GFDL HFIP/HRH Comparison Results

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National Hurricane Center

Outline of Talk

- GFDL HRH model experimental design
- GFDL HRH model physics
- Summary of overall results (track and intensity)
- Summary of individual storms: Hurricanes Katrina, Rita, Felix, Philippe

GFDL HRH Experimental Design

- Grid configurations

URI1

Mesh 1: 75^ox75^o – 1/6^o res

Mesh 2: 11^ox11^o – 1/6^o res

Mesh 3: 5^ox5^o – 1/12^o res

URI2

Mesh 1: 75^ox75^o – 1/2^o res

Mesh 2: 11^ox11^o – 1/6^o res

Mesh 3: 5^ox5^o – 1/18^o res

- No asymmetries added during bogusing to the initial axisymmetric vortex (operational GFDL model includes vortex asymmetries based on the forecast fields from the previous 12-h forecast)

GFDL HRH Model Physics

- Simplified Arakawa-Schubert scheme for cumulus parameterization and Ferrier cloud microphysics package for large-scale condensation.
- Smagorinsky’s nonlinear viscosity scheme for horizontal diffusion .
- Troen and Mahrt’s non-local scheme for vertical diffusion.
- Monin-Obukhov scheme for surface flux calculations with an improved air-sea momentum flux parameterization in strong wind conditions.

GFDL HRH Model Physics (cont'd)

- Radiation effects are based on Schwarzkopf and Fels (1991) infrared and Lacis and Hansen (1974) solar radiations parameterizations, including diurnal variations and interactive effects of clouds.

- Coupled with Princeton Ocean Model at 1/6° horizontal resolution with 23 vertical sigma levels.

GFDL HRH Model Physics (cont'd)

- Model physics changes compared to GFDL operational model include:

  - Penetrative solar radiation included in ocean model

  - Bug fixed in C_h calculations

Both changes are consistent with HWRF/POM model physics

GFDL HRH Test Experiments

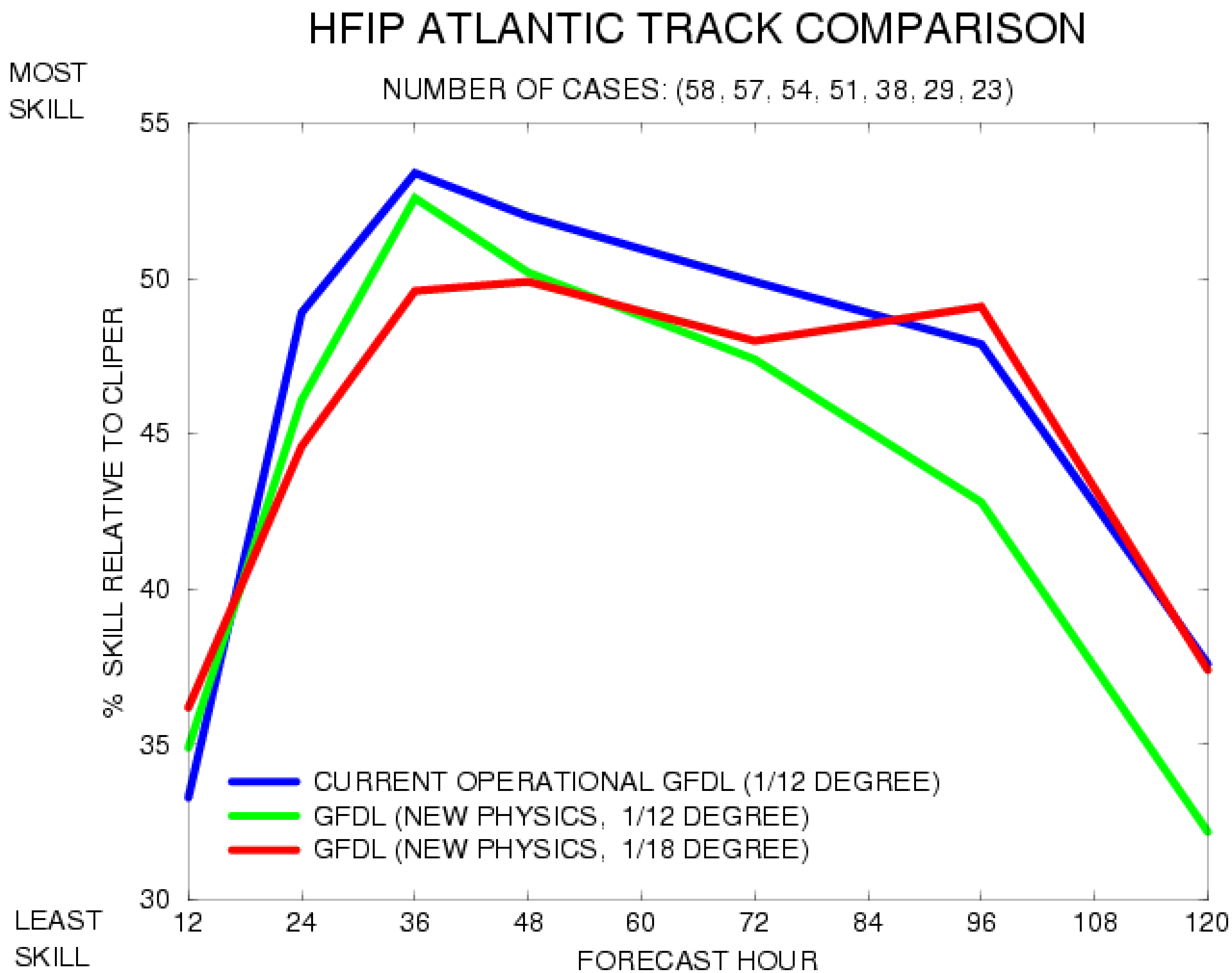
- Same physics in all URI1 and URI2 experiments

- Total 58 cases run:

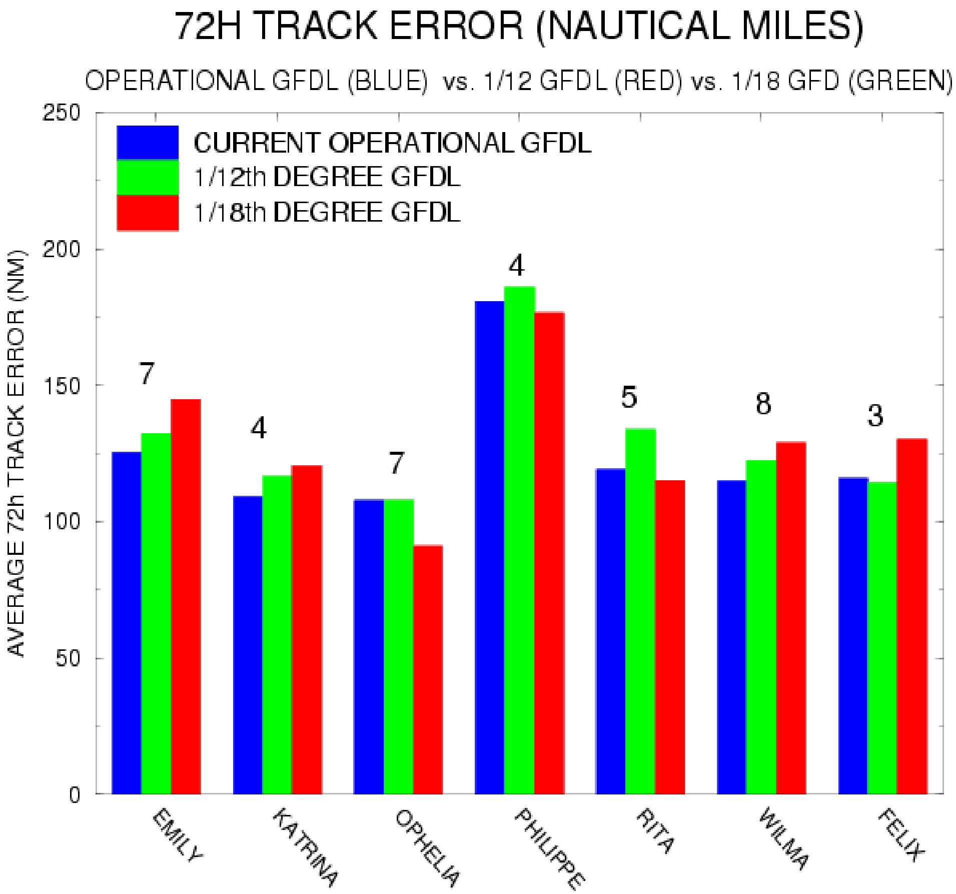
  Emily – 8, Felix – 7, Katrina - 6, Karen – 4,

