Applications of High Frequency Radar Surface Currents for Response to the Deepwater Horizon Oil Spill

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University of Southern Mississippi

GRI PI Workshop

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Acknowledgements

- Richard Slaughter and Jamie Davis of USM
- CODAR Ocean Sensors
- NOAA
  - Coastal Services Center
  - IOOS Office
  - National Data Buoy Center
- Northern Gulf Institute
- Office of Naval Research
- Members of GCOOS and SECOORA

Outline

- IOOS
- IOOS Surface Current Initiative
- Gulf of Mexico Coastal Ocean Observing System Region Association (GCOOS) & Southeast Coastal Ocean Observing Regional Association (SECOORA): Developing the HFR Network in the Gulf
- Central Gulf of Mexico Ocean Observing System (CenGOOS) HFR Network
- Response to Deepwater Horizon
- Post-spill studies

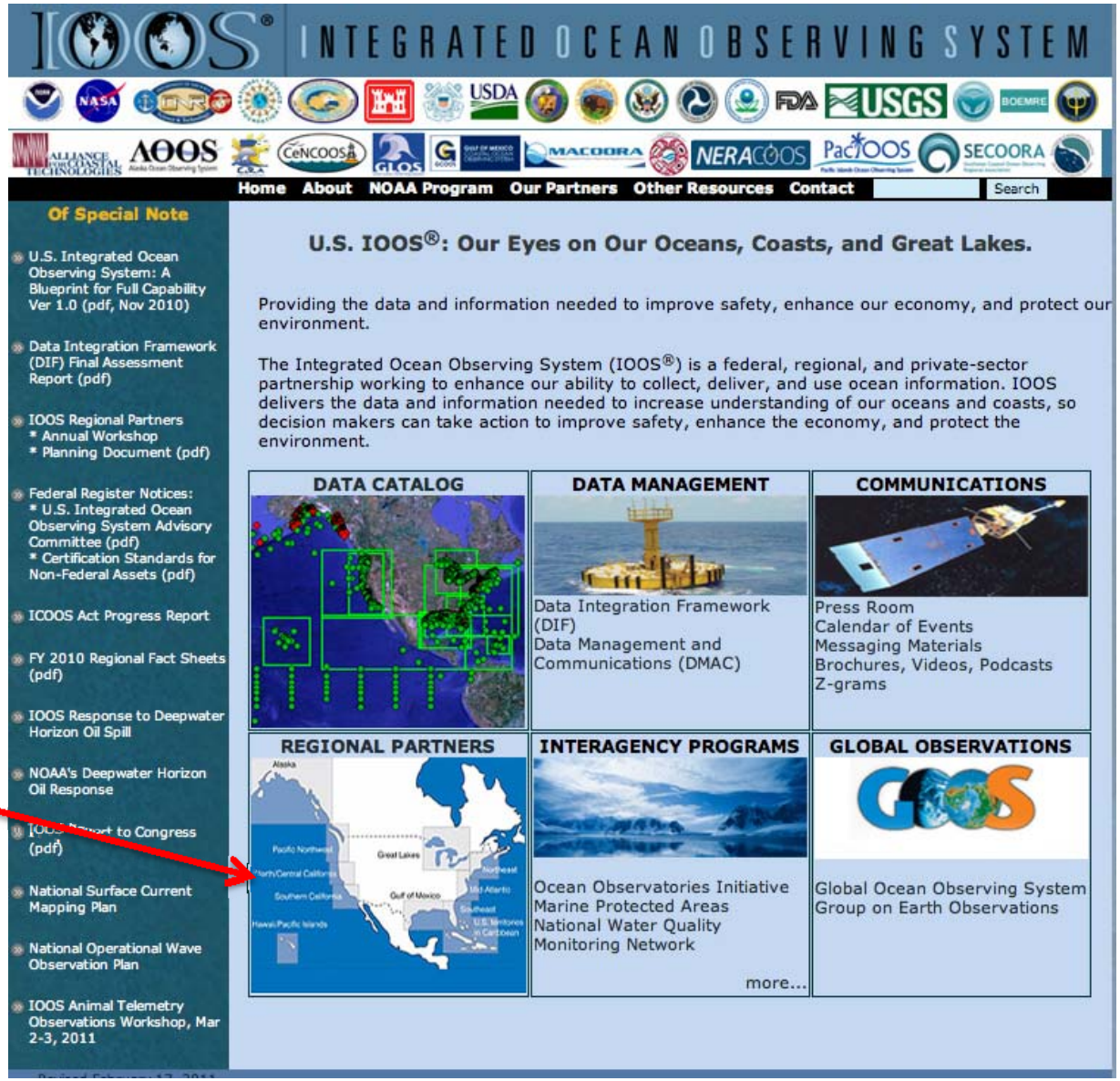
Global Ocean Observing System

IOOS® INTEGRATED OCEAN OBSERVING SYSTEM

Provides the data and information decision makers need to improve safety, enhance our economy, and protect our environment

