National Centers for Environmental Prediction: An Overview

Dr. Louis W. Uccellini
National Centers for Environmental Prediction
Director

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

Outline

- NCEP's Role in NOAA's Seamless Suite of Products and Forecast Services
- Forecast Metrics
- Forces for Change
- Summary

NOAA ORGANIZATION

CORPORATE FUNCTIONS

Under Secretary of Commerce for Oceans & Atmosphere & Administrator
Dr. Jane Lubchenco

Assistant Secretary of Commerce for Oceans & Atmosphere and Deputy Administrator
Dr. Larry Robinson

Deputy Under Secretary for Oceans & Atmosphere
Mary M. Glackin

Chief of Staff
Margaret Spring

Deputy Assistant Secretary for International Affairs
Dr. James M. Turner

Deputy Assistant Secretary for Oceans & Atmosphere
Vacant

Deputy Chief of Staff
Emily Lindow (A)

Office of Decision Coordination & Executive Secretariat
Kelly Quickle

Program Coordination Office
Emily Lindow (A)

Office of Military Affairs
LT Col David Miller, USAF
CDR Ashley Evans, USN

General Counsel
Lois Schiffer

Legislative Affairs
John Gray

Communications
Justin Kenney

Workforce Management
Sam Manning (A)

Education
Louisa Koch

Chief Information Officer/High Perf. Computing & Comm.
Joe Klimavicz

Program Analysis & Evaluation
Stephen D. Austin

Chief Administrative Officer
William Broglie

Chief Financial Officer
Maureen Wylie

Federal Coordinator for Meteorology
Sam Williamson

Acquisition & Grants
Mitchell J. Ross

Marine & Aviation Operations
RADM Jonathan W. Bailey

LINE OFFICES

Assistant Administrator
Oceanic & Atmospheric Research (OAR)
Craig McLean (A)

Assistant Administrator
National Ocean Service (NOS)
David Kennedy (A)

Assistant Administrator
National Environmental Satellite, Data & Information Service (NESDIS)
Mary Kicza

Assistant Administrator
National Marine Fisheries Service (NMFS)
Eric Schwaab

Assistant Administrator
National Weather Service (NWS)
Dr. Jack Hayes

Assistant Adminstrator
Program Planning & Integration (PPI)
Laura Furgione

MISSION GOALS

Ecosystem
Dr. Steve Murawski

Climate
Dr. Chet Koblinsky

Weather & Water
Edward Johnson (A)

