250, v850 (9)

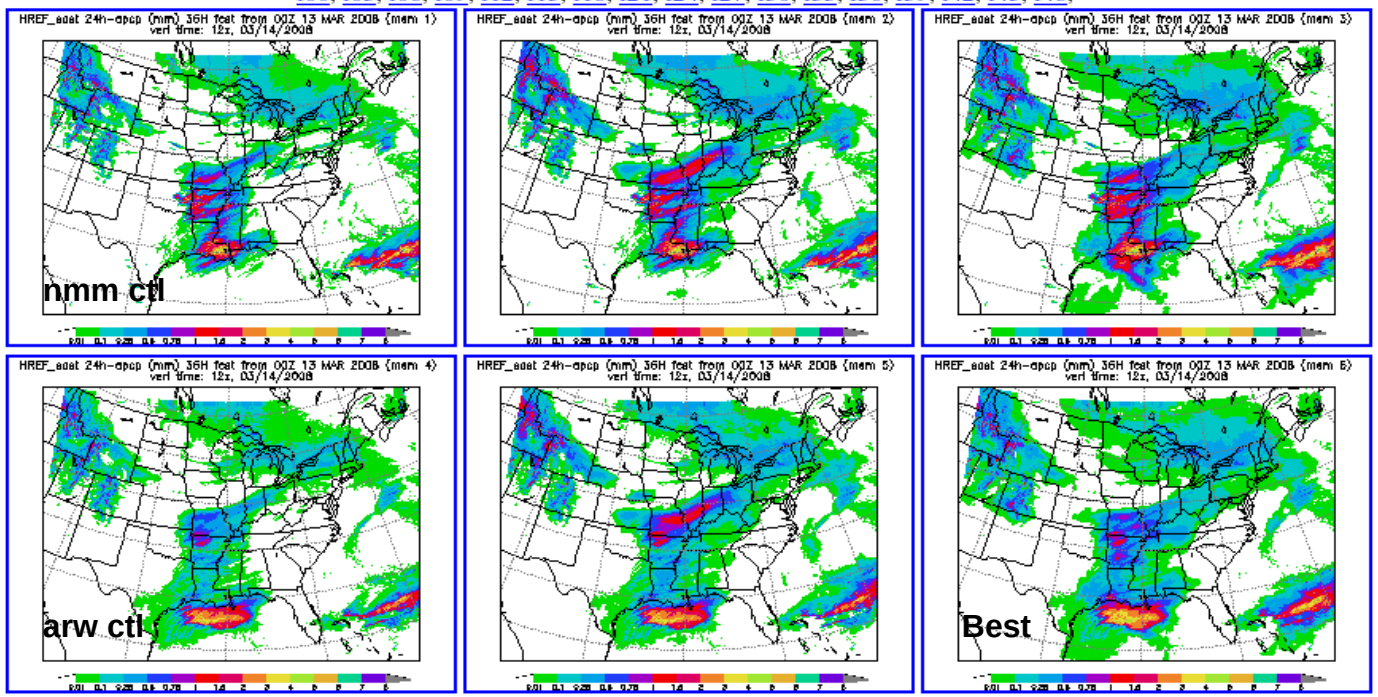
f00, f03, f06, f09, f12, f15, f18, f21, f24, f27, f30, f33, f36, f39, f42, f45, f48,



40km-WRF members

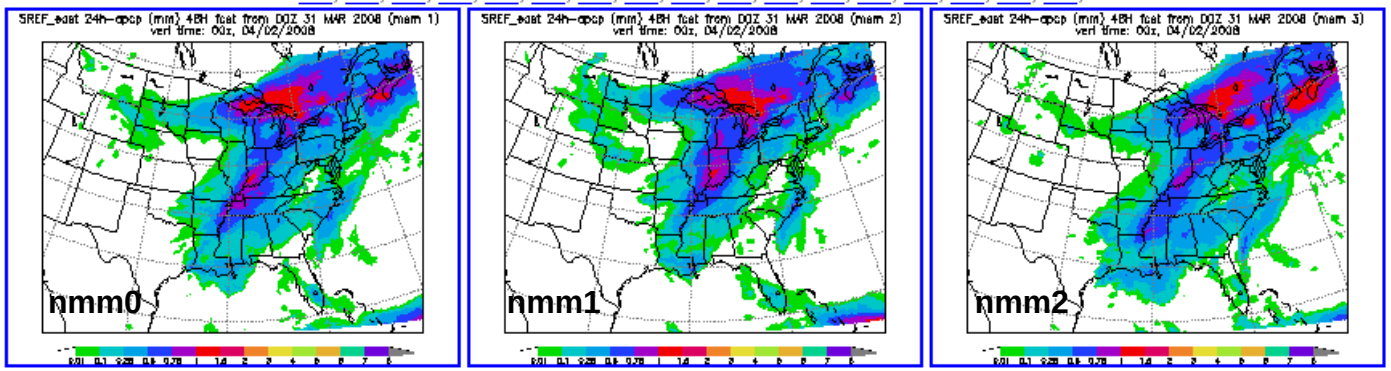


f00, f03, f06, f09, f12, f15, f18, f21, f24, f27, f30, f33, f36, f39, f42, f45, f48,

