Progress in AXCTD/AXCP Sampling Strategies Since 2010: Ocean Profiling

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RSMAS

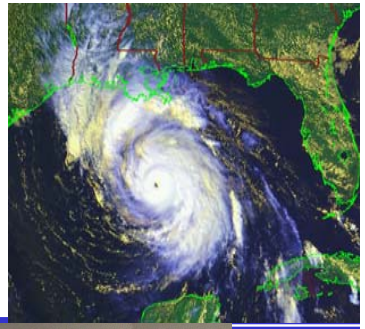
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION NOAA U.S. DEPARTMENT OF COMMERCE

Deep-C CONSORTIUM

U.S. DEPARTMENT OF THE INTERIOR MINERAL REVENUES OFFSHORE MINERALS MINERALS MANAGEMENT SERVICE STEWARDSHIP

MMS

Permanent Installation on P-3 In 2011Working With AOC



AXBT RX Units

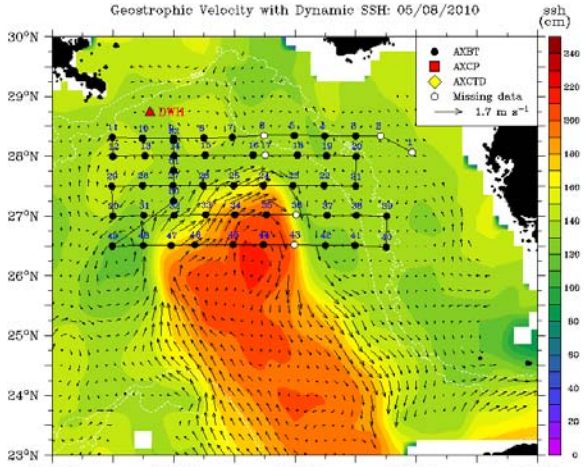
Mark 21 Processors

Marantz 560 Units for Storage

LM Mark 10a RX Unit (200 kHz Bandwidth)

Summary of Flights Since 2010

Year	Event	# Flights	AXBT	AXCTD	AXCP	Total Ocean	GPS-DS
2010	DwH	9	363/405	35/41	74/142	472/588	67/77
	Bonnie	1	33/35	–	–	33/35	2/2
	Test	1	6/6	–	**5/6**	11/12	–
	Matthew	2	88/92	37/40	**5/10**	130/142	27/27
2011	Pre-season	3	47/50	41/41	**32/51**	120/142	37/38
2012	Isaac	6	107/121	53/56	**27/41**	187/218	153/158
2013	Pre-season	1	32/34	15/15	**1/12**	48/61	15/15
	Test	1	–	–	**1/11**	1/11	–
Total		24	676/743	181/193	**145/273**	1002/1209	301/317
Success			91%	93%	53%	83%	95%


