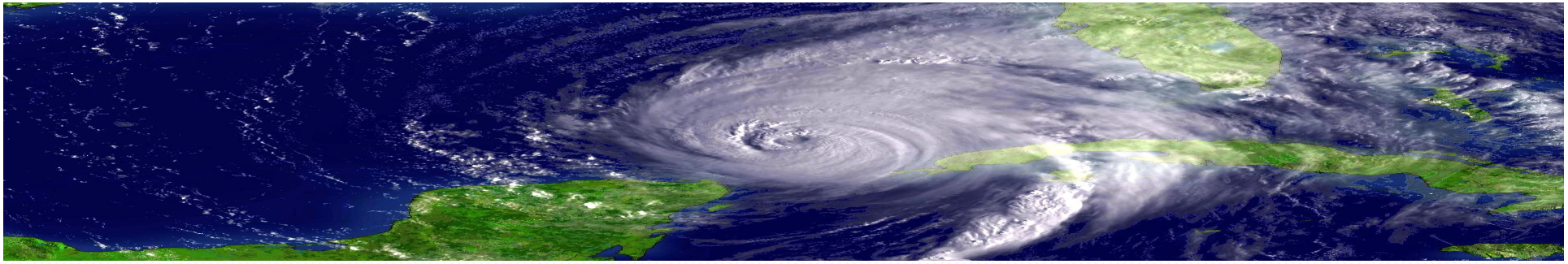


Advancing HWRF and GFDL/GFDN Prediction Systems Through New and Enhanced Physics of the Air-Sea-Wave Coupling Planned for 2013

Isaac Ginis, Richard Yablonsky, Biju Thomas (URI)
Vijay Tallapragada, Hendrik Tolman (NCEP/NOAA),
Morris Bender (GFDL/NOAA)

Funding for this project is provided by NOAA's HFIP and JHT

THINK BIG WE DO

THE UNIVERSITY OF RHODE ISLAND

67th IHC, 6 March 2013

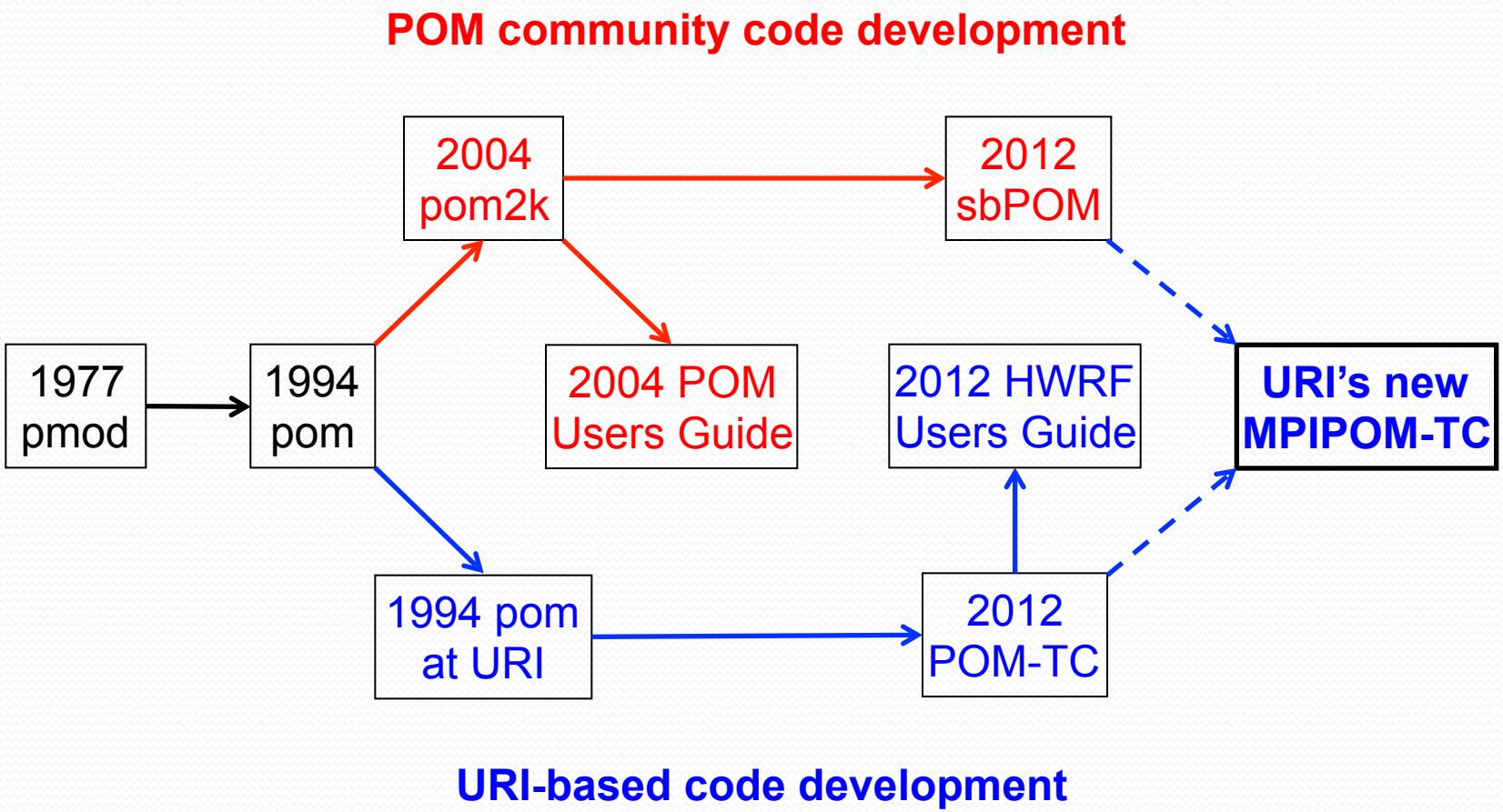
Major Upgrades of the Operational HWRF and GFDL Ocean Components:

