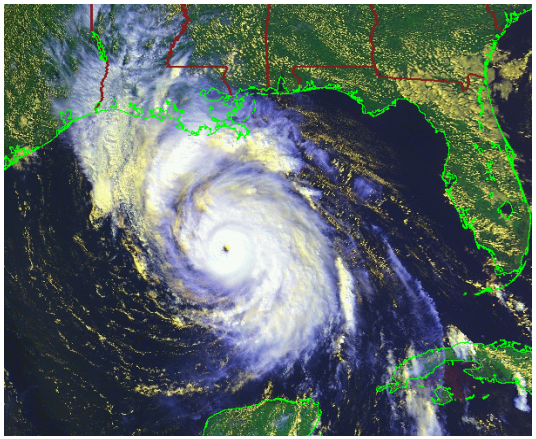
Systematically Merged Atlantic Regional Temperature and Salinity (SMARTS) Climatology: Application to Hurricane Earl



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(J. Ault, J. Luo, N. Hammerschlag, J. Rooker)

Goal: Using satellite, in situ data, build an improved ocean model to couple to HWRF and ***carefully assess*** *the oceanic role in intensity changes (Its more than just SST).*

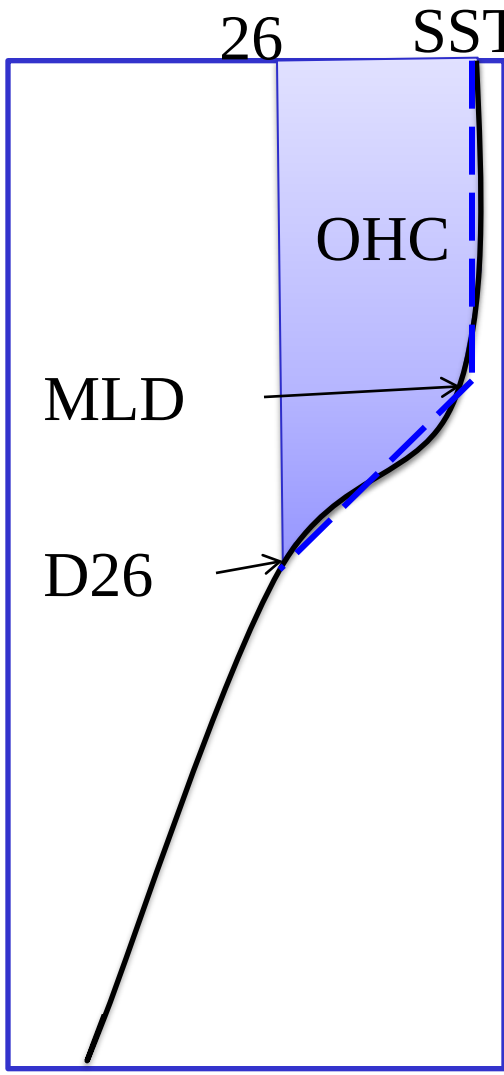
RSMAS

Motivation and Background

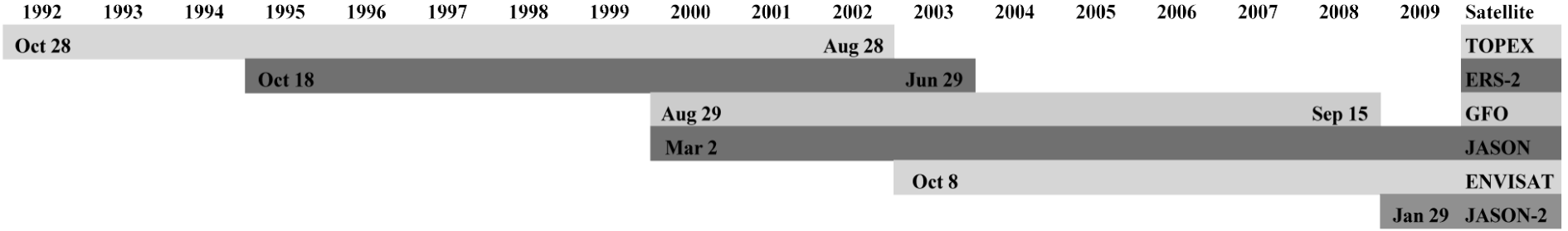
- Minimum sea surface temperature threshold for hurricane formation: SST >26ºC (Palmen, 1948)
- Leipper (1972) introduced Ocean Heat Content
  - Integrated thermal energy from surface to 26º isotherm

