NCEP/EMC Climate Modeling Capabilities and the Transition Process

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"Where America's Climate, Weather and Ocean Services Begin"

Presentation Outline

- NOAA, NWS and EMP Strategic Plans
- NCEP Structure
- The EMC Mission
- Global Coupled Climate Forecast System
- Transition of research to operations

Workshop Relevance to NOAA and NWS Strategic Plans…

NOAA Strategic Themes (Draft)	NWS Strategic Goals (Draft)	S&T Roadmap Themes
Climate Adaptation and Mitigation	Enable Integrated Environmental services supporting healthy communities and ecosystems	✓ Integrated observing and analysis system
Weather Ready Nation	Enhance Climate Services to help communities, businesses, govts	✓ Integrated environmental modeling: data assimilation, prediction, post-processing (e.g. ensembles)
	Deliver broader suite of improved Water Services …	
Sustainable and Resilient Fisheries, Habitats, Species	Improve sector-relevant information [for] economic productivity, homeland security	✓ Next generation Forecast and Decision Support System ✓ 4D Digital Weather Information Database (WIDB)
Sustainable Coastal Communities and Economies	Deliver Comprehensive Weather Services for [high-impact] events	✓ Transforming dissemination/communication/ outreach capabilities ✓ Incorporating social sciences strategies in research and operations
Accelerate transition of applications from research to operations		

Science-service Focus Areas

The NOAA Environmental Modeling Program Strategic Plan…..

VISION : **An interconnected and comprehensive NOAA modeling enterprise improving the Nation's ability to understand, plan for, and respond to environmental, economic, and societal change**

MISSION: **To develop, maintain, and operate state-of-the-science environmental models that support critical decision making and help America build a more resilient society**

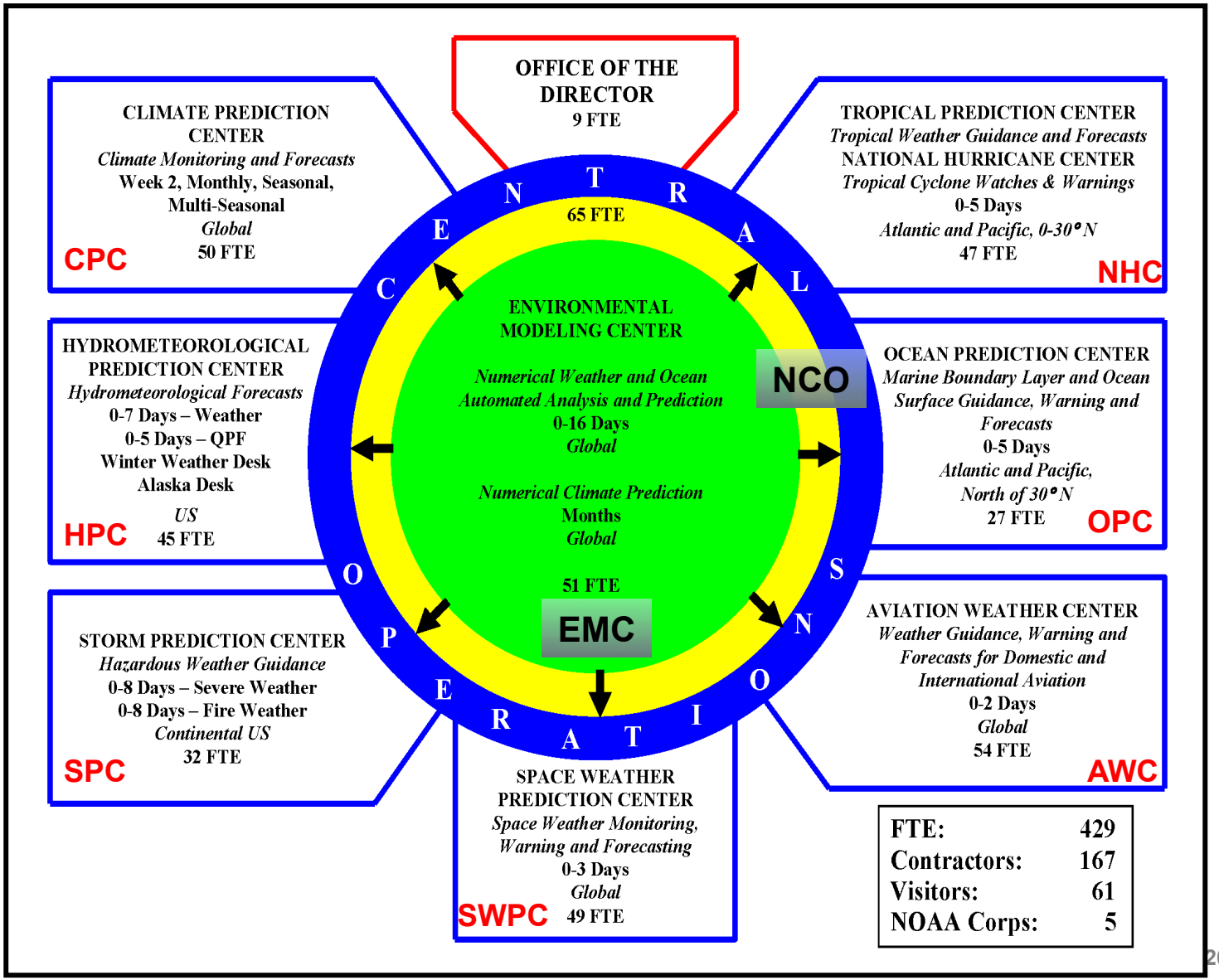
EMP Ten Year Goals (draft)

