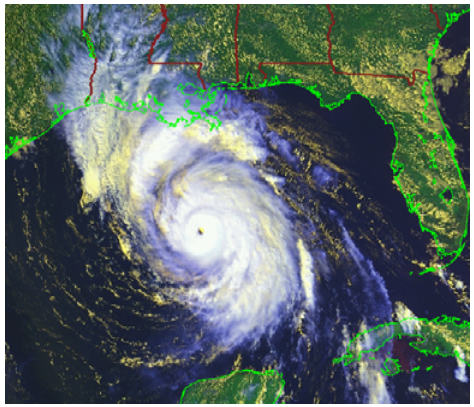
Aircraft Surveys of Loop Current Variability Observed During Deepwater Horizon



L. K. (Nick) Shay

Collaborators: B. Jaimes, J. Brewster, P. Meyers, C. McCaskill (RSMAS/UM), F. Marks, G. Halliwell, E. Uhlhorn (NOAA-AOML) O. M. Smedstad and P. Hogan (NRL)

J. McFadden and S. Paul (NOAA/OMAO/AOC)

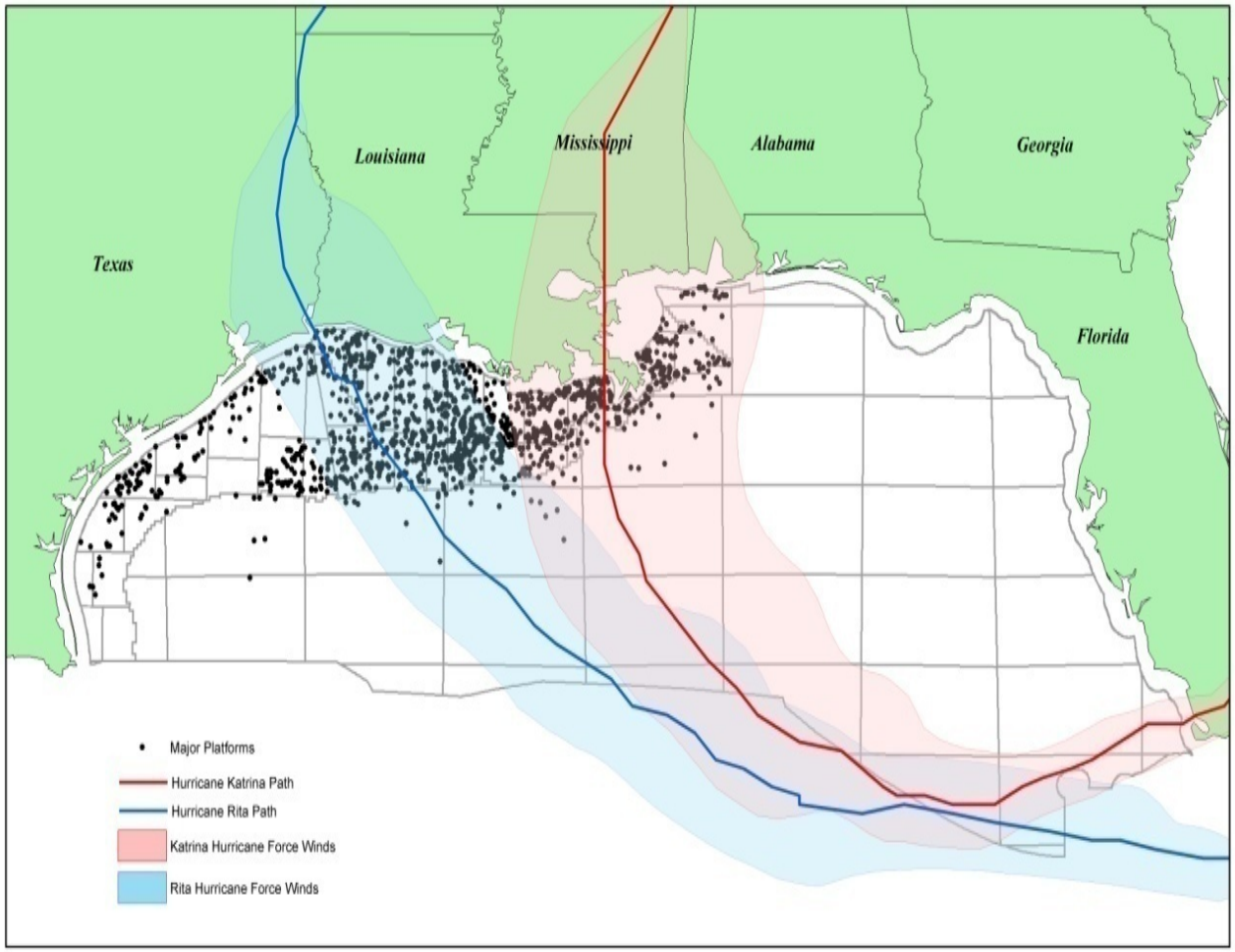
R. Lai, A. Luqo-Fernandez (DOI/BOEMRE)

RSMAS

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

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

MMS



Tracks of Katrina and Rita (2005) in Northern Gulf of Mexico Relative to Oil Rigs.

Over 35% of the Rigs were damaged or destroyed in the Gulf.

Pain at the pump!

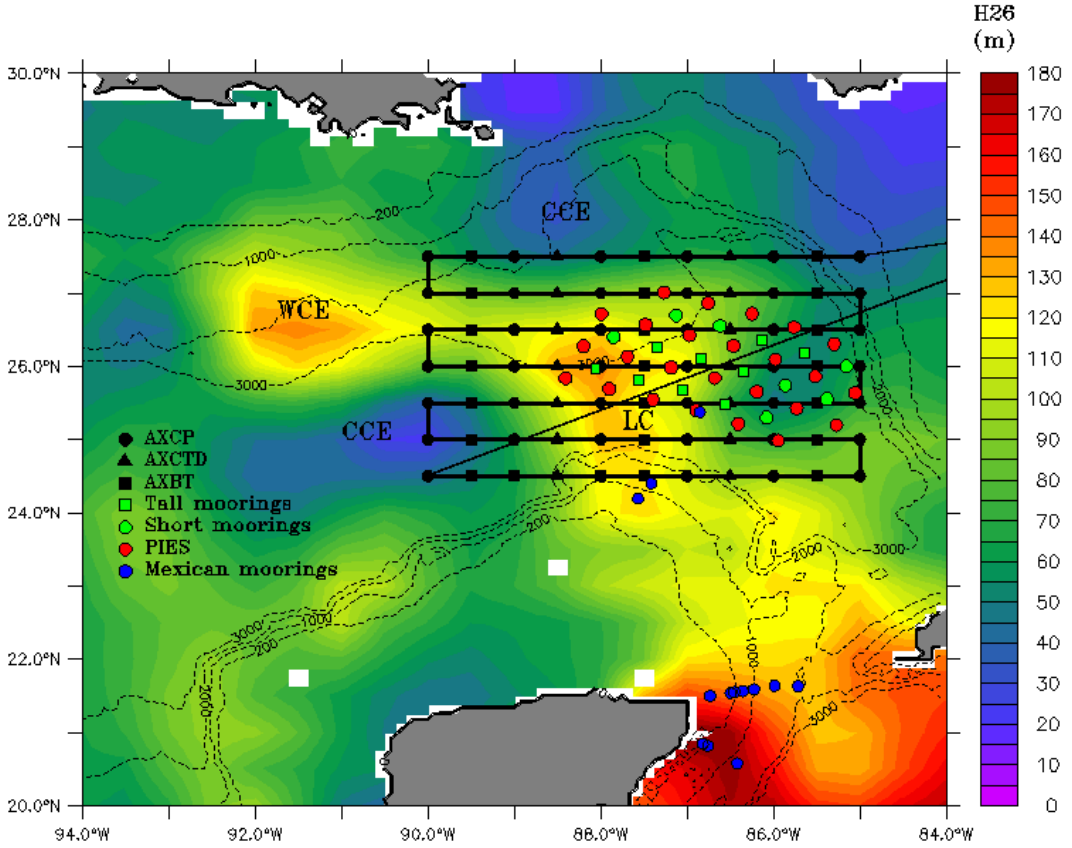
Plan for NOAA WP-3D profiling over BOEMRE Moorings (collaboration with AOML HRD, AOC, NCEP)

Deliverables include:

V, T, S profiles to 1000 m @ 2-m resolution.

Surface winds (SFMR, GPS) provided by HRD.

Atmospheric profiles of V, T and RH @ 5-m resolution.



