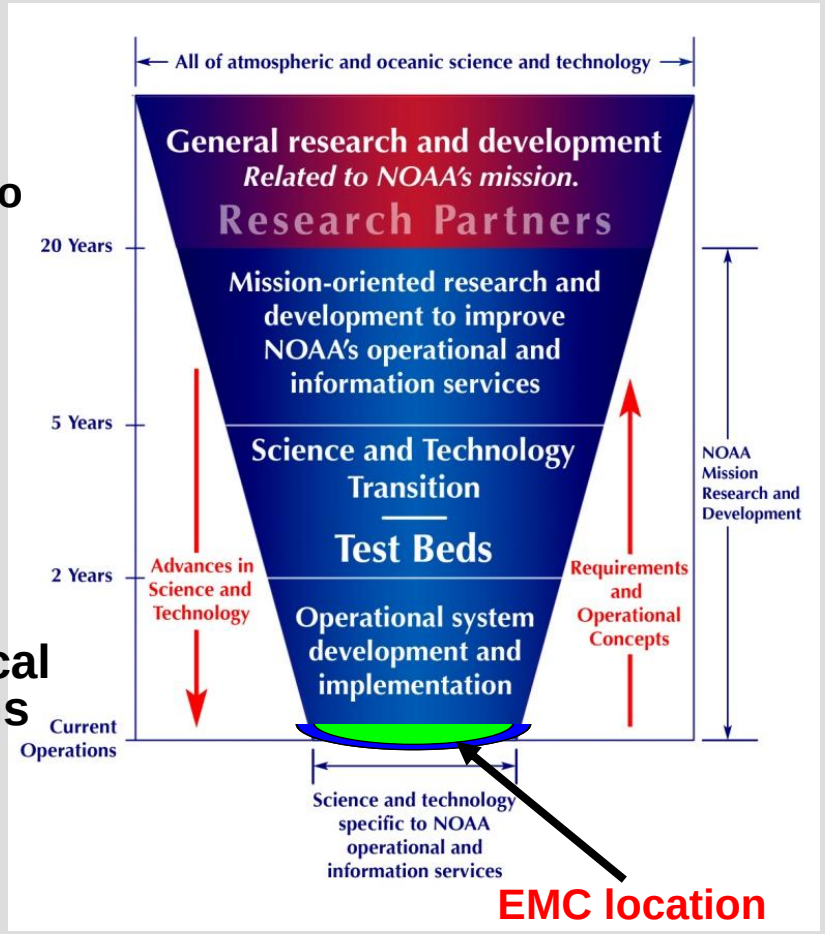
The EMC Mission…..

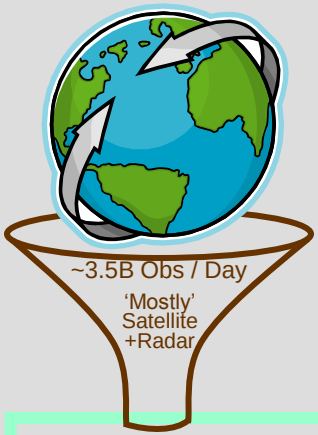
In response to operational requirements:

- **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
- **Enhance numerical guidance**
  - Test and improve NCEP's numerical forecast model systems via
    - Scientific upgrades
    - Tuning
    - Additional observations
- **Transition and Develop operational numerical forecast models from research to operations**
  - Transform & integrate
    - Code
    - Algorithms
    - Techniques
  - Manages and executes transition process including
    - Government technical and system performance review before implementation



1

Linkage of Model Systems Within Production Suite

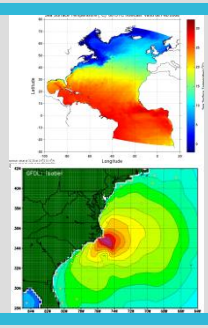


CLIMATE
CFS
GFS + MOM3/4

Hurricane
GFDL
HWRF (**NMM**)

Coupled

Oceans
HYCOM
WaveWatch III

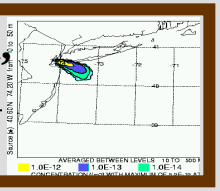


Global Data Assimilation

Global Forecast System

North American Mesoscale
NMM

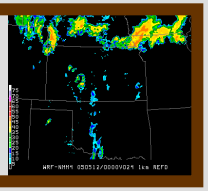
Dispersion, Ash, Smoke & Dust
ARL's HYSPLIT



Regional Data Assimilation

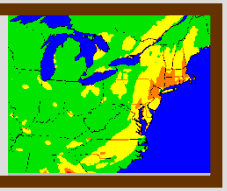
Short-Range Ensemble Forecast
NMM + ARW + ETA + RSM

