

# **General Circulation of the Gulf of Mexico and Satellite Oceanography**

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University of South Florida  
College of Marine Science**

# Biographical Information

## Frank Muller-Karger

### Education:

- 1979 BS Biological Oceanography. Florida Institute of Technology. Melbourne, FL.
- 1984 MS Oceanography. Institute of Marine Science. University of Alaska.
- 1988 PhD in Marine and Estuarine Sciences. University of Maryland.
- 2001 Master of Science in Management. University of South Florida.

### Employment:

- 1989-present Professor, University of South Florida, College of Marine Science
- 2007/09 Dean, School for Marine Sci. and Technology, U Mass Dartmouth
- 2001/04 Commissioner, U.S. Commission on Ocean Policy / JOCI

### Professional Interests and Expertise:

- Interdisciplinary Earth science and Earth observation
- Oceanography, coastal and estuarine science
- Satellite oceanography
- Science education
- Ocean Policy

# **Acknowledgement**

**Material used obtained from:**

**NASA, NOAA, Navy/NRL**

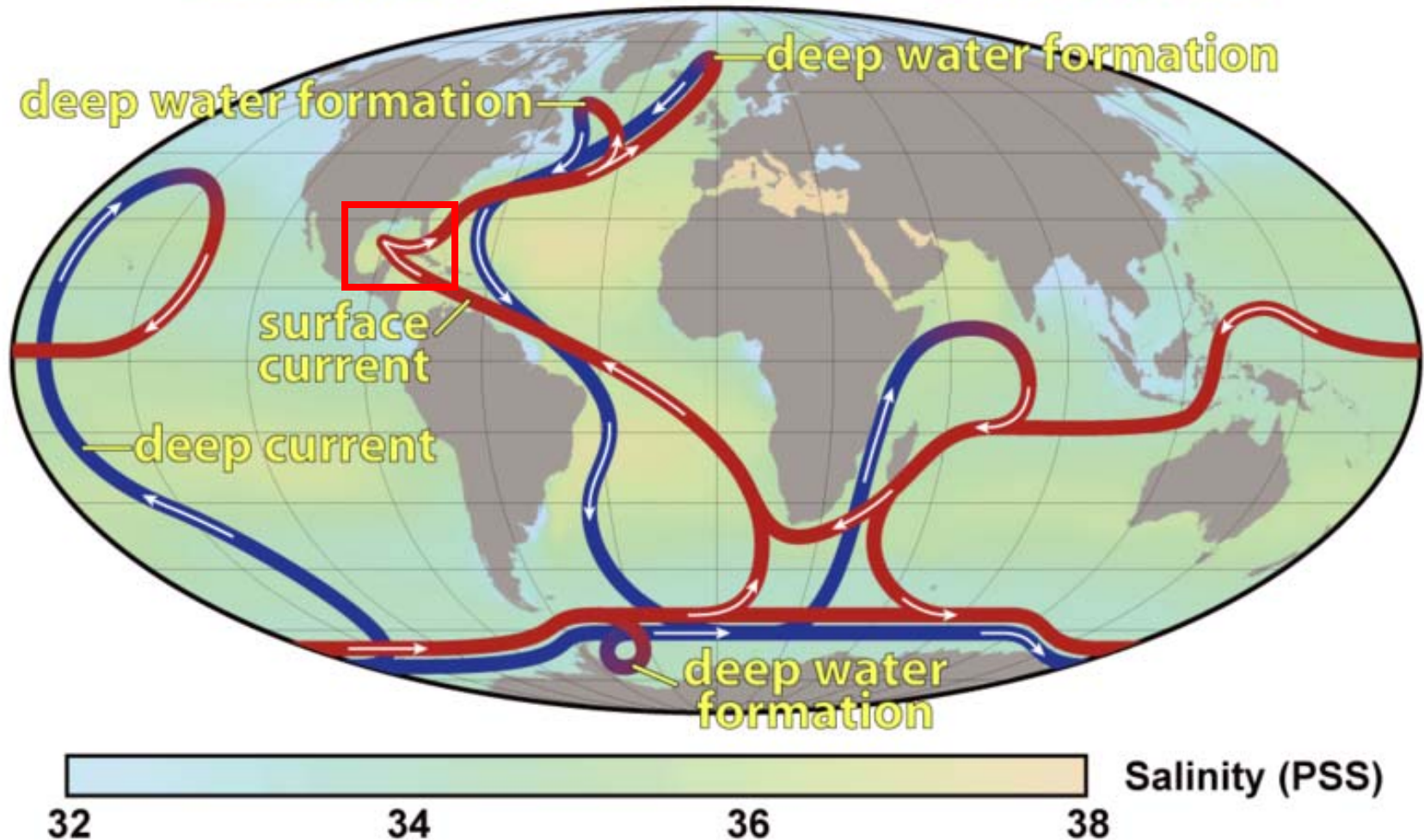
**State of Florida**

**ROFFS, Inc.**

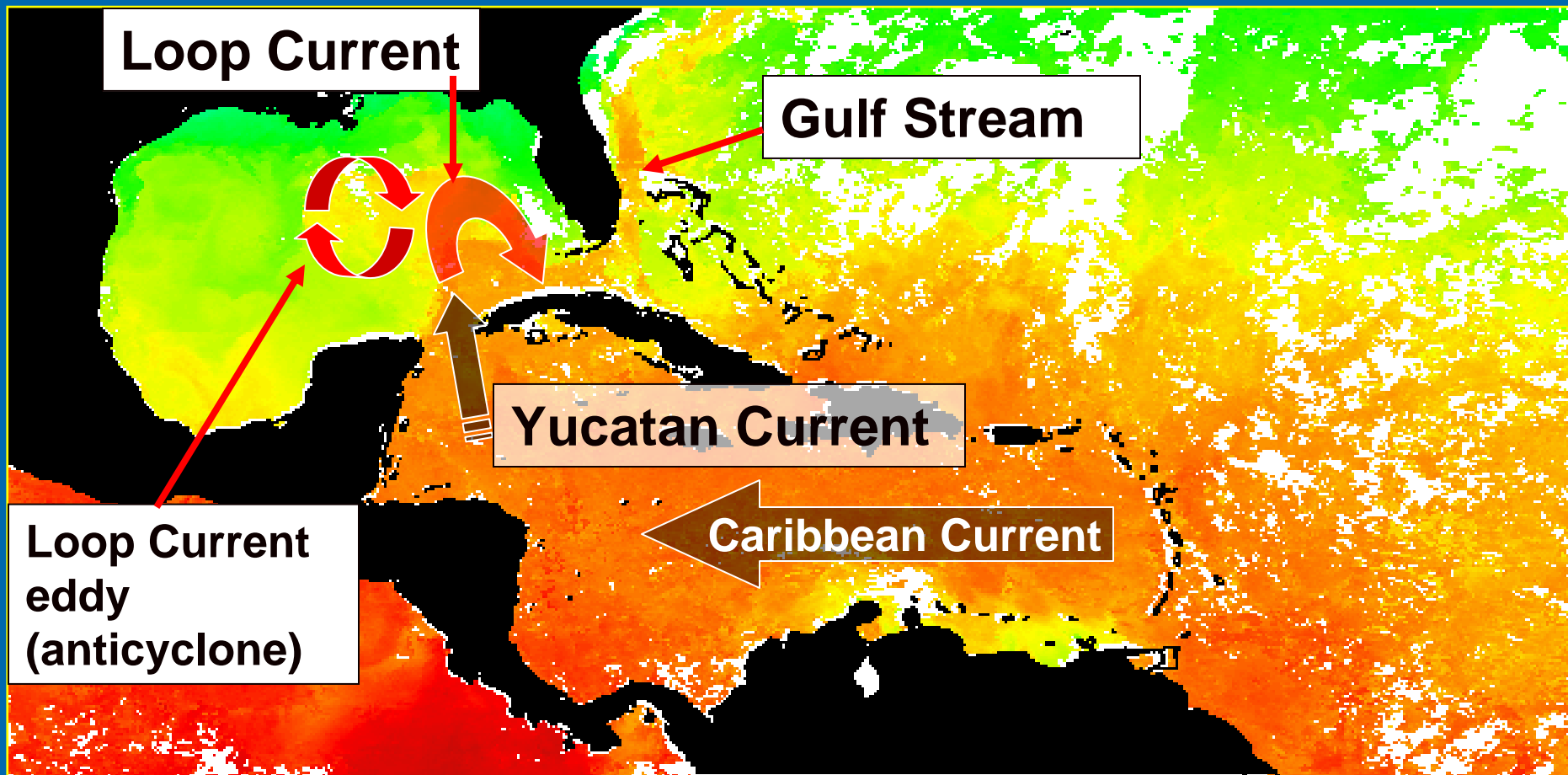
**University of South Florida**

# Simplified circulation of the ocean and location of the Gulf of Mexico

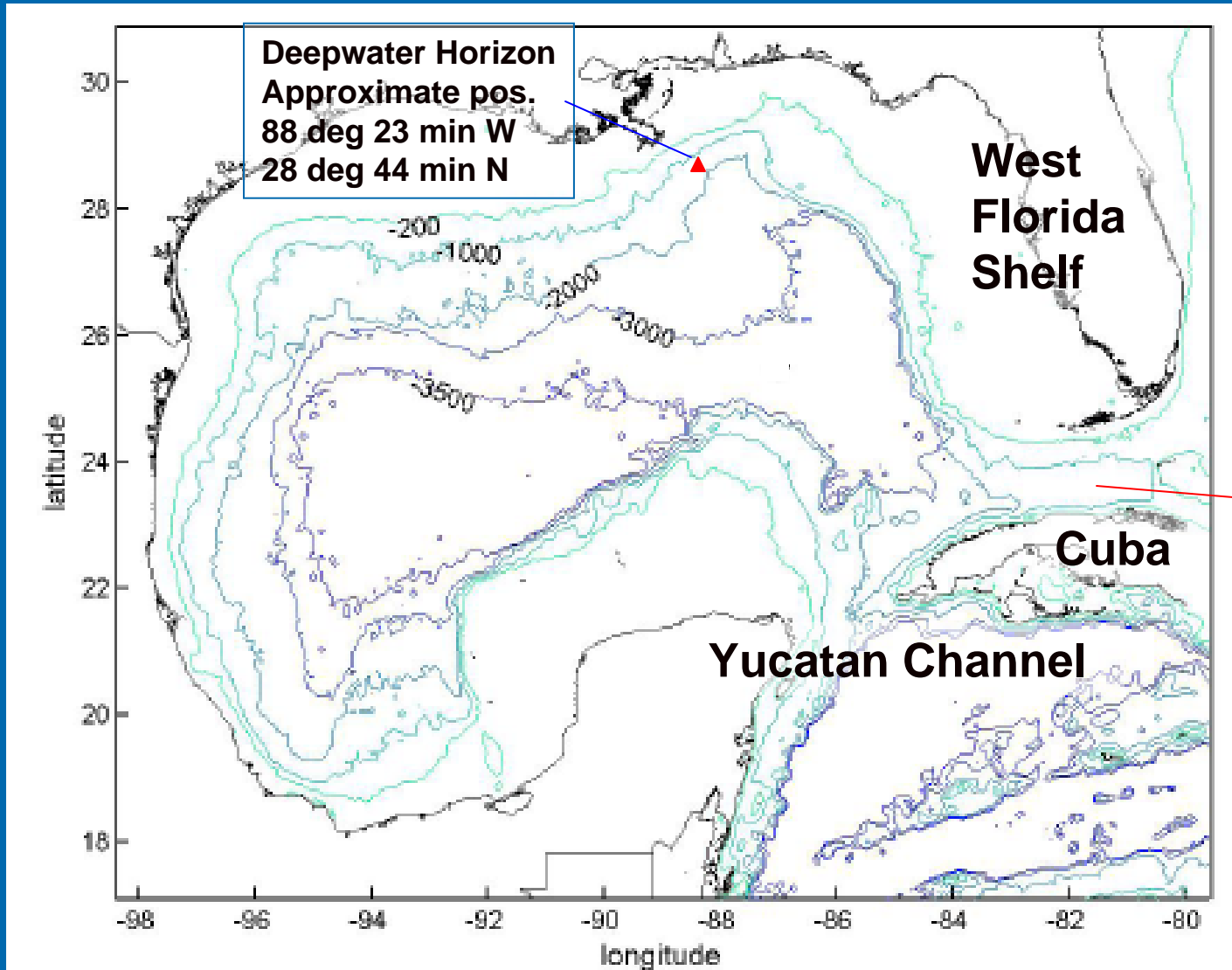
## Thermohaline Circulation



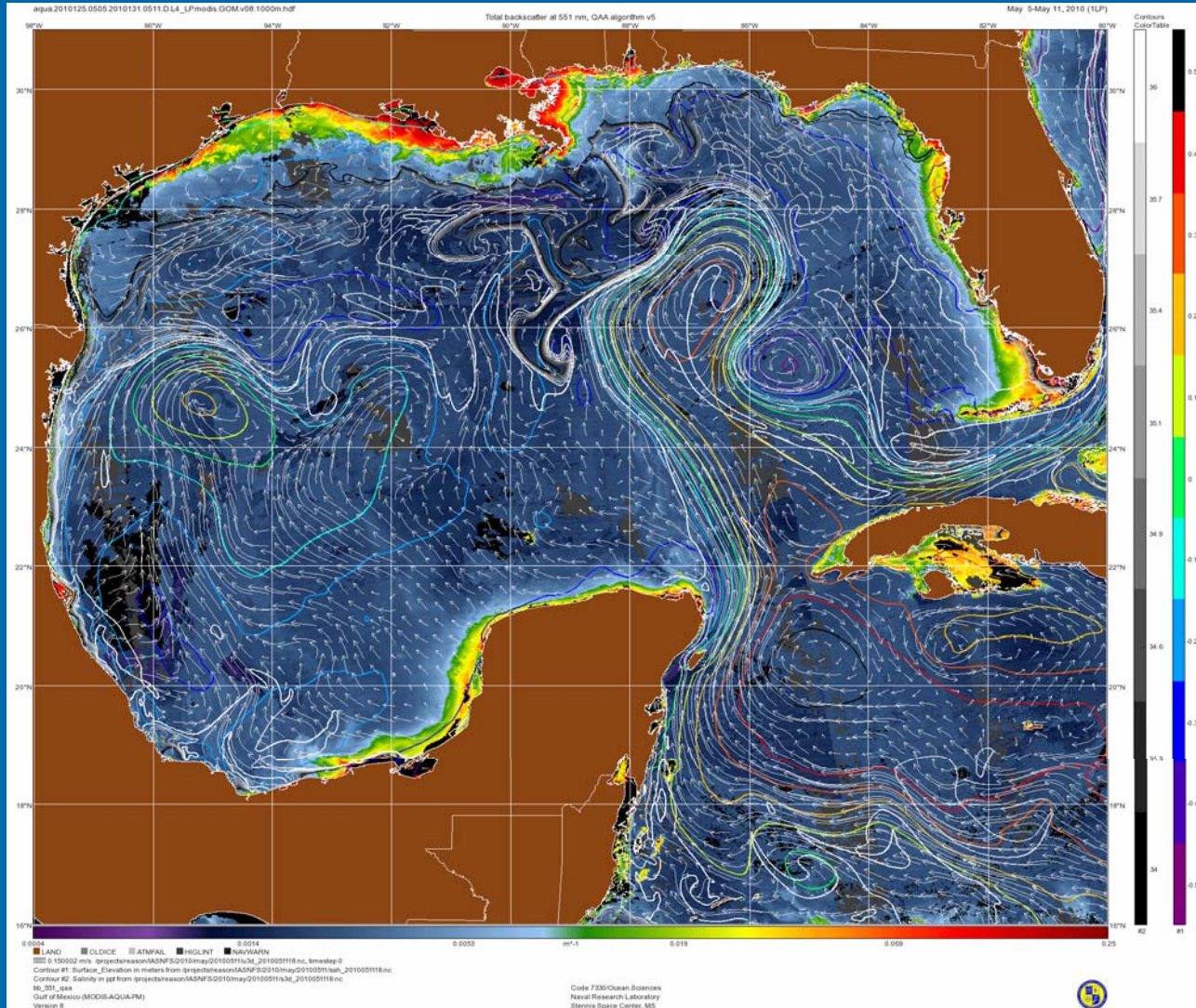
# Intra-Americas Sea (Sea Surface Temperature Satellite Image)



