# Coupled ARW-HYCOM and Applications in Air-Sea Interaction and Hurricane Studies

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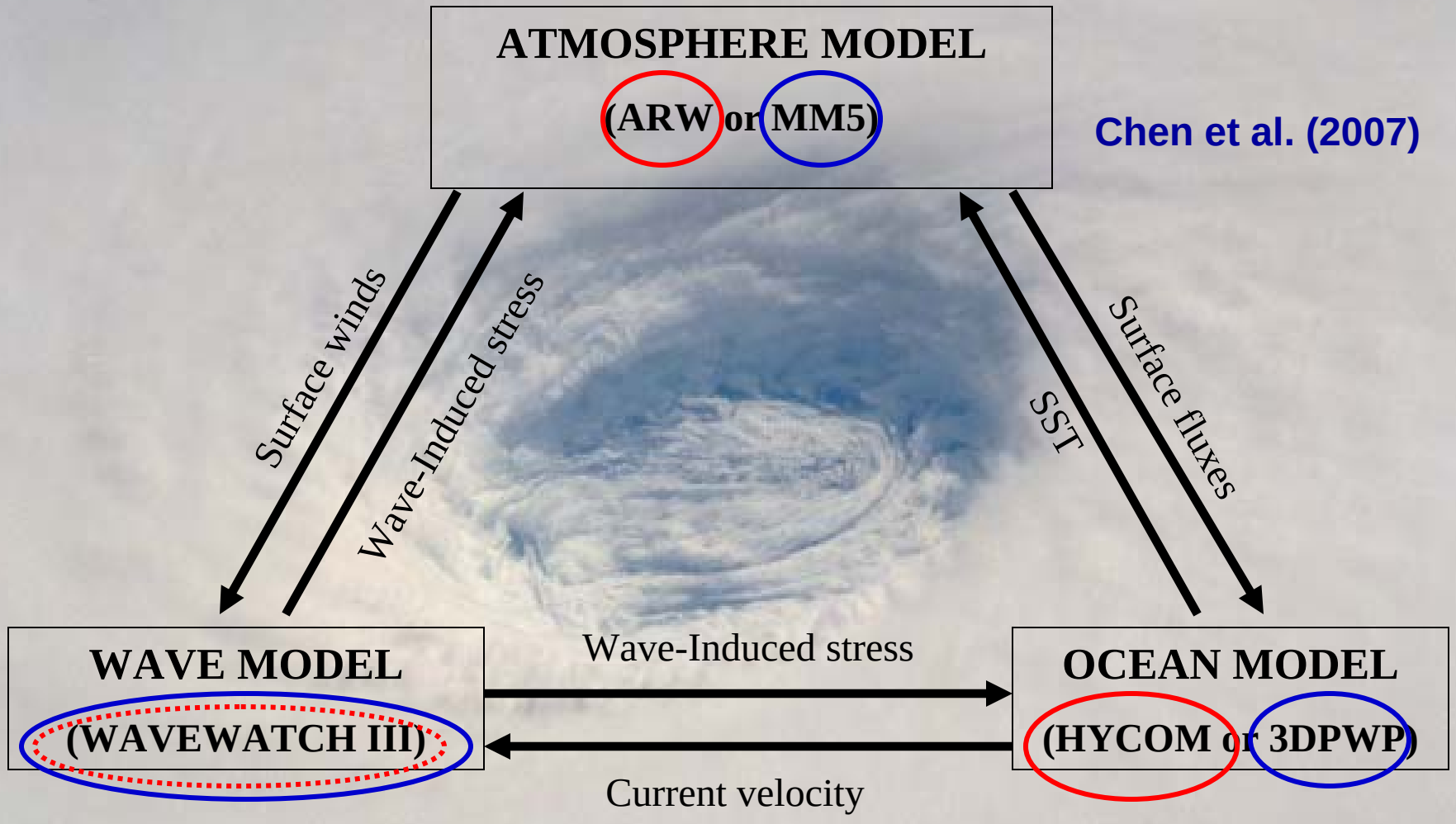
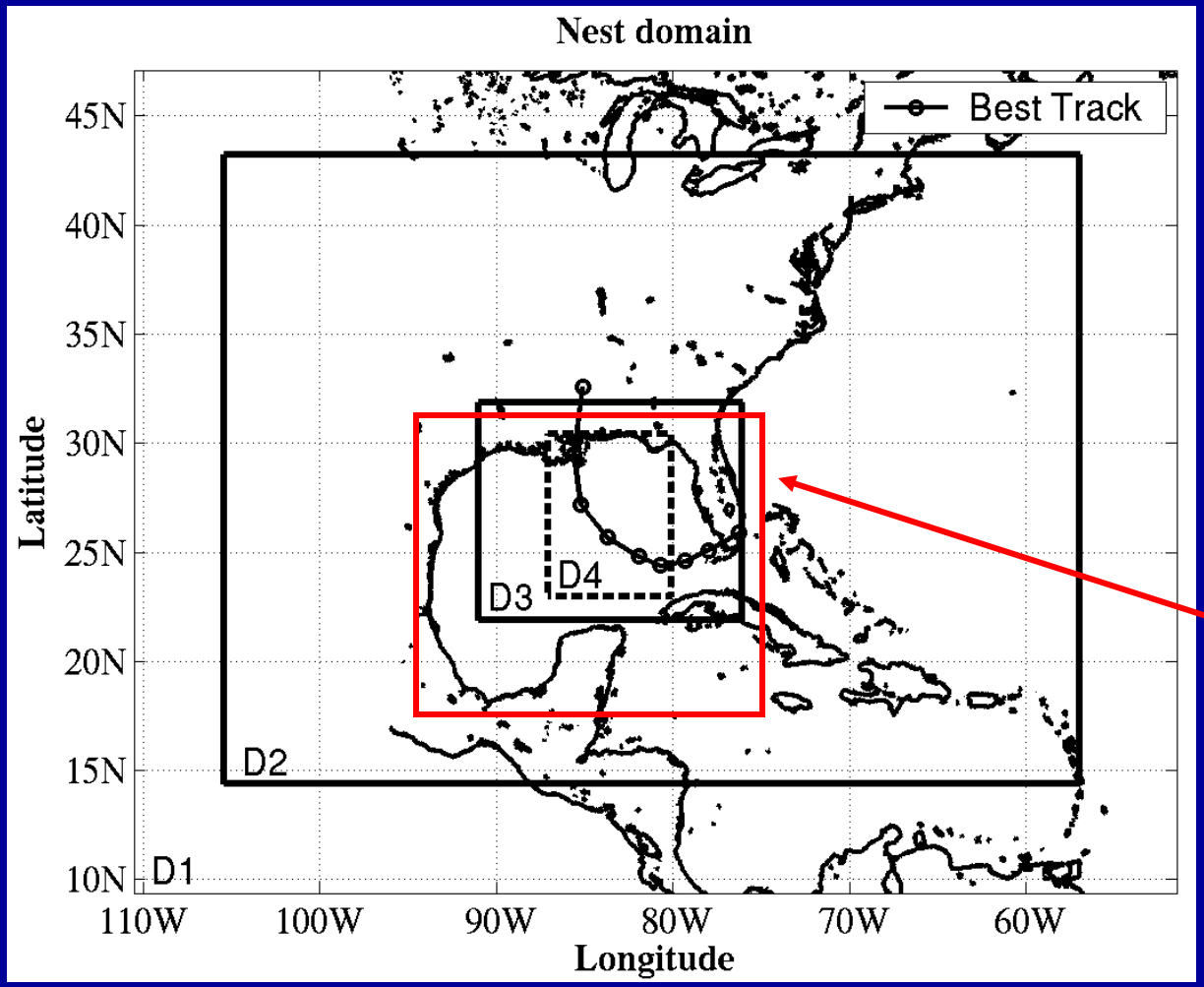
# Objectives

