Proposed HFIP Demo system for the 2010 hurricane season

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Introduction

Each hurricane season HFIP will conduct an experiment, referred to as the Demonstration System or Demo System were the program attempts to demonstrate model capability including high resolution ensembles using both regional and global models that go well beyond the current capability of the operational global and regional models. The focus of course will be on the prediction of hurricanes.

The Demo System is part of the overall HFIP development program where we seek computer resources beyond those available to operation to push testing of model technology to its current limits. This is referred to as Stream 2 of the HFIP program as opposed to Stream 1 where we are emphasizing continued development of the current operational models. In addition to these two streams HFIP supports an intermediate part, referred to as Stream 1.5 where some of the components of the Demo system will have undergone enough retrospective testing to provide useful information to hurricane forecasters in real-time during the hurricane season. During the 2010 hurricane season, Stream 1.5 will be limited to regional models with a multi-model ensemble of at least some of those regional models. The tables below identify the demo system and those components that will be part of Stream 1.5.

Details of the 2010 HFIP Demo System

Computing resources for the Demo System will come from several sources. These resources are summarized in Table 1.

Table 1 Computing Resources directly to HFIP:

computer	Available cores	Processor hours available Aug-Oct	Notes
n-jet	**472**	**1 m-h**	**Reserved for small development jobs**
t-jet	**10056**	**21 m-h**	**Entire machine available to HFIP**
Jaguar	**220,000**	**10 m-h**	**About half of our ORNL allocation will be available for the summer program**
TACC	**60,000**	**waiting for approval**	**Penn State allocation for PSU model**
NCAR	**4608**	**0.2 m-h**	**MMM Allocation**
GFDL	**216**	**no specific allocation**	**GFDL**
Navy	**640**	**1.4 m-h**	**Navy will run their models on the DoD High Performance Computing facility at the Navy DSRC in Stennis Mississippi**
NCEP			**The operational HWRF and GFDL models will be run on the operational computer. Development versions of the operational models (GFD5, HWRF HYCOM, HWRF NOAH and HWRF DA) will be run on the NCEP development computer. HWRF3 and HWRF-HRD DA will be run on t-jet.**

Objectives for 2010 Demo system

In 2010 we hope to extend the experiments of 2009 to more ensemble members, better models and higher resolution, especially for the global models. In addition, stream 1.5 is new this year and we plan additional products from each of the experiments beyond what was provided last year.

Stream 1.0

Stream 1.0 is represented by the two operational models run at NCEP—the HWRF and the GFDL. These are listed in tables 3 and 4 for completeness. They will be included in the multi-model ensemble and in that context will be part of stream 1.5 but otherwise they are the normal regional model guidance available to NHC.

Stream 1.5

Provide real-time experimental guidance to NHC forecasters from promising models under development by HFIP.

Regional models

- Multi model regional ensemble with as many models for which we have a year of retrospective runs available for bias correction to provide quasi operational products to NHC. See table 4

- In addition to being run as an ensemble COAMPS-TC, AHW, and FSU-ARW will also be presented separately to NHC

- HWRF/GFDL Regional Models:

    - Stream 1: NCEP/EMC will run operational hurricane models HWRF and GFDL for all storms in the Atlantic and Eastern Pacific (maximum 5 storms per cycle) at every 6-hr interval.

    - Stream 1.5: EMC parallel, GFD5 (GFDL with modified physics) will be run on NCEP CCS. GFDL (parallel) will be run for both East Pac and Atlantic. EMC will provide TPC with basic Tier-I products from these runs in real-time.

Global Models

- Demo system global model activity will all fall in Stream 2

Stream 2

Test and demonstrate various configurations of global and regional models and their ensembles to test strategies for meeting the HFIP goals for improving track and intensity forecasts.

Regional models

- Test high resolution single model regional ensemble. This will use the Penn State version of the WRF ARW and an EnKF assimilation system. Purpose is to test value of high resolution ensembles from a single model. In addition the EnKF system will use available aircraft derived radar data.