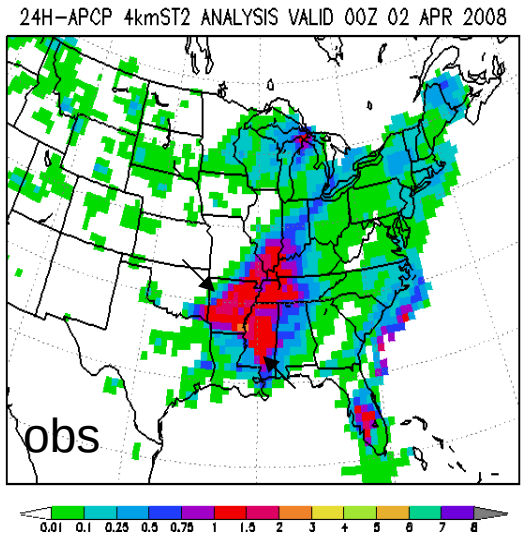


4km-HYB members

f00, f03, f06, f09, f12, f15, f18, f21, f24, f27, f30, f33, f36, f39, f42, f45, f48,

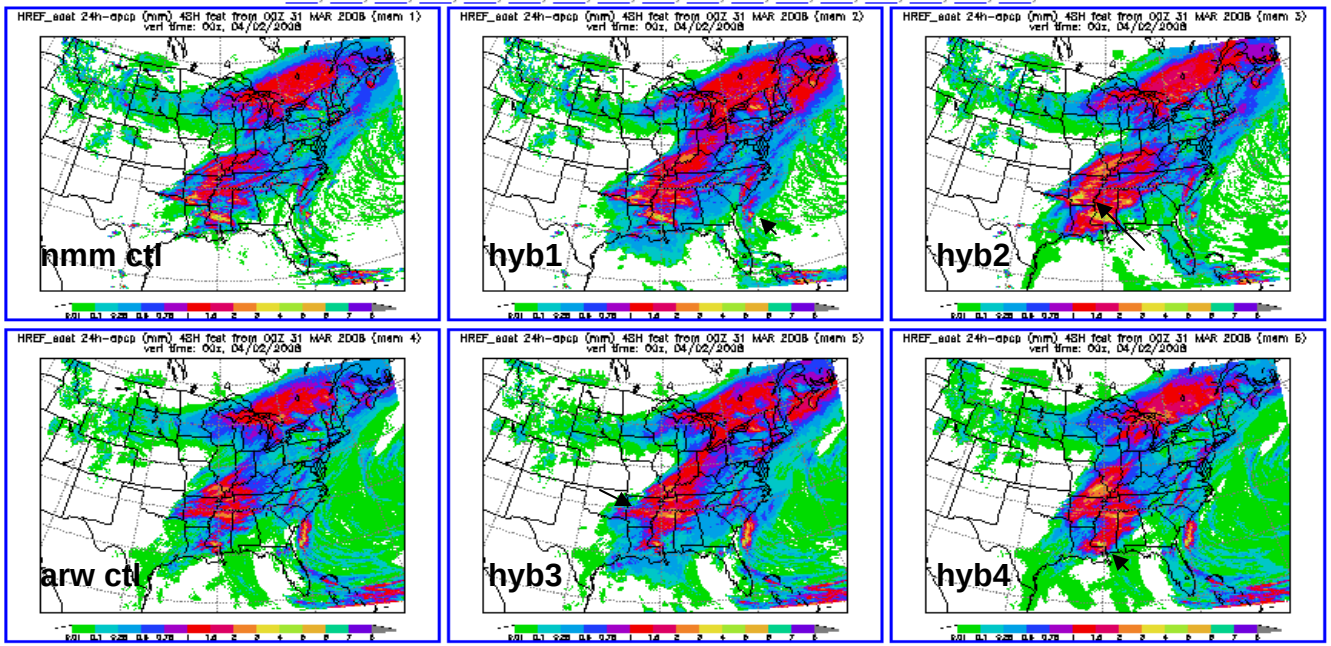


40km-WRF members

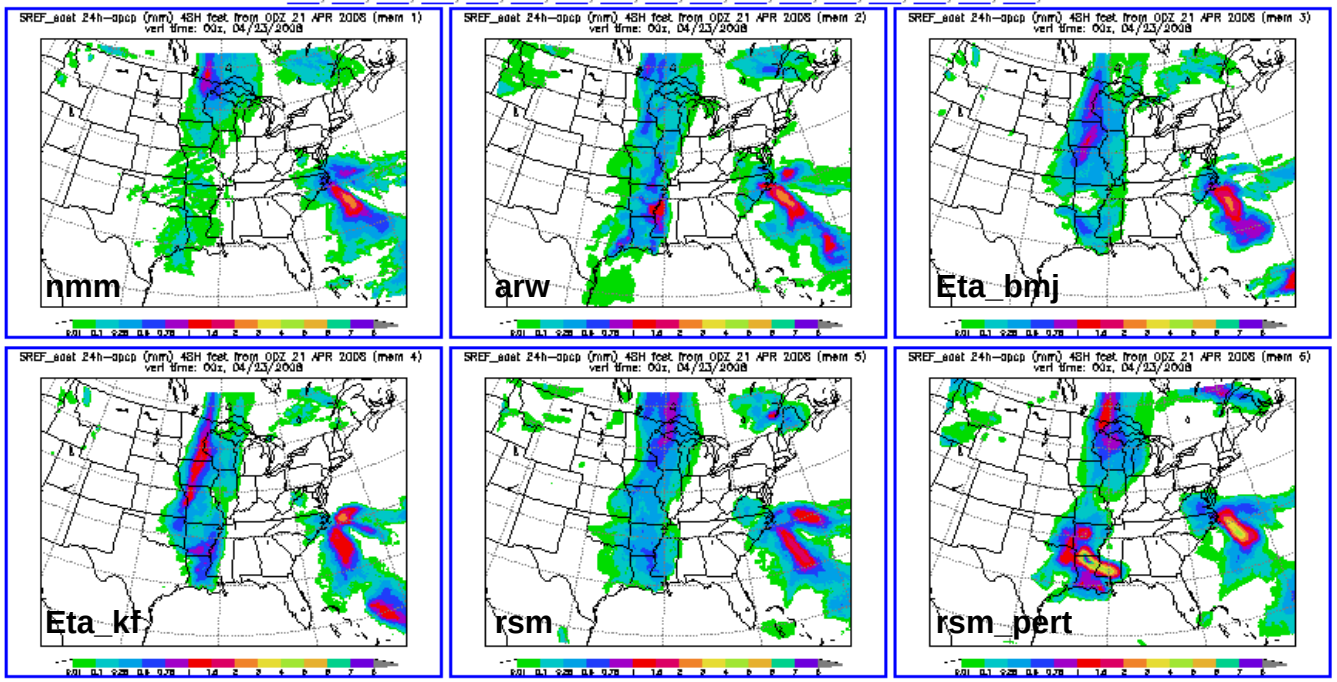


4km-HYB members

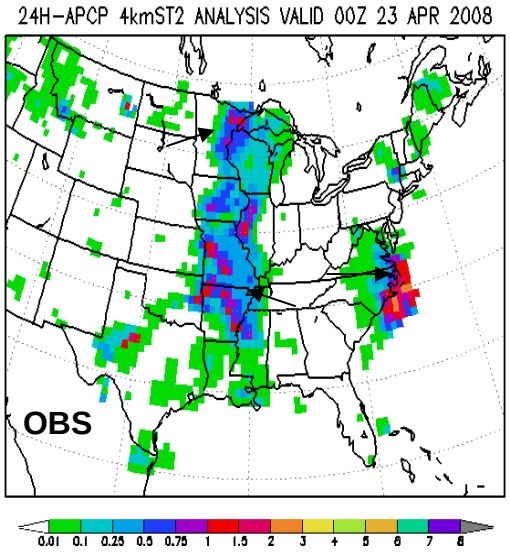
f00, f03, f06, f09, f12, f15, f18, f21, f24, f27, f30, f33, f36, f39, f42, f45, f48,



f00, f03, f06, f09, f12, f15, f18, f21, f24, f27, f30, f33, f36, f39, f42, f45, f48,



