Utilizing In Situ Observations and Satellite Measurements to Examine the Extent and Variability of the DWH Oil Spill

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presented by Ryan Smith
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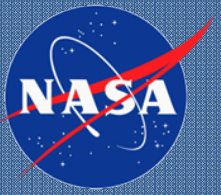
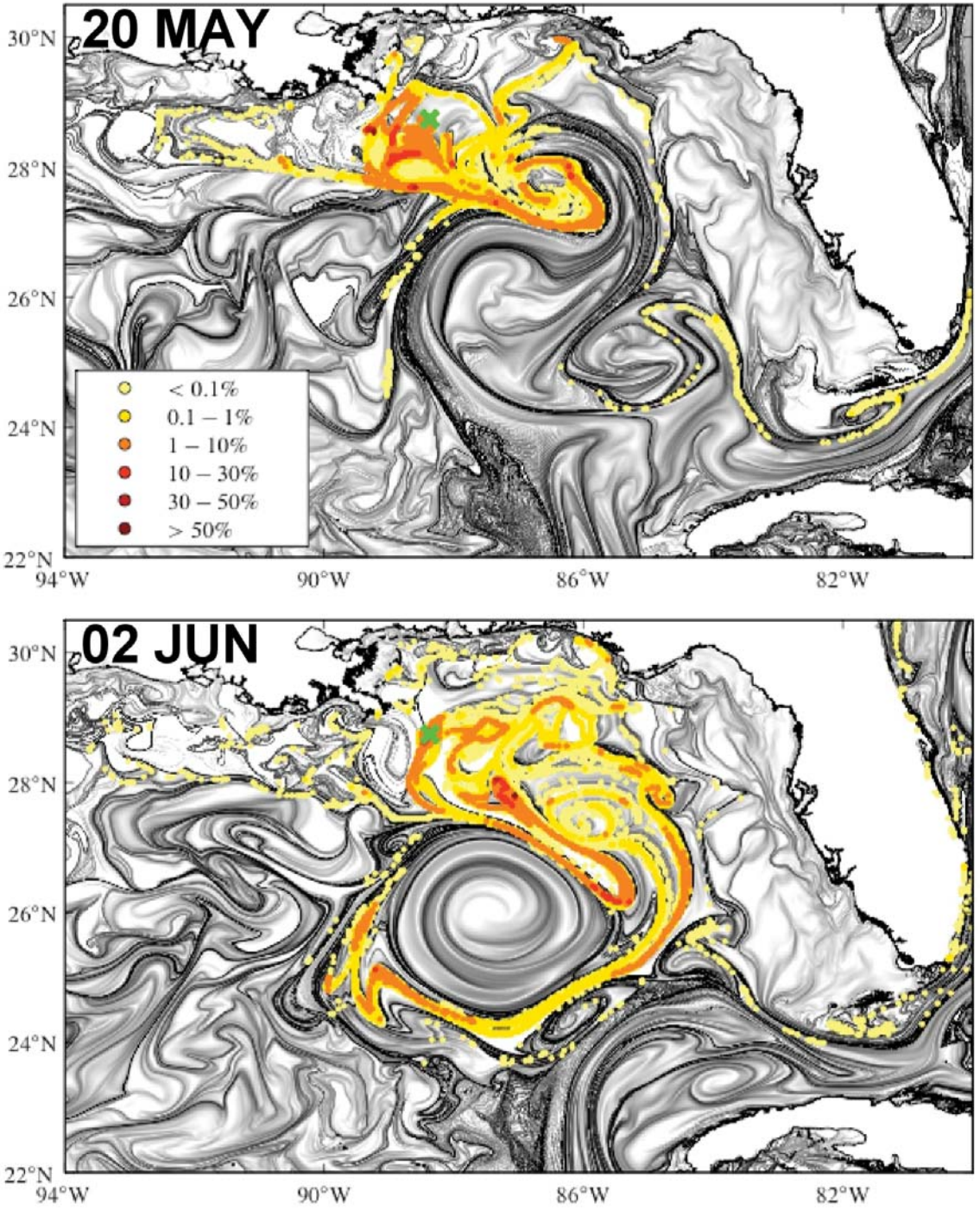


Lagrangian Particle Trajectory Maps

While particle density is extremely low, maps suggest potential contaminant entrainment in Loop Current

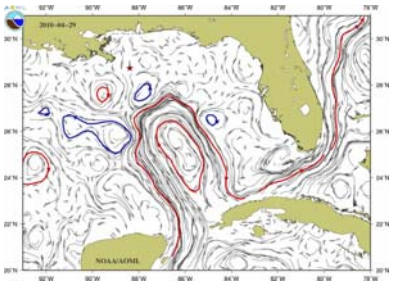
Finite Time Lyapunov Exponent (FTLE) fields reveal Lagrangian Coherent Structures (LCS) by UM/RSMAS
Based upon Adcroft et al., 2010

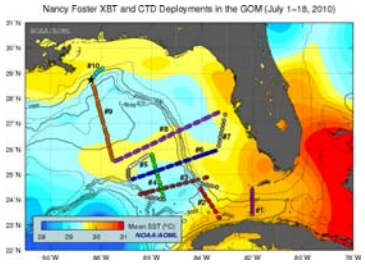


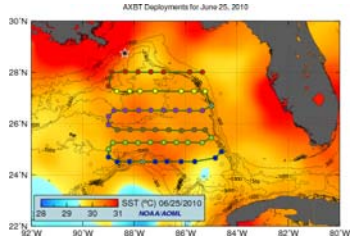
AOML DWH Response Efforts:

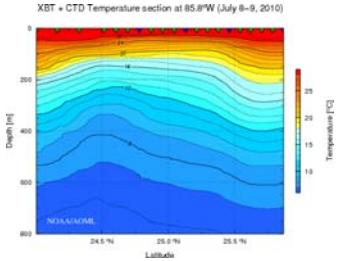
In collaboration with NMFS, NESDIS, ORR, RSMAS, USF, USM, ROFFS and others

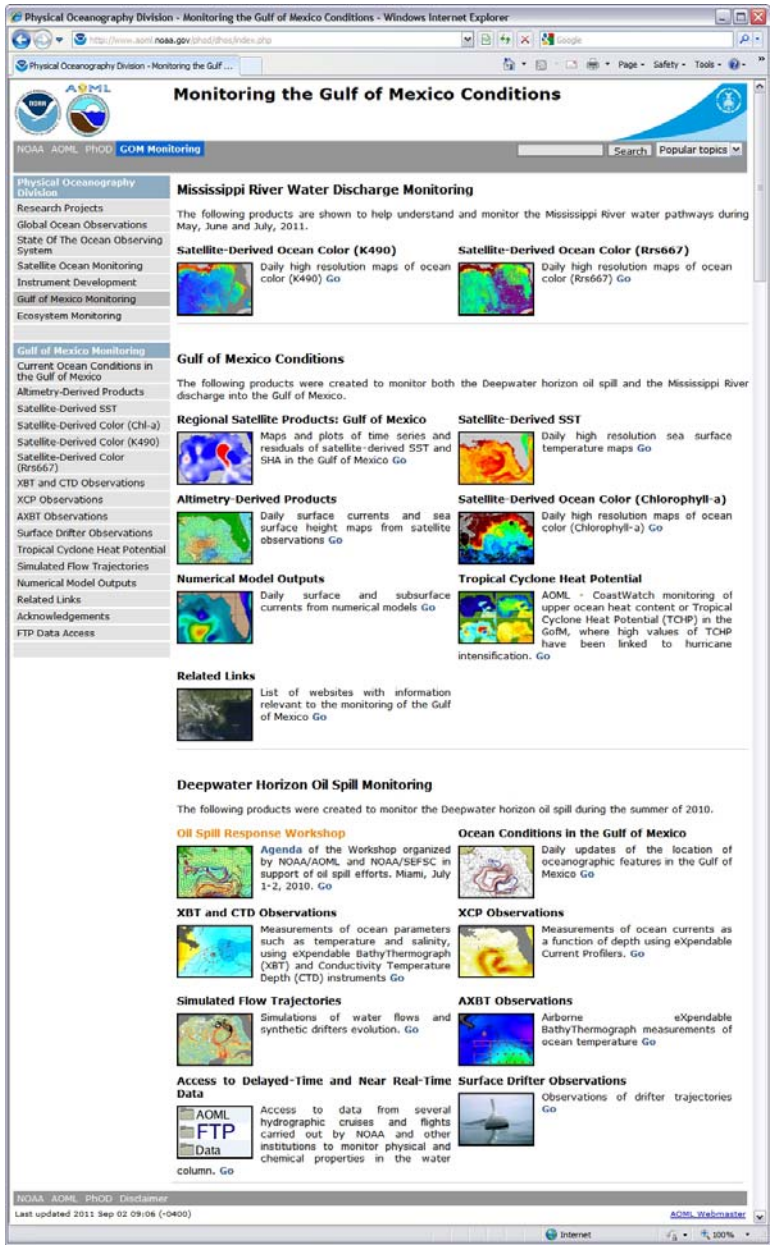
- *Real-time oceanographic data products (via web, ftp, GTS)*
- *AXBT deployment flight coord. / data QC*
- *Research cruises / drifter deployments*











