Transition of Research to Operations

Ligia Bernardet

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http://www.dtcenter.org/HurrWRF/users

External collaborators:

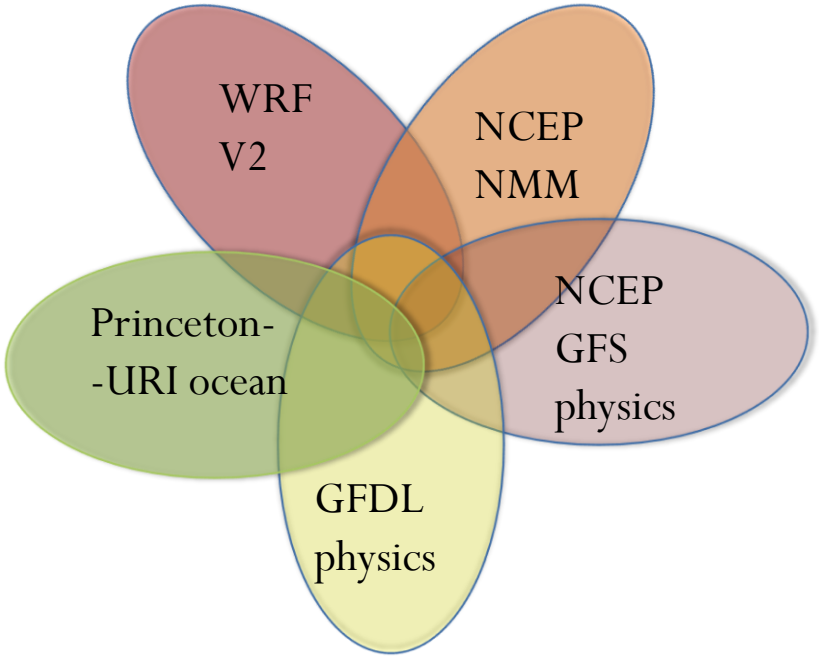
NOAA Environmental Modeling Center
NOAA Geophysical Fluid Dynamics Laboratory
NOAA Atlantic Oceanographic and Meteorological Laboratory
NCAR Mesoscale and Microscale Meteorology Division
University of Rhode Island

Outline

- GFDL (limited development)
- COAMPS-TC (limited knowledge)
- HWRF (Focus of this presentation)
  - HWRF initial implementation, development 2008-2009
  - DTC Involvement 2009-present
  - Support to HWRF users
  - Recent R2O: does it meet our needs?
  - Revised HWRF code management and R2O protocols
  - Testing at DTC (past and future)
  - DTC facilitation of testing and transition, issues and challenges
  - Evaluation and verification