32/45km-SREF members



4km-HYB members

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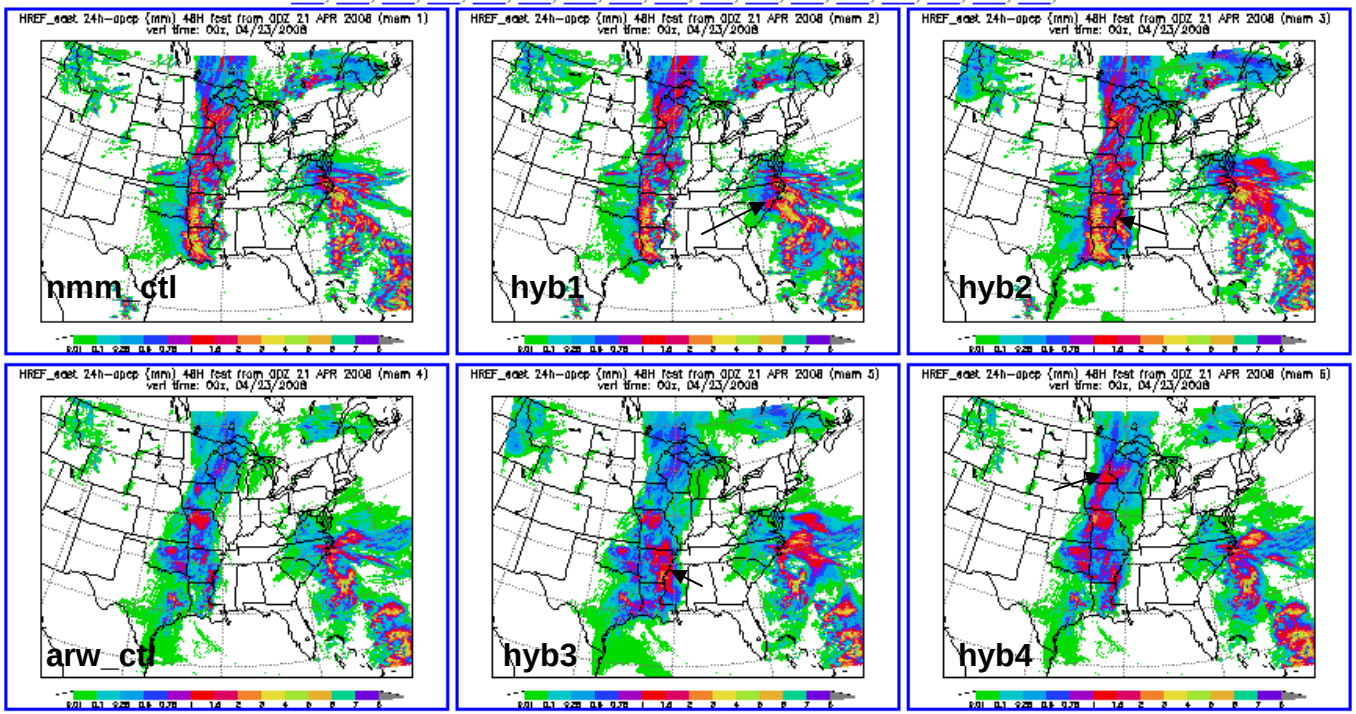
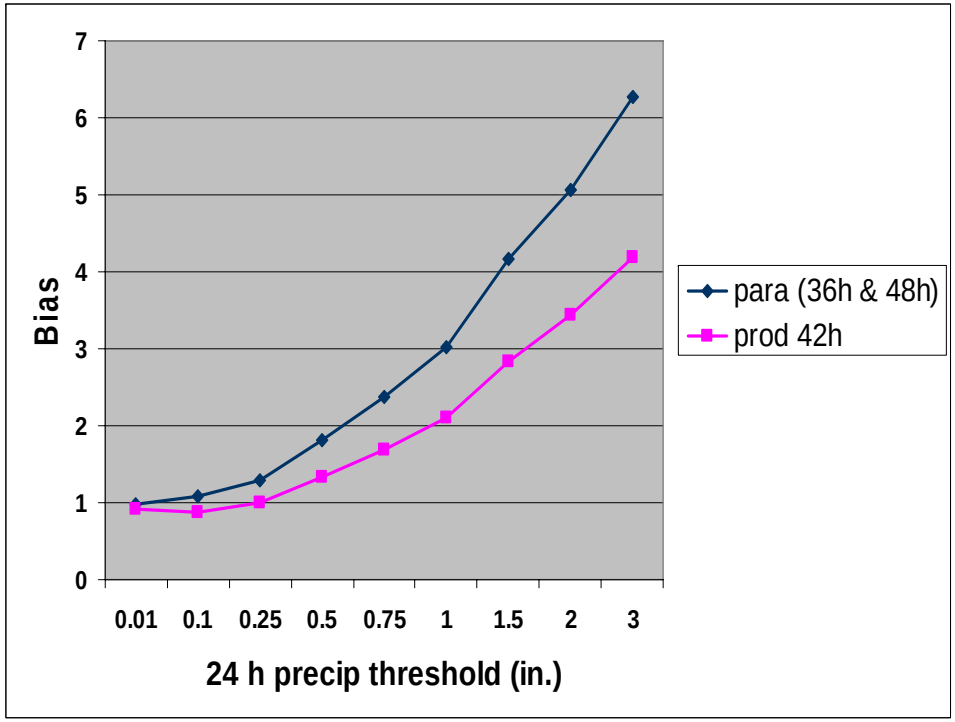
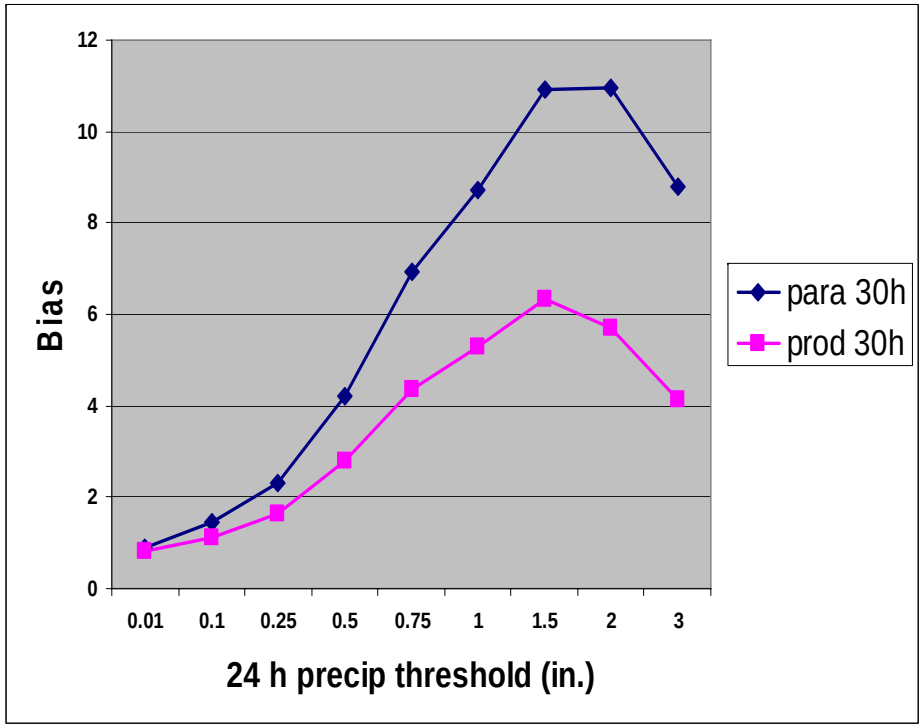


Eastern & Western QPF bias with WRF_NMM changing from 5.2km-prod to 4km-para (2007, both explicit): **removal of "high-precipitation" bias residing in hi-res forecasts is critical in the Dynamical Downscaling**



