Hurricane WRF (HWRF) at the DTC

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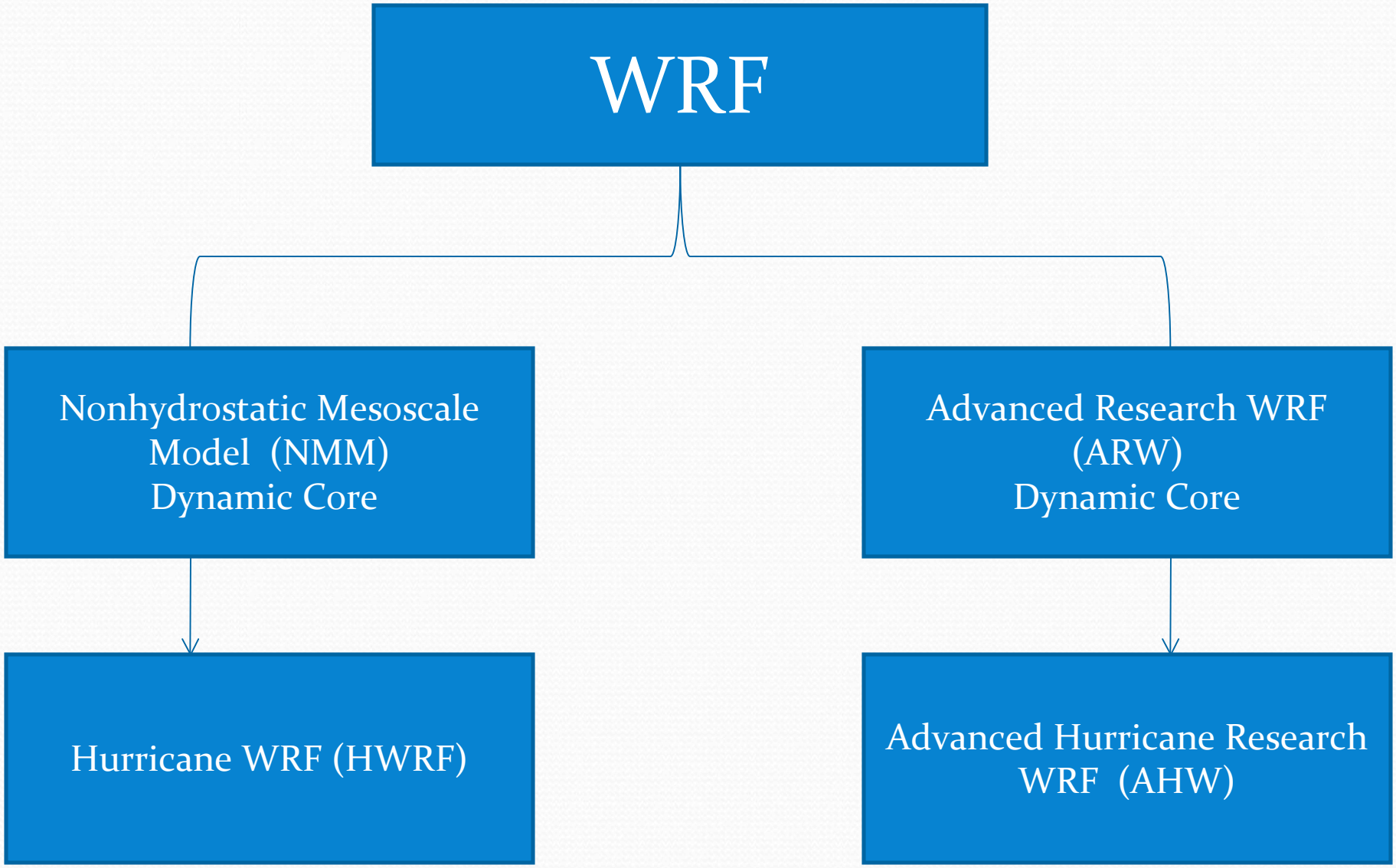
1st NOAA USWRP Testbed Workshop, Boulder, CO


WRF
Nonhydrostatic Mesoscale Model (NMM) Dynamic Core
Advanced Research WRF (ARW) Dynamic Core
Hurricane WRF (HWRF)
Advanced Hurricane Research WRF (AHW)

HWRF History/Unique features

- HWRF developed by NCEP/EMC – operational at NCEP in 2007
- 9km(inner)/27km(outer) over ~75X75 deg domain with 42 vertical levels
- Vortex-following movable two-way nested grid
- Vortex initialization techniques (cycled: GSI, vortex relocation; cold start: bogus vortex)
- Advanced hurricane physics (Air-Sea Boundary Layer)
- Ocean-atmosphere coupling (2-way)

HWRF Porting to DTC

HWRF is based on WRF NMM dynamic core V2.0

HWRF is being upgraded to WRF-NMM dynamic core V3.01 and V3.2

<u>Completed (the following components compile and run on DTC IBM and Linux)</u>:

- **HWRF Physics (V3.01)**
- **Vortex-following movable nested grid (V3.01)**
- **Initial Vortex improvement techniques**
- **HWRF ocean component: POM (initialization of loop current, warm/cold core eddies, gulf stream)**
- **Post Processing (WPPV3, Vortex Tracker, atcfplot etc)**

<u>In progress</u>:

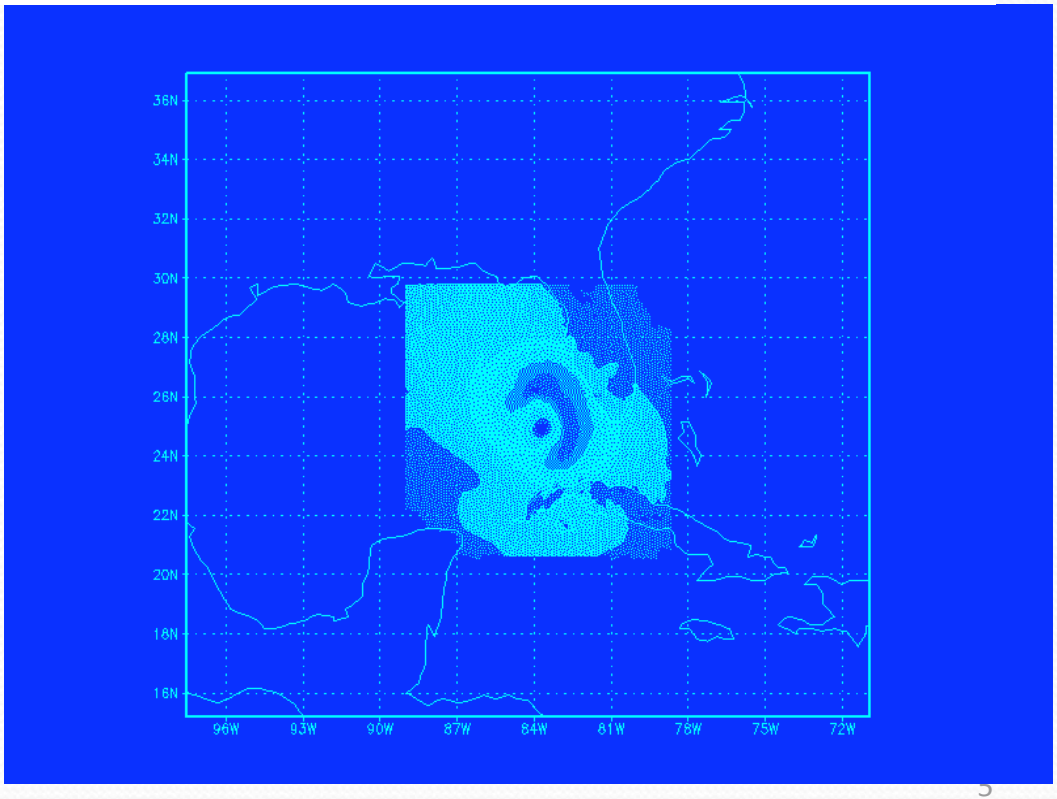
Testing of HWRF physics (June 2009)
Repository update (July 2009)
Documentation - Scientific and Technical user's guide (October 2009)
Tutorial: Feb 2010
HWRF helpdesk

Vortex-Following Movable Nested Grid

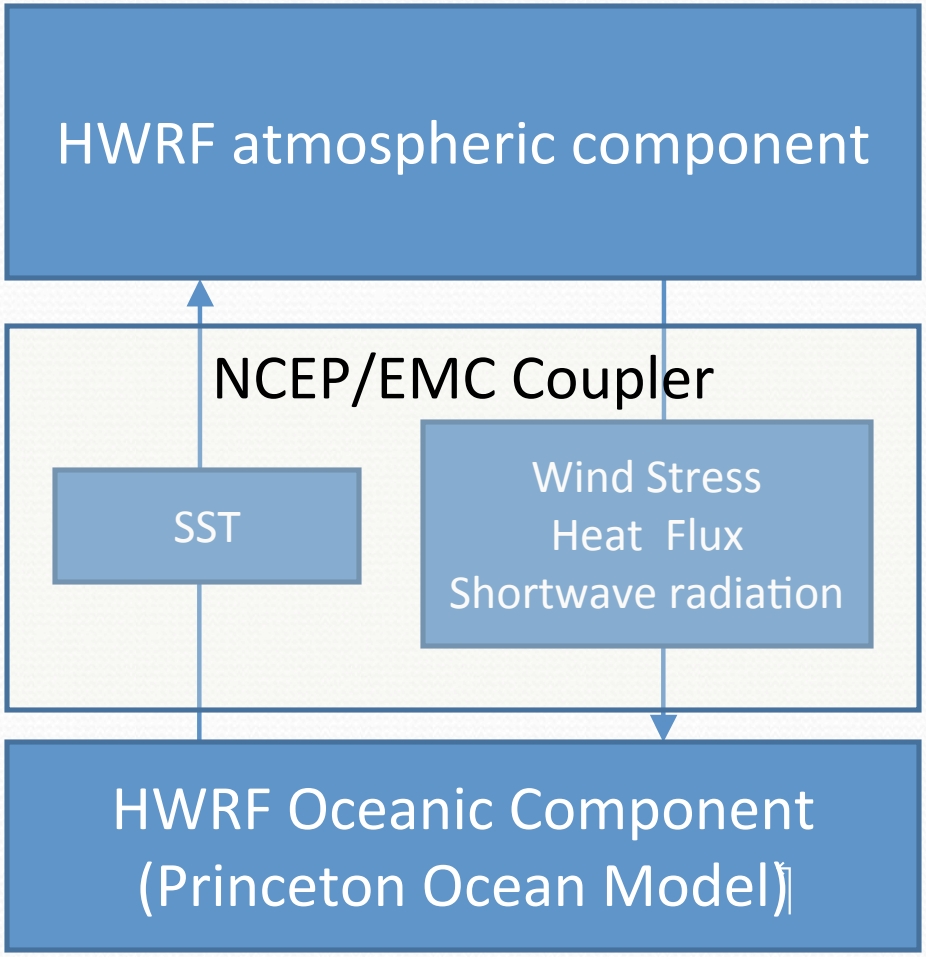
- The field used to track the vortex centre: <u>dynamic pressure</u>
- Dynamic Pressure = Sea Level Pressure + $1.1*(U^2+V^2)/2.0$