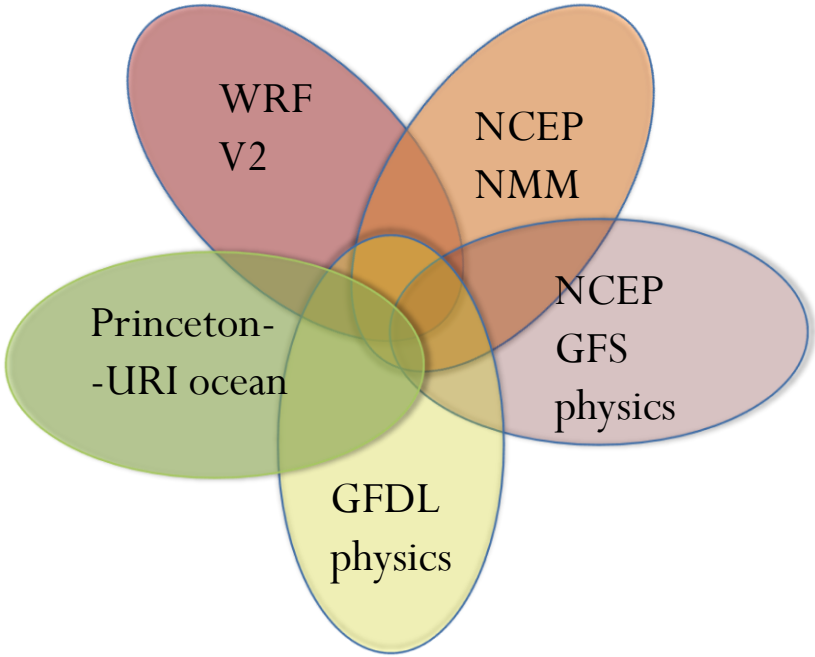
2007: HWRF Initial Implementation

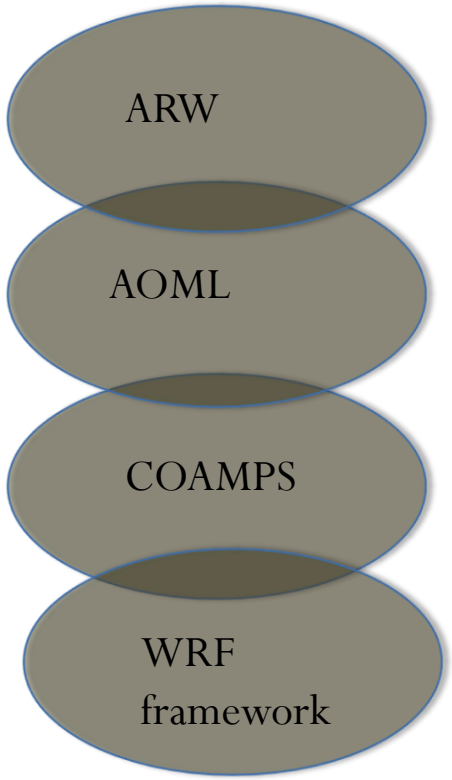
- Developed 2004-2007 from a significant collaboration



HWRF Subsequent development

- 2007-2009 HWRF remained somewhat isolated from collaborations





2009: Collaboration with DTC starts

- Recognition of importance of collaborations
- Decision to interface with community through DTC
  - Make operational code available to community
  - Manage code so that there is a single code base
  - Additional T&E to be performed by DTC

How is this being done and is it meeting our needs?

Timeline of DTC work in Hurricanes

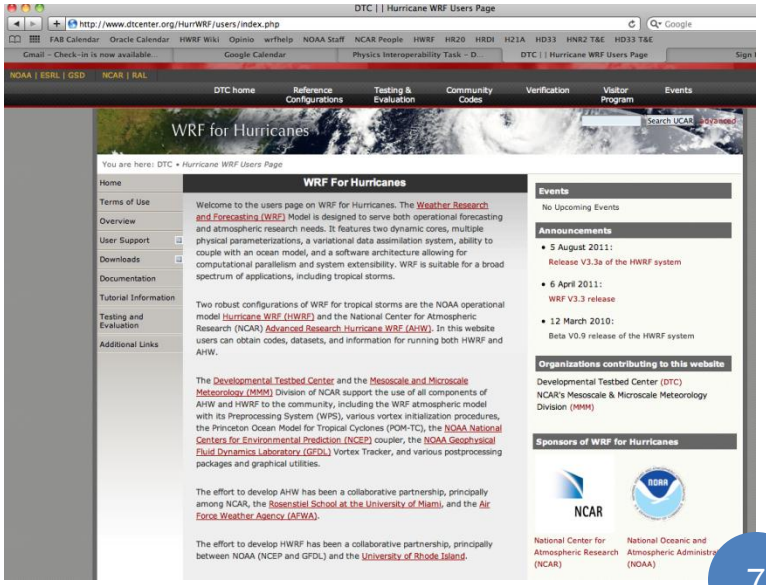
- 2009
  - Obtained HWRF codes
  - Established operational capability in existing repositories: WRF, WPS, WPP
  - Created community code repositories: POM, coupler, tracker, vortex initialization
- 2010
  - HWRF Beta-release, 1st HWRF Tutorial
  - Developed functionally-similar T&E suite
  - Testing for internal consistency, bug fixes
  - Operations: remain V2
- 2011
  - HWRF V3.3a release, 2nd HWRF Tutorial
  - Testing for internal consistency, bug fixes
  - Operations: upgraded to V3.2

