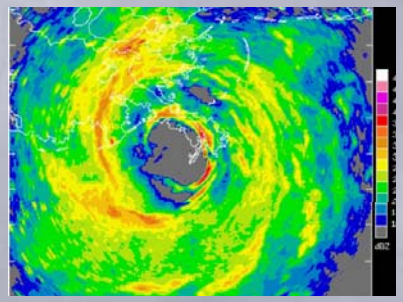
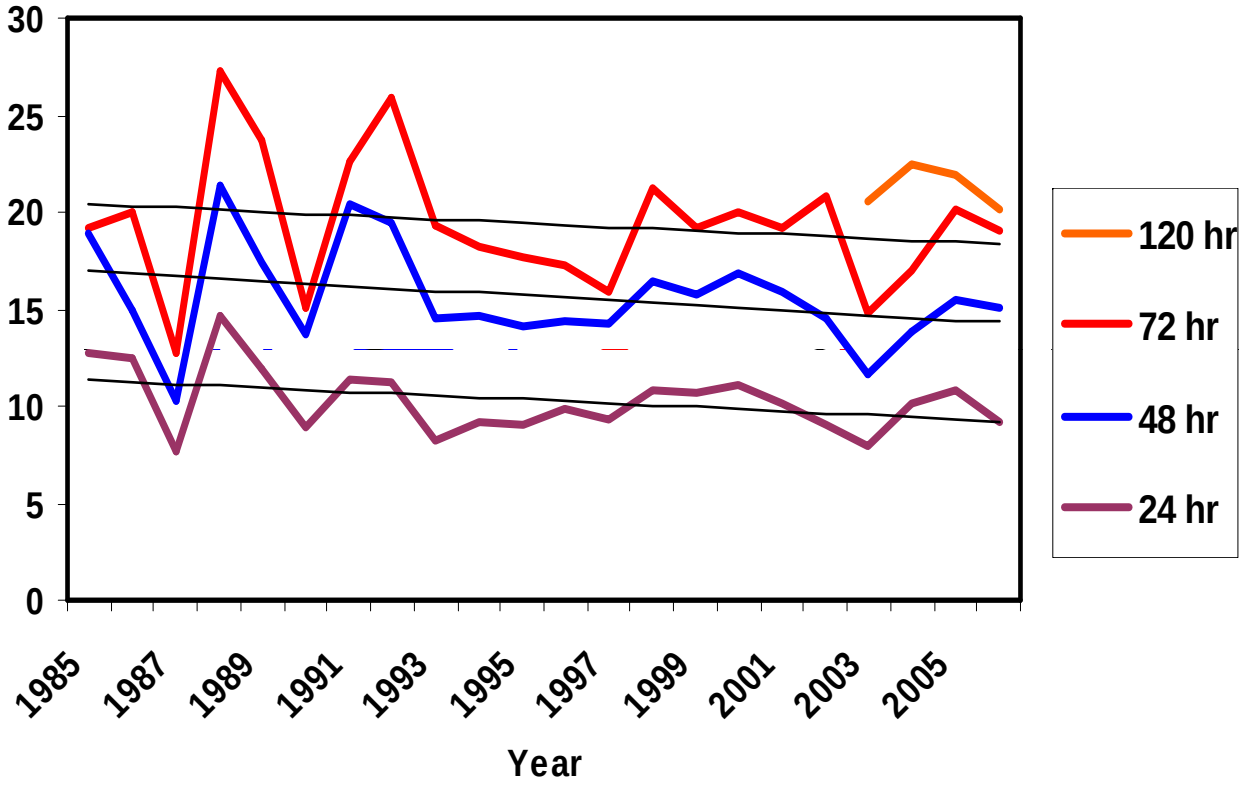
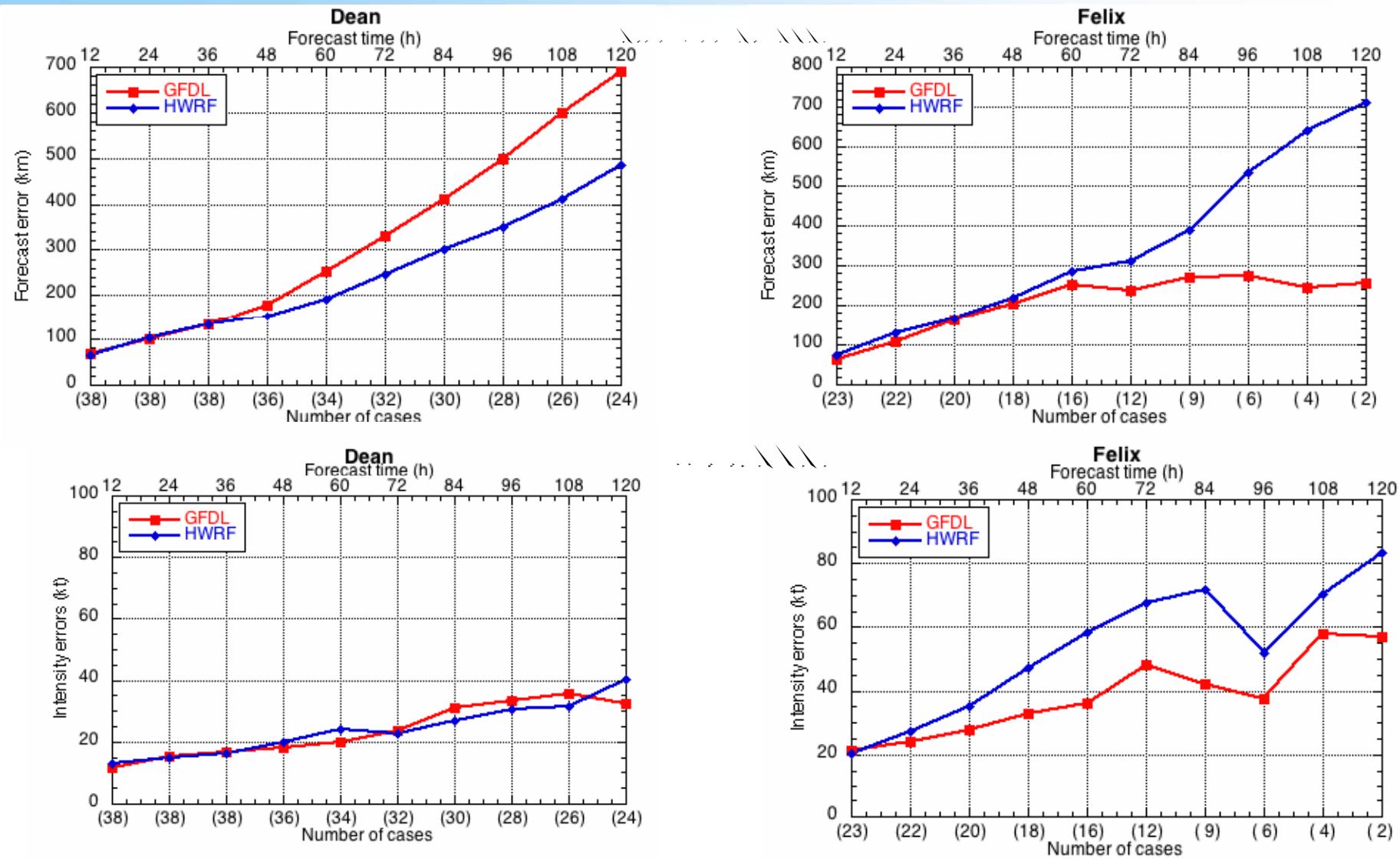


