



NOAA HPC Site Update

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HPC 2012
September 18, 2012



NOAA HPC Site Update



- Operations
- Research
- Applications
- Future Directions



NWS/NCEP: Where America's Weather, Climate, Ocean and Space Weather Prediction Services Begin



Major Components of NOAA's Numerical Prediction Enterprise

- Global Observing System
- Data Assimilation & Modeling/Science
- Weather and Climate Computing Infrastructure Services

Everything you read, see or hear about weather, climate and ocean forecasts is based on numerical prediction

• NOAA Operational Super Computers

- Where the entire forecast process begins
- A NOAA enterprise asset
- 1 of 4 NWS National Critical Systems
- Foundation for forecast accuracy, extended forecasts for extreme events, on-time delivery





NCEP Operations

- Primary and Backup System
 - Backup is a “warm” backup
 - Real-time data in place
 - Models not running in parallel
 - Development and transition to operations activities
- Two geographically diverse sites
 - Reston, VA
 - Orlando, FL



Operational Systems

- Identical systems per site
- IBM Dataplex (transitioning from P6)
 - Intel Sandy Bridge ~208 TFLOPS
 - 10,048 Cores
 - 2 PB GPFS
- 99.9% Operational use time
- 99% On-time delivery of real-time products



Operational System

- Inputs
 - 3.5 Billion observations/day
 - Over 15 million products/day
- Produces model guidance at global, national, and regional scales
 - *Examples:*
 - Hurricane Forecasts
 - Aviation / Transportation
 - Air Quality
 - Fire Weather





Research & Development



- Three major compute sites
 - ORNL
 - Fairmont, WV
 - Boulder, CO
- Analysis & Storage
 - Princeton, NJ (Analysis & Storage)
 - Fairmont, WV (Storage)
- NOAA Network



Research & Development ORNL



- Collaborative relationship with ORNL funded by NOAA
- Cray XT
 - <120,00 cores
 - AMD Bulldozer 2.7GHz
 - <1PF
- <75% Climate research





Research & Development Fairmont, WV



- SGI Altix 8400
- Intel Westmere (3.46 GHz)
 - Enhanced Hypercube based on QDR Infiniband
 - Dual-rail
 - 27,648 Cores
 - 383TF
- <75% Weather research





Research & Development Boulder, CO



- More aggressive implementation of technology
- Three Intel Xeon/Infiniband systems sharing Lustre & Panasas file systems
 - Nehalem, Westmere, Sandy Bridge
 - 25,200 cores
- 325TF
- Exclusively Hurricane Research
- Also includes very small number of GPUs and MICs



Some Challenges

- Large number of jobs per day
 - <1M jobs/day
- Many small jobs
 - Pre- & Post-processing jobs
- Real-time (standing) reservations
 - Mixed with standard batch jobs



Research & Development Analysis & Storage



- Princeton, NJ
 - Linux-based analysis cluster
 - SGI DMF
 - Oracle SL-8500
 - <30PB
- Fairmont, WV
 - IBM HPSS
 - Oracle SL-8500
 - ~50PB



