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Fire Weather Support From NCEP: Selectable Runs of Nonhydrostatic Mesoscale Model

Jeff McQueen Mesoscale Modeling Branch EMC

Jeff.mcqueen@noaa.gov 301-763-8000 ext7226

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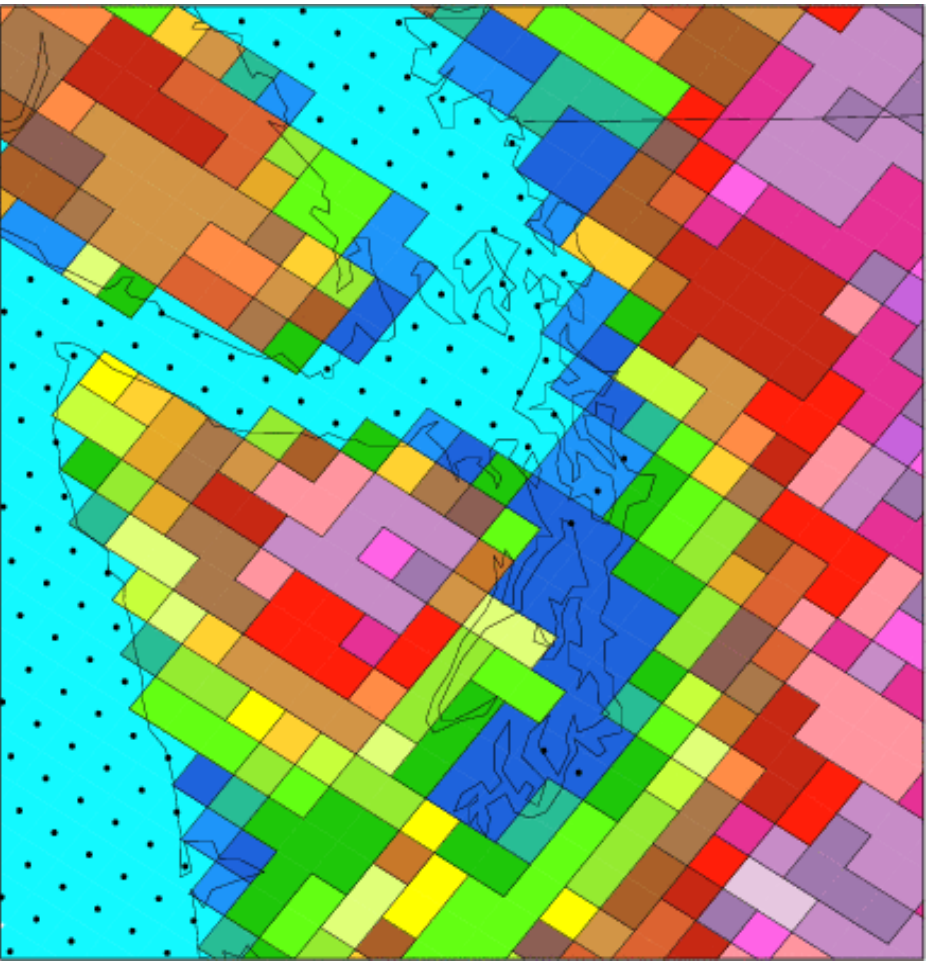
Where the Nation's climate and weather services begin

