Hurricane Model Transitions to Operations at NCEP/EMC

2006 IHC Conference, Mobile, AL

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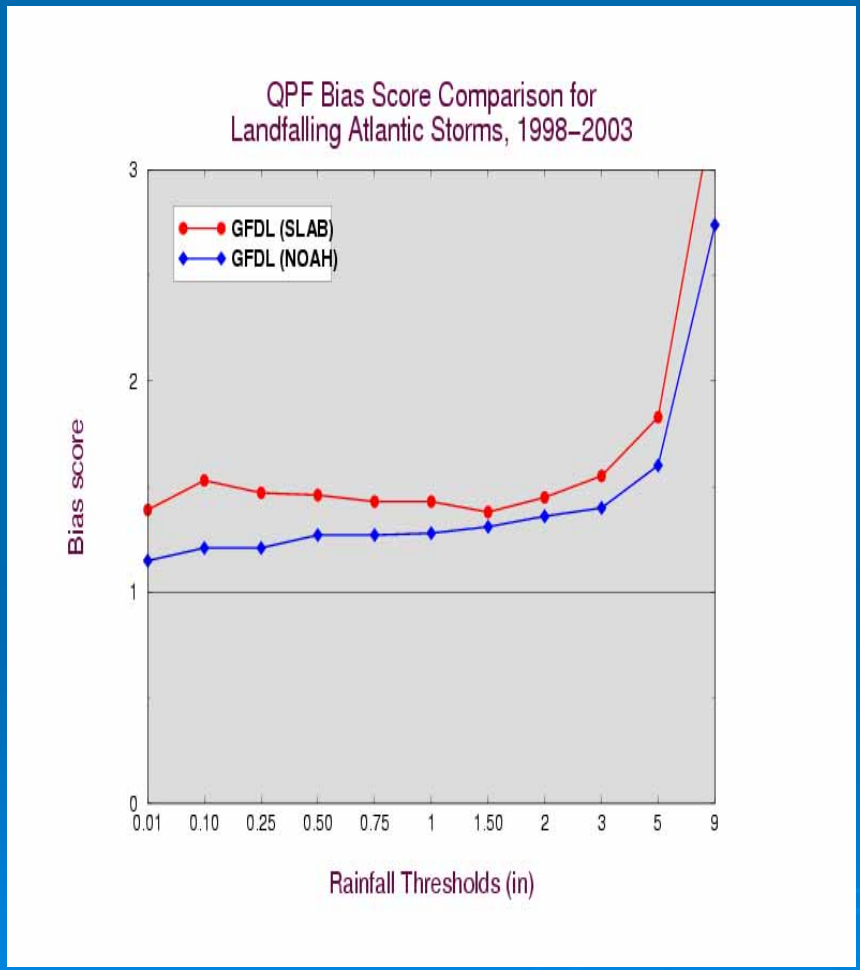
JHT sponsored

Project Goals and Emphasis

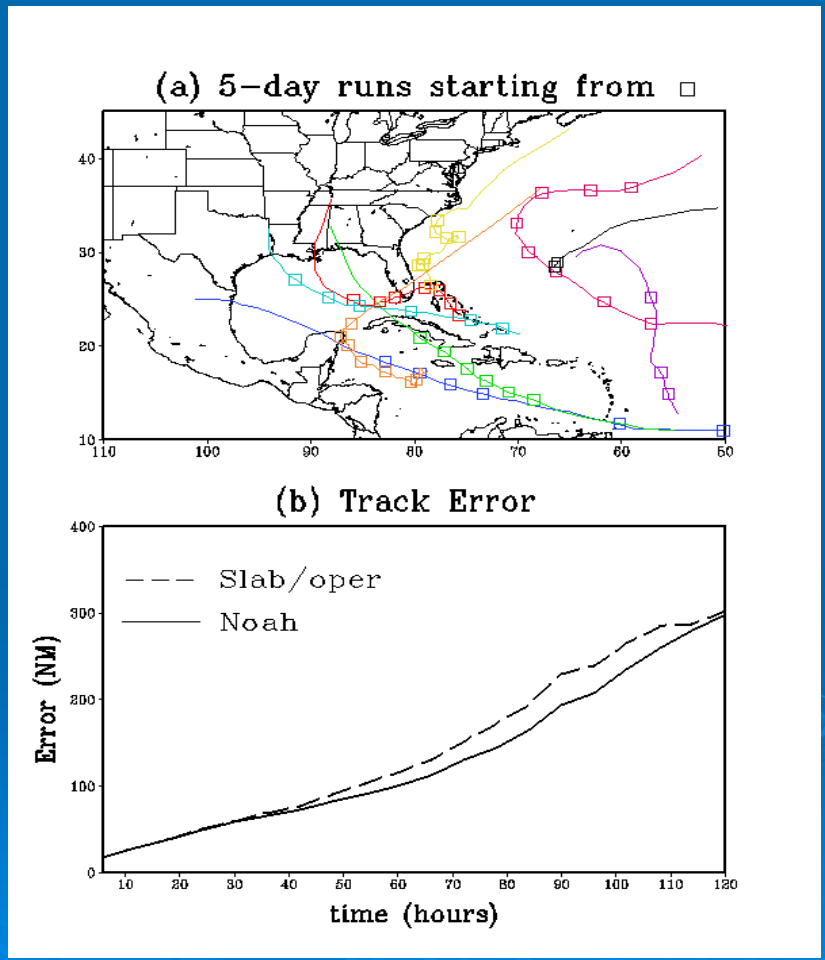
- EMC interested in upgrading the GFDL model through implementing improved physics packages… microphysics & LSM already in WRF
- Establish baseline of skill for WRF development …use of GFDL physics
- Begin transition of Hurricane model from GFDL to WRF
- *EMC, GFDL and URI collaborate and rely on one another for their respective areas of expertise*