Good job of bringing community code and operational codes in sync

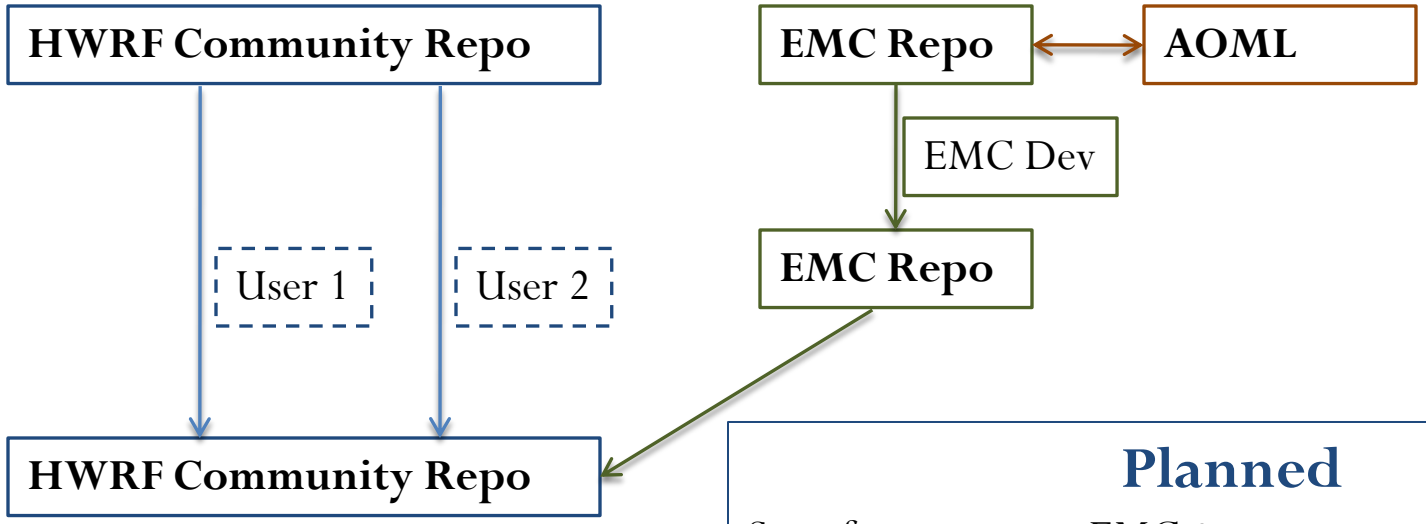
With commitment, can keep them in sync as we go forward

HWRF User Support

- Code releases : HWRF V3.3a released 8/4/2011
  - All HWRF components: WRF, WPS, Vortex Initialization, GSI, POM, coupler, UPP, tracker
  - 270 registered users
- Documentation: Users Guide, Scientific Documentation
- Datasets
- Email helpdesk
  - Average 40 messages a month



Recent R20



Planned

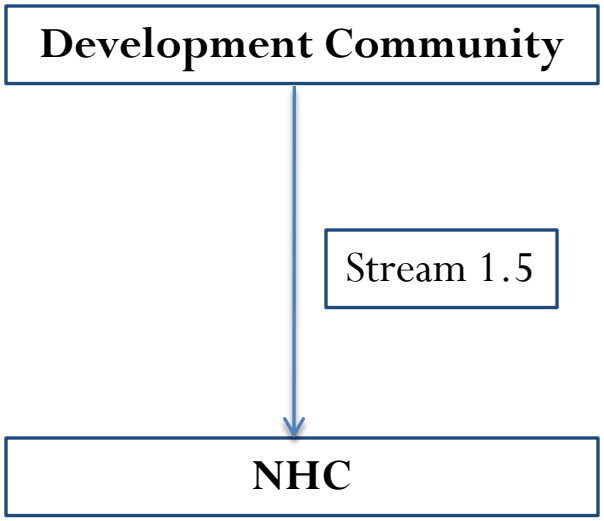
Start from separate EMC & community repos, somewhat synched

User gets release tarfile, adds HWRF development, DTC helps it get to community code repository (did not happen)