Geostrophic Velocity with Dynamic SSH: 05/08/2010
ssh (cm)
AXBT
AXCP
AXCTD
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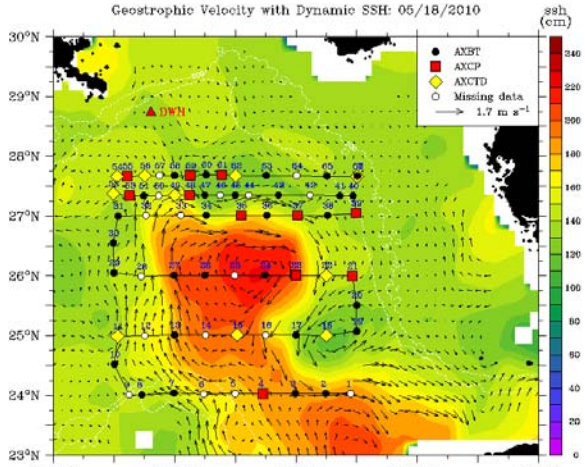
DWH
30°N
29°N
28°N
27°N
26°N
25°N
24°N
23°N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28°N
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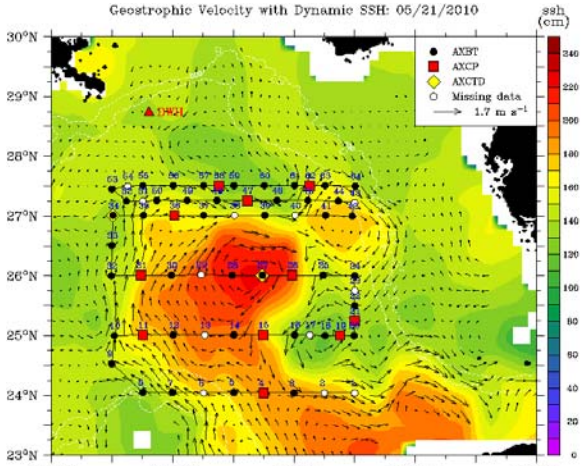
86.0°W
84.0°W
82.0°W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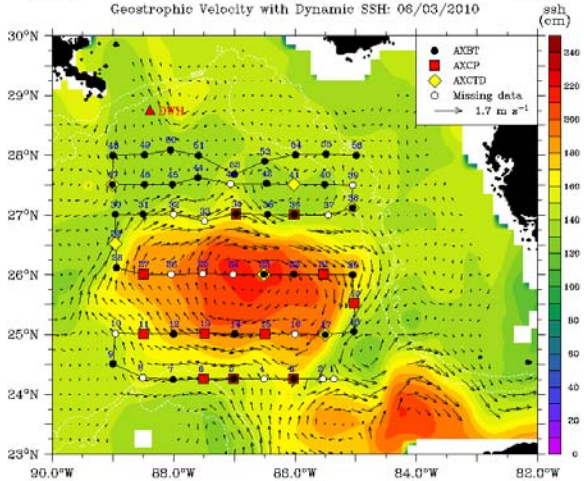
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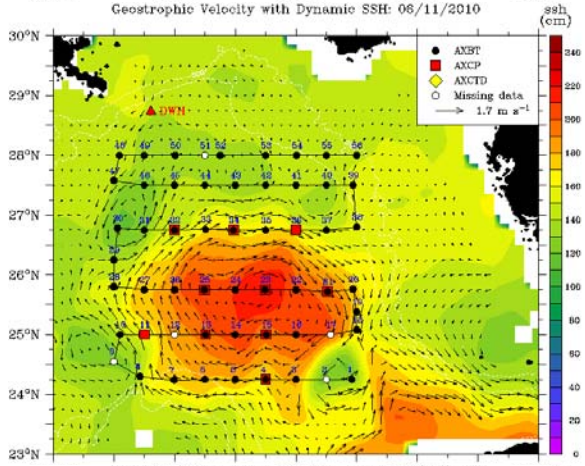
82.0°W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AXCP
AXCTD
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27°N
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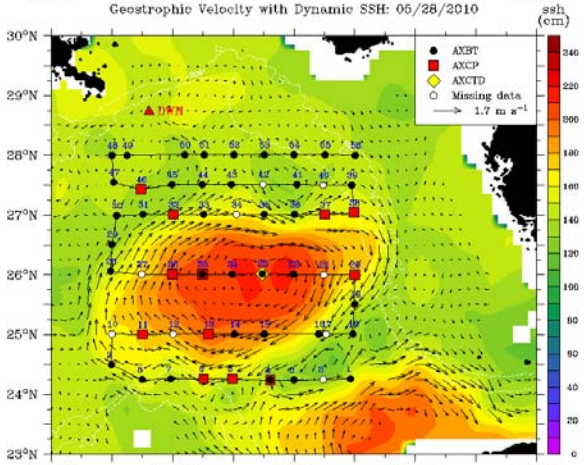
24°N
23°N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AXCP
AXCTD
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88.0°W
86.0°W
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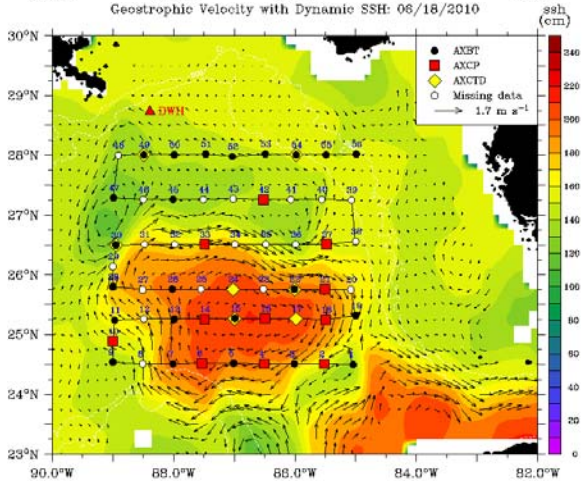
Geostrophic Velocity with Dynamic SSH: 06/18/2010
ssh (cm)
AXBT
AXCP
AXCTD
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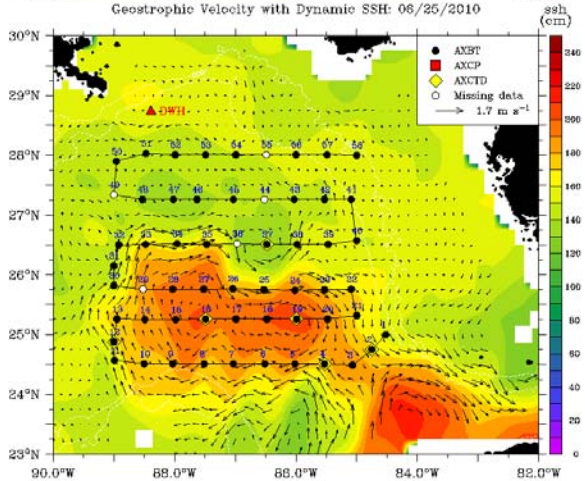
86.0°W
84.0°W
82.0°W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AXCP
AXCTD
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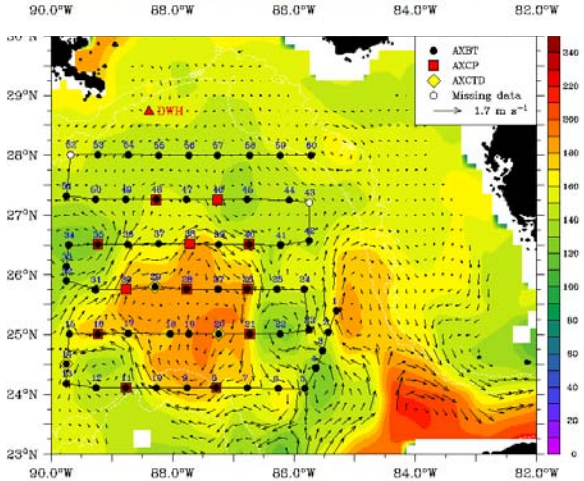
88.0°W
86.0°W
84.0°W
82.0°W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AXBT
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Missing data
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30°N
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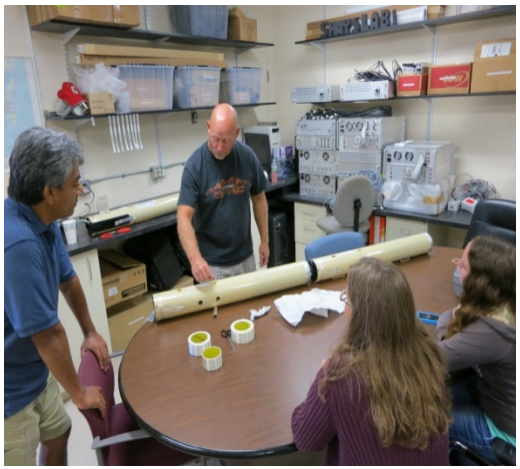
27°N
26°N
25°N
24°N
23°N
90.0°W
88.0°W
86.0°W
84.0°W
82.0°W

AXCP Refurbishment with Lockheed Martin

Low success rates of AXCPs (60% versus 90%) during DWH.