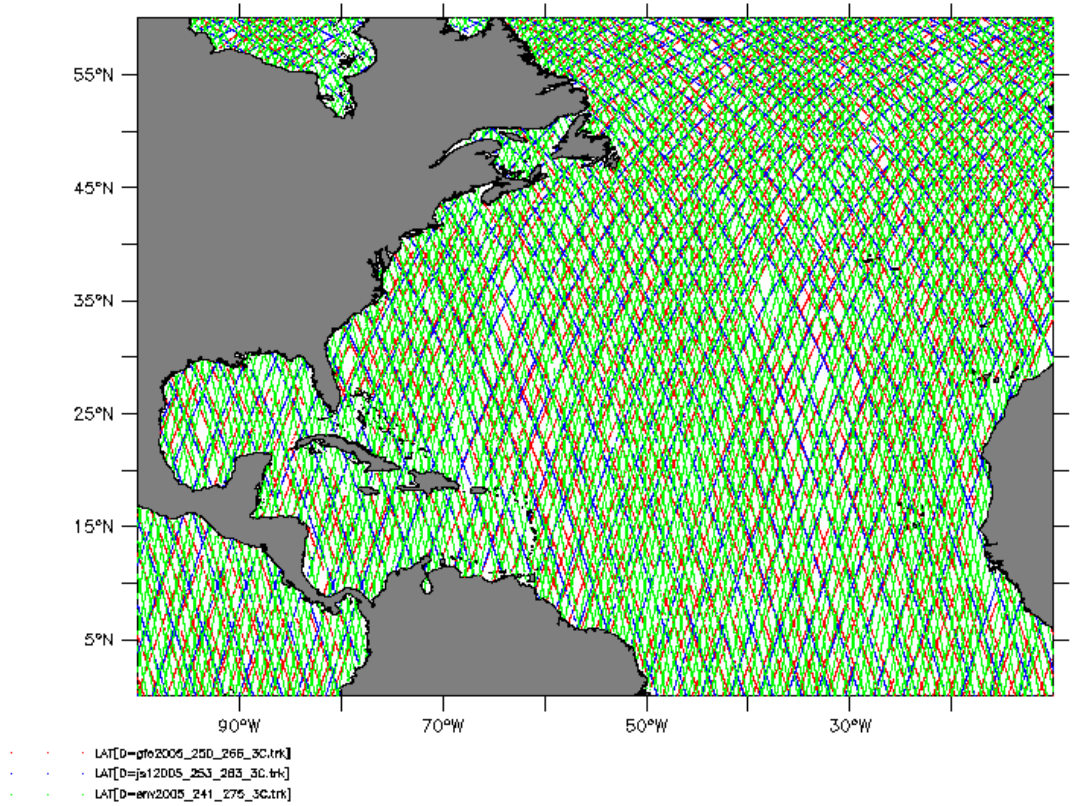
$$OHC = c_p \rho \int_{D26}^{\eta} (T_z - 26°) dz$$

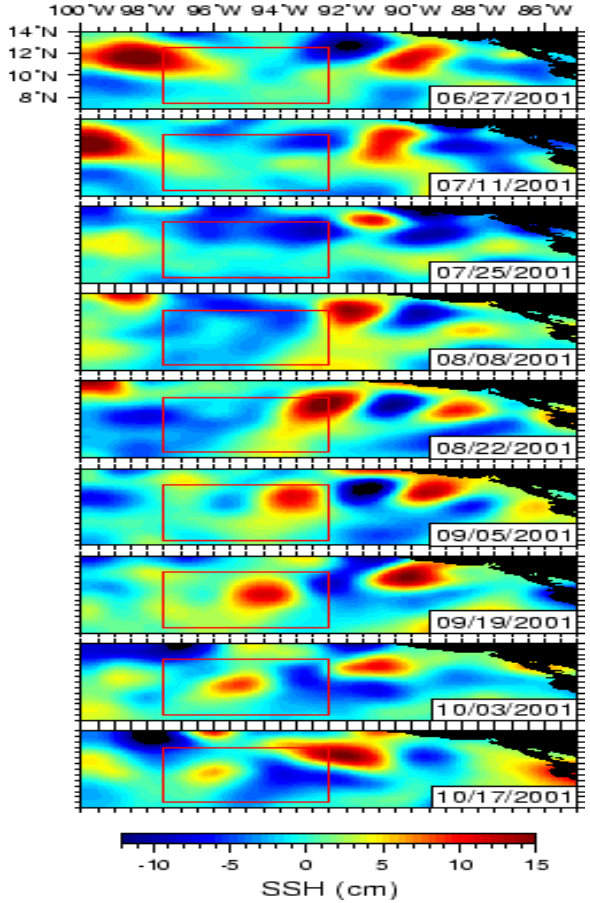
- Empirical approach to estimate OHC from satellite altimetry (Shay and Brewster, 2010)
- Ocean thermal structure is important feedback mechanism (Chang and Anthes, 1978)
- Warm core eddies inhibit mixing and provide deep energy source for hurricanes (Shay et al., 2000; Jaimes and Shay, 2009)



