Update on WRF+ in NCEP Operations

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N C E P

Where the nation's climate and weather services begin

T O P I C S

- Condensed Chronology with lots of links, oh boy!
- Unsolicited Endorsement
- Unified Post Processor
- HiResWindow
- Short Range Ensemble Forecast
- North American Mesoscale NEMS-NMMB
- Future Plans: NARRE & HRRRE

Chronology of NMM & ARW in Operations at NCEP

• Pre-WRF NMM at NCEP

• May 2000: nonhydrostatic option released in upgrade to NCEP's workstation Eta

• May 2001: NMM model equations, solution techniques & test results published in Janjic, Gerrity, and Nickovic, 2001, Mon. Wea. Rev. also Janjic, 2003, Met&Atmos Phys

• February 2002: HiResWindow runs upgraded to use 8 km NMM replaces 10 km Eta (hydrostatic)

• February 2002: On-Call Emergency Response begins using 4 km NMM to support HYSPLIT

• May 2003: Fire Weather / IMET Support runs implemented using 8 km NMM, suspended 2006-2011

• WRF ARW&NMM at NCEP

• September 2004: HiResWindow the first operational WRF v1.3 implementation: 8 km NMM & 10 km ARW replace single 8 km pre-WRF NMM

• June 2005: HiResWindow upgraded to 5.1 km NMM & 5.8 km ARW with explicit convection

• December 2005: Short Range Ensemble Forecasting (SREF) system adds WRFv2.0: 3 members each of 40 km NMM & 45 km ARW

• September 2007: HiResWindow expanded domain, upgrade to WRFv2.2.1 4 km NMM + 5.1 km ARW

•October 2009: SREF upgrade to WRFv2.2.1, bias corrected, add 2 members each, and increase resolution to 32 km NMM & 35 km ARW

• March 2011: HiResWindow upgrade to WRFv3.2 add Guam runs, expand PR, add bufr sndgs + href

• Other NMM & ARW at NCEP

• April 2004 thru present: for SPC and the NSSL/SPC Spring Program, expanding & evolving routine daily developmental runs of ~4 km WRF-NMM with explicit convection

• June 2006: first NAM runs using 12 km WRF-NMM v2.1 & GSI replaces Eta & its 3dvar

• May 2007: first Hurricane WRF (HWRF) using WRF-NMM v2.0; 27 km outer with moving 9 km inner nest; annual updates

• March 2008: NAM uses NMM w/IJK array index

• December 2008: final major NAM upgrade to v2.2.1 WRF-NMM , WPS replaces WRF-SI

• August 2011: first NAM use of NEMS-NMMB with 6-3 km fixed nests and 1.33-1.5km placeable Fire Weather/IMET Supporting runs reinstated

• October 2011: Rapid Refresh using WRF-ARW v3.3 & GSI, on expanded domain replaces non-WRF RUC & its 3dvar.

• November 2011: SREF upgrade to WRFv3.3, add 2 more members each, and increase resolution to 22 km NMM & 25 km ARW

Recommended Tutorials (all of 'em!)

- GSI Community Tutorial a few openings are still left for the 2011 summer GSI Tutorial scheduled from June 29 to July 1 held at the NCAR Foothills Laboratory, Boulder, Colorado.
  - •The tutorial will be a two and half day event (with the last half day optional), consisting of both lectures and hands-on practical sessions. The lecturers are invited from various GSI development/support teams including NCEP/EMC, NASA/GMAO, NOAA/GSD, NCAR/ MMM and DTC. The practical sessions will provide essential skills to run GSI system with basic and advanced implementations.
  - •Participants can choose to attend only lectures or entire event (lecture and practical sessions) for registration.
  - •Please visit the web site above for more information.
  - •If you have any questions, please send email to gsi_help@ucar.edu
- WRF User's Tutorials July 11-22, 2011
- WRF Tutorial for Hurricanes TBD (last held April 26-29, 2011)
- DTC Ensemble Testbed Workshop/Tutorial TBD (last held August 18-19, 2010)

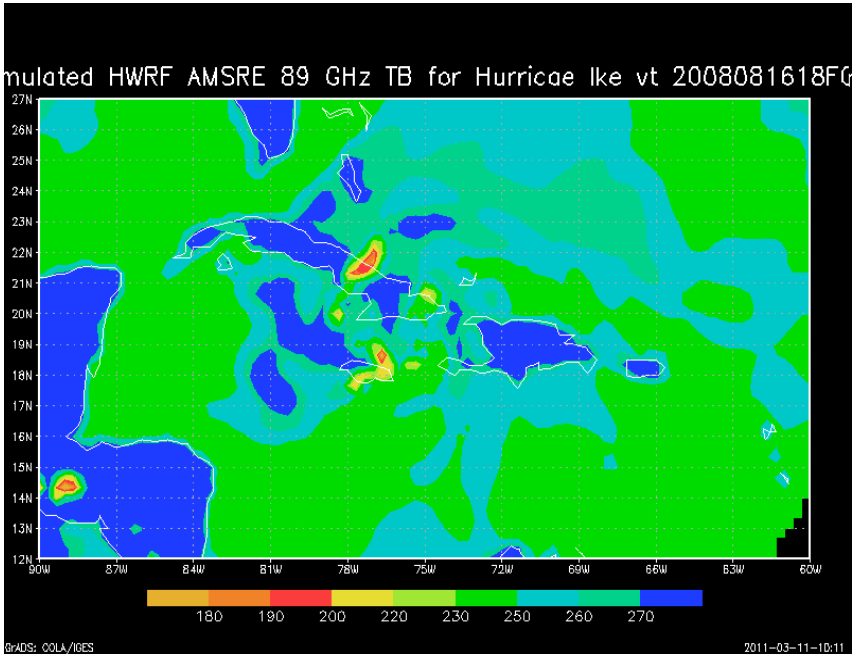
NCEP's Unified Post-Processor (UPP)

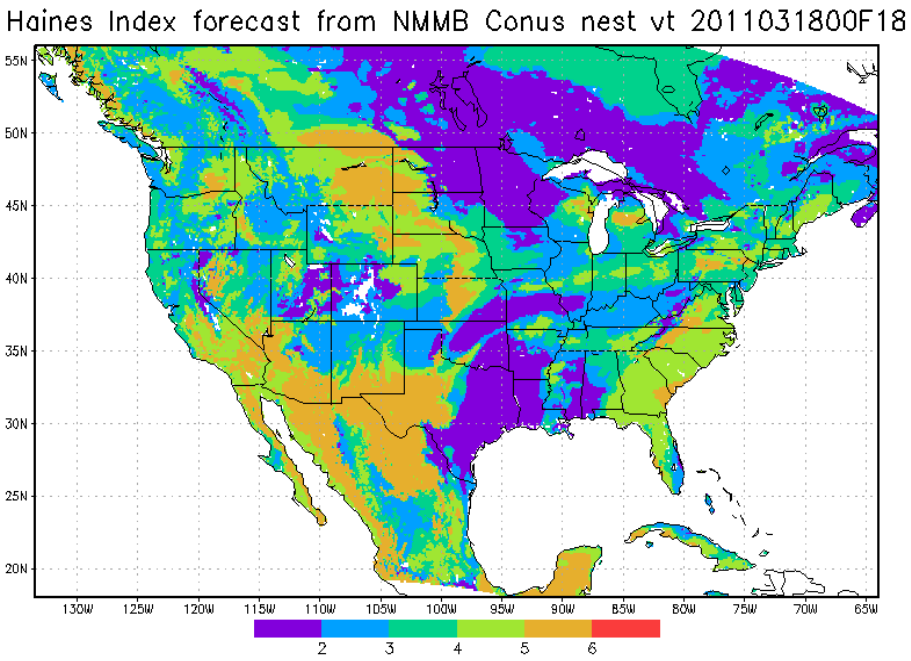
- Generates diagnostic quantities in model's computational domain, i.e. prior to any horizontal or vertical interpolation.
- Runs on all NCEP atmospheric models: RUC/RAP, NAM (NMM/NMMB), HiResWindow (ARW & NMM), SREF (Eta, RSM, ARW & NMM), Hurricane-WRF, GFS, GEFS, and CFS.
- Produces myriad of products including simulated radar reflectivity and satellite imagery & radiances.

NCEP, DTC and the UPP

- NCEP and DTC are transitioning to Unified Post Processor (UPP) from WPP this summer.
- DTC made a beta release of portable UPP v0.5 in April 2011.
- UPP retains existing WPP capability while expanding beyond to offer global application and many new derived fields.

New Fields in UPP in 2011





- New fields in UPP include isentropic levels, dynamical tropopause, fire weather, wind energy, as well as AMSR-E simulated IR and microwave products.

UPP Future Plan

- DTC is planning make an official release of UPP in June 2011.
- NCEP recently updated UPP to include capability to write Grib2 output directly using parallel IO. NetCDF4 is coming next.
- DTC is planning to include Grib2 output capability as well as capability to process NMMB output in its 2012 UPP release.

March 2011 Upgrade of HiResWindow

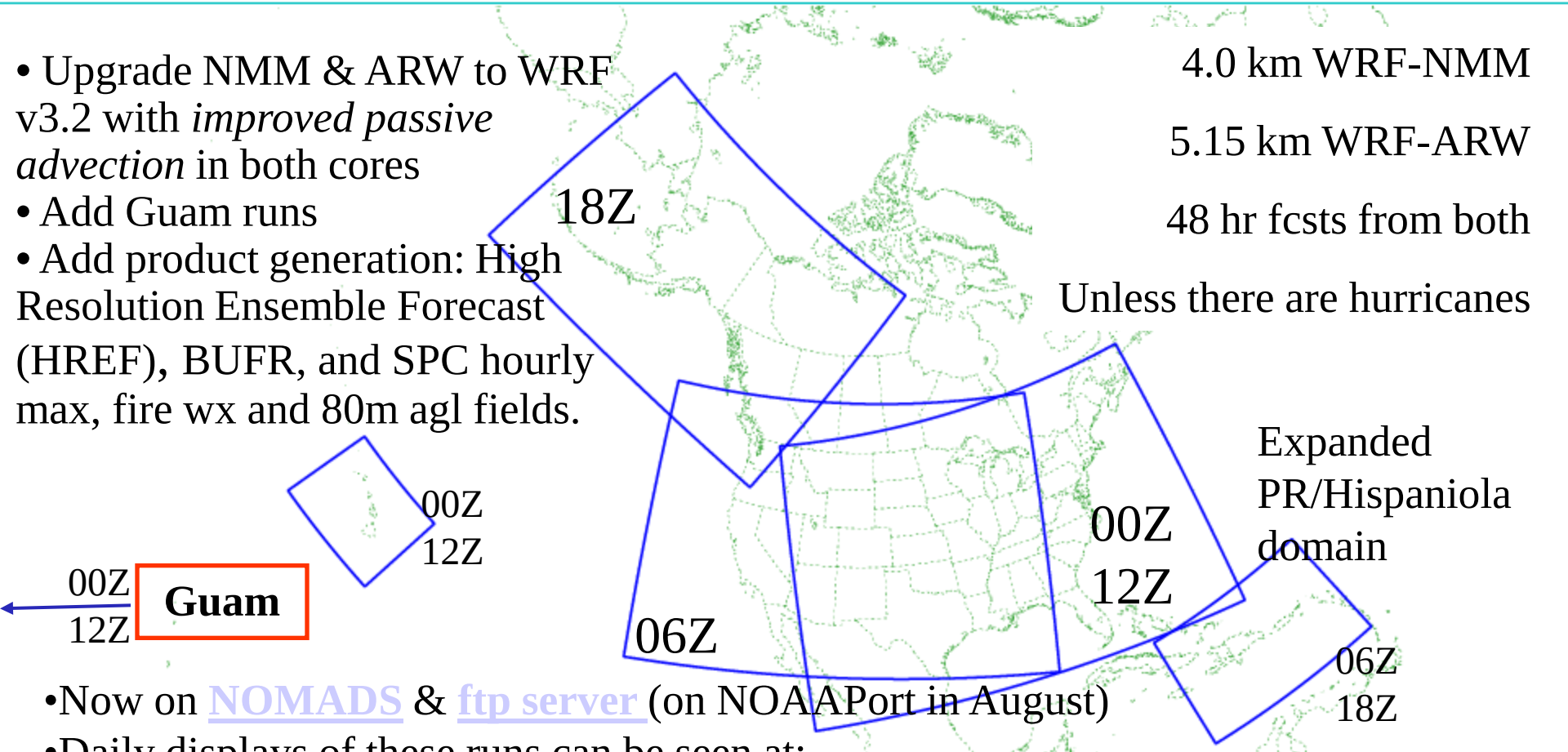
- Upgrade NMM & ARW to WRF v3.2 with *improved passive advection* in both cores
- Add Guam runs
- Add product generation: High Resolution Ensemble Forecast (HREF), BUFR, and SPC hourly max, fire wx and 80m agl fields.

4.0 km WRF-NMM

5.15 km WRF-ARW

48 hr fcsts from both

Unless there are hurricanes



- Now on NOMADS & ftp server (on NOAAPort in August)
- 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 NMM runs [/00 or /12] for SPC can be seen at http://www.emc.ncep.noaa.gov/mmb/mpyle/cent4km/conus/

HiResWindow WRF v3.2 Configurations

(No Parameterized Convection)

Dynamic Core	WRF-NMM	WRF-ARW
Horizontal Spacing	4.0 km	5.1 km
Vertical Domain	35 levels 50 mb top Sigma-Pressure	35 levels 50 mb top Sigma
PBL/Turbulence	MYJ	YSU
Microphysics	Ferrier	WSM3
Land-Surface	NOAH	NOAH
Radiation (Shortwave/Longwave)	GFDL/GFDL Lacis-Hansen/Fels-Schwartzkopf	Dudhia/RRTM
Advection of Passive Variables	Conservative Positive Definite	Monotonic Positive Definite

HiResWindow Product Upgrades

- Add / enhance product generation:
  - Add generation of BUFR output (hourly point forecast soundings) for both cores
  - Produce High Resolution Ensemble Forecast (HREF) products (Du 2004).
  - Add simulated radar echo top and hourly maxima of select severe weather forecasting fields for SPC
  - Add PBL height and other fields for Fire Weather IMET support
  - Add 80m agl (above ground level) temp, wind, moisture and pressure for wind energy sector.

HiResWindow 2010 Upgrade QFP Test Results Summary

- QPF stats show:
  - NMM: small improvement (except at .01”) in cold season testing, but a big improvement in the warm season especially reduced bias (but still too large). HPC is happy, but SPC is mostly unhappy due to suppressed extrema due to passive advection change.
  - ARW: neutral impact for the cold season, and a more significant positive impact at higher thresholds in the warm season.

HiResWindow 2010 Upgrade Fcst-vs-Obs Test Results Summary

- Upper air stats:
  - NMM shows big improvement in warm season, little impact in cold season.
  - ARW shows big improvement in cold season, smaller improvement in warm season.

- Surface stats:
  - NMM shows improved 2m T, 10 m winds for cold season, West & AK regions.
  - ARW cold season impact more mixed - distinctly warmer 2 m temperatures West & AK.
  - Warm season impacts are more muted, daytime max 2 m T generally improved (warmer) for ARW.

Plans For 2012 HiResWindow

- Use Guam forecast as first guess for RTMA
- Upgrade ARW to Version 3.3
- Replace NMM with NMMB
- Some or all of the following:
  - Increase resolution to ~2 km
  - Expand to full CONUS – new schedule:
    - 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-NDAS
    - GSI adapted specially for Level II 88D winds
    - Digital filter with Level II 88D reflectivity (ala RUC/RR)
  - Start generating HRRRE-TL [Time Lagged]

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

A comparison between the current and upgrade

	Current	2011 Upgrade	Comment
Size	21 members	21 members	
Model	4 models [5 NMM$_{v2.2}$, 5 ARW$_{v2.2}$, 5 RSM, 6 Eta]	3 models [7 NMM$_{v3.3}$, 7 ARW$_{v3.3}$, 7 NMMB]	Toward NEMS modeling framework and use newest model version
Resolution	32km/35km	22km/25km	Resolve more detailed spatial features
Control IC analysis	NDAS and GFS	NDAS, GFS and RAP	Increase IC diversity
IC perturbation	Some with regional Breeding (smaller scale), and some with global ETR (larger scale) perturbations	All with “blend”of larger-scale ETR and smaller-scale regional Breeding perturbations	Improve IC perturbation
Physics perturbation	Multi-physics	Multi-physics	See Tables
Stochastic physics parameterization	No	New	Improve physics diversity in storm scale
Precipitation bias correction	No	New	Improve precipitation forecasts

2011 SREF Physics Diversity
Getting help from DTC & DET

	NMMB (22km)	WRF NMM (22km)	WRF ARW (25km)
Control+ 1st Pair	NAM	NAM	NCAR
2nd Pair	GFS	HWRF	RAP
3rd Pair	Stochastic? (WSM6? Older version of Ferrier?)	NCAR?	NMM?

New Canadian Partnership

- North American Ensemble Forecast System (NAEFS) will be expanded to include a limited-area regional ensemble (called NAEFS_LAM): combining 21-member NCEP SREF with 20-member MSC regional ensemble (which will be operational in Summer 2011) for better ensemble products.