Transitioning from Princeton Ocean Model (POM-TC) to MPIPOM-TC

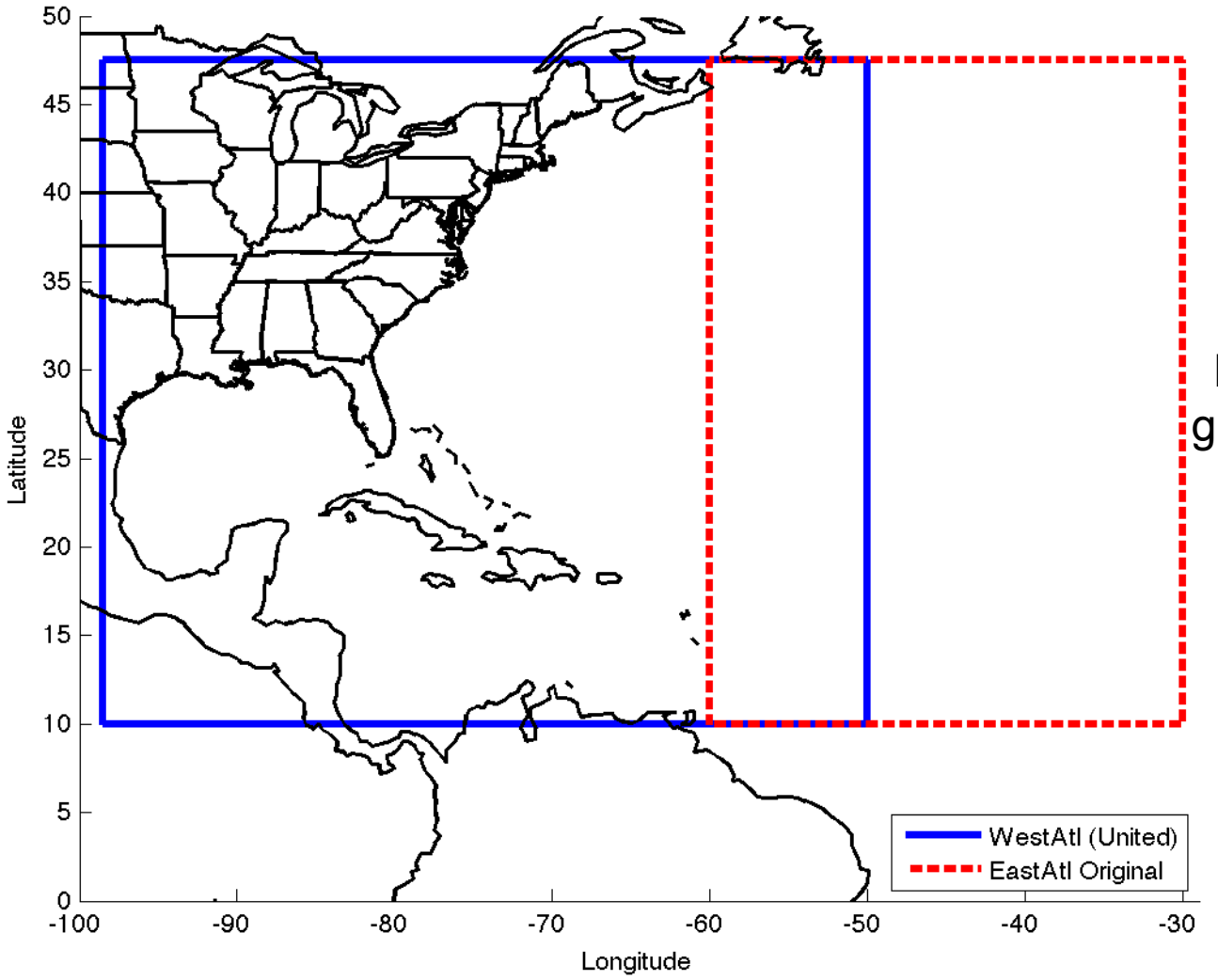
Why create a new MPIPOM-TC?

- MPIPOM-TC uses MPI software framework for running on multiple processors, allowing for both higher resolution and larger domain sizes
- MPIPOM-TC accepts flexible initialization options
- MPIPOM-TC is an adaptation of sbPOM, which has community support and includes 18 years of physics updates and bug fixes
- MPIPOM-TC is a modernized code with netCDF I/O

Developing a new MPIPOM-TC at URI

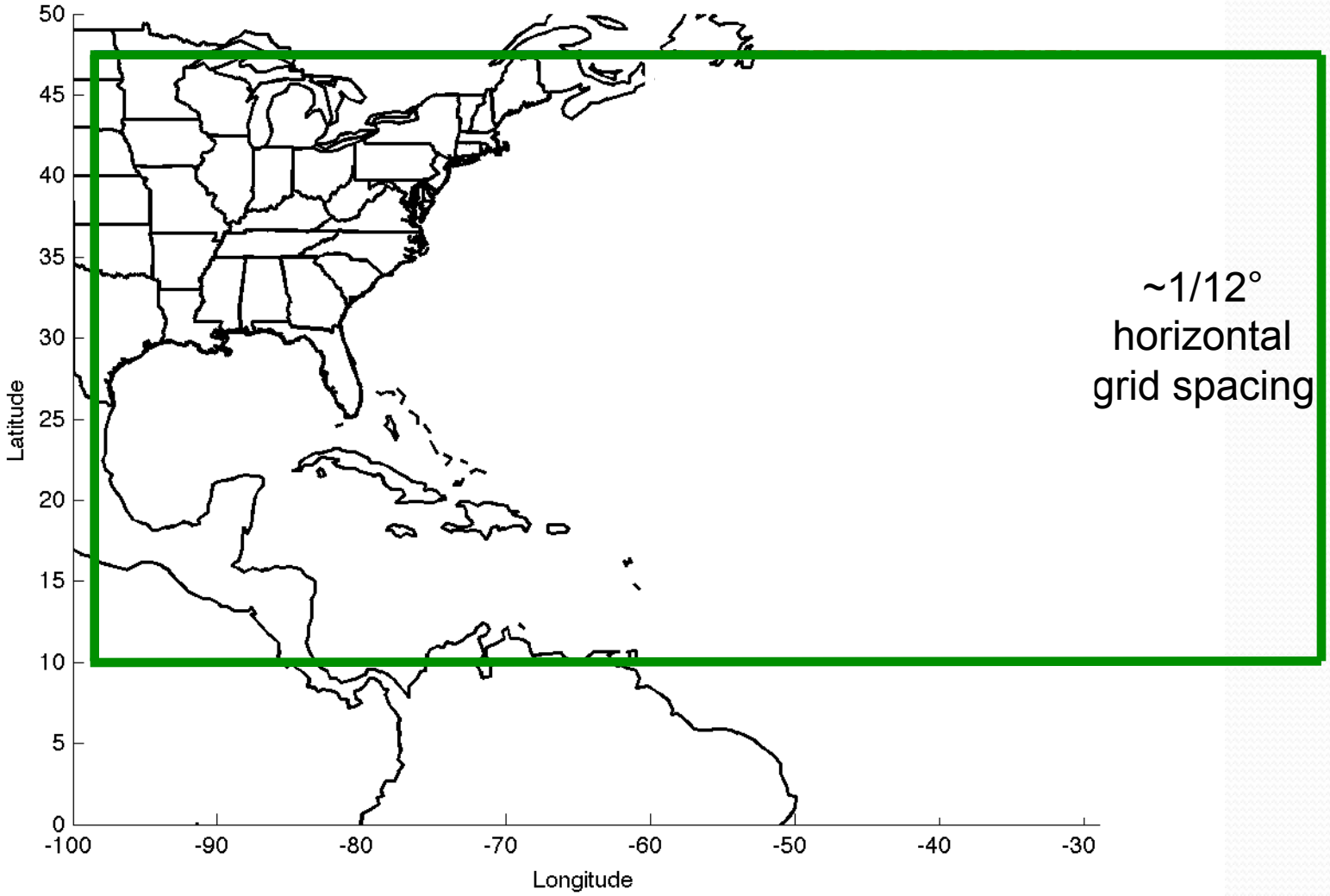


POM-TC Operational United and East Atlantic domains



~1/6° horizontal grid spacing

New MPIPOM-TC Transatlantic Domain



MPIPOM-TC Initialization Options

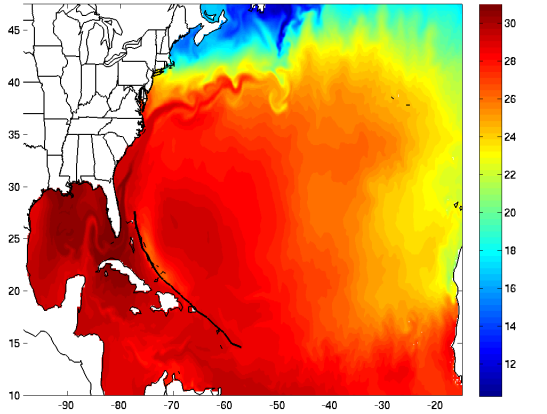
- **Global HYCOM** - utilizes Navy Coupled Ocean Data Assimilation (NCODA), which incorporates satellite, buoy, AXBT, and float data, when available

