N Update on WRF+ in NCEP Operations

C Geoff DiMego, Zavisa Janjic, Tom Black, Eric Rogers,
Matt Pyle, Jun Du, Ying Lin, Hui-Ya Chuang, Brad Ferrier,
Dusan Jovic, Binbin Zhou, Guang Ping Lou, HWRF Team

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26 June 2012

Where the nation's climate and weather services begin

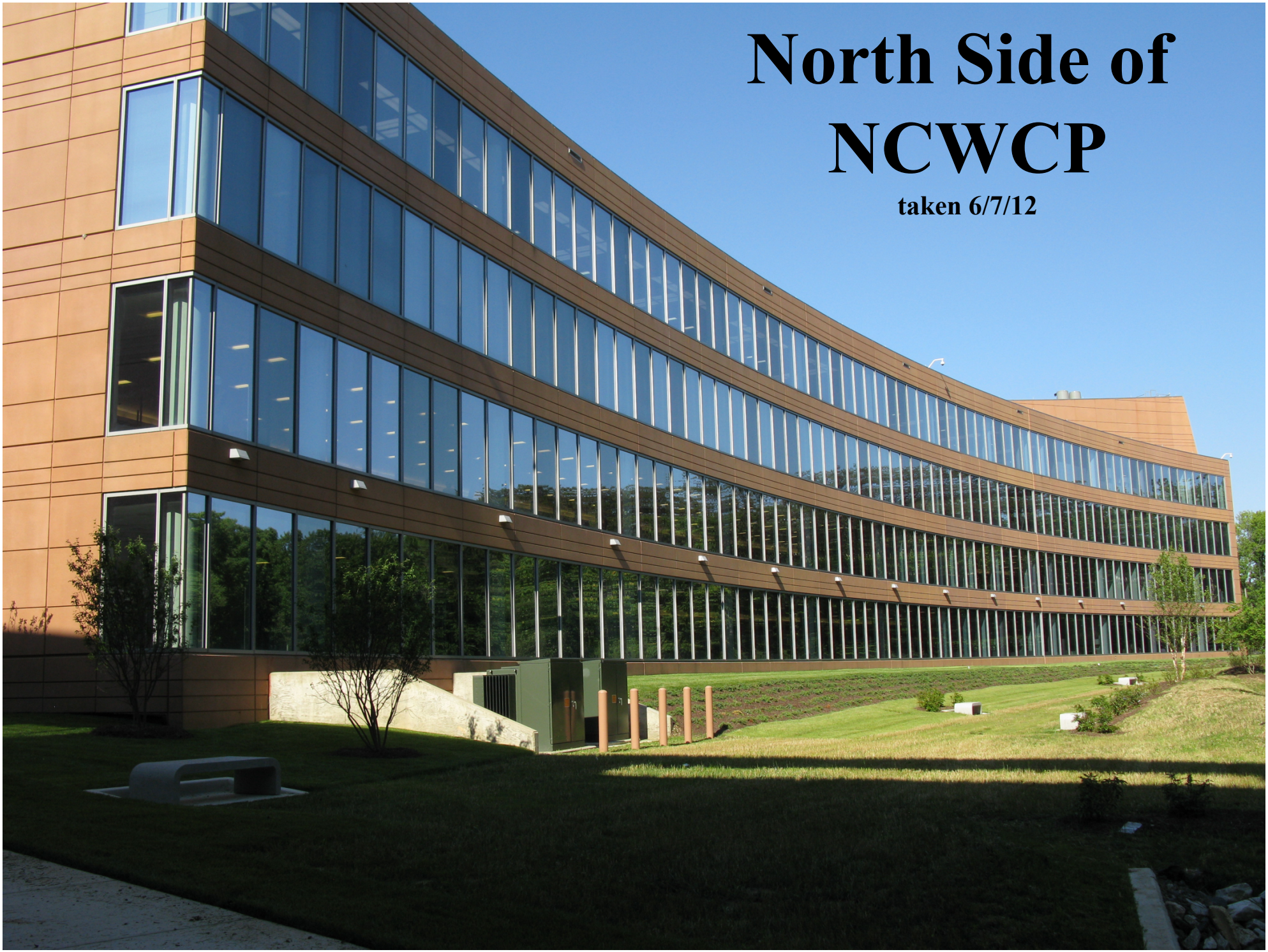
F

T O P I C S

- Building+Computer Transitions at NCEP
- Unified Post Processor
- Hurricane WRF
- Rapid Refresh (and NARRE)
- HiResWindow (and HRRRE)
- Gridpoint Statistical Interpolation
- North American Mesoscale NEMS-NMMB
- Short Range Ensemble Forecast

NOAA Center for Weather and Climate Prediction

- Four-story, 268,762 sq ft building in College Park, MD
- Housing 800+ Federal employees, and contractors
  - 5 NCEP Centers (NCO, EMC, HPC, OPC, CPC)
  - Joint Center for Satellite Data assimilation
  - 2 NESDIS:
    - Center for Satellite Applications and Research (STAR)
    - Satellite Analysis Branch (SAB)
  - 1 OAR: Air Resources Laboratory
- 40 spaces for visiting scientists
- 465 seat auditorium & conference center, library, deli, fitness center & health unit
- EMC moves in 20 August 2012

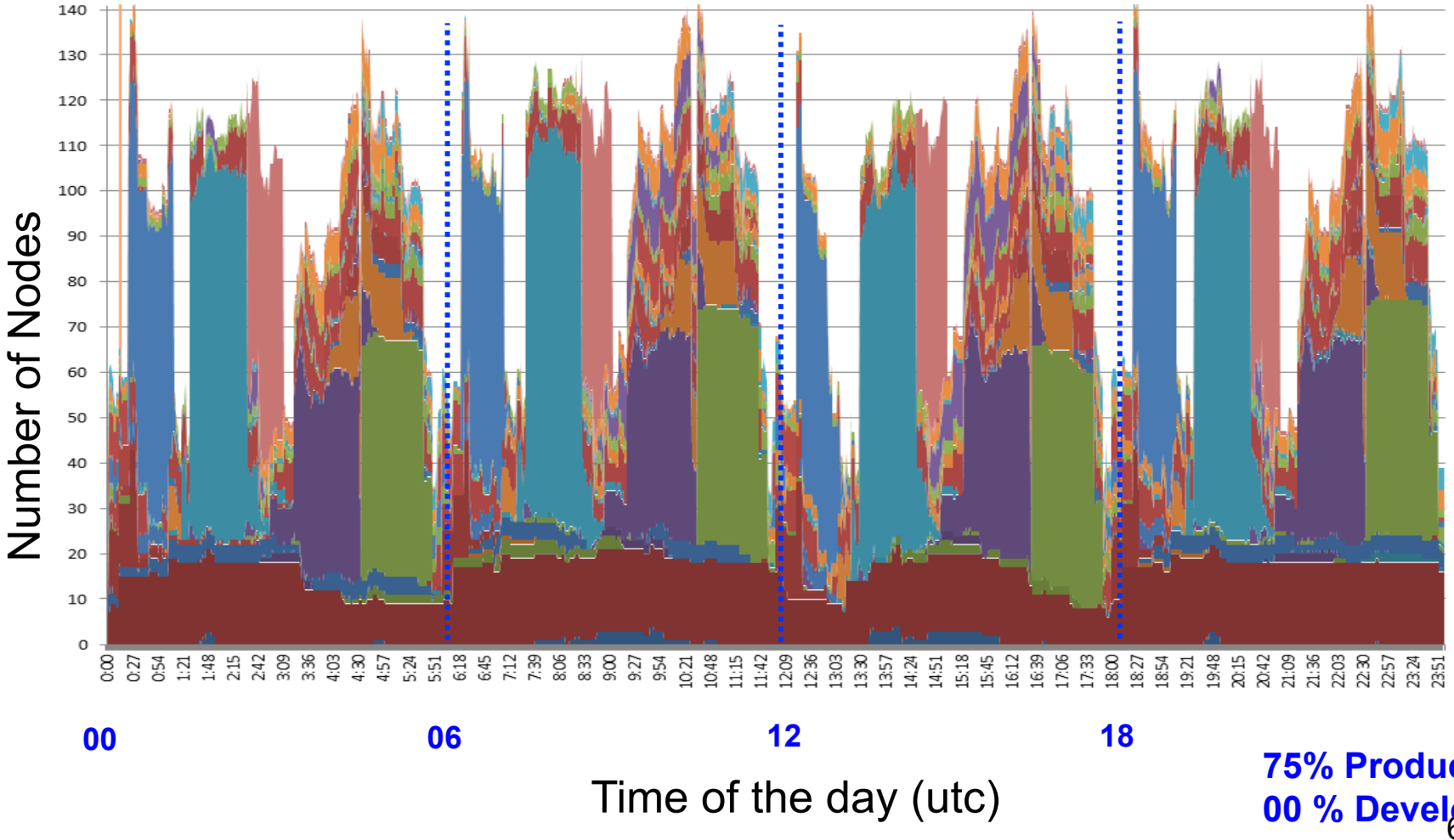

North Side of
NCWCP
taken 6/7/12

Weather and Climate Operational Supercomputing System (WCOSS)

	Lifecycle Date	Architecture	OpnlUse Time / Vendor facilities	Average Capability	Average Capacity	Number of compute cores	TeraFLOP	Storage Useable (bandwidth)
Original System	Jan 2009	Power6 / AIX	99.0%/ One	0.94X	0.94X	4,994	69.4 TF	0.35 PB
Bridge System	Oct 2012– Sep 2013	Power6 / AIX	99.9%/ One	1.0X	1.0X	5,314	73.9 TF	0.80 PB
WCOSS Phase 1	Dec 2012 Planned Acceptance "Go-Live" ~4QFY13	iDataPlex /Linux [Sandy Bridge 2.6GHz]	99.9%/ TWO	~2.1X over Bridge P6	~2.3X over Bridge P6	10,048	~210 TF	2.59PB (24gb/s)
WCOSS Phase 2	Dec 2014 Planned Acceptance	iDataPlex /Linux	99.9%/ TWO	2X over Phase 1	3.3X over Phase 1	TBD	TBD	4.89PB (60gb/s)

It's About Dang Time!!!
Production Suite on Supercomputer

May 2012



75% Production
00 % Development

Update on Post Processor

EMC (Hui-Ya Chuang, Guang Ping Lou) + DTC (Tricia Slovacek)

- Activities conducted with the DTC
  - Replaced WRF Post Processor (WPP) with Unified Post Processor (UPP) in 2011.
  - Now merging different versions of UPP between SubVersion repositories for release in 2013.
  - 2013 version supports parallel I/O and **Grib2**, netCDF coming next.
- New products in UPP include regional and global *fire weather* (Haines Index, transport wind, ventilation index), turbine level output for *wind energy*, parameters of interest to *aviation & severe weather*, and simulated *microwave satellite* products (e.g. HWRF).

Regional Hurricane Modeling Upgrade for 2012 season (HWRF)

- **A high-resolution hurricane model operating at cloud-permitting 3km resolution was implemented on 24 May 2012**
- **Reflects multi-agency efforts supported by the Hurricane Forecast Improvement Project (HFIP)**
- **Three atmospheric telescoping nested domains:**
  - **27km outer domain 75x75 degree**
  - **9km intermediate nest ~11x10 degree**
  - **3km inner-most nest ~6x5 degree**
- **New centroid based nest motion algorithm, 1-D coupling in East-Pac, improved physics & vortex initialization**
- **Upgraded tracker and new high-temporal resolution (every time step) track and intensity product and new SSMI/S synthetic microwave imagery**

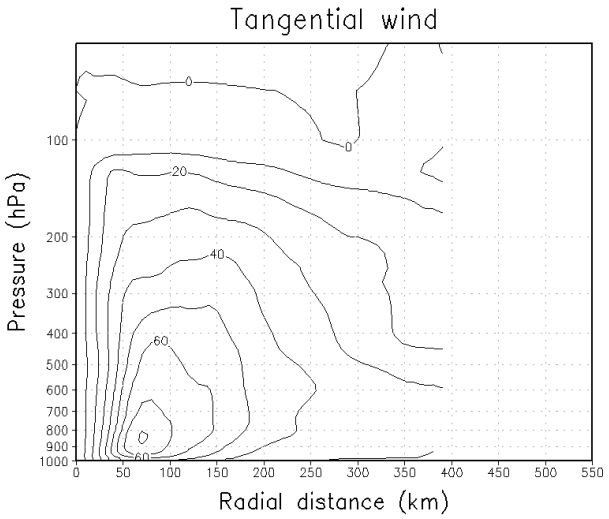
HWRF-POM Updated 24 May-1

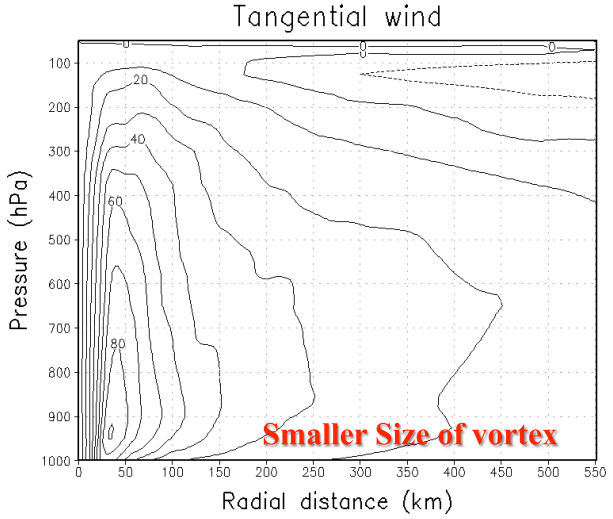
- HWRF - Princeton Ocean Model (POM) coupled system enhancements:
  - Upgrade HWRF to use of WRF-NMM version 3.4a
  - Implement **triple-nesting capability at 27-9-3** with centroid based movement algorithm
  - Configure inner-most grid with explicit representation of convective processes
  - Implement GFS Shallow Convection, modify SAS deep convection, GFS PBL, GFDL surface physics and Ferrier microphysics parameterizations suitable for higher resolution and based on observations
  - Redesign vortex initialization for 3 km resolution with improved interpolation algorithms and better representation of composite storm
  - Improved POM initialization in the Atlantic domain and new 1-D ocean coupling for Eastern Pacific basin (as has been in Atlantic Basin)
  - Upgrade the HWRF GSI to V3.5 and use of new Hybrid GSI/GFS for initial and boundary conditions once the Hybrid GSI/GFS has been implemented operationally
  - Improved HWRF Unified Post Processor to simulate SSM/I microwave imagery products
  - Very high-resolution (every 5 sec.) storm tracker output to support NHC operations
- Test results from the combination of these upgrades showed significantly improved track, intensity and structure forecast skills and improved track, intensity and storm radius forecast biases in both Atlantic and Eastern North Pacific basins.

Improved Vertical Structure

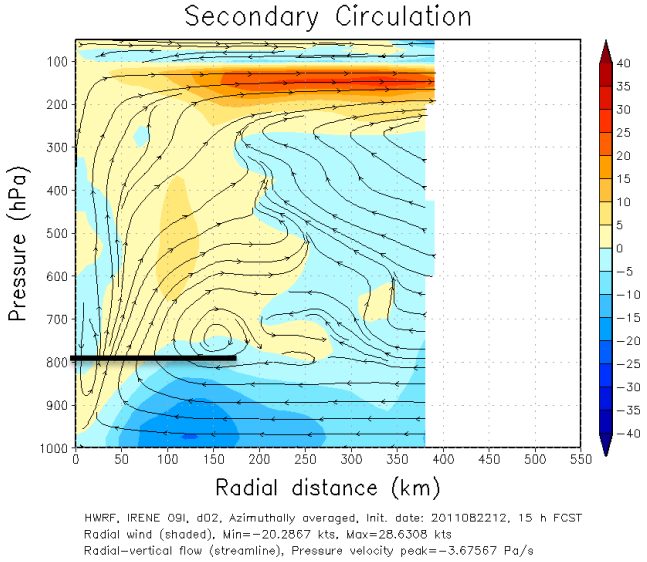
(Irene09L.2011082212 15h forecast)

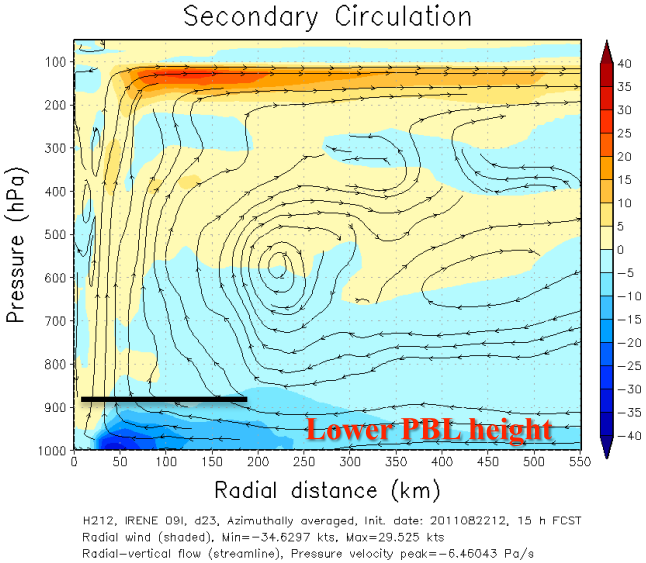
Wind structure



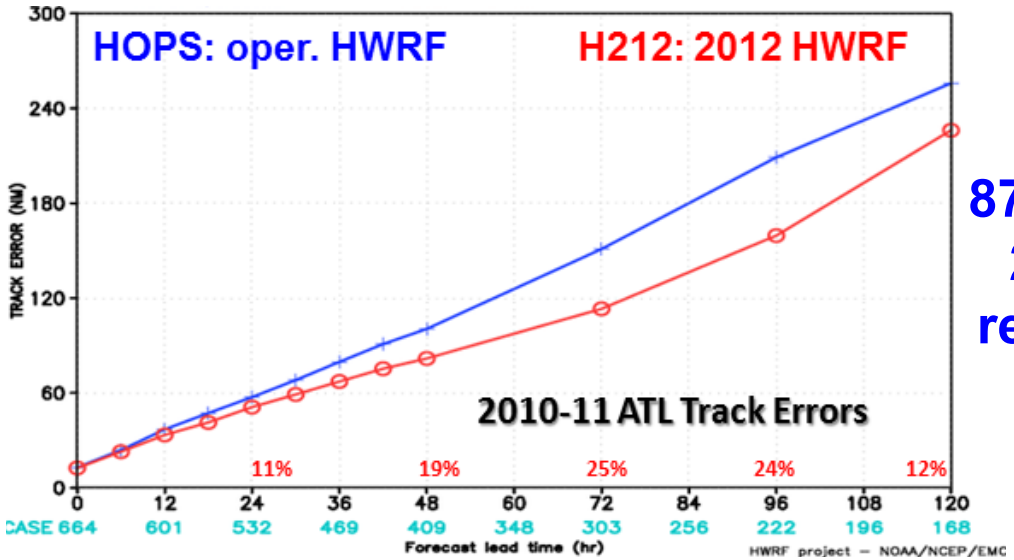


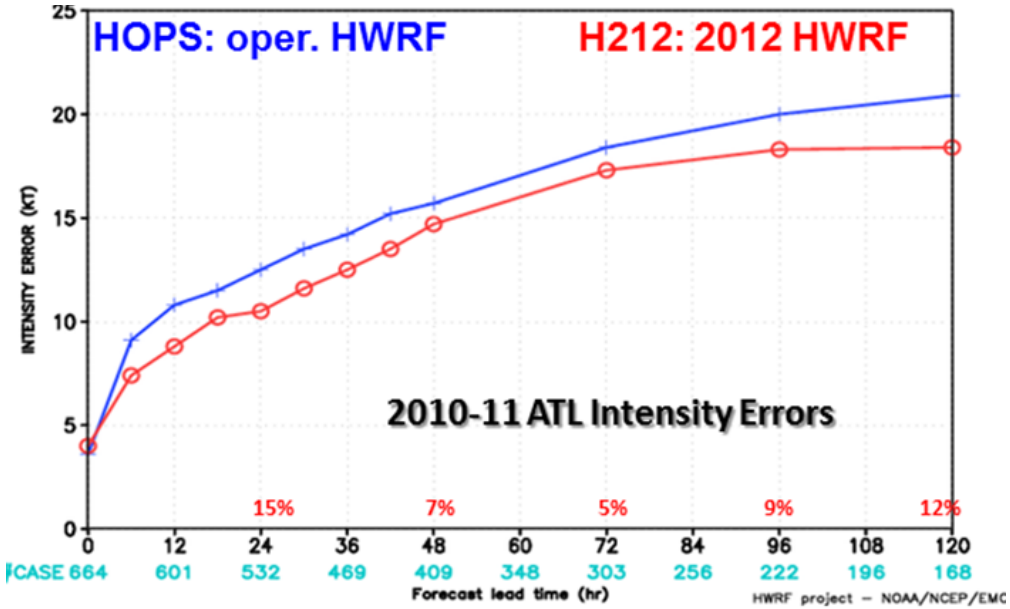
PBL height





2010 and 2011 3km HWRF Pre-Implementation Test Results





Atlantic Basin

87% of total retrospective runs from 2010-2011 seasons show 10-25% reduction in track errors and 5-15% reduction in intensity errors

37 Storms

2010: Alex, Two, Bonnie, Colin, Five, Danielle, Earl, Fiona, Gaston, Hermine, Igor, Karl, Matthew, Nicole, Otto, Paul Richard, Shary, Tomas

2011: Arlene, Bret, Cindy, Don, Emily, Franklin, Gert, Harvey, Irene, Ten, Lee, Katia, Maria, Nate, Philippe, Rina, Sean

HWRF-POM Updated 24 May-2

- The following were added to HWRF output GRIB files:
  - simulated microwave satellite imagery products for SSM/I-S sensors.
  - new intermediate grid output GRIB files (*hwrfprs_i.grb* and *hwrfsat_i.grb*) at a horizontal resolution of 0.1 deg. lat/lon.
  - nest (innermost domain) GRIB files (*hwrfprs_n.grb* and *hwrfsat_n.grb*) will now be at highest resolution of 0.03 deg. lat/lon (Note: this change will result in a filename change on the NWS FTP server. The current filename is ns.{stormname}.YYYYMMDDHH_fh.00##_tl.press_gr.0p1deg. The filename will change from *press_gr.0p1deg to *press_gr.0p03deg).
  - new merged grid (innermost + intermediate) output GRIB files (*hwrfprs_m.grb* and *hwrfsat_m.grb*) for selected variables at a horizontal resolution of 0.03 deg. lat/lon.
  - combined grid output GRIB files (*hwrfprs_c.grb* and *hwrfsat_c.grb*) will now be a combination of all three domains at highest resolution of 0.03 deg. lat/lon.
  - parent grid output GRIB files (*hwrfprs_p.grb* and *hwrfsat_p.grb*) remain unchanged and will be at the same 0.25 deg. lat/lon resolution.
- Viewable at the MAG with specific storm results available here.