- To better understand the air-sea interaction and its impact on hurricane structure and intensity change using a coupled atmosphere-ocean model and observations.
- To develop and improve the coupled modeling system for hurricane research and prediction.

# Coupled Atmosphere-Wave-Ocean Modeling System for Hurricane Predictions



# ARW and HYCOM Configurations




- ARW: 35 levels
- D1 36km (160x120)
- D2 12km (391x271)
- D3 4km (361x271)
- D4 1.3km (508x604)

- HYCOM: 20 levels
- 1/24 degree (515x349)

**ARW Physics:**

| Domains | D1 | D2 | D3 | D4 |
|---|---|---|---|---|
| Cu | KF | KF | none | none |
| MicroPhys | WSM-5 | WSM-5 | WSM-5 | WSM-5 |
| Sfc_layer | SLAB | SLAB | SLAB | SLAB |
| PBL | YSU | YSU | YSU | YSU |

**HYCOM Physics:**

**GISS mixed layer physics**

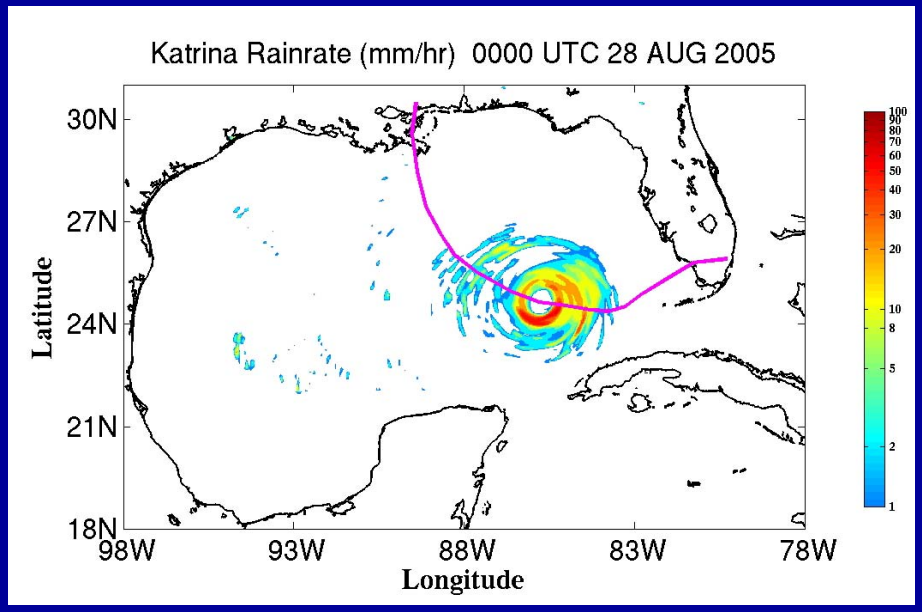
**(Goddard Institute for Space Studies)**

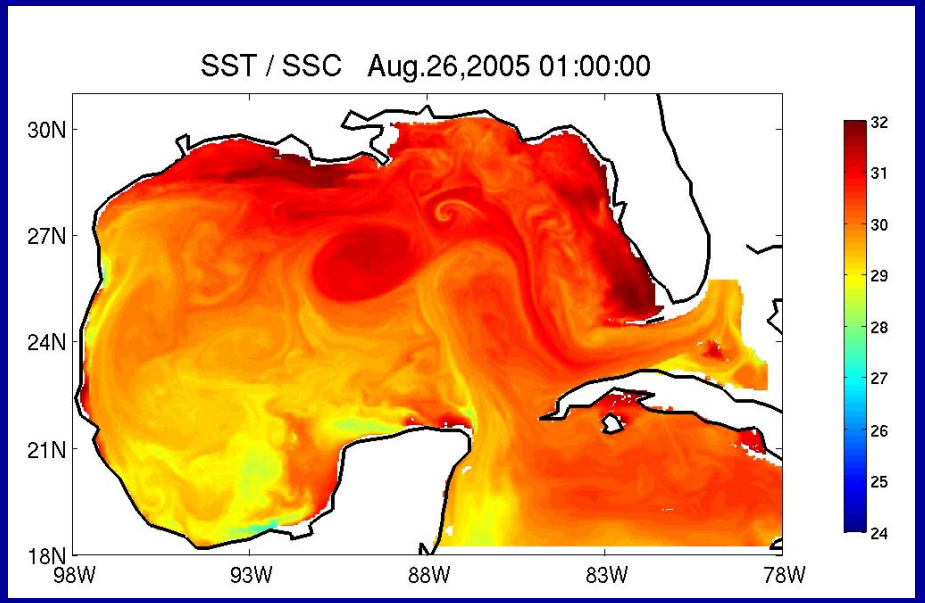
# Initial conditions

- **ARW: initial and lateral boundary condition are from the NCAR's EnKF data assimilation (Dr. Y.-S. Chen) started at 0000 UTC 26 August 2005**