Commerce & Transportation
CAPT Gerd Glang

MISSION SUPPORT

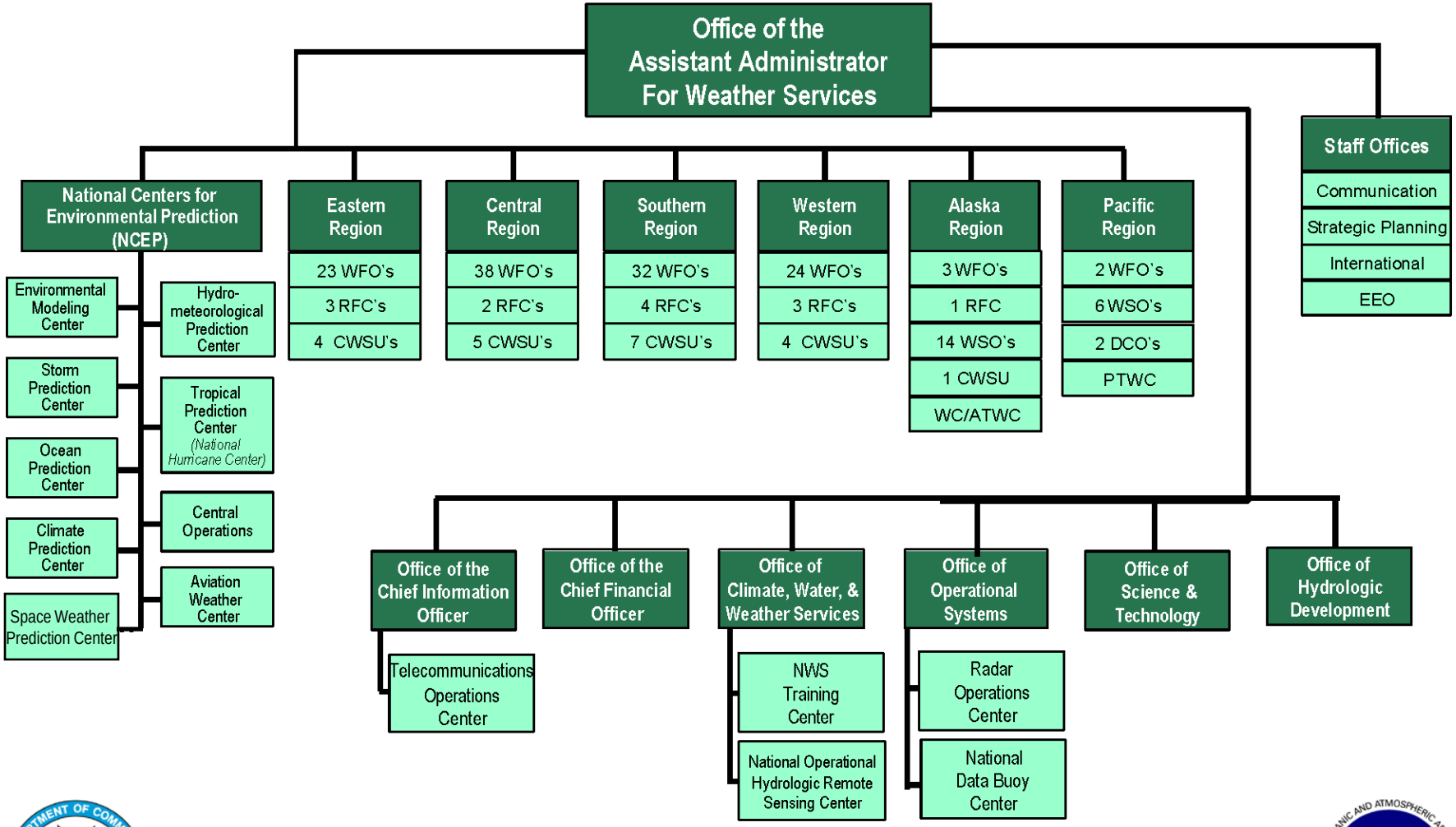
Satellite Services
Vacant

Modeling & Observing Infrastructure
Kenneth McDonald

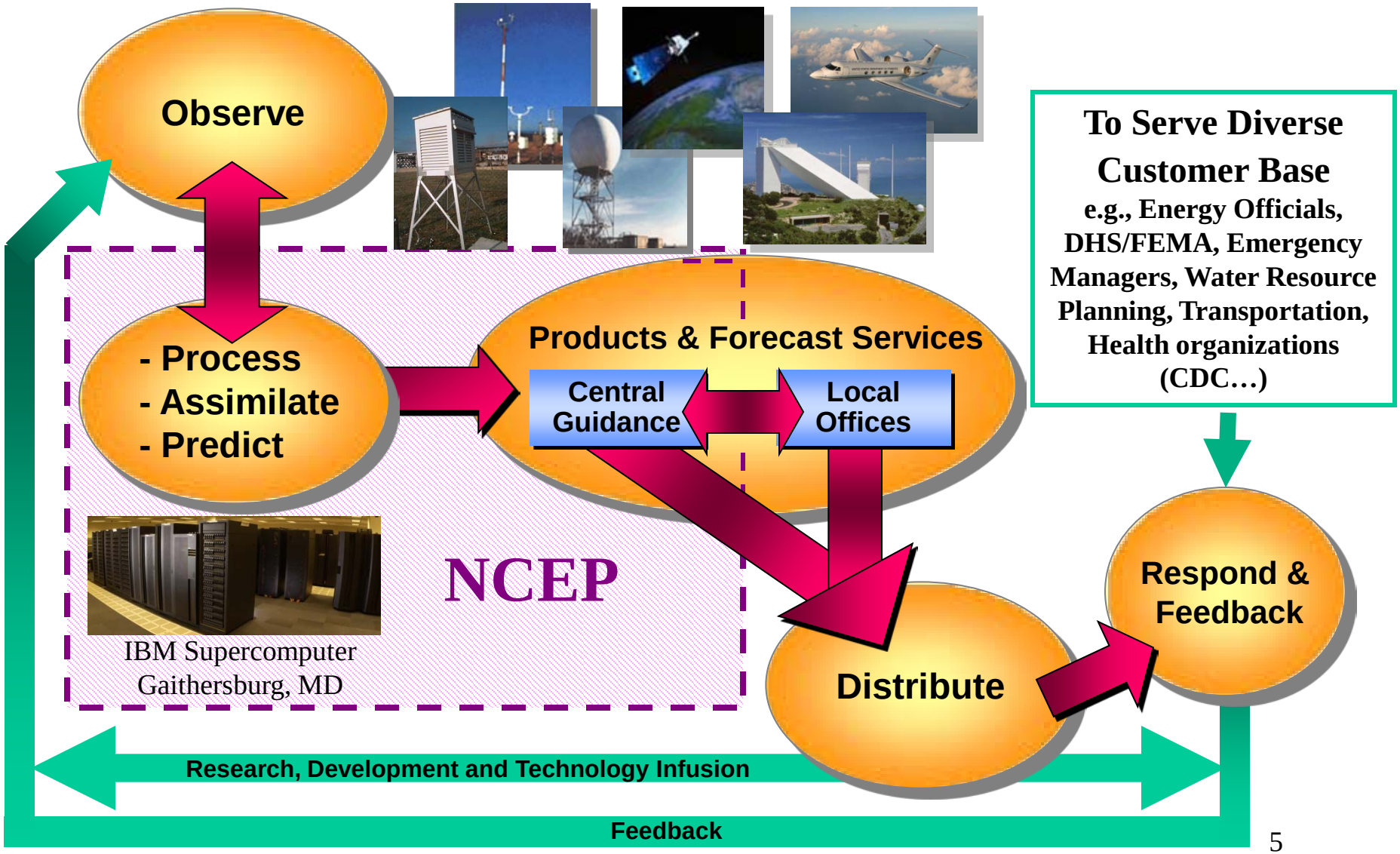
Fleet Services
Tajr Hull

Leadership & Corporate Services
William Broglie

Organizational Chart for the National Weather Service



NCEP's Role in NOAA's Seamless Suite of Products and Forecast Services

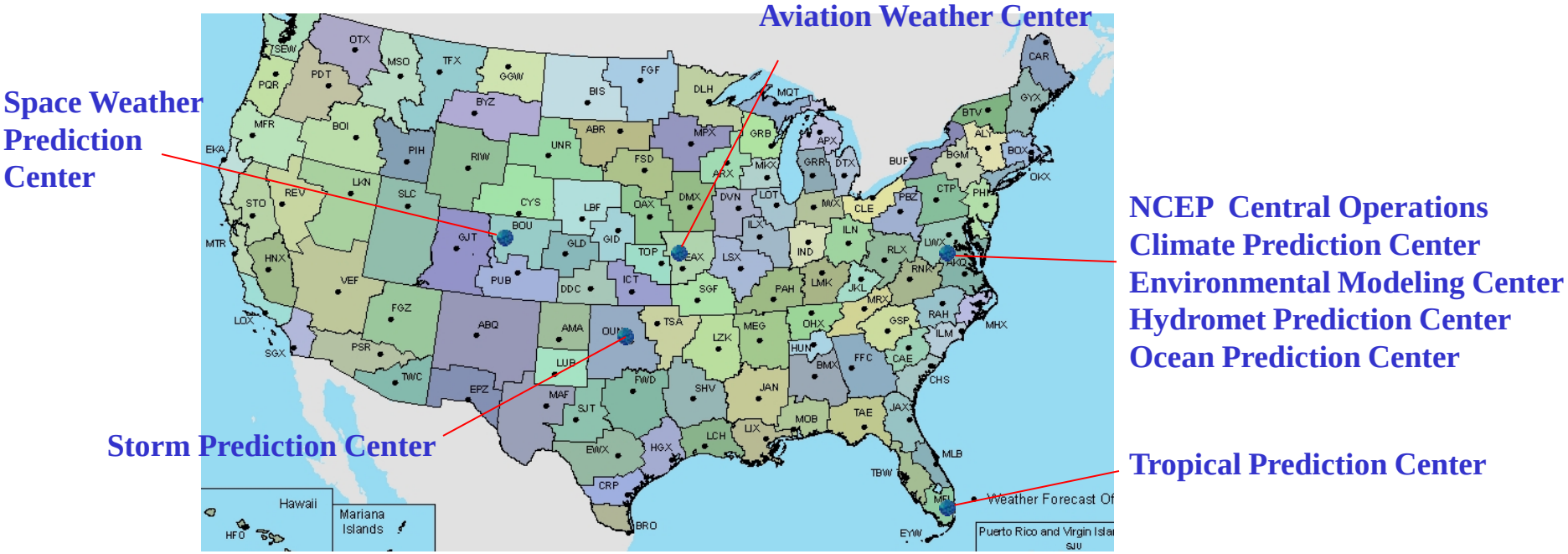


Prediction is now inherently linked to numerical models

NCEP Supports the NOAA Seamless Suite of Climate Weather and Ocean Products