HWRF Real-Time 2012 Runs … so far

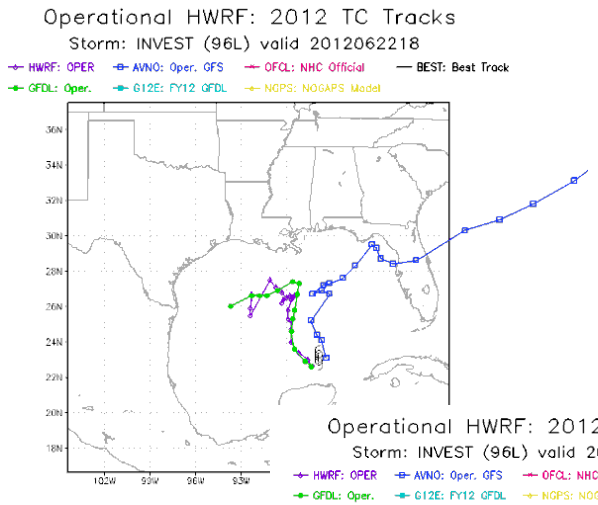
Real-Time Atlantic 2012

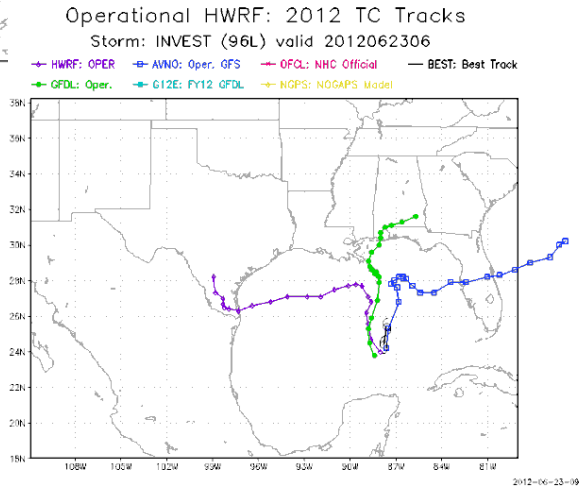
- INVEST91L (April)
- INVEST92L (May)
- ALBERTO01L
- BERYL02L
- CHRIS03L
- INVEST96L (June)

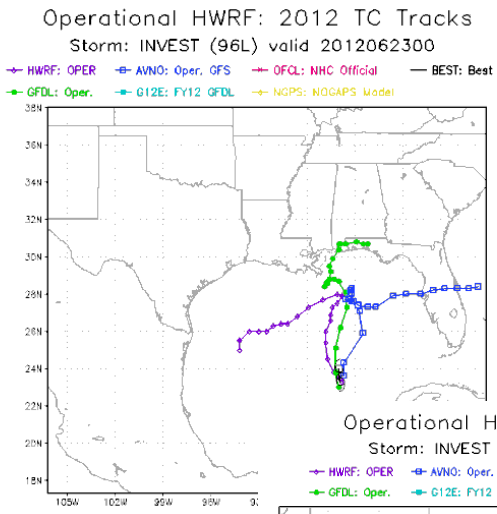
Real-Time East Pacific 2012

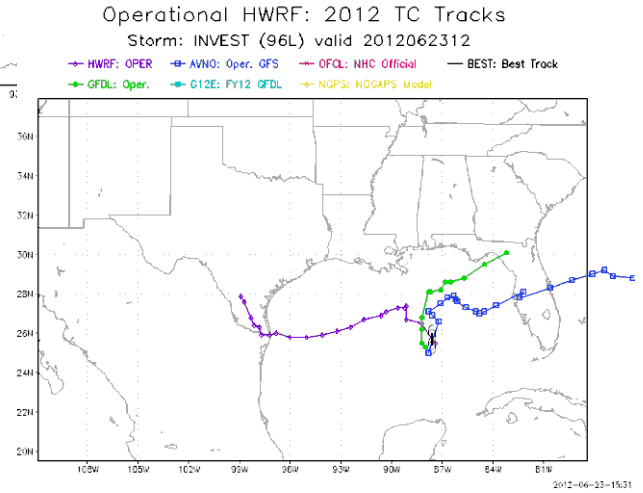
- ALETTA01E
- BUD02E
- INVEST93E (June)
- CARLOTTA03E
- INVEST95E (June)

DEBBY early guidance is a challenge:

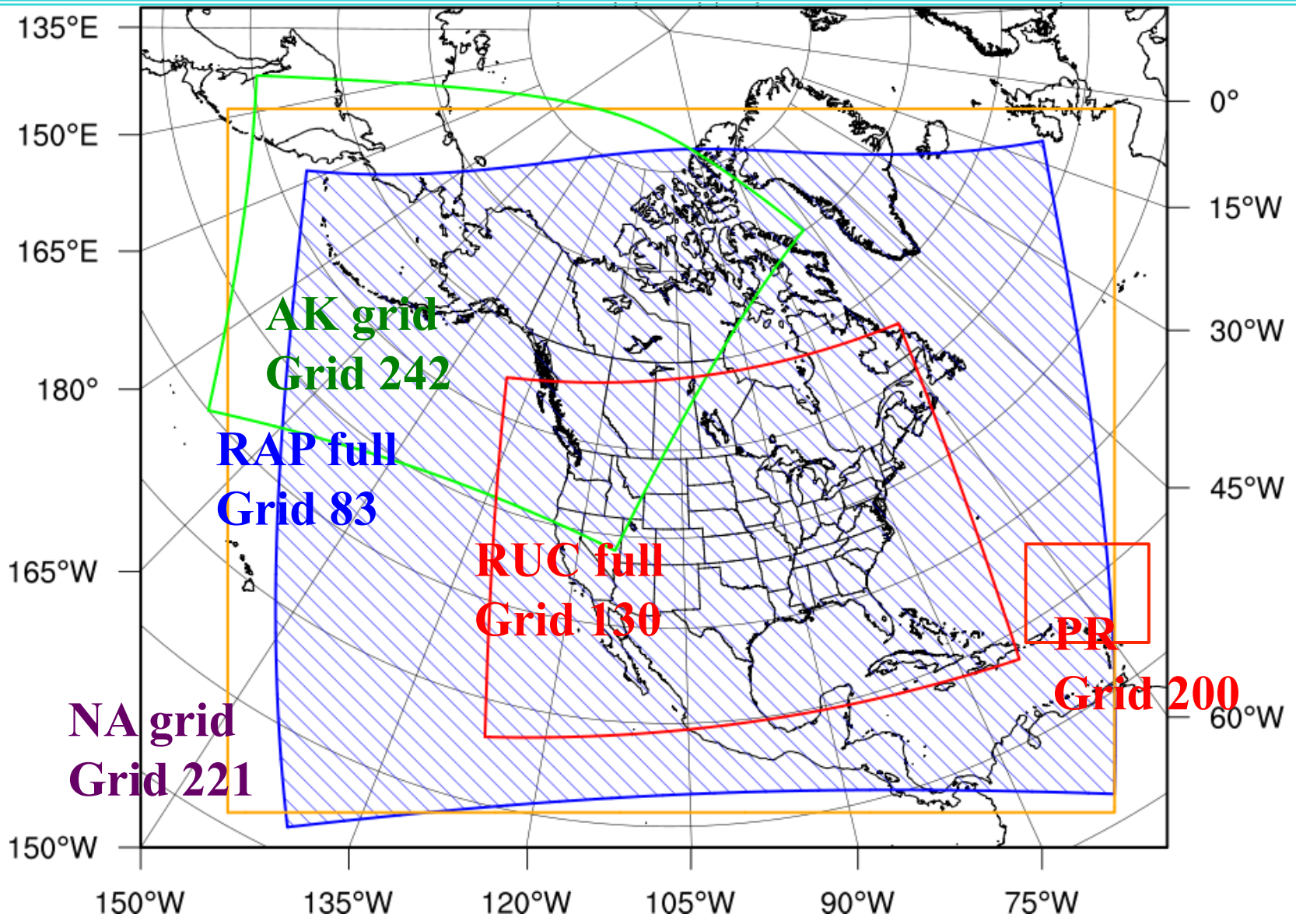








Rapid Refresh (RAP), using GSI and WRF-ARW, implemented 1 May 2012



RAP was accompanied by* a time-lagged North American Rapid Refresh Ensemble (NARRE^ – see)

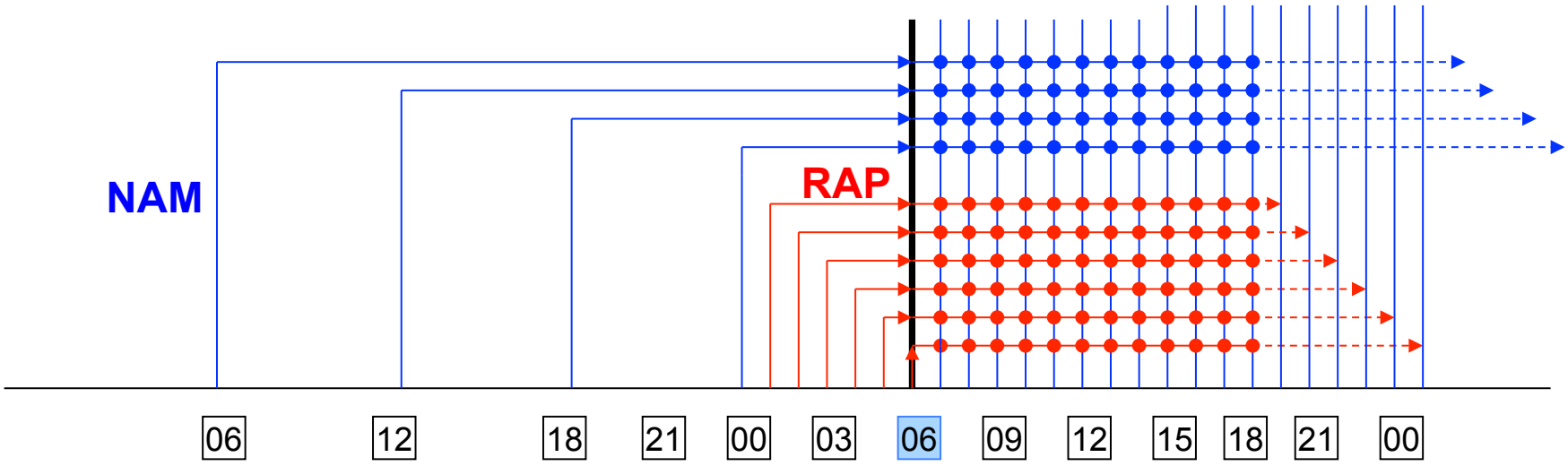
(courtesy of Binbin Zhou)

- **Hourly updated 12/13km ensemble for aviation out to 12 hr**
- **Combines members from RAP & NAM over CONUS & Alaska**
- **NARRE-TL example member combination for 06z cycle run**

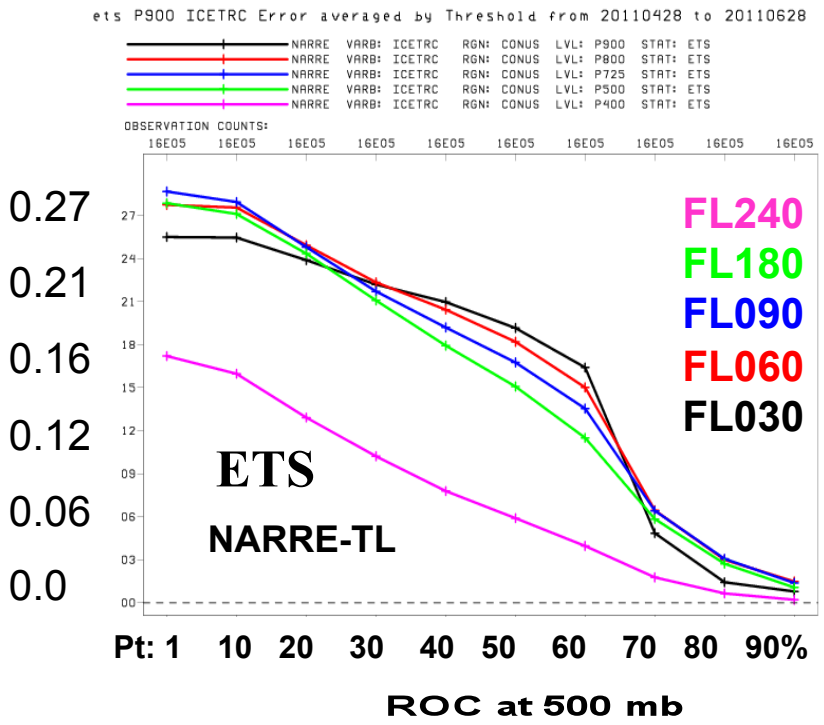
  4 most recent NAM cycles (6z & previous 0z, 18z and 12z)

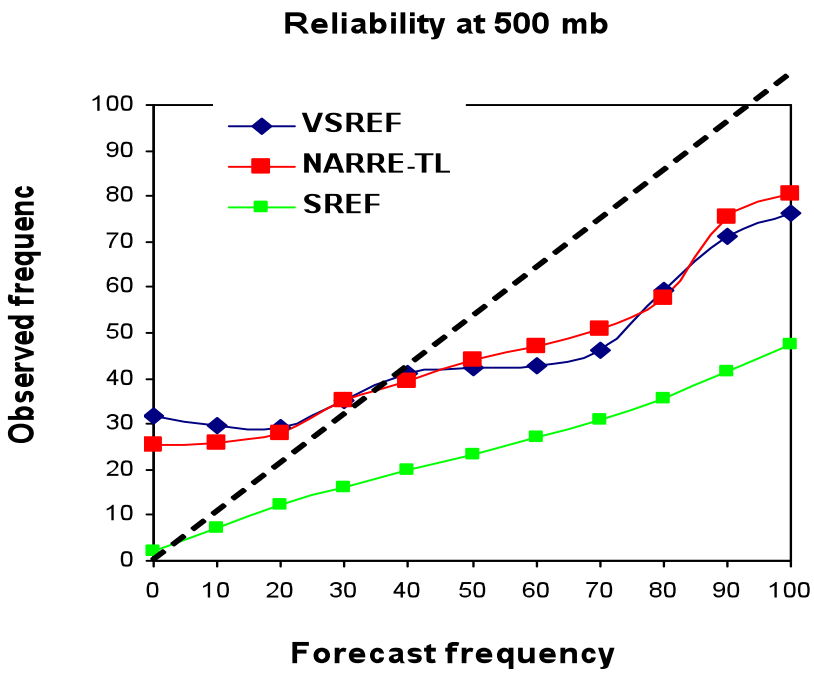
  6 most recent RAP cycles (6z & previous 5z, 4z, 3z, 2z, and 1z)

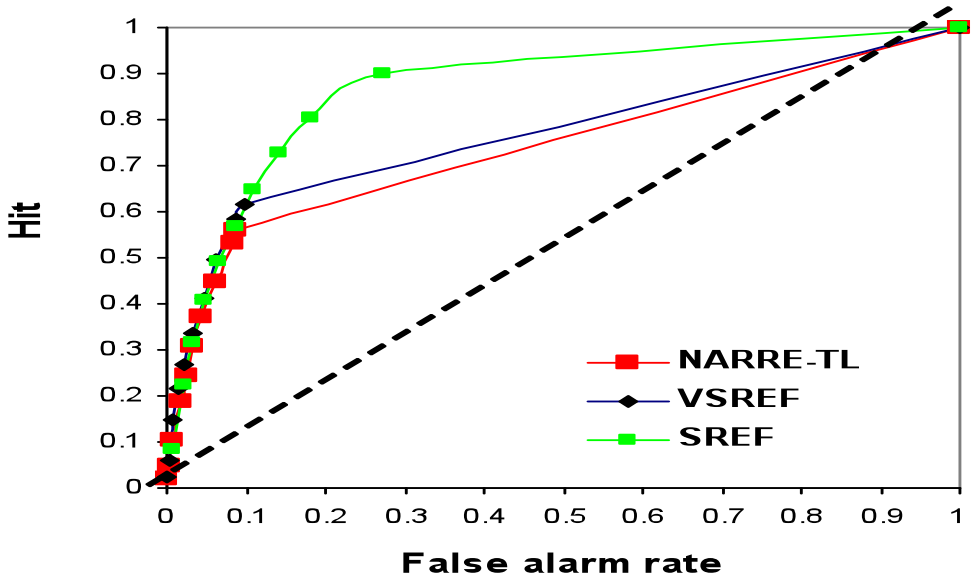
Member Weighting = 1 - forecast range (hr)/30:



*Implemented with the Rapid Refresh on 1 May, 2012 ^Used to be called VSREF







Examples of verification of icing probability forecast from NARRE
ETS: left-top
Reliability: right-top
ROC: left-below

March 2011 Upgrade of HiResWindow

Briefing Package can be seen HERE

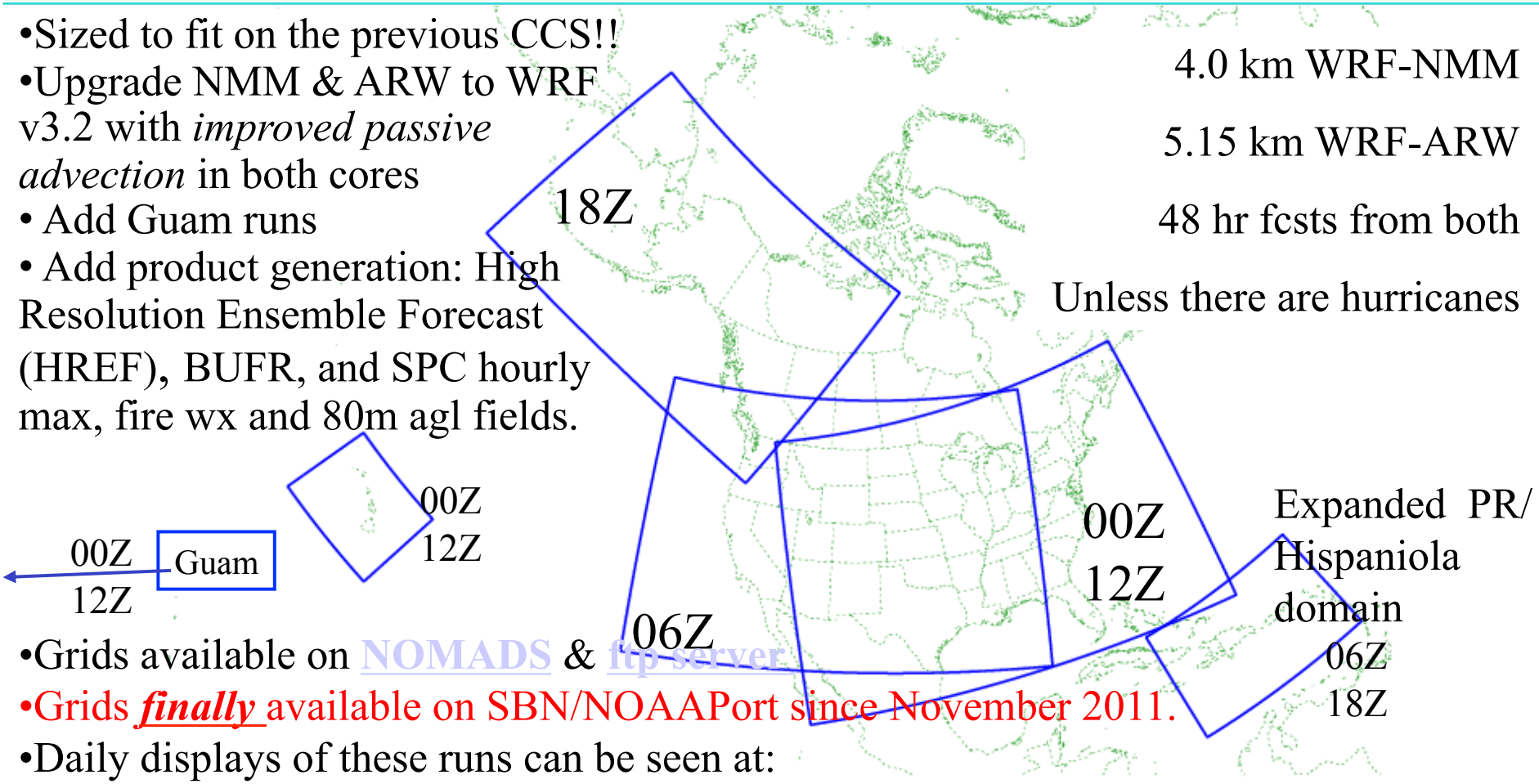
- Sized to fit on the previous CCS!!
- Upgrade NMM & ARW to WRF v3.2 with *improved passive advection* in both cores
- Add Guam runs
- Add product generation: High Resolution Ensemble Forecast (HREF), BUFR, and SPC hourly max, fire wx and 80m agl fields.