NWAVE – NOAA Network





Applications

- Weather
-
- Climate
- Oceans
- Air Quality
- Aviation
- Space Weather
-



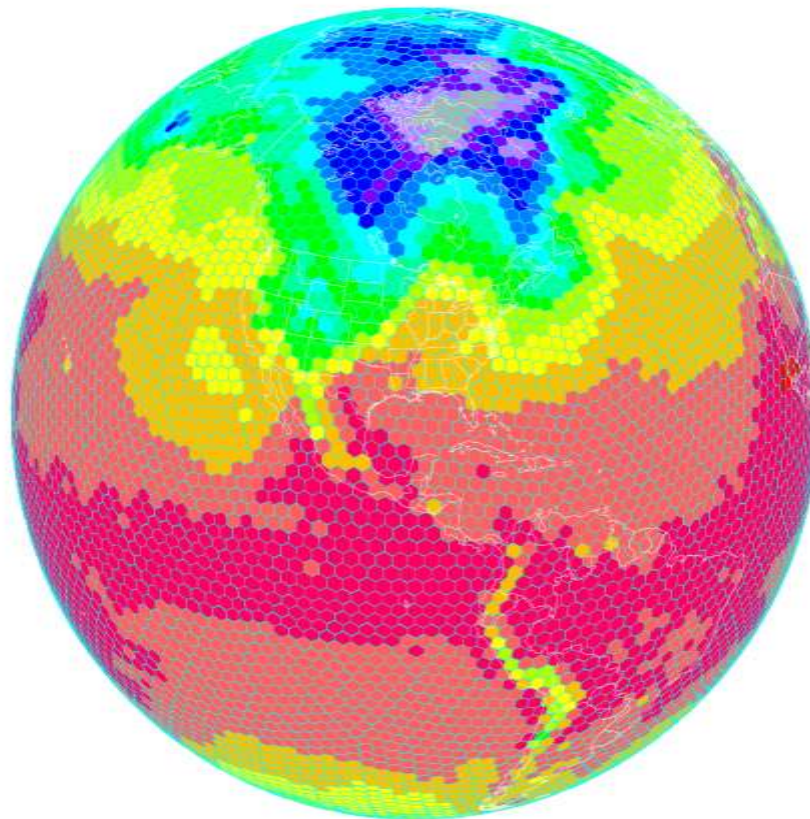
Global Weather/Climate FIM



- Icosahedral horizontal grid, mostly hexagons except for 12 pentagons ("I" in FIM)
- Isentropic-sigma hybrid vertical coordinate, adaptive, concentrates around frontal zones, tropopause, similar to RUC model ("F" for Flow-following in FIM)
- Finite-volume horizontal transport (Also under "F", for "finite-volume" in FIM)