- **Global RTOFS** - initialized from Global HYCOM and forced by GFS thermal and wind forcing

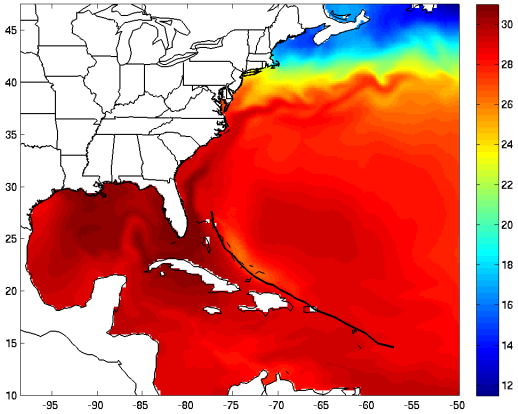
- **Feature-based** - initialized from GDEM monthly T and S climatology, uses SSH real-time analysis to determine feature boundaries, sharpens fronts and assimilates daily NCEP GFS SST

MPIPOM-TC vs. POM-TC (FB initialization): Hurricane Irene Observed wind forcing through 00Z 26 Aug 2011

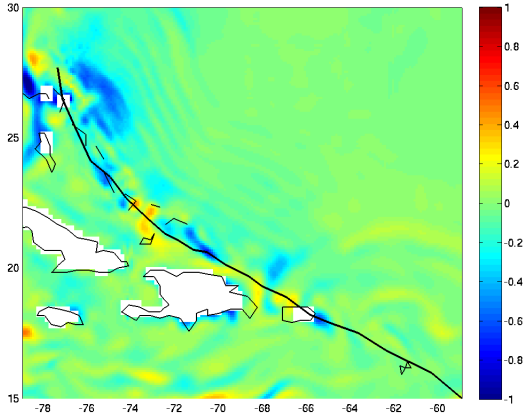
MPIPOM-TC SST (full domain)



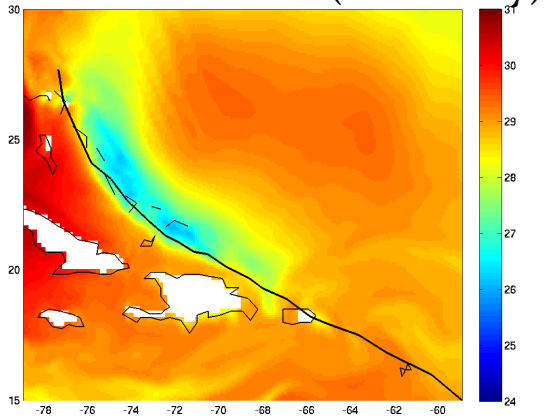
POM-TC SST (full domain)



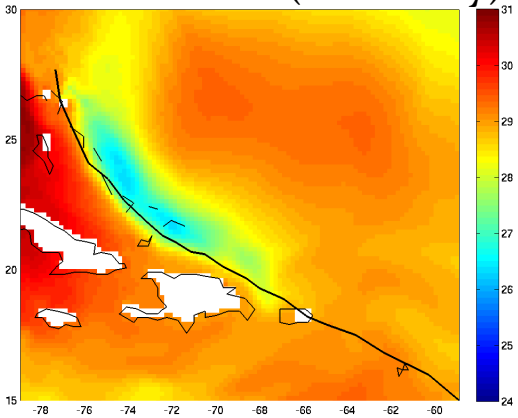
MPIPOM-TC – POM-TC SST



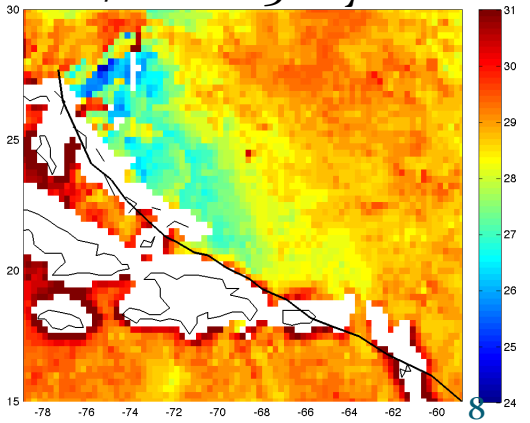
MPIPOM-TC SST (wake only)



POM-TC SST (wake only)



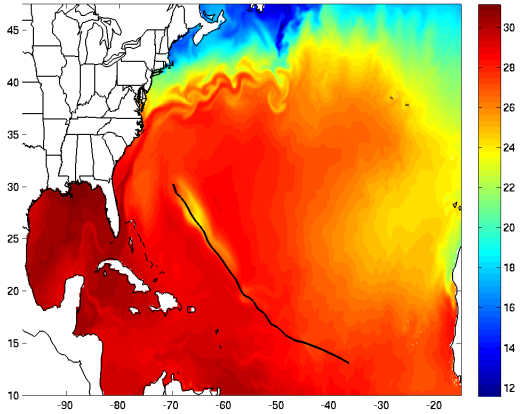
8/26 TMI 3-day SST



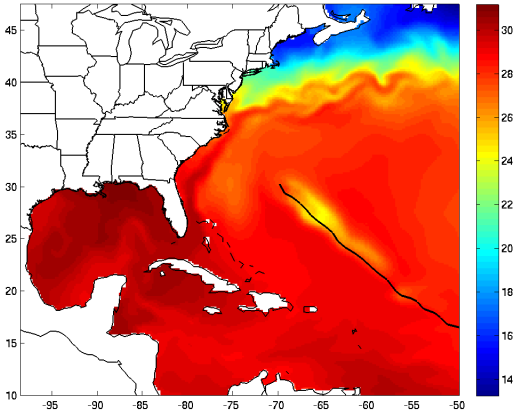
MPIPOM-TC vs. POM-TC (FB initialization): Hurricane Katia

Observed wind forcing through 00Z 08 Sep 2011

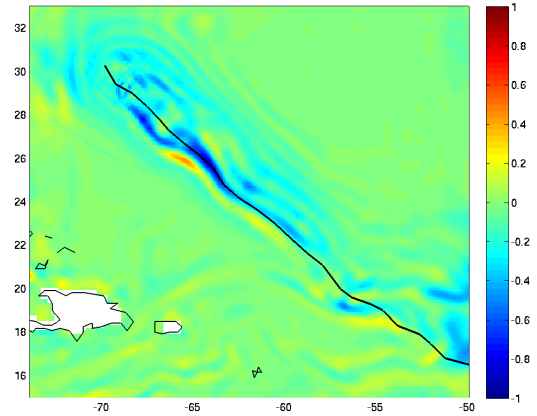
MPIPOM-TC SST (full domain)



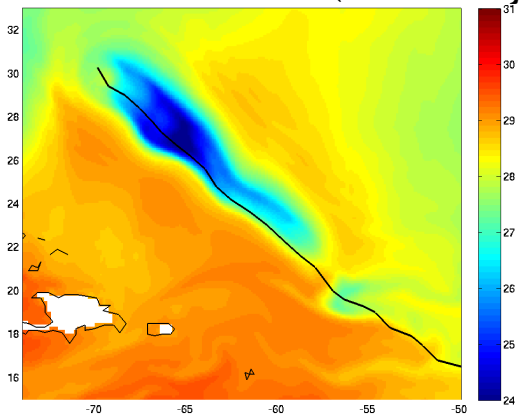
POM-TC SST (full domain)