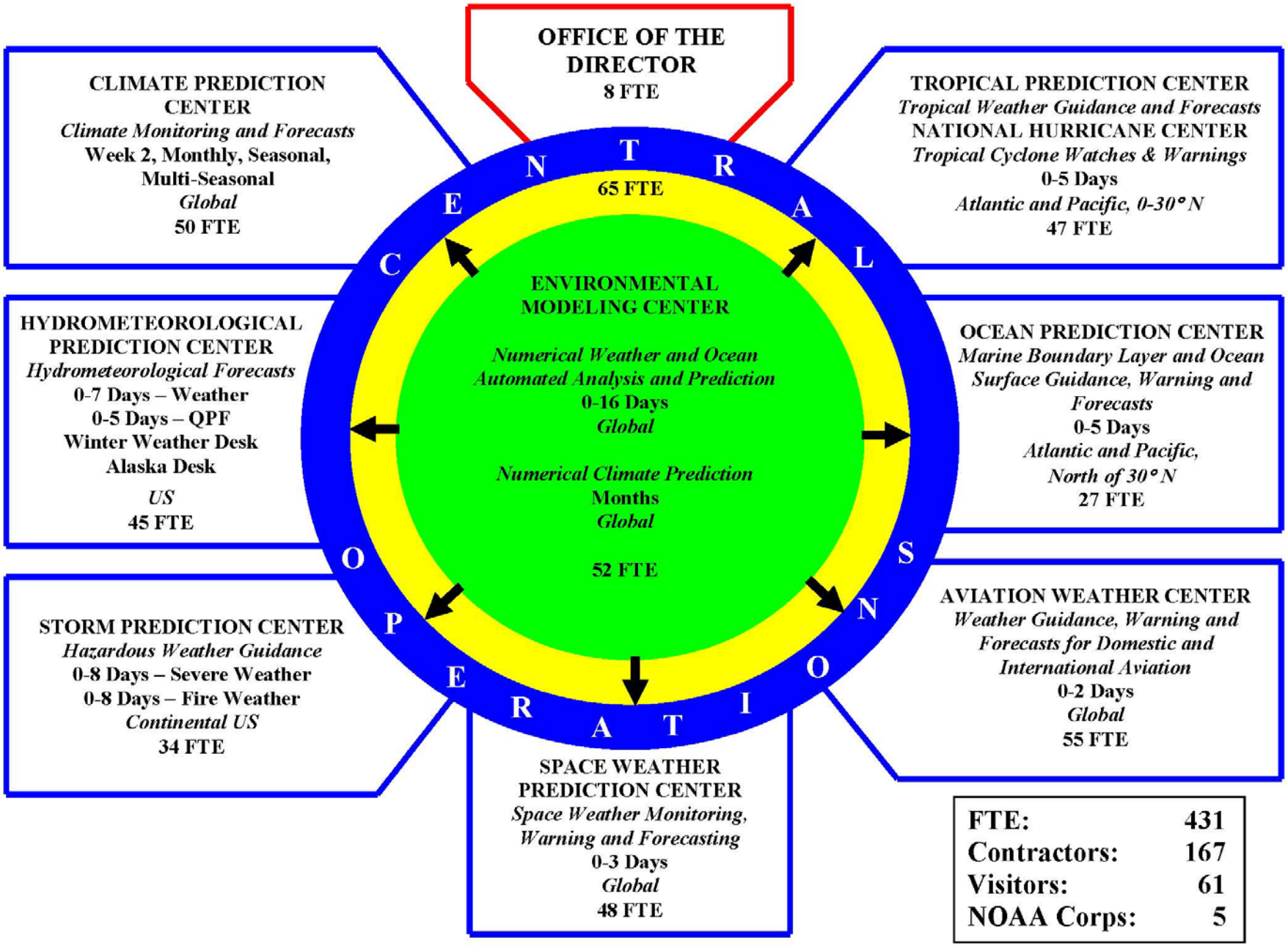
Organization: Central component of NOAA National Weather Service

Mission: NCEP delivers science-based environmental predictions to the nation and the global community. We collaborate with partners and customers to produce reliable, timely, and accurate analyses, guidance, forecasts and warnings for the protection of life and property and the enhancement of the national economy.

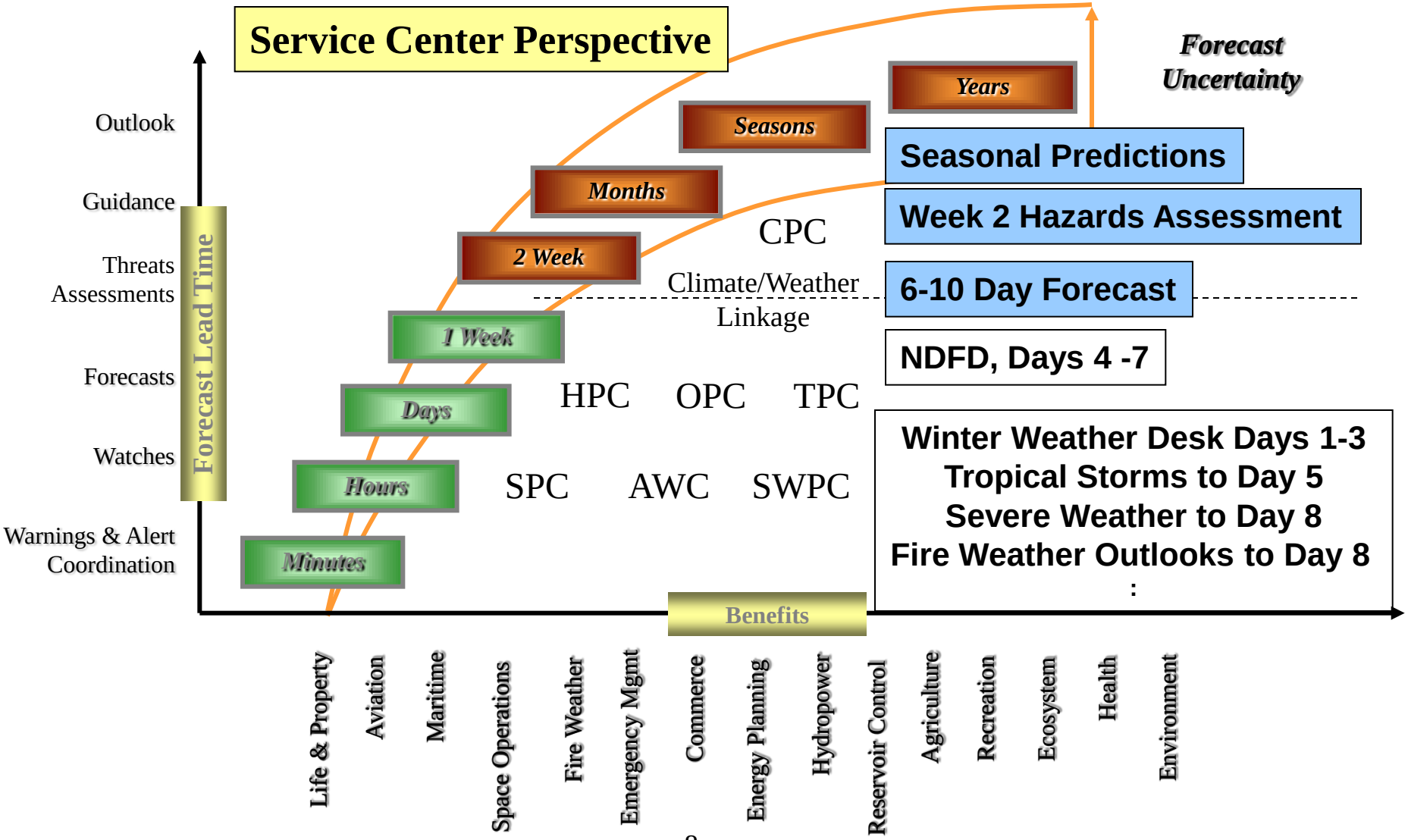


Vision: The Nation's trusted source, first alert and preferred partner for environmental prediction services