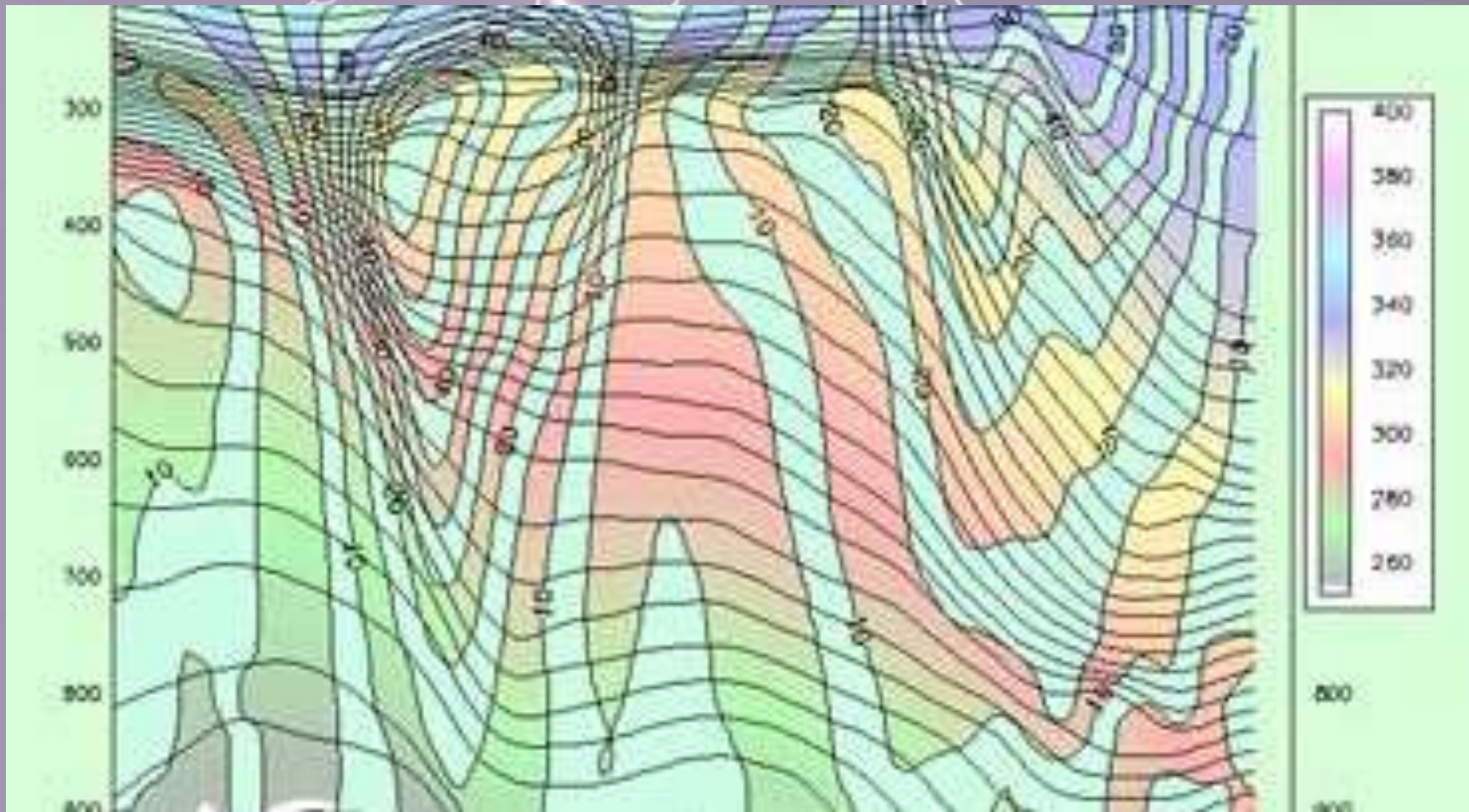


FIM Grid





FIM Isentropic Coordinate





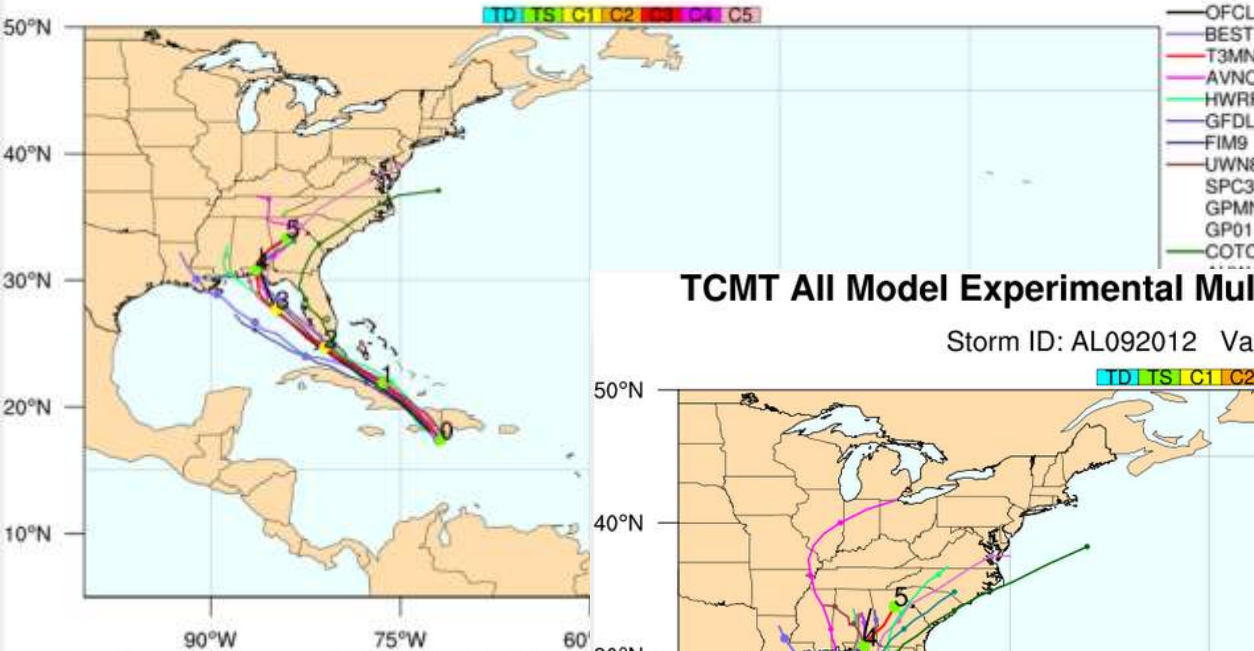
Hurricane Isaac

(Landfall around 0Z on 8/29)