EMC uses its repository, DTC lifts code to include in community repositories

AOML gets code from EMC, develops, returns to EMC

More recent R2O : HFIP Stream 1.5



System

HFIP has large computational facility

No NCEP/NCO involvement:

Researchers/Developers deliver forecasts to NHC

R2O does not involve operational models

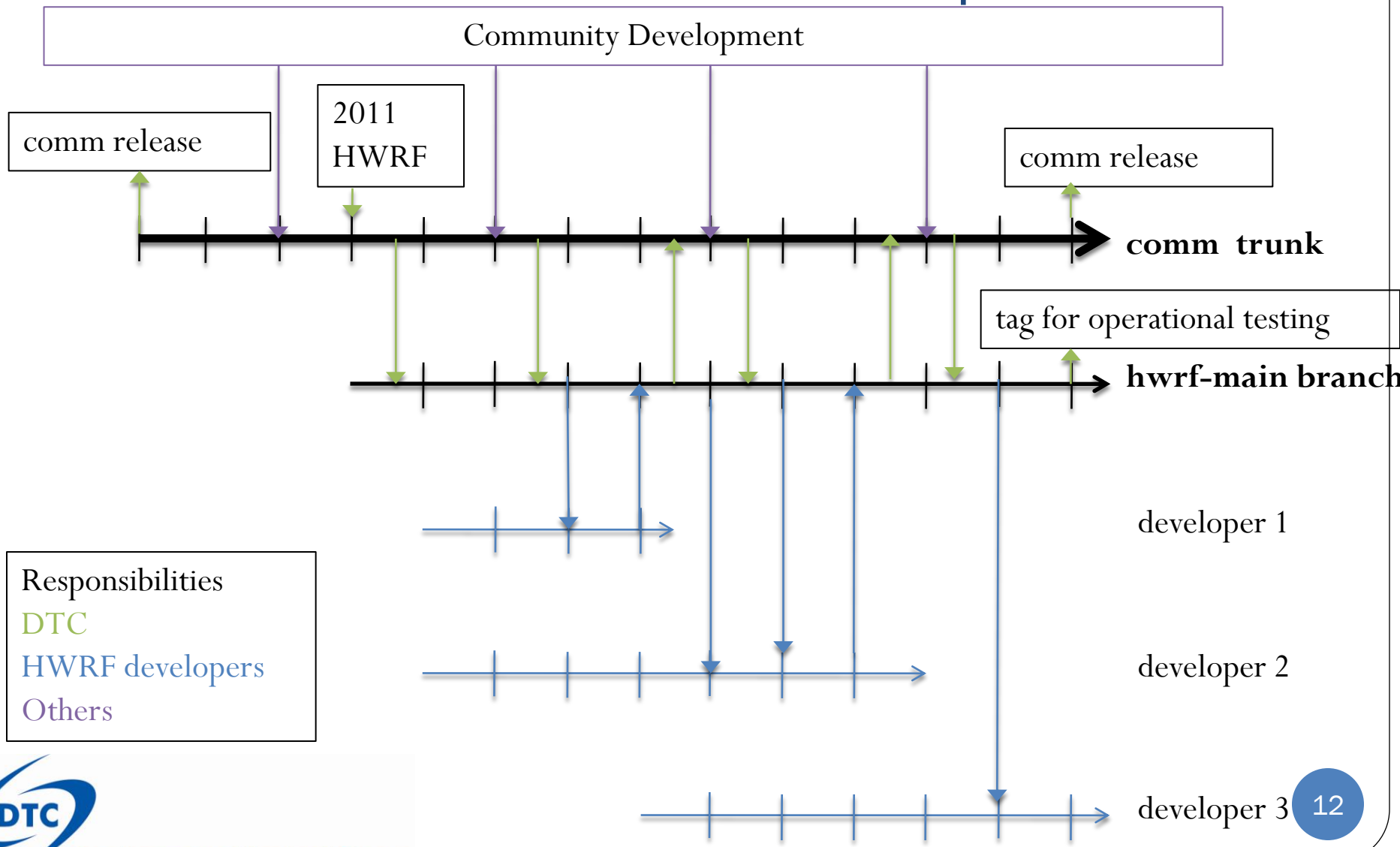
Does current system meet our needs?

