



NCAR

Hurricane WRF: 2012 Operational Implementation and Community Support

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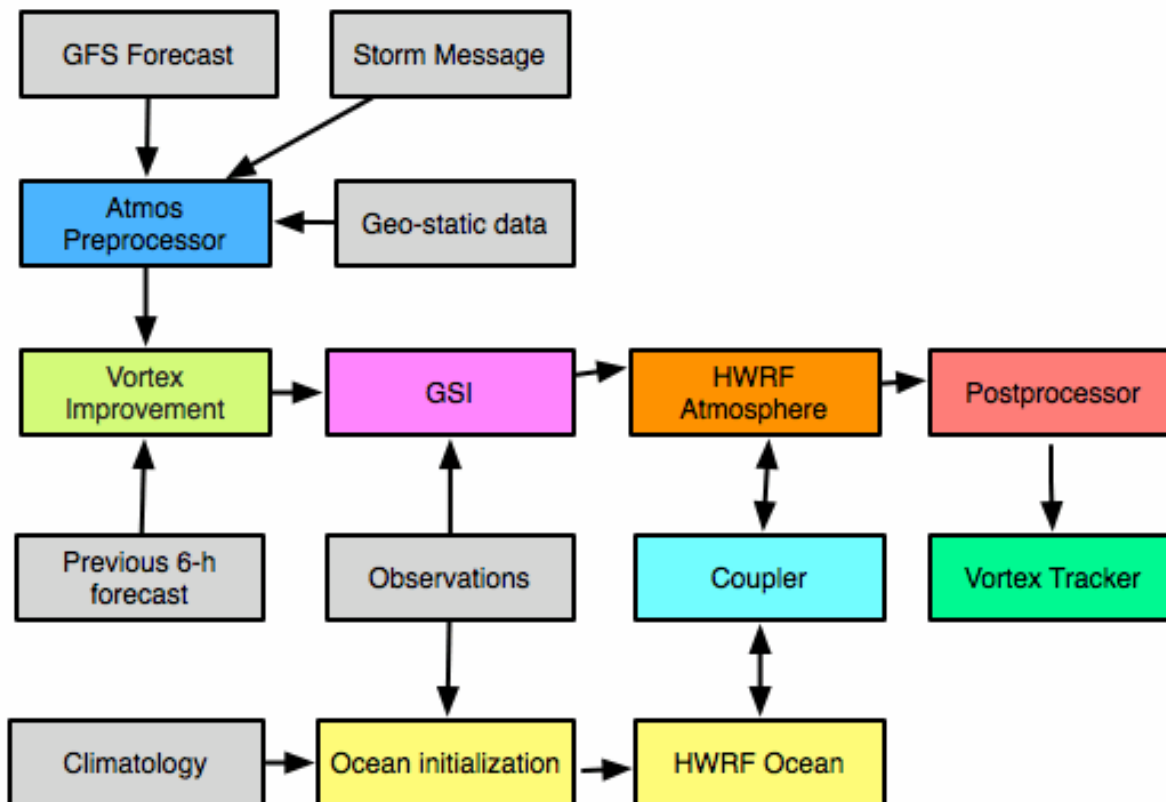