Objective:

- To increase resolution near the hurricane vortex region;
- To be still computationally efficient
- Future version: additional moving nest

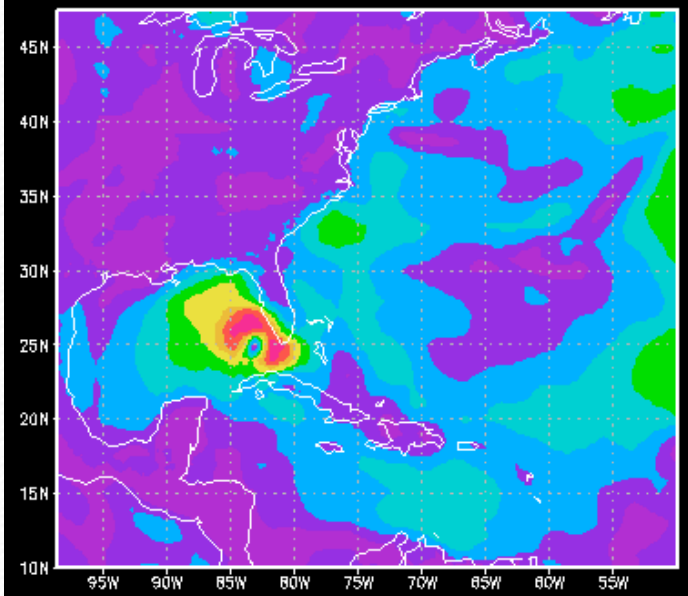


Atmosphere-Ocean Coupling

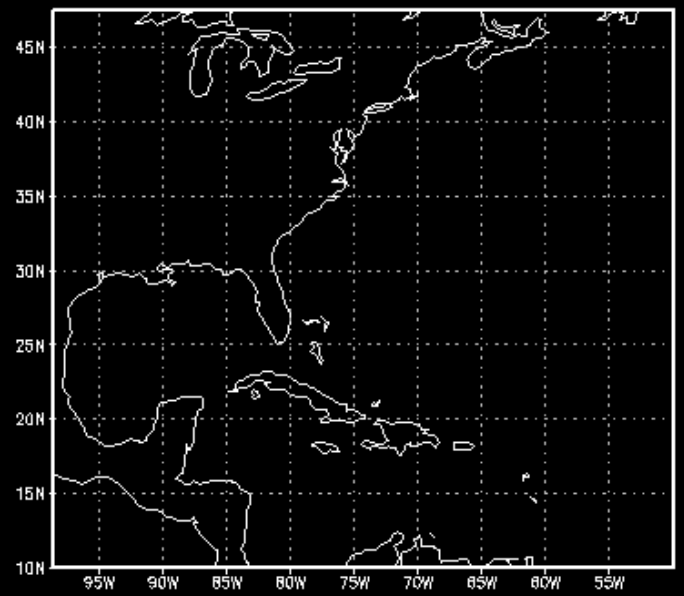


Hurricane Katrina Coupled Run (at DTC)