Air-Cannon Test (simulates terminal fall speeds) by vendor revealed

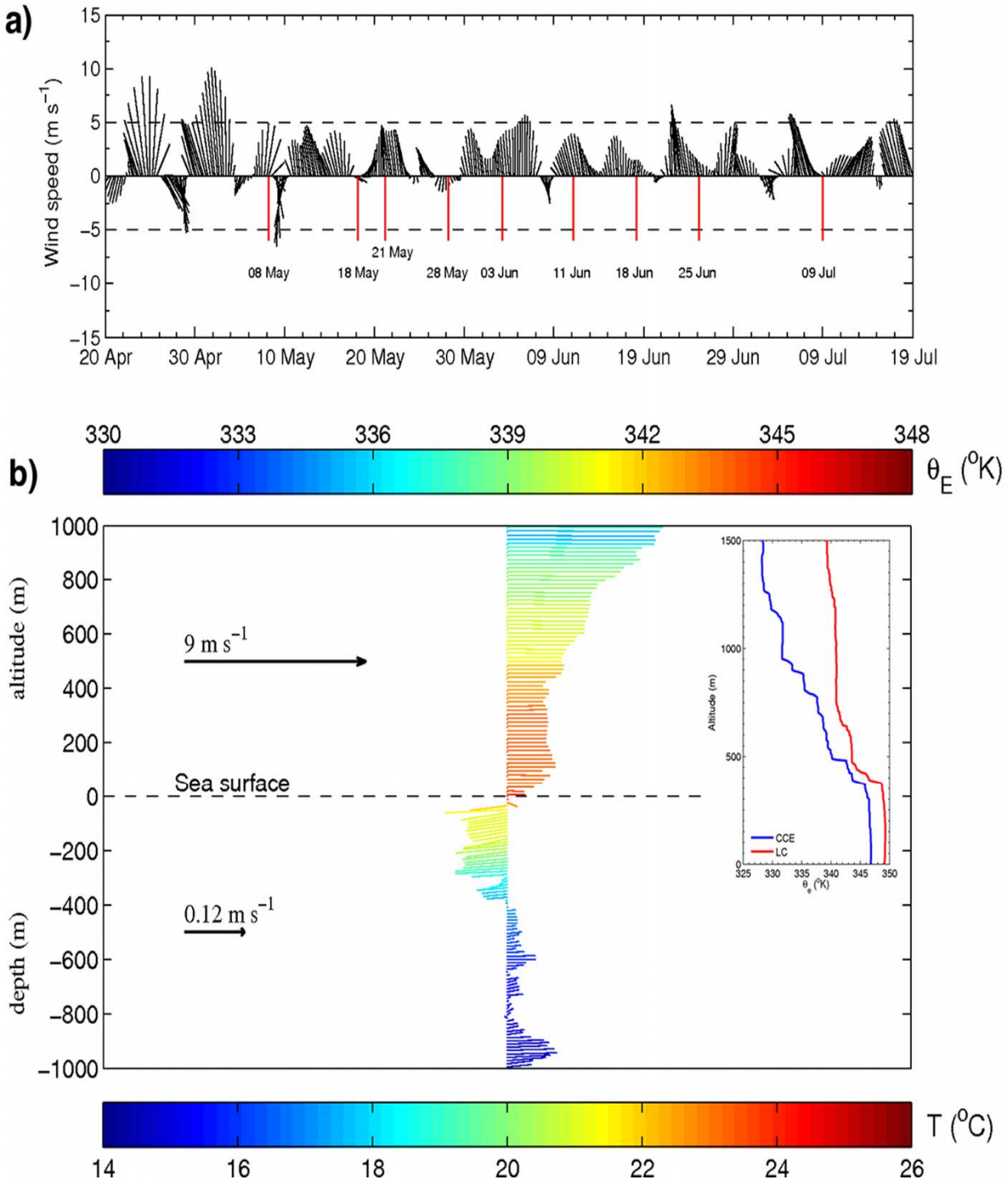
- High Success at 90 to100 ft/sec
- Low Success at 115 to 120 ft/sec



Discovered faulty parachutes

- July 2012 Chutes replaced in 80 units to decrease terminal fall speeds
- Agar replaced (surrounds sensor)
- Tension on lanyard checked.

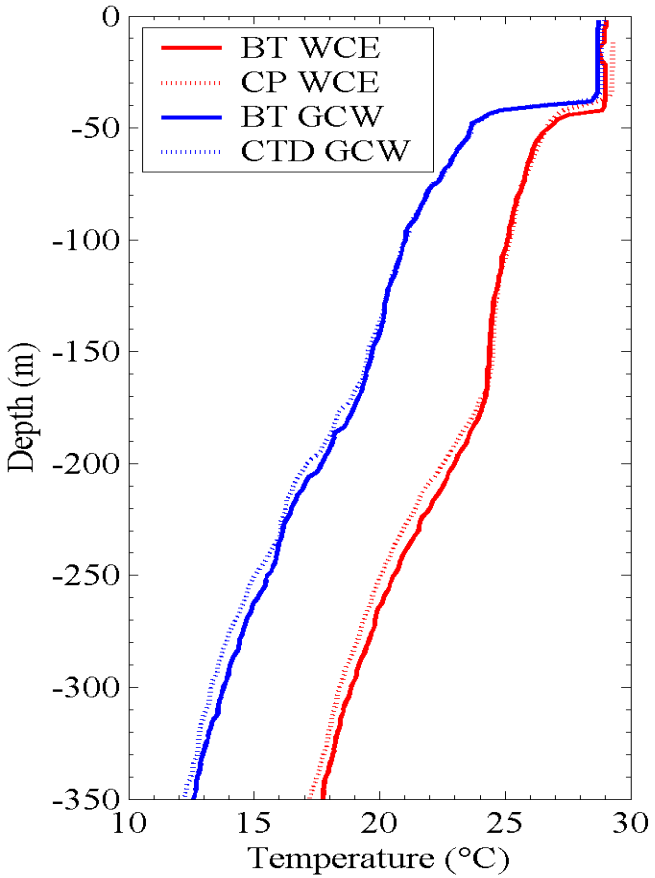
A test flight on P-3 in 15 Aug 2012 to assess.

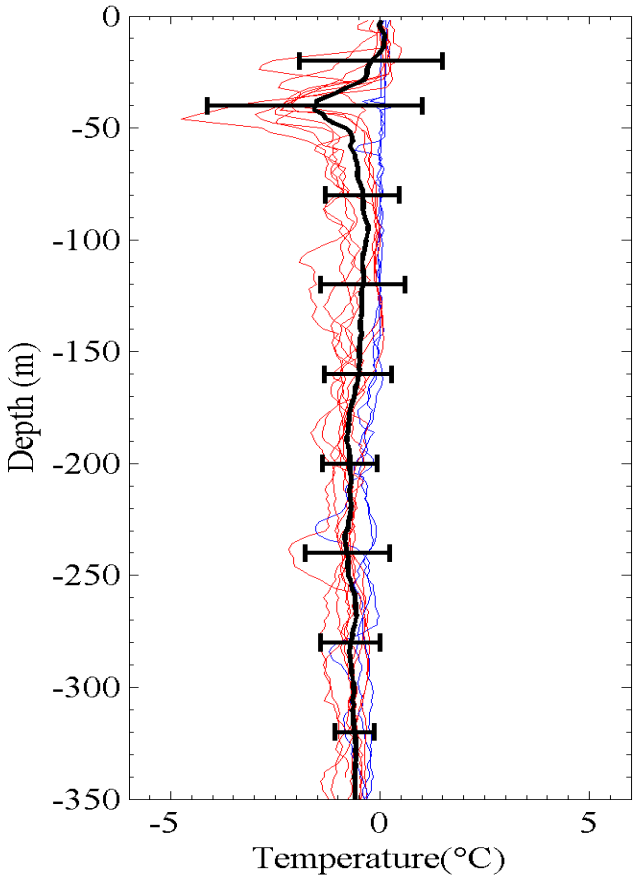


Upper: adjusted surface winds (10-m) at NOAA Data Buoy 42040 located ~55 km NE of DWH-Red lines depict day of the flights.