# The Gulf of Mexico Bathymetry



# The Loop Current



**Characteristics:**

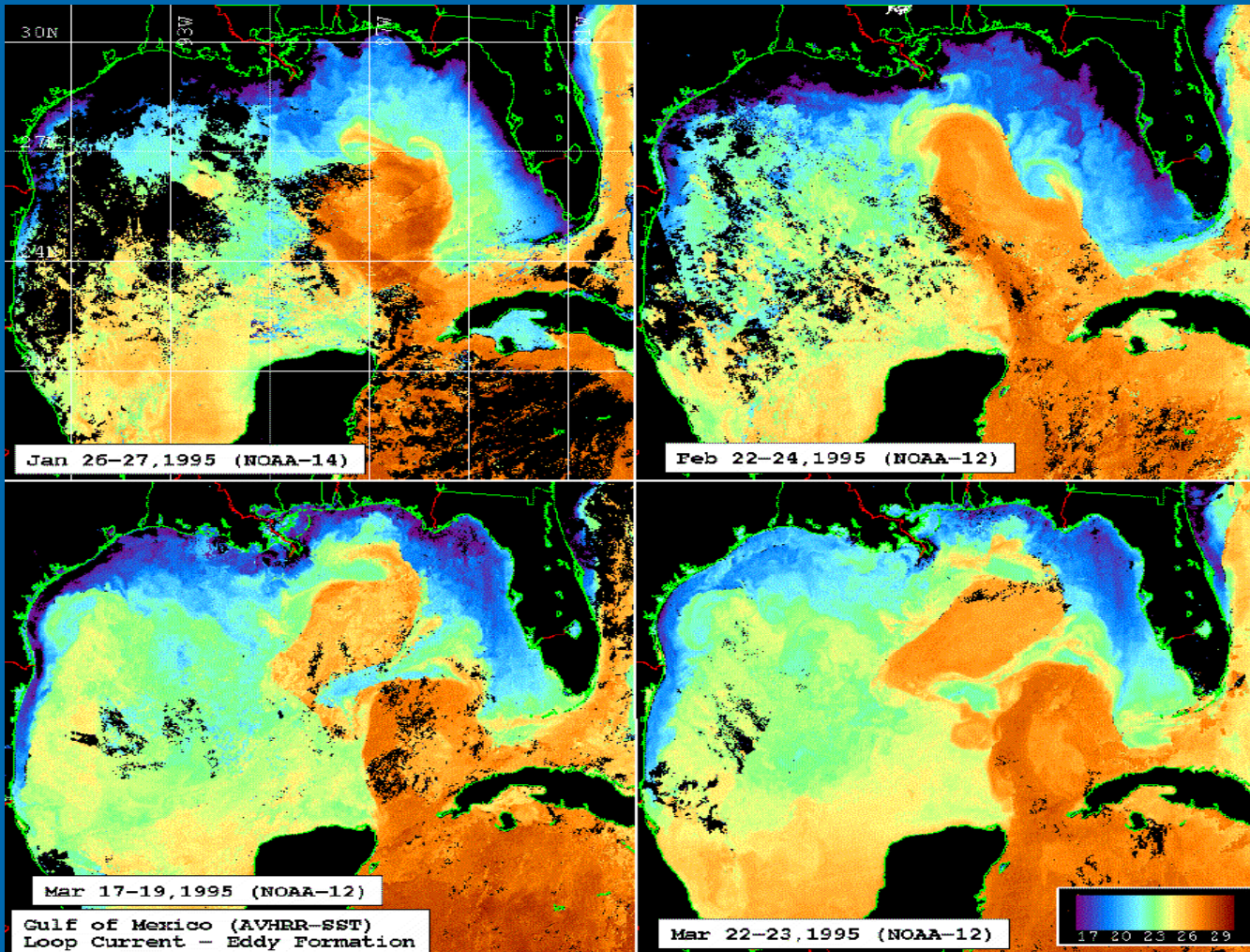
**Large “loop”**

**~27 million cubic  
meters per second**

**~1 to 3 knots**

**May 5-17 2010  
Simulation Image:  
Naval Research Lab  
(NRL)**

# Typical eddy-shedding cycle of the Loop Current: 9-14 months

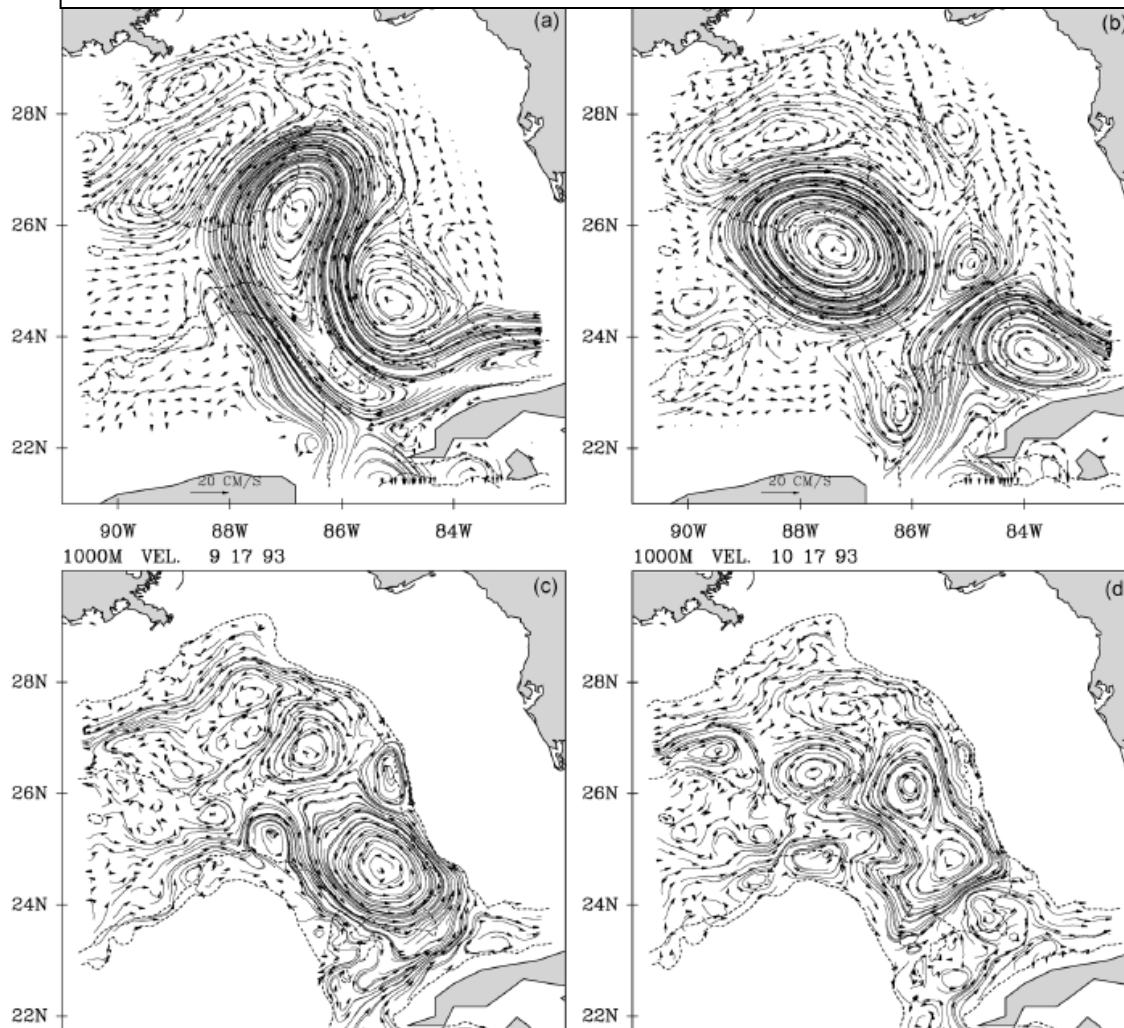


Loop Current,  
fully extended

Loop Current  
eddy:  
anticyclone  
(clockwise)  
motion,  
Westward drift



# Anticyclone (clockwise) at surface



# Cyclone (counter-clockwise) at ~1,000 m

**Figure 3.** Simulated circulation from a doubled-resolution POM experiment (Oey and Lee, 2002) showing an example when east Campeche Bank and Tortugas cyclones *appear* to cleave the Loop Current, leading to separation; please see text for more details. The top panels (a and b) are for currents at  $z = -50$  m and the lower panels (c and d) for  $z = -1000$  m. Left panels precede right panels by 30 days. The picture is from the 12<sup>th</sup> year of a 17-year run. Contours show the 1000 m and 3000 m isobaths.

# Simulated Circulation

## Near-surface and 1,000 m depth

From:

Oey, L.-Y., T. Ezer, and H.-C. Lee  
Loop Current, Rings and Related  
Circulation in the Gulf of Mexico: A  
Review of Numerical Models and  
Future Challenges. Geophysical  
Monograph Series. AGU. 2005

**Note: we have NO observing system in place to observe below the surface**

# Observing the surface ocean with satellites

## NASA, NOAA, European satellites

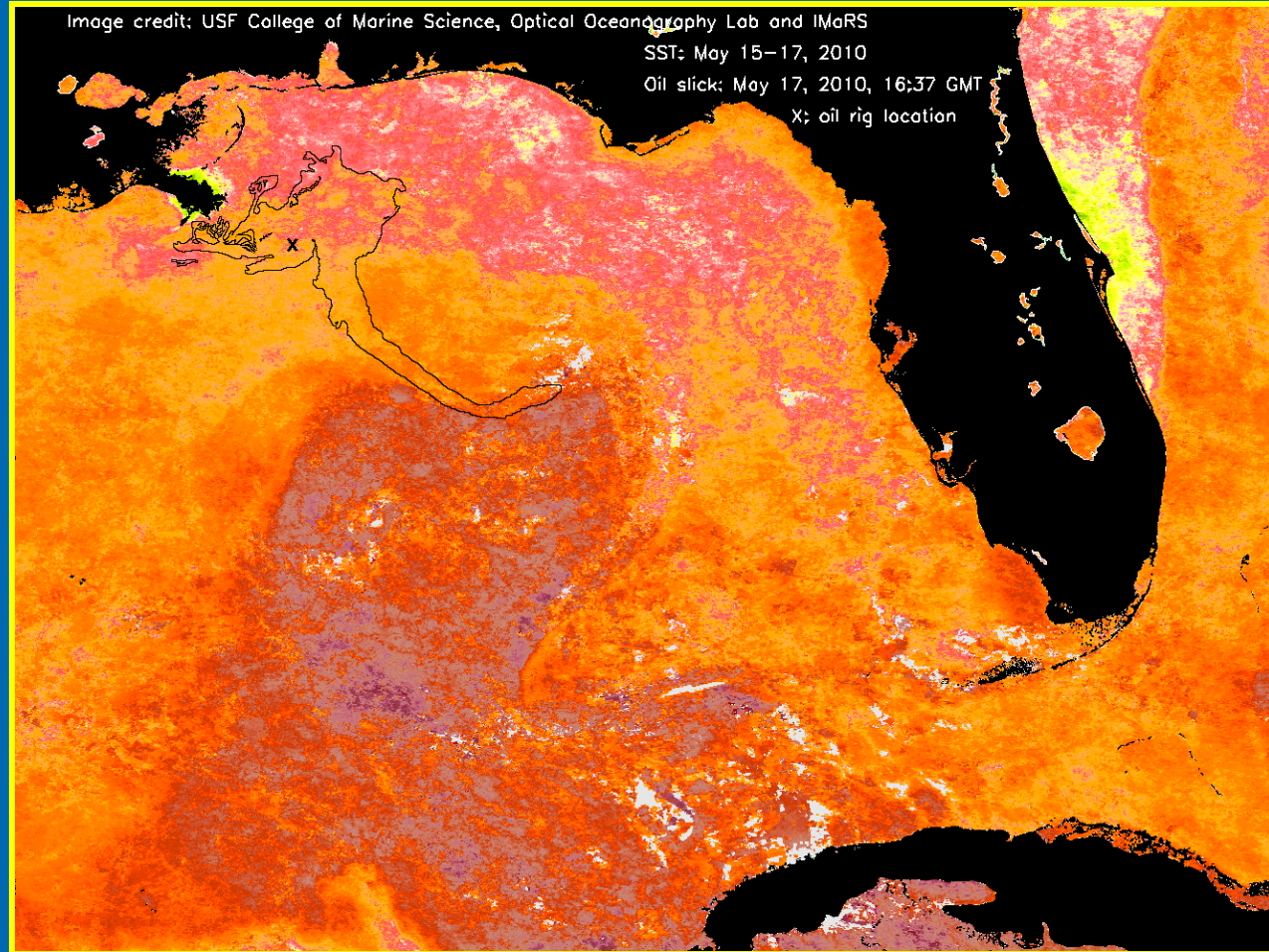
- NOAA AVHRR (15, 16, ,17, 18, 19)
  - (IR - 1.1km)
- Metop\_A (1.1km)
- TERRA & AQUA MODIS
  - IR and Ocean Color 1.1km
  - RGB 250m and 1.1km
- ENVISAT MERIS
  - Ocean Color 300m and 1.1km