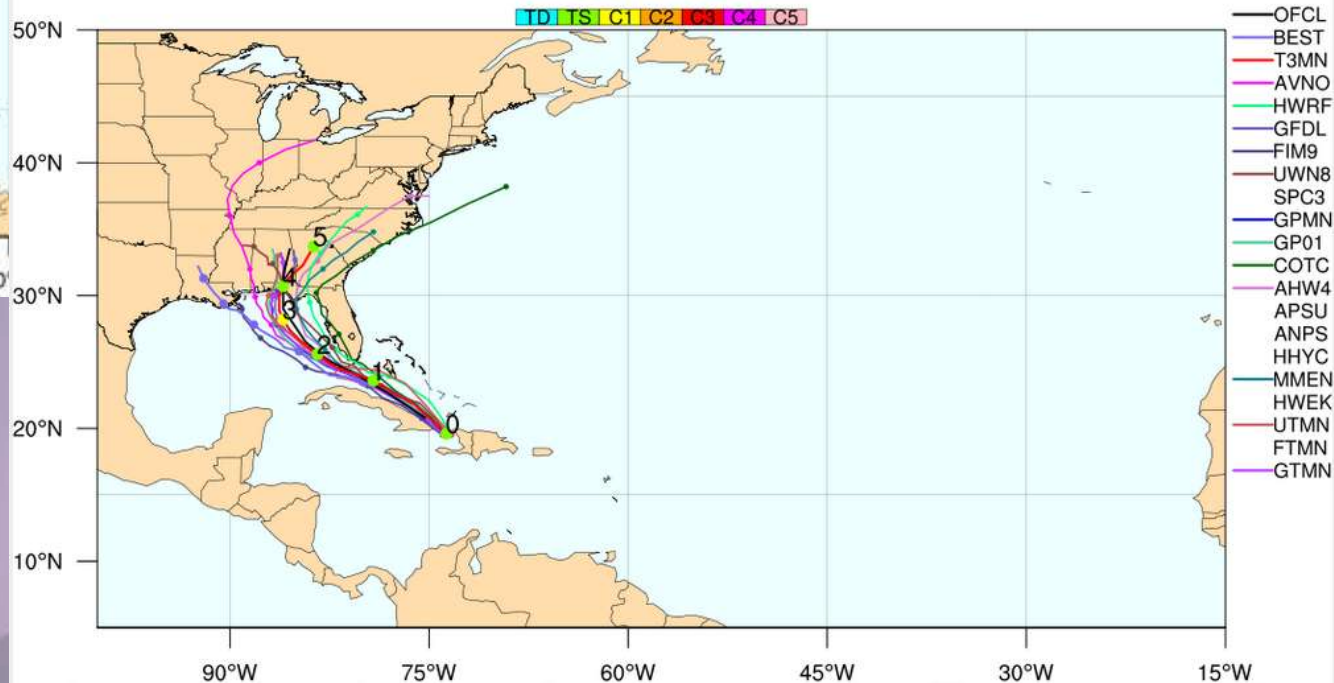
TCMT All Model Experimental Multi-Model Ensemble Mean (T3MN)

Storm ID: AL092012 Valid: 08/25/2012 00 UTC



TCMT All Model Experimental Multi-Model Ensemble Mean (T3MN)