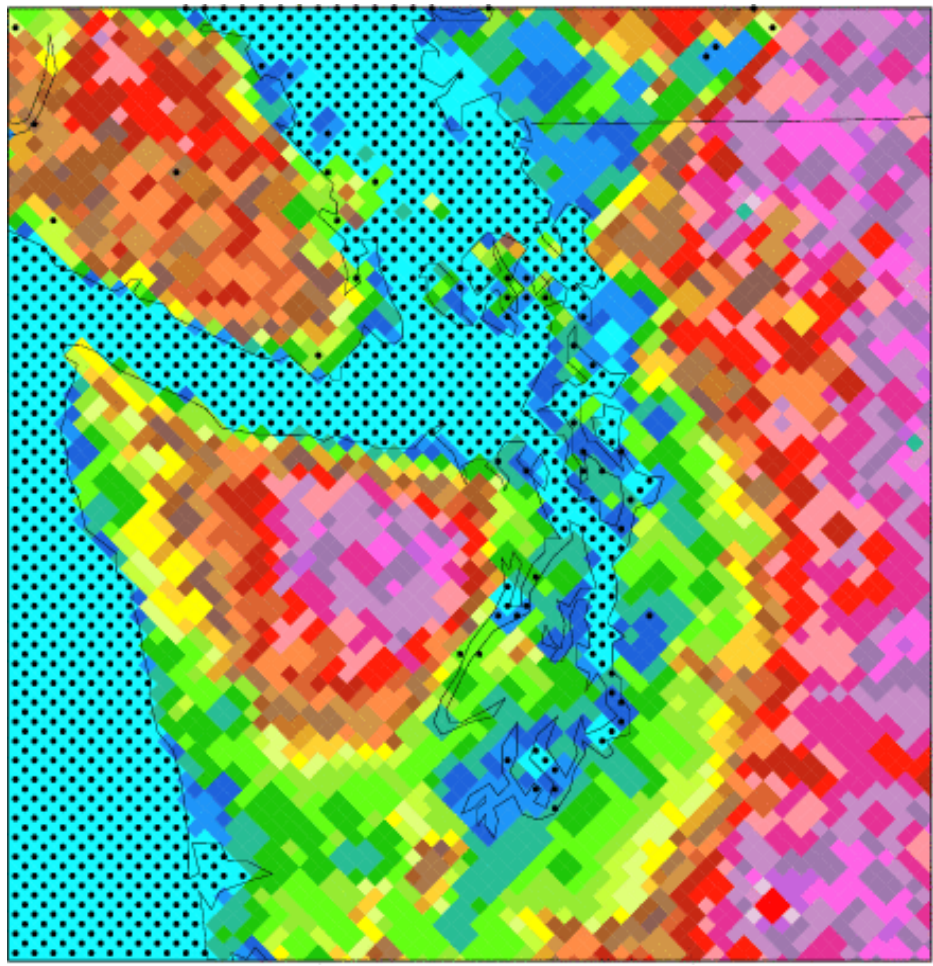
WRF
Nonhydrostatic Mesoscale Model

- See Janjic, Gerrity,and Nickovic, 2001 for model equations, solution techniques & other test results [MWR,Vol. 29, No. 5, 1164-1178]
- Highly refined version of nonhydrostatic option released in May 2000 upgrade to NCEP's workstation Eta
- NMM retains full hydrostatic capability
  - Incorporate nonhydrostatic effects through ε where $\varepsilon=(1/g)\ dw/dt$
  - Then split prognostic equations into:
    - hydrostatic parts plus
    - corrections due to vertical acceleration
  - Set ε to zero to run in hydrostatic mode

