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Numerical Modeling: Where We Are and Where We're Going

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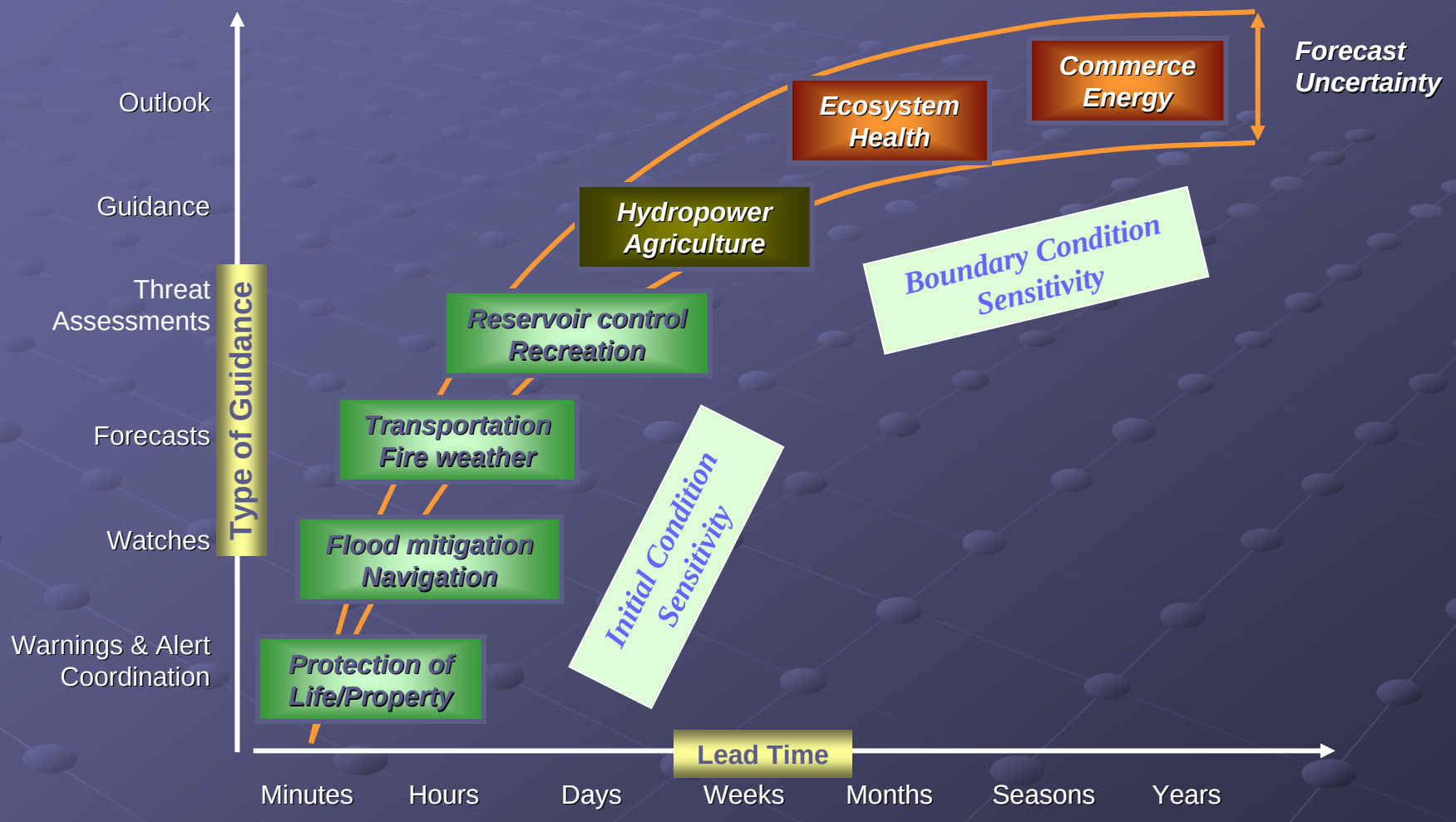
Where the Nation's climate and weather services begin

TOPICS

- Mission and Role of Model Guidance
- NCEP Operational Production Suite
- Sources of Model Uncertainty
- Recent Changes in NCEP Modeling Systems and Plans
- Model Data Products and Access
- Future Directions

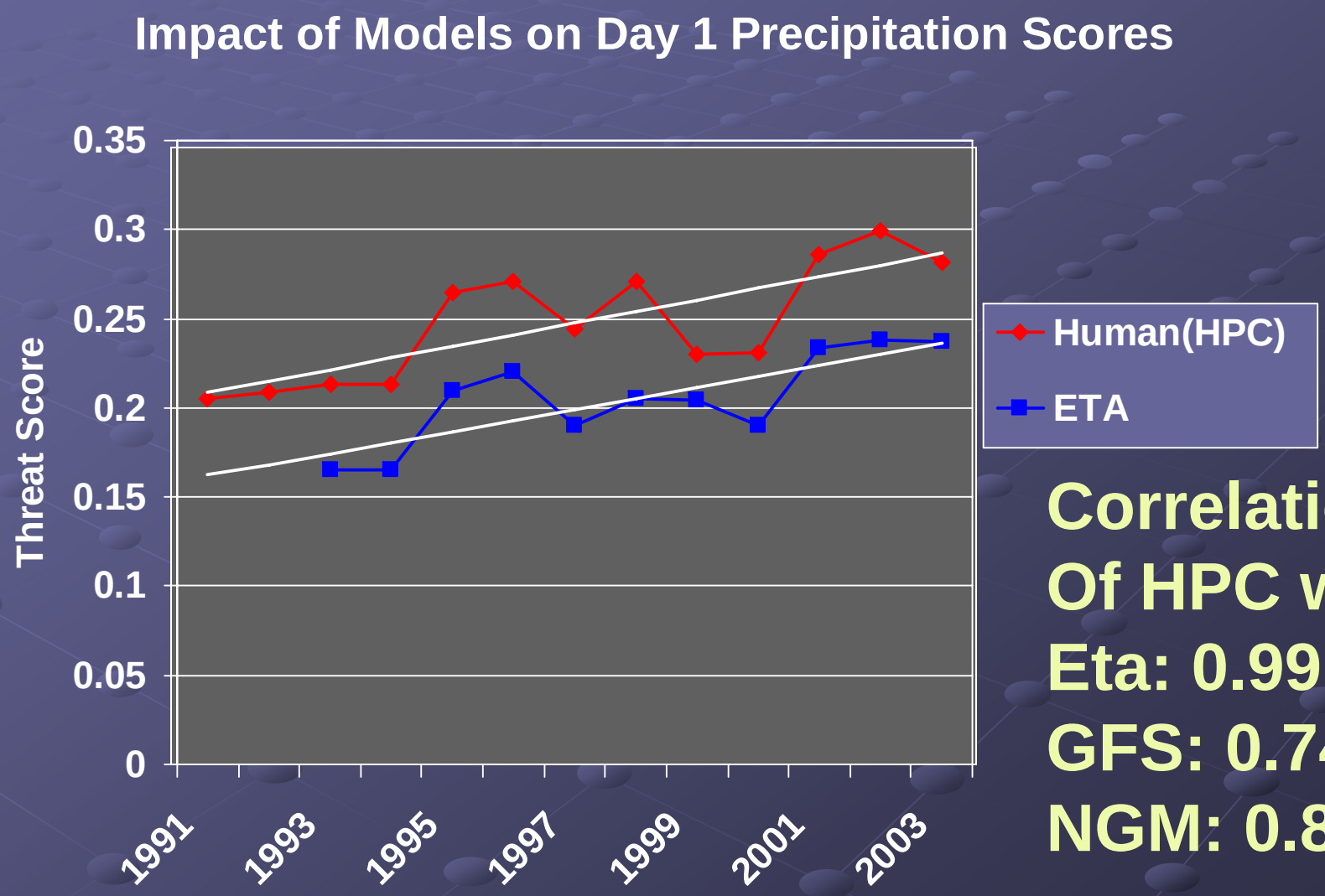
Seamless Weather/Climate Forecast Suite

EMC provides the numerical model guidance upon which the *forecasts* are based.



Why Models?

"As go the models, so go the forecasts"

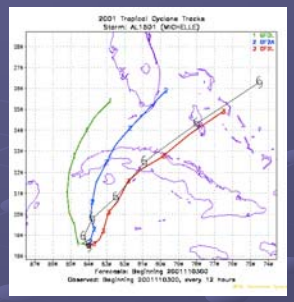


Correlations Of HPC with:
Eta: 0.99
GFS: 0.74
NGM: 0.85

2006-2009 NCEP Production Suite Atmospheric Model Dependencies

GENS
NAEFS

Hurricane WRF
GFDL

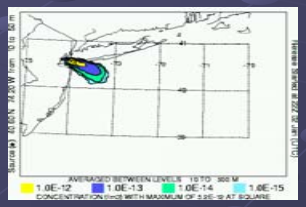


G
G
S
I

GFS

SREF
WRF-NMM
WRF-ARW
ETA
RSM

Dispersion
HYSPLIT



CFS

R
G
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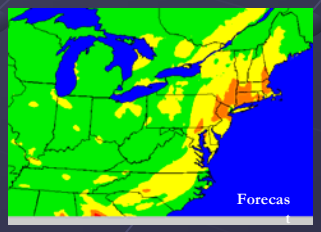
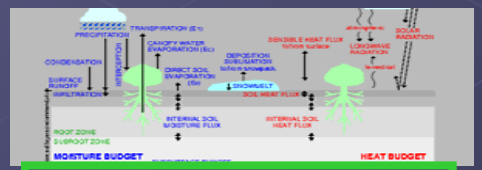
NAM-WRF

Sev Wx
WRF-NMM
WRF-ARW

Air Quality
w/ WRF Chem

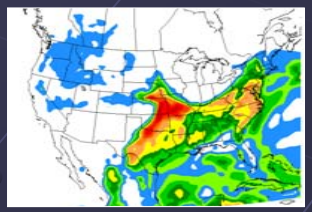


NOAH Land Surface Model



L D A S

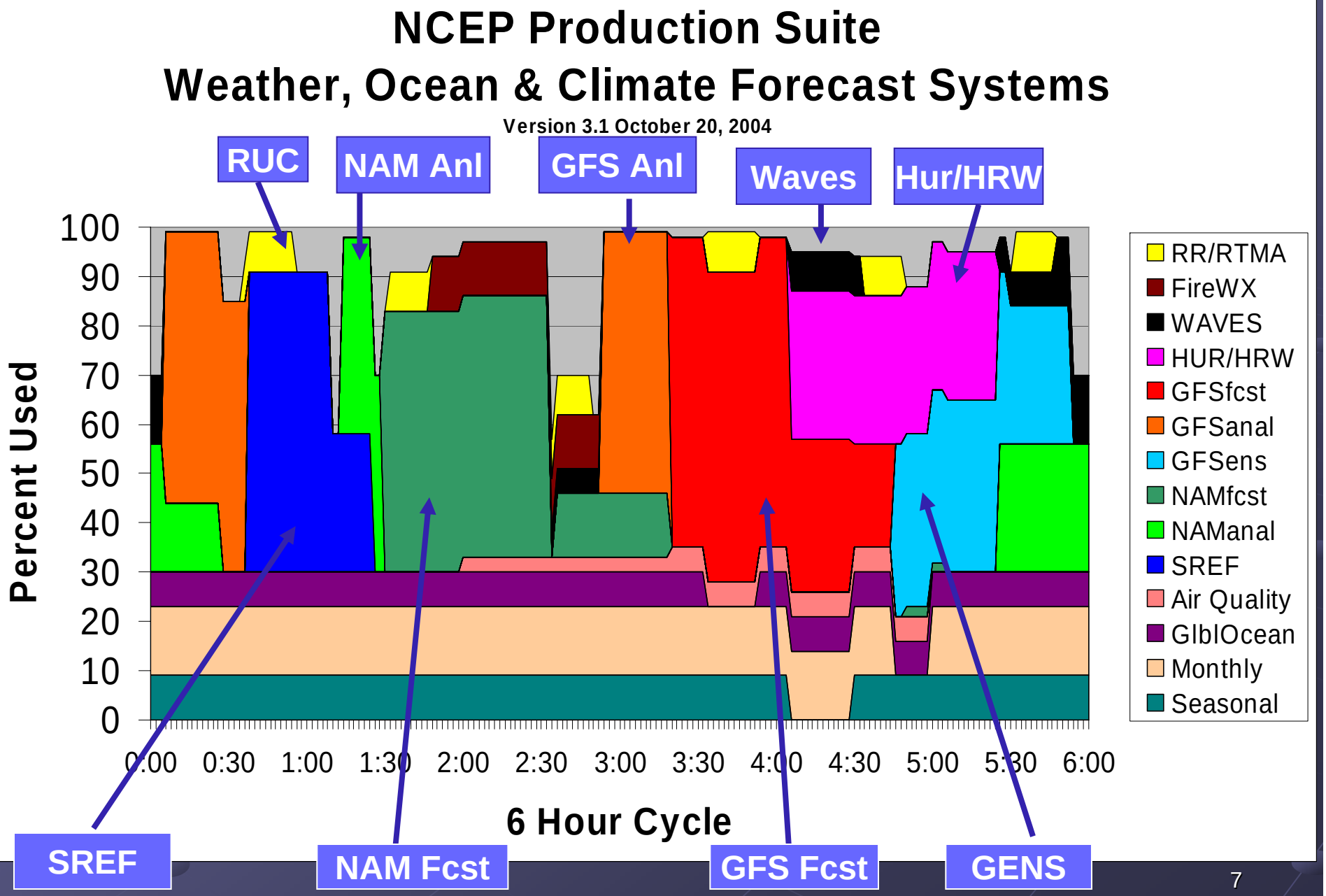
RUC / Rapid
Refresh WRF



NCEP Operations:
A Few Words About The Computers

- NCEP's New Central Computer System
  - 2496 processors per machine
    - IBM's 5th Generation Power+ Series
    - 1.9 GHz clock speed
  - 156 IBM pSeries 575 Nodes
    - 16 physical (32 logical) cpu per node
    - 32 Gbytes of Memory per node
    - 2 links per node to high performance switch
- Two machines - 18 TFlops peak each
- Increasing to 2 x 54 TFlops ~late 2009

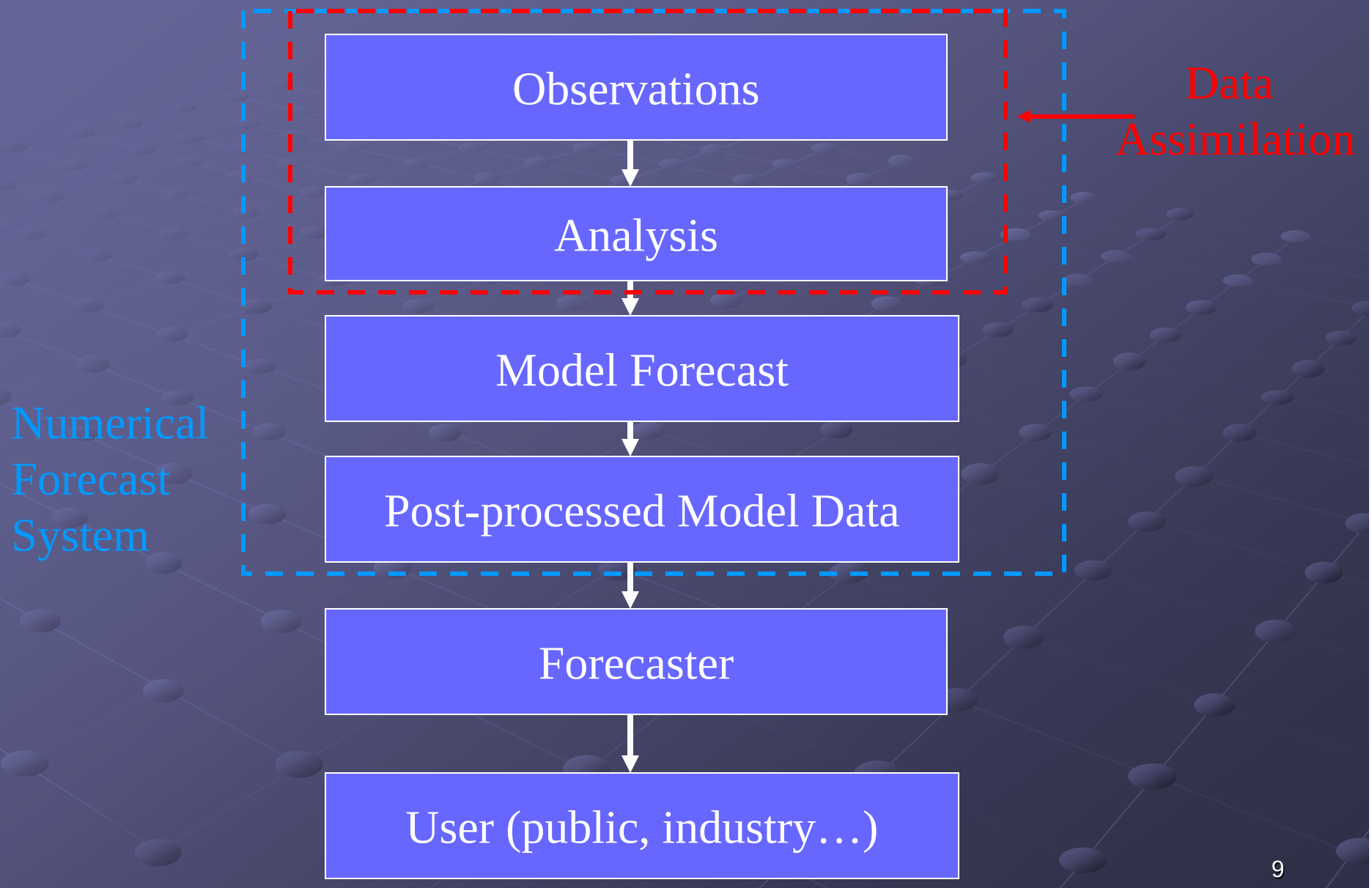
The Jigsaw Puzzle



Limitations of Numerical Forecast Systems

- Sources of Model Uncertainty Are Identical to the Ingredients We Are Working on Constantly to Improve Our Numerical Forecast Systems
  - **Initial conditions**
  - **Resolution**
  - **Prediction Model**

The Environmental Forecast Process



NASA-NOAA-DOD Joint Center for Satellite Data Assimilation (JCSDA)

- **Mission**
  - **Accelerate and improve the quantitative use of research and operational satellite data in weather and climate prediction models**
    - **Current generation data**
    - **Prepare for next-generation (NPOESS, METOP, research) instruments**
- **Supports applied research**
  - **Partners in NOAA, NASA, DOD**
  - **University, Government and Commercial Labs**

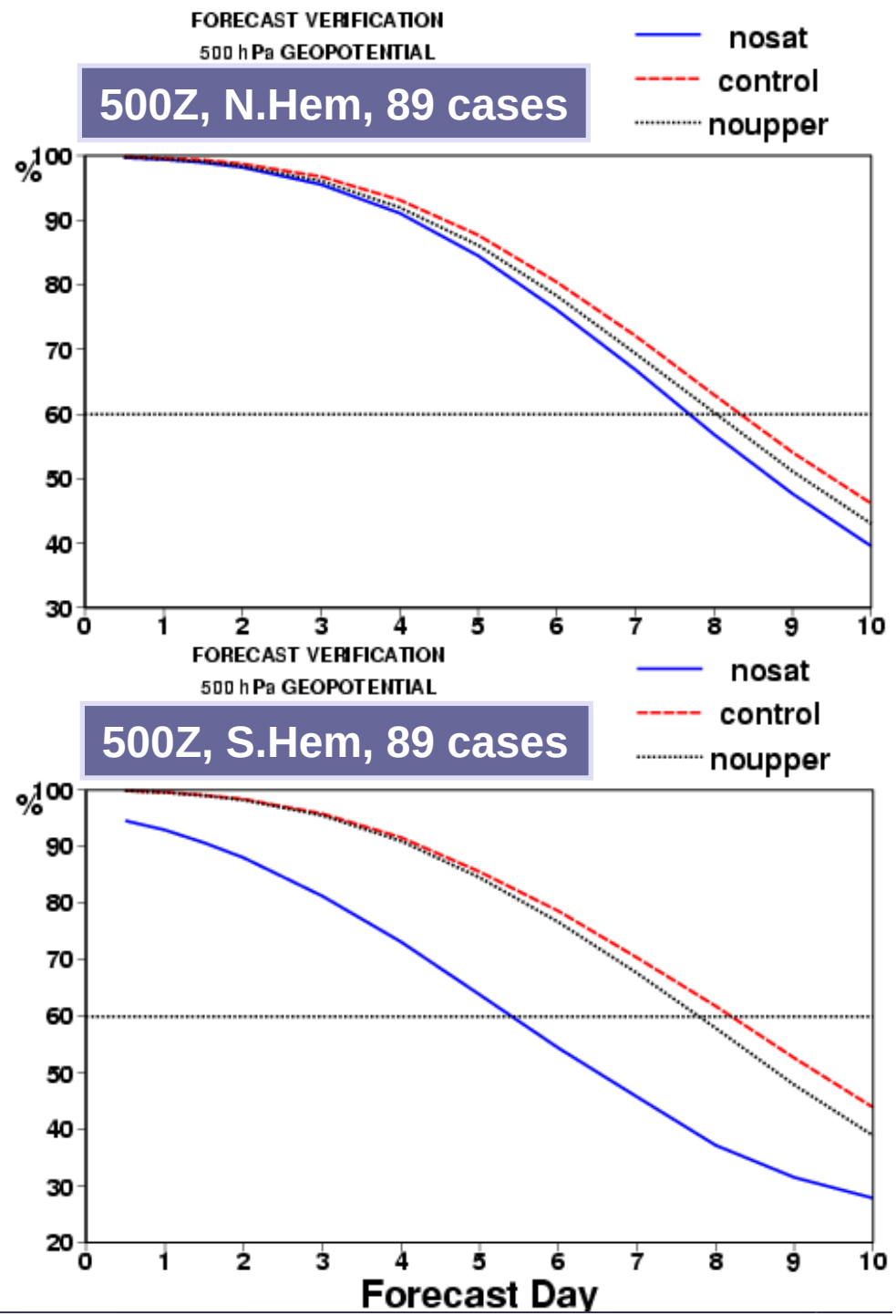
Assimilation of Satellite Radiances Now Has Larger Impact on Accuracy of Model Guidance Than Assimilation of Radiosonde+ Observations

Observing System Experiments
(ECMWF - G. Kelly et al.)

NoSAT= no satellite radiances or winds

Control= like operations

NoUpper=no radiosondes, no pibal winds, no wind profilers



GSI (Gridpoint Statistical Interpolation) NCEP's Next Generation Analysis

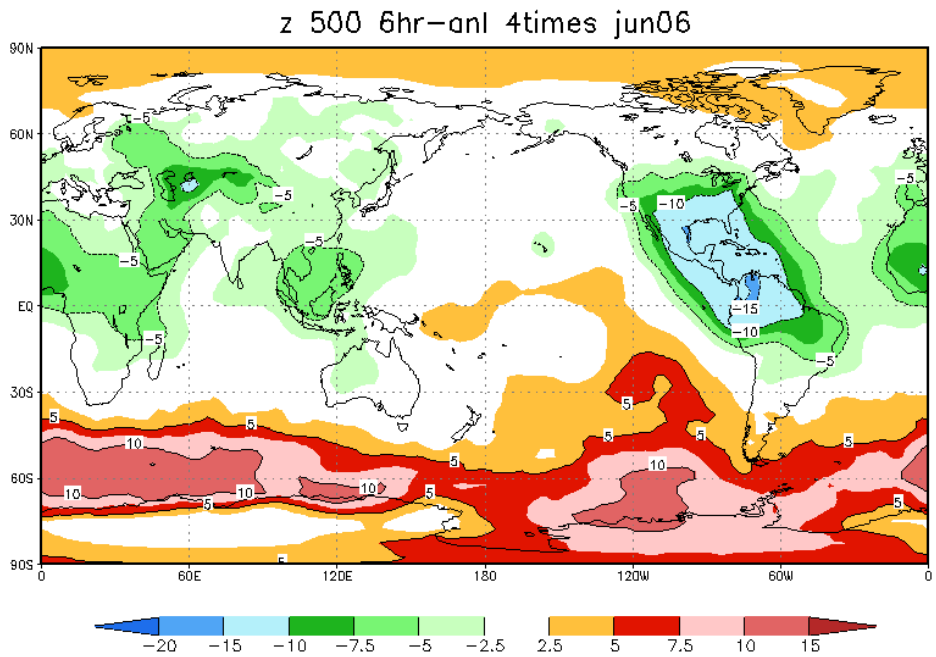
- Concentrates analysis development on a single unified analysis system
- GSI is an evolutionary combination of global (SSI) and regional (Eta) 3DVAR analysis systems
- Will add temporal components to GSI that will approach 4DVAR capability but at ~3DVAR expense.