Developmental Testbed Center

WRF Users Workshop. June 26, 2012

HWRF: NOAA operational Hurricane model

HWRF Flow Diagram



HWRF Components

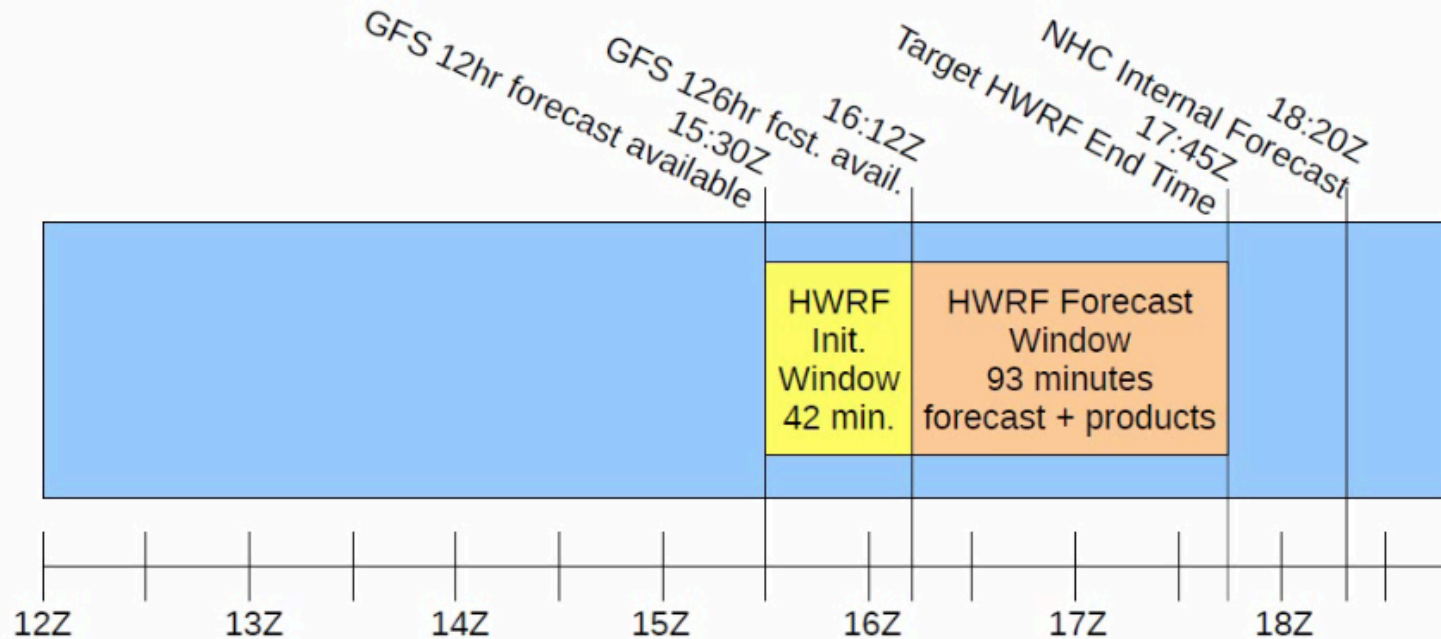
- WRF model (NMM)
- Pre-Processor
- Vortex initialization
- Data assimilation (GSI)
- Coupler (NCEP)
- Ocean (POM-TC)
- Post-Processor (UPP)
- Vortex Tracker (GFDL)

HWRF Operational: now dx=3 km

		2011	2012
Atmos	Domains (outer + nests)	2	3
	Hor grid spacing (km)	27:9	27:9:3
	Grid sizes (deg)	75 x 75	75 x 75
		6 x 6	10 x 10
			5.5 x 5.5
	Dynamics Δt (s)	54:18	45:15:5
	PBL, cu, microphysics Δt (min)	54:18	3 min
	Radiation Δt (min)	54:9	60:60:60
Ocean	Basin	Atl	Atl and E N Pac

Multi-agency effort facilitated by the NOAA Hurricane Forecast Improvement Project (EMC, AOML/HRD, ESRL, NHC, URI, DTC)

27:9:3 HWRF Operational Window



HWRF is triggered when NHC issues an advisory.

If more than one storm present, several independent HWRF runs launched.

Model must be robust and complete reliably for up to 5 simultaneous storms.

Three-minute physics timestep an undesirable but necessary constraint.

HWRF 2012 operational physics

Physics	Parameterization
Cumulus	Simplified Arakawa Schubert with shallow convection
Microphysics	Ferrier for the tropics
Planetary Boundary Layer	GFS (Hong and Pan 1996, modified)
Surface Layer	GFDL (modified)
Land Surface Model	GFDL slab model
Radiation	GFDL