- Transferring code between EMC-DTC 10repositories and back-forth EMC-AOML can introduce errors
  - And it has!
- Not sustainable for many developers
  - EMC cannot closely interact with all HFIP AO recipients
- No mechanism for developers to interact and share code
  - Example: How will URI test ocean model using developmental AOML/EMC 3-nest capability?
- Difficult for DTC to conduct relevant tests if developers only release code that is already tested
  - Example: How can DTC improve computational performance of 3-nest HWRF if code is yet to be transitioned to DTC?
- Important role for operational models (reliability etc.)
  - Stream 1.5 does not fill

Revised HWRF Code Management

- DTC/EMC conducted about 20 h of meetings in 04/2011
- Decided to unify all development in community repositories
- Devised system of branches to support developers
- System undergoing implementation
- EMC requires all development to be conducted in this framework

Code evolution in a HWRF component



Implementation of HWRF Code Management

HWRF Code Management Procedures

A collaboration between DTC and EMC

Point of Contact Ligia Bernardet (ligia.bernardet@noaa.gov)

First Draft: May 10, 2011; Second draft: May 31, 2011; Third draft: July 15, 2011

Goals

- Facilitate transfer of code between EMC, DTC, HWRF developers and HWRF users by improving the way code is shared and managed.
- Reduce the overhead in transferring code between multiple repositories.
- Minimize human error in the code management process.
- Install safeguards to protect integrity of the code.

Document is available at http://www.dtcenter.org/HurrWRF/users/others/index_links_HurrWRF.php

August 2011: 2011 HWRF operational capability is available

- To users in public release
- To beta-test developers in SVN checkout

Developers: please contact DTC to obtain code and get your branch
DTC will provide extensive support in using new system

DTC Testing: functionally-similar T&E suite

- Pre-processing (including ability to ingest binary spectral GFS)
- Cycled HWRF vortex initialization and relocation
- GSI Data Assimilation
- Coupled (POM + WRF) model
- Post-processing
- Tracking
- NHC Verification & confidence intervals
- Display
- Archival

- Uses NOAA Workflow Manager automation
- Most runs done on jet; also available on bluefire IBM

2011 Operational Baseline Reference Configuration

Goals

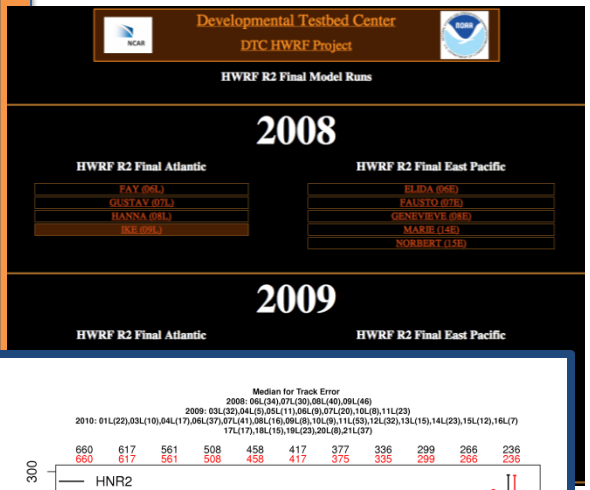
- Create benchmark for community
- Verify if 2011 Operational Baseline capability had been correctly ported to community codes and