# NASA and NOAA Satellite Imagery



17 May 2010

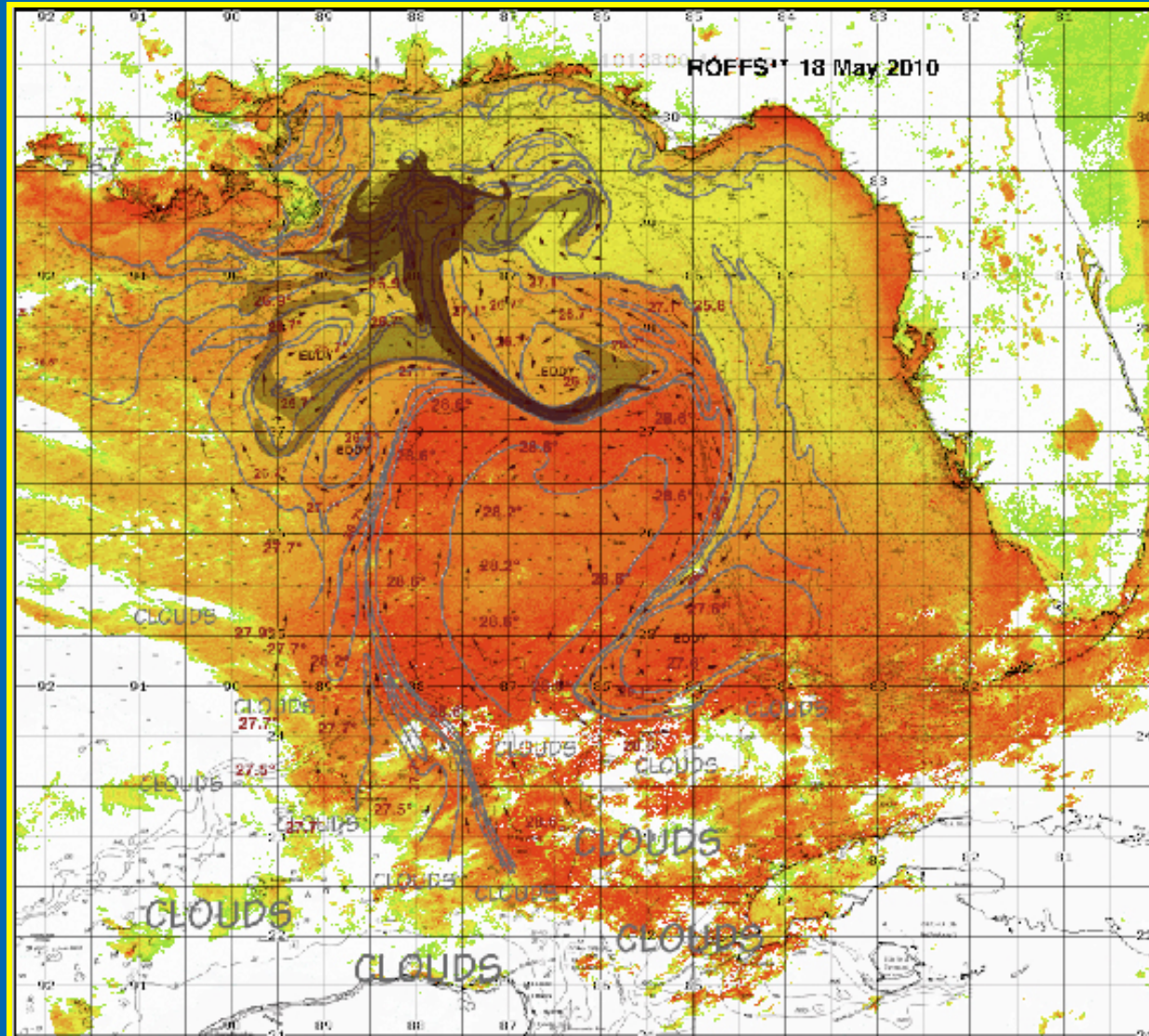
Images analyzed  
by Dr. C. Hu,  
University of  
South Florida