- **HYCOM: initial and lateral boundary conditions are from the global HYCOM data assimilation system with 7-9 layers in the mixing layer and the 1st layer at 3 m**

# ARW-HYCOM Coupling




**ARW m processors**

**HYCOM n processors**

ARW sends
- surface winds
- air T and q
- precipitation
- radiative fluxes

ARW receives:
- SST

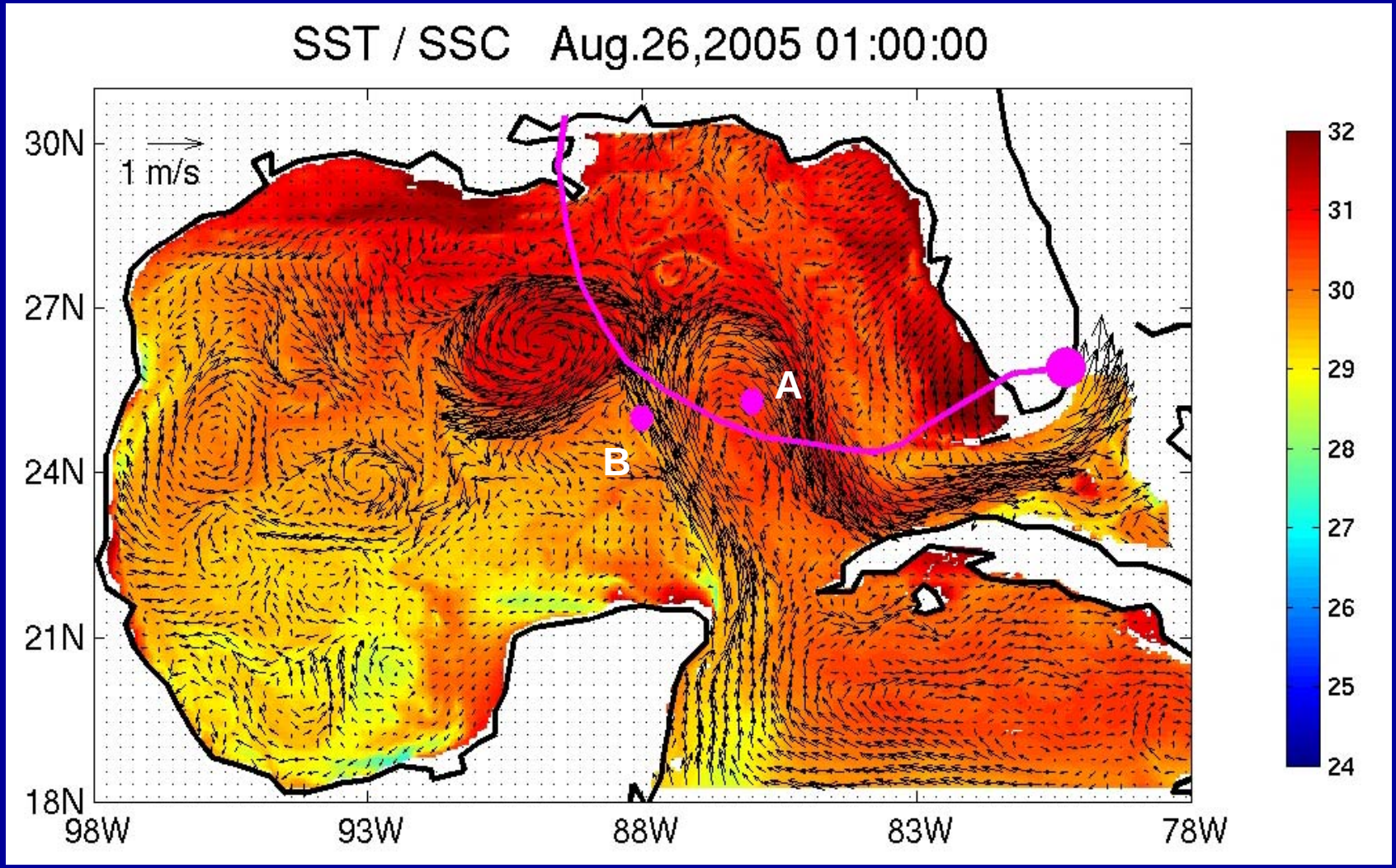
**MCEL**

**(Model Coupling Executable Lib)**

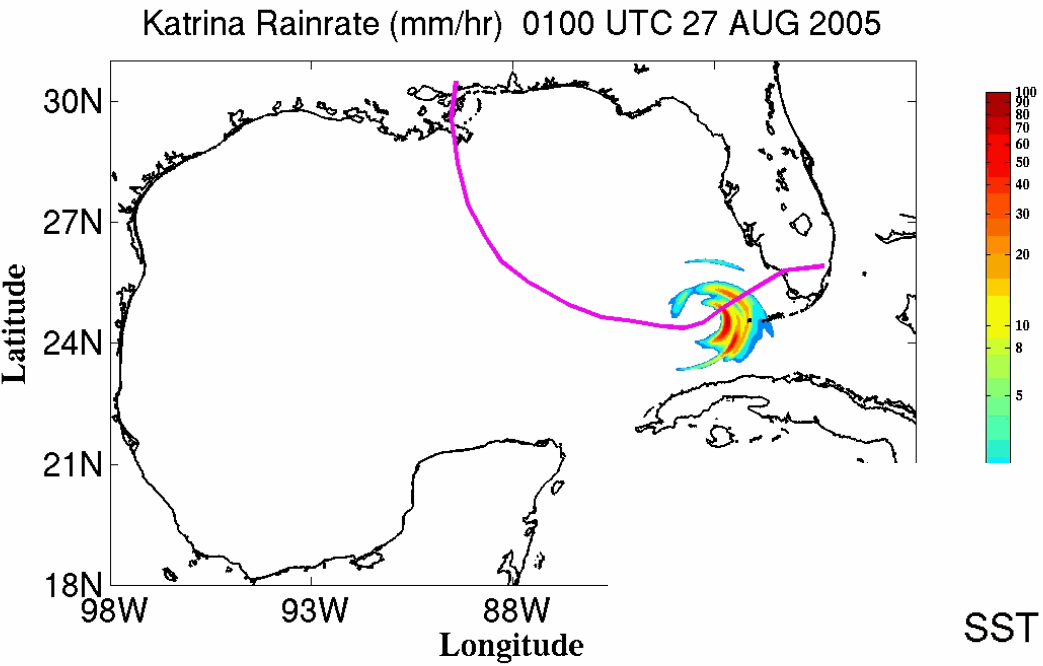