12 km Terrain

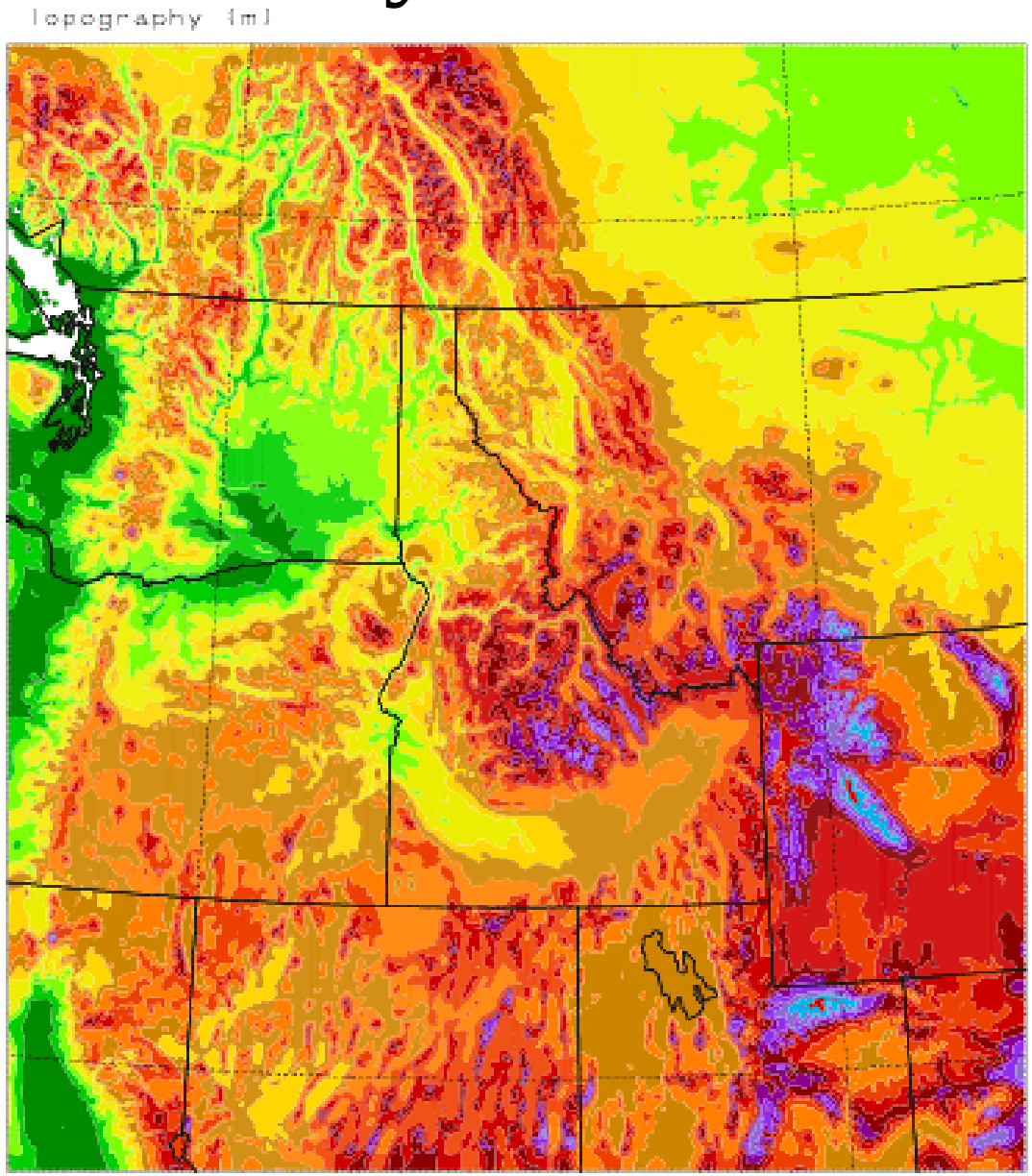


4 km Terrain



Dots represent water points Domain is Puget Sound

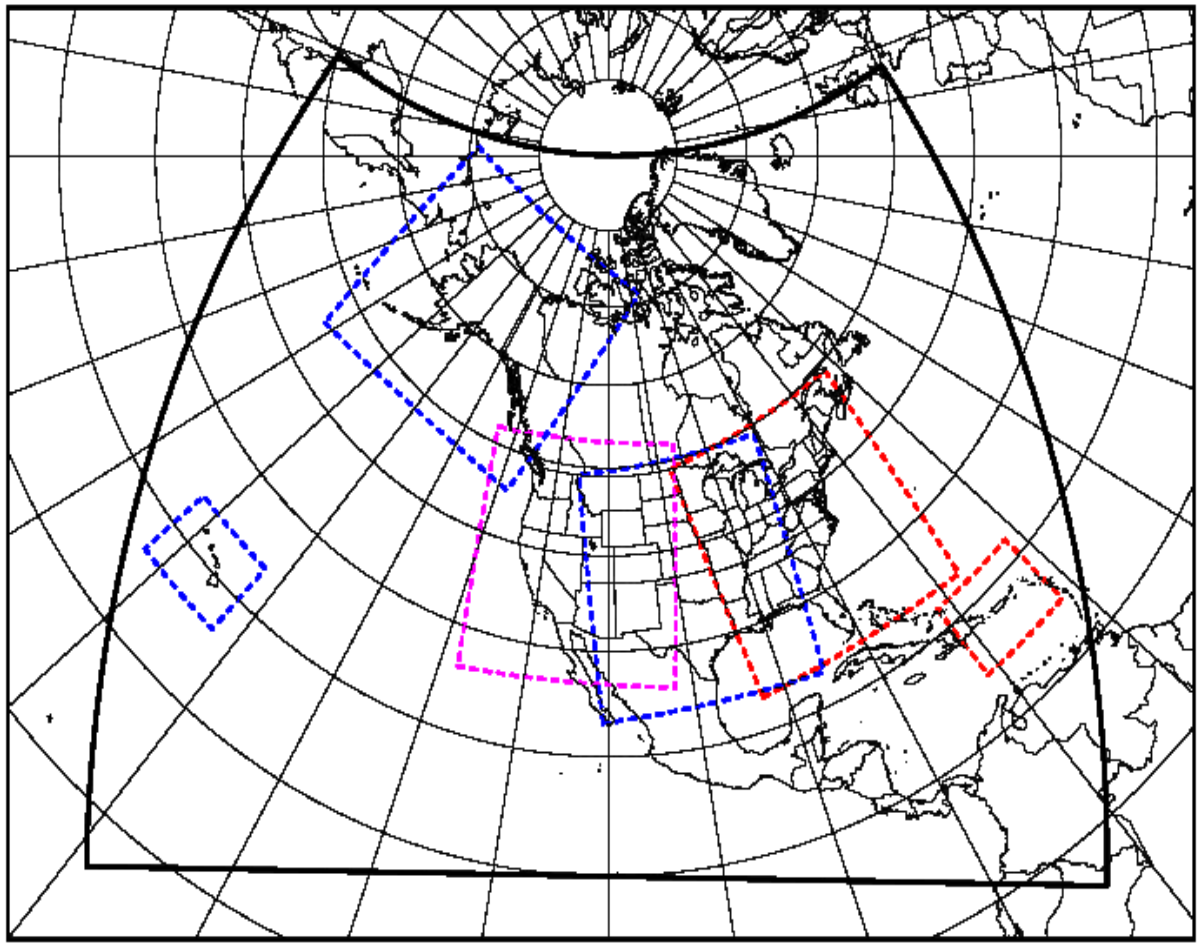
4 km Hybrid Terrain



HiResWindow

Fixed-Domain Nested Runs

- Routine runs made at the same time every day
- 00Z : Alaska-10 & Hawaii-8
- 06Z : Western-8 & Puerto Rico-8
- 12Z : Central-8 & Hawaii-8
- 18Z : Eastern-8 & Puerto Rico-8
- This gives everyone a daily high resolution run when <2 hurricane runs need to be made