S.G.Gopalakrishnan
AOML Program Review
18-20 March 2008

Background

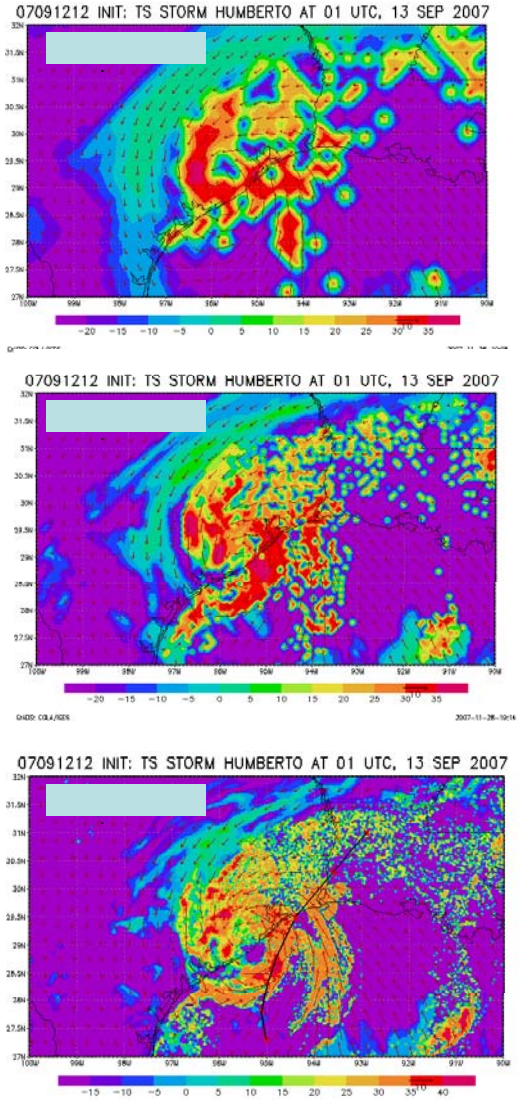

30
25
20
15
10
5
0
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
Year
120 hr
72 hr
48 hr
24 hr

Motivation


Dean
Forecast time (h)
12 24 36 48 60 72 84 96 108 120
GFDL
HWRF
Forecast error (km)
0 100 200 300 400 500 600 700
(38) (38) (38) (36) (34) (32) (30) (28) (26) (24)
Number of cases
Felix
Forecast time (h)
12 24 36 48 60 72 84 96 108 120
GFDL
HWRF
Forecast error (km)
0 100 200 300 400 500 600 700 800
(23) (22) (20) (18) (16) (12) (9) (6) (4) (2)
Number of cases
Dean
Forecast time (h)
12 24 36 48 60 72 84 96 108 120
GFDL
HWRF
Intensity errors (kt)
0 20 40 60 80 100
(38) (38) (38) (36) (34) (32) (30) (28) (26) (24)
Number of cases
Felix
Forecast time (h)
12 24 36 48 60 72 84 96 108 120
GFDL
HWRF
Intensity errors (kt)
0 20 40 60 80 100
(23) (22) (20) (18) (16) (12) (9) (6) (4) (2)
Number of cases