GSI Analysis System

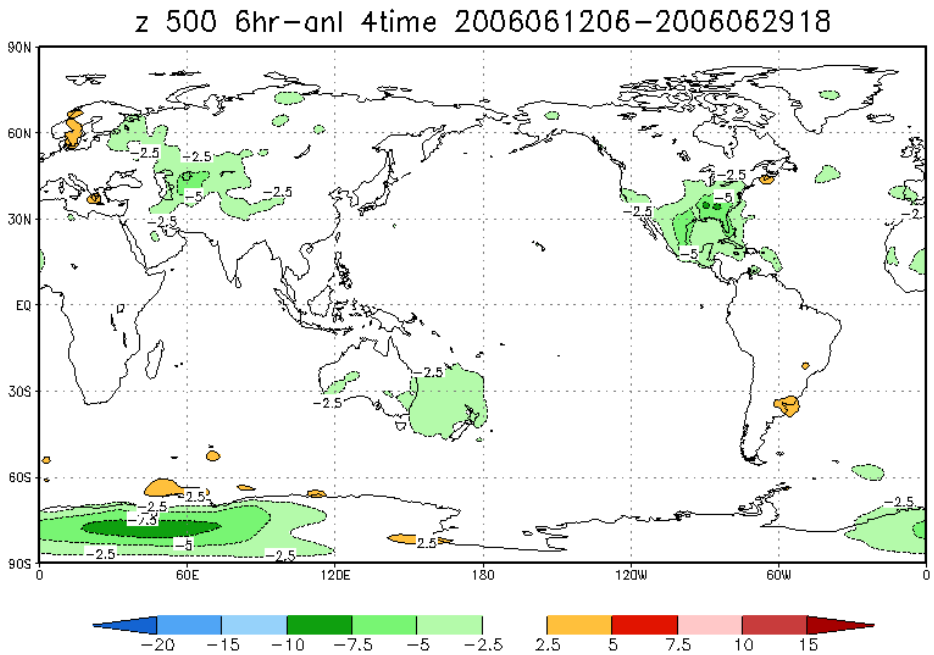
- A grid space definition of the background errors is used to allow the use of situation dependent (anisotropic) background errors
- The GSI is a *multipurpose* system for use to address
  - Global forecast problem
  - Regional/Mesoscale forecast problem
  - Rapid Update system
  - Surface Analysis/verification system
  - Research problems
- The GSI analysis system is basis for our collaborative work with other groups.
  - F90/95 structures and utilities
  - Improved efficiency
    - Redesigned data distribution
    - Some OpenMP
  - Better documentation
  - Less dependency on IBM

6 hr Forecast Error Reduced Using GSI – June 2006

Operations



GSI Parallel



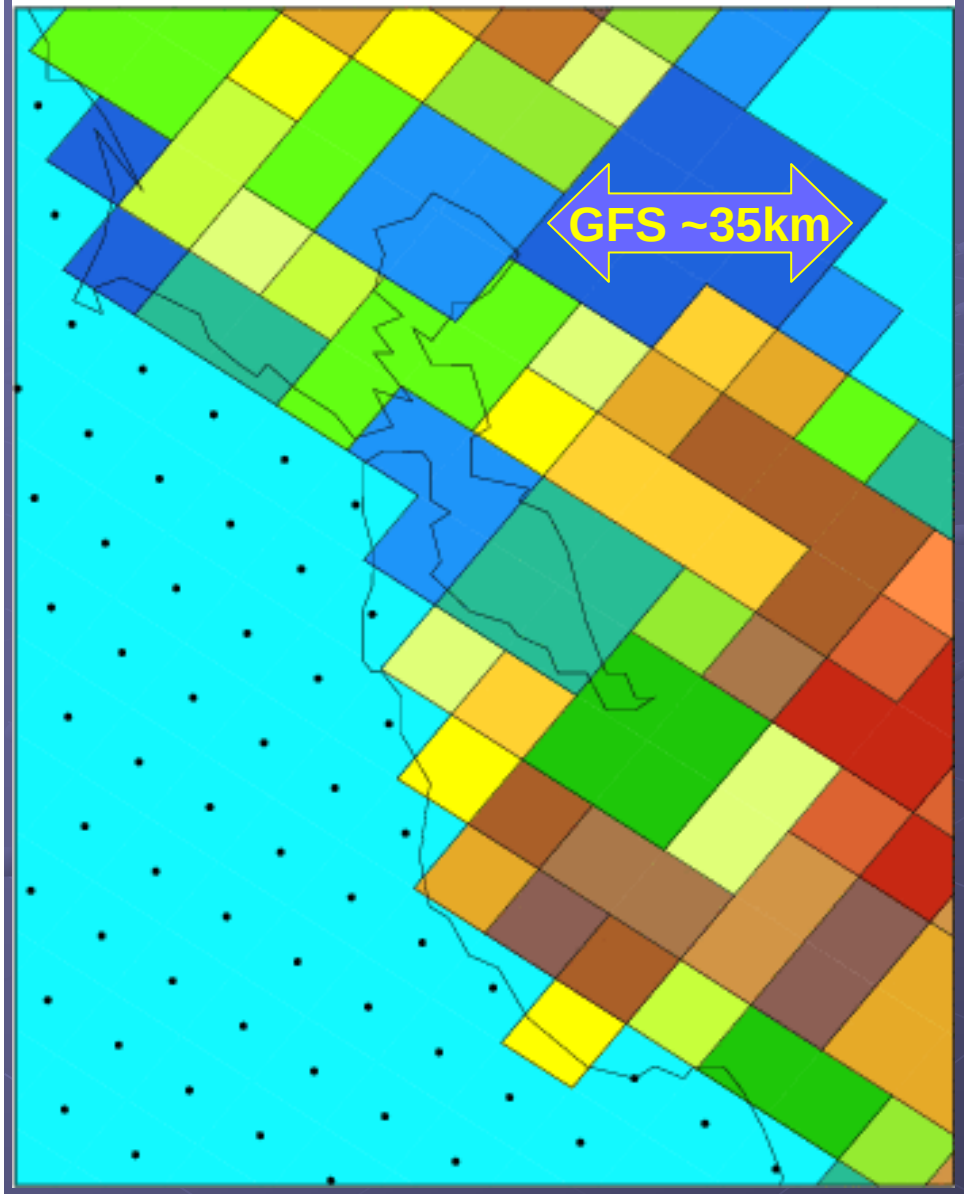
SSI – large 6 h fcst error but Smaller error beyond 48 h

GSI – well balanced increment Fields lead to small 6 h error

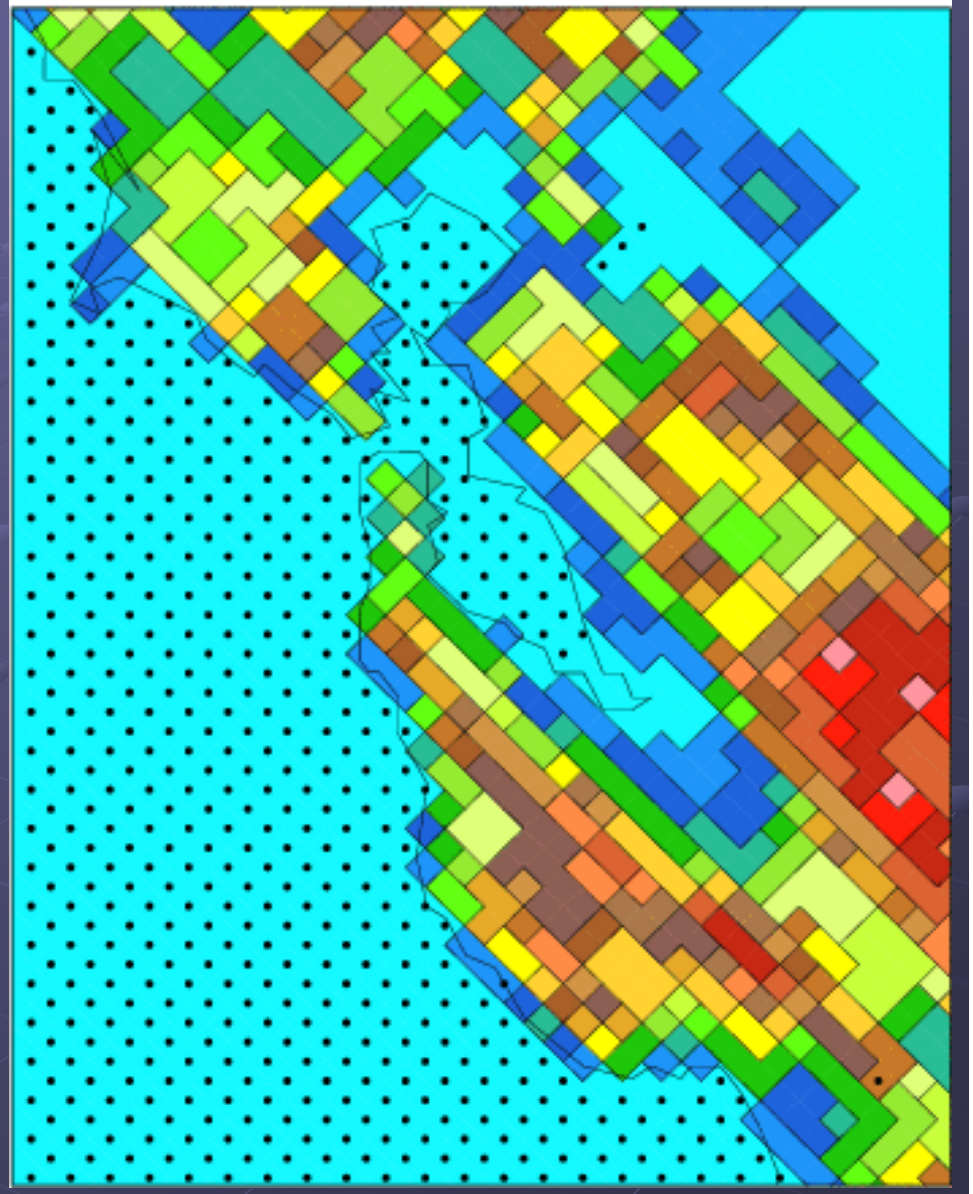
Resolution

- More is ALWAYS better
- Grid spacing is driven by computer power
  - To reduce a model's grid spacing by half requires 8X computer power (to run in same time window)
- Grid spacing does not equal resolution
  - For atmospheric features to be properly simulated, they need to be covered by 10 grid points
- Unresolved physical features (like terrain & coasts etc) can not easily be parameterized

12 km Terrain

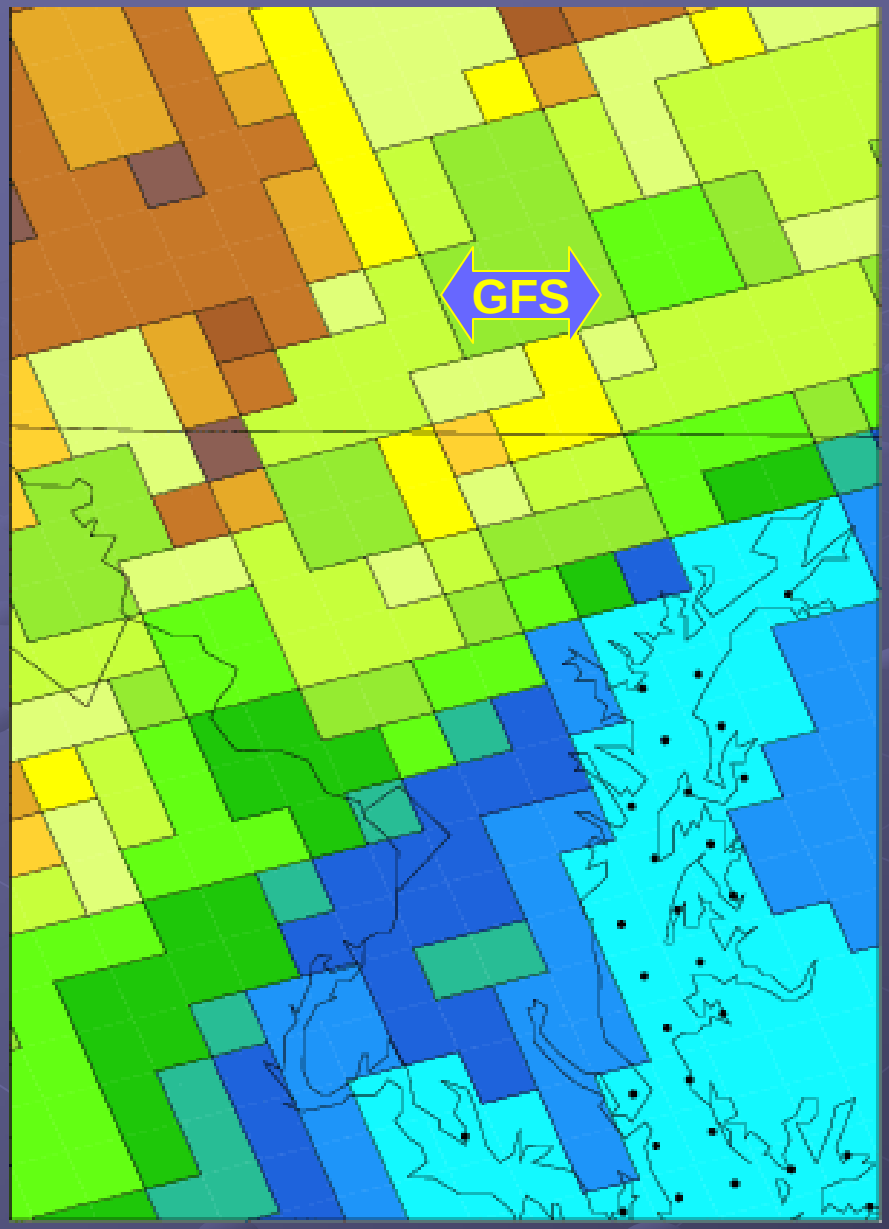


4 km Terrain

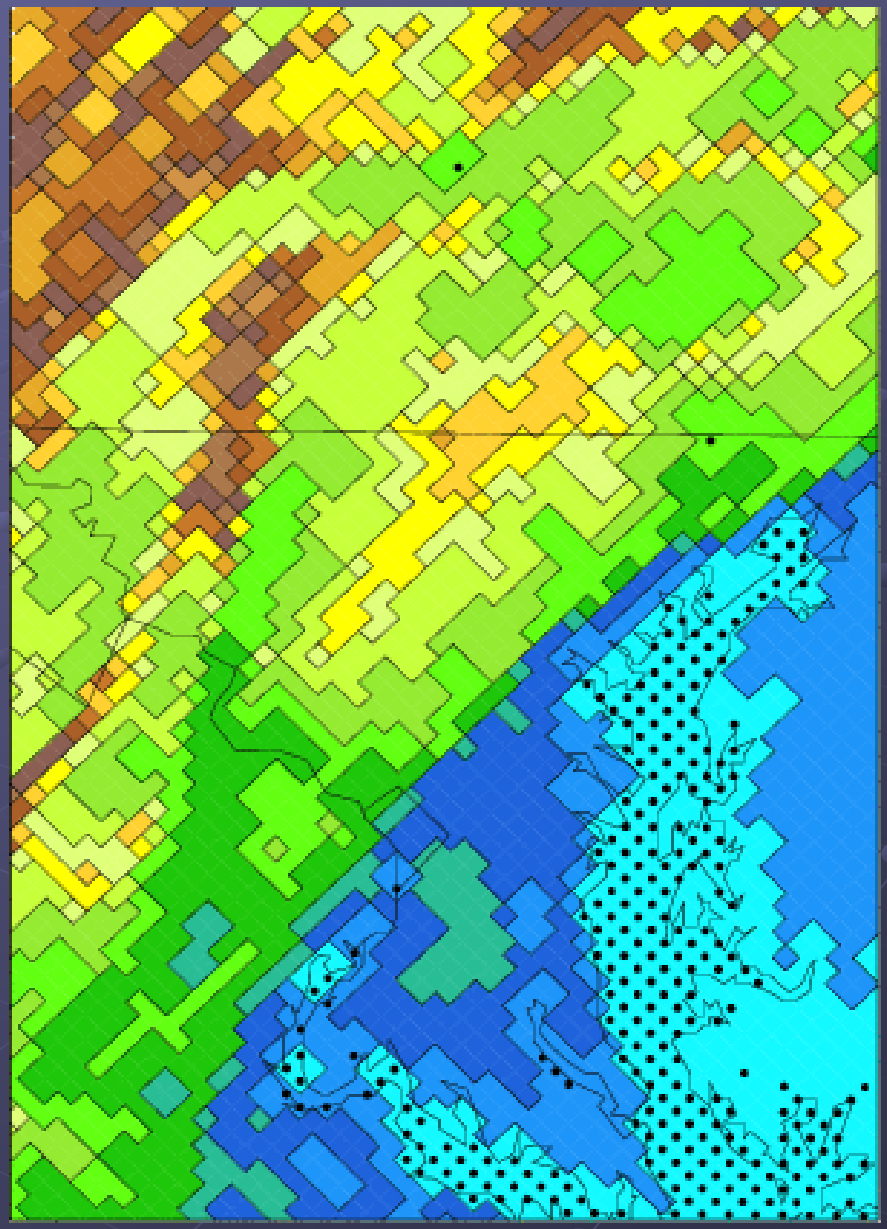


Dots represent water points Domain is San Francisco Bay

12 km Terrain

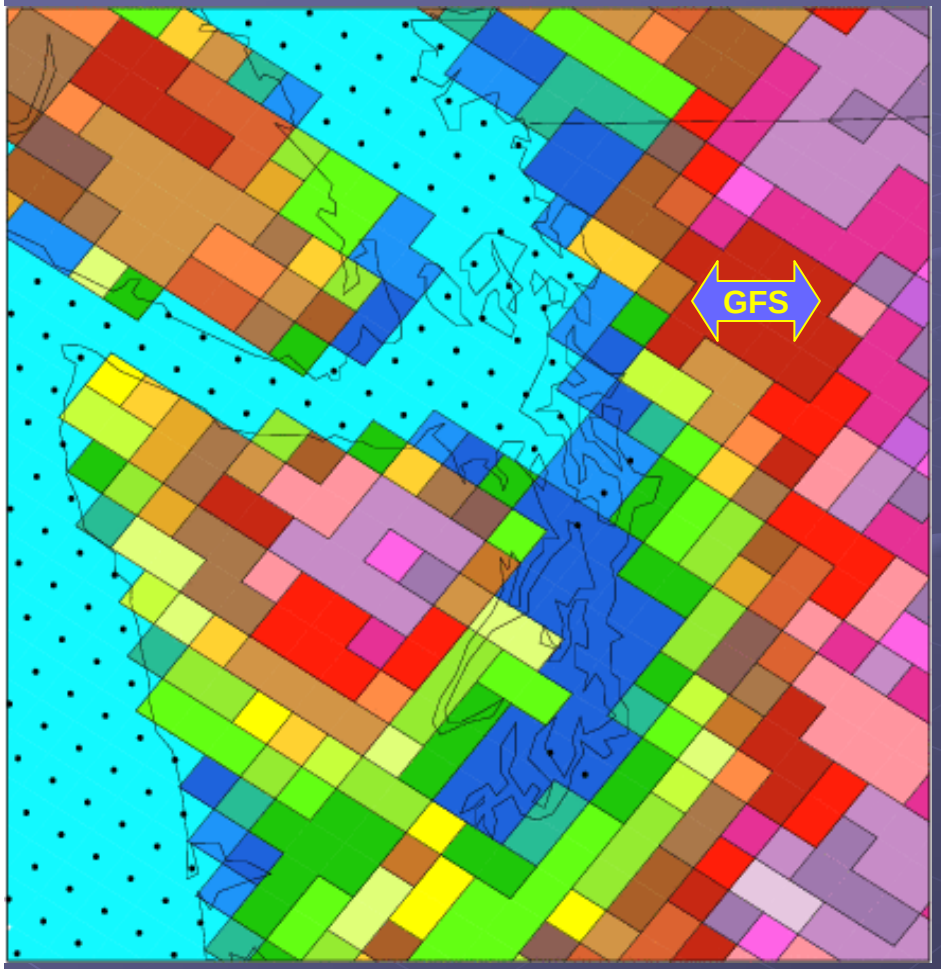


4 km Terrain

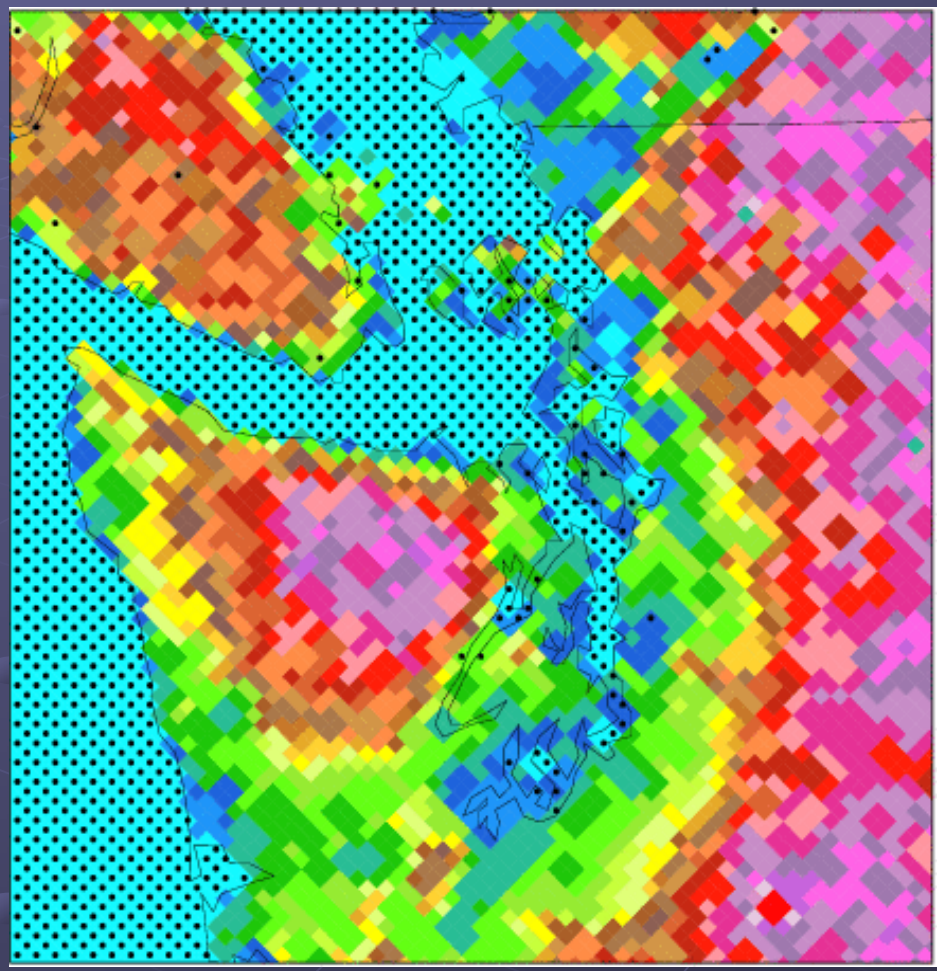


Dots represent water points Domain is Chesapeake Bay

12 km Terrain



4 km Terrain

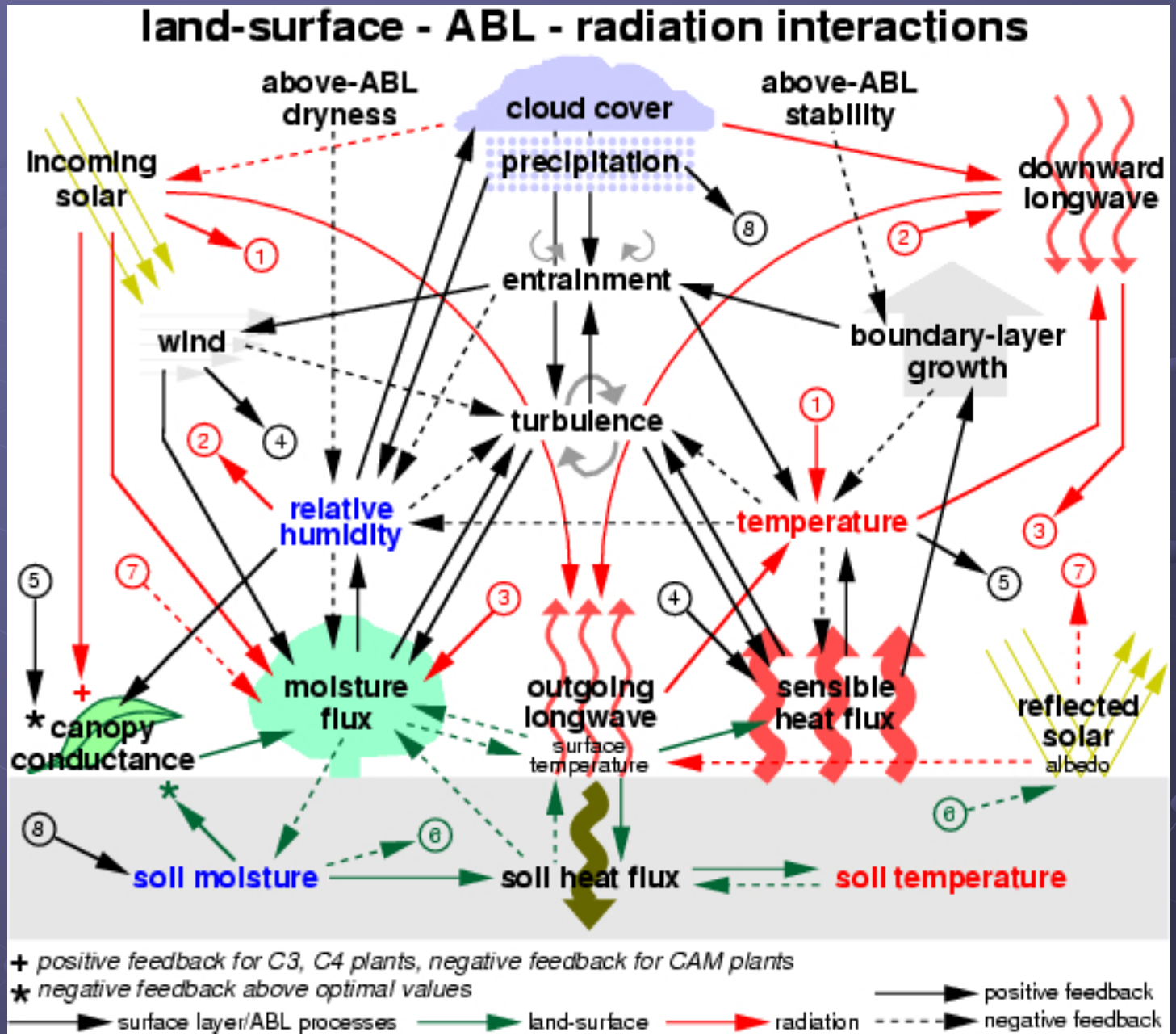


Dots represent water points Domain is Puget Sound

Limitations in Model Formulation

- Dynamics
  - Grid layout, diffusion, advection, time-stepping etc
  - Numerical techniques and approximations
  - Dependent on grid-spacing
  - Nonhydrostatic dynamics are important whenever there are strong vertical motion and accelerations
- Physical Parameterizations
  - Represent unresolved physical processes
  - Inherently lack accuracy & universal applicability

PHYSICS "WHEEL OF PAIN"



Uncertainty Can Be Estimated From Ensemble Forecasts

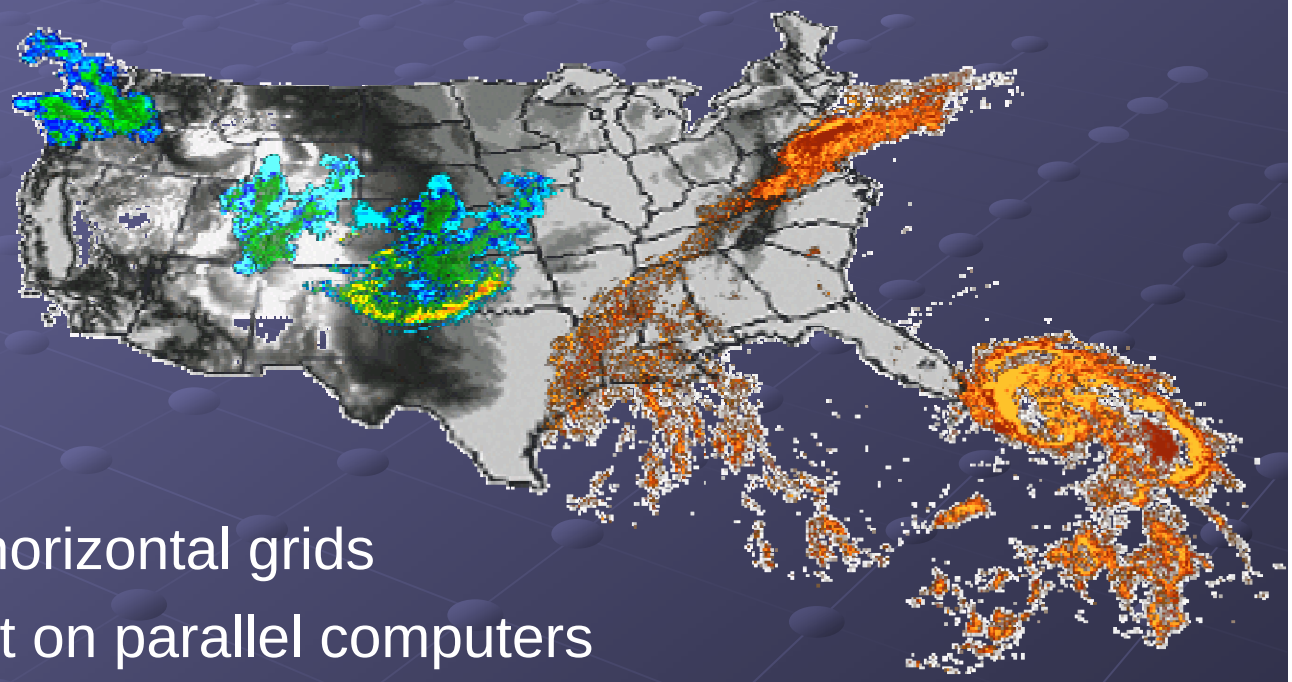
- Uncertainty of Model Forecast
- Uncertainty of Atmospheric Regime
- Accurate Estimates of the Complete Probability Density Function Can Be Obtained From A Well Calibrated Ensemble Forecast System
- NCEP Runs:
  - Short Range Ensemble Forecast (SREF)
  - Global Ensemble System (GENS)
  - North American Ensemble Forecast System (NAEFS) with Canada and Mexico