Expendables deployed from P-3 and proposed moorings relative to the LC, WCE and CCE superposed on late Sept 05 altimetry derived 26°C isotherm Depth (After Rita).

Approach:

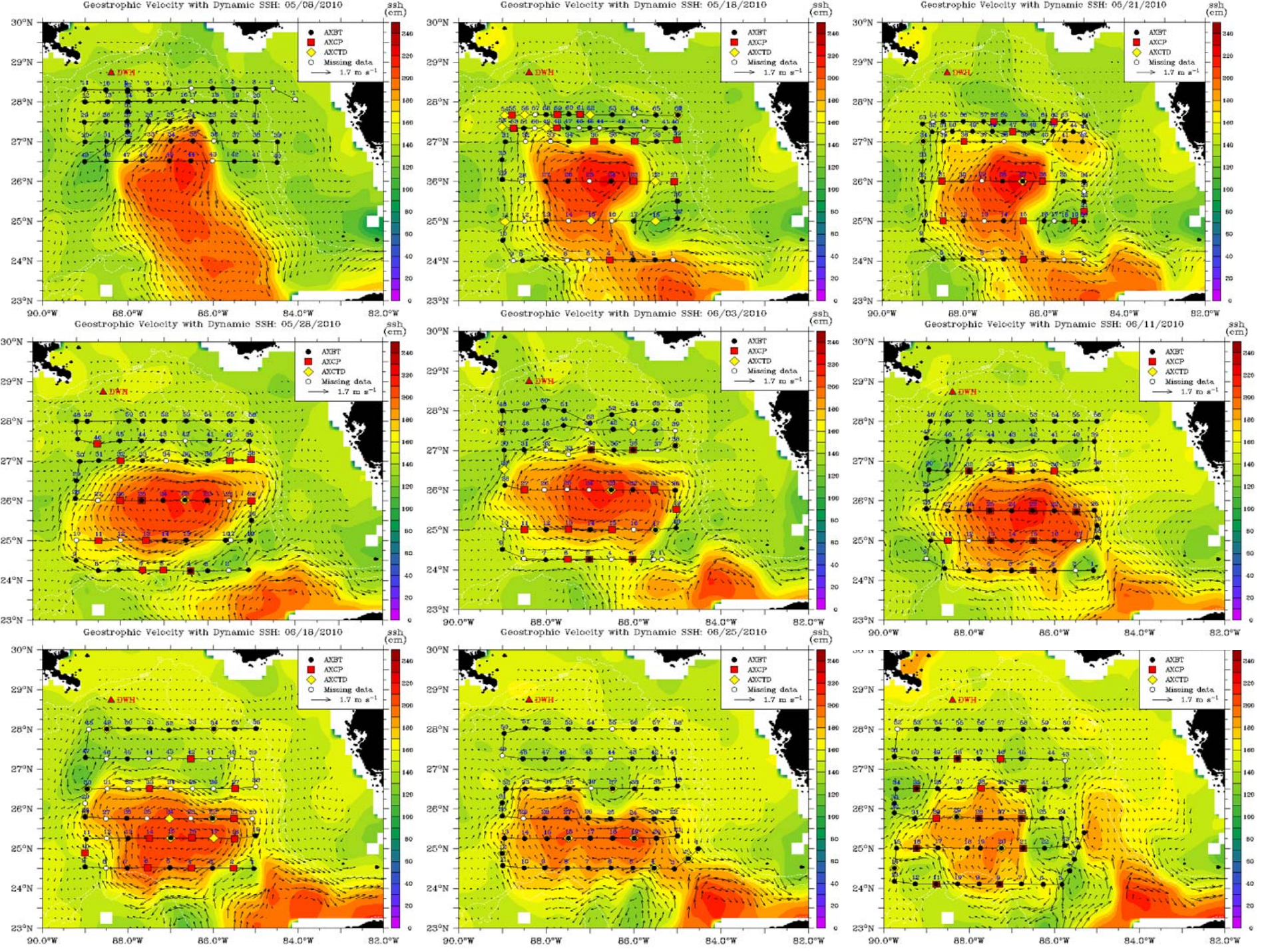
- Airborne Expendables (AXCP :1500 m; AXBT: 350 m; AXCTD:1000 m; GPS) deployed in lawnmower pattern across the LC/Warm and Cold eddy features.
- Flight level winds, temperatures, etc
- Brightness temperatures from the Stepped Frequency Microwave Radiometer (SFMR)
- Downward Looking IR
- Downward Looking Camera
- Nine Flights plus *Bonnie Wake/Pre Matthew over same grid*
- Two Ocean Heat Content Mapping Flights for Hurricane Intensity Forecasting (satellite calibration)

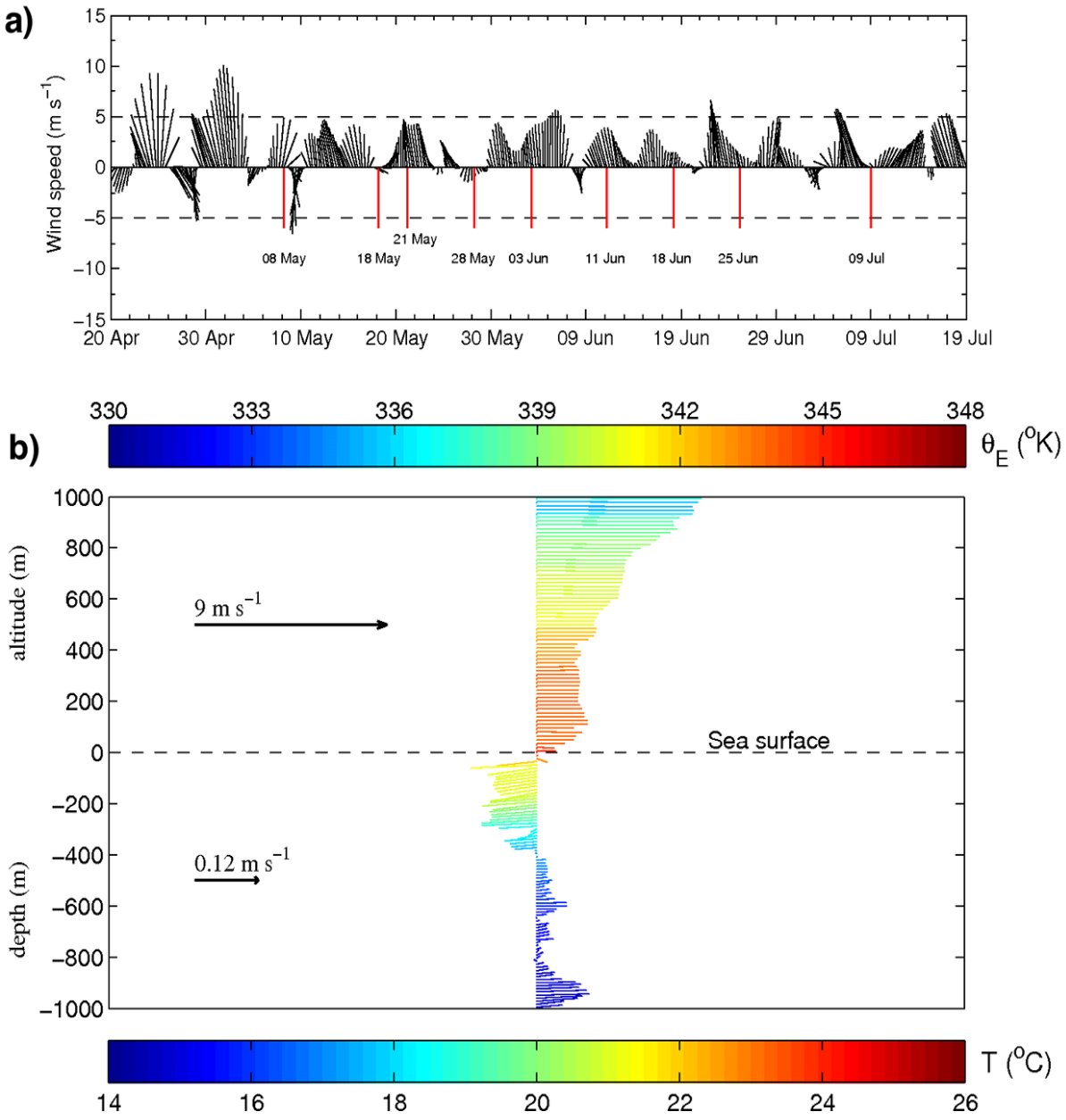
Recurrent Theme: Ocean observations critical in improving oceanic and coupled modeling under weak and strong winds.