NATIONAL CENTERS for ENVIRONMENTAL PREDICTION



NOAA Seamless Suite of Forecast Products Spanning Climate and Weather



Test Beds

Service – Science Linkage with the Outside Community

- EMC — WRF Developmental Test Center, NASA/ NOAA/DoD Joint Center for Satellite Data Assimilation
- CPC — Climate Test Bed
- TPC — Joint Hurricane Test Bed
- HPC — Hydrometeorological Test Bed
- SPC — Hazardous Weather Test Bed with NSSL
- SWPC — Space Weather Prediction Test Bed with AFWA
- AWC — Aviation Weather Test Bed
- OPC — linked with EMC's Marine Modeling and Analysis Branch

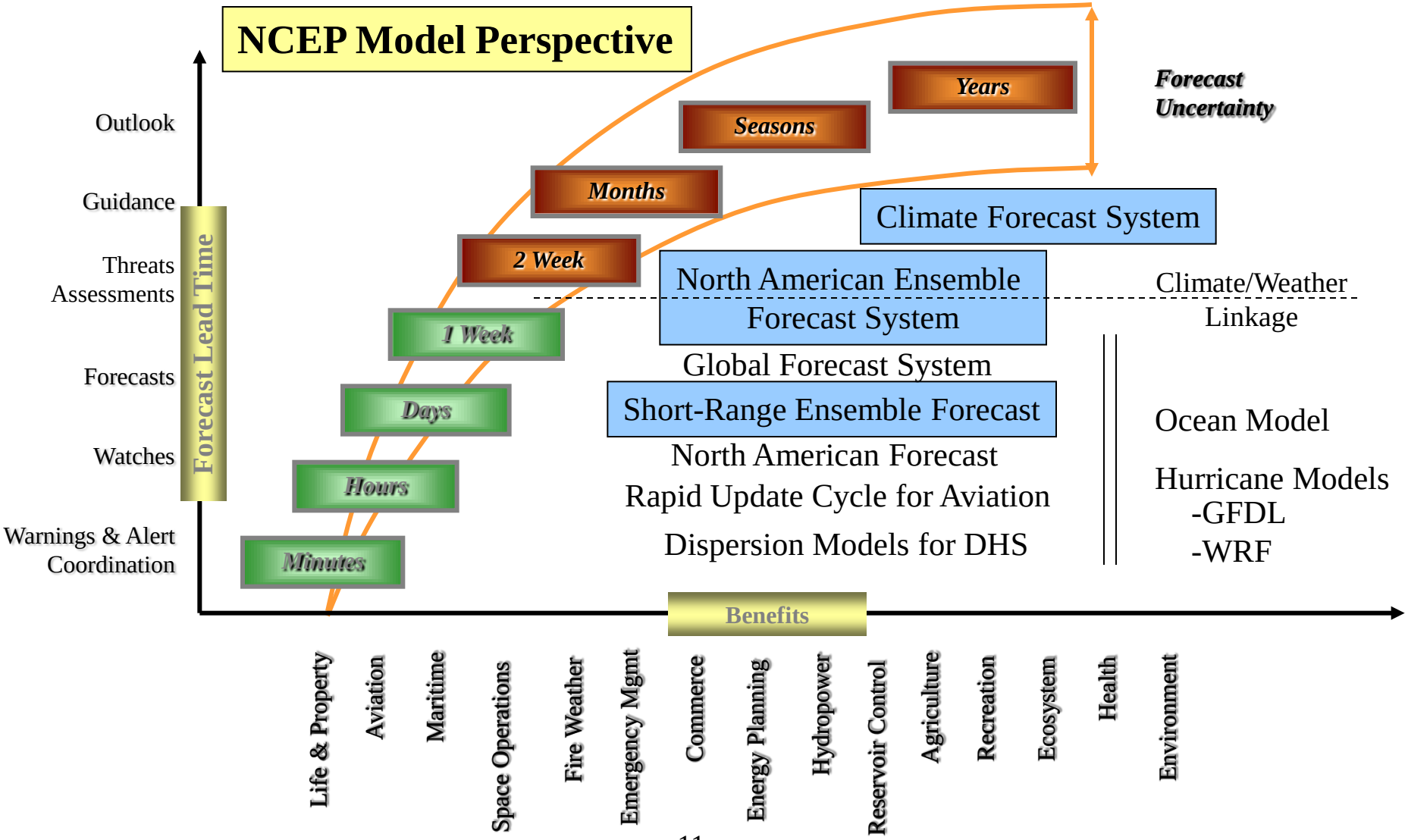
What Does NCEP Do?

"From the Sun to the Sea"

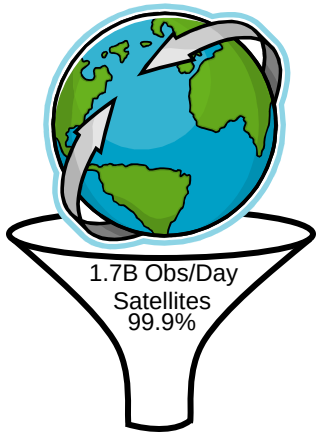
- Solar Monitoring, Warnings and Forecasts
- Climate Forecasts: Weekly to Seasonal to Inter-annual
- El Nino – La Nina Forecast
- Weather Forecasts to Day 7
- Hurricanes, Severe Weather, Snowstorms, Fire Weather
- Aviation Forecasts and Warnings
- Offshore and High Seas Forecasts and Warnings

- Model Development, Implementation and Applications for Global and Regional Weather, Climate, Oceans and now Space Weather
- International Partnerships in Ensemble Forecasts
- Data Assimilation including the Joint Center for Satellite Data Assimilation
- Super Computer, Workstation and Network Operations

NWS Seamless Suite of Forecast Products Spanning Climate and Weather



NOAA's NWS Model Production Suite



Global Data Assimilation

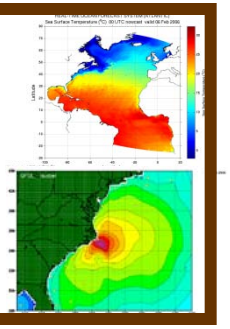
Global Forecast System

Climate CFS
MOM3

Hurricane
GFDL
HWRF

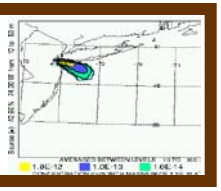
Coupled

Oceans
HYCOM
WaveWatch III

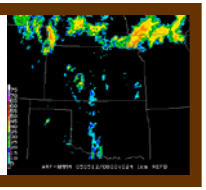


Regional DA
Regional NAM
WRF NMM

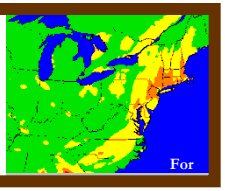
Dispersion
ARL/HYSPLIT



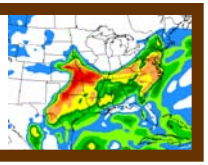
Severe Weather
WRF NMM/ARW
Workstation WRF