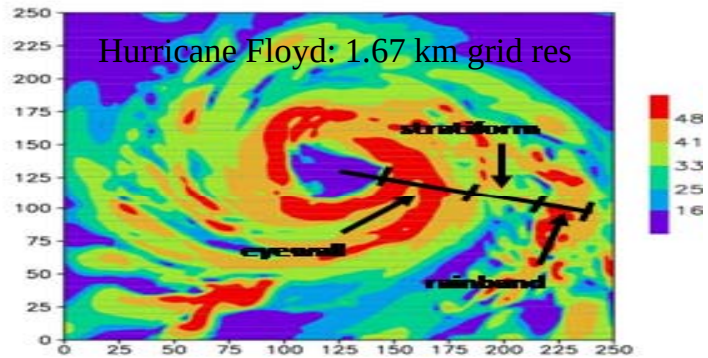
Requirements for improved prediction

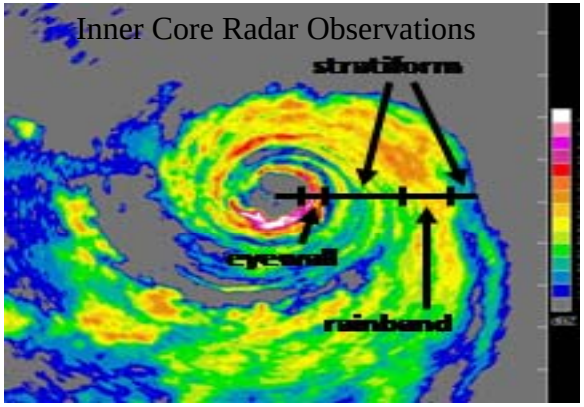
- ✓ Apart from larger-scale environment it is imperative to resolve inner core structure of the hurricanes at 1-3 km resolution.
- ✓ Though state-of-the art, non-hydrostatic models offer such a resolution, huge data gaps exist in initializing these models. Also, these voids reduces our ability to verify simulated structures!
- ✓ We need improved understanding of physical processes within the inner core.



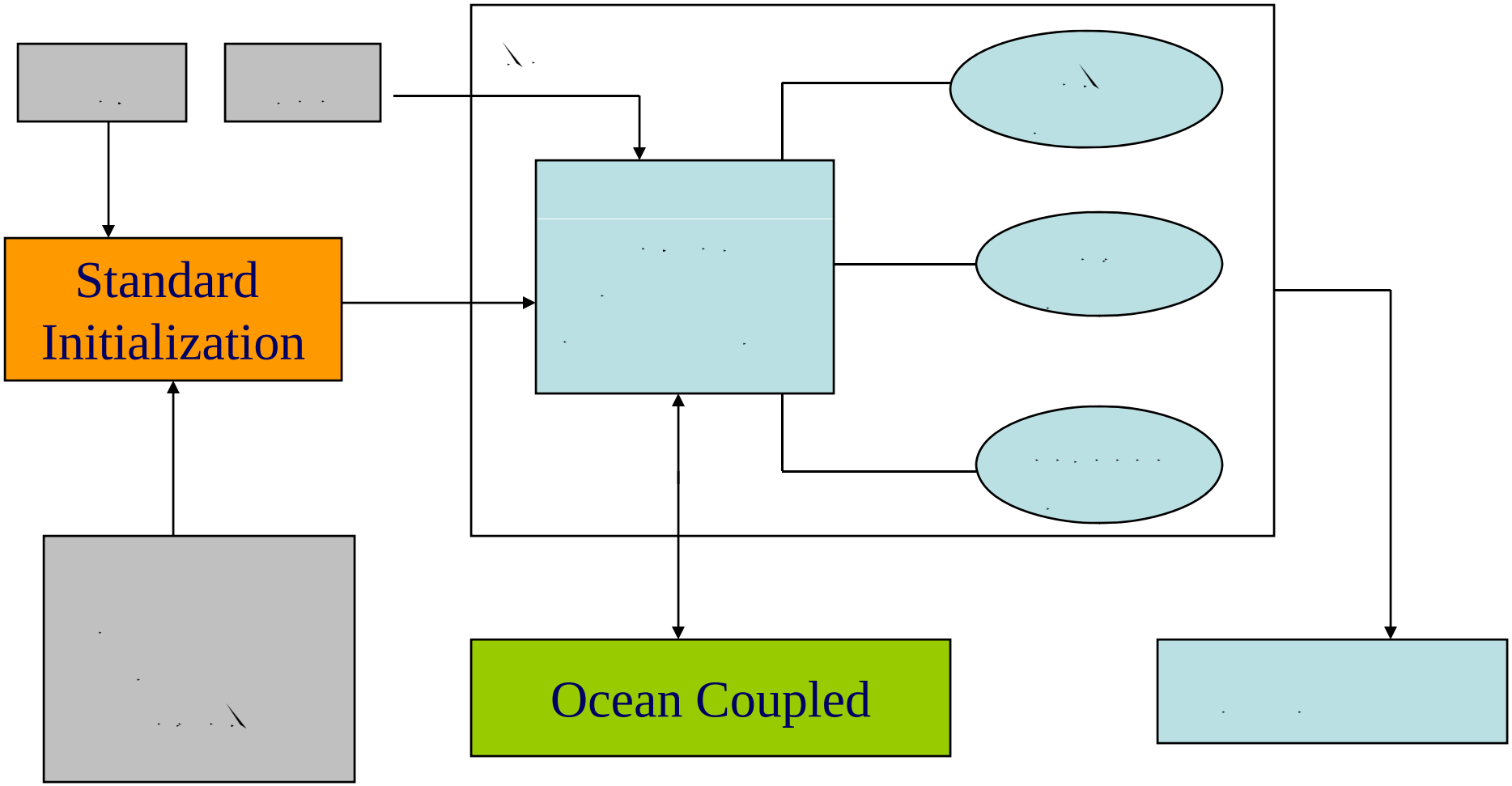
Justification

Given ability to procure unconventional observations down to vortex scales in hurricanes and expertise in understanding inner core structure of hurricanes, HRD has unique capability to advance and improve numerical models for tropical cyclone prediction.

