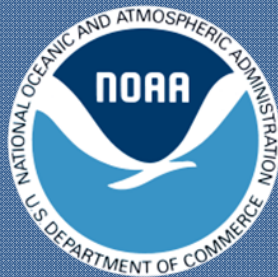


Utilizing In Situ Observations and Satellite Measurements to Examine the Extent and Variability of the DWH Oil Spill



Gustavo Jorge Goni
presented by Ryan Smith
NOAA / AOML Miami, FL

*NTSC SOST 2011 Deepwater Horizon Oil Spill PI Workshop
October 25, 2011*

NOAA/OAR, Atlantic Oceanographic and Meteorological Laboratory

Ryan H. Smith, Joaquin A. Trinanes, Francis Bringas, Elizabeth M. Johns, Rick Lumpkin, A. Michelle Wood, Christopher R. Kelble, George Halliwell, and Shailer S. Cummings

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John T. Lamkin, and Sarah Privoznik

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M. Josefina Olascoaga and Javier Beron-Vera

NASA, Goddard Space Flight Center

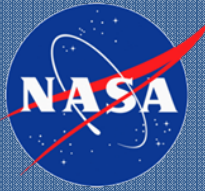
Marc L. Imhoff

Univ. of South Florida, College of Marine Science

Frank Muller-Karger

Roffer's Ocean Fishing Forecasting Service

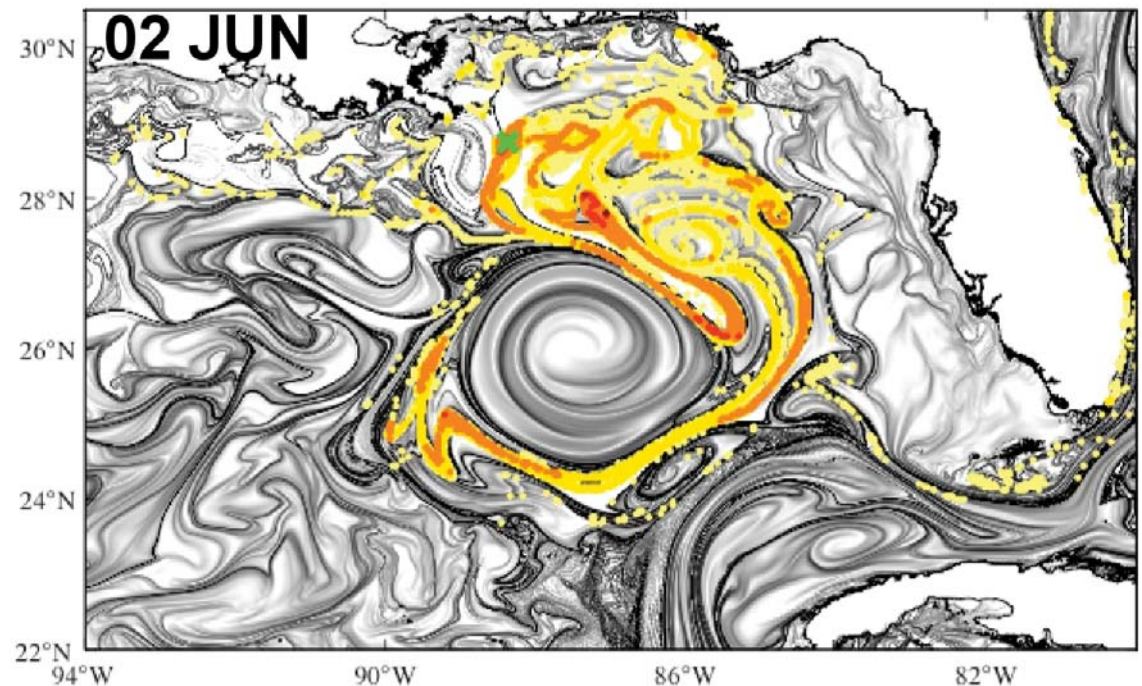
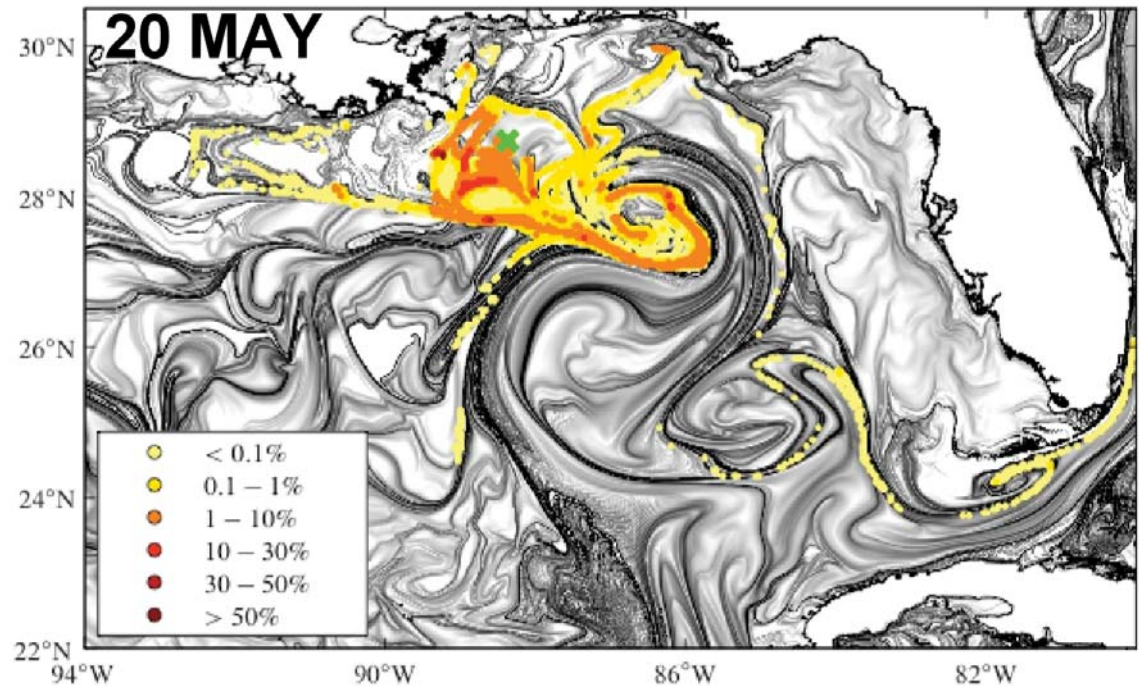
Mitch A. Roffer



Lagrangian Particle Trajectory Maps

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

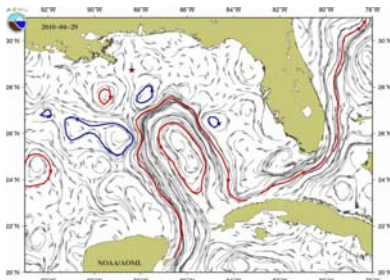
*Finite Time Lyapunov Exponent (FTLE) fields reveal Lagrangian Coherent Structures (LCS) by UM/RSMAS
Based upon Adcroft et al., 2010*



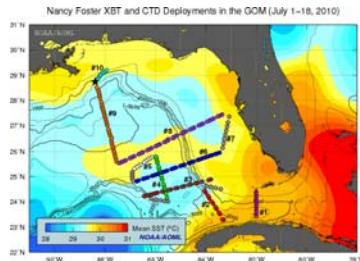
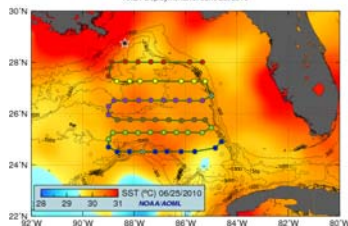
AOML DWH Response Efforts:

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

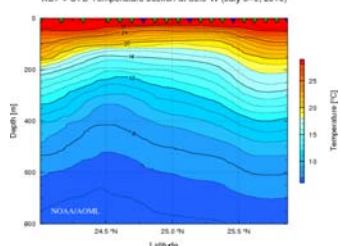
- *Real-time oceanographic data products (via web, ftp, GTS)*
- *AXBT deployment flight coord. / data QC*
- *Research cruises / drifter deployments*



AXBT Deployments for June 25, 2010



XBT + CTD Temperature section at 85.8°W (July 8-9, 2010)



Physical Oceanography Division - Monitoring the Gulf of Mexico Conditions - Windows Internet Explorer

Physical Oceanography Division - Monitoring the Gulf of Mexico Conditions

NOAA AOML PHOD GOM Monitoring

Physical Oceanography Division

Research Projects

Global Ocean Observations State Of The Ocean Observing System

Satellite Ocean Monitoring

Instrument Development

Gulf of Mexico Monitoring

Ecosystem Monitoring

Gulf of Mexico Monitoring

Current Ocean Conditions in the Gulf of Mexico

Altimetry-Derived Products

Satellite-Derived SST

Satellite-Derived Color (Chl-a)

Satellite-Derived Color (K490)

Satellite-Derived Color (Rrs667)

XBT and CTD Observations

XCP Observations

AXBT Observations

Surface Drifter Observations

Simulated Flow Trajectories

Numerical Model Outputs

Related Links

Acknowledgements

FTP Data Access

Mississippi River Water Discharge Monitoring

The following products are shown to help understand and monitor the Mississippi River water pathways during May, June and July, 2011.