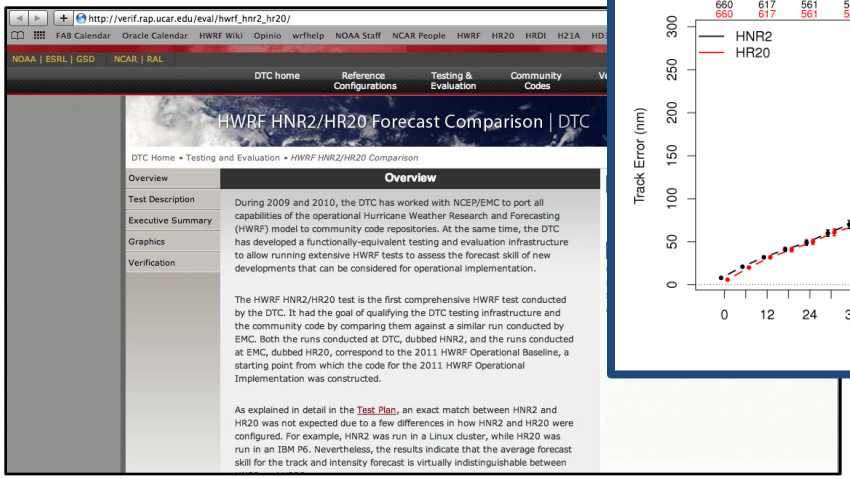
Outcome

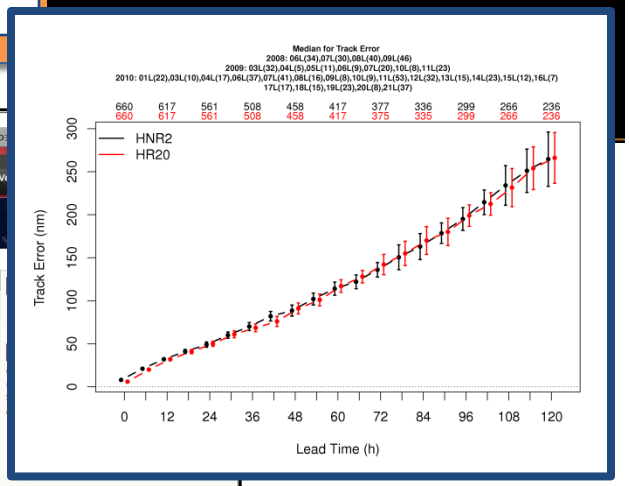
- Reference Configuration established
- Porting OK

The Developmental Testbed Center
HWRF 2011 Baseline Test Plan
Point of Contact: Ligia Bernardet
December 15, 2010

Introduction
The DTC will be performing testing and evaluation for the Hurricane WRF system, known as HWRF (Gopalakrishnan et al. 2010). HWRF will be configured as close as possible to the operational HWRF model, employing the same domains, physics, coupling, and initialization procedures as the model used at the NOAA NCEP Central Operations and by the model developers at NCEP EMC. The configuration to be tested matches the 2011 HWRF Baseline, which is the configuration that served as control for all developments at EMC geared towards the 2011 operational implementation.







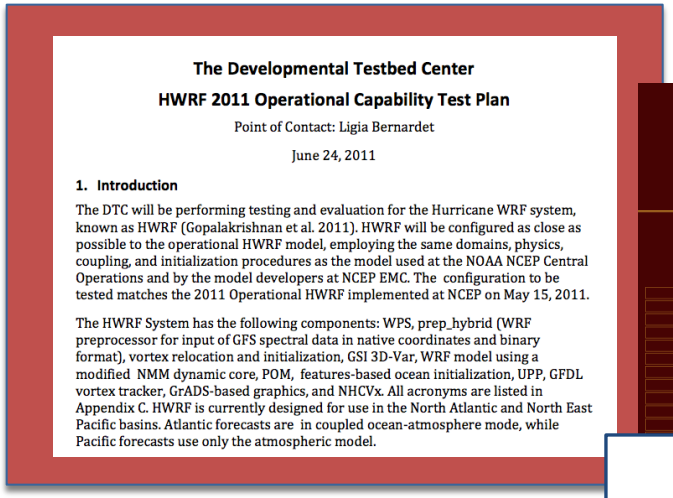
2011 Operational capability in community code

Goal

Verify if 2011 operational capability had been correctly ported to community codes

Outcome

Test identified issues which led to crisis-RFC



The Developmental Testbed Center

HWRF 2011 Operational Capability Test Plan

Point of Contact: Ligia Bernardet

June 24, 2011

1. Introduction

The DTC will be performing testing and evaluation for the Hurricane WRF system, known as HWRF (Gopalakrishnan et al. 2011). HWRF will be configured as close as possible to the operational HWRF model, employing the same domains, physics, coupling, and initialization procedures as the model used at the NOAA NCEP Central Operations and by the model developers at NCEP EMC. The configuration to be tested matches the 2011 Operational HWRF implemented at NCEP on May 15, 2011.