Goal 1: Create a NOAA environmental modeling backbone capable of addressing the complex and interconnected issues and mandates of the 21st century

Goal 2: Integrate environmental models into NOAA's research, observational and decision support services

Goal 3: Support the best possible predictions and projections through modern and sustained infrastructure, sound business practices, and strategic partnerships

The National Centers for Environmental Prediction



The EMC Mission…..

In response to operational requirements:

- **Develop and Enhance numerical guidance**
  - Improve NCEP's numerical forecast model systems via
    - Scientific upgrades
    - Optimization
    - Additional observations

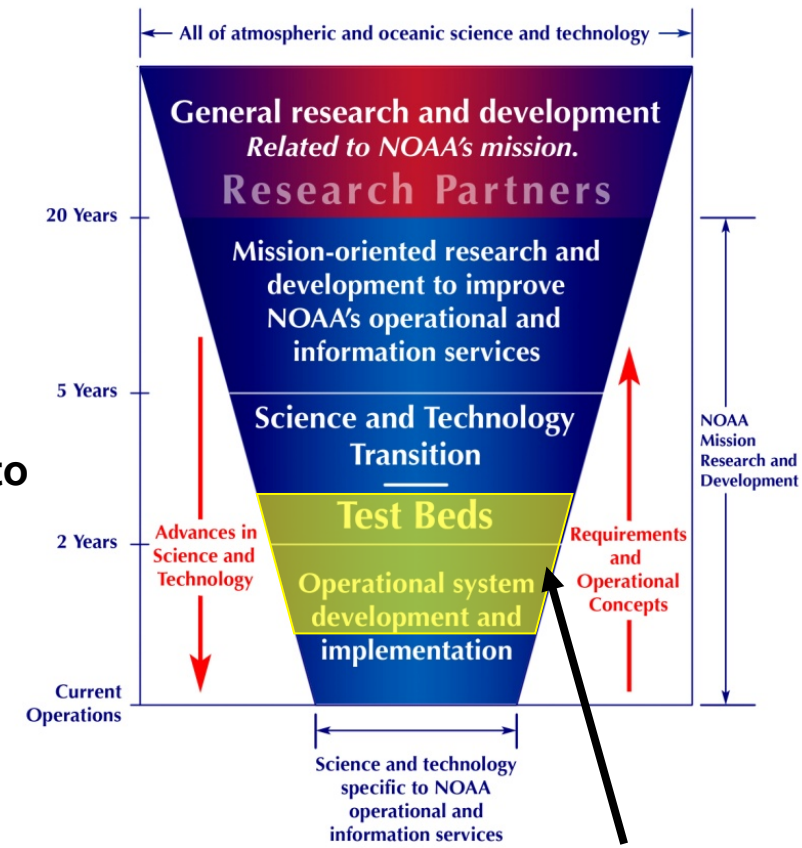
40%

- **Maintain operational model suite**
  - The scientific correctness and integrity of operational forecast modeling systems
  - Modify current operational system to adapt to ever-present external changes

30%

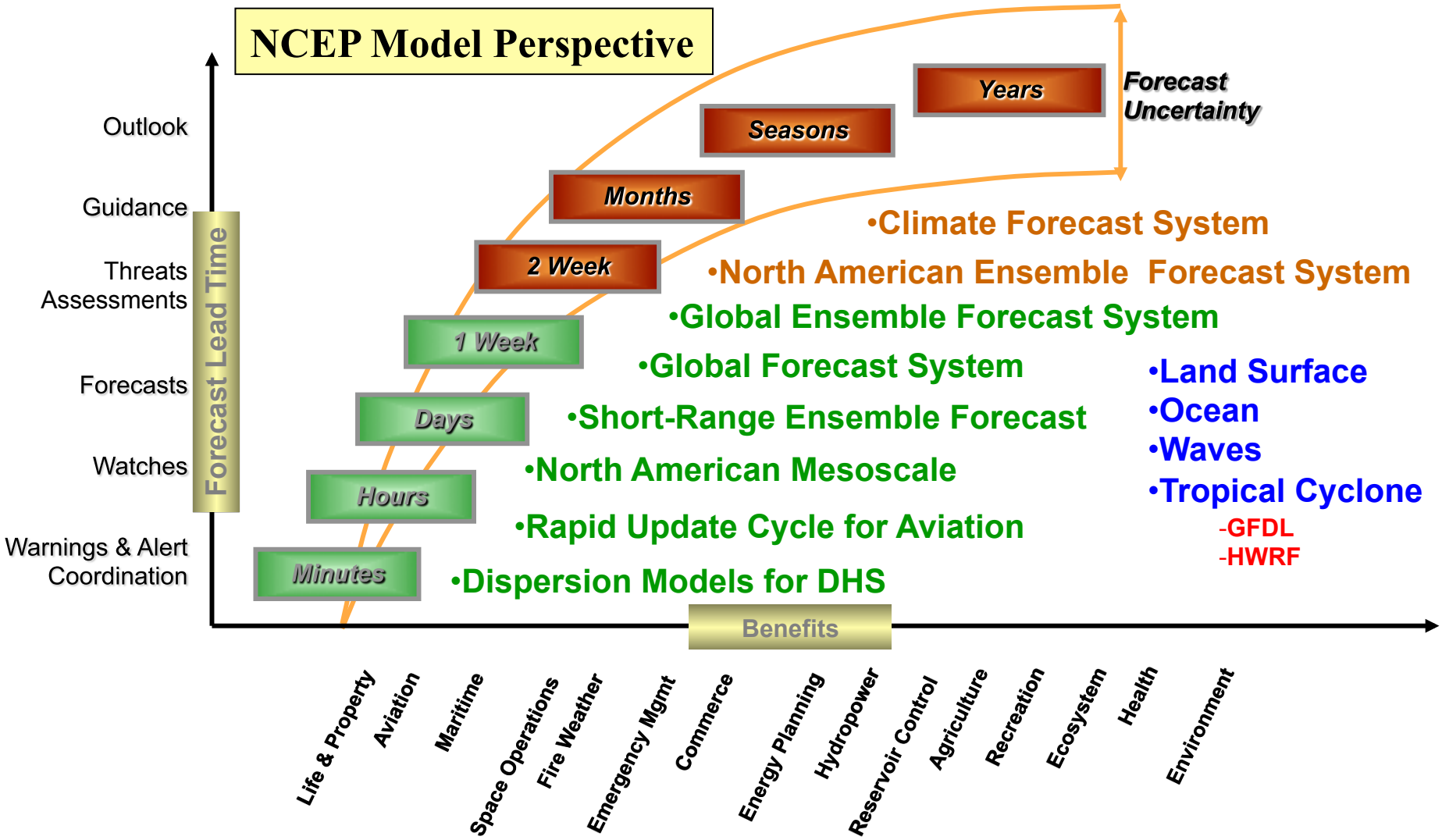
- **Transition operational numerical forecast models from research to operations**
  - Transform & integrate
    - Code
    - Algorithms
    - Techniques
  - Manages and executes transition process including technical and system performance review before implementation