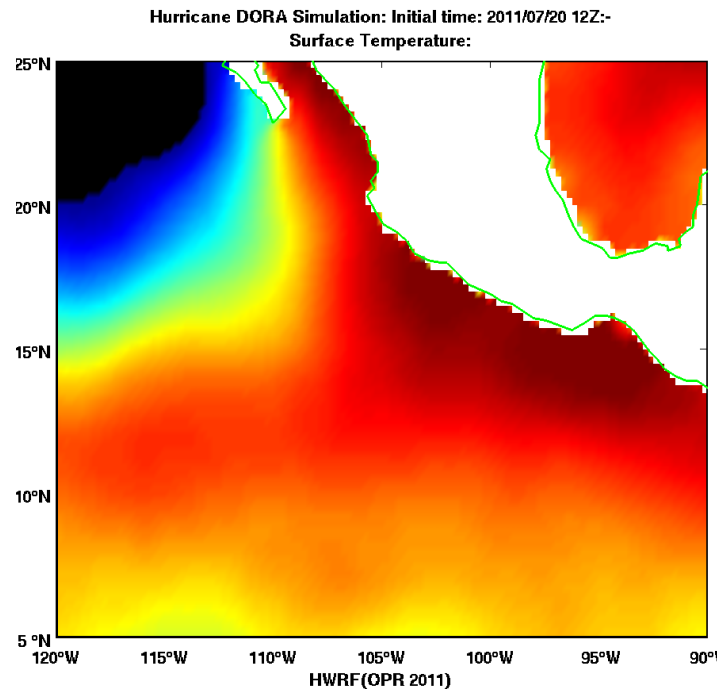
Main changes for 2012 season (WRF v3.3+):

- Cumulus:** addition of shallow convection
- PBL:** update of Ri_c from 0.5 to 0.25 and
 α from 1.0 to 0.5 in $K_m = \kappa (U_* / \Phi_m) z \{ \alpha (1-z/h)^2 \}$
- Microphysics:** use more realistic values of number conc and snow fall speed
- Surface:** use constant C_h profile with wind speed (consistent with obs)