The HWRF System has the following components: WPS, prep_hybrid (WRF preprocessor for input of GFS spectral data in native coordinates and binary format), vortex relocation and initialization, GSI 3D-Var, WRF model using a modified NMM dynamic core, POM, features-based ocean initialization, UPP, GFDL vortex tracker, GrADS-based graphics, and NHCVx. All acronyms are listed in Appendix C. HWRF is currently designed for use in the North Atlantic and North East Pacific basins. Atlantic forecasts are in coupled ocean-atmosphere mode, while Pacific forecasts use only the atmospheric model.

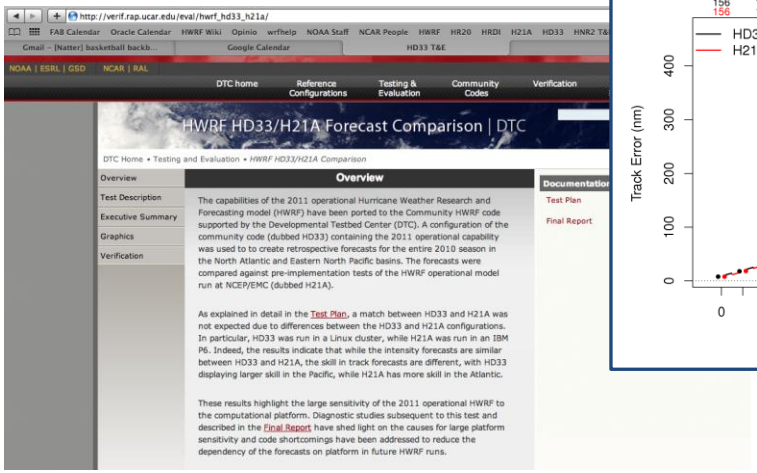
Developmental Testbed Center

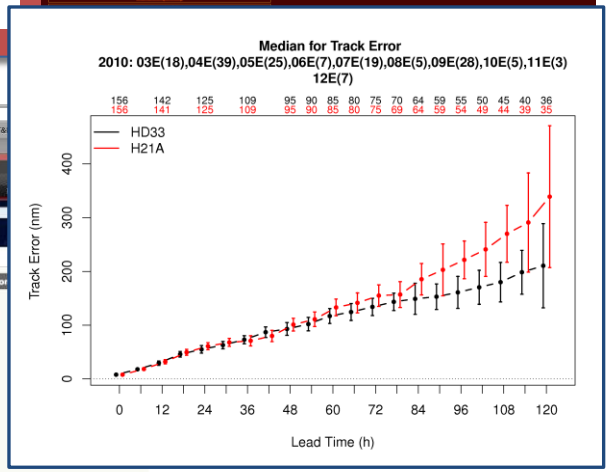
WRF for Hurricanes

HWRF HD33 Model Runs

2010

HWRF HD33 Atlantic	HWRF HD33 East Pacific
ALEX (01L)	BLAS (03E)
TWO (02L)	CELIA (04E)
BONNIE (03L)	DARBY (05E)
COLIN (04L)	SIX (06E)
FIVE (05L)	ESTELLE (07E)
DANIELLE (06L)	EIGHT (08E)
EARL (07L)	FRANK (09E)
FIONA (08L)	TEN (10E)
GASTON (09L)	ELEVEN (11E)
HERMINE (10L)	GEORGETTE (12E)
IGOR (11L)	





Upcoming Test at DTC

Revised code management should allow more relevant testing

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Consist Check	Expand, test, report	Expand, test, report	Expand, test, report	Test, report	Test, report	Test, report	Test, report	Test, report	Test, report	Test, report	Test, report	Test, report
Establish 2011 oper capab in comm code	POM Vortex	UPP	WRF Scripts Namel Fix fils	Test, reconc diffs	Report Code Releas	HWRF large scale diagnostics	HWRF large scale diagnostics	HWRF large scale diagnostics				
Physics inter operability			Devel	Devel	Devel	Report						
Computational Perform					Assess	Improve	Improve	Improve	Improve	Improve	Improve	
High-res						Test	Report					
Incorporate new devs							Coupl 3rd nest	Vortex initialization 3rd nest and flex	Ideal	Other transition	Other transition	Other transition
HYCOM									Port	Port	Port	Prelim test
Ref Conf								Test	Test	Report		
Comprehe test									Test	Report		