Remote Sensing Methods:

Surface Currents

Surface Maps of Altimetry-Derived Geostrophic Current Fields produced by NOAA/AOML Physical Oceanography Division (PhOD) incorporated:

- *Sea Height Anomaly (SHA) alongtrack data from Jason-2 and Envisat*
- *Synthetic mean dynamic topography (Rio 2004)*

Surface Features from Sea Surface Temperature (SST) and Ocean Color

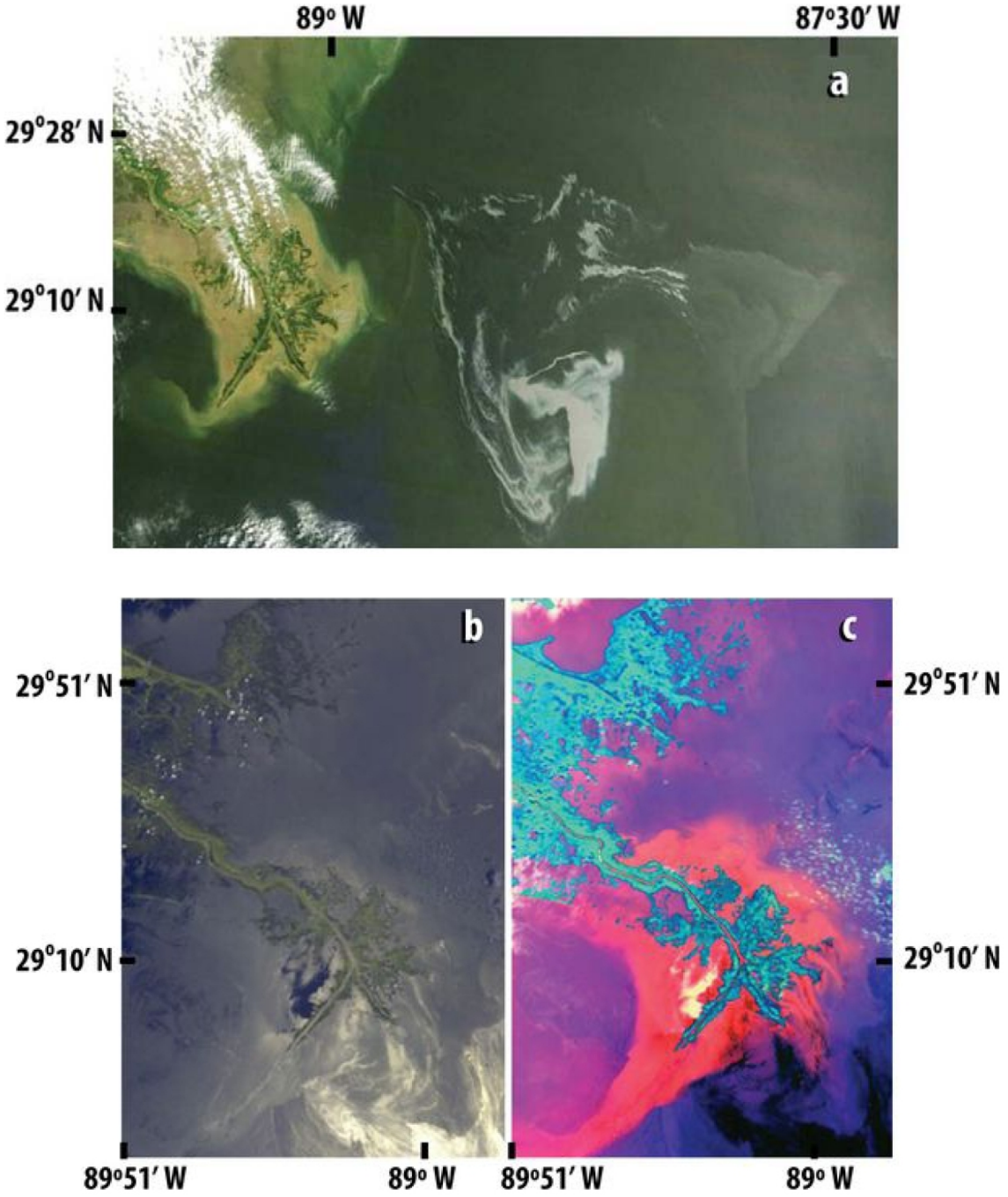
Surface Maps of SST and ocean color were produced by NOAA, NASA, ROFFS, and others to delineate mesoscale circulation features. These products utilized:

- *SST: via Thermal Infrared (IR) and Microwave Radiation recorded by multiple sensors such as AVHRR, MODIS, and AMSR-E*
- *Ocean Color: MODIS, SeaWiFS, MERIS, MISR sensors (ocean color useful when GOM SST fields are uniformly warm during summer months)*

Surface Oil Extent

*Daily **Marine Pollution Surveillance Reports (MPSR**) produced by NOAA/NESDIS Satellite Analysis Branch (SAB) incorporated:*

- *Surface Roughness from Synthetic Aperture Radar (SAR)*
- *Reflectivity from Visible and Near Infrared (VNIR) Radiation*
- *Supplementary data from overflight and in situ obs. when available*

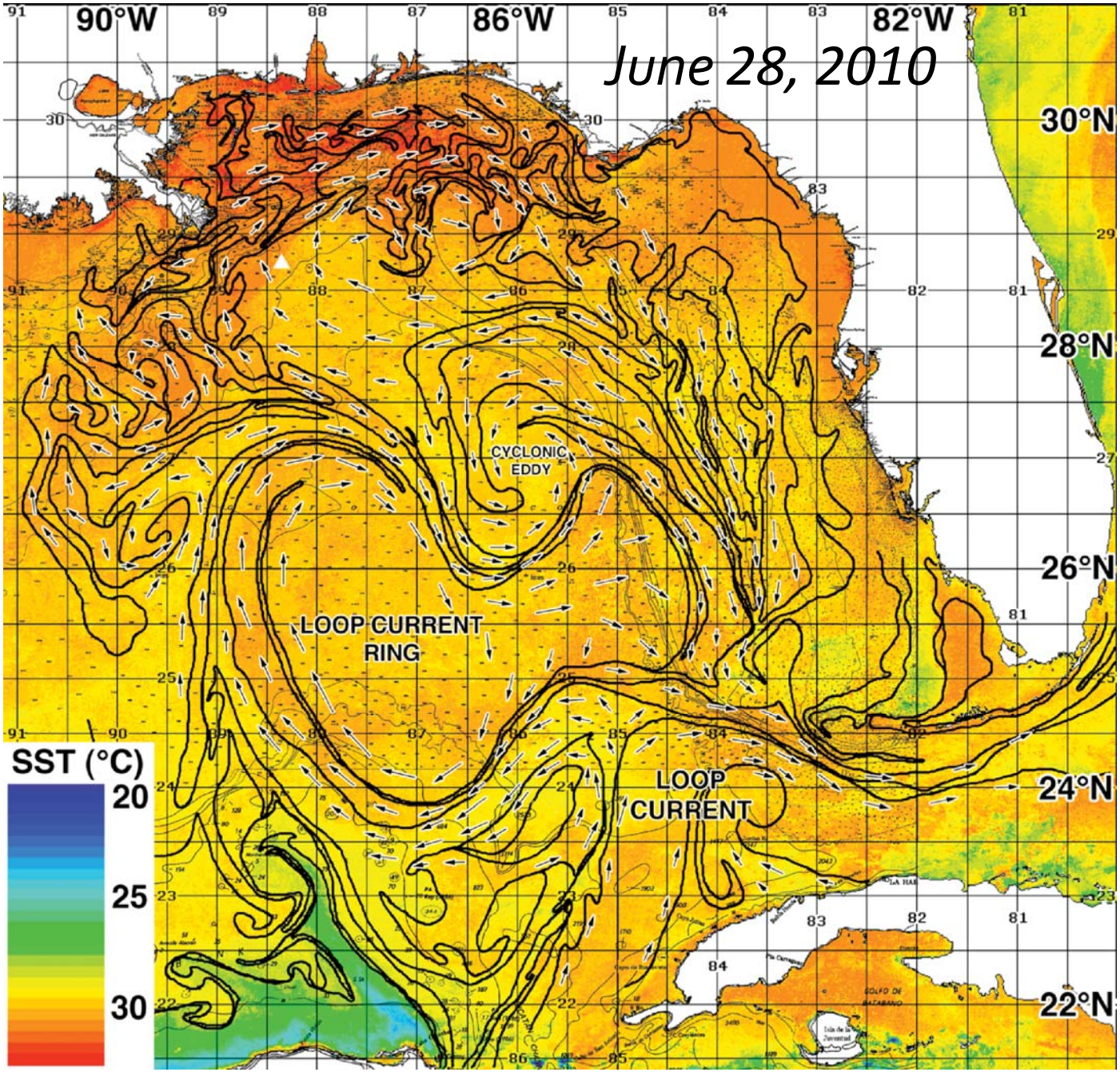


A)
Terra MODIS visible-near IR (May 1, 2010)