NOAA IOOS Office Web Site

11 Regional Associations ensure unique local needs are addressed



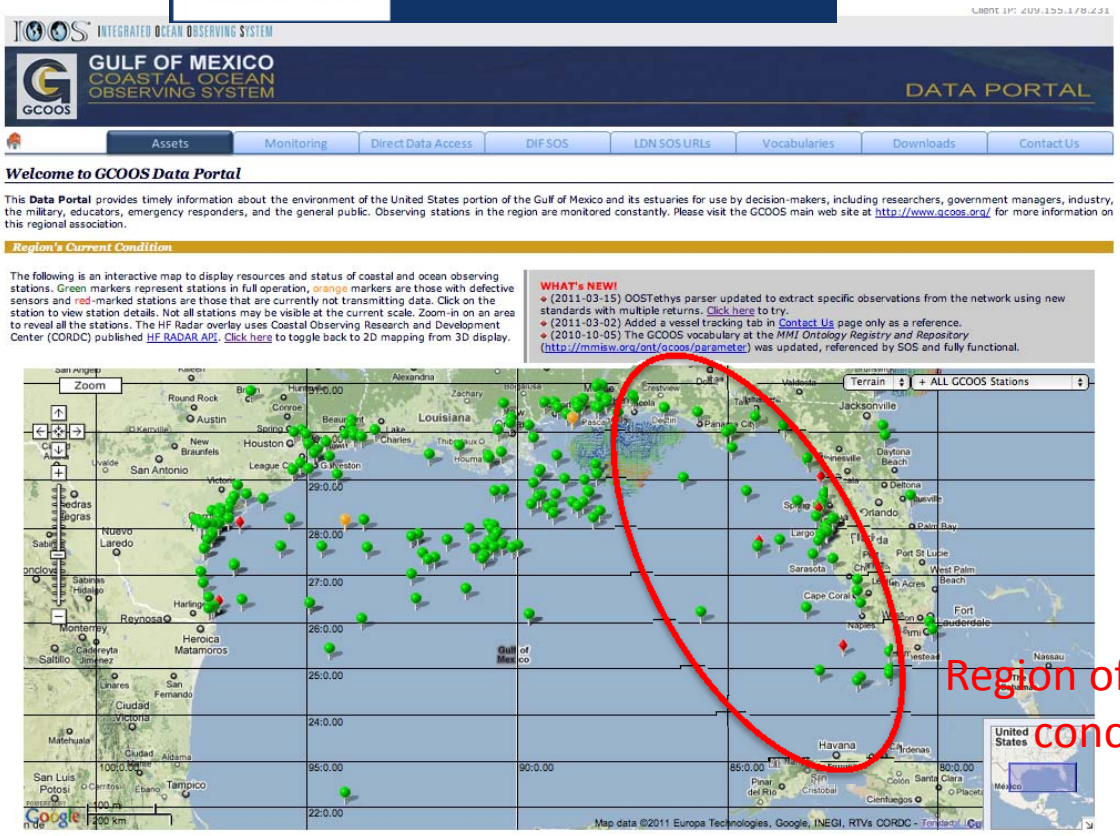
IOOS in the Gulf of Mexico

GULF OF MEXICO COASTAL OCEAN OBSERVING SYSTEM

GCOOS

SECOORA

Southeast Coastal Ocean Observing Regional Association



gcoos.org

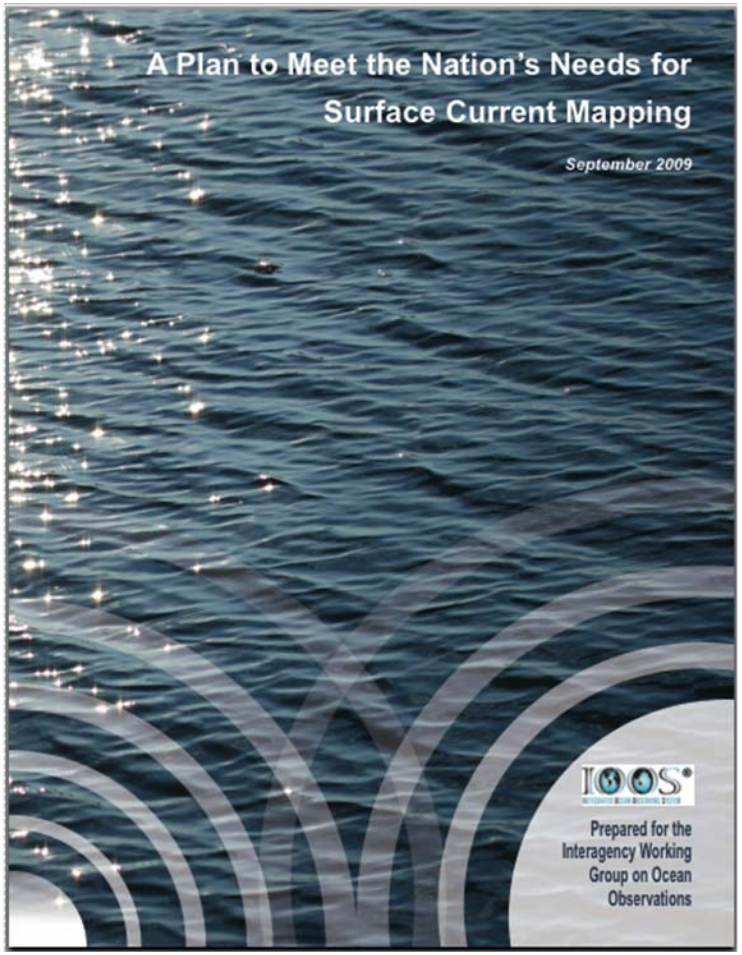
secoora.org

Region of mutual concern

NOAA/IOOS High Frequency Radar Surface Current Mapping Plan

Released September 2009

- Five Year Build-out
- Cover US Coast in lower 48 with long-range HFR
- Approximately 4 nested higher resolution systems per RA



http://www.ioos.gov/library/surfacecurrentplan9_3hres.pdf

National HF Server and Architecture Project (NOAA/NOS/NDBC/IOOS)

- Integrated National Network for “Radials”
- Scalable and distributed data management system
  - Data Storage
  - Data Access
  - Data Delivery
- Enhancements include:
  - Compute “Totals”
  - Objectively Interpolated “Totals”
- Single source of surface currents for
  - Coast Guard Search and Rescue
  - NOAA ER&R
  - Mariners
  - …