4.0 km WRF-NMM

5.15 km WRF-ARW

48 hr fcsts from both

Unless there are hurricanes



- Grids available on NOMADS & ftp server
- Grids ***finally*** available on SBN/NOAAPort since November 2011.
- Daily displays of these runs can be seen at:

  http://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller and

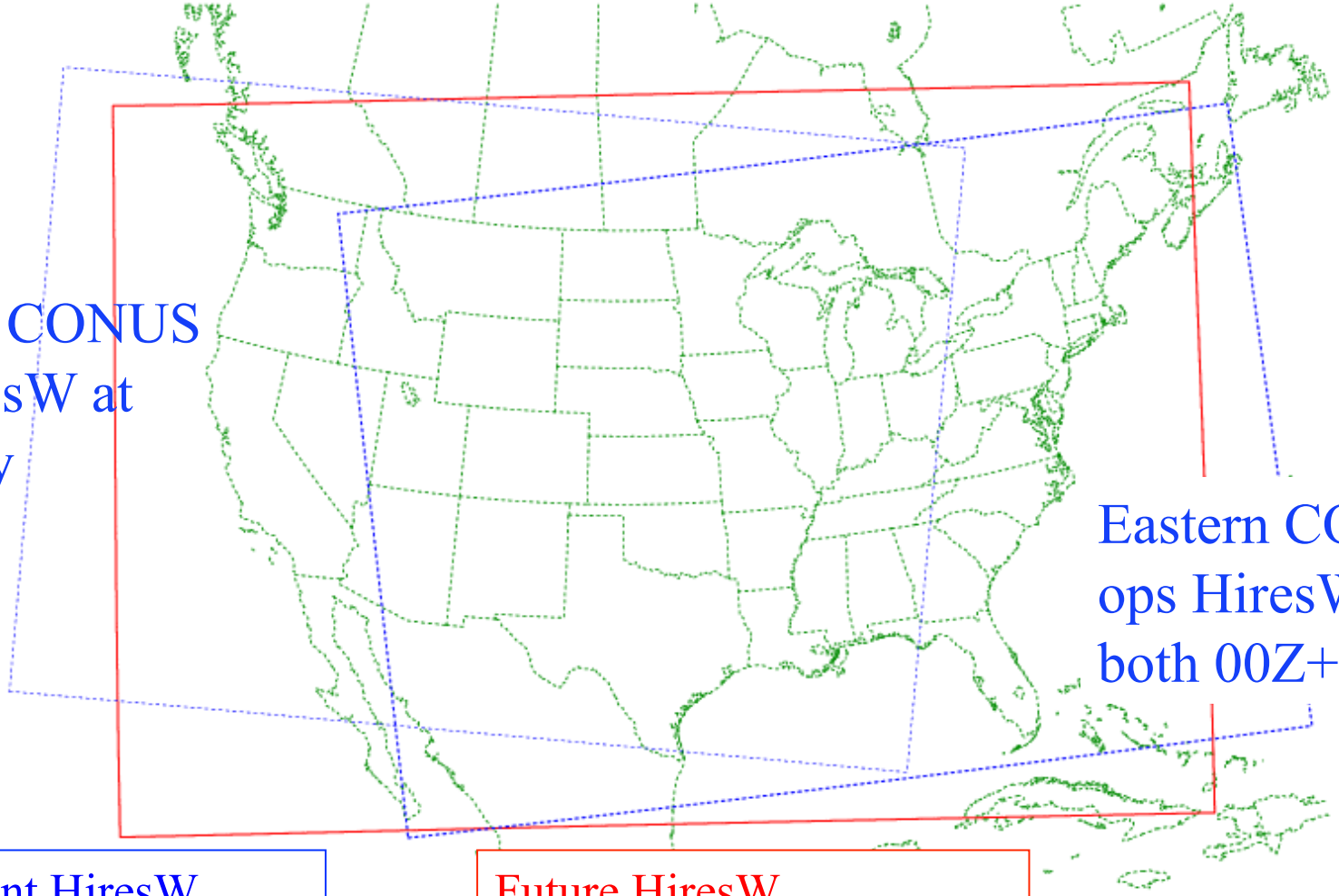
  http://www.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/

- Matt Pyle's full CONUS WRF-NMM runs [/00 or /12] for SPC can be seen at http://www.emc.ncep.noaa.gov/mmb/mpyle/cent4km/conus/

Plans For 2013 HiResWindow

- Upgrade ARW to Version 3.4 or 3.5
- Replace NMM with NMMB v1.2
- Generate a time-lagged NCEP Storm Scale Ensemble as precursor to HRRRE (see)
- Some or all of the following:
  - Increase resolution, expand to full CONUS (next slide)
    - CONUS, Hawaii & Guam at 00z and 12z
    - **Alaska**, Puerto Rico-Hispaniola at **06z and** 18z
  - Improve Initialization of HiResWindow runs
    - GSI using all available data & mini-cycle
    - GSI adapted specially for Level II 88D winds
    - Digital filter with Level II 88D reflectivity (ala RAP)
- Fix interpolation of precip type to nearest neighbor
- Use HRW Guam forecasts as first guess for RTMA

Current HRW w/2 CONUS vs Future HRW w/1 CONUS



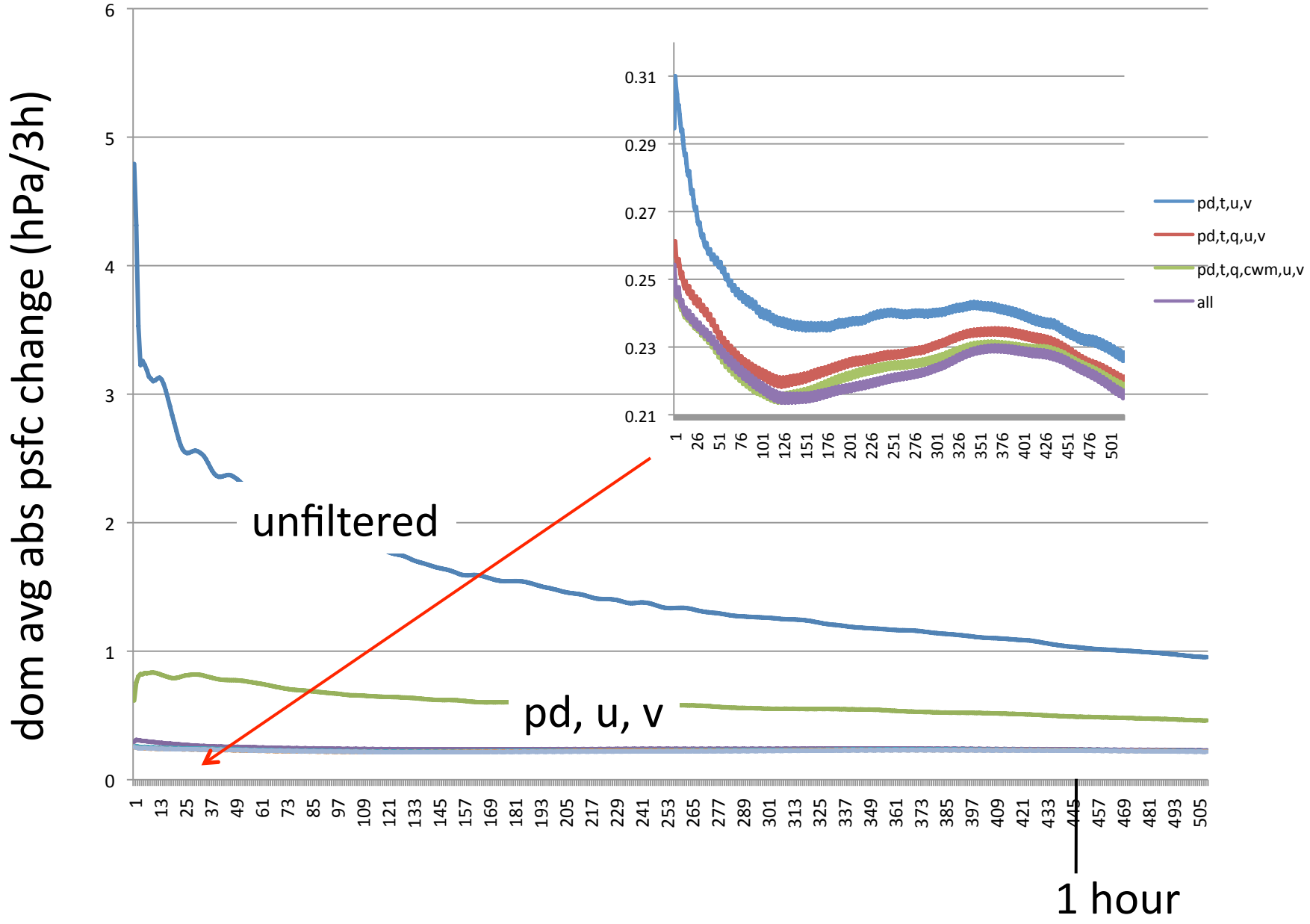
Western CONUS
ops HiresW at
06Z only

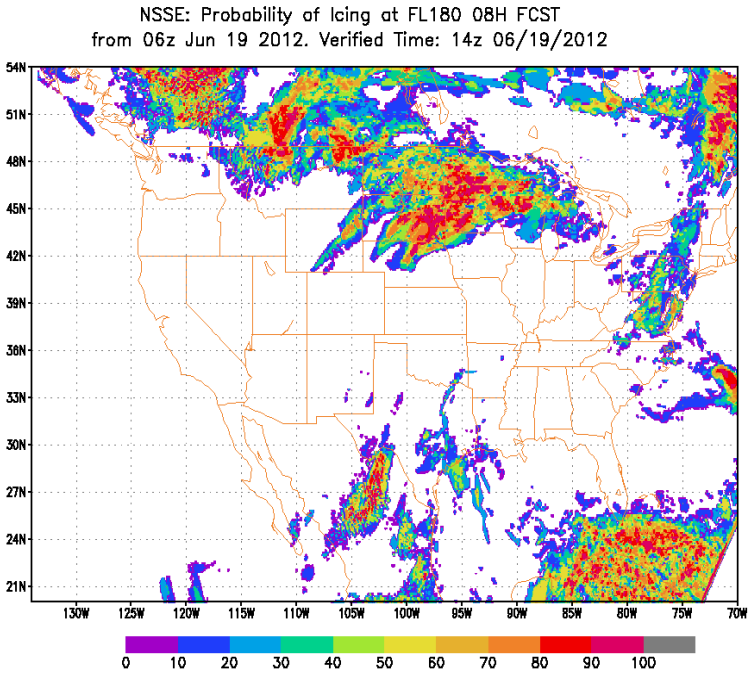
Eastern CONUS
ops HiresW at
both 00Z+12Z

Current HiresW
(4 km WRF-NMM
5.15 km WRF-ARW)

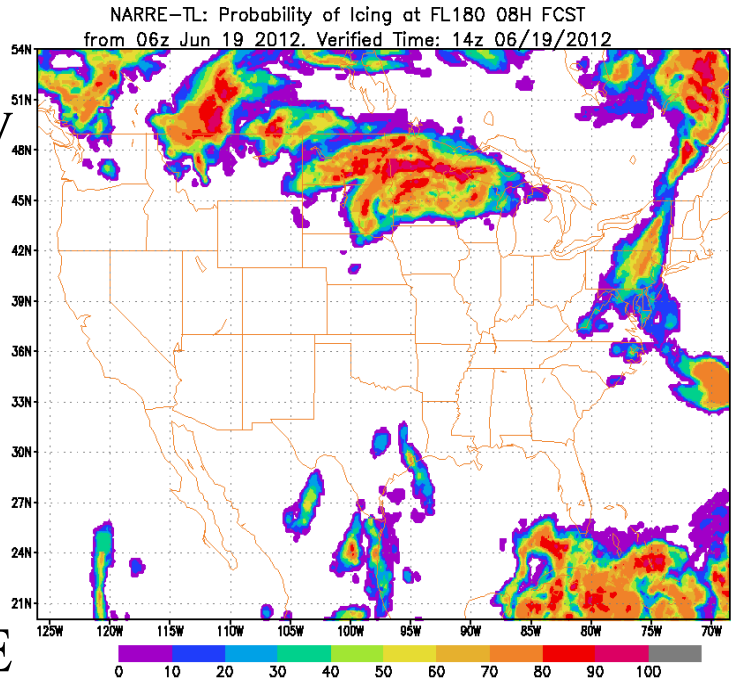
Future HiresW
(2.5-3 km NEMS-NMMB
3-3.8 km WRF-ARW)

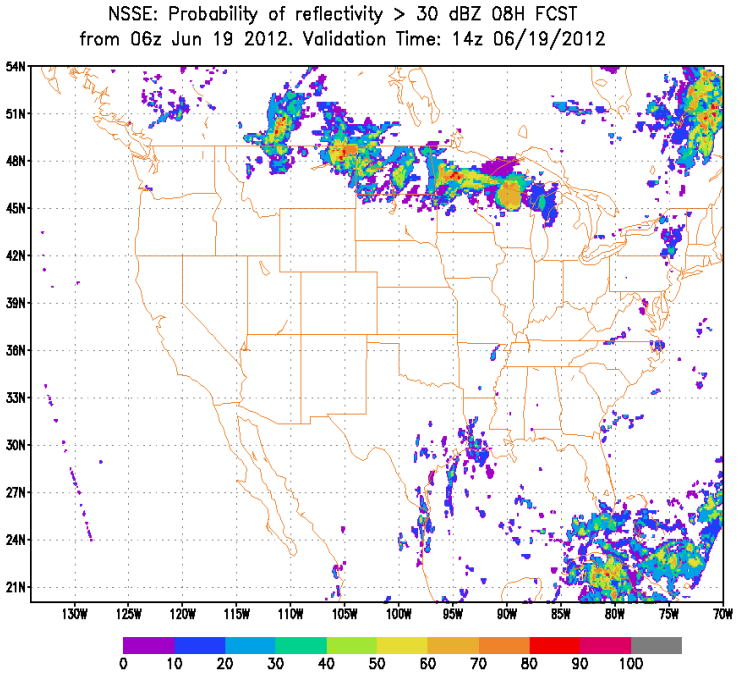
Impact of different variables being filtered in DFI



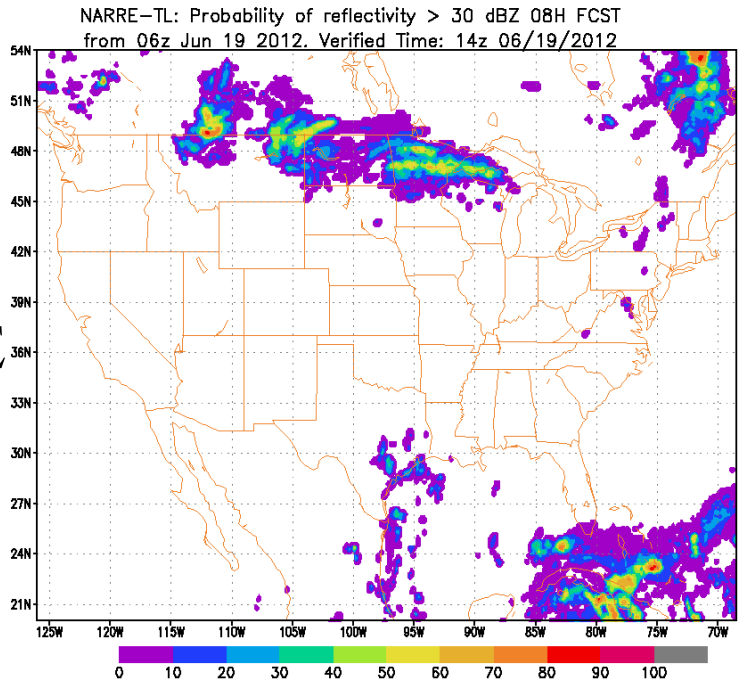


8 hr forecast for Probability of Icing at Flight level 18000 feet, valid at 14Z, June 19, 2012
Left NSSE, Right NARRE



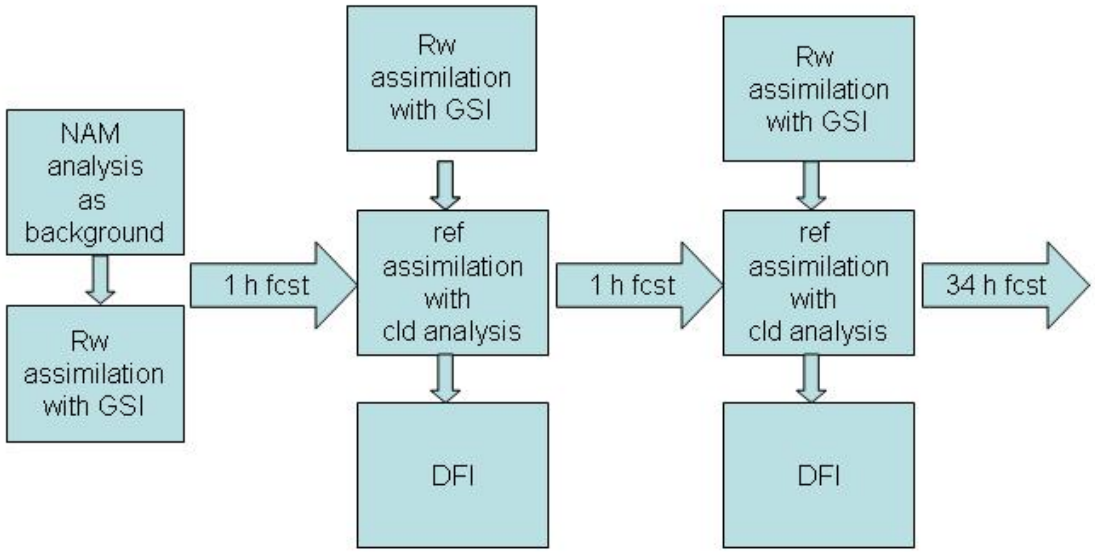


Probability of Reflectivity > 20dBZ
Left NSSE, Right NARRE
NSSE shows more detailed structure than NARRE



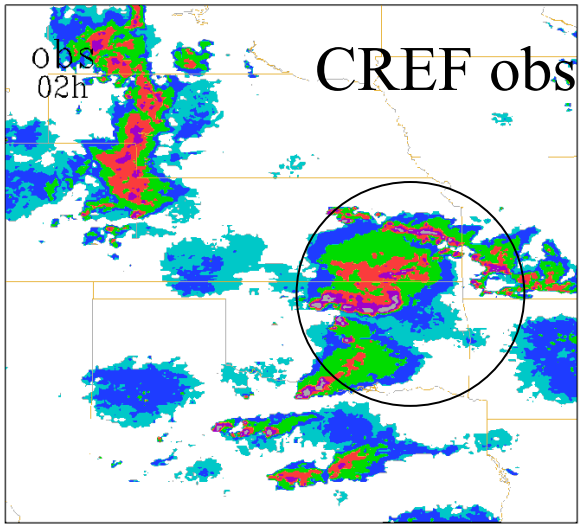
HiRes Initialization with radar data
Shun Liu and Ming Hu

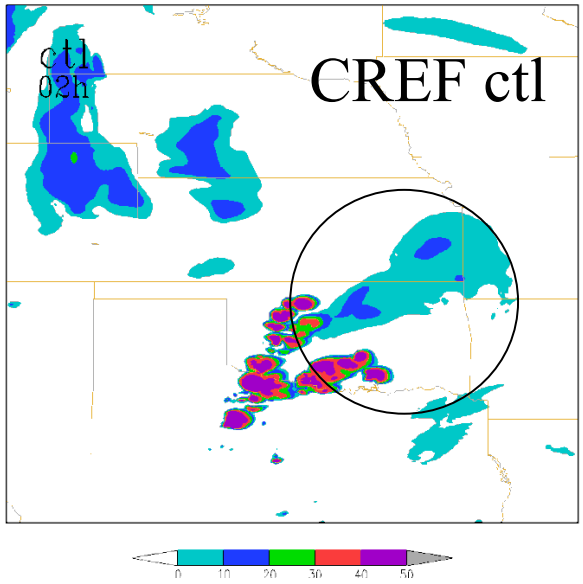
- The radial wind is directly analyzed by GSI.
- The cloud analysis package developed by GSD is modified and used to analyze reflectivity with NCEP's forecast model background.
- Hourly cycle is used