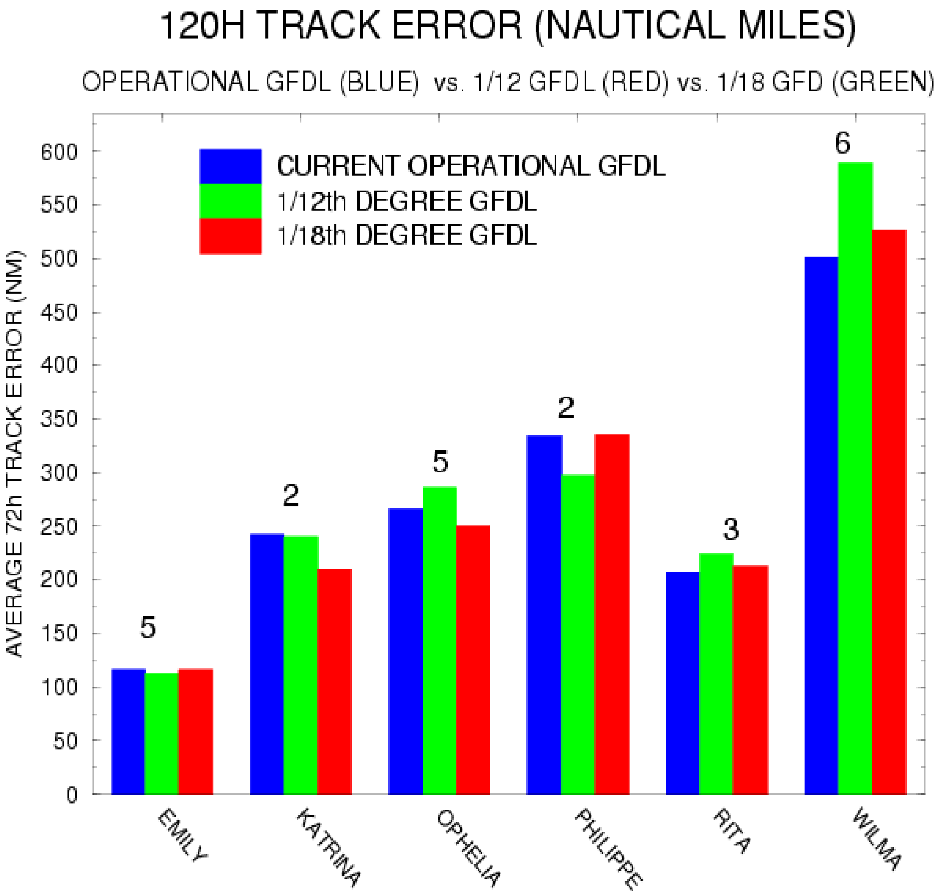
  Ophelia - 10, Philippe - 6, Rita - 6, Wilma – 11.

Small Increase in Track Skill with Higher Resolution

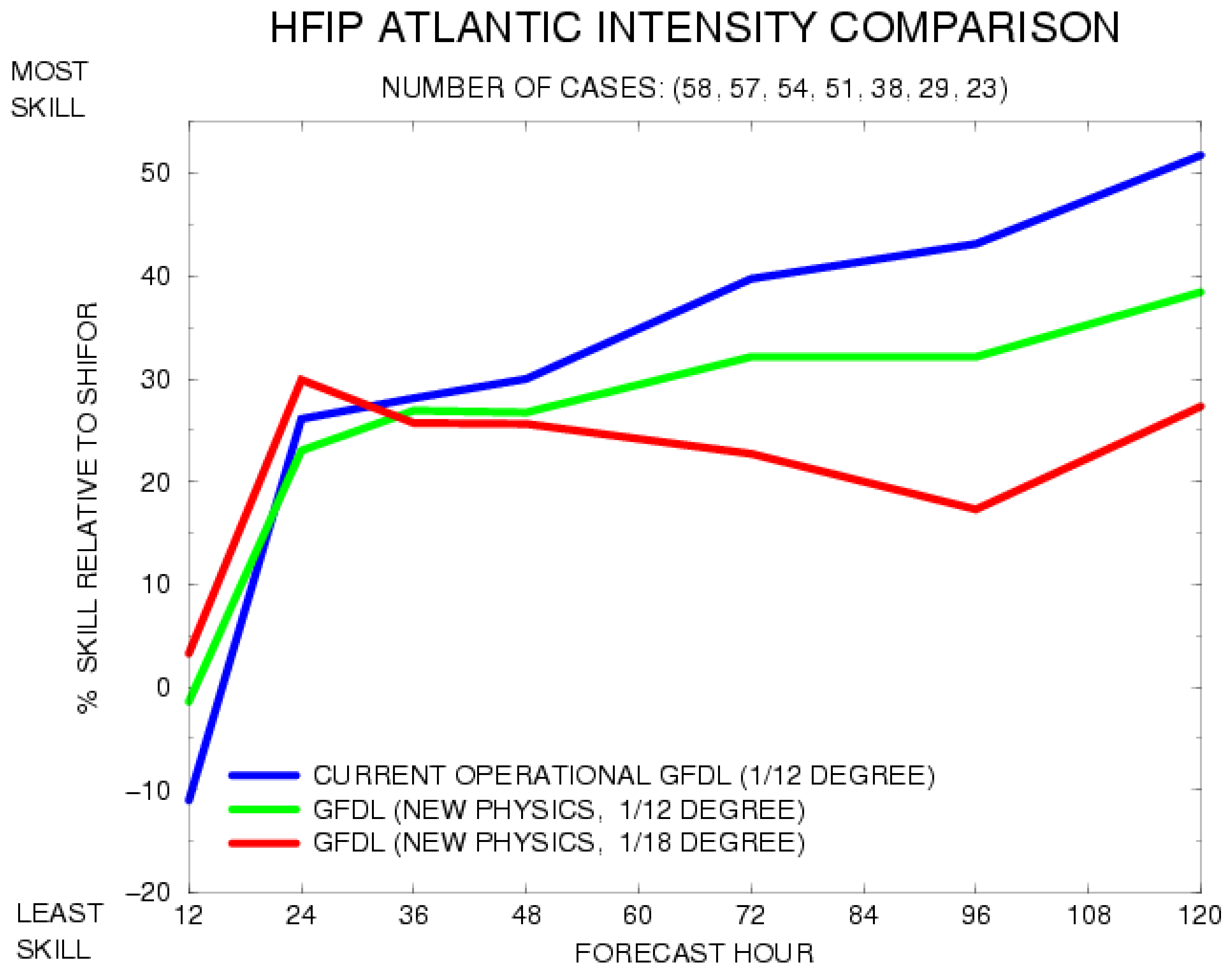


Track Error for Each Individual Storm (nm)