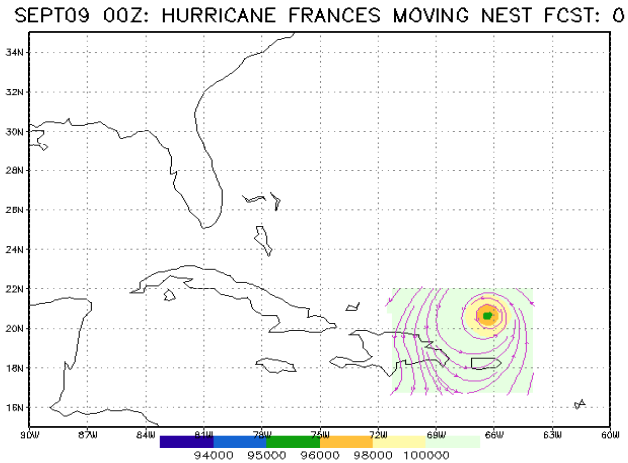


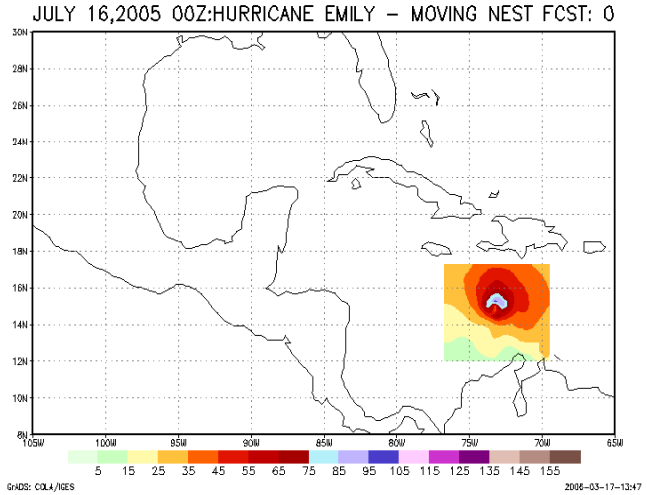


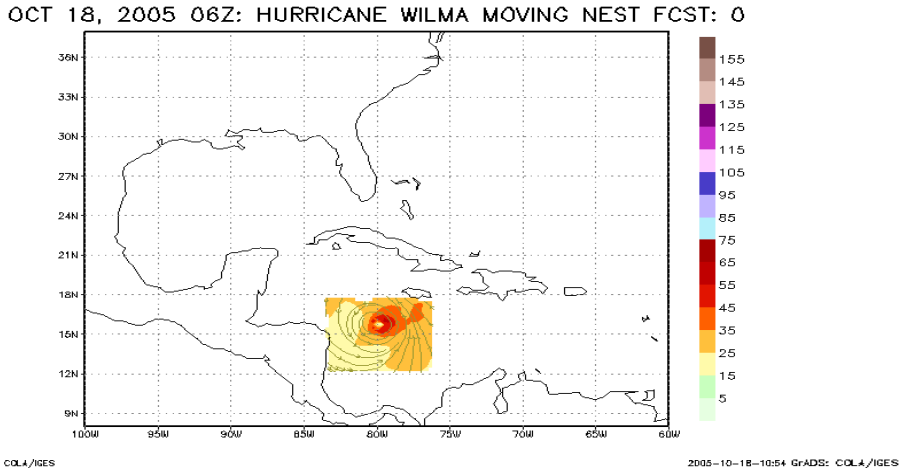
The Hurricane Forecasting System

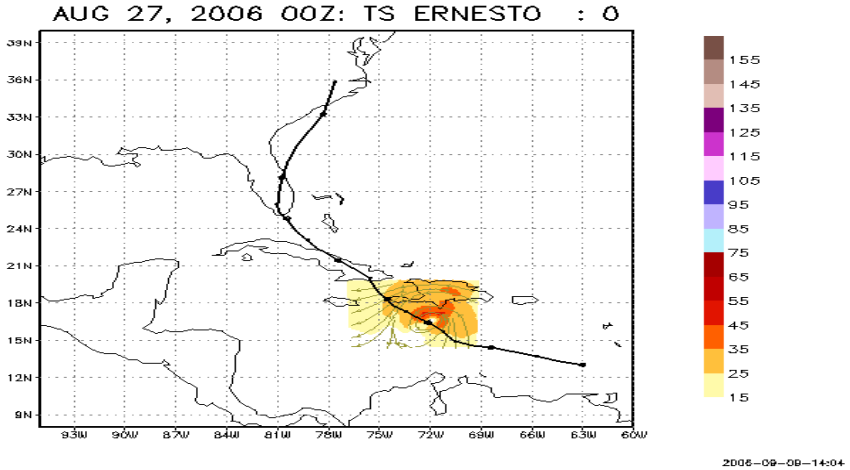


HFS: WRF-NMM/HWRF™ SYSTEM









Our Goals

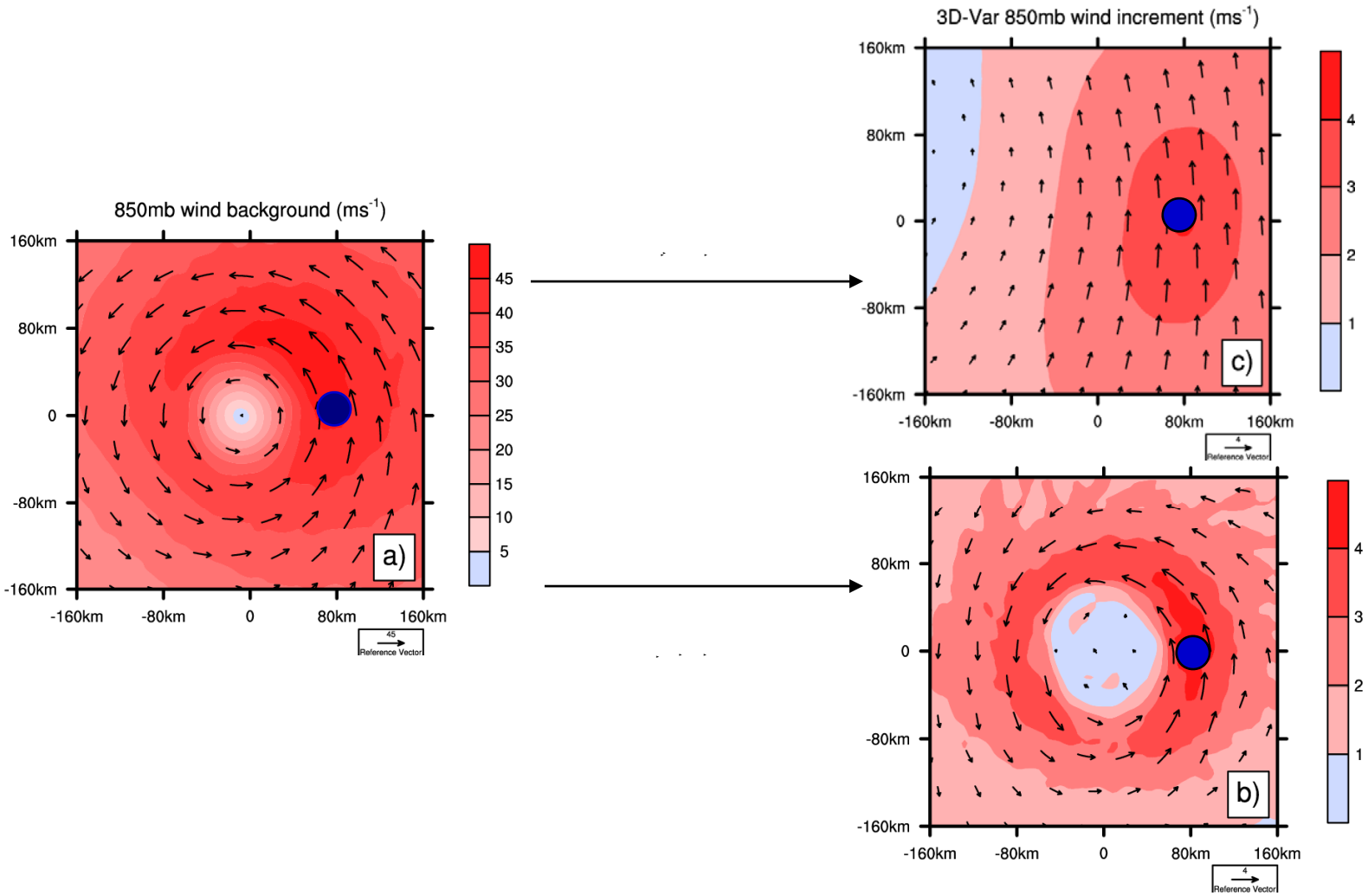
- Advancing the HFS with improved assimilation techniques for forecasts of tropical cyclones valid at 1-3 km grid length.

- Advancing HFS by evaluating and improving physical parameterization schemes appropriate for tropical cyclones.

- Determining the value of high-resolution deterministic and ensemble forecasts and exploring predictability issues.

- Advancing our understanding of tropical cyclone processes and tropical cyclone interactions with the larger-scale environment using high resolution numerical models down to about 1-3 km grid resolution.