Satellite-Derived Ocean Color (K490)

Daily high resolution maps of ocean color (K490) Go

Satellite-Derived Ocean Color (Rrs667)

Daily high resolution maps of ocean color (Rrs667) Go

Gulf of Mexico Conditions

The following products were created to monitor both the Deepwater horizon oil spill and the Mississippi River discharge into the Gulf of Mexico.

Regional Satellite Products: Gulf of Mexico

Satellite-Derived SST

Daily high resolution sea surface temperature maps Go

Altimetry-Derived Products

Daily surface currents and sea surface height maps from satellite observations Go

Satellite-Derived Ocean Color (Chlorophyll-a)

Daily high resolution maps of ocean color (Chlorophyll-a) Go

Numerical Model Outputs

Daily surface and subsurface currents from numerical models Go

Tropical Cyclone Heat Potential

AOML - CoastWatch monitoring of upper ocean heat content or Tropical Cyclone Heat Potential (TCHP) in the GOM, where high values of TCHP have been linked to hurricane intensification. Go

Deepwater Horizon Oil Spill Monitoring

The following products were created to monitor the Deepwater horizon oil spill during the summer of 2010.

Oil Spill Response Workshop

Agenda of the Workshop organized by NOAA/AOML and NOAA/SEFSC in support of oil spill efforts. Miami, July 1-2, 2010. Go

Ocean Conditions in the Gulf of Mexico

Daily updates of the location of oceanographic features in the Gulf of Mexico Go

XBT and CTD Observations

Measurements of ocean parameters such as temperature and salinity, using expendable BathyThermograph (XBT) and Conductivity Temperature Depth (CTD) instruments Go

XCP Observations

Measurements of ocean currents as a function of depth using expendable Current Profilers. Go

Simulated Flow Trajectories

Simulations of water flows and synthetic drifters evolution. Go

AXBT Observations

Airborne eXpendable BathyThermograph measurements of ocean temperature Go

Access to Delayed-Time and Near Real-Time Data

Access to data from several hydrographic cruises and flights carried out by NOAA and other institutions to monitor physical and chemical properties in the water column. Go

Surface Drifter Observations

Observations of drifter trajectories Go

NOAA AOML PHOD Contact Us

Last updated 2011 Sep 02 09:08 (-0400)

Internet

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

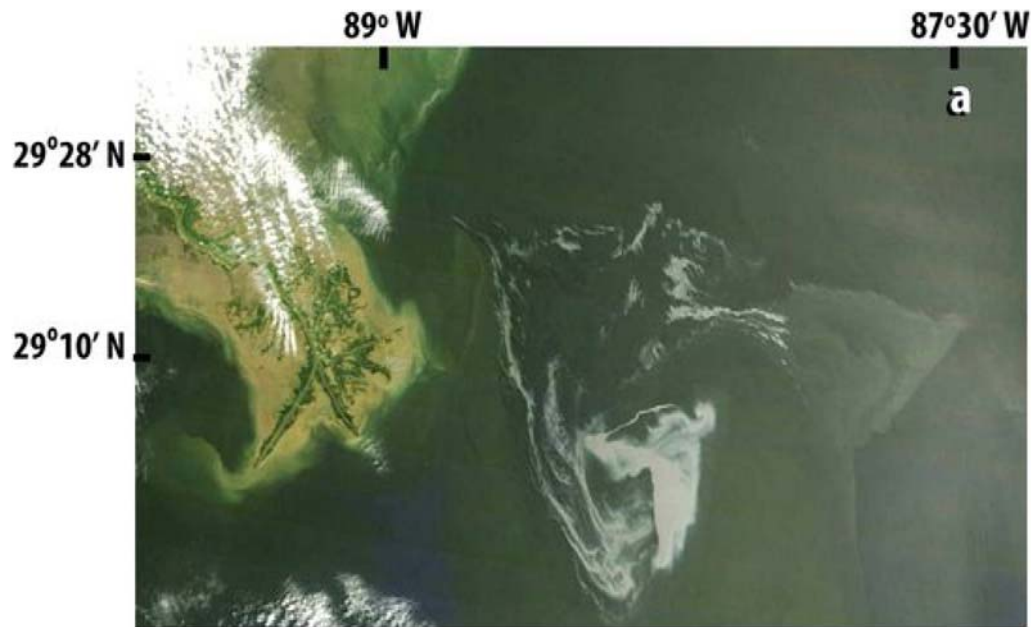
Surface Maps of SST and ocean color were produced by NOAA, NASA, ROFFS, and others to delineate mesoscale circulation features. These products utilized:

- *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)*

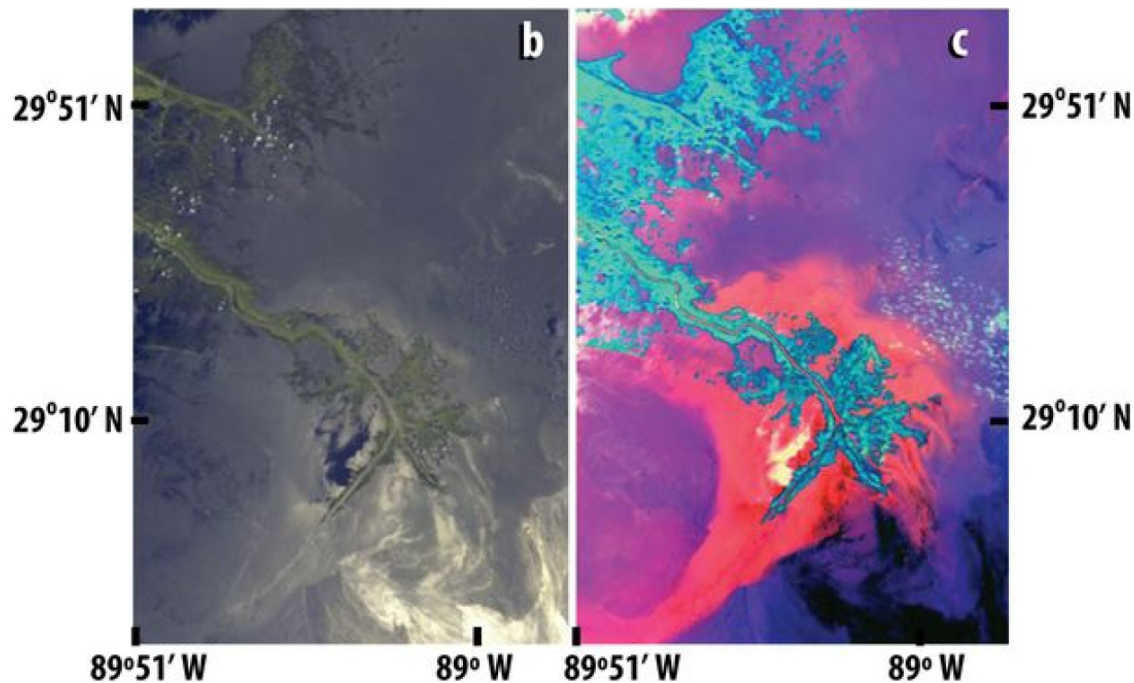
Surface Oil Extent

*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*

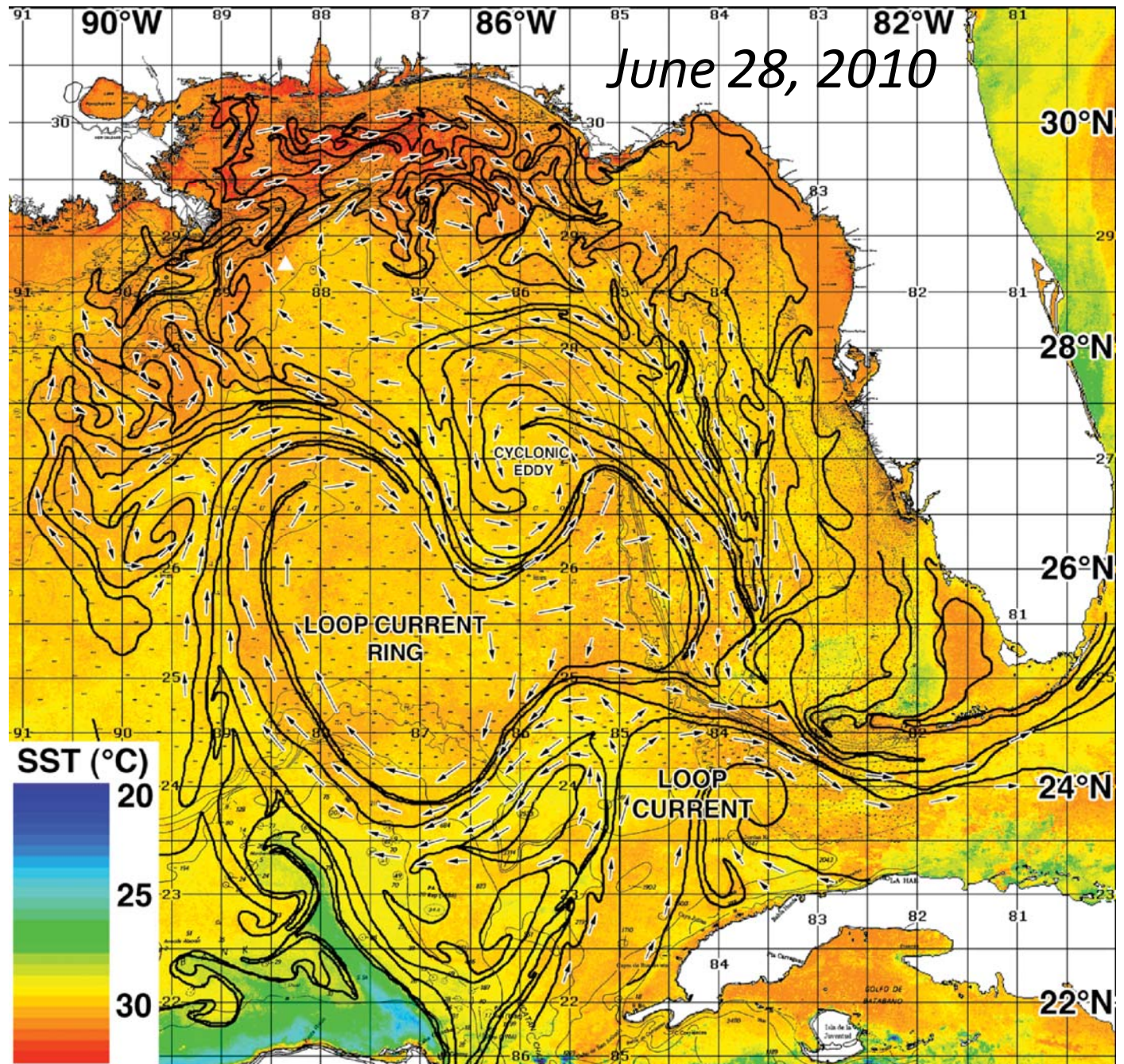


A)
Terra MODIS
visible-near IR
(May 1, 2010)

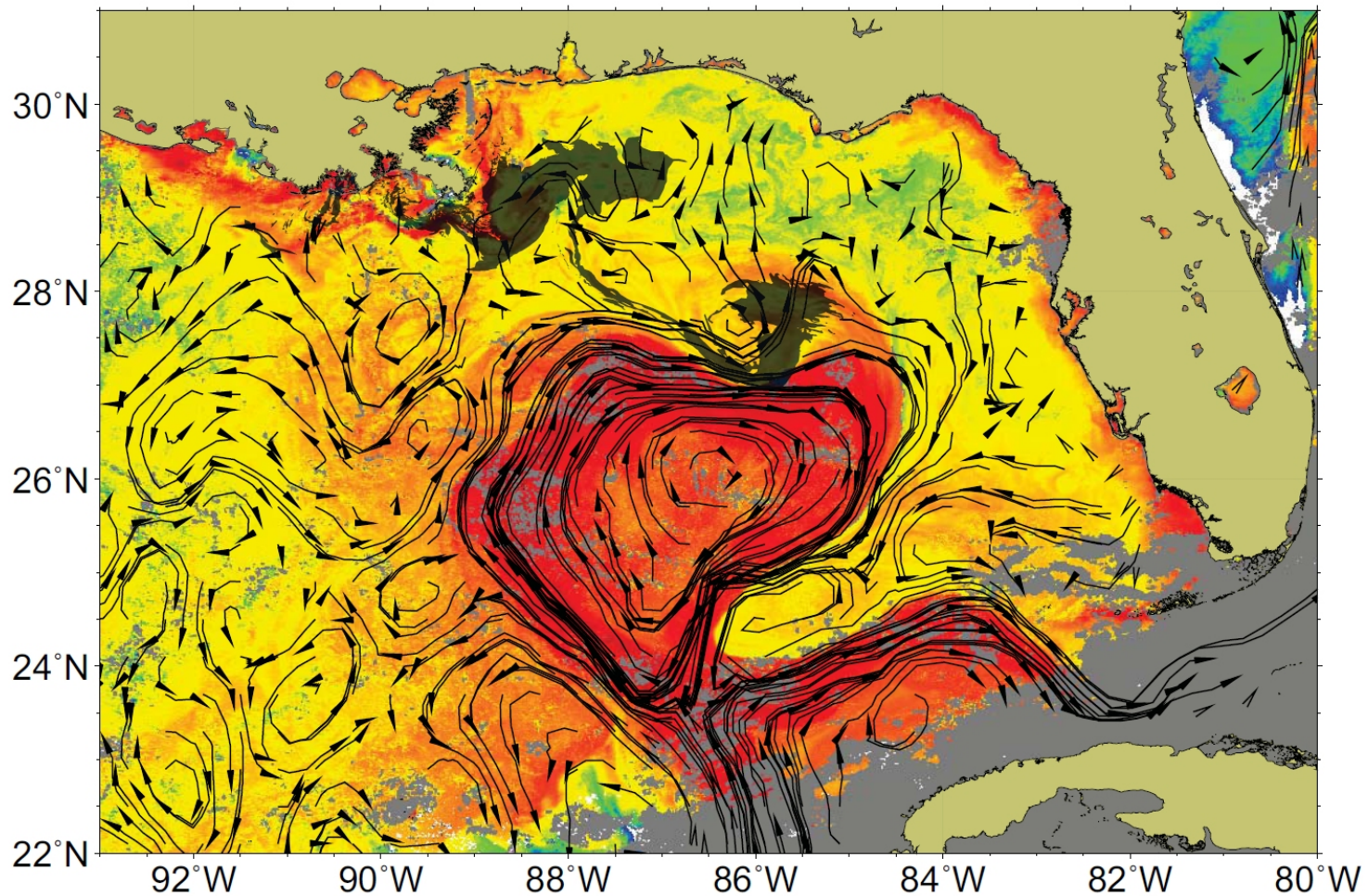


B)
MISR true color
(May 17, 2010)