September 18, 2011

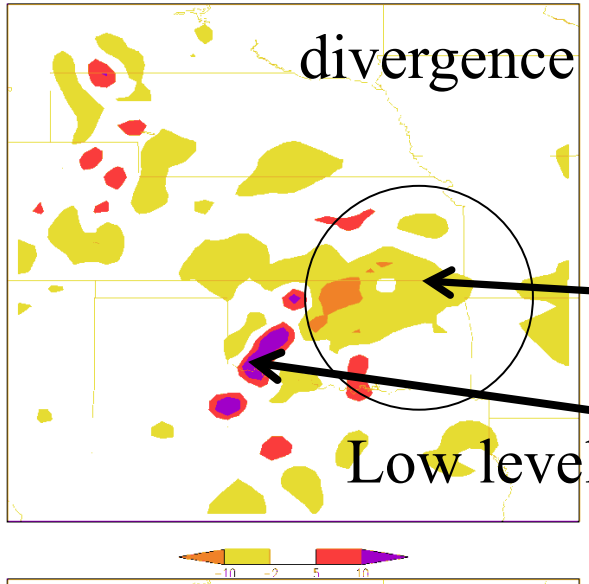
02 Z observation

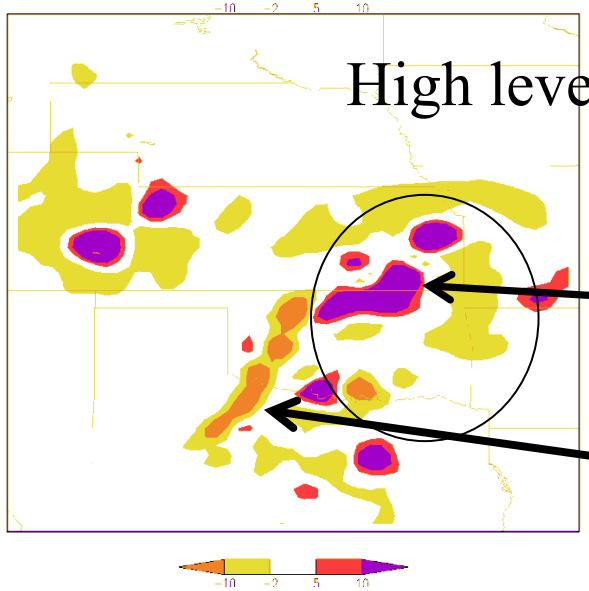




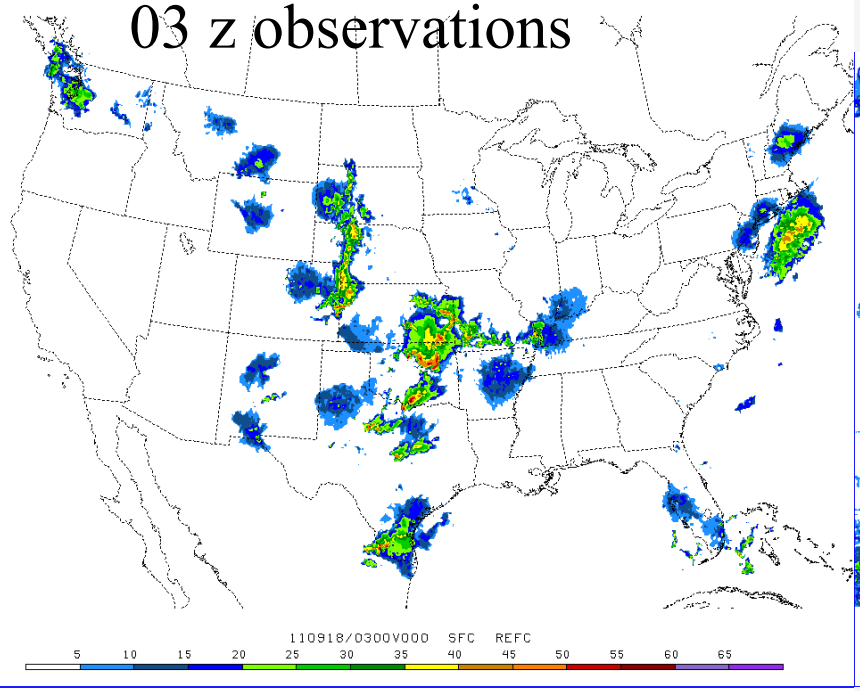
02 Z control run

EXP-CTL
at the end of data assimilation cycle
wind divergence

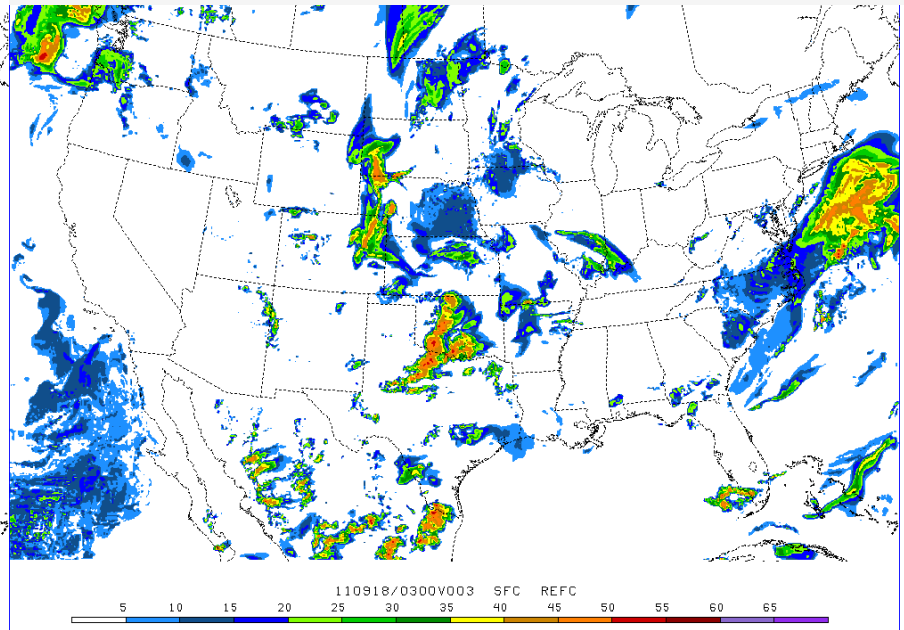




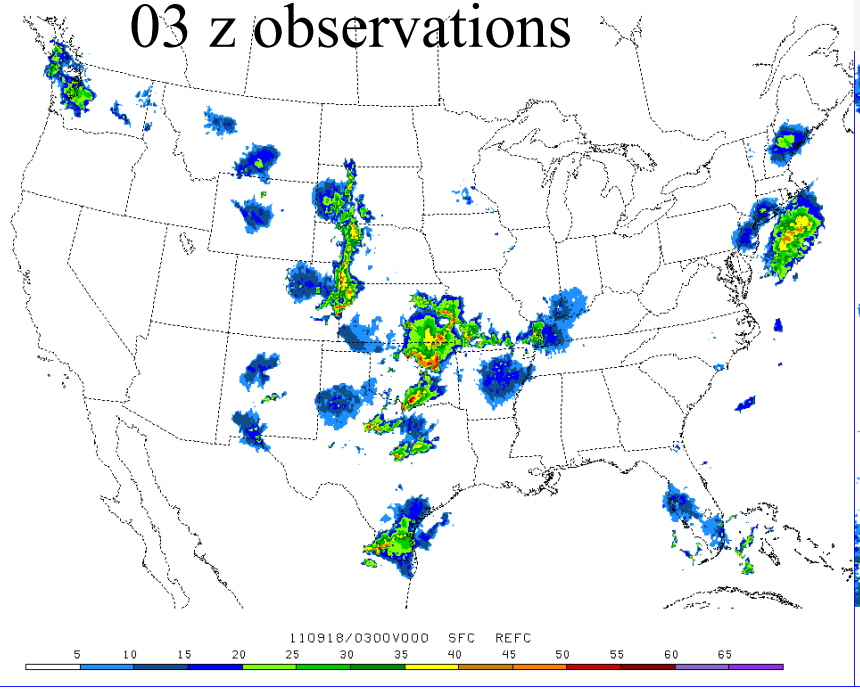
03 z observations



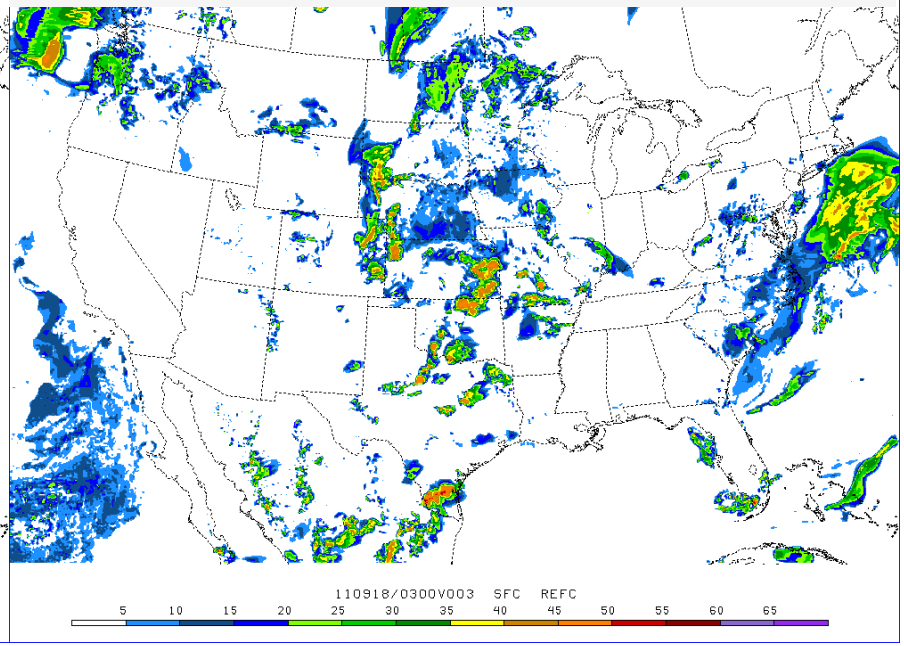
CTL without radar data assimilation, 03z fcst



03 z observations



EXP with radar data assimilation, 03z fcst



Hybrid Ensemble-3DVar Radar Data Assimilation

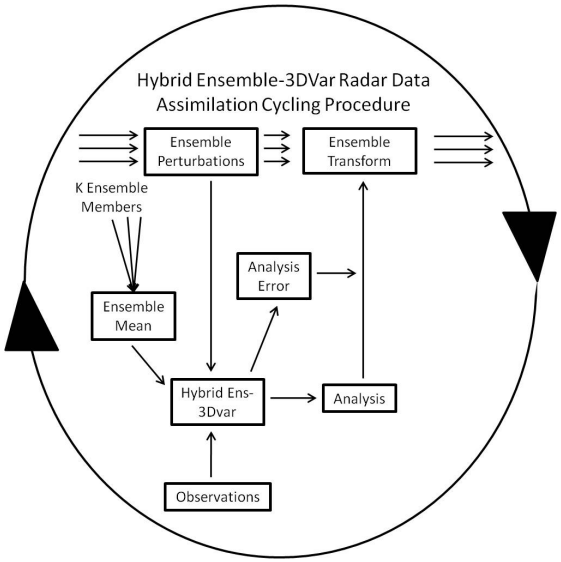
Forecast Hourly Maximum Updraft Helicity (Kain et al. 2011) Over 1hr Forecast Period

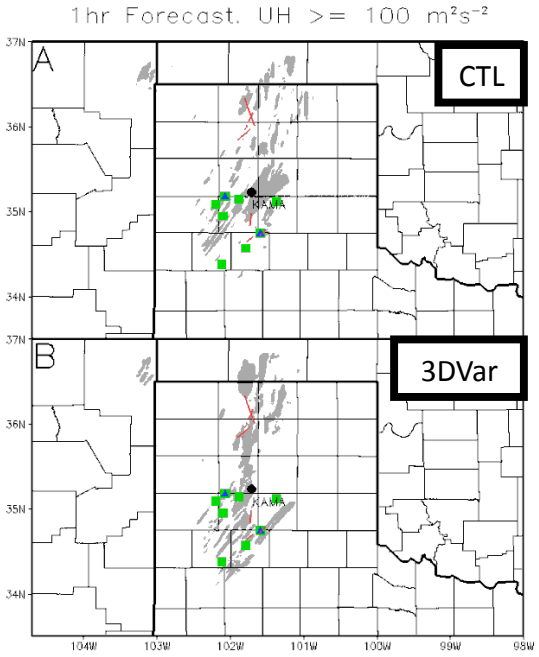
Valid April 22 01-02 UTC 2007

Jacob Carley, Dave Parrish, Mike Baldwin, Shun Liu

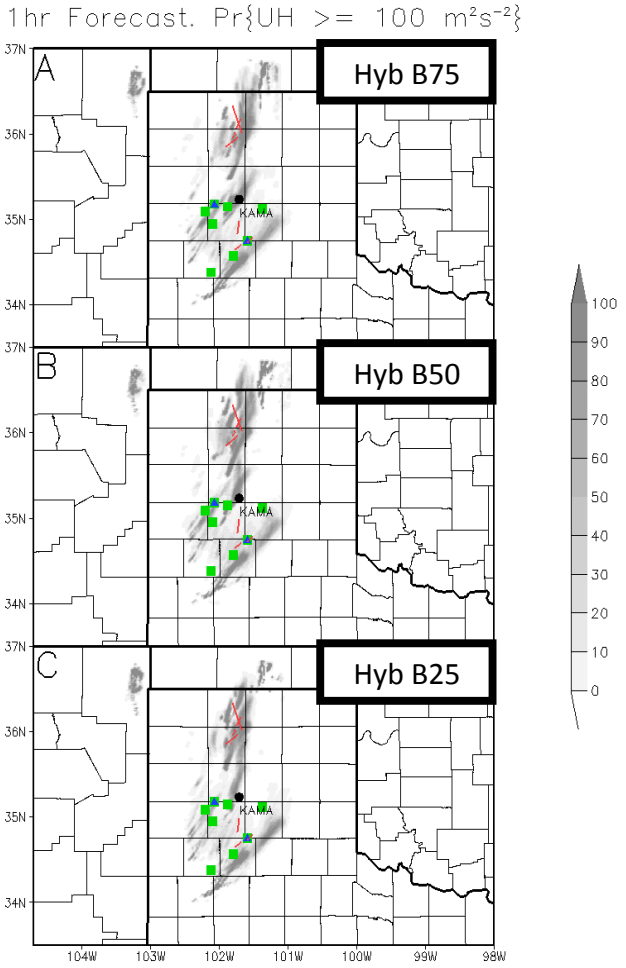
GSI + NMMB (currently operational NAM code, 1.33 km grid spacing)
Assimilate both dBZ and velocity over a 1 hour period at 5 min. intervals
Followed by 1hr forecast

Experiments:
3DVar
Single, deterministic simulation
Hybrid ensemble-3DVar (32 ensemble members)
3 configurations
25%, 50%, 75% static **B** contribution (Hyb B25, Hyb B50, Hyb B75)
Control (CTL)
No data assimilation
Single, deterministic forecast





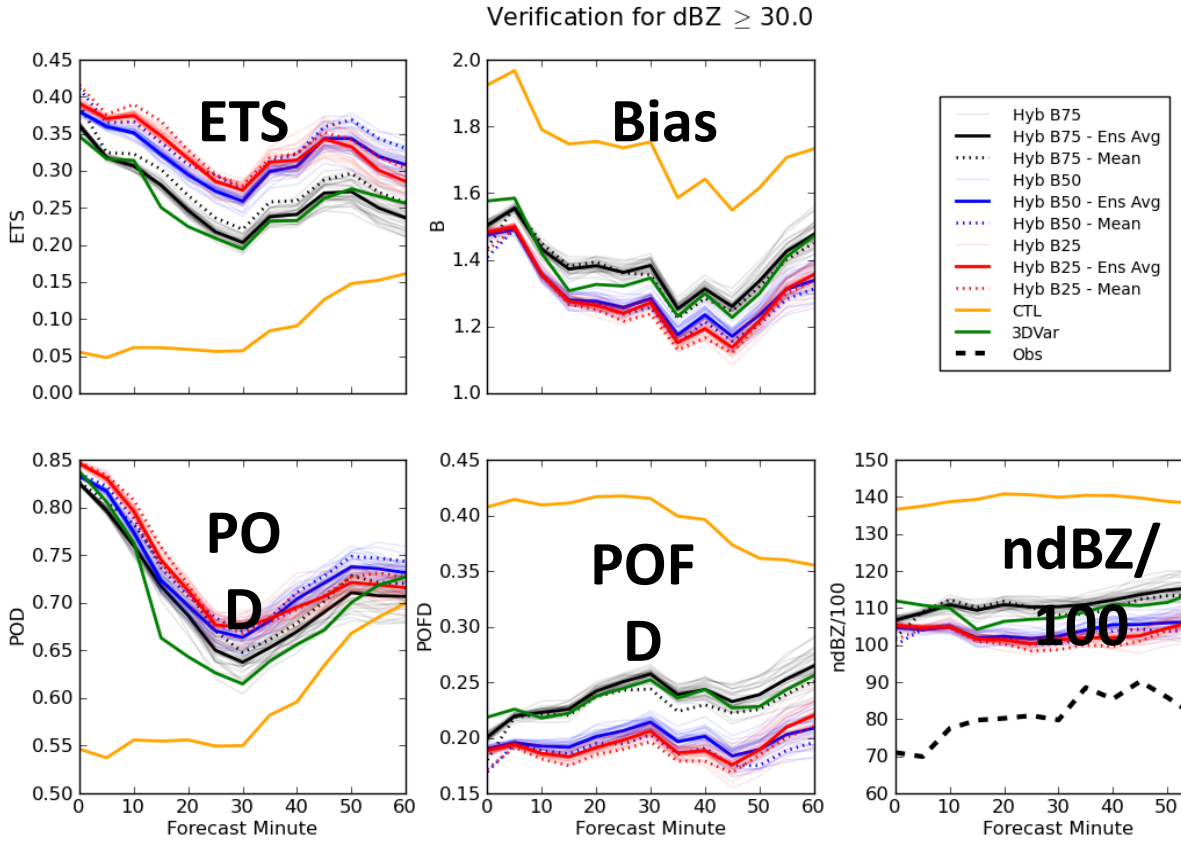
Ensemble probability of UH >= 100 m^2s^{-2}



Hybrid Ensemble-3DVar Radar Data Assimilation

Verification Throughout 1hr Forecast Period

30 dBZ threshold (column-maximum dBZ)



ndBZ = Number of gridpoints with dBZ >= threshold

Radar data assimilation (3DVar or Hybrid) can improve very short-term forecasts (1 hr)

- Updraft helicity fields correspond well, visually, with storm reports

Verification indicates Hybrid B50 and B25 experiments are generally superior for this case

- All radar DA experiments superior to no-radar DA (CTL)

Caveat: Results are from a single case

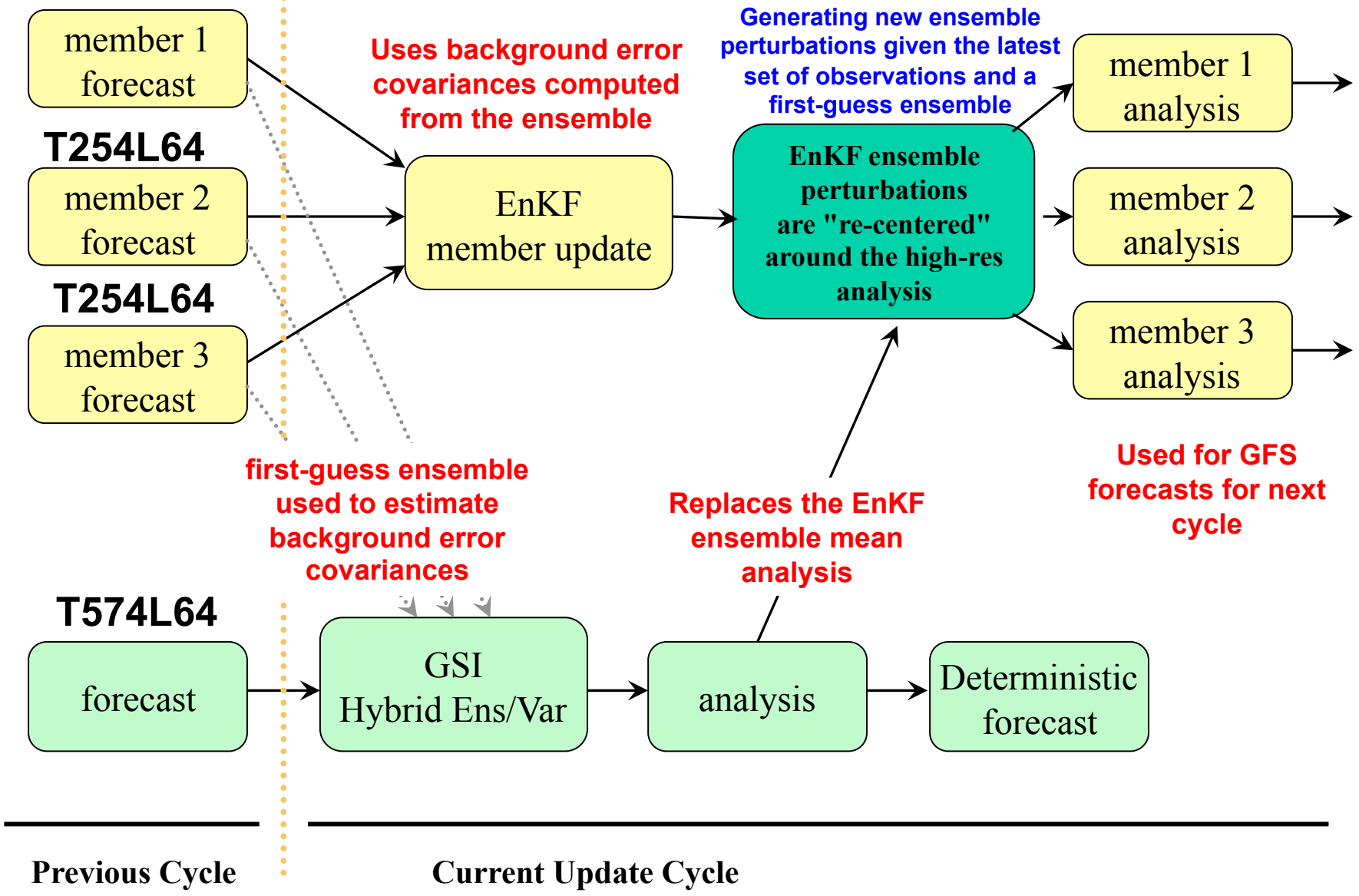
Global Data Assimilation System Upgrade

Implemented 22 May 2012 more details here

- **Hybrid system (next slide)**
  - Most of impact comes from this
  - Uses ensemble forecasts to help define background error
- **NPP (ATMS) assimilated**
  - Quick use of data after launch
- **Use of GPSRO Bending Angle rather than refractivity**
  - Allows use of more data (especially higher in atmos.)
  - Small positive impacts
- **Satellite radiance monitoring code**
  - Allows quicker awareness of problems (run every cycle)
  - Monitoring software can automatically detect many problems
- **Post (UPP) changes**
  - Additional fields requested by forecasters & industry (e.g. 80m agl turbine level*)
- **Partnership between research and operations**

* Bug in 80m pressure field along Greenwich Meridian causes WPS failures for numerous users [of GRIB2] worldwide - fixed within a week.