North American Mesoscale (NAM)

- Now on NOMADS & ftp server

- NAM / WRF-NMM Displays etc. are available at:

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

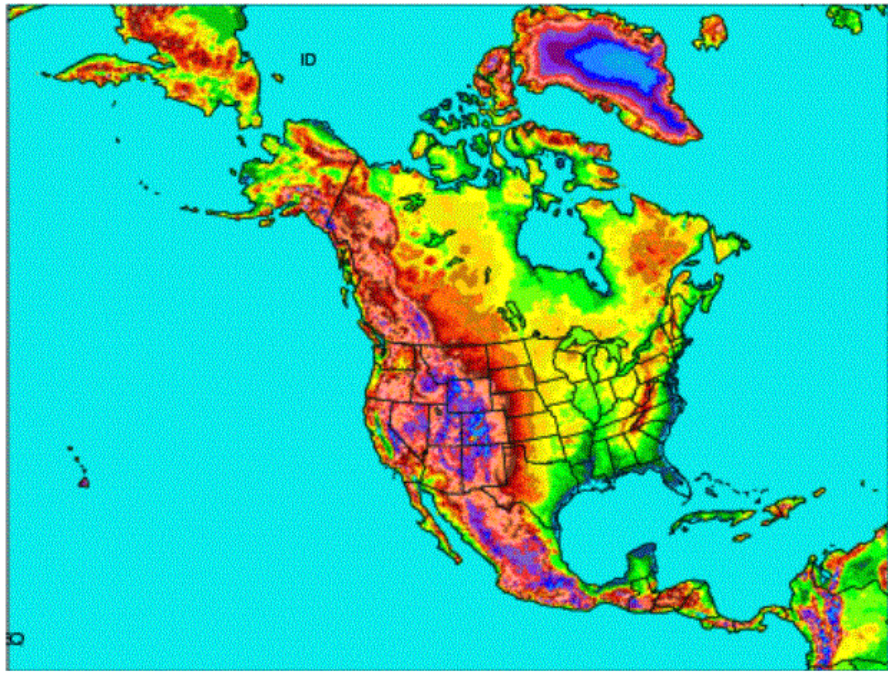
  http://mag.ncep.noaa.gov/NCOMAGWEB/appcontroller

- NAM Forecast Meteograms
- NAM Precipitation Type Meteograms
- NAM Forecast Soundings
- NAM Convective Forecasting Page
- Hourly National Precipitation Analyses

~August 2011 NAM Upgrade

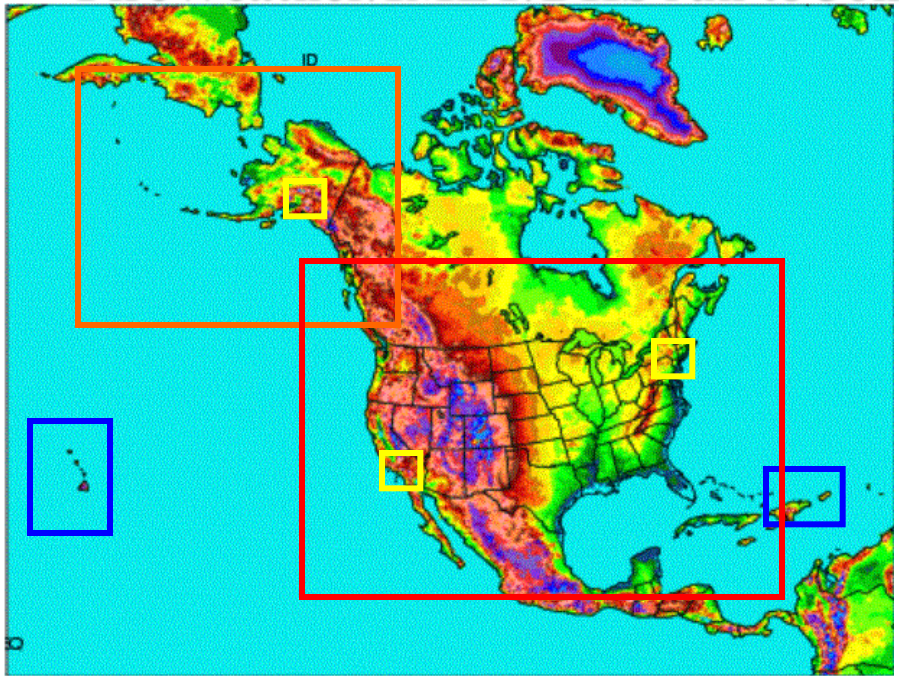
Current NAM

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



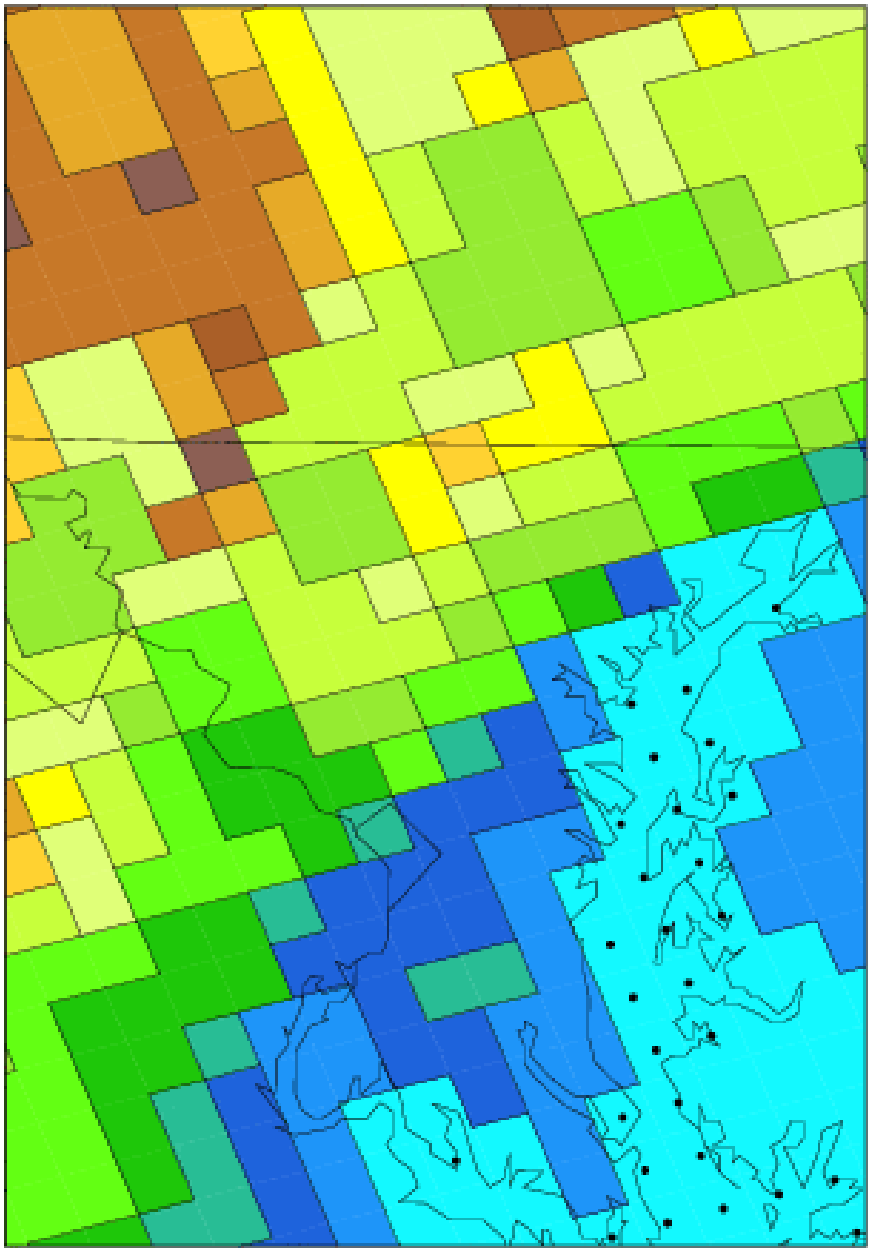
New NAM

- 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**

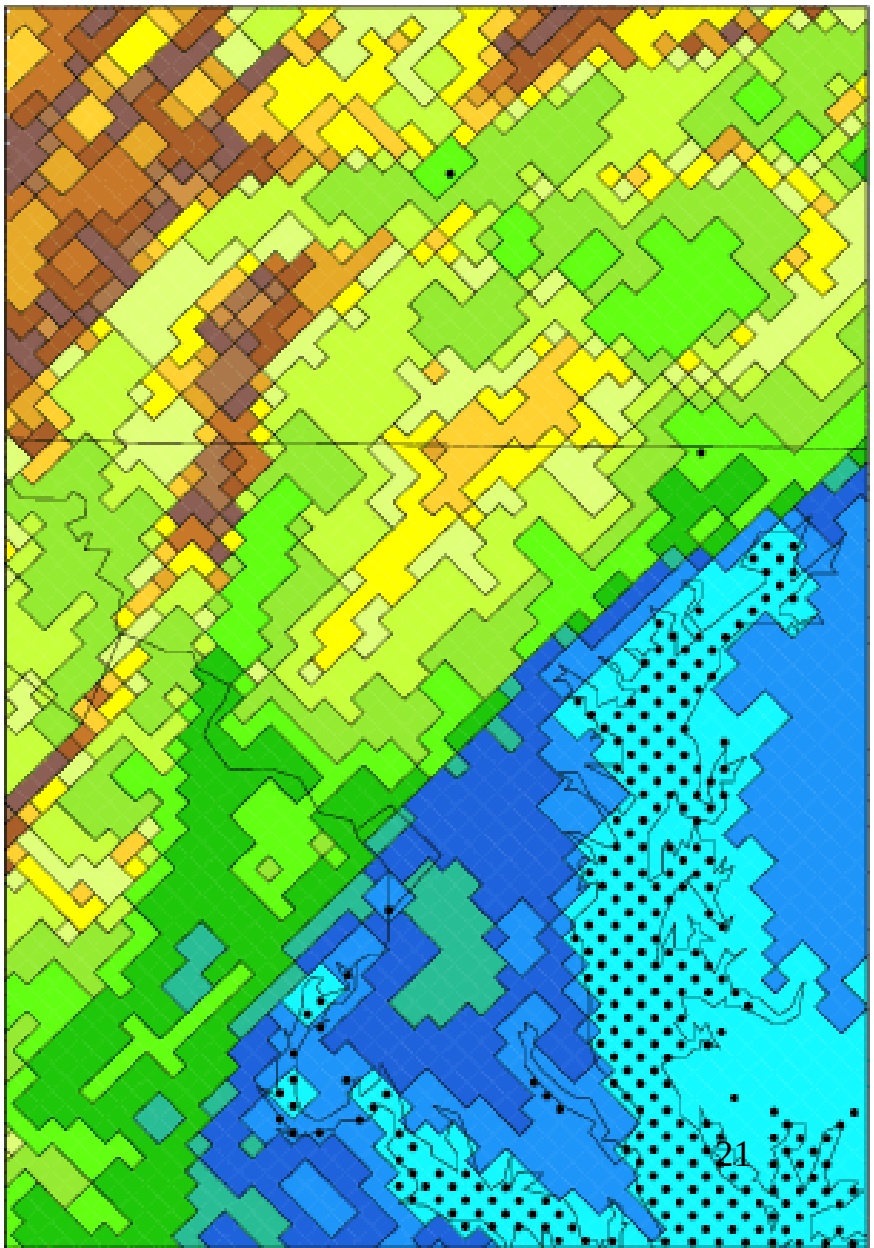


Dots represent water points Domain is upper Chesapeake Bay

12 km Terrain

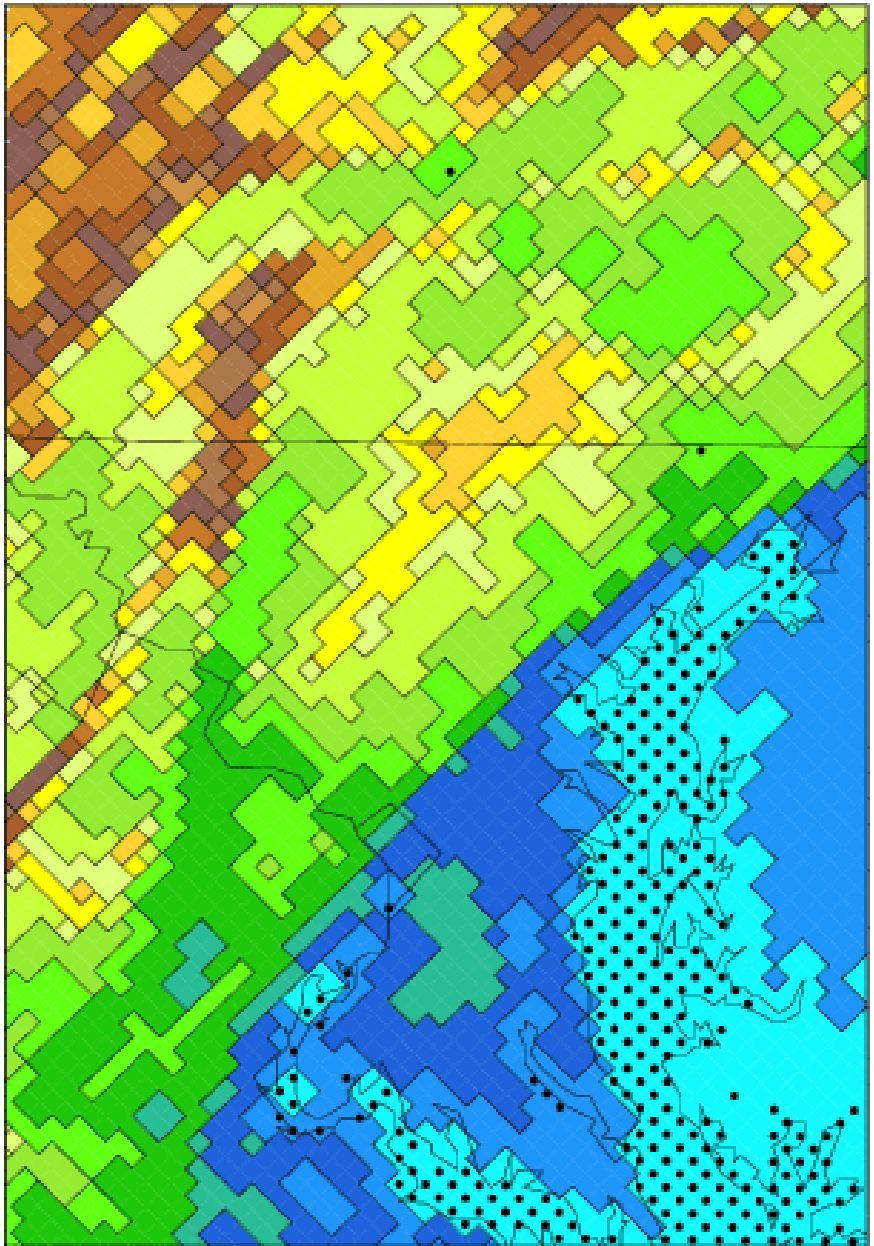


4 km Terrain

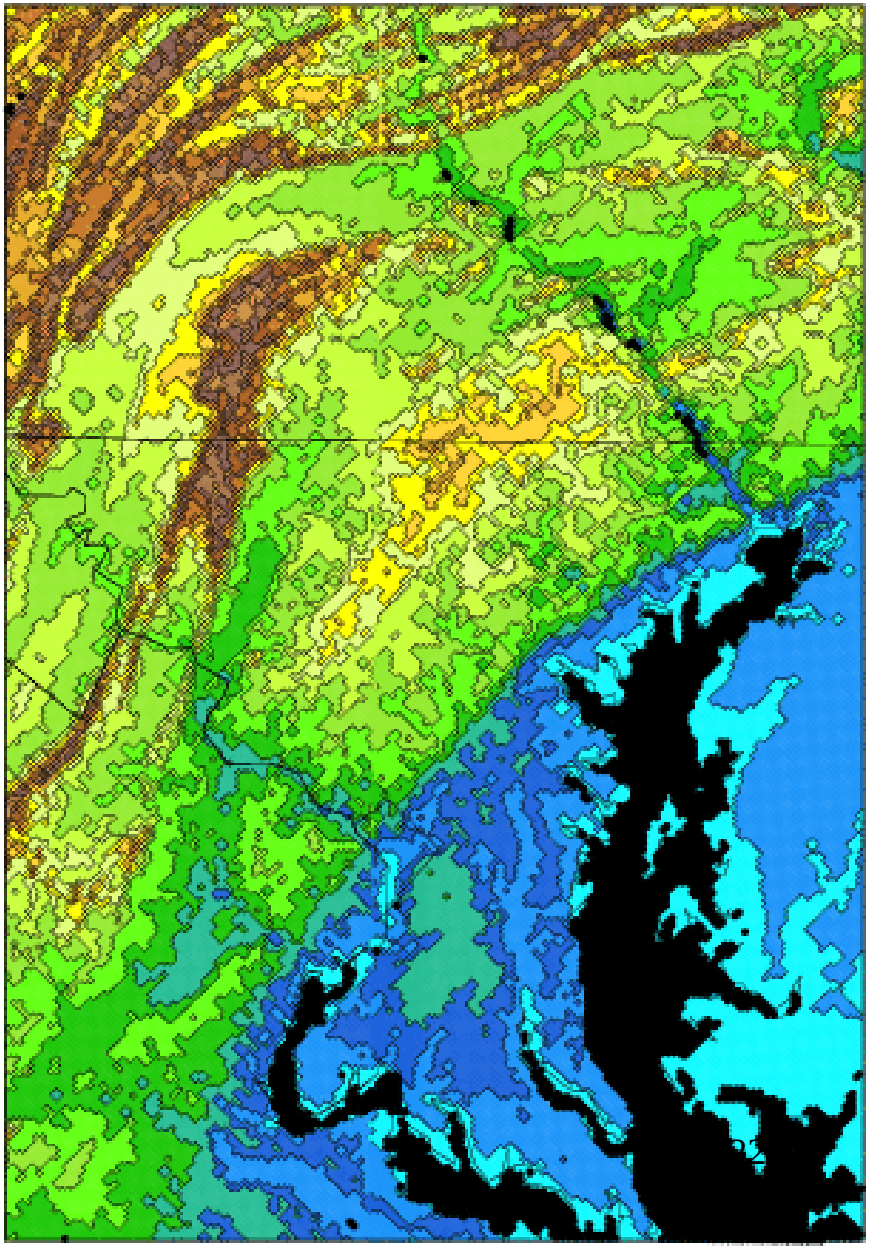


Dots represent water points Domain is Chesapeake Bay

4 km Terrain



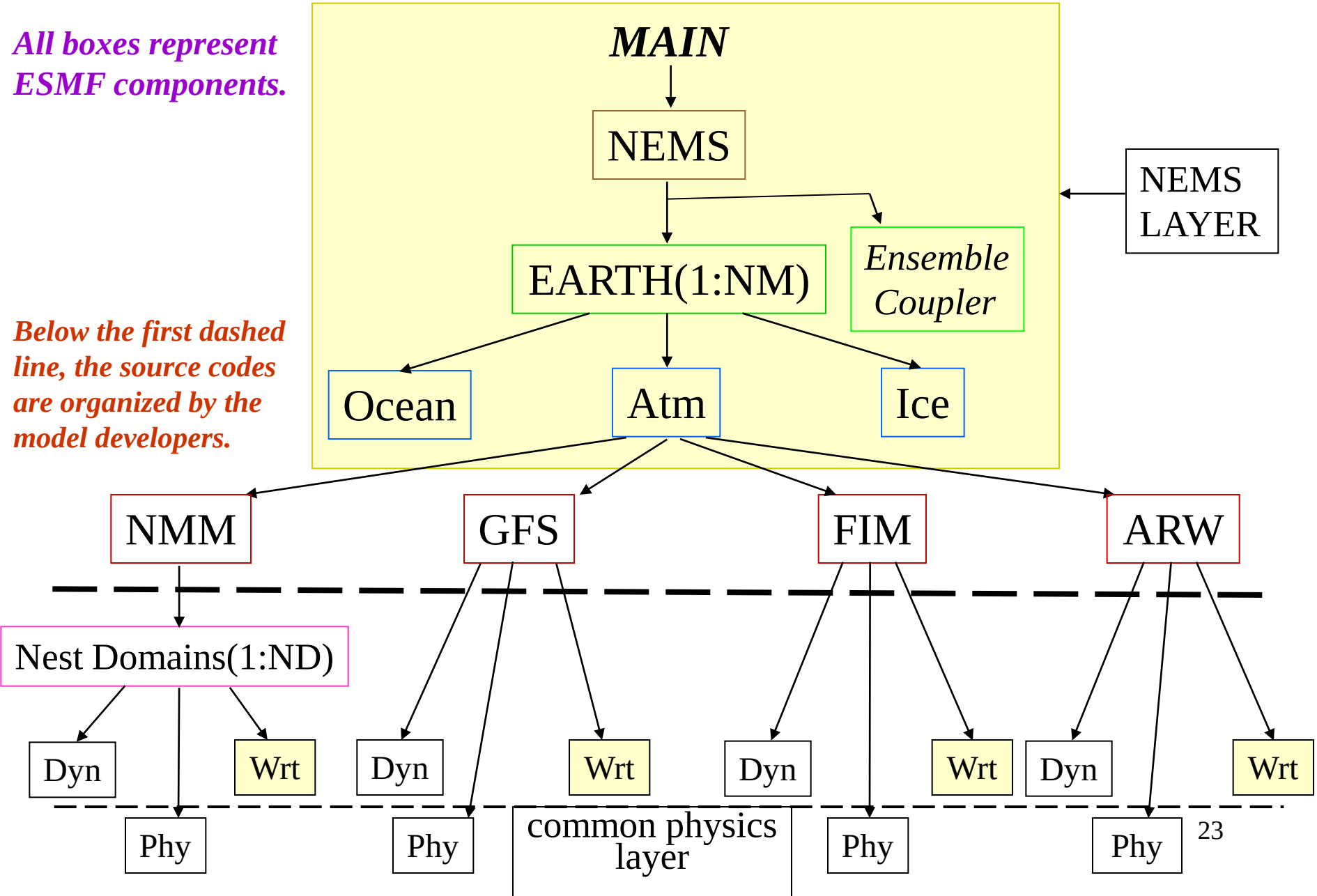
1 km Terrain



NEMS Component Structure

All boxes represent ESMF components.