Air Quality
NAM/CMAQ

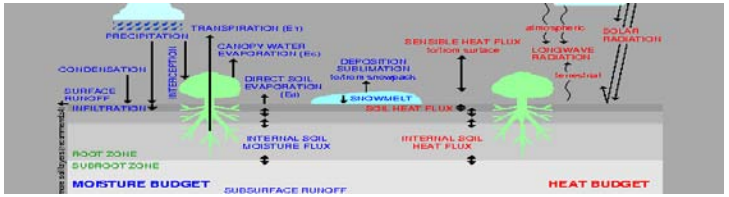


Rapid Update for Aviation



North American Ensemble Forecast System
GFS, Canadian Global Model

Regional DA
Short-Range Ensemble Forecast
WRF: ARW, NMM
ETA, RSM



NOAH Land Surface Model

Prediction Requires “Coupling” of Basic Earth “Systems” within Global Numerical Forecast Models

Atmosphere

Ocean

Cryosphere

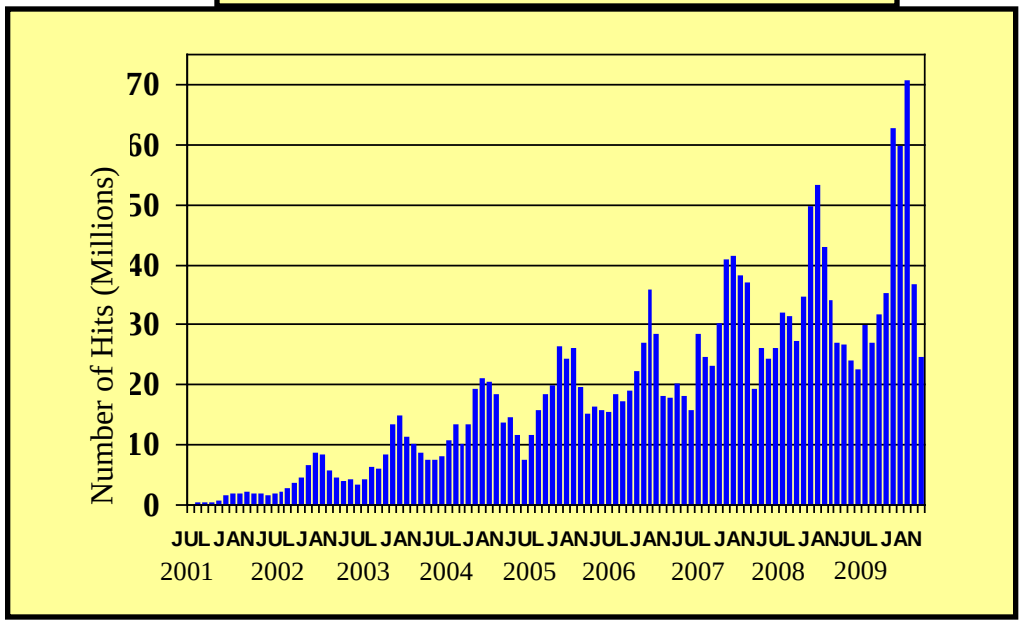
Land

- Predictions Driven by Global Observing Systems
- Real-time operations require world’s largest computers