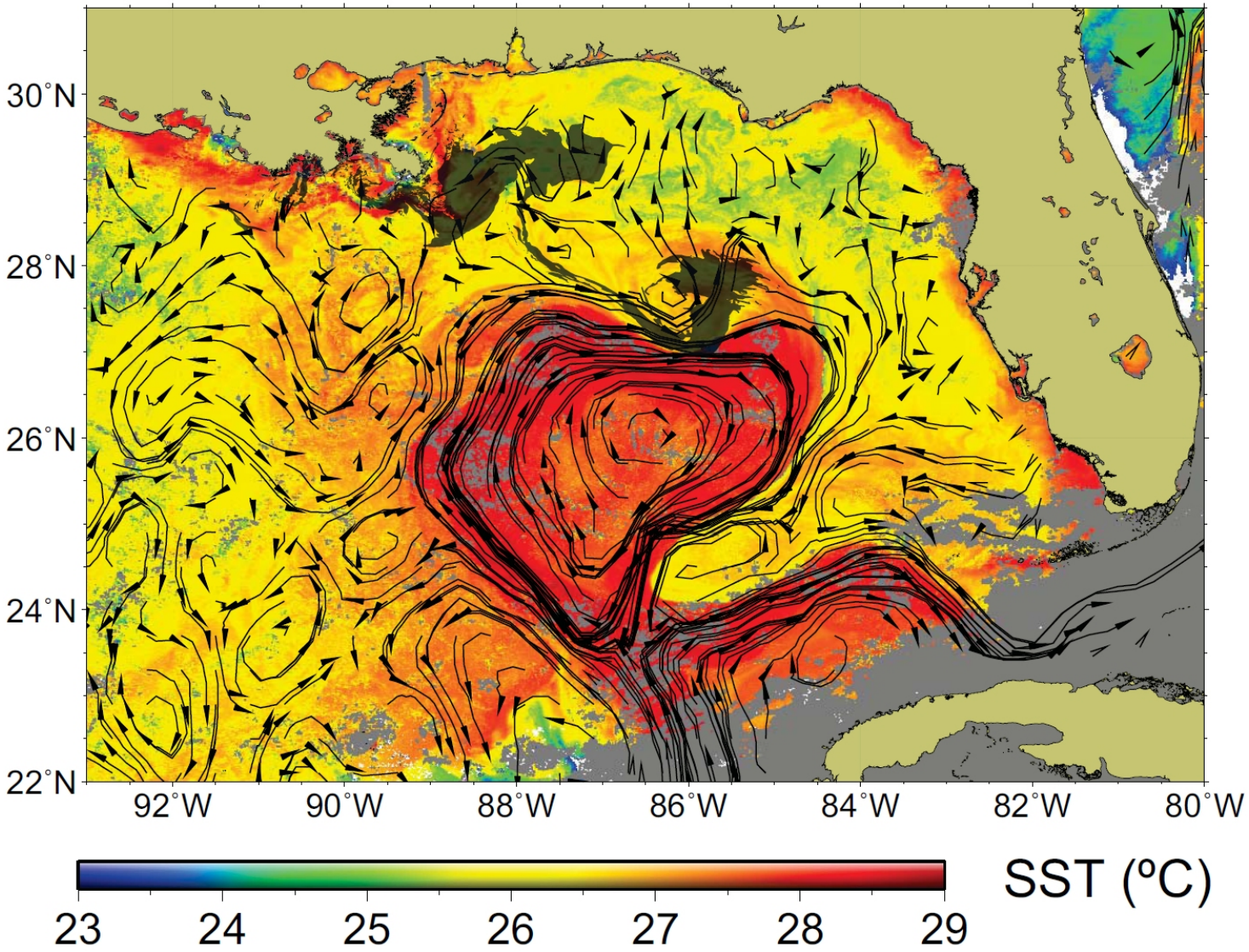
B)
MISR true color (May 17, 2010)

C)
MISR multi-angle composite (May 17, 2010)

ROFFS™

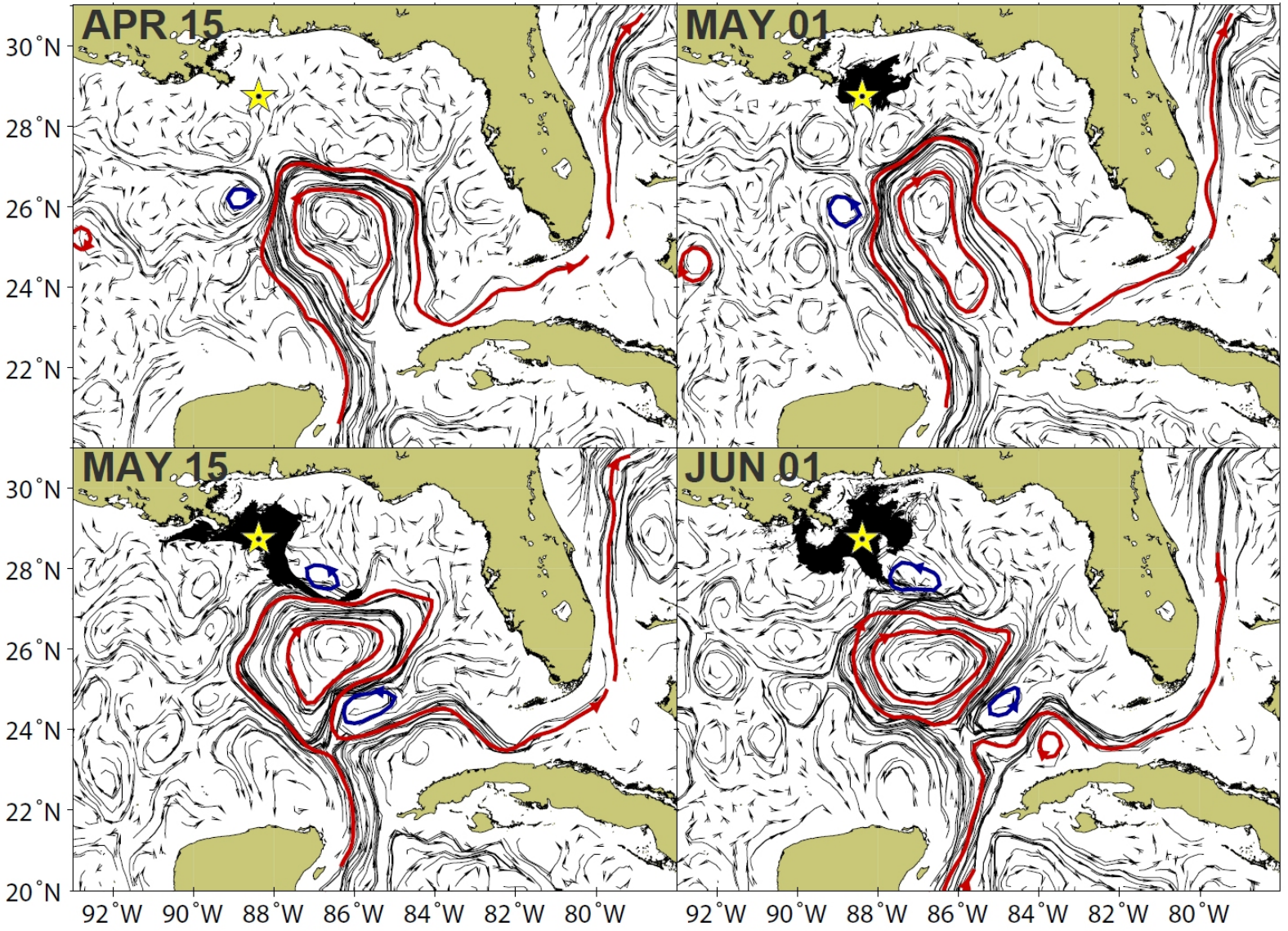


Mesoscale features identified from variability in multiple SST (16) and ocean color (2) obs. over a 24-hour period.