Satellite Altimetry Availability Since 1992



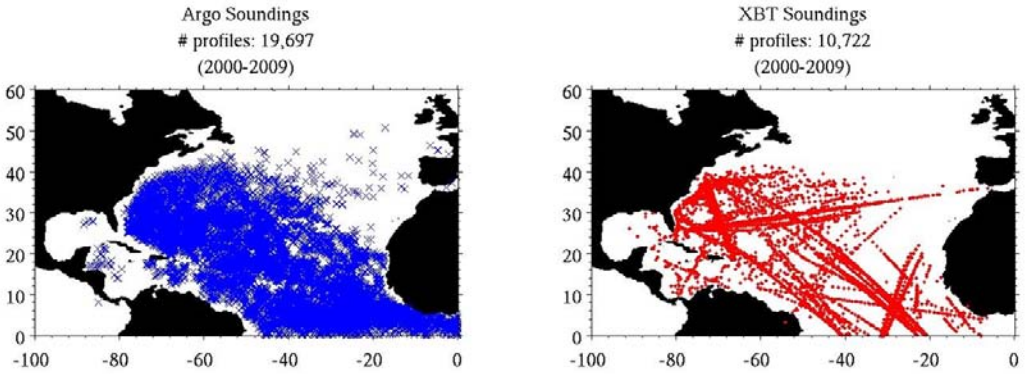


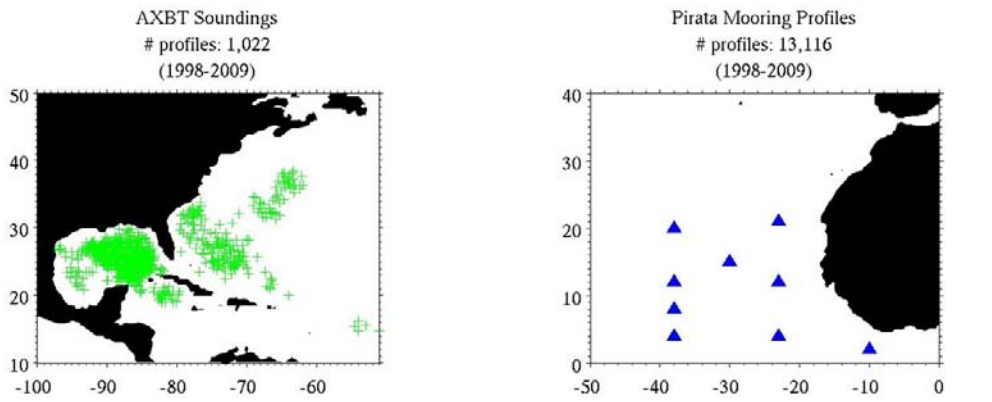


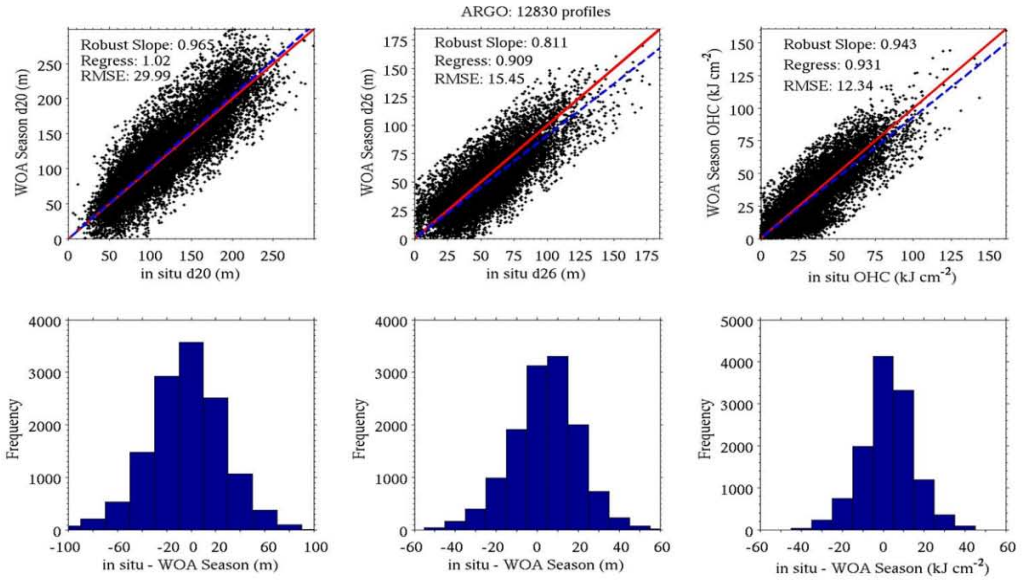
Various data sets (44, 000) from ARGO floats, XBT Transects, AXBTs and equatorial Atlantic PIRATA Moorings from 1998 to 2009.

Scatter and Histograms for D20, D26 and OHC from 13,000 ARGO floats in Western Atlantic Ocean.

Meyers (2011).