- There will be other regional models run during the demo that will not have be run with sufficient retro cases to be considered part of stream 1.5. These will be presented as part of the multi model results when available but it won't be possible to perform bias correction in real time. This will include the HWRF HRD system that will be initialized with an EnKF system for those storms for which there is aircraft obtained data.

- Some models that did run enough retro runs to be considered for stream 1.5 but do not get thumbs up from NHC based on evaluation of those retro runs will also fall into this category.

- Tables 4 and 5 outline all the models to be run as part of streams 1, 1.5 and 2. The bullets below add some additional details.

- HWRF Regional Models:

    - Additional runs of the experimental HWRF will be run with initial conditions from an EnKF data assimilation system in which inner-core aircraft observations are assimilated. Another run using the operational HWRF initial conditions will be run as a control. All these experiments will be run on t-jet.
    - EMC will also have three additional parallel runs based on operational HWRF – one coupled to NOAH LSM, one coupled to HyCOM and another that makes use of available aircraft/radar datasets. These parallels will be run on NCEP CCS in real-time

- UW-NMS Model
    - University of Wisconsin will participate in a Stream 2 demo project using the n-jet system. The NMS model will utilize the GFDL initialization. The NMS system will be run for the 00z and 12z initialization cycles and optionally for the 06 Z and 18Z initialization cycles if resources are available. Planned are two stream 2 projects:
        - A 5-10 member ensemble of 45/9 km configurations for 5 day forecasts
        - A single 45/9/3 km configuration for a 2-5 day forecast

Global Models

- A high resolution ensemble initialized with an EnKF system made up of 20 members including 10 20 km FIM members and 10 27 km GFS members
- Test runs of the Cubed sphere run as a single model at 20 km for comparison with the 20 km FIM.
- A high resolution NOGAPS ensemble using the NAVDAS-AR (4DVAR) to produce the control analysis and using an ensemble transform method for ensemble initial perturbations. 20 members at 41 km resolution.

Tables 2 and 3 provide details for the global models that are part of Stream 2 of the Demonstration system. Tables 4 and 5 provide the same information for the regional models and indicate which ones are possible components of Stream 1.5

Table 2 Computer resources for the Global models

Models	Retro runs 2008-2009	Stream (tentative)	Computer	Number of cores	Run time for a 5 day forecast	Point of contact
GFS	yes	2.0	t-jet	??	??	Jeffrey.S.Whitaker@noaa.gov
FIM	yes	2.0	Jaguar	120	2h	Stan.Benjamin@noaa.gov
NMM-B	No	2.0	Jaguar	??	??	George.Vandenberghe@noaa.gov
GEFS	No	2.0	Jaguar	??	??	George.Vandenberghe@noaa.gov
Cubed Sphere	yes	2.0	GFDL	216 (minimum)	2-3 hours	Shian-Jiann.Lin@noaa.gov
NOGAPS	No	2.0	NAVO	TBD	TBD	carolyn.reynolds@nrlmry.navy.mil

Table 3 Specifications for the global models

Models	Horizontal resolution	Vertical levels	Cumulus Parameterization	Microphysics	PBL	Land Surface	Radiation	Initialization	Ocean coupling
FIM	20 km	64	From 2010GFS - Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	Noah LSM	GFDL/RRTM	ESRL EnKF	none
GFS	27 km	??	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	Noah LSM	GFDL scheme	ESRL EnKF	none
NMM-B	10 km (or 15 km)	64	Simplified Arakawa Schubert + Shallow Convection	Zhao	GFS PBL (stability dependent local/non-combination)	Noah LSM	RRTM	GSI	none
GEFS	T254	42	Simplified Arakawa Schubert + Shallow Convection	Zhao	GFS PBL (stability dependent local/non-combination)	Noah LSM	RRTM	GSI/ET	none
Cubed Sphere	25 km	32	Shallow only	Modified Lin, 6-class	Lock (AM2)	GFDL LM3	GFDL	nudging to NCEP analysis	None
NOGAPS	41 km	42	Emanuel	N/A	NOGAPS	NOGAPS	Harshvardhan/ Fu-Liou	NAVDAS-AR	none

Output products

Basic output products will be similar to last year:

- Tracks from all models including all members of the ensembles. For the global models these will be provided on the FIM site, same as last year, for both the GFS and FIM. For the regional models, the data will be collected by FSU. FSU will provide both raw tracks (for all the regional models) and bias corrected tracks for the stream 1.5 models.