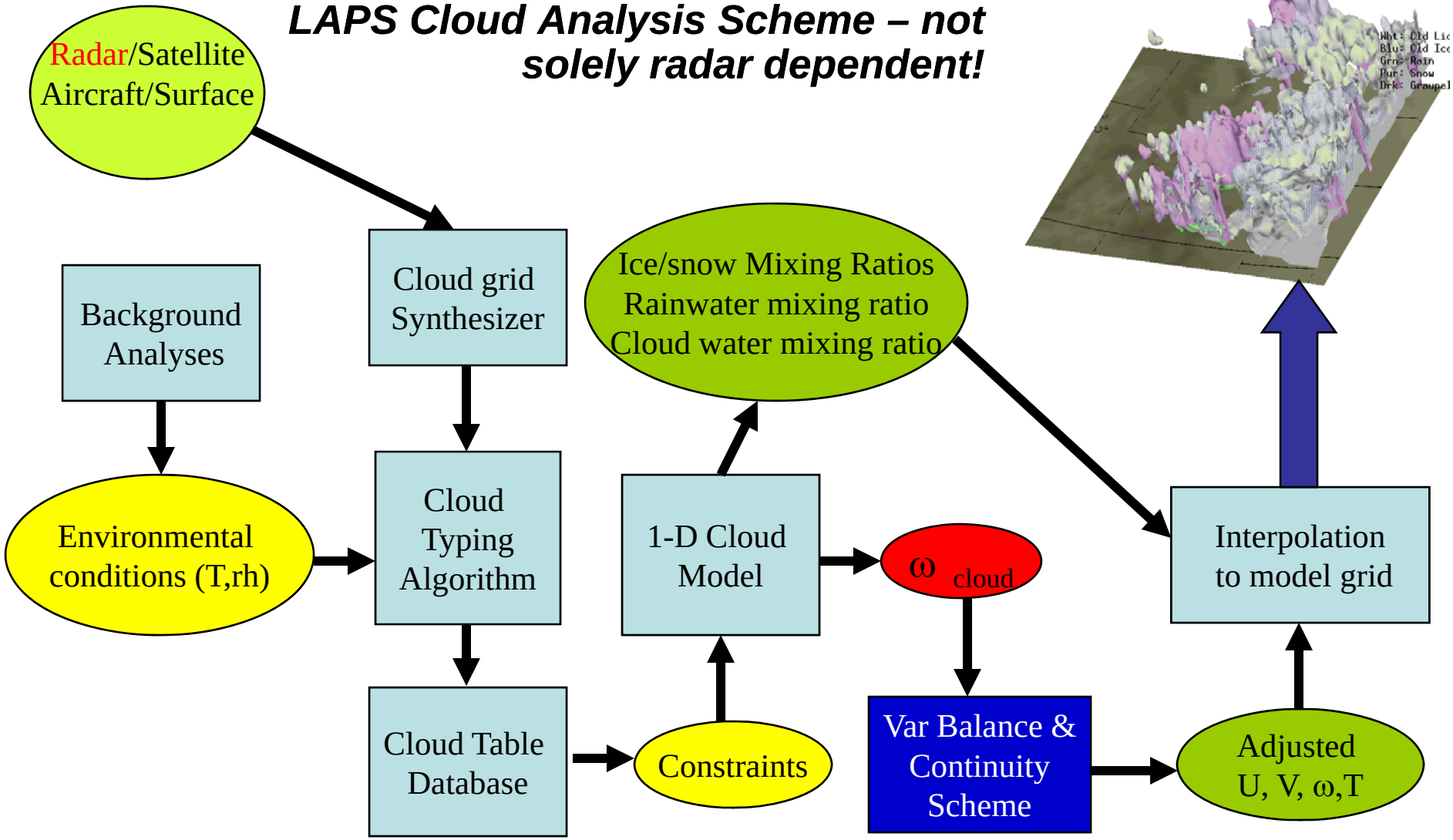
Improving Vortex Scale Data Assimilation: EnKF



Assimilation of one *V* ob: 5 m s^{-1} higher than first guess *V* (Xuguang Wang, NOAA/CIRES)

Improving Vortex Scale Data Assimilation: LAPS

LAPS Cloud Analysis Scheme – not solely radar dependent!



