NCEP/EMC Modeling Systems: FY12-FY13 Prioritized Stream 1.0 needs

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Outline

- Recap of FY11 Priorities and current status
- Implementation Schedule and its impact on prioritizing Stream 1.0 activities
- FY2012 Priorities and Resource Requirements
- Two-year approach to address Stream 1.0 priorities
- Proposal for a senior scientist to come to EMC
- NHC's wish list for real-time operational model diagnostics (w/inputs from Dave Zelinsky)

Status of FY11 Stream 1.0 Tasks Supported by HFIP (1)

Task	Status	Remarks
Improved initialization procedure	Completed, Implemented in FY11	Further modifications for 2012 implementation
GFS Physics upgrades in HWRF and GFDL (EMC+GFDL)	Deep Convection implemented in FY11	Shallow and PBL schemes for 2012 implementation
HWRF Model Diagnostics: (EMC+NHC+CIRA)	Most of the tasks completed, used in 2011 forecast evaluation	Community diagnostics effort for more focused diagnostics (Special Session at HFIP Annual Meeting on Nov. 8th)
Modified nest motion algorithm & 3rd nest development (EMC/AOML)	Completed, tested in 2011 real-time demo	Possible operational implementation in 2012
Initialization for third nest (EMC+AOML)	Development completed Oct. 2011	Possible operational implementation in 2012
Coupler for third nest (EMC)	Completed, tested in 2011 real-time demo	Possible operational implementation in 2012
Optimization of 3-km HWRF (EMC, DTC)	Not listed in FY11 tasks. Completed, Oct. 2011	Essential for 2012 implementation

Status of FY11 Stream 1.0 Tasks Supported by HFIP (2)

Task	Status	Remarks
Multi-center, multi-model global ensemble tracks and probabilistic products; GFDL tracker for SREF; storm calibration using ensemble bias corrections (EMC+GFDL)	Completed, tested in 2011 real-time demo	Possible operational implementation in 2012
Improve ocean model SST forecast accuracy through continued evaluation and validation of HYCOM and POM in the HWRF and GFDL operational models. (EMC+URI+AOML)	HYCOM Coupling withdrawn from 2011 implementation. Extended POM domain implemented for GFDL	Modified work plan for HWRF-HYCOM coupled system based on Global RTOFS
Physics Development for HWRF: (EMC+ESRL+AOML+DTC+URI+GFDL)	Work in progress. Conducted HFIP Physics Workshop at EMC in August 2011	Operational implementation in FY12-FY13 time frame
Evaluation of impacts of lateral boundary conditions on HWRF forecasts. (EMC+ESRL)	Not started yet	Re-visit this task in FY12-FY13 time frame
Assimilation of real-time aircraft radar data in GSI framework. (EMC+AOC+AOML)	Work in progress, tested in 2011 real-time demo	Continue real-time tests in parallel

Annual Regional Hurricane Model Implementation Schedule at EMC/NCO

May-Nov
- Implementation for current season
- Operational Support, real-time parallels, model diagnostics

Oct-Dec
- Identify potential upgrades for next season
- T&E of individual upgrades, identify potential configuration (combined upgrades) for next year implementation

Dec-March
- Final T&E, possible association with GSI/GFS upgrades, NHC evaluation and EMC CCB, Code Freeze
- Prepare and submit RFCs to NCO

March-May
- NCO Parallel Testing and Operational Implementation

- Infrastructure improvement
- Scientific development
- Resource manipulation
- R2O coordination
- Extensive T&E requirements
- Performance metrics

- **Inclusion of R2O activities require longer-term planning**
- **Tight implementation schedules make it difficult to include all possible upgrades**
- **Availability of resources (computational and personnel) add to the complexity**

FY2012 HWRF Priorities

- Implementation of a very high resolution triple-nested ocean-coupled hurricane model operating at 3 km horizontal resolution - a major step towards improving intensity forecast skill and rapid intensity changes

FY2012-2013 HWRF Priorities (1)