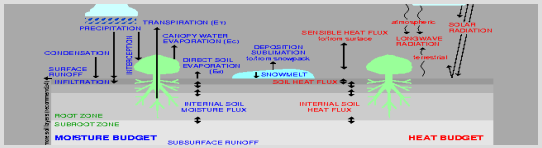
Severe Weather
NMM + ARW



North American Ensemble Forecast System
GFS + Canadian Global +…

Air Quality
NAM + EPA/ ARL's CMAQ

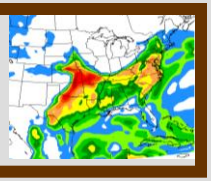




NOAH Land Surface Model

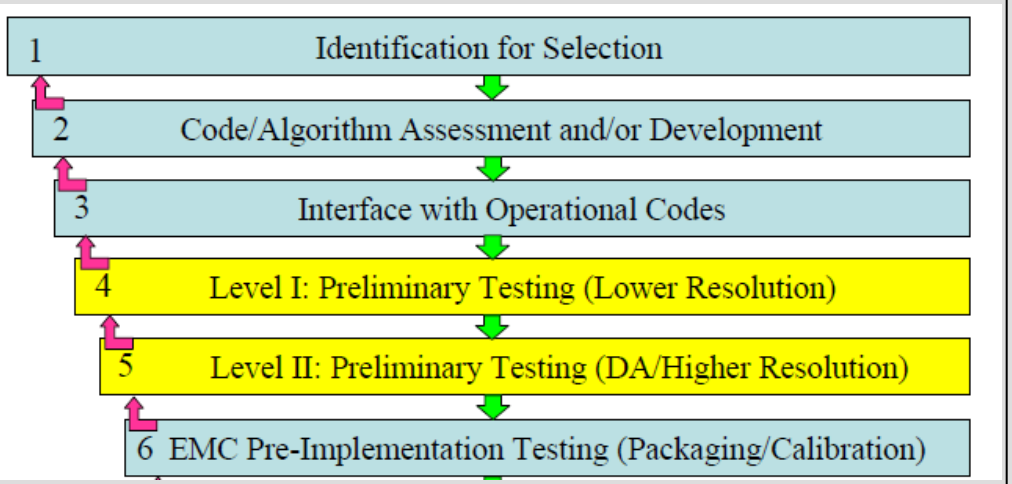
Very Short Range Ensemble Forecasts
Time-Lagged RUC+NAM

Rapid Update for Aviation
GSD's RUC



Process to Implement Major Upgrades to The Production Suite

EMC Model Upgrade Process



EMC Change Control Board

- Scientific Integrity
- Product Quality
- Test all downstream codes
- EMC Mgmt Approval

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

NCO Takes Handoff

- 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

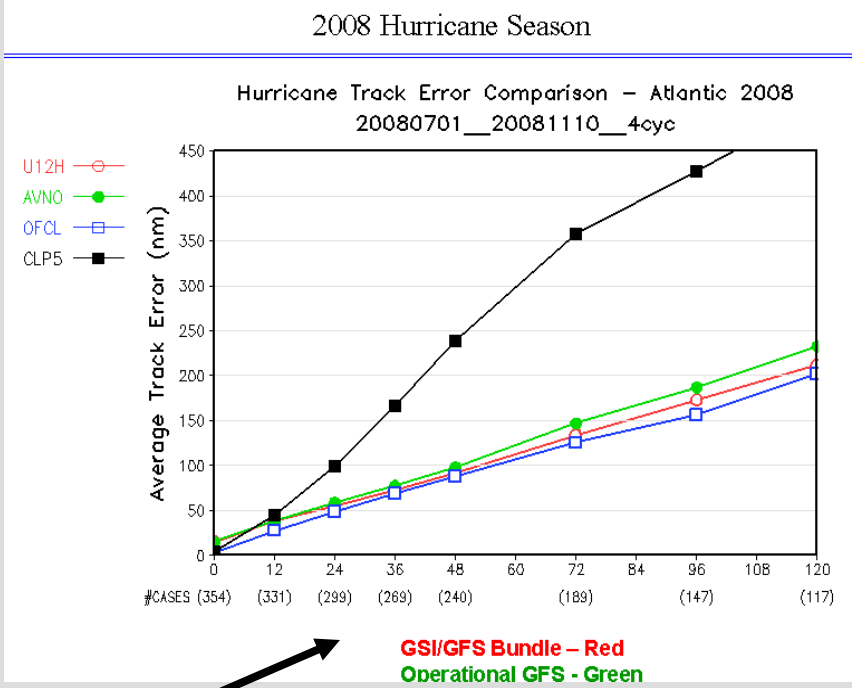
- 30-day NCO parallel stable
- NCEP centers approve

- Briefing to NCEP Director for final approval

Implementation

Apply Implementation Processes to GFS/GSI Phase 1 Implementation Below…

- **December 2009 upgrade**
- **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