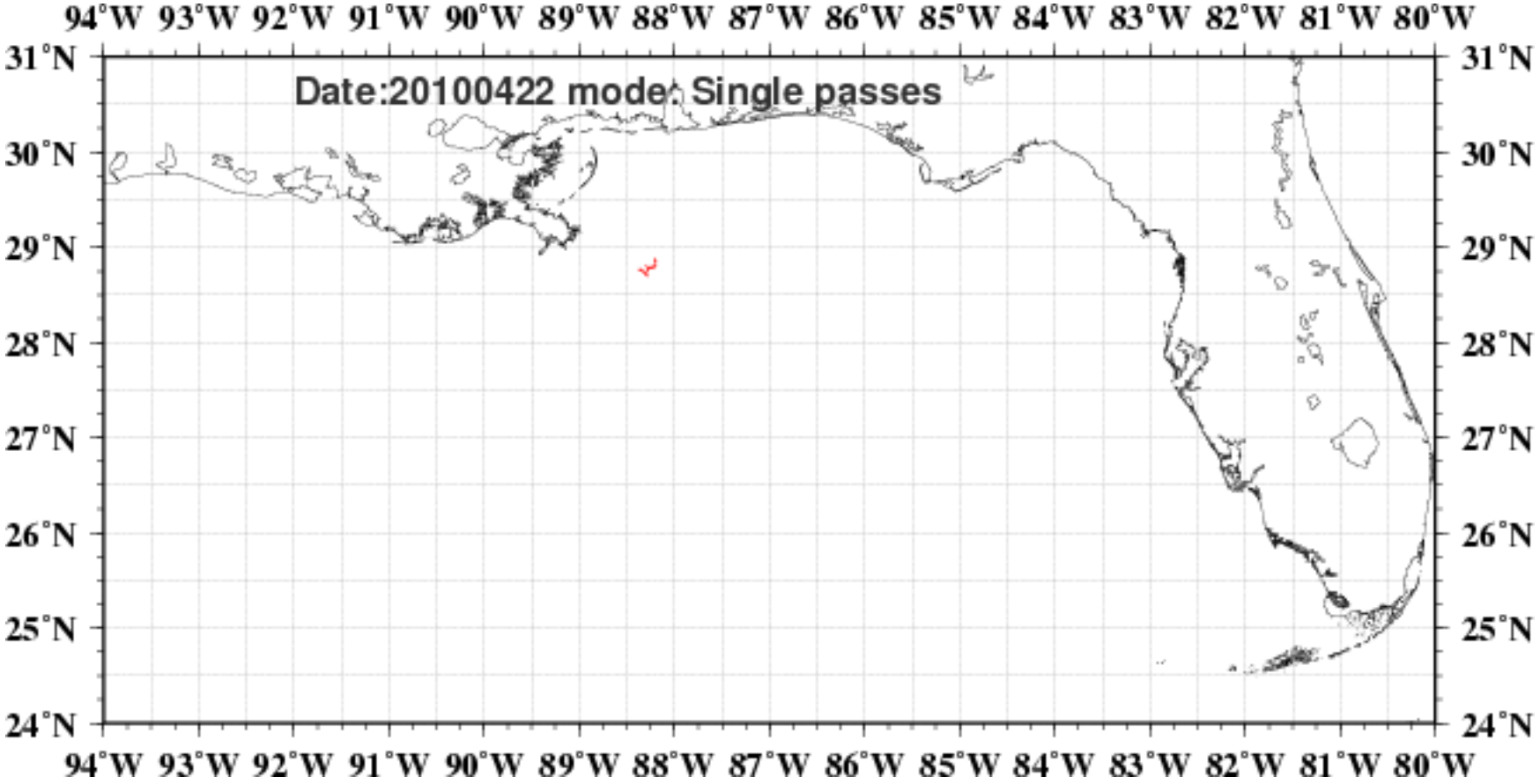


Altimetry-Derived Surface Currents*, SST**, and MPSR utilized together***

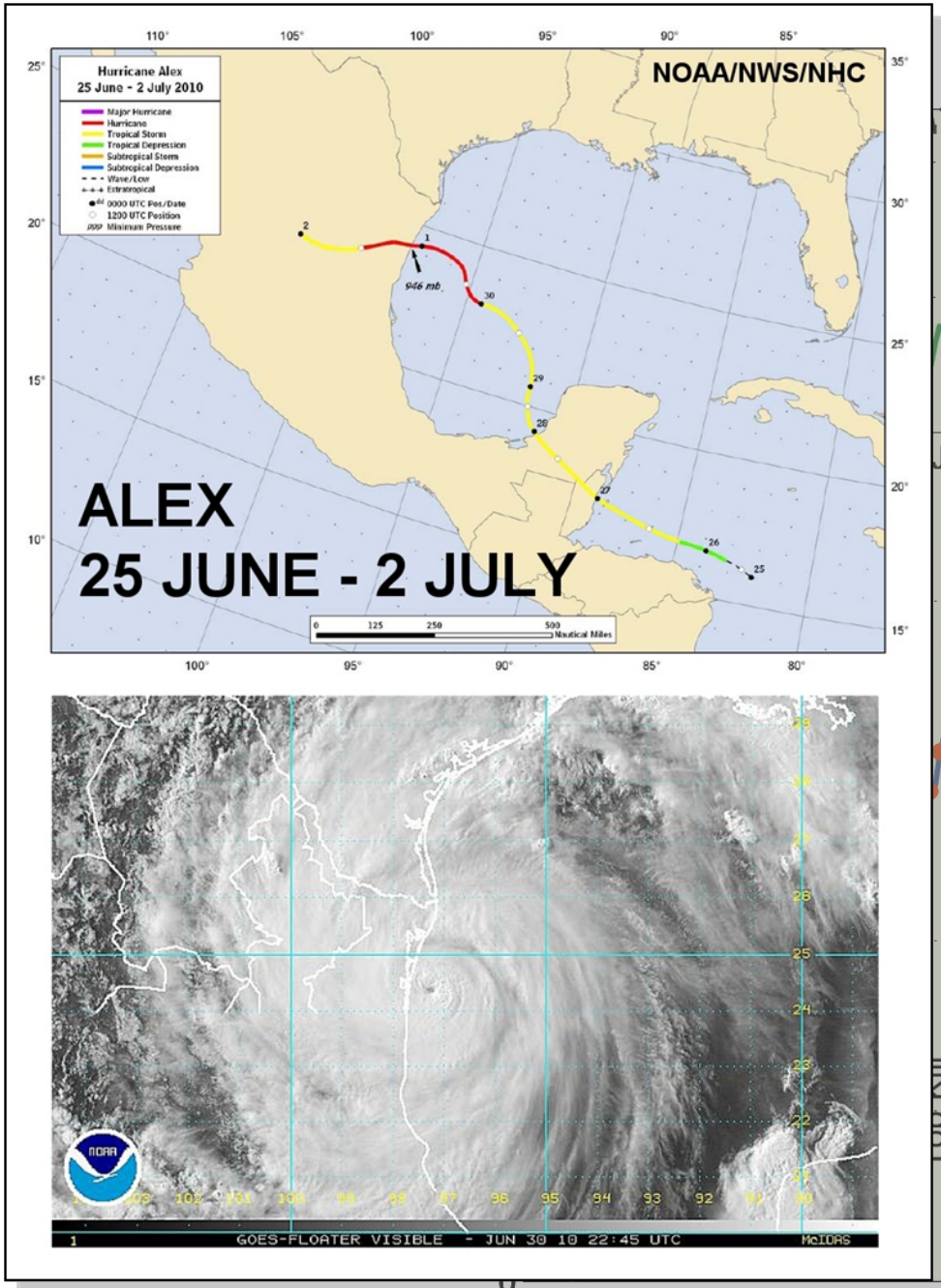
*May 15 (11 days of data) , **May 20, ***May 20-21