Eastern (WRF-NMM), 8/18 to 8/28



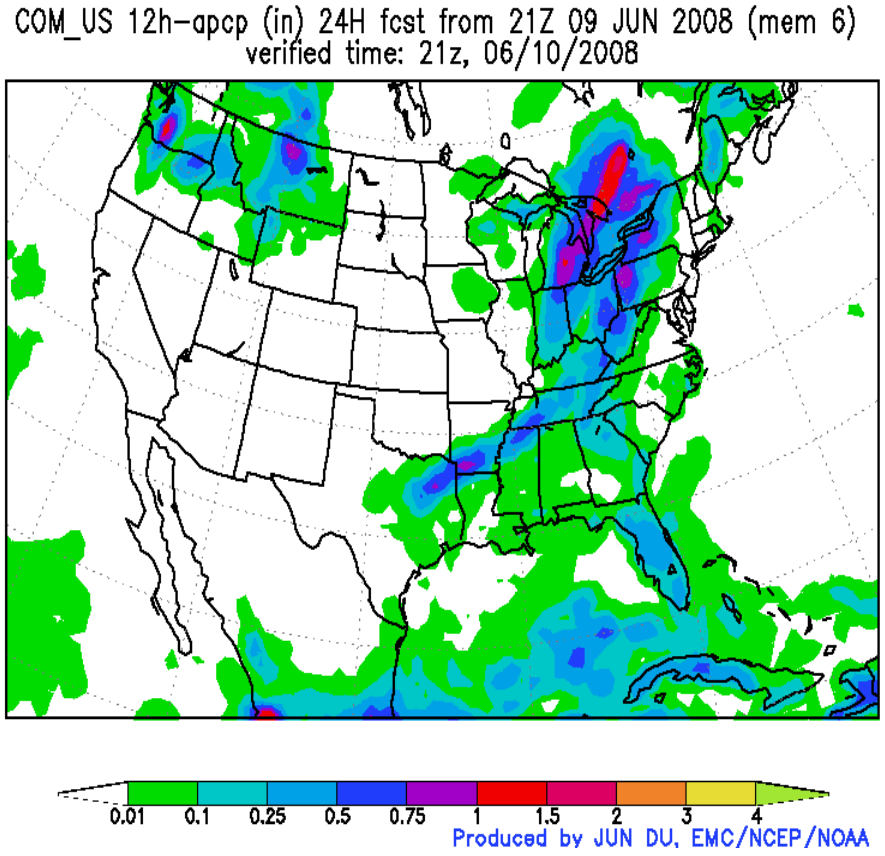
Western (WRF-NMM), 8/18 to 8/28

(2) SREF System Upgrade in Fall 2008

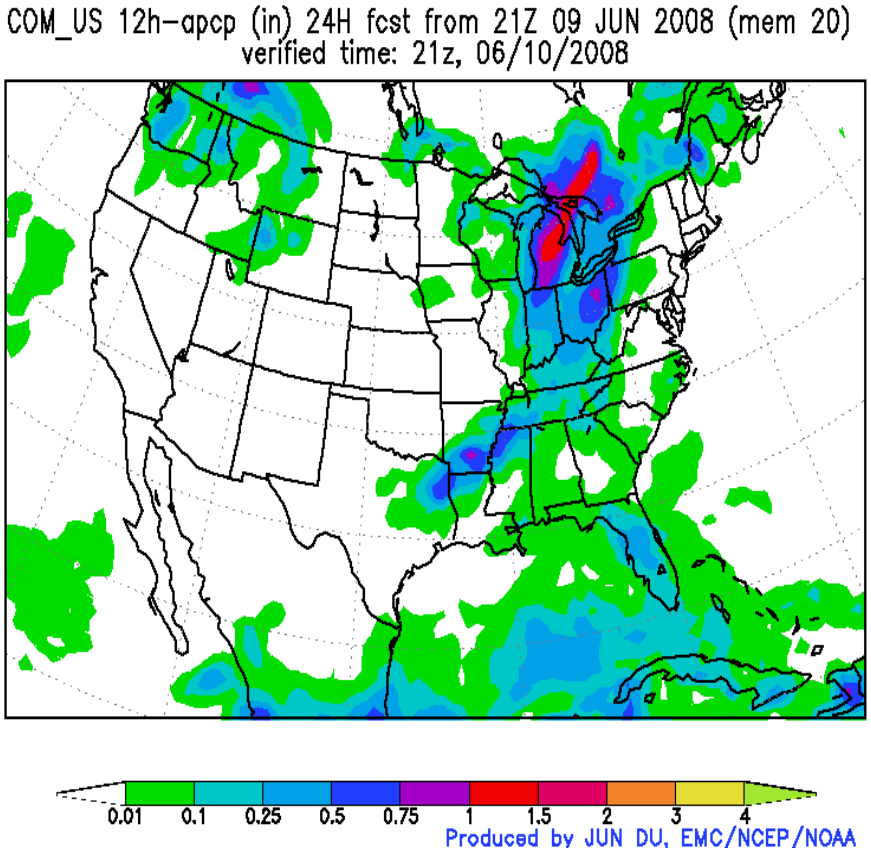
Relevant Changes

- **Model version upgrade for NMM (2.2), ARW (2.2) and RSM (2008)**
- **Resolution increase to 32km for 40kmNMM, 45kmARW and 45kmRSM**
- **Increase WRF membership: from 6 to 10 (5 NMM and 5 ARW) and reduce Eta membership from 10 to 6**
- **Replace Ferrier microphysics scheme with WSM3 scheme for ARW members for good**
- **More physics diversity for RSM members: replace Zhou cloud scheme with Ferrier scheme for 3 SAS members**
- **September 23, 2008 targeted implementation date.**