Below the first dashed line, the source codes are organized by the model developers.

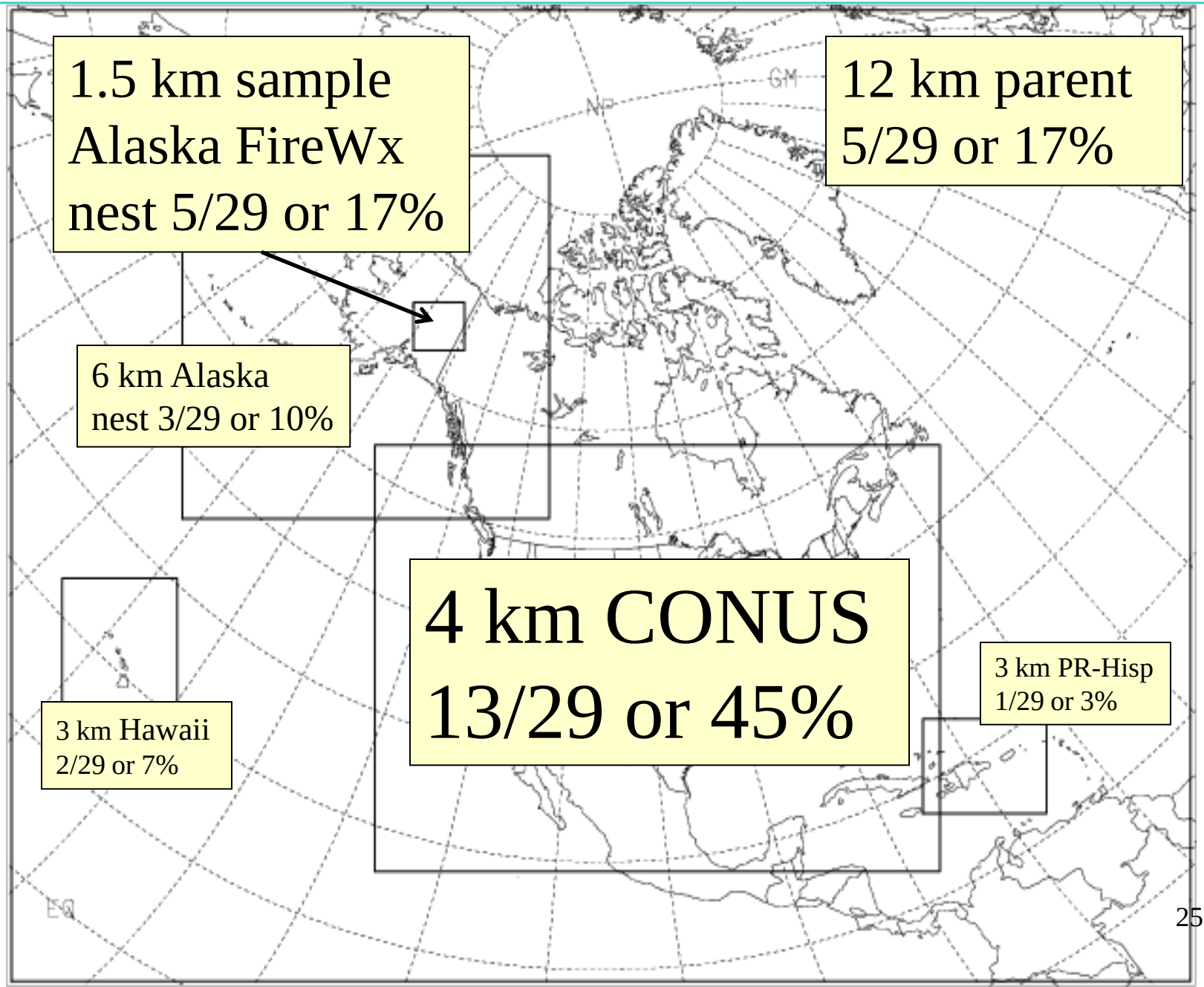


NOAA Environmental Modeling System (NEMS)

Nesting in NMMB (courtesy Tom Black)

- Static, 1-way interaction but boundaries are fed by the parent every parent time step during the integration
- Unique sets of processors are assigned to each domain to optimize the balance of work and minimize the clock time required to run (not possible in WRF)
- While the nests have to be ‘grid-associated’ with their parent, any integer parent-to-nest factor can be used
- Next steps: movable then two-way interactive

Proportional expense of high-resolution nesting in NAM parallel



GSI Upgrades Related to NAM

Global upgrade May 2011

Faster code (~9%), improved optimization and additional options

Recomputed background errors

Limit moisture to be >= 1.e-10 in each outer iteration and at the end of analysis

Locate buoys at 10 m (from 20 m)

Ambiguous vector qc for ASCAT data

Satellite radiance related changes

- Update to radiative transfer model - CRTM 2.0.2
- Inclusion of Field of View Size/Shape/Power for radiative transfer
- Relax AMSU-A Channel 5 QC
- Remove down weighting of collocated radiances
- Inclusion of uniform (higher resolution) thinning for satellite radiances

Stratospheric satellite

- Improved OMI QC
- Removal of redundant SBUV/2 total ozone
- Retune SBUV/2 ozone ob errors
- Inclusion of SBUV from NOAA-19

New ob sources for NAM August 2011

New conventional obs

- **MESONET p_s, T, q** (winds already used)
- ACARS moisture (WVSS-II)
- MAP Profiler winds
- RASS Profiler T_v
- WINDSAT & ASCAT ocean winds (from scatterometer)

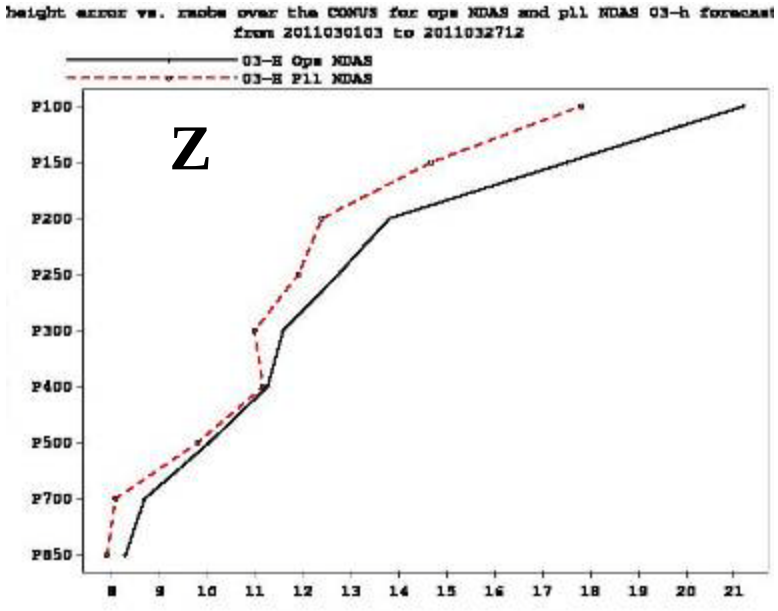
New unconventional obs

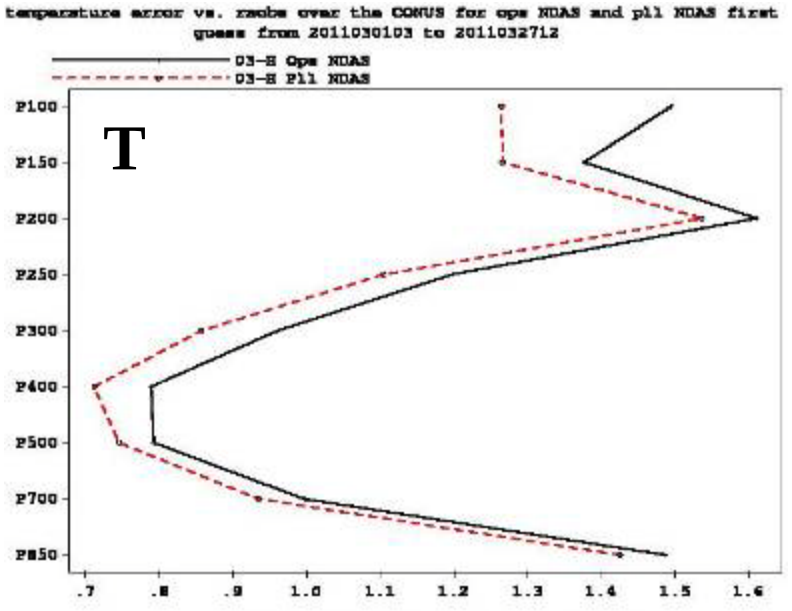
- Satellite Radiances
  - AMSUA from aqua & NOAA19
  - HIRS4 & MHS from NOAA19
  - IASI from METOP-A
- Refractivity
  - GPS radio occultation

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

NDAS First Guess vs RAOBs

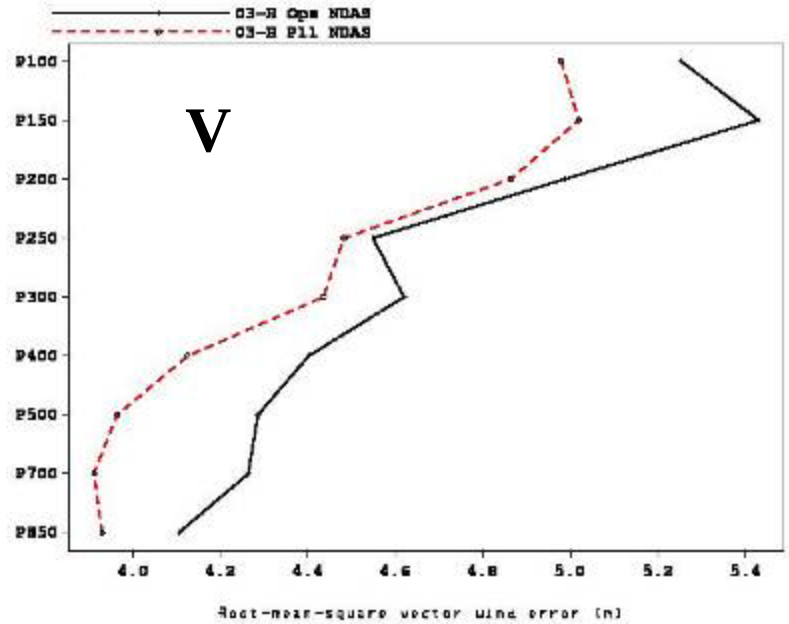


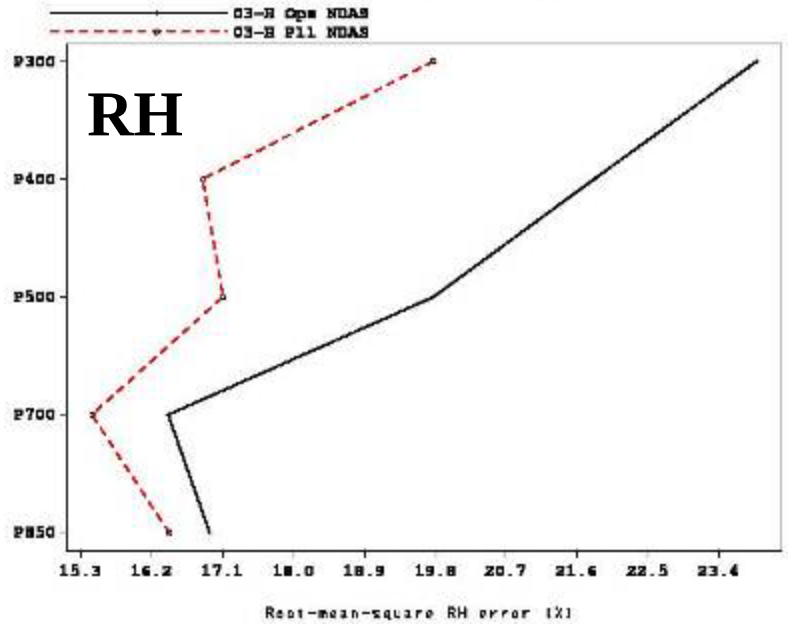


March 2011

Black/ Solid = Opnl

Red / Dash = Parallel



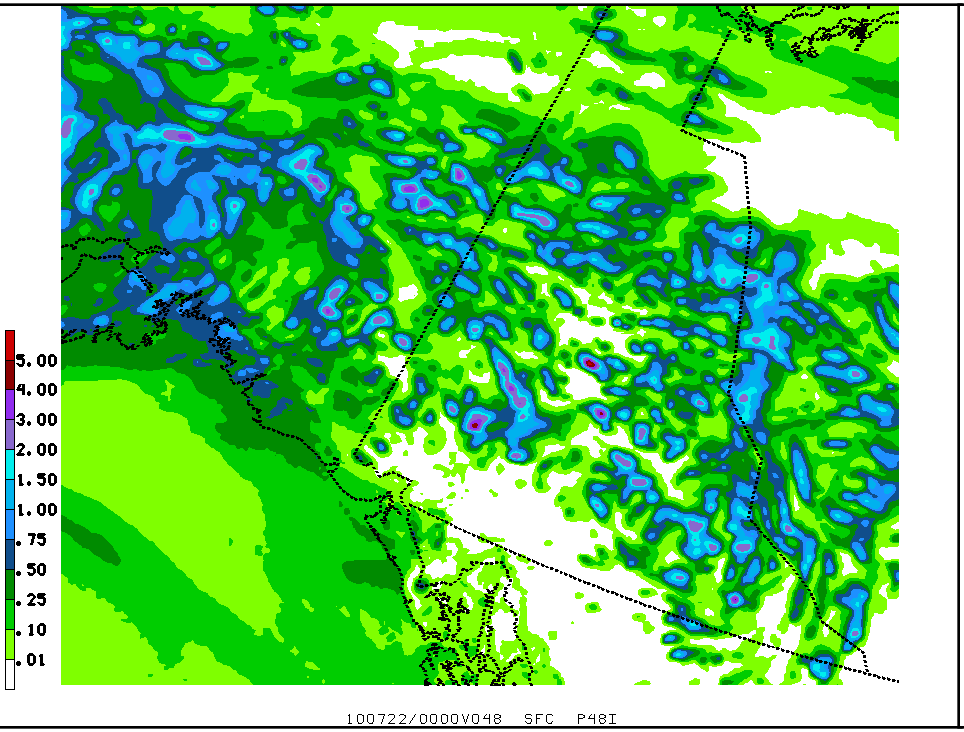


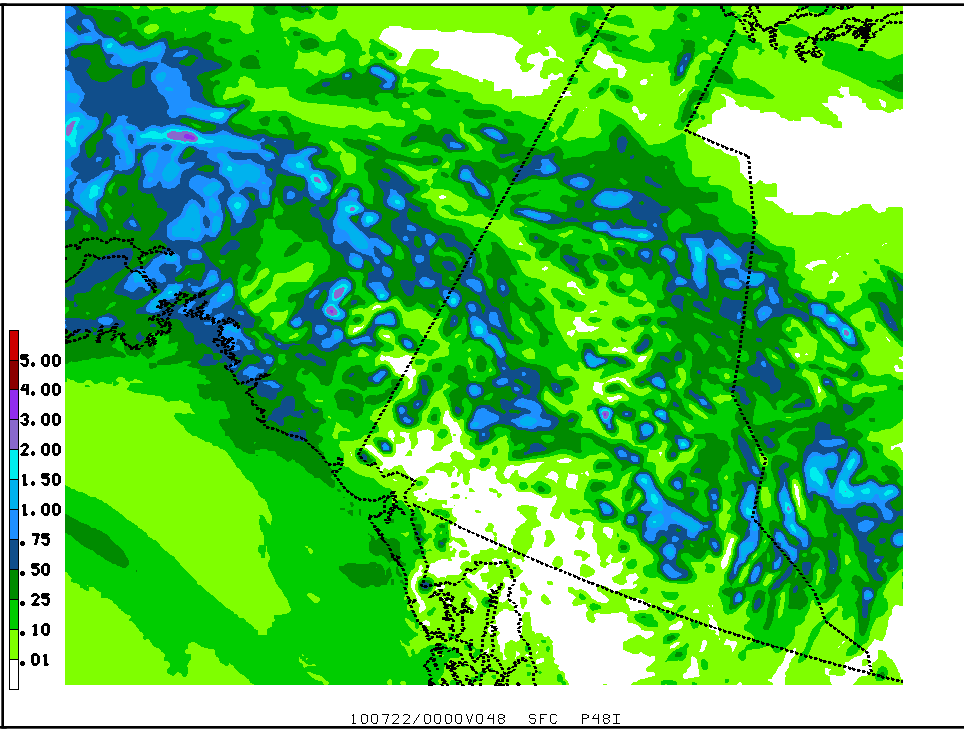
Scaled down BMJ convection for NMMB nests

(Matt Pyle for AK)