Recent Operational Changes in Regional Modeling

- Weather research and Forecast (WRF) common modeling infrastructure
  - HiResWindow – NMM & ARW at ~5 km explicit convection June 2005
  - SREF – added 3 NMM & 3 ARW members at ~40 km December 2005
  - NAM: 12 km WRF-NMM replaces Eta and GSI replaces Eta 3DVar – June 2006
  - NAM updates in Aug., Sept. & Dec. 2006
- Real-Time Mesoscale Analysis (RTMA)

Weather Research and Forecast (WRF) Modeling System

- Develop an advanced mesoscale forecast and assimilation system
- Promote closer ties between research and operations



Concept:

Design for 1-10 km horizontal grids

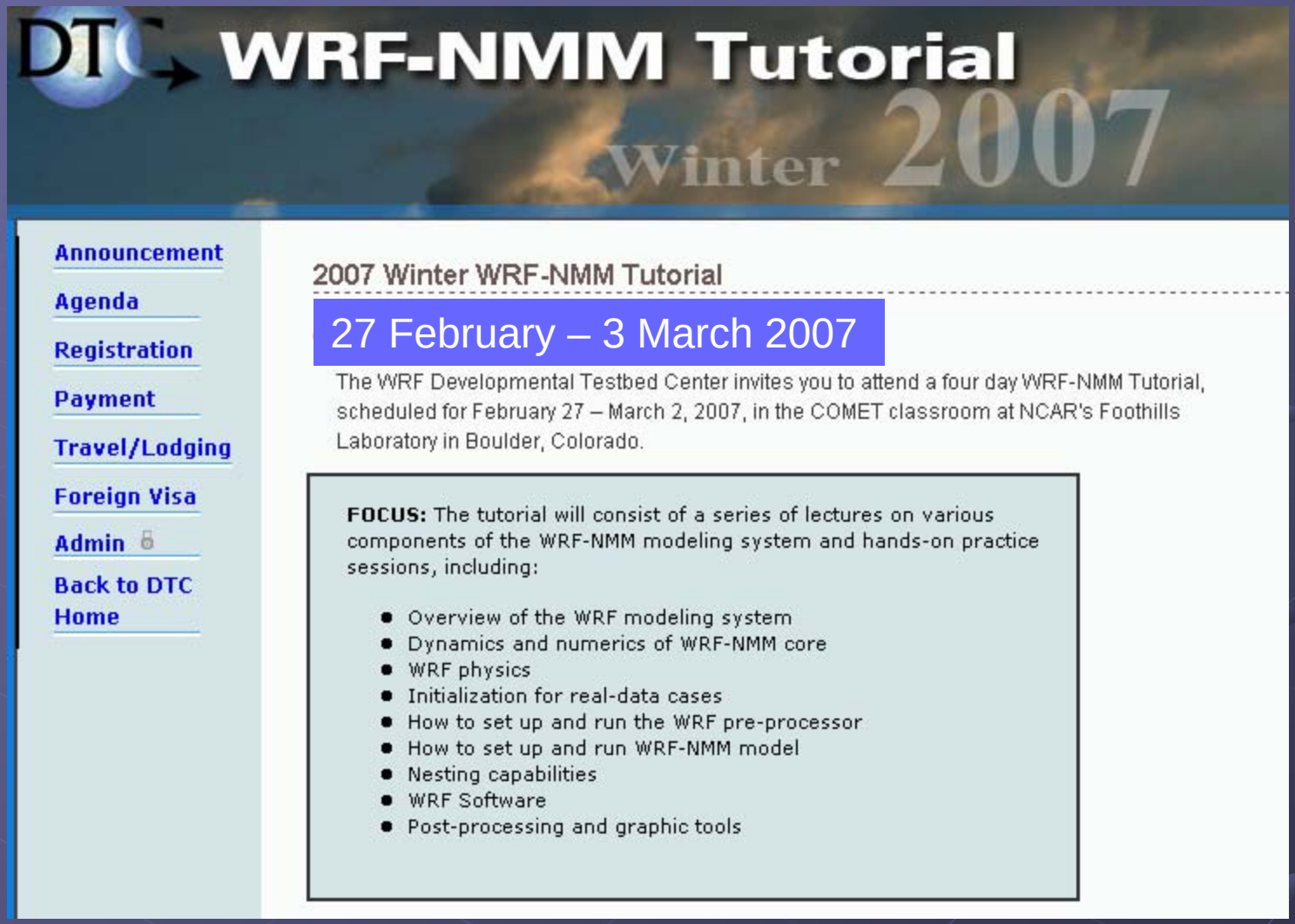
Portable and efficient on parallel computers

Well suited for a broad range of applications

Community model with direct path to operations

Collaborators: NCAR, NCEP/EMC, AFWA, Navy, NOAA/FSL, U. Okla.

Registration Deadline Extended



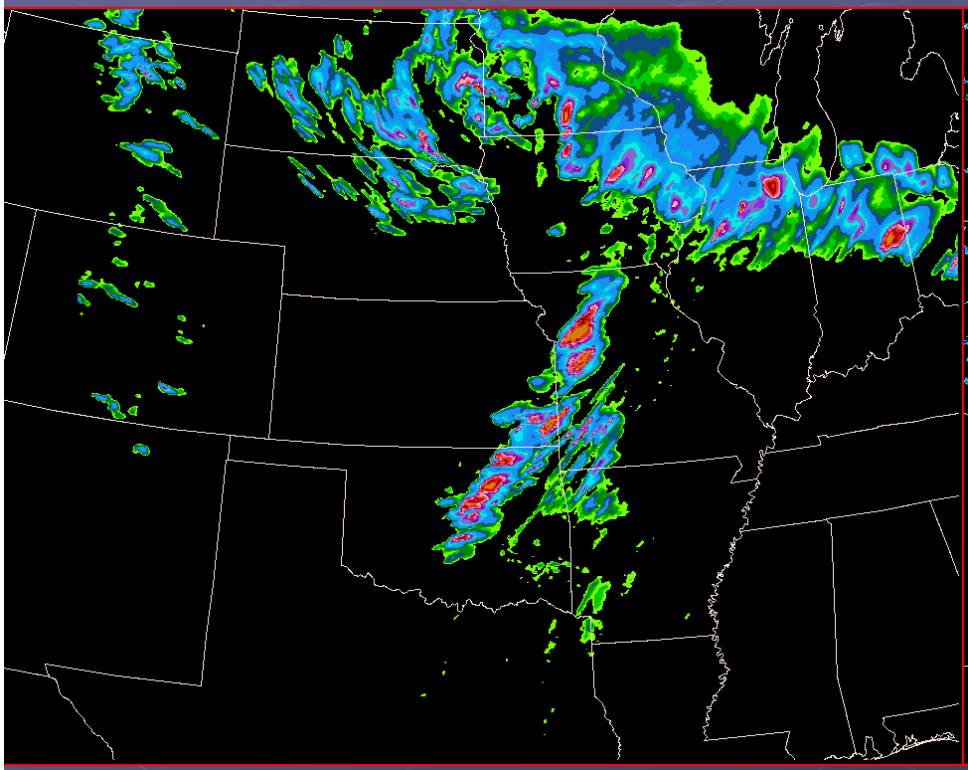
http://www.dtcenter.org/events/tutorial07_winter/index.html

Example of Explicit WRF-NMM

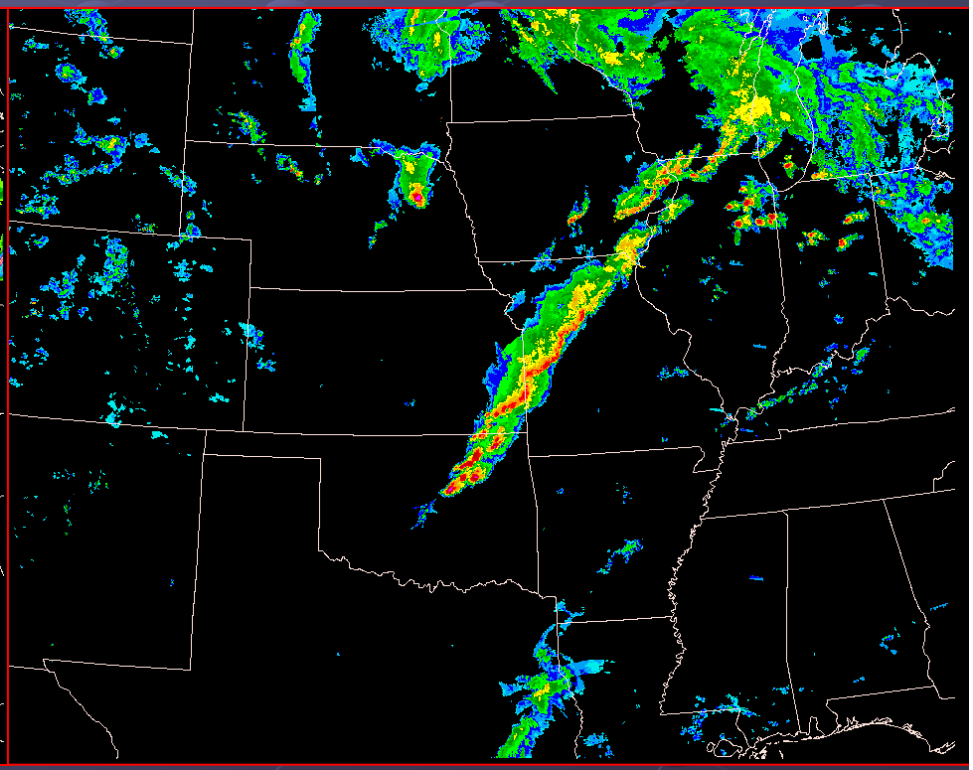
courtesy of NSSL's Jack Kain

WRF 24 hour 4.5 km forecast of 1 hour accumulated precipitation valid at

00Z April 21, 2004 (better than 12 hour forecasts by operational models)



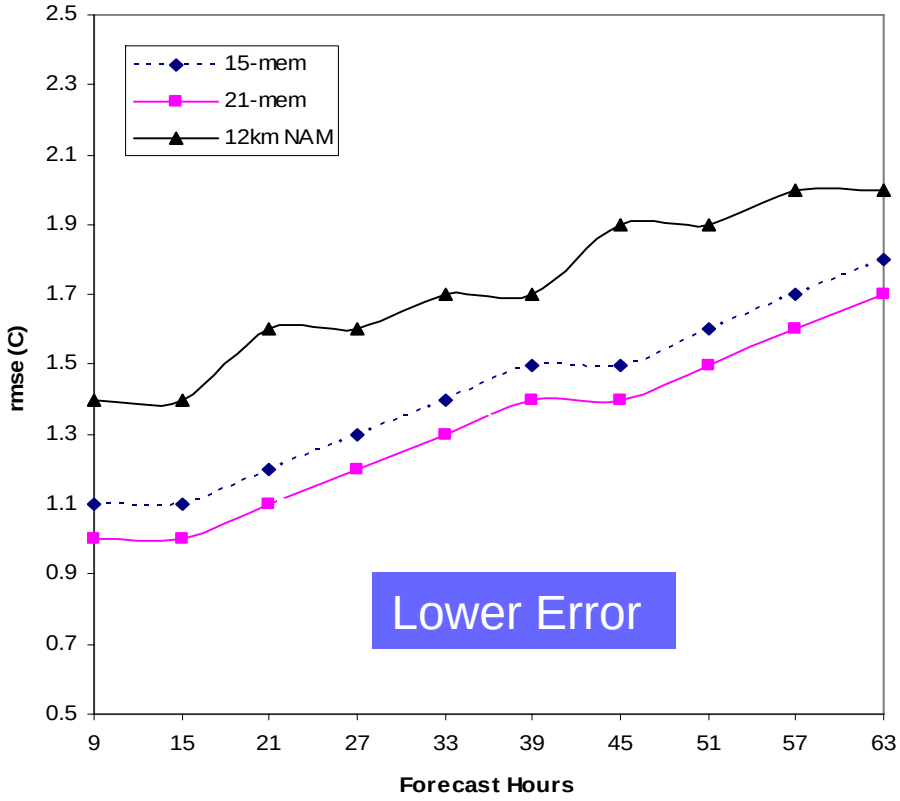
4.5 km WRF-NMM



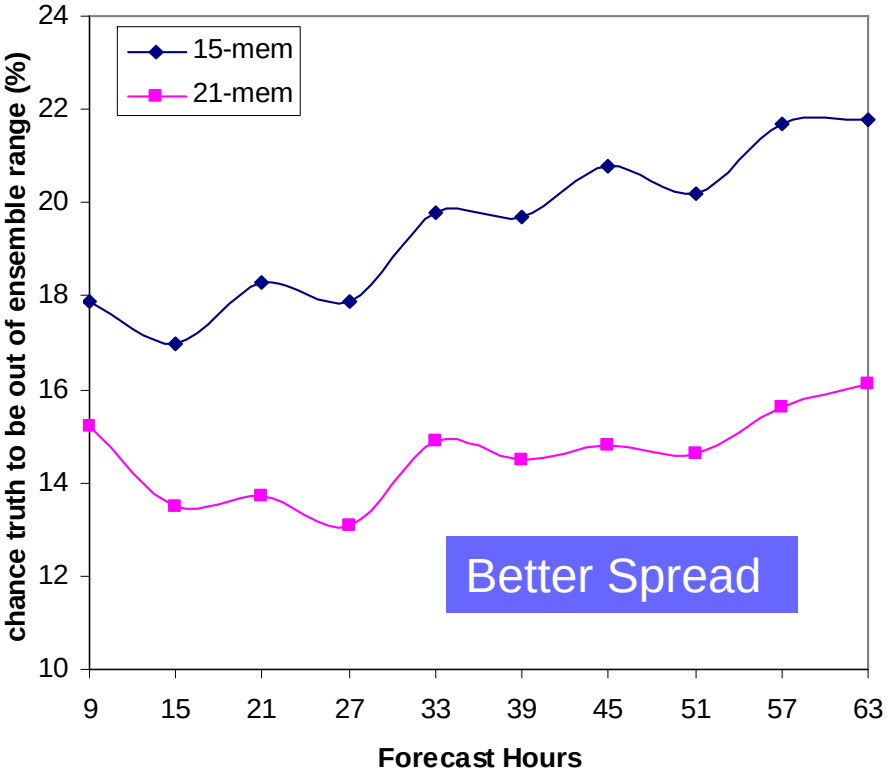
Verifying 2 km radar reflectivity

SREF Enhancement with 6 WRF-based Members

RMS Error



Chance that truth is outside ensemble range



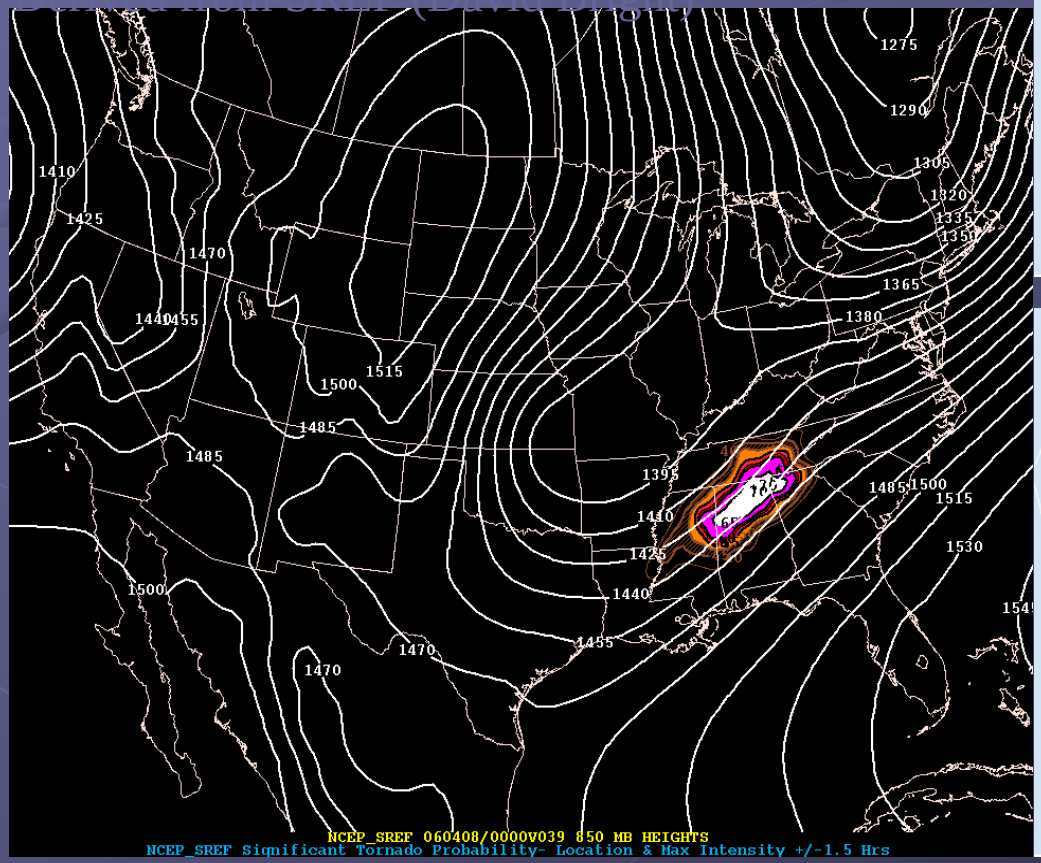
http://wwwt.emc.ncep.noaa.gov/mmb/SREF/SREF.html

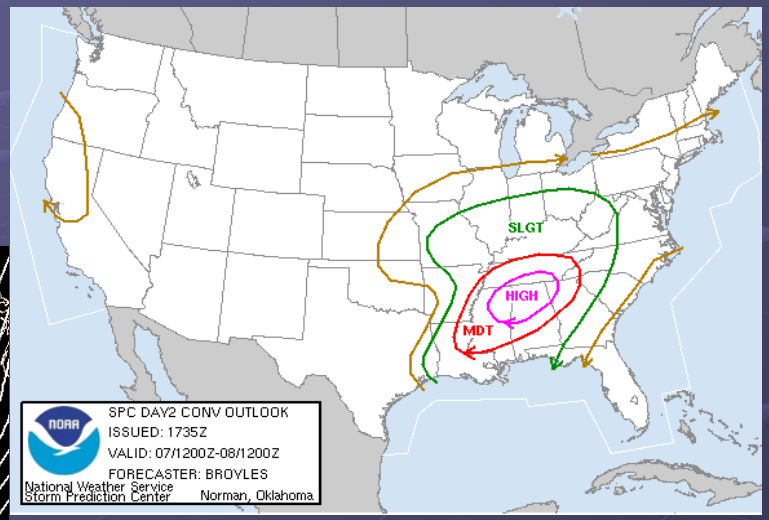
SREF Guidance Contributes to SPC *First-Ever* Day-2 High Risk Outlook for April 7, 2006

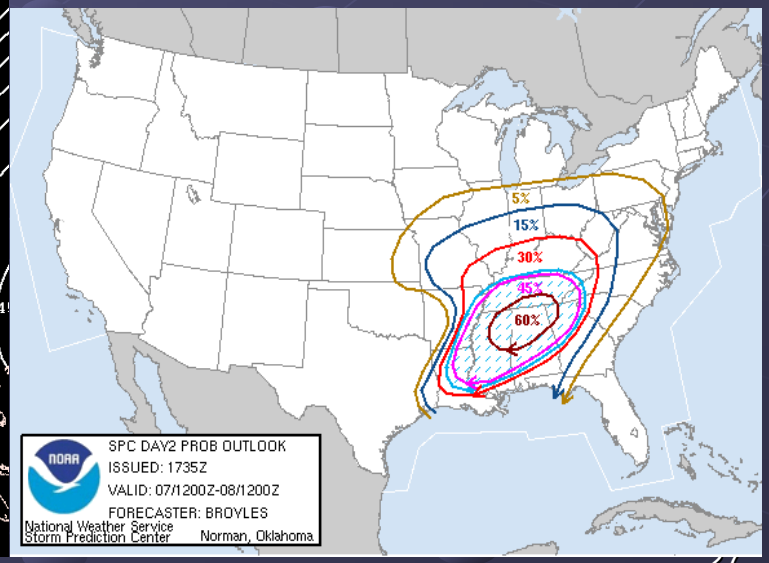
over 60 tornadoes observed!

SREF Guidance

Significant Tornado Probability forecast
Derived from SREF (David Bright)







20 June 2006 NAM

http://www.emc.ncep.noaa.gov/WRFinNAM/Update_WRF-NMM_replacing_Eta_in_NAM2.pdf

- **Replace Eta Model with WRF version of Nonhydrostatic Mesoscale Model (NMM)**
  - WRF Common Modeling Infrastructure
  - Non-hydrostatic dynamics
  - Use of hybrid sigma-pressure vertical coordinate
  - Extended model top to 2 mb
  - Refined advection, diffusion, numerics and physics
- **Replace Eta 3D-Var analysis with Gridpoint Statistical Interpolation (GSI) analysis**
  - Unified (regional+global) 3D-VAR analysis adapted to WRF
  - Begin use of background errors based on WRF-NMM to 2 mb
  - Use of new moisture analysis variable(coupled to temperature)
  - Use of dynamically retuned observational errors

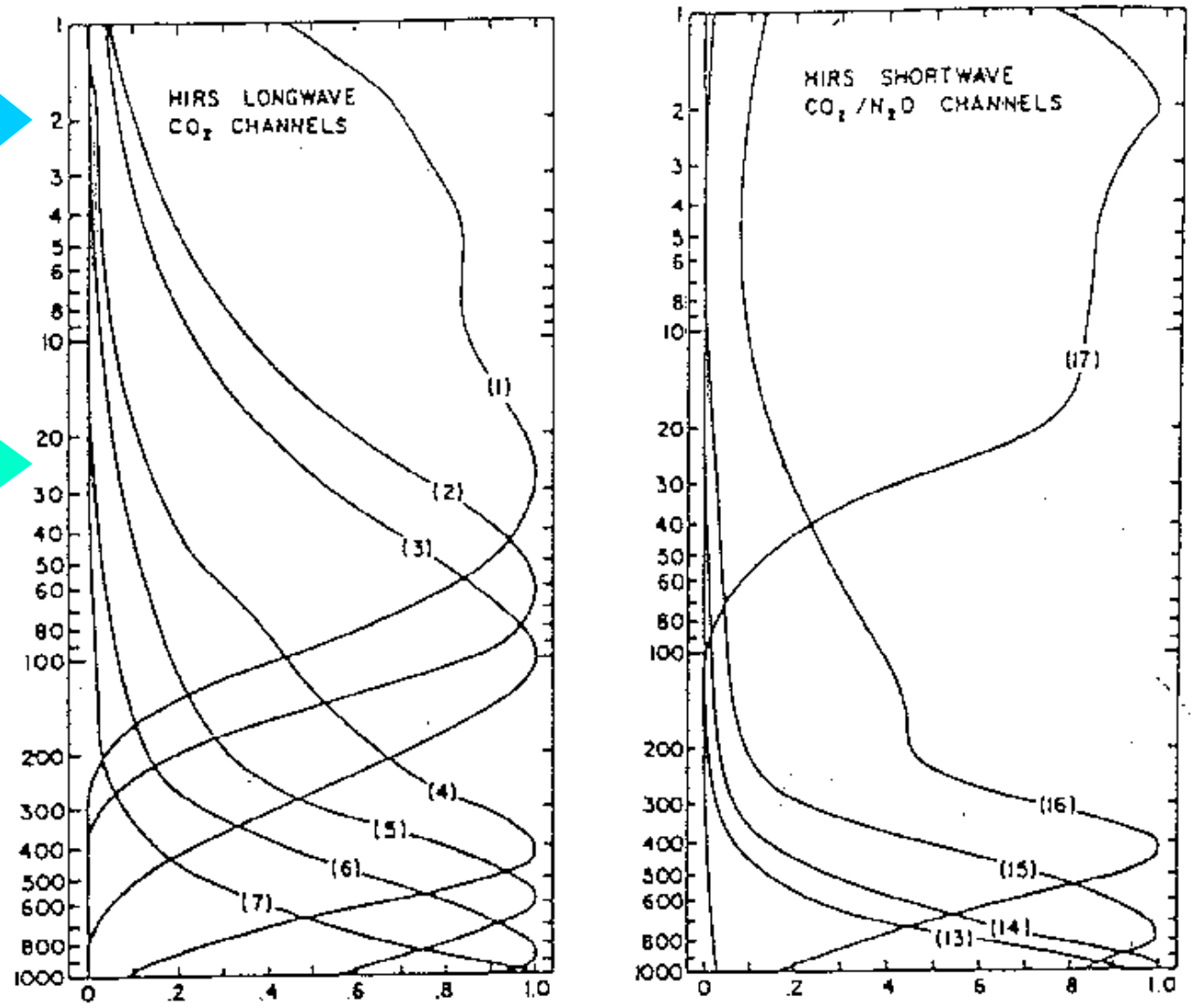
20 June 2006 NDAS

- Model initialization
  - Use of new unified (regional + global) package (George Gayno) for bringing in external fields for WRF-NMM
  - Begin use of high resolution (1/12th degree) SST
  - Begin use of high resolution (4 km) snow
  - Common specification of terrain, land-sea mask
- Data assimilation changes
  - Use of bias-corrected observed precipitation analysis values in land-surface physics (but without nudging T, moisture & cloud)
  - Start assimilating WSR-88D Level II radial wind data
  - Start assimilating GPS-Integrated Precipitable Water (IPW)
  - Start assimilating NOAA-18 radiances
  - Drop use of GOES Precipitable Water retrievals
  - Drop use of SSM/I Total Precipitable Water retrieval

TOVS/HIRS Satellite Channel Weighting Functions and Model Top Pressure

New top 2 mb

Old top 25 mb



Real-Time Parallel Stats

http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll/pll12stats.nmmx_01jan06-23may06/

1. PRECIPITATION THREAT AND BIAS SCORES

CONUS, 24-84 hour forecasts	Eastern US, 24-84 hour forecasts	Western US, 24-84 hour forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel

CONUS, 24-h forecasts	CONUS, 36-h forecasts	CONUS, 48-h forecasts	CONUS, 60-h forecasts	CONUS, 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel
Eastern U.S., 24-h forecasts	Eastern U.S., 36-h forecasts	Eastern U.S., 48-h forecasts	Eastern U.S., 60-h forecasts	Eastern U.S., 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel
Western U.S., 24-h forecasts	Western U.S., 36-h forecasts	Western U.S., 48-h forecasts	Western U.S., 60-h forecasts	Western U.S., 84-h forecasts
Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel	Eta-12 parallel