Storm ID: AL092012 Valid: 08/25/2012 12 UTC



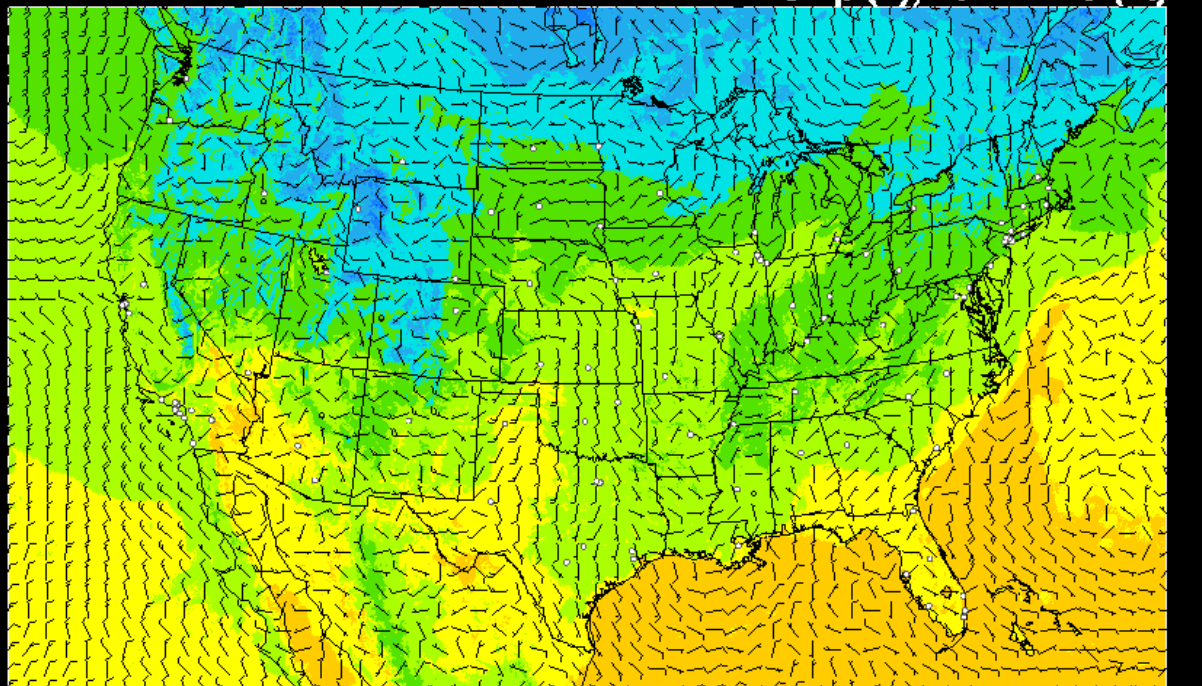


Regional Weather Forecasts

- High Resolution Rapid Refresh
 - One target community is aviation.
 - The HRRR is an experimental real-time 3-km resolution, hourly updated, cloud-resolving atmospheric model. The HRRR is run as a real-time demonstration.
 - A configuration of the WRF model
 - initialized with latest 3-d radar reflectivity via the 13km hourly updated. The 13km assimilation/model systems (RAP or RUC) both include radar reflectivity assimilation via radar-DFI (digital filter initialization) technique.