HYCOM sends:
- SST

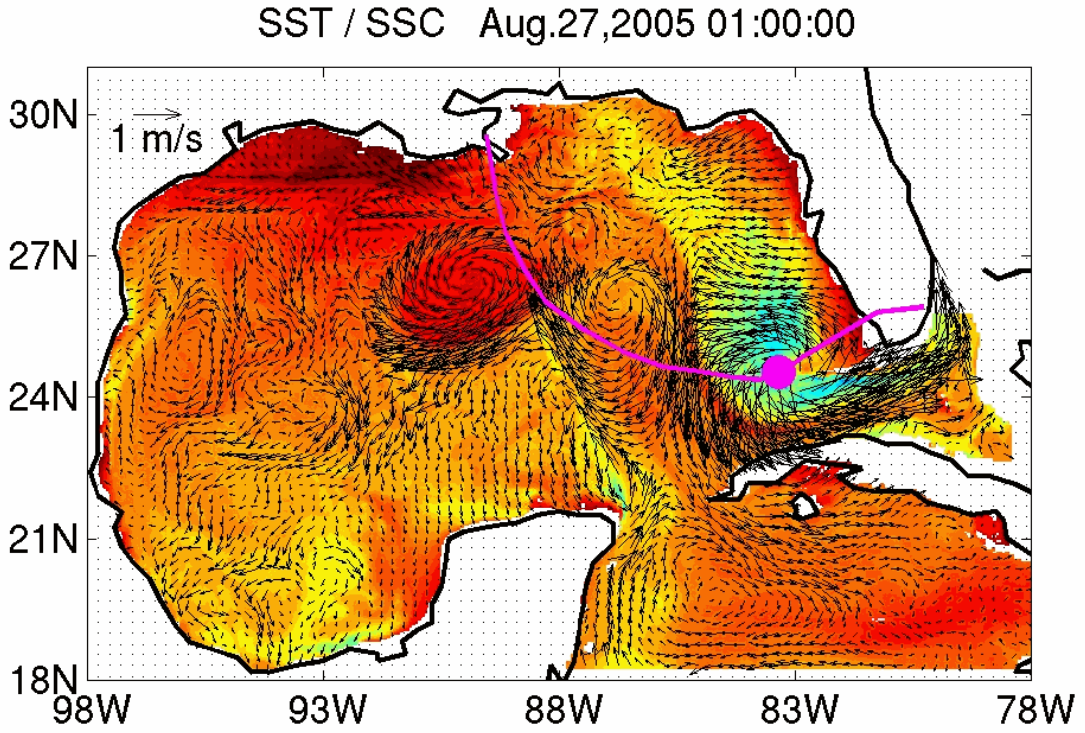
HYCOM receives:
- surface winds
- air T and q
- precipitation
- radiative fluxes

# SST and surface currents from Coupled ARW-HYCOM simulation of Hurricane Katrina



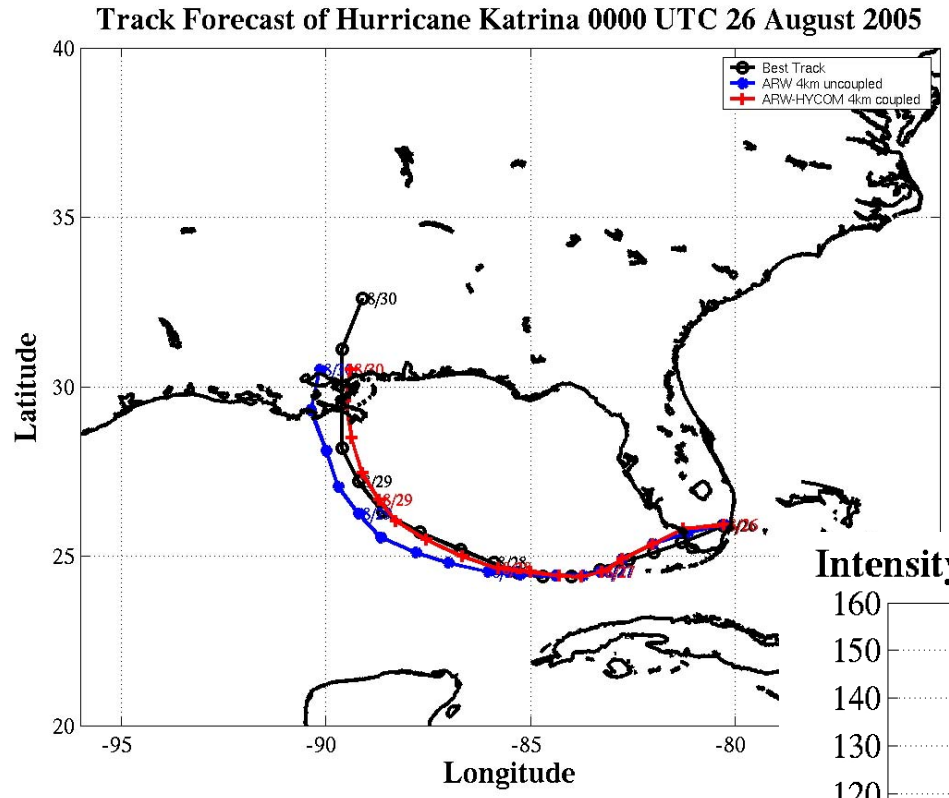

**A and B indicate the locations of the Loop Current and Gulf common water where the vertical temperature profiles will be compared.**