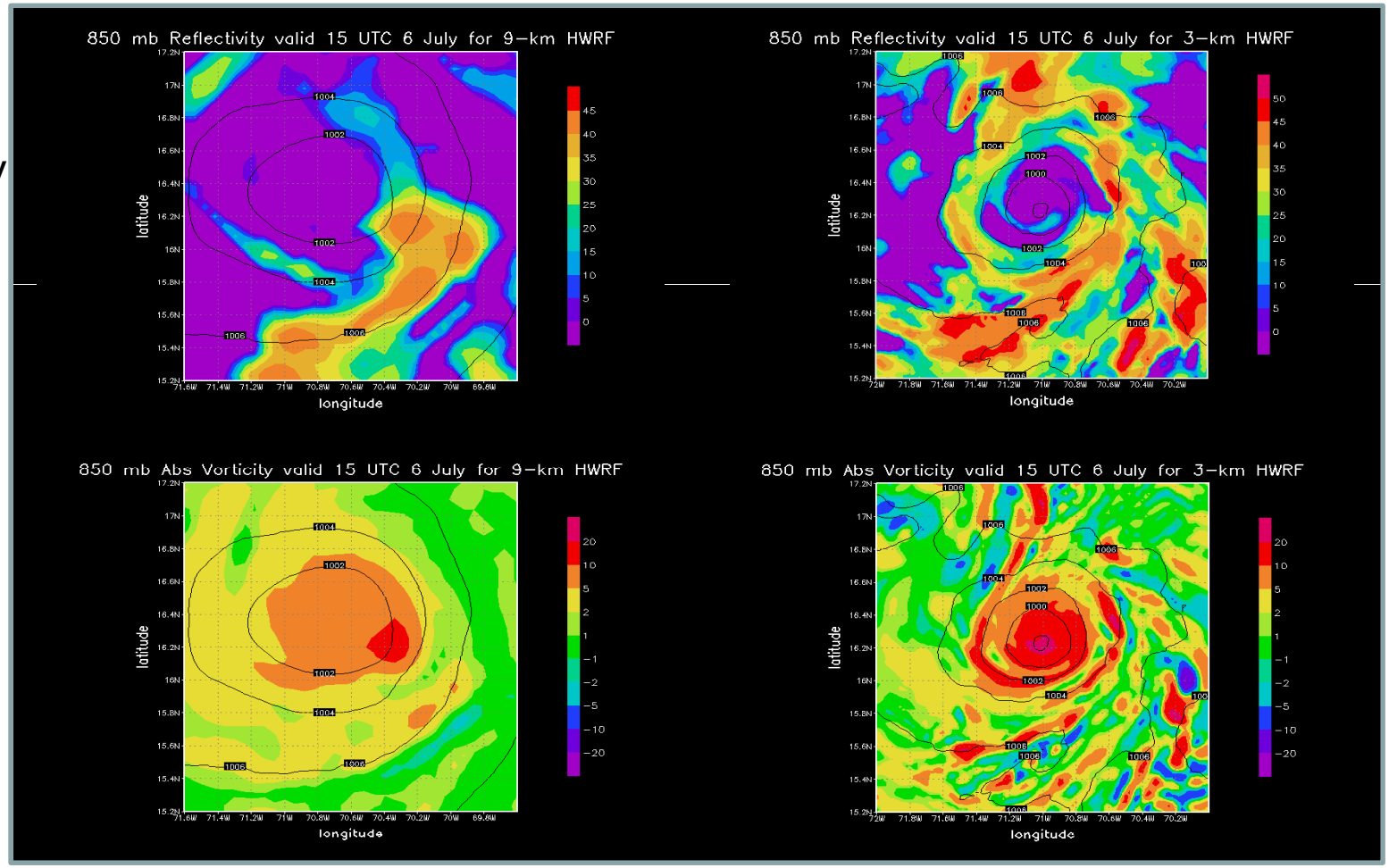
Value of Resolution: Example of Hurricane Dennis