- Different model forecast customers interpret high-resolution guidance differently (literal vs. qualitative)
- With the NMMB implementation in NAM, an efffort is being made to partially satisfy both camps.
- New scaling factor in the BMJ allows for relaxation toward moister profiles in finer grid-spacing runs:
  - Smaller modification of thermodynamic profiles
  - Goal is to improve QPF performance in nests without destroying fine-scale forecast structure

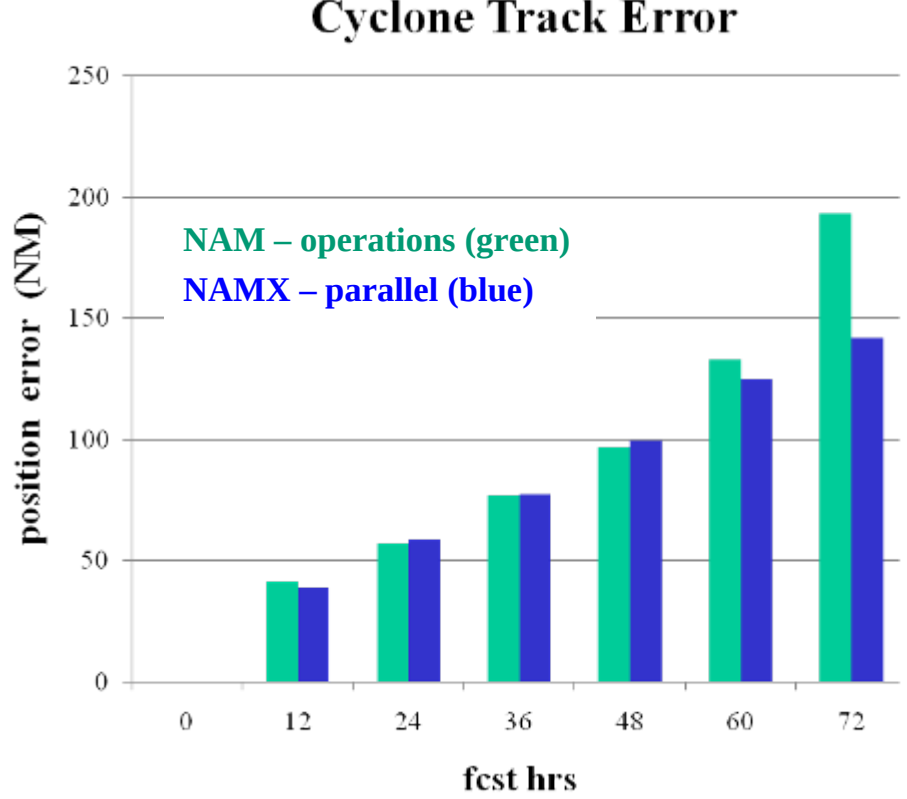
6 km NMMB nest
48 h total precip ending 20100722/00Z

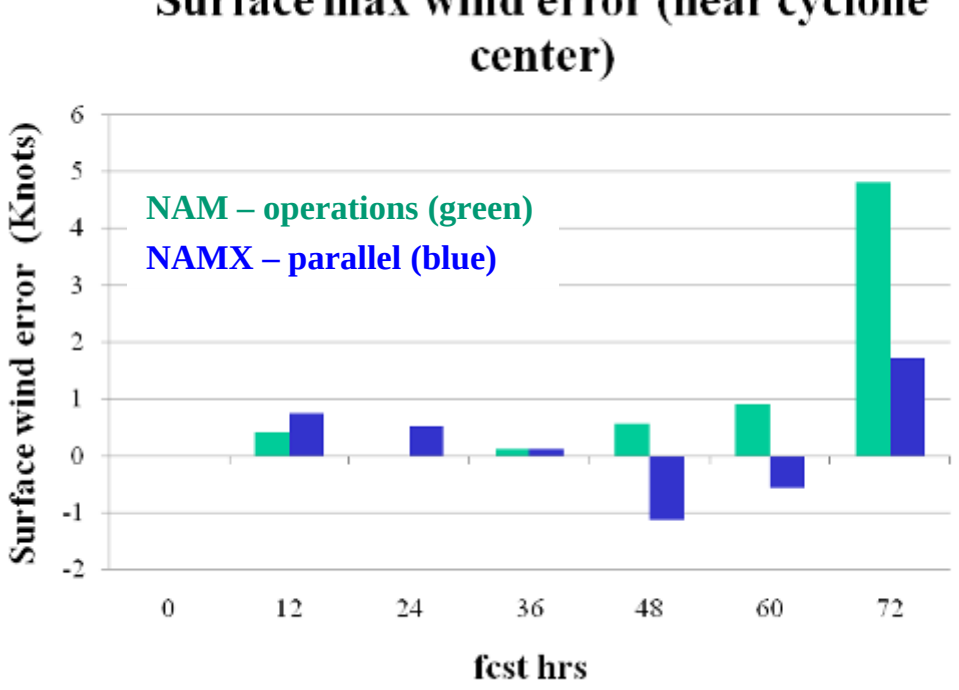




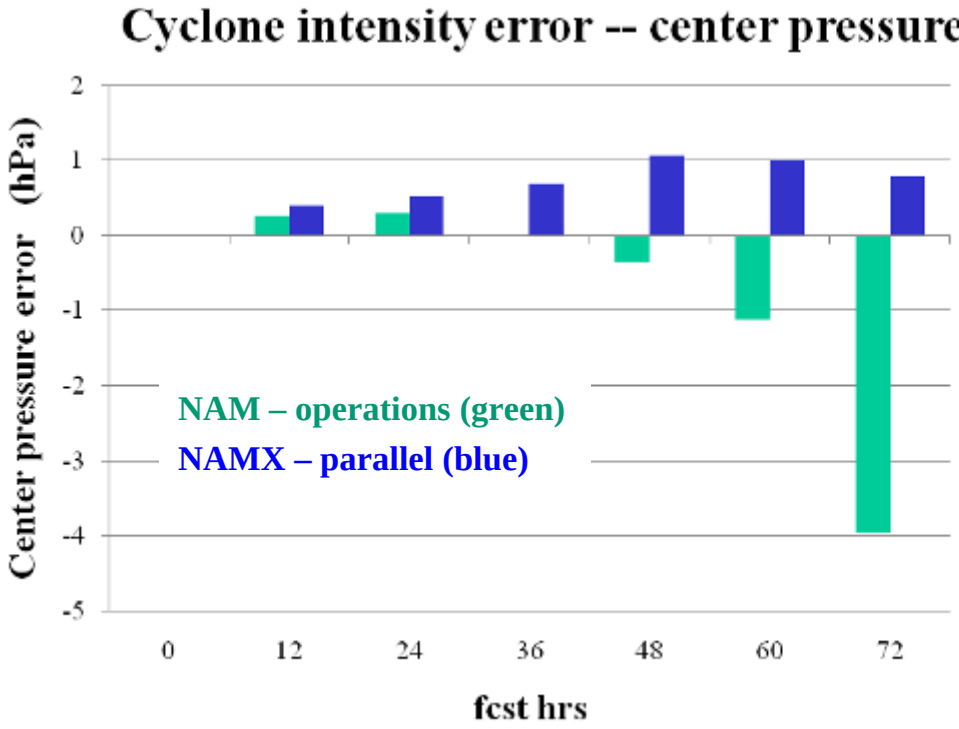
w/o parameterized convection
Max precip = 4.91”

w/ scaled down BMJ convection
Max precip = 3.39”





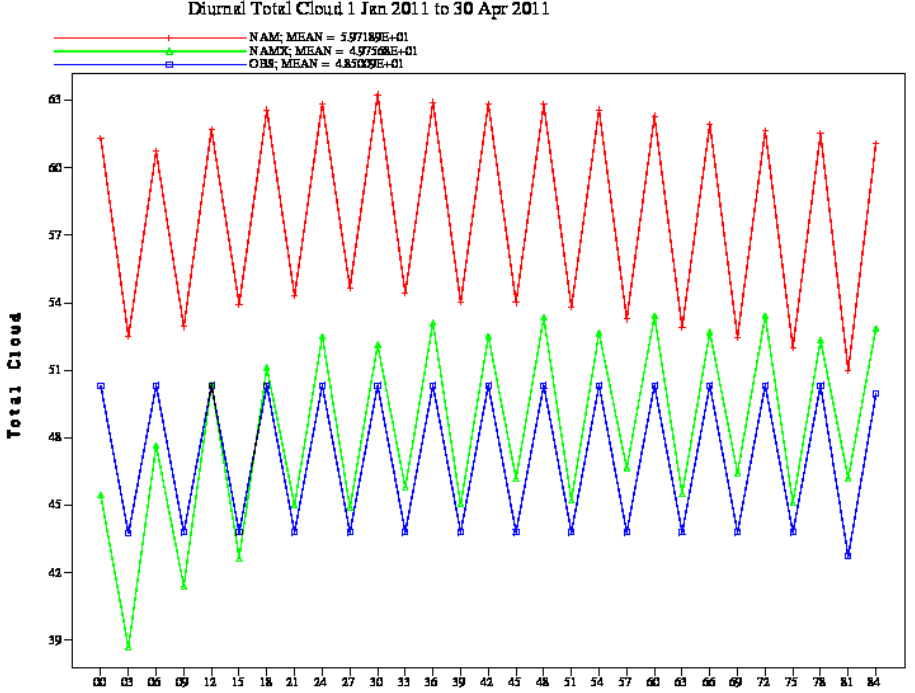
Various mean cyclone errors for operational NAM (green) versus NAMX parallel (blue) for the 7-month time period from 00z October 1, 2010 to 18z April 30, 2011

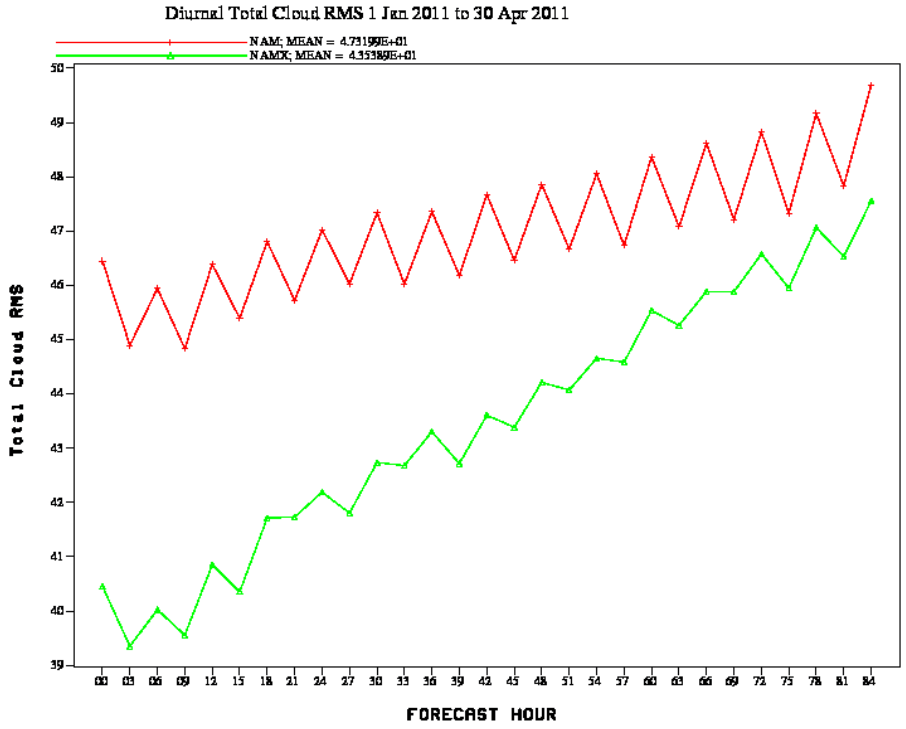


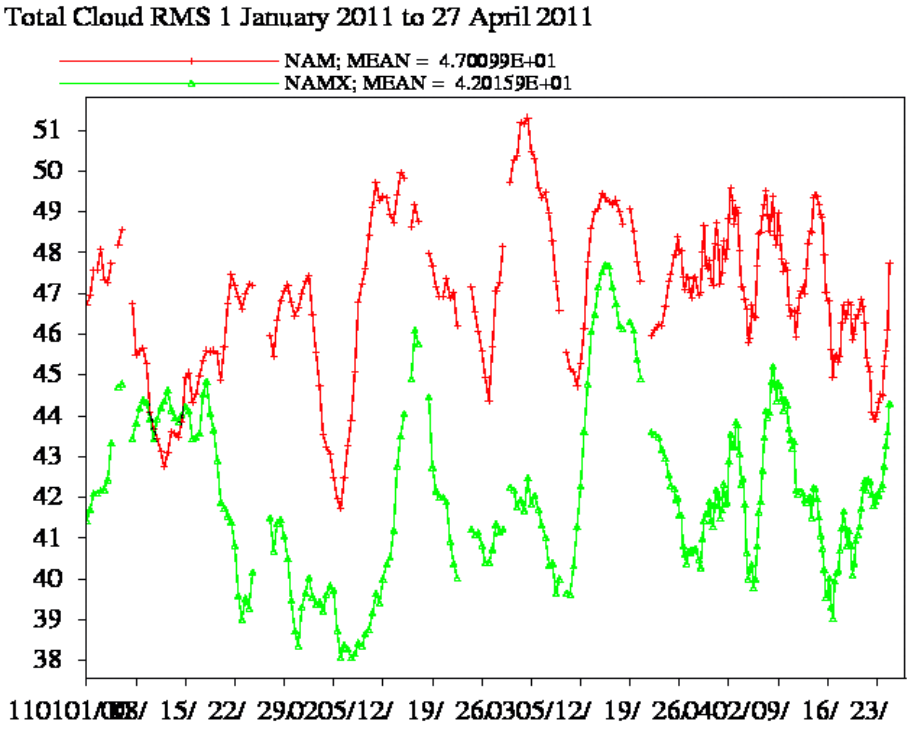
Number of forecast cases for each forecast range, Grid 221