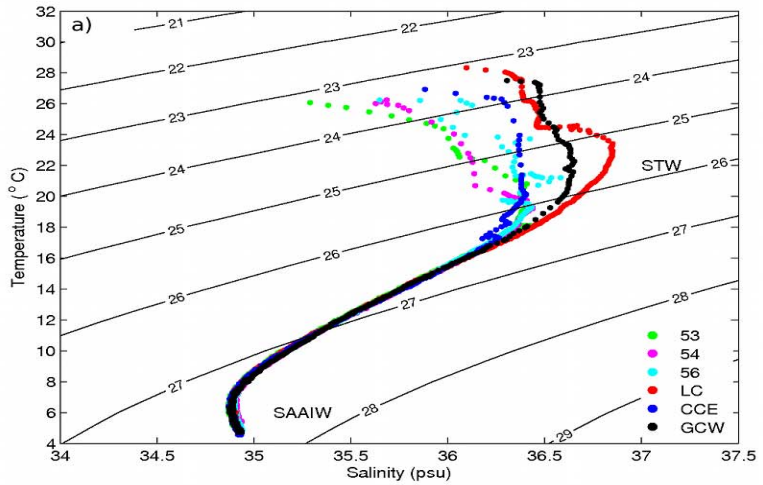
Lower: atmospheric boundary layer winds from GPS sonde and ocean currents from an AXCP (stick plots) colored to depict equivalent potential temperature (K) and ocean temperature (C).

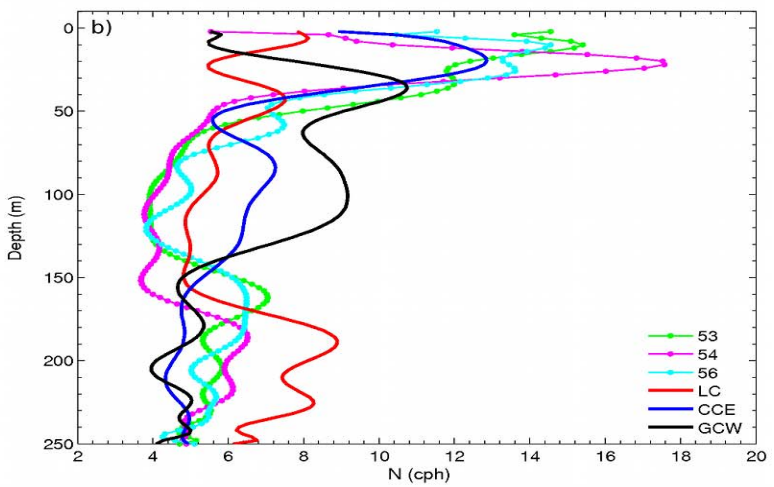
AXBT Versus AXCP and AXCTD

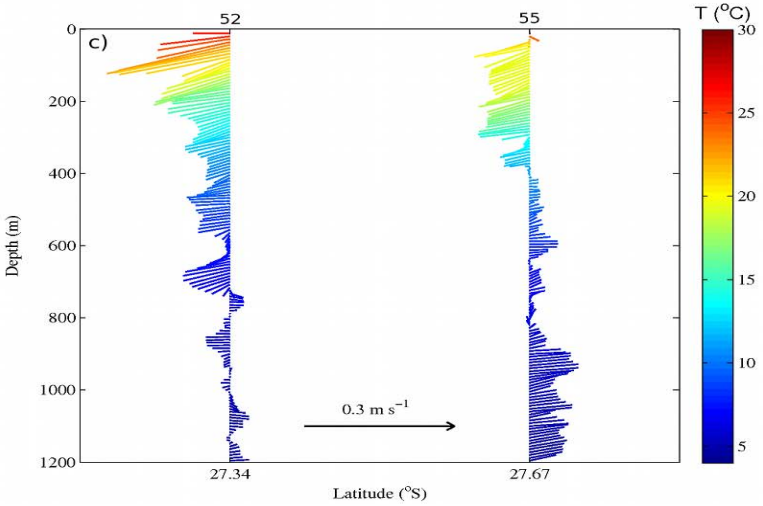


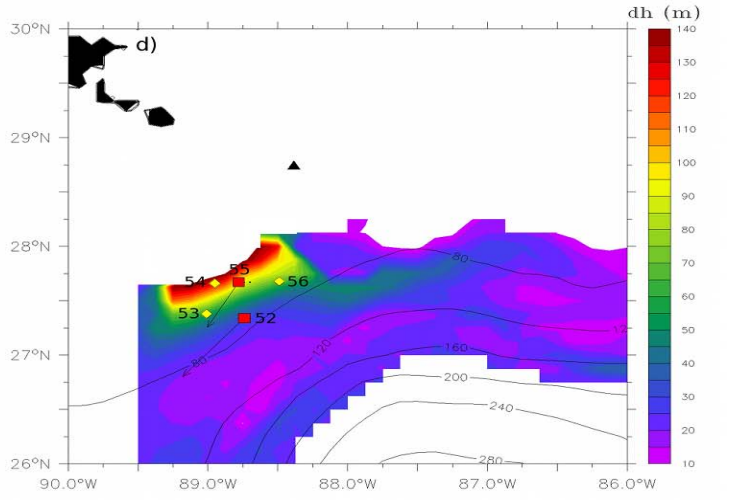


Water Mass Characteristics: T-S, Buoyancy and Current Profiles in Thermostad Region Due South of DWH