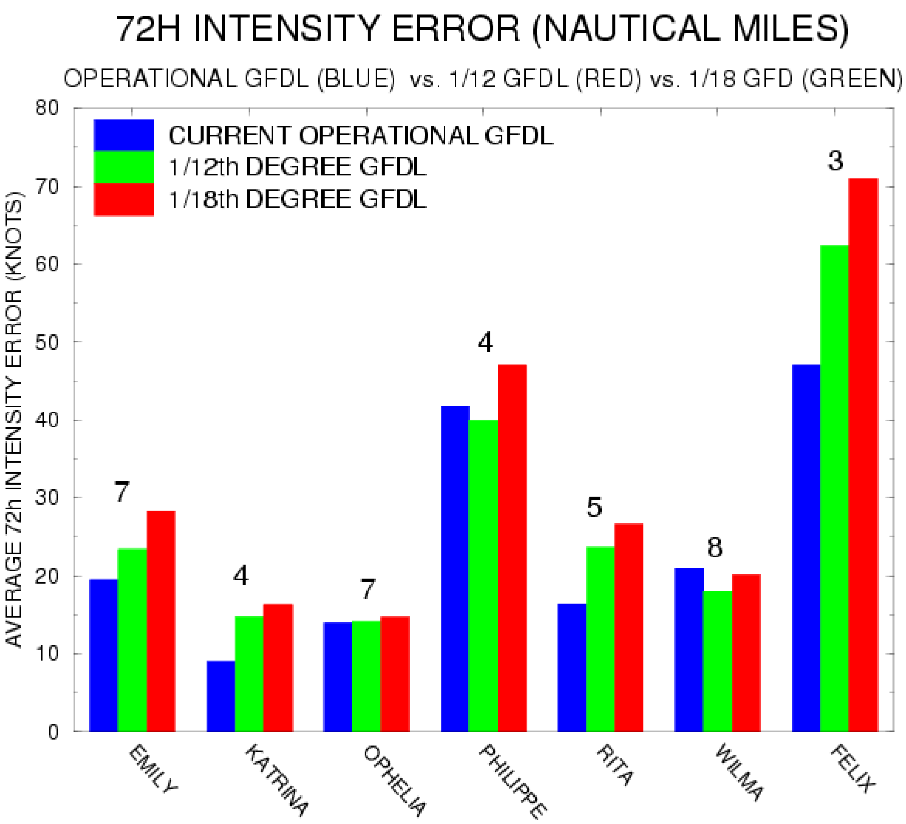


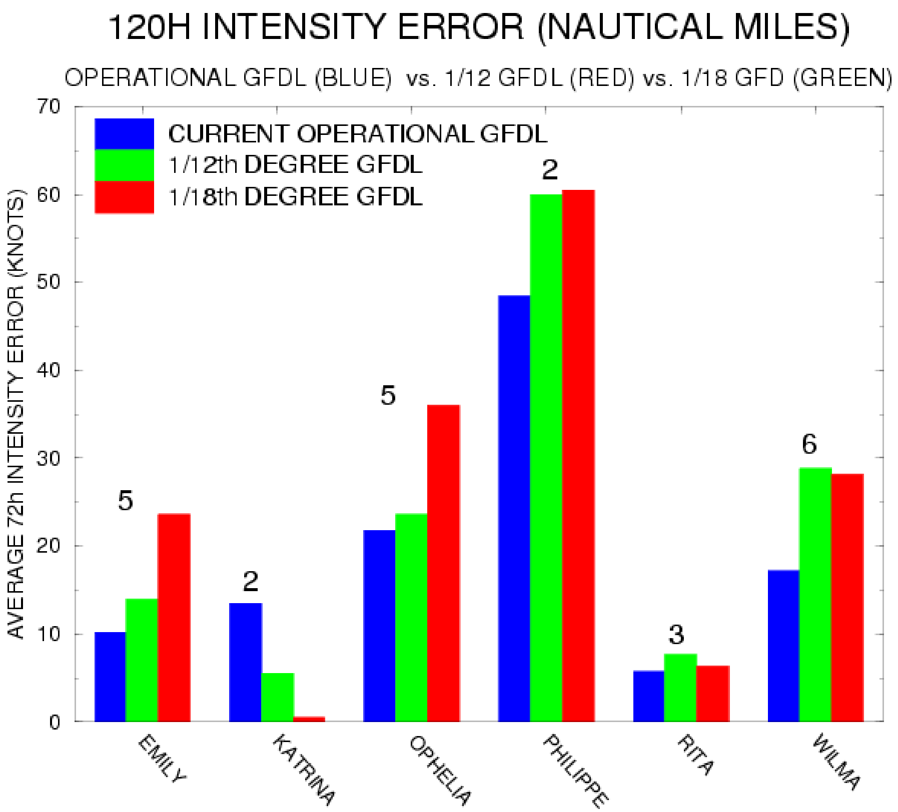


Degraded Intensity Skill with Higher Resolution (Increased Positive Wind Bias)

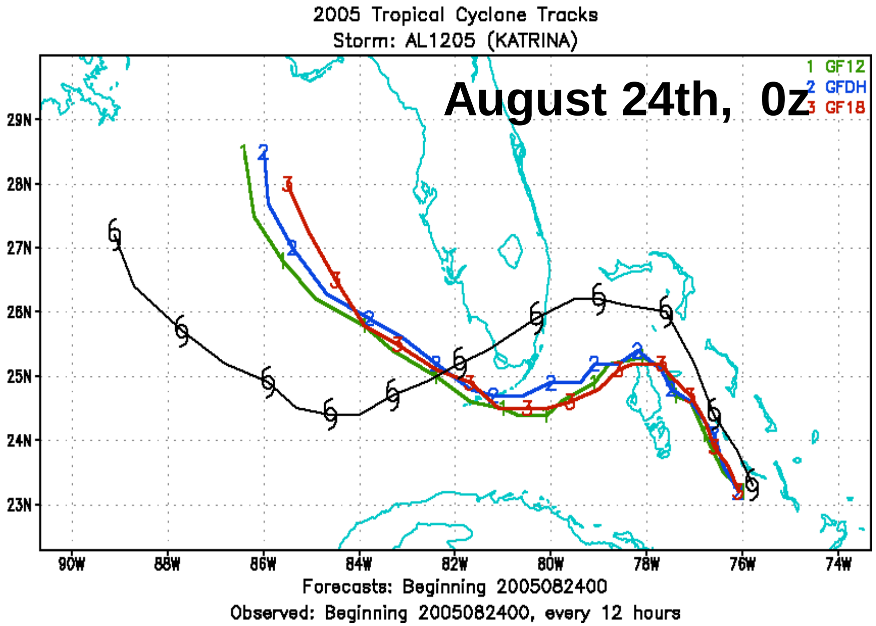


Wind Intensity Error for Each Individual Storm (knots)