Summary of DWH and *OHC* Flights Deployed (Successful)

Flight	AXBT	AXCP	AXCTD	TOTAL
100508H	52 (48)	0	0	52 (48)
100518H	29 (28)	26 (10)	11 (10)	66 (48)
100521H	42 (39)	22 (11)	2 (2)	66 (52)
100528H	41 (37)	22 (9)	2 (1)	63 (47)
100603H	37 (34)	23 (11)	6 (6)	66 (51)
100611H	53 (49)	15 (10)	0	68 (59)
100618H	34 (23)	22 (8)	8 (7)	63 (38)
100625H	58 (53)	0	6 (6)	64 (59)
100709H	59 (54)	12 (12)	6 (3)	77 (69)
100724H	*35(33)*	*0*	*0*	*35(33)*
100812H	*6(6)*	*6(5)*	*0*	*12(11)*
100909H	*62(58)*	*0*	*20(17)*	*82(75)*
100924H	*30(30)*	*10(5)*	*20(20)*	*60(55)*
TOTAL	538(492)	158 (88)	81 (72)	777 (645)

RSMAS

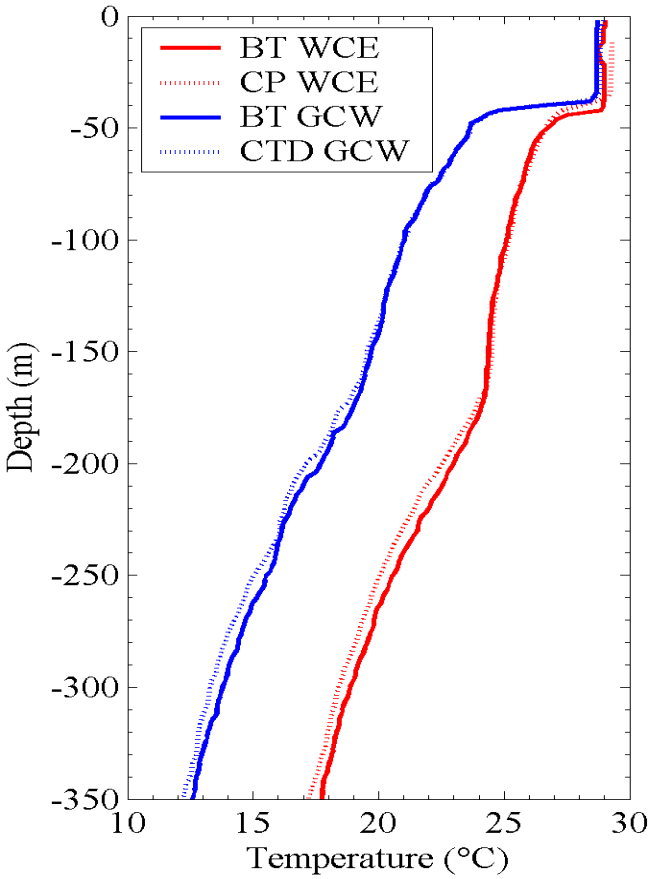

Geostrophic Velocity with Dynamic SSH: 05/08/2010
Geostrophic Velocity with Dynamic SSH: 05/18/2010
Geostrophic Velocity with Dynamic SSH: 05/21/2010
Geostrophic Velocity with Dynamic SSH: 05/28/2010
Geostrophic Velocity with Dynamic SSH: 06/03/2010
Geostrophic Velocity with Dynamic SSH: 06/11/2010
Geostrophic Velocity with Dynamic SSH: 06/18/2010
Geostrophic Velocity with Dynamic SSH: 06/25/2010
ssh (cm)
AXBT
AXCP
AXCTD
Missing data
1.7 m s⁻¹
DWH
30°N
29°N
28°N
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

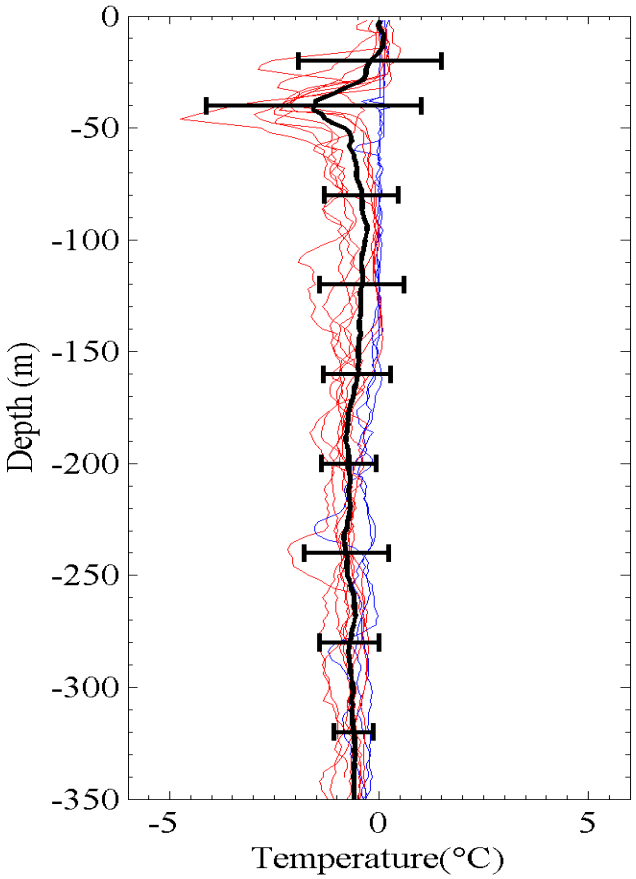


Upper: adjusted surface winds (10-m) at NOAA Data Buoy 42040 located ~55 km NE of DWH-Red lines depict day of the flights.

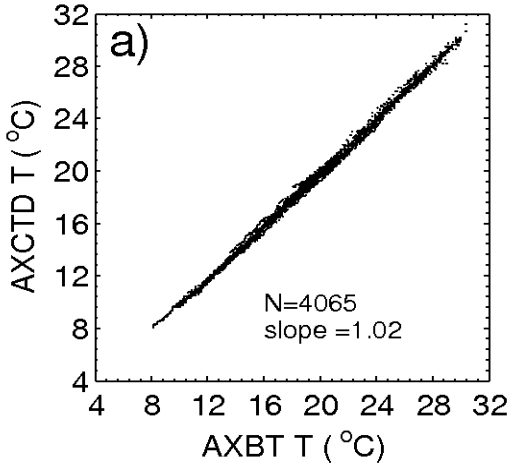
Lower: atmospheric boundary layer winds from GPS sonde and ocean currents from an AXCP (stick plots) colored to depict equivalent potential temperature (K) and ocean temperature (C).

