GFDL Coupled Hurricane-Wave-Ocean Prediction System for Transition to Operations

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Air-Sea Interaction Upgrades for Possible Implementation in 2006 GFDL Forecast System

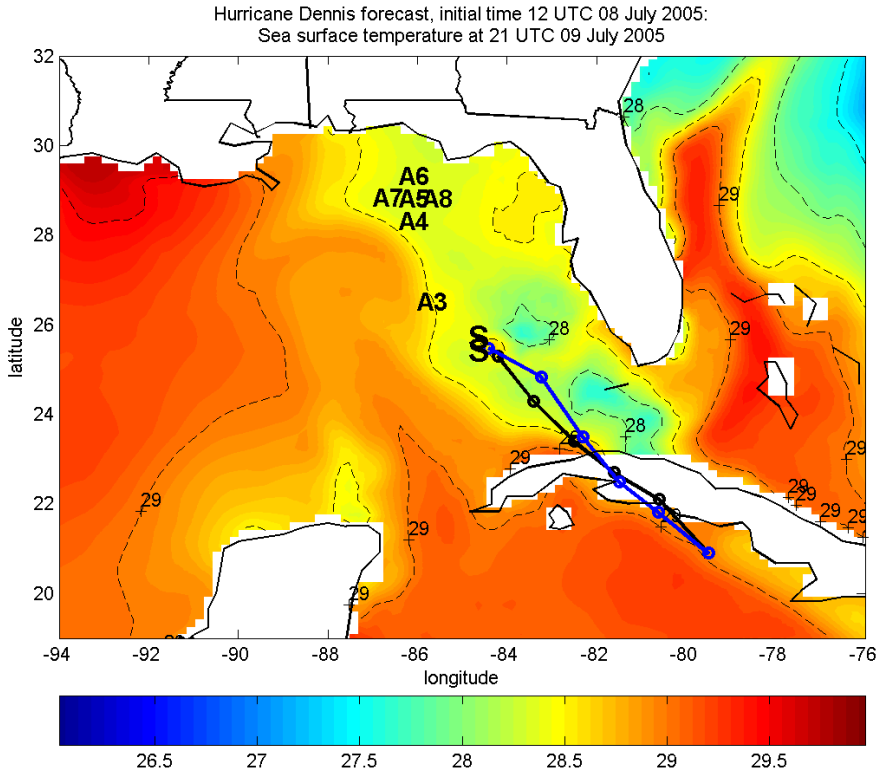
- Ocean model initialization
- Loop Current and warm-core rings initialization in the Gulf of Mexico
- Air-sea momentum flux parameterization
- Coupled hurricane-wave-ocean system

Improved Ocean Initialization

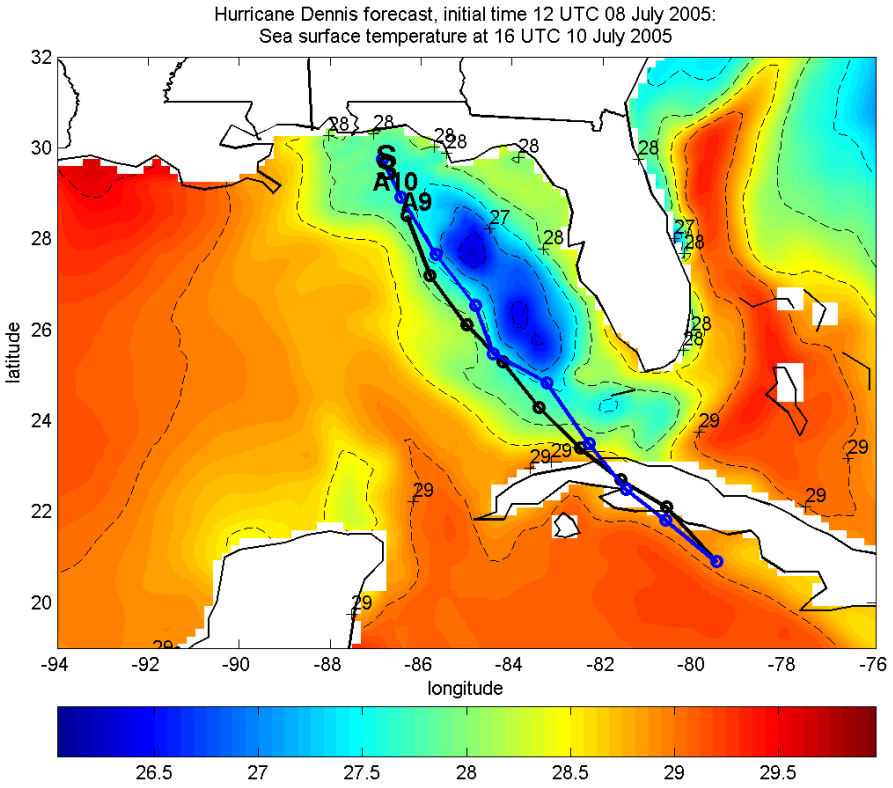
Ocean climatology data sets evaluated:
GDEM 0.5, GDEM 0.25, LEVITUS 0.25

Comparisons with AXBT profiles in Hurricane Dennis (2005)

AXBTs in Front



AXBTs in Wake

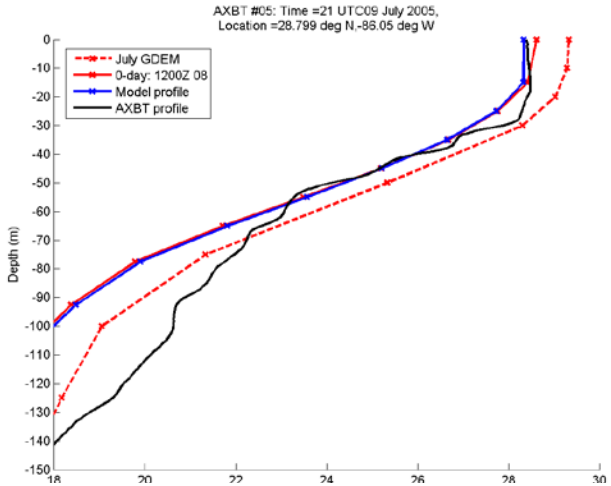


AXBT data provided by Eric Uhlhorn, NOAA HRD

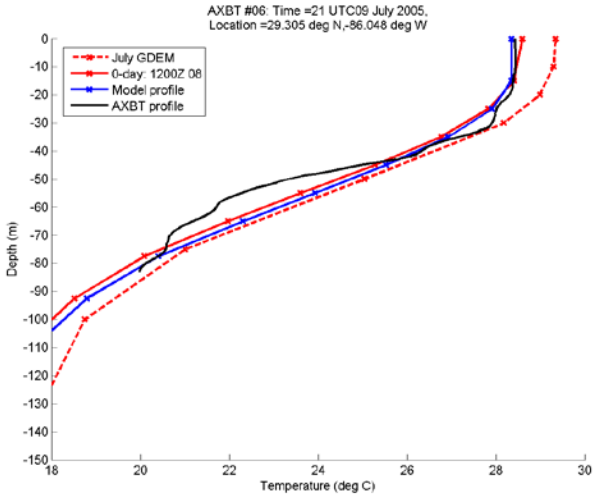
Improved Ocean Model Initialization

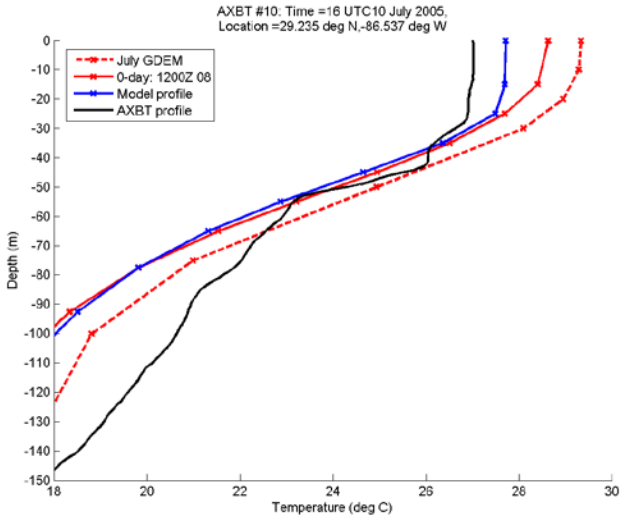
GDEM 0.5 Ocean climatology provides better comparisons with AXBTs

Comparisons with AXBT profiles in Hurricane Dennis (2005)