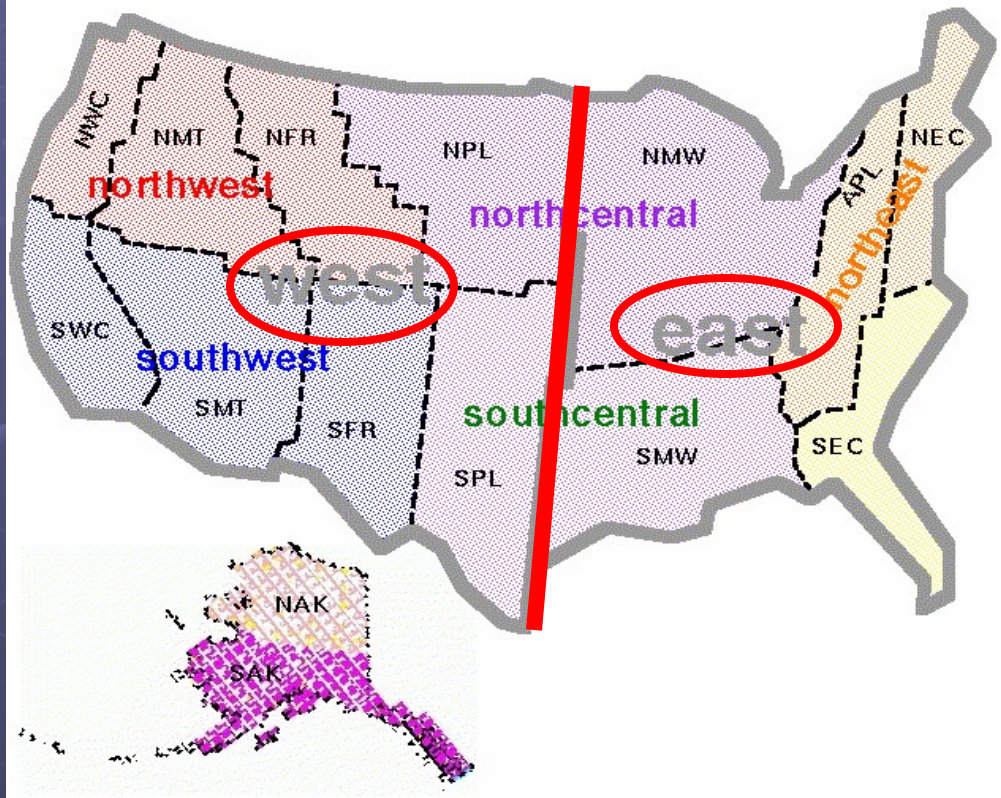
2. UPPER AIR RMS STATISTICS (12, 24, 48, 60, and 84-h forecasts)

CONUS vector wind	CONUS temperature	CONUS relative humidity	CONUS height
RMS error	RMS error	RMS error	RMS error
	Bias	Bias	Bias

Alaska vector wind	Alaska temperature	Alaska relative humidity	Alaska height
RMS error	RMS error	RMS error	RMS error
	Bias	Bias	Bias

3. NEAR-SURFACE STATISTICS

Verification Regions:



2-M Temperature 00Z CYCLE	2-M Temperature 12Z CYCLE	2-M Relative Humidity 00Z CYCLE	2-M Relative Humidity 12Z CYCLE	10-M Wind Speed (squared) 00Z CYCLE	10-M Wind Speed (squared) 12Z CYCLE
Eastern US	Eastern US	Eastern US	Eastern US	Eastern US	Eastern US
Western US	Western US	Western US	Western US	Western US	Western US
Alaska	Alaska	Alaska	Alaska	Alaska	Alaska

Real-Time Monitoring Webpage

http://www.emc.ncep.noaa.gov/mmb/mmbpll/nampll12_fullcyc_2mbtop/

All Evaluation Materials

http://www.emc.ncep.noaa.gov/WRFinNAM/

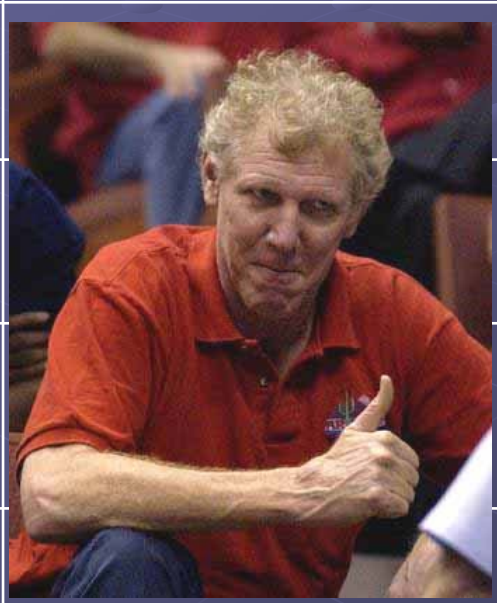
Performance Summary

- Upper-Air guidance overall comparable
  - Better than Eta at short range 12-36 hr
  - Tails off by 84 hours
- More realistic mesoscale structure than Eta
- Most surface variables and visibility improved with smaller biases than Eta
- More realistic oceanic and tropical cyclones

Remaining Issues

- Dry Drift with forecast range
- Over-deepening troughs
- Over active with tropical storms
- Unrealistically shallow pbl
- Very short-range Precip Spin-Down (convective)
- Turn overland surface temperatures back on
- Need for extra levels in solving the radiative transfer equations (for radiance assimilation)
- Extract more information from Level II radial winds

Subjective Evaluation Summary "Thumbs Up" From All

NCEP Center	Recommendation
AWC	
SPC	
HPC	
OPC	

Non-NCEP	Recommendation
Alaska Region	
Central Region	
Eastern Region	
Southern Region	
Western Region	
Air Quality Program	

Aug & Sept NAM Upgrades

- Diffusion – increase amount and allow at more points
- Redefine roughness length z0=z0base (veg component) + z0land, removing terrain height component
- Turn on assimilation of surface temperature data over land in the GSI
- Sea-Surface Temperature
  - Modified the SST preprocessing job to use new climatological values for **Great Salt Lake, Salton Sea** in southern California and **Fort Peck Reservoir** in Montana
  - Revert back to using the 1/2 degree RTG_SST analysis used in the NAM-Eta due to problems with a persistent cold bias in the hi-res (1/12th degree) RTG_SST analysis in and north of the Bering Strait and in Hudson's Bay

December 2006 NAM Upgrade

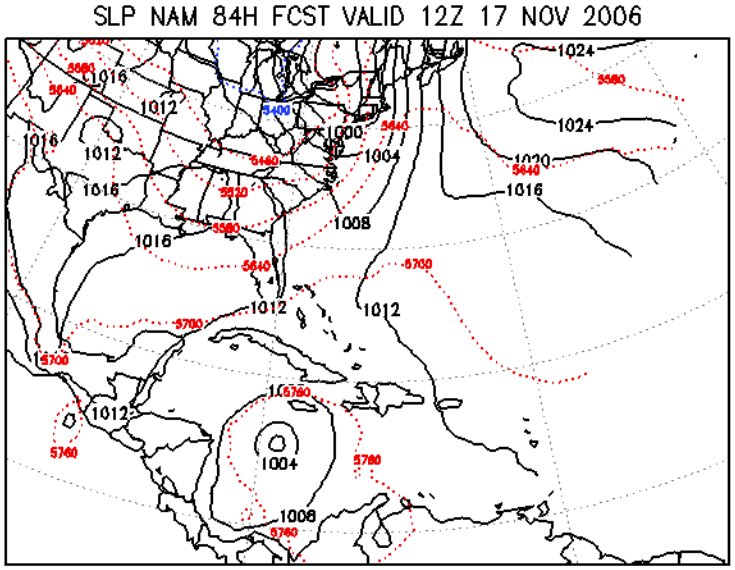
http://www.emc.ncep.noaa.gov/mmb/namchanges_dec2006/NAM_Upgrades.Nov2006.html

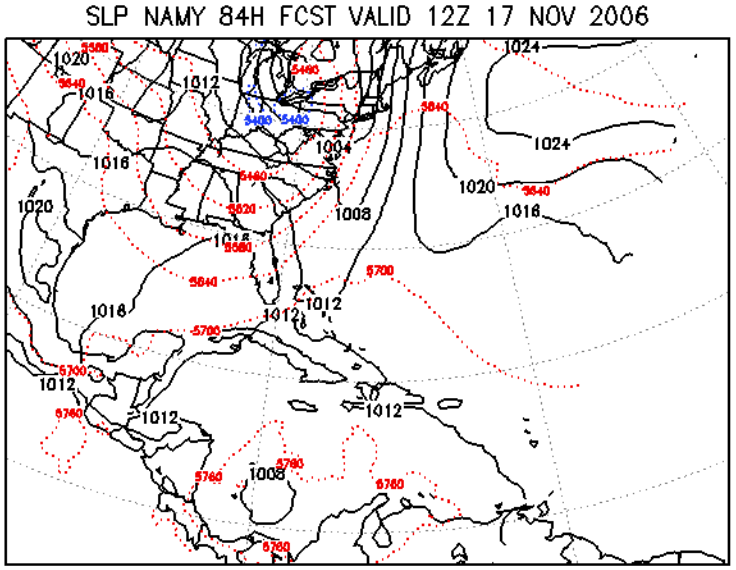
- Geared to address:
  - Overdevelopment of mid-latitude cyclones
  - Exaggerated “digging” of troughs too far south
  - Convection (deep & shallow) triggering issues
  - Overactive tropical cyclone behavior
- Parallel runs are:
  - In data assimilation: new divergence damper with extra damping of the external mode, applied (5x) more heavily in NDAS to reduce noise
  - Allow more points to experience diffusion
  - Tuning of convection and microphysics
    - Triggers adjusted for buoyant parcel point of view
    - Water-loading effects on buoyancy included
    - Microphysics tuned for more super-cooled water

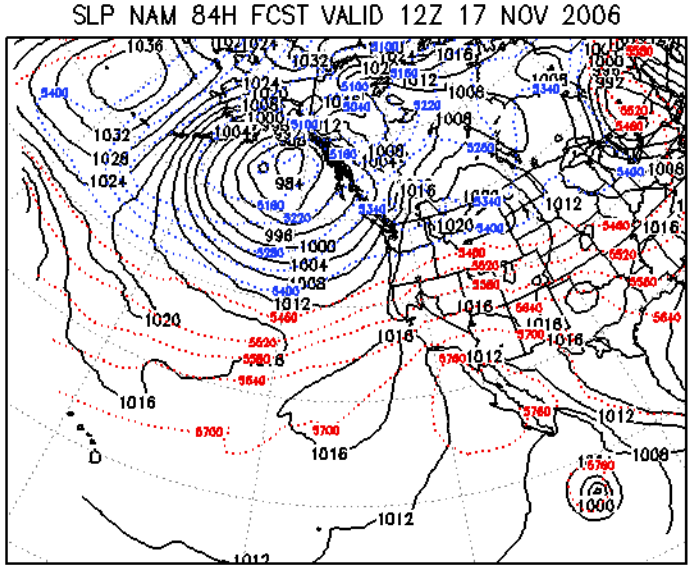
Dec 2006 NAM Upgrade Impacts

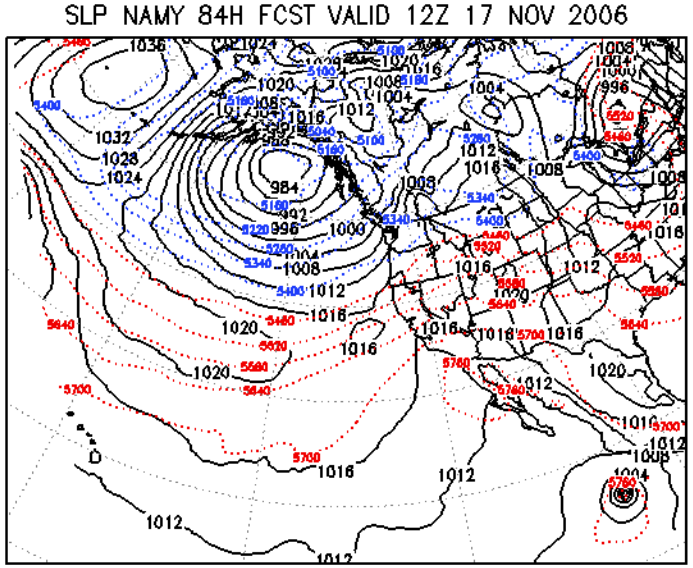
- Slight improvement in NAM QPF scores
- A 5-10% reduction in NAM height, temperature and vector wind root-mean-square errors compared to radiosondes
- Positive impacts increase with forecast range
- A significant reduction in the false alarm rate for tropical storms
- The numerical instability observed off Newfoundland in ops NAM runs from 1-4 December was eliminated by these changes

Unobserved TC eliminated while Observed storm (Sergio) retained





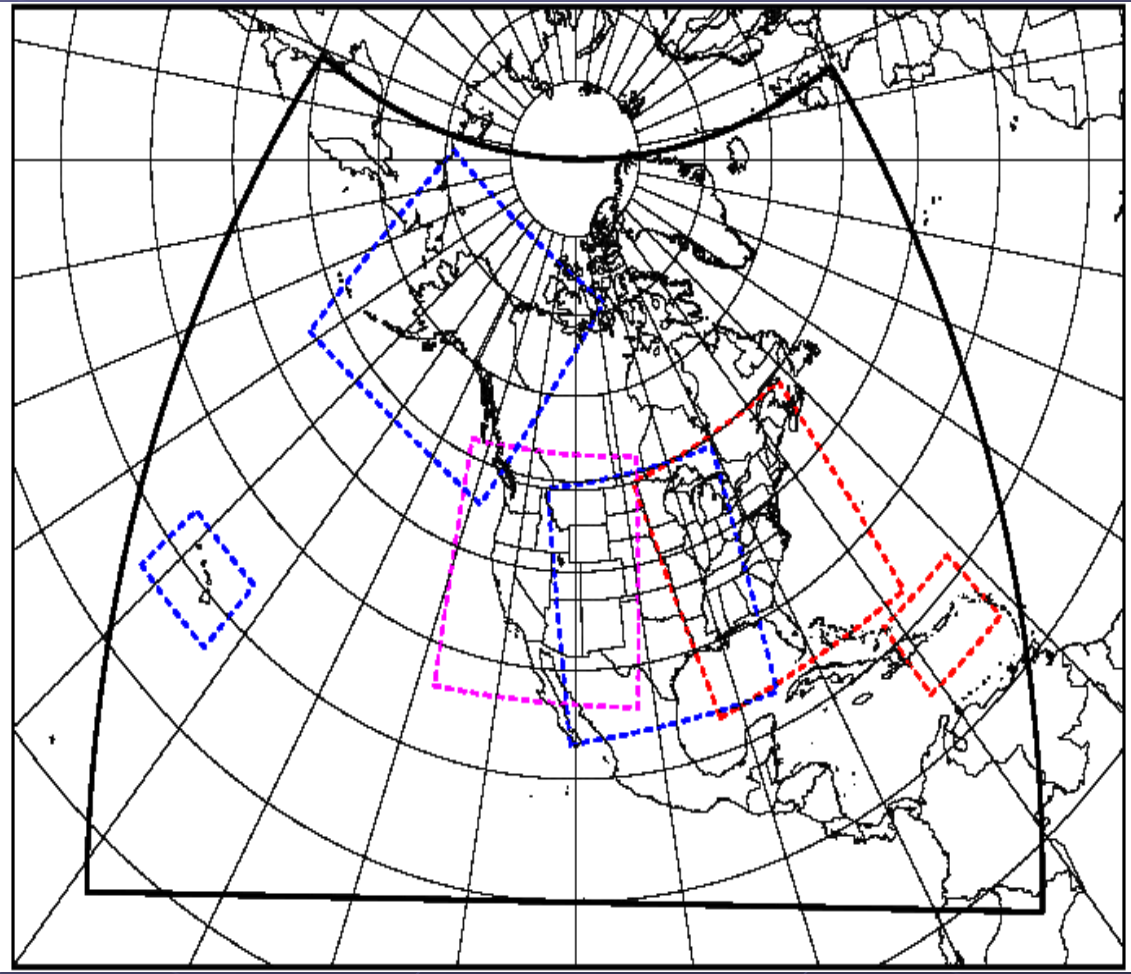




HiResWindow Fixed-Domain Nested Runs

28 June 2005 Become Explicit WRF Runs

- FOUR routine runs made at the same time every day when no hurricanes
- 00Z : Alaska & Hawaii
- 06Z : Western & Puerto Rico
- 12Z : Central & Hawaii
- 18Z : Eastern & Puerto Rico
- In 2007, will update to WRF v2.2 and push the resolution to ~4 km



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

Alaska domain is smaller than depicted

Pyle Webpage Now Displaying Simulated Reflectivity

http://www.emc.ncep.noaa.gov/mmb/mmbpll/cent4km/v2/

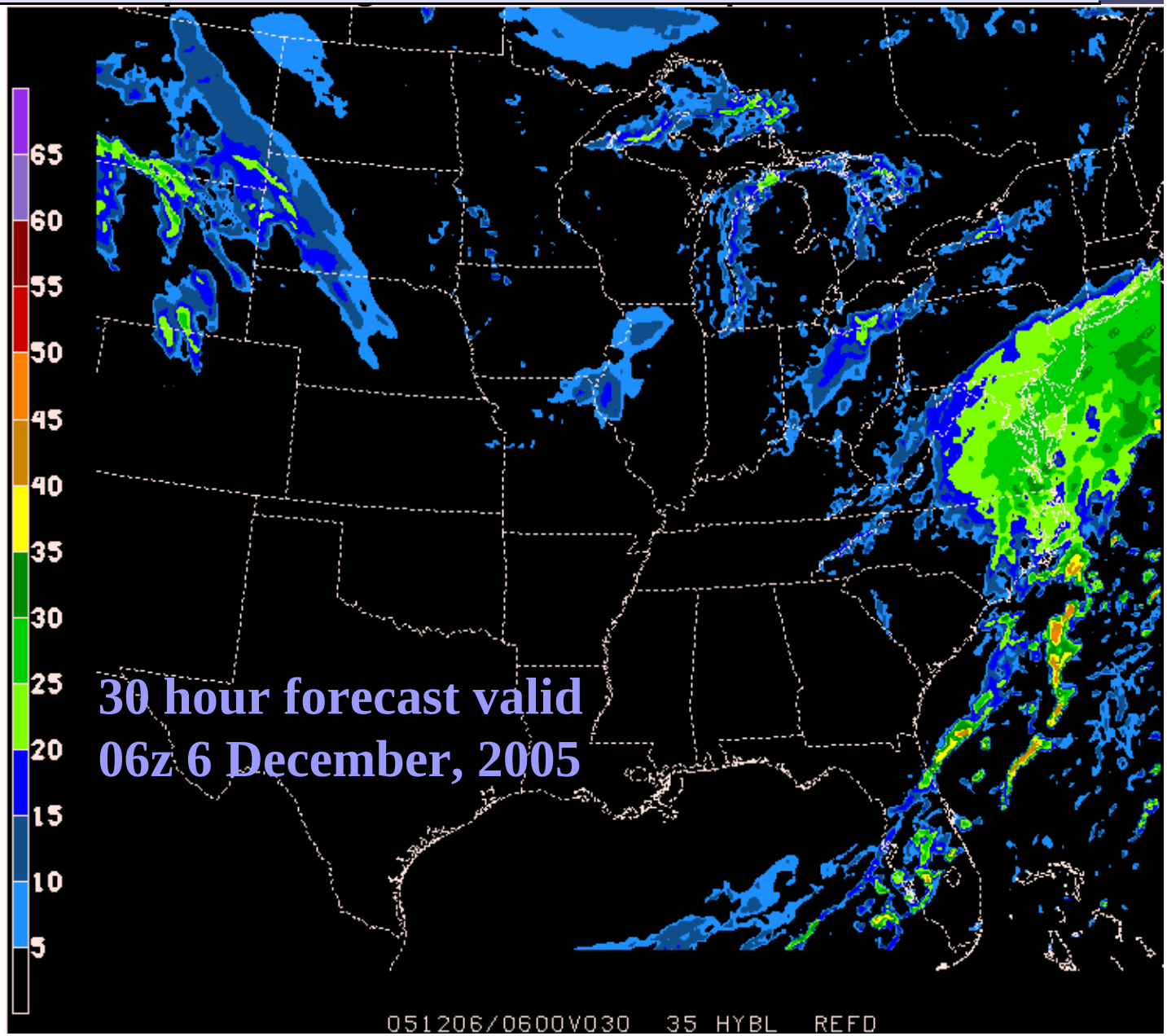
1 h Precipitation totals (in.)

01h	02h	03h	04h
05h	06h	07h	08h
09h	10h	11h	12h
13h	14h	15h	16h
17h	18h	19h	20h
21h	22h	23h	24h
25h	26h	27h	28h
29h	30h	31h	32h
33h	34h	35h	36h
0-36h	NMM WRF Loop		

Simulated radar reflectivity, lowest model level (dBZ)

00h	01h	02h	03h
04h	05h	06h	07h
08h	09h	10h	11h
12h	13h	14h	15h
16h	17h	18h	19h
20h	21h	22h	23h
24h	25h	26h	27h
28h	29h	30h	31h
32h	33h	34h	35h
36h	NMM WRF Loop		

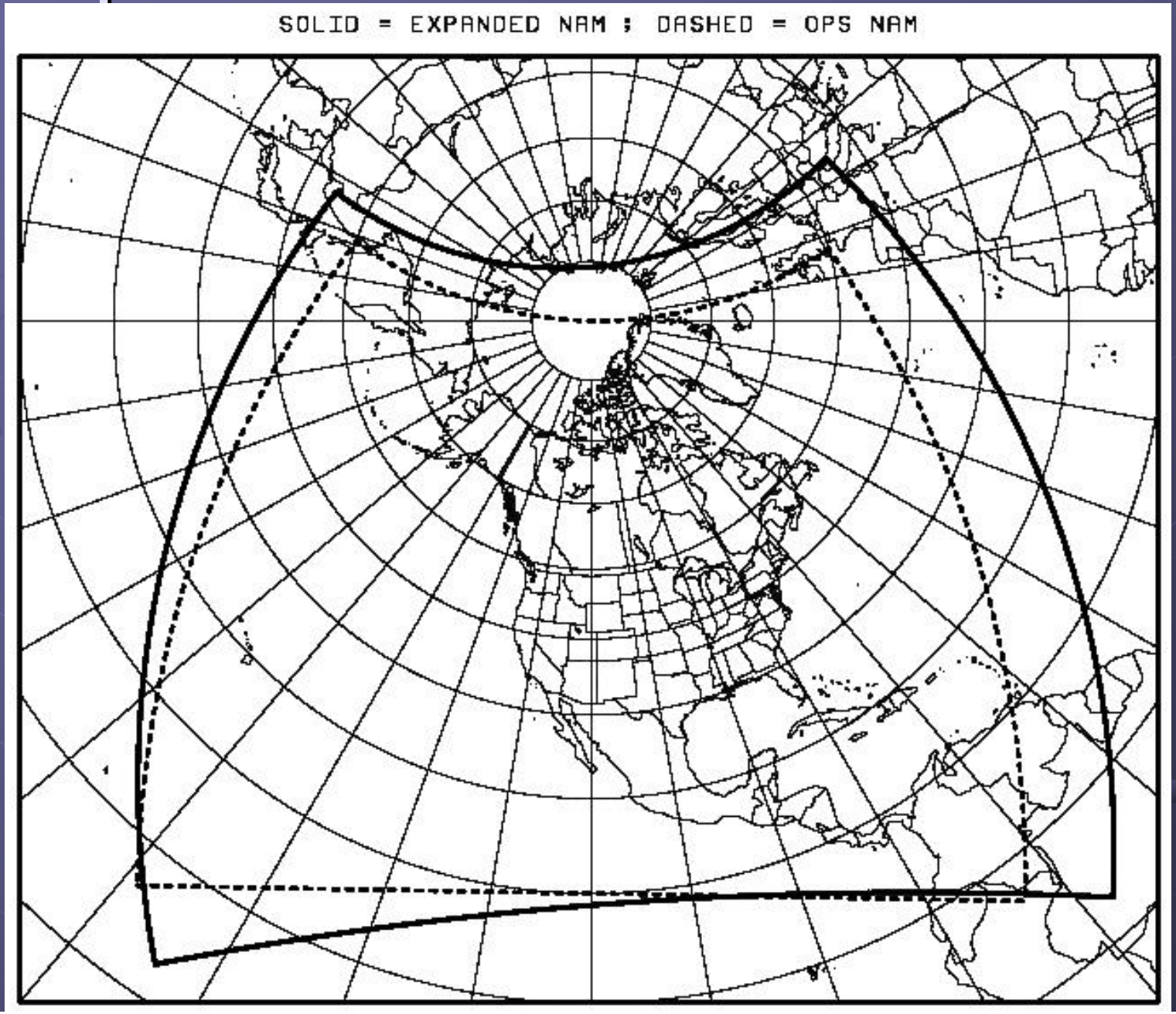
Simulated composite radar reflectivity (dBZ)



NAM Plans for June 2007

- NMM Model
  - Expand Domain ~22%
  - Unified NOAH Land-Surface Model
  - Reformulated Lateral Diffusion
  - Momentum Mixing in BMJ Convection
  - Mountain Blocking & Form Drag
- NAM GSI analysis
  - Strong dynamic constraint
  - Assimilate GPS bending angles
  - Nonlinear QC
  - Assimilate AIRS satellite data
  - Ability to utilize multiple guess files; FGAT: first guess at observation time

Expanded NAM Domain 2007

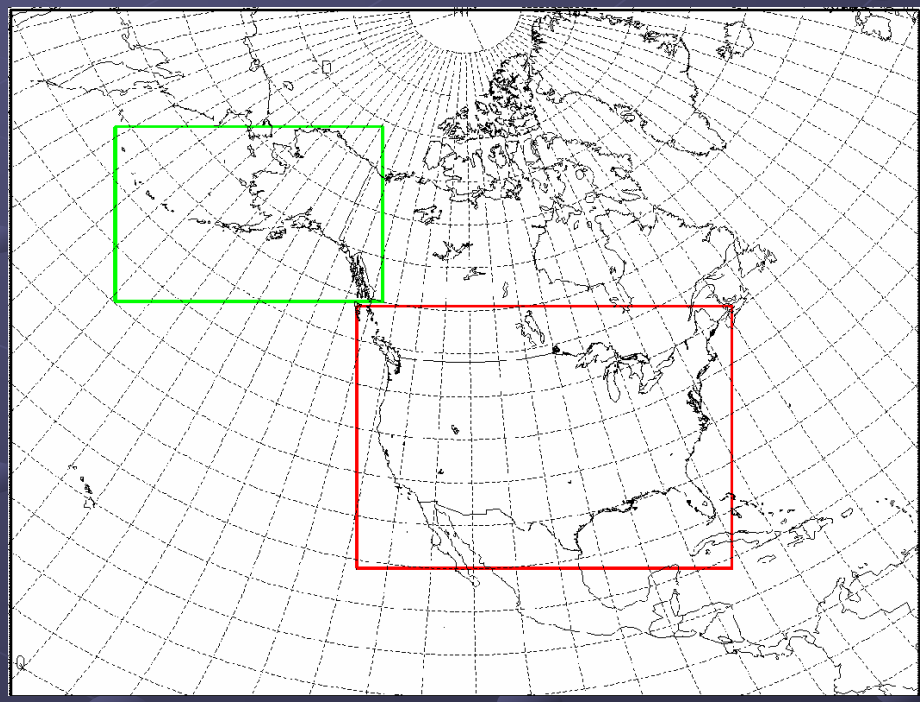


NAM Plans 2009

- Next machine (providing ~5x blue/white) 2009-2010
  - Add 4 km nests over CONUS and Alaska run to 48 hours only
  - Nested fields available ~3 hours earlier than HiResWindow
  - Parent run is 12 km with all its normal NAM products out to 84 hr
  - 4 km output grids would be additional to existing NAM 12 km suite

- Future 4 km Nests Imbedded in 12km NAM

- Move NMM from WRF common modeling infrastructure to Earth System Modeling Framework