Task	Status	FTE /People EMC
Model development: Triple-nesting and new nest movement algorithm HWRF Code optimization, Code Management and community support (EMC/DTC/HRD)	Tripled nested system tested in real-time (Stream 1.5). Optimization work started in August and completed in October. Code management is ongoing process	7.0 (9) **4.0 (2)**
Physics Improvements: HWRF Physics upgrades to include new GFS PBL, Shallow Convection, modified Ferrier Microphysics and Surface Physics (EMC/GFDL/ESRL/HRD) (high priority for NHC)	Work in progress	4.0 (5) **2.0 (4)**
Vortex Initialization and GSI: HWRF Vortex Initialization for high-resolution grids (EMC/HRD), Upgrade GSI to V3.0 (EMC/DTC)	Vortex initialization work started in March and completed in October . Continuous evaluation required. GSI upgrades work in progress.	2.5 (4) **2.0 (2)**

8.0 (8)

FY2012-2013 HWRF Priorities (2)

Task	Status	FTE /People EMC
HWRF Ocean Upgrades: (EMC/URI)	Work in progress	1.0 (2) **0.5 (1)**
HWRF post-processing and tracker upgrades (EMC/NHC/GFDL), Very high-temporal-resolution (every time step) track and intensity forecast data as per NHC's specified format (EMC) (high priority for NHC)	Post-processing work in progress, tracker upgraded in October. High-frequency output generation completed.	1.75(4) **1.0 (2)**
Operational configuration (EMC) and pre-implementation T&E (EMC/NHC)	Work in progress	7.0 (7) **5.5 (5)**
Advanced inner-core diagnostics (EMC/HRD)	Work in progress	2.0 (2) **1.0 (2)**
Improved use of inner-core observations through GSI (very high priority for NHC)	Work in progress	2.0 (2) **2.0 (2)**
Regional Hybrid-EnKF-3DVAR GSI for HWRF (high priority for NHC)	Workshop planned for Nov. 10, 2011	2.0 (4) **1.0 (2)**

11.0 (14)

FY2012-2013 HWRF Priorities (3)

Task	Status	FTE /People EMC
HWRF ensembles and product generation (EMC/ESRL/GFDL)	Work in progress	1.0 (2) **1.0 (2)**
Optimal physics configurations (alternate physics suites) (EMC/ESRL/URI/GFDL/DTC)	Work in progress	4.0 (4) **1.5 (3)**
Improved ocean-wave coupling and air-sea physics (EMC/URI)	Work in progress	1.5 (3) **0.5(1)**
Advanced downstream applications for storm surge, inundation, rainfall, and inland flooding (EMC/ODU)	Work in progress	2.0 (2) **2.0 (2)**
Basin scale HWRF model with multiple moving nests and transition to NEMS (EMC/HRD)	Future work	6.0 (4) **4.0 (2)**

9.0 (10)

Human Resource Requirements for Advancing the HWRF Development

Resources	FTE/People
Existing FTEs in HWRF Team at EMC	9.0 FTE, 9 people
Collaborators within EMC	3.0 FTE, 5 people
Total	12.0 FTE, 14 people,
For two years (2012-2013)	24.0 FTE, 14 people,
Prioritized HWRF Development and Operational Implementation Tasks FY2012-2013	**28.0 FTE, 16 people**
Additional Support Requested	**2 additional scientists (2.0 FTE per year)**
One Senior Level Scientist with expertise in tropical cyclone model development*	New proposal

NHC* Model Diagnostics Wish List

*This is my personal wish list, based on my work at NHC

David Zelinsky

Simulated Satellite

- Using a uniform RTM:
  - GOES-13 and GOES-11
    - Channel 2,3,4,6
  - Microwave
    - 37 GHz Vertical and Horizontal Polarization
    - 85 GHz Vertical and Horizontal Polarization
- Useful for:
  - Microphysics Comparisons and Structure Analysis