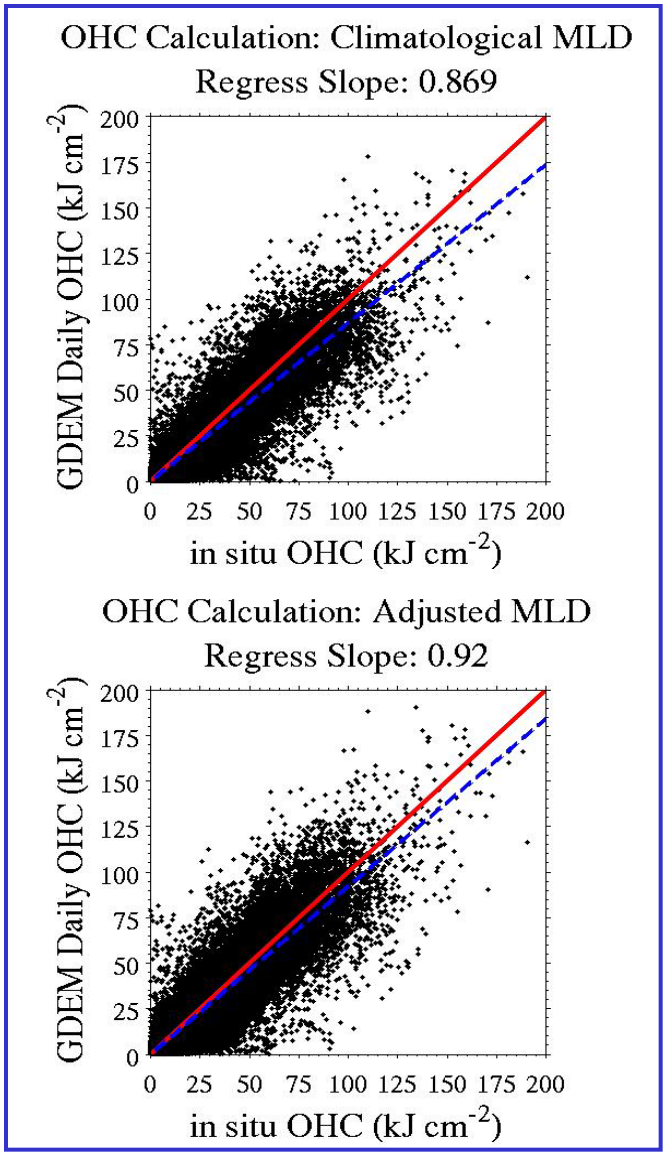






Satellite-Estimated MLD Considerations

- Improvement to OHC regression slope. More realistic variability
- Decreased accuracy after strong wind-forcing events (entrainment)
- Most useful during hurricane season when there is more variability of MLD



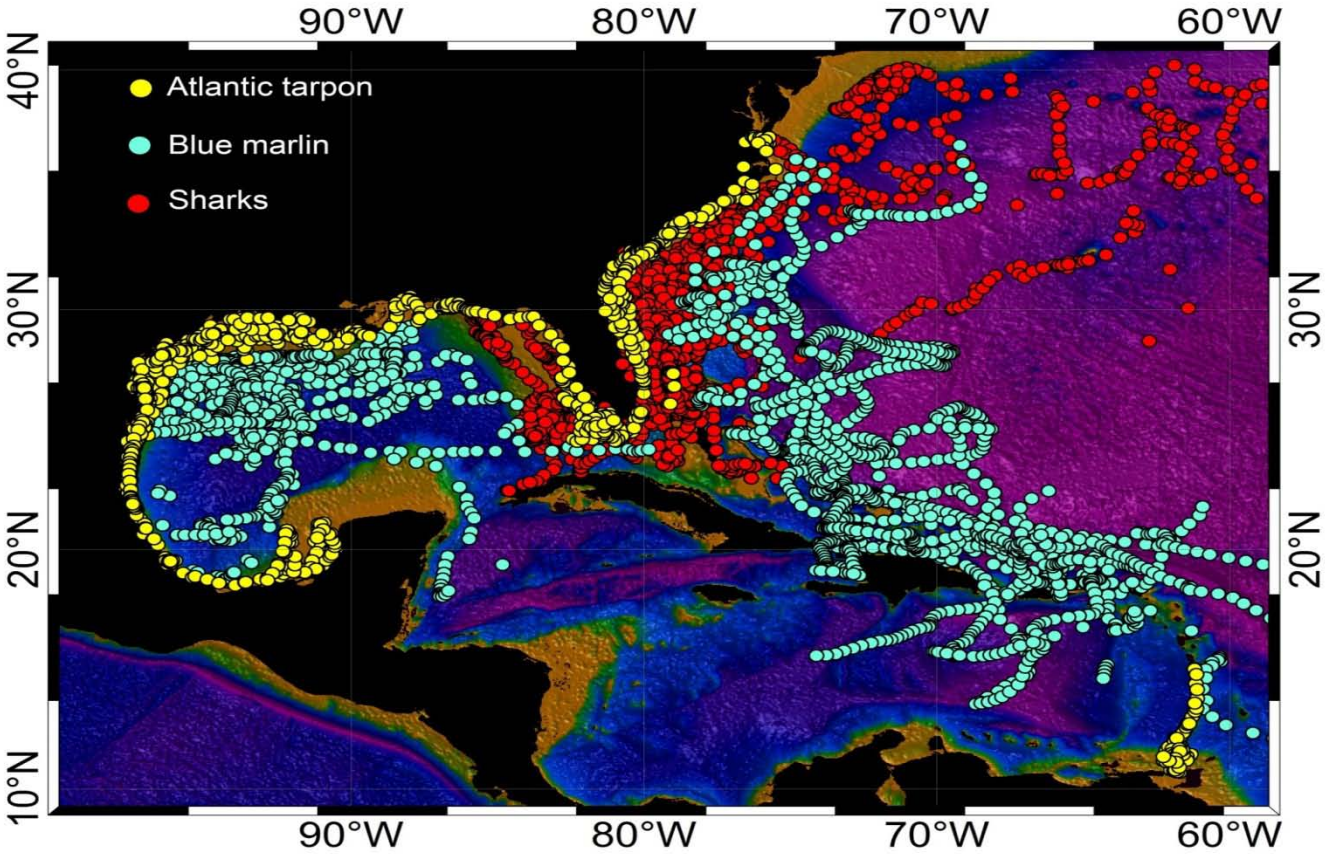
Question?

What do tarpon, blue marlin and tiger sharks have in common with hurricanes?