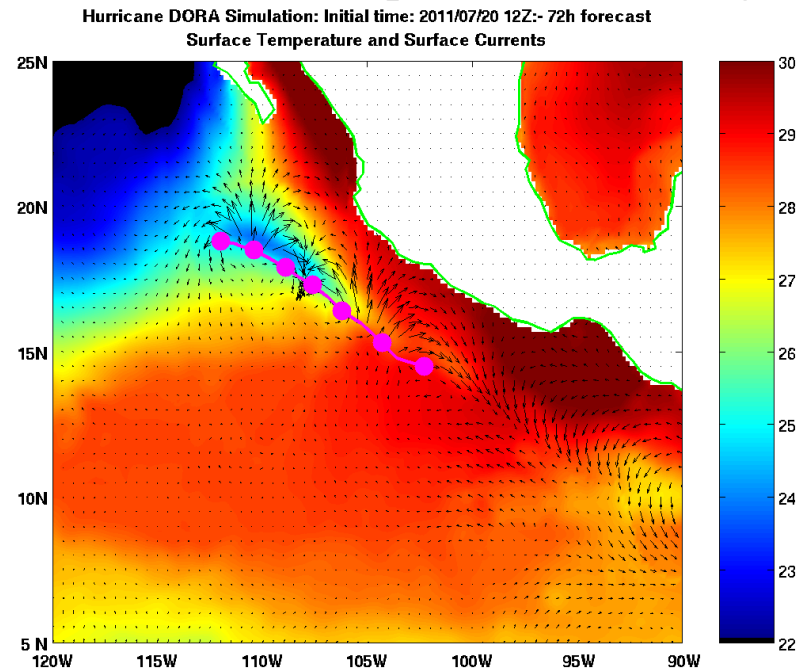
Impact of East Pac ocean coupling

SST 72-h forecast Hurricane Dora, initialized 2011072012

HOPS: Operational



H212: 2012 EMC pre-release testing



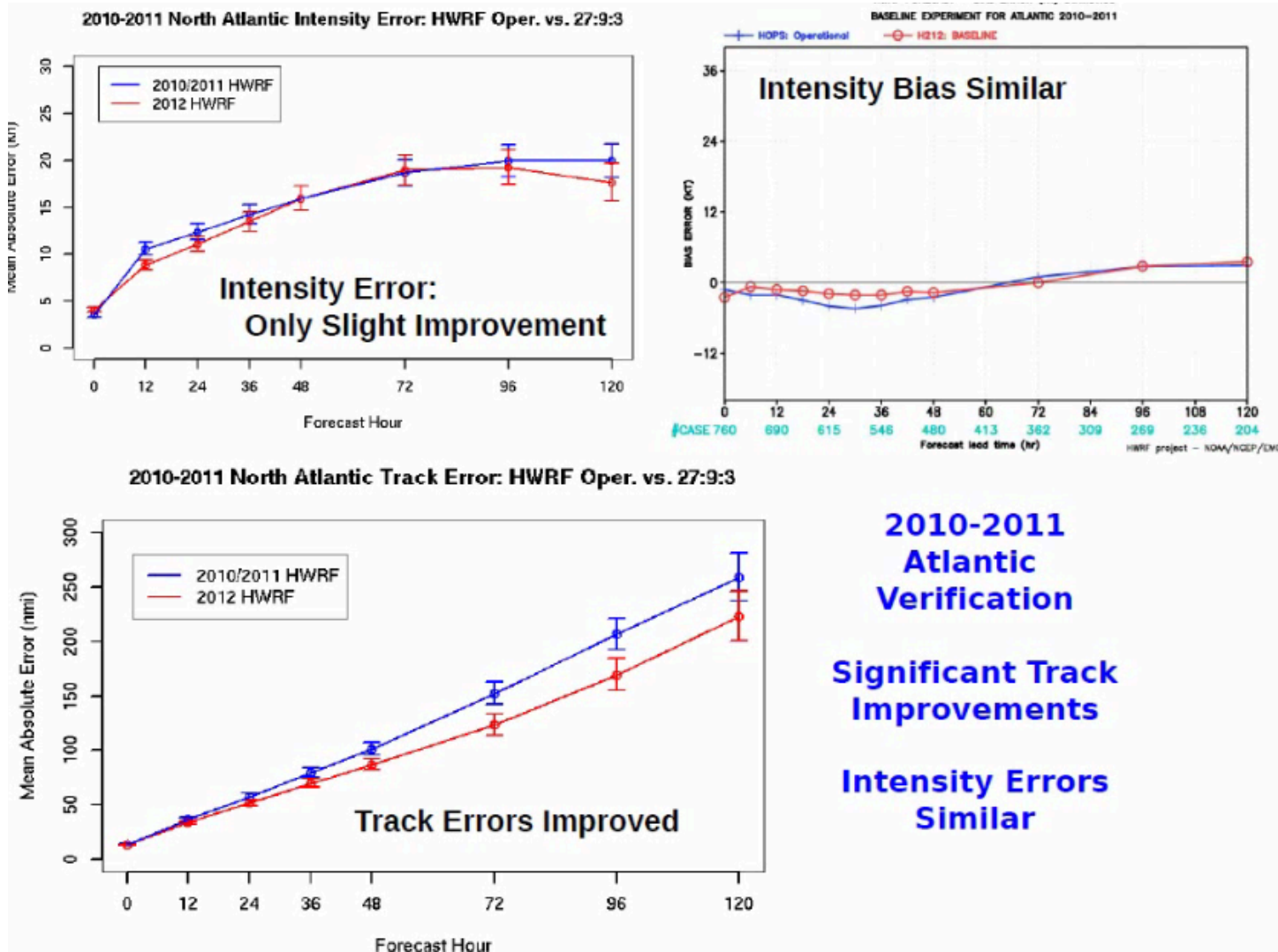
Coupling better represents SST and feeds back onto hurricane intensity