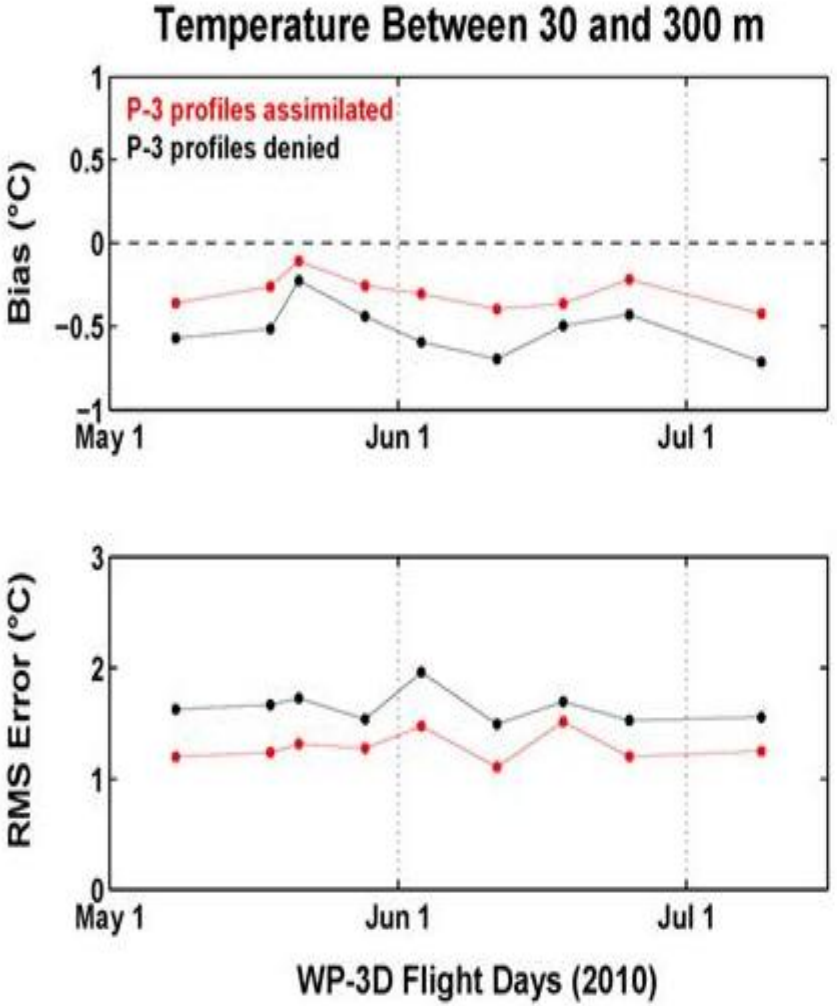


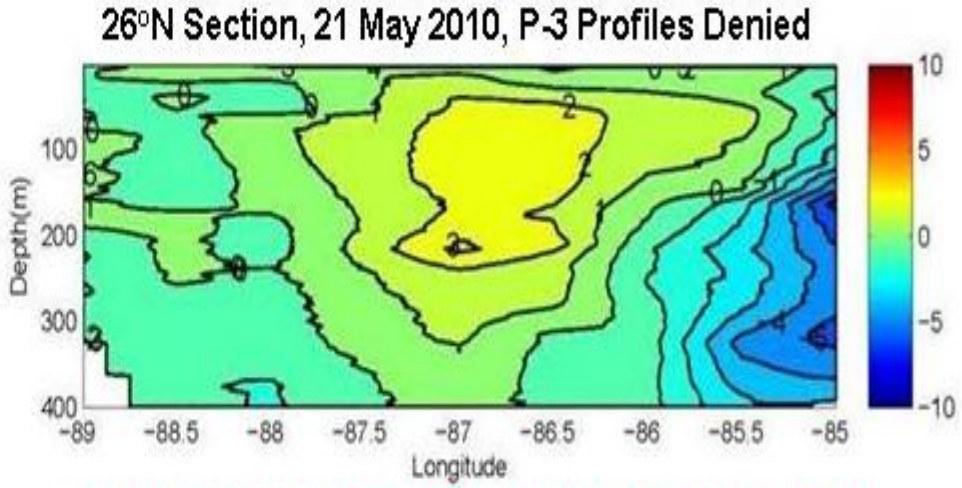


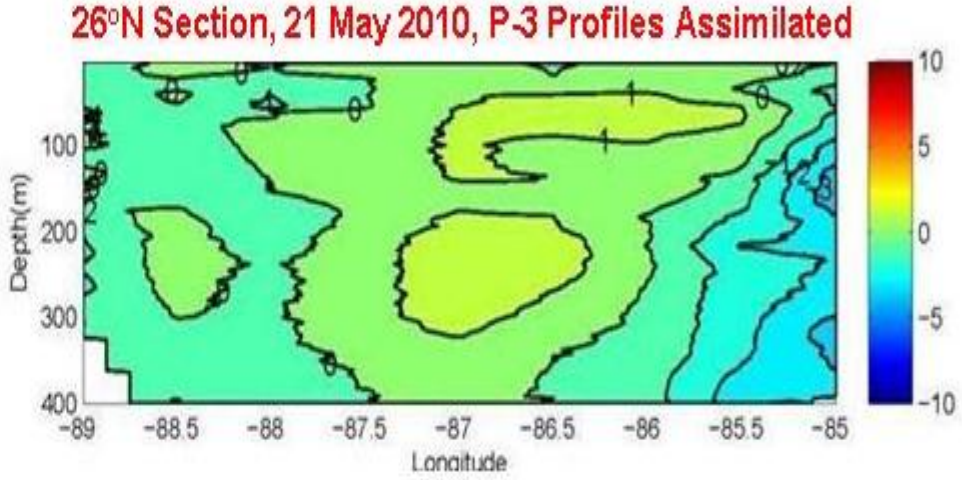




Assimilation of T(z) Into HYCOM (Analysis Courtesy of G. Halliwell)