Noah LSM in GFDL model

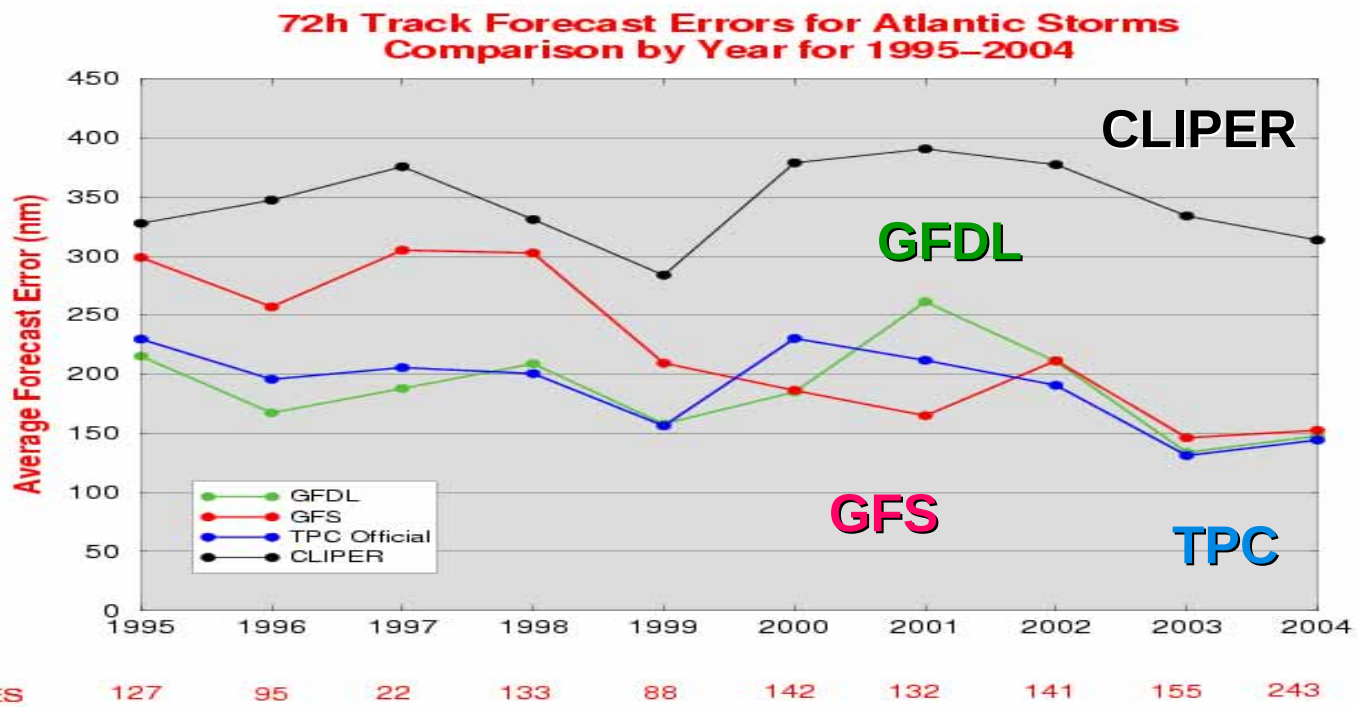
1998-2003 rainfall



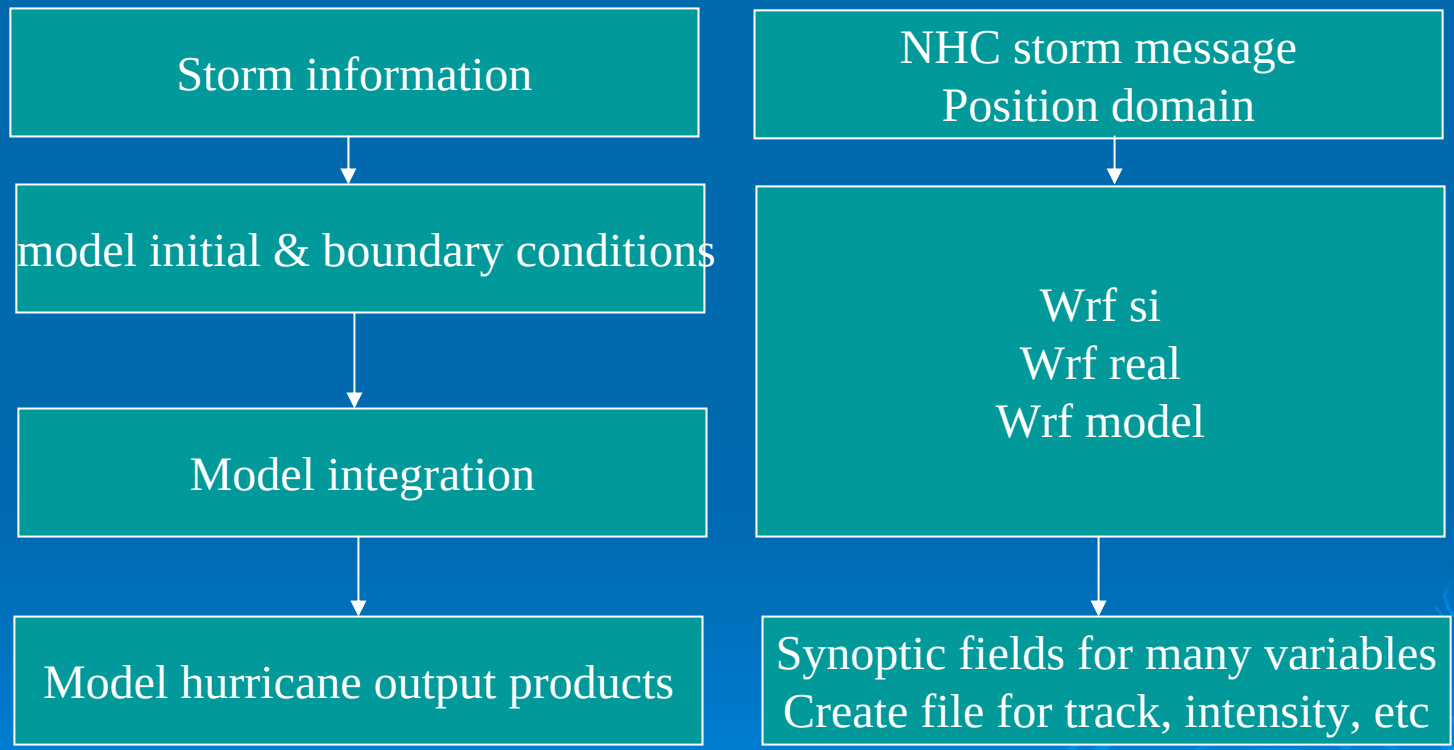
2005 season tracks



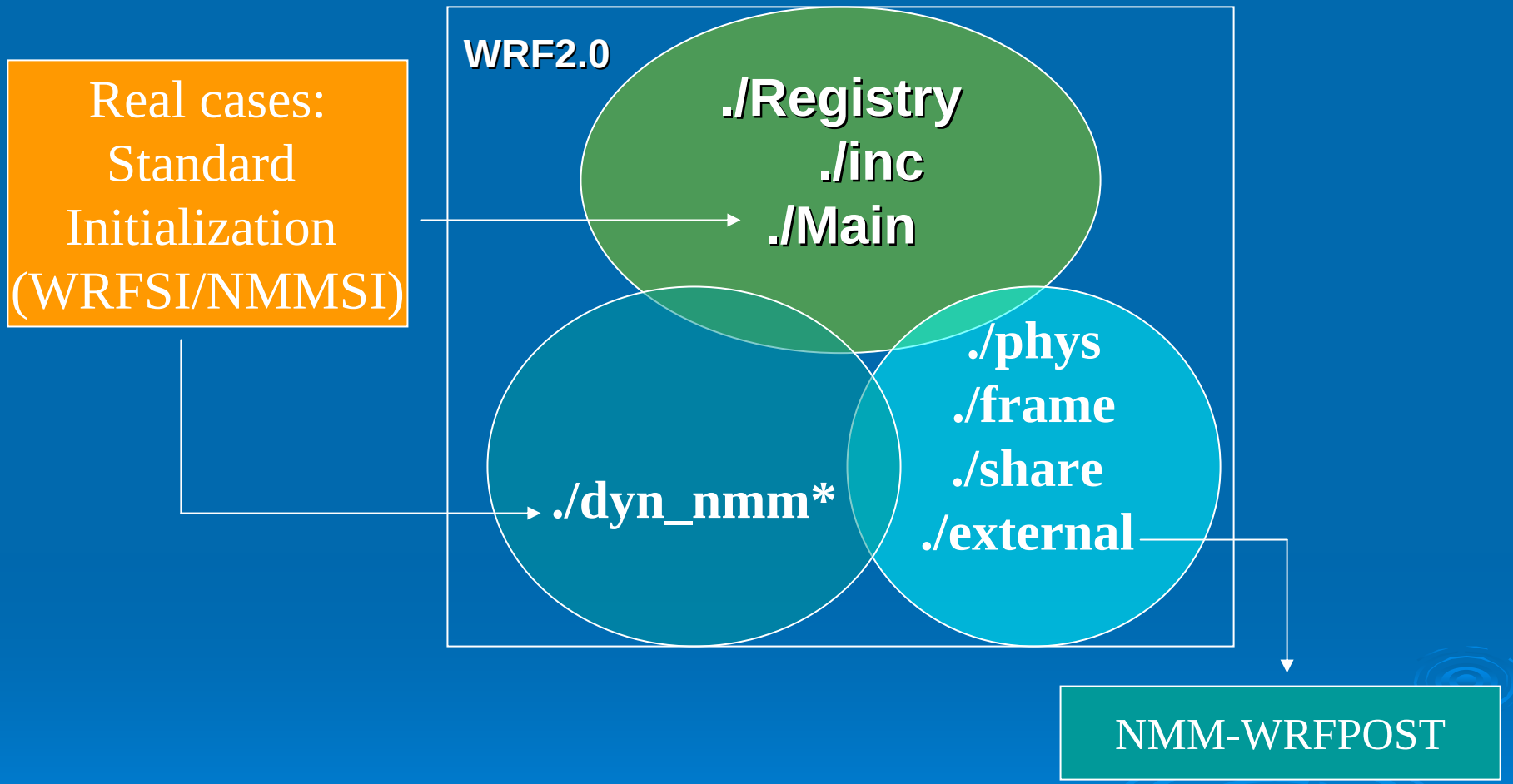
- ✓ **Dramatic improvement in tropical cyclone track forecasts have occurred through advancements in high quality observations, high speed computers and improvements in dynamical models. Similar advancement now need to be made for tropical cyclone intensity, structure and rainfall prediction. Can these advancements be made with advanced non-hydrostatic models while achieving track and intensity skill comparable to GFDL??**