hrs	00	12	24	36	48	60	72
NAM	1421	1145	443	213	103	51	27

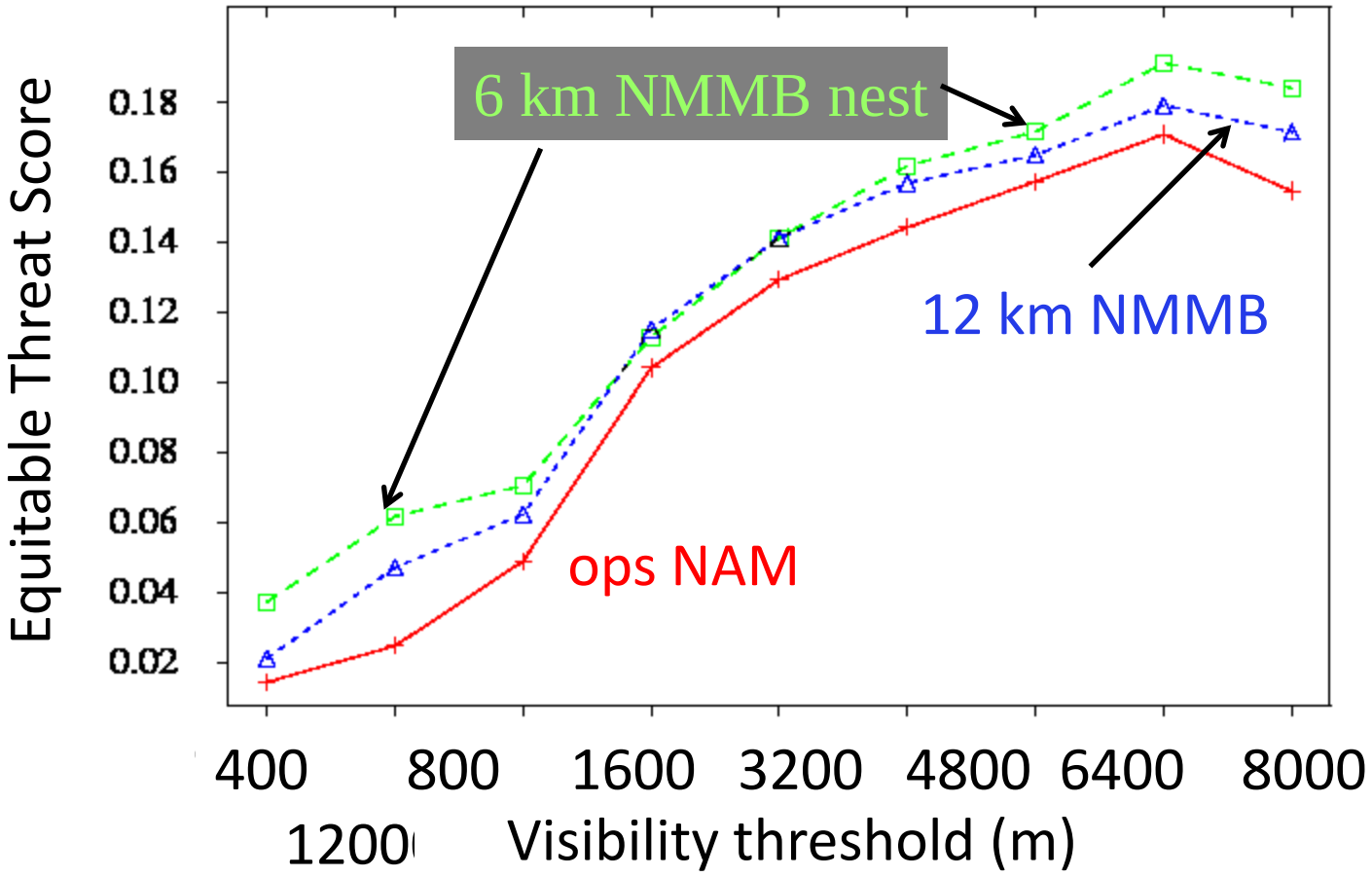
Verification Cloud vs METAR





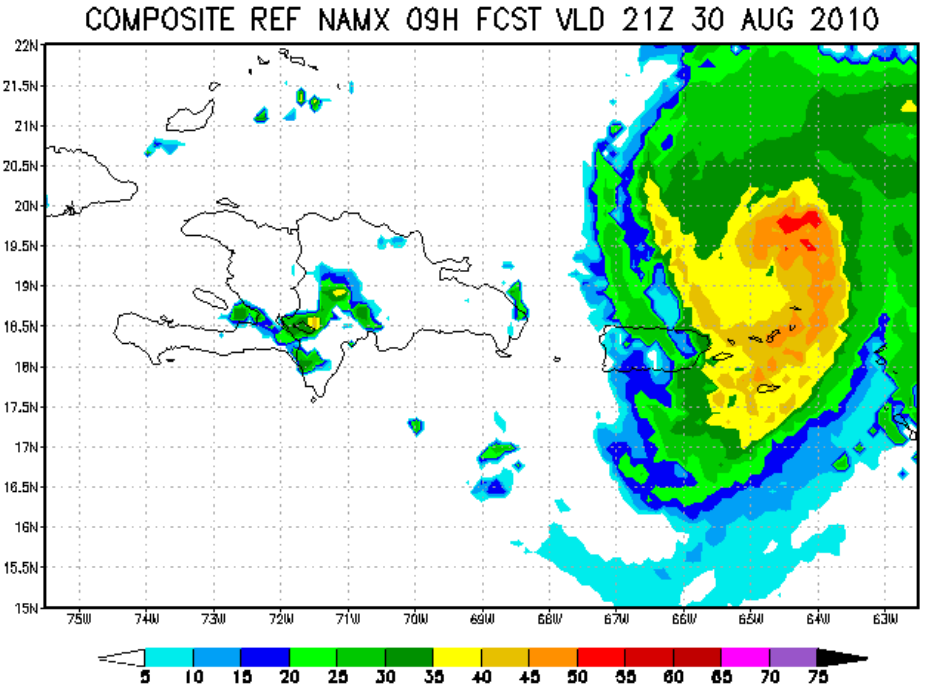


Visibility verification over AK
1 Sep 2010 to 1 Jan 2011

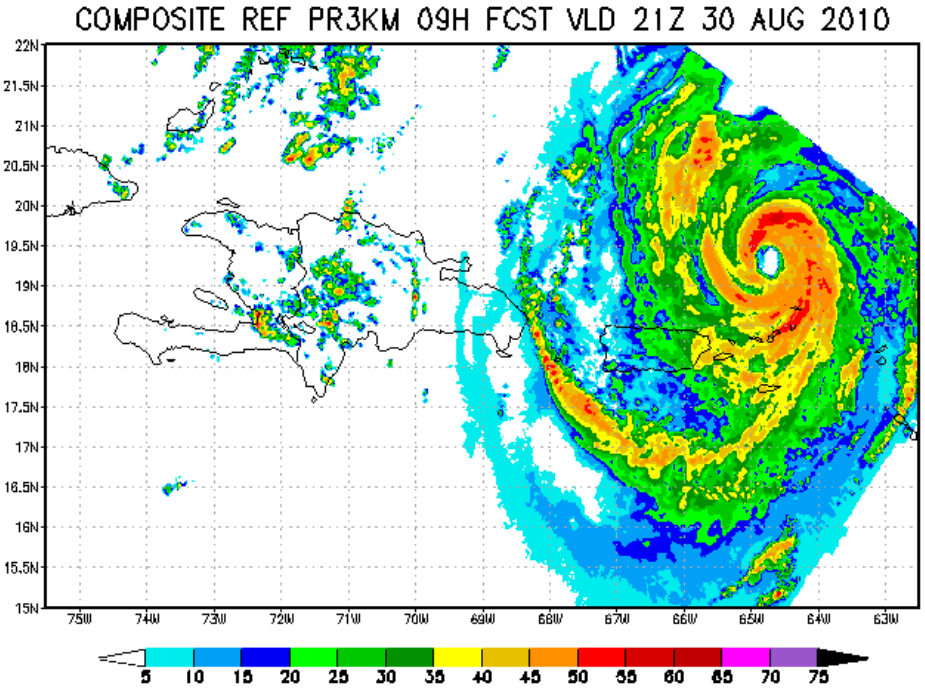


Slide courtesy

Hurricane Earl near Puerto Rico

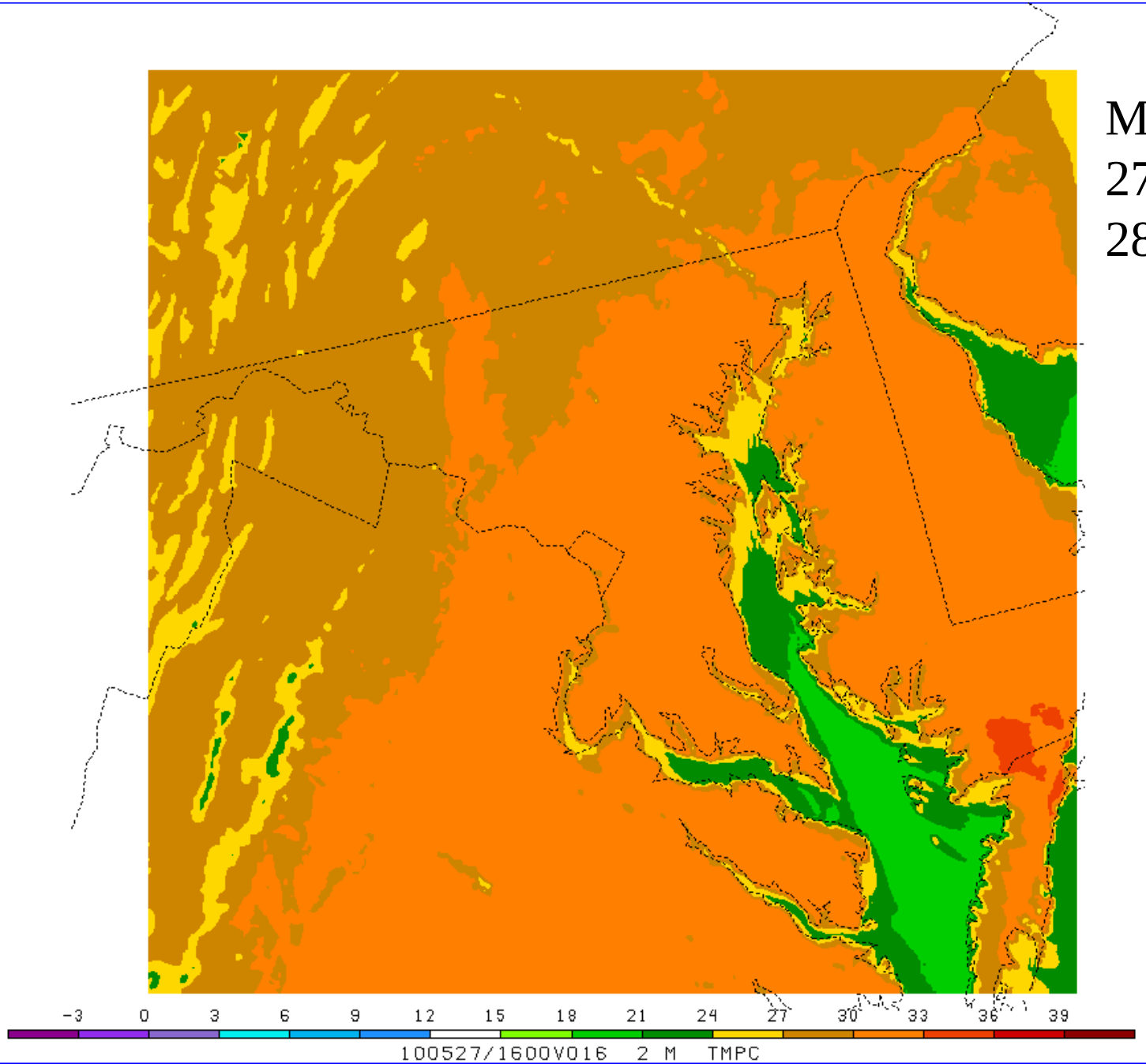


12 km NMMB parent



3 km Puerto Rico nest

MD Backdoor Coldfront in 1.33km Nest



May 2010
27/16Z to
28/12Z

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

NAM Fire Weather High Resolution Nested Runs

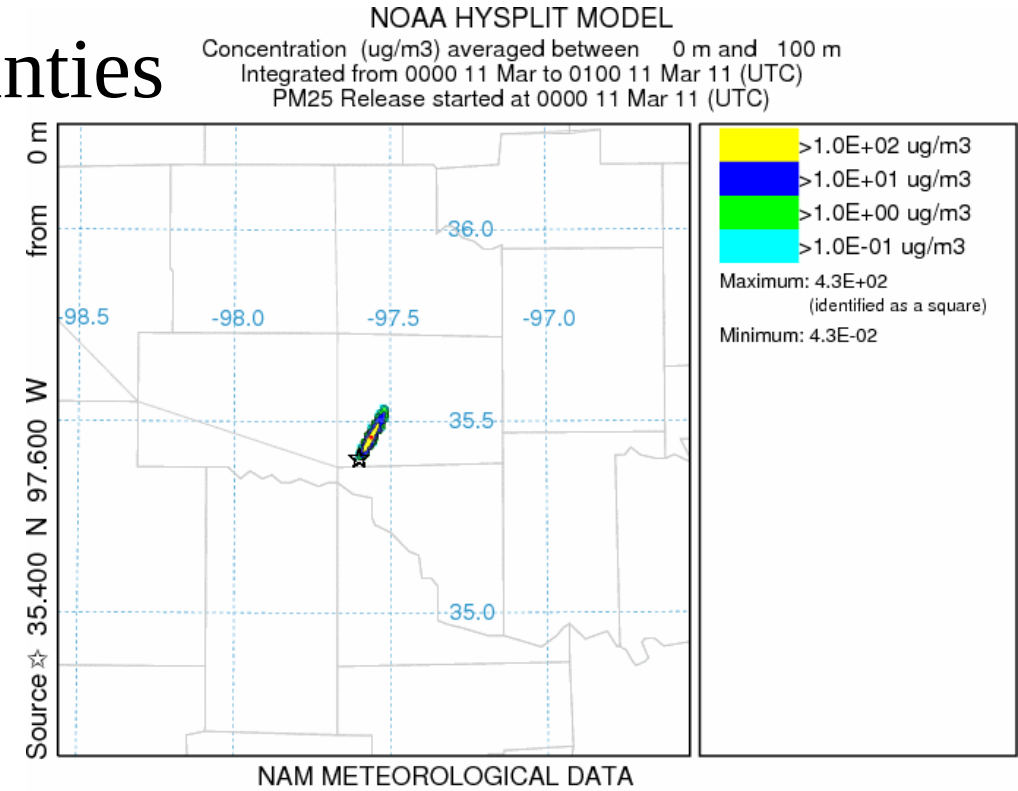
This page will show selected fields from the most recent 00z, 06z, 12z, and 18z NAM Parallel High Resolution "Fire Weather" nested run. This nest runs inside either parallel NAMX CONUS or Alaska nest. It runs to 36-h and has a resolution of 1.333 km (if in CONUS) or 1.5 km (if in Alaska).

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

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



2014-2015

North American Rapid Refresh ENSEMBLE (NARRE)

- NEMS-based NMMB/ARW models & GSI analysis
- Common NAM parent domain at 10-12 km
- Initially ~6 member ensemble made up of equal numbers of NMMB- & ARW-based configurations
- Hourly updated with forecasts to 24 hours
- NMMB & ARW control assimilation cycles with 3 hour pre-forecast period (catch-up) with hourly updating
- NAM & SREF 84 hr forecasts are extensions of the 00z, 06z, 12z, & 18z runs.

2016-2017

High Resolution Rapid Refresh ENSEMBLE (HRRRE)

- Each member of NARRE contains
  - 3 km CONUS and Alaskan nests
  - Control runs initialized with radar data
- Positions NWS/NCEP/ESRL to
  - Provide NextGen Enroute A N D Terminal guidance
  - Provide PROBABILITY guidance
  - Improve assimilation capabilities with radar & satellite
  - Tackle Warn-on-Forecast as resolutions evolve towards ~1 km
- NAM nests are extensions of the 00z, 06z, 12z & 18Z runs.
- HRRRE subsumes the current experimental VSREF
- Control members likely to make up core of Analysis of Record

Both NARRE and HRRRE Require Bigger NCEP Computer

North American Rapid Refresh Ensemble Time Lagged (NARRE-TL)

[courtesy of Binbin Zhou]

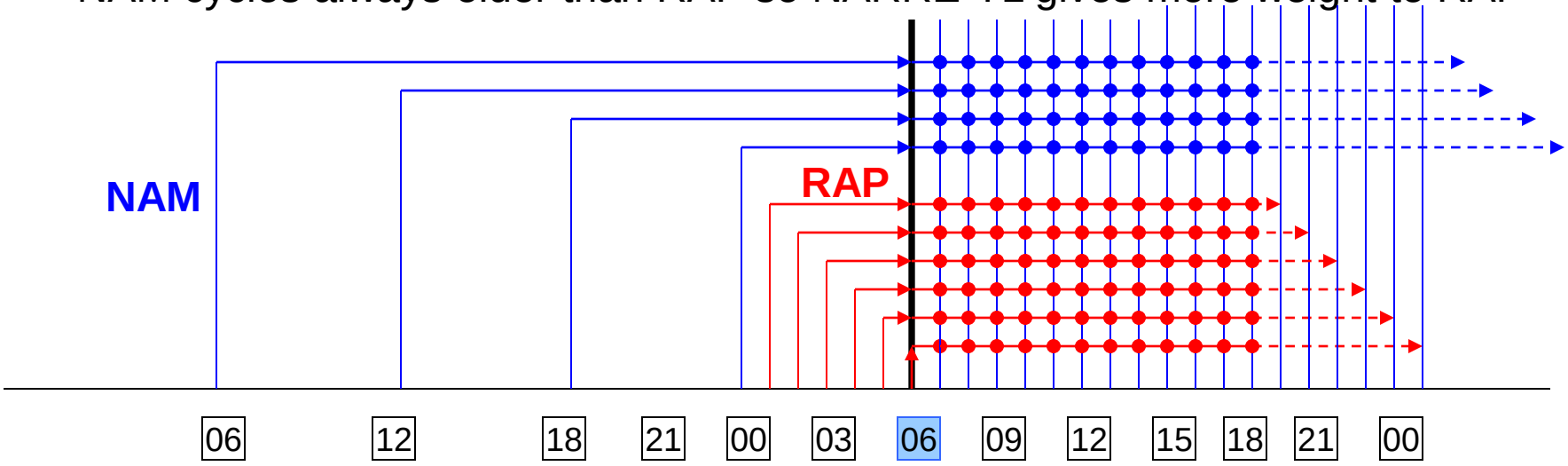
Example: Ensemble member combination for 06th cycle run

4 NAM cycles, weighted 0.7, 0.5, 0.3, 0.1, respectively

6 RAP cycles, weighted 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, respectively

Forecast range extends to 12 hr with extension of RUC/RAP forecasts to 18hr

NAM cycles always older than RAP so NARRE-TL gives more weight to RAP



06Z cycle NARRE-TL's ensemble member configuration

High Resolution Rapid Refresh Ensemble Time-Lagged (HRRRE-TL)

- **Example: Ensemble member combination for 06Z cycle run**

4 NAM-nest cycles, weighted 0.7, 0.5, 0.3, 0.1, respectively

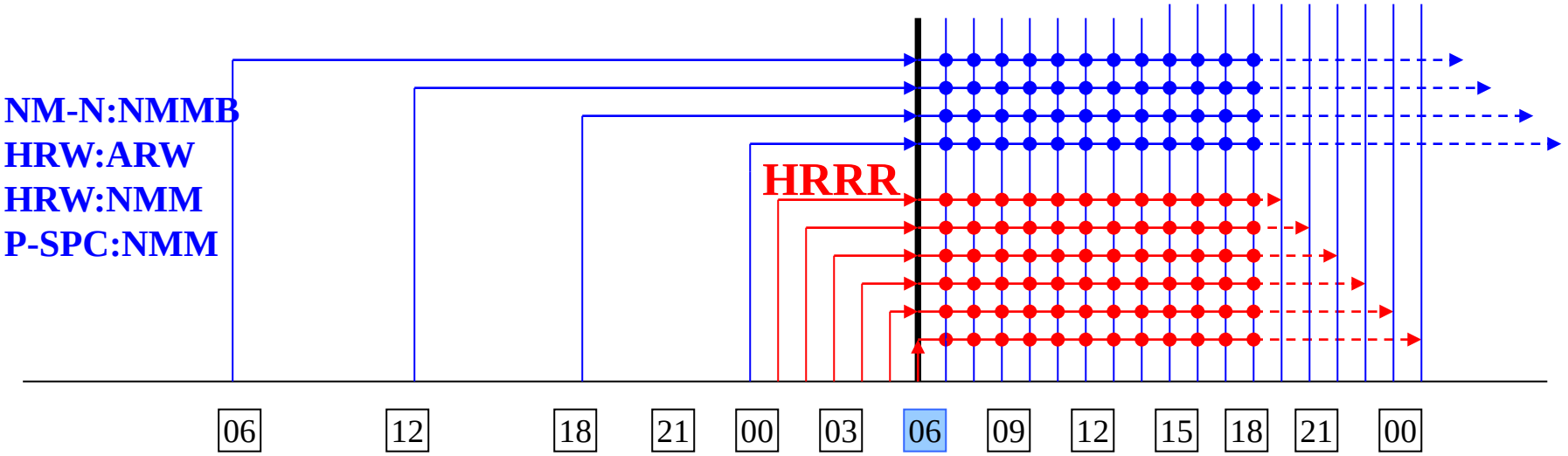
4 HRW-ARW cycles, weighted 0.7, 0.5, 0.3, 0.1, respectively

4 HRW-NMM cycles, weighted 0.7, 0.5, 0.3, 0.1, respectively

4 Pyle-SPC cycles, weighted 0.7, 0.5, 0.3, 0.1, respectively

6 HRRR cycles, weighted 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, respectively

Forecast range could be extended beyond 12 hr without HRRR



Like VSREF, soon-to-be-known-as the NARRE-TL for Time Lagged NARRE

B A C K U P
S L I D E S

Some Recommended Talks

- **2.1** Hurricane WRF: Testing activities and Community Support by the DTC. **Ligia Bernardet**, *NOAA/ESRL and University of Colorado/CIRES*, Shaowu Bao, Timothy Brown, Donald Stark, Mrinal Biswas, Laurie Carson, and Christopher Harrop
- **3.3** Simulating lake water surface temperature for USCONUS. **Yihua Wu**, *NOAA/NCEP*
- **3.5** Impact of land processes on WRF precipitation process. **Vince Wong**, *NOAA/NCEP*, and Michael Ek
- **4.3** Overview of the NOAA Environmental Modeling System (NEMS). **Bill Lapenta,** *NCEP*, Mark Iredell and Tom Black
- **7B.2** Community GSI System and its role in bridging research and operation data assimilation community. Xiang-Yu Huang, *NCAR*, **Ming Hu**, Hui Shao, and Don Stark
- **7B.8** Assimilating cloudy radiances with MLEF using NCEP Operational HWRF system: A case study. Man **Zhang**, *CIRA/ CSU*, Milija Zupanski, Min-Jeong Kim, and John Knaff
- **8B.6** QPF Verification Comparison Between the GFS and NAM Operational Models. **Wolff, Jamie**, *NCAR*, Barbara Brown, John Halley Gotway, Michelle Harrold, Zach Trabold, Louisa Nance, and Paul Oldenburg