- Intensity for all models and all ensemble members including both minimum pressure and max wind. For the global models this will be presented on the FIM site. For the regional models, FSU will provide bias corrected intensity forecasts for the Stream 1.5 models and raw intensity forecasts for all models

- ATCF files from both the global and regional models participating in the 2010 Demo System will be provided to the TCMT. The TCMT will create merged files from the individual contributions that will be made available to all HFIP participants via the TCMT website. Modeling groups will use their assigned model identifiers determined in consultation with NHC.

- Tier 2 (files containing select gridded fields) from both the global and regional models participating in the 2010 Demo System will also be provided to the TCMT. These files will be made available to all HFIP participants through a data service provided by the TCMT. These files will also be used by the TCMT to perform further evaluation.

Table 4 Computer resources for regional models

Models	Retro runs 2008-2009	Stream tentative	Computer	Number of cores	Wall clock time for a 5 day forecast	Runs per day	Point of Contact
HWRF (OPS)	yes	1.0 and 1.5	Ops	80	1 hr	4	Vijay.Tallapragada@noaa.gov
GFDL (OPS)	yes	1.0 and 1.5	Ops	80	1 hr	4	Vijay.Tallapragada@noaa.gov
HWRF IC	no	2.0	Ops	80	1 hr	2	Mingjing.Tong@noaa.gov
HWRF 3	no	2.0	t-jet	1000	2.6	4	Sundararaman.G.Gopalakrishnan@noaa.gov and Vijay.Tallapragada@noaa.gov
HWRF HYCOM	yes	2.0	Ops	96	1 hr	4 (ATL)	Hyun-Sook.Kim@noaa.gov
HWRF-HRD (ENKF DA)	no	2.0	t-jet	1024/256 (EnKF/model forecast)	4/2.6 hr (EnKF/model forecast)	2, when aircraft data available	Altug.Aksoy@noaa.gov
HWRF-HRD (HWRF-IC)	No	2.0	t-jet	256	2.6	2, when HWRF-HRD (EnKF-DA) runs	Sundararaman.G.Gopalakrishnan@noaa.gov and Altug.Aksoy@noaa.gov
HWRF NOAH LSM	No	2.0	Ops	80	1 hr	4 (ATL)	Robert.Tuleya@noaa.gov
GFDL Parallel	yes	1.5	Ops	80	1 hr	4	Morris.Bender@noaa.gov
WRF ARW FSU	yes	1.5	t-jet	512	5 hr	2	biswas@met.fsu.edu
WRF ARW (NCAR)	yes	1.5	NCAR and t-jet	256	5 hr	2	cdavis@ucar.edu and weiwang@ucar.edu
WRF ARW Utah	no	2.0	Linux-Cluster	120	15h	1	Zhaoxia.Pu@utah.edu
COAMPS-TC	yes	1.5	Navy DRSC	640	1.9 hr	4	james.doyle@nrlmry.navy.mil
Wisconsin Model	no	2.0	t-jet	11 total (10 9 km ensemble members	5 hrs (9km member) 12 hrs (3 km	2 (possibly 4)	tripoli@aos.wisc.edu

				and 1 3 km run)	**member)**		
Penn State ARW	**no**	**2.0**	**t-jet** **TACC**	**2000** **60,000**	**6 hr** **3.5hr**	**4** **When airborne radar available**	**fzhang@psu.edu and yhweng@psu.edu**

Additional products

- GOES Channels 2-5 synthetic satellite images from HWRF, GFS and possibly GFDL in the Atlantic basin. These will be available on an EMC website using special grads code adapted by M. Fiorino to extend the range of available colors, and color tables from CIRA IR enhancements adapted from McIDAS.
    - Work will begin on development of similar capabilities from COAMPS-TC and HWRFx.
- Ensemble products
    - Basic track products showing ensemble mean and individual member forecasts
    - Prototype product combining track and intensity information via ESRL web page
    - Ensemble intensity forecast product from application of SHIPS and LGEM statistical models to output from multiple global models
- Basic model products for NHC forecasters
    - Vertical shear product from user-selected models and vertical levels
    - Vertical cross-section plots with user specified input
- Large-scale diagnostic files in a common format from HWRF, GFDL and most operational global models. COMAPS-TC and HWRFx might also be included.
    - Will facilitate model inter-comparsion and new product development