10-m WINDS



SST decrease



Joint NCAR/MMM and NCEP/EMC WRF Tutorial for Hurricanes - Feb 2010

Heads up announcement to community released last week

2 days invited scientific lectures
3 days hands-on HWRF and AHW tutorial

Future HWRF at DTC

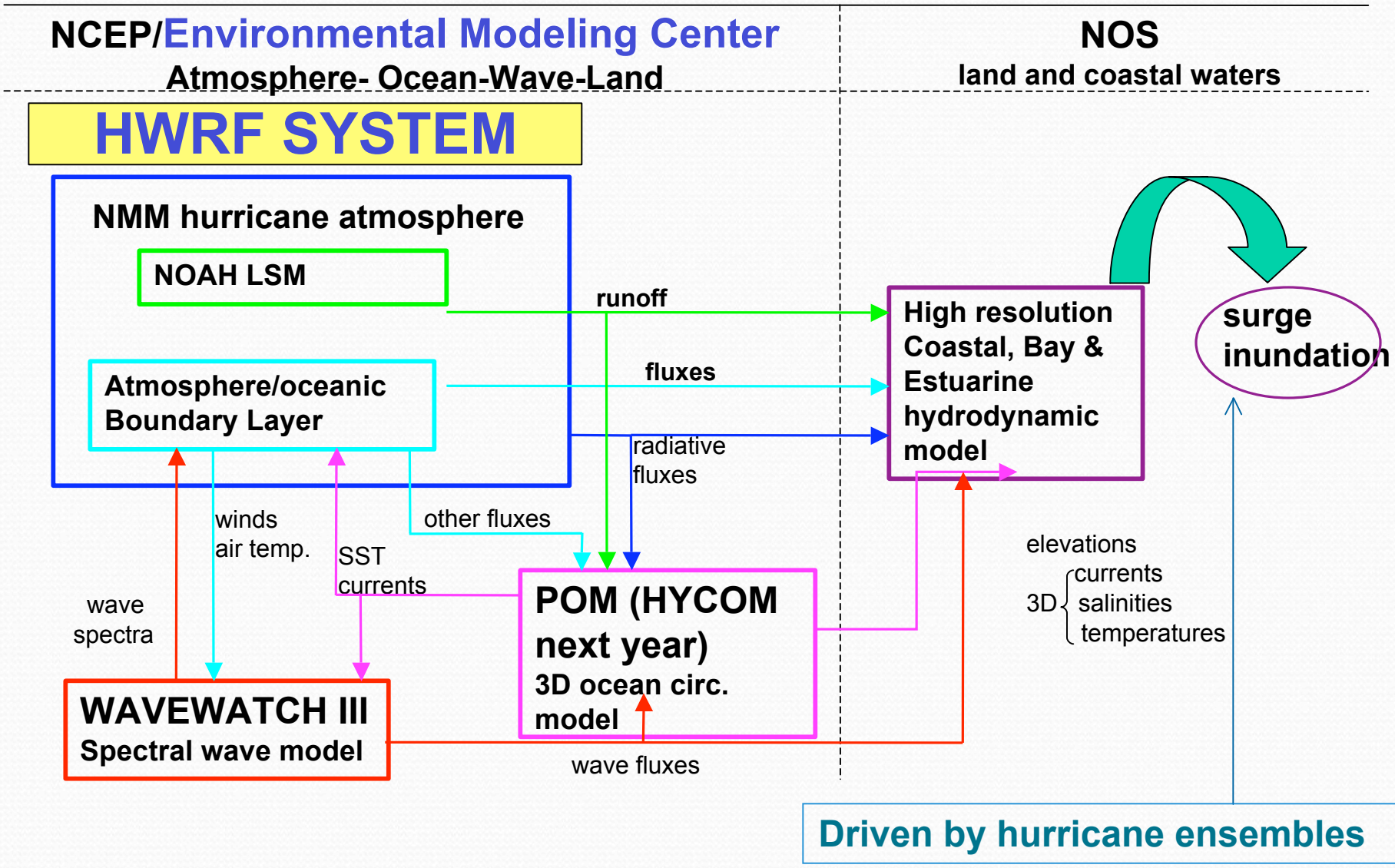
HWRF – will be advanced to address coastal inundation problem (waves, storm surge) ….e.g. coupled to HYCOM (complex 3-D ocean circ. + ocean data assimilation), coupled with WAVEWATCH + dynamic storm surge model

For inland flooding: eventual coupling with land sfc. Model for input to hydrology and inundation models

Also HWRF to run off of GSI – assimilate core observations

High-res ENSEMBLES (Multi-model – being run as demonstration project this hurricane season through HFIP)