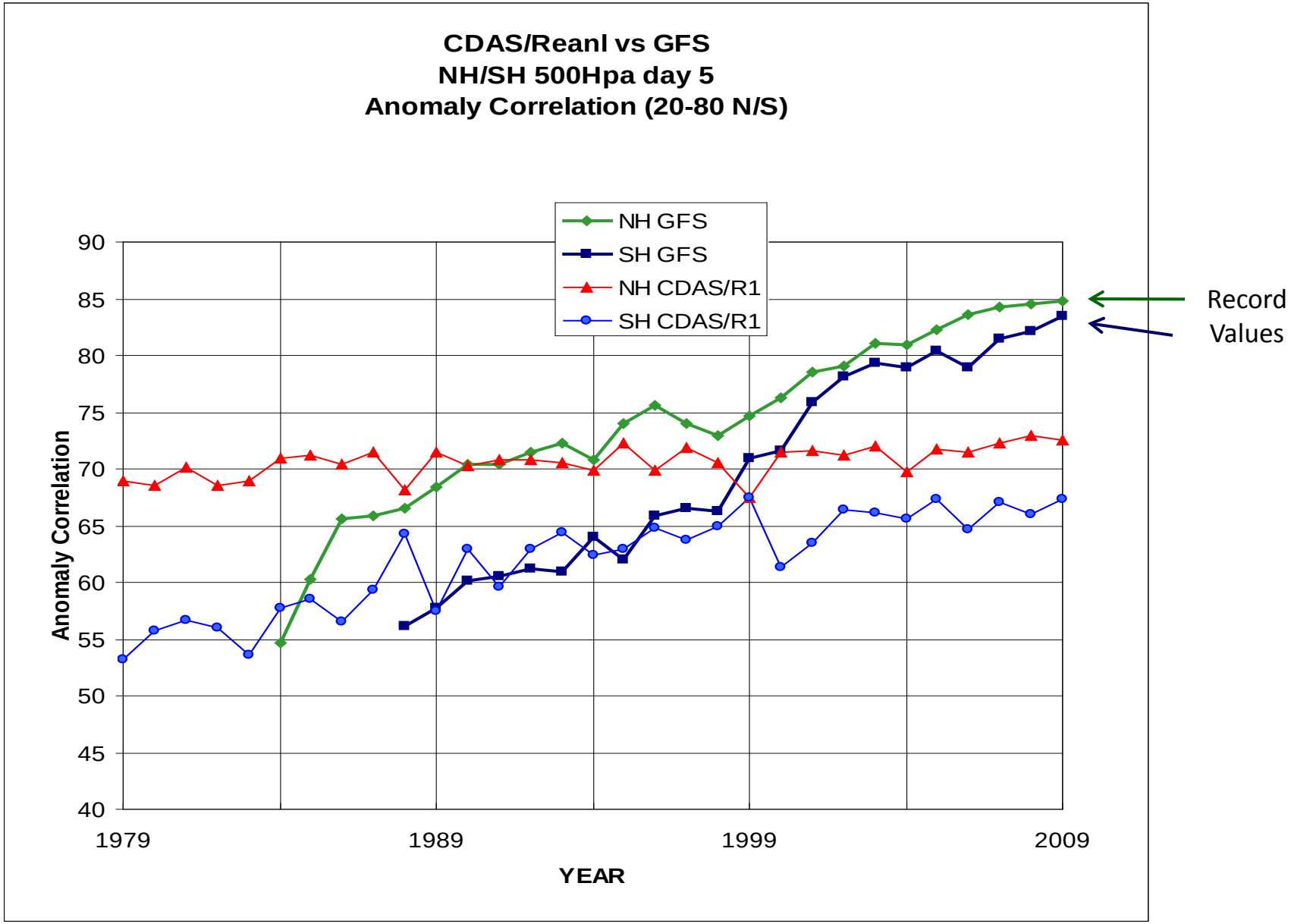
Computing Capability

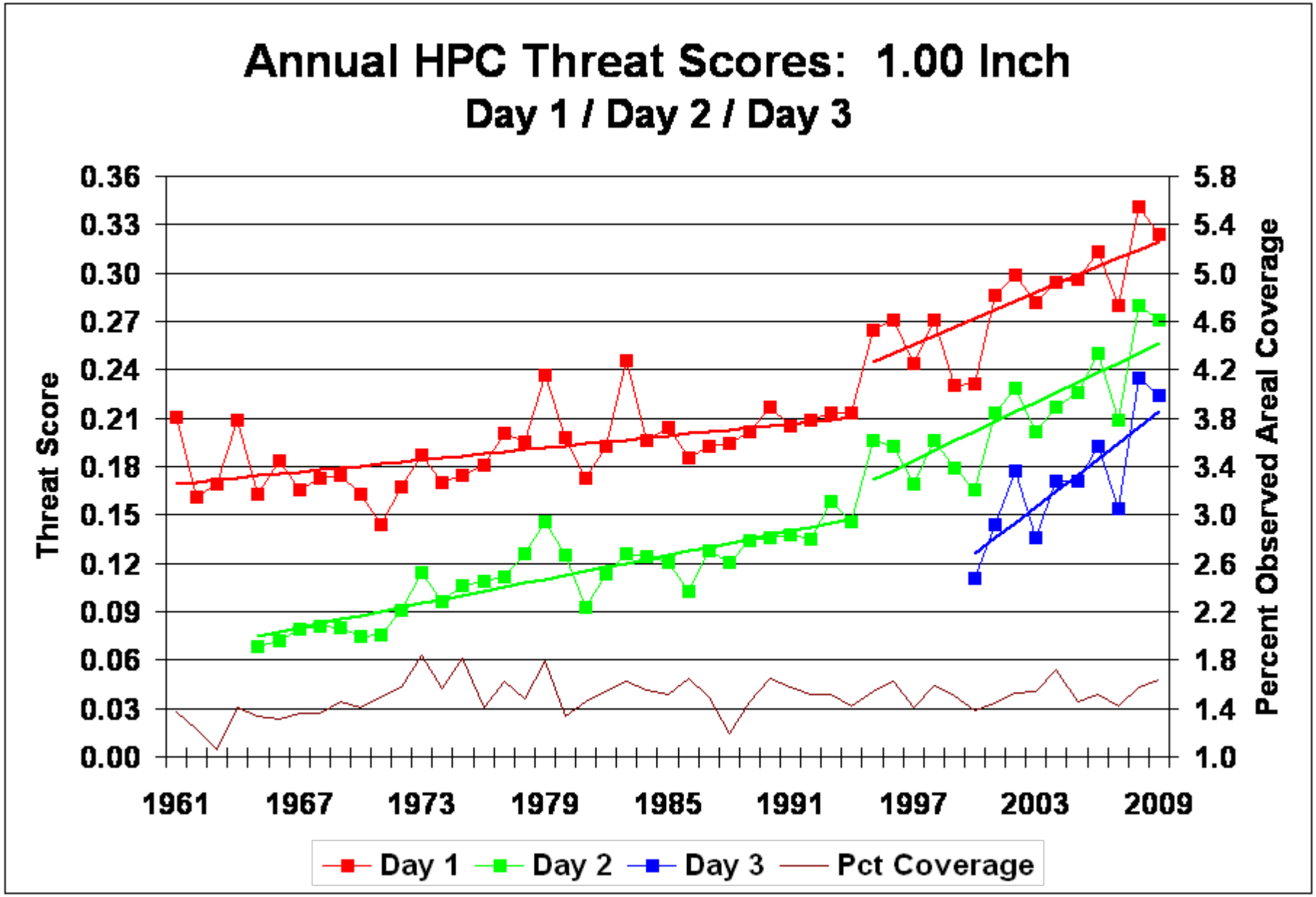
- Transition to IBM Power 6 complete
  - Declared operational August 12, 2009
  - 69.7 trillion calculations/sec
  - Factor of 4 increase over the IBM Power5
  - 4,992 processors
  - 20 terabytes of memory
  - 330 terabytes of disk space
  - 1.7 billion observations/day
  - 27.8 Million model fields/day
- Primary: Gaithersburg, MD
- Backup: Fairmont, WV
  - Guaranteed switchover in 15 minutes
  - Web access to models as they run on the CCS