Hurricane Forecast System



NMM- HWRF: The Hurricane Model



***This WRF core has to be linked to a complete hurricane forecast system**

The GFDL Modeli

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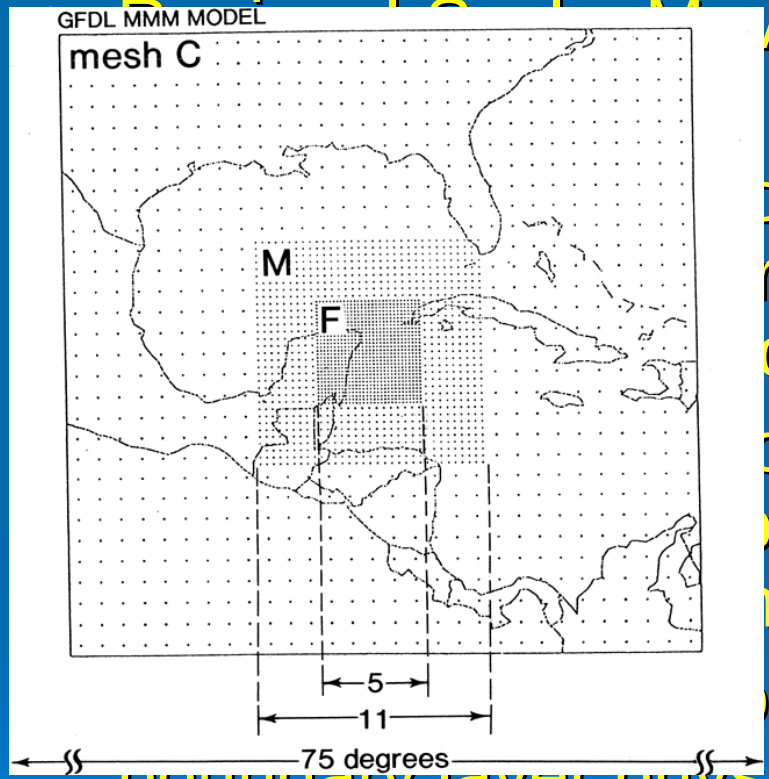
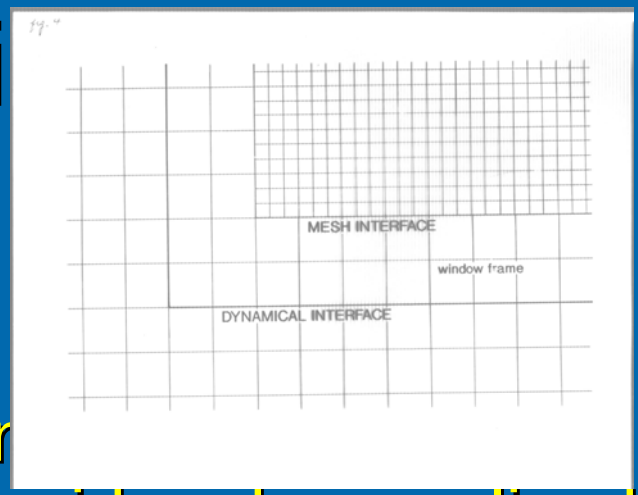
- Ocean coupled modeling syst





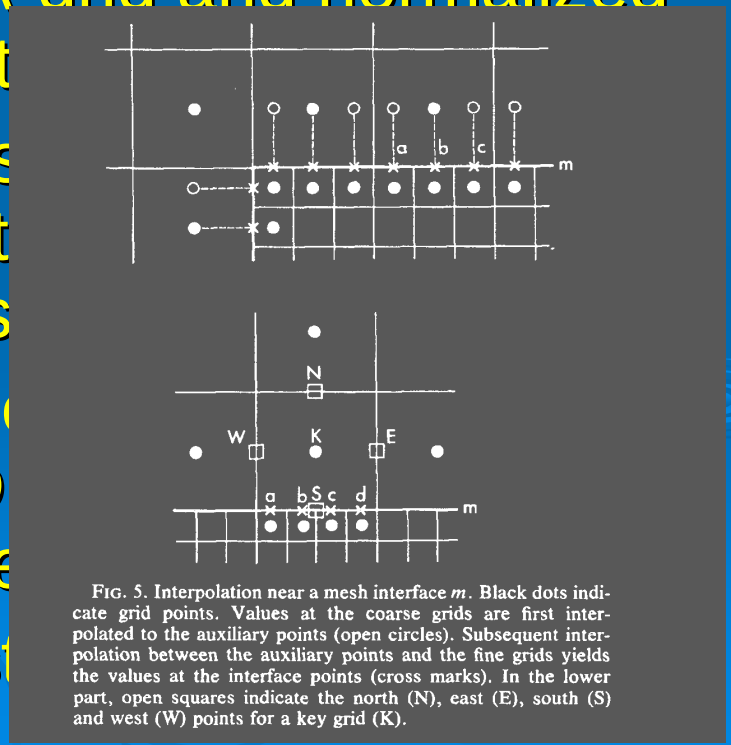
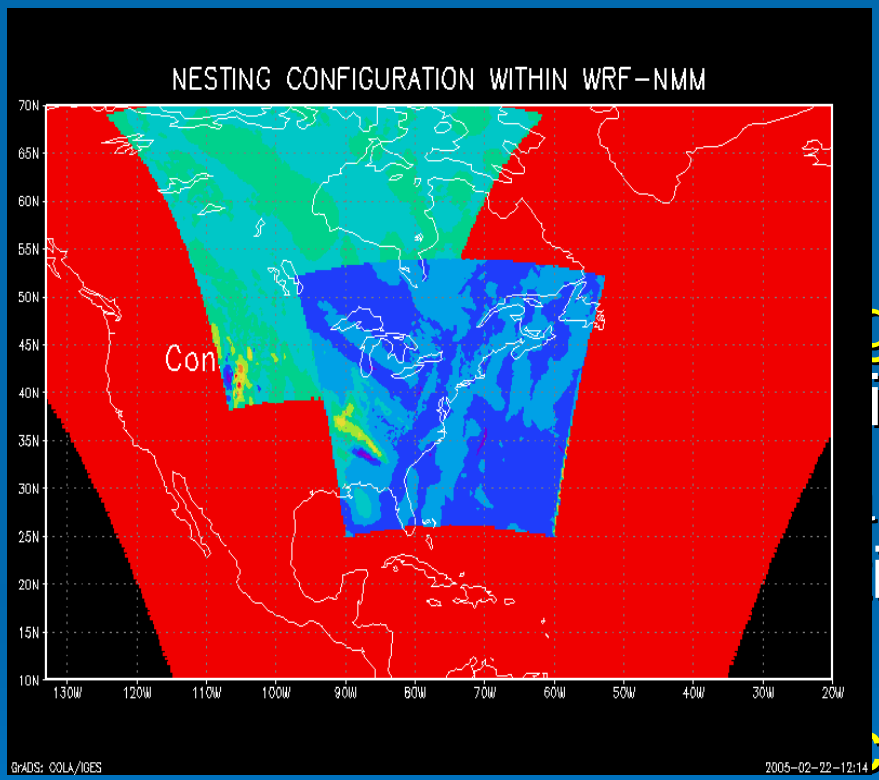
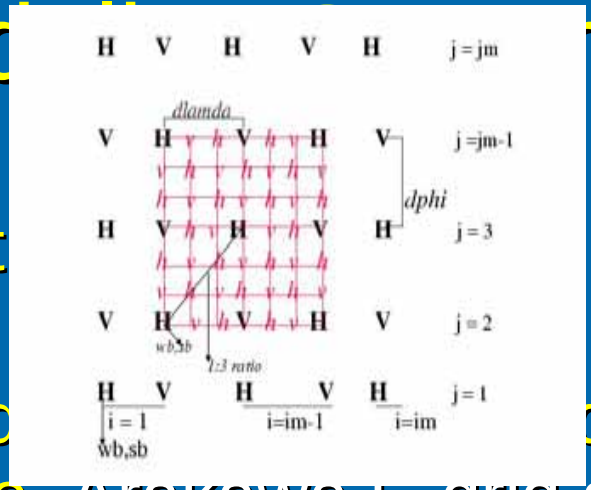