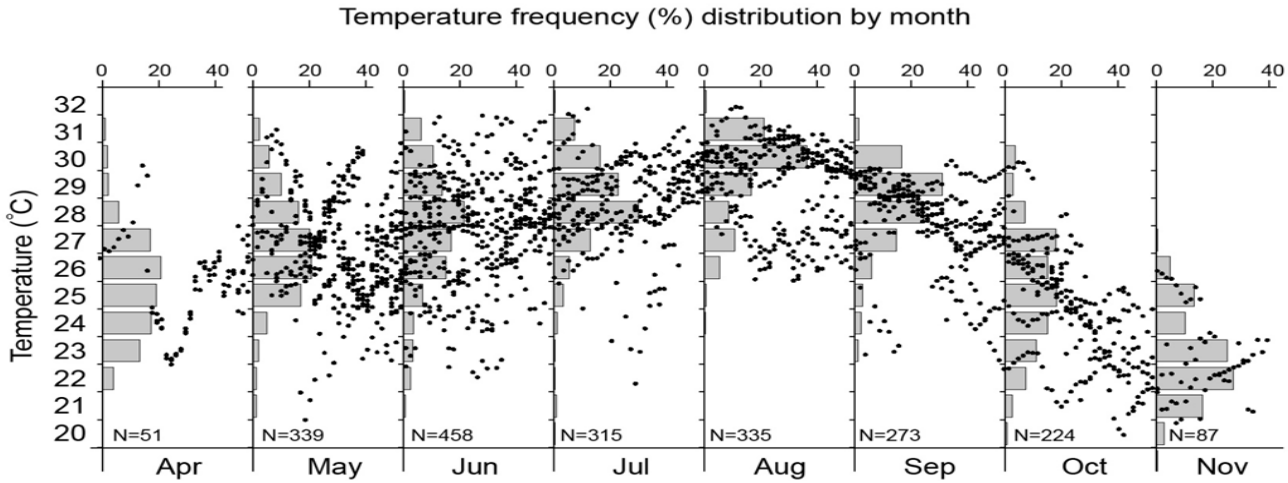
These fish like warm water temperatures of 26C or more!

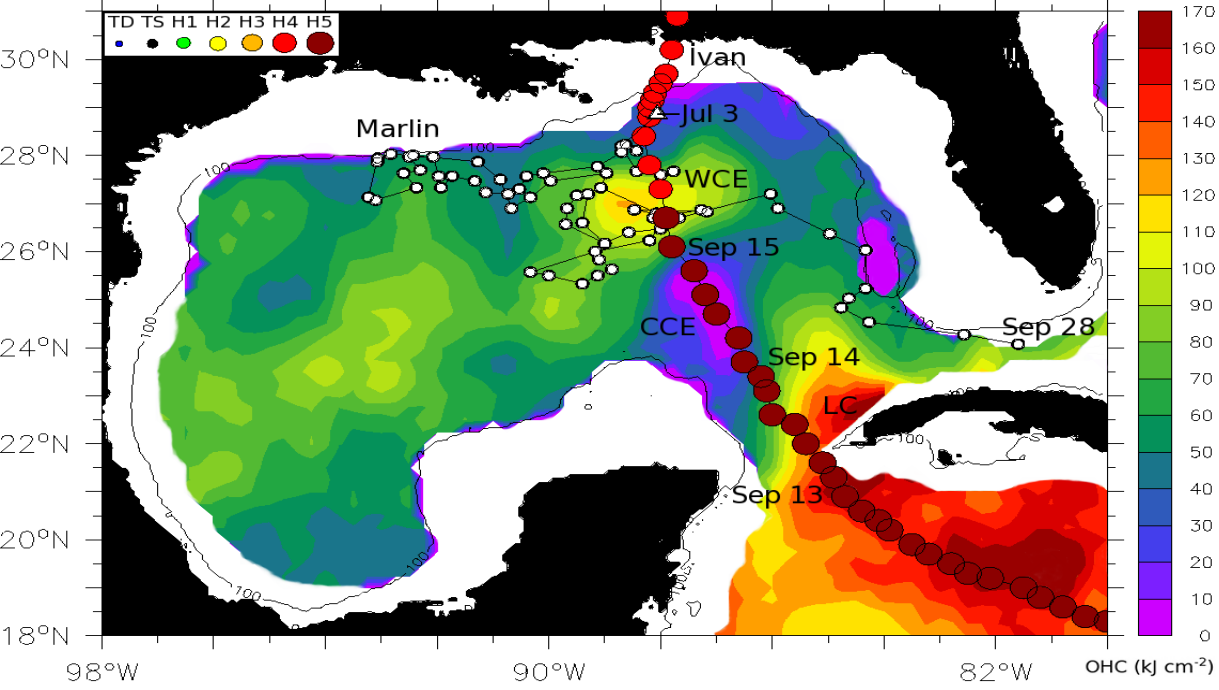
Partnering with Fishery Biologists to acquire ocean data…..