Improved initialization for 2012

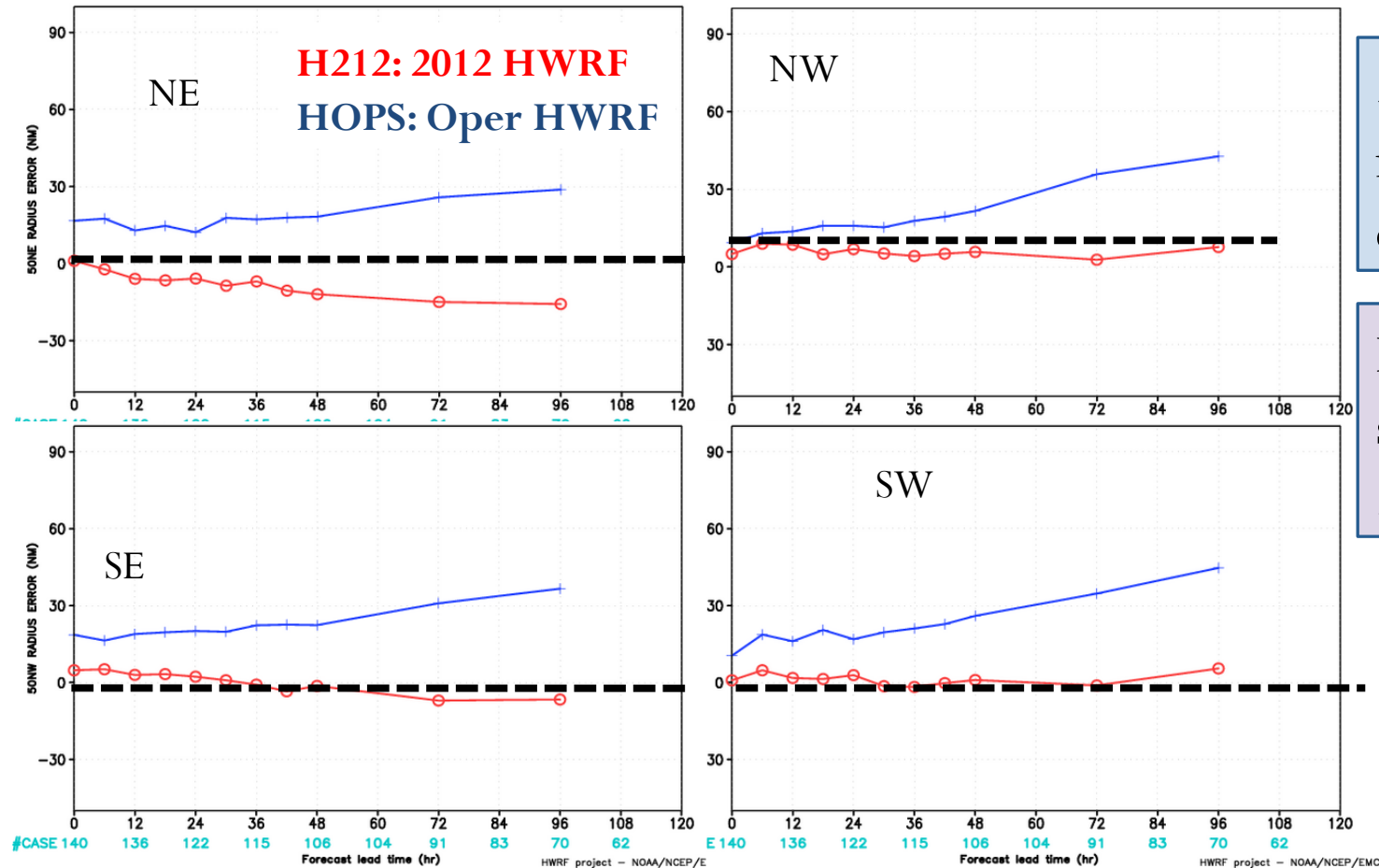
- **Vortex relocation**
 - Performed at the 3 km grid
 - Better use of structure information (34 kt radii and RMW)
 - Much improved initial storm structure
- **Data assimilation upgraded to GSI v3.0+**
 - Assimilation of conventional data only
 - Data excluded within a radius of 1,200 km around the storm
 - Observational errors inflated wrt default GSI

Operational Implementation of High-Resolution Triple-Nested HWRF at NCEP/EMC - A Major Step Towards Addressing Intensity Forecast Problem: Vijay Tallapragada, Y. C. Kwon, Q. Liu, S. Trahan, Z. Zhang, E. Aligo, C. Kieu, W. Wang, J. Oconnor, R. E. Tuleya, S. Gopalakrishnan, X. Zhang, B. Lapenta, F. D. Marks Jr., and R. L. Gall

Pre-implementation test (H212 vs HOPS)