FIG. 5. Interpolation near a mesh interface *m*. Black dots indicate grid points. Values at the coarse grids are first interpolated to the auxiliary points (open circles). Subsequent interpolation between the auxiliary points and the fine grids yields the values at the interface points (cross marks). In the lower part, open squares indicate the north (N), east (E), south (S) and west (W) points for a key grid (K).

The NMM-WRF Mod m





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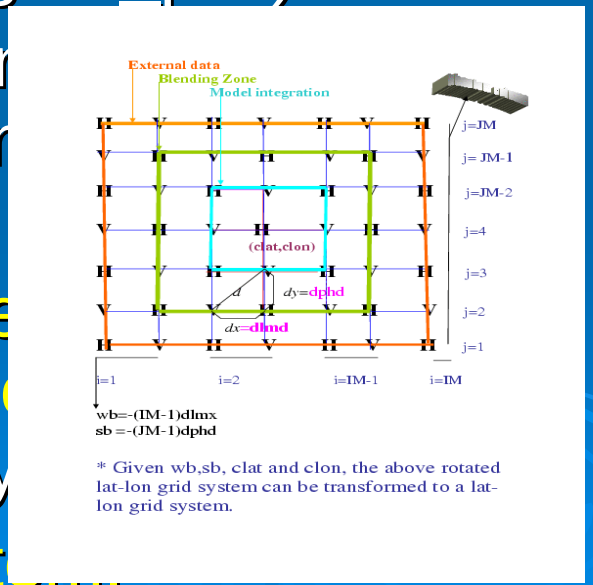


- Ocean coupled modeling syst

Some Numerical Details

Time stepping method

fast waves: forward-backward

vertically propagating sound waves: implicit

Advection:

horizontal: Adams-Bashforth for U,V and T (and Coriolis)

vertical: Crank-Nicholson for U,V and T

forward, flux-corrected for q and water species

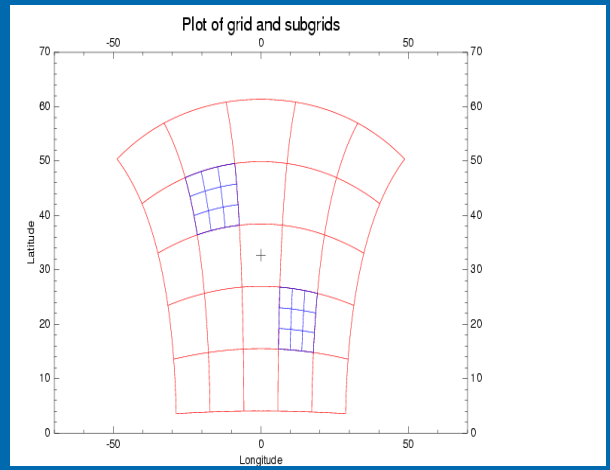
Horizontal diffusion

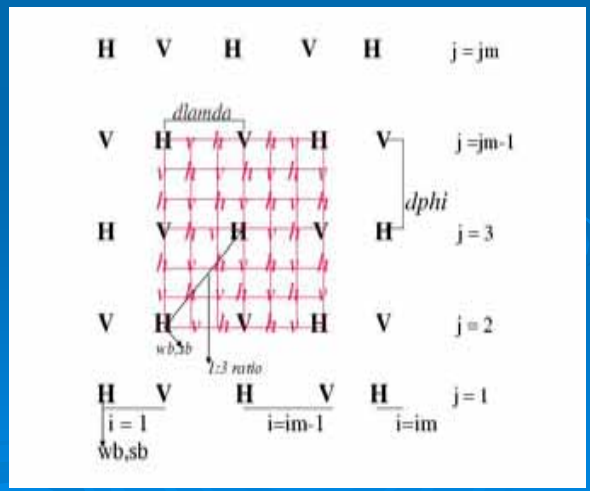
forward, 2nd order “Smagorinsky-type”