Table 5 Specifications for the regional models

Models	Nesting / Horizontal resolution (km)	Vertical levels	Cumulus Parameterization	Microphysics	PBL	Land Surface	Radiation	Initial and boundary conditions	Initialization	Ocean coupling
HWRF (OPS)	2 27/9	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	GFDL Slab Model	GFDL scheme	GFS	GSI 3DVAR	POM
GFDL (OPS)	3 30/15/7.5	42	Arakawa Schubert	Ferrier	GFS Non-Local PBL	Slab Model	Schwarz-kopf-Fels scheme	GFS	GFDL synthetic bogus vortex	POM
HWRF IC	2 27/9	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	GFDL Slab Model	GFDL scheme	GFS	GSI 3DVAR with inner core data	POM
HWRF 3	2 9/3	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	GFDL Slab Model	GFDL scheme	GFS	GSI 3DVAR	POM
HWRF HYCOM	2 27/9	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	GFDL Slab Model	GFDL scheme	GFS	GSI 3DVAR	HYCOM
HWRF-HRD (EnKF- DA)	2 9/3	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	GFDL Slab Model	GFDL scheme	GFS	EnKF with aircraft data	none
HWRF-HRD (HWRF-IC)	2 9/3	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	GFDL Slab Model	GFDL scheme	GFS	HWRF initial condition	none
HWRF NOAH LSM	2 27/9	42	Simplified Arakawa Schubert	Ferrier	GFS Non-Local PBL	NOAH LSM	GFDL scheme	GFS	GSI 3DVAR	POM
GFDL Parallel	3 30/15/7.5	42	Arakawa Schubert	Ferrier	GFS Non-Local PBL	Slab Model	Schwarz-kopf-Fels scheme	GFS	GFDL synthetic bogus vortex	POM
WRF ARW FSU	2 12/4	40	Simplified Arakawa Schubert	WSM5	YSU	5-layer thermal diffusion soil model	RRTM (longwave) / Dudhia (shortwave)	GFS (initial and boundary condition)	Initialized from GFS	none
WRF ARW (NCAR)	2 12/4	36	New Kain Fritsch (12 km only)	WSM5	YSU	5-layer thermal diffusion soil model	RRTM (longwave) / Dudhia (shortwave)	GFS	EnKF method in a 6-hour cycling mode	1-d ocean
WRF ARW Utah	3 27/9/3	31	Betts-Miller	Lin	YSU	5-layer thermal diffusion scheme	RRTM	GFS	Vortex relocation & WRF 3DVAR	none
COAMPS-TC	3 45/15/5 (15/5 km following the storm)	40	Kain Fritsch on 45 and 15 km meshes	Explicit microphysics (5 class bulk scheme)	Navy 1.5 order closure	Slab with the NOAH LSM as an option	Harshvardhan	NOGAPS (could use GFS if desirable)	3D-Var data assimilation with synthetic observations	Option to run coupled with NCOM may be used depending on computational resources
Wisconsin Model	UW NMS (3D enstrophy/ entropy/KE conserving dynamics core)	3-4 90/45/9 km 90/45/9/3 km	52	Modified Emanuel	Explicit bulk microphysics (cloud/rain/pristine/ aggregate/graupel)	1.5 order closure	WRF vegetation/land surface/Andreas emulsion layer	RRTM	GFS/GFDL	GFDL Synthetic Vortex
Penn State ARW	3 40.5/13.5/4.5 for ensemble forecast 1.5-km nest for control	35	Grell-Devenyi ensemble scheme (40.5 km only)	WSM 6-class graupel scheme	YSU	5-layer thermal diffusion scheme	RRTM (longwave) / Dudhia (shortwave)	GFS	EnKF with NOAA airborne radar	none

Table 6 T- Jet Schedule