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



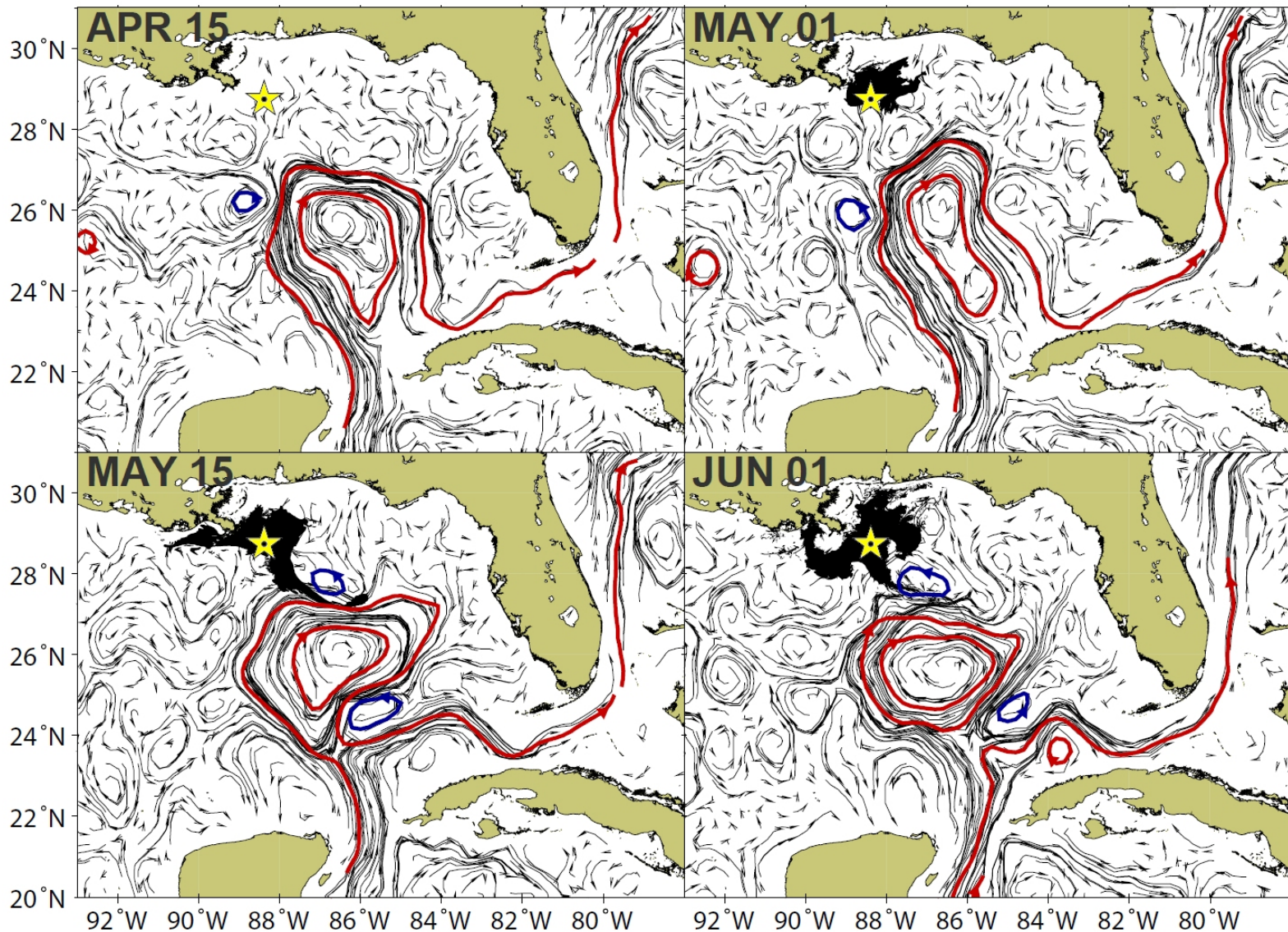
Mesoscale features identified from variability in multiple SST (16) and ocean color (2) obs. over a 24-hour period.



23 24 25 26 27 28 29 SST (°C)

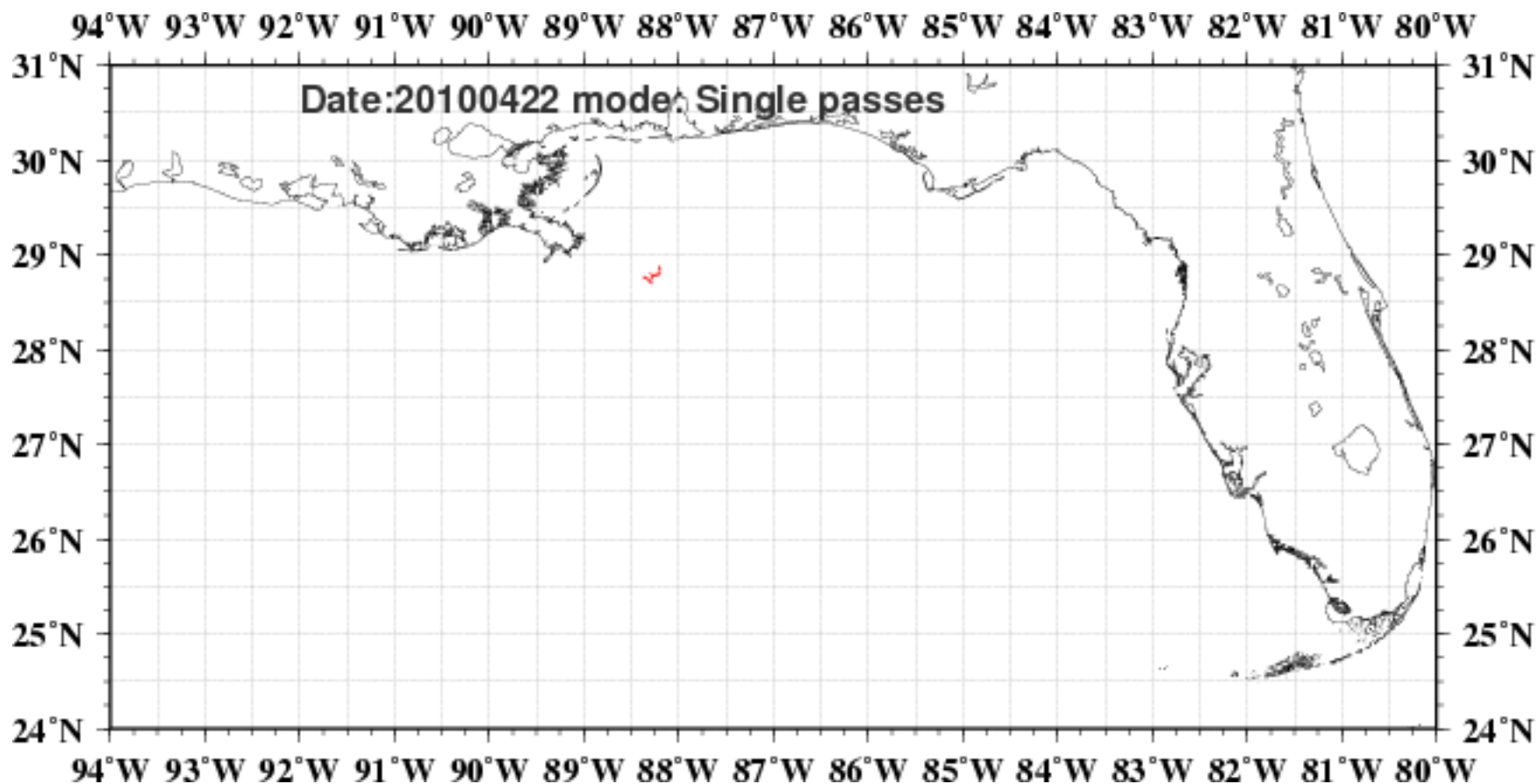
Altimetry-Derived Surface Currents*,
SST**, and MPSR utilized together***