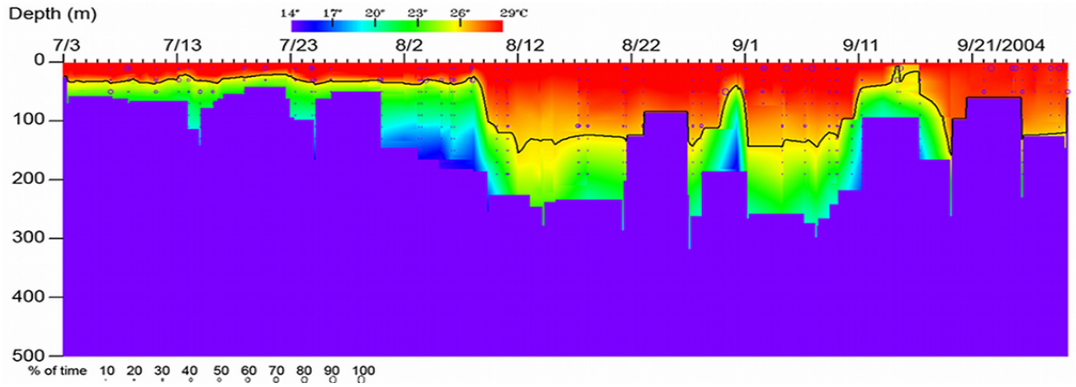
Tracks of tarpon, blue marlin, tiger sharks from 2001-2010 using PAT (Courtesy of J. Ault). Notice the fish tracks tend to be in coastal regimes and in the LC, FC and GS regimes-Improve OHC estimates?

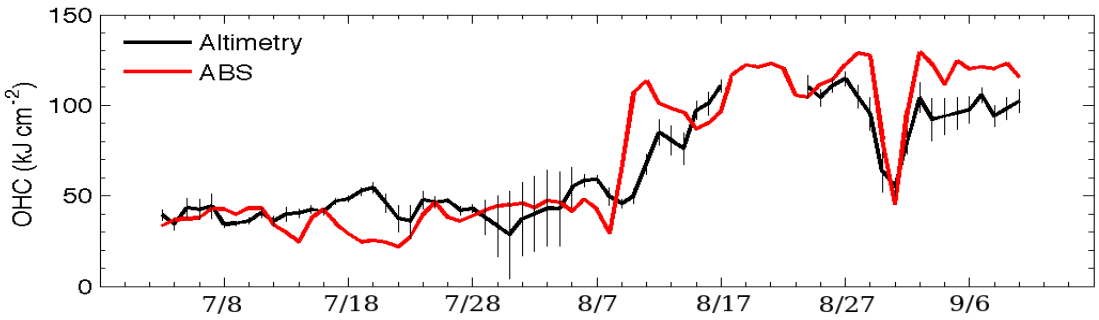


Histograms and scatter show these species seek warm water especially T(z) of 26C or more. Adding S(z) on the CTD tags SMRU.