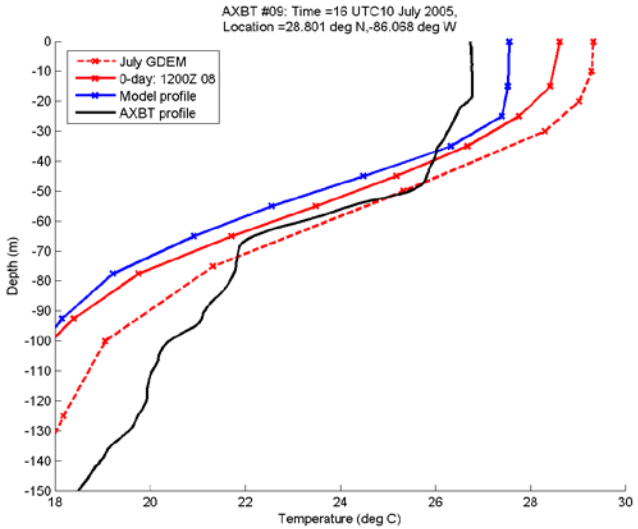


AXBTs in Front



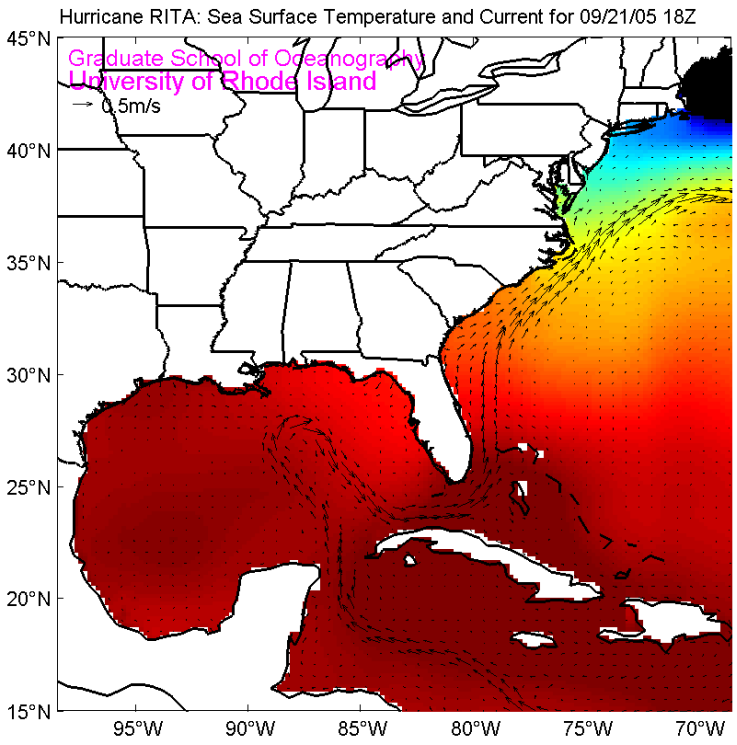


AXBTs in Wake

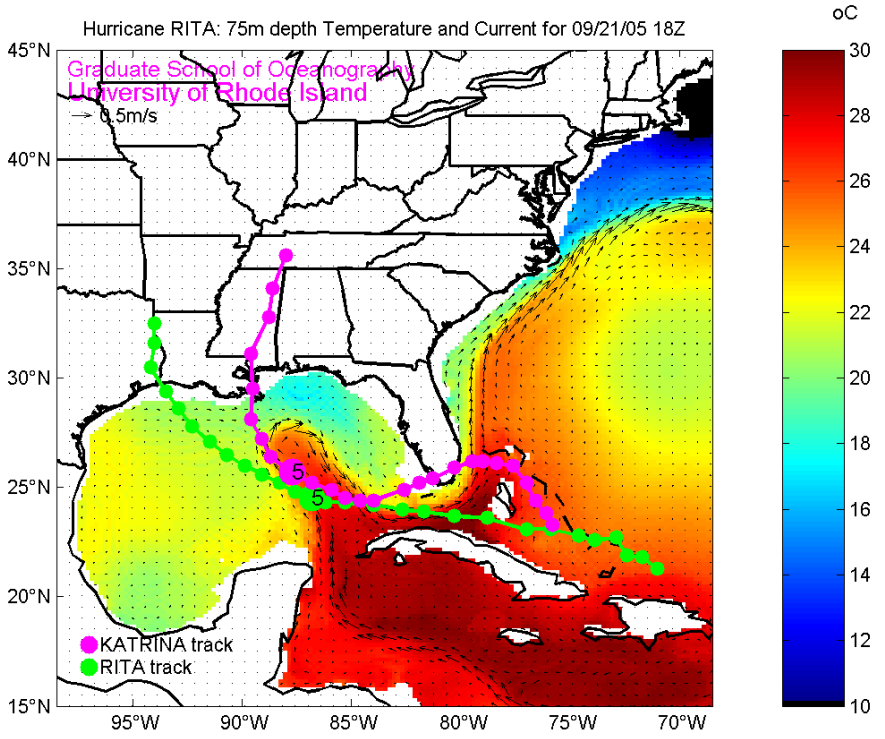


Hurricanes Katrina and Rita – “Perfect” Storms ?

NCEP SST Analysis



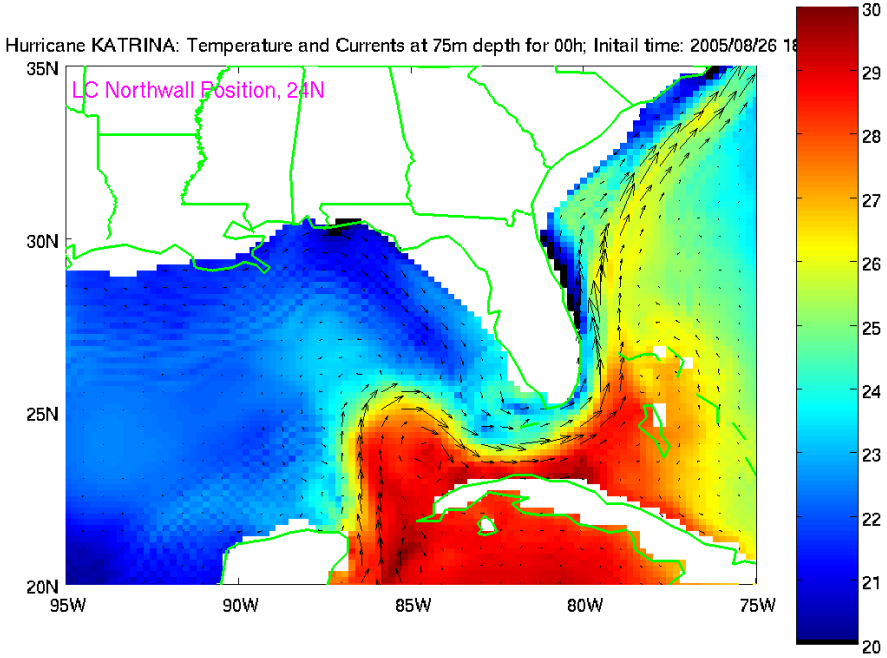
GDEM 0.5 temperature at 75 m depth with LC