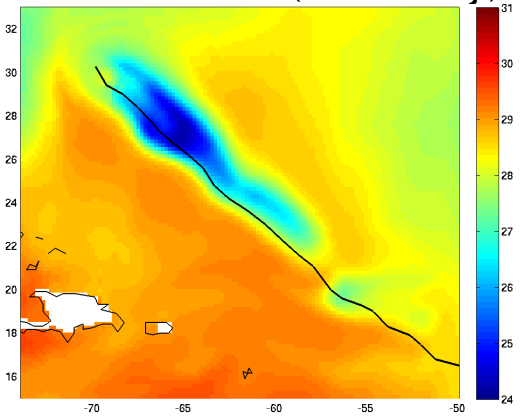
MPIPOM-TC – POM-TC SST



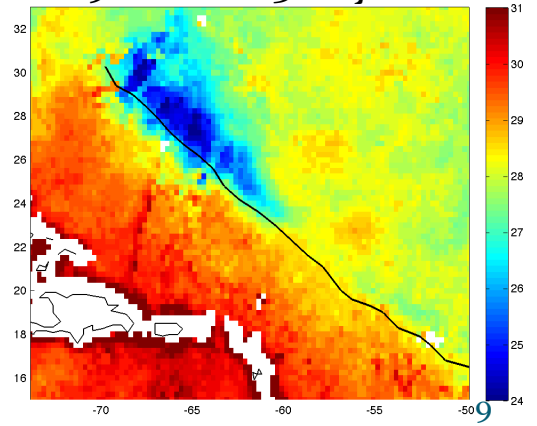
MPIPOM-TC SST (wake only)



POM-TC SST (wake only)



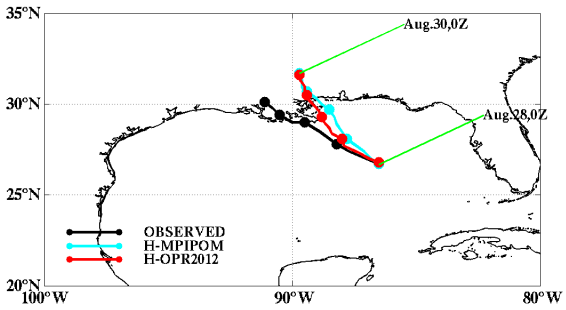
9/08 TMI 3-day SST



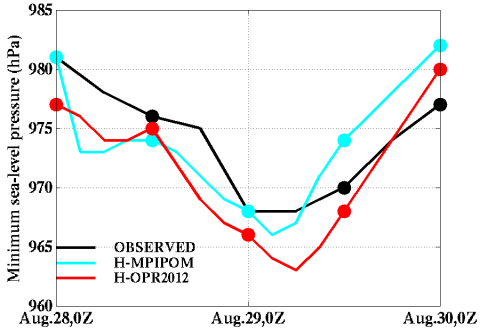
MPIPOM-TC vs. POM-TC (FB initialization): Hurricane Isaac

48-h HWRF coupled forecast 00Z 30 Aug 2012

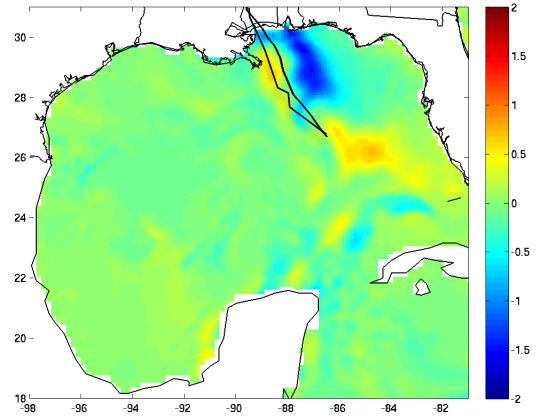
HWRF Track Forecasts



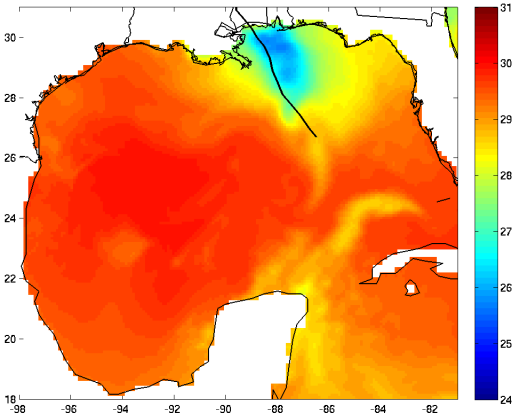
HWRF Intensity Forecasts



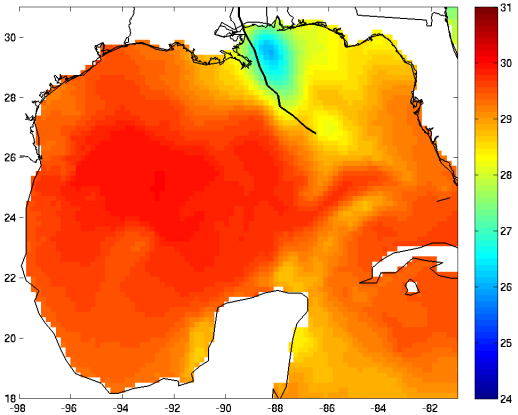
MPIPOM-TC – POM-TC SST



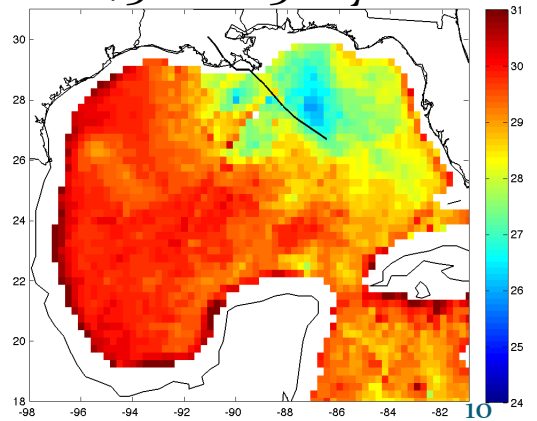
MPIPOM-TC SST



POM-TC SST

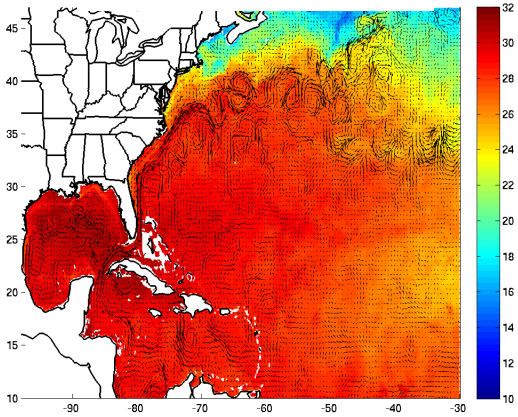


8/30 TMI 3-day SST

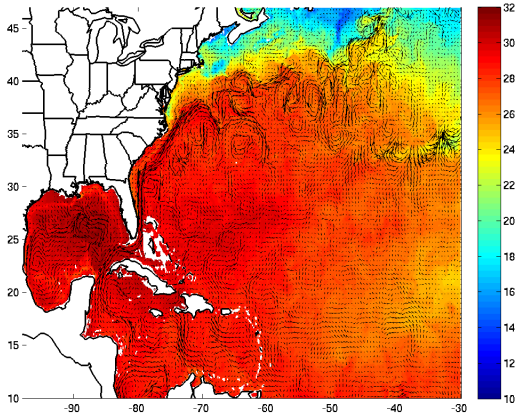


MPIPOM-TC: Global HYCOM or Global RTOFS initialization (20120828)