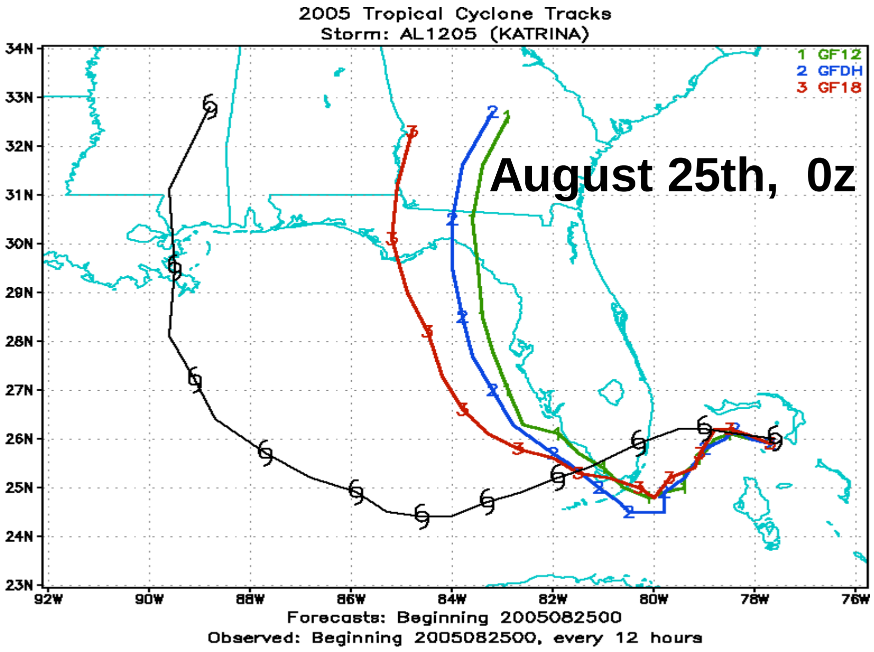
HURRICANE KATRINA

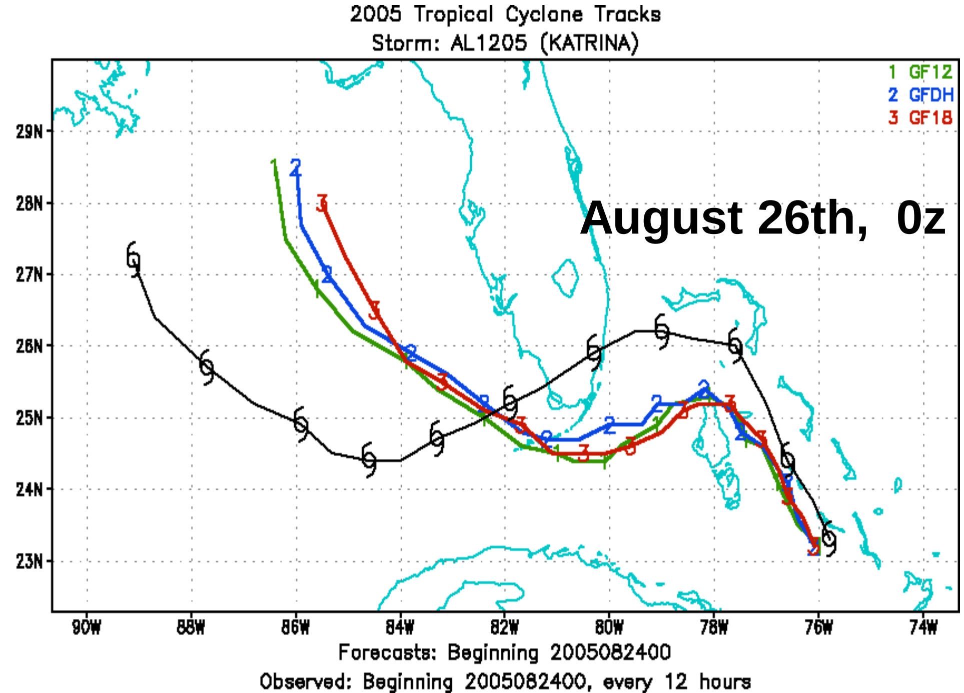


2 Current Operational GFDL

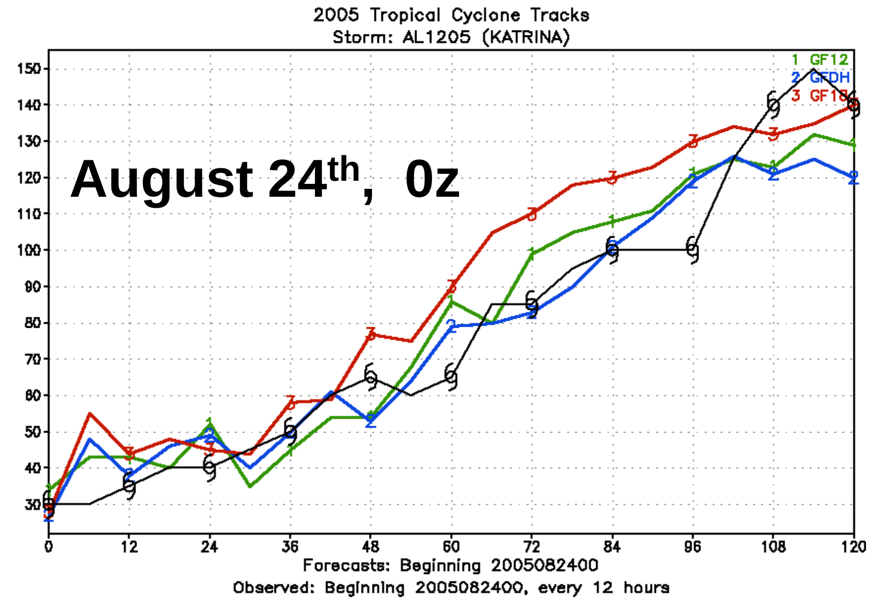
2 12th Degree GFDL

3 18th Degree GFDL





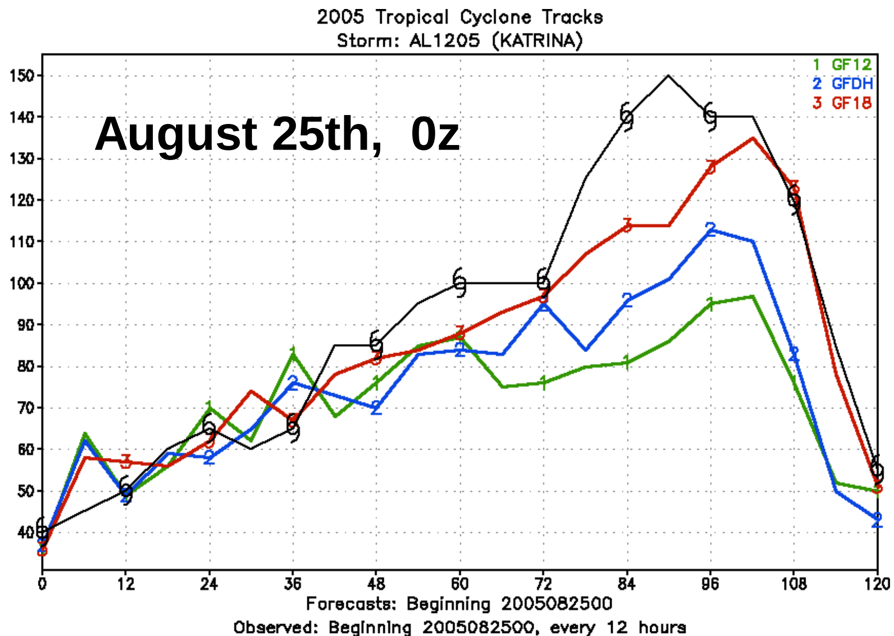
Increased Resolution Gave Improved Intensity Prediction with Katrina during RI

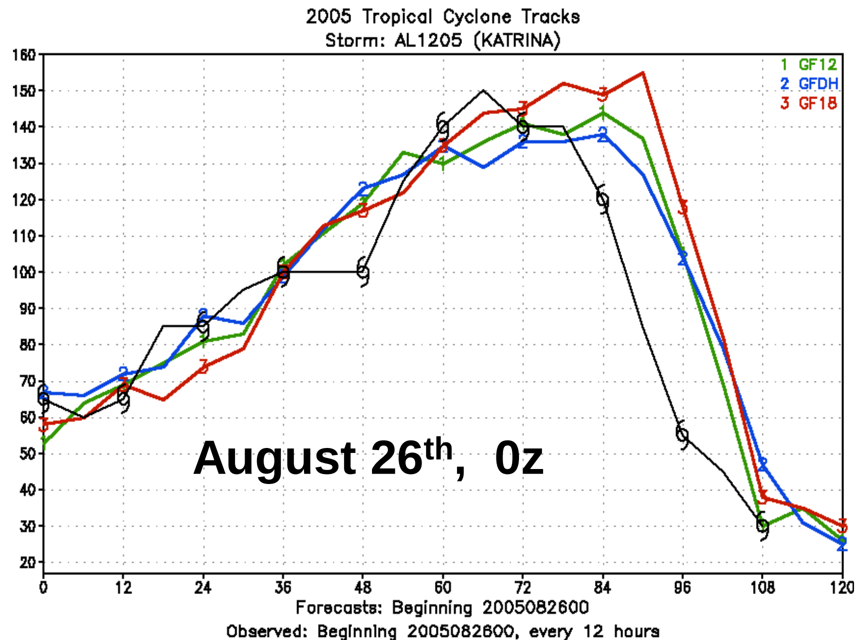


2 Current Operational GFDL

1 12th Degree GFDL

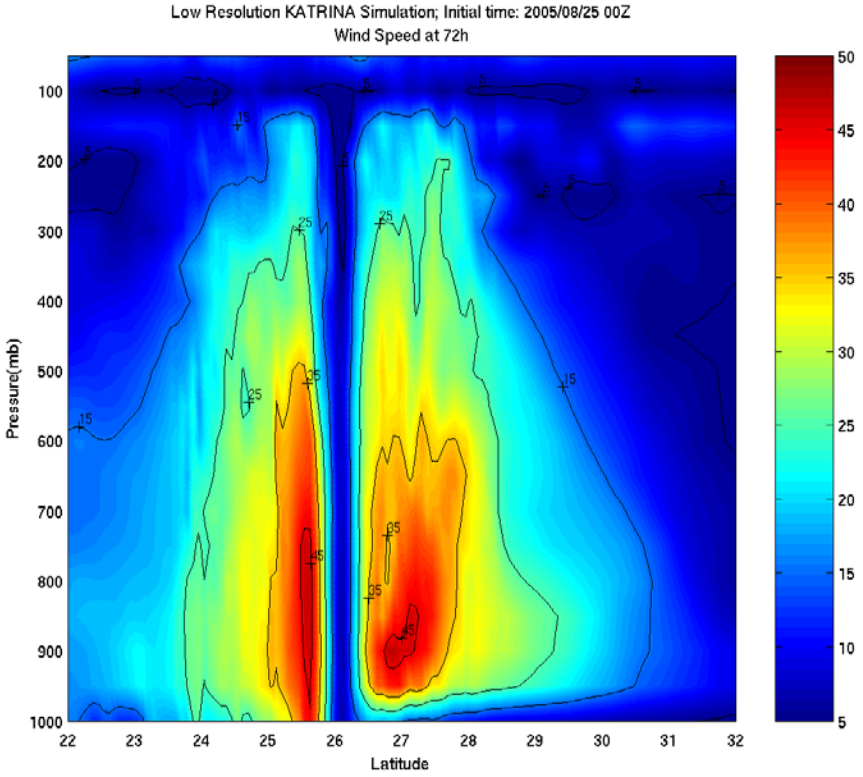
3 18th Degree GFDL



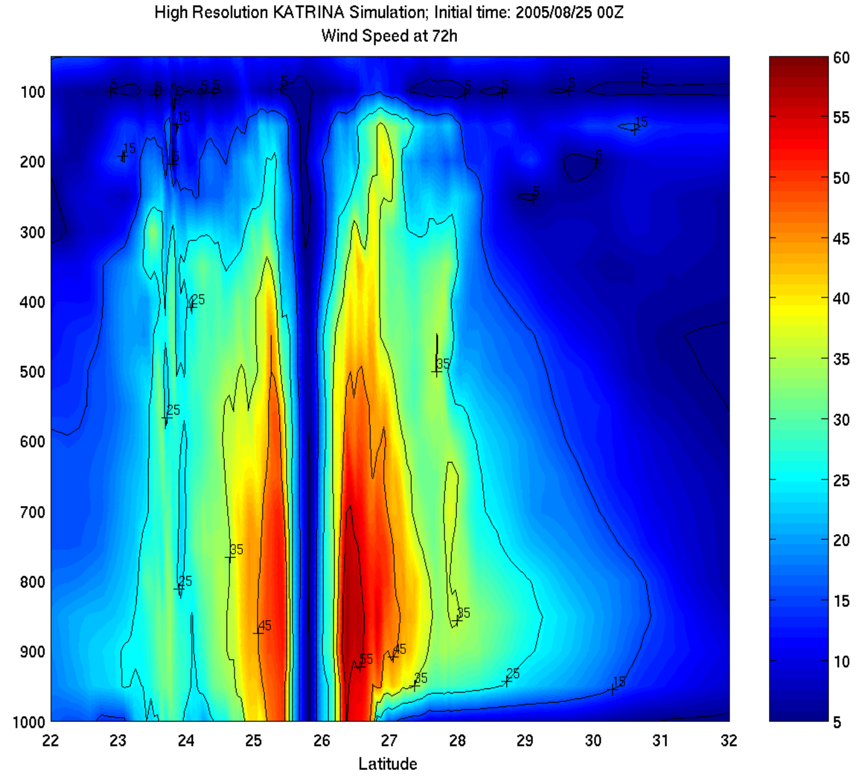


Wind Speed Cross-Section (72h)
Katrina: August 25th, 0z forecast
Improved Structure with Higher Resolution