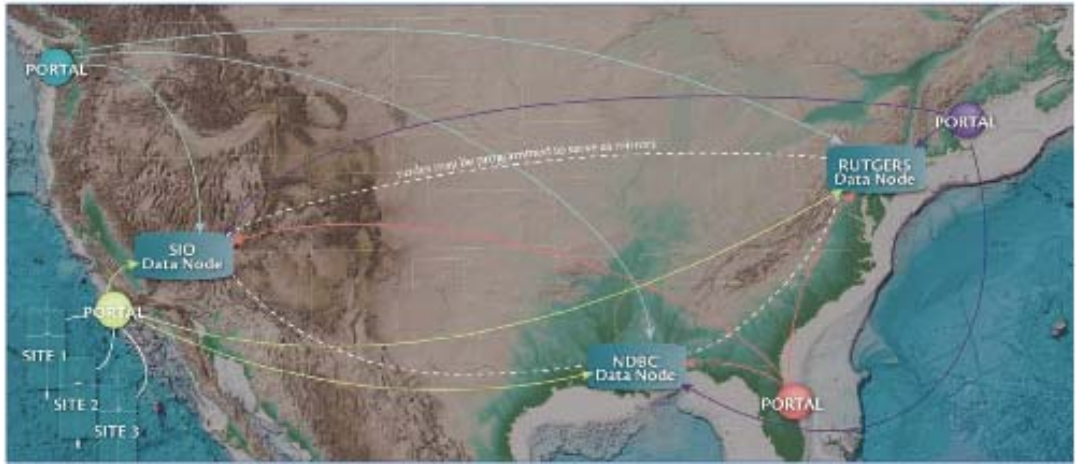
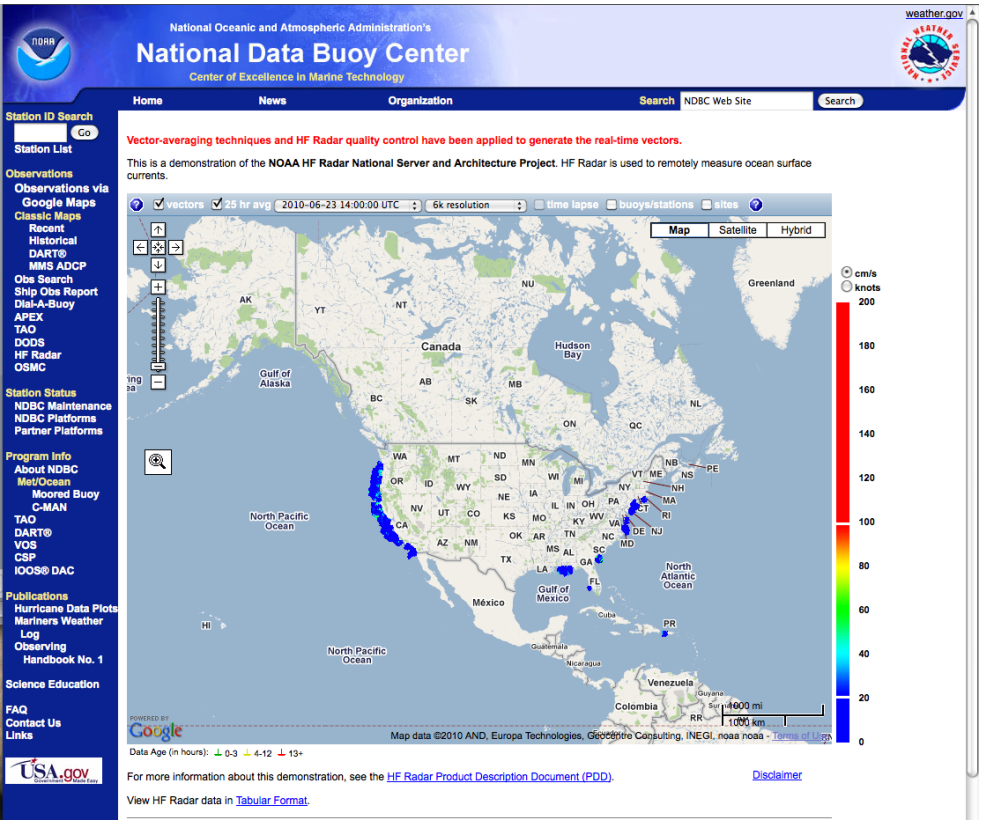