Old version vs. New version: precipitation forecast

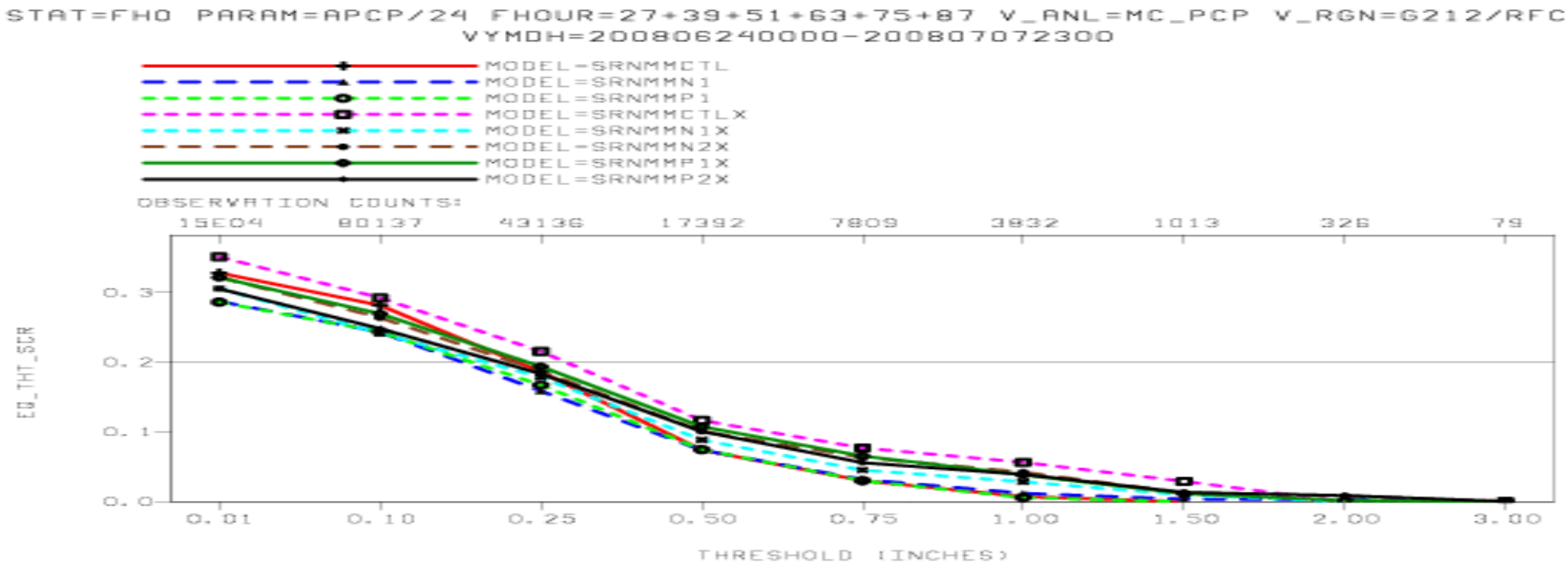


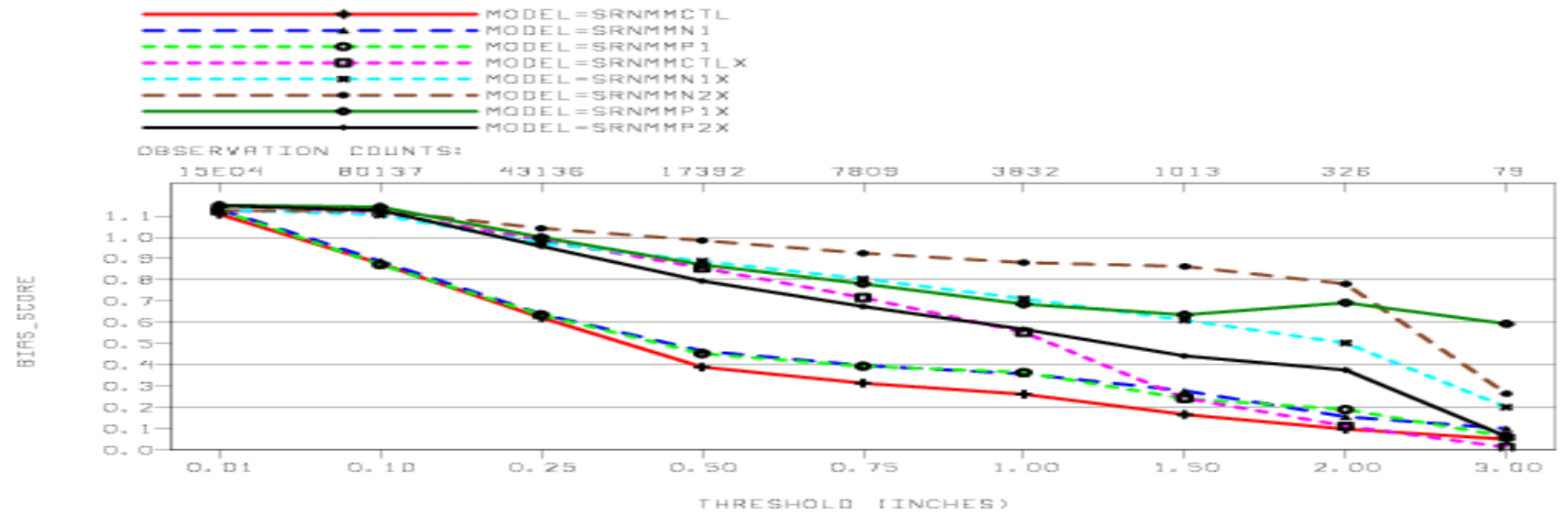
32km new ARW