1/12th Degree Resolution

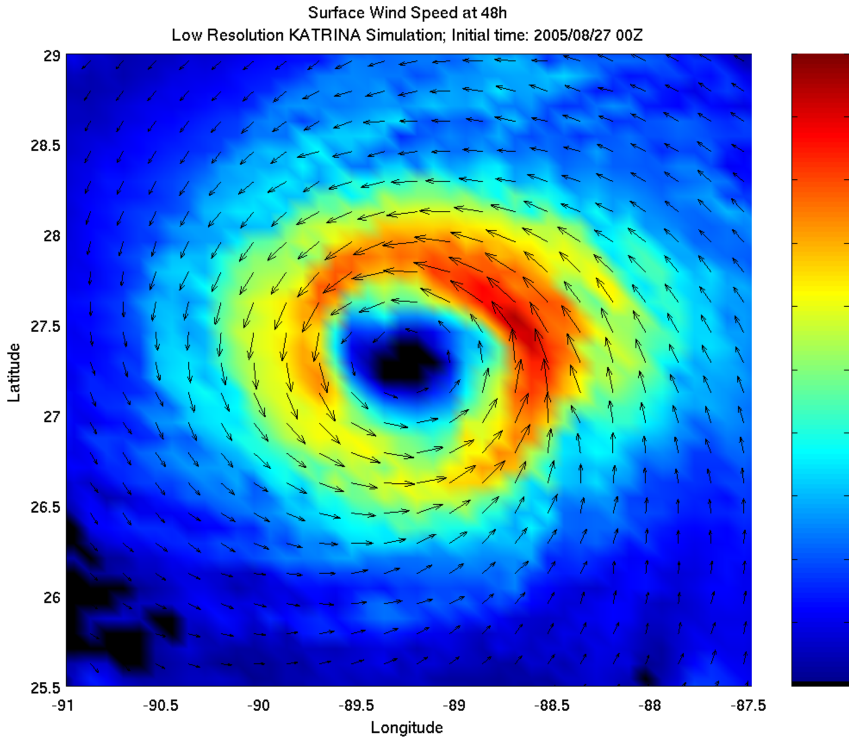


1/18th Degree Resolution

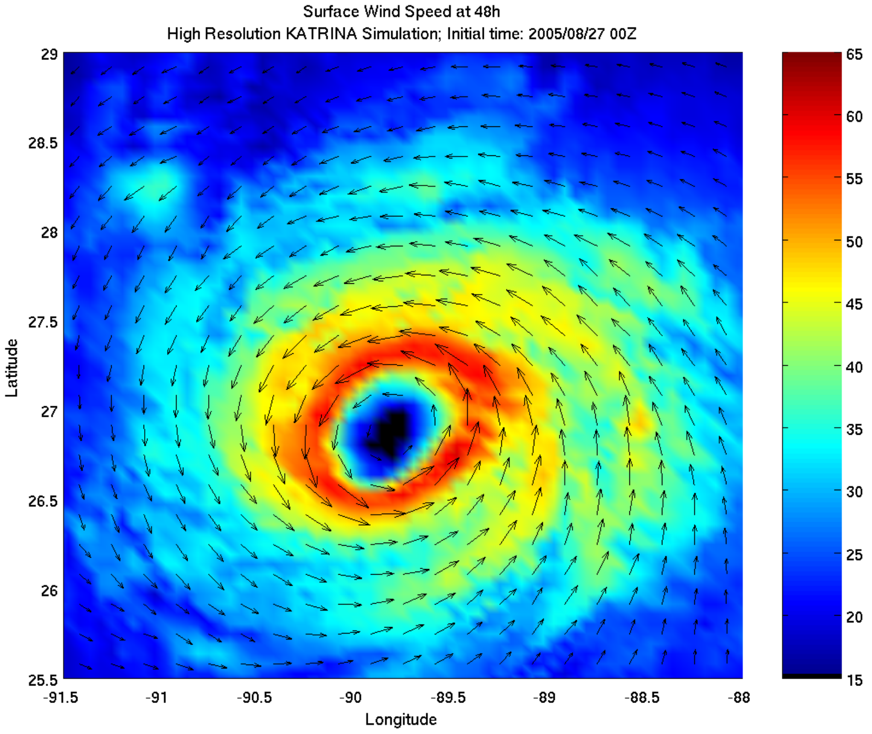


Surface Winds (72 hr)
Katrina: August 25th, 0z forecast
Improved Structure with Higher Resolution

1/12th Degree Resolution

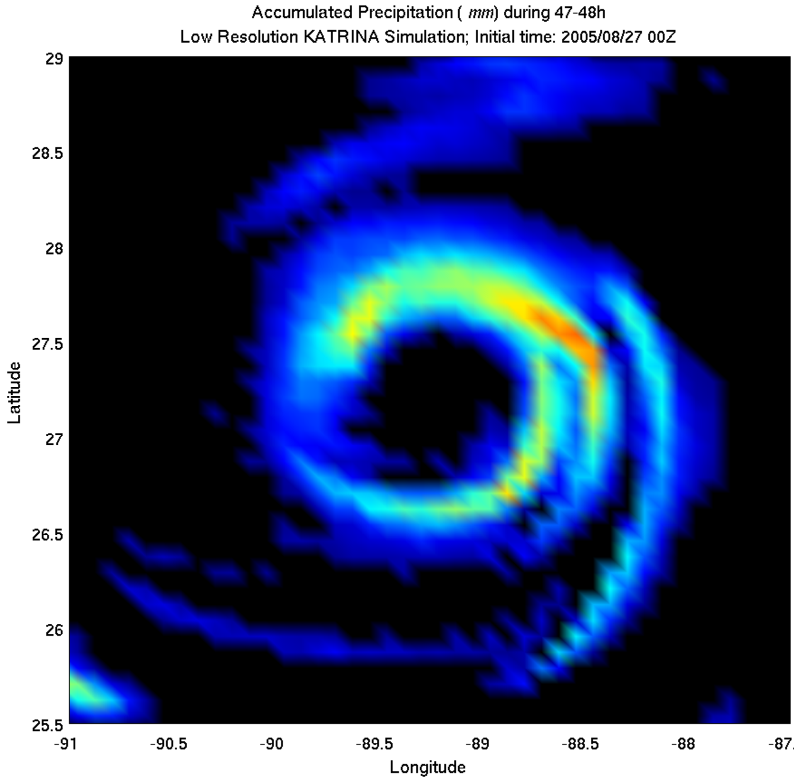


1/18th Degree Resolution

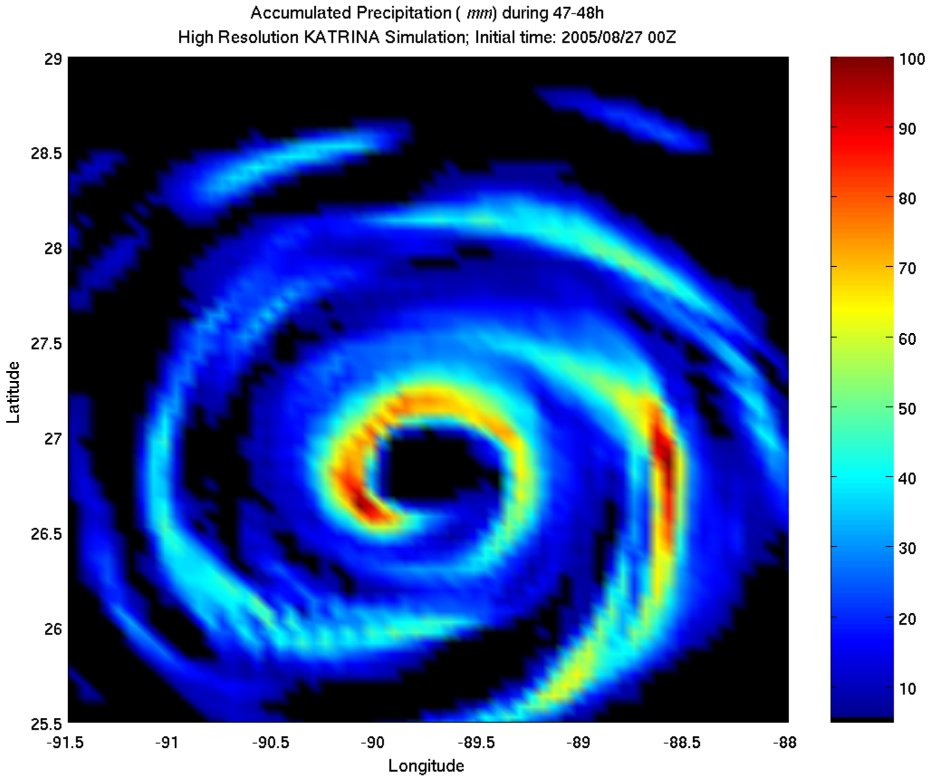


Accumulated precipitation (47-48 hr)
Katrina: August 25th, 0z forecast
Improved Structure with Higher Resolution