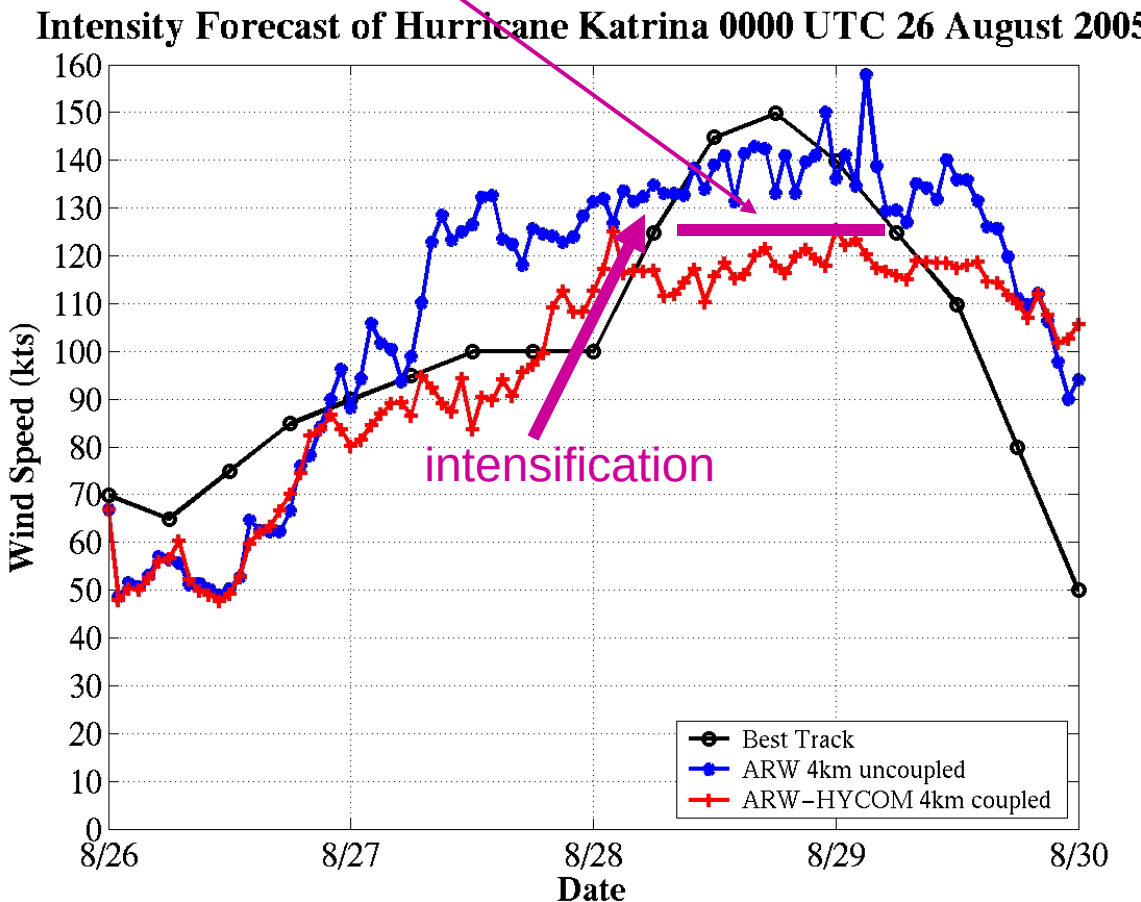

Katrina Rainrate (mm/hr) 0100 UTC 27 AUG 2005
30N
27N
24N
21N
18N
98W
93W
88W
Latitude
Longitude
100
90
80
70
60
50
40
30
20
10
8
5


SST / SSC Aug.27,2005 01:00:00
1 m/s
30N
27N
24N
21N
18N
98W
93W
88W
83W
78W
32
31
30
29
28
27
26
25
24

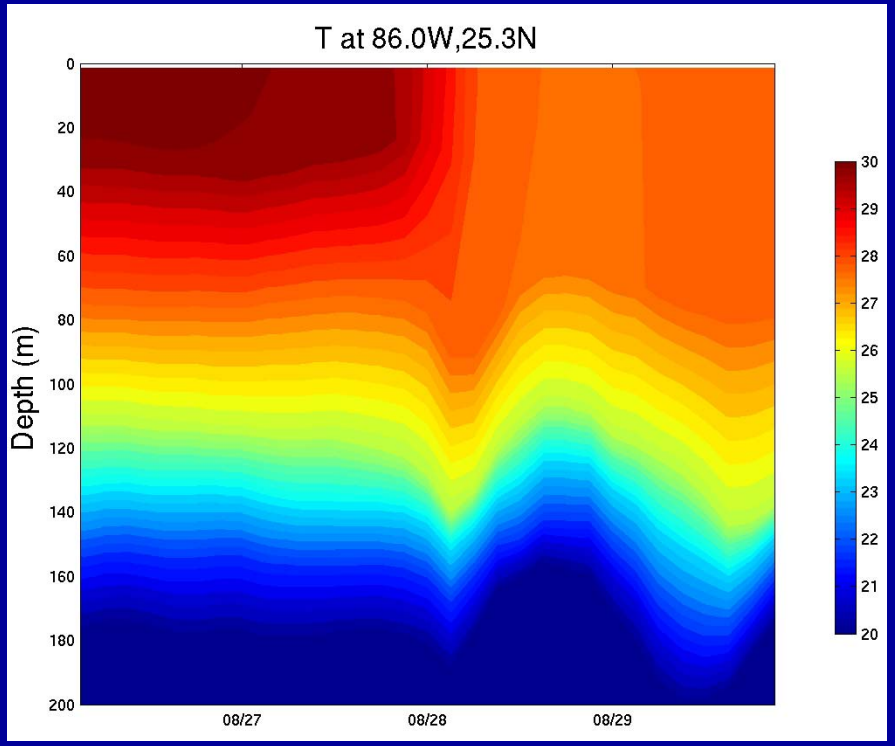
# Hurricane Katrina (2005)