30%



EMC location within the funnel

NWS Seamless Suite of Forecast Products Spanning Weather and Climate

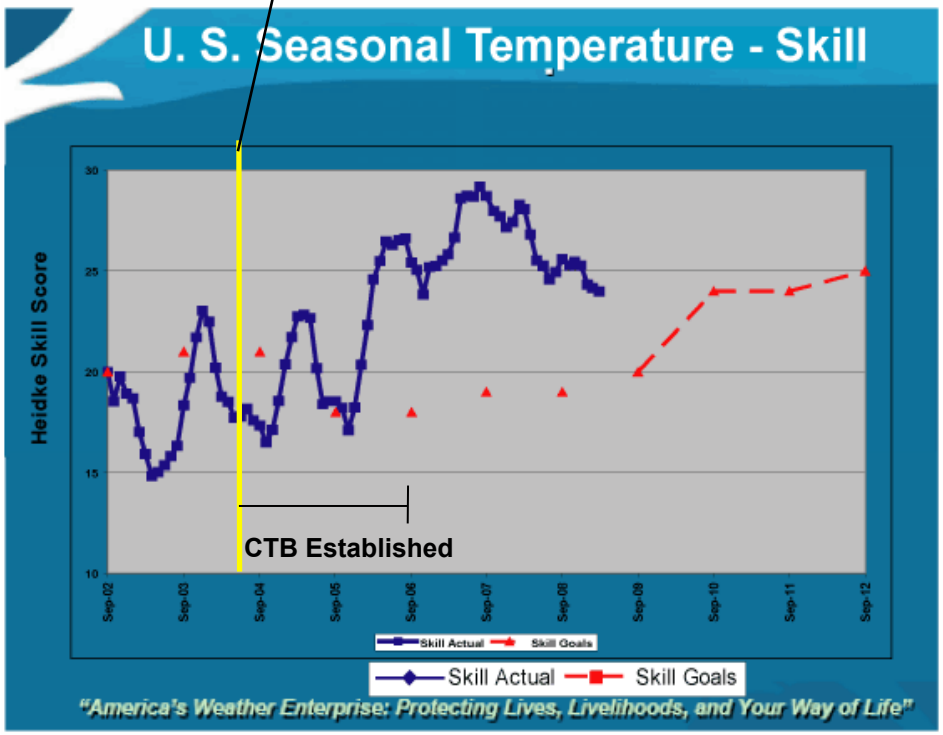


Climate Prediction Advances at NCEP

CFS – first dynamic operational climate forecast model (implemented Aug 2004)

- Increases in the skill of CPC official seasonal outlooks (20% or more; O'Lenic et al. 2008) due in part to CFS and to CTB milestones (e.g. consolidation tool)
- Improvements to CFS will result in improved forecast skill