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

Positive Aspects of HiResWindow/NMM for FireWx

- Higher resolution and use of sigma-pressure vertical coordinate should yield
  - Better low level winds (especially vs Eta)
  - Better low level temperatures
  - Better low level dew points
- Nonhydrostatic dynamics should yield
  - Better predictions in cases with strong vertical circulations / accelerations

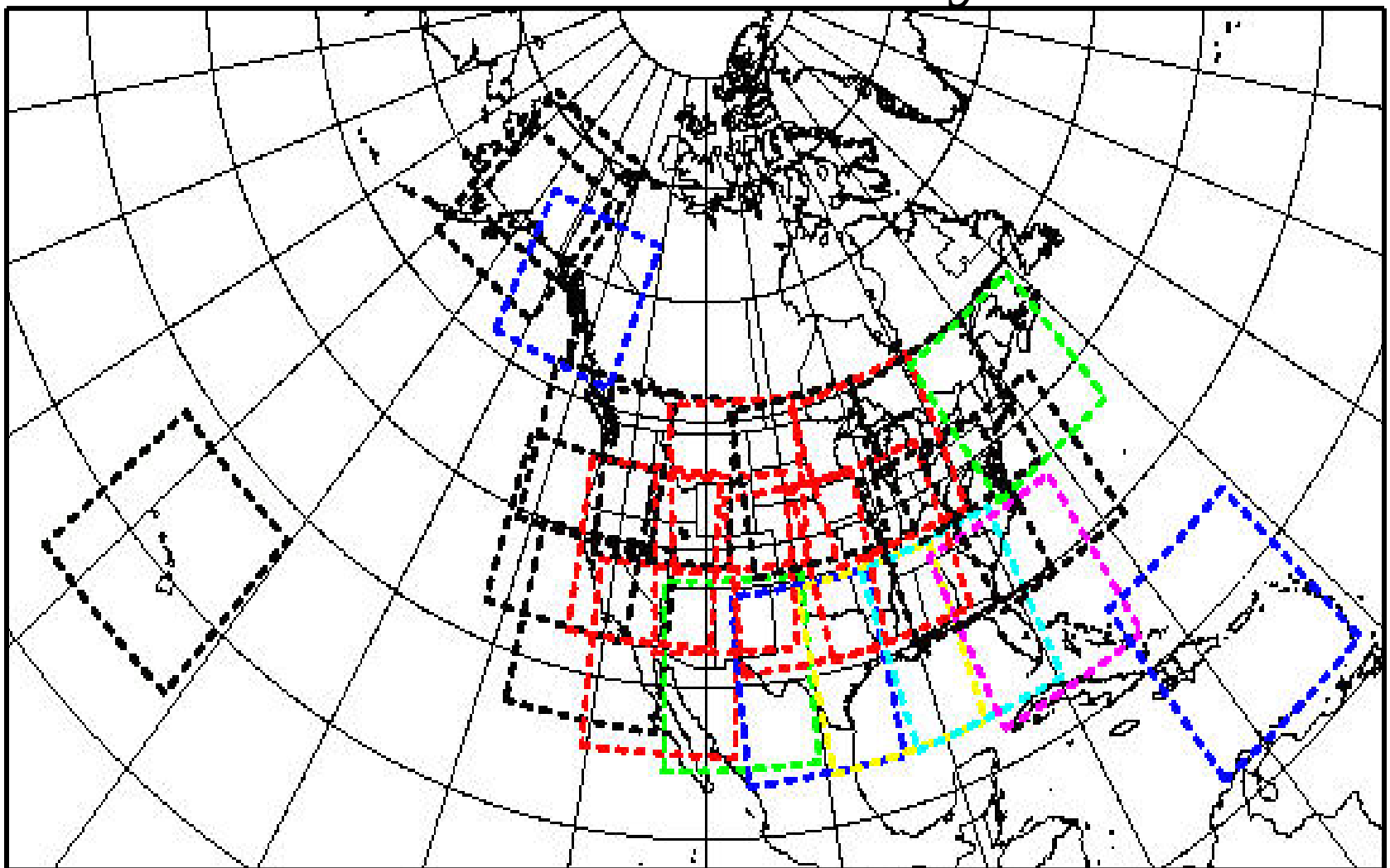
Fire Weather Nests Implemented in May 2003