New Loop Current Initialization

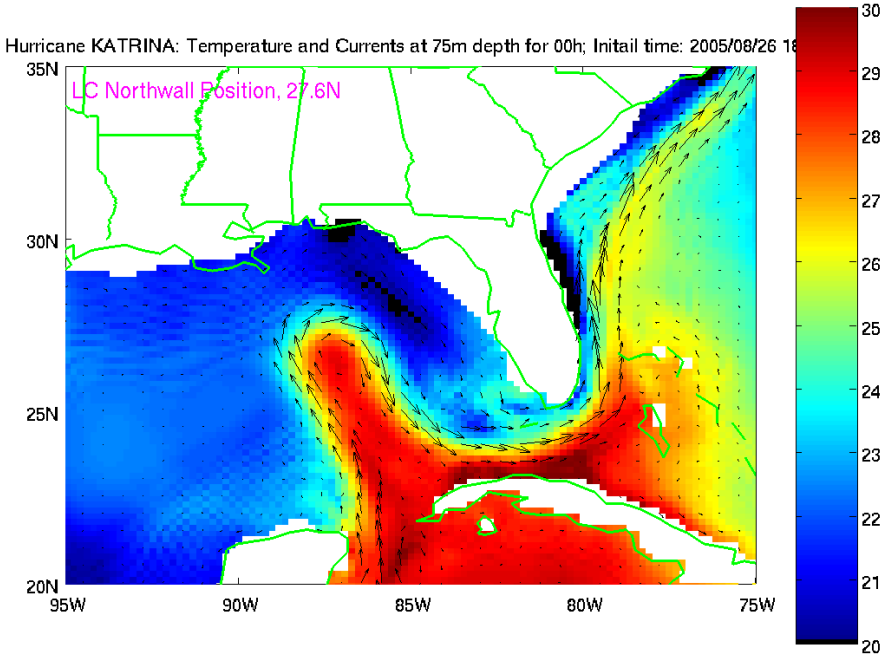
2005 GFDL

Temperature 75 m depth



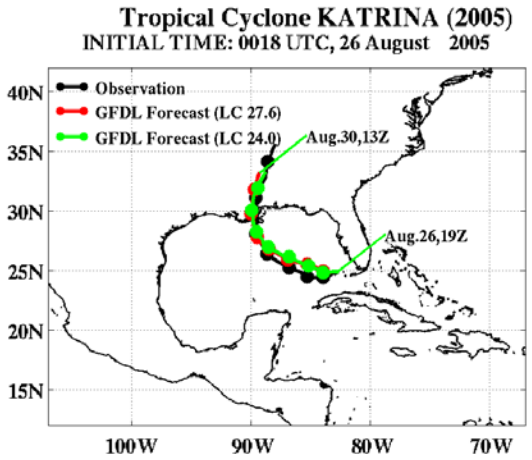
2006 GFDL

Temperature 75 m depth

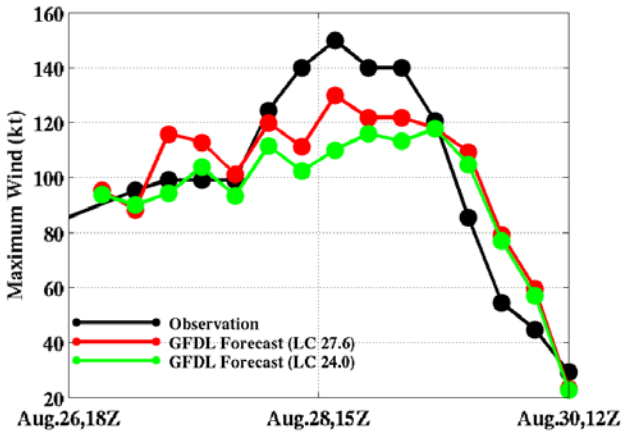


Effect of Loop Current on Hurricane Katrina

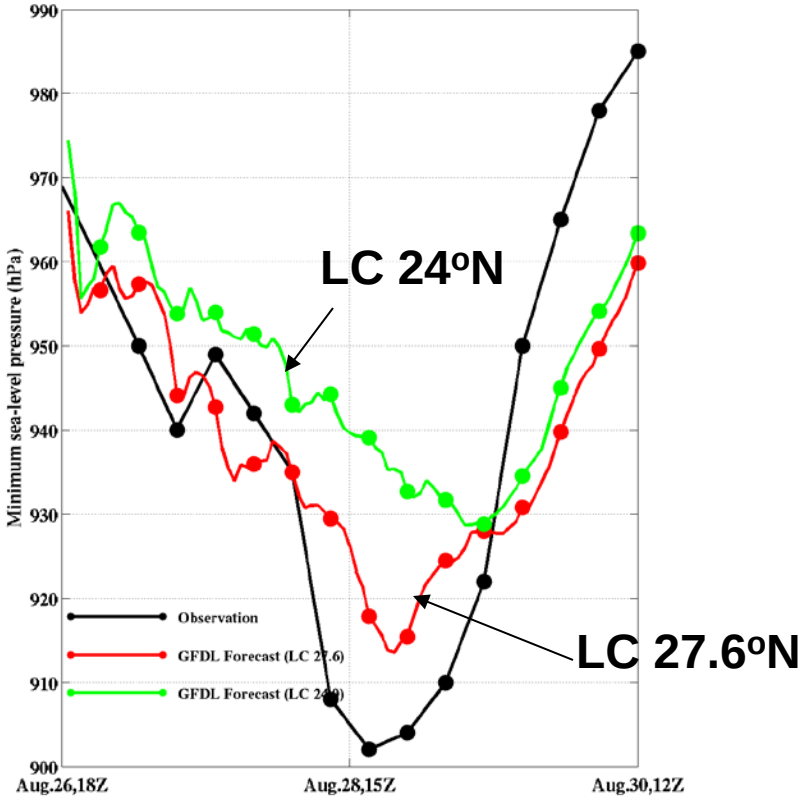
Red – LC 27.6ºN, **Green – LC 24ºN**



Maximum Winds

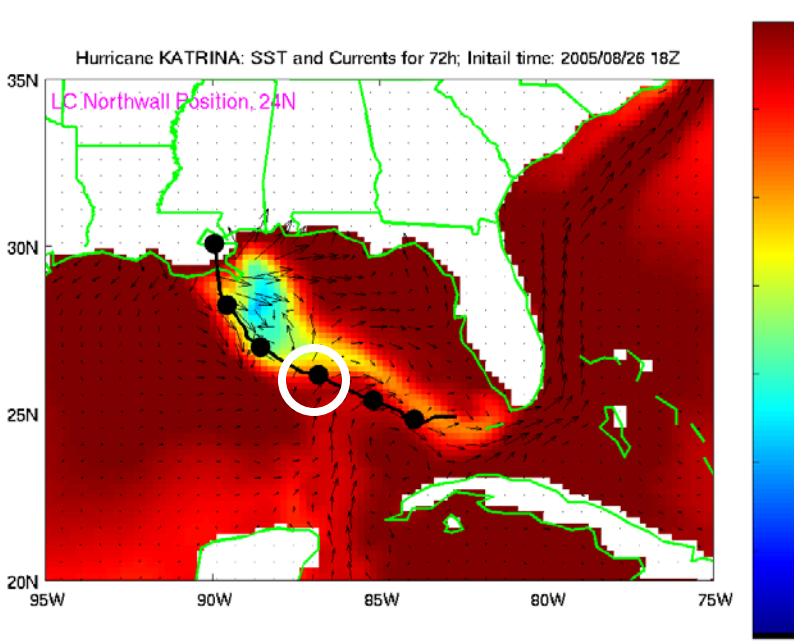


Central Pressure

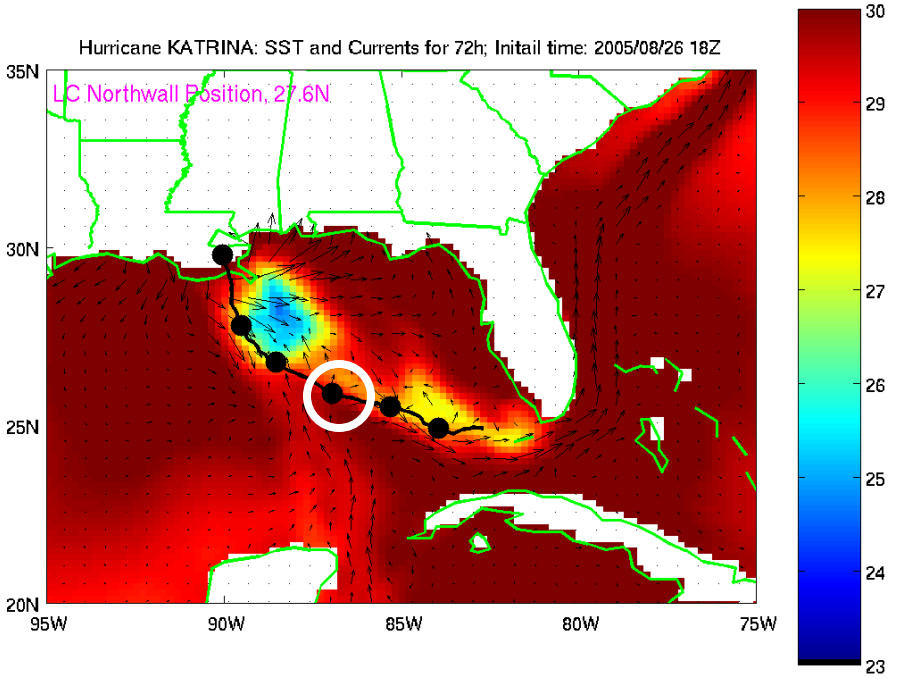