Recent Operational Changes in Global Modeling Mark Iredell

- May 2006 Global Ensemble System (GENS) and NAEFS
- August 2006 GFS and GENS

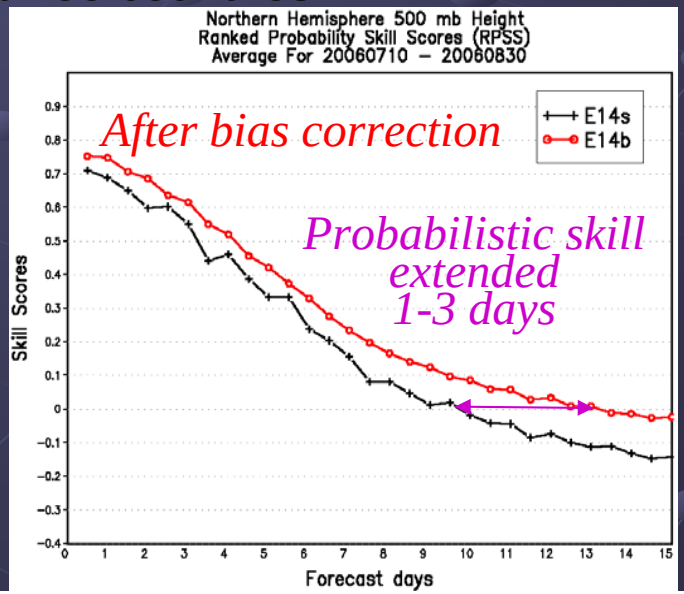
31 May 2006 GENS

- GENS replaces bred modes with ensemble transform method to create perturbed initial conditions
- Now maintaining a 56 member ensemble with 14 16-day forecasts per 6 hour cycle
- North American Ensemble Forecast System (NAEFS)

North American Ensemble Forecast System

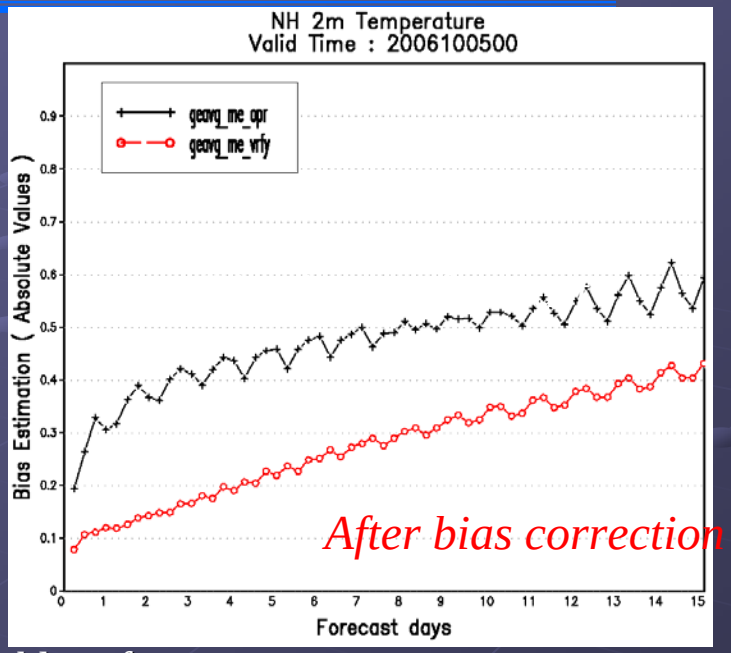
International project to produce operational multi-center ensemble products

- Combines global ensemble forecasts from Canada & USA
  - Now:CAN 40/day out to 16 days, US – 56/day out to 16 days
  - '07 – CAN 40/day out to 16 days, US – 80/day out to 16 days
- Generates products for
  - Intermediate users: forecasters at NCEP, WFOs, academia, media, private sector, …
  - Specialized users: hydrologic applications in all three countries
  - End users: forecasts for public distribution in US, Canada (MSC) and Mexico (NMSM)
- Future activities
  - Adding products (probabilistic in nature)
  - Incorporating ensemble data from other centers (e.g., FNMOC)
  - Unified evaluation/verification procedures



NAEFS Products

- **NAEFS basic products – Gridded data**
  - Ensemble members – NCEP & MSC
    - 50 variables - U,v,t,z,CAPE, precip type, etc.
  - Bias corrected ensemble forecasts - 35 variables
  - Climate percentile (anomaly) forecasts -19 variables
  - Availability through ftp
    - Ensemble members currently, rest to be added later
    - ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gens/prod/



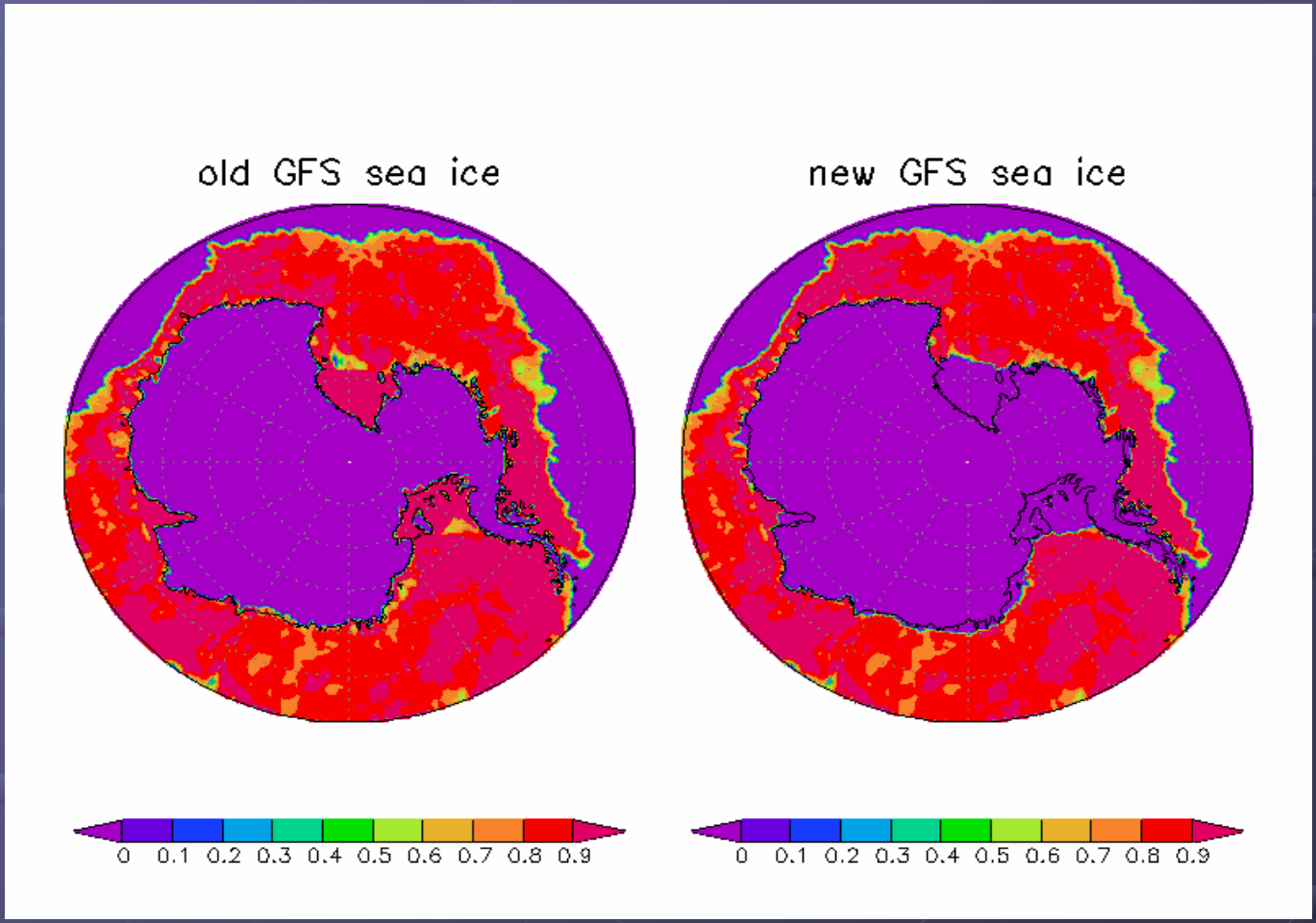
- **Derived products – Probabilities, etc**
  - Generation tools: Use recently developed NAWIPS ensemble software
    - 11 functionalities - Ensemble mean, spread, probabilities, etc
  - Request list: Assembled from NCEP Service Centers and other users
    - 600+ graphical products for 7 domains
      - Global, NH, NA, CONUS, SA Carib., Africa
  - Product availability – in priority order
    - Graphics: NCEP Model Web Page, beginning FY07
    - NAWIPS grids, beginning FY07
    - NDGD grids – planning phase

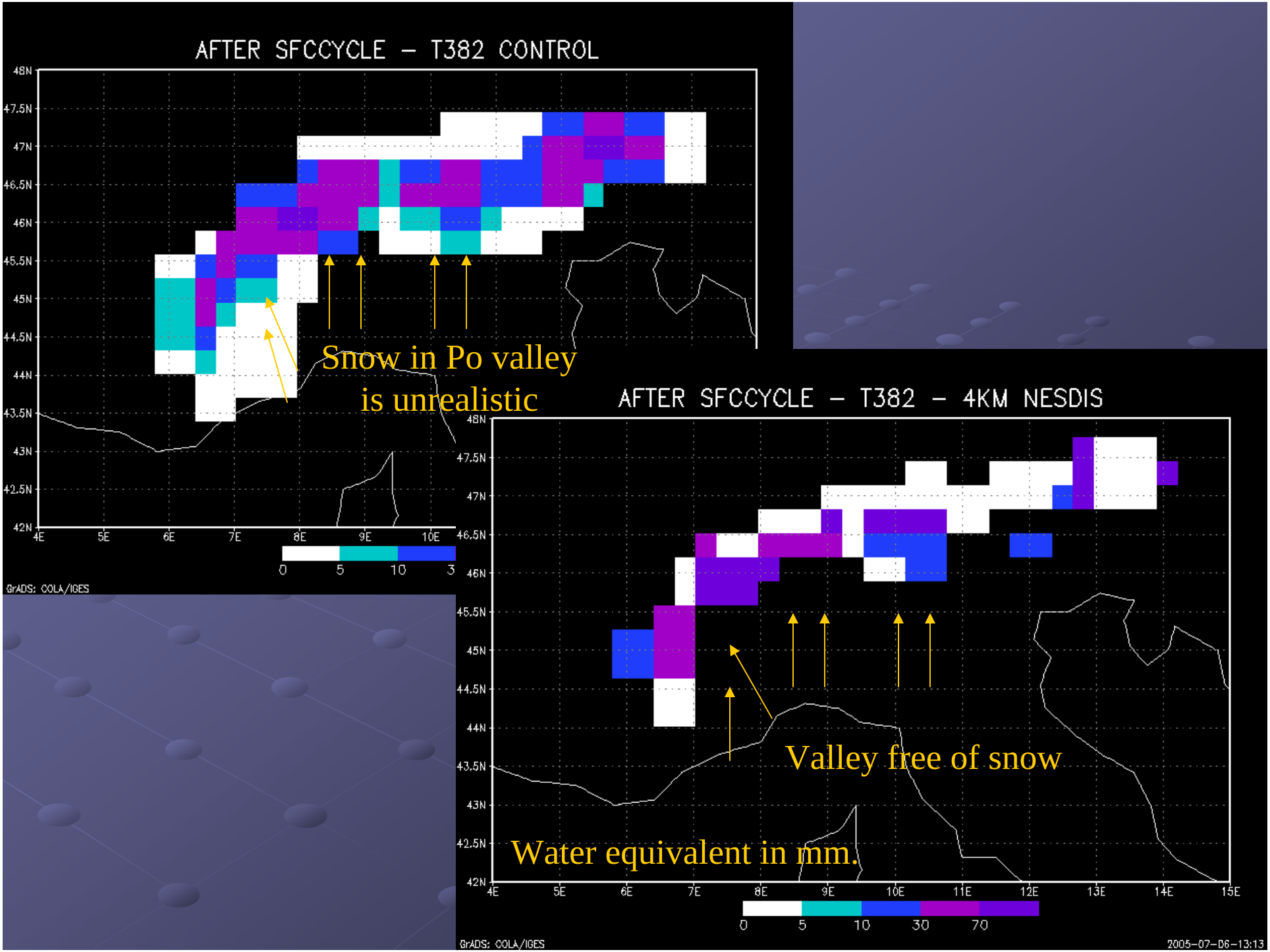
August 22, 2006 GFS Upgrade

- Forcing changes
  - Orography and land sea mask
  - Snow analysis processing
  - Land property quality control
- Physics changes
  - Ozone physics
  - Glacial ice
  - Longwave radiation at surface
- Dynamics changes
  - Time filter
- Infrastructure changes
  - Full **ESMF** compliance
  - Consolidated I/O

New Antarctic Ice Shelves

(graphics from analyses valid 2006-08-15)




AFTER SFCCYCLE – T382 CONTROL
48N
47.5N
47N
46.5N
46N
45.5N
45N
44.5N
44N
43.5N
43N
42.5N
42N
4E
5E
6E
7E
8E
9E
10E
0
5
10
3
GrADS: COLA/IGES
Snow in Po valley
is unrealistic
AFTER SFCCYCLE – T382 – 4KM NESDIS
48N
47.5N
47N
46.5N
46N
45.5N
45N
44.5N
44N
43.5N
43N
42.5N
42N
4E
5E
6E
7E
8E
9E
10E
11E
12E
13E
14E
15E
0
5
10
30
70
GrADS: COLA/IGES
2005-07-06-13:13
Valley free of snow
Water equivalent in mm.

Global Modeling Plans 2007

- Replace SSI with GSI
  - Met-8 Winds
  - COSMIC radio - occultation data
  - GPS IPW
  - AIRS every FOV
  - GOES 1x1 replaces GOES 5x5
  - SSM/I, AMSR-E, SSM/IS radiances (possible)
- Implement new GFS model
  - Hybrid sigma-pressure vertical coordinate
  - Updated radiation module
- Increasing ensemble memberships
  - 80 perturbations in cycling
  - 20 perturbation long forecasts in each cycle

NCEP POST

- NCEP POST: a unified POST for ALL NCEP atmospheric models
  - Generalization of the NAM POST (aka WRF POST).
  - Several GFS post algorithms will be included
    - GFS definition of relative humidity
    - isentropic level output
    - dynamic tropopause
- User requested fields available by mid 2007:
  - Sigma layer temperature at .90, .85, .80, .75, .70, 3 hourly intervals
  - Omega on 500-700 mb layer
  - Satellite look-alike product (broadband channel)
  - Richardson number & Ellrod index
  - Elevated CAPE diagnostic (300-60 pressure difference)
  - Diagnostic surface visibility
  - Satellite look-alike product (narrower instrument channels)
- User requested fields waiting until at least FY08:
  - Simulated radar reflectivity
  - Turbulent kinetic energy
  - Simulated echo tops
  - Model gravity wave diagnostic

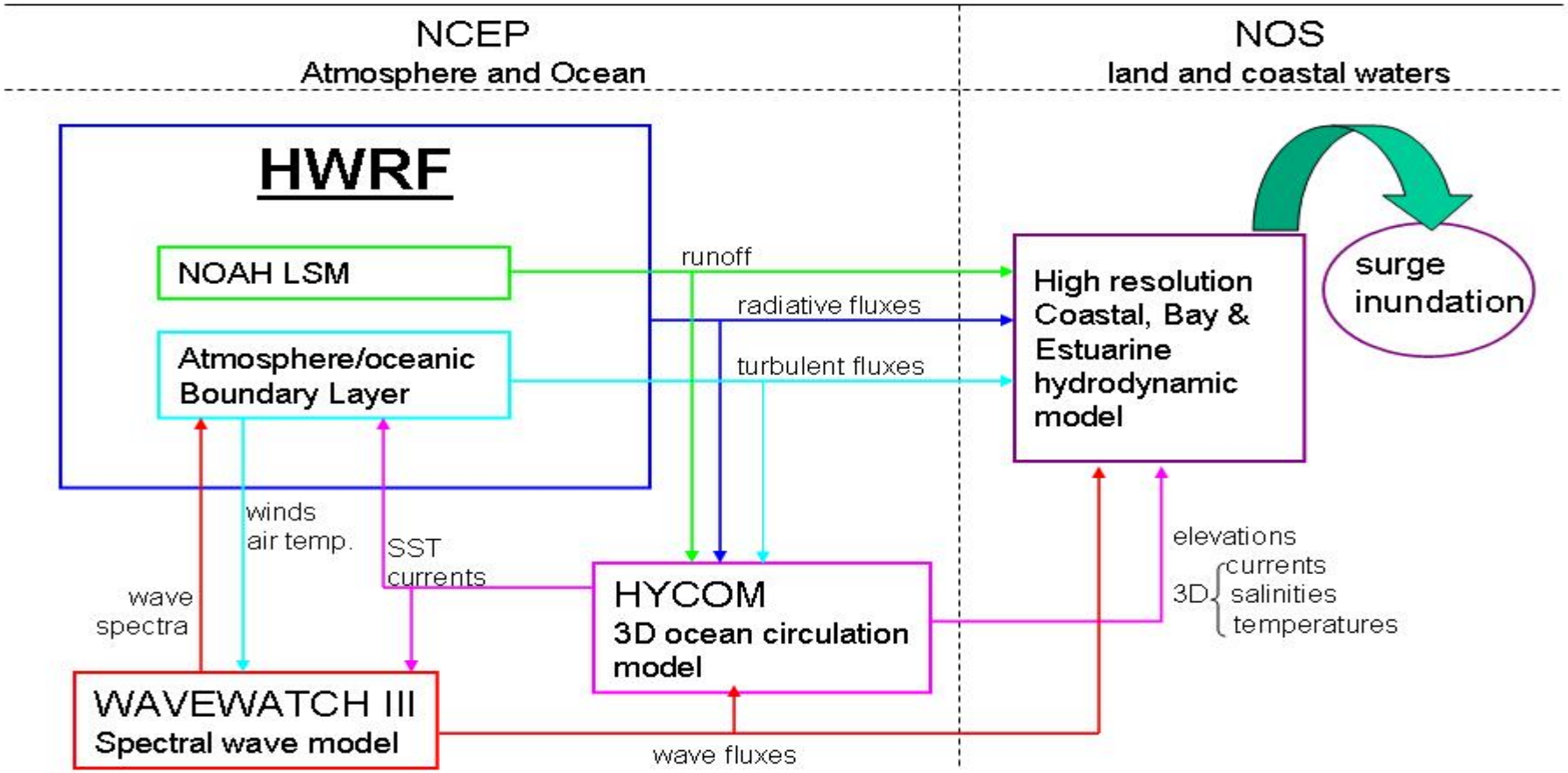
To FY08, and Beyond!

- New observations
- Refined GSI techniques
- Hybrid isentropic coordinate with enthalpy
- Ferrier microphysics
- Convection
- Boundary Layer
- Modular design (ESMF)
- Reforecasting
- Advanced data assimilation
- Semi-Lagrangian and increased resolution
- Raise top to the thermosphere and couple with ionosphere
- Couple short-term ocean
- Add aerosol and chemistry species

NCEP's Hurricane Forecast Guidance

- GFS
  - T382/64L
  - 3-D var
  - Vortex relocation
  - State of the science physics
- GFDL
  - Movable nested
  - Air-sea coupled
  - Inner nest
    - 9 km/42L
  - Specialized vortex initialization,
  - Upgraded with some GFS physics (2003, 2004)
- HWRF to replace GFDL in 2007

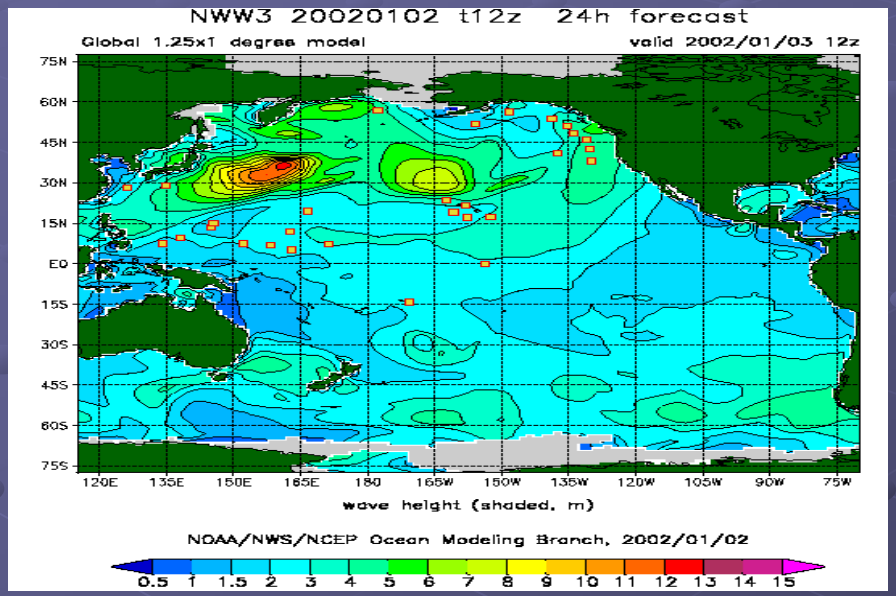
Hurricane-Wave-Ocean-Surge-Inundation Coupled Models

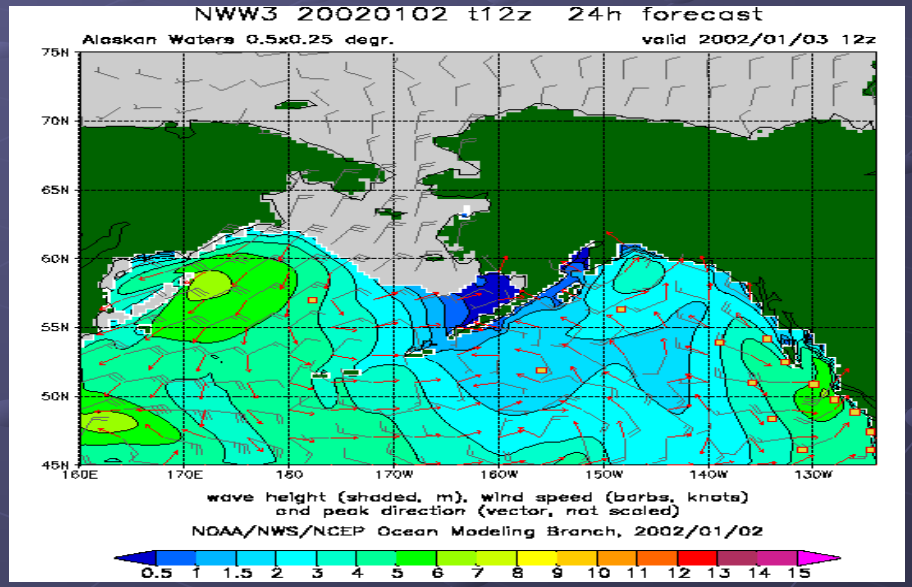


Real Time Ocean Forecasting

- Wave Modeling
  - Global and Regional
  - Unified model approach
  - NOAA Wavewatch III
- Sea Surface Temperature & Winds
  - NCEP Ocean Prediction Center support
    - Gulfstream analysis & forecast
- Real-time Sea Ice products
- Basin-scale Ocean Model (new system)

NCEP/MMAB Wave Products



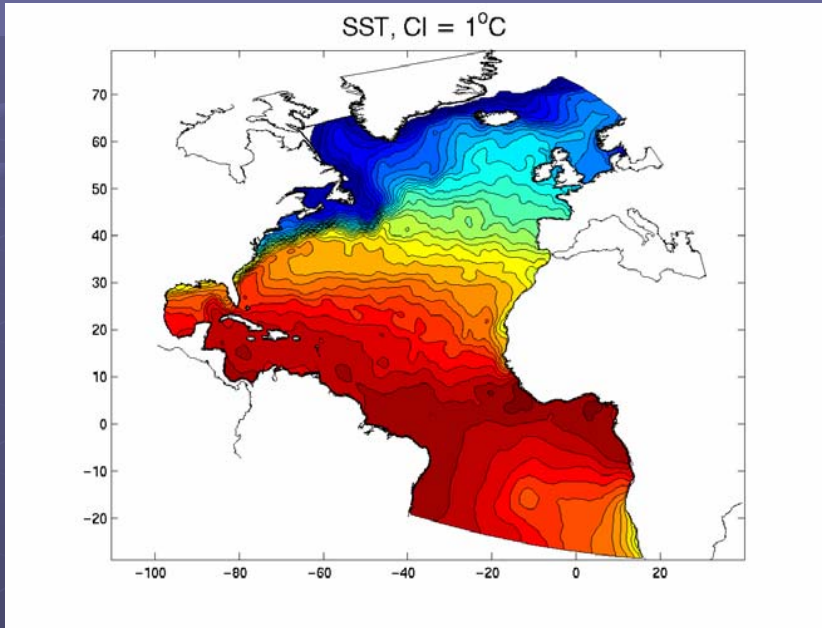


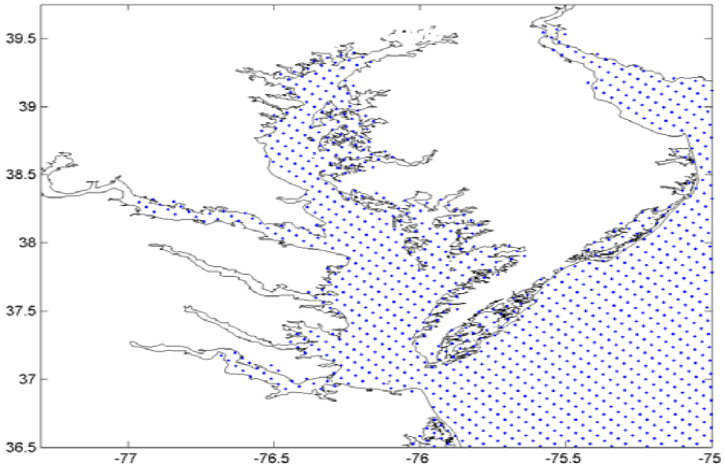
- Global and regional models for Alaskan Waters and **Western North Atlantic and Eastern Pacific** with up to 168 h forecasts, 4 times daily
  - Hurricane wave model combining global and GFDL model winds (Atlantic & East Pacific)

- NOAA Wavewatch III operational at FNMOC
- Recent NWW3 upgrades
  - Propagation
  - Sub-grid islands
  - Data assimilation (improves 0-12 h forecasts)

Global Ocean Prediction with HYCOM

- Hybrid Coordinate Ocean Model (HYCOM) is a hybrid isopycnal-sigma-pressure ocean model
- Goal: to develop and demonstrate real-time, operational, high resolution ocean prediction systems for the Global Oceans and Basins
- NCEP Partners with
  - University of Miami/RSMAS
  - NRL Stennis, NRL Monterey, FNMOC
  - NOAA PMEL, AOML
  - Los Alamos National Laboratory
  - Others (international, commercial)





NAM & GFS Products

Data Access Portals

http://www.emc.ncep.noaa.gov/mmb/nammeteograms/

NAM FORECAST METEOGRAMS

Need more complete NAM time series data?? Try the ftp site . A guide to BUFR unpacking is also available.