- EMC gave up some growth potential for Eta and built a Fire Wx Support run designed to run over the top of the Eta at all four runtimes of 00z, 06z, 12z & 18z
- Better than using HiResWindow because it has no conflict with hurricanes
- Established reduced domain nests patterned after NCEP's On-Call Emergency Response capability for Homeland Security
- Nests to run at 8 km resolution like the HiResWindow

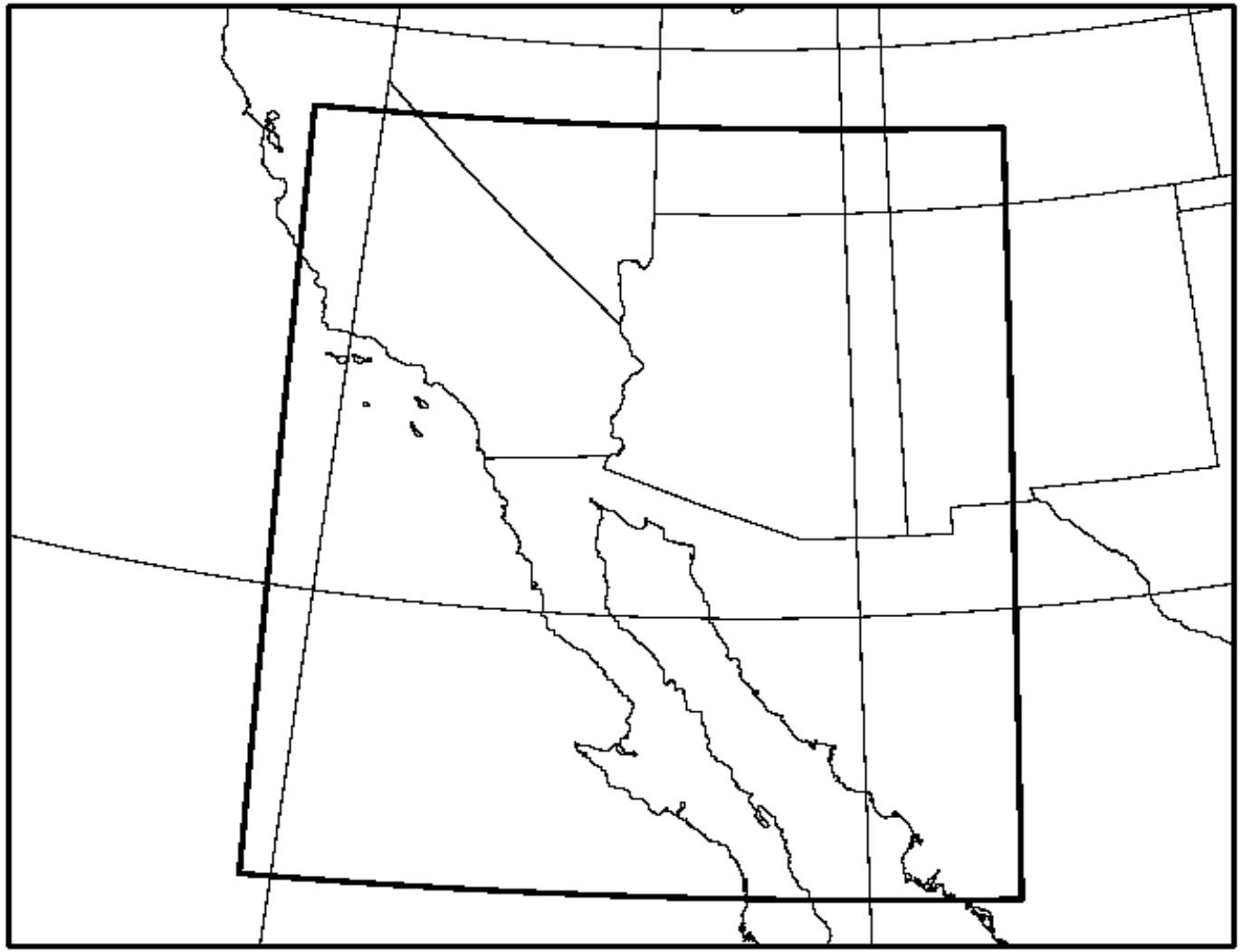
Fire Weather / IMET Support Run

- SDM receives request for run via coordination call *with Boise, WR, SPC etc.*
- Runs are made within dedicated run slots at 00z, 06z, 12z and 18z running over the top of the Meso Eta
- 8 km NMM run produces 1 hourly output grids
- Output grids (look just like HiResWindow) picked up by WR, clipped to relevant subregion and prepared for transmission to the IMET laptops using same FX-NET procedure developed for Olympics. SPC gets grids directly.