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

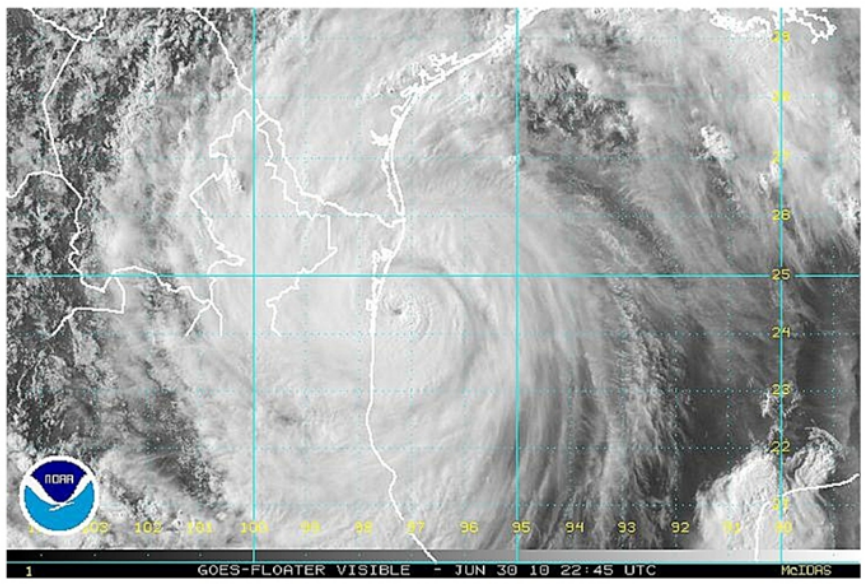
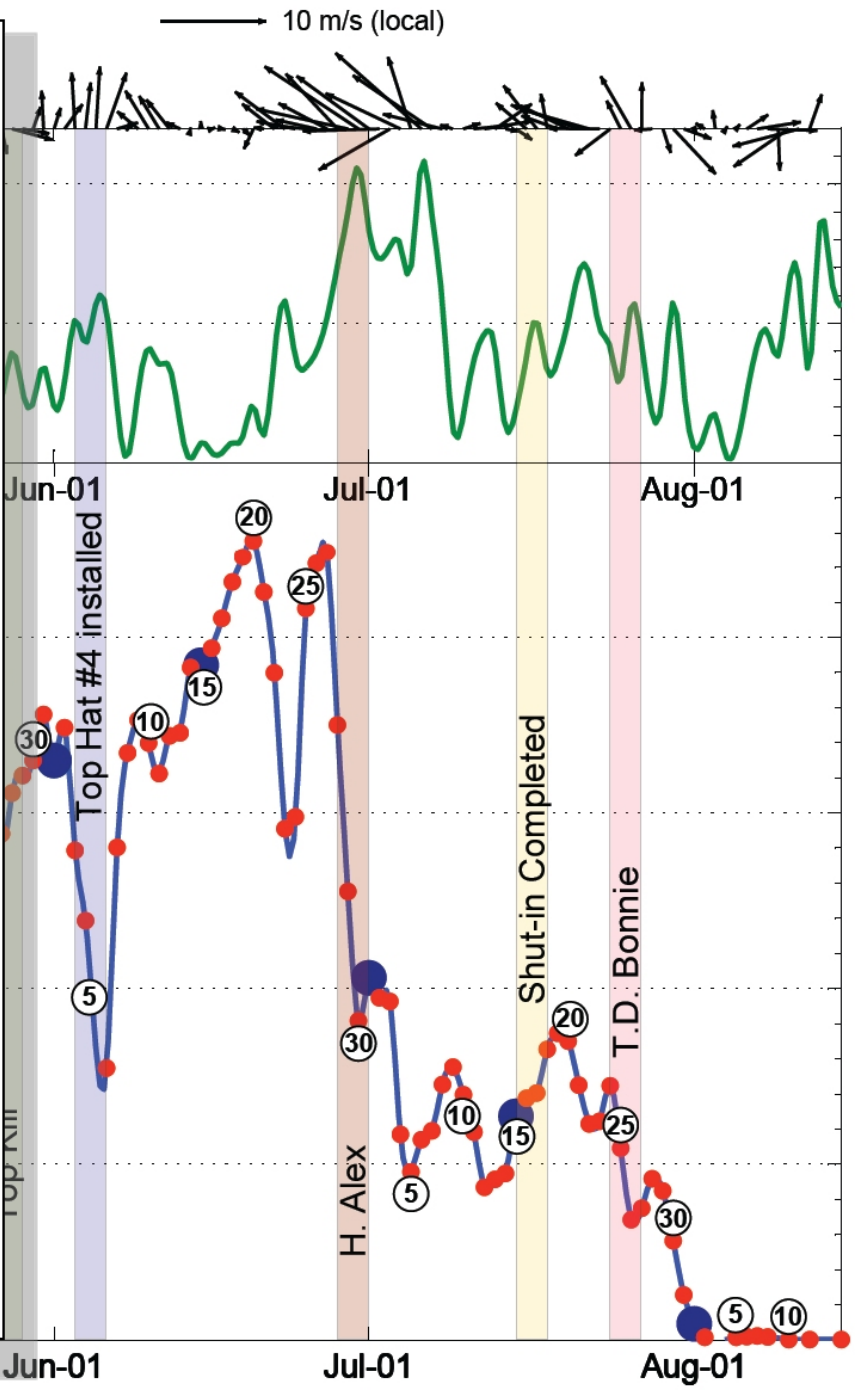
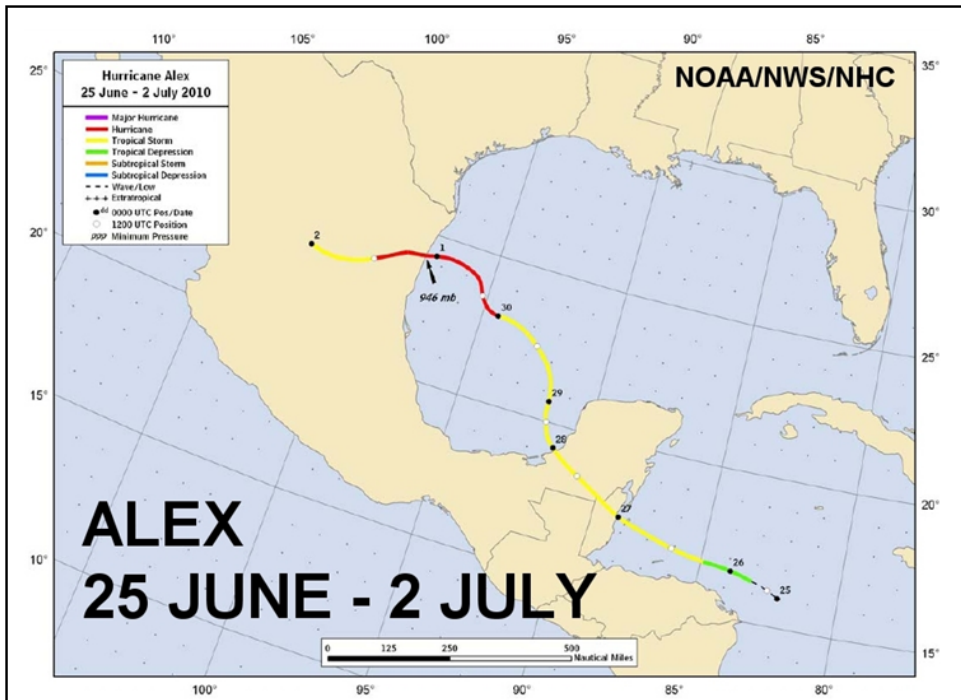


*Altimetry-Derived Geostrophic Surface Currents with
NOAA/NESDIS Satellite Analysis Branch (SAB)*

Daily Marine Pollution Surveillance Report (MPSR) Surface Oil Coverage



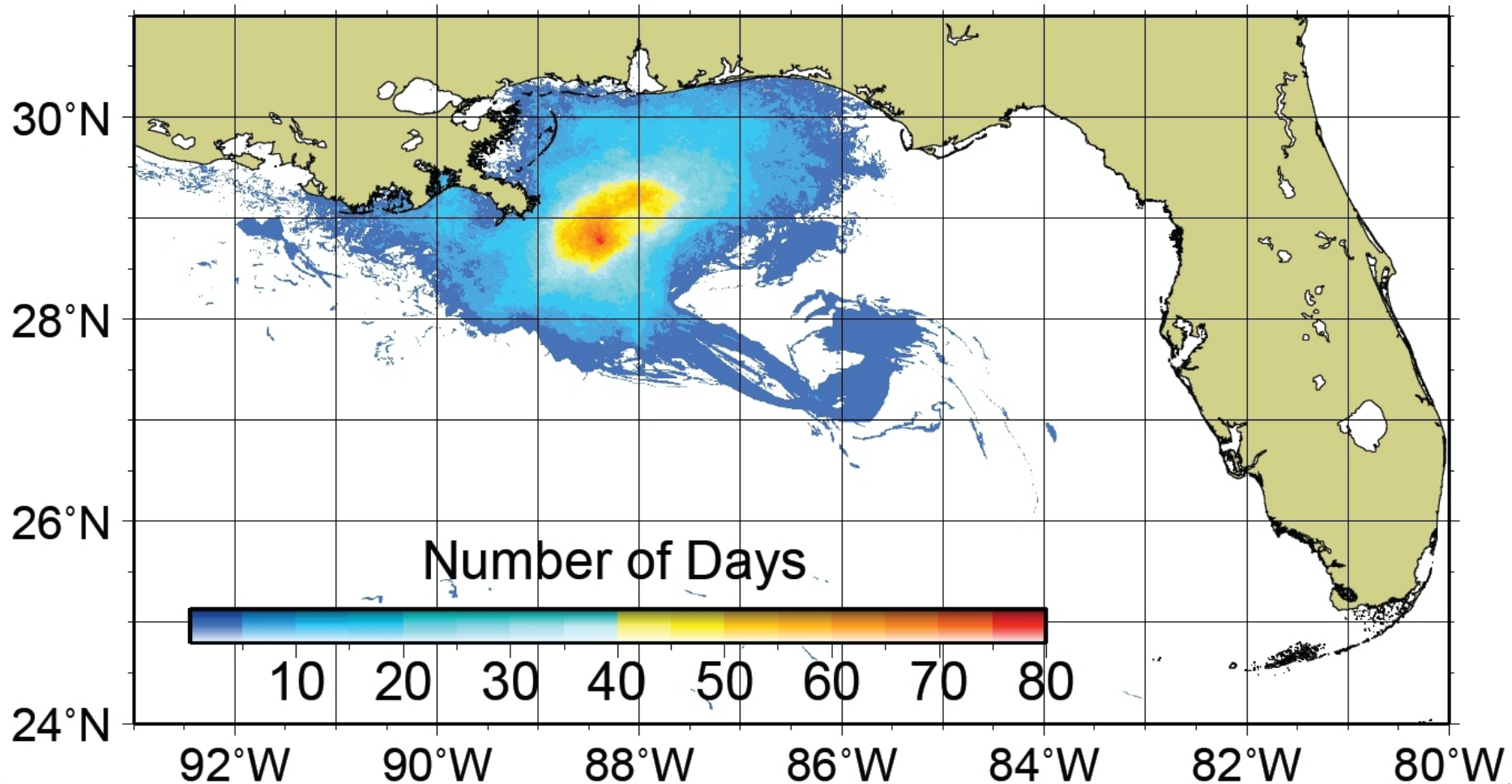
*NOAA/NESDIS Satellite Analysis Branch (SAB)
Daily Marine Pollution Surveillance Report (MPSR) Surface Oil Coverage
Time-Series (5-day running mean filter)*