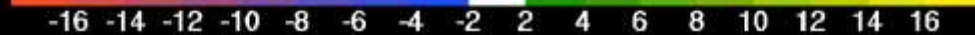


HRRR Temperatures



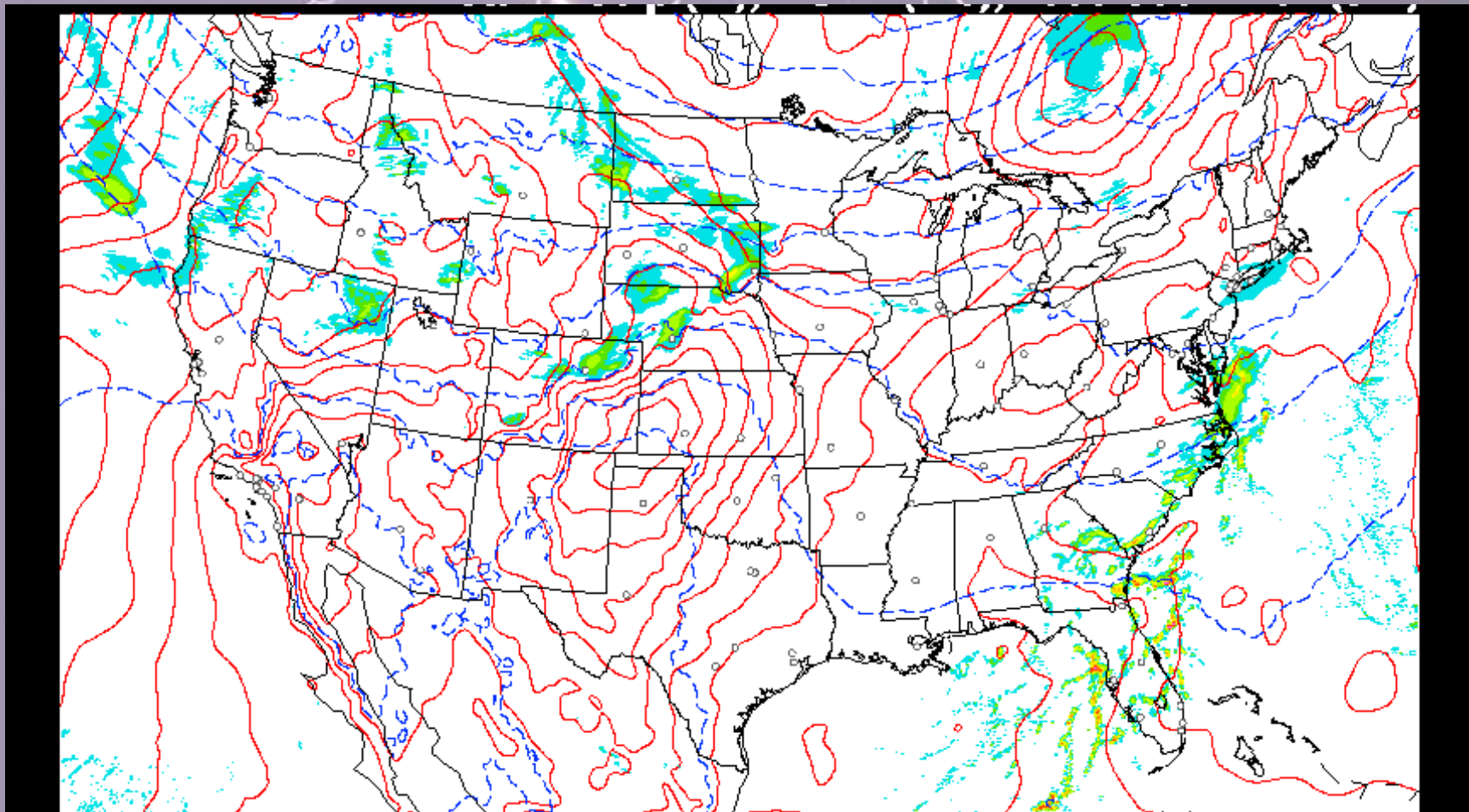
it - Experimental

Valid 04/19/2012 09:00 UTC
2m Temp - Skin Temp (F)