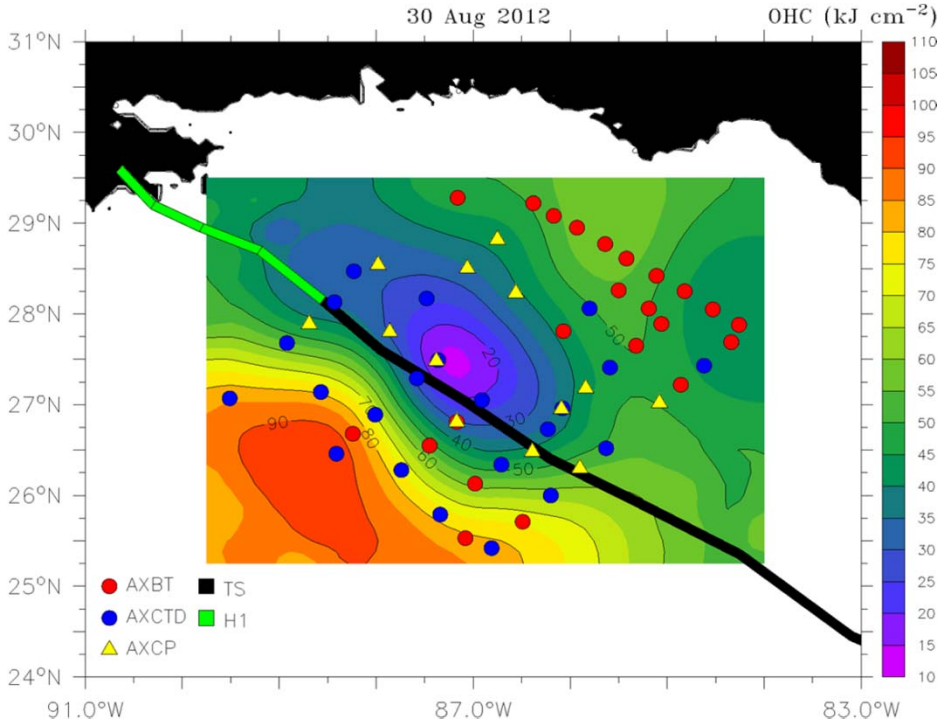






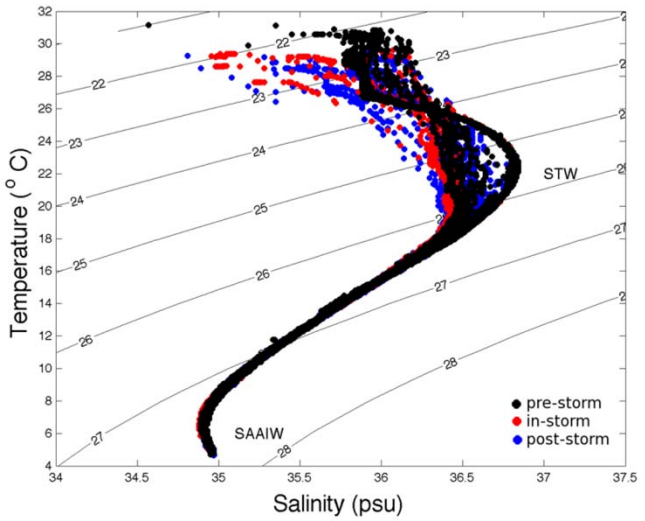
Post-Isaac flight (30 Aug)

	Deployed	Good	Bad	Success
AXBTs	23	20	3	87%
AXCTDs	24	23	1	96%
AXCPs	20	17	3	85%
Overall	**67**	**60**	**7**	**90%**



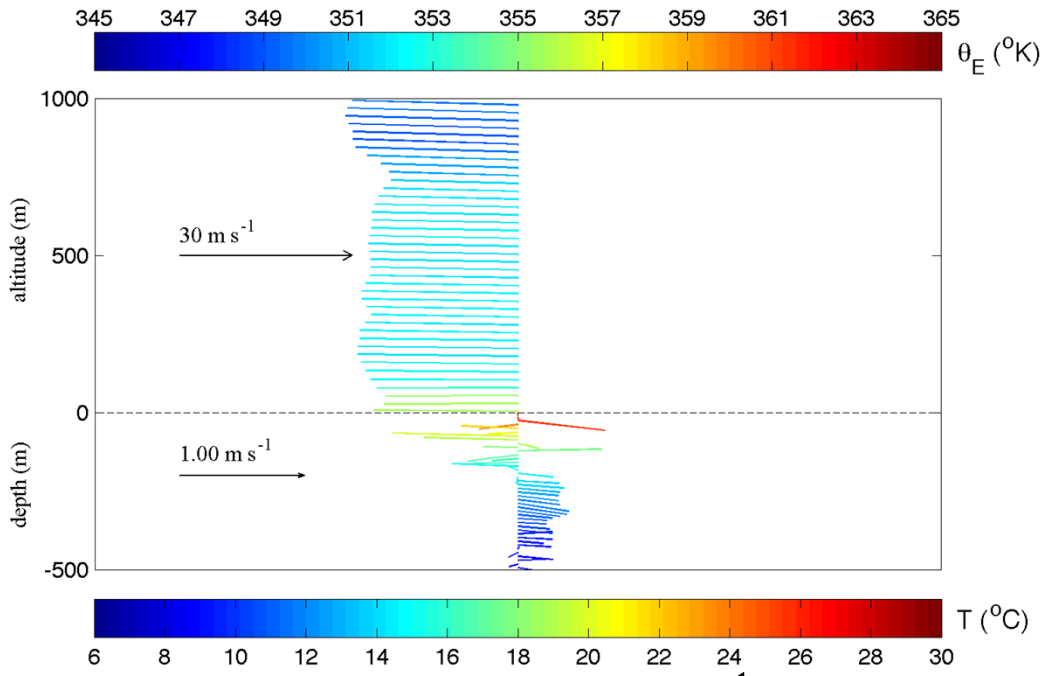
Isaac Flight Summary

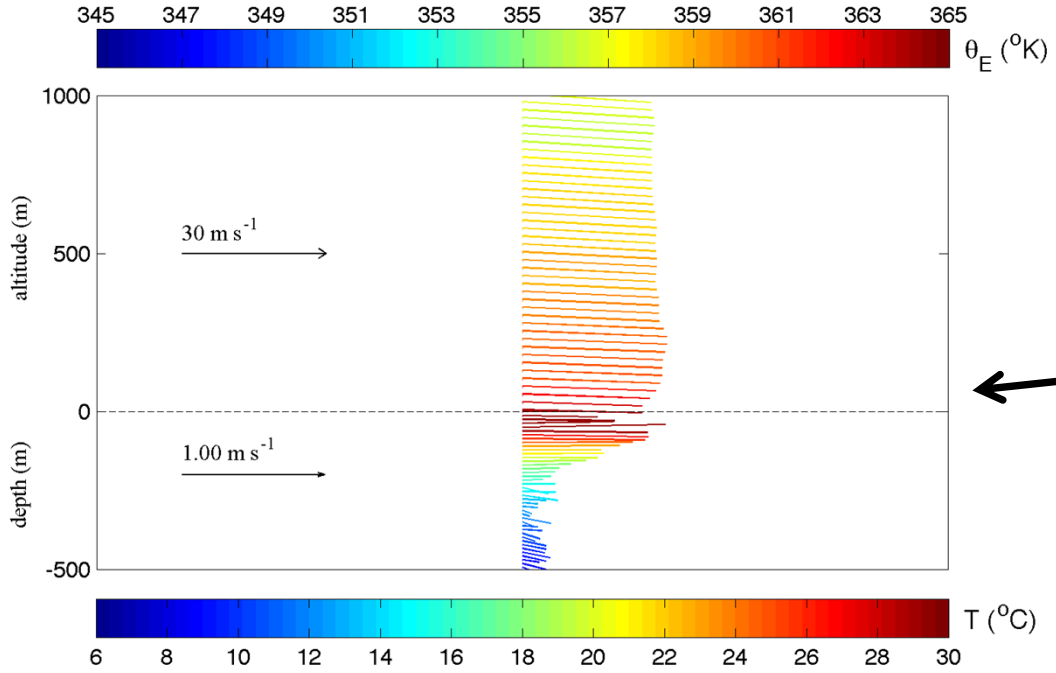
- **58 AXBTs deployed in other 3 in-storm flights (97%)**
- **218 Ocean probes**
- **overall success: 88% during six flights**
- ***Below are the T/S curves from XCTDs prior, during and after Isaac.***