Effect of Loop Current on SST Response in Hurricane Katrina

2005 GFDL

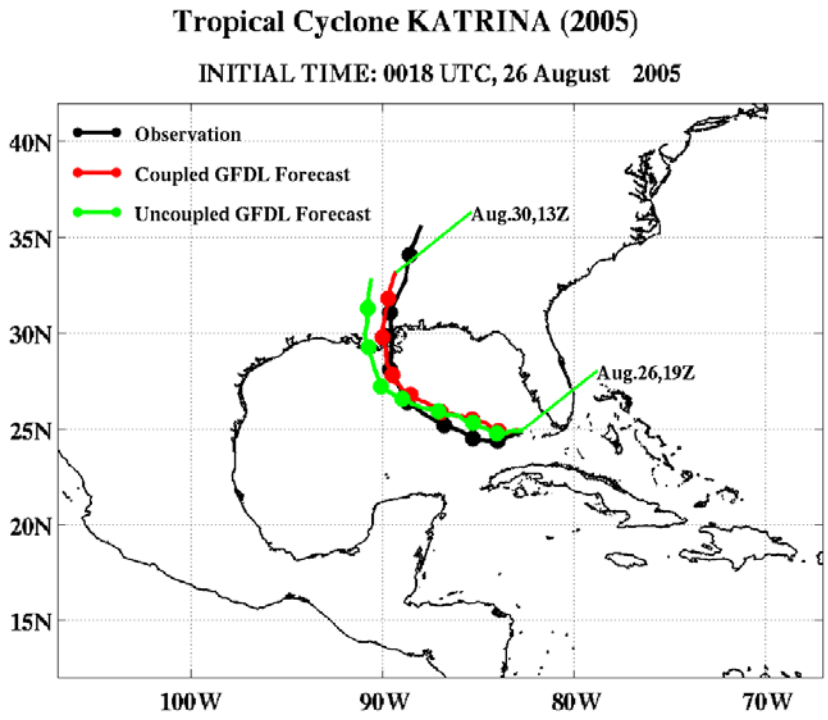


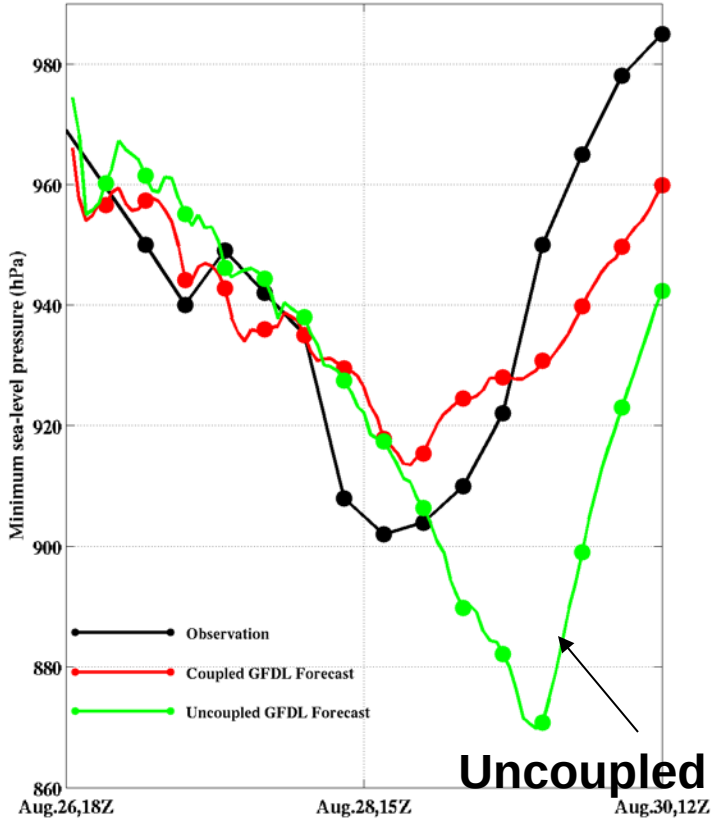
2006 GFDL



Effect of Ocean Coupling on Hurricane Katrina

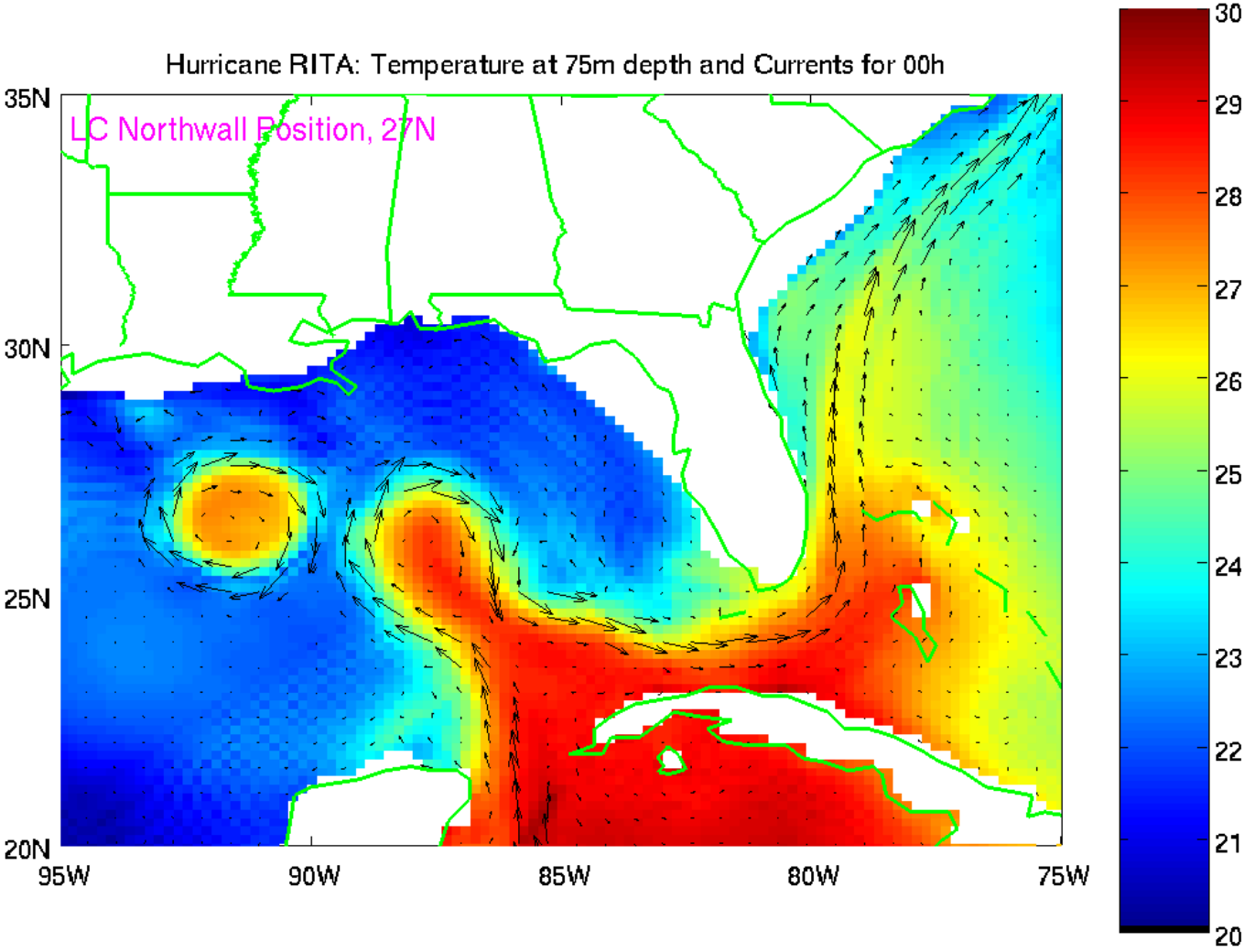
Red – Coupled Model, **Green – Uncoupled Model (fixed SST)**



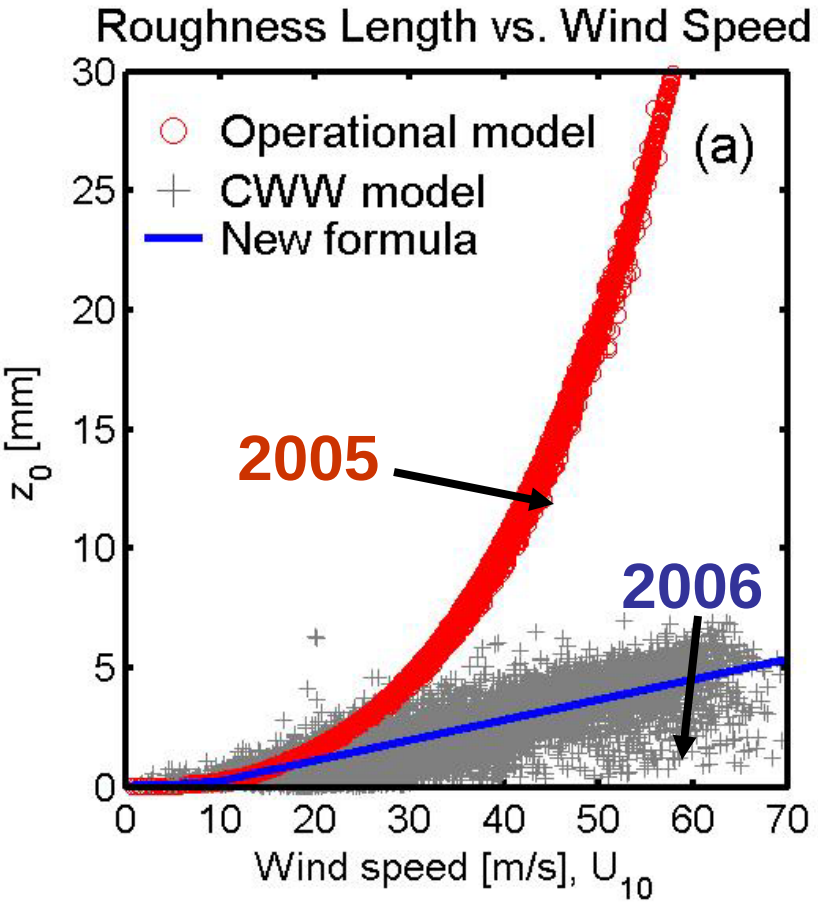


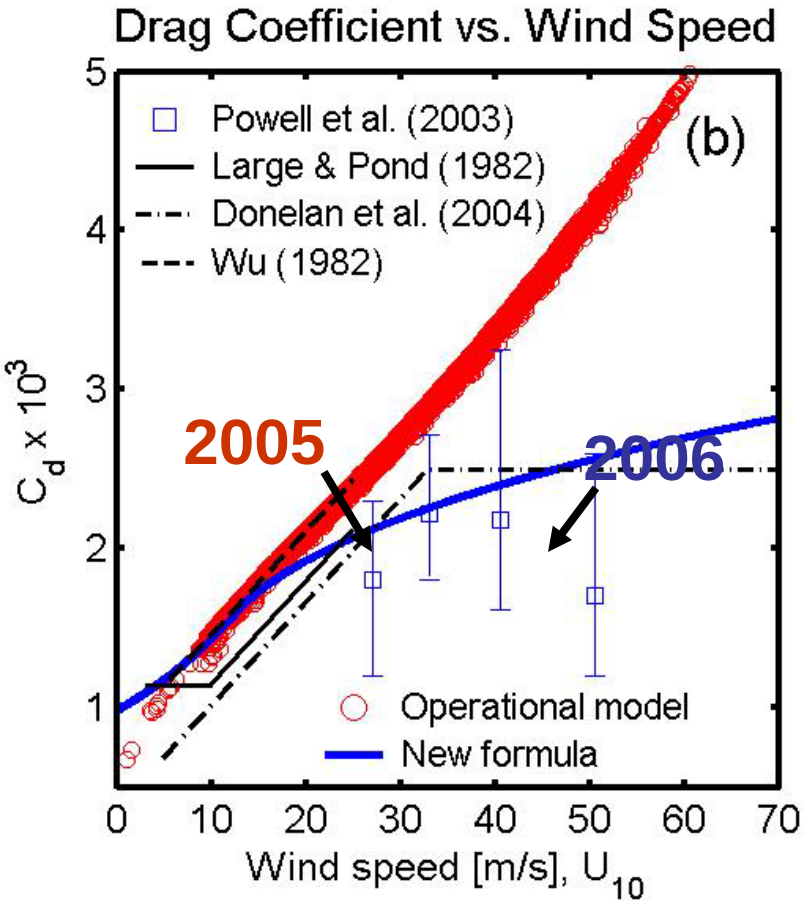
New Loop Current and Warm-Core Ring Initialization