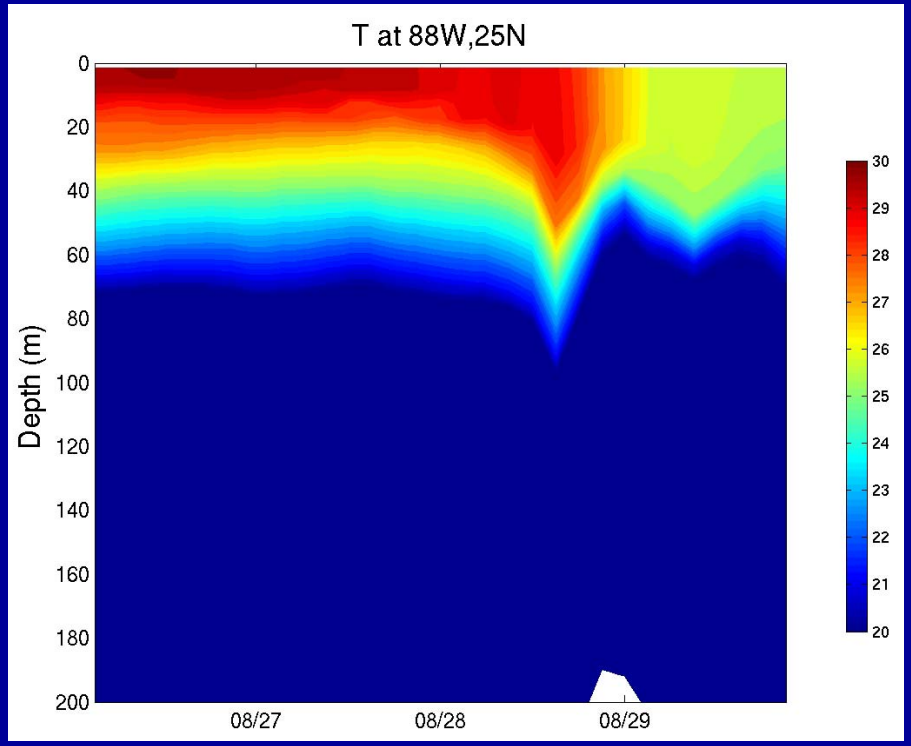
Large eye due to low 4km resolution



# Ocean vertical temperature profiles in HYCOM



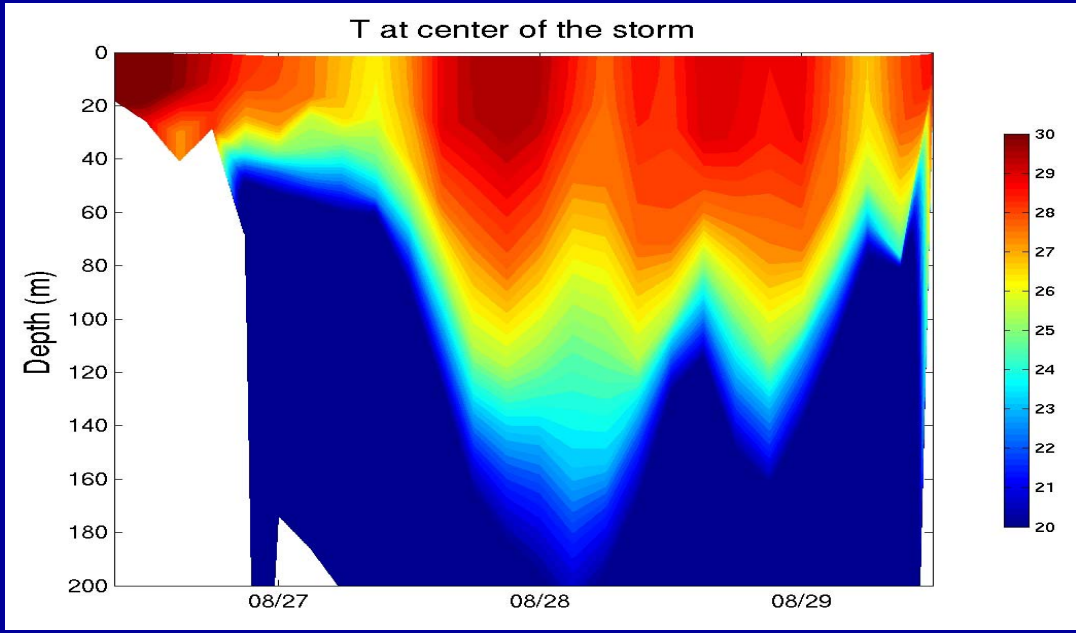

**A: Loop Current**

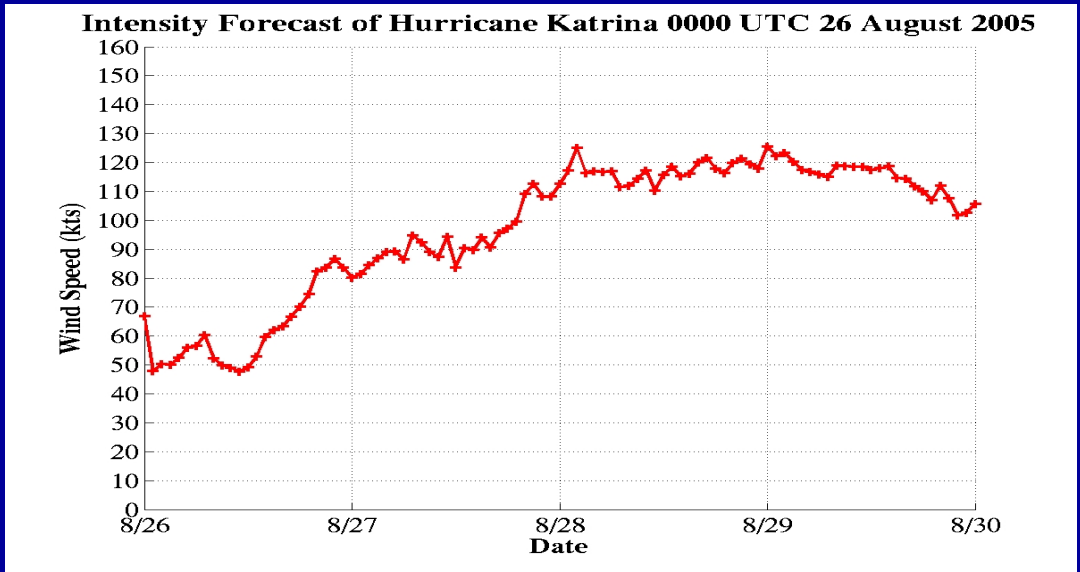
**(deep OML)**

**B: Gulf Common Water**