CFS (v1.0) implemented 2004



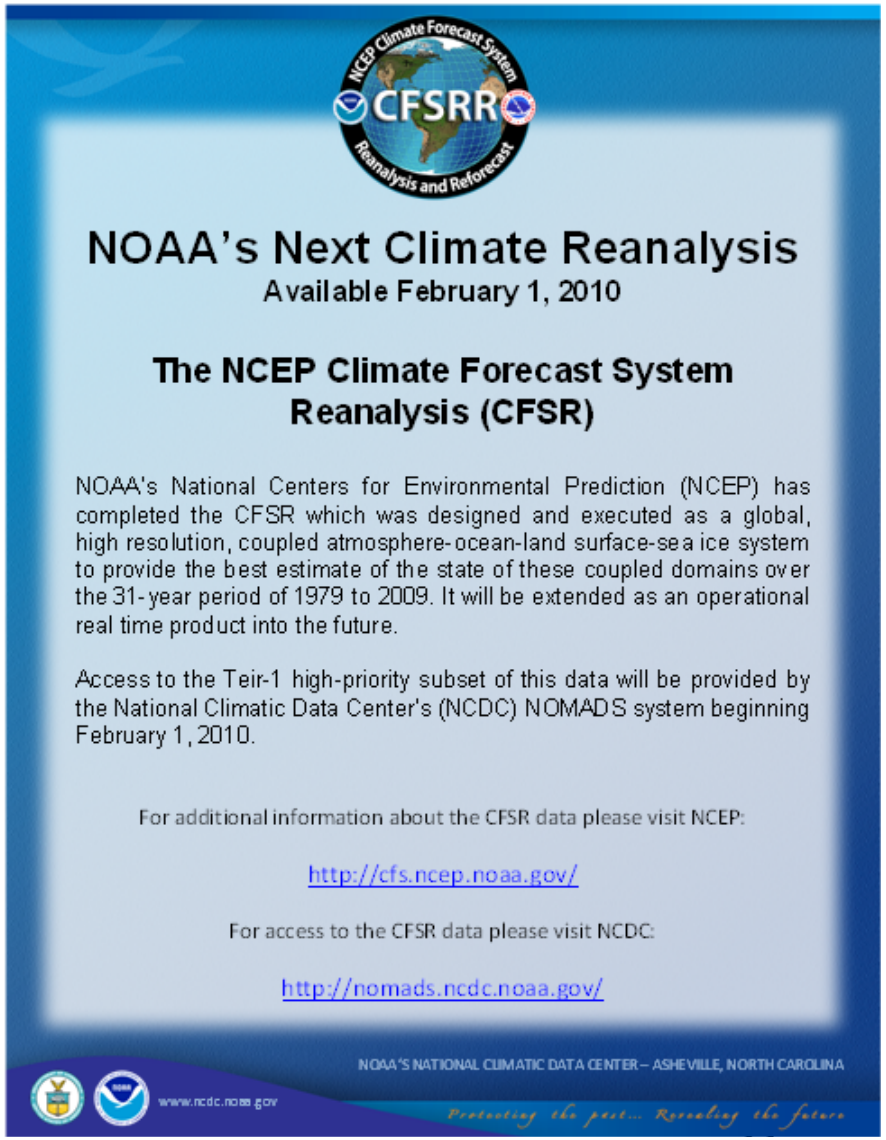
NCEP Climate Forecast System Reanalysis

System components:

- A new Reanalysis of the atmosphere, ocean, seaice and land
- 31-year period (1979-2009)
- Provides stable calibration and skill estimates of the new system, for operational seasonal prediction at NCEP

Key differences with the earlier NCEP Reanalysis efforts:

1) Increased horizontal and vertical resolution (T382L64 vs T62L28) of the atmosphere (~38km)
2) The guess forecast was generated from a coupled atmosphere – ocean – seaice - land system
3) Radiance measurements from the historical satellites were assimilated in this Reanalysis



NCEP Climate Forecast System CFSRR Reanalysis and Reforecast

NOAA's Next Climate Reanalysis

Available February 1, 2010

The NCEP Climate Forecast System Reanalysis (CFSR)

NOAA's National Centers for Environmental Prediction (NCEP) has completed the CFSR which was designed and executed as a global, high resolution, coupled atmosphere-ocean-land surface-sea ice system to provide the best estimate of the state of these coupled domains over the 31-year period of 1979 to 2009. It will be extended as an operational real time product into the future.