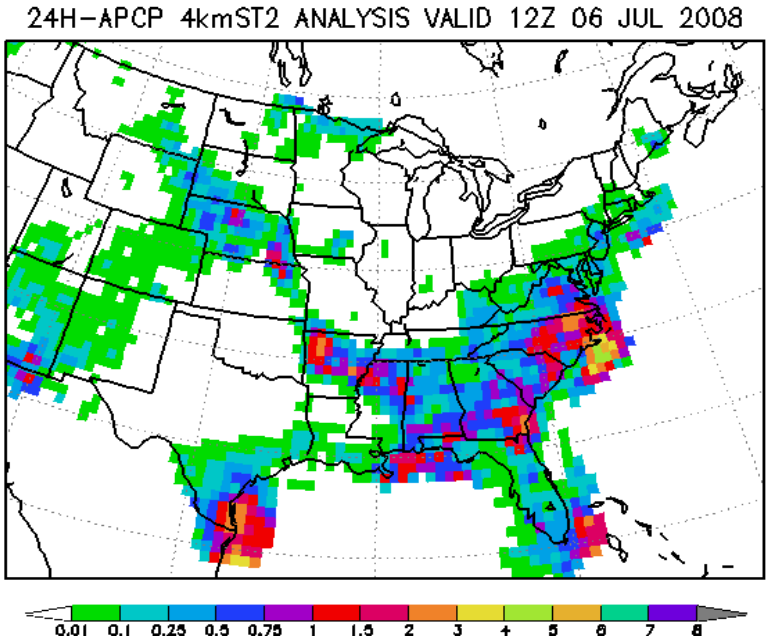
45km old ARW

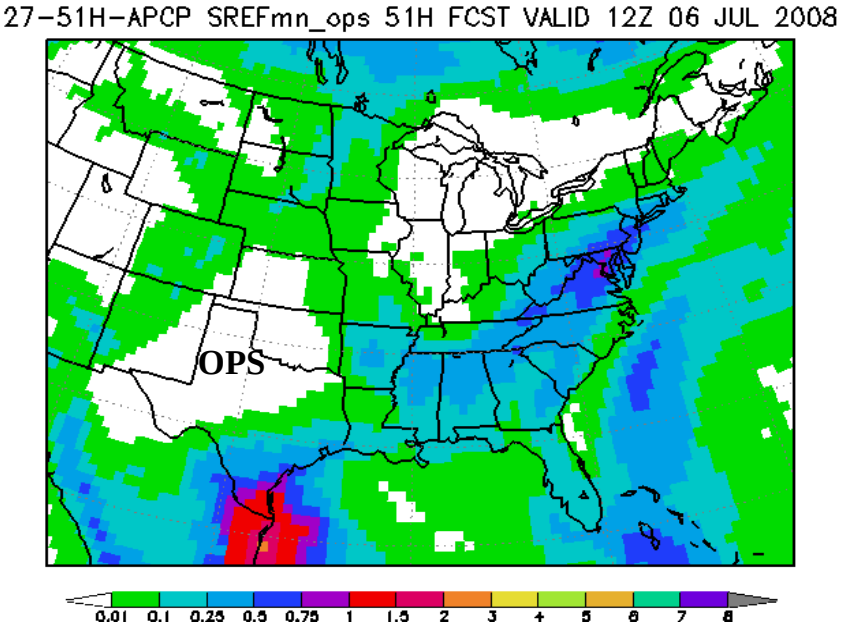
NMM component: ETS and Bias (from Ying Lin)