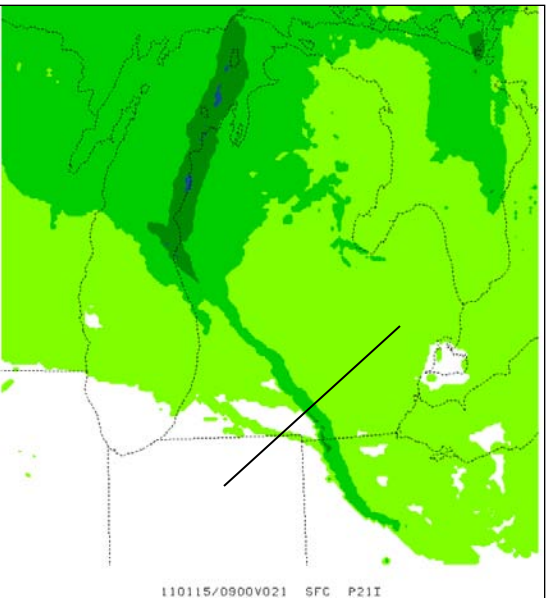
Some Recommended POSTERS

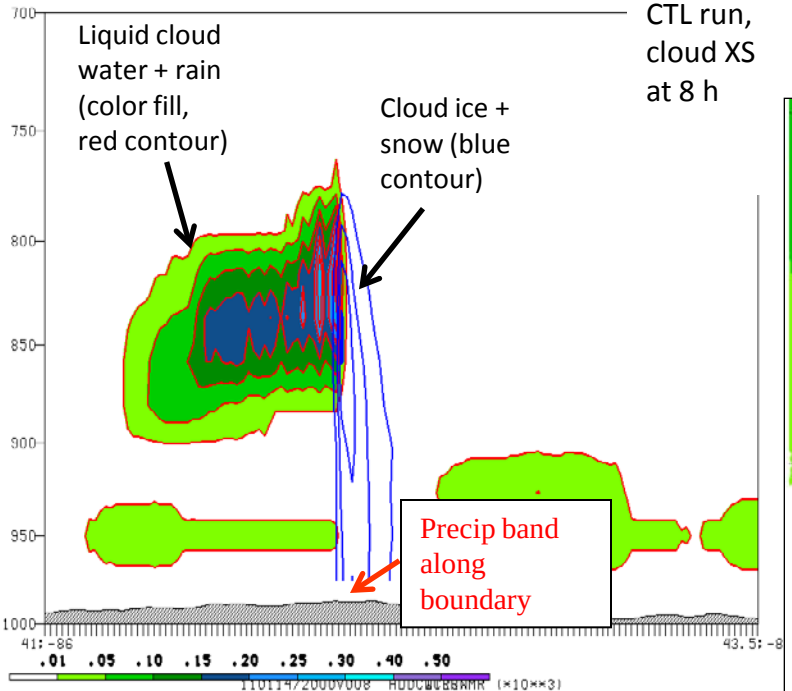
2:30 P.M. – 5:30 P.M, Wednesday, June 22

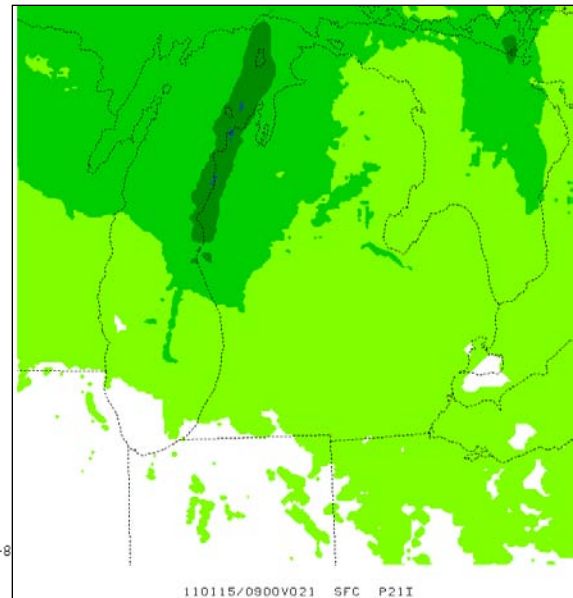
- **P8** Sensitivity of Asymptotic Behavior of Idealized Tropical Cyclone Intensification to Physics: ARW vs HWRF. **Michelson, Sara**, University of Colorado/CIRES and NOAA/ESRL and Jian-Wen Bao
- **P14** Improvement of Snow Processes in the Noah LSM in Support of JCSDA Land Modeling. **Barlage, Michael**, NCAR, Zhuo Wang, Fei Chen, Xubin Zeng
- **P17** Testing of a wind farm parameterization in the WRF-ARW as verified against tower and surface data. **Olson, Joseph B.,** NOAA-ESRL, Anna Fitch, and John M. Brown
- **P32** The DTC Objective Evaluation Performed During the HWT 2011 Spring Experiment. **Jensen, Tara**, NCAR, Steve Weiss, Mike Coniglio, Fanyou Kong, Michelle Harrold, Lisa Coco, Jack Kain, Adam Clark, Patrick Marsh, Brian Etherton, Israel Jirak, Chris Melik, Matthew Pyle, and Ming Xue
- **P59** DTC Testing and Evaluation of Surface Data Impacts on the GSI Data Assimilation System. **Newman, Kathryn M.,** NCAR, C. Zhou, H. Shao, M. Hu, X.Y. Huang
- **P60** Testing and Evaluation of Radiance Data Assimilation Using the WRF-GSI System. **Zhou, Chunhua**, NCAR, K.M. Newman, H. Shao, X.Y. Huang, and M. Hu

HiResWindow Upgrade

- Microphysics code change – background
  - HPC noticed a persistent (and bogus) precipitation band
  - The band was in **both** the opnl and parallel NMM runs
- Quick insight from Brad Ferrier led to a test modification of the cloud microphysics allowing ice nucleation to begin at warmer temperatures: T_ice_init changed from -15 C to -5 C
- This change worked perfectly, eliminating the specific pathology, and had very small forecast impact on other cases.





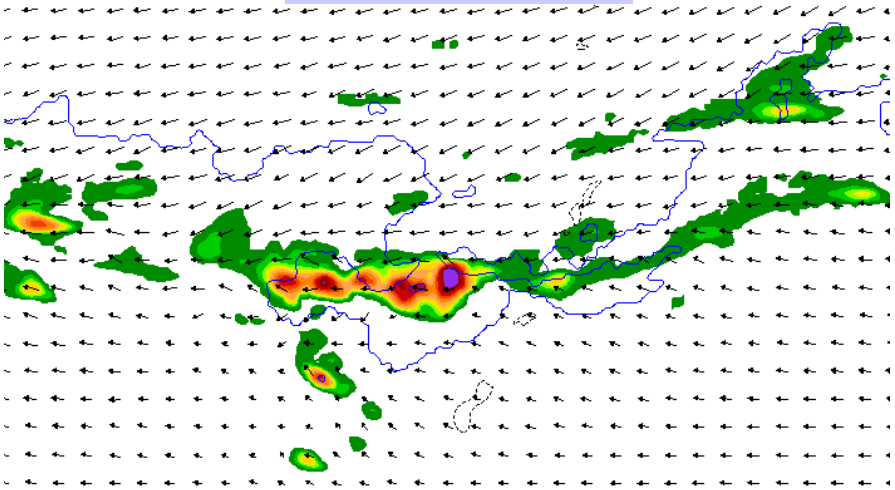


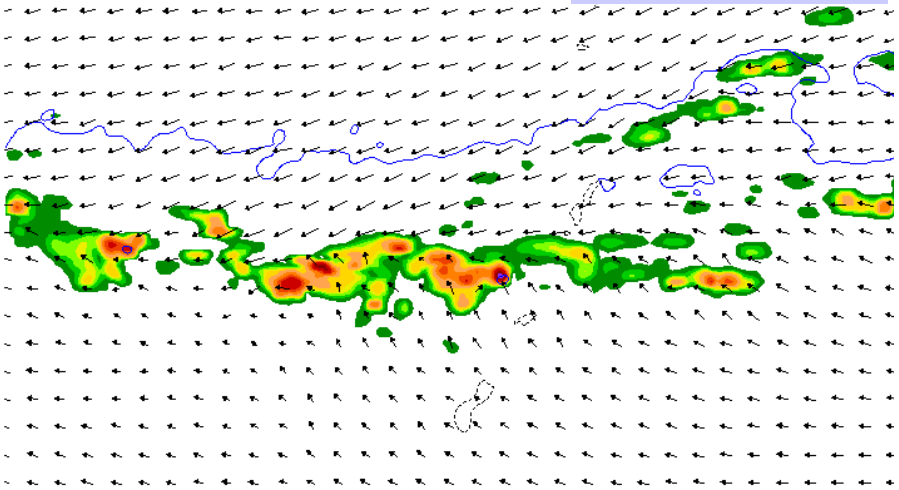
Sample 1 hr Precip Forecasts at 18 hr

NMM Guam

from 8 Feb 00z

ARW Guam

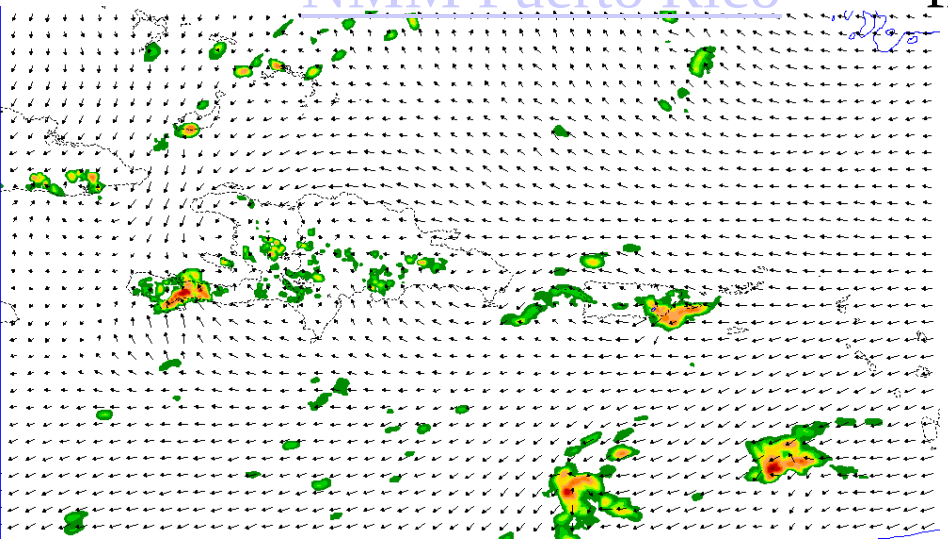


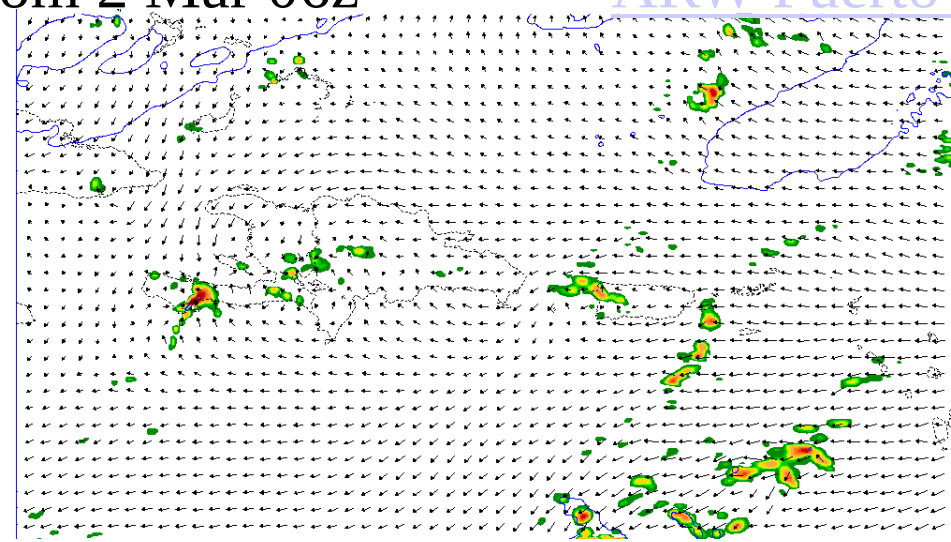


NMM Puerto Rico

from 2 Mar 06z

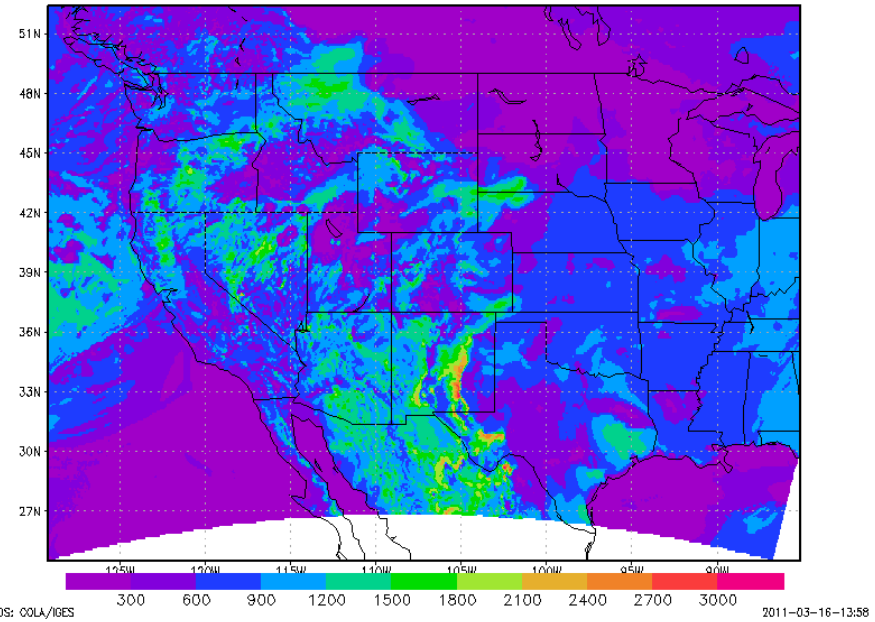
ARW Puerto



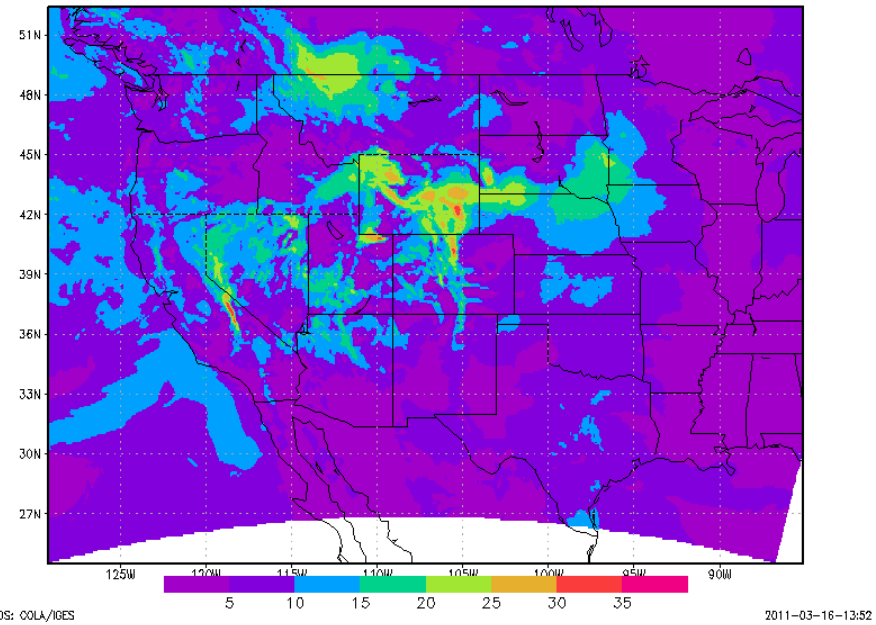


Sample Fire Wx Fields

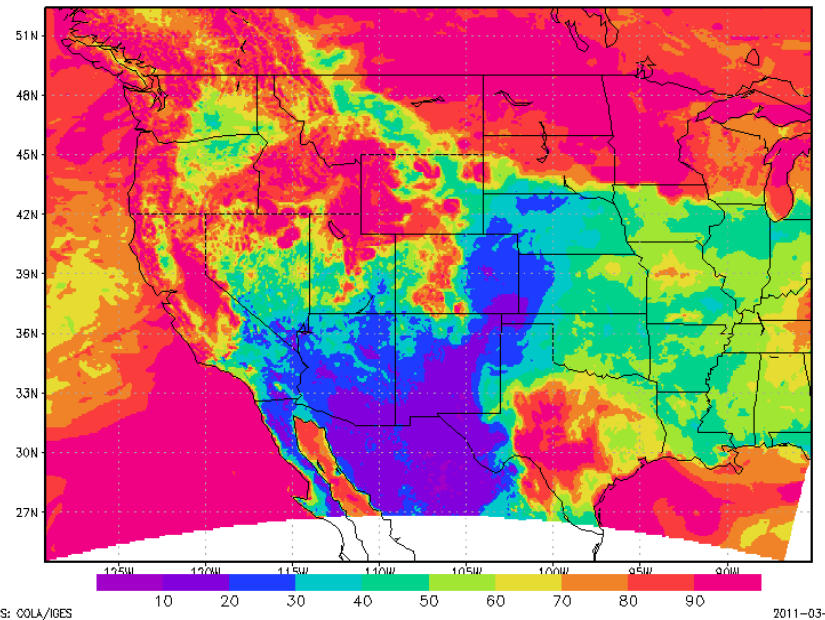
PBL H forecast from HIRES NMM run vt 2011031606F12



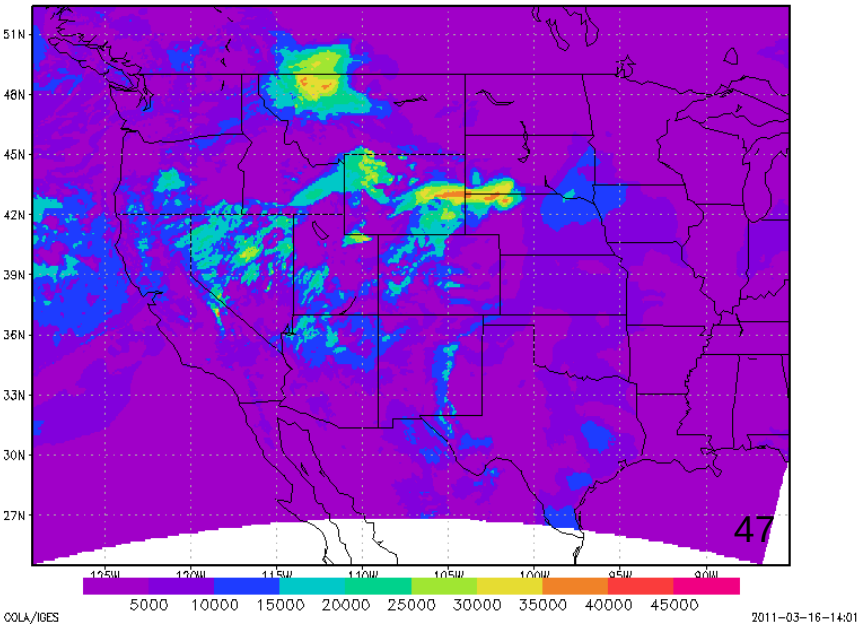
Transport wind speed forecast from HIRESNMM run vt 20110316