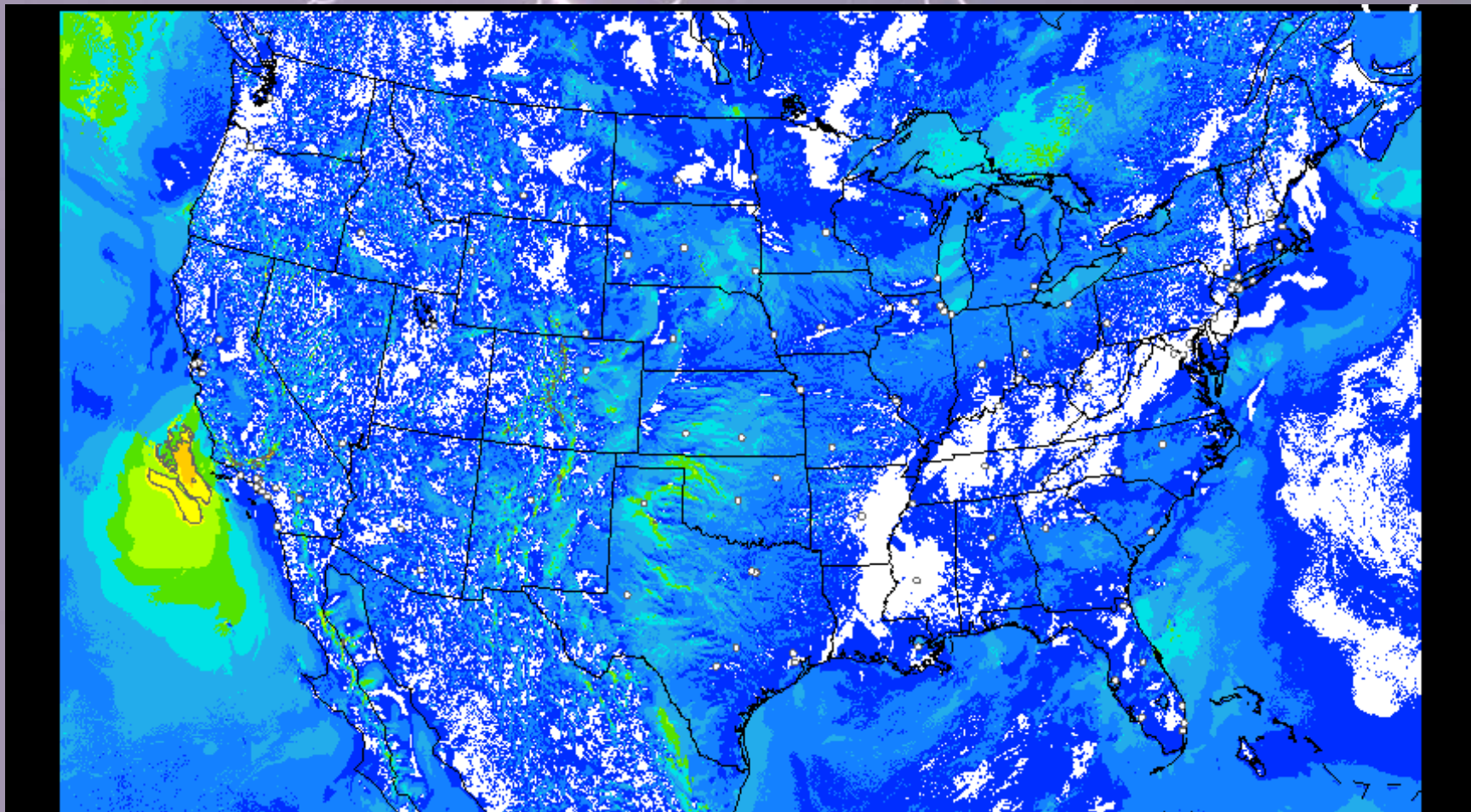


HRRR Precip





HRRR Wind Gusts





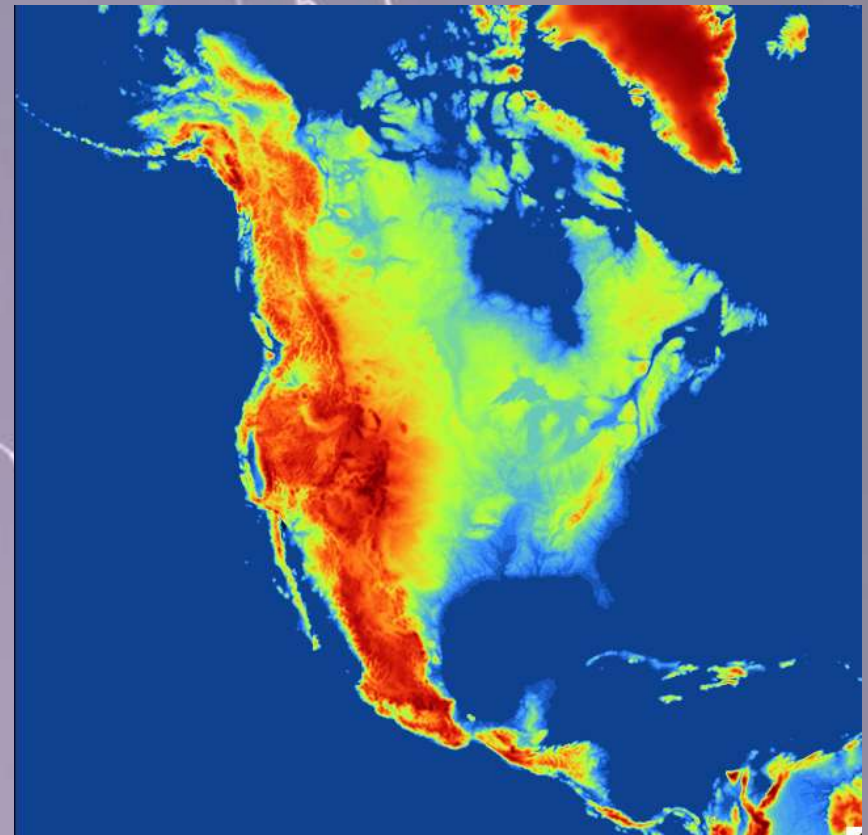
Air Quality (WRF-Chem)

- The Weather Research and Forecasting (WRF) Model is a next-generation mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs.
- Various chemistry modules have been implemented into the WRF framework, creating an “online” WRF/chem model. That is, the transport of species is done using the same vertical and horizontal coordinates (no horizontal or vertical interpolation), the same physics parameterization, and no interpolation in time.
- Real time forecasts are made using this model for use in air quality research programs (e.g., DC3 and SEACRS, <http://www.eol.ucar.edu/projects/dc3>) and model performance evaluation.