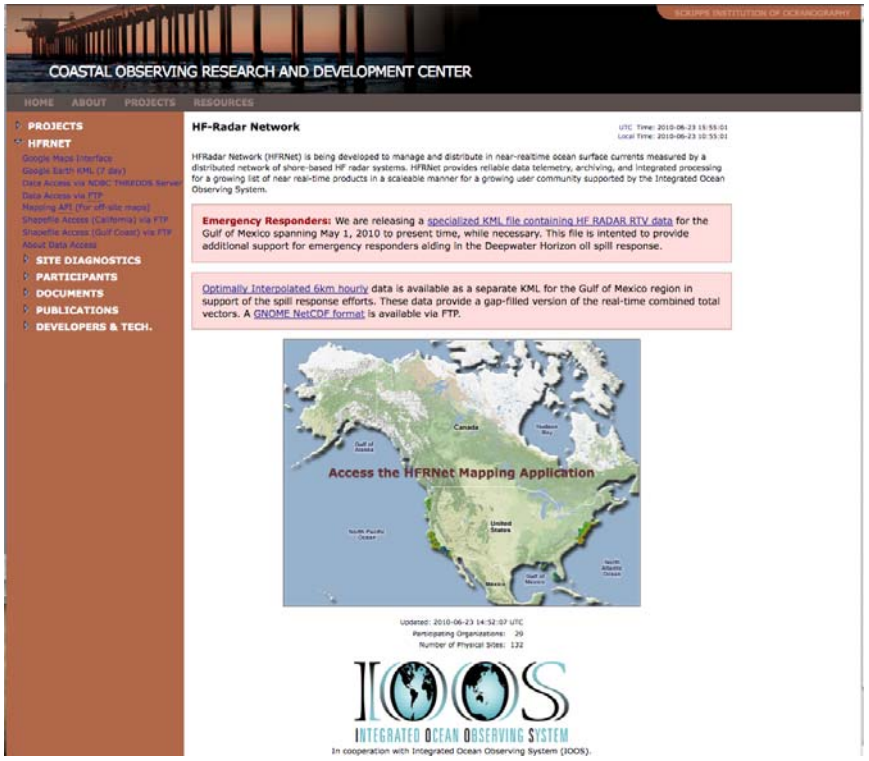
Image Source: Terrill, E., M. Otero and L. Hazard: Mapping Surface Currents Around U.S. Coasts: A Network of High-Frequency Radar for the Integrated Ocean Observing System. Sea Tech., Sept. 2007.

NOAA HF Radar National Server and Architecture Project

NDBC HF Radar Network Node Page
http://hfradar.ndbc.noaa.gov/



Scripps National HF Radar Network Node Page
http://cordc.ucsd.edu/projects/mapping/