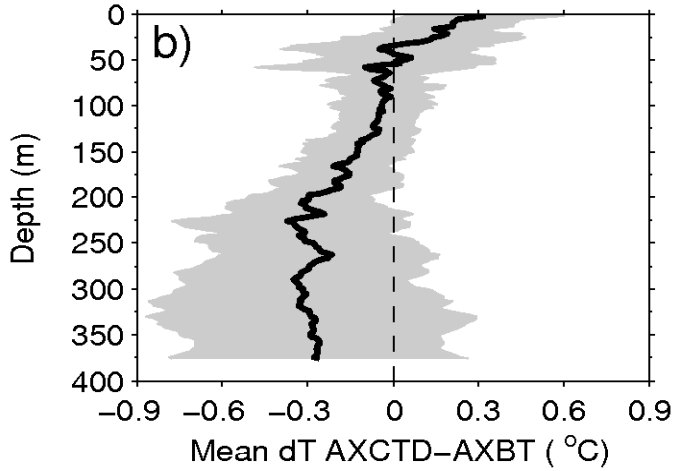
AXBT Versus AXCP and AXCTD

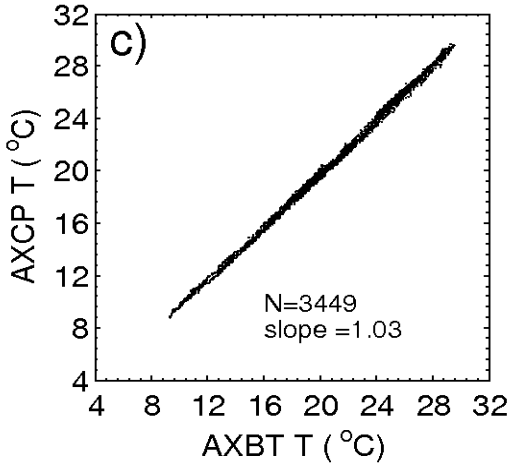


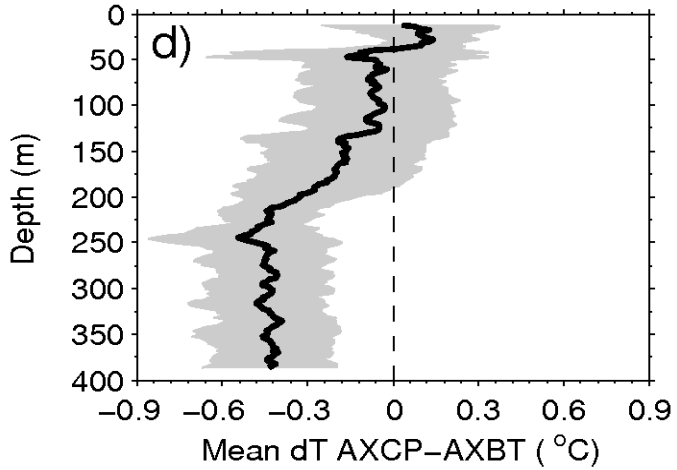


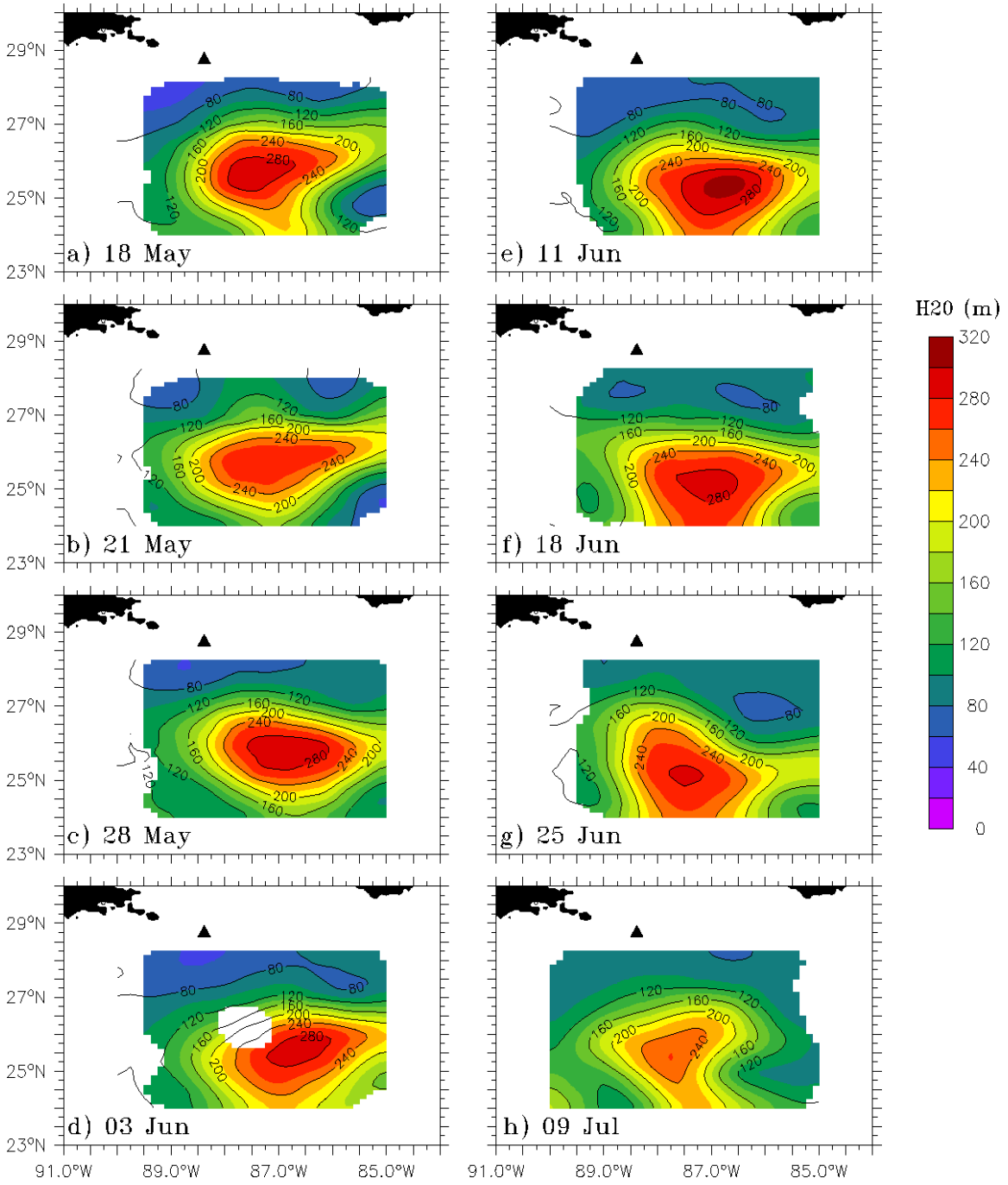
Temperature comparisons (C) between pairs of AXBTs and a,b) AXCTDs and c,d) AXCPs