Temperature 75 m depth



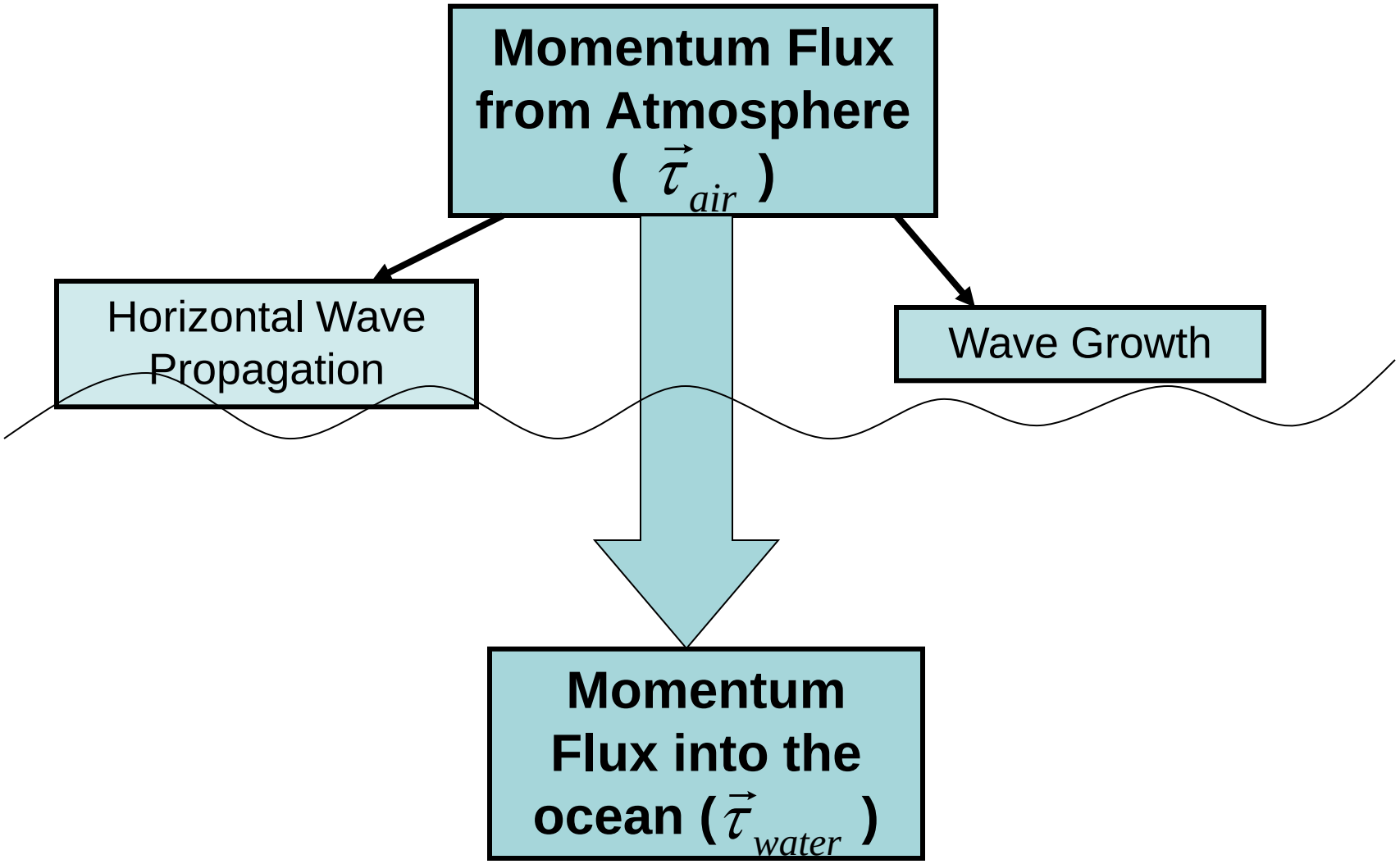
Improved Momentum Flux Parameterization



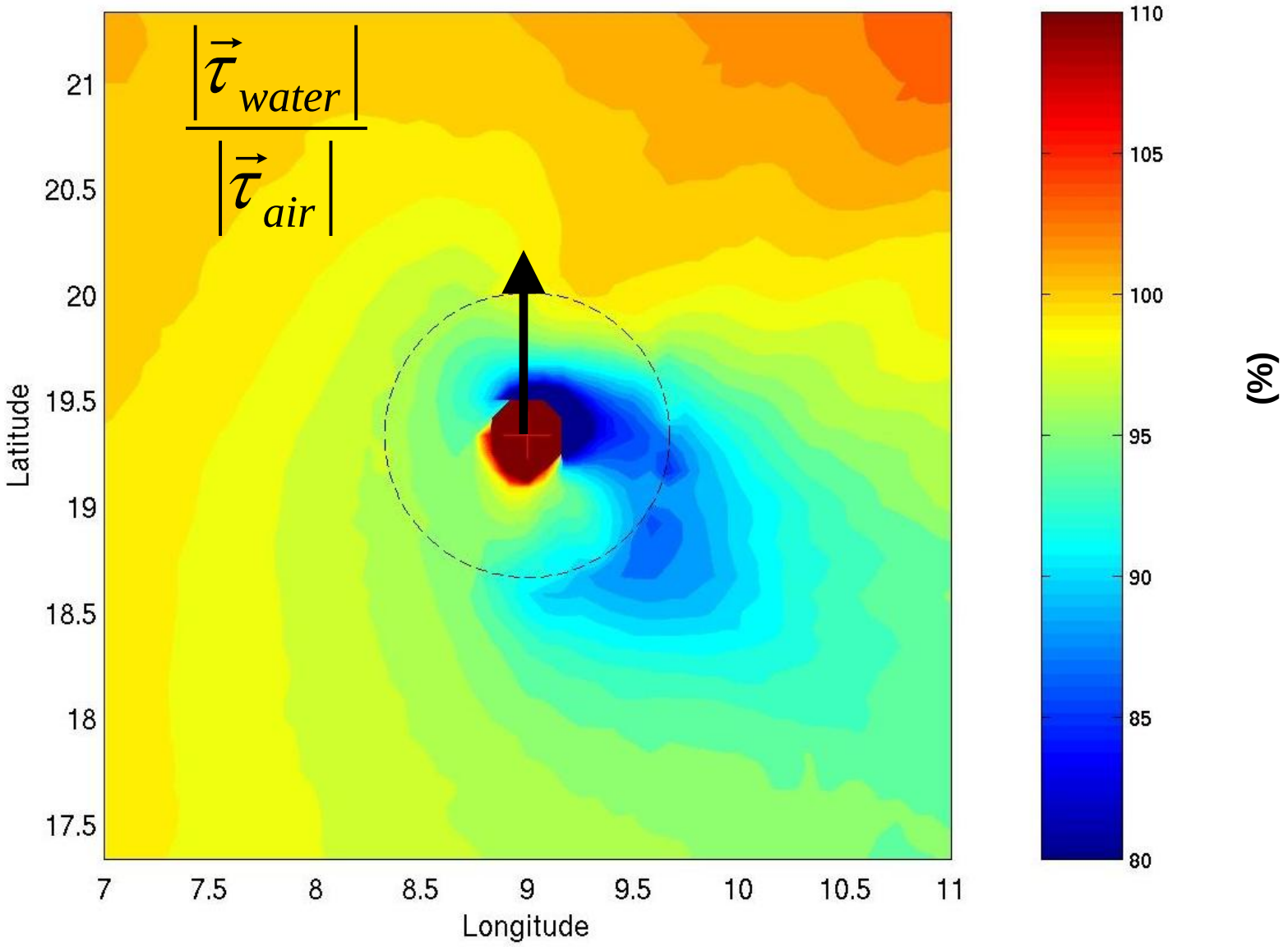


New roughness length and drag coefficient parameterization are based on coupled wind-wave simulations (CWW) in hurricanes using an improved version of WAVEWATCH III