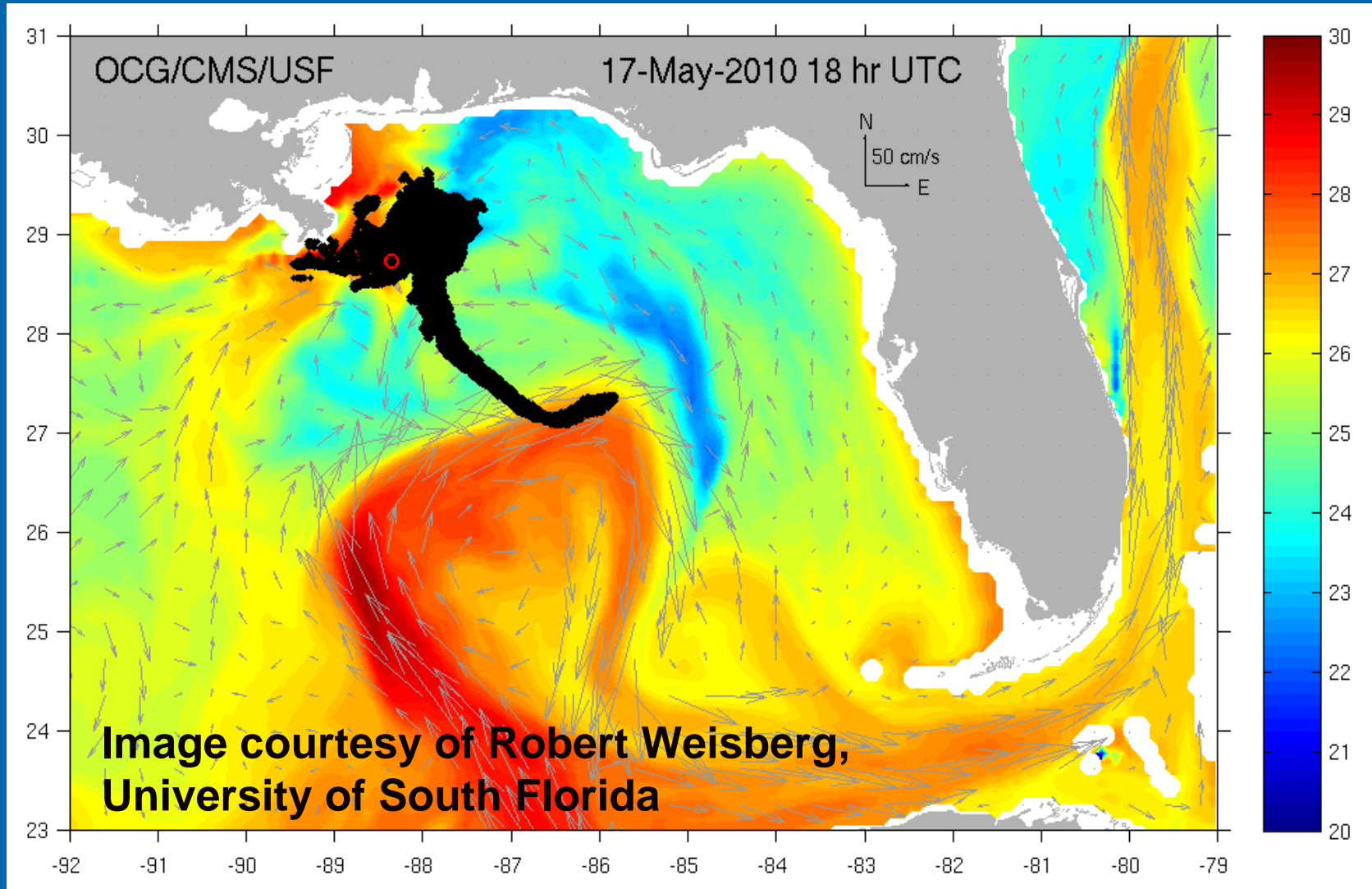
# ROFFS, Inc. Analysis 18 May 2010

## NOAA AVHRR temperature, Aqua and Terra MODIS

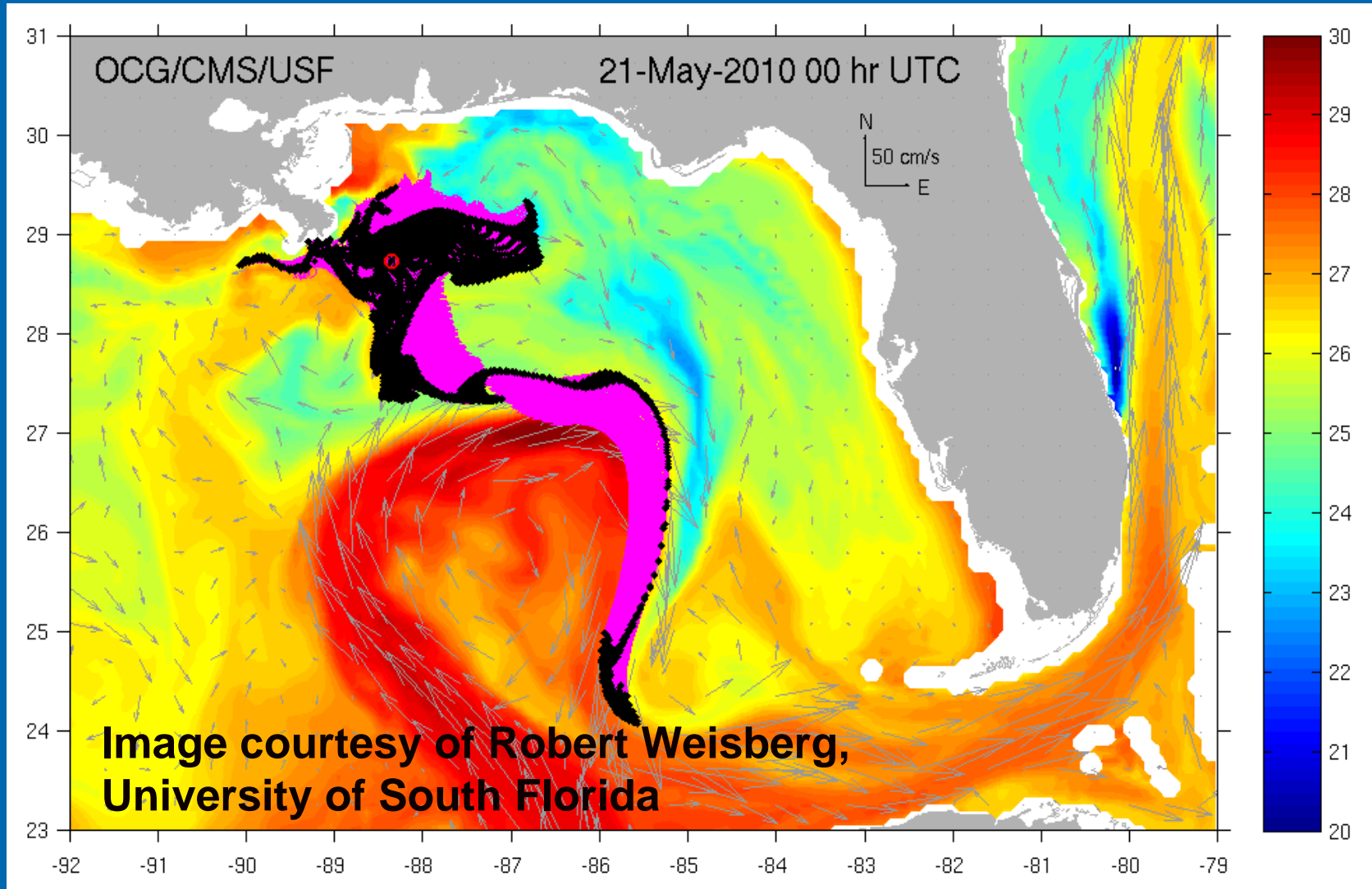
### Analysis of oil location



# Simulations of oil trajectory at the surface (17 May 2010)



# Simulations of oil trajectory at the surface (21 May 2010)



# Coastal Ocean Observing Systems: <http://secoora.org>; <http://gcoos.org>

Remote Sensing Interactive Map – Seacoos - Netscape

**Current View**  
 05/30/05 2:00 pm  
 Add to cart View cart (0)

**Go to time...**  
 More info EDT|AST 05/30/2005 14:00:00 go

**Animation**  
 Show last 6 hrs Show each hour Play: .gif custom

**Map Tools**  
 2 Zoom Factor  
 Zoom In Zoom Out Full Extents Recenter GET INFO  
 Java is off

**Predefined Regions**  
 US Atlantic & Gulf Caribbean SEACOOS South Atlantic Bight East Florida Shelf West Florida Shelf Alaska