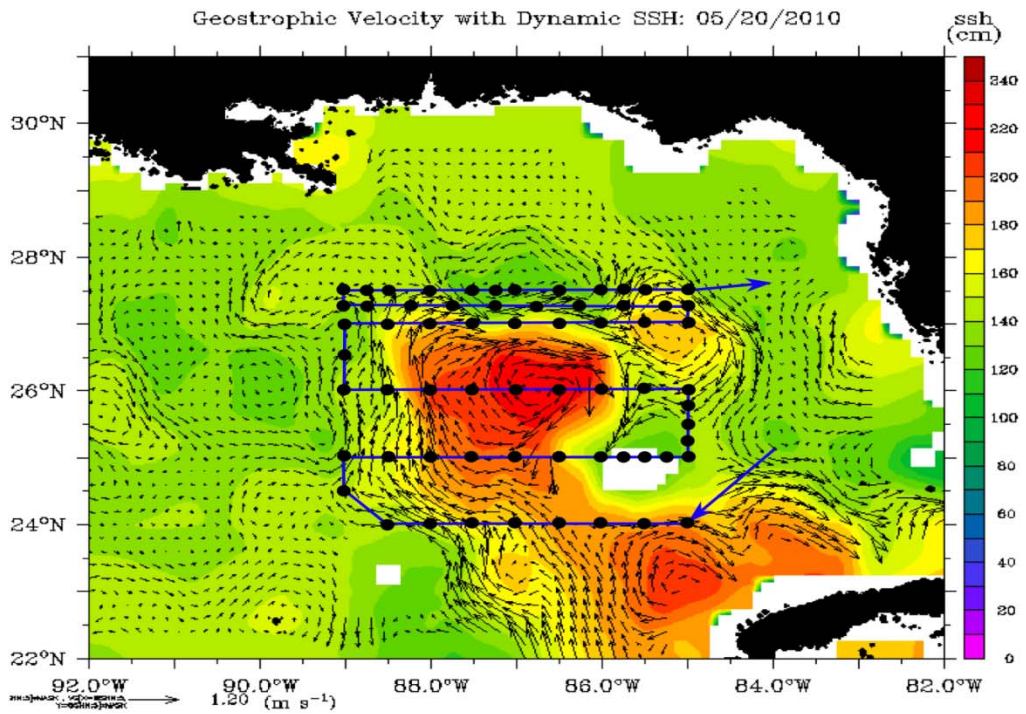


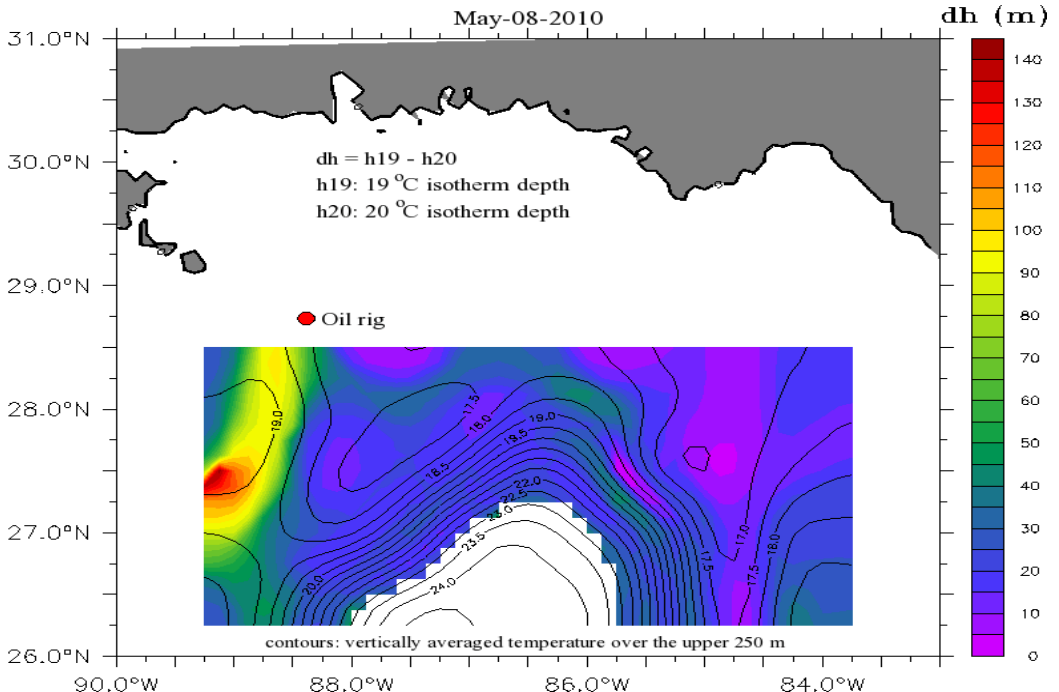






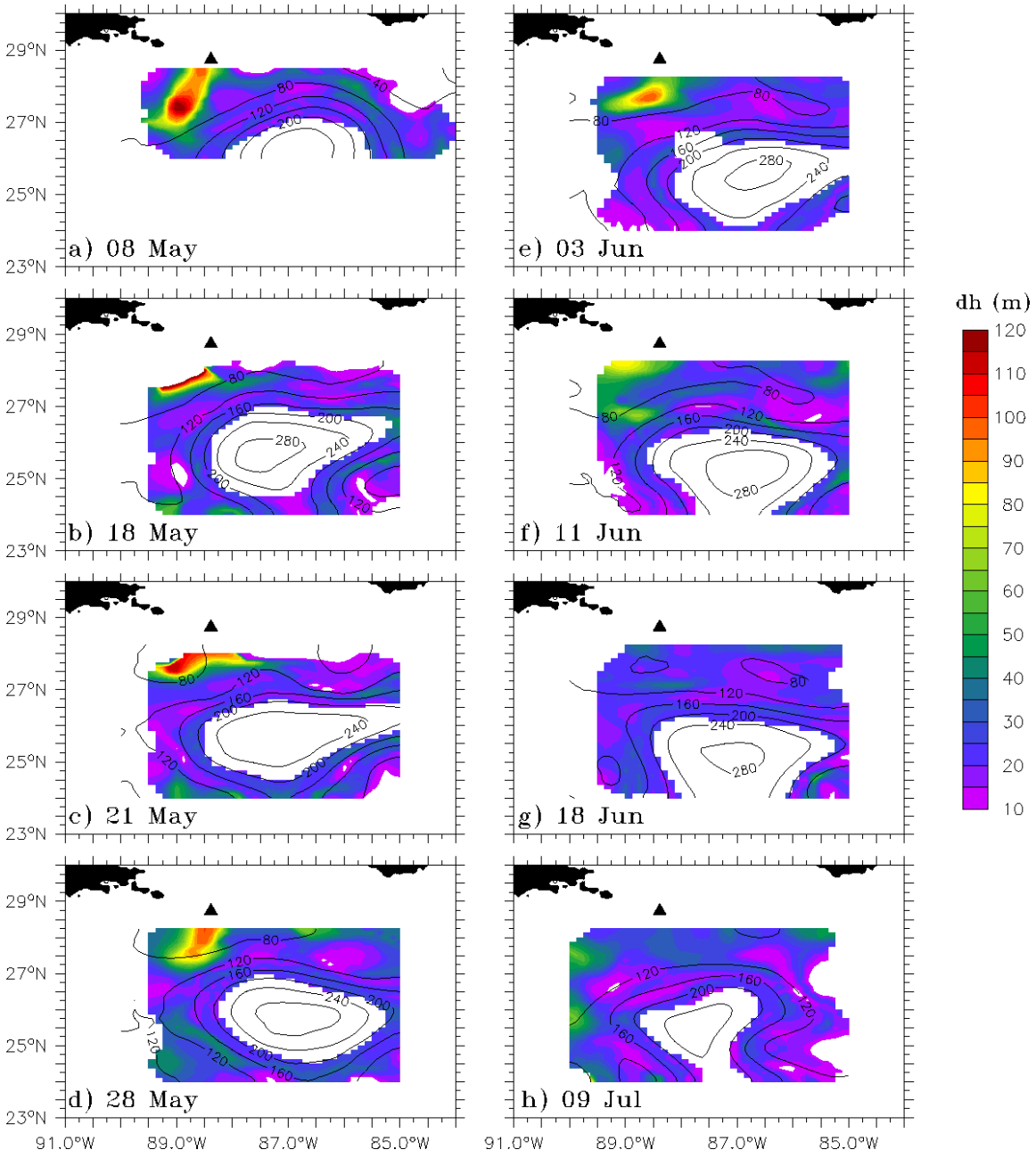
Evolution of the LC and Eddy Franklin based on the depth of the 20C isotherm.



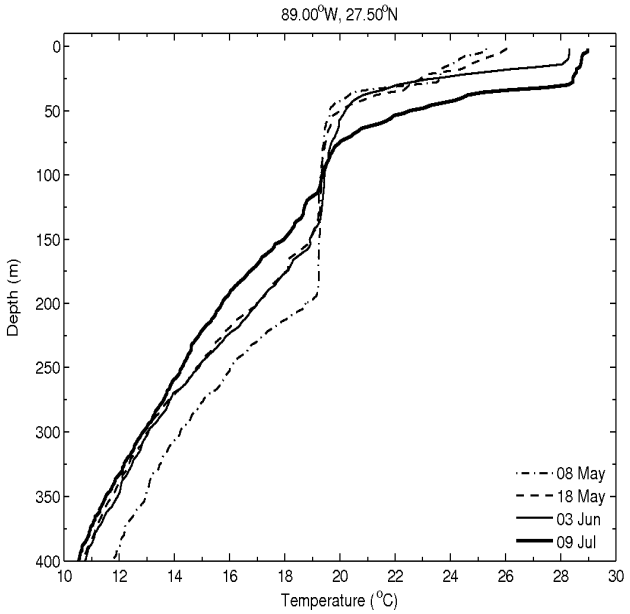


Deep Water Horizon Oil Spill Grid Spanning From 24 to 28N using AXBTs, AXCTDs and AXCPs (from Early May 2010).

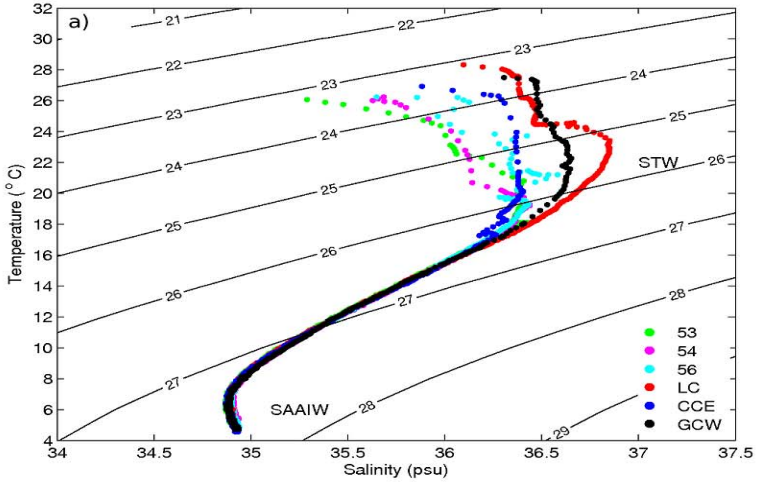
Found Thermostad between 50 to 140 m in water between 19-20C. Notice the coherent structure.