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)****

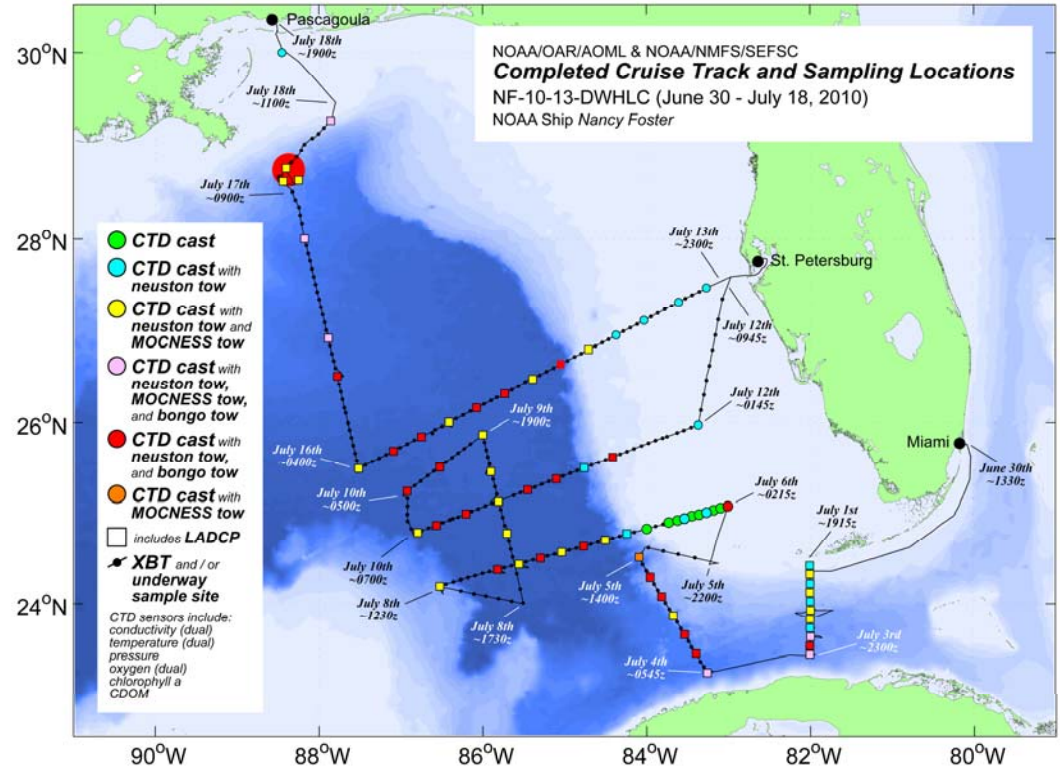
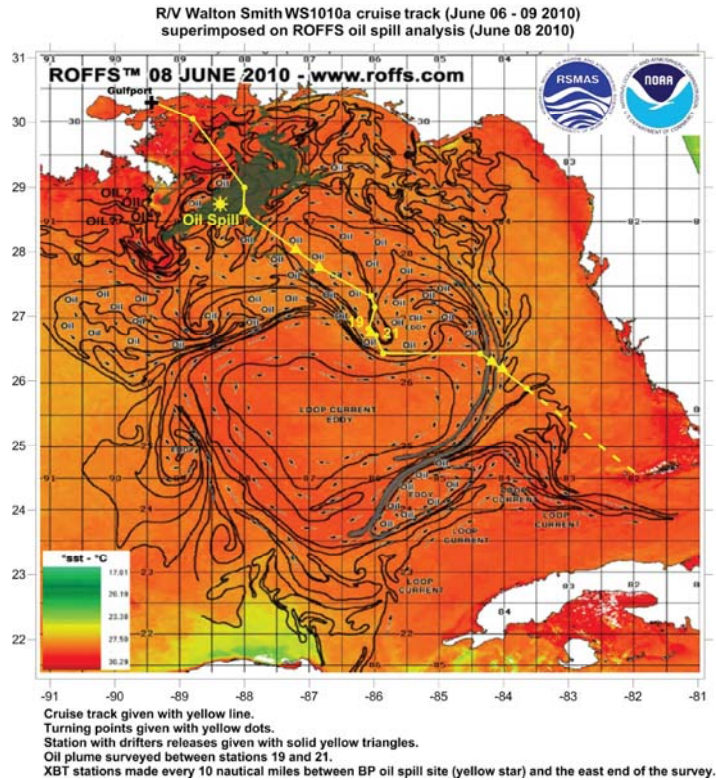
Laboratory analysis performed by:

* *University of Georgia*

** *Louisiana State University*

*** *University of South Florida*

AOML DWH Response Research Cruises:

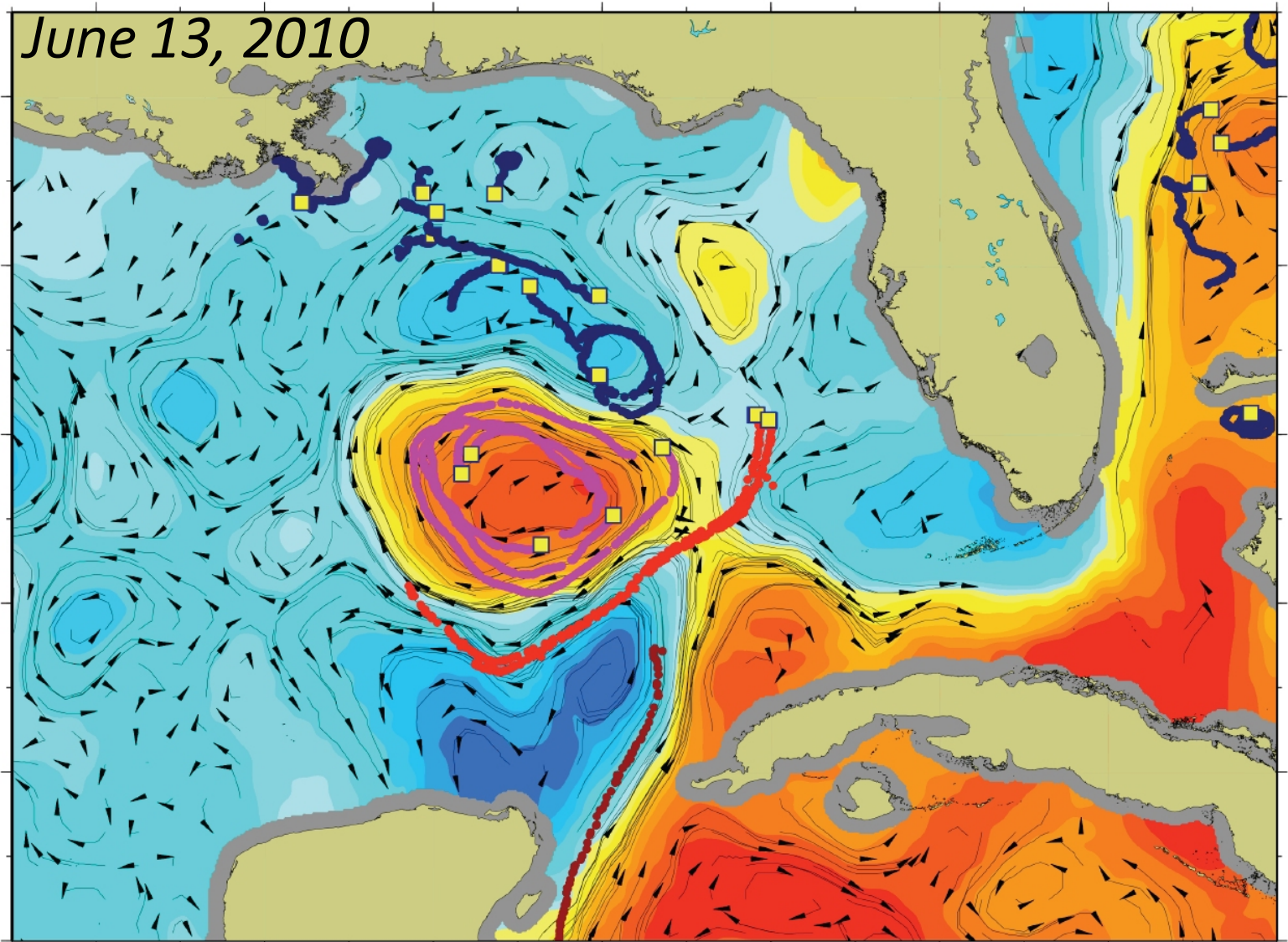
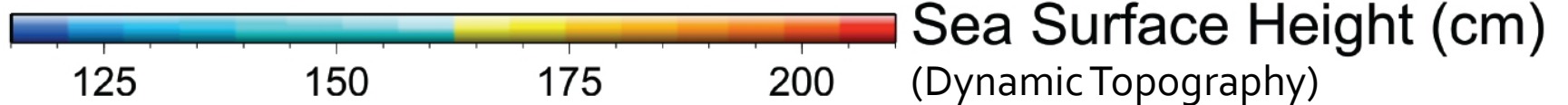