Access to the Teir-1 high-priority subset of this data will be provided by the National Climatic Data Center's (NCDC) NOMADS system beginning February 1, 2010.

For additional information about the CFSR data please visit NCEP:

http://cfs.ncep.noaa.gov/

For access to the CFSR data please visit NCDC:

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

NOAA'S NATIONAL CLIMATIC DATA CENTER – ASHEVILLE, NORTH CAROLINA

www.ncdc.noaa.gov

Protecting the past... Revealing the future

Climate Forecast System (CFS) Planned Upgrade for Q1FY11

Attribute	Operational Configuration	Q1FY11 Configuration
Analysis Resolution	200 km	38 km
Atmosphere model	1995: 200 km/28 levels Humidity based clouds	2009: 100 km/64 levels Variable CO2 AER SW & LW radiation Prognostic clouds & liquid water Retuned mountain blocking Convective gravity wave drag
Ocean model	MOM-3: 60N-65S 1/3 x 1 deg. Assim depth 750 m	MOM-4 fully global ¼ x ½ deg. Assim depth 4737 m
Land surface model (LSM) and assimilation	2-level LSM No separate land data assim	4 level Noah model GLDAS driven by obs precip
Sea ice	Climatology	Daily analysis and Prognostic sea ice
Coupling	Daily	30 minutes
Data assimilation	Retrieved soundings, 1995 analysis, uncoupled background	Radiances assimilated, 2008 GSI, coupled background
Reforecasts	15/month seasonal output	25/month (seasonal) 124/month (week 3-6)

Advancing Climate Prediction: The Climate Test Bed

Mission

- *To accelerate the transition of scientific advances from the climate research community to improved NOAA climate forecast products and services*

Vision

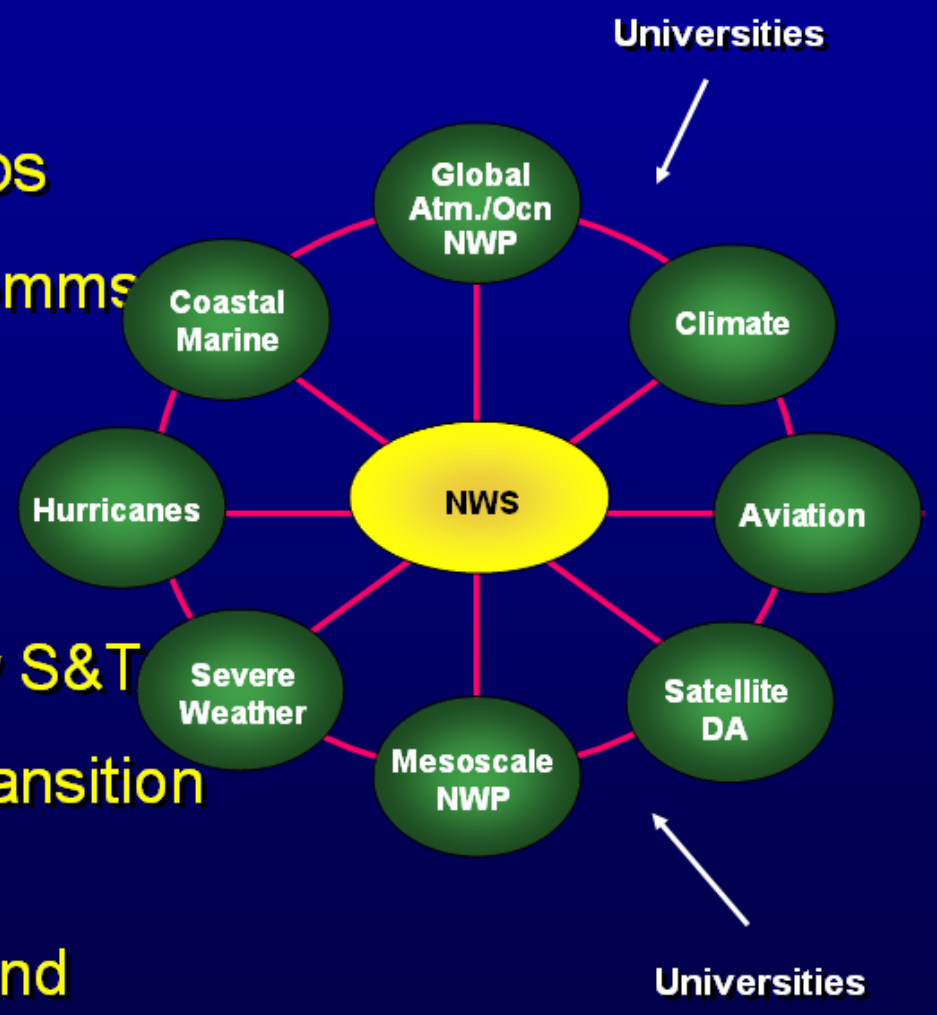
- *To significantly increase the accuracy, reliability, and scope of NOAA's suite of operational climate forecast products to meet the needs of a diverse user community.*