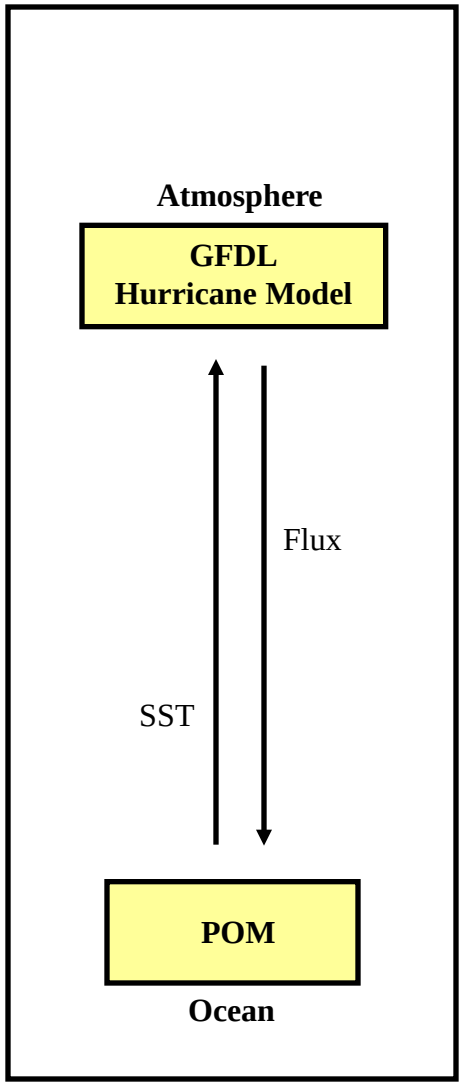
Improved Ocean Momentum Flux Parameterization



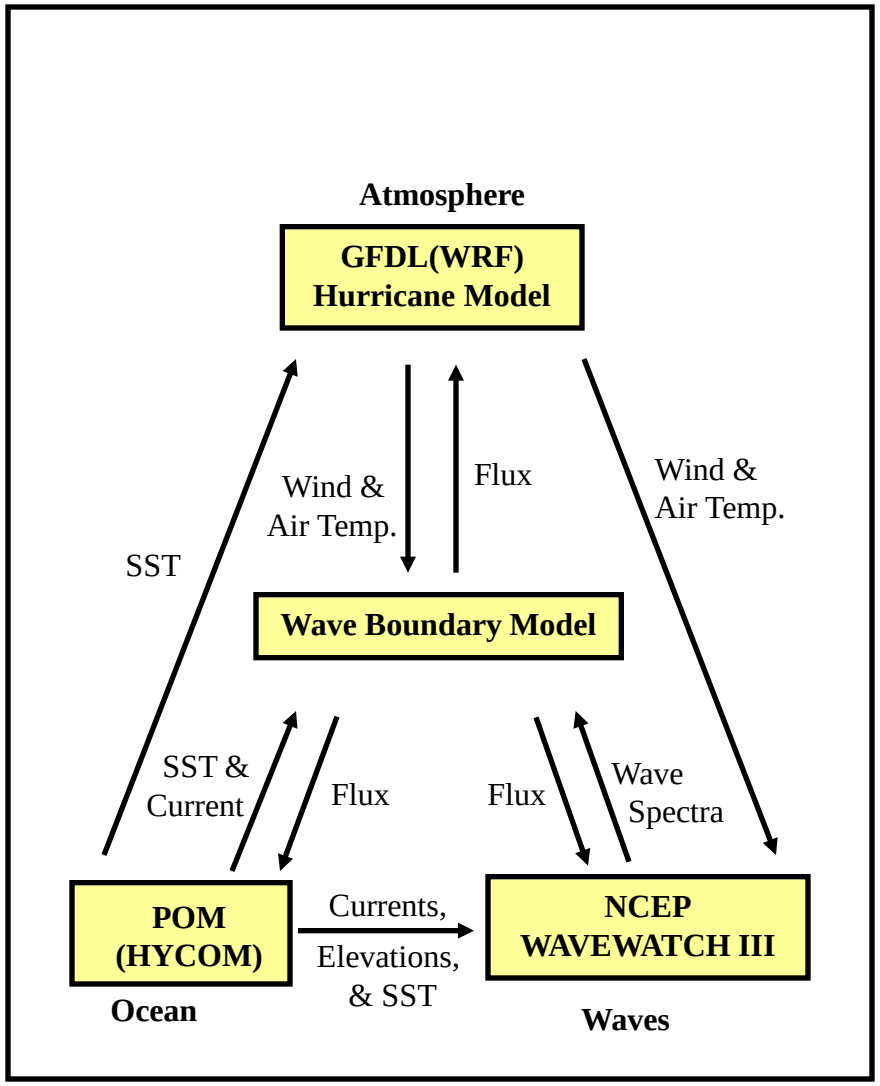
Surface Waves in Hurricanes Reduce Momentum Flux Into Ocean by 10-15%