http://www.mmm.ucar.edu/mm5/workshop/ws04/Session7/Janjic.Zavisa.pdf

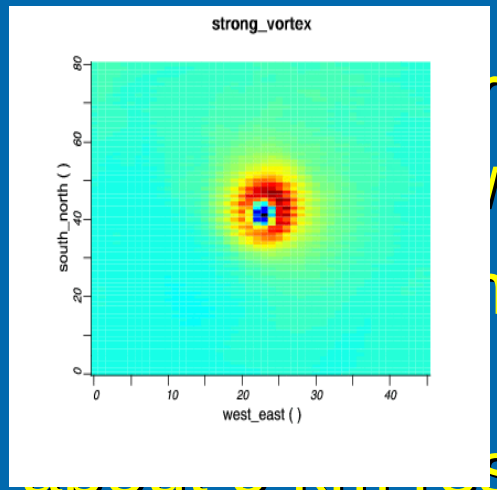
Salient Features: Telescopic E-Grid

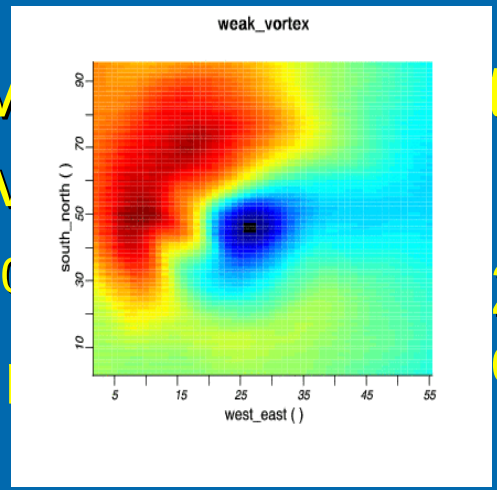
- All interpolations are done on a rotated lat-lon, E-grid with the reference lat-lon located at the centre of the parent domain.
- Consequently the nested domain can be freely moved anywhere within the grid points of the parent domain, yet the nested domain lat-lon lines will coincide with the lat-lon lines of the parent domain at integral parent-to-nest ratio.
- This coincidence of grid points between the parent and nested domain eliminates the need for more complex, generalized remapping calculations in the WRF Advanced Software Framework and is expected to aid better distributed memory performance, and portability of the modeling system.