Management and Oversight

- *Oversight Board*
- *Steering Committee*
  - *To provide guidance and knowledge on CTB issues*
  - *Contribute to setting science priorities*
- *Competitive Grants Program managed by CPO*
- *External PI's and NCEP collaborators for projects*
- *Infrastructure Support (1/3 NCEP research computer; Reallocated FTE's)*

National Test Bed Architecture

- ✓ NCEP Test Bed - Virtual
- ✓ Vision: NCEP "clone" in labs
  - Near identical, h/w, s/w, comms etc.
  - Identical observations and operating systems
  - Labs develop and test new S&T
    - When mature: timely transition to NCEP production
  - Extensible to have RFCs and WFOs as a focus



Process to Implement Major Upgrades to The NCEP Model Production Suite

R&D and Pre-Implementation Phase

1 Identification for Selection

2 Code/Algorithm Assessment and/or Development

3 Interface with Operational Codes

4 Level I: Preliminary Testing (Lower Resolution)

5 Level II: Preliminary Testing (DA/Higher Resolution)

6 EMC Pre-Implementation Testing (Packaging/Calibration)

Systematic Testing

EMC Change Control Board

- Scientific Integrity
- Product Quality
- EMC Mgmt Approval

- Generate RFC's
- Submit RFC's to NCO

Implementation Phase

- SPA's build NCO parallel from RFC's
- 30-day NCO parallel
  - Test code stability
  - Test dataflow
  - Products to NCEP Centers and EMC code developers
- NCEP Centers
  - Evaluate impact
  - Assessments to NCEP OD