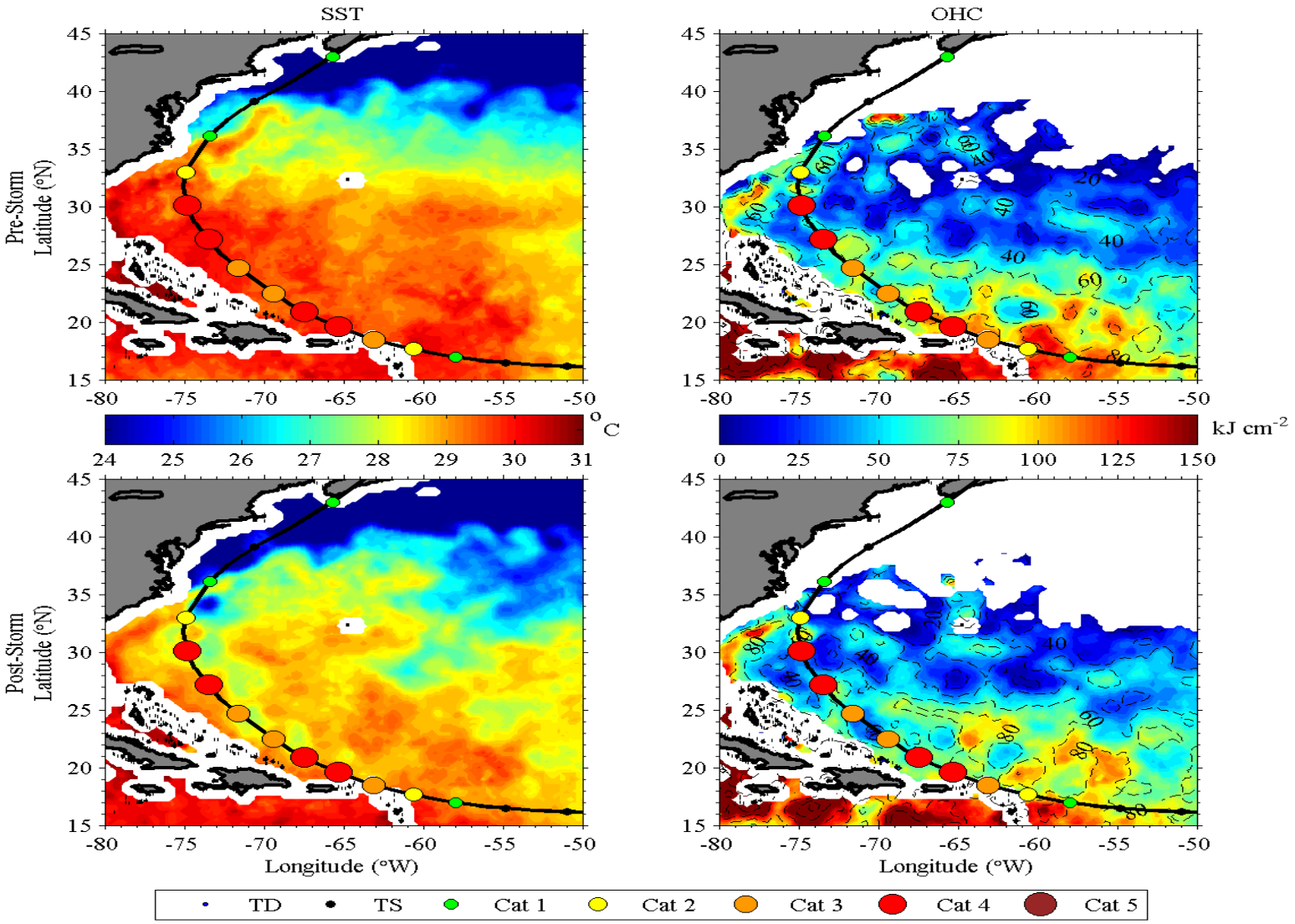


Ivan (2004) track and intensity (colored circles) relative to OHC product using SMARTS and the track of a tagged blue marlin from 3 Jul to 29 Sept.

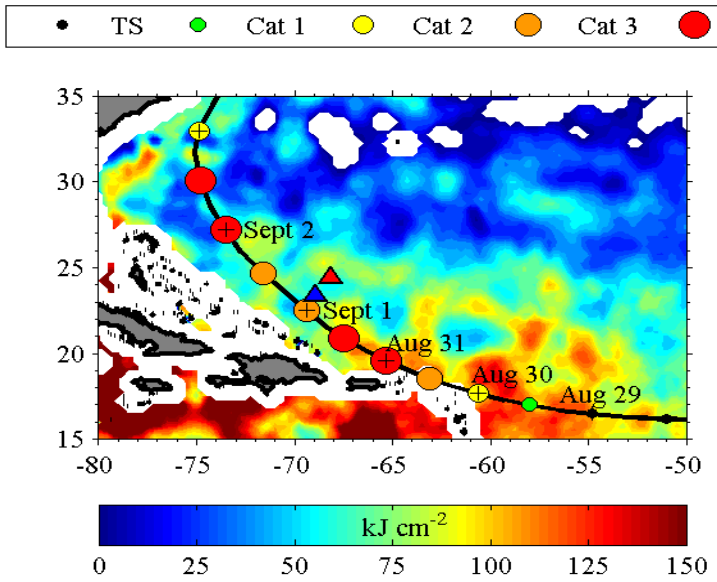
Blue marlin profiles of T(z) using a PAT (data courtesy of Ault and Luo UM) and Rooker (TAMU).

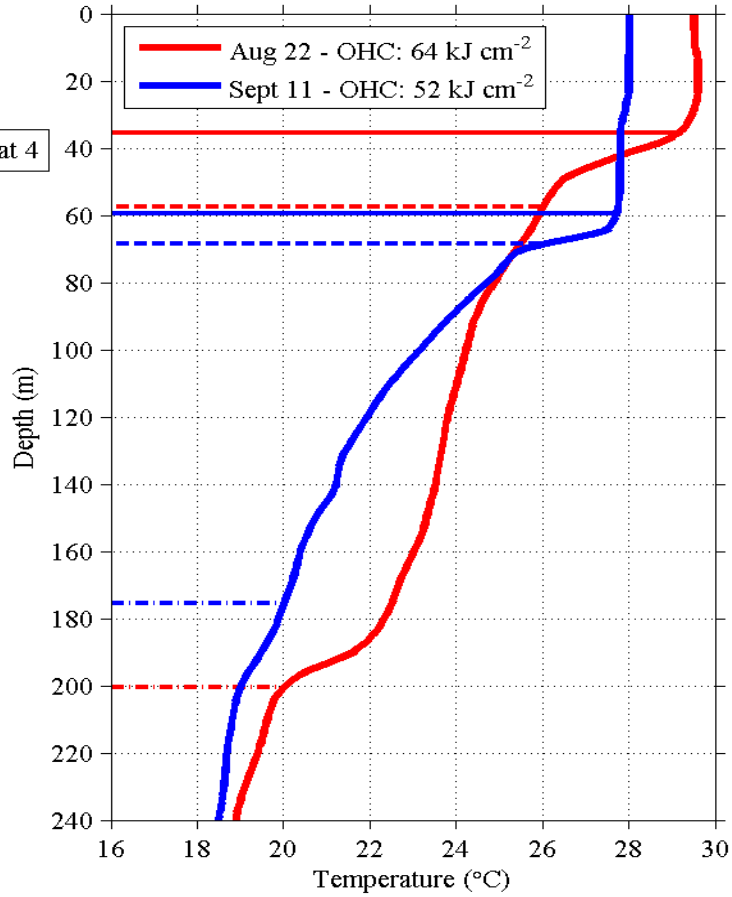
Comparison of OHC from altimetry and blue marlin in fish coordinate system

Hurricane Earl (2010): SST (TMI: Courtesy of RSS) and OHC (Jason, Envisat Altimeters)