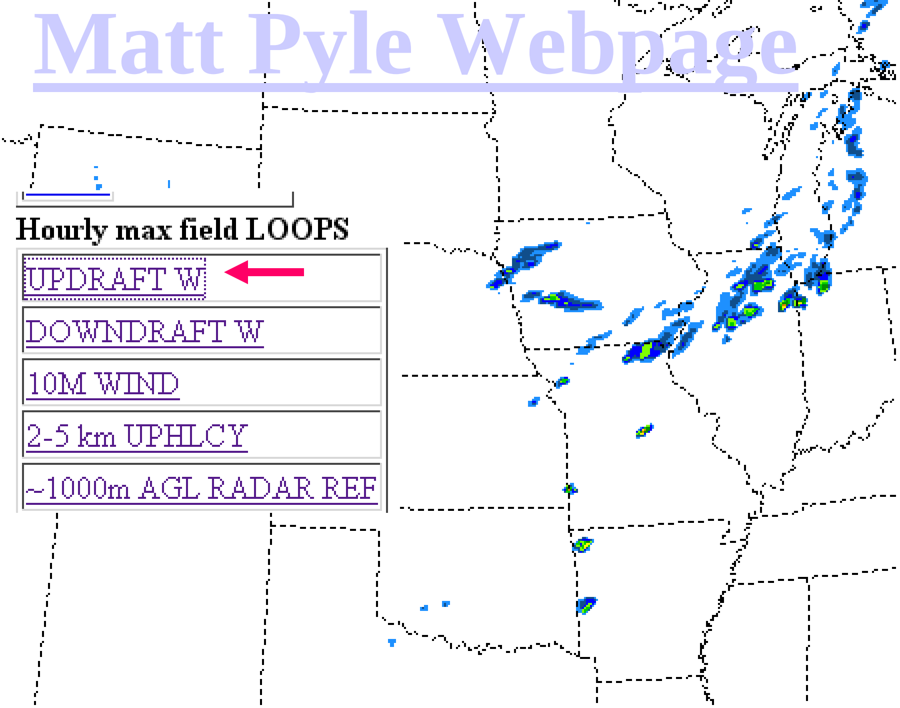


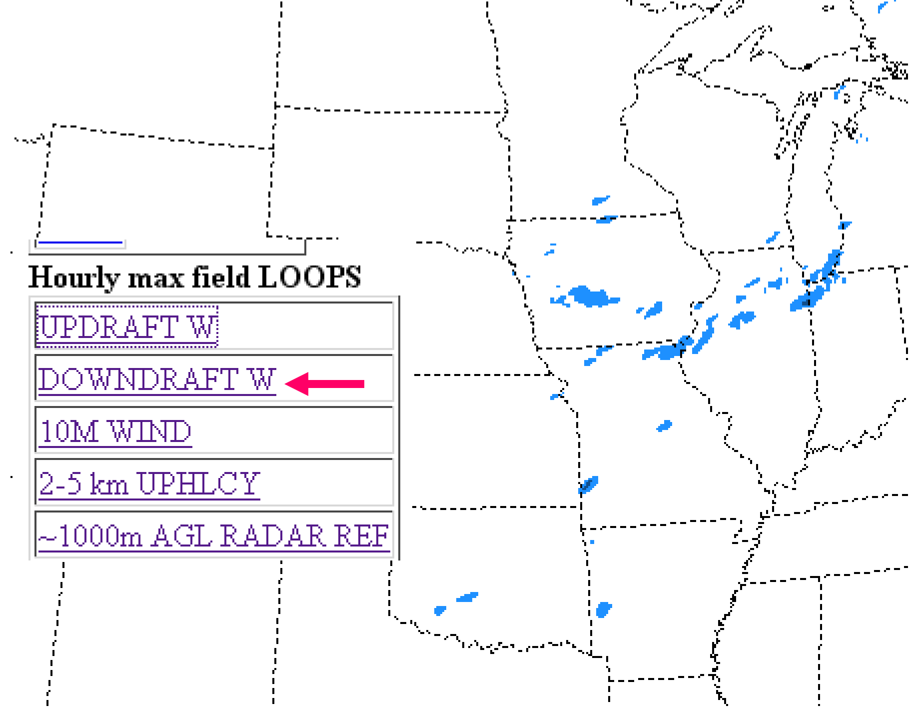
Min 2m RH orecast from HIRES NMM run vt 2011031606F12

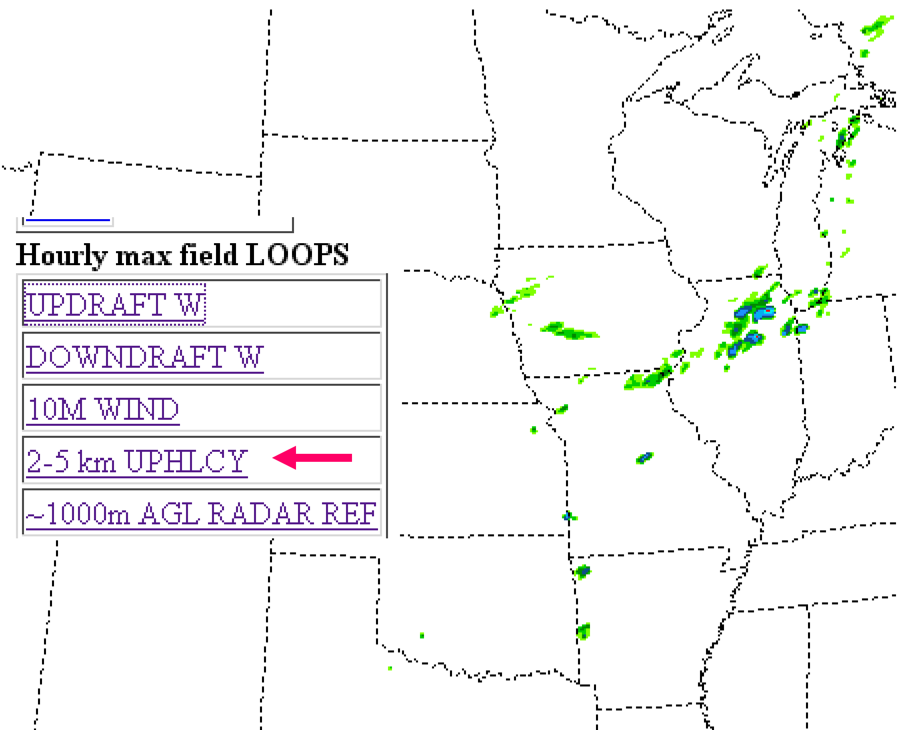


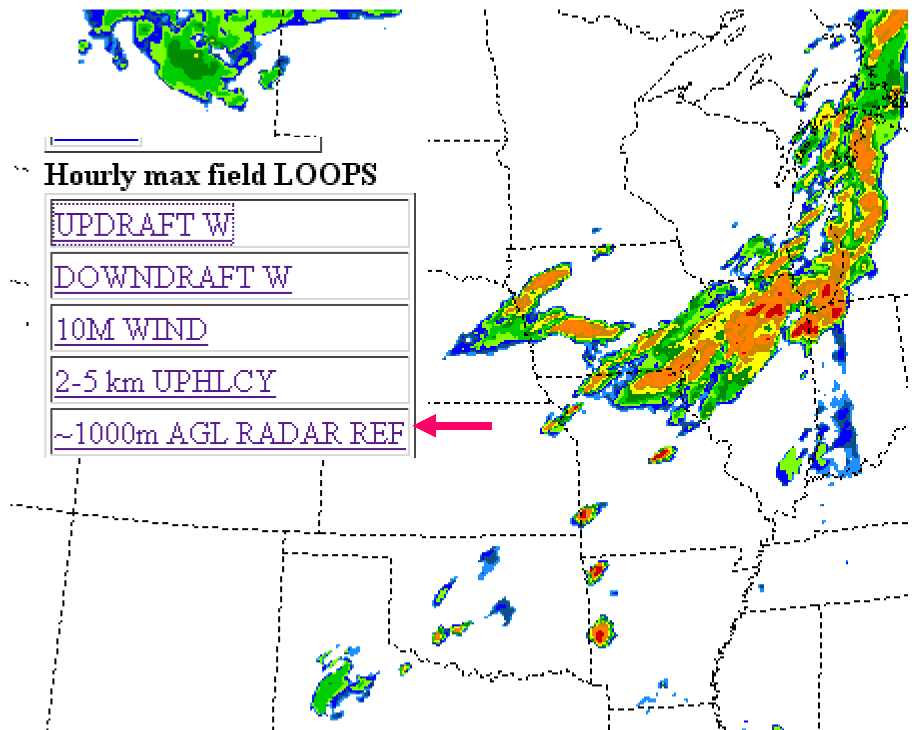
Ventilation rate forecast from HIRES NMM run vt 2011031606F12




Matt Pyle Webpage
Hourly max field LOOPS
UPDRAFT W
DOWNDRAFT W
10M WIND
2-5 km UPHLCY
~1000m AGL RADAR REF

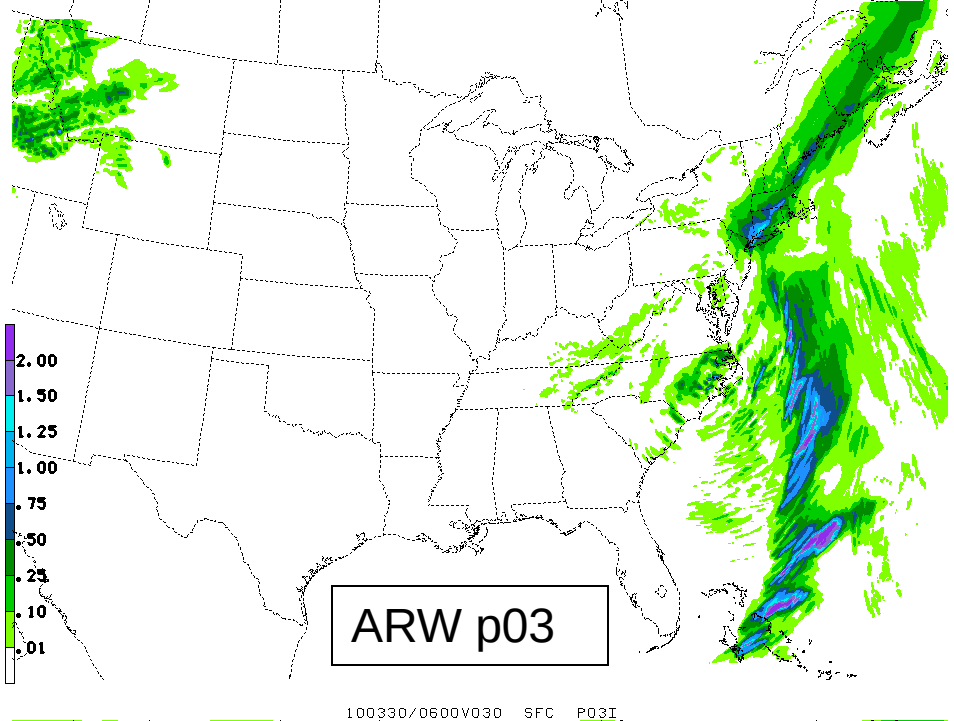

Hourly max field LOOPS
UPDRAFT W
DOWNDRAFT W
10M WIND
2-5 km UPHLCY
~1000m AGL RADAR REF

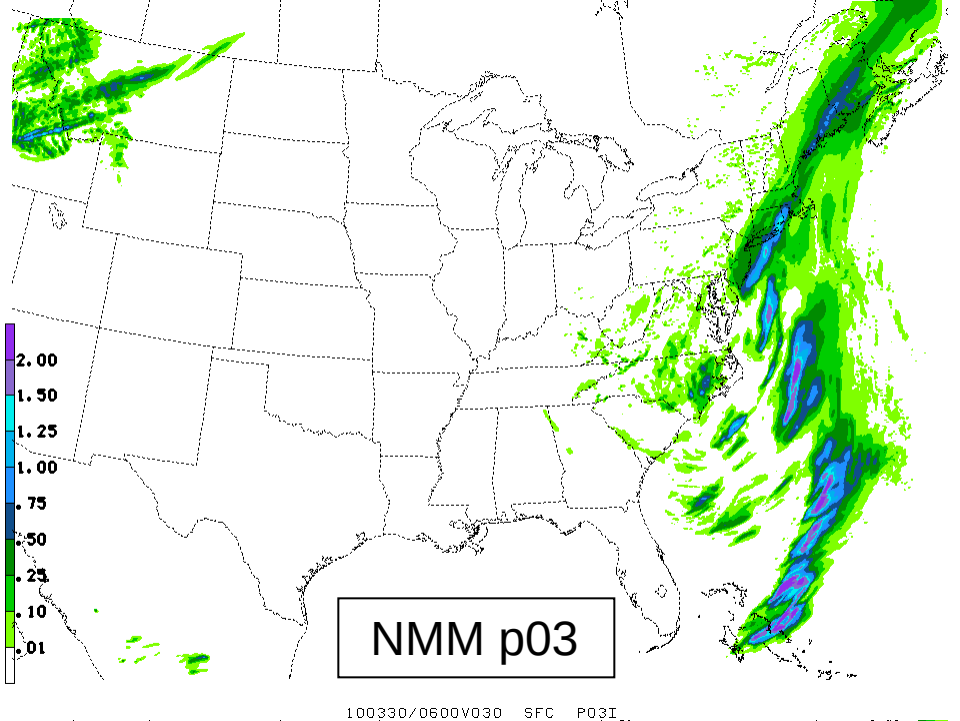

Hourly max field LOOPS
UPDRAFT W
DOWNDRAFT W
10M WIND
2-5 km UPHLCY
~1000m AGL RADAR REF

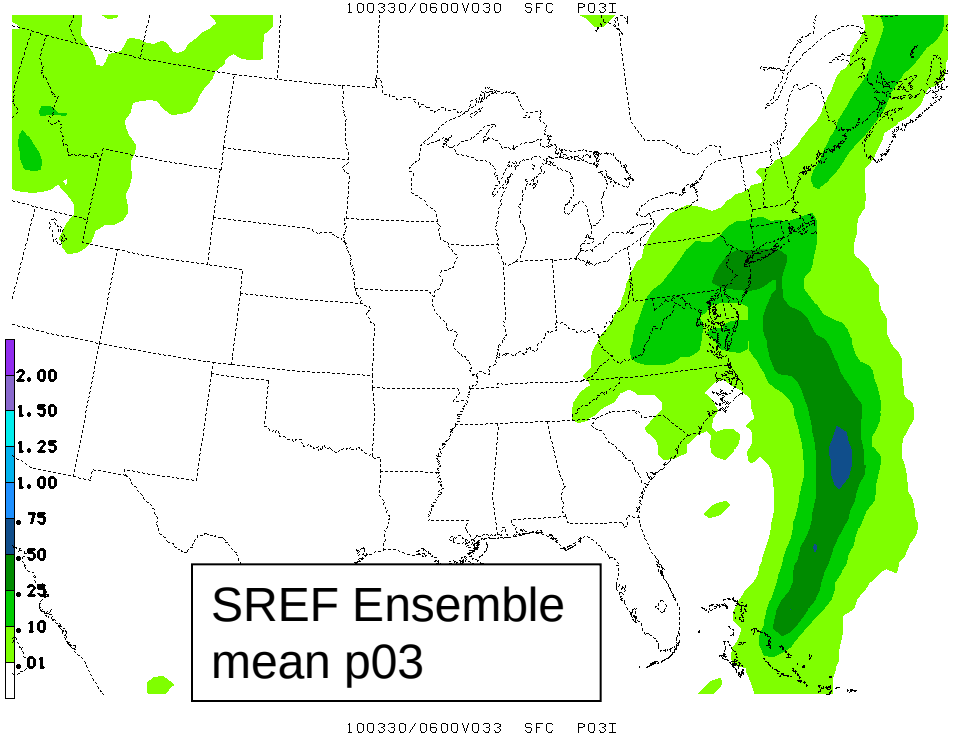

Hourly max field LOOPS
UPDRAFT W
DOWNDRAFT W
10M WIND
2-5 km UPHLCY
~1000m AGL RADAR REF

HREF Ensemble Guidance (aka Hybrid)

- 21 SREF members are interpolated to the HiResW output domains (except Guam, which isn't covered by SREF).
- The 21 SREF perturbations (difference each member with the ensemble mean) are combined with the two HiResW (NMM and ARW) deterministic runs to produce a 44-member high resolution 'ensemble'.
- Provides higher-resolution probabilistic and ensemble-mean guidance at minimal computational expense.
- Motivated initially by the request for QPF support for the Hanson Dam crisis in Washington.