**Map Layers**  
 = In-situ =  
 Winds Wind gusts 10m standard. winds 10m standard. wind gusts Water level  
 = Satellite =  
 QuikSCAT winds QuikSCAT winds (AOS) MODIS chl-A AVHRR SST MODIS SST MODIS Enhanced RGB MODIS CRGB high res. MODIS RGB high res. MODIS RGB low res.  
 = Radar =  
 Surface currents TAMU Mesonet = Model =  
 OI SST ETA Sea Level Pressure

**Map Layers Legend**  
 Deg C 33 30 26 22 19 15 12 8 5 1 -2  
 0 280 km

**Data Providers in Current Map**

Map layer	Provider details (if applicable for given view area and/or time)	Timestamp details (if applicable)
In-situ SST	Skidaway Institute of Oceanography (SKIO) ( <a href="http://www.skio.peachnet.edu">http://www.skio.peachnet.edu</a> ) United States Geological Survey ( <a href="http://www.usgs.gov/">http://www.usgs.gov/</a> ) University of South Florida, College of Marine Science ( <a href="http://comps.marine.usf.edu/">http://comps.marine.usf.edu/</a> ) National Ocean Service (NOS) ( <a href="http://nos.noaa.gov">http://nos.noaa.gov</a> ) National Data Buoy Center ( <a href="http://ndbc.noaa.gov/">http://ndbc.noaa.gov/</a> )	N/A

View map in a new window: [small](#) | [med](#) | [large](#) Interactive map size: [small](#)

Redraw Map Printable Map



# RECOMMENDATIONS:

## Short-term, oil-spill related

- US Government coordinate and fund broad coalition of academic, industry, government researchers to energize Coastal Ocean Observing Systems (COOS/IOOS):
  - Use regional experts, with most comprehensive knowledge and infrastructure dedicated to Gulf of Mexico research
  - Establish time series of sampling and monitoring in a grid covering the Gulf of Mexico and US East Coast
    - Integrate biological, chemical, physical and geological oceanography, focusing on ecological studies (fish, fish larvae, corals, other benthic and pelagic organisms)
    - Estimate volume, concentration, motion of dispersing material and impacts
  - Use satellites, ships, autonomous vehicles, moorings, numerical simulations



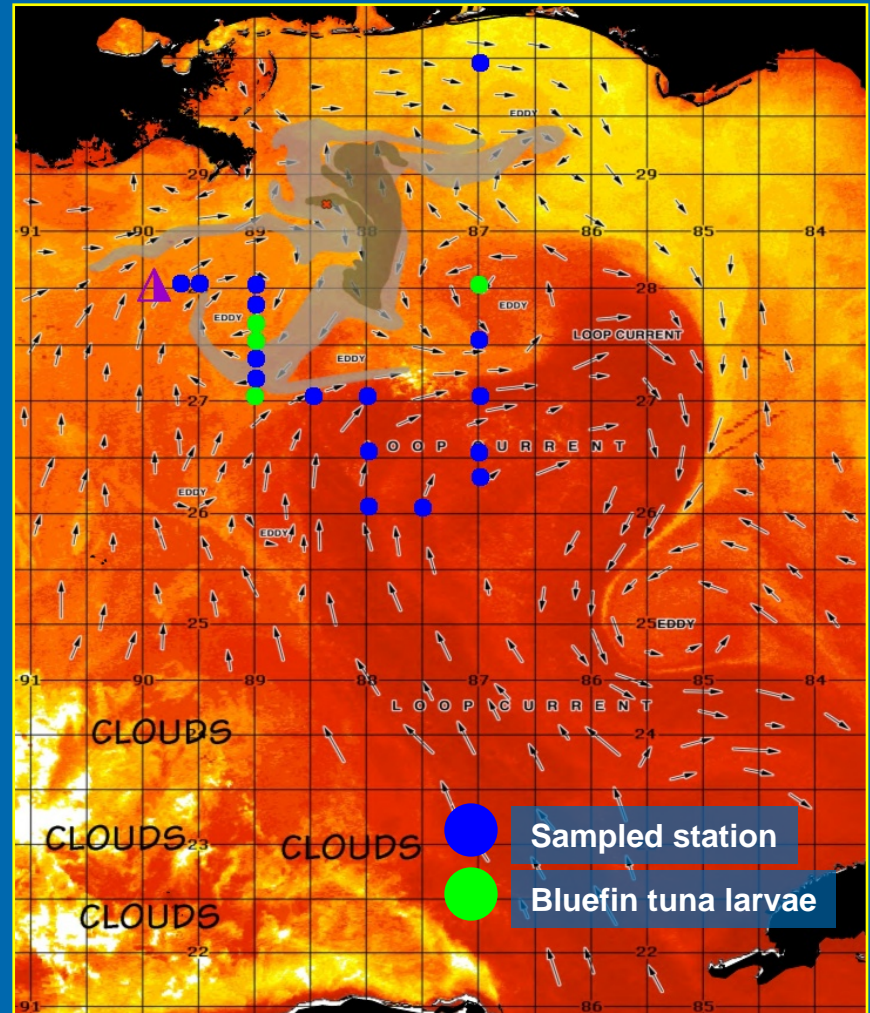
# RECOMMENDATIONS:

## Short and mid-term

- NASA, NOAA, USGS coordinate and fund a capable and robust national (U.S.) constellation of Earth-observing satellite missions, to enable serious ecosystem and climate science and management programs
- This needs to be FULLY planned and integrated with in-situ observing systems
- Engage in international collaboration in the region to conduct joint research and assess impacts

# 2010 NOAA Atlantic Bluefin Tuna cruise and oil spill

- The oil slick is impinging on spawning habitat for bluefin tuna and other organisms
- We are using daily satellite imagery to track the spill
- Sampling before oil reaches the spawning habitat may allow some quantification of the impacts on spawning habitat



Analysis from ROFFS, Inc.