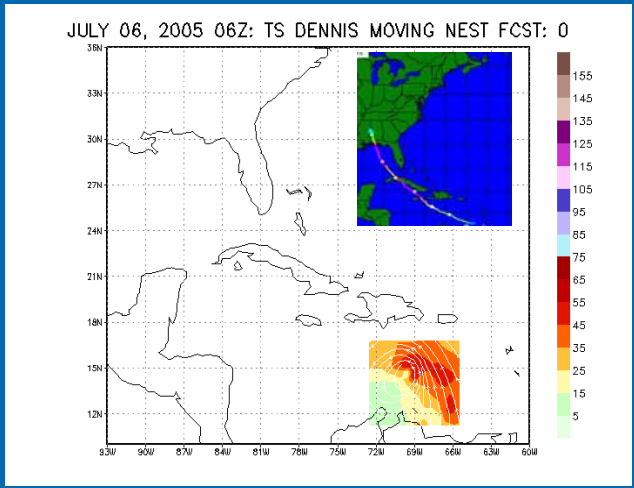
NMM-WRF GRID MOTION

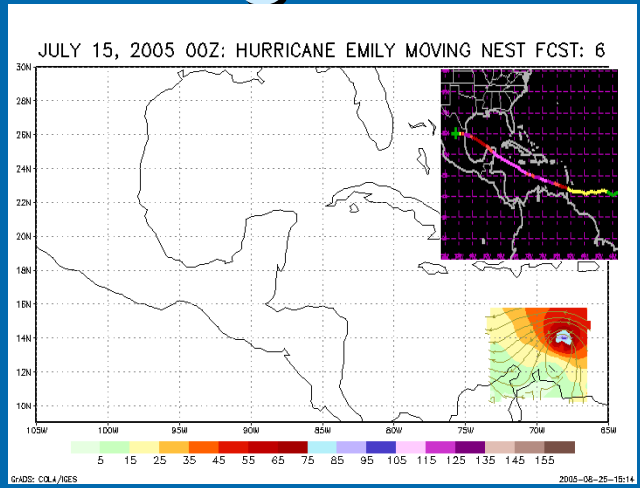


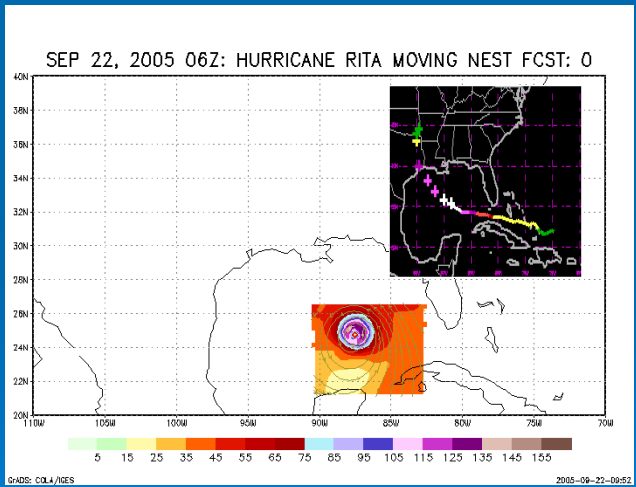


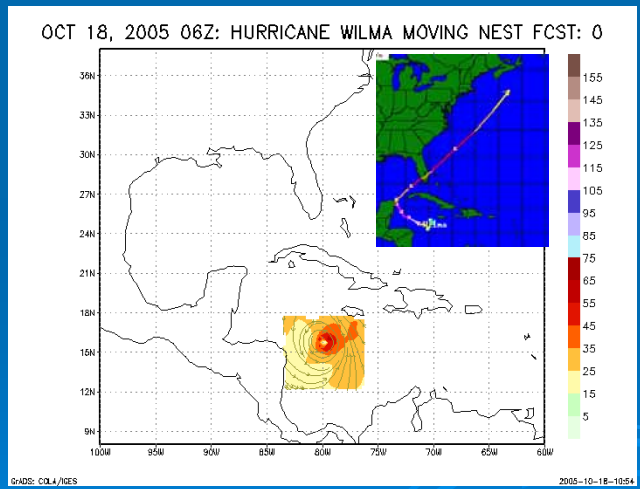
- rocedure is M t and is way interacti
- n is about 60 27 km the moving $^{0}x6^{0}$ at solution.
- The nest is "set to sail" on the parent domain using a simple criterion based on variations in dynamic pressure. The so called “stagnation point” was chosen to be the center of the storm (Gopalakrishnan et al 2002, MWR.)

