HURRICANE MODELING AND FORECASTING AT GFDL

Presented by

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Geophysical Fluid Dynamics Laboratory Review

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GFDL Hurricane Model: Timeline

1970: Kurihara starts hurricane research project at GFDL

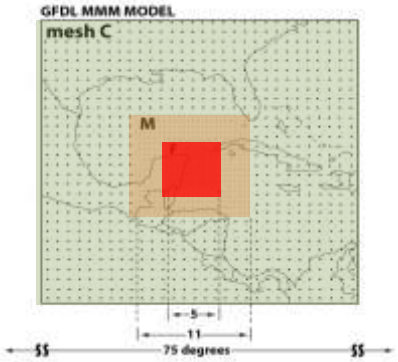
1995: GFDL hurricane model becomes operational at NWS.

2014+: Continued model development, plus work on a hurricane ensemble.

1970-1994: Extensive research centered around development of 3-D hurricane model

1996: GFDL model adopted by the U.S. Navy for operational use globally

2001: GFDL becomes first operational coupled hurricane model



GFDL Hurricane Group: Key Collaborations

NOAA / HFIP Program: Interactions on a wide range of modeling topics

University of Rhode Island: Ocean coupling, surface physics

NWS / EMC: Cloud microphysics, convective and boundary layer parameterizations; Provide scientific upgrades for operational use

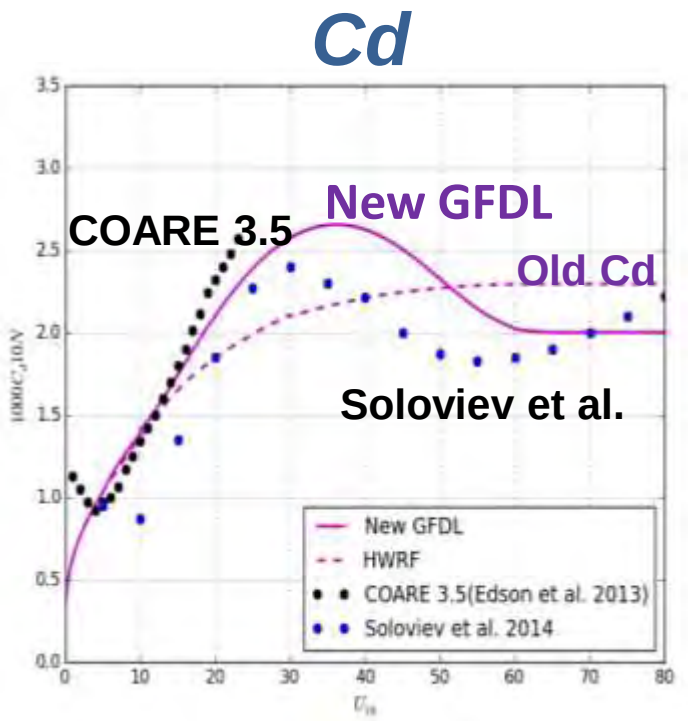
U.S. Navy: Feedback on performance of model in various global basins; Provide scientific upgrades for operational use

AOML / HRD: Boundary layer parameterizations; Development of advanced verification techniques

NWS / NHC: Comparison of forecasts with observations

Major upgrades to hurricane model for 2014

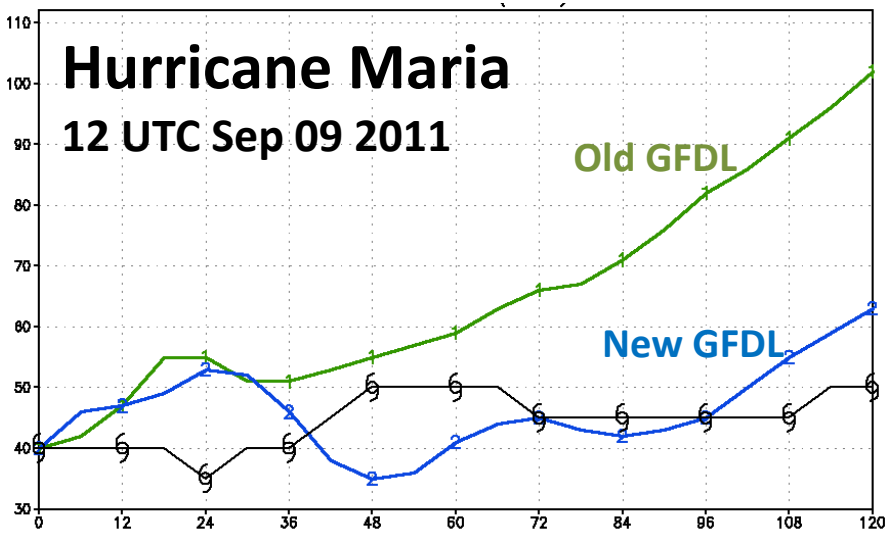
- Increased horizontal resolution of inner nest from 9 km to 6 km.
- Improved formulation of surface exchange coefficients (*Ch, Cd*).
- Increased resolution of ocean model to ~9 km.