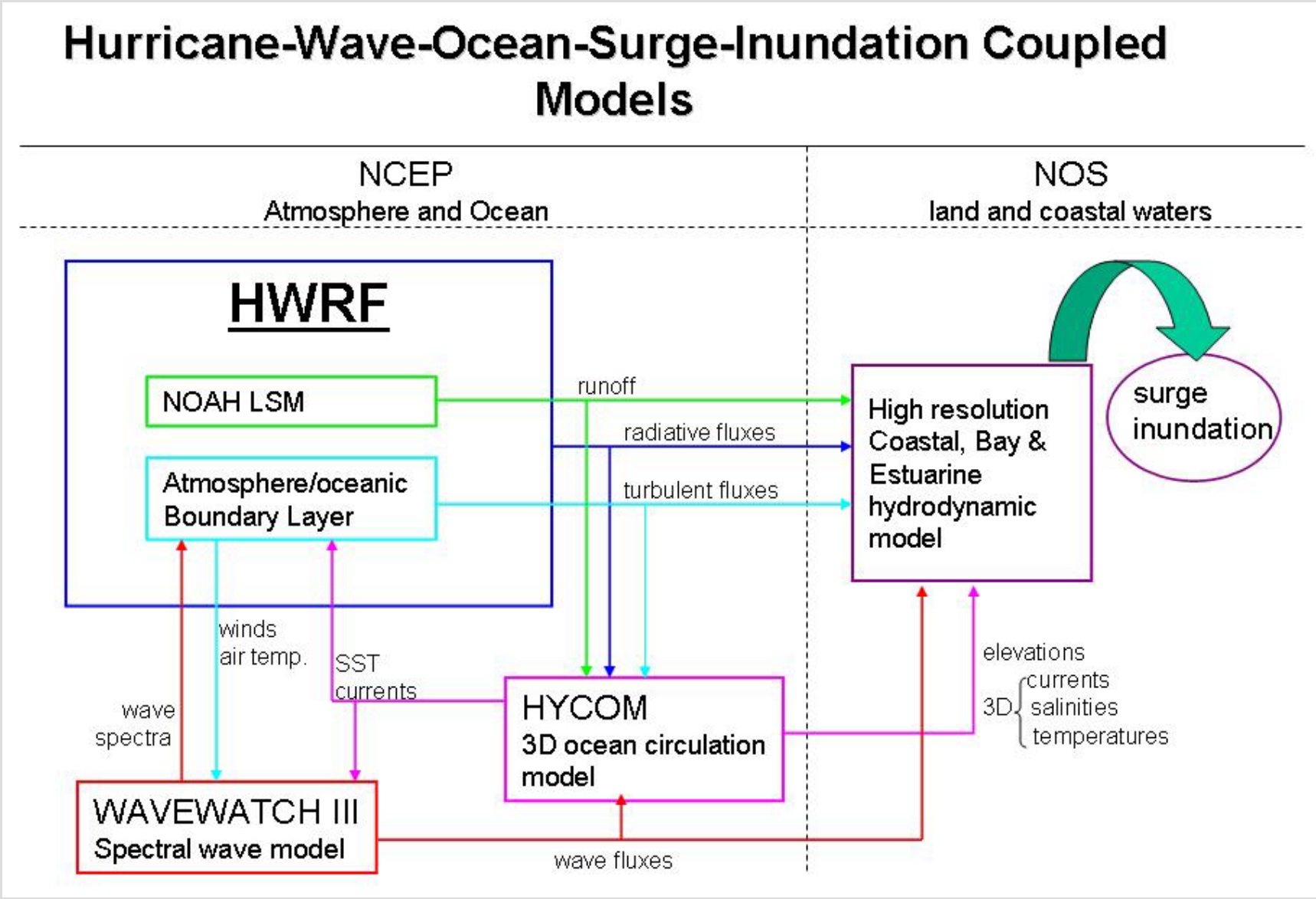


NCEP

Resources Required for GFS/GSI Phase 1 Implementation

- **17 months required to develop, test and implement**
- **119 person months of effort (EMC, NCO, GFDL, TPC, SPC, HPC, AWC)**
- **17 months of fully cycled 4x/day with 16 day forecasts retrospective/real-time testing conducted**
- **508 HWRF and 600 GFDL cases simulated**
- **1000 node hours and 75 TB of disk consumed**

NCEP Hurricane Forecast System—Regional Component



Preparation for FY10 HWRF (H210) Implementation

1. **DTC V3 HWRF:**
   - Desire to use V3 based system to be deposited in DTC repository
   - V3 HWRF experiencing spurious TC genesis on outer domain
   - EMC and DTC working to diagnose problem
   - DTC goal to have frozen code 15 December
   - May have to accept degraded V3 system for HWRF tutorial Feb 2010