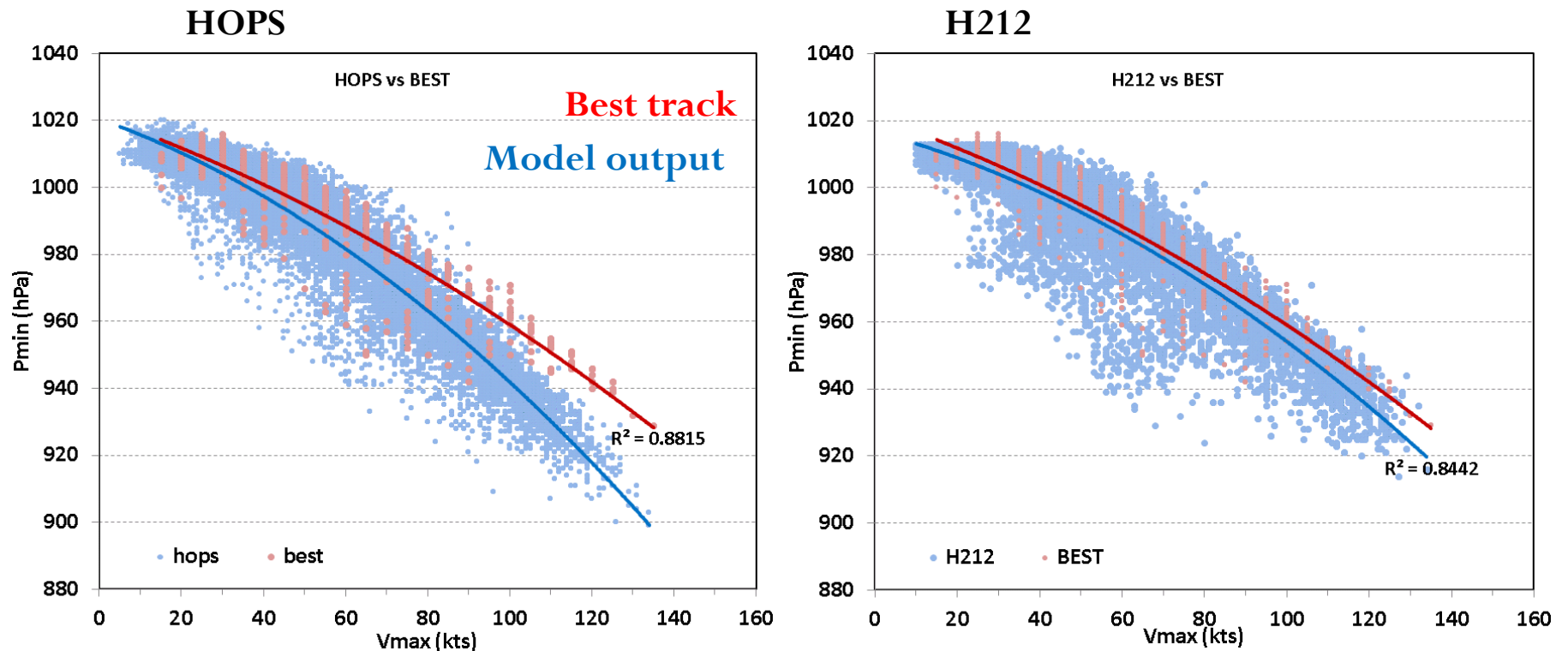
Pre-implementation test (H212 vs HOPS)