Hurricane-Wave-Ocean-Surge-Inundation Coupled Models



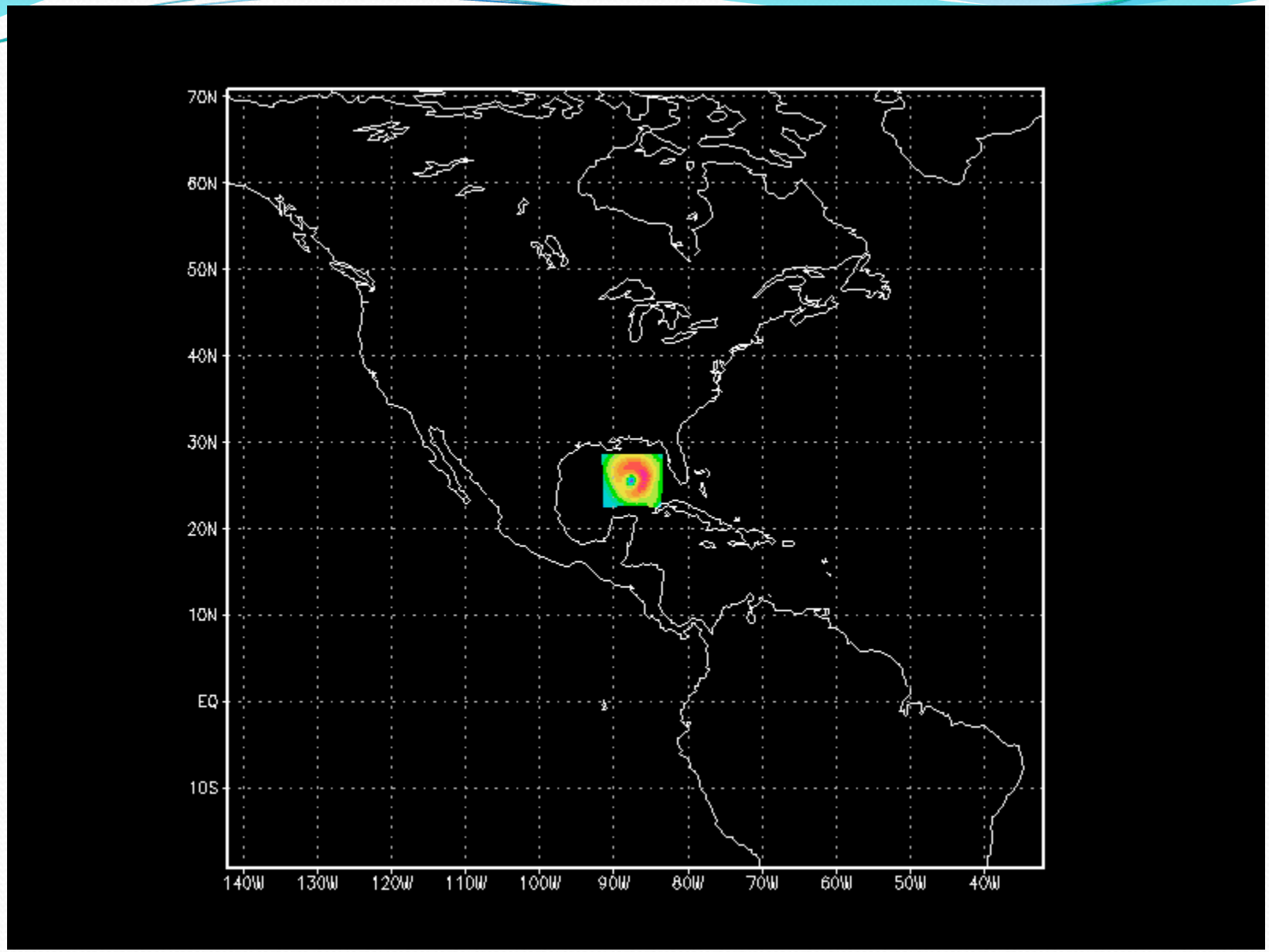
HWRF at the DTC - facilitate interaction between research and operations

Creates code-management framework for collaboration

Support acceleration of transition of research to operations

DTC vision: upgrades to HWRF proposed by researchers, e.g. through the JHT, will be first committed to the WRF repository and later extensively tested for a potential operational implementation