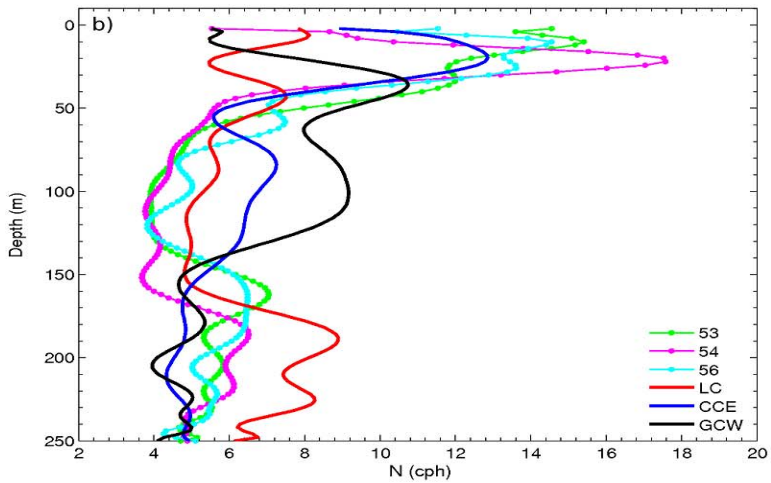


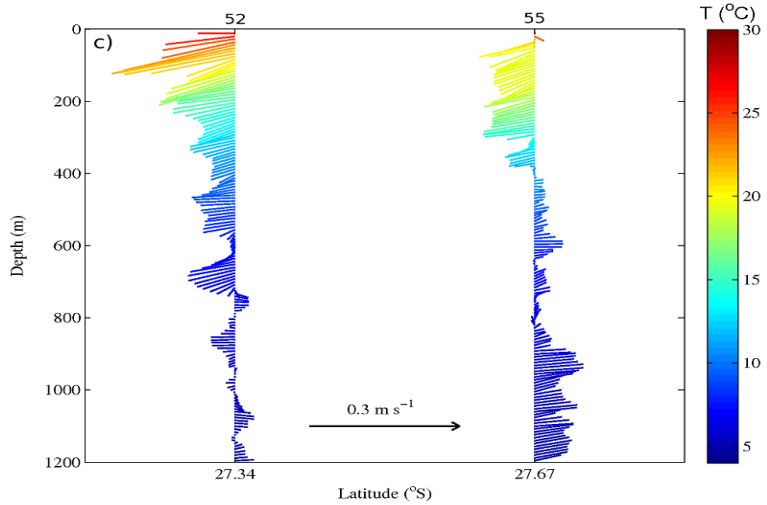
Evolution of the thermostad thickness (dh) based on T(z) and isotherm depths for the 19 and 20C. Notice the coherent structure.

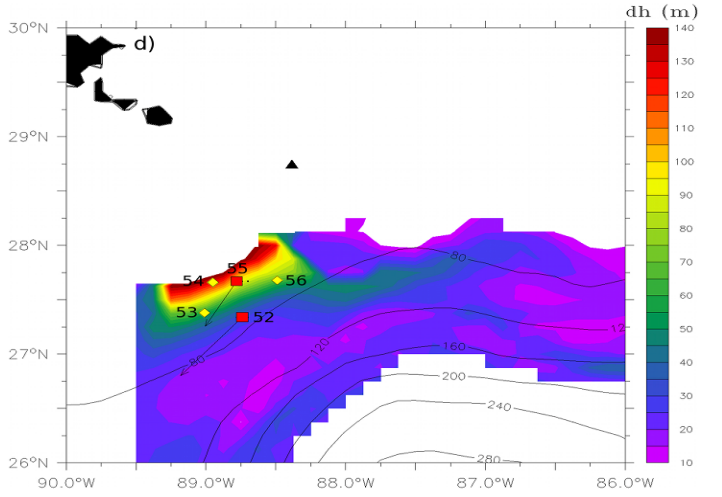


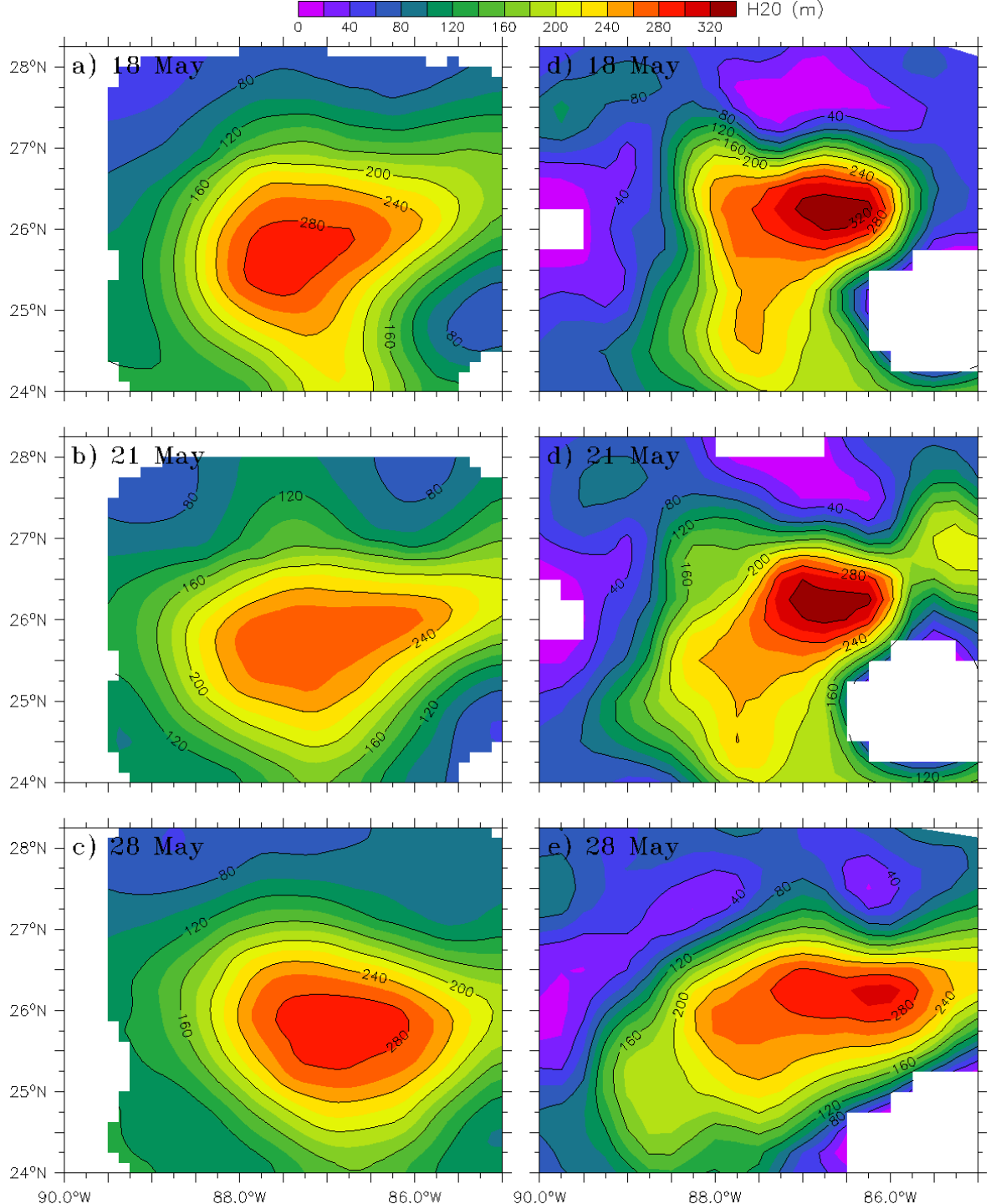
Water Mass Characteristics: T-S, buoyancy and current profiles in thermostad region due south of DwH