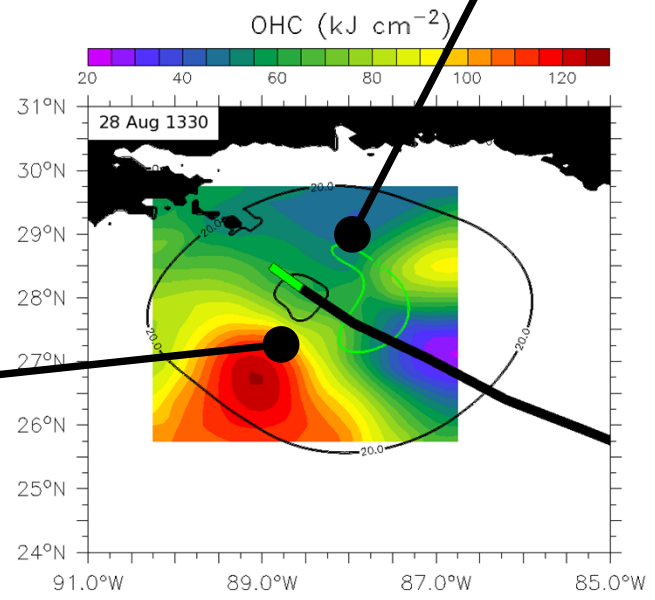


Contrasting ocean response in oceanic geostrophic features.

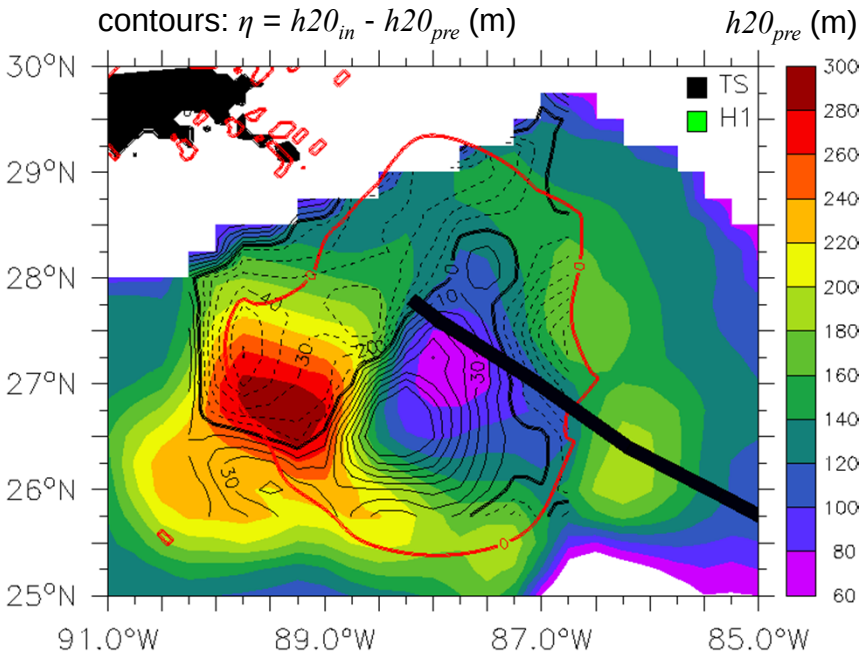
Contrasting distribution of θ_E as a function of underlying oceanic features.







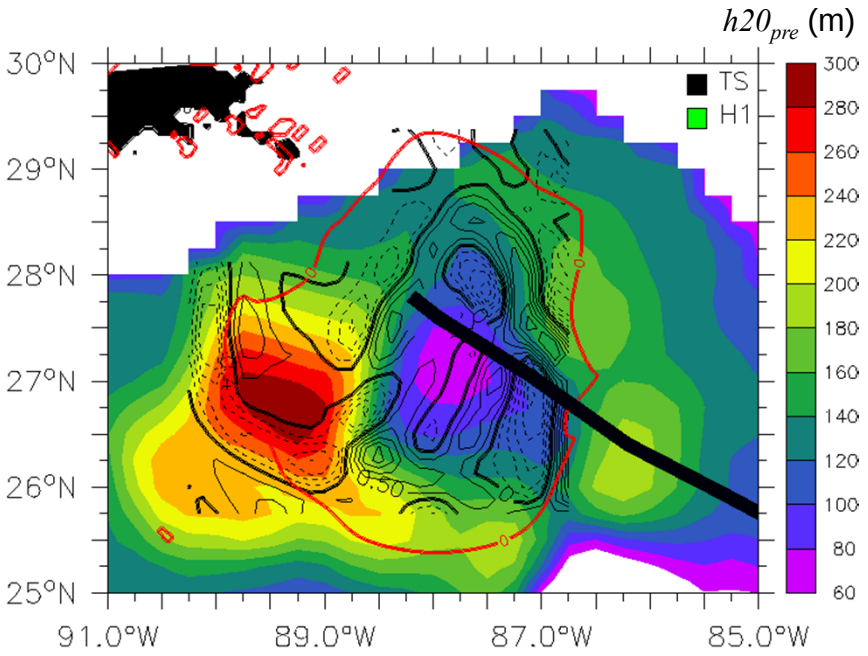
Contrasting upwelling (dashed contours) and downwelling (solid contours) regimes developed inside the region of cyclonic curl of the wind stress.