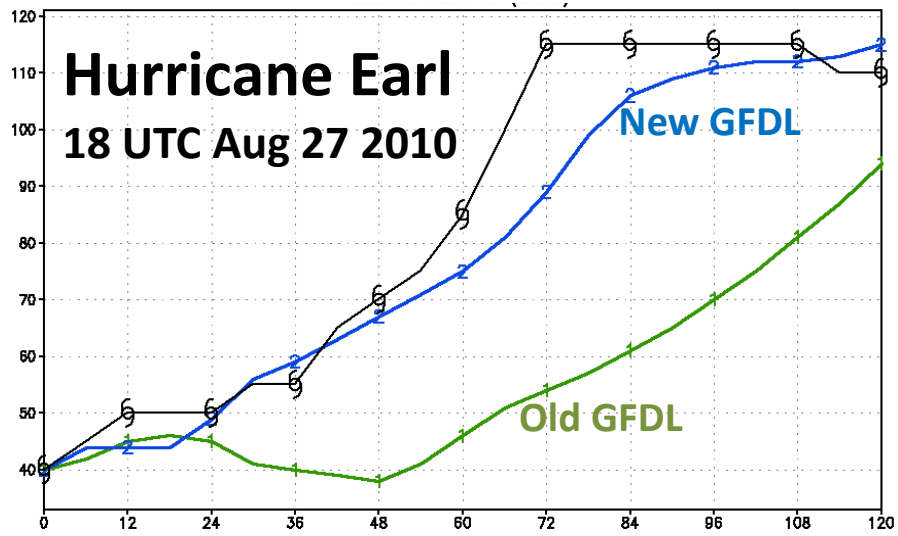
- Improved targeting of initial storm maximum wind speed and storm structure in initialization.