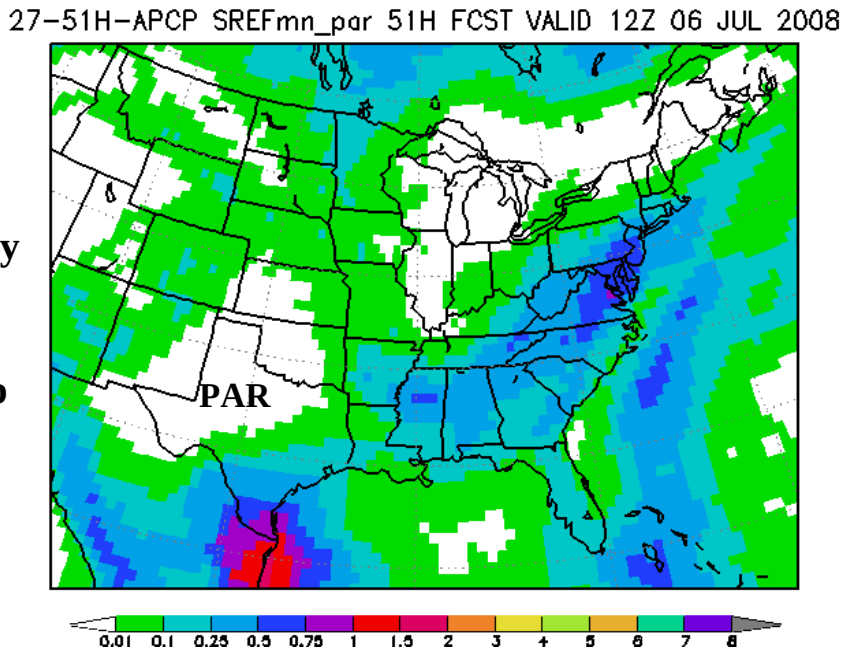




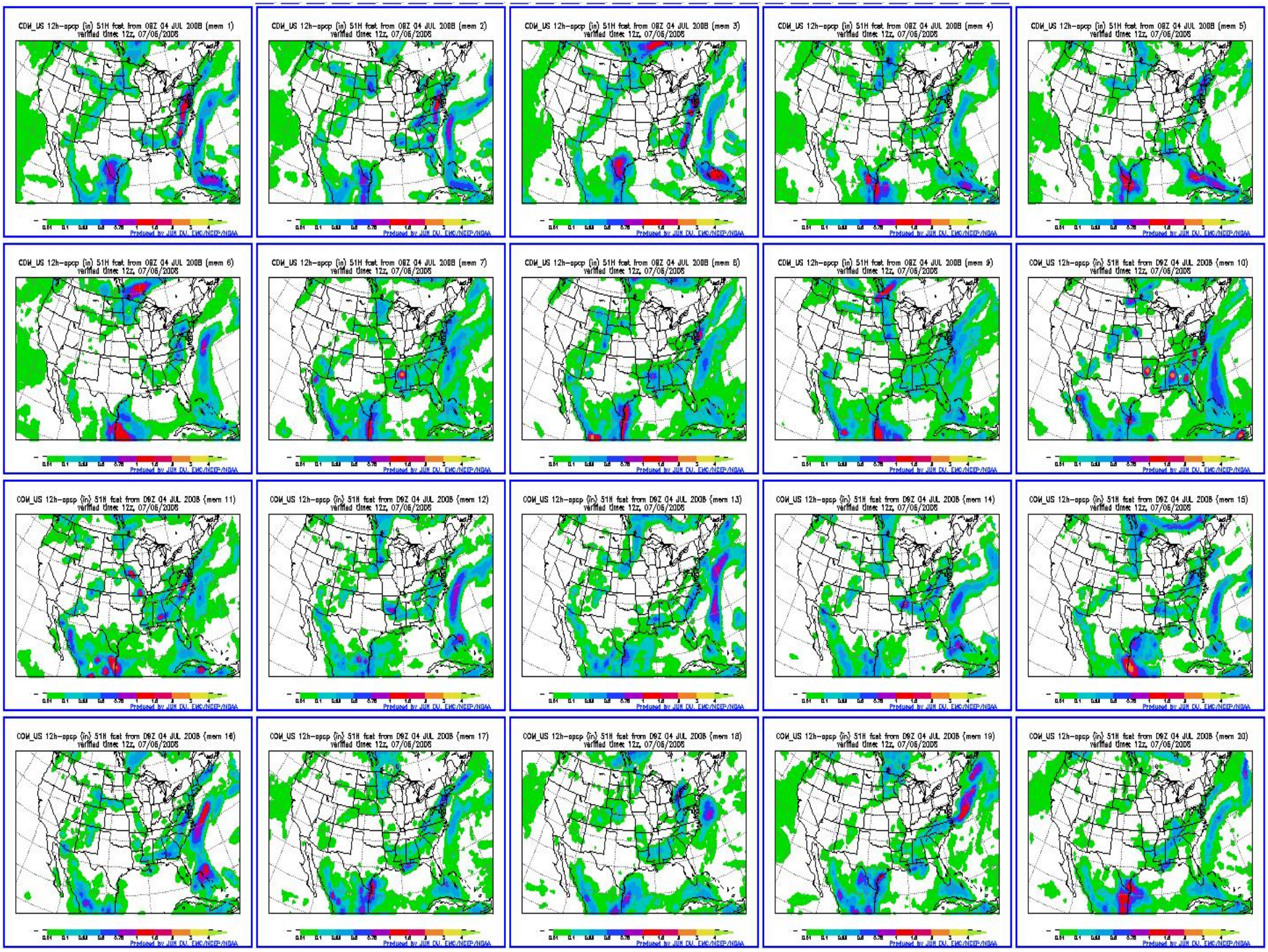
SREF mean precip fcsts: old vs. new







(1). There is really not much difference between old and new SREF means;
(2). As a common characteristic, ens mean always severely over-estimates light-precip area and underestimates heavier-precip area.
(3). Therefore, it is recommended that ens mean of precip should not be used but probabilistic precip fcst should be used instead.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verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 2)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 3)
verified time: 12z, 07/06/2008
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verified time: 12z, 07/06/2008
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verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 6)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 7)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 8)
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CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 9)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 10)
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CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 11)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 12)
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verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 14)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 15)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 16)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 17)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 18)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 19)
verified time: 12z, 07/06/2008
CDW_US 12h-apcp (in) 51H fcst from 08Z 04 JUL 2008 (mem 20)
verified time: 12z, 07/06/2008

Science Behind SREF

IC uncertainty: multi-analysis (NDAS and GDAS) and IC perturbations (breeding);
Model physics uncertainty: multi-model (4 models) and multi-physics schemes (e.g., 6 different convective schemes and various microphysics) etc.;
LBC/large-scale flow forcing uncertainty: coupled with GEFS;
Lower-boundary forcing uncertainty: perturbing land surface initial states (tested but not implemented yet);

Bias correction: decaying-average statistical approach;
Downscaling: both dynamical and statistical approaches.

Outlooks

- All-WRF SREF system with about 20km resolution (~**2010**)
- Relocatable fine-res High-impact Weather Forecast Ensemble (HWEF) system (after **2010**)
- NAEFS-LAM (combining with Canadian SREF, after **2010**)
- Concurrent run with NAM, GFS (00, 06, 12, 18z) (after **2011**)
- All ensemble systems run under ESMF/NEMS framework (after **2012**)