- WS1010A: June 6-10, 2010
- NF1013: June 30 – July 18, 2010

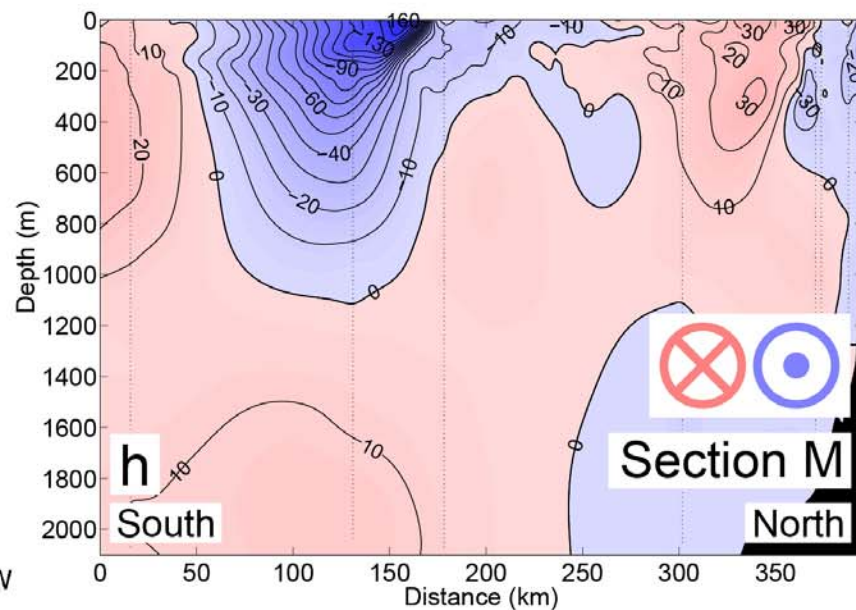
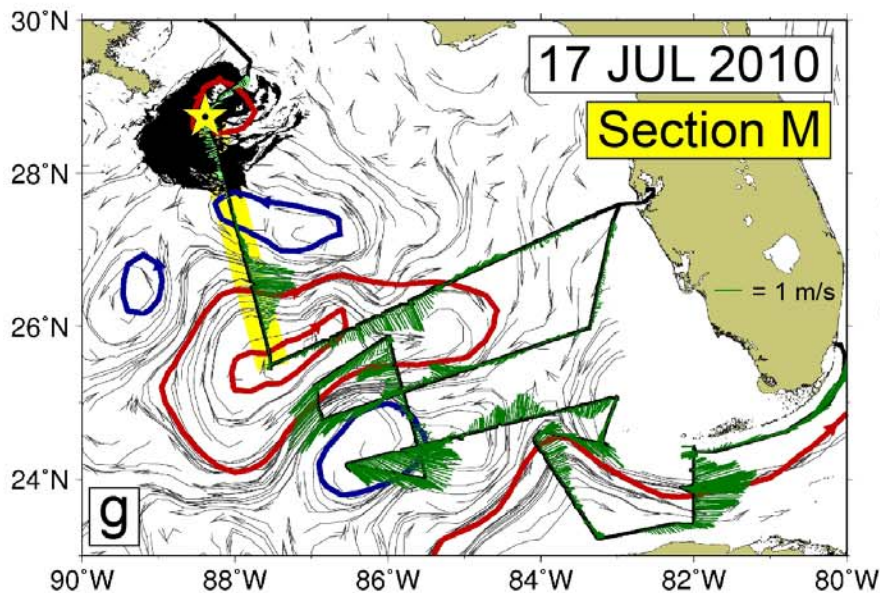
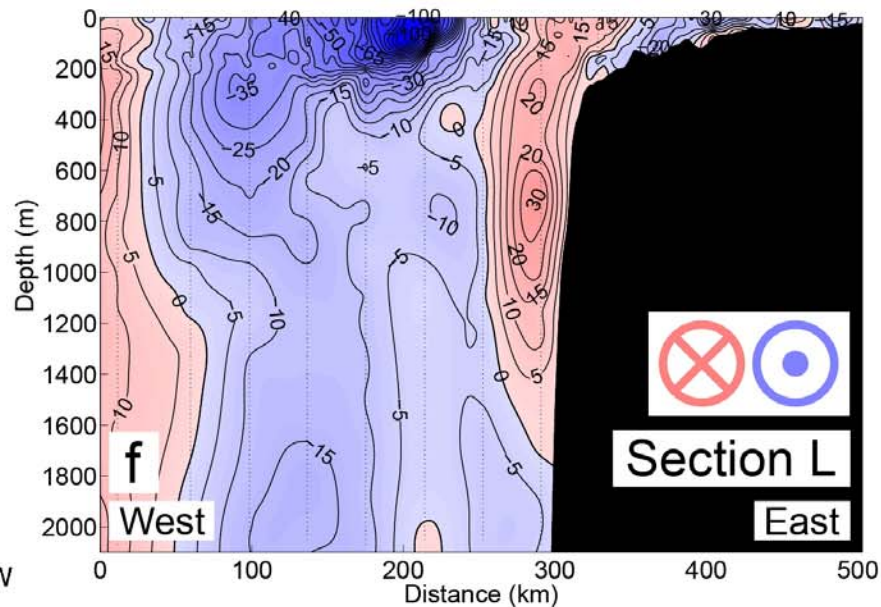
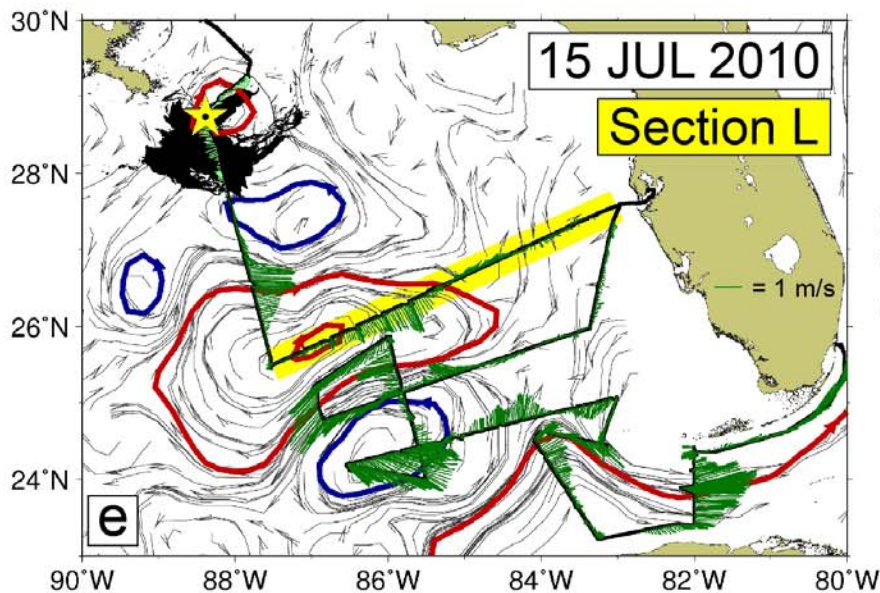
June 13, 2010