2. **NCEP/EMC FY10 (H210)**
   - Will be based on V3 if spurious TC genesis problem corrected
   - Contingency plan: H210 baseline will be operational HWRF scheduled for operational implementation on 10 November

3. **Testing for GFS Phase1 Implementation:**
   - Must be conducted with H208 physics configuration
   - All experiments will use 10 November HWRF Implementation
   - Qingfu working with Morris & Bob to adjust HWRF initialization
   - Testing completed 30 November to support GFS Phase 1 Implementation scheduled for 15 December

Proposed Test Plan for FY10 HWRF Implementation (H210)

4. Test/verify positive impact of bug fixes in H208:

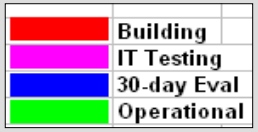
- Land Surface Temperature
- Solar radiation
- Non-hydrostatic advection of vertical velocity

5. Configuration & Testing for H210:

- Must take a systematic approach
- Define priorities
  - a) Reduction of intensity bias
    - Initialization Procedure (0-12h intensity bias)
    - Surface fluxes (+24h intensity bias)
  - b) Improve physics
    - Addition of gravity wave drag
    - Modification of shallow convection
    - HYCOM coupling
- Enhance model diagnostic capabilities to accelerate HWRF development
  - TPC visiting Hurricane Specialist to EMC during cols season?
  - EMC visiting HWRF scientist(s) to TPC during hurricane season?
  - Ties with HFIP community (DeMaria et al.)

DRAFT

GFS and HWRF Implementation Schedule
Updated 12 October 2009



Implementation	2009					2010							
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Phase 1: GFS/GSI Fall Bundle													
EMC Parallel													
NCO Parallel													
HWRF08 Testing													
Operational													
Phase 2: GFS Physics													
EMC Parallel													
NCO Parallel													
HWRF2010-A Testing													
Operational													
Phase 3: GFS Resolution Increase													
EMC Parallel													
NCO Parallel													
HWRF2010-B Testing													
Operational													
HWRF 2010													
NCO Parallel													
Operational													

Key questions to be addressed by the HFIP for success in HFS/GFS improvements:

- **At 1-km or less grid resolution which physical processes are crucial to the intensity change problem and are they predictable on the time scales needed? What is the necessary vertical resolution vs. horizontal?**

- **What is the appropriate physics package and what complexity is essential to address the intensity change problem (e.g. atmosphere-ocean boundary layer, microphysics, radiation)**

- **What is the best way to determine predictability with reference to the forecast metrics? Can ensembles be used to increase the predictability and at what scales?**

- **What is the best way to develop ensembles for the intensity change problem, i.e., multi-models, different physics packages, different initial conditions?**

Steps required to address the HFS/GFS modeling systems to accurately represent the physical processes responsible for rapid intensity change:

Develop, test, and implement:

- **Near (~5 years) and long term (~10-15 years) high resolution (1 km), non-hydrostatic HFS and establish baseline performance for track, intensity, and rapid intensity change**
  - **Next-generation high-resolution GFS (10 km) to improve track guidance,**
  - **HFS, GFS, and multi-model ensembles to quantify and bound uncertainty, and**
- **Next-generation storm surge modeling system**

Research & Development Strategies for HFS/GFS:

- Research to insure the physical processes are represented accurately, and assess how these processes influence the predictability of track and intensity changes, particularly rapid intensity change,
- Research and development to enhance modeling techniques (e.g., high-resolution, data assimilation, ensembles, on-demand computing), and
- Develop and implement High Performance Computing strategy for HFS/GFS

Improving the Operational HRS at NOAA/NCEP to Better Serve Customers….

FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14

Initialization/DA
Resolution 9km to 4km to 1km?
Coupling—atm/ocean/waves/surge
Physics—ocean, PBL, precipitation, clouds, radiation
Ensembles—global, regional, moving nests?

EMC HRS Staff ~ 10 (includes ocean, GFS and HWRF)
HPC availability (what lies beyond P6?)
Technological advances in the above
Maintenance of HRS—must leverage off production suite

- **Regional Model Initialization**
  - **Factors for change**
    - **Global Models increasing resolution**
    - **Need to improve 3D vortex dynamic/thermodynamic structure**
    - **Need for cycling in DA system**
    - **Observations in vicinity of and surrounding vortex**
    - **Adopting coupled atm/ocean systems**
  - **Requirements**
    - **Advanced DA methodology that is computationally affordable and can be applied at high resolution**
    - **Coupled atm/ocean DA**
    - **Must not forget about model physics**

  - **Higher Resolution:**
    - **Currently at 9km**
    - **Testing at 4km in 2009 not very encouraging**
    - **Where to place emphasis for future HWRF upgrades next 5 years?**

NWS Seamless Suite of Forecast Products Spanning Weather and Climate