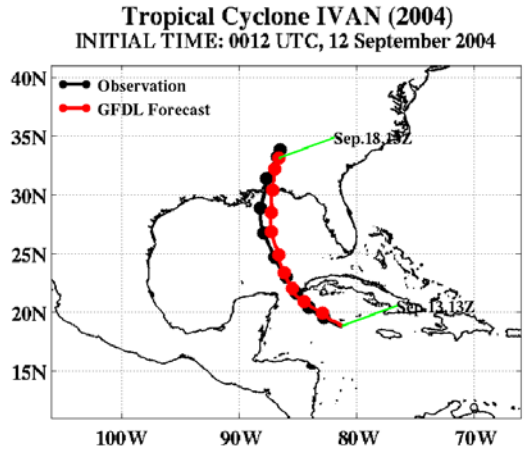
2005 GFDL

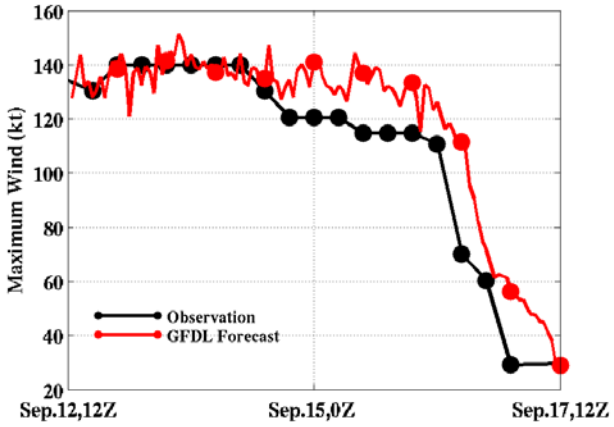


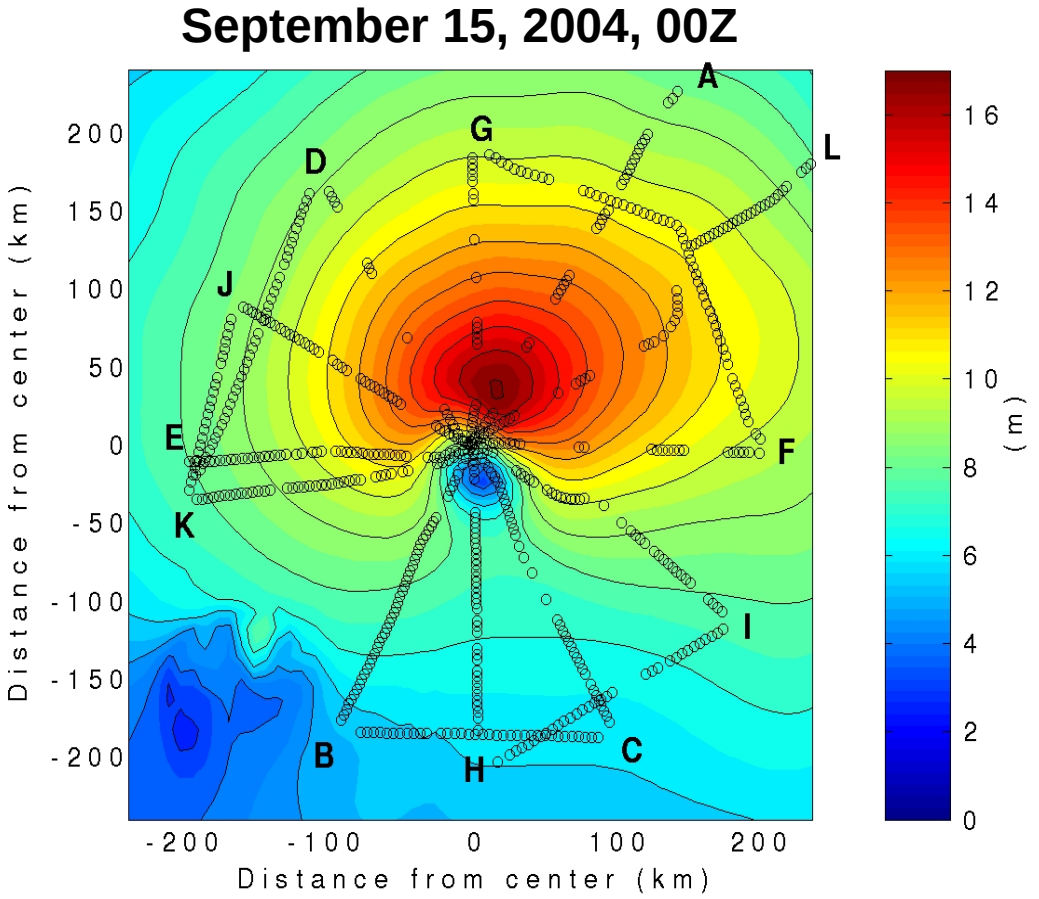
GFDL Hurricane-Wave-Ocean Model



Hurricane Ivan: Wave Field in the GFDL Model Coupled with WW3

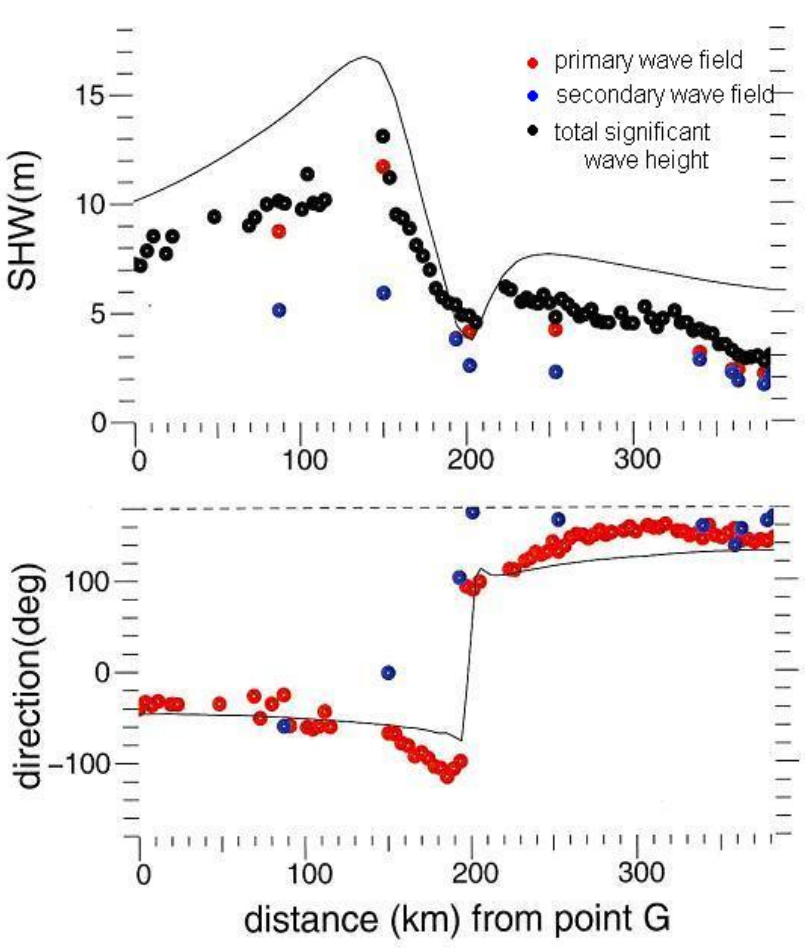


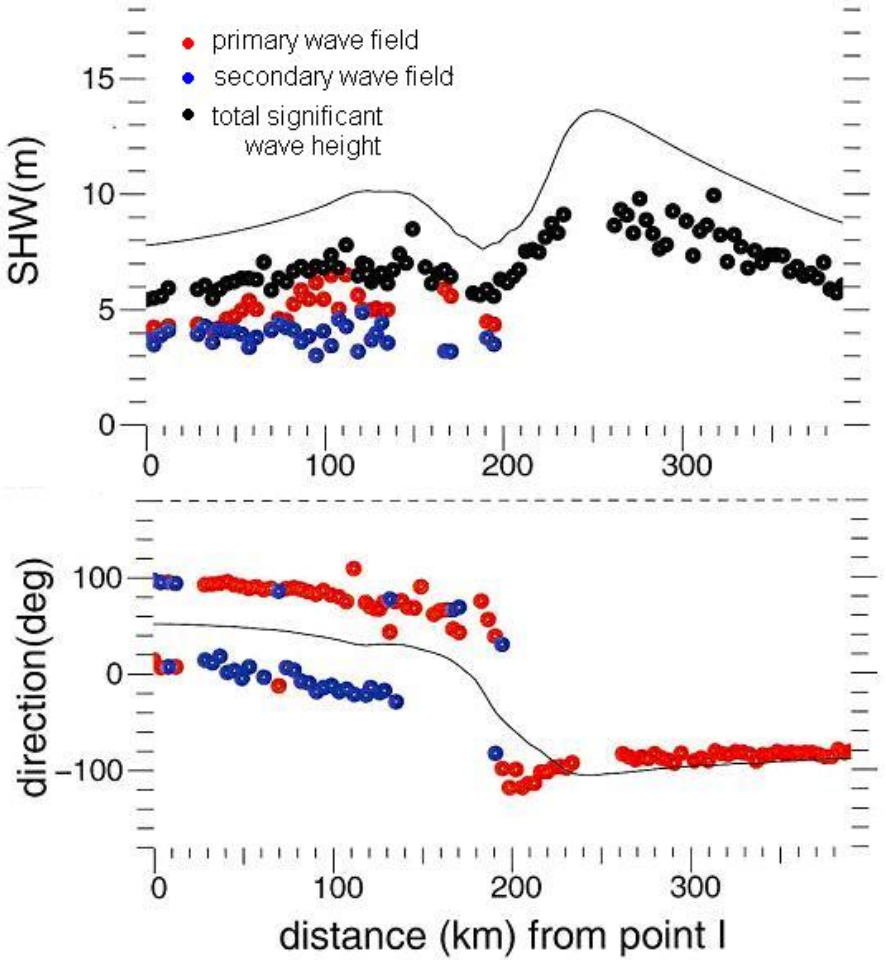




Circles indicate the locations of the SRA measurements, courtesy of Ed Wash, NASA