Dual-Resolution Coupled Hybrid 3D-VAR/EnKF



Regional GSI Obs Changes in NAM Upgrade

- Upgrade to latest GSI code
- Add new conventional obs
  - MESONET p_s, T, q with RTMA's dynamic reject list (mesonet winds already used in NAM subject to both use and reject lists)
  - ACARS moisture (WVSS-II)
  - CAP/MAP Profiler winds (but only below 400 mb)
  - RASS Profiler T_v (virtual temp)
  - WINDSAT & ASCAT ocean winds (from scatterometer)
- Stop using estimated sfc pressures
- Add new satellite obs
  - Satellite Radiances
    - AMSUA from aqua & NOAA19 (exCh8)
    - HIRS4 from NOAA19
    - IASI from METOP-A
  - Refractivity
    - GPS radio-occultation (e.g. COSMIC)
- Turn off NOAA15 AMSUB
- Radar 88D winds
  - Fix height assignment error
  - Increase ob error of Level 3 88D winds
  - Turn off use of Level 2.5 88D winds except over Alaska
- Use retuned ob errors (adaptive tuning using Desroziers et al.)
- Use NMMB background errors

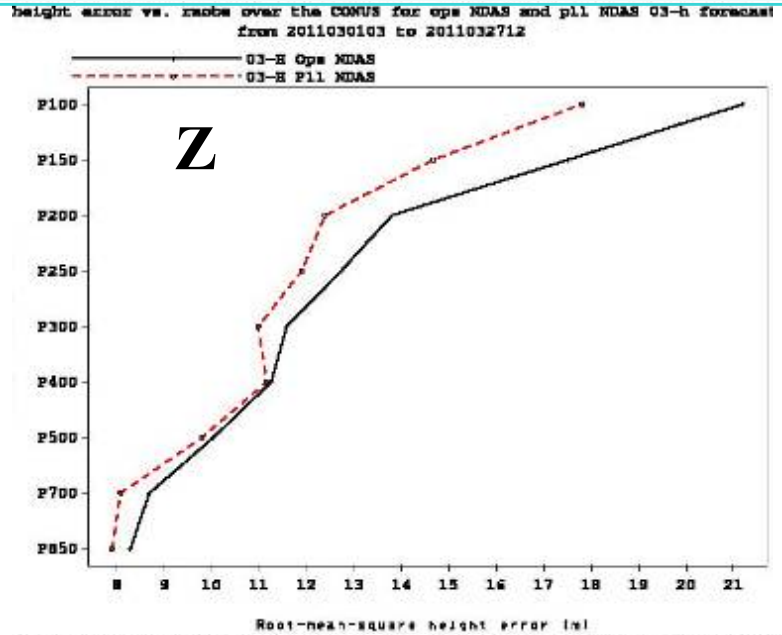
Added ~2.7 M New Observations Per Day after NAM Upgrade

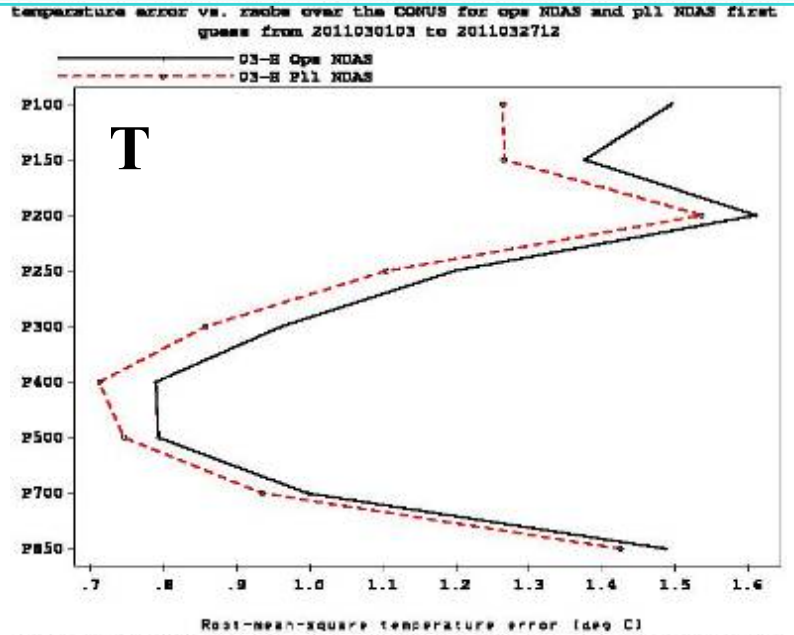
- Upper Air ~43K
  - RASS 126 t = 1403
  - MAP 227 uv= 8859
  - AIRCAR133 q = 8533
  - WDSATR 289 uv =17392
  - WDSATR 290 uv =7198
- Surface ~1170K
  - MESONET 188 q = 393341
  - MESONET 188 t = 453584
  - MESONET 188 p= 322949
- New Satellite ~1528K
  - Radiance
    - NOAA19 AMSUA= 151214
    - NOAA19 HIRS4 = 65914
    - AQUA AMSUA= 83794
    - IASI METOPA= 1227199
  - Refractivity
    - GPS-RO [COSMIC] = 54589

NPS & Changes to NDAS

- **NEMS Preprocessing System (NPS) for NMMB (Matt Pyle)**
  - To create the first guess at the start of the NDAS (at time T-12hr), NPS uses GFS spectral coefficients rather than post-processed pressure level fields on a 1 deg lat/lon grid as has to be done with WRF Preprocessing System (WPS)
  - Lateral boundary conditions also based on GFS spectral coefficients (as was done in prior NAM but not in WRF REAL)
- **Changes to the NAM Data Assimilation System (NDAS)**
  - First guess at T-12 reflects relocation of tropical cyclones
  - Use of 1/12th deg SST (RTG_SST_HR) in place of ½ deg
  - GSI updates 2 m temperature & moisture and 10 m winds with portion of 1st layer correction
  - Updated background errors for NMMB
  - 5X divergence damping in NMMB in NDAS only (temporary in lieu of DFI)

NDAS First Guess vs RAOBs

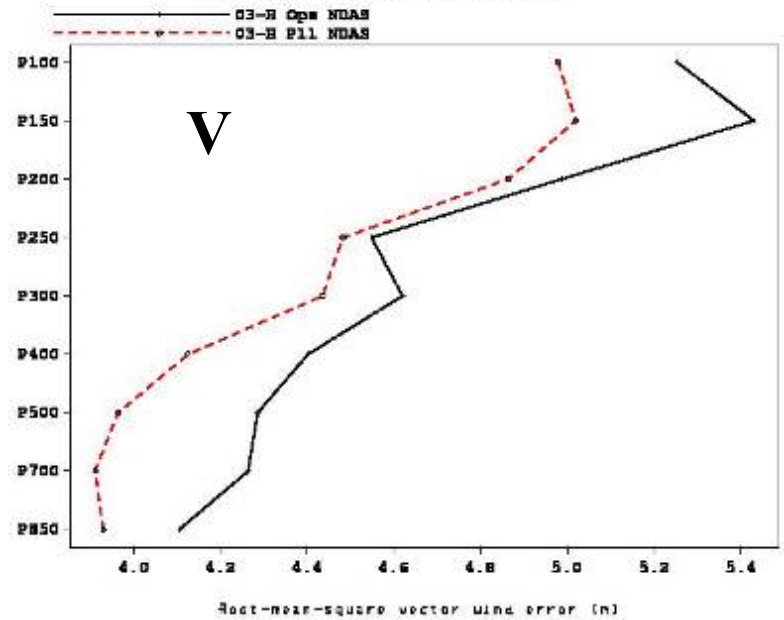


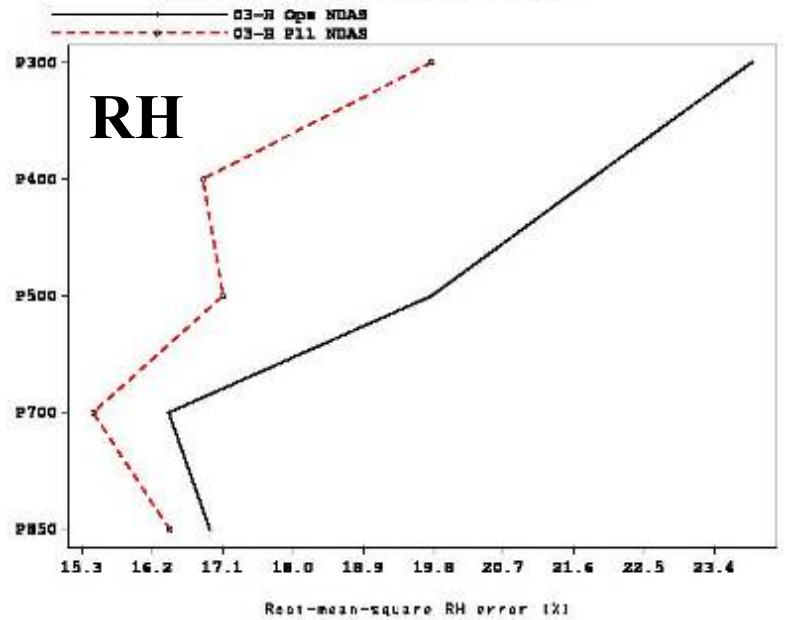


March 2011

Black/ Solid = Opnl

Red / Dash = Parallel





2013 Regional GSI changes

Already in regional parallel

- Hybrid var-ensemble analysis:

  vertically integrated contribution for Psfc

  ability to bias correct the first guess with the ensemble mean

  vertically varying contributions from 3dvar and ensemble

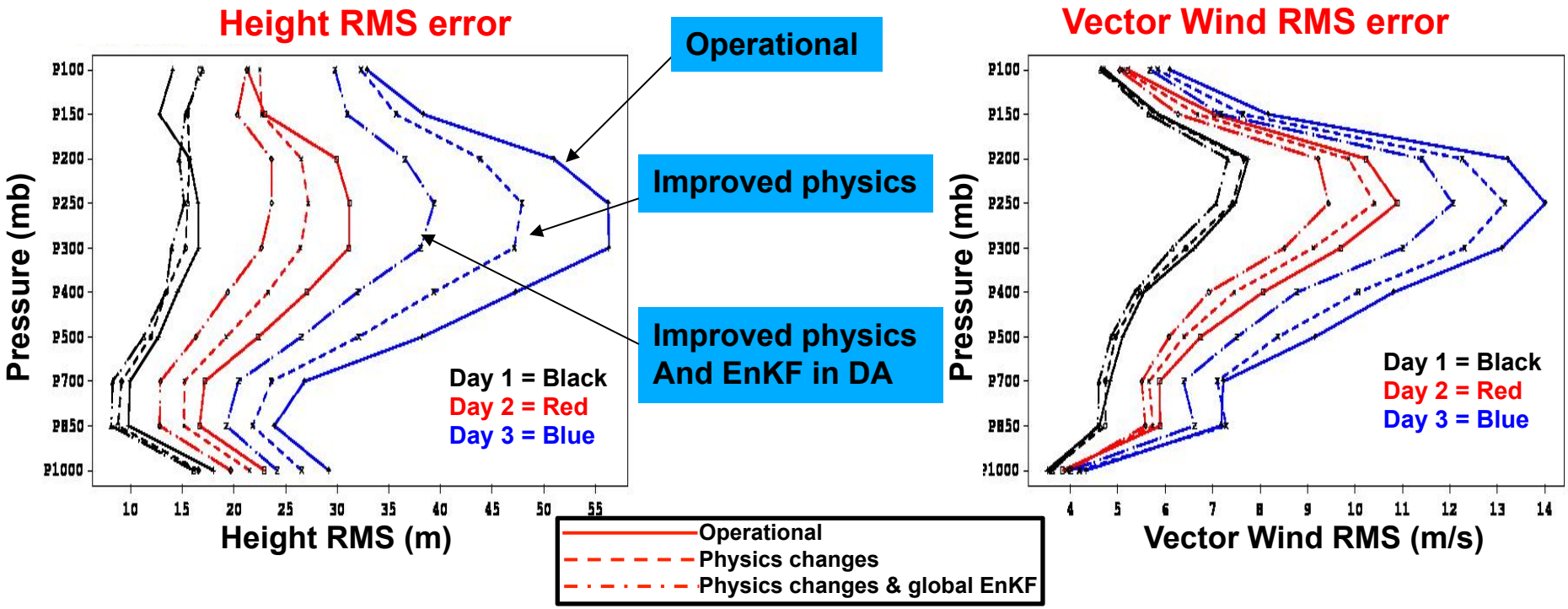
- RAOB level enhancement: Using significant level characters to create bogus data in the vertical, help reducing non-meteorological analysis profiles.
- Use RARS satellite radiances feed: created by direct read-out stations and collected more quickly than the standard feed.
- New version of GSI

To be included

- New radar VAD winds:
- GOES 15 radiances:
- Surface observations without pressure
- Use new RTMA QC: reject and use lists (more lenient for winds – direction dependent)
- Bug fixes for qoption2 + background error

Preliminary Testing for NAM FY13 Upgrade Package

Upper air verification against raobs (25 April to 12 June 2012)



- **Physics Modifications:**
  - GWD updated
  - BMJ_DEV, fres=0.85
  - RRTM, latest version as of 3/24
  - Remove 4x diffusion of q, cloud water
  - Microphysics changes
- **Data Assimilation Modifications:**
  - Raob level enhancement in GSI
  - Use ensemble forecasts from the global EnKF system to compute background error covariances

WARNING : Still a SMALL sample size

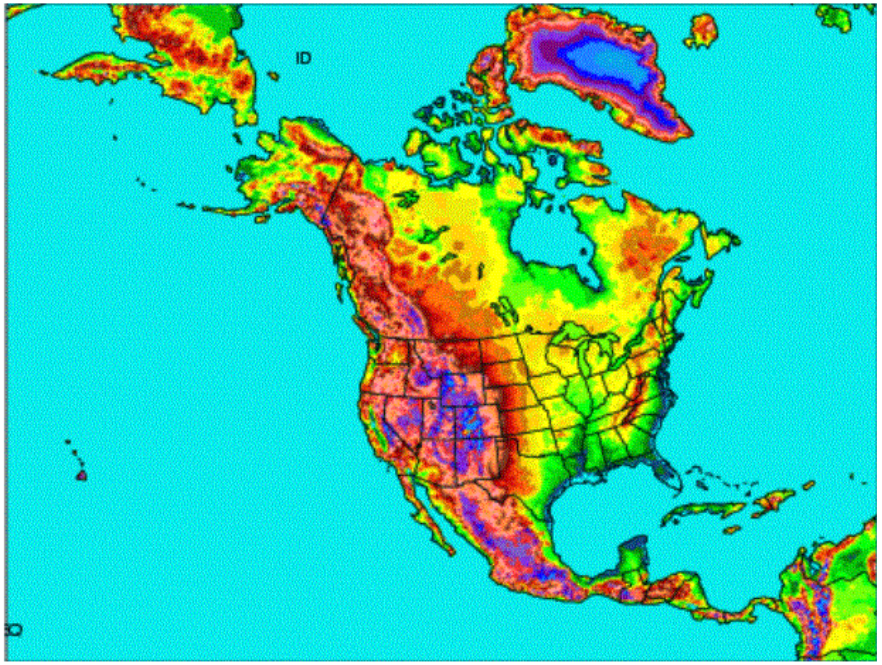
Zavisa Janjic's NMMB

- NMMB = Nonhydrostatic Multiscale Model on B-grid, but no fundamental differences in the dynamics versus current NMM
- These are the main B grid advantages:
  - The B-grid requires narrower halos, i.e. less communications;
  - On the global scale, the polar filtering on the B-grid is more effective and the polar boundary condition is more straightforward, code now fully scalable
  - E-grid code is more complex , indirect addressing (slower too) and is more difficult for debugging and maintenance;
  - The B-grid is better for application of the model in idealized 2D studies, e.g. in the x-z plane;
  - NEMS physics interface streamlined compared to WRF infrastructure, facilitating development, debugging and maintenance.
- Other NMMB differences / enhancements
  - New Eulerian passive advection (see HiResWindow above)
  - New generalized hybrid vertical coordinate embodies:
    - Sangster 1960; Arakawa and Lamb 1977; "SAL"
    - Simmons and Burridge (1981) "SA" + Eckerman (2008)
    - Hybrid used by GFS
  - WRF & GFS physics options available

October 2011
NAM Upgrade

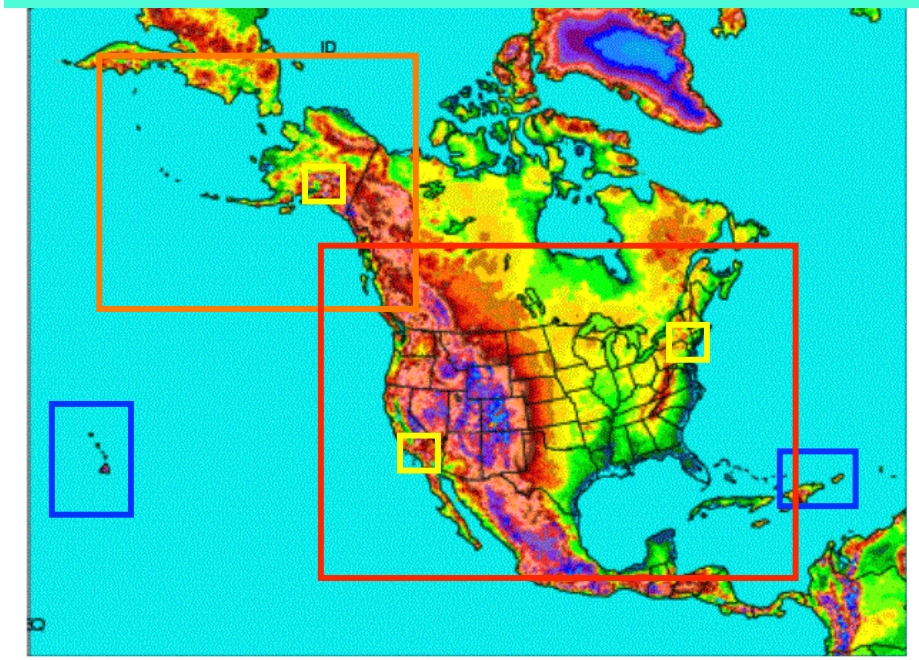
Current NAM

- WRF-NMM (E-grid)
- 4/Day = 6 hr update
- Forecasts to 84 hours
- 12 km horizontal grid spacing



New NAM

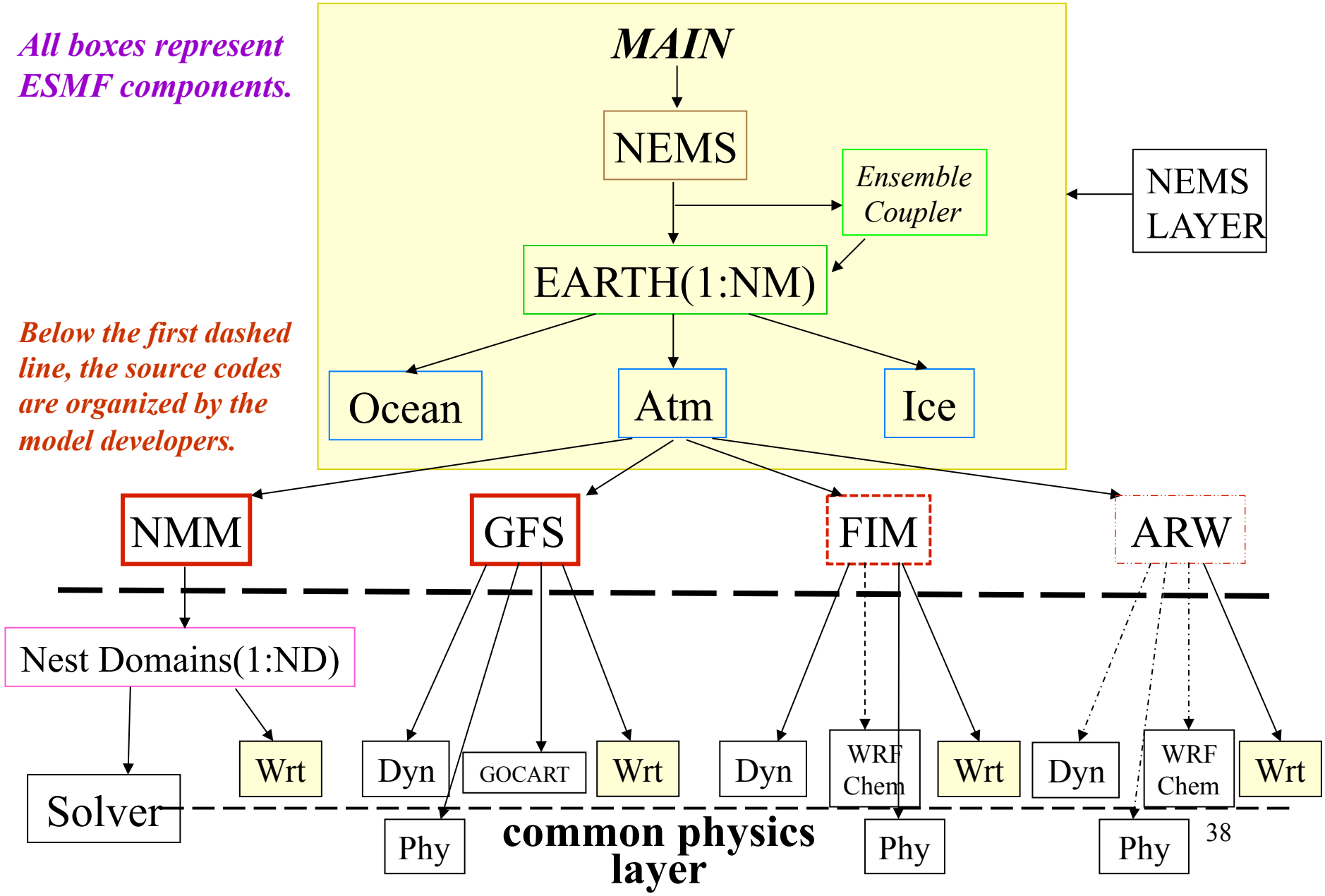
- NEMS based NMMB
- B-grid replaces E-grid
- Parent remains 12 km to 84 hr
- Four Fixed Nests Run to 60 hr
  - **4 km CONUS nest**
  - **6 km Alaska nest**
  - **3 km HI & PR nests**
- **Single placeable 1.33km or 1.5 km FireWeather/IMET/DHS run to 36hr**



October 2011 NAM Upgrade

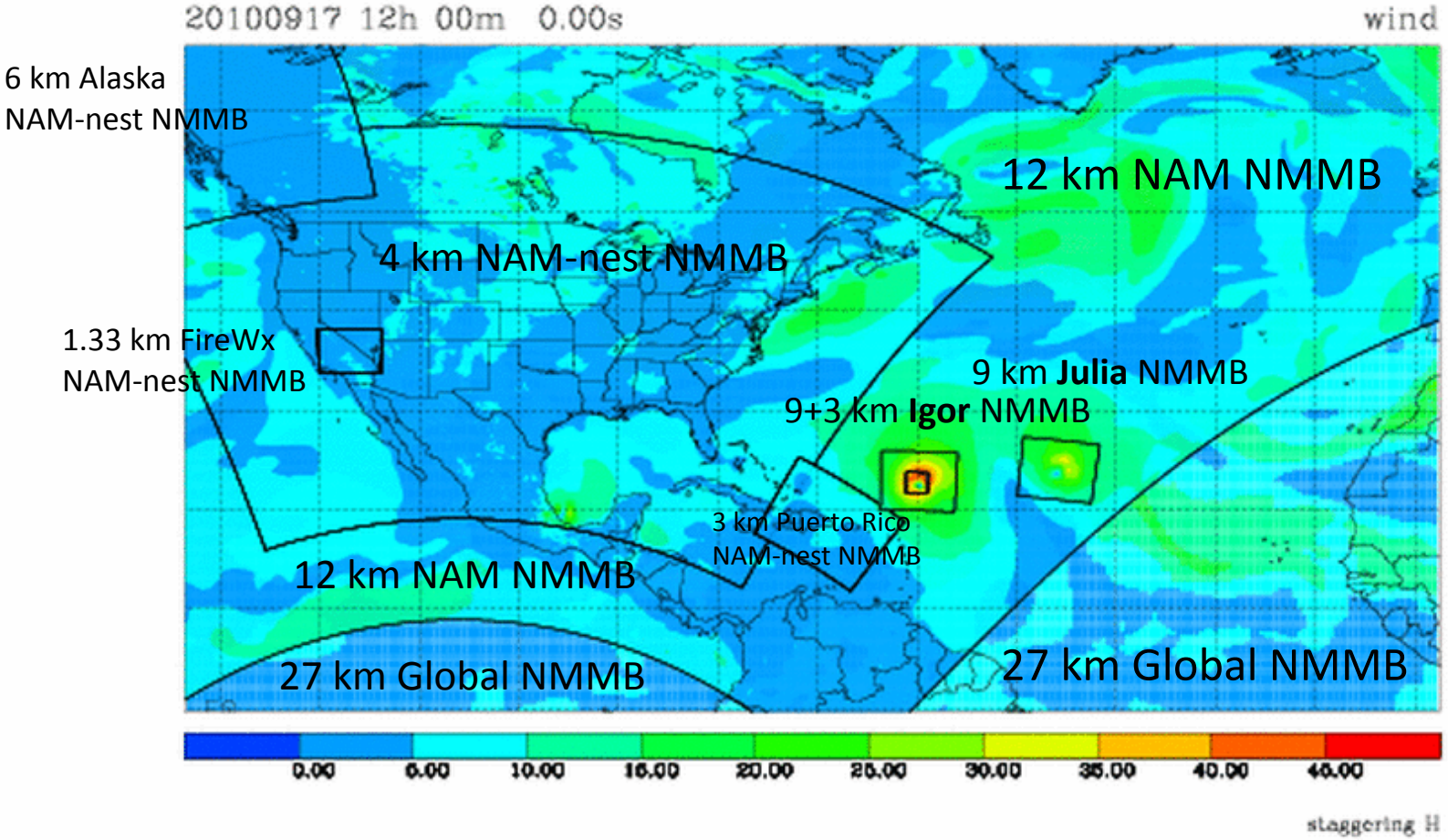
- Four large slide decks covering this major upgrade of every major component of NAM
  - http://www.emc.ncep.noaa.gov/pptfiles/NAMupgradeDecisionBrief.12Sept2011.ppt
  - http://www.emc.ncep.noaa.gov/pptfiles/Q4FY11NAMupgradeBACKUP1to77.ppt
  - http://www.emc.ncep.noaa.gov/pptfiles/Q4FY11NAMupgradeBACKUP78to163.ppt
  - http://www.emc.ncep.noaa.gov/pptfiles/NAM_briefing_091911_enhanced-1.pptx

NEMS Component Structure



Hypothetical NEMS Simultaneous Run

Global [with Igor & Julia] and NAM [with its nests]



Is a Unified Modeling Approach Possible at NOAA?