Selected intensity forecasts with 2014 model

Reduced over-intensification tendency

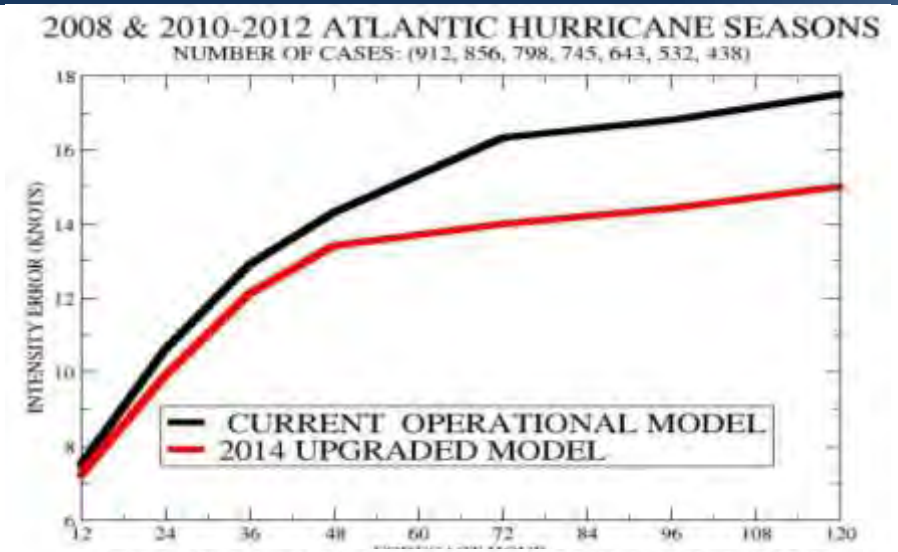


Improved prediction of rapid intensification



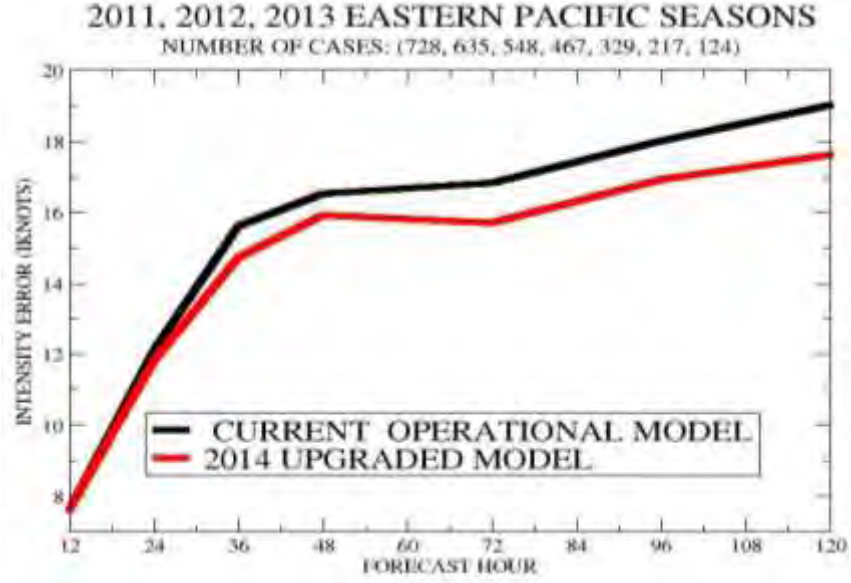
Significantly improved intensity skill at all lead times

Atlantic



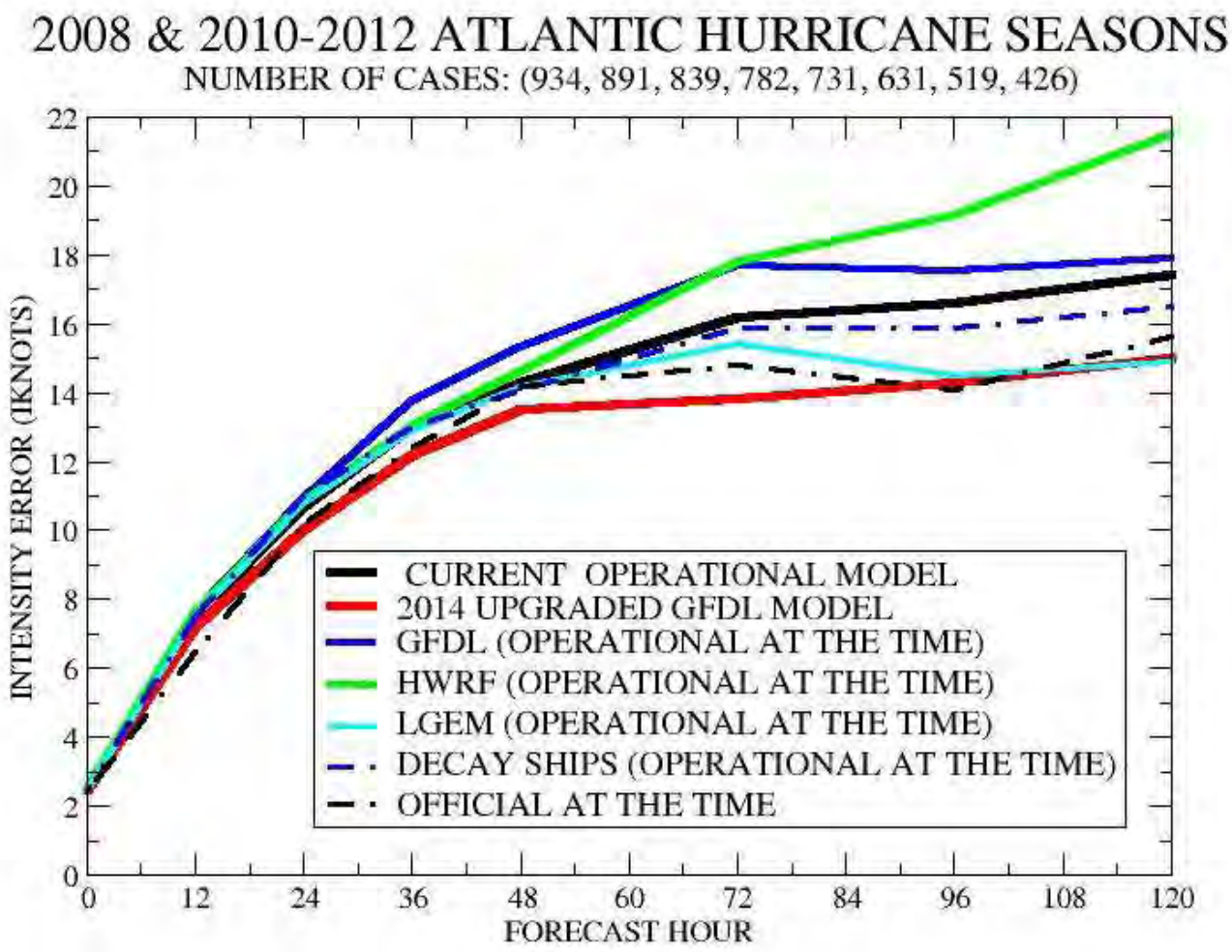
Error reduction:
Days 1-2: 6%
Days 3-5: 15%
Statistically significant for all lead times