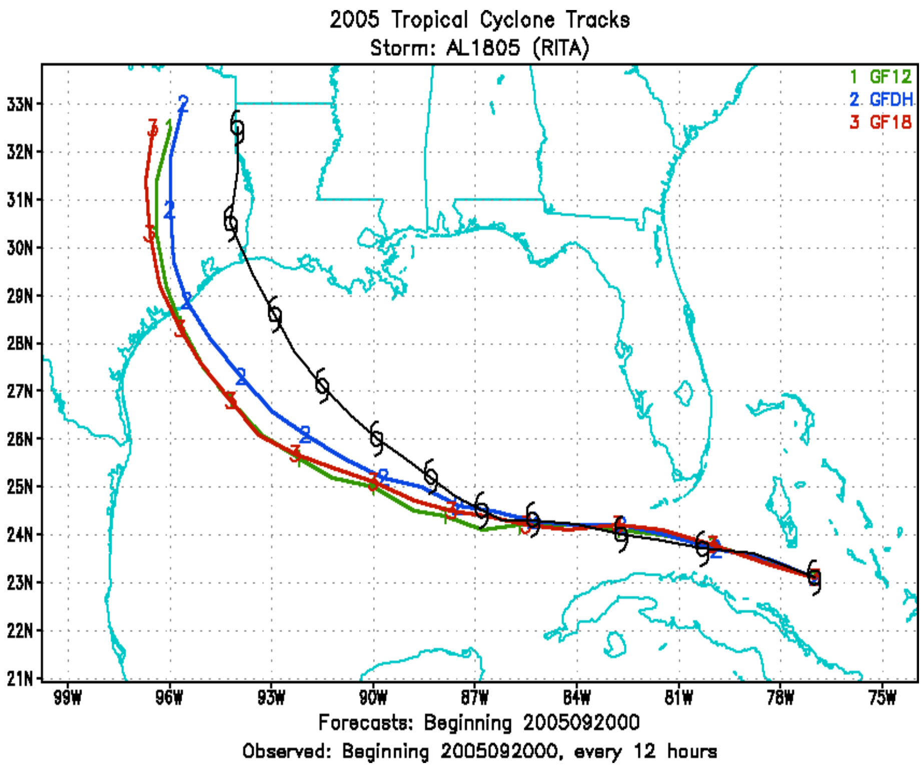
1/12th Degree Resolution

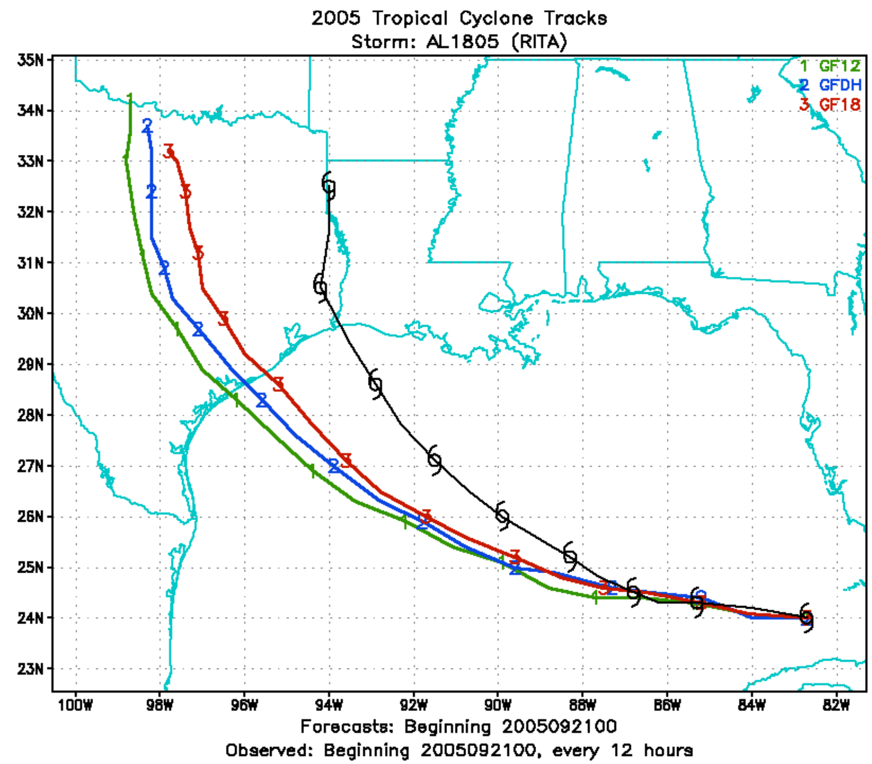


1/18th Degree Resolution



Hurricane Rita Selected Tracks



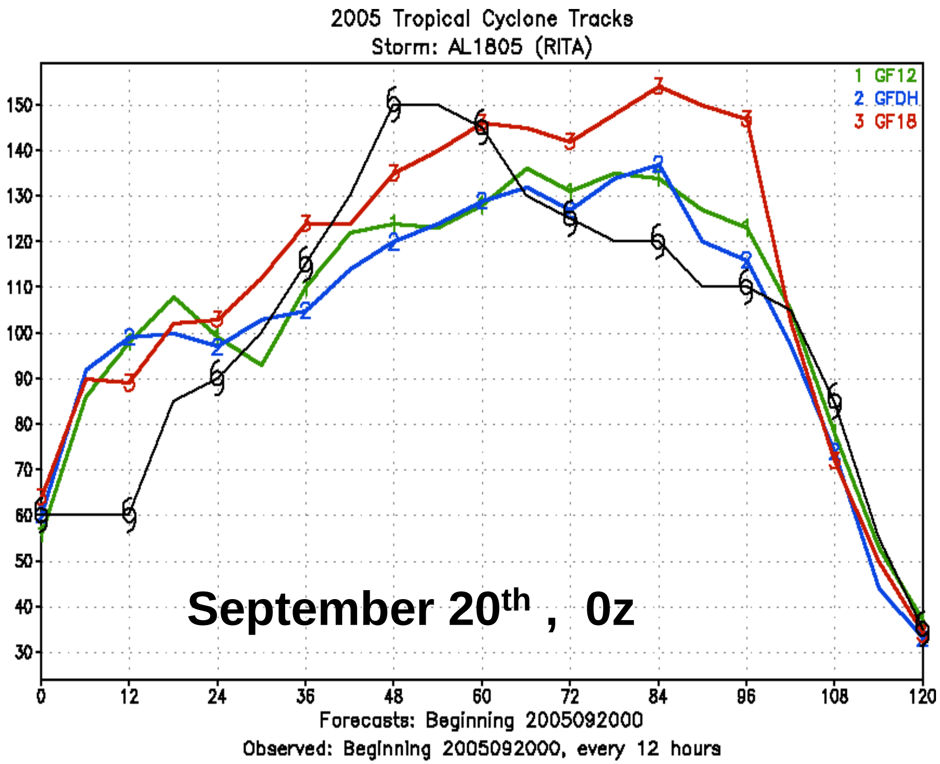


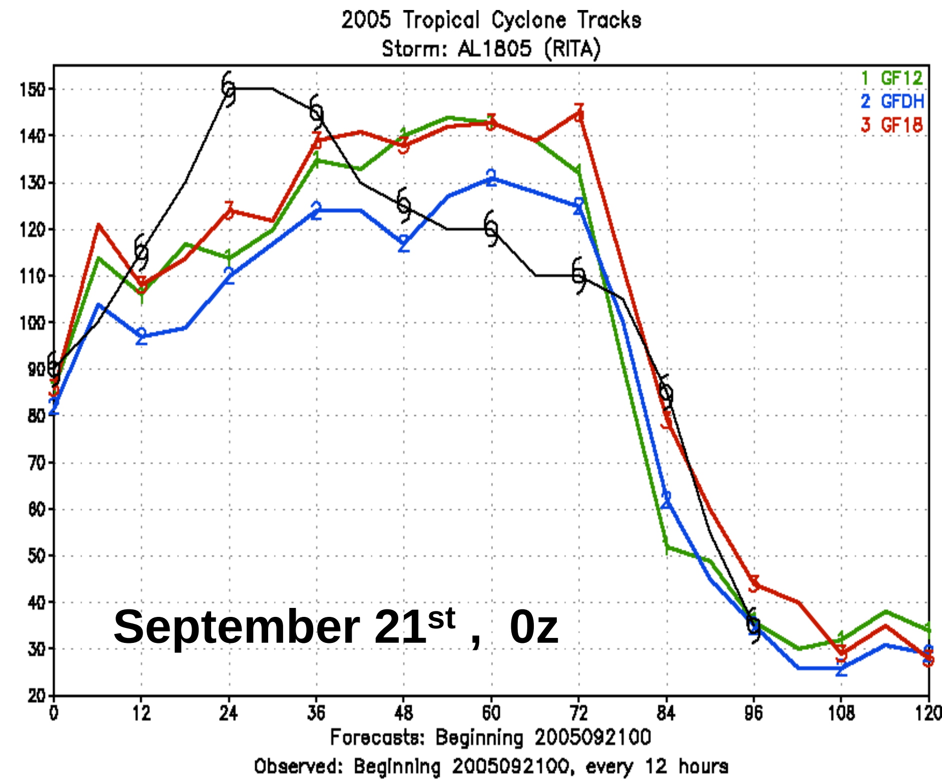
2 Current Operational GFDL

1 12th Degree GFDL

3 18th Degree GFDL

Mixed Result with Rita for Intensity Prediction with Higher Resolution





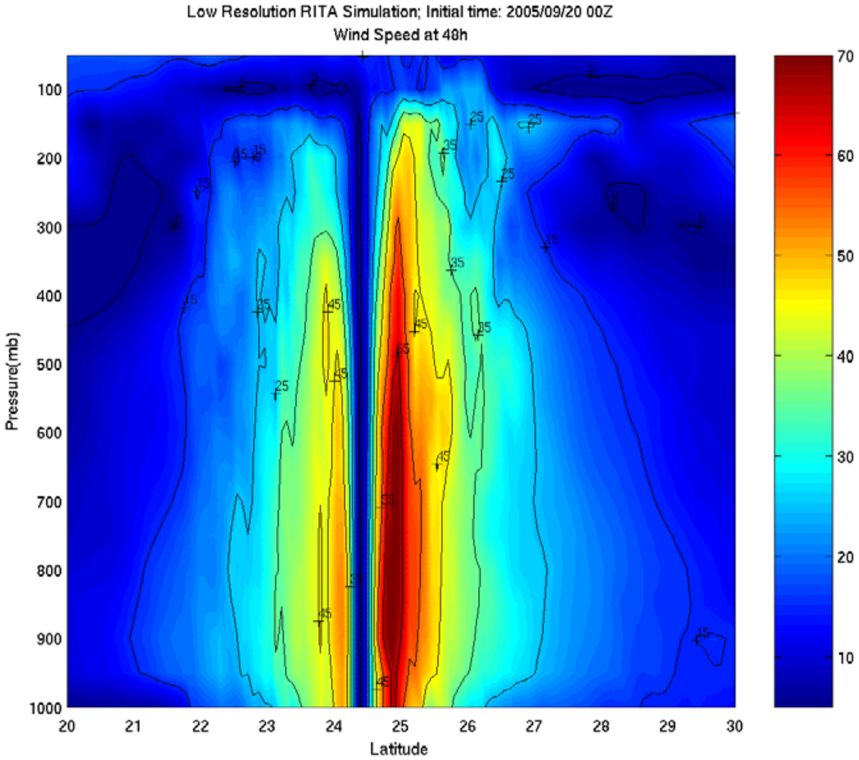
2 Current Operational GFDL

1 12th Degree GFDL

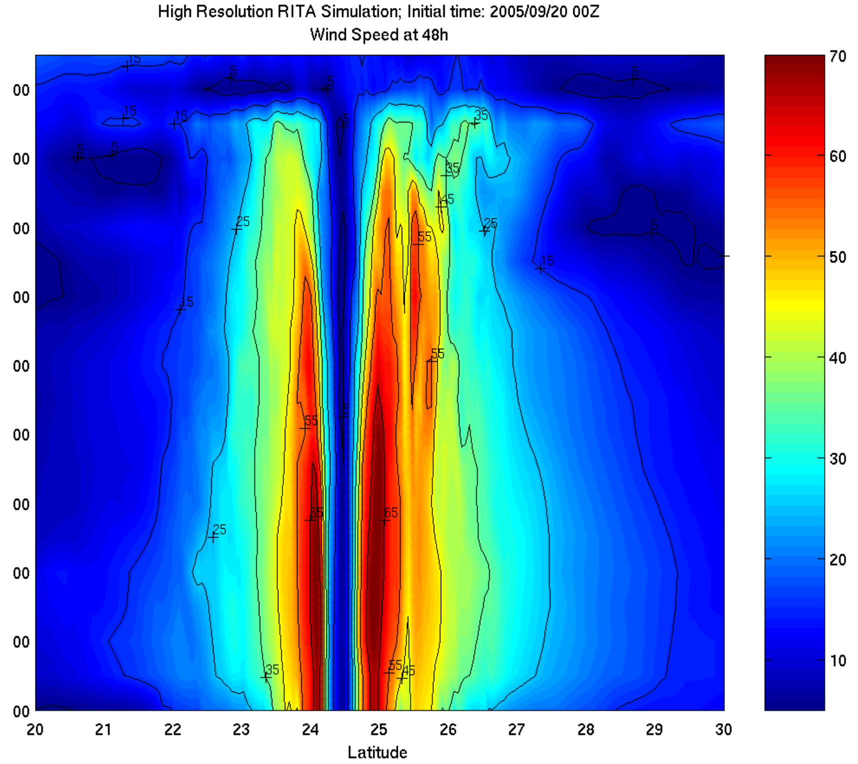
3 18th Degree GFDL

Wind Speed Cross-Section (48h)
Rita: September 20th , 0z forecast

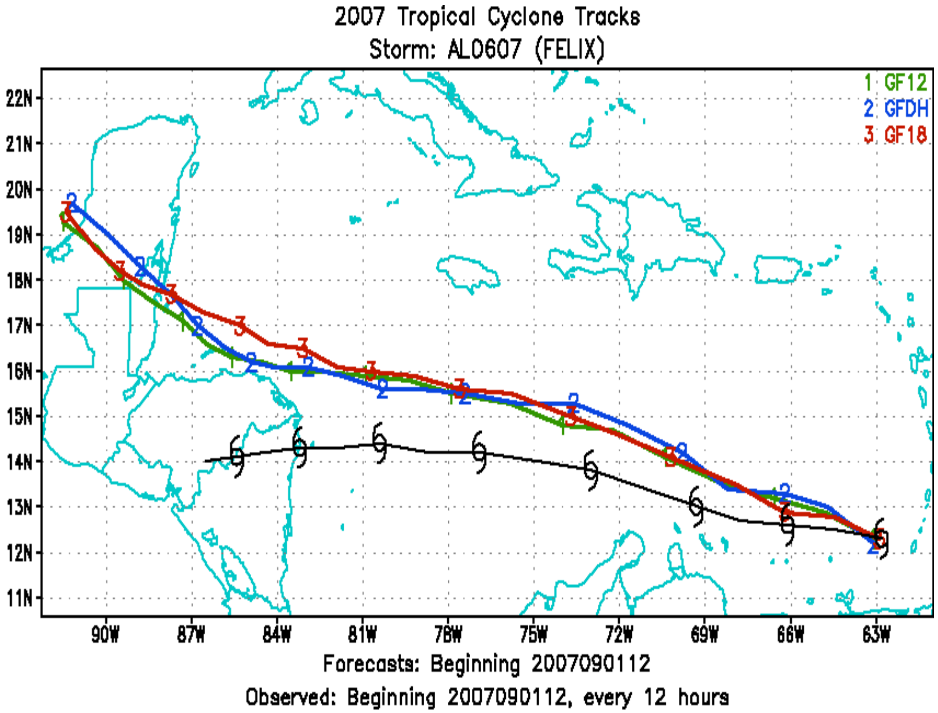
1/12th Degree Resolution

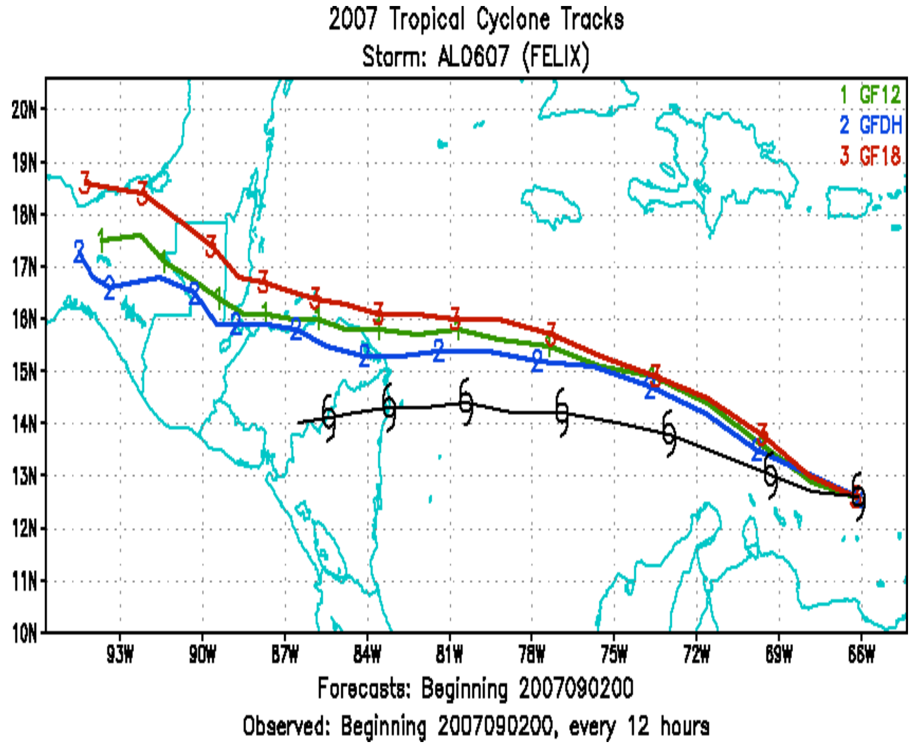