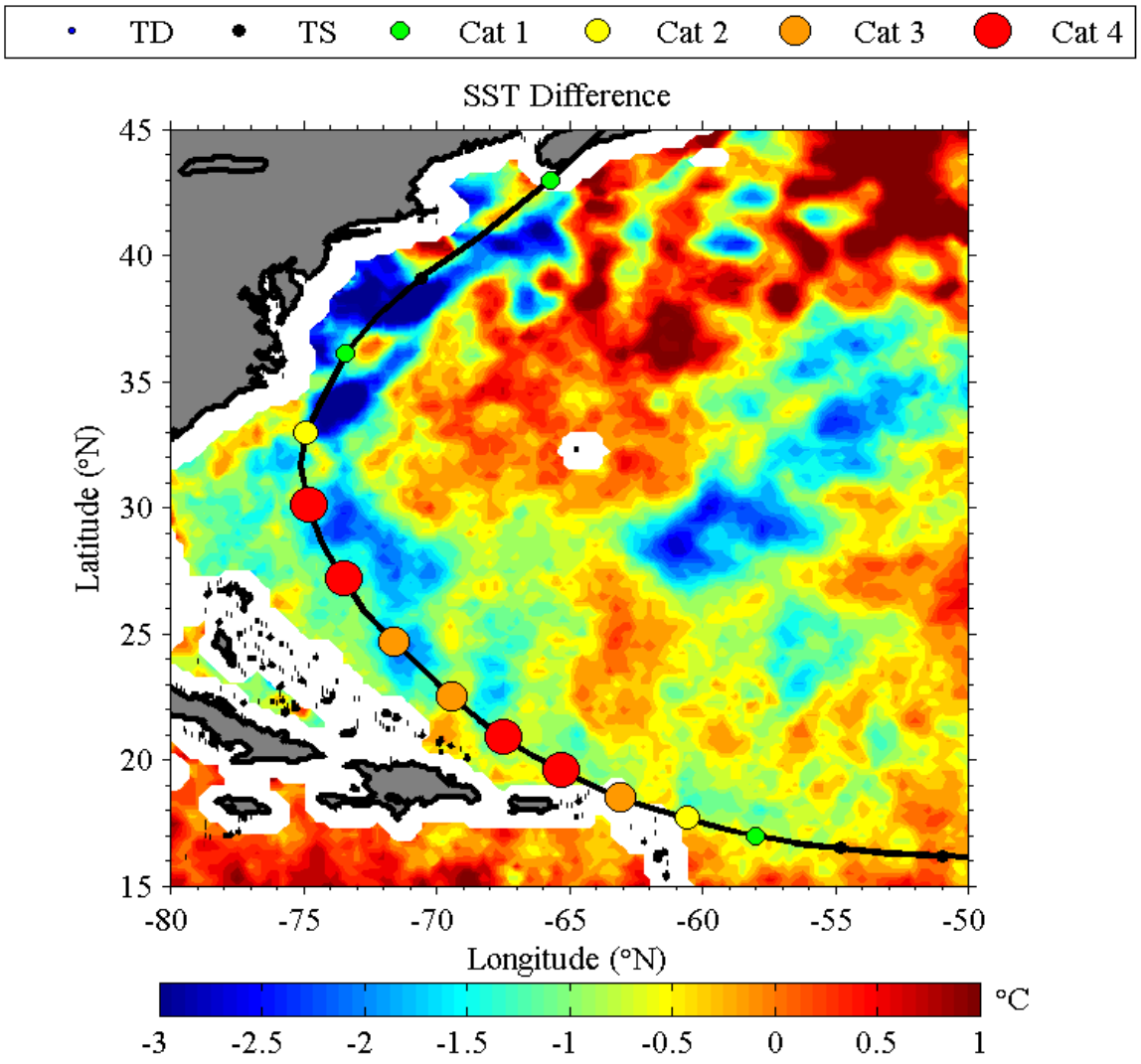


Hurricane Earl (2010): satellite and ARGO Float Measurements





Hurricane Earl SST Differences (2010)



Summary

- Extensive in-situ temperature profile data (now T(z) from Fish) used to evaluate GDEMv3.0 and WOA01 regionally and seasonally in Atlantic basin.
- MLD algorithm a more uniform deepening rather than changing stratification improves OHC by ~4 to 7%. Fish profile the OML for higher resolution measurements for ground truthing.
- SMARTS Approach is being successfully transitioned to NESDIS for Global Real Time Product (NASA, NSF, NOAA).
- Extend OHC estimates towards the coast from profiling ABS measurements.
- *Application of OHC to RI in Earl and Karl and assessing fluxes from GPS sondes/ DAWN from the GRIP instrumentation including the heat/moisture balances in the ABL in collaboration with NASA PIs.*

SMRU CTD Tags Developed Under ONR Grant.

- Cost is $4K per tag (less for higher volumes).
- Up to 50,000 data transmissions over a year at 4-sec intervals.

High Resolution:

1. Temperatures: -5 to 35C; Accuracy 0.005C Precision 0.001C;
2. Conductivity: 0 to 80 mS/cm; 0.01 mS/cm; 0.002 mS/cm
3. Pressure: 0-2000 dBar; Accuracy 2dBar; Resolution 0.05 dBar

- Wet/dry sensor signals the tags to transmit via ARGOS GTS.
- Glider Cost O($100 to 200K) and 24/7 operations-Maintenance Costs are large-Avoid LC/GS complex.
- Floats lower cost ($40 to 80K), but have to avoid LC/FC/GS.
- AX……Require aircraft time (difficult to get time for full up ocean missions during hurricanes to resolve mesoscale ocean structures).
- **Note $400K yields 5M data points/profiles!**

Got Questions?