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

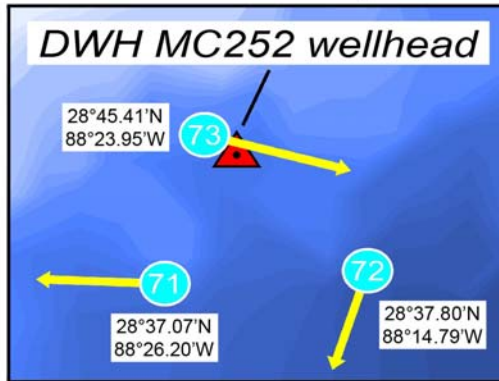


Altimetry and Section Velocities

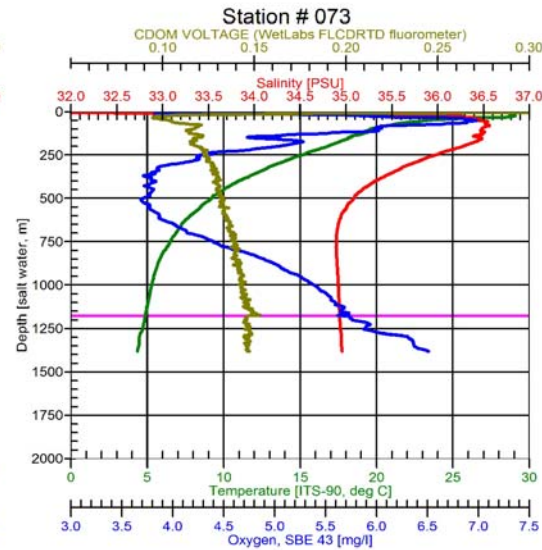
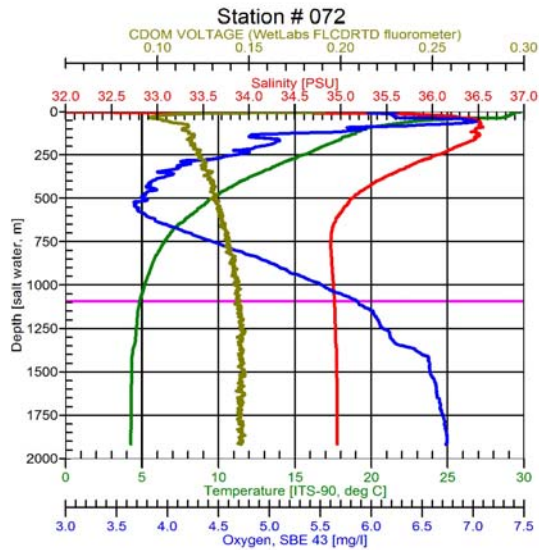
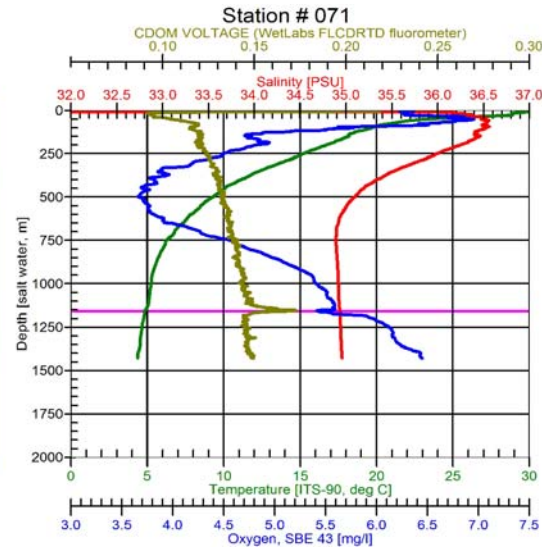


Evidence of Subsurface Plume

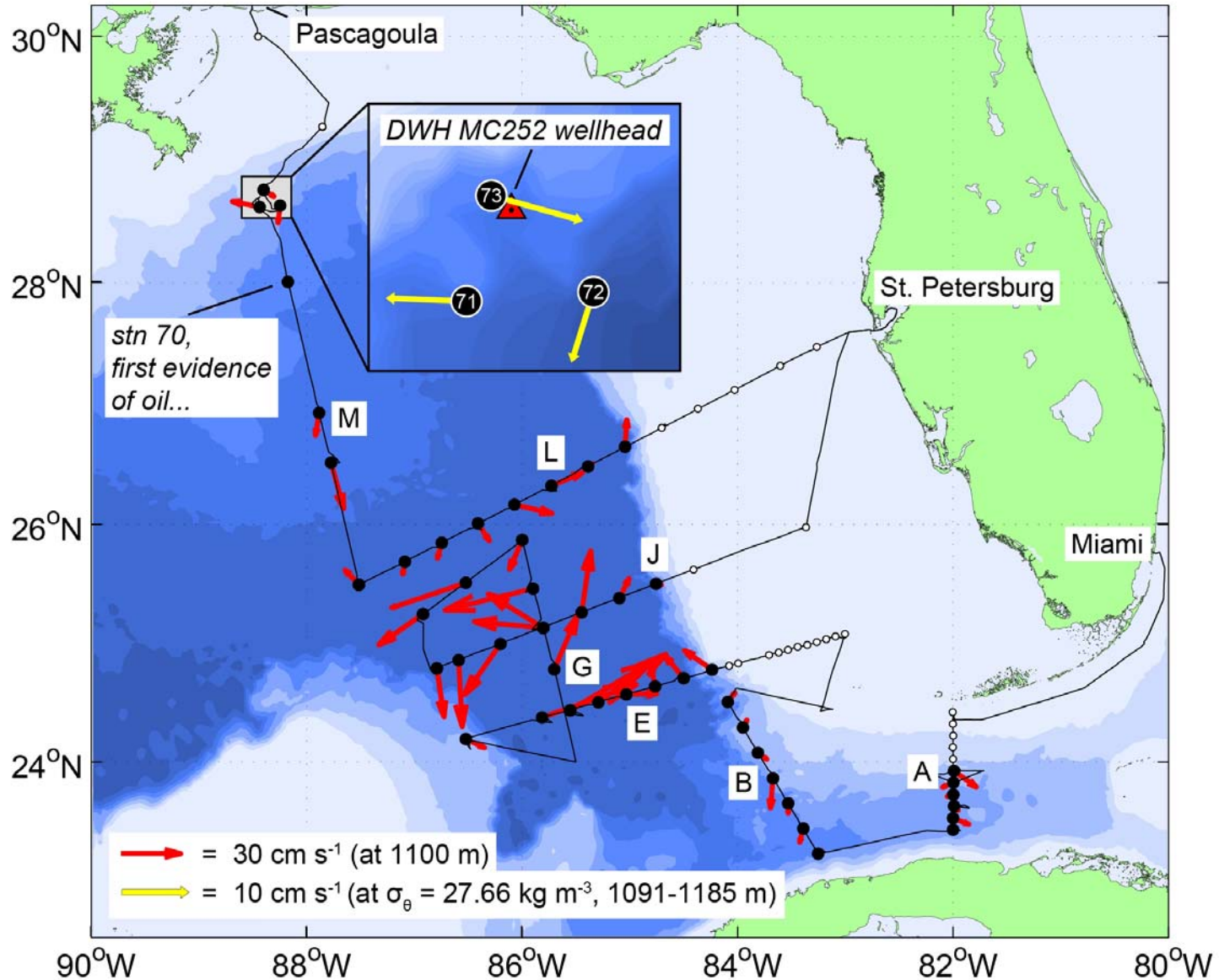
CTD/LADCP Stations - July 17, 2010



→ = 10 cm s⁻¹ at $\sigma_\theta = 27.66 \text{ kg m}^{-3}$
(1091-1185 m)



Subsurface Circulation (LADCP velocities)



In Situ Findings:

WS1010A: June 6-10, 2010

- *Tar balls sourced as Macondo were observed at $26^{\circ} 45.85'N$ $86^{\circ} 03.65'W$ 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 km²*
- *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 km²*
- *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 km²*
- *Daily surface oil extent exceeded 40,000 km² 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 km² to less than half that amount (~20,000 km²)*