Additional slides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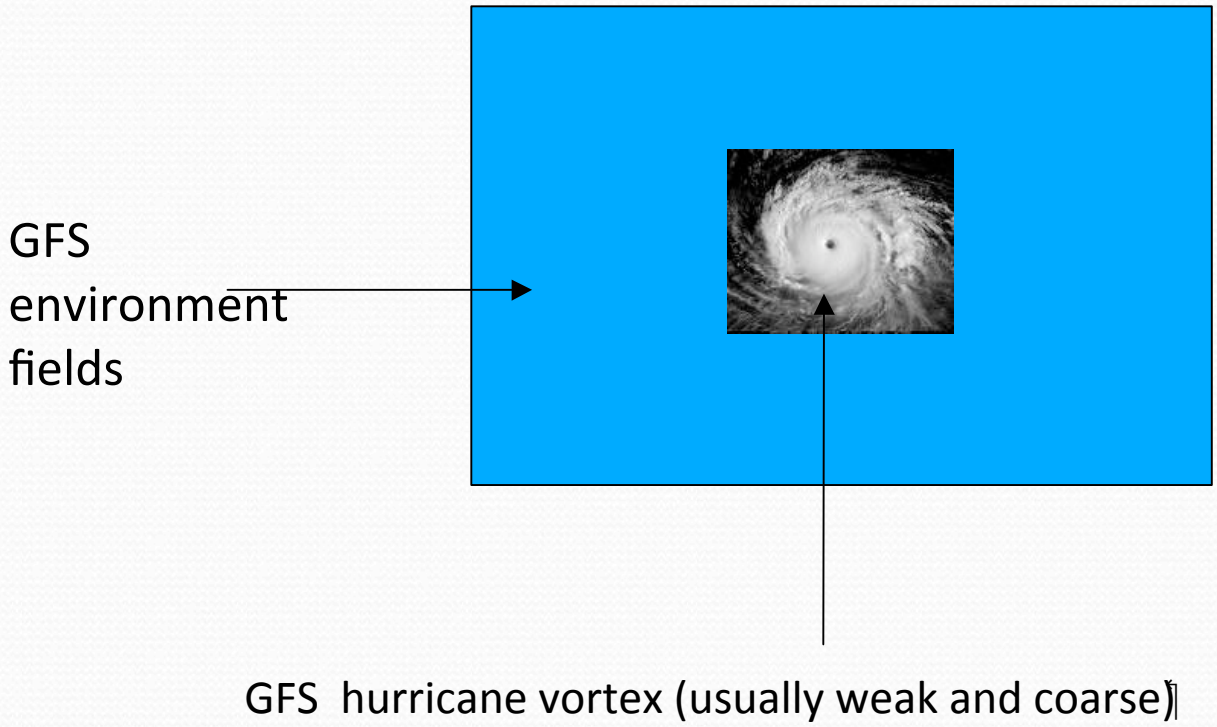
HWRF Physics Schemes

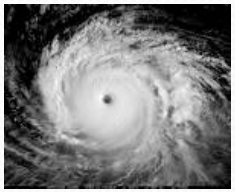
- Surface layer: Monin-Obukhov scheme is used for surface flux calculations with an improved air-sea momentum flux parameterization in strong wind conditions
- One layer slab land surface scheme
- Simplified Arakawa-Schubert scheme for cumulus parameterization
- Ferrier microphysics
- PBL: Troen and Mahrt first order vertical diffusion scheme

HWRF Vortex Initialization



HWRF Vortex Initialization (I)

Environment Component



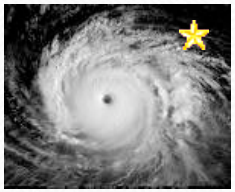
Hurricane vortex
(Needs Correction)

Replace the weak coarse vortex with

- a bogus vortex (for cold start runs) , OR
- the previous cycle model output vortex (for cycle runs)

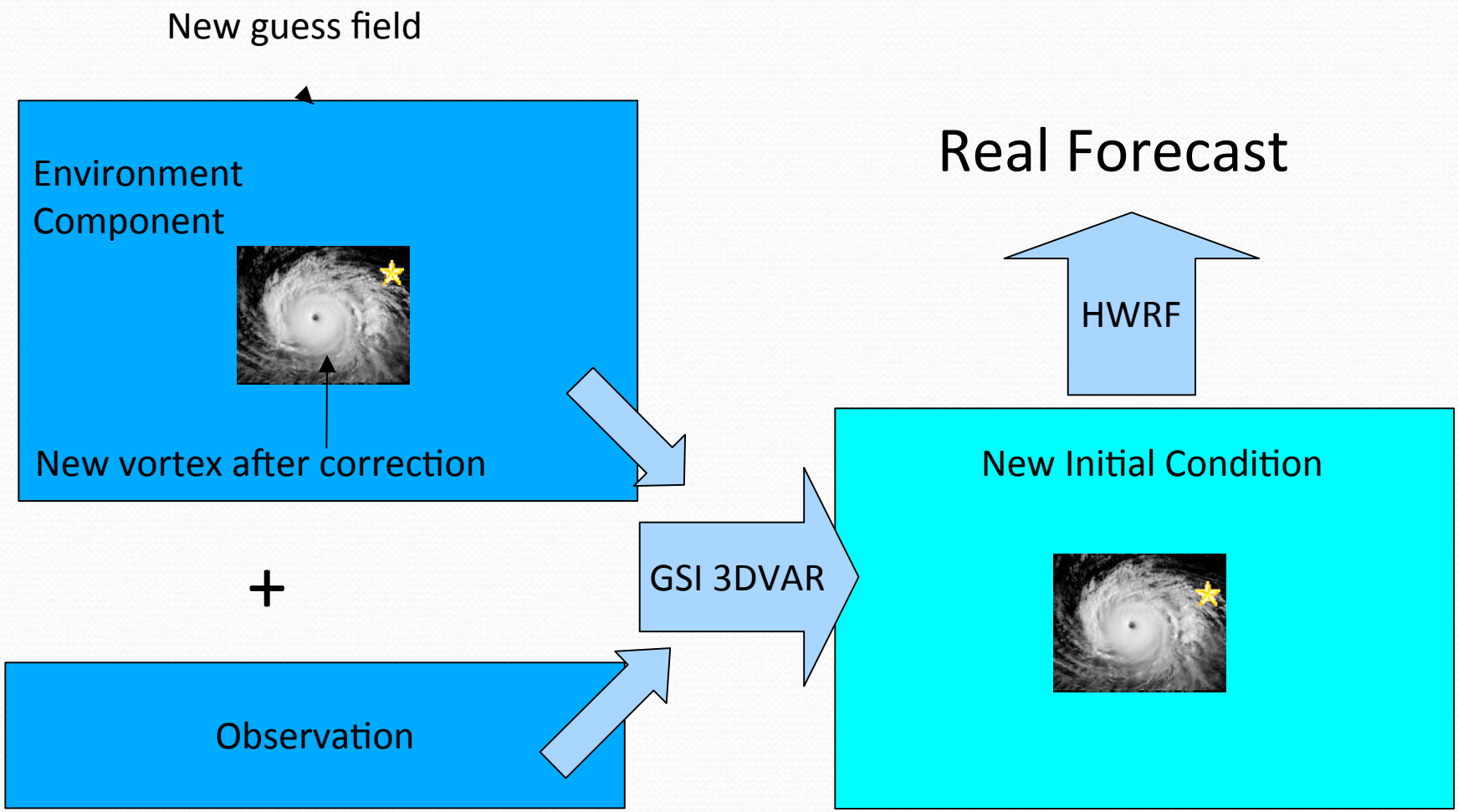
Use the observed vortex info (vortex size, intensity etc.)