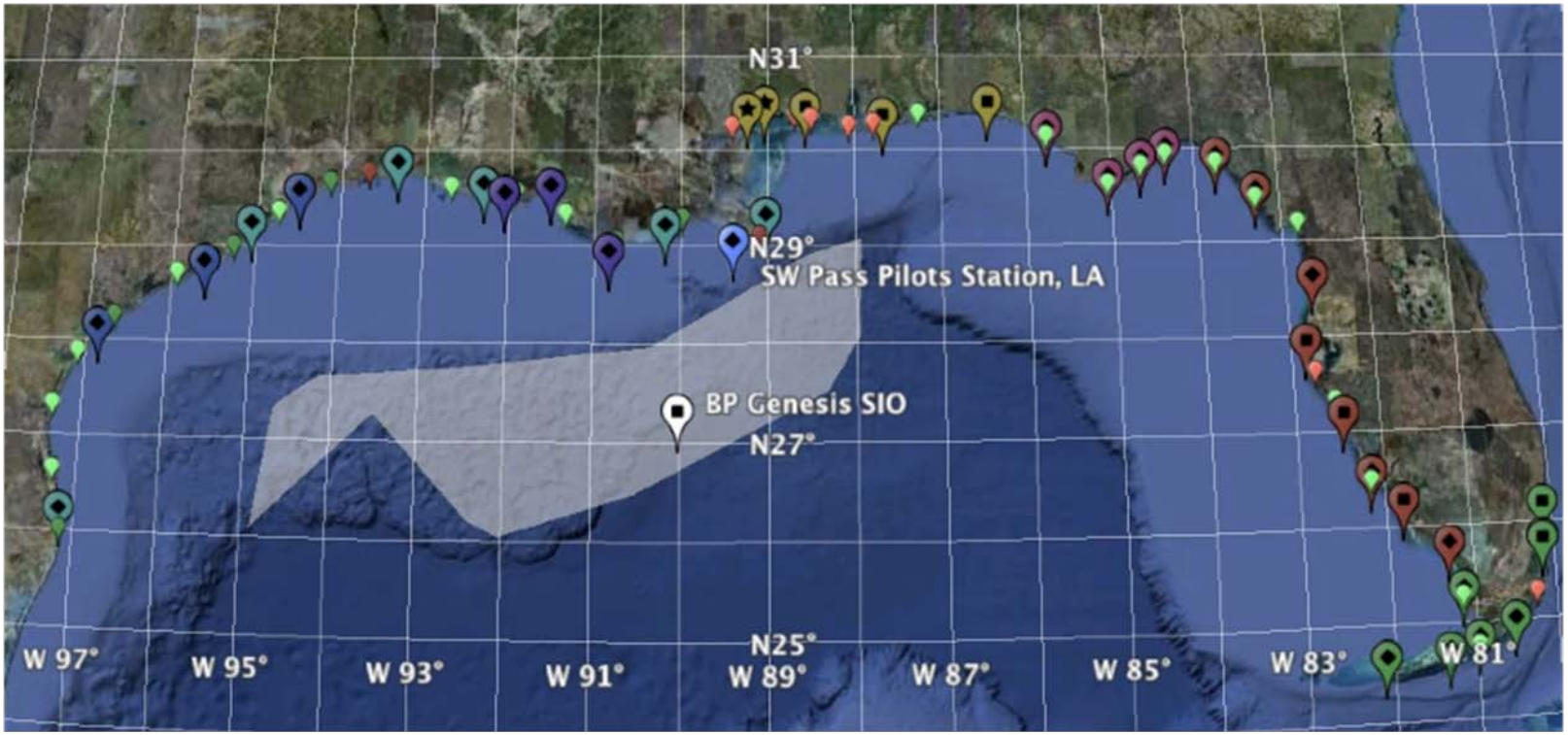


Where HFR coverage is sufficient, USCG uses this system for search and rescue operations

GULF OF MEXICO COASTAL OCEAN OBSERVING SYSTEM

GCOOS

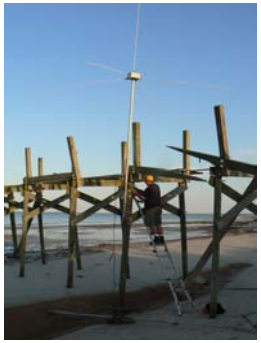
GCOOS and SECOORA 5-year HFR Build-out Plan



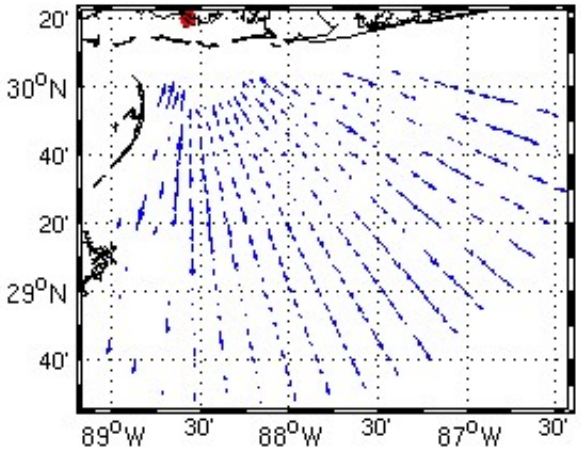
SECOORA

Southeast Coastal Ocean Observing Regional Association

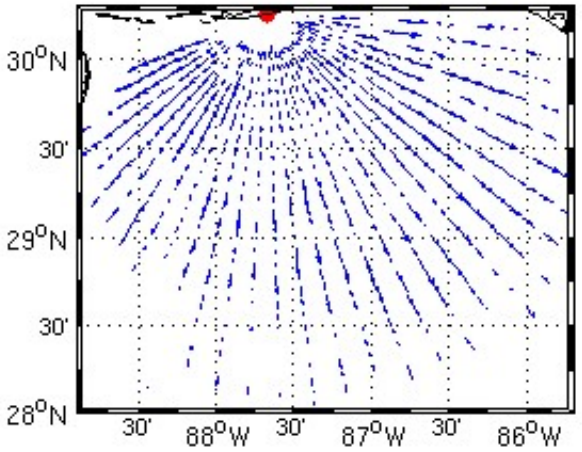
Radial Currents from CODAR Stations of the Central Gulf of Mexico Ocean Observing System CenGOOS