Eastern Pacific



Error reduction:
Day 2: 5%
Days 3-5: 8%
Statistically Significant at 36h and 72h

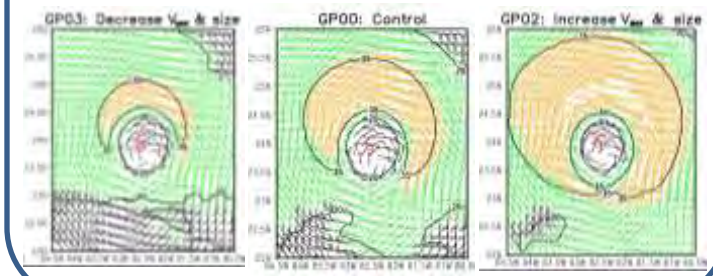
Comparison with other Operational Guidance



GFDL Hurricane Ensemble

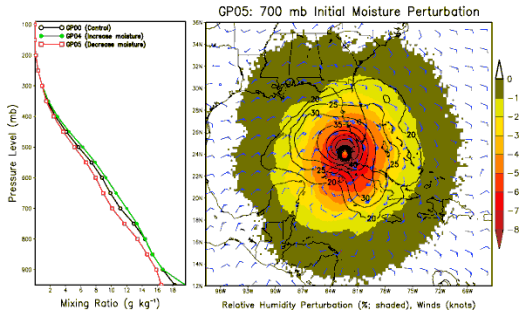
- **Part of the regional modeling effort for the NOAA / Hurricane Forecast Improvement Program (HFIP).**