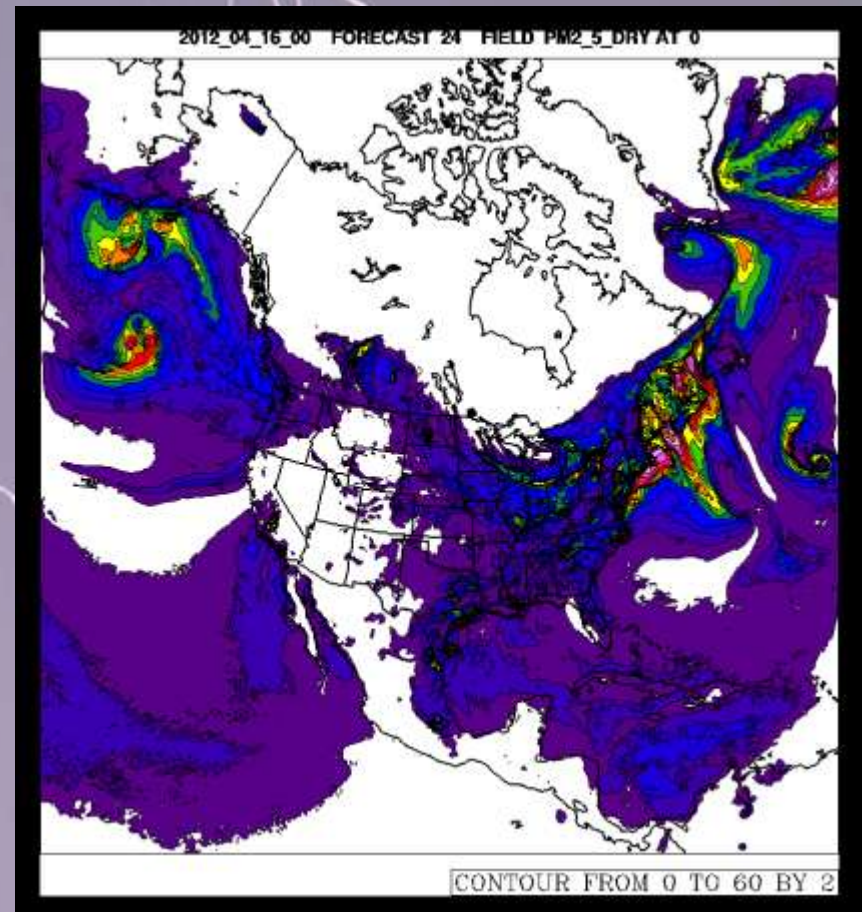
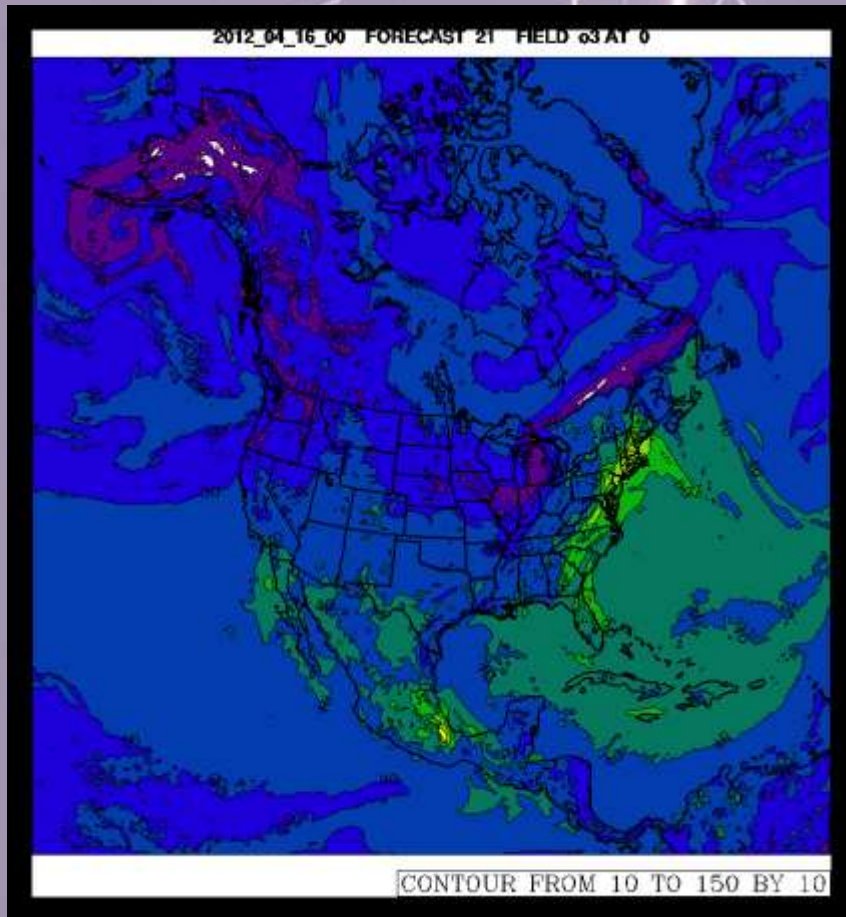
WRF-Chem

- Domain Dimensions
 - 649x648x51
- Meteorology
 - Approx. 20 species
- Chemistry
 - 42 gas species,
 - 40 aerosols (fine, coarse)
 - Sea salt included
- Emissions that can be included:
 - Anthropogenic, biogenic, biomass burning, sea salt, dust
- Forecast length
 - 48 h forecast in 6 h wall clock
 - 512 processors





WRF-Chem





Future Directions

- Developing a portable strategy for GPUs, MICs, and CPUs
- Models are “flat-profile”
 - Must port all of the code to see performance gains
 - Entire model and data must fit on the architecture
- “Fair” comparisons are essential to determine actual advantages
- There is some advantage to motherboard-based solutions



Thank you! Questions?