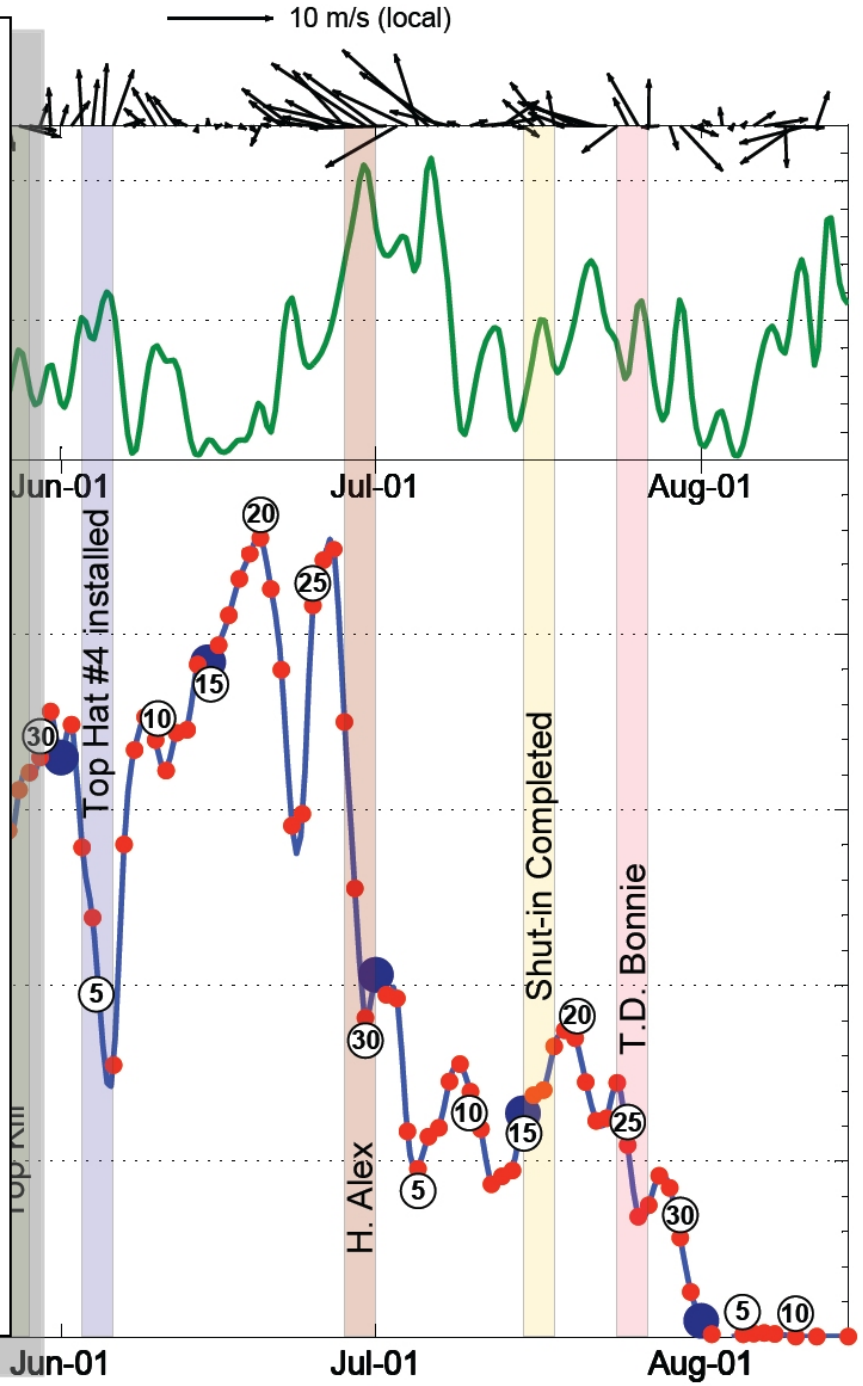


Altimetry-Derived Geostrophic Surface Currents with
NOAA/NESDIS Satellite Analysis Branch (SAB)
Daily Marine Pollution Surveillance Report (MPSR) Surface Oil Coverage

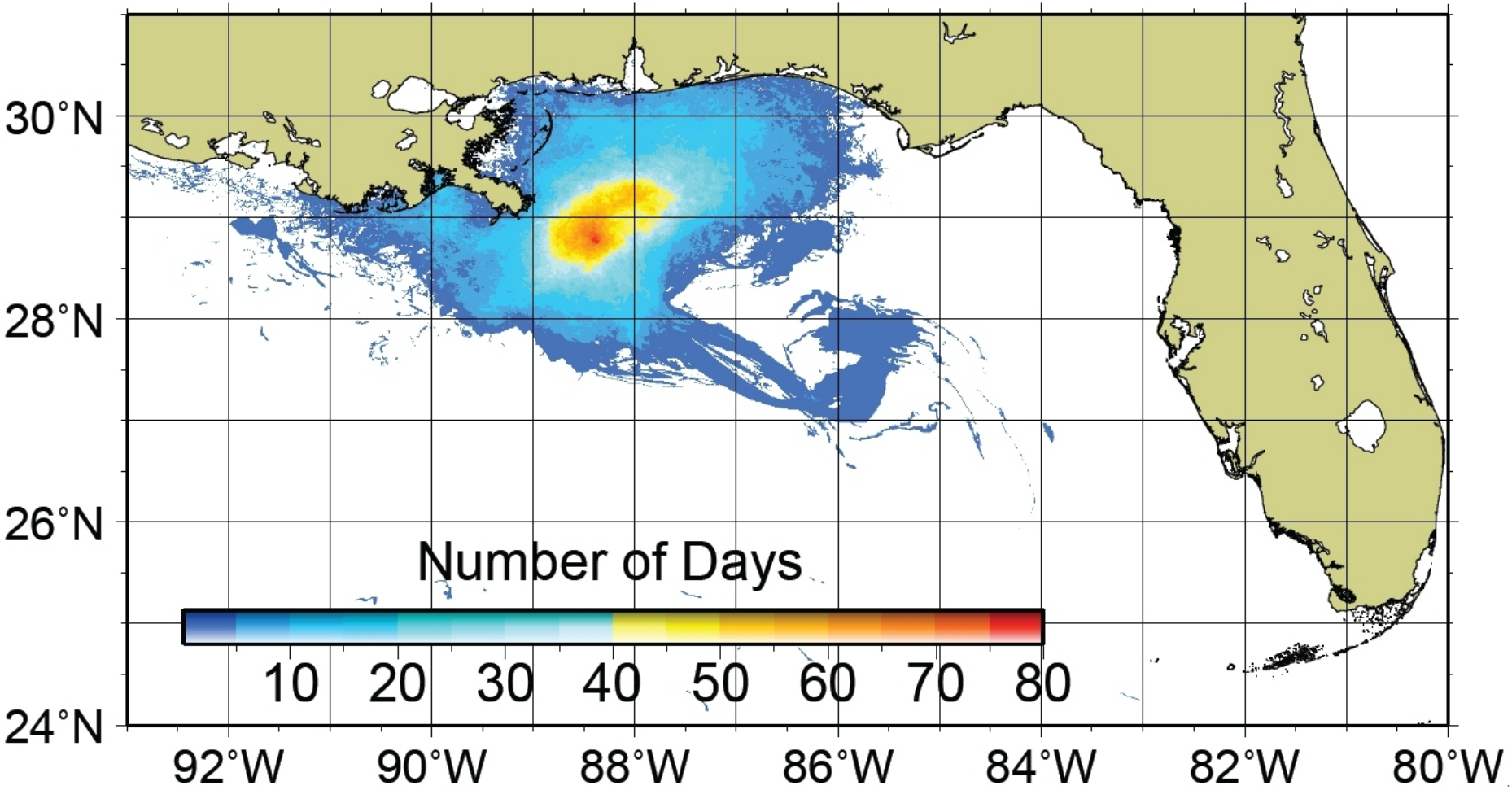


NOAA/NESDIS Satellite Analysis Branch (SAB)
Daily Marine Pollution Surveillance Report (MPSR) Surface Oil Coverage
Time-Series (5-day running mean filter)


Hurricane Alex
25 June - 2 July 2010
Major Hurricane
Hurricane
Tropical Storm
Tropical Depression
Subtropical Storm
Subtropical Depression
Wave/Low
Extratropical
0000 UTC Pos/Date
1200 UTC Position
Minimum Pressure
NOAA/NWS/NHC
946 mb
ALEX
25 JUNE - 2 JULY
Nautical Miles
GOES-FLOATER VISIBLE - JUN 30 10 22:45 UTC
NOAA


10 m/s (local)
Jun-01
Jul-01
Aug-01
Top Hat #4 installed
H. Alex
Shut-in Completed
T.D. Bonnie
May-01
Jun-01
Jul-01
Aug-01

Cumulative Surface Oil Coverage:



From accumulated MPSR time-series

87 days (April – August, 2010)

In Situ Methods:

Ocean Circulation

Tools utilized to assess GOM circulation features potentially influencing surface and subsurface oil extent:

- *Conductivity-Temperature-Depth Casts (CTD+O2+chl_a+CDOM, 0-2000 meters)*
- *Lowered Acoustic Doppler Current Profilers (dual, 0-2000 meters)*
- *Hull-Mounted Acoustic Doppler Current Profiler (0-250 meters)*
- *Surface flow-through Thermosalinograph (TSG+chl_a+CDOM)*
- *Expendable Bathythermographs (XBT, 0-900 meters)*
- *SVP surface drifting buoys*

In Situ Methods:

Surface and Subsurface Oil

Tools utilized to sample or indicate the potential for the presence of surface or subsurface hydrocarbons:

- *Surface and subsurface nets (neuston, bongo, MOCNESS)*
- *CTD-mounted CDOM fluorometer (WET Labs ECO FLCDRTD)*
- *CTD-mounted dissolved oxygen sensor (dual SBE43)*
- *Surface flow-through CDOM fluorometer (Seapoint Ultraviolet)*
- *Teflon sheen nets (surface collection)*
- *Visual sighting*

Potential oil samples collected for methane analysis, Polycyclic Aromatic Hydrocarbons (PAH)**, and Volatile Organic Aromatic Compounds (VOA)**, 3D excitation/emission spectra (EEM)****

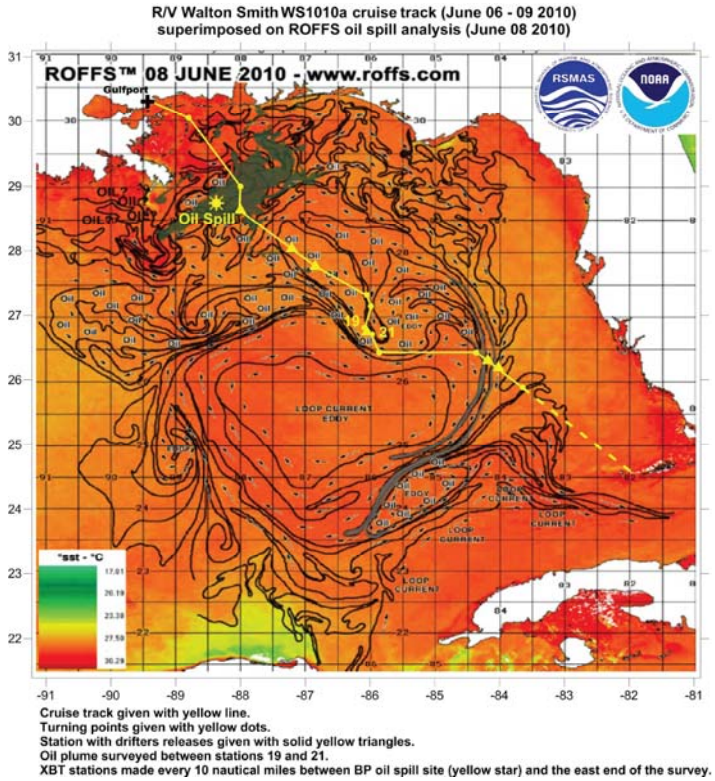
Laboratory analysis performed by:

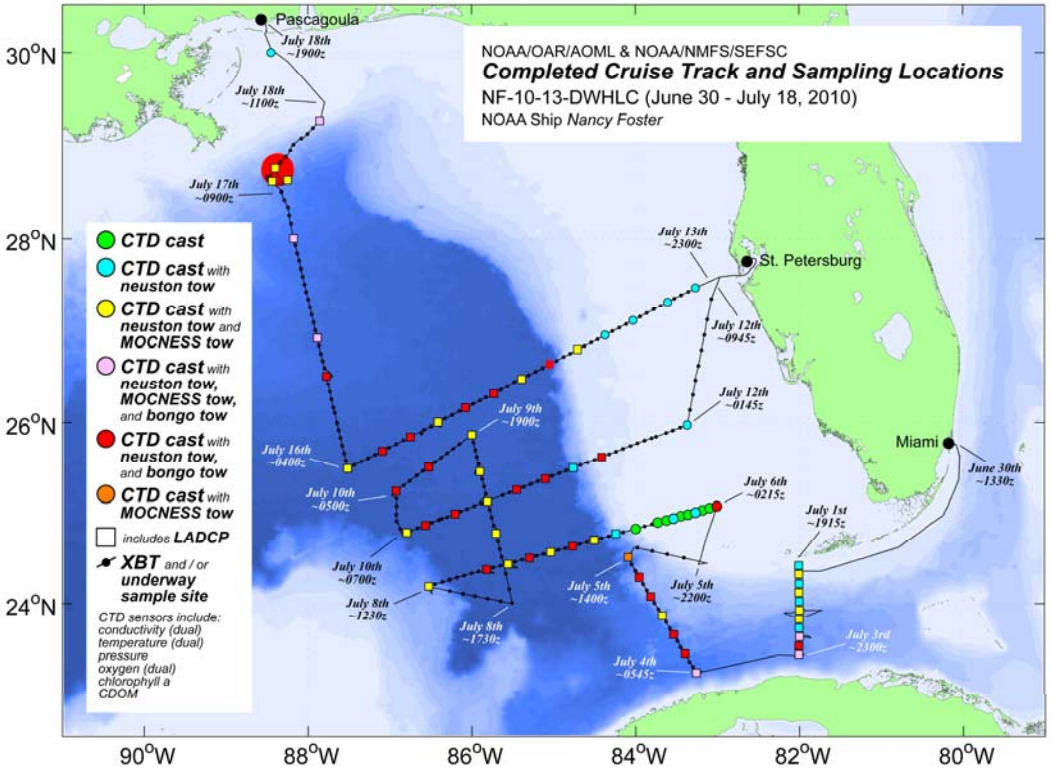
* *University of Georgia*

** *Louisiana State University*

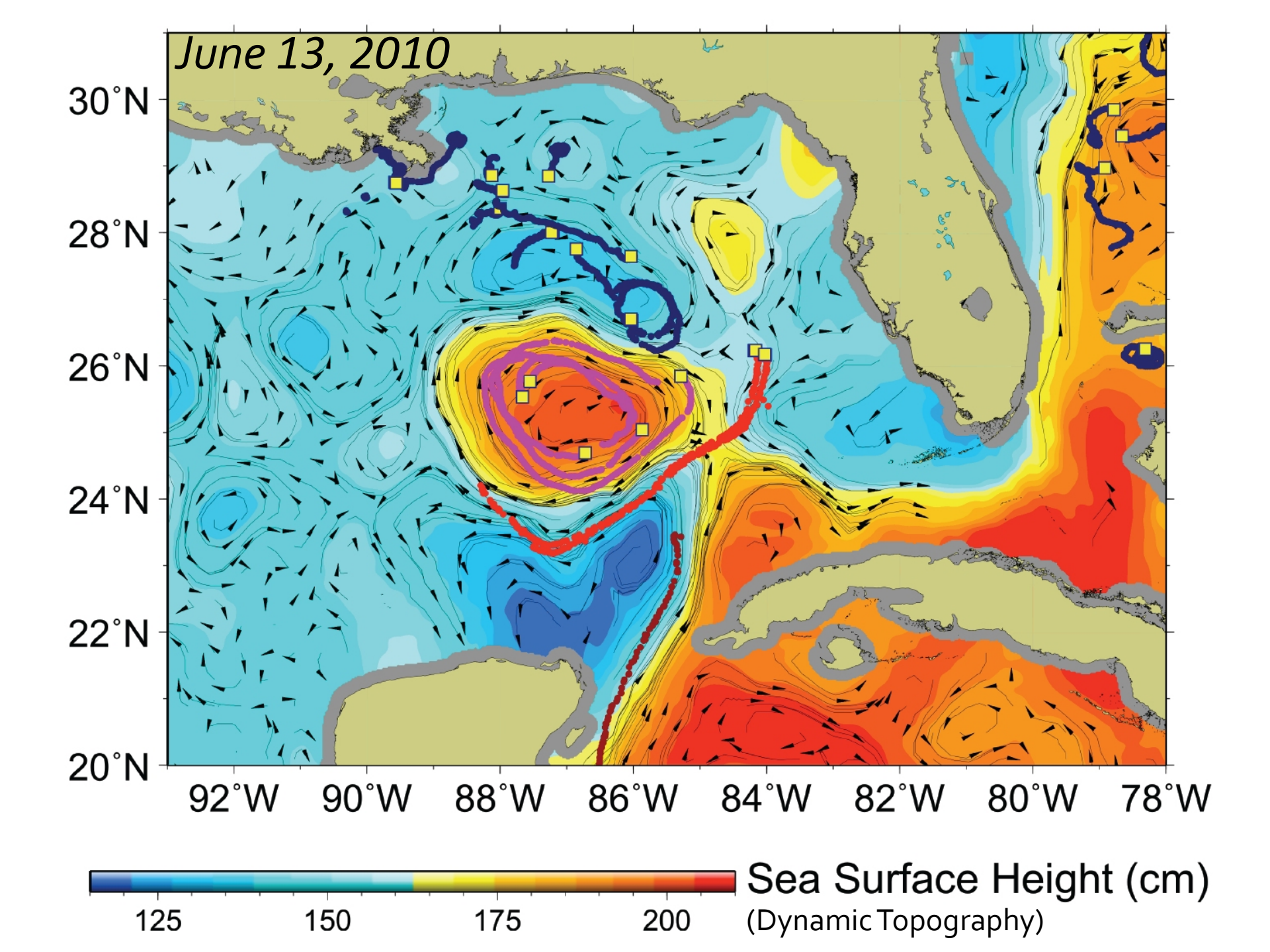
*** *University of South Florida*

AOML DWH Response Research Cruises:

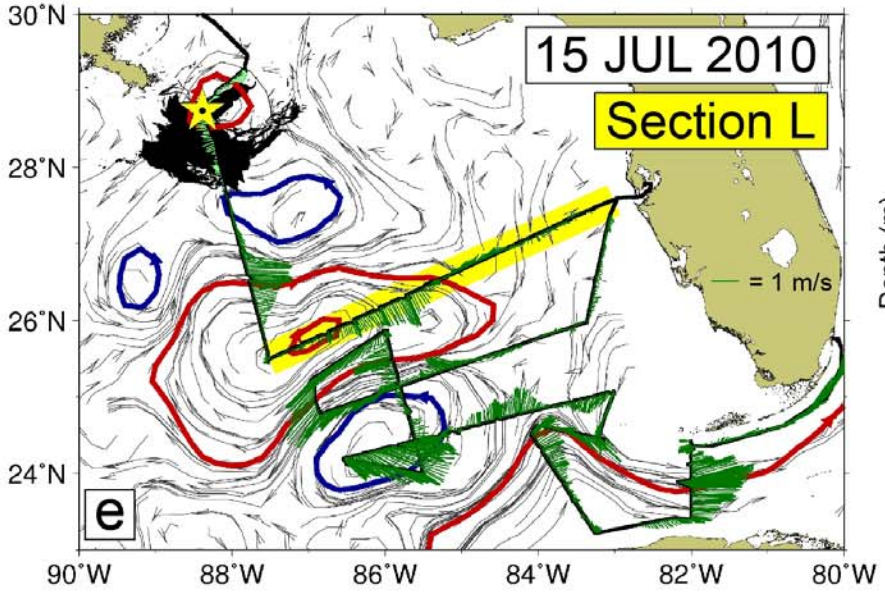


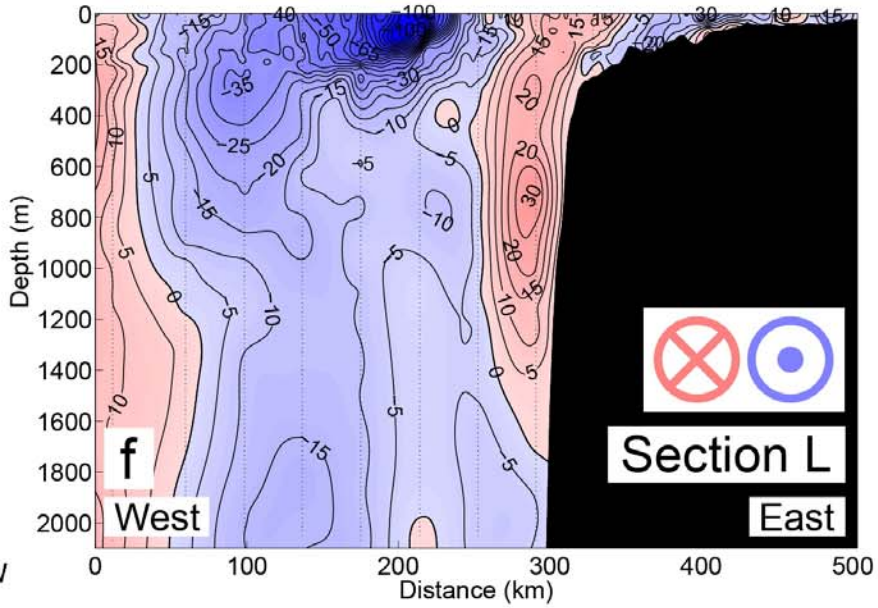


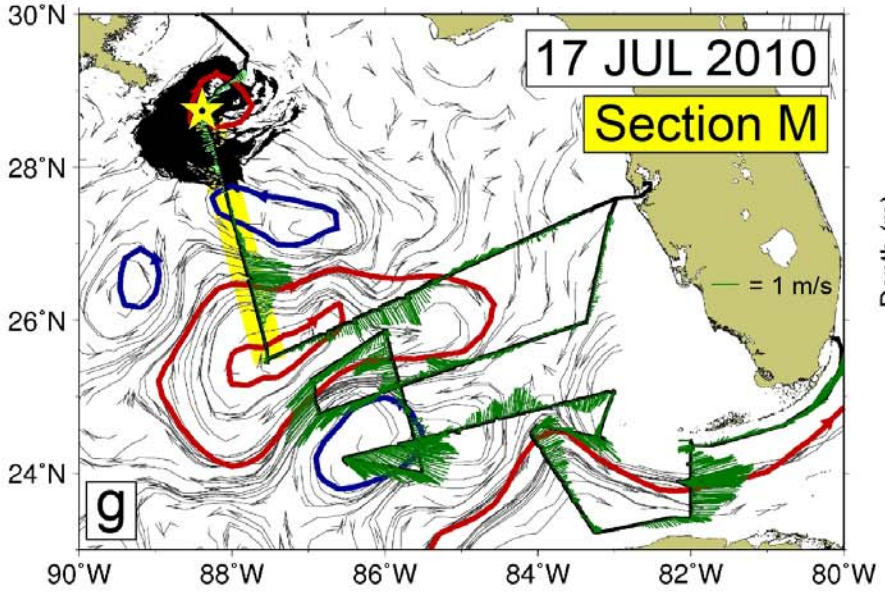
- WS1010A: June 6-10, 2010
- NF1013: June 30 – July 18, 2010

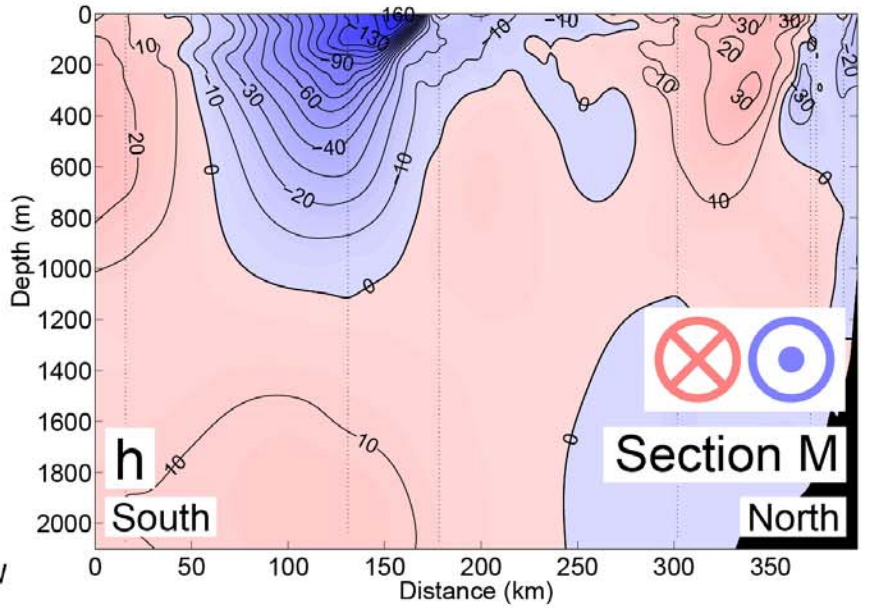

June 13, 2010
30°N
28°N
26°N
24°N
22°N
20°N
92°W
90°W
88°W
86°W
84°W
82°W
80°W
78°W
125
150
175
200
Sea Surface Height (cm)
(Dynamic Topography)