26 Selectable 8 km Domains For Fire Weather / IMET Support Identical To 4 km Homeland Security Domains

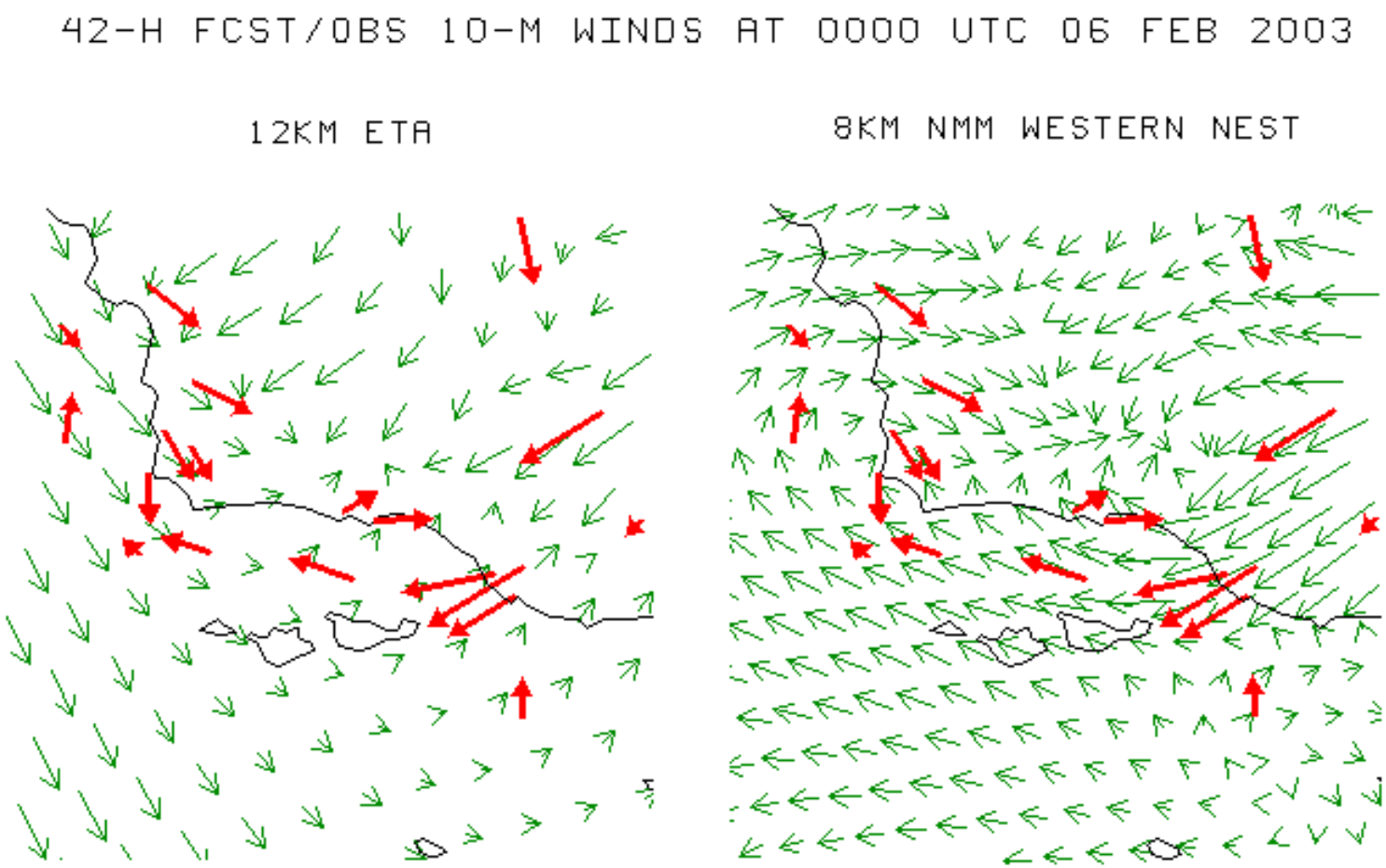


Sample GIF File Denoting Area of Fire Wx Run



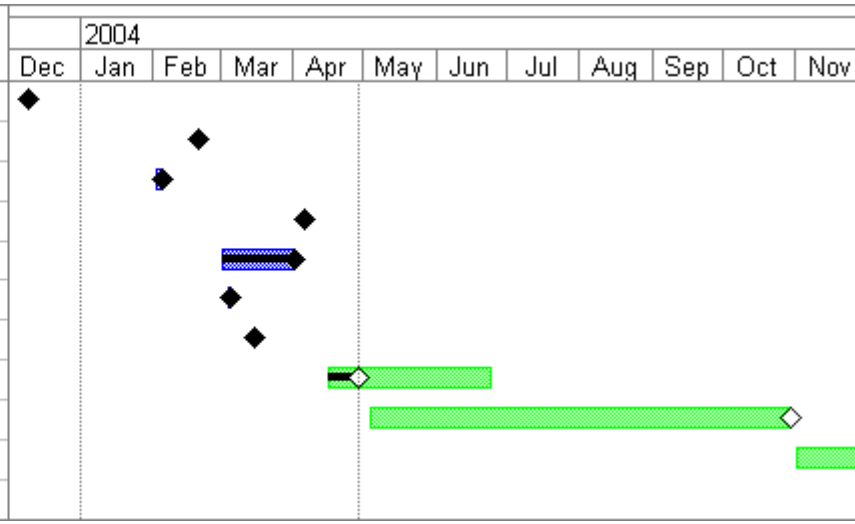
8 km Fire Weather Domain fw02

12 km Meso Eta vs 8 km NMM Winds



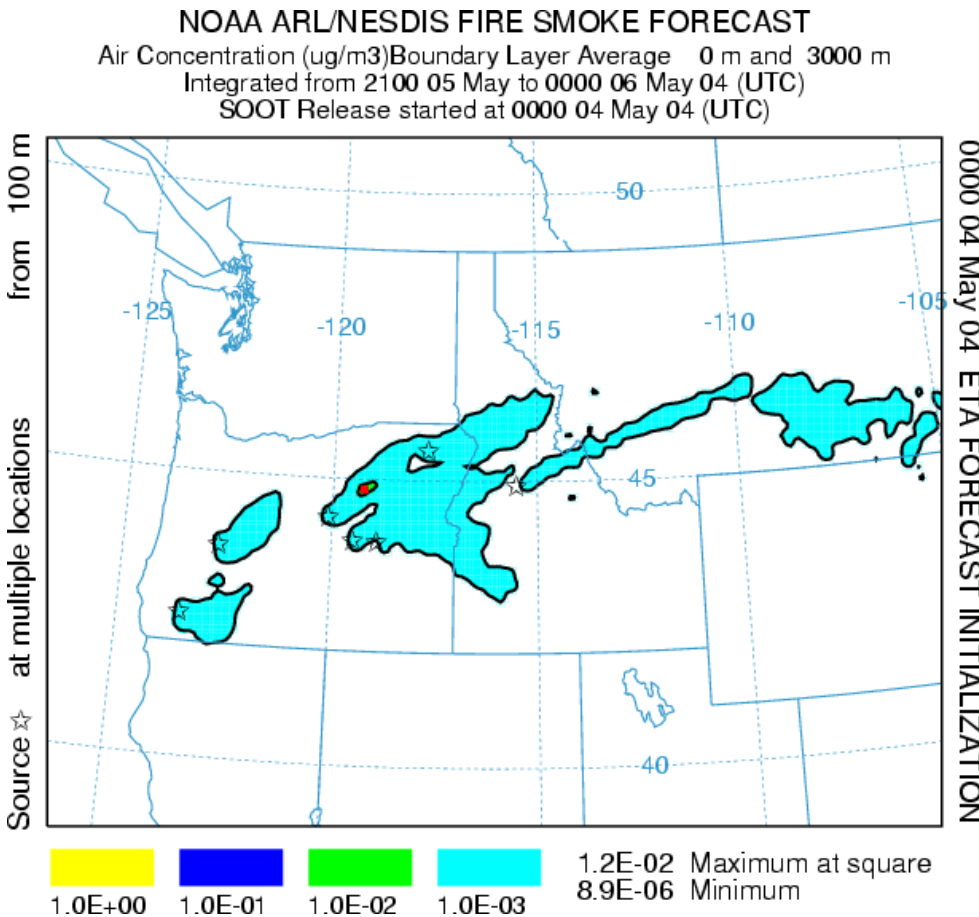
Current Plans for 2004 Season: Training Given to IMETs, IMETs to Provide Feedback Following FX-Net Upgrade

ID		Task Name
1	✓	Initial Coordination
2	✓	Dry Run of Jascourt Training
3	✓	Test Fire Weather End-End Comms
4	✓	SDM Readiness (SOPs in place)
5	✓	Complete and test FX-Net Upgrades
6	✓	Complete Training
7	✓	IMETs Directed to provide ongoing NMM feedback
8		Repeat End-to-End Testing
9		Ongoing Coordination with SPC,BOI, and IMETs on Tiles
10		Comments on NMM Fire Wx Support Summarized
11		Summary of IMET Feedback Presented at EMC Review



Current Smoke Forecast Capability (HYSPLIT)

- HY-SPLIT-4 Semi-Lagrangian Particle/puff model
- Driven with NCEP Eta or NMM meteorology
- Source Locations: NESDIS SSD fire locations
- Emissions: Simple emission factors based on surface characteristics



National Air Quality Forecasting

CMAQ *Planned Capabilities*

- *Initial: 48 hour forecasts of ozone (O_3) : 12z and 6z run*
  - **Develop and validate in North-eastern US by Q4FY04**
  - **Deploy Nationwide by FY07**

- *Intermediate (FY07-09):*
  - **Develop and deploy nationwide capability to forecast particulate matter (PM) concentration**
  - **WRF drives CMAQ with full aerosol capabilities**
  - ***Particulate size $\leq$ 2.5 microns***

- *Longer range (within 7 years):*
  - **Extend air quality forecast range to 72 hours**
  - **Include broader range of significant pollutants**
  - **Indirect WRF-CHEM with radiation/cloud feedbacks**

National Air Quality Forecasting
Initial Operational System

Linked numerical prediction system

NCEP mesoscale NWP: Eta-12 L60

NOAA/EPA community model for AQ: CMAQ L22

AQ Observational Input:

- *1999 EPA emissions inventory*
- *Met. Dependent biogenic emissions*
- *Climatological averaged mobile sources*