1/18th Degree Resolution



Hurricane Felix Selected Tracks





2 Current Operational GFDL

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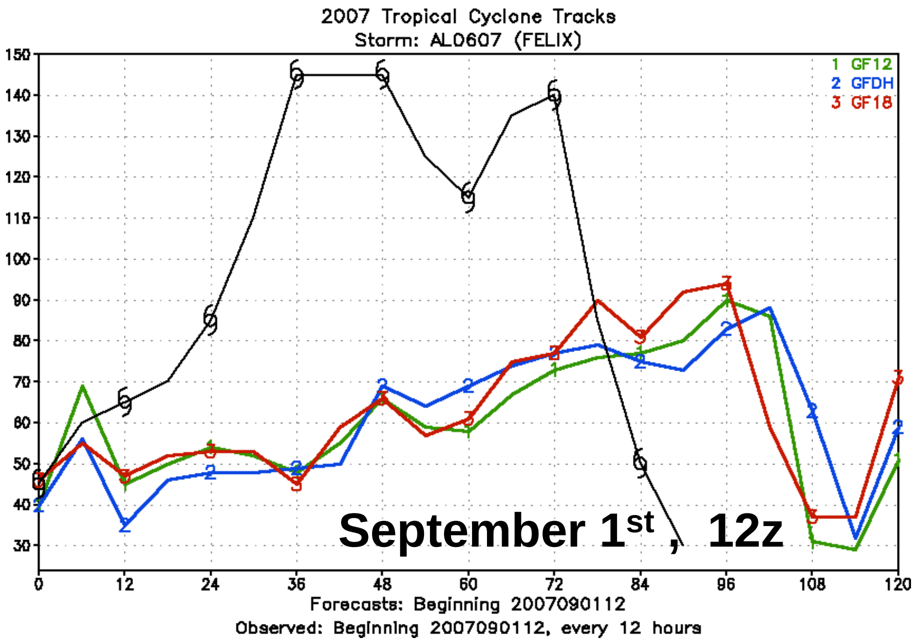
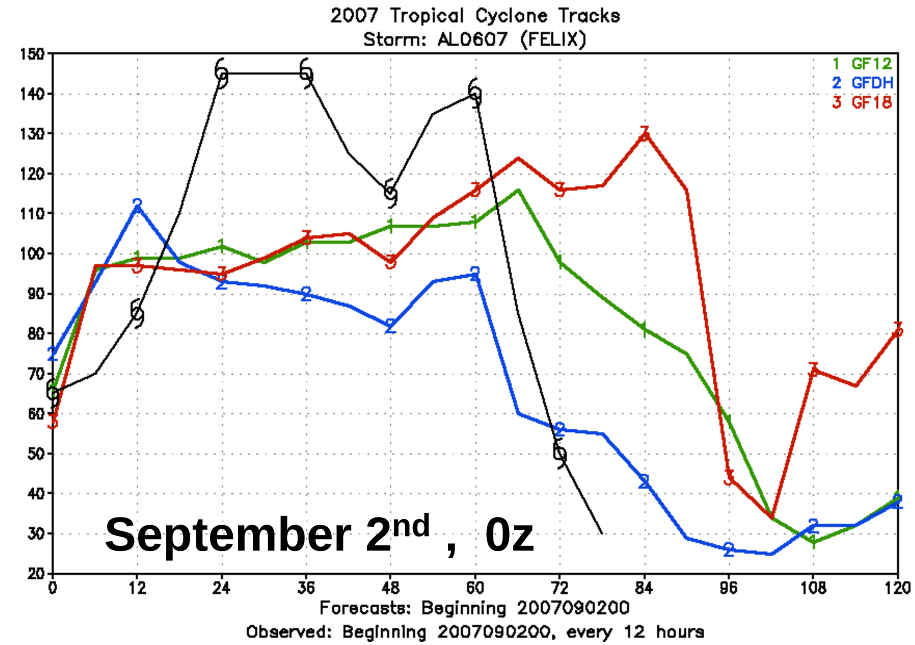
3 18th Degree GFDL

No Improved Intensity Prediction for Felix with Higher Resolution
(Inner Core still not properly resolved ?)





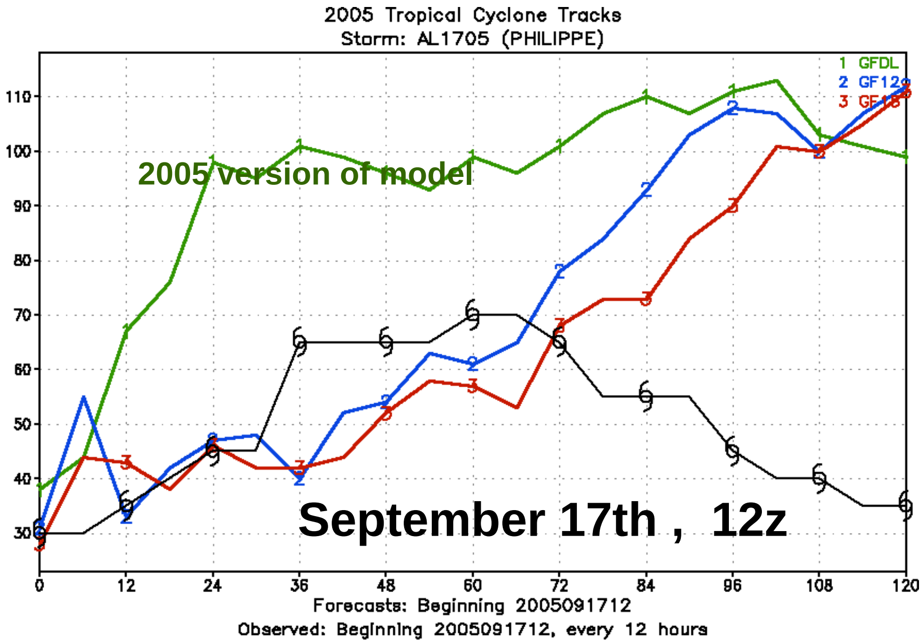
2 Current Operational GFDL

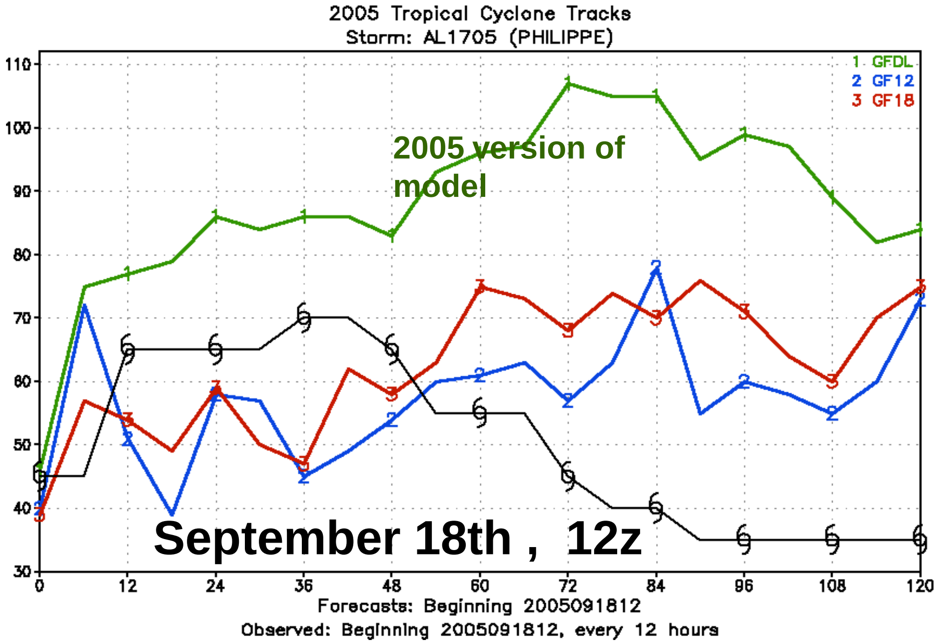
1 12th Degree GFDL

3 18th Degree GFDL

Over Intensification with Philippe

Effect of shear still not properly resolved but much improved at 1-3 days compared to 2005 Version





1 2005 Operational GFDL

2 12th Degree GFDL

3 18th Degree GFDL

Summary

- Increased resolution had <u>mixed</u> impact on GFDL model performance for HRH test cases.
- Improved horizontal and vertical structure in high-resolution experiments.
- Small improvements in track forecast skill.
- Degraded intensity forecast skill due to increased positive bias.
- Results suggest physics may need to be retuned for high resolution for better performance

Future Plans

- Improving physics of the GFDN 1/18th model: air-sea momentum and heat flux parameterizations, cloud microphysics parameters, radiation package.
- Increasing horizontal resolution in the ocean model.
- Improving initialization of the ocean model by implementing Navy's real-time NCODA analysis.
- Coupling with the WAVEWATCH wave model and introducing sea spray effects.