Test Cases with NMM grid motion



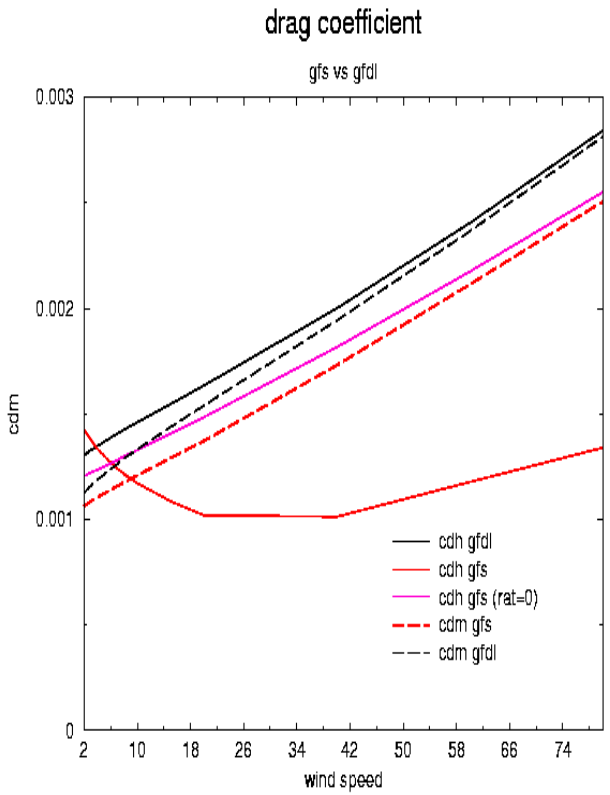


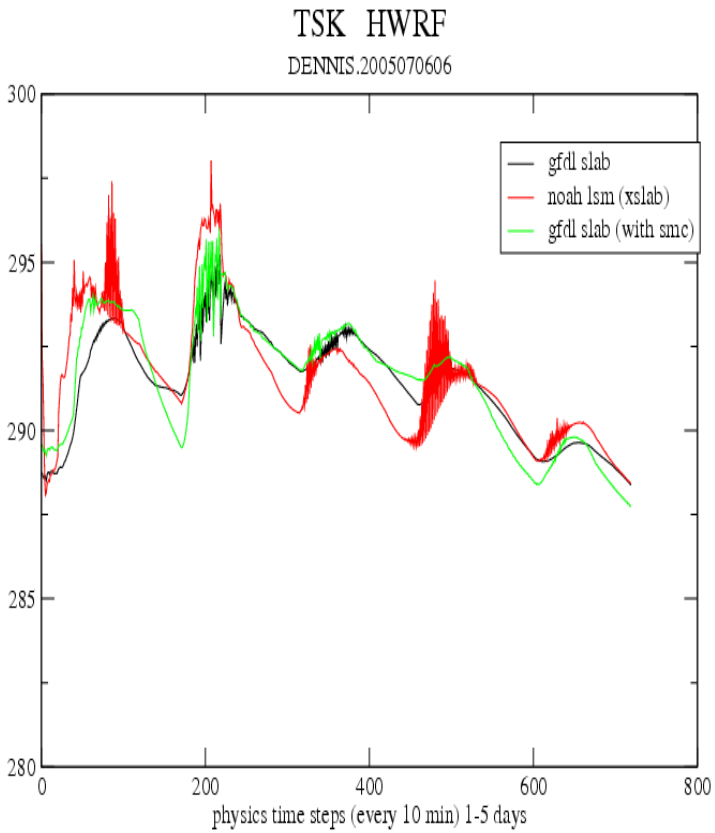


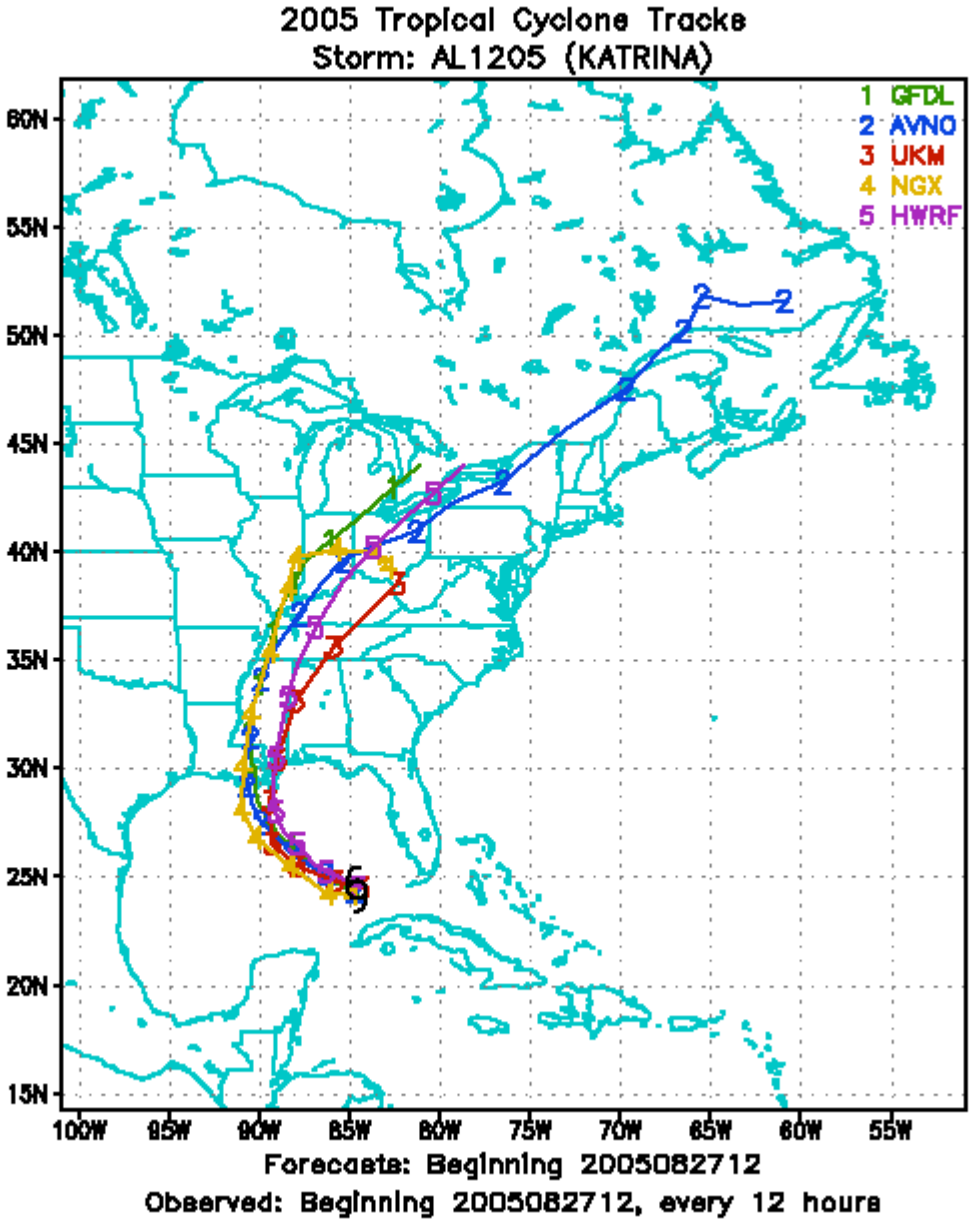


****** For configuration provided earlier, it takes about 55 minutes of run time (excludes wrfsi and real). . for 5 days of forecast using 72 processors in our IBM cluster.**

Sensitivity of physics packages
Surface exchanges…..Ground temperatures



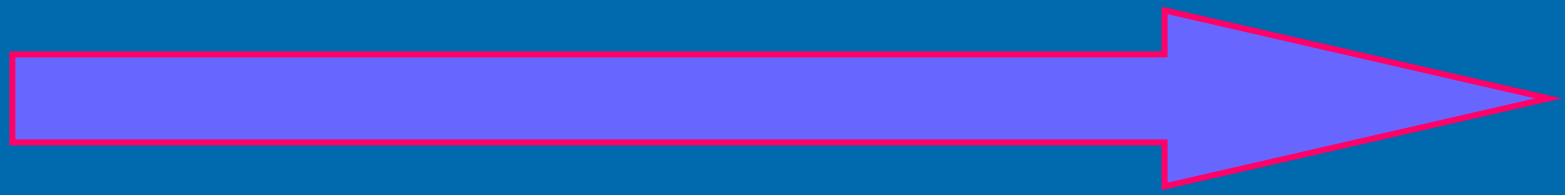



2005 Tropical Cyclone Tracks
Storm: AL1205 (KATRINA)
1 GFDL
2 AVNO
3 UKM
4 NGX
5 HWRF
60N
55N
50N
45N
40N
35N
30N
25N
20N
15N
100W
95W
90W
85W
80W
75W
70W
65W
60W
55W
Forecasts: Beginning 2005082712
Observed: Beginning 2005082712, every 12 hours
NCEP Hurricane Forecast Project

HWRF accomplishments

- Ran real-time parallel moveable nested 5-day runs for 2005 season (1-way interaction with GFS physics/GFDL&GFS initial conditions) in robust fashion
- Added moveable 2-way nested grid option
- Integrated nested files into HWRF post
- Added GFDL surface physics & ground slab
- Reconfigured GFS physics to conform to GFDL standards
- In 2004, ran 4 days with uniform mesh using GFS initial conditions and with NMM standard physics

Advancing HURRICANE WRF System



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Mesoscale Data Assimilation for Hurricane Core

Implement advance (reflectivity) → **A4DDA**

Atm. Model physics and resolution upgrades (continuous)

Air sea fluxes: wave drag, enthalpy (sea spray)

Microphysics

Incr. resolution

(4km/>64L?)

Waves: moving nest Multi-scale imp. Highest-Res coast

Ocean: 4km. - continuous upgrades in ODAS, model res.

Summary & Plans

- Upgrade and evaluate physics….surface layer, lsm, microphysics, radiation
- Continue parallel HWRF runs…. forecast/analysis cycle ….initiate moveable, nested HWRF
- Compare with GFDL and other models

TRANSITIONING TO HURRICANE WRF

GFDL Begin Physics Upgrades — Continue upgrades — GFDL frozen

HWRF T&E

HWRF Operational

(9km/42?L)

HWRF Begin R&D — Prelim. Test HWRF physics → HWRF T&E