**(shallow OML)**

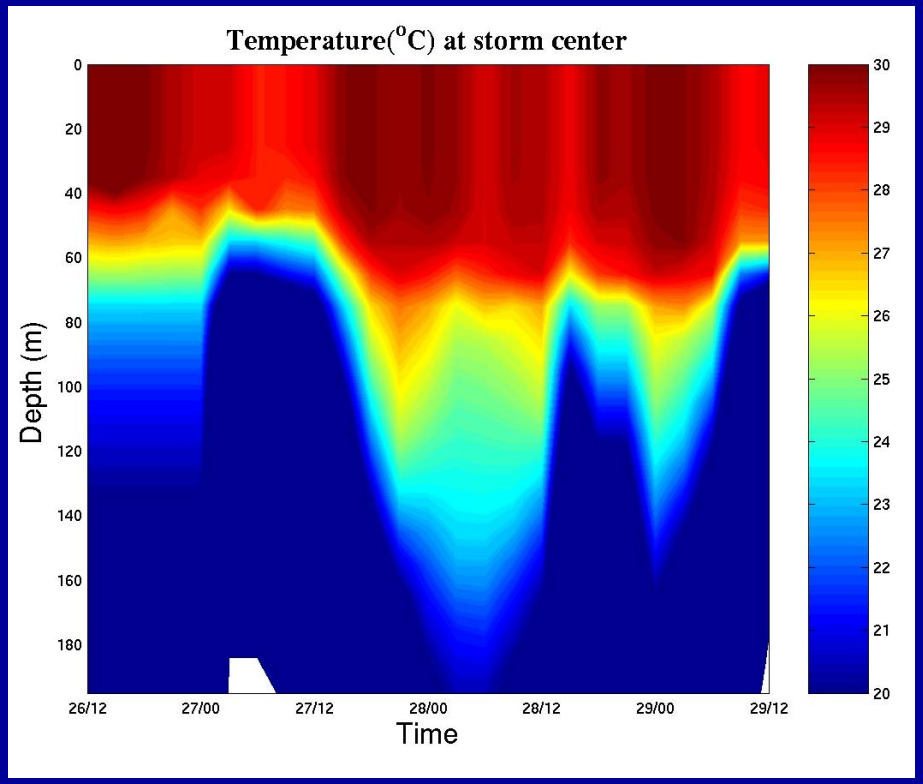
# Coupled ARW-HYCOM simulated ocean vertical temperature profile along the storm track and max wind speed



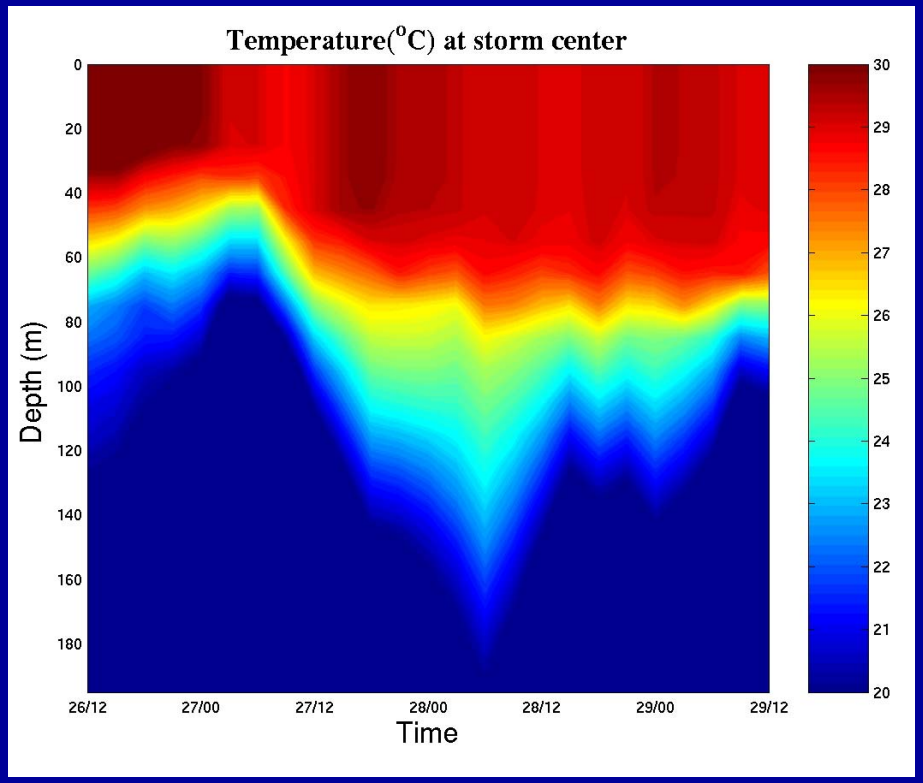



# Coupled ARW-PWP (1D & 3D)

(Poster by Chiaying Lee and Shuyi Chen)