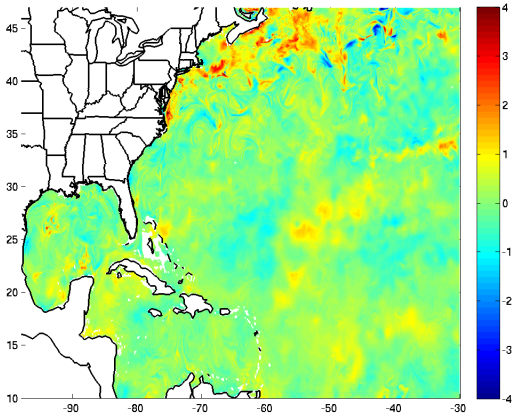
HYCOM SST init



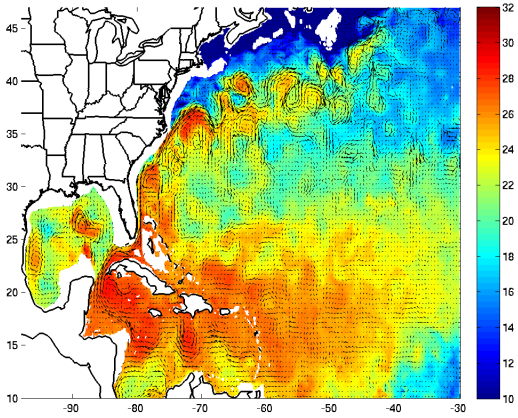
RTOFS SST init



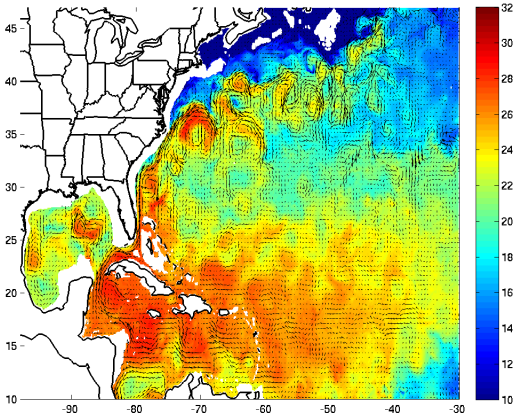
HYCOM-RTOFS SST init



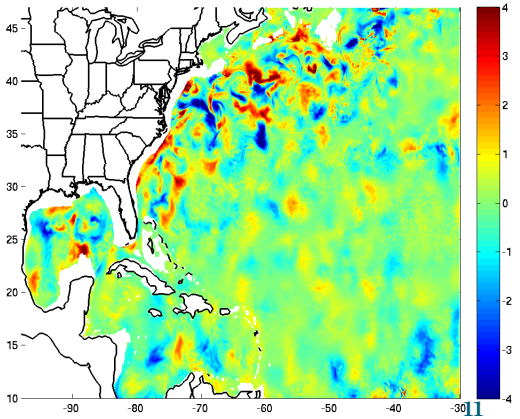
HYCOM 75-m T init



RTOFS 75-m T init



HYCOM-RTOFS 75-m T init

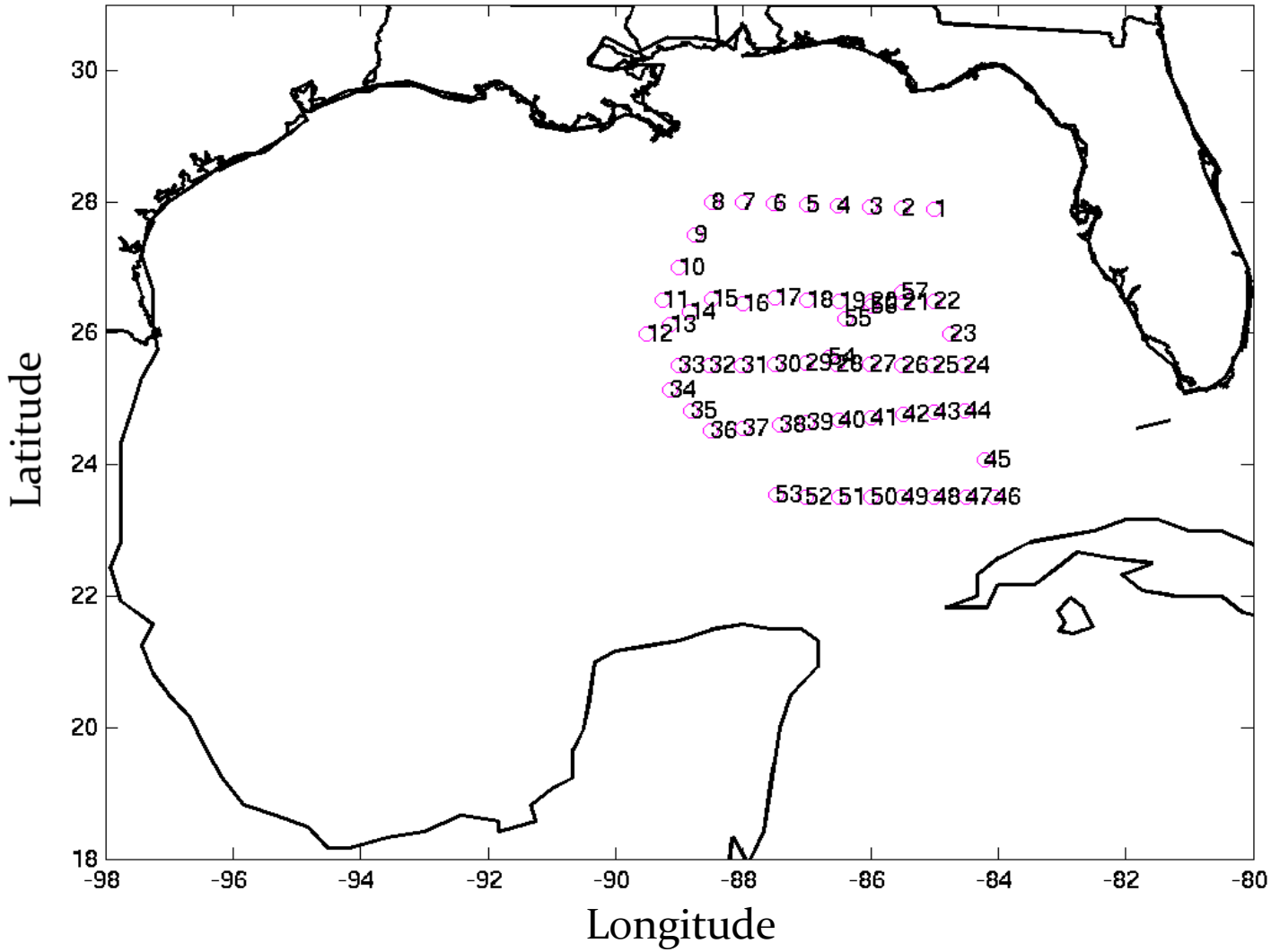


Evaluating ocean model initializations for hurricane prediction

Initializations Tested:

- **HYCOM**: Global HYCOM
- **FB**: Feature-based
  - **FB-CCAR**: Feature-based with only Colorado Center for Astrodyanmic Research (CCAR) SSH data assimilated
  - **FB-AXBT**: Feature-based with CCAR SSH and AXBT data assimilated to adjust ring position and profiles
  - **FB-AXBT-POSONLY**: Feature-based with CCAR SSH and AXBT data assimilated to adjust ring position only

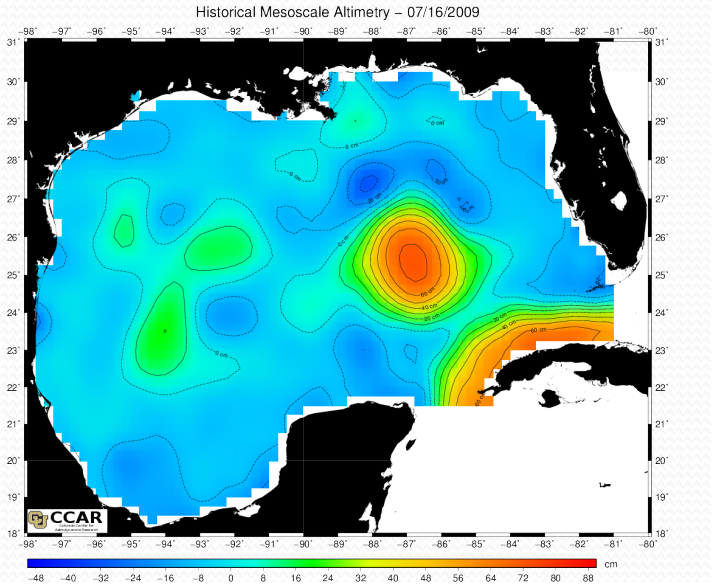
AXBT Survey-July 16, 2009



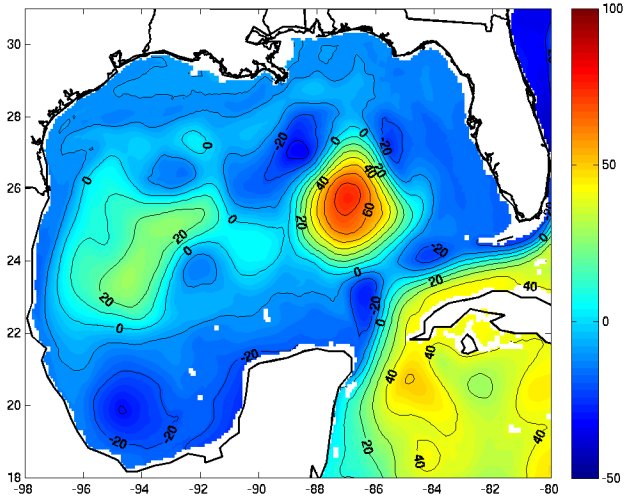
57 AXBTs deployed by NOAA/AOML/HRD to access SST and ocean heat content (OHC) in the Gulf of Mexico