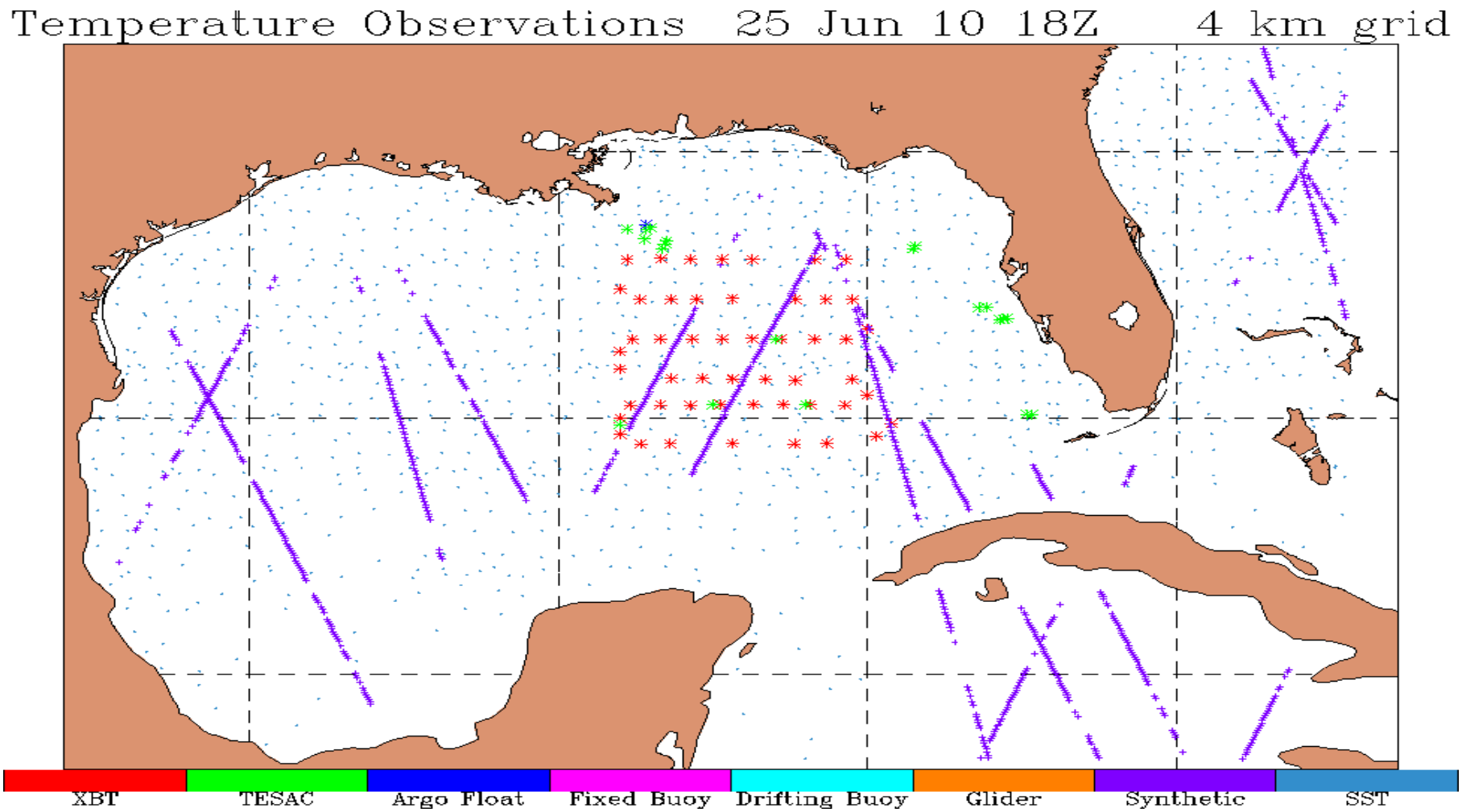


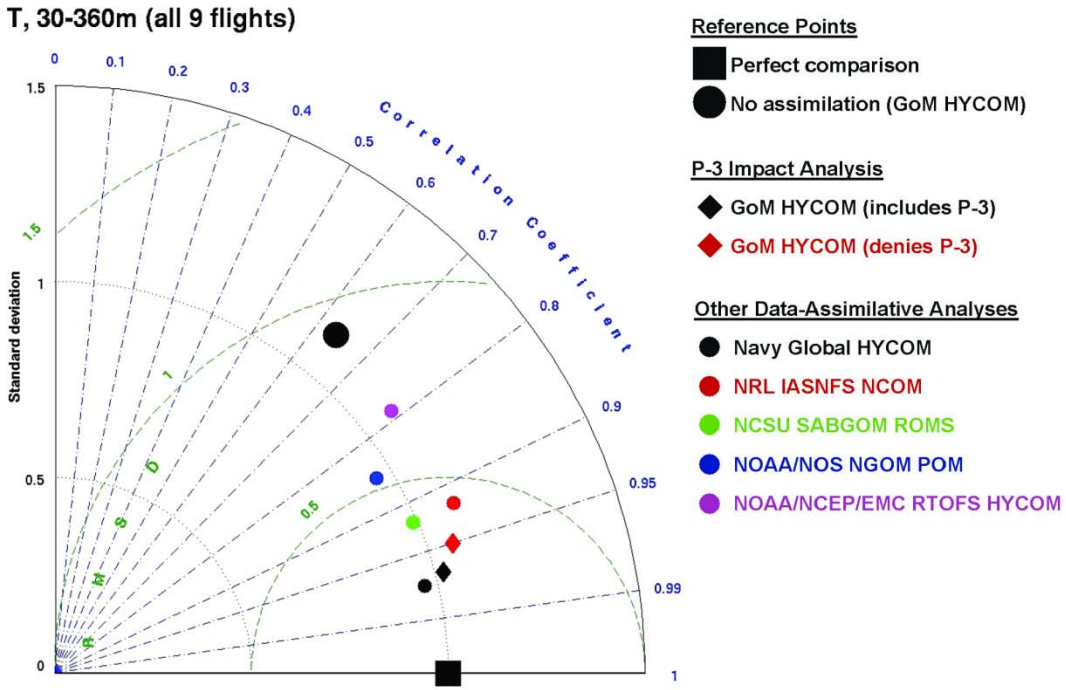


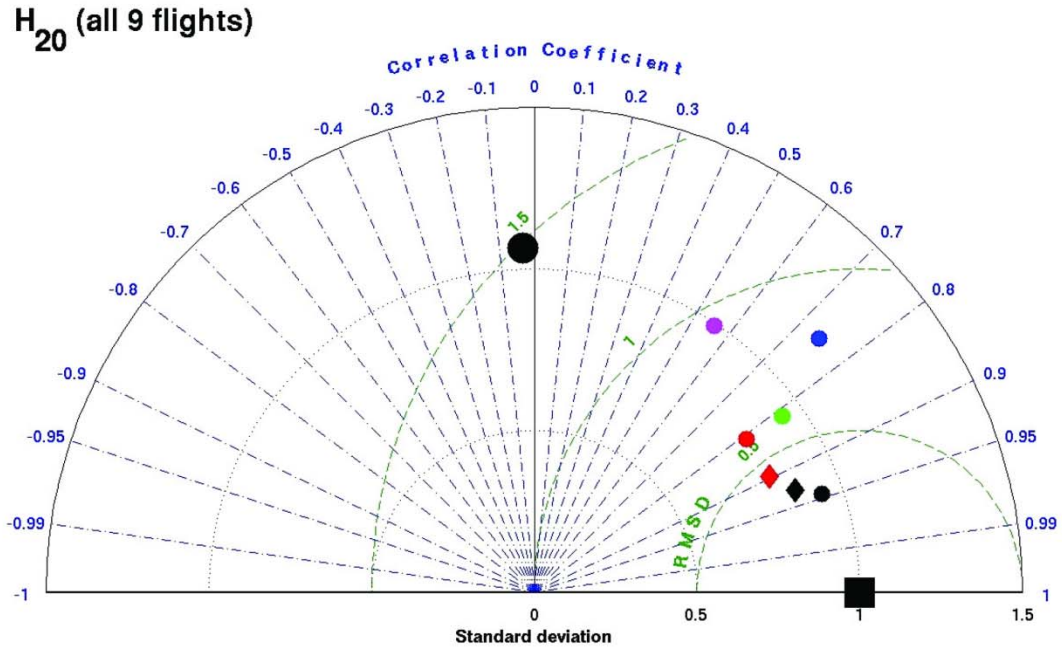


Comparison of the 20C isotherm depths (m) from in situ data (left panels) and that derived from radar altimetry (right panels) using the SMARTS climatology and a 2-layer reduced gravity (Meyers, 2011).