27-9 km run

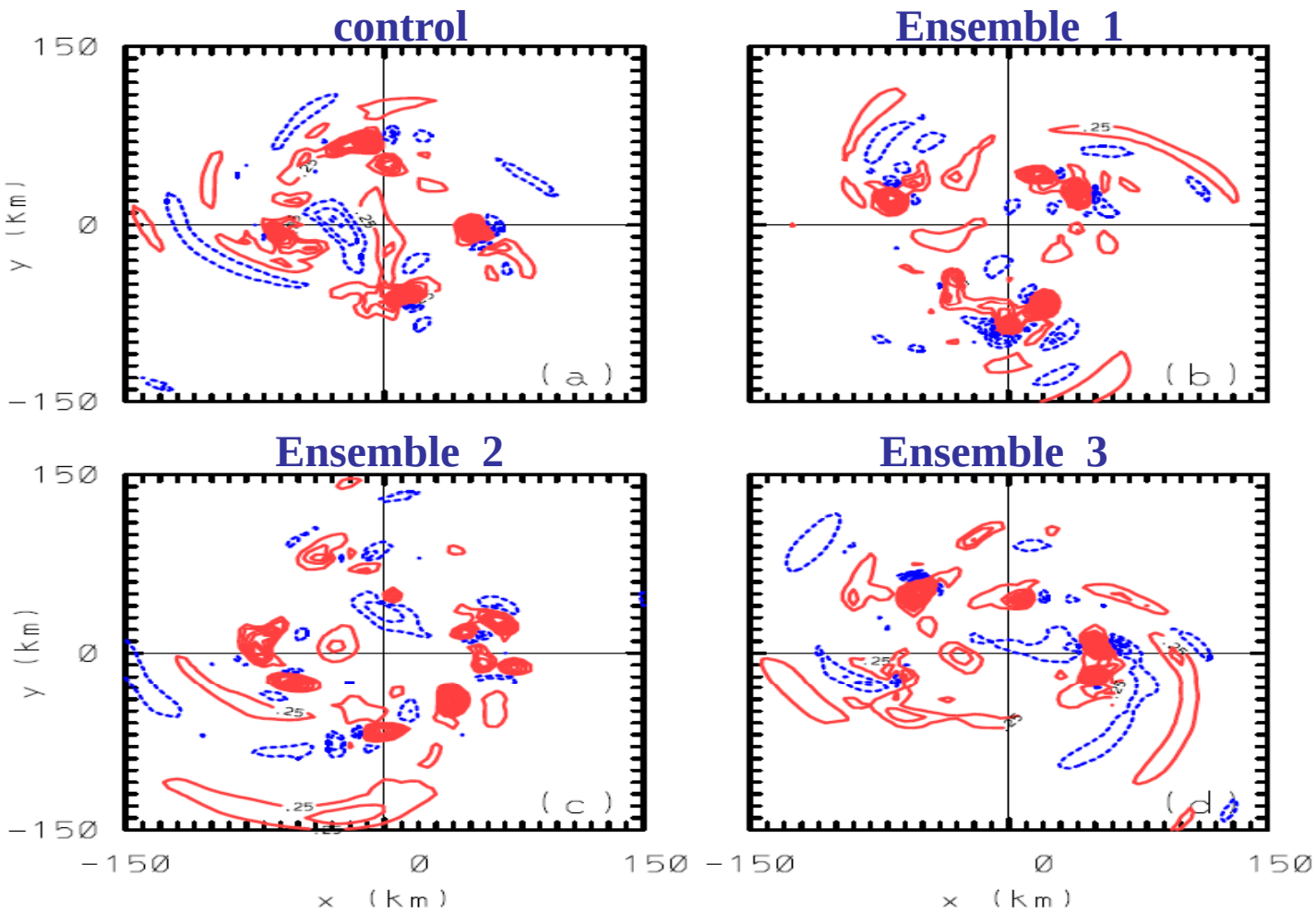
9-3 km run

Reflectivity and MSLP

vorticity



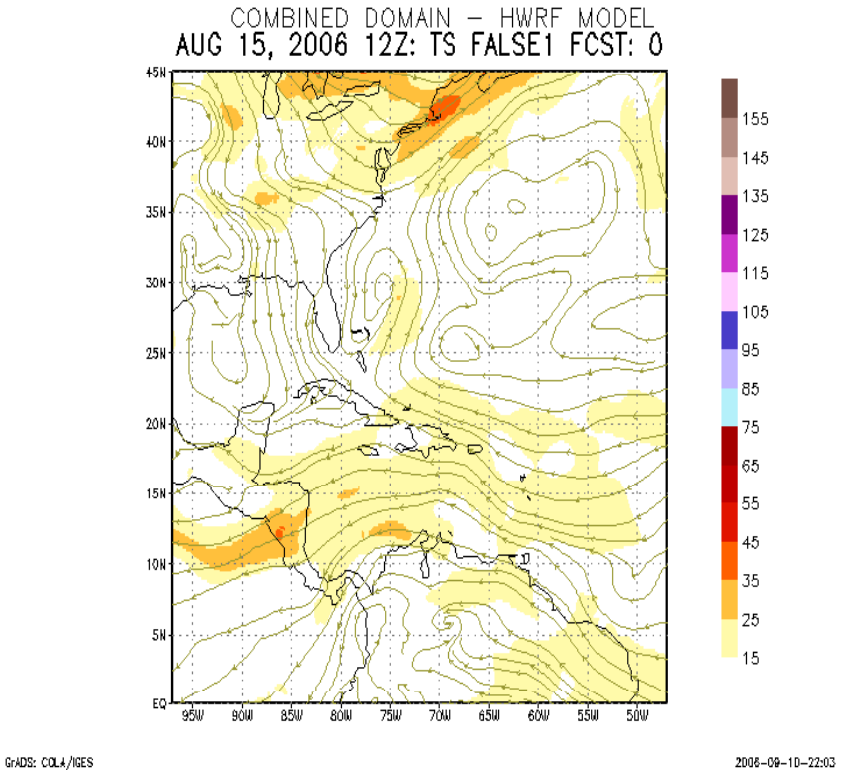
Exploring Issues Related Predictability of the Vortex Scale Motions

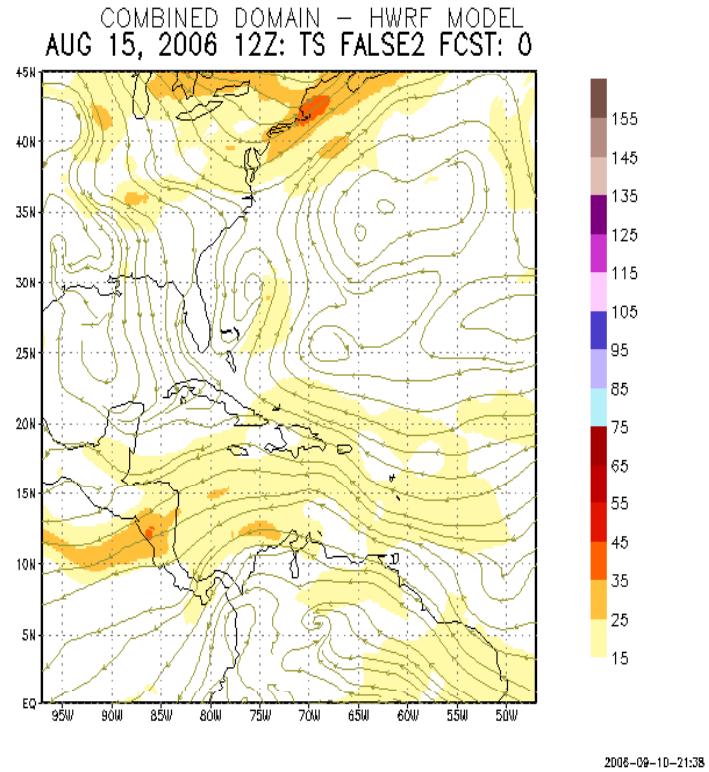


From Nguyen et al. 2008

Modeling Convection

- Will better resolutions alone improve track & intensity forecast?
- How predictable is the inner core structure in tropical cyclones ?
- What is the role of convection on track and intensity ?





Science Issues

- Saharan dust
- Vortex vs. large scale
- Inner core processes, e.g. eyewall replacement cycles, mixing
- Relationship between structure and intensity
- Physics, e.g. air-sea, microphysics, convection etc.
- Coupled models
- Boundary layer processes

Collaborations

NCAR: John Michalakes

NCEP: Robert Tuleya, Zavisa Janjic & Tom Black

DTC: Bob Gall & Steve Koch

India: U. C. Mohanty

* Part of the modeling system was done while the author worked at NOAA/NCEP/EMC.