Altimetry and Section Velocities

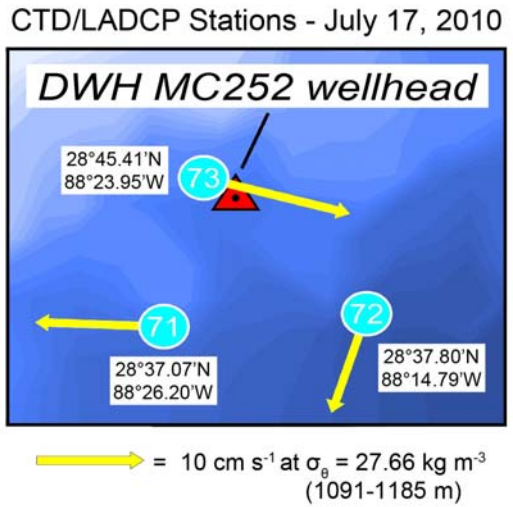


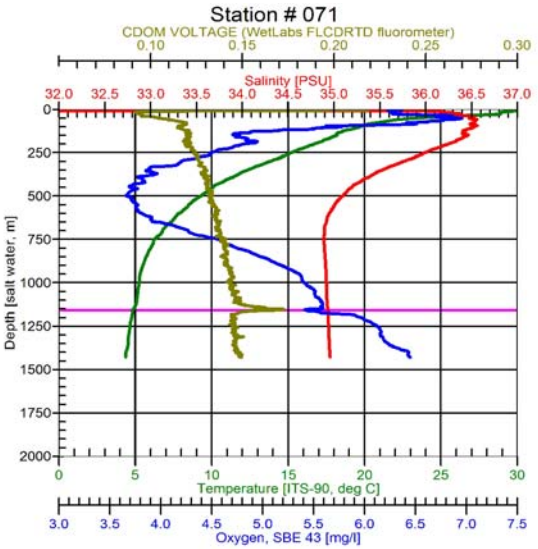


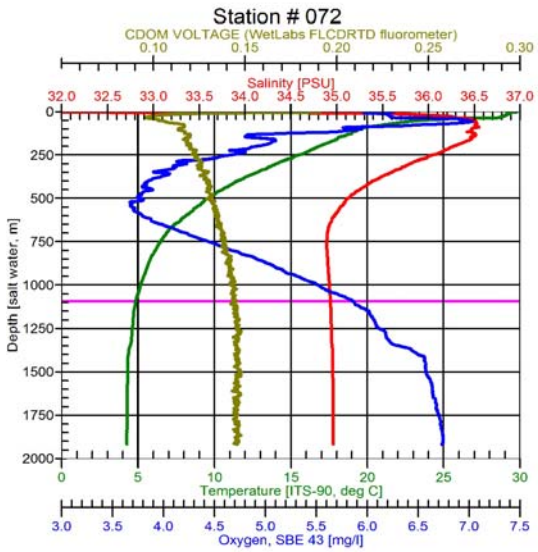


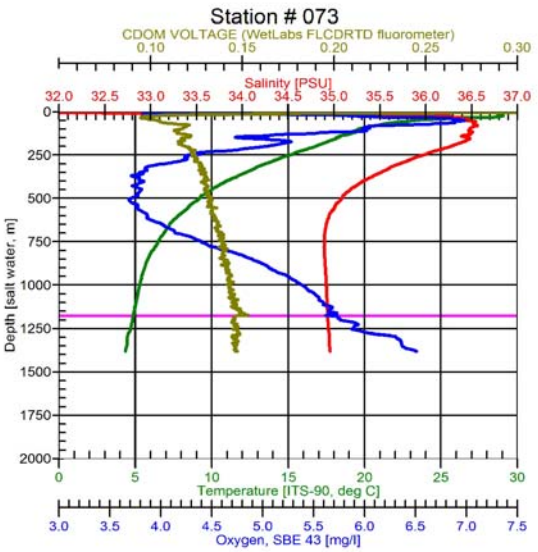


Evidence of Subsurface Plume

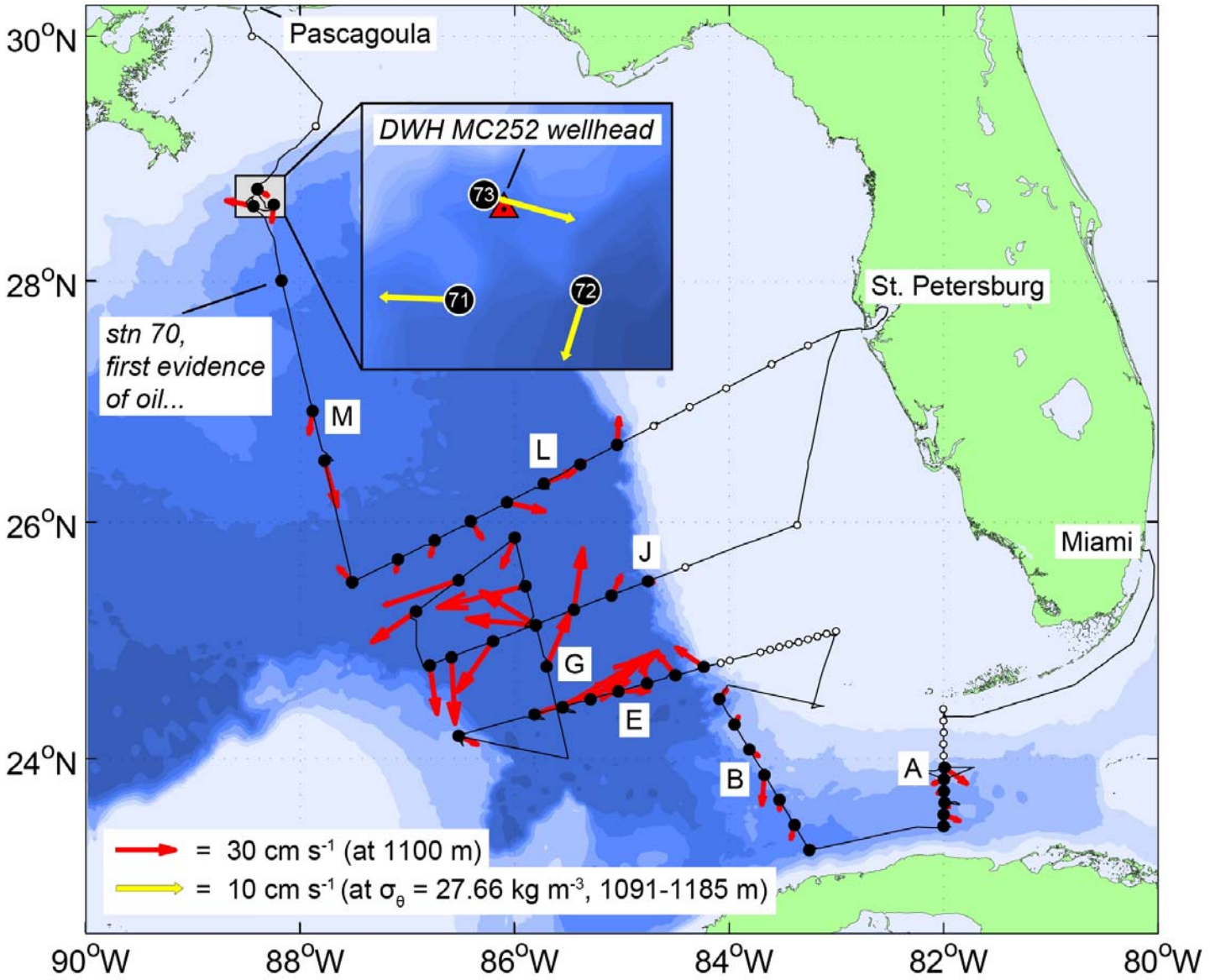








Subsurface Circulation (LADCP velocities)



In Situ Findings:

WS1010A: June 6-10, 2010

- *Tar balls sourced as Macondo were observed at 26° 45.85'N 86° 03.65'W possibly originating from "Tiger Tail" Filament observed in satellite data and aerial overflights in June*

NF1013: June 30 – July 18, 2010

- *No surface/subsurface oil found in GOM south of 28N along July 2010 survey track*
- *Direct pathway from northern GOM to FL Straits no longer in place by July 2010*
- *Subsurface hydrocarbon plume confirmed 15 km SW of wellhead at 1154 m on July 17, 2010*

Remotely Sensed Findings:

Surface Oil Coverage

- *Daily mean surface oil extent: 20,000 km^2*
- *Surface oil coverage area reached a southernmost extension at approximately 27° N, 85° W in early June*
- *Total cumulative surface oil extent over 87 days of the spill: 130,000 km^2*
- *Greatest increase in coverage between April 22 and May 22, 2010 the average increase per day during this time was found to be 1,300 km^2*
- *Daily surface oil extent exceeded 40,000 km^2 multiple times between late may and the end of June*
- *Southeast winds associated with Hurricane Alex helped to reduce a pre-storm surface oil coverage of greater than 45,000 km^2 to less than half that amount (~20,000 km^2)*