HWRF operational physics

Physics	Package
Microphysics	Tropical Ferrier
Cumulus	GFS SAS
Surface	GFDL
PBL	GFS
LSM	Slab
Radiation LW/SW	GFDL

- DTC (Biswas) is collaborating with NCAR/MMM (Dudhia) to increase HWRF interoperability
- Document which physics are working for HWRF
- Connect more packages to HWRF

Microphysics options in WRF

- Tropical Ferrier
- Ferrier
- Kessler
- Lin
- WSM3
- WSM5
- WSM6
- Goddard
- Thompson
- Milibrandt-Yau Double 7-class
- Morrison Double
- WRF Double 5-class
- WRF Double 6-class
- Stony Brook

Operational HWRF

Does not work with HWRF

Only working scheme is Ferrier because of advection of species

Cumulus options in WRF

HWRF 2011 SAS
Kain-Fritsch
Betts-Miller-Janjic
Grell-Devenyi
HWRF 2010 SAS
Grell-3D
Tiedke
GFS SAS for ARW
Zhang-McFarlane
Old Kain Fritsch

Operational HWRF

Works when used with other HWRF packages

Does not work with HWRF

Not tested with HWRF

Surface /PBL options in WRF

GFDL	GFS
MMM Similarity	YSU
Eta Similarity	MYJ
GFS	GFS
QNSE	QNSE
MYNN	MYNN (2.5 or 3.0)
Pleim-Xu	ACM2
	BouLac
	UW
	TEMF
	MRF

Radiation LW and SW

Modified GFDL
GFDL
RRTM
CAM
RRTMG
Goddard

Modified GFDL
GFDL
Dudhia
CAM
RRTMG
New Goddard
Goddard
Held-Suarez (ideal)

Land Surface Models in WRF

GFDL slab
5-layer diffusion
Noah
RUC
Pleim-Xiu

Work at DTC

1. Connect individual physics correctly
2. Test entire physics suites
3. Go beyond run/fail to diagnostics

Priorities for testing

- Helpful to DTC to have priorities of tests (focus on operational/HFIP needs)
- Easier to test
  - Physics already in WRF framework for NMM
  - Tunable parameters within physics
- Next level of complexity
  - Physics in WRF framework for ARW
  - Requires connecting to HWRF (physics and dynamics) – not trivial
- Next level of complexity
  - Other physics (COAMPS etc.)
  - Added cost to make them available – not trivial

Issues regarding physics testing

- **Resolution**
  - Physics can be targeted to certain resolutions; should we focus on 3 km?
  - Is model top at 50 hPa adequate?
- **Ocean**: should HWRF experiments be done with POM or HYCOM?
  - If planning 2012 HYCOM implementation, should physics tests be done with HYCOM?

Idealized Simulations

- Important for developing and testing physics
- DTC working with J-W Bao to incorporate idealized hurricane case in community release
- Non-hurricane cases for NMM are also important

NMM-B and NEMS

- NCEP is transitioning all its models to the NOAA Environmental Modeling Framework
- Operational hurricane model will not be WRF-based
- NMM-E will be replaced by NMM-B
- How will we transition researchers from WRF to NEMS?
  - Strive for plug-n-play packages that work on both
  - Put NMM-B in WRF??
- How much to invest in current system
  - Worth to add advection of microphysical species to WRF-NMM, since it is already working in NMM-B?

Evaluation and Verification at DTC

- Current Activities
  - Performs Reference Configuration and other testing
  - Engaged in diagnostic activities
  - Started development of Hurricane Evaluation Toolkit
- Possible future activities
  - Maintain archive of benchmarked case studies
  - Conduct non-traditional verification (object-based etc.)
  - Develop Diagnostic toolkit

How can the DTC best serve the community (R and O)?

- Feedback is welcome on testing, code management, user support etc.