Gridded forecast guidance products

Verification basis

EPA ground-level ozone observations

Customer outreach/feedback

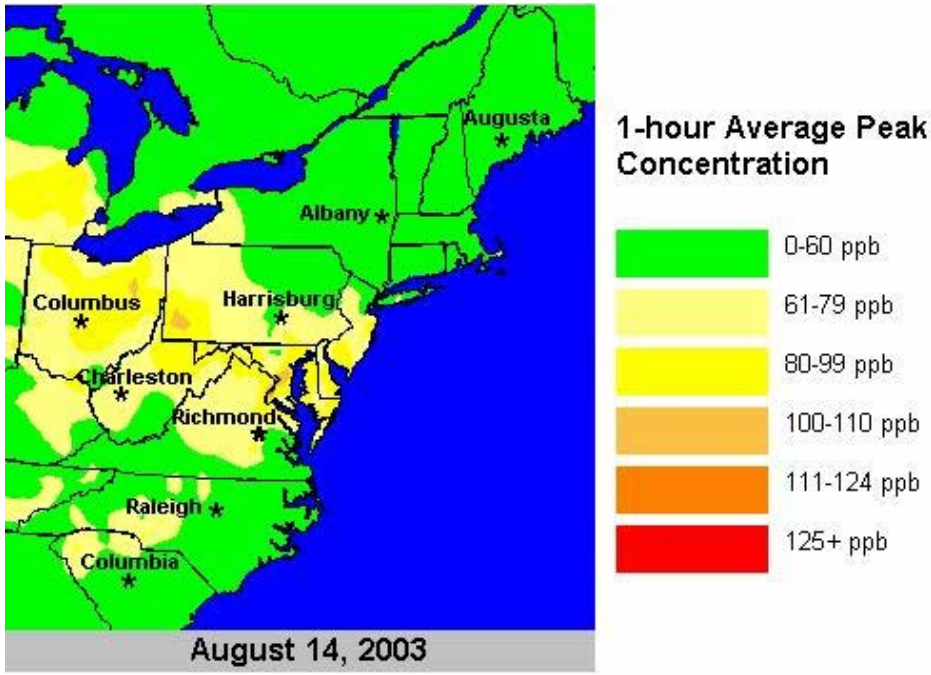
State and Local AQ forecasters coordinated with EPA

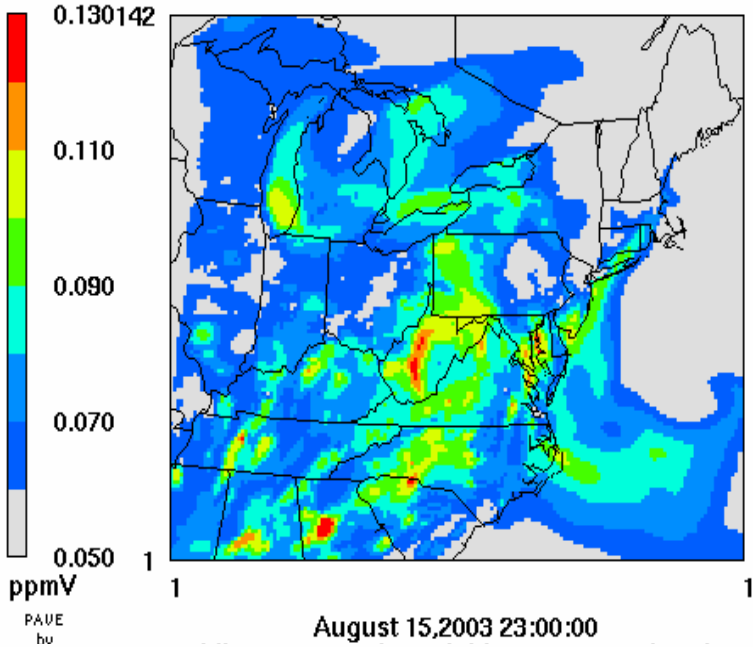
Public and Private Sector AQ constituents

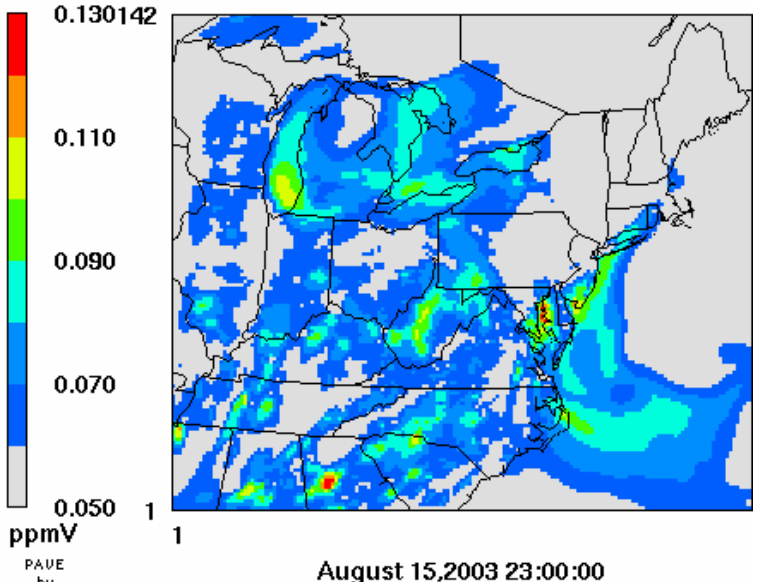
CMAQ

- *Chemical Transport Mechanism*
  - Advection: Piecewise Parabolic method (PPM)
  - Vertical Diffusion: Pleim-Xu PBL*
  - Horizontal Diffusion: Eddy-diffusivity with grid size dependent
- *Cloud processes:*
  - Aqueous chemistry & sub-grid clouds from RADM
- *Plume-in-Grid:*
  - Subgrid Lagrangian plume effects: OFF
- *Dry Deposition:*
  - M3dry: deposition velocities computed from the Pliem-Xu LSM
- *Gas-Phase Chemistry Mechanisms*:
  - Smaller Carbon Bond 4 (CB4), limited species
  - Use Chemical steady states
- *Gas-phase Chemistry Solver:* *Fast Hertel solver*