- ***Included in operational HWRF product line***

High Temporal Resolution Data

- ATCF style text output every time step (or smallest time step possible):
  - Minimum Sea Level Pressure and location of Pmin
  - Maximum 10-m Wind and location of Vmax
  - Storm (or inner-nest) Center Gridpoint
  - Wind Radii
- Useful for:
  - Analyzing initial spin-up/spin-down
  - Comparing relative variability of standard variables
- ***Will be provided in real-time from operational HWRF (except wind radii)***

FY2012 HWRF Issues

- **5th Storm Capability could be jeopardized**
  - High-Resolution HWRF requires one additional node to fit in the operational window, and hence only 4 storms to run in operations
  - 5th storm can still be run in delayed mode (about 2 hours delay)
- **Run time increased by 15-20 minutes**
  - Still can meet the cut-off time of t+6
  - Post-processing and tracker to be run in parallel to the forecast job
  - Current operational GFDL delivers products about 15 minutes later than current operational HWRF – we are going to use that window
- **NHC's concurrence is required to proceed with these plans**
- **Major limitation of T&E on NCEP CCS.**
  - Proposing to use t-Jet resources for majority of pre-implementation T&E. Requires allocation of dedicated resources of about 3000 cores for a period of 3 months.

Computational Resource Requirements for implementation in FY2012 and beyond

- Existing resources on IBM CCS developmental machine (about 1/3rd of the machine) are being diverted to run high-priority Q2/Q3FY12 GEFS, Hybrid-GSI/GFS and SREF implementation parallels.
- Proposed FY2012 T&E plans for HWRF and GFDL implementations require dedicated resources on t-Jet machine.
- For HWRF, six different high-resolution configurations to be tested (about 4000 retrospective runs) before finding optimal combination of model/physics/initialization upgrades.
- We propose to have dedicated resources of 3600 cores on t-Jet for a period of 3 months from December 1, 2011 to February 28, 2011.
- We expect to continue dependence on external computational resources for further model improvements and evaluation.

FY2012 GFDL Priorities

- Continue with physics upgrades for GFDL model:
  - Cumulus-Microphysics interactions through convective detrainment (ncloud=1), advection of individual species in microphysics scheme
- Implementation of new GFS PBL and Shallow Convection schemes and reconfigure GFS Deep Convection parameters
- Develop a modified GFDL ensemble for 2012 hurricane season, including examining the impact of the use of other global models and global ensemble data sets to improve forecast track spread.
- Implement upgraded and unified tracker at NCEP, to include NAEFS upgrade, FNMOC ensembles, cyclone phase determination, and genesis detection capability.
- Possible inclusion of microphysical variables in GFDL vortex initialization

FY2012 GDAS/GFS Priorities

- **Major upgrade to GSI analysis:**
  - Hybrid EnKF-3DVAR Data Assimilation
  - Rerun 2011 Season with Hybrid GSI/GFS Q3FY12
  - Rerun operational HWRF and GFDL models with new Hybrid GSI/GFS IC and BC in support of Q3FY12 GSI/GFS implementation.
  - Run proposed 2012 configurations of HWRF and GFDL models with new Hybrid GSI/GFS IC and BC.

FY2012 GEFS Priorities

- **Major upgrade to GEFS:**
  - Increase resolution from T190 to T254
  - Increase vertical resolution from 28 to 42 levels
  - Deterministic GFS model (GEFS Control run) identical to operational GFS run at T254 resolution
  - Increase initial perturbation size for lower atmospheric levels
  - Adjust stochastic total tendency perturbation
  - Adjust tropical storm initial perturbation intensity

A proposal for an expert senior scientist helping EMC with high-resolution hurricane model development

- As a major step forward in providing improved intensity forecast skill, the operational HWRF model is being configured with ***triple-nest capability*** that includes a ***cloud-resolving inner most grid operating at 3 km horizontal resolution,*** thanks to the dedicated team effort from EMC and HRD/AOML and to the support provided by HFIP.
- ***Additional HFIP support is being requested to bring a senior scientist, with expertise in model physics or data assimilation or other tropical cyclone model development, to EMC to participate in the HWRF effort.***