Popularity of NCEP Models Web Page

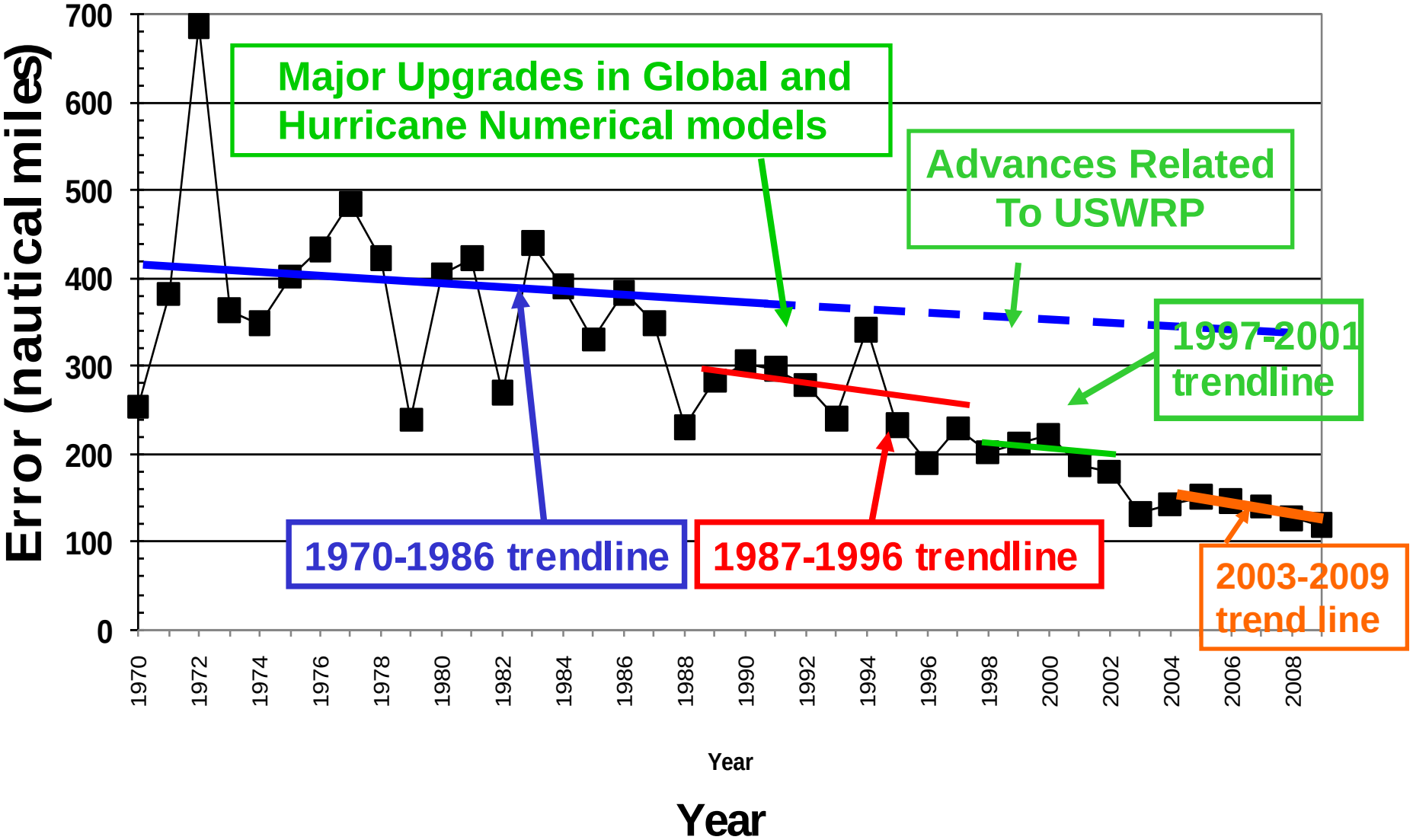


Forecast Metrics


CDAS/Reanl vs GFS
NH/SH 500Hpa day 5
Anomaly Correlation (20-80 N/S)
NH GFS
SH GFS
NH CDAS/R1
SH CDAS/R1
Anomaly Correlation
90
85
80
75
70
65
60
55
50
45
40
1979
1989
1999
2009
YEAR
Record
Values


Annual HPC Threat Scores: 1.00 Inch
Day 1 / Day 2 / Day 3
Threat Score
0.36
0.33
0.30
0.27
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0.00
Percent Observed Areal Coverage
5.8
5.4
5.0
4.6
4.2
3.8
3.4
3.0
2.6
2.2
1.8
1.4
1.0
1961
1967
1973
1979
1985
1991
1997
2003
2009
Day 1
Day 2
Day 3
Pct Coverage

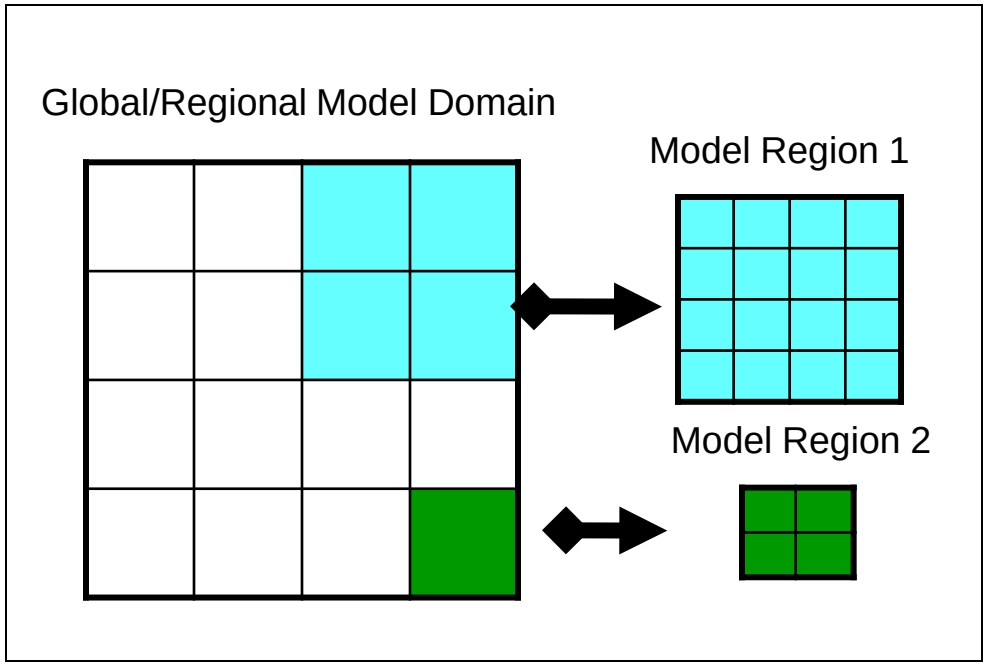
NHC Atlantic 72 hr Track Forecast Errors



Forces for Change

- Increasing emphasis on multi-model ensemble approaches that build on the NCEP model suite
  - SREF
  - NAEFS
  - Climate Forecast System
- Entering the NPOESS era
  - More rapid access to hyperspectral data
  - GPS soundings
  - Higher resolution surface radiance data
- All models run within ESMF
  - Models run concurrently
  - Hybrid vertical coordinate
  - Coupled
  - Spanning all scales
- Operational Earth System model – more explicit hydro, climate and ecosystems applications