50 kt wind
radii bias in 4
quadrants

Improved
storm size in
2012 model

Pressure-wind relationship



Pressure-wind relationship much improved in 2012 model

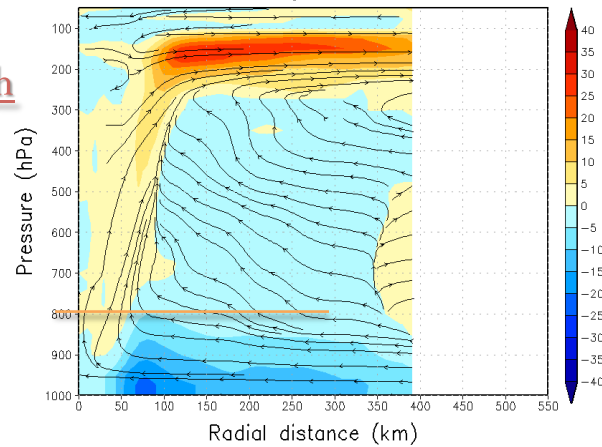
Transition of the High-Resolution, Research Version of HWRF to Operations - Sundararaman Gopalakrishnan, V. Tallapragada, X. Zhang, S. B. Goldenberg, T. Quirino, K. Yeh, and F. Marks (30th Conference on Hurricanes and Tropical Meteorology, 15-20 April 2012, Ponte Vedra Beach, FL)

PBL comparison: Irene 2011082518

HOPS

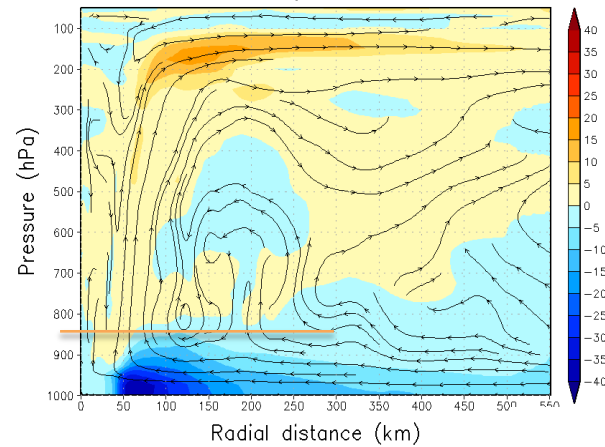
Secondary Circulation

18 h



H212

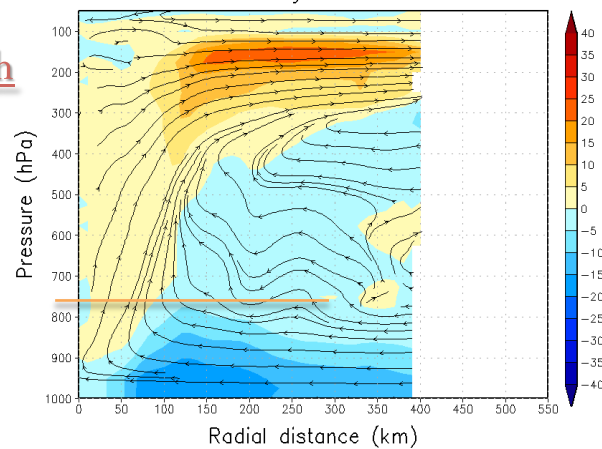
Secondary Circulation



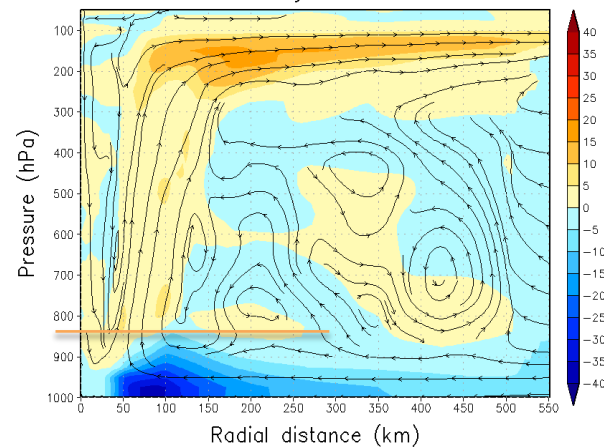
PBL height
PBL is shallower in
H212 than HOPS