GFS soundings (3 hrly @ 44mb each) can be downloaded from ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gfs/prod/

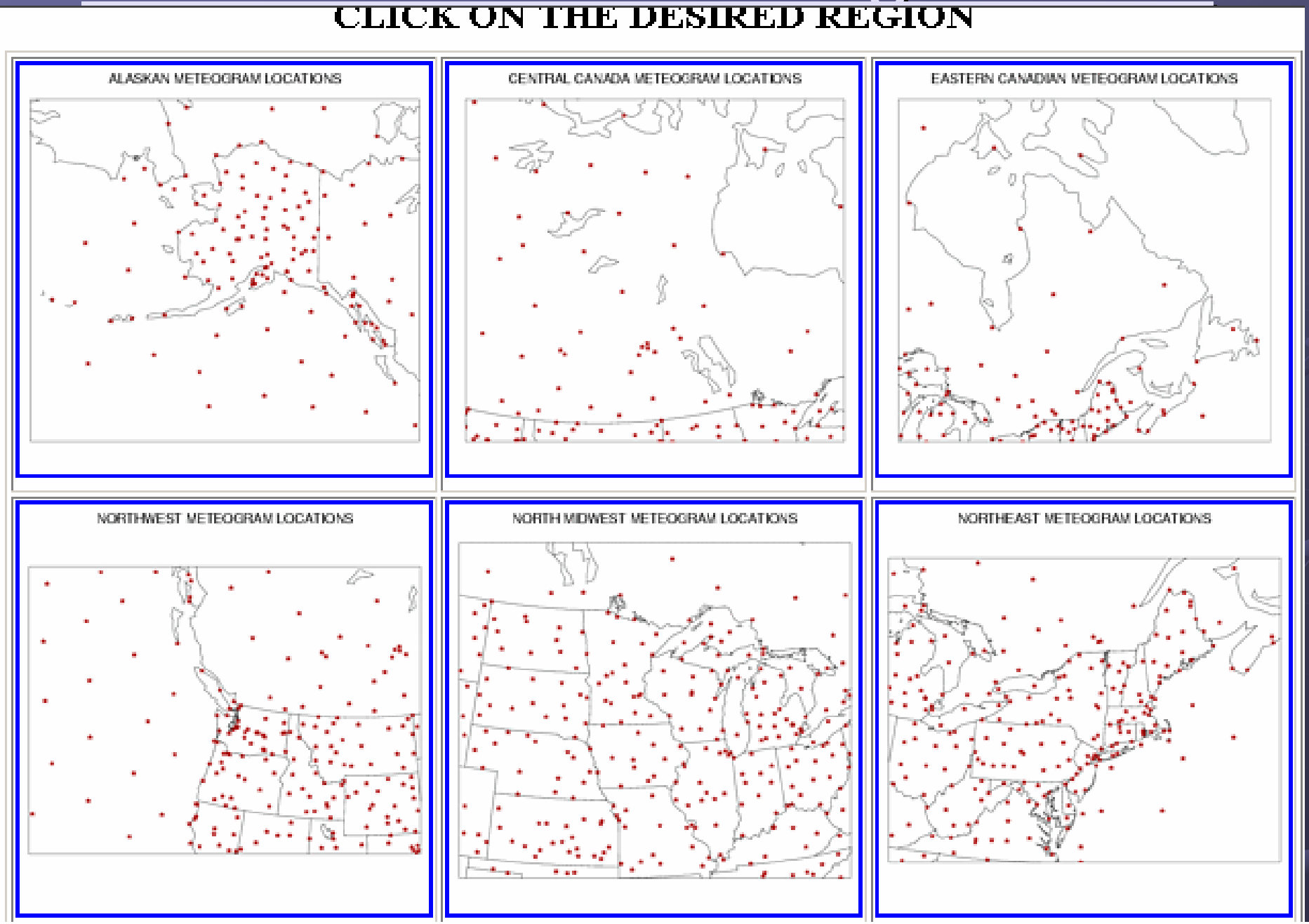
Forecasts of surface variables and vertical profiles of cloud and wind are available for over 1300 stations within the North American Meso model domain. A complete list of the available stations can be found here . Select a region below, and you will be sent to a local map where you can click on the star representing the location you want.

If you want to bypass the stars, please enter a 6-digit ID from the table linked above. Get data

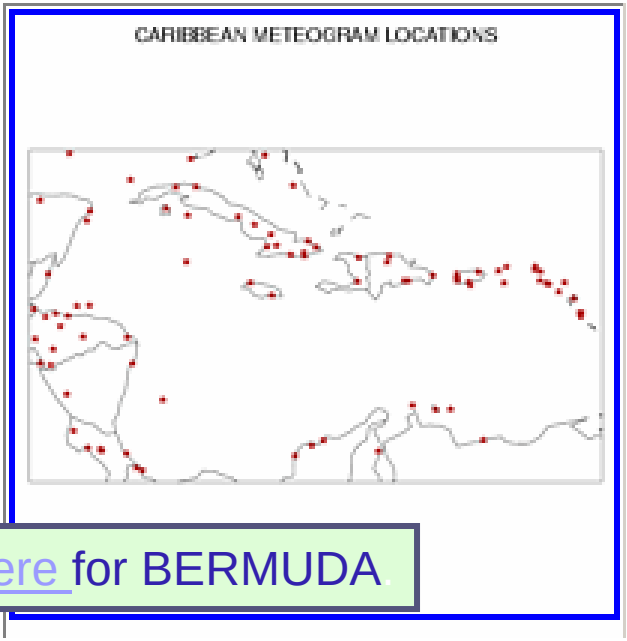
CLICK ON THE DESIRED REGION

North American Domain is split into 12 Regions

Northern Six Sounding Sectors



Southern Six Sounding Sectors

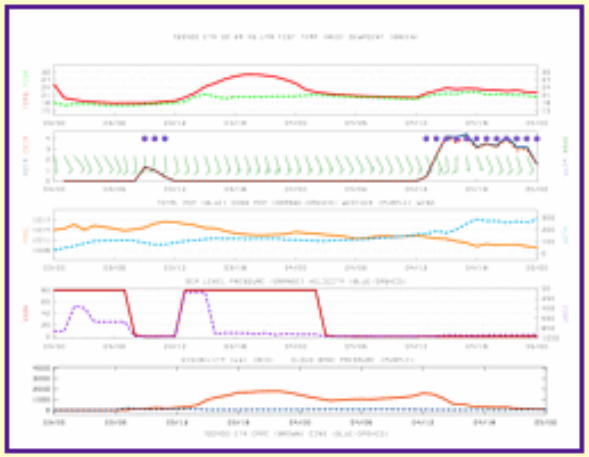


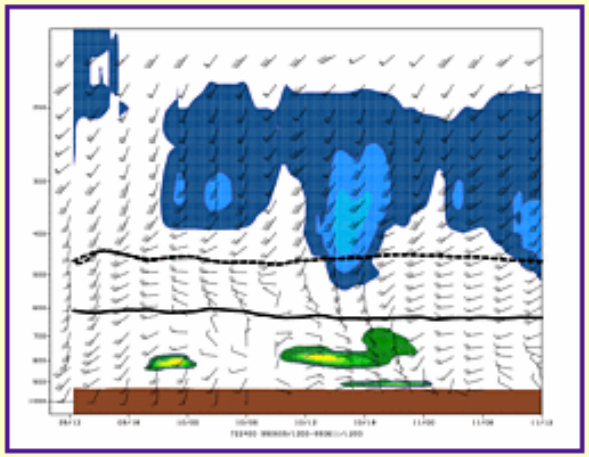
We couldn't fit it on the maps above, but click here for BERMUDA.

Choice of Display and Cycle

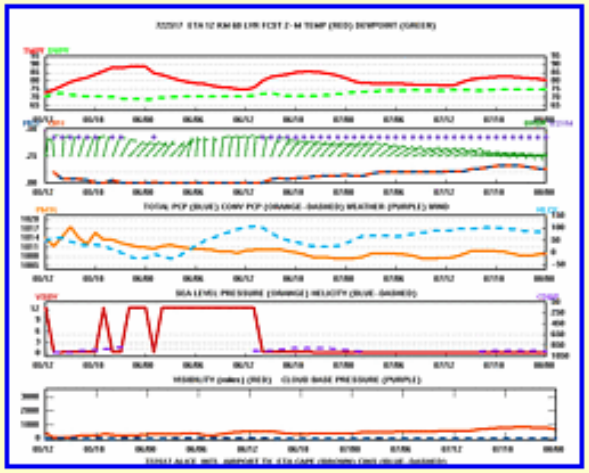
A set of NAM forecast surface meteograms and a time-section plot of forecast winds and cloud/ice water are available for this station. Click on a **SAMPLE** meteogram plot below to get the ACTUAL forecast surface meteograms for this station, or click on a **SAMPLE** wind/cloud plot to get the time-section forecast.

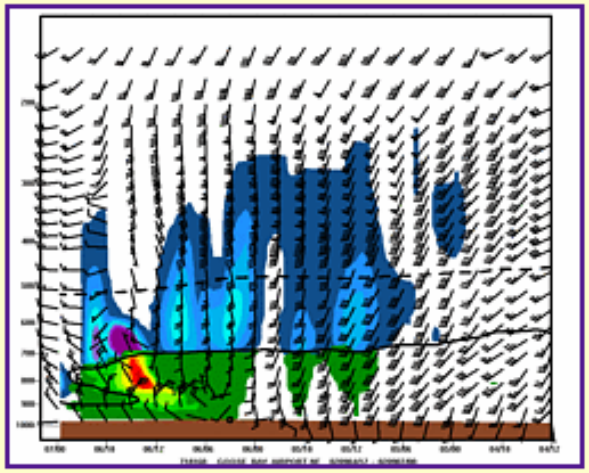
MOST RECENT 00/12Z CYCLE





MOST RECENT 06/18Z CYCLE





http://www.emc.ncep.noaa.gov/mmb/research/tiles.221.html

NAM 32km Tiled Output

NAM model output on grid #221 (32km Lambert Conformal projection) is available in small subsets, called *tiles*. These files contain the same information as the full-field grid #221 file (AWIP32) with the same precision, only over a smaller domain.

NAM tiles are now available on the ftpprd.ncep.noaa.gov server in /pub/data/nccf/com/nam/prod/nam.YYYYMMDD/tiles.tHHz The directory for the current day contains the two most recent cycles (00z, 06z, 12z, 18z), and the tiles directories are listed at the very bottom of the list. Inside these subdirectories are files called:

nam.tCCz.AWIP32*HH.YY*

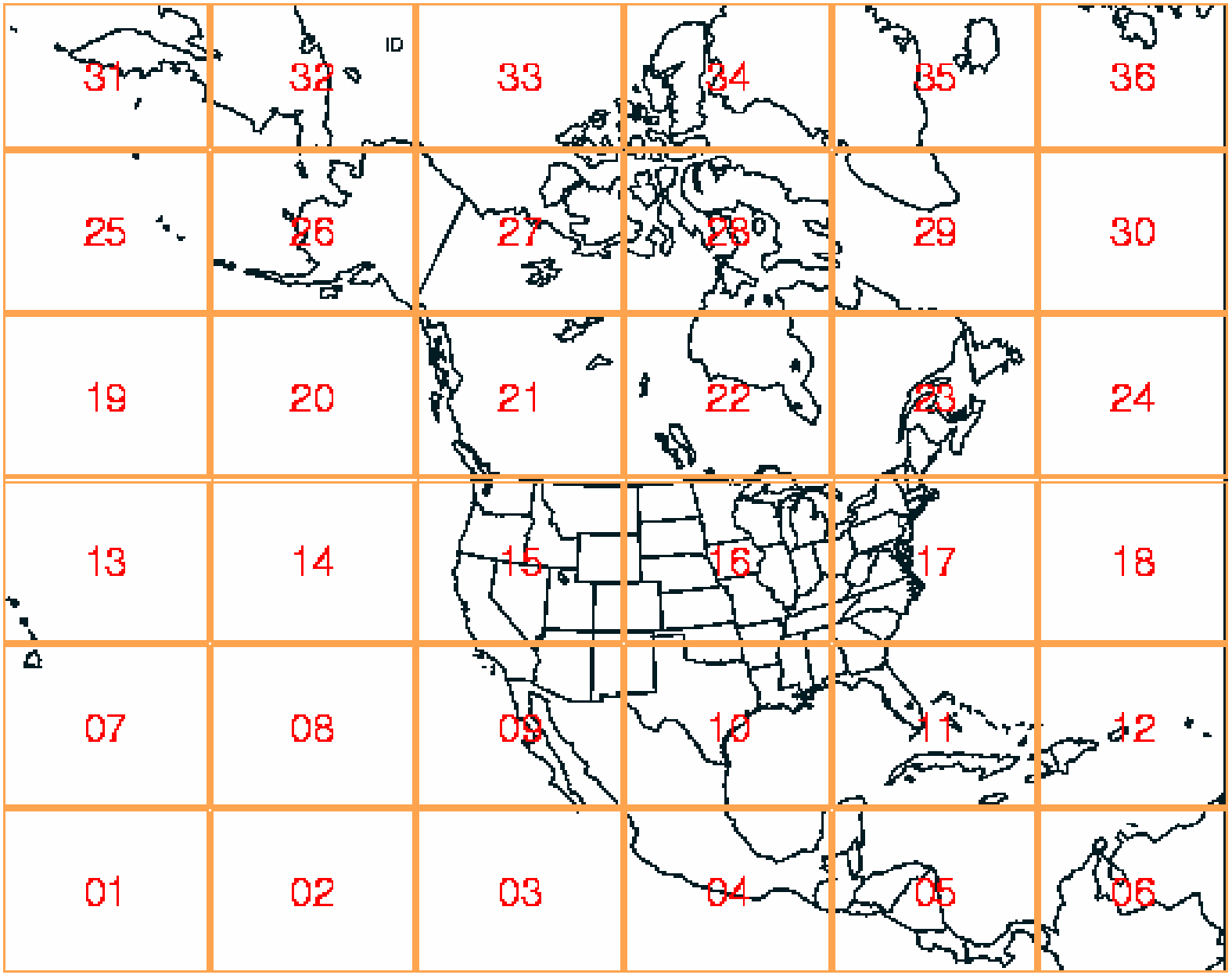
where:

- *CC* is the model cycle (00,06,12,18)
- *HH* is the forecast hour
- *YY* is the tile number (see below)

Each tile file is approximately 2 mb in length

GRID 221 TILE LOCATIONS

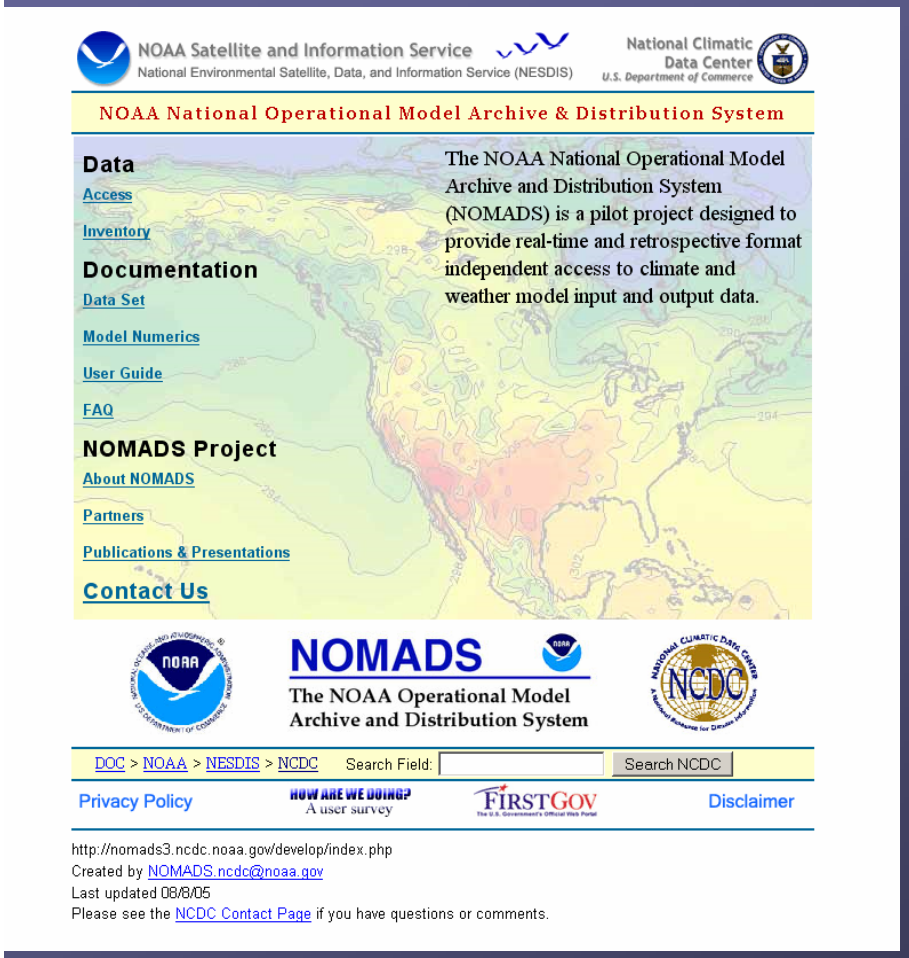
Grid 221 Tile Locations



NOAA Operational Model Archive and Distribution System

NOMADS
The NOAA Operational Model Archive and Distribution System

nomads.ncdc.noaa.gov



NOMADS Goals

- Provide distributed access to models and associated data,
- Promote model evaluation and product development,
- Foster research within the geo-science communities (ocean, weather, and climate)

Glenn.Rutledge@noaa.gov

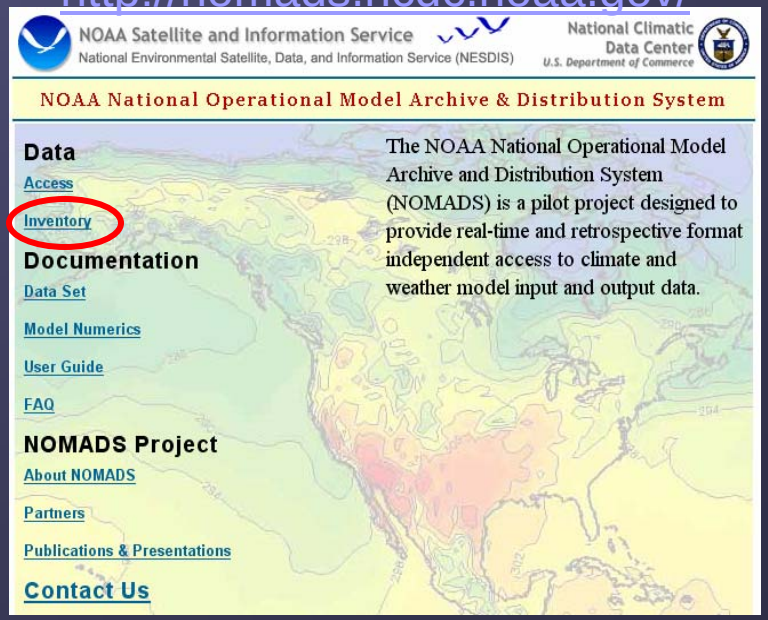
NOAA National Operational Model Archive and Distribution System

NOMADS
The NOAA Operational Model Archive and Distribution System

Tools for Users

- Pare down large file sizes of high resolution data including Grib2 NDFD for access under a pull technology
- (re-) Group data sets to create needed products – such as model input files for local model initialization, model development, analysis, or by forecast projection.
- Subset the data:
  - in parameter space
  - in physical space
  - in temporal space
- Access to digital files:
  - Click on Inventory

http://nomads.ncdc.noaa.gov/



NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

National Climatic Data Center
U.S. Department of Commerce

NOAA National Operational Model Archive & Distribution System

NOMADS Home > Data Access Contact Us

<< Back

Model Data Access
NOMADS Web Interface

Data Access by Provider

Access by Data Type

Introduction

National Oceanic and Atmospheric Administration (NOAA)

NCDC NOMADS Server: Model Data (Real-time and Historical)

- Numerical Weather Prediction (NWP) Input and Output
  - North American Mesoscale (NAM, formally Eta)
  - Global Forecast System (GFS, formally AVN/MRF)
  - Rapid Update Cycle (RUC)
  - GDAS Model Input Assimilation Data
  - AWIPS NOAAPort Grids *(historical only; reduced resolution and variable)*
  - NAM hourly forecast fields for HYSPLIT Air Quality Model
- Ensembles
  - Low Res GFS Ensembles
  - Hi Res GFS Ensembles
- Reanalysis
  - North American Regional Reanalysis (NARR) (32km, 1979 to present)
  - Global Reanalysis (R1 & R2)
- Climate
  - Coupled Climate Forecast System (CFS) *(coming soon)*
  - Limited GFDL CM2.X Coupled Climate Model data from NCDC NOMADS Server
- NCDC In-situ Reference Quality Datasets (NCDC)
  - Blended Ocean Winds
  - Reynolds SST
  - Global Historical Climate Network (GHCN)
  - Integrated Global Radiosonde Archive (IGRA)
  - Paleoclimate Datasets
- NCDC Mirror R/T NOMADS Server *(backup server for NCEP real-time)*
- NOMADS Live Access Server

Click here for NCEP R/T (Real-Time)

NCEP R/T NOMADS Server ***(Real-Time NOMADS server with rotating access up to two weeks)***

NCEP Real-Time NOMAD5 Page

N.O.M.A.D.S.

nomad5 at NCEP

NOAA Operational Model Archive Distribution

Click on either of these

Real Time NCEP NOMADS server at NCEP -- nomad5: at http://nomad5.ncep.noaa.gov

Real Time NCEP NOMADS server at NCEP -- nomad3: at http://nomad3.ncep.noaa.gov

Real Time NCEP NOMADS server at NCDC -- nomads6.ncdc.noaa.gov/ncep_data at http:/

Real Time NOMADS NCEP Component on nomad5 server

REAL-TIME NCEP Data Access

NOMADS: NCEP server 5

Plots, Data, Points of Contact

last update to this web page:20060810

The following table list several data sets. By clicking on the appropriate command, you can (1) make plots, (2) FTP the files to your computer -- slice, dice and subset large files or (3) obtain documentation or or (4) use the DODS(OPeN-DAP)/GDS server to get data values directly from our matrix of holdings. At this time, some options are not available (N/A).

Data Set	freq	plot	ftp	http	doc	gds	contact 1	contact 2
Forecasts								
GFS Ensemble low resolution	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
GFS Ensemble high resolution	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
GFS high resolution (rotating)	6 hours	plot	ftp2u	http	doc	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
GFS high resolution (5 days)	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
GFS 0.5x0.5 degree (5 days)	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
GFS Low Resolution (2 month archive)	1 day	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	Wesley.Ebisuzaki@noaa.gov
NAM(ETA)	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
Climate forecast	monthly	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	N/A
fnl	monthly	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	Jun.Wang@noaa.gov
SEA ICE	daily	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	N/A
AMIP/ETA	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
AMIP/GFS	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
SREF	12 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	N/A
RUC	12 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
Wave model forecast	6 hours	plot	ftp2u	http	N/A	DODS	Jordan.Alpert@noaa.gov	jun.wang@noaa.gov
RTOFS model forecast	daily	plot	ftp2u	http	doc	DODS	Jordan.Alpert@noaa.gov	bhavani.balasubramaniyan@noaa.gov

Display Interface from NOMAD5

NCEP GFS Forecast 0.5 degree: gfs_master_00z.ctl

Instructions
1. Select a variable (previous page has definition option)
2. Select level, time and other options
3. Click on "Plot"
4. A blank image indicates the data are not available

Variable 1: winds 10m

Level: 1000

extra operation 1: (none) 2: (none)

Data available from 00Z 04 jan 2007 to 12Z 11 jan 2007 at 3 hours intervals

Time 00Z 09 jan 2007

Map projection: custom only for custom maps long. 250 long. width 50 lat. 5 lat. height 25

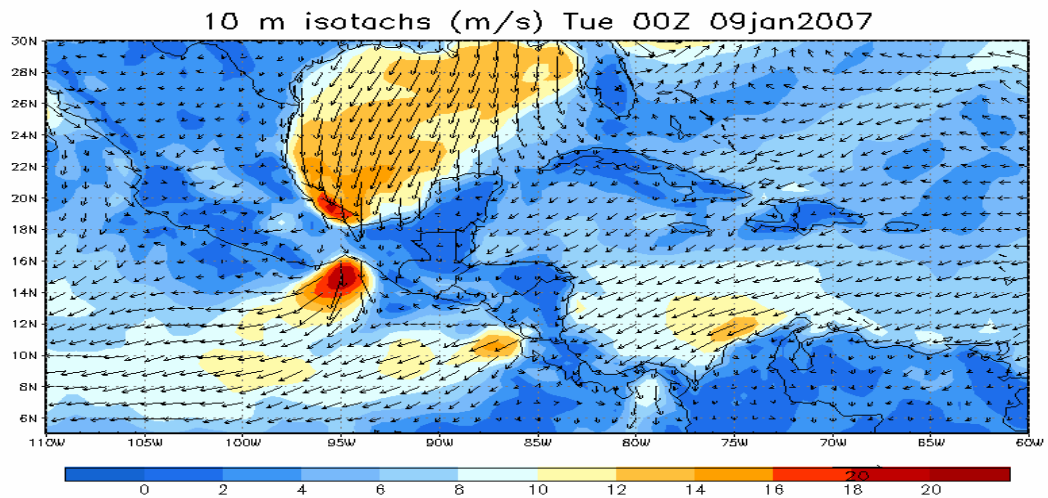
Draw: shaded Contour interval for var1: def

white: def Create binary file and .ctl file: off

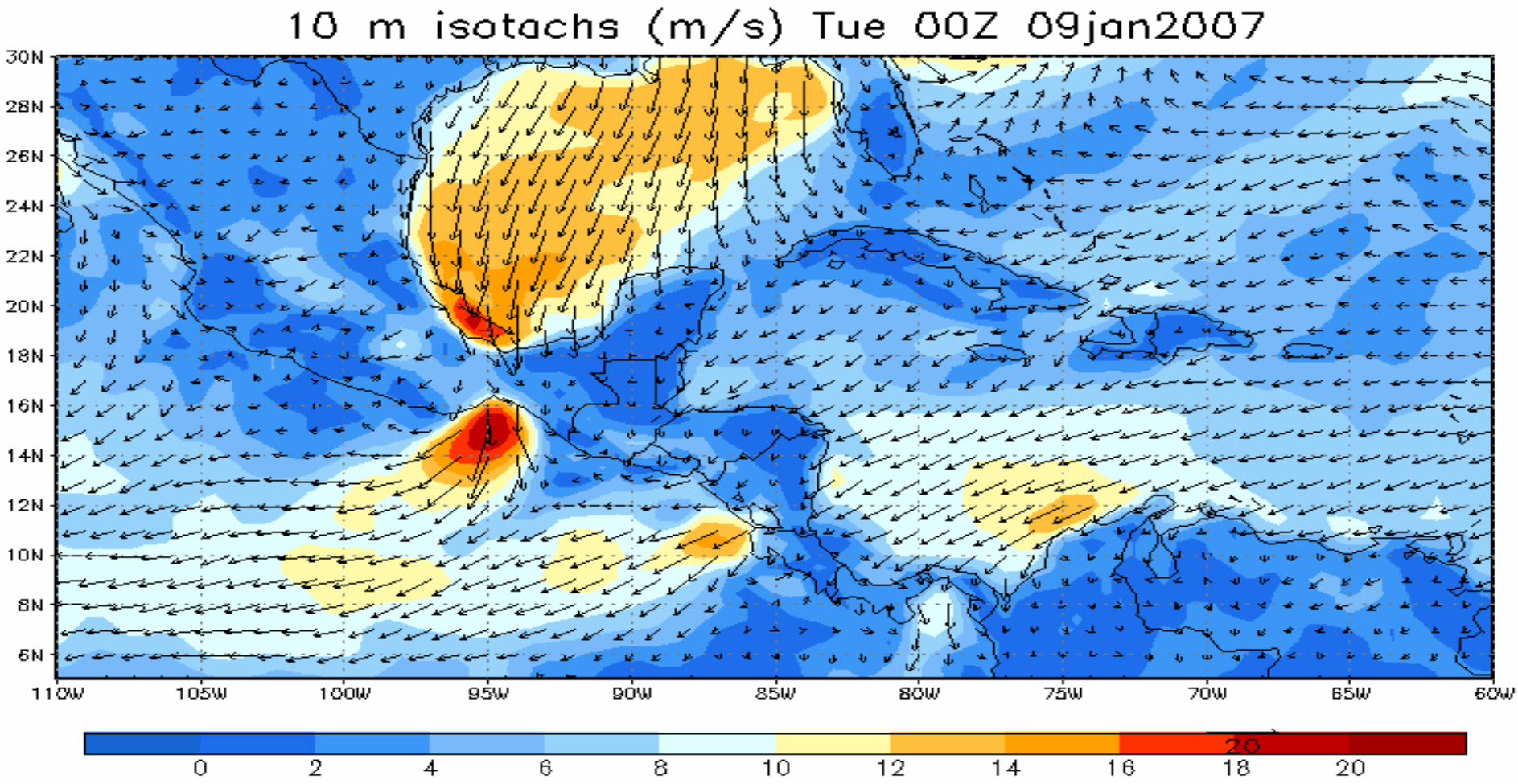
Title (leave blank for default):