T(z) Data Assimilation Into Models

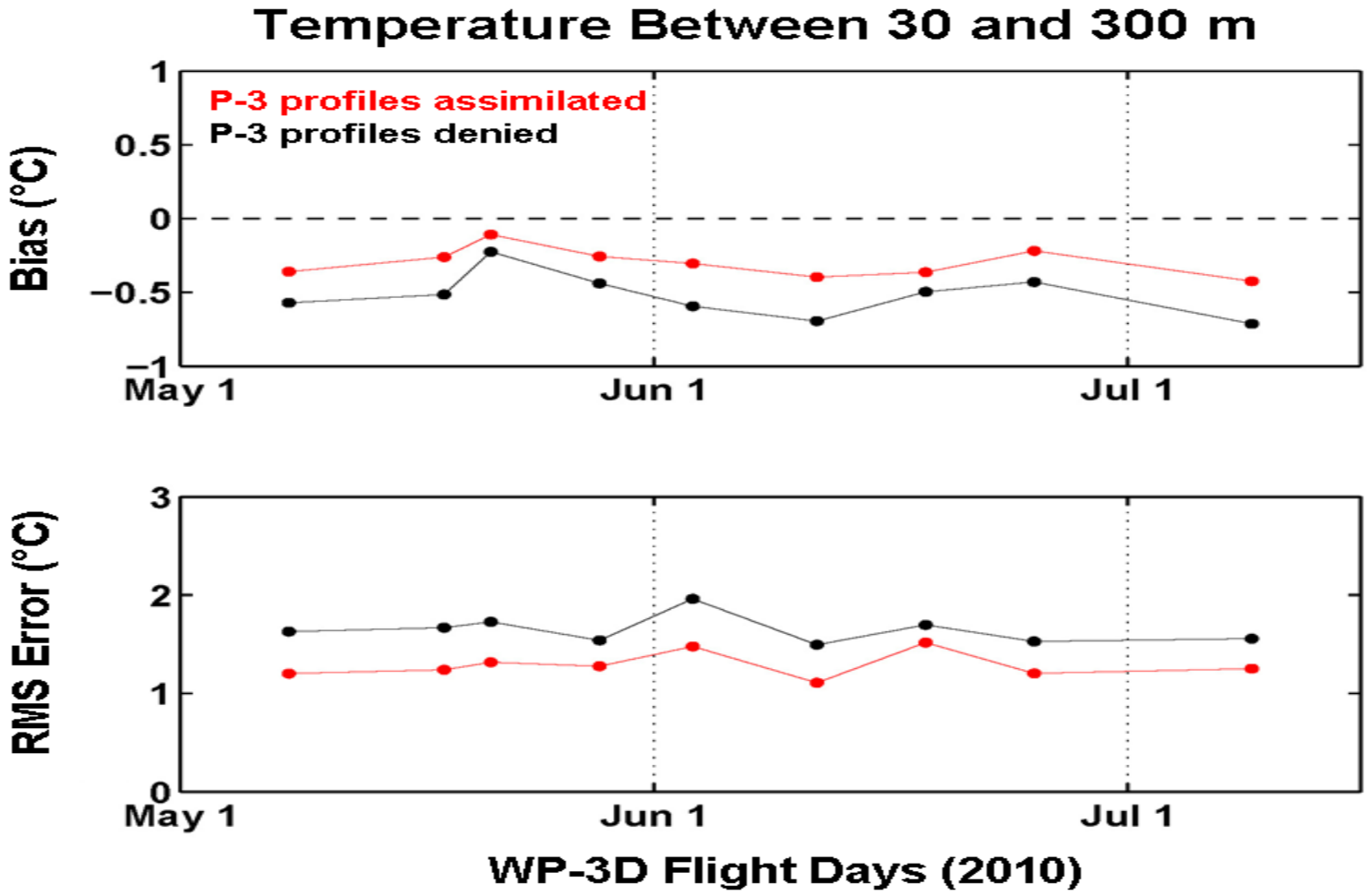


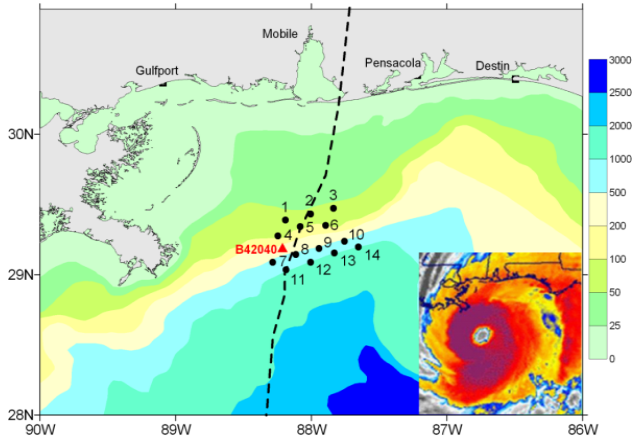




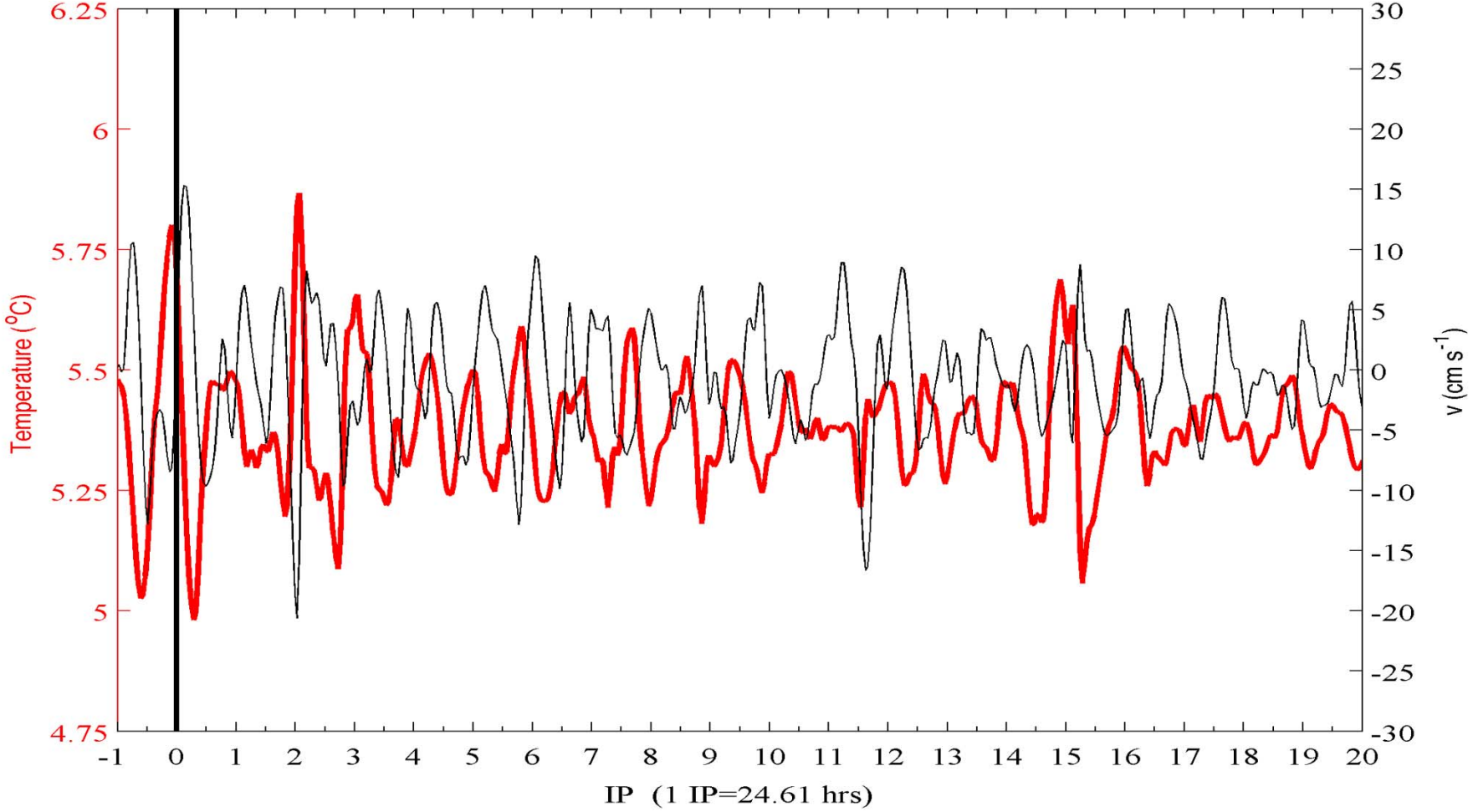
Taylor diagrams of T(upper) and H20 (lower) representing standard deviation, correlation coefficient and RMS differences for all models with and without assimilating aircraft data.

Assimilation of T(z) Into HYCOM





Example of deep (950 m) ocean current and temperature (red) response to Ivan (04) along the DeSoto Canyon-impacted by the oil spill. Data courtesy of NRL.



Summary and Concluding Remarks

What happens in the Gulf doesn't always stay in the Gulf.

Need to construct a more coherent blueprint in case of another spill. The GOM is an important contributor to circulation in the western Atlantic.

Targeted obs (LC, eddies, hurricanes, cold fronts) of ocean and atmosphere needed to improve the ocean and coupled models.

Synthesizing and combining various data sets into a coherent mosaic of complex multi-dimensional processes that impact ecosystems.

Effectively assimilate data into the models to improve our understanding of potential pathways of oil and its derivatives in 4-D (x, y, z and t).