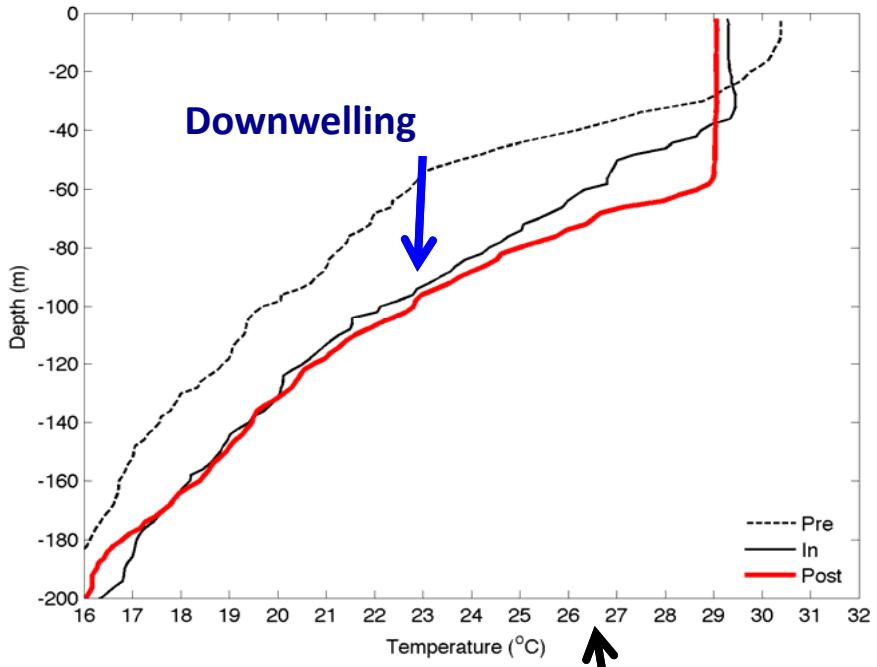
- $h20_{pre}$ *is from SMARTS (25 Aug)*
- $h20_{in}$ *is from in situ P-3 data (28 Aug)*
- τ *is from Hwind (1030z, 28 Aug)*

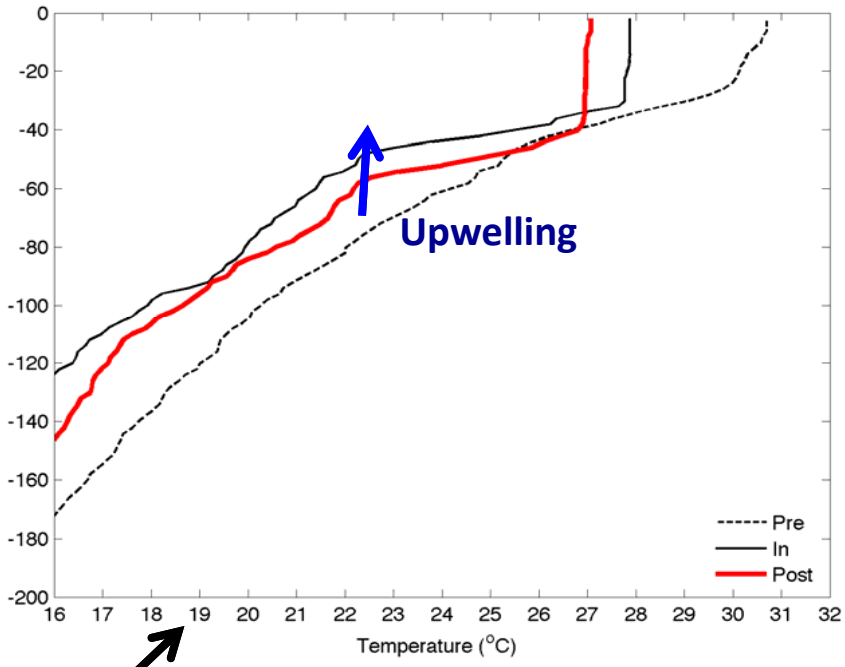
Vertical velocity associated with isopycnal displacements are a function both the geostrophic current vorticity and the curl of the wind stress (Stern, 1965; Jaimes and Shay 2009; Jaimes et al. 2011):

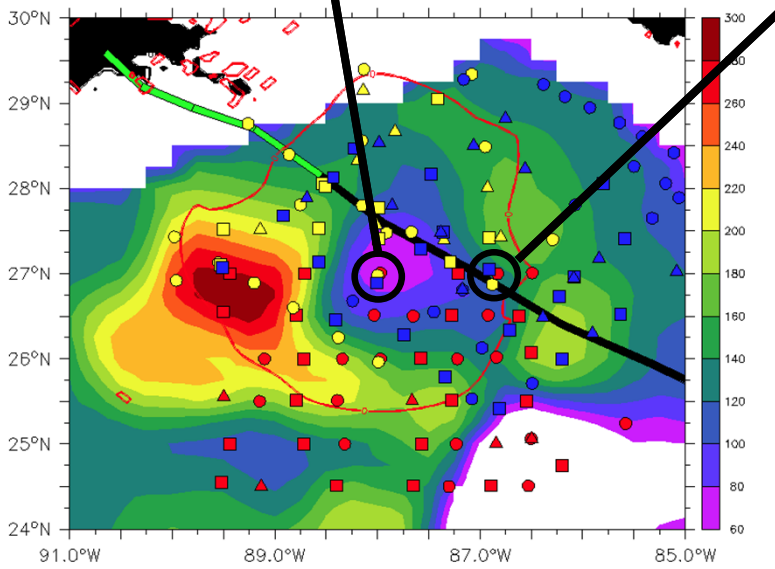
$$w = \frac{\mathbf{K} \times \tau}{\rho_0 f^2} \cdot \nabla\left(\frac{\partial v_g}{\partial x} - \frac{\partial u_g}{\partial y}\right)$$ (contours)



Upwelling/Downwelling Inside the Region of Cyclonic Wind Stress







In-storm data is from the 28 August morning flight (during intensification to hurricane level)

AXCP Test Flight Recovery by Daisy Mae in Oct 2013 with LM.

Deployed 11 AXCPs (10 Surface housings recovered):

- Mesh over wire spool was displaced-inducing wire problems;
- Cracking of the shell housing XCP sensor; and
- Pins holding probe in place punctured surface canister (water leak).

Summary

Sample strategies with deeper profiles for Loop Current/Eddy regimes.
Ocean cannot be ignored in the western parts of the basin-an integral part of RI/RW-that has been shown (e.g., Katrina/Rita).

Targeted ocean profiles to improve the ocean/coupled models. Data sets to resolve mixing and (3-D) upwelling issues that cool the ocean mixed layer (***AND SSTs that affect Enthalpy Fluxes***!). Adding EM/APEX floats this summer to platform mix.

Approach compliments *AXBT Demonstration Project* from C-130s.

Re-engineering AXCP (needed for transports/shears). Digital TSK AXCTD performance has been exceptional ~94%!

Effectively assimilate 3-D data into the models to better understand oceanic impact on hurricane intensity changes.