Secondary Circulation

39 h



Secondary Circulation



Inflow layer
Stronger in H212
than HOPS

www.dtcenter.org/HurrWRF/users

Developmental Testbed Center support

The screenshot shows the 'WRF for Hurricanes' website. At the top, there's a header with a satellite image of a hurricane and a search bar. Below the header, a navigation menu on the left lists: Home, Terms of Use, Overview, User Support, Downloads, Documentation, Tutorial Information, and Additional Links. The main content area is titled 'WRF For Hurricanes' and contains a welcome message, a list of features, and information about the model's development. It mentions the Weather Research and Forecasting (WRF) Model, its dynamic cores, and its suitability for a broad spectrum of applications. It also lists two robust configurations: Hurricane WRF (HWRF) and Advanced Research Hurricane WRF (AHW). The page lists contributing organizations: Developmental Testbed Center (DTC), Mesoscale and Microscale Meteorology (MMM) Division of NCAR, the National Center for Atmospheric Research (NCAR), the Princeton Ocean Model for Tropical Cyclones (POM-TC), the NOAA National Centers for Environmental Prediction (NCEP), the NOAA Geophysical Fluid Dynamics Laboratory (GFDL), Vortex Tracker, and various postprocessing packages and graphical utilities. It also mentions the effort to develop AHW as a collaborative partnership between NCAR, the Rosenstiel School at the University of Miami, and the Air Force Weather Agency (AFWA), and the effort to develop HWRF as a collaborative partnership between NOAA (NCEP and GFDL) and the University of Rhode Island. On the right side, there are sections for 'Events' (listing a tutorial from 04.26.2011 to 04.29.2011), 'Announcements' (listing releases from March 2010), 'Organizations contributing to this website' (listing DTC, NCAR, and MMM), and 'Sponsors of WRF for Hurricanes' (listing NCAR and NOAA).

Code downloads,
datasets,
documentation,
helpdesk

410 registered users

Yearly releases
corresponding to
operational model of
the year

Stable, tested code

Benchmarks available

Current release: HWRF v3.3a (2011 operational)

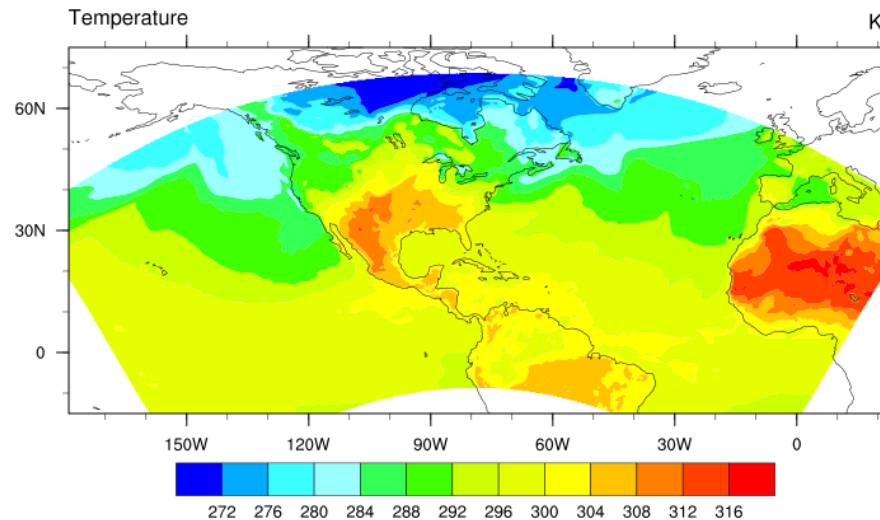
Next release: HWRF v3.4a (2012 operational) – August 2012



Developmental Testbed Center

Challenges and ongoing work

- **Configuration:** larger parent with multiple moving nests, vert lev
- **Physics:** radiation, PBL, LSM, convection, microphysics, sea spray
- **Ocean initialization:** RTOFS
- **Data Assimilation and Ensembles**
 - Hybrid (EnKF) variational data assimilation
 - Use of all available datasets, including storm-scale observations
 - Ensemble systems for uncertainty estimation
- **Internal vortex tracking:** features-based



Summary

Much improved model for 2012

High-resolution moving nest & updated physics improved track and structure

Community Support by DTC

Model freely available and supported

Upcoming release in August will have 2012 operational capability

DTC interested in engaging with this community about new developments that could be evaluated for HWRF

Opportunities

- DTC Visitor Program
- DTC Testing and Evaluation capability

Wed Model Evaluation I: Kuo et al. on Developmental Testbed Center

Thu Model Evaluation II: Biswas et al. on cumulus parameterization intercomparison for HWRF

Wed Poster: Bao et al. on Community HWRF and user support