Plot Reset

plot displayed

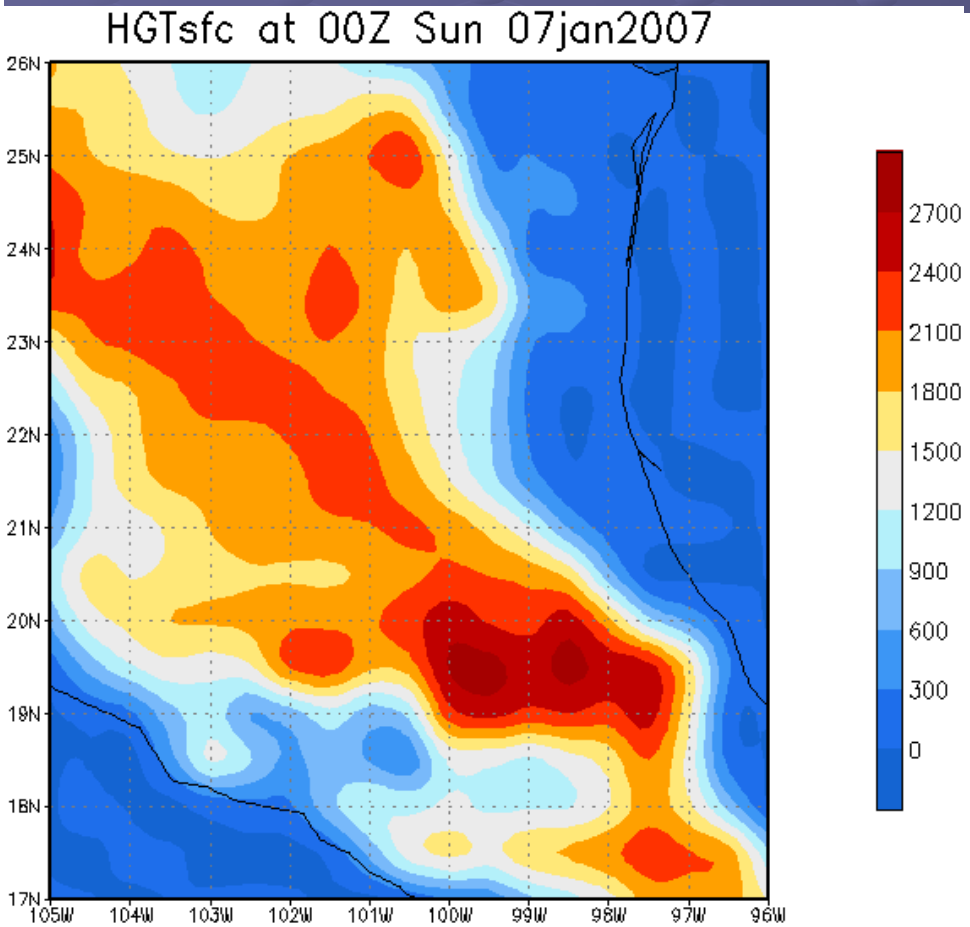


Plotted Display From NOMAD5

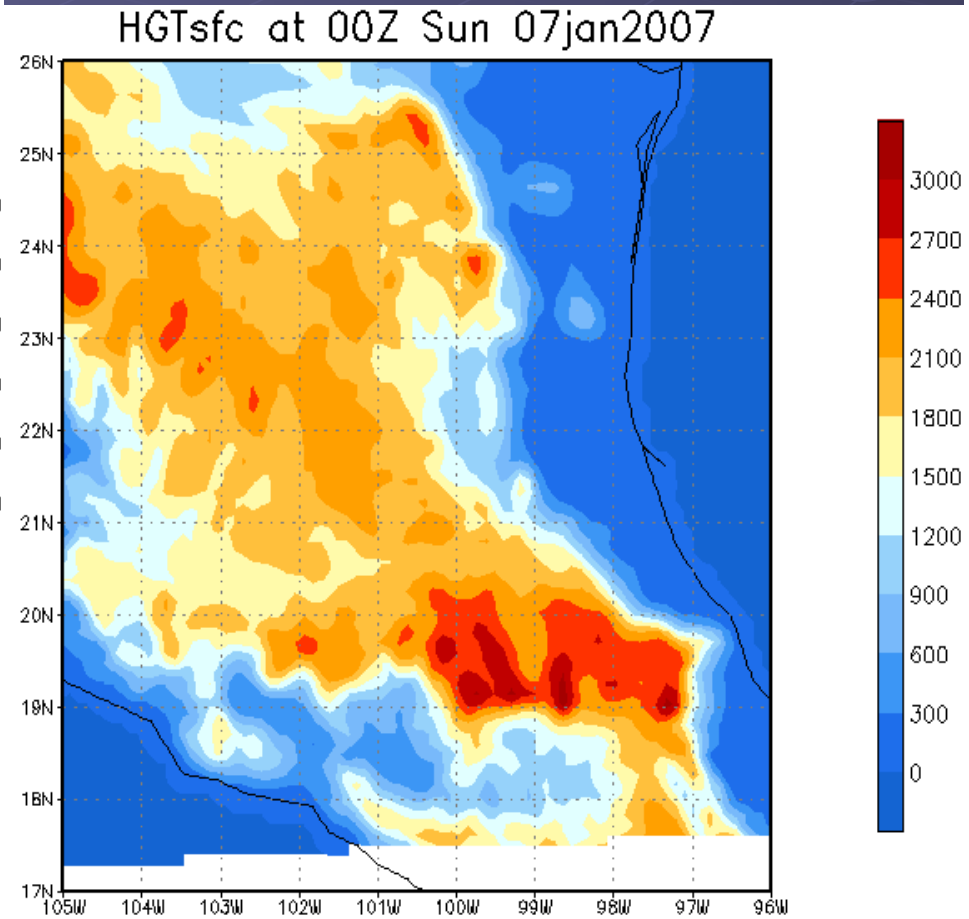


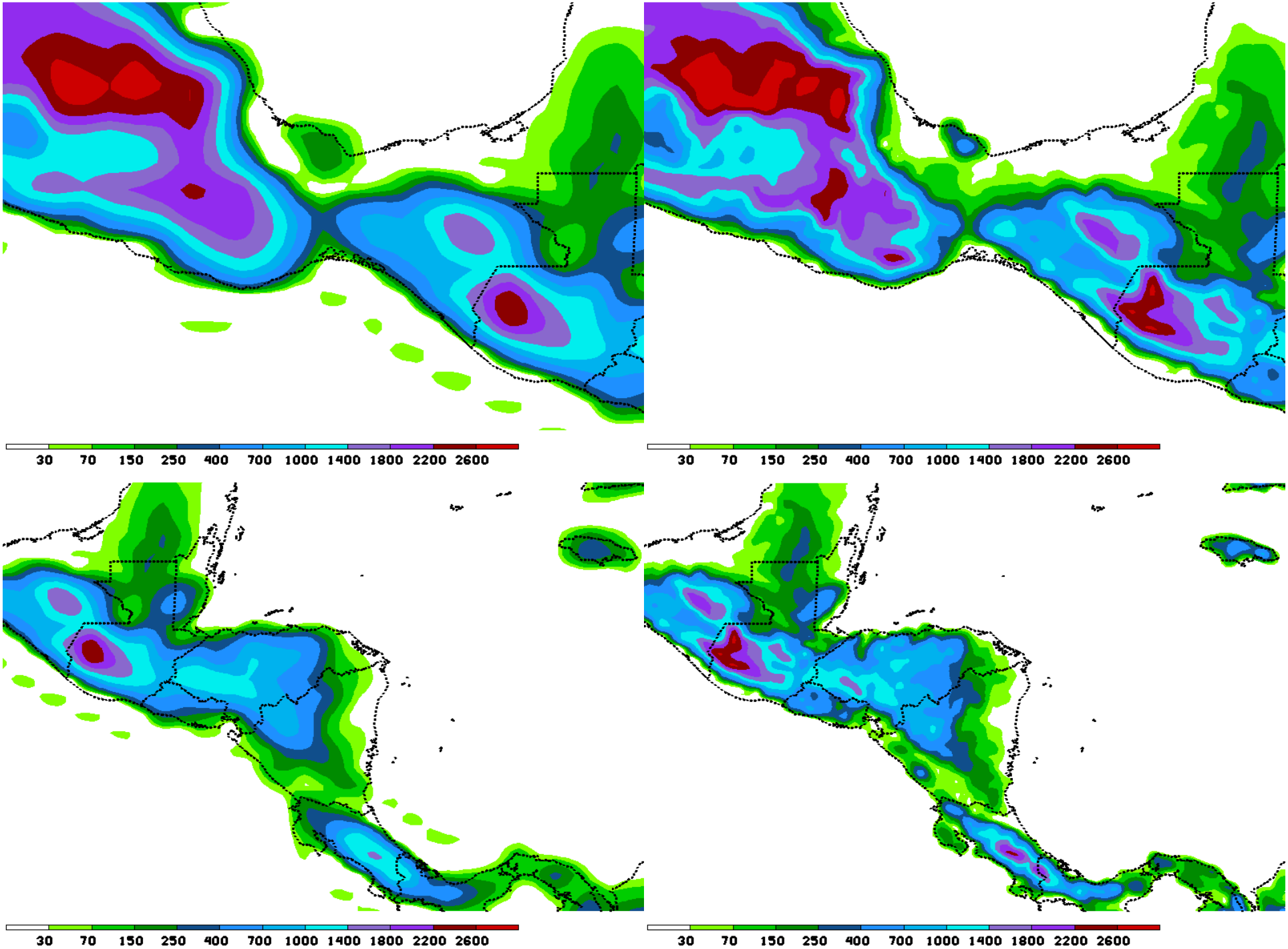
Model Terrain Comparison From NOMAD5 at 300m

GFS from 0.5 deg x 0.5 deg

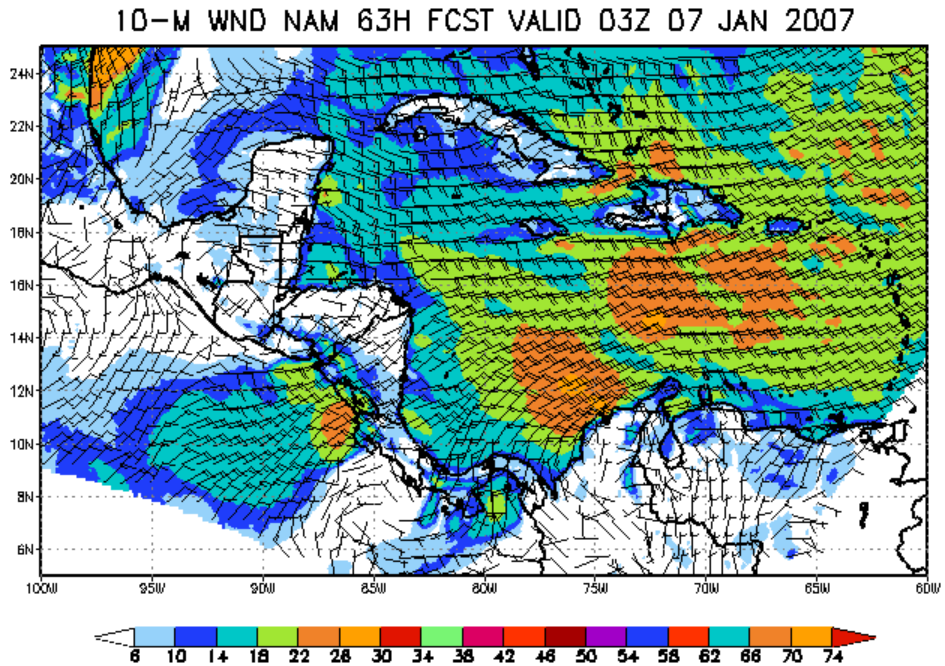


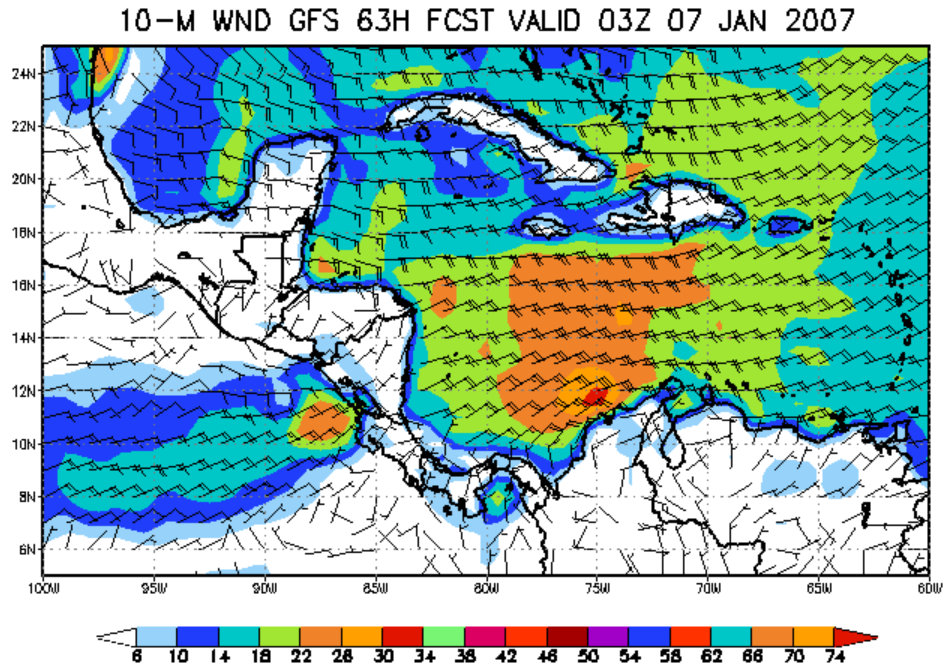
NAM from 12 km

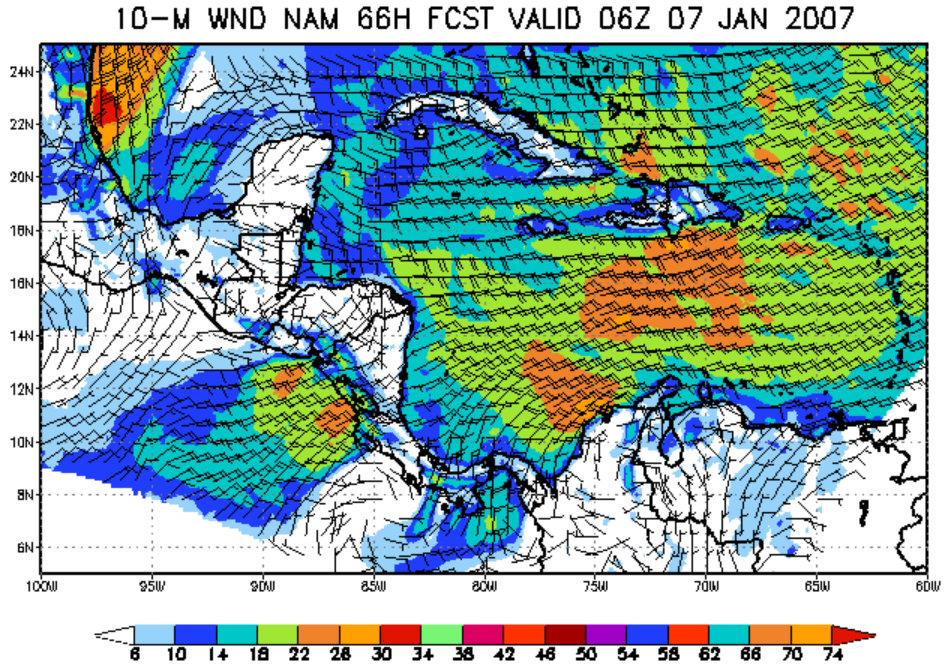


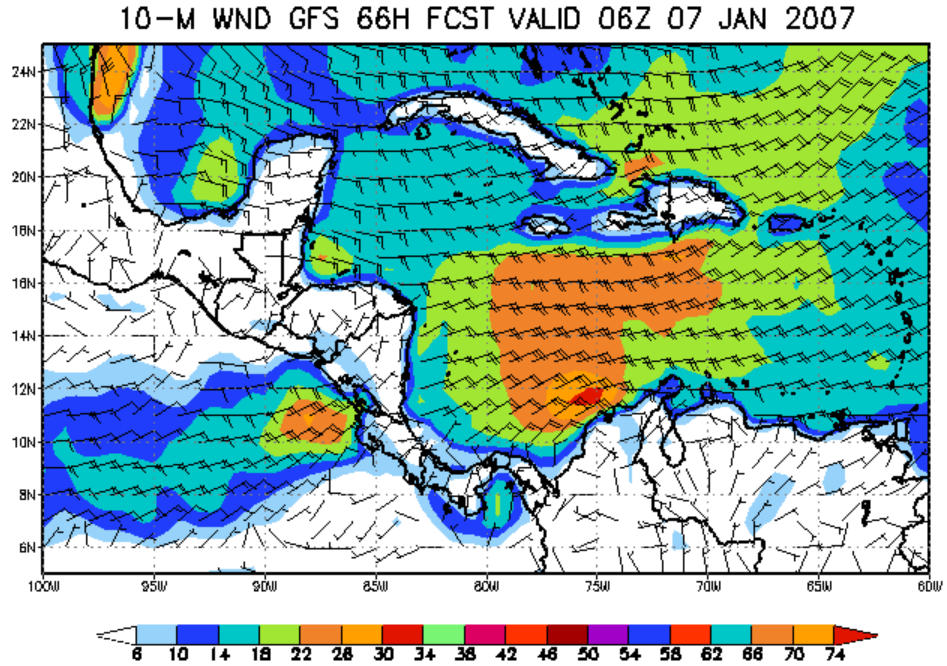

30 70 150 250 400 700 1000 1400 1800 2200 2600
30 70 150 250 400 700 1000 1400 1800 2200 2600
30 70 150 250 400 700 1000 1400 1800 2200 2600
30 70 150 250 400 700 1000 1400 1800 2200 2600