Land-use Coupling to Eta (Base)



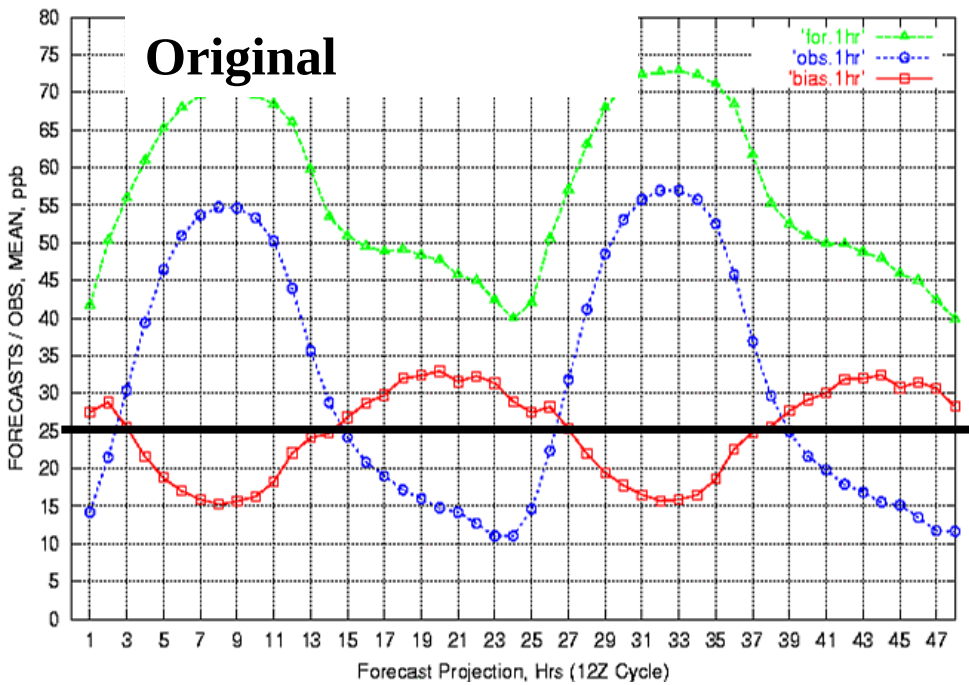


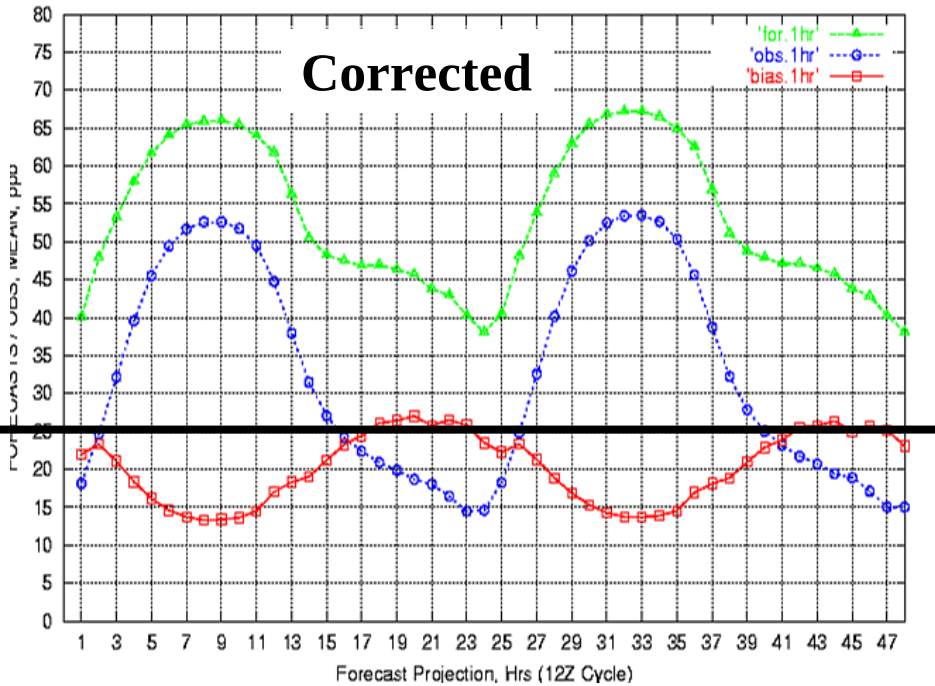


1 hr Averaged Ozone Error

1 hr avg (ppb) Forecast(green), obs(blue), bias(red)

August 12-19, 2003





Summary

- *Summer O3 NE US 48 hour prediction capability demonstrated*
- *FY04: implementation with*
  - Improved O3 boundary conditions (GFS predictions)
  - Improved Coupling to Eta PBL mixing
  - *Expanded parallel domain on development machine*
  - *Improved Emissions (Mobile 6)*
  - *Improved met cloud & radiation routine*
  - *Additional products for AIRMAP/ICARRT*
  - *FVS Evaluation (O3, pbl hgt…)*

National Air Quality Forecast Capability

Beyond IOC: Goals/Targets

- Near-Term: Ozone prediction, pm development
- Mid-Term : Initiate nationwide forecasting
- Improved fire source emissions
- WRF fire wx/smoke nests
- Longer-term: Enhanced capabilities (Inline, interactive with weather)

Proposed Products	*Current*	*3 year Target*	*7 year Target*
Ozone forecasts	IOC 1-day forecasts: Northeast US	1-day forecasts for the Nation	Extend to day 2 and beyond
Aerosols	R&D	1-day forecasts: Northeast US	1-day forecasts for the Nation
System	Eta-CMAQ	WRF-CMAQ (w /PM) WRF-fire wx & smoke nests	WRF-inline coupled chemistry