Sea Surface Height

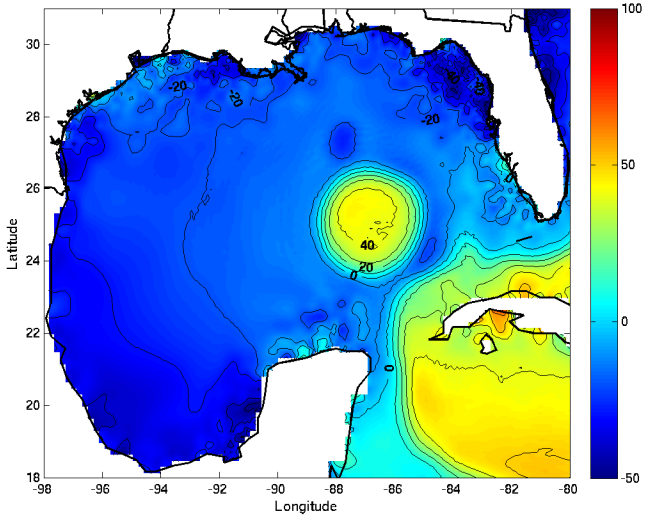
CCAR



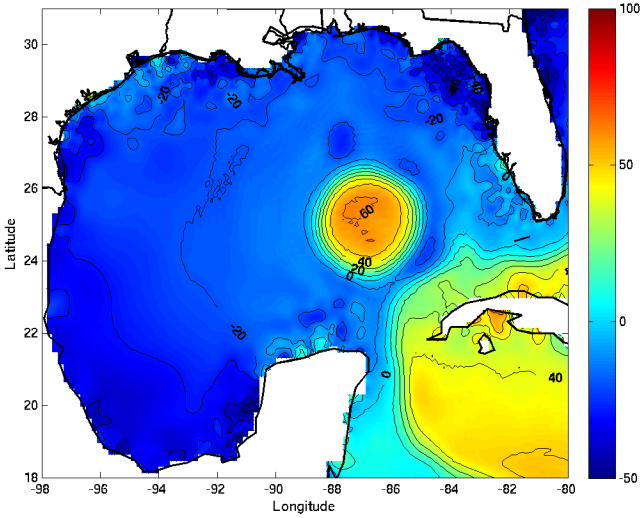
HYCOM



FB-CCAR

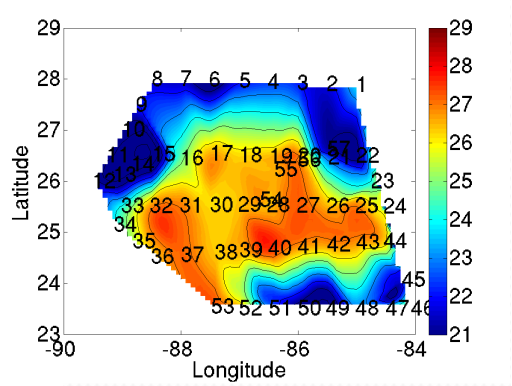


FB-AXBT

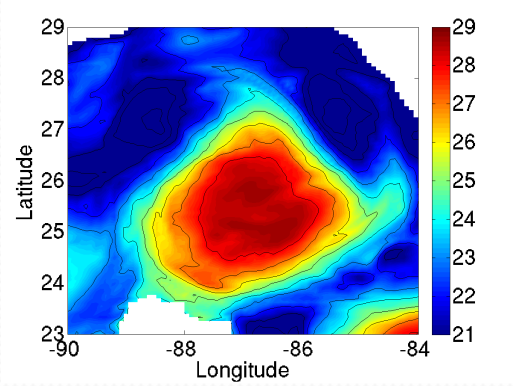


75-m Temperature

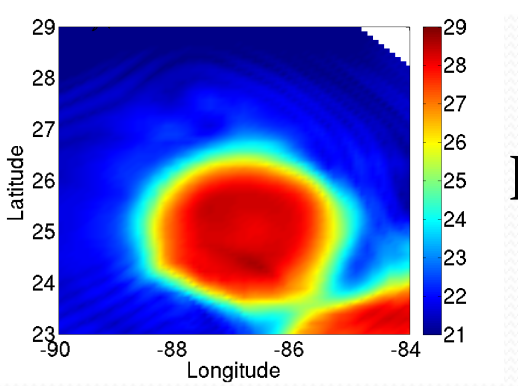
AXBT



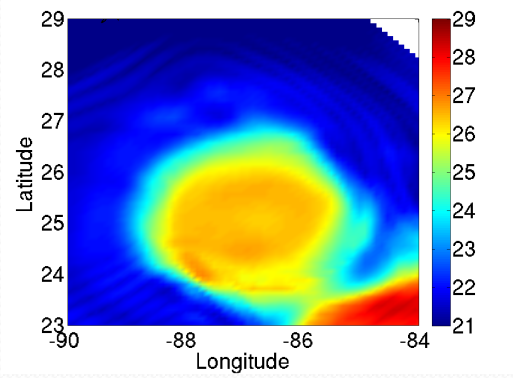
HYCOM



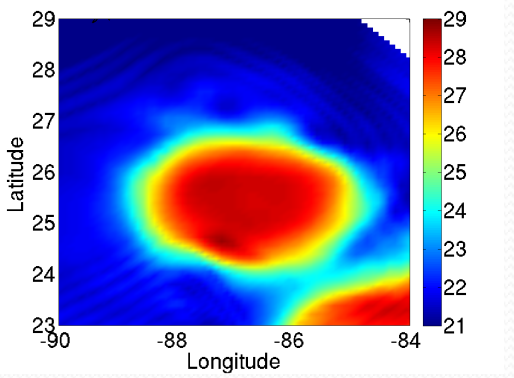
FB-CCAR



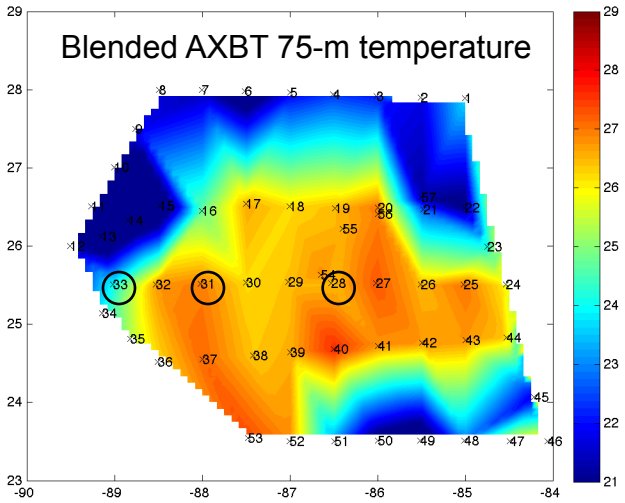
FB-AXBT

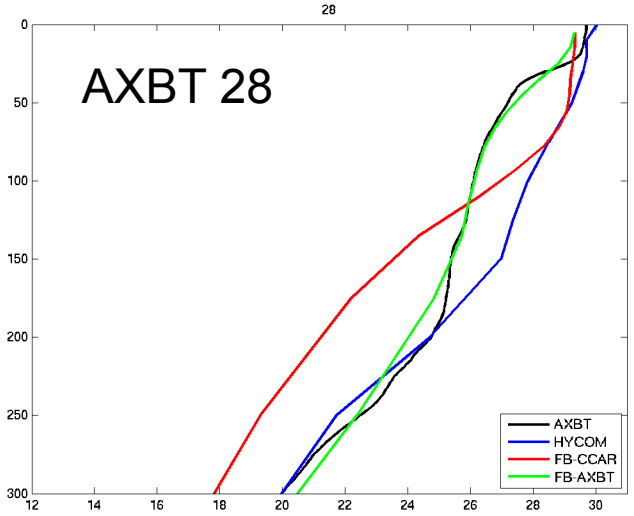


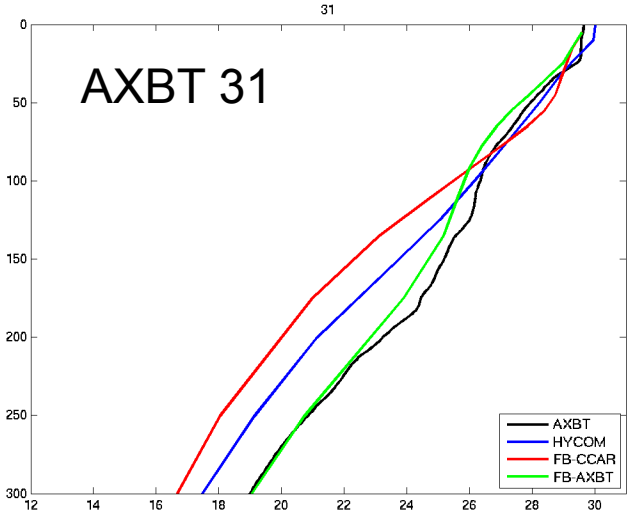
FB-AXBT-POSONLY

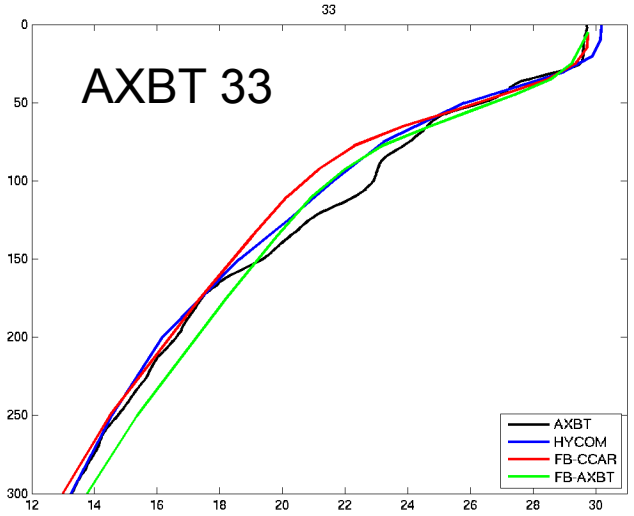


AXBT temperature profiles





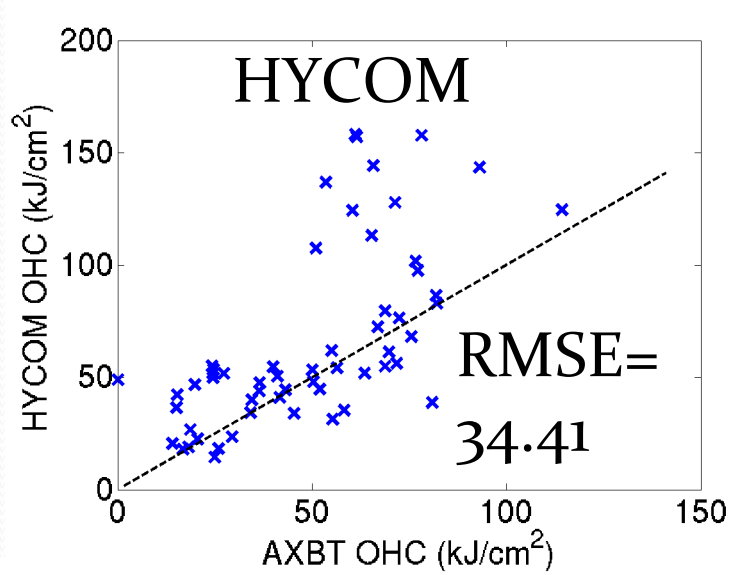


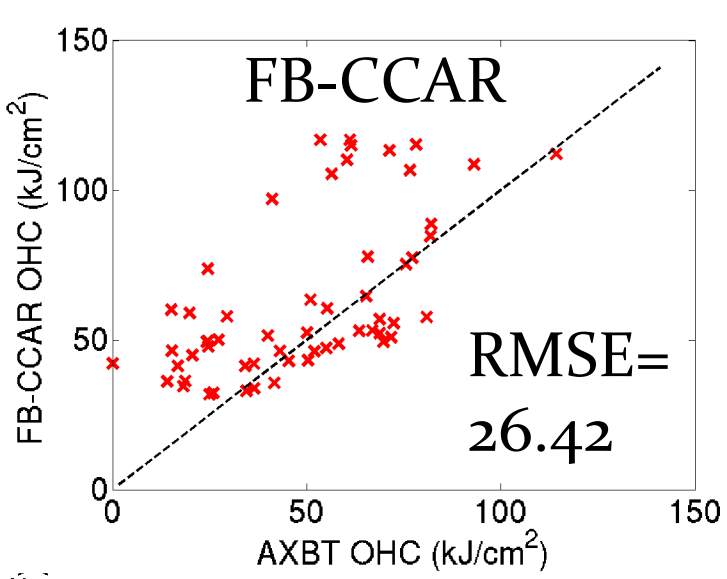


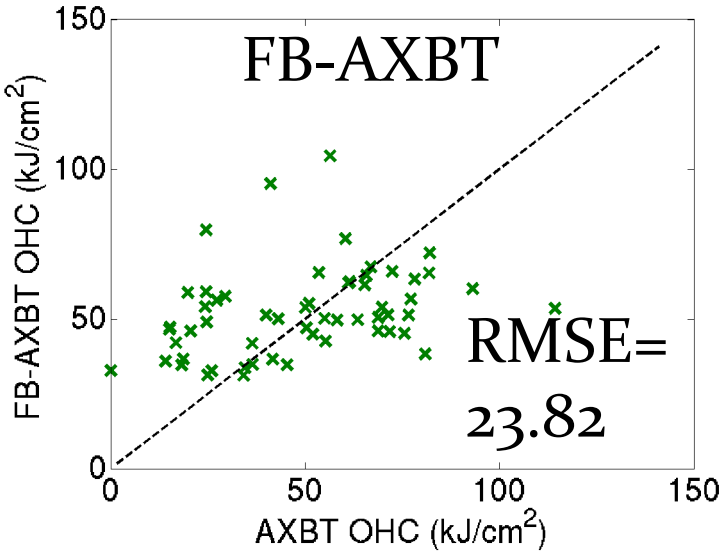
Temperature profiles:

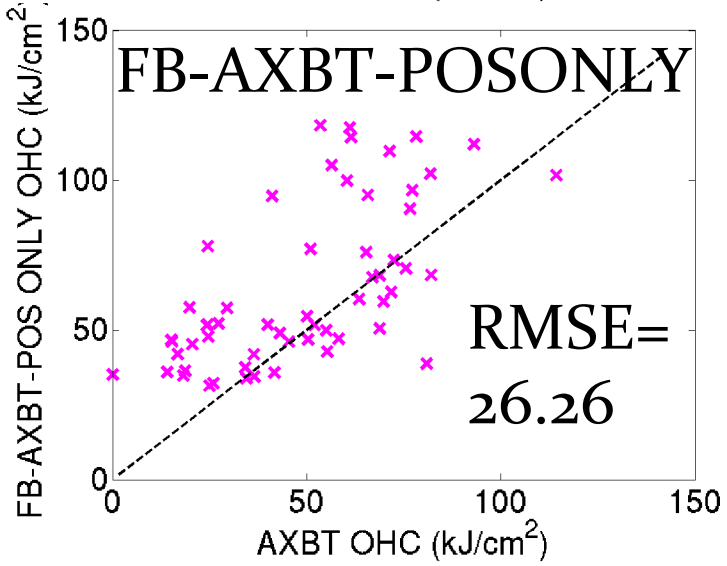
- Global HYCOM (blue)
- FB without AXBT assimilation (red)
- FB with AXBT assimilation (green)
- AXBT observation (black)

Ocean Heat Content Comparisons

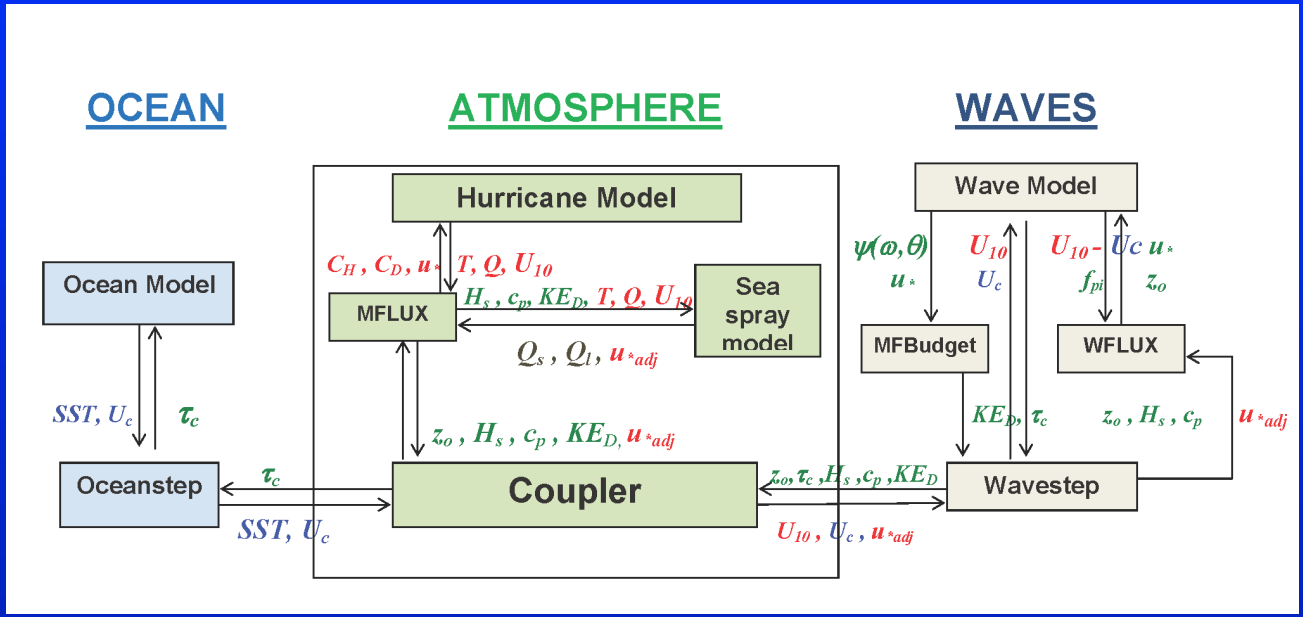








HWRF-WW3-POM and GFDL-WW3-POM will be tested in 2013



Red - atmospheric parameters, Green – wave parameters, Blue - ocean parameters

- ***Hurricane model:*** air-sea fluxes depend on *sea state, sea spray* and include *surface current.*

- ***Wave model:*** forced by *sea state* dependent wind forcing and includes *surface current*

- ***Ocean model:*** forced by *sea state* dependent wind stress modified by *growing or decaying wave fields* and *Coriolis-Stokes*. Turbulent mixing is modified by the Stokes drift (*Langmiur turbulence*).