Hurricane Ivan: Comparisons Between WW3 and SRA data

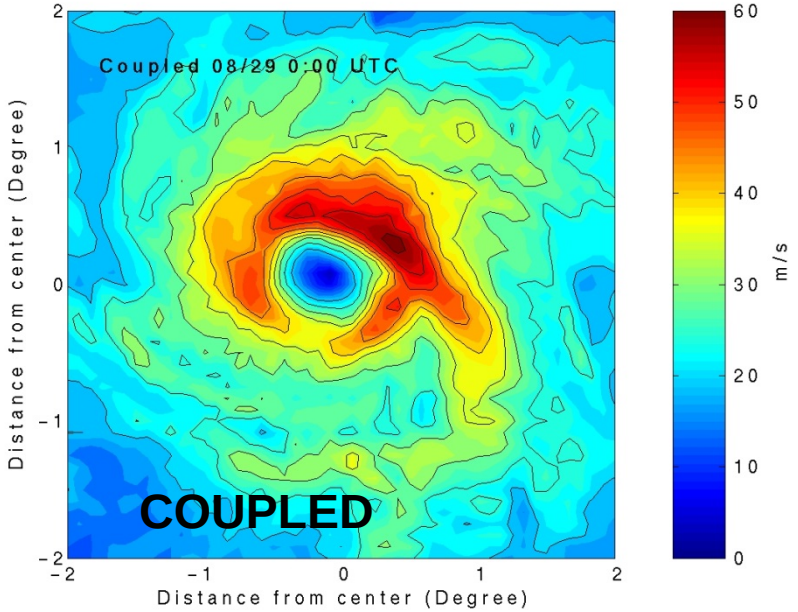


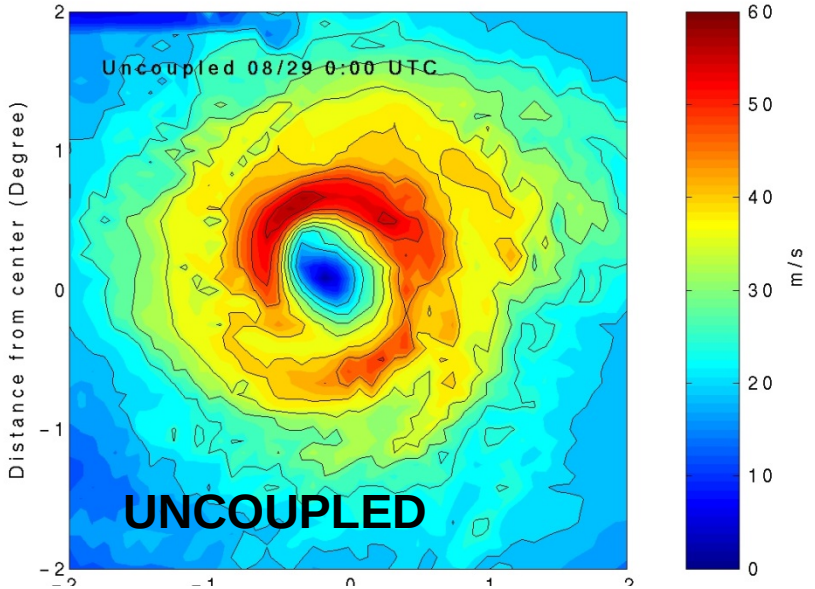


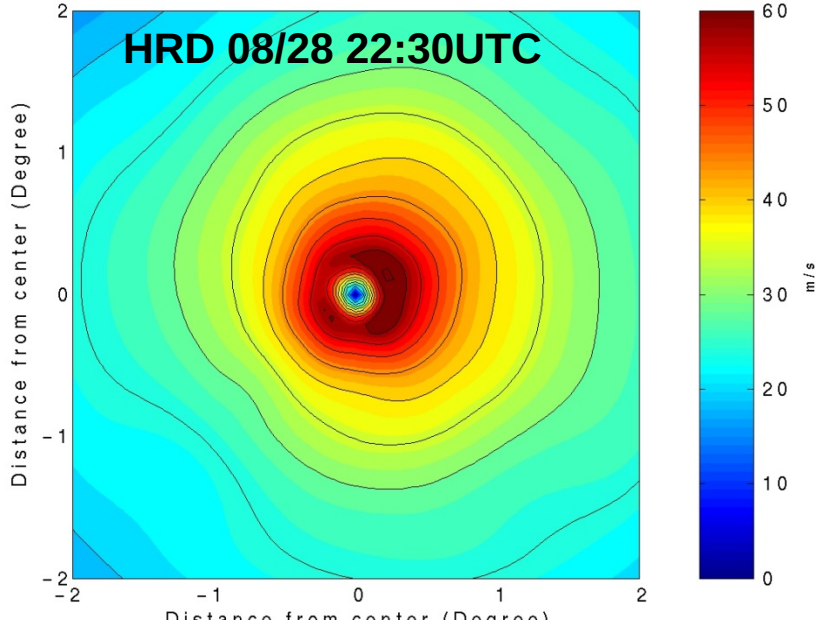
SRA Data Courtesy of Ed Wash, NASA

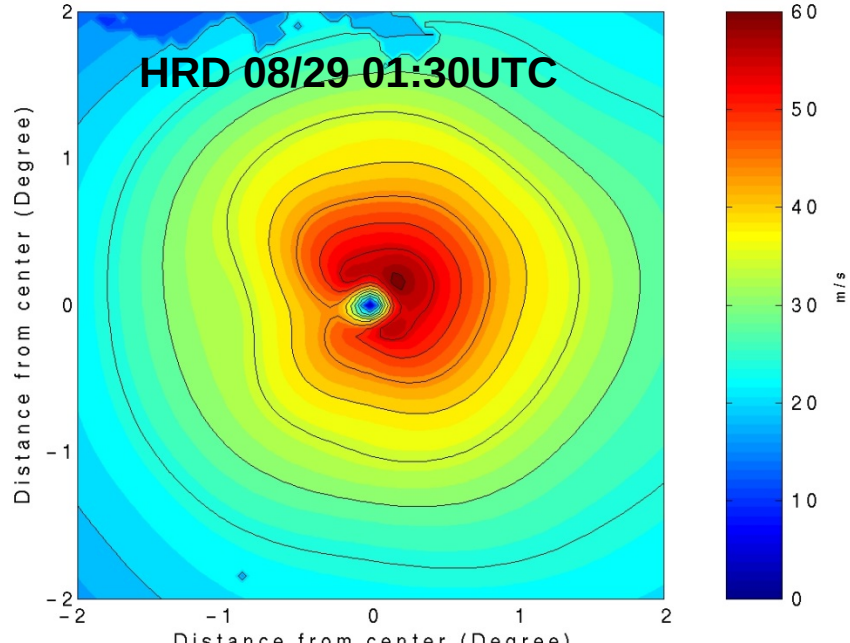
Structure Change due to Wave Coupling

Hurricane Katrina: Surface Wind Field on Aug. 29, 0Z

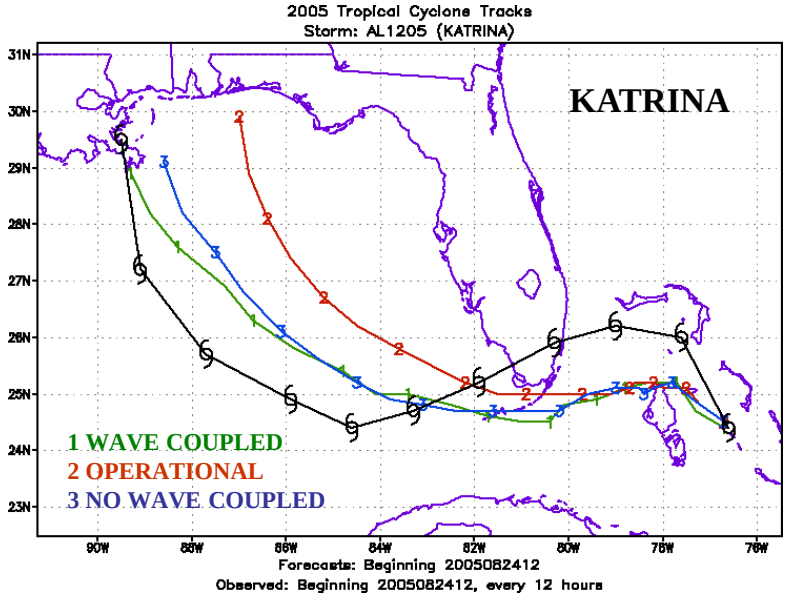


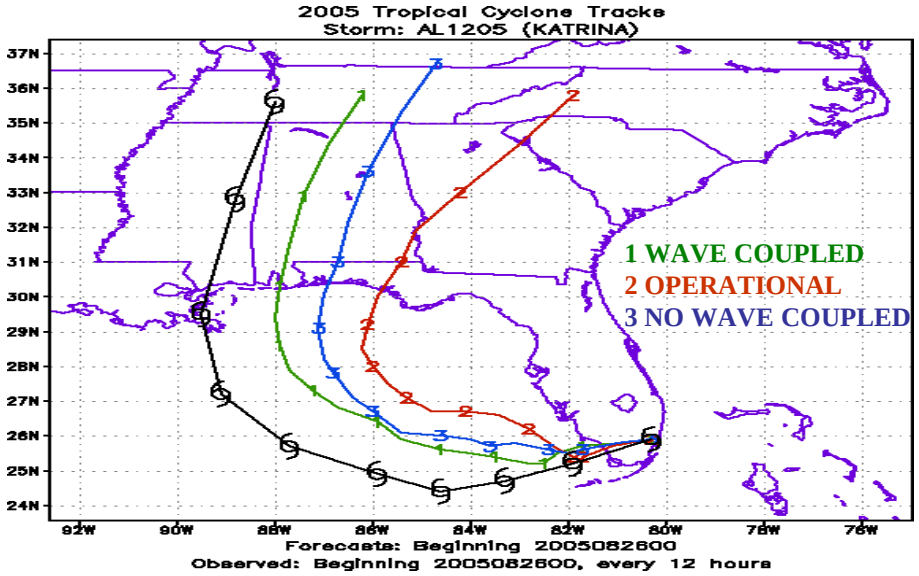


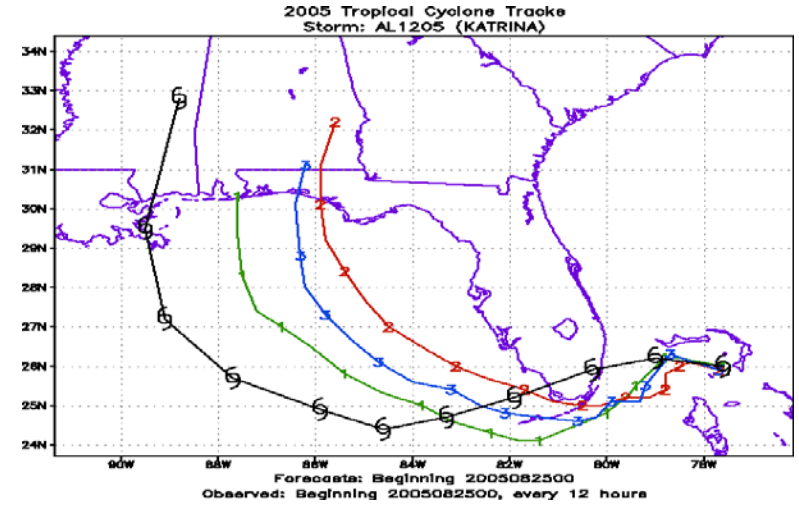


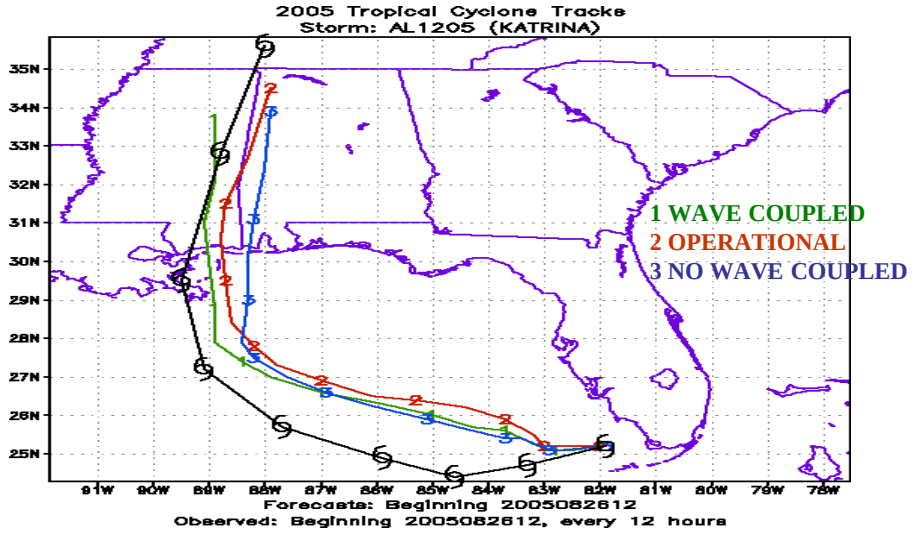


Potential of Further Track Forecast Improvements With Full Wave Coupling









Summary

- Major improvements to the air-sea interaction component of the GFDL model for 2006 hurricane season.

- Evaluation of the GFDL coupled hurricane-wave-ocean system is currently underway for its possible implementation in 2006, depending on amount of resources available and the extend of the positive impact.