Global, Regional, Local and Hurricane

Why Does It Run So Much Faster?

	NMMB	NMM	
Runtimes	**1619 s**	**5857 s**	**3.6 x faster**
			Contribution to speed up
New Model Dynamics	**NMMB**	**NMM**	**~2%**
Infrastructure	**NEMS**	**WRF**	**~2%**
Nesting	**• NMMB specific • Outside of the NEMS infrastructure • Processor apportionment • 1-way nests solved simultaneously**	**• ~Core independent* • Part of the WRF infrastructure • No processor apportionment • 1-way nests solved sequentially**	**~96%**
Horizontal resolution step-down ratio	**Any integer ratio, e.g. 2:1, 3:1, 4:1, …**	**Only 3:1***	**0% - this relates to flexibility, not speed**

Additional Considerations

- Much improved computational efficiency and increased throughput. Runtime for NAM w/ 5 nests: Current opnl code: > 4 hours

  New code: 70 minutes

- New NAM is doing ~11 times more work than the current NAM but only using 7.7 times more compute resources to finish at the same time!
- IBM estimates the NMMB will scale well, up to at least ~24,000 cores.

Parallel Performance Statistics

- Seasonal FVS stats (ops NAM versus NMMB control run, started with 1 June 2010 since the change with the biggest impact [multiple boundary rows] was put into the control run on on 5/17/2010:
  - June-August 2010 and
  - September-November 2010
- Seasonal stats for nests (ops NAM vs NMMB parent vs CONUS/Alaska nest), end date is when we switched from purely explicit convection to BMJ_DEV (light amount):
  - 12 July - 30 August 2010
- Chronology of major changes in the NMMB control run and the nested runs can be found here.

Moist Physics Modifications

Modified Convection in Nests

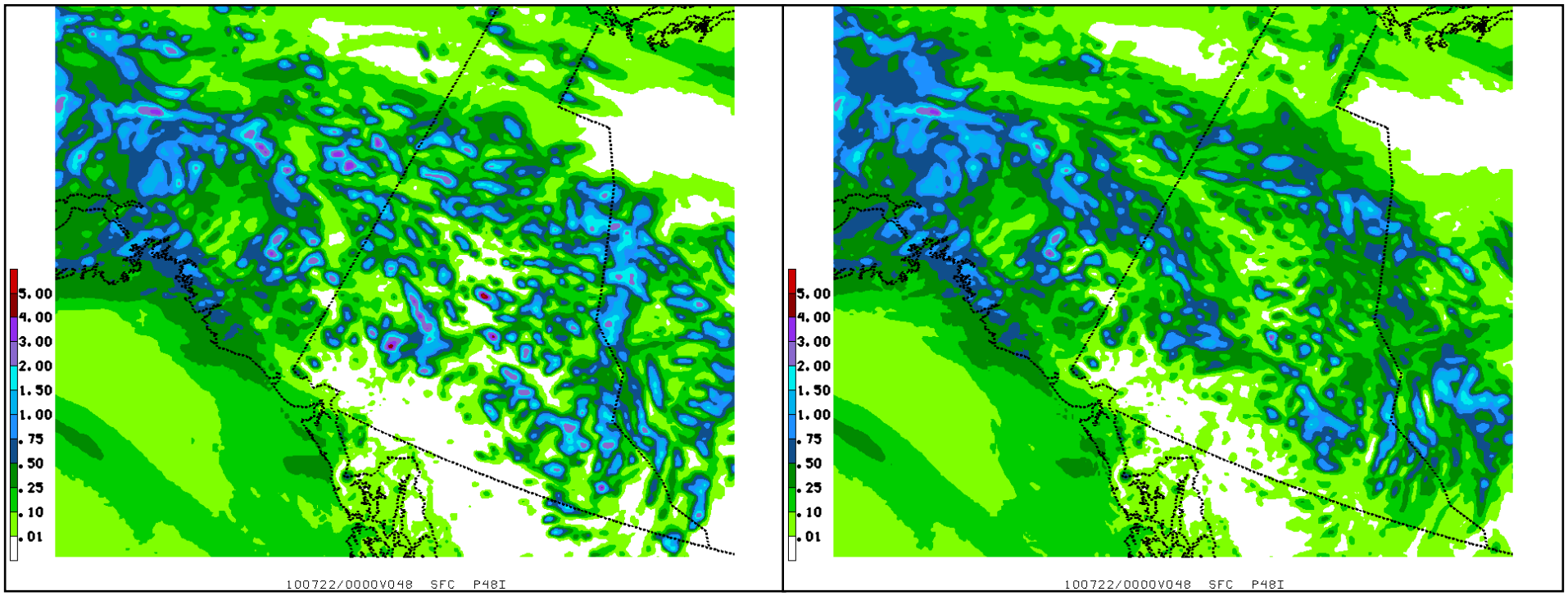
- BMJ_DEV tests in 4-km CONUS runs
  - Moister profiles
  - Less triggering of deep convection
  - Reduced convective QPF
  - Better QPF bias than running w/o convection
  - Improved surface & upper-level scores (not shown)
  - Small impact on CAPE forecasts

Modifed Microphysics

- Modified Ferrier
  - Higher peak dBZ, RR (1D column runs)
  - Small impact on QPF
  - Improved >50 dBZ, but worse (higher) biases ≤45 dBZ
- Cloud fraction changes
  - Reduced high (overcast) bias for high, thin cirrus
  - Improved scores vs CLAVRx using newest formulation

Example of the ROCK and the HARD PLACE

6 km NMMB nest 48 h total precip ending 20100722/00Z



without parameterized convection

Max precip = 4.91”

SPC is happy, but HPC is sad!

with Janjic BMJ_DEV convection

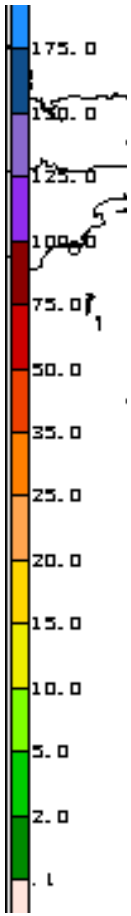
Max precip = 3.39”

HPC is happy, but SPC is sad!

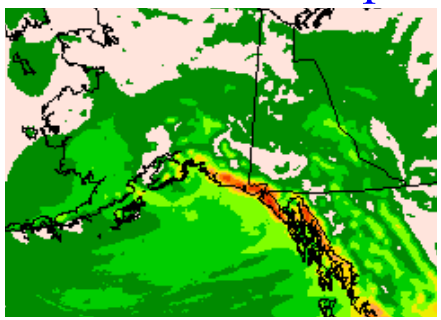
OCONUS QPF Verification (courtesy of Ying Lin)

NAM/NEMS implementation on 18 Oct 2011 included 3 OConUS nests: AK (6km), HI and PR (3km), each running four times a day to 60h.

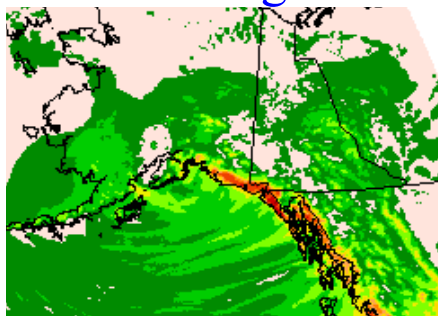
Verifying analysis: AKQPE for AKnest, CMORPH for HInest and PRnest



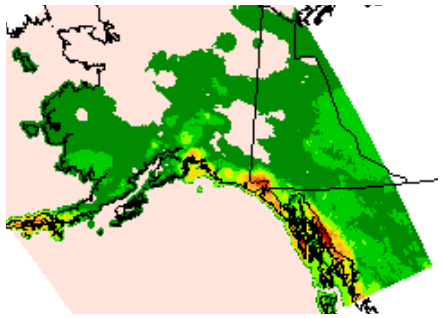
24h precip accum ending 12Z 3 Mar 2012



NAM 00-24h fcst

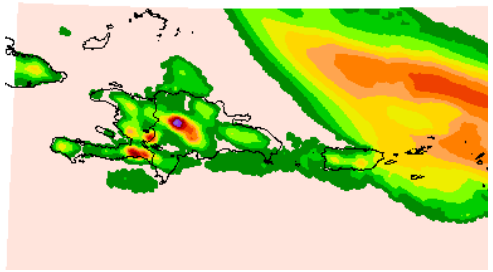


AKNEST 00-24h fcst

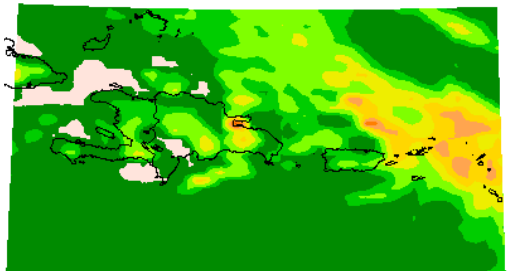


AKQPE

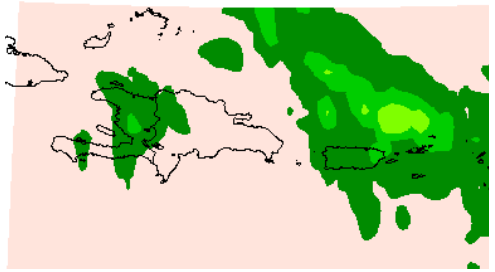
24h precip accum ending 12Z 17 May 2012



NAM 00-24h fcst



GFS 00-24h fcst



CMORPH

Fire Weather / IMET-DHS Support (FWIS) Runs

- Locations selected daily for next 4 NAM runs.
  - SOP developed among National Interagency Fire Center (NIFC) in Boise, the SPC and SDM – using IMET SharePoint site.
  - Regions, other NCEP centers and NWS-DHS liaison can all nominate locations
  - Default position is Washington, DC but the SDM can also persist previous day's positions
- Now on CONDUIT for NWS regions to pick up and load onto FXNET server for viewing by IMETs in the field, FWIS runs can still be viewed at Eric Rogers' most excellent website:

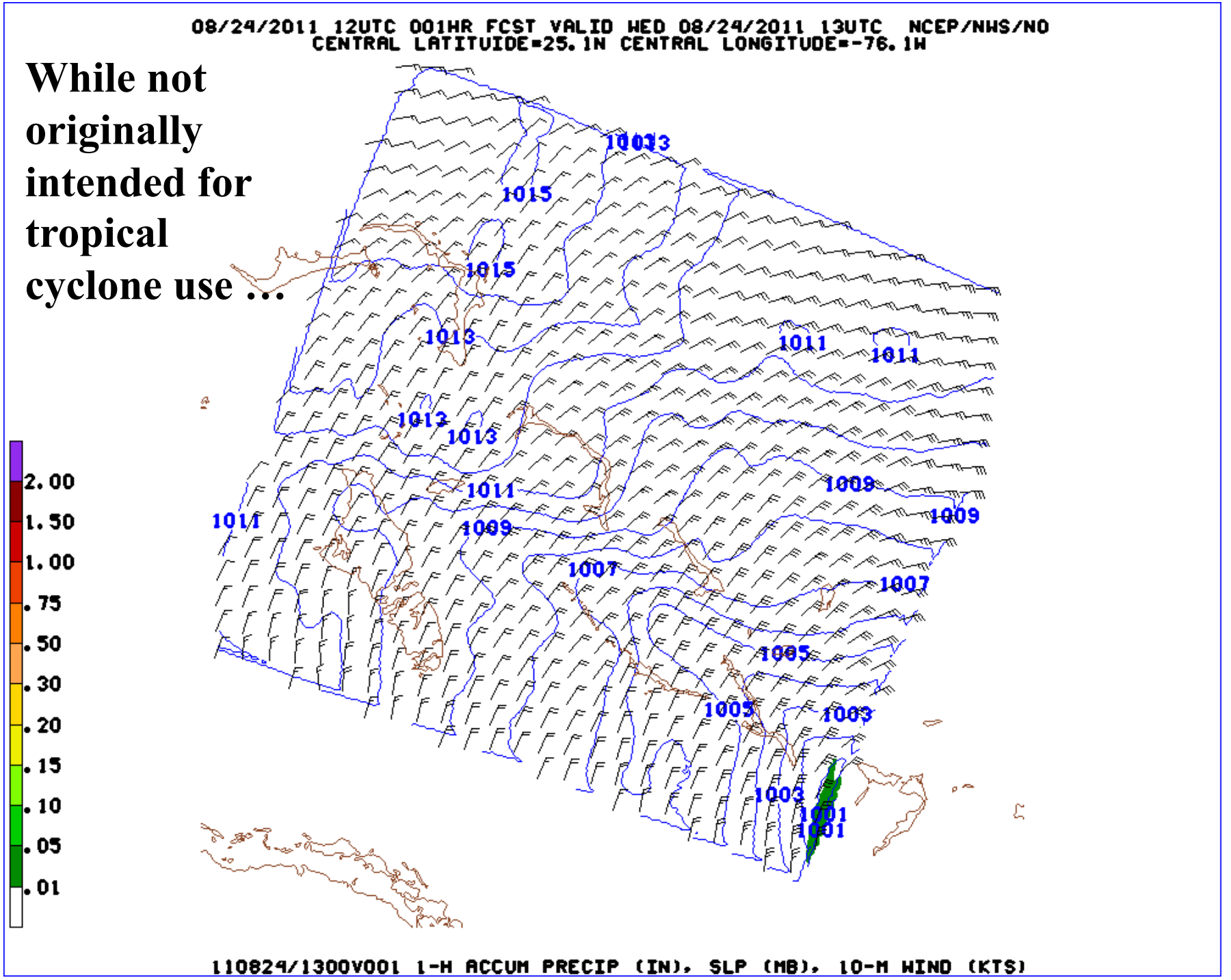
http://www.emc.ncep.noaa.gov/mmb/mmbpll/firewx/

NAM Fire Weather High Resolution Nested Runs

This page will show selected fields from the most recent 00z, 06z, 12z, and 18z NAM Parallel High Resolution "Fire Weather" nested run. This nest runs inside either parallel NAMX CONUS or Alaska nest. It runs to 36-h and has a resolution of 1.333 km (if in CONUS) or 1.5 km (if in Alaska).

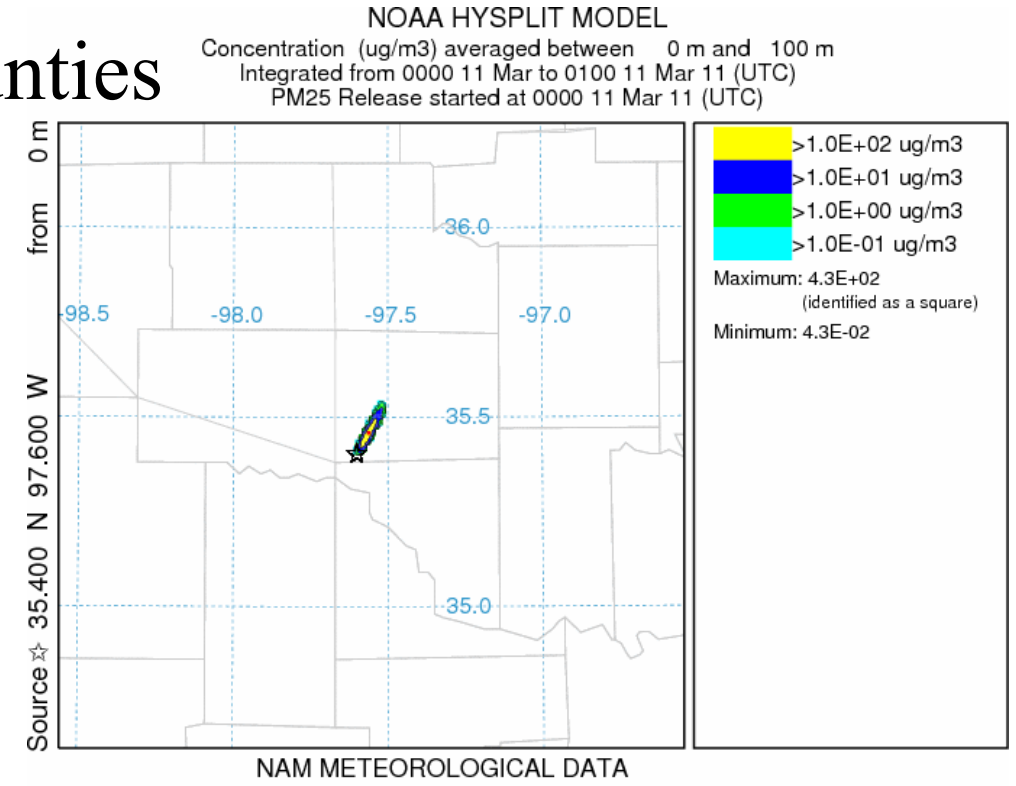
During parallel testing the domain will move around to test this capability over different regions.

Parameter	Most recent 00z Run	Most recent 06z Run	Most recent 12z Run	Most recent 18z Run
Haines Index	X	X	X	X
Ventilation Rate	X	X	X	X
Transport Wind, Terrain Height	X	X	X	X
PBL Height	X	X	X	X
1-H Minimum Relative Humidity, 10-m Wind	X	X	X	X
Sea-level Pressure, 1-h Accumulated Precip, 10-m Wind	X	X	X	X
1-h Accumulated Convective Precip, 10-m Wind	X	X	X	X
Categorical Precipitation Type	X	X	X	X
Composite Radar Reflectivity, 10-m Wind	X	X	X	X
1000 m AGL Radar Reflectivity, 10-m Wind	X	X	X	X
Shelter (2-m) Temperature, 10-m Wind	X	X	X	X
Shelter (2-m) Relative Humidity, 10-m Wind	X	X	X	X
Terrain Height, 10-m Wind	X	X	X	X
Total Column Condensate	X	X	X	X
925 mb Height, Wind	X	X	X	X
850 mb Height, Temperature	X	X	X	X
700 mb Height, RH	X	X	X	X
500 mb Height, Wind	X	X	X	X
250 mb Height, Wind	X	X	X	X
250 mb Wind Speed	X	X	X	X


08/24/2011 12UTC 001HR FCST VALID WED 08/24/2011 13UTC NCEP/NWS/NO
CENTRAL LATITUDE=25.1N CENTRAL LONGITUDE=-76.1W
While not originally intended for tropical cyclone use …
2.00
1.50
1.00
.75
.50
.30
.20
.15
.10
.05
.01
1015
1015
1013
1013
1013
1011
1011
1011
1011
1009
1009
1009
1007
1007
1005
1005
1003
1003
1001
1001
110824/1300V001 1-H ACCUM PRECIP (IN), SLP (MB), 10-M WIND (KTS)

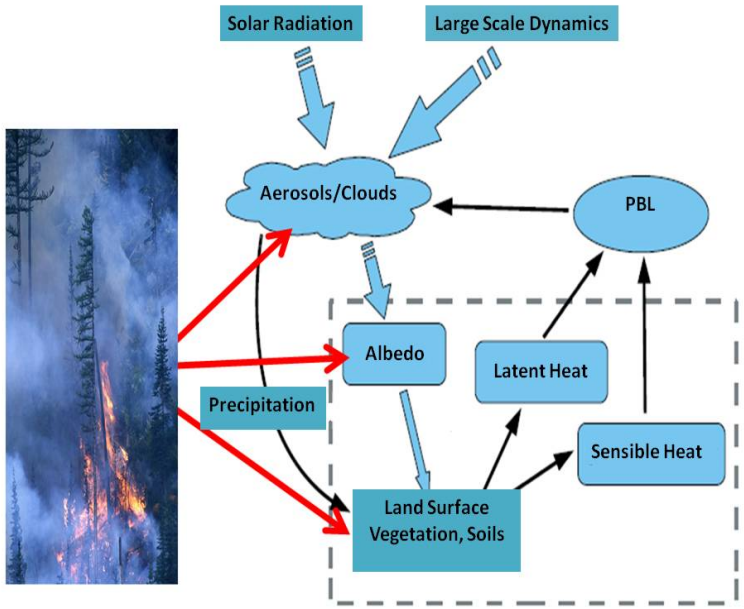
NOAA/ARL's HYSPLIT Dispersion Model

- Wild-fire smoke applications driven by NAM, NAM nests & FireWx IMETSupport runs via NOAA/ ARL's READY-testbed site
- Example for March 11, 2011 fires in Central OK: Harrah and Chatow counties



Future: Wildfire Effects in NMMB

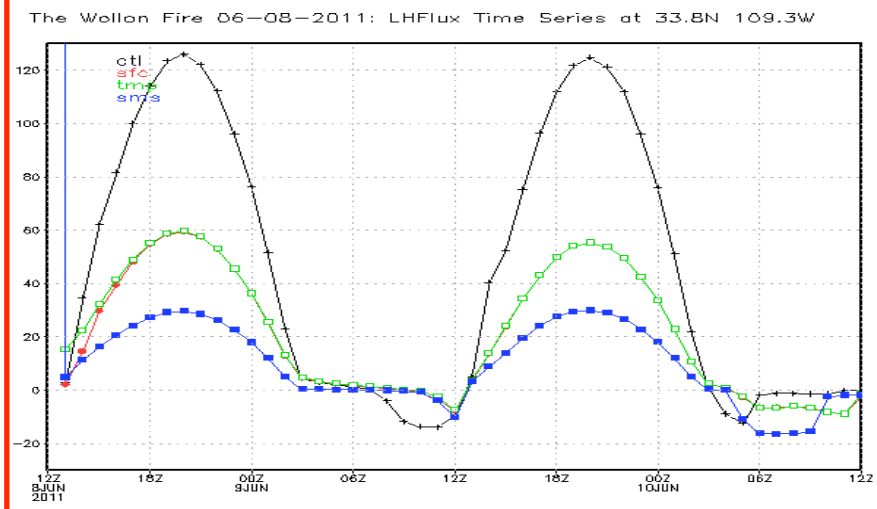
Wildfires affect surface physical properties



Burned area products: (1) A high resolution data (1 km) twice a day, the data covers the North American Area between 20°N and 70°N; (2) And relative lower resolution data (12 km) four times a day, the data covers the area from the equator to the north pole. All products are in GRIB2 Format with unit in percent.