NAM vs GFS 63hr & 66hr

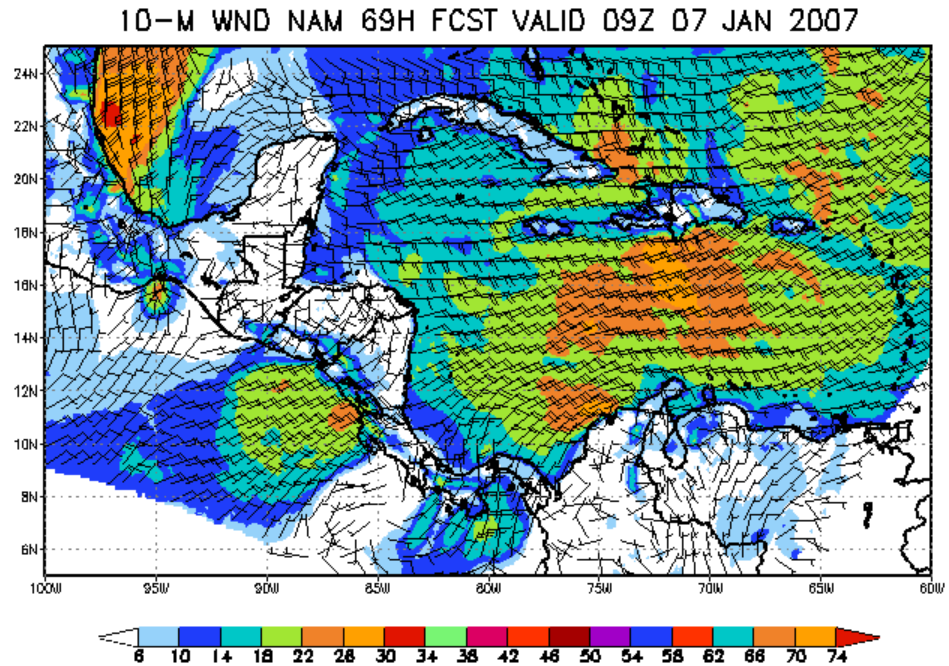


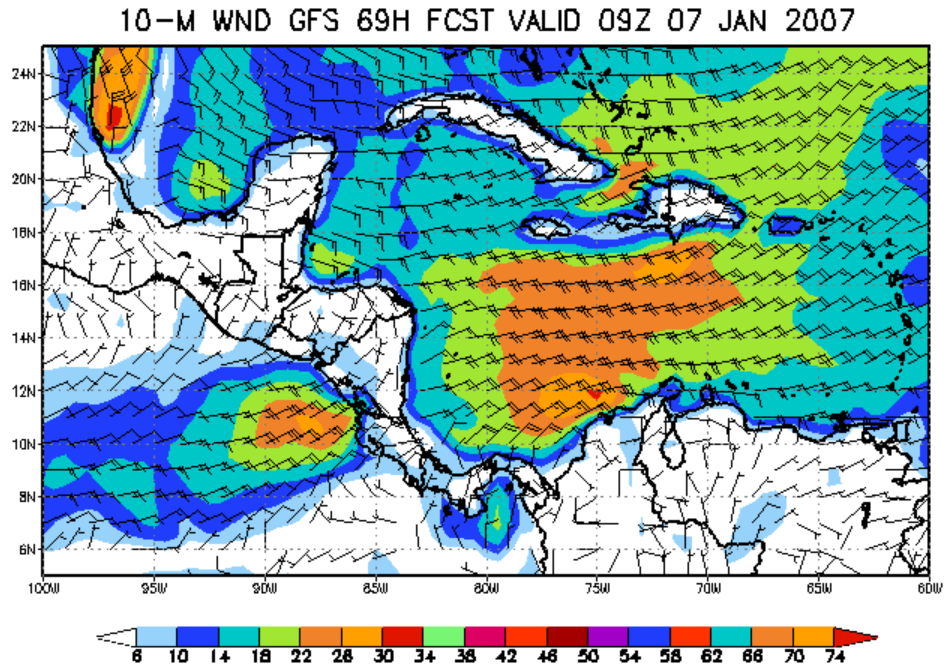


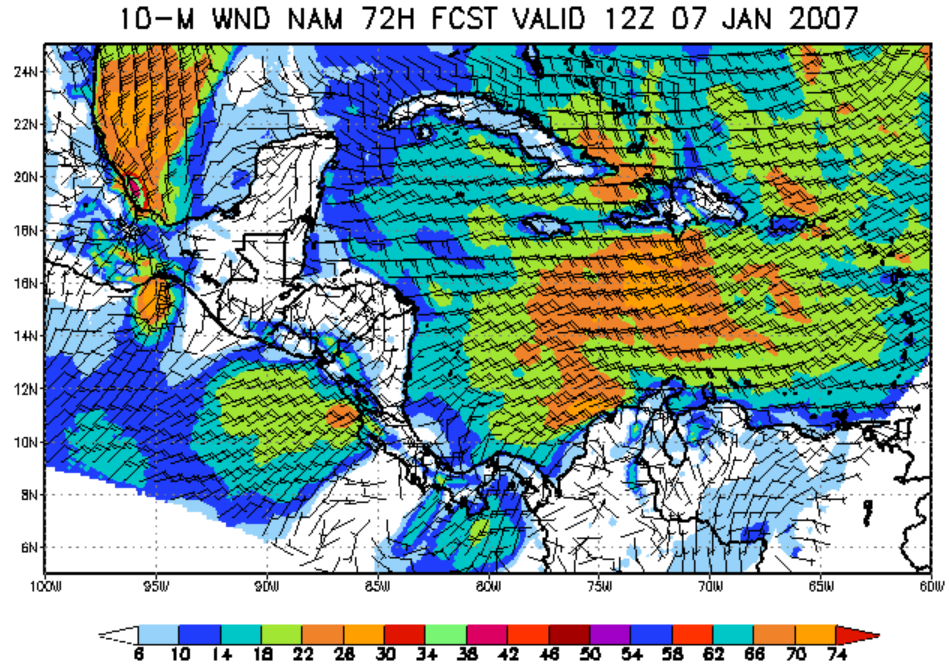


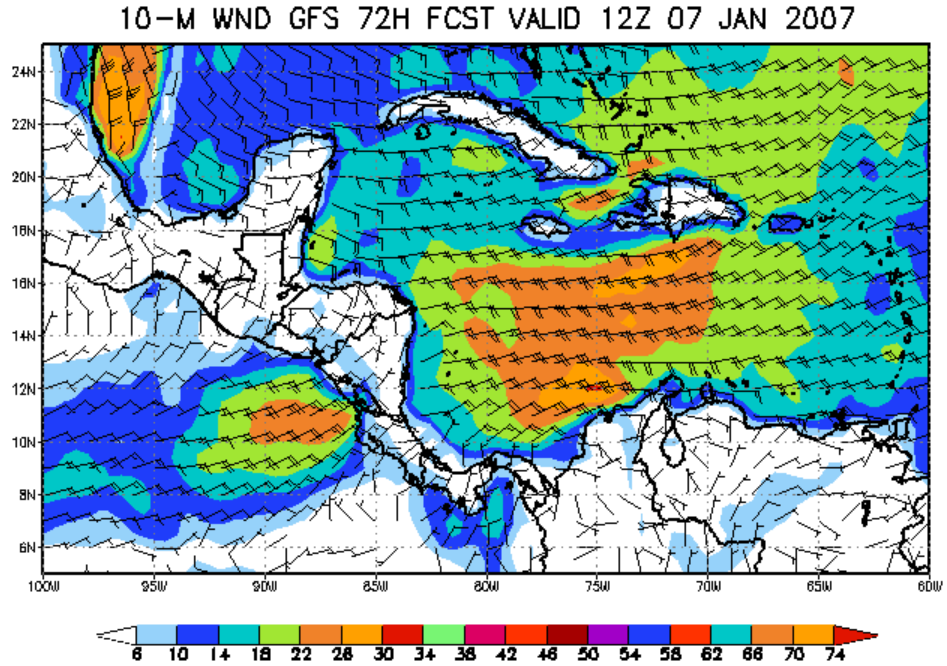


NAM vs GFS 69hr & 72hr

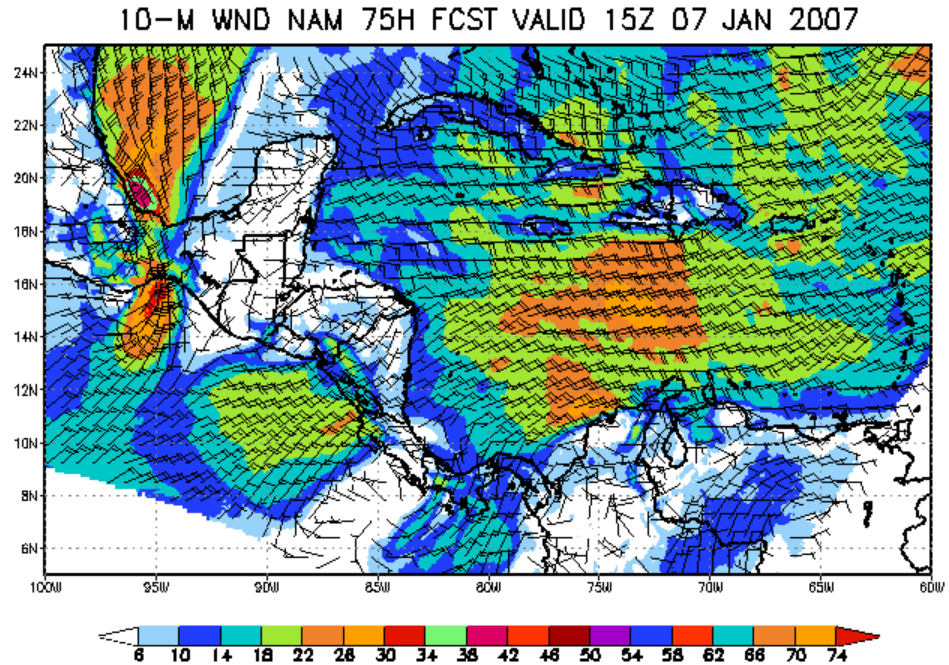


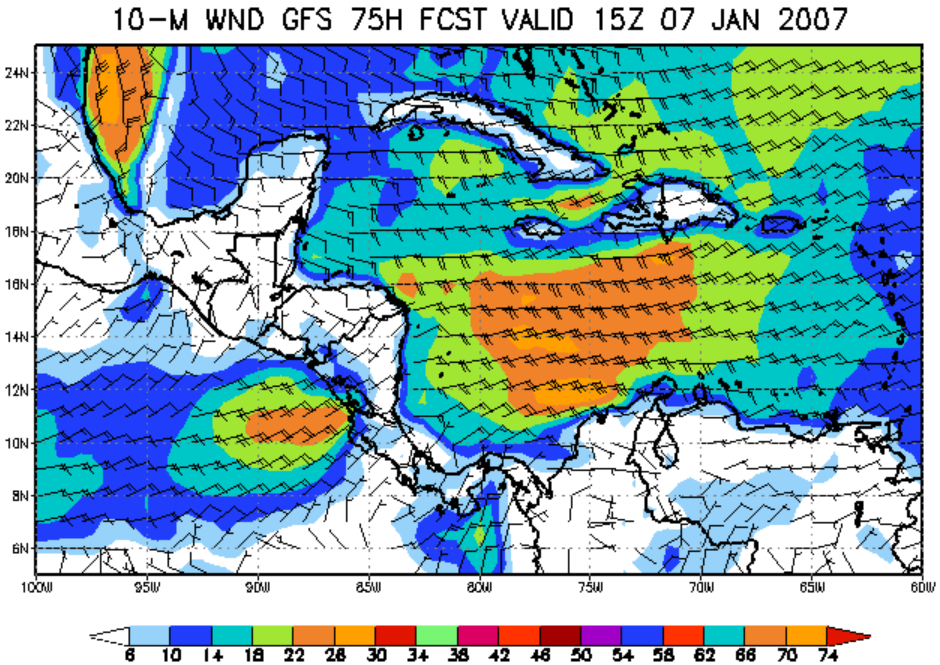


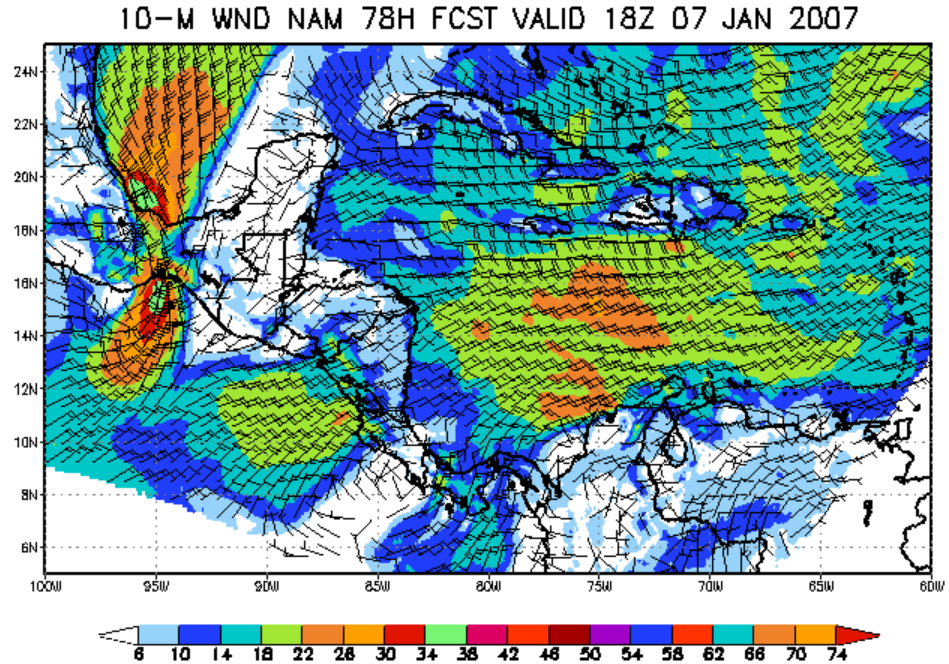


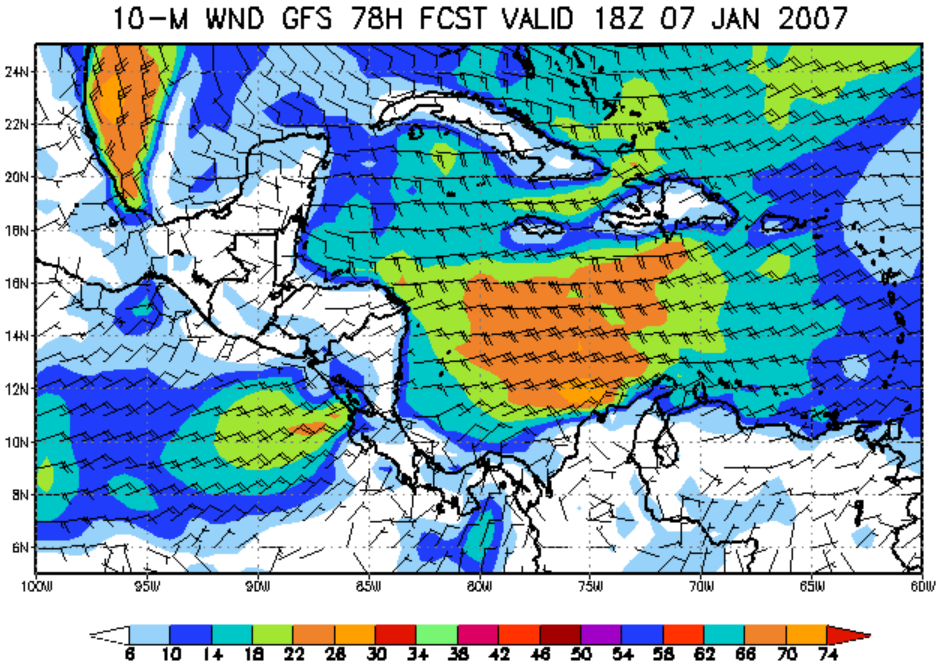


NAM vs GFS 75hr & 78hr

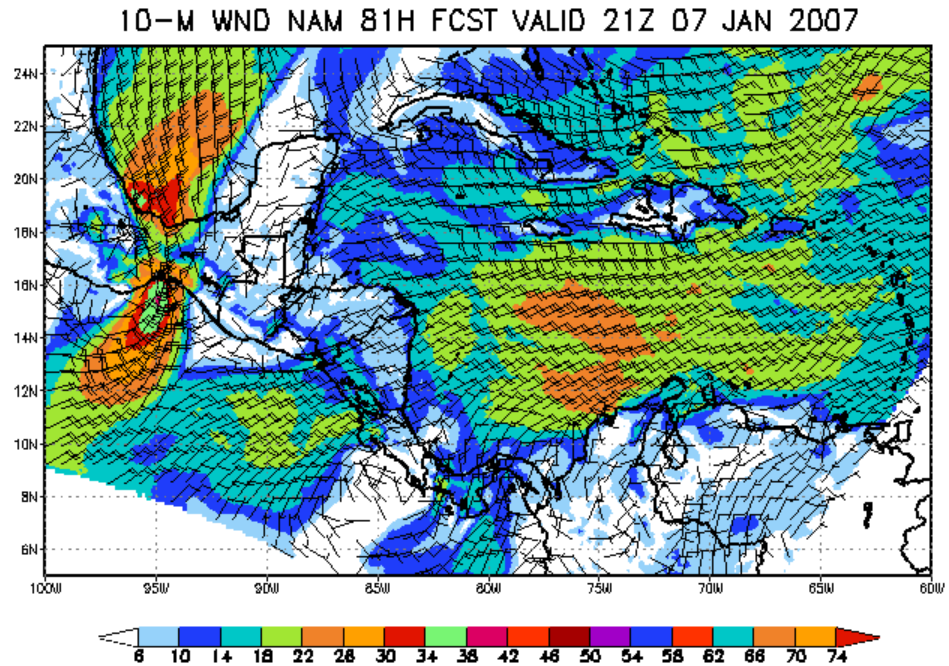


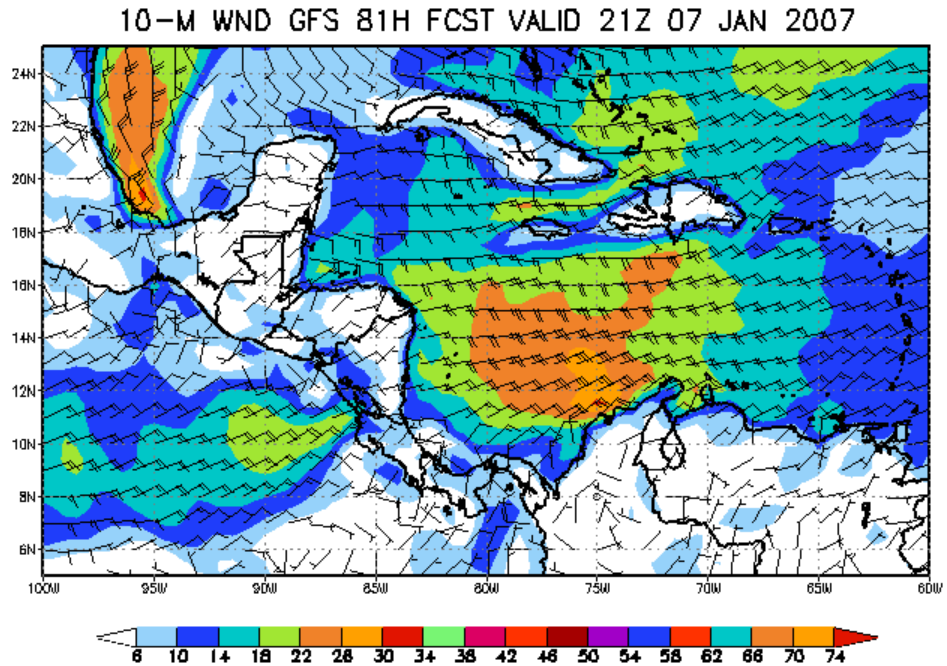


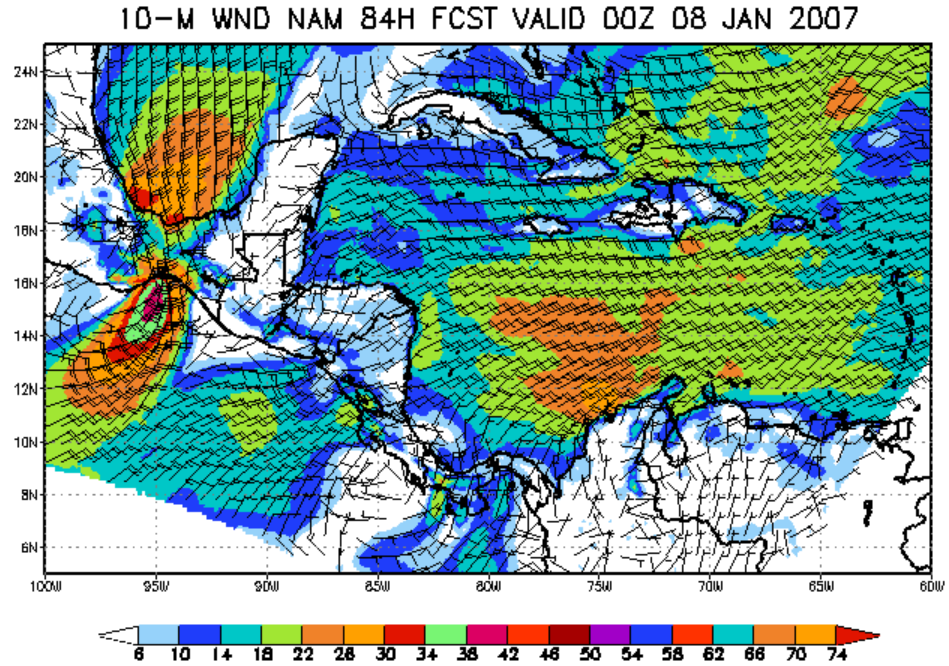


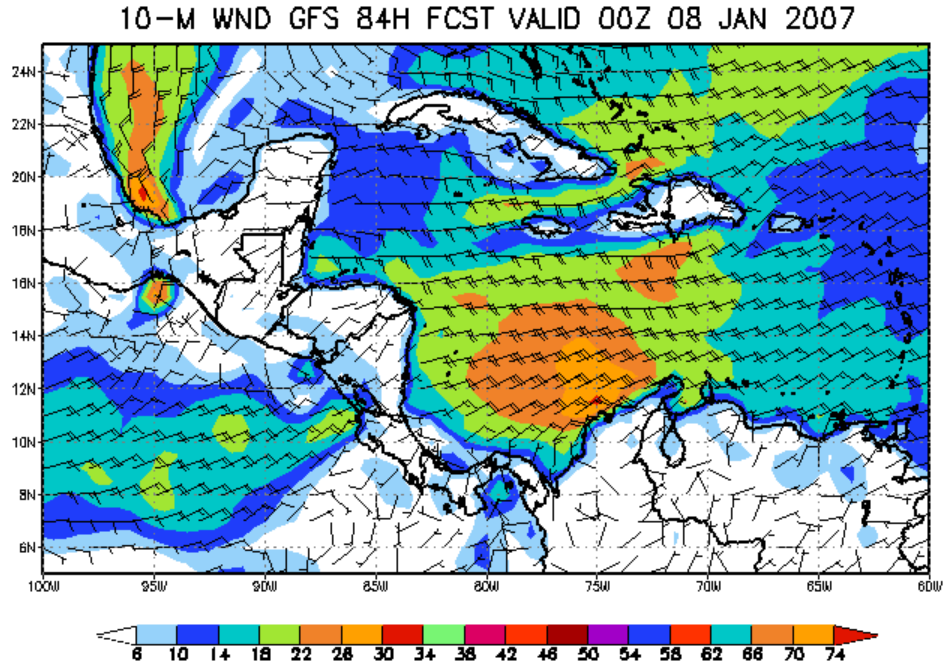


NAM vs GFS 81hr & 84hr









Massive Unification Campaign Across All of EMC

- *Unified* Framework - **ESMF**
- *Unified* Data Assimilation - GSI
- *Unified* Forecast Model
- *Unified* Physics
- *Unified* Postprocessor – NCEP Post
- *Unified* Verification
- *Unified* Ensemble
- *Unified* Reanalysis & Reforecasting
- *Unified* NCEP-ESRL strategy
- *Unified* NCEP-GMAO strategy
- *Unified* NCEP-Navy-USAF strategy

ESMF

Earth System Modeling Framework

NSF NCAR

Tim Killeen, PI
Byron Boville
Cecelia DeLuca
Roberta Johnson
John Michalakes
Al Kellie

MIT

John Marshall, PI
Chris Hill

NASA GMAO

Arlindo da Silva, PI
Leonid Zaslavsky
Will Sawyer
Max Suarez
Michele Rienecker
Christian Keppenne
Christa Peters-Lidard

NOAA GFDL

Ants Leetmaa
V. Balaji
Robert Hallberg
Jeff Anderson

NOAA NCEP

Stephen Lord
Mark Iredell
Mike Young
John Derber

DOE Los Alamos Nat'l La

Phil Jones

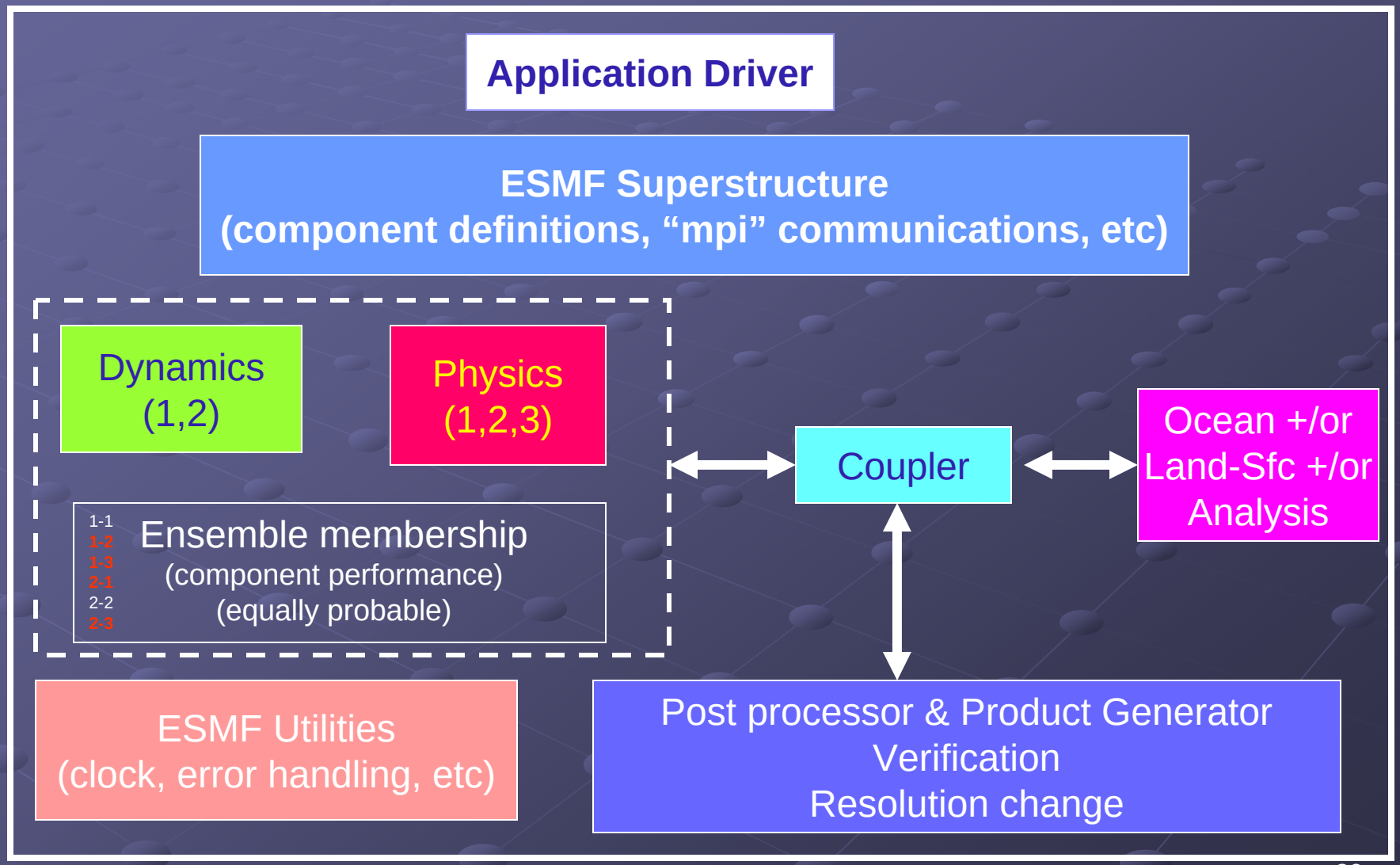
DOE Argonne Nat'l Lab

Jay Larson
Barry Smith

University of Michigan

Quentin Stout

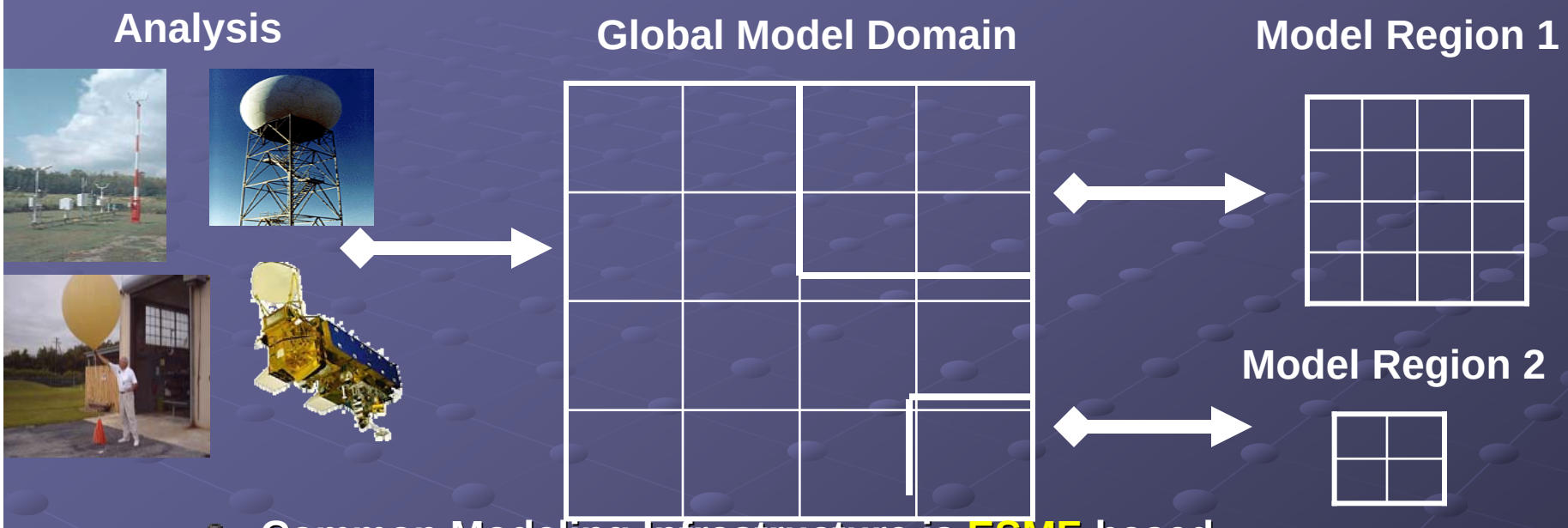
ESMF* Compliant Component System



* **Earth System Modeling Framework**

Concurrent execution of global and regional forecast models

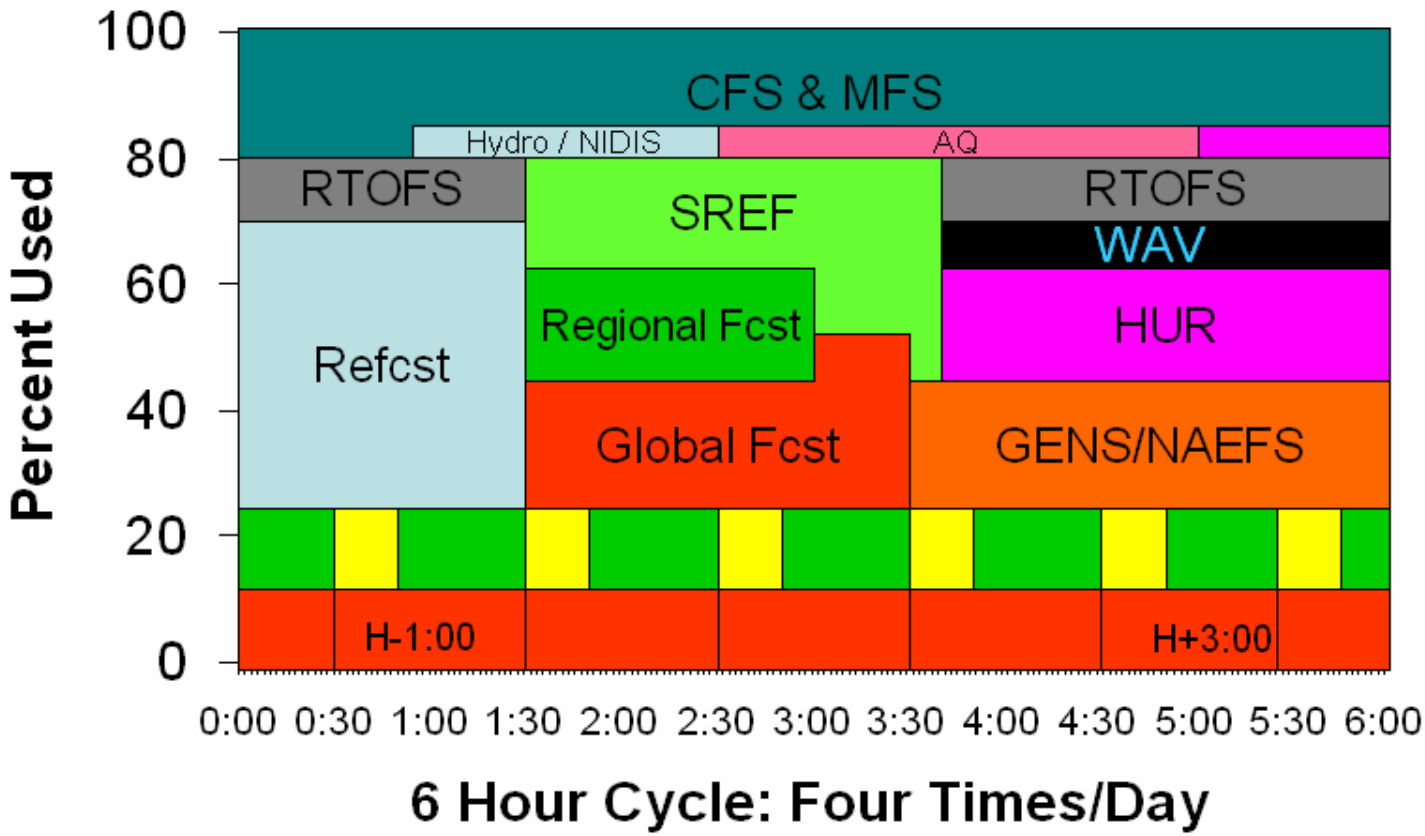
Phase 1



- **Common Modeling Infrastructure is ESMF-based**
- **In-core Solution**
  - Single executable for analysis, all model domains
  - No file writes or reads except for saving output
- **Concurrent execution of ensembles**
  - Single executable
- **More efficient execution of rapid updating**
  - In-core updating for analysis increments
  - Global
  - Regional (CONUS, Alaska, Hawaii, Caribb. & Puerto Rico)

NCEP Production Suite
Weather, Ocean & Climate Forecast Systems

Next Generation Prototype
2009-2015



6 Hour Cycle: Four Times/Day

- **Rap Refresh**
- WAVES
- HUR/HRW
- **Global**
- **Regional**
- **Refcst**
- Air Quality
- OCEAN
- Seasonal