- 30-day NCO parallel stable
- NCEP centers approve

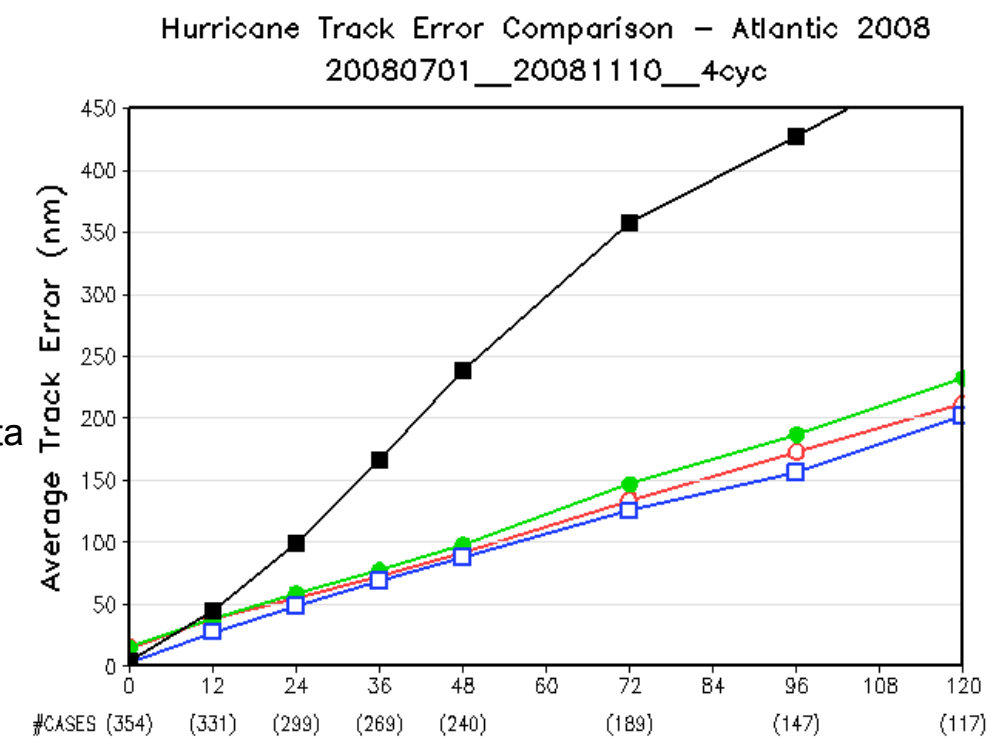
- Briefing to NCEP Director for final approval

Implementation

Apply Implementation Processes to GFS/GSI December 2009 Implementation…

- **Adding new observation data sources.**
  - **Tropical storm pseudo sea-level pressure obs**
  - NOAA19 hirs/4,AMSU-A, & MHS brightness temp obs
  - NOAA18 sbuv/2. Monitor N19 GOME, and OMI ozone (no assimilation)
  - RARS (currently only EARS) 1B data
  - EUMETSAT-9 atm motion vectors
- **Implementing improved techniques in GSI analysis.**
  - Use uniform thinning mesh for brightness temp data
  - Improvements to assimilation of GPS RO data (QC, retune ob errors, improved forward operator)
  - Add dry mass pressure constraint
  - Merge GMAO & EMC codes for 4d-var capability
  - Update background error covariance
  - Proper use of different spectral truncation between background and analysis
- **Benefits**
  - **Improved GFS tropical storm track & intensity forecasts**
  - Small improvement in global forecast accuracy

2008 Hurricane Season



GSI/GFS Bundle – Red
Operational GFS - Green

Time and Dedication for GFS/GSI December 2009 Implementation

- 17 months required to develop, test and implement
- 119 person months of effort (EMC, NCO, GFDL, TPC, SPC, HPC, AWC)
- 17 months of continuous cycles 4/day with 16 day forecasts retrospective/real-time testing conducted for GFS/GSI
- 500 HWRF and 600 GFDL TC/Hurricane cases simulated
- 1000 Node hours and 75 TB of disk consumed

In Summary

- The NCS and NWS continue to evolve and modeling is critical to success
- NCEP/EMC continues to build partnerships to satisfy customer needs (EMC is a NOAA Support Center)
- NCEP provides foundational numerical guidance
  - Global Forecast & Data Assimilation System
  - Global Real-time Ocean Forecasting System (FY11)
  - The Coupled Climate Forecast System (CFS)
- NCEP/EMC providing modeling priorities and plans to the external community
- Facilitation of R&D results into operations through partnerships and National testbeds