NMMB model surface physical properties are updated based on the burned area

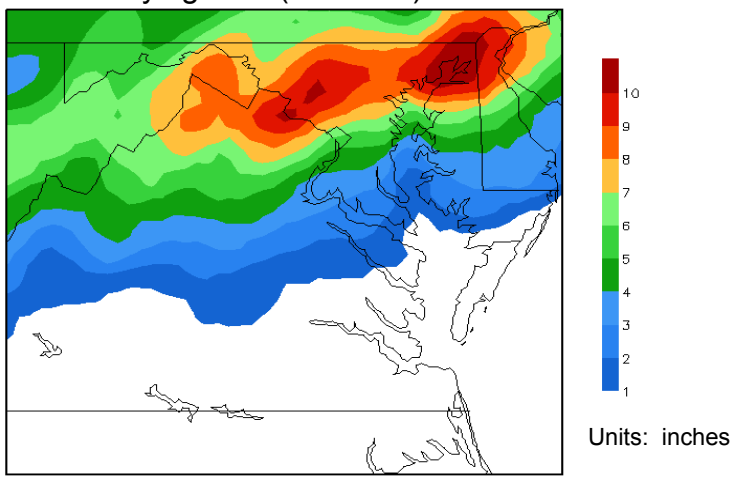
Tests: The Wallow fire in 2011
Albedo reduced by half
Greenfrac = (1-FireFrac/100)* Greenfrac
Roughness reduced by half
SfcTemp = sfctemp+15
Tsoil_layer1 = Tsoil1+15
Msois_layer1 = 0.25*Msoil1



30-h Accumulated Snow/Ice (Ferrier)

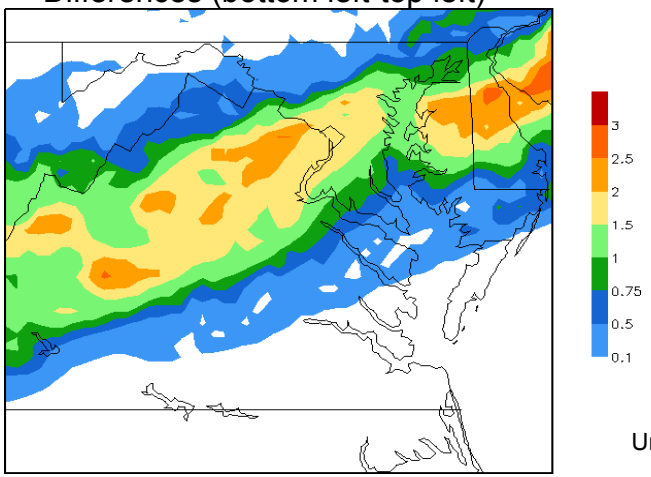
Valid: 06Z/27

Varying SLR (Uses RF)



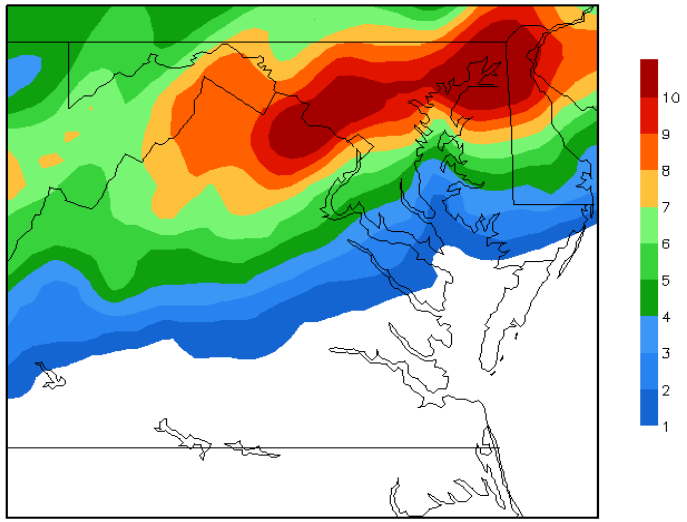
Units: inches

Differences (bottom left-top left)



Units: inches

Constant SLR (RF not used)



- This new tool combines the accumulations of lightly rimed snow, heavily rimed snow, graupel and sleet/ice pellets
- Upper left plot shows snow/ice accumulation using the snow-liquid-ratio (SLR) with an assumed 10:1 ratio for unrimed snow, as described below left (yellow/gold). A more general algorithm for reducing SLRs using other methods in combination with forecast values of the rime factor (RF) is proposed below right (pink).

10:1	for	1 < RF < 2
5:1	for	2 < RF < 5
2.5:1	for	5 < RF < 20
1:1	for	RF > 20

1 < RF < 2	=> No change to SLR
2 < RF < 5	=> Reduce SLR by 2
5 < RF < 20	=> Reduce SLR by 4
RF > 20	=> Reduce SLR by 10

- *Bottom left plot uses a **10:1** SLR for the entire region shown*
- The varying SLR approach reduced the accumulated snow/ice by as much as 3 inches in some places and more than 1 inch over a large region.

Final Algorithm

Input fields or 'ingredients' for the final algorithm

- A = hourly accumulated QPF
- B = % frozen precipitation (hourly, instantaneous)
- C = Function of Rime factor (below; hourly, instantaneous)
- D = SLR from Roebber *et al*. (hourly, instantaneous)

Accumulated snow/graupel/sleet = A*B*C*D, where

$$C = \begin{cases} 1.0 \text{ if } 1<RF<2 \\ 0.5 \text{ if } 2<RF<5 \\ 0.25 \text{ if } 5<RF<20 \\ 0.10 \text{ if } RF>20 \end{cases}$$

Short Range Ensemble Forecast (SREF) System

- Common ensemble product generator
- Four-per-day runs since July 2006
- Now on NOMADS & ftp server
- Routine displays etc. are available at:

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

  http://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller
- Various Displays of ensemble BUFR soundings

  http://www.emc.ncep.noaa.gov/mmb/srefmeteograms/sref.html

FY2012 – SREF implementation

Target Implementation August 2012

- **Model Changes**
  - **Resolution increase from 32-35km to 16km**
  - **Eliminate Eta and RSM legacy models**
  - **Upgrade WRF cores from v2.2 to version 3.3**
  - **Set all members to 35 levels in the vertical and 50 mb model top**
- **Initial condition and physics diversity improvement**
  - **Control ICs (NDAS, GDAS, RAP blended @ edges w/GFS) provide Land IC diversity**
  - **IC perturbation is a blend of regional breeding and downscaled ETR**
  - **Physics package diversity (NAM, NCAR, RAP, HWRF, and GFS)**
  - **Lateral boundary condition diversity from 21 different GEFS forecasts**
- **New capabilities of post-processing & product generation**
  - **Precipitation bias correction**
  - **Clustering and associated mean/prob/spread within a cluster**
  - **Member performance ranking**
  - **Downscaling to 5km using RTMA and associated ensemble products**
- **New ensemble products**
  - **Max/min, mode, 10-25-50-75-90% forecasts**
  - **Probs of severe thunderstorm, lightning, dry lightning, fire weather (SPC) as well as fog, LLWS, composite reflectivity and echo top**
  - **Addition of hourly ensemble product output from 1-39 hr**
  - **New snow-liquid ratio (Manikin)**
  - **New ensemble BUFR products**

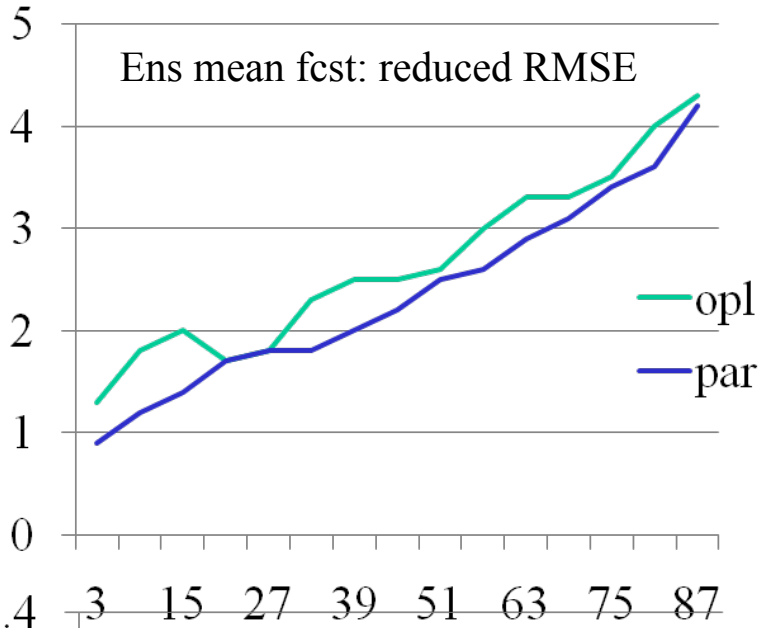
WRF v2.2 Members (5 each) since October 2009 Upgrade

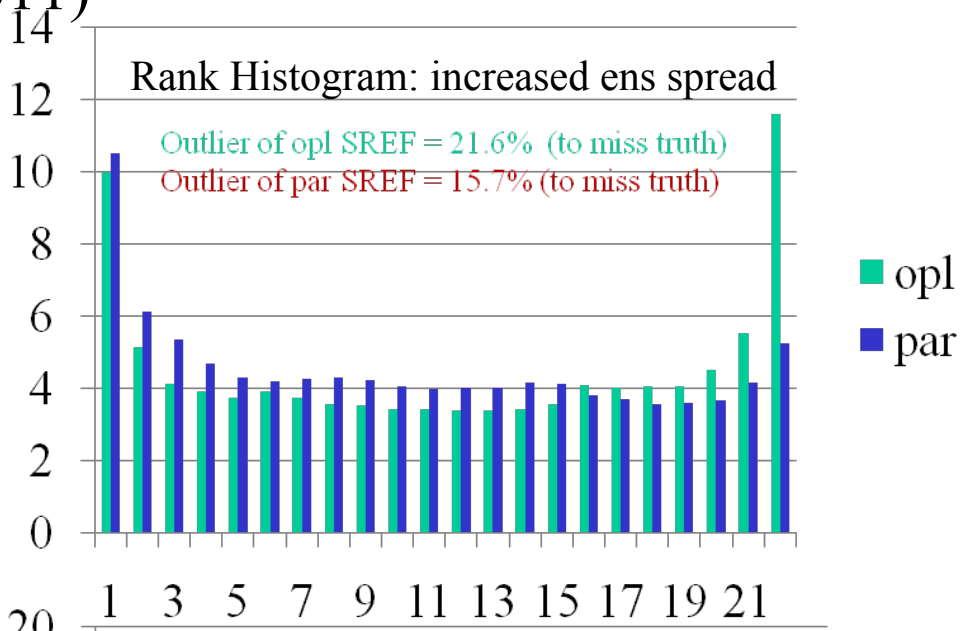
	WRF-NMM "NAM physics"	WRF-ARW "NCAR physics"
Horizontal Grid	32 km	35 km
Vertical Domain	52 levels 50 mb top Sigma-Pressure	36 levels 50 mb top Sigma
Convection	BMJ	KF
PBL/Turbulence/ Surface Layer	MYJ	YSU
Microphysics	Ferrier	WSM3
Land-Surface	NOAH	NOAH
Radiation (SW/LW)	GFDL/GFDL Lacis-Hansen/Fels-Schwartzkopf	Dudhia/RRTM

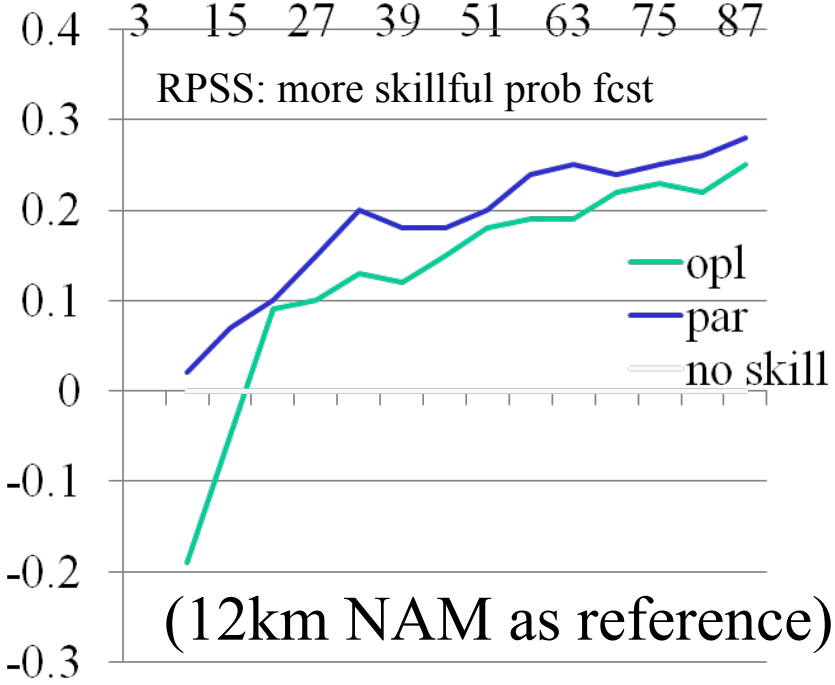
Physics Package Options in August 2012 SREF Upgrade

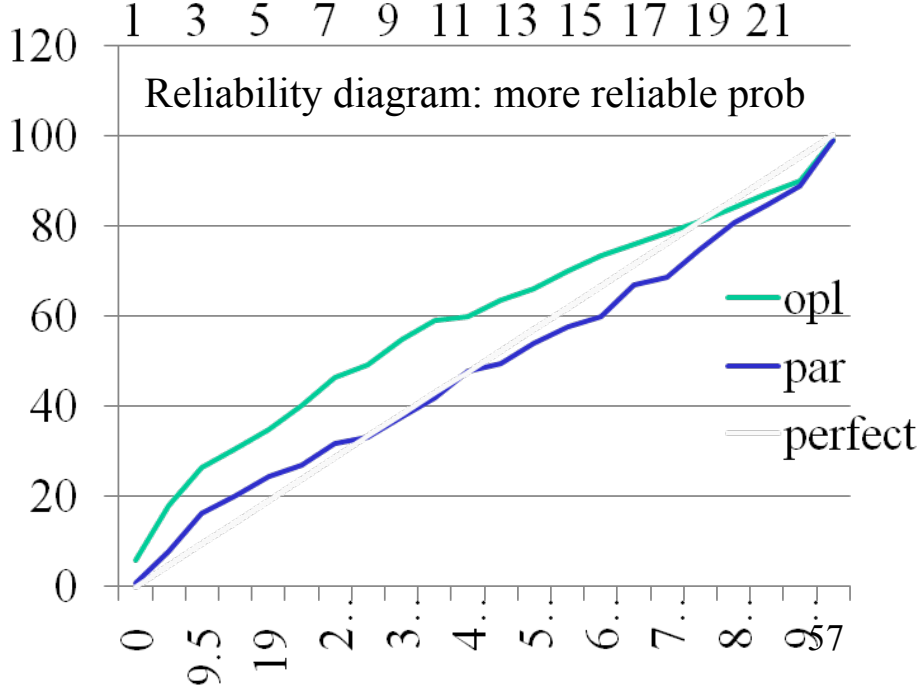
	NEMS-NMMB	WRF-NMM	WRF-ARW
Control & 1st Pair	NAM	NAM	NCAR
2nd Pair	GFS_moist	HWRF	RAP
3rd Pair	NAM-WSM6	NCAR	NAM

Evaluation of SLP (opl SREF vs. par SREF, Oct. 23 – Dec. 31, 2011)









HPC Winter Weather Experiment (2011-2012)
mean snowfall forecast -- SREFp vs. SREF

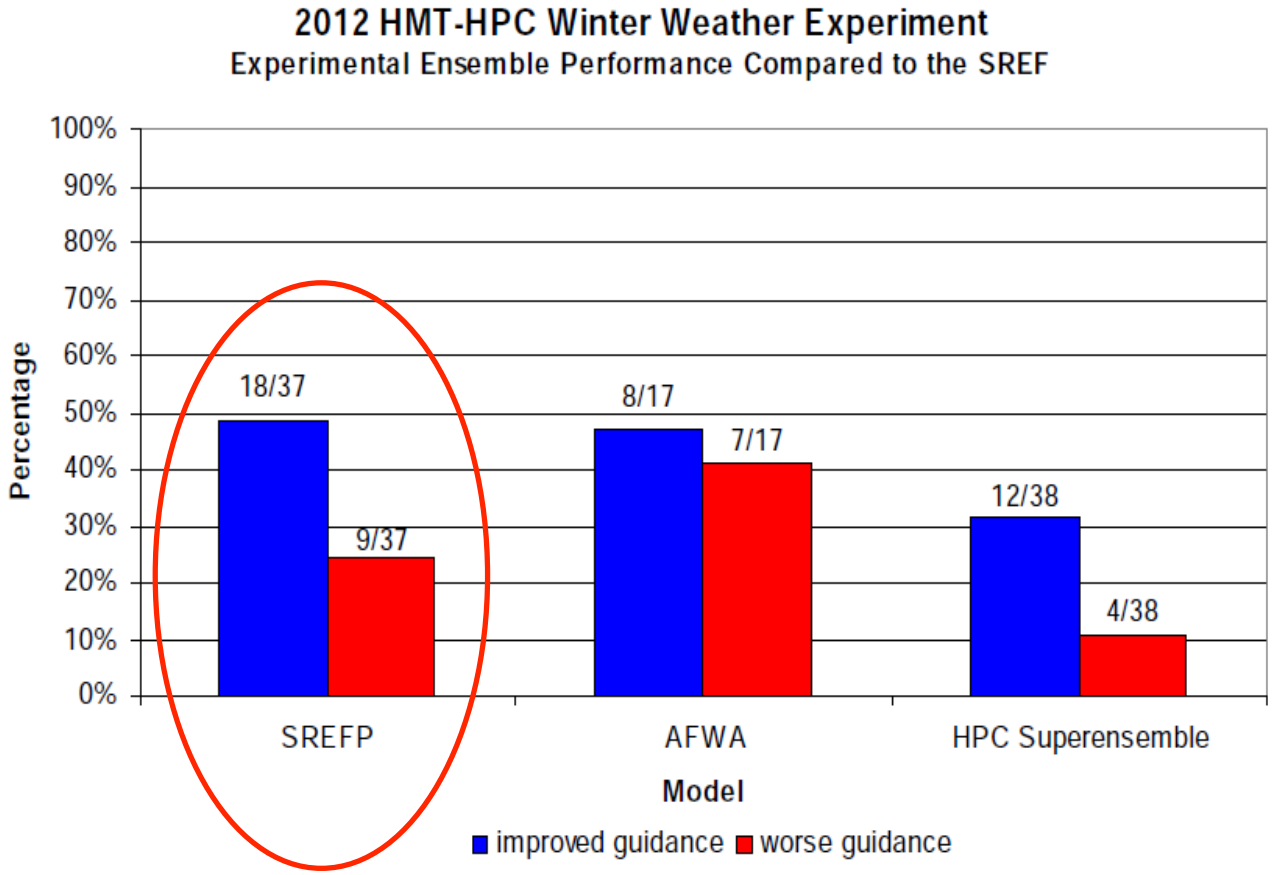


Figure 1. Experimental ensemble performance based on participant feedback from subjective model evaluations conducted during the 2012 HMT-HPC Winter Weather Experiment. Participants were asked to determine whether the ensemble mean snowfall forecasts from the 00Z experimental guidance (21Z SREFP) were much better, better, about the same, worse, or much worse than the guidance provided by the operational 21Z SREF, based on observations from the gridded HPC snowfall analysis. The AFWA ensemble was only available for the Day 1 (24-48hr) forecast period.