2.00
1.50
1.25
1.00
.75
.50
.25
.10
.01
ARW p03
100330/0600V030 SFC PO3I


2.00
1.50
1.25
1.00
.75
.50
.25
.10
.01
NMM p03
100330/0600V030 SFC PO3I


2.00
1.50
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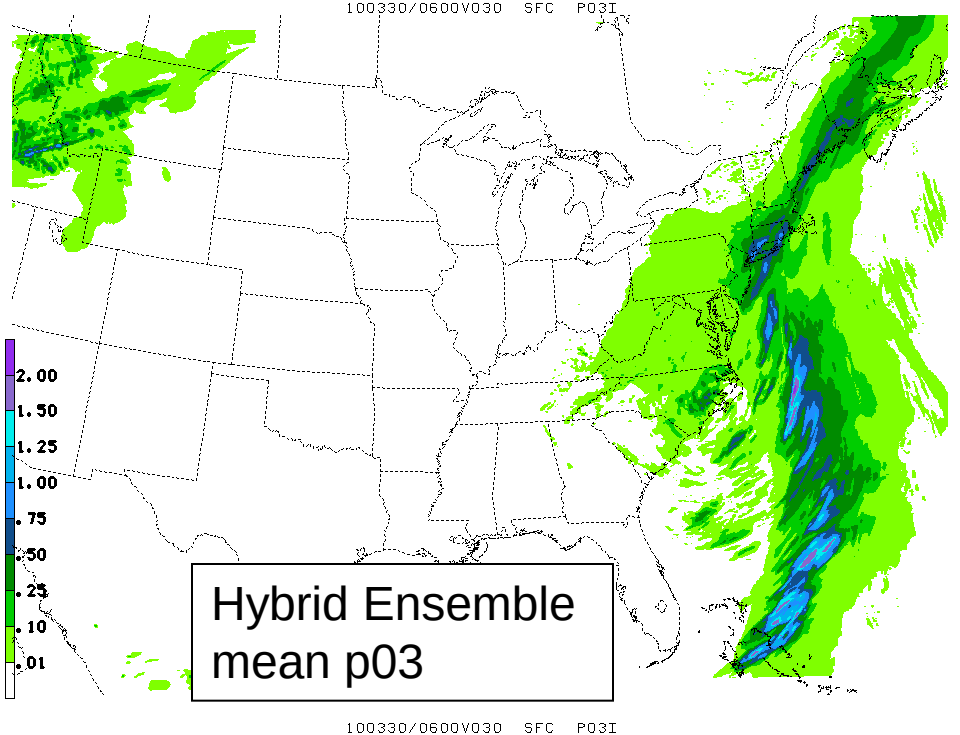
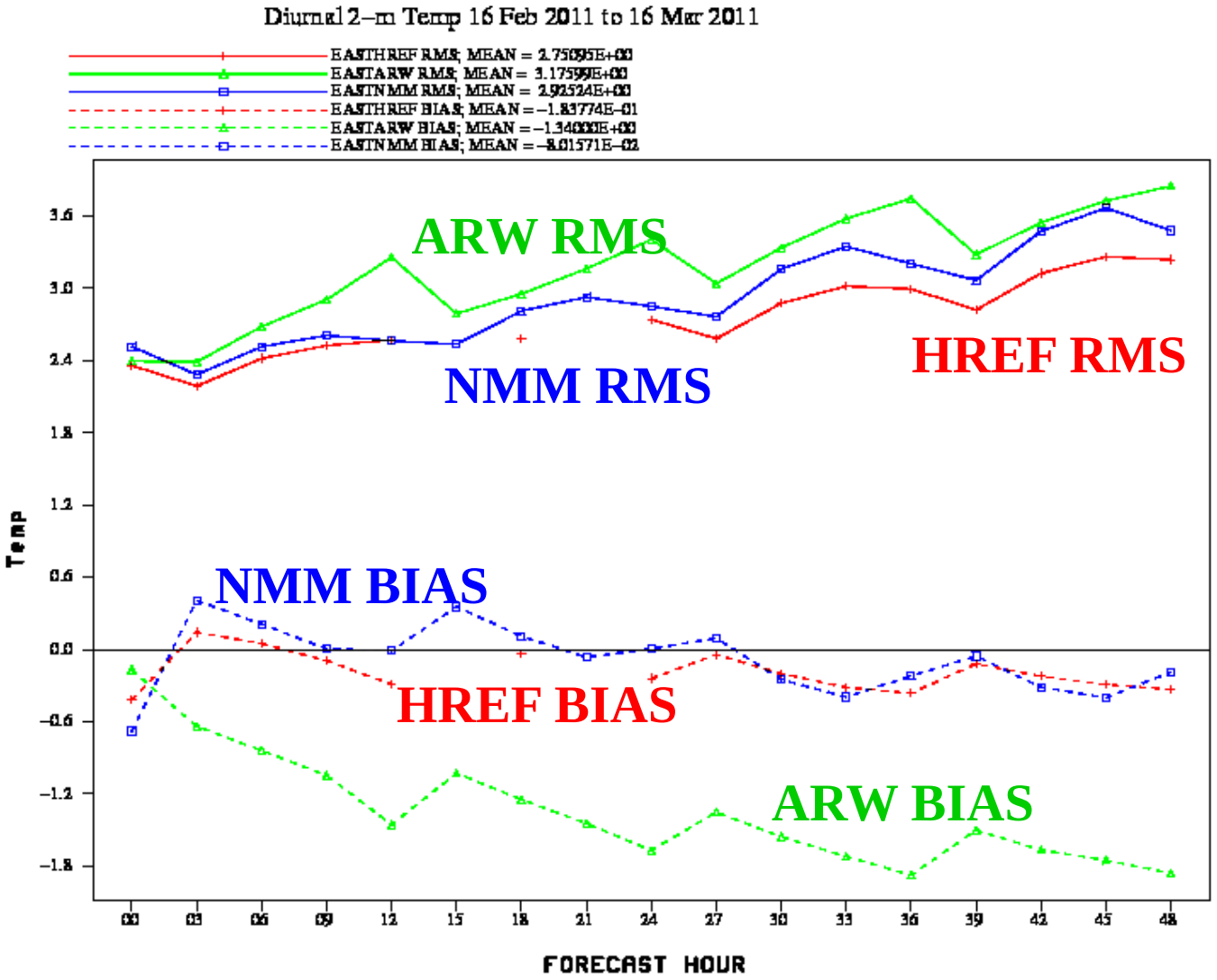
SREF Ensemble mean p03
100330/0600V033 SFC PO3I


2.00
1.50
1.25
1.00
.75
.50
.25
.10
.01
Hybrid Ensemble mean p03
100330/0600V030 SFC PO3I

HREF Mean, ARW & NMM
2m Temperature vs Surface Obs



HREF has Lowest RMS & BIAS Near Zero

Current NCEP SREF System (21 members)

Model	Membership	Resolution	Forecast Hours	IC/IC perturbation	LBC/LBC perturbation	Output Frequency for pgrb files	Output Frequency for bufr soundings
Eta_BMJ	3 (ctl1, n1, p1)	32km	87hr	ndas/regional bred	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
Eta_KF	3 (ctl2, n2, p2)	32km	87hr	ndas/regional bred	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
RSM_SAS (Ferrier MP)	3 (ctl1, n1, p1)	32km	87hr	GFS 3hr fcst/regional bred	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
RSM_RAS (Zhao MP)	2 (n2, p2)	32km	87hr	GFS 3hr fcst/regional bred	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
WRF-NMM	5 (ctl, n1, p1, n2, p2)	32km	87hr	GFS 3hr fcst/global ET	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
WRF-ARW	5 (ctl, n1, p1, n2, p2)	35km	87hr	GFS 3hr fcst/global ET	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites

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

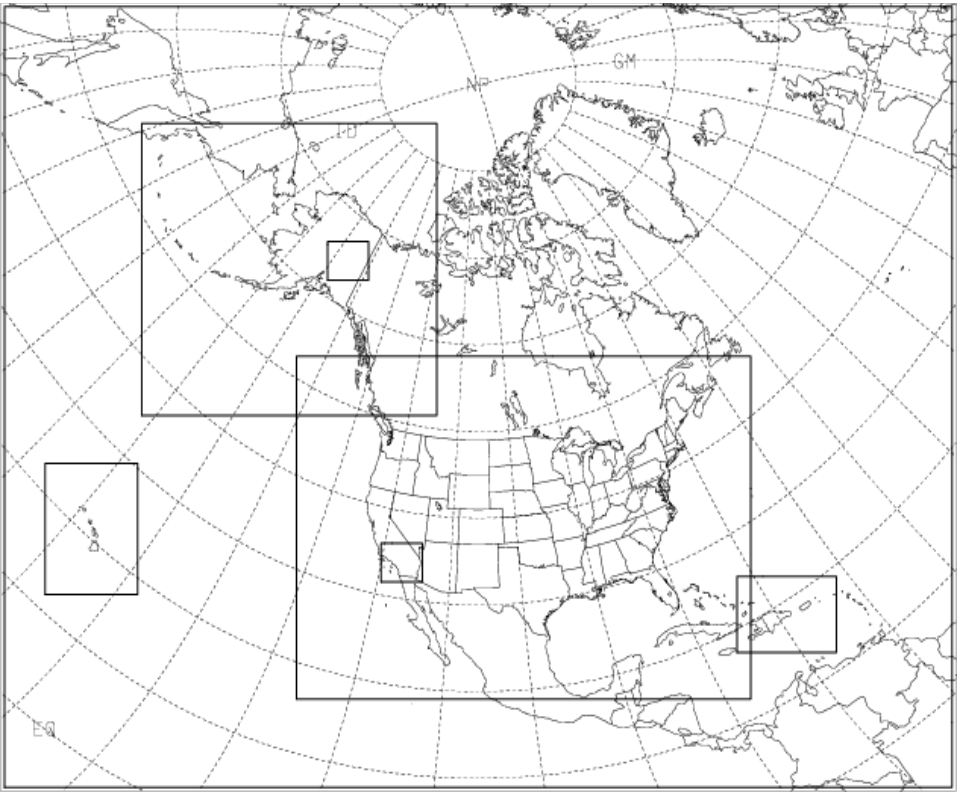
	WRF-NMM	WRF-ARW
Horizontal Grid	32 km	35 km
Vertical Domain	52 levels 50 mb top Sigma-Pressure	36 levels 50 mb top Sigma
Convection	BMJ	KF
PBL/Turbulence/Surface Layer	MYJ	YSU
Microphysics	Ferrier	WSM3
Land-Surface	NOAH	NOAH
Radiation (SW/LW)	GFDL/GFDL Lacis-Hansen/Fels-Schwartzkopf	Dudhia/RRTM

ARW (WRF) Physics options – help from DTC

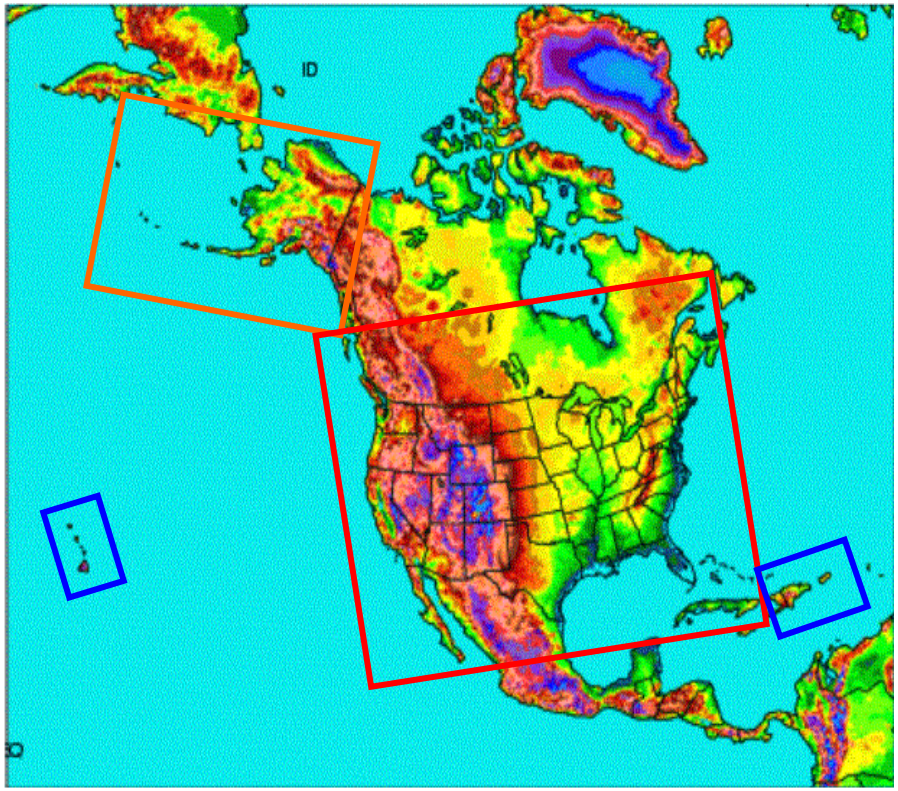
	Control **NCAR**	Pair 1 **NCAR**	Pair 2 **RAP**	Pair 3 **NMM** (?)
Microphysics	5- Ferrier	3– WSM 3	8- Thompson	
Longwave	1- RRTM	1 - RRTM	1- RRTM	
Shortwave	1- Dudhia	1 - Dudhia	2- Goddard	
Surface layer	1- MM5 similarity	1– MM5 similarity	2- Eta similarity	
Land surface	2- NOAH	2- NOAH	3- RUC LSM	
PBL	1- Yonsei U.	1- Yonsei U.	2- MYJ	
Convection	1- Kain-Fritsch	1- Kain-Fritsch	5-Grell (in V3.3)	

Grid Association Revealed

Nests **Are** Grid Associated



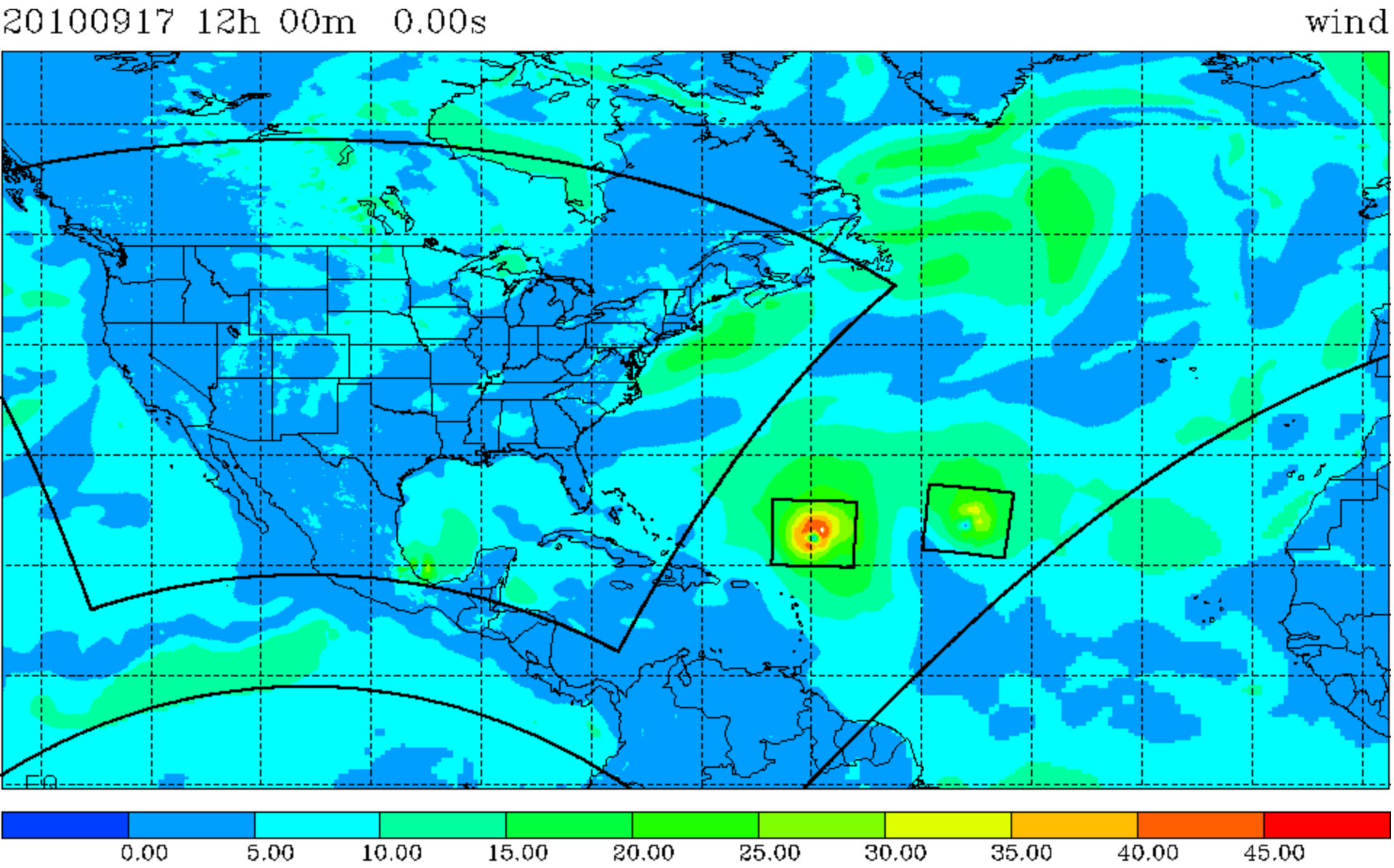
Nests are **Not** Grid Associated



When this is relaxed we'll be able to run a continental scale nest (NAM that crosses the pole) inside a global NMMB with multiple hurricanes…

Hypothetical NEMS Simultaneous Run

Global [with Igor & Julia] and NAM [with CONUS nest]

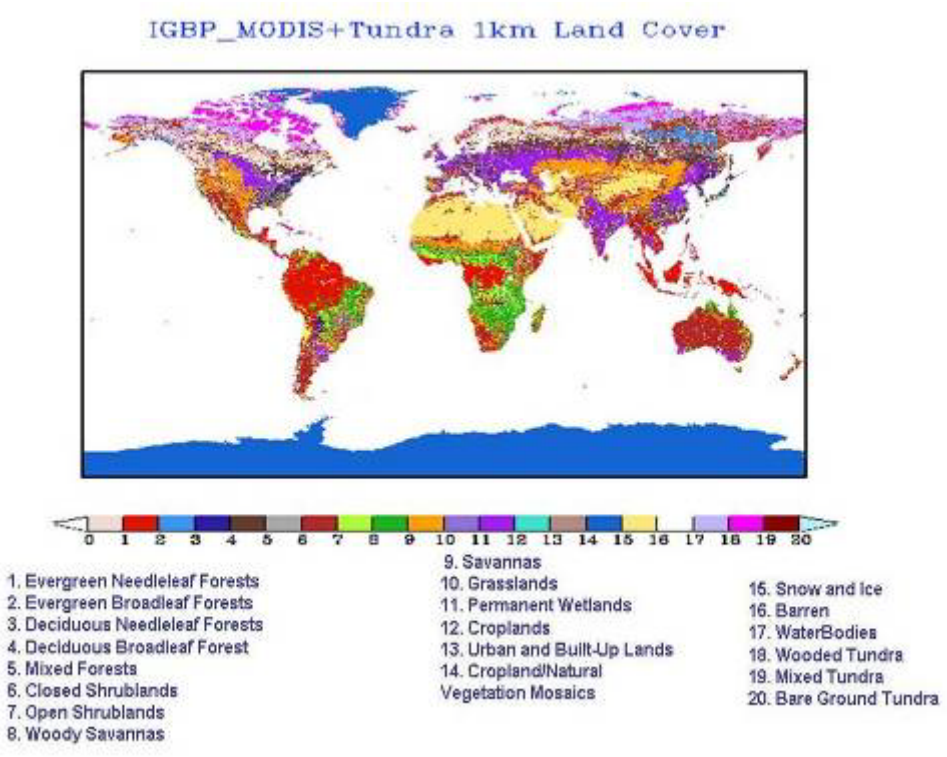


Highlights of NEMS Preprocessing System (NPS) for NMMB (courtesy Matt Pyle)

- 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 is done in current NAM but not in WRF REAL)

MODIS-IGBP land-use specifications will replace USGS (Wong and Ek, Conference on Hydrology)



Little difference in near-sfc T, Td between NMMB runs w/ IGBP & USGS land-use (based on many tests run for all seasons)

Classification Scheme	IGBP	USGS
Satellite Instr.	MODIS 2001-2006	AVHRR 1992-1993
Coastline	More Details	
Urban	More	
Evergreen	More in Alaska	More in SE of US
Deciduous Broadleaf	More in SE of US	
Savanna		More in Oklahoma