to correct the bogus vortex or the previous cycle vortex

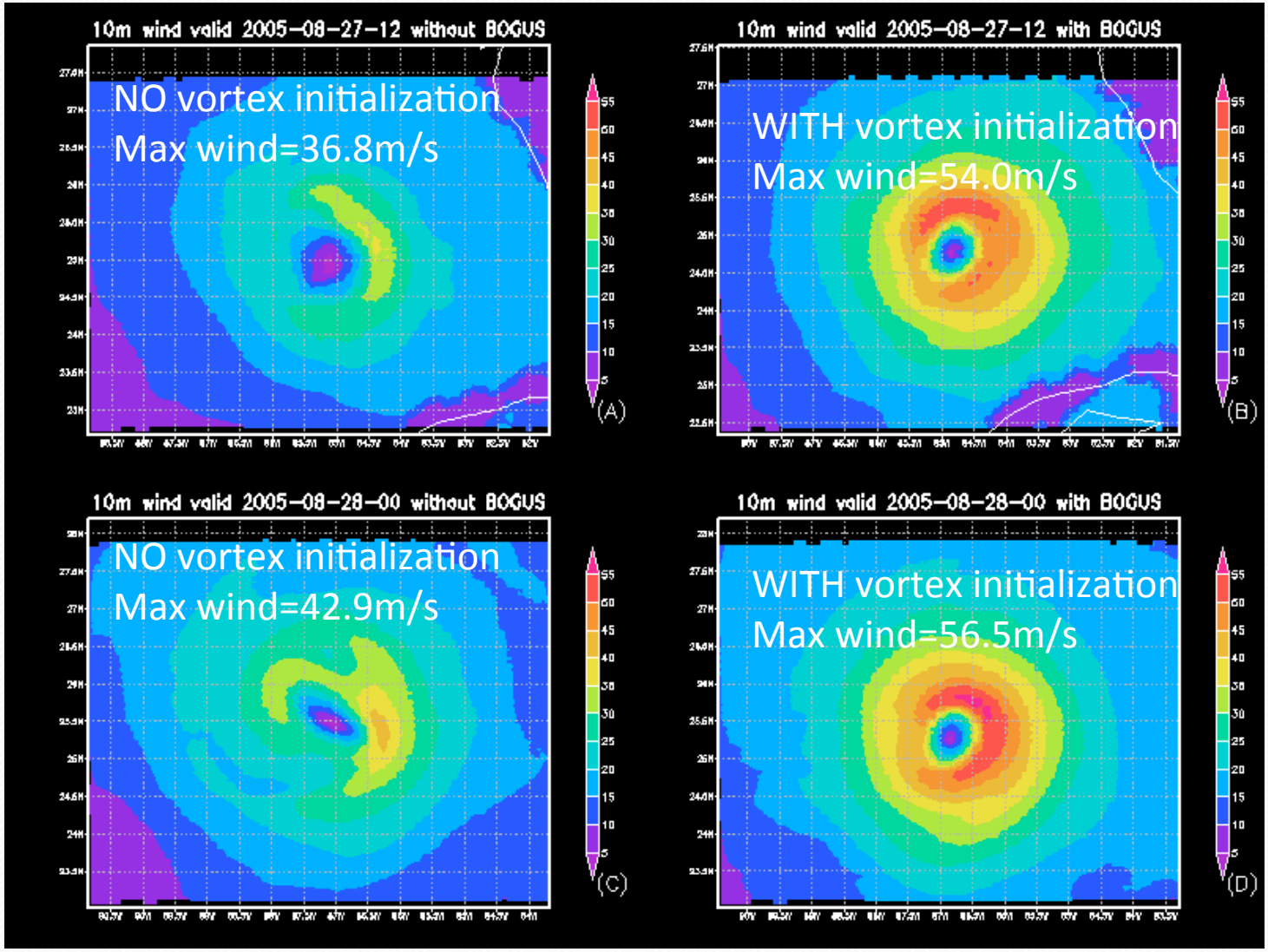


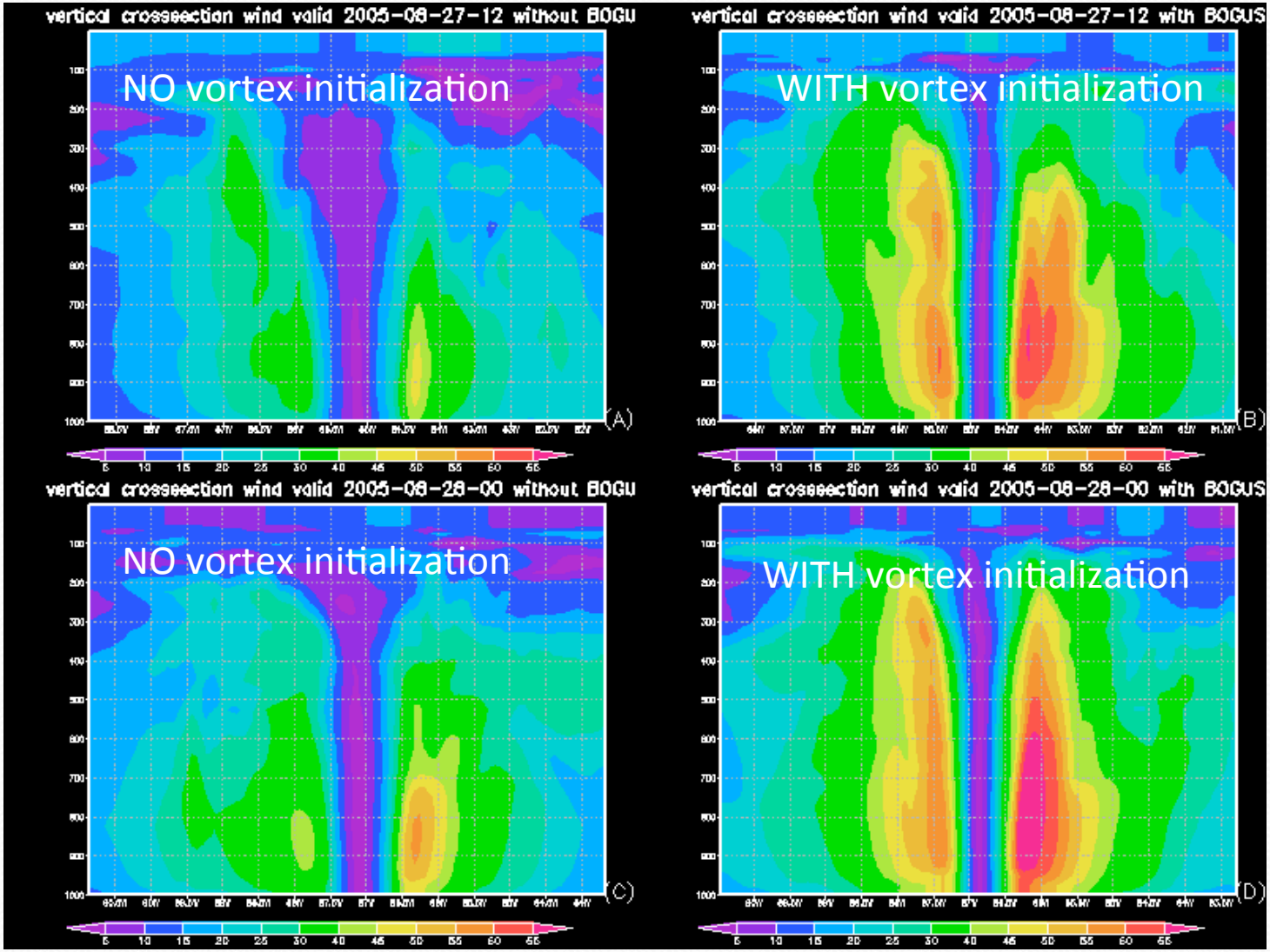
New hurricane vortex
(After Correction)

HWRF Vortex Initialization (2)



Comparison of 12-hr and 24-hr 10m winds results with and without HWRF bogus vortex initialization schemes.



NOTE: The BEST-TRACK Maximum wind for 08-27-12 and 08-28-00 are both 100 kt (51.4m/s) (http://www.nhc.noaa.gov/pdf/TCR-AL122005_Katrina.pdf)

Comparison of 12-hr and 24-hr winds vertical cross-section with and without HWRF bogus vortex initialization schemes.