HPC Winter Weather Experiment (2011-2012)
"capture" of 2"/24h event -- SREFp vs. SREF

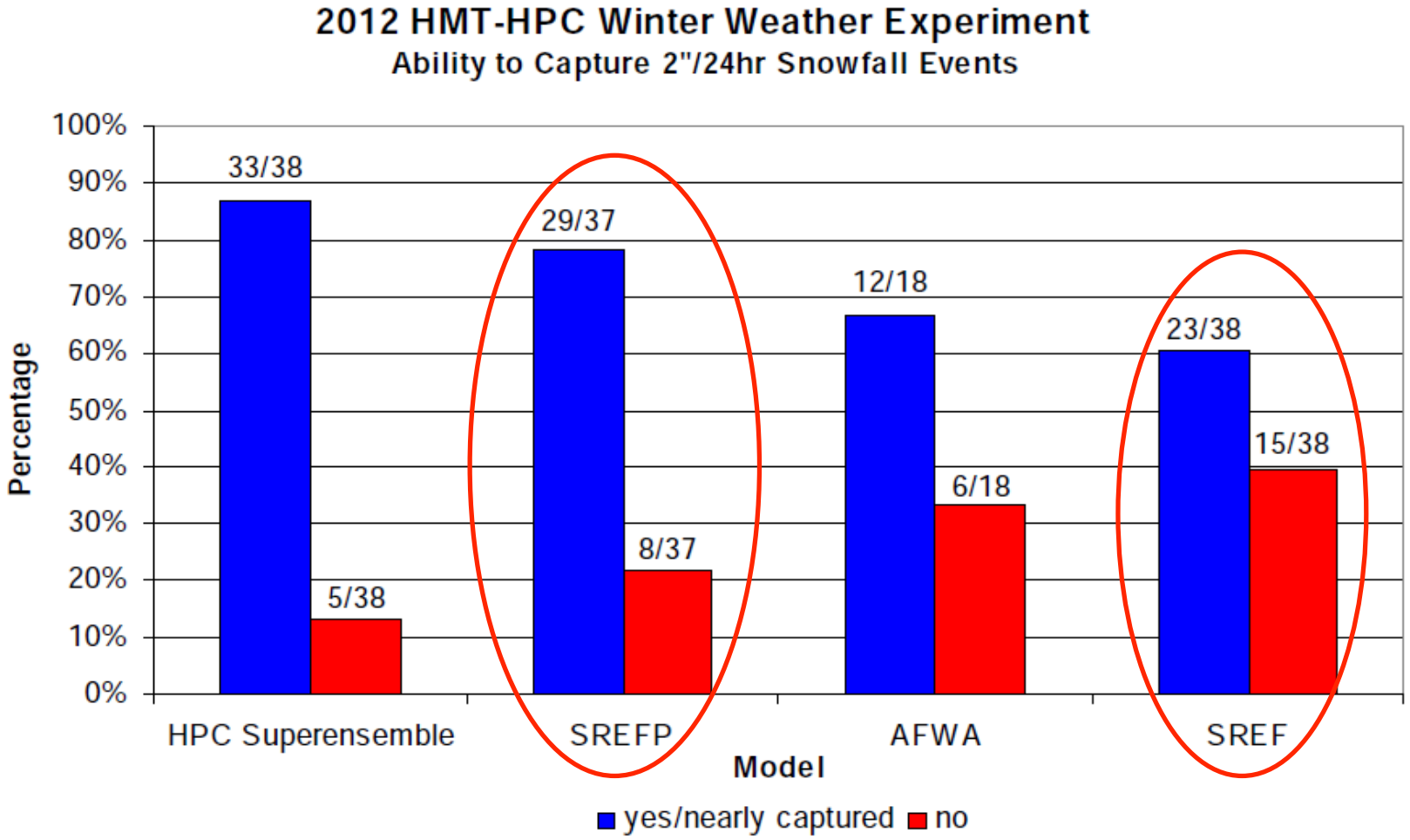
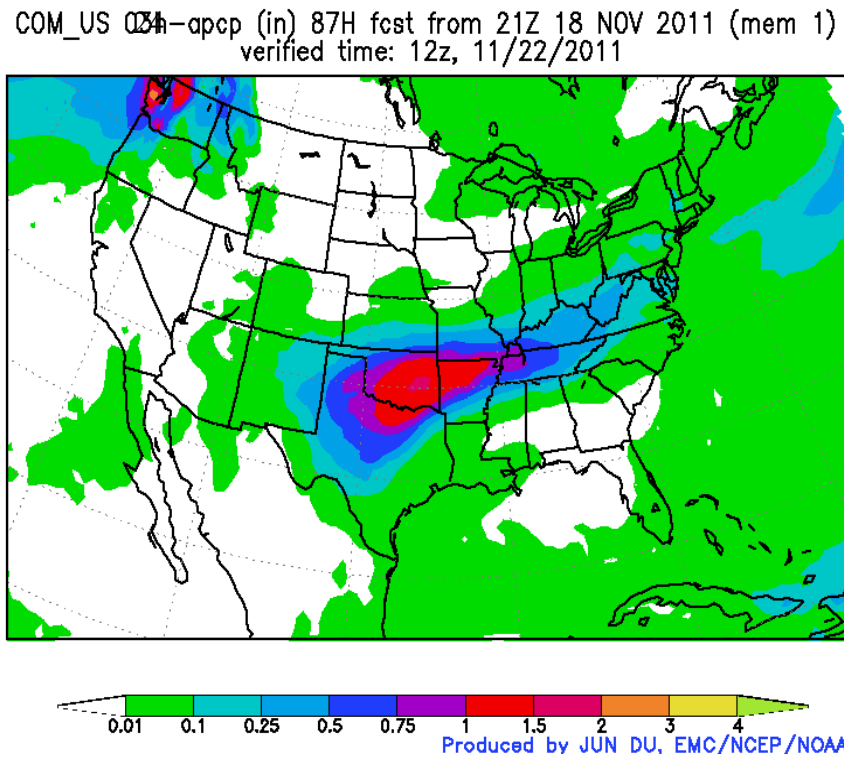


Figure 2. Ability of the experimental ensembles to capture the 2in/24hr snowfall events with the model 1% probability contour. "Nearly captured" represents cases in which there were only very small areas of observed 2 inch snowfall outside of the 1% probability contour. The AFWA ensemble was only available for the Day 1 (24-48hr) forecast period.

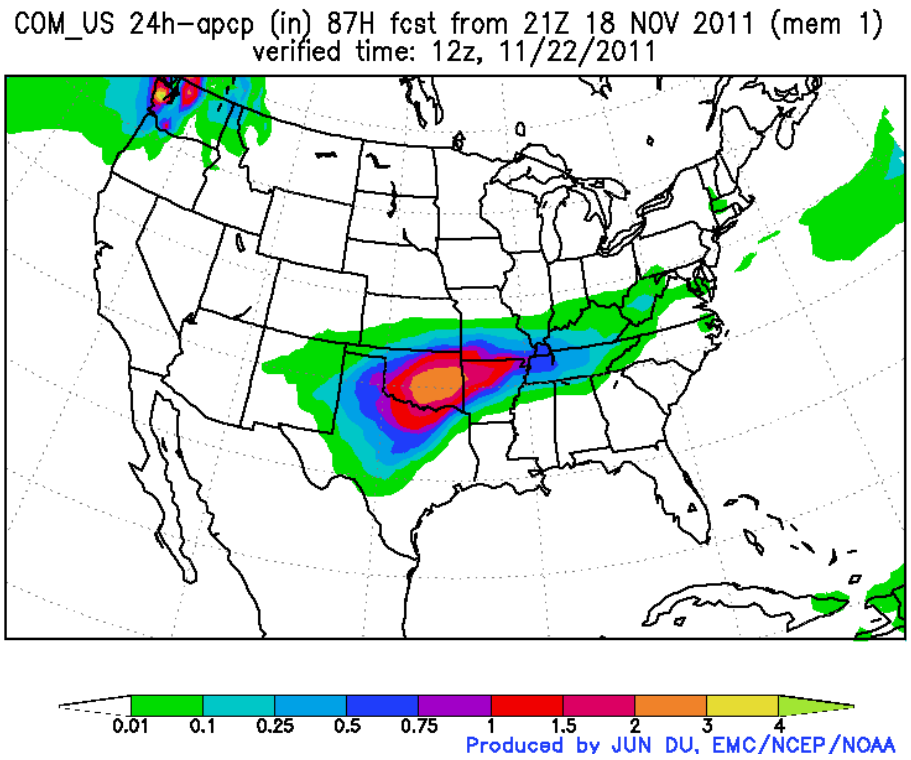
Bias correction can effectively remove over-predicted light precipitation area!

(frequency-matching method similar to that used in GEFS)

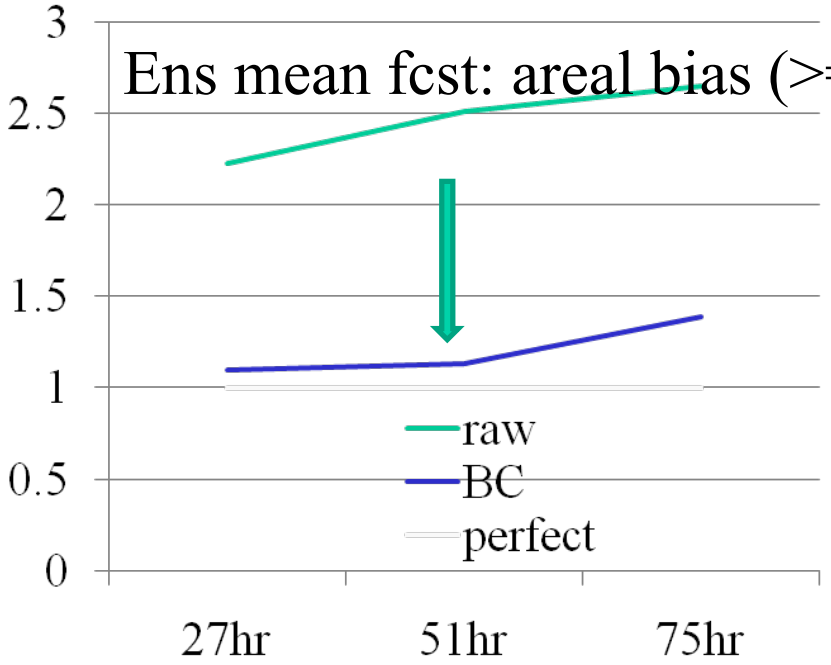
16km SREF mean (raw)

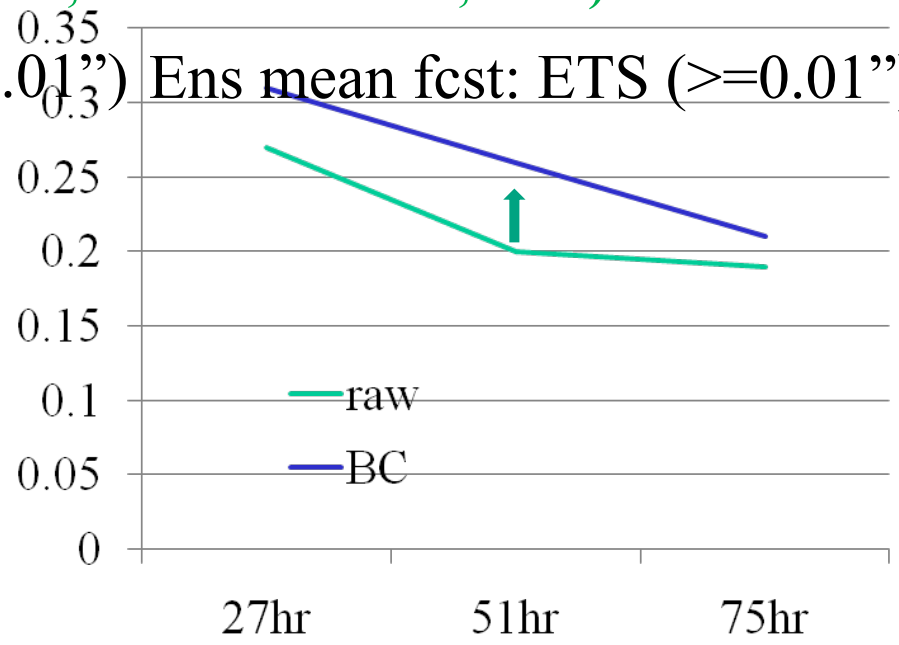


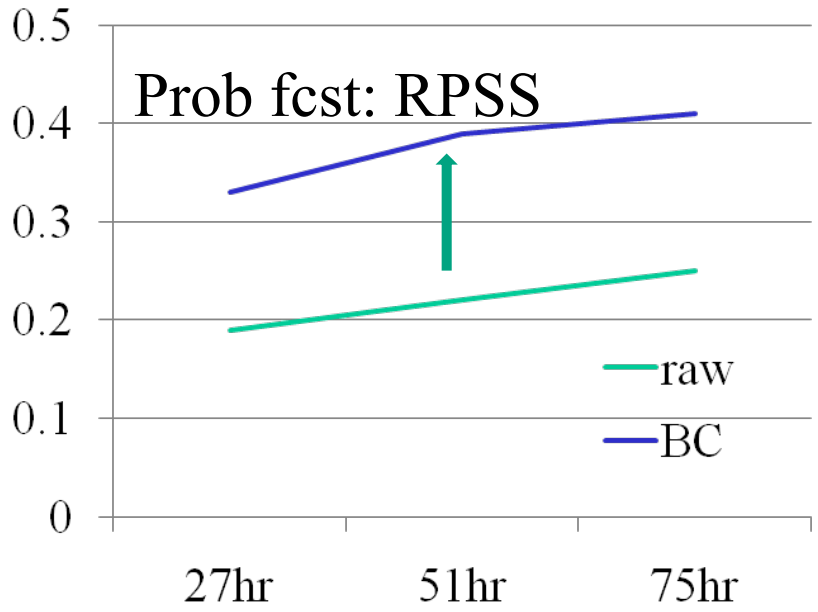
16km SREF mean (bias corrected)



Precipitation bias correction verification (against CCPA, using 12km NAM as reference for RPSS, Nov. 10- Dec. 31, 2011)



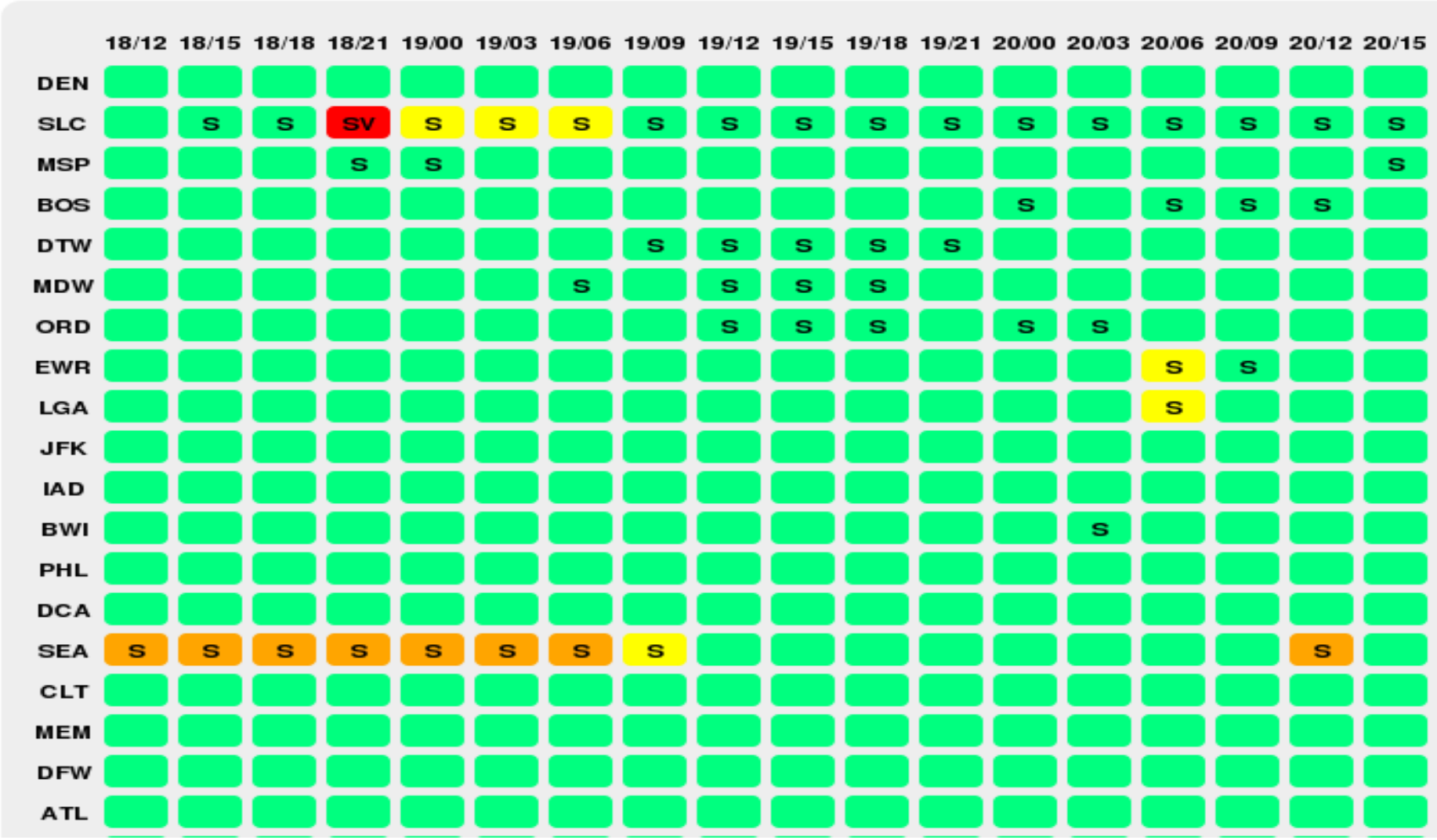




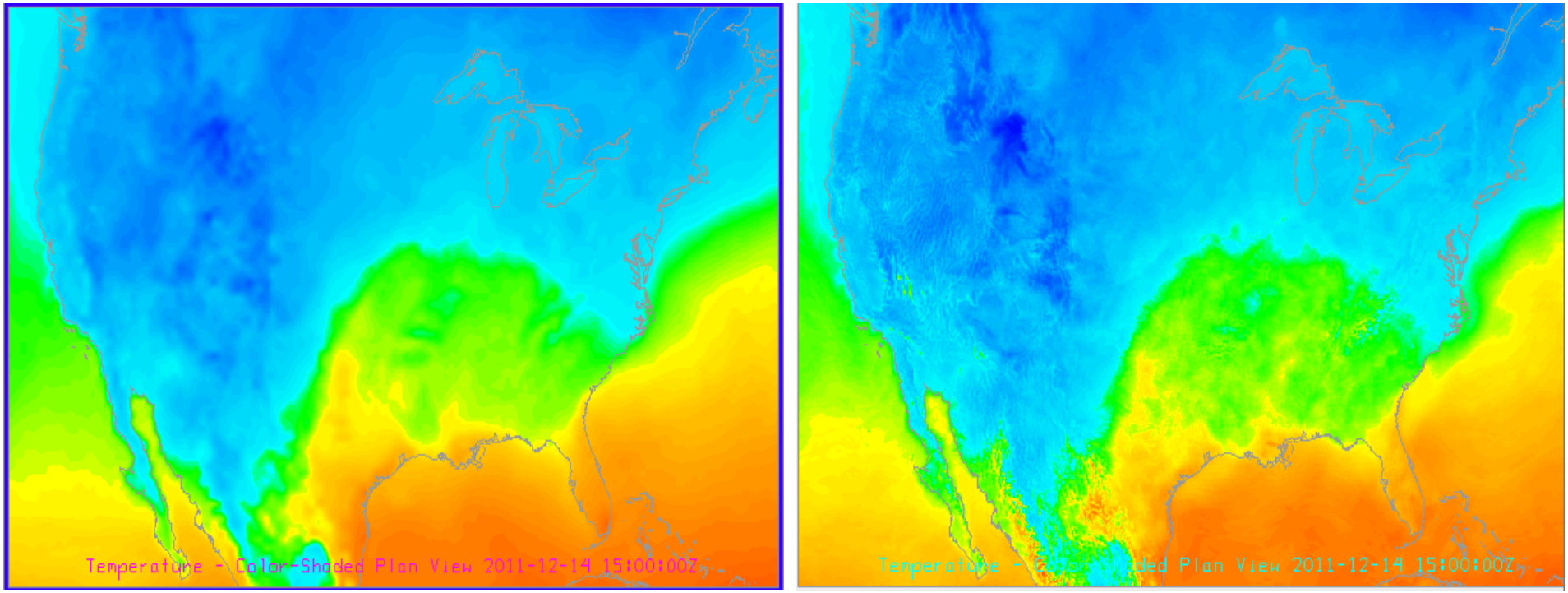
SREF-based AWC hazardous weather risk forecasts for U.S. airports

Legend: Impact type: S=Snow, F=Freezing Rain, V=Visibility. Mouseover colored box for airport group impact criteria.
Green = Nominal impact Yellow = Slight impact Orange = Moderate impact Red = High impact

Last update: 2012-01-18-14:11 UTC Approximate next update time: 2012011820 UTC SREF model initialization date: 2012011809 UTC Next SREF update: 2012011815 UTC



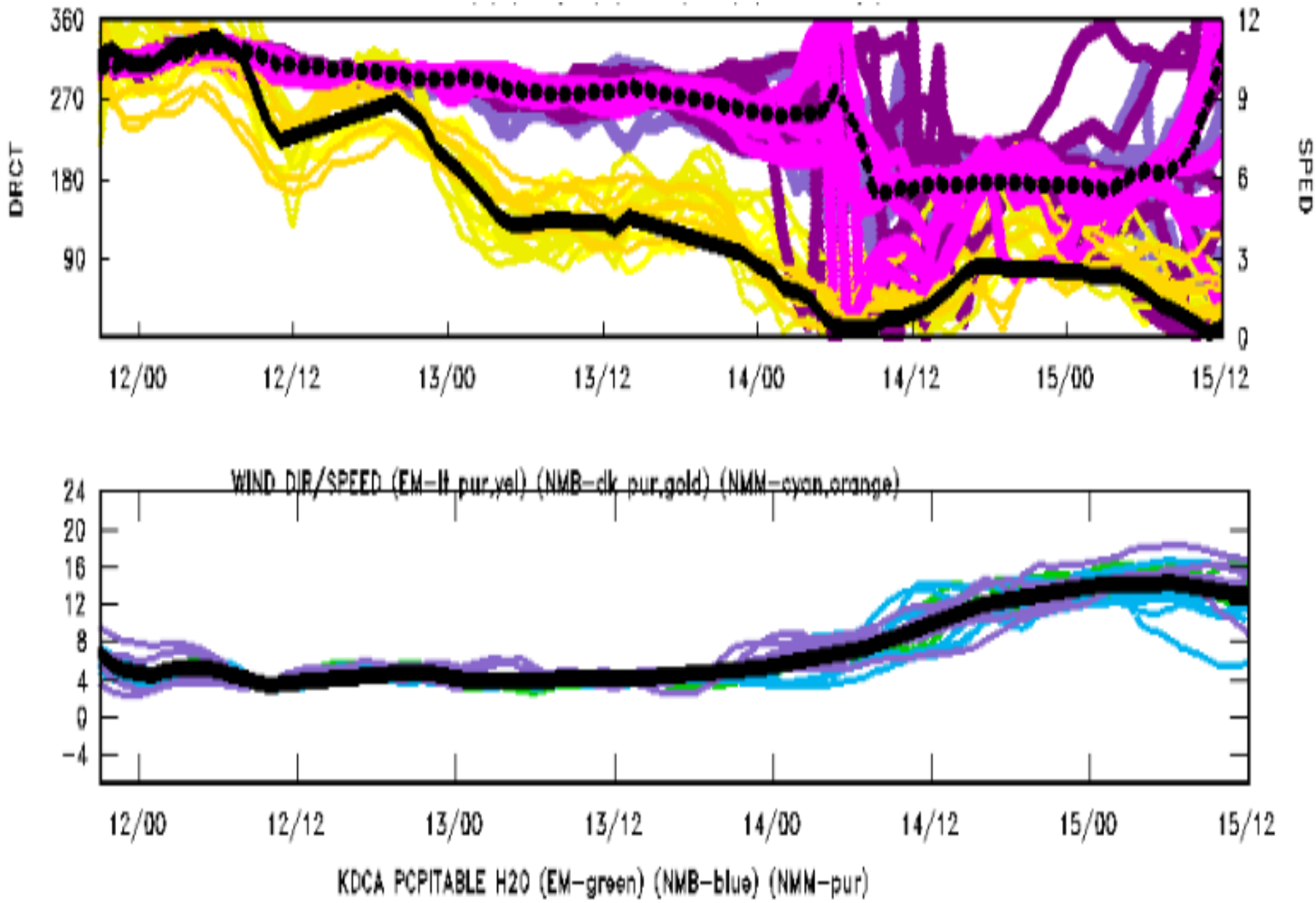
Example of Downscaling with RTMA
T2m (valid at 15Z, Dec. 14, 2011)



Before (40km)

After (5km)

Ensemble mean bufr forecast at a station



Plans with DTC's Ensemble Folk

- To test EnKF IC perturbations
- To test stochastic physics scheme
- To test KE backscatter scheme
- To test GEFS variance adjustment scheme
- To calibrate ensemble spread
- To explore a 9km-SREF (with DTC) as well as storm-scale ensemble
- NAEFS_LAM combined products with CMC REPS