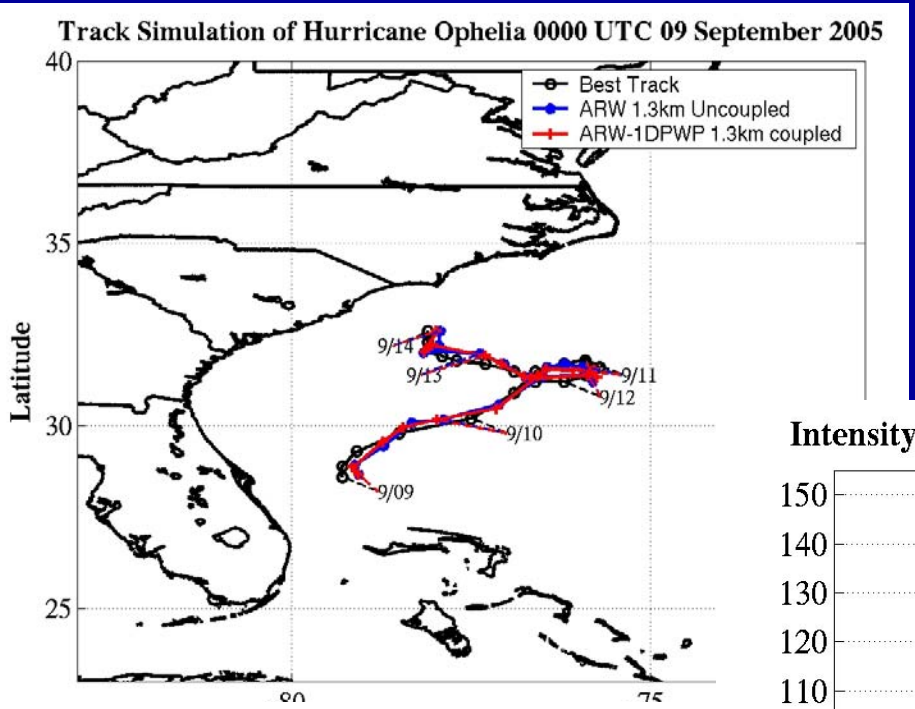


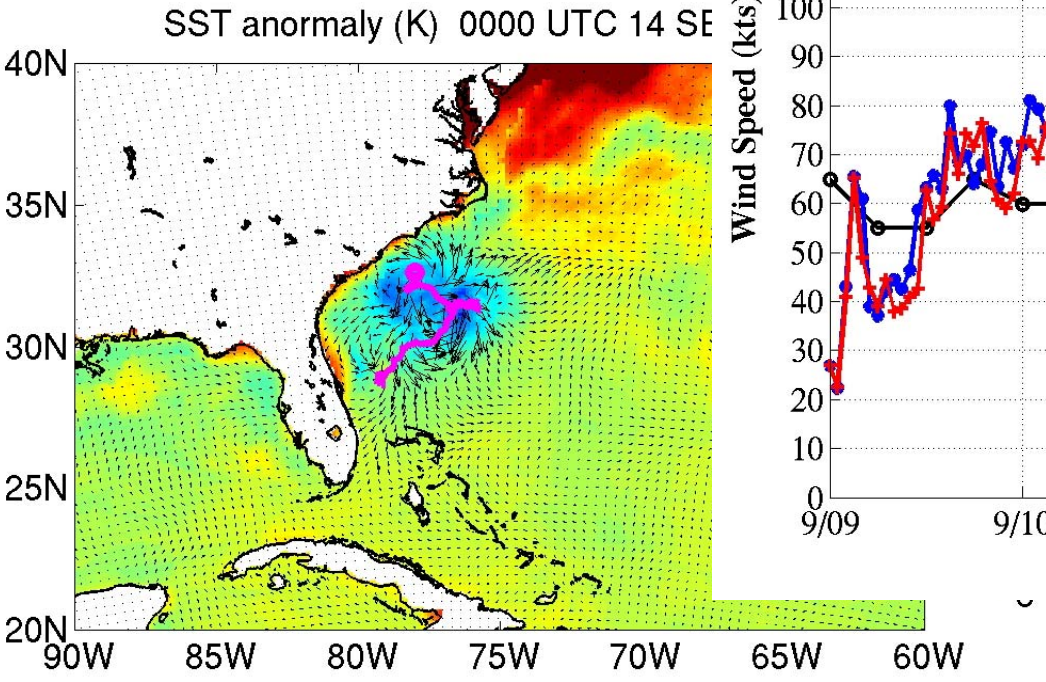

1DPWP

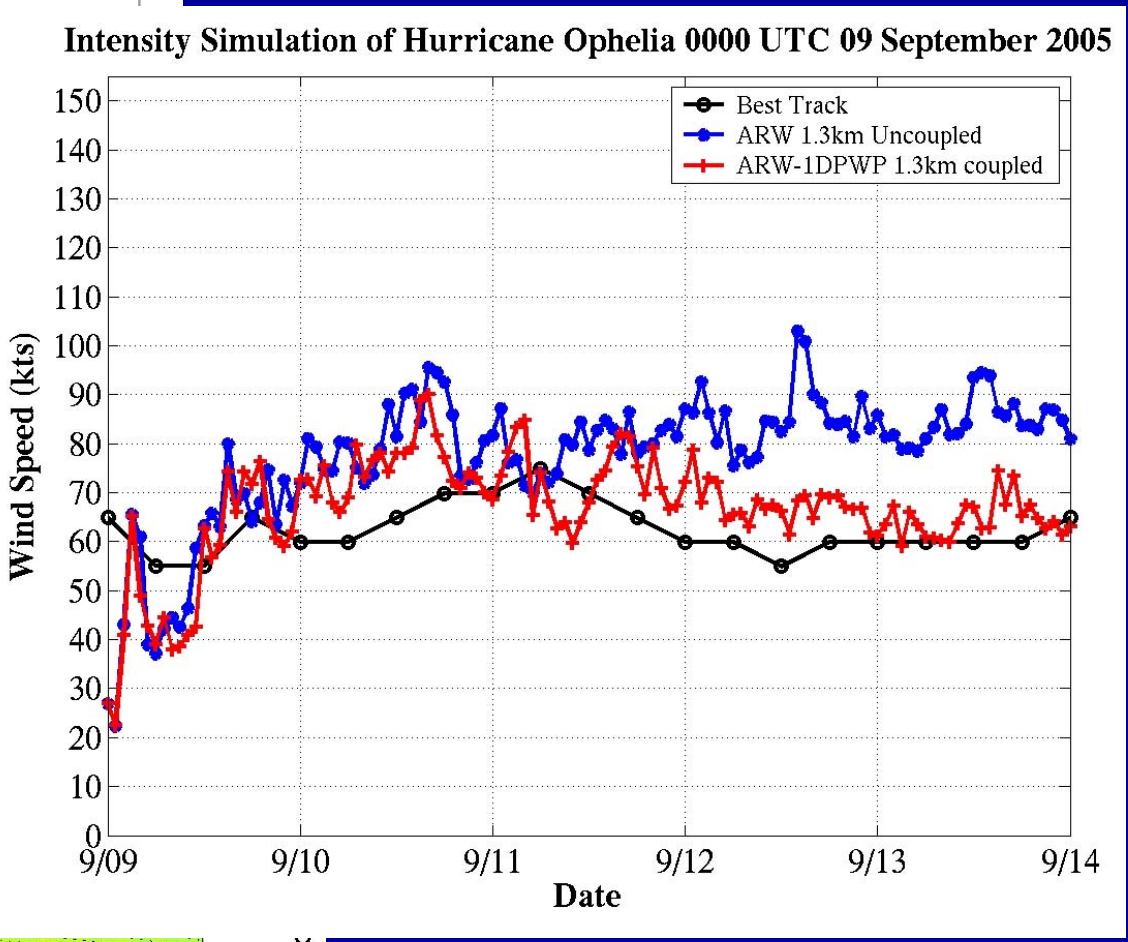



3DPWP

# Coupled ARW-1DPWP simulation of Hurricane Ophelia (2005)



# SUMMARY AND FUTURE WORK

- **Coupled ARW-Ocean (HYCOM and PWP) modeling system has been tested in Hurricane Katrina and Ophelia simulation**
- **Preliminary results indicate the ocean impact on storm structure and intensity varies from case to case depending on how well the storm is resolved in ARW (e.g., resolution)**
- **Increase spatial resolution in the coupled Katrina simulation to better resolve the inner core structure in Katrina (e.g., Davis et al. 2008)**
- **A fully coupled atmosphere-wave-ocean model will be tested in the near future**