Modify observed max winds and storm size



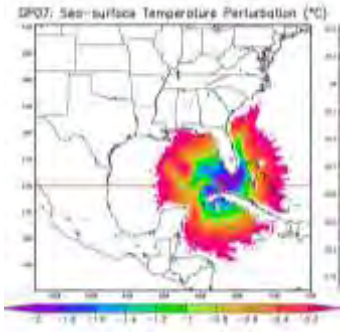
Unbogussed Member

Modify observed moisture



Control Member

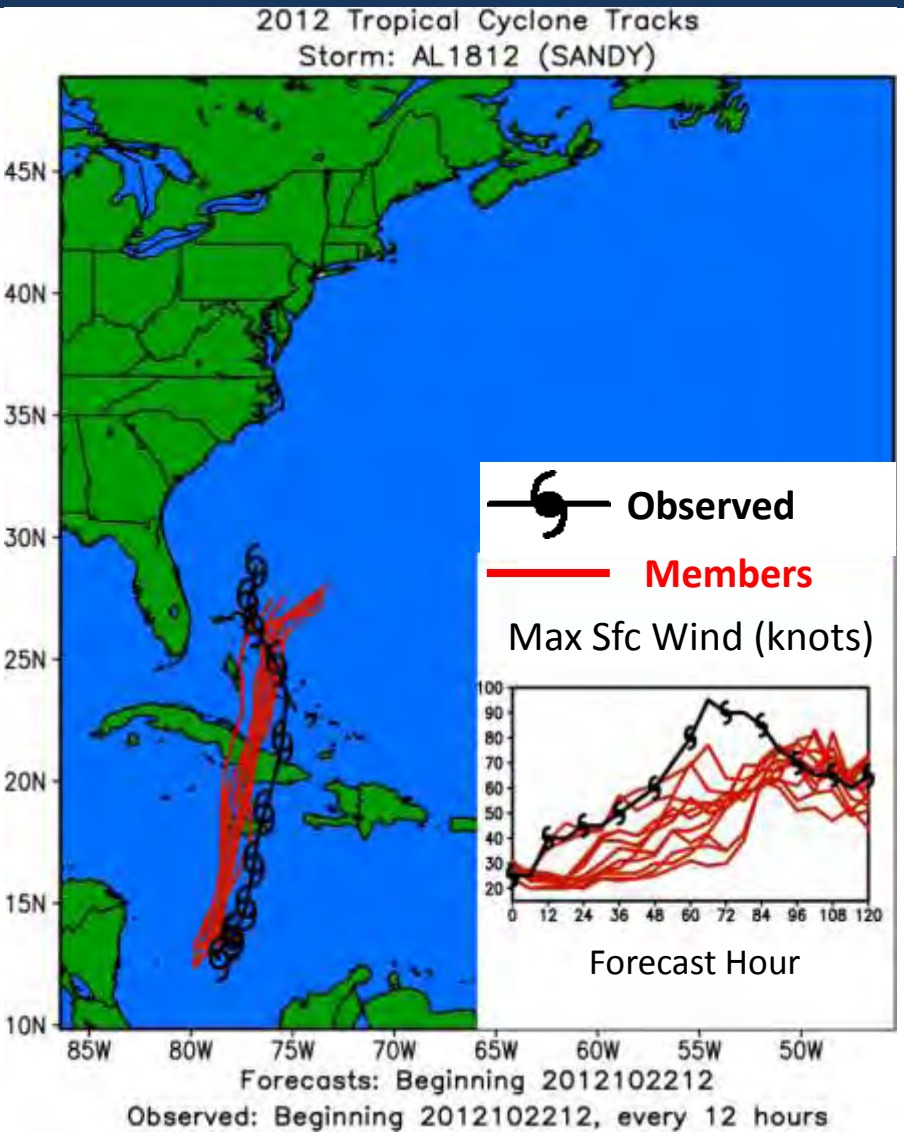
Modify observed SST



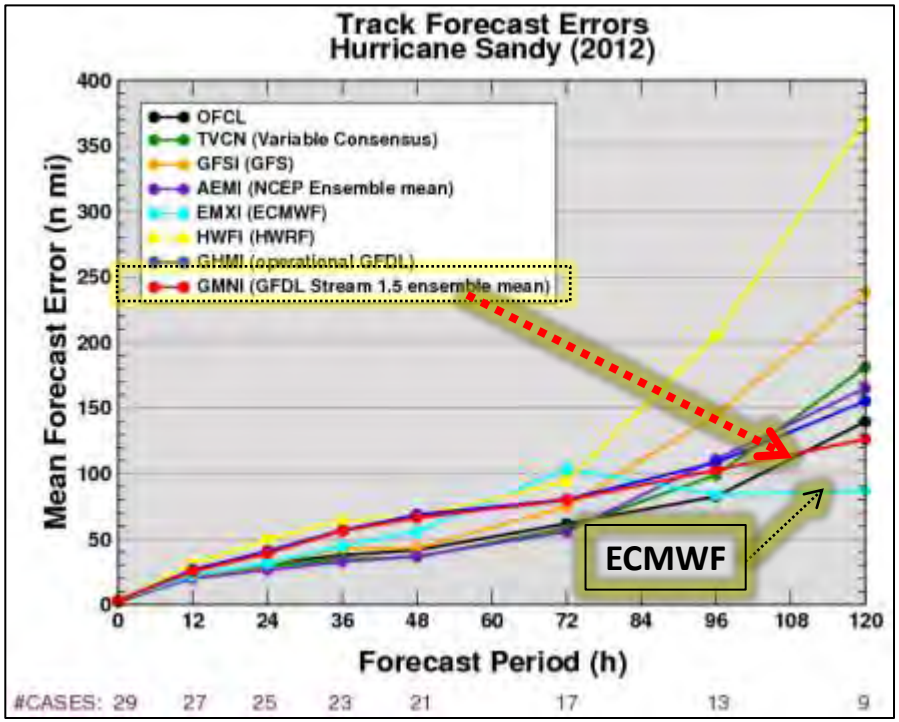
Modify surface physics parameters

- **Cd**
- **Ch**

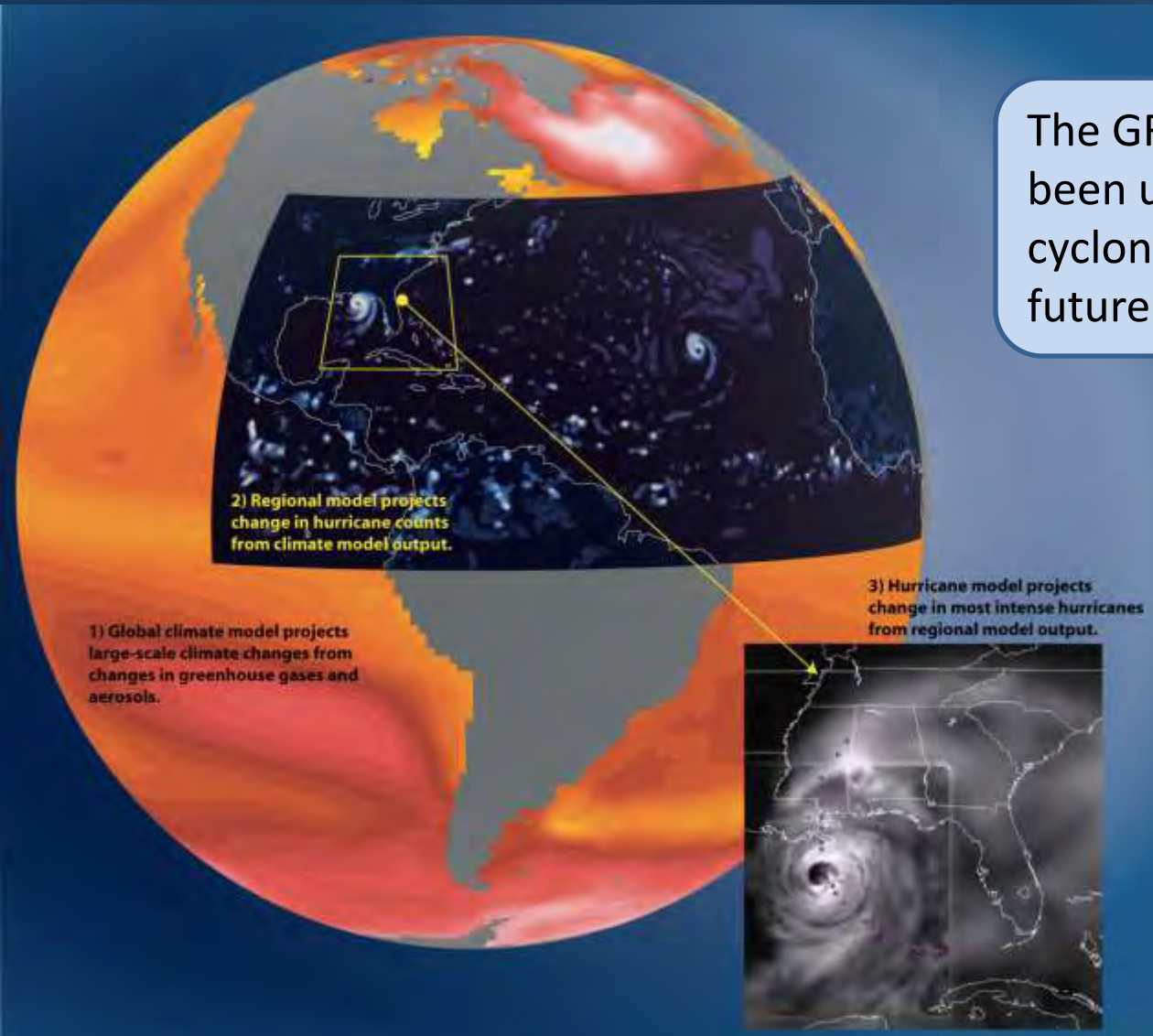
GFDL Hurricane Ensemble: Sandy



The GFDL ensemble outperformed the control for track on Sandy and was comparable with the ECMWF



Use of GFDL Hurricane Model in climate studies



The GFDL Hurricane Model has been used to project tropical cyclone intensities under future climate scenarios.

Summary

- 40+ years of model development: Research Operations

- Operational upgrades continue, including major improvements for 2014

- GFDL Hurricane Model has recently also been used as a tool for:
  - Creating an ensemble forecast system
  - Investigating projections of future hurricane intensities in climate studies