ESMF-based System

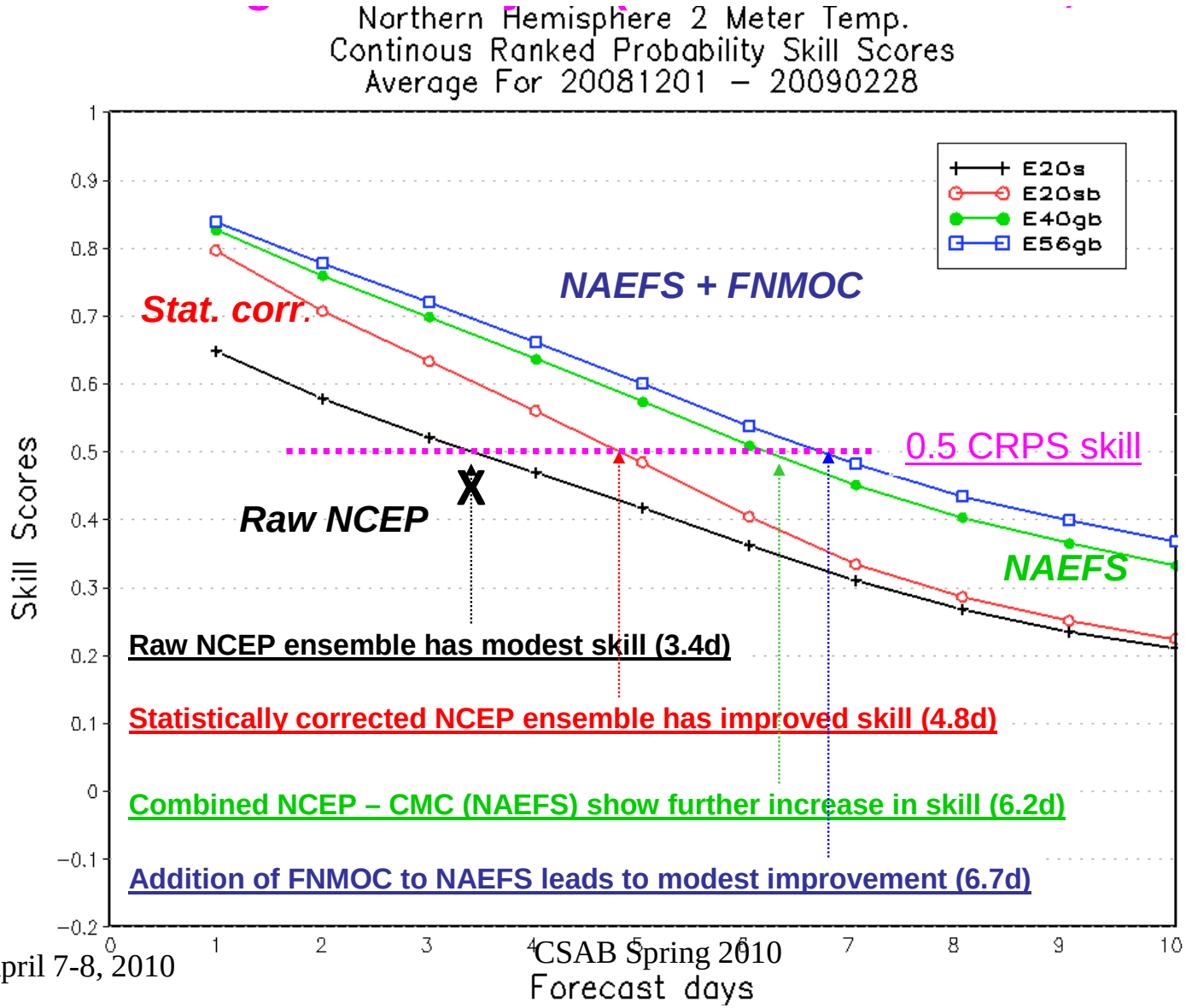


Multi Model Ensemble: Opportunity to Interact with the Navy through North American Ensemble Forecast System (NAEFS)

- **Collaboration between NCEP, Meteorological Service of Canada (MSC), FNMOC and Mexico Weather Service**
  - **Elements:**
    - **Demonstrate value of Multi-Model Ensemble (MME)**
    - **Engage in collaborative software development, focused on postprocessing products from an arbitrary number of forecast systems**
    - **Establish operational data transfer**
    - **Application to operational products with shared software**
    - **Continue to monitor value-added with MME strategy**

- **Global ensemble products**
  - **NCEP Global Ensemble Forecast System (GEFS)**
    - **operational in NAEFS**
    - **20 members -16 days**
  - **CMC**
    - **operational in NAEFS**
    - **20 members - 16 days**
  - **FNMOC**
    - **experimental in NAEFS**
    - **16 members – 10 days**

Value-added by including FNMOC ensemble into NAEFS 2m Temperature

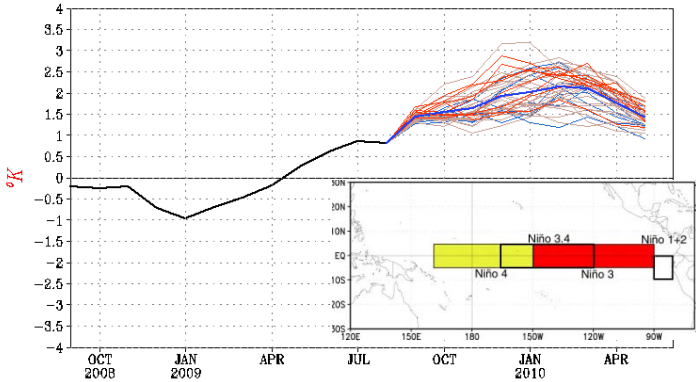


NCEP's Interaction with the Navy

- JCSDA
  - NRL; FNMOC
- COPC CONOPS
  - Shared processing; NCEP providing direct support through GFS and for NA sector through WRF
  - Use of COAMPS for Pacific Region
- OPC/TPC use of NCOM
- EMC transfer of the global HYCOM to NWS
- NUOPC – Tri-agency partnership to address common operational global NWP needs for next generation global model system

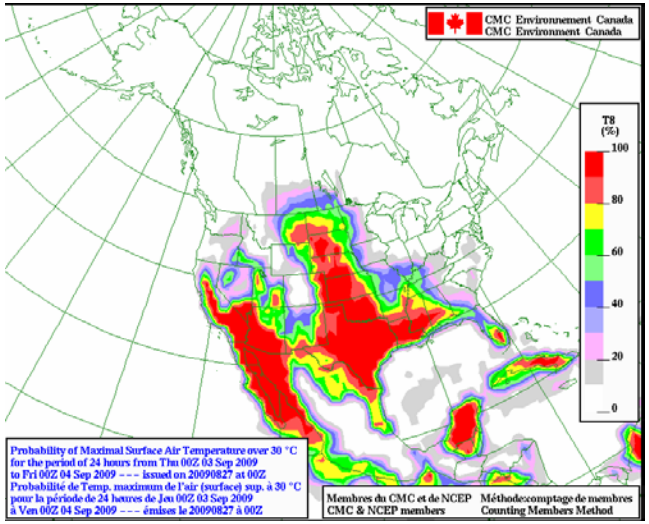
Impending Domination of Ensemble Based Model Systems

Forecast Nino 3.4 SST Anomalies from CFS



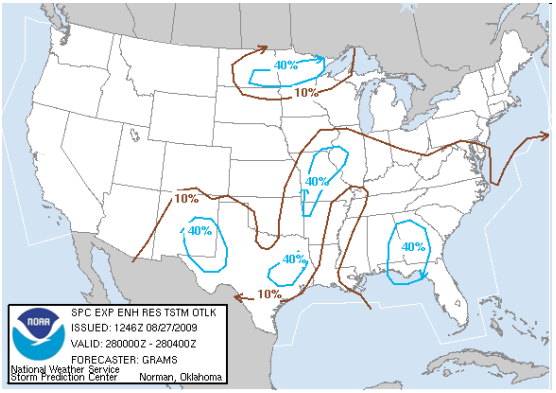
- **Climate**: Climate Multi-Model Ensemble
  - NCEP Climate Forecast System + GFDL Climate Model

- **Medium Range Weather**: North American Ensemble Forecast System (NAEFS)
  - GFS + MSC + Navy FNMOC NOGAPS



Probability of Temperature over 30C over 24 hour period
(7 day forecast valid Sept 3-4, 2009)

Experimental Enhanced Resolution Thunderstorm Outlooks



- **Mesoscale**: Short Range Ensemble Forecasts
  - WRF/ARW + WRF/NMM + RSM

Building Update

- NOAA Center for Weather and Climate Prediction
  - Five NCEP Centers (EMC, NCO, HPC, OPC, CPC)
  - NESDIS Research and Satellite Services
  - OAR Air Resources Laboratory
  - 40 Spaces for visiting scientists
- Approximately 270,000 ft^2
- Includes space for over 800 employees/contractors/visiting
  - Five NCEP Centers
  - NESDIS research and satellite services
  - OAR Air Resources Laboratory

Building Update

- Construction halted (Dec 08)
- Developer files federal
- suit and goes bankrupt (Jul 08)
- Leaser identified (Fall 09)
- Awaiting resolution of federal suit (May-Jun 10)

Construction Restart	Jul 10?
Move Start	Jul 11?
Move Complete	Dec 11?

- Continues to have major implications for achieving Strategic Goals and UCAR review recommendations

Summary

- NCEP is
  - Strategically aligned with NOAA's "seamless suite" of products from the "Sun to the Sea"
  - Working with NOAA on expanded responsibilities (e.g, oceans air and water quality, ecology, space weather…); success is based on interdisciplinary approach
  - A critical transition agent in the NOAA "research to operations" process involving observations, data assimilation, modeling, and service delivery
  - Actively pursuing opportunities for collaboration in research, transition to operations and operational production and delivery of services with national and international communities