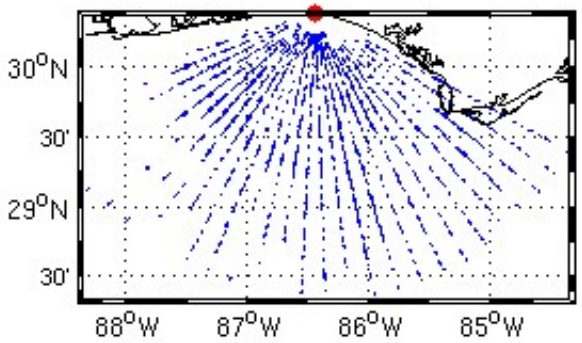
Pascagoula MS



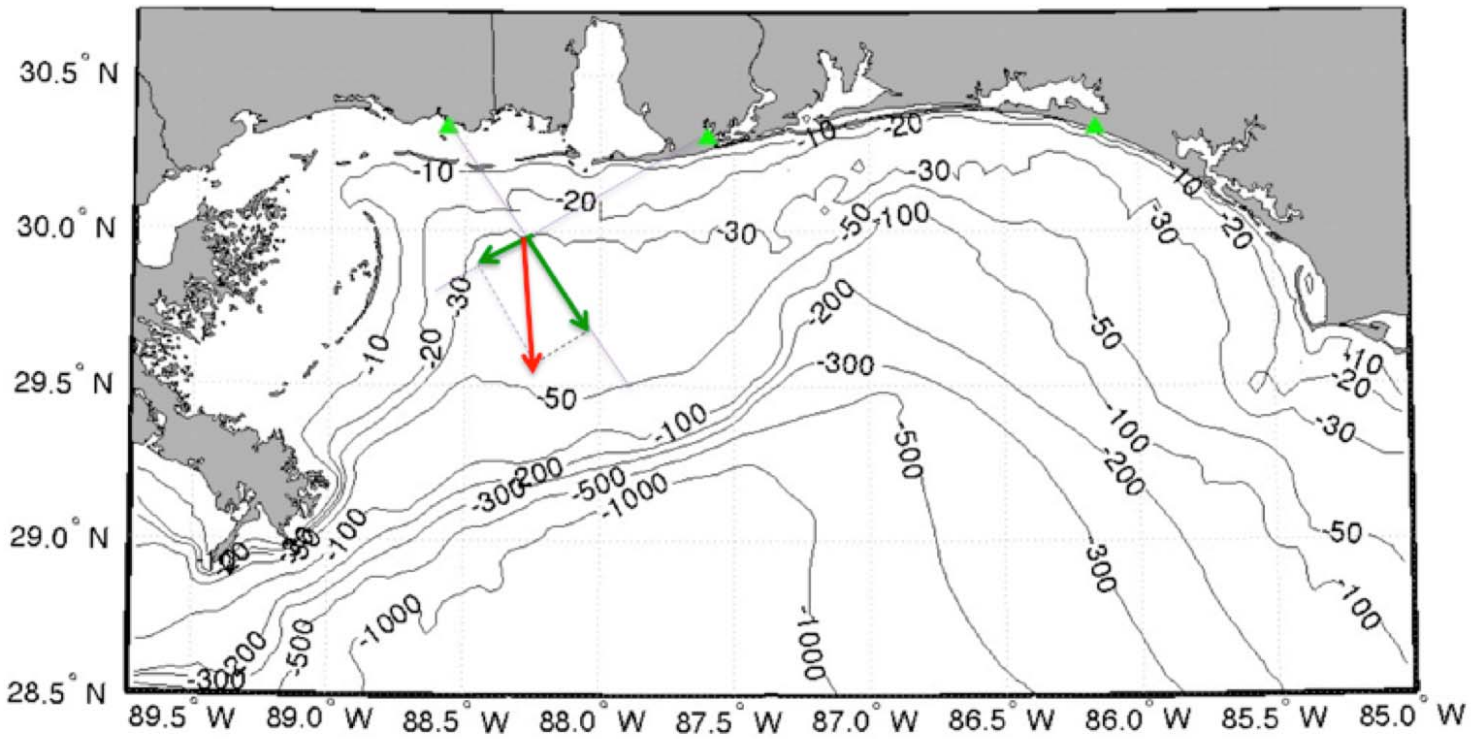
Orange Beach/Gulfshores



Destin



Total Current Vector Estimation



Models can assimilate more accurate radials

April 20, 2011 Deepwater Horizon Drilling Rig Explodes

Image Source: eoearth.org

CenGOOS CODAR on April 20, 2010

- Gulfport station disassembled for move to singing River Island
- Permission to reinstall on Singing River Island received, but installation had just begun
- Central site disassembled since 11/2009 under the direction of Gulf State Park because of a dune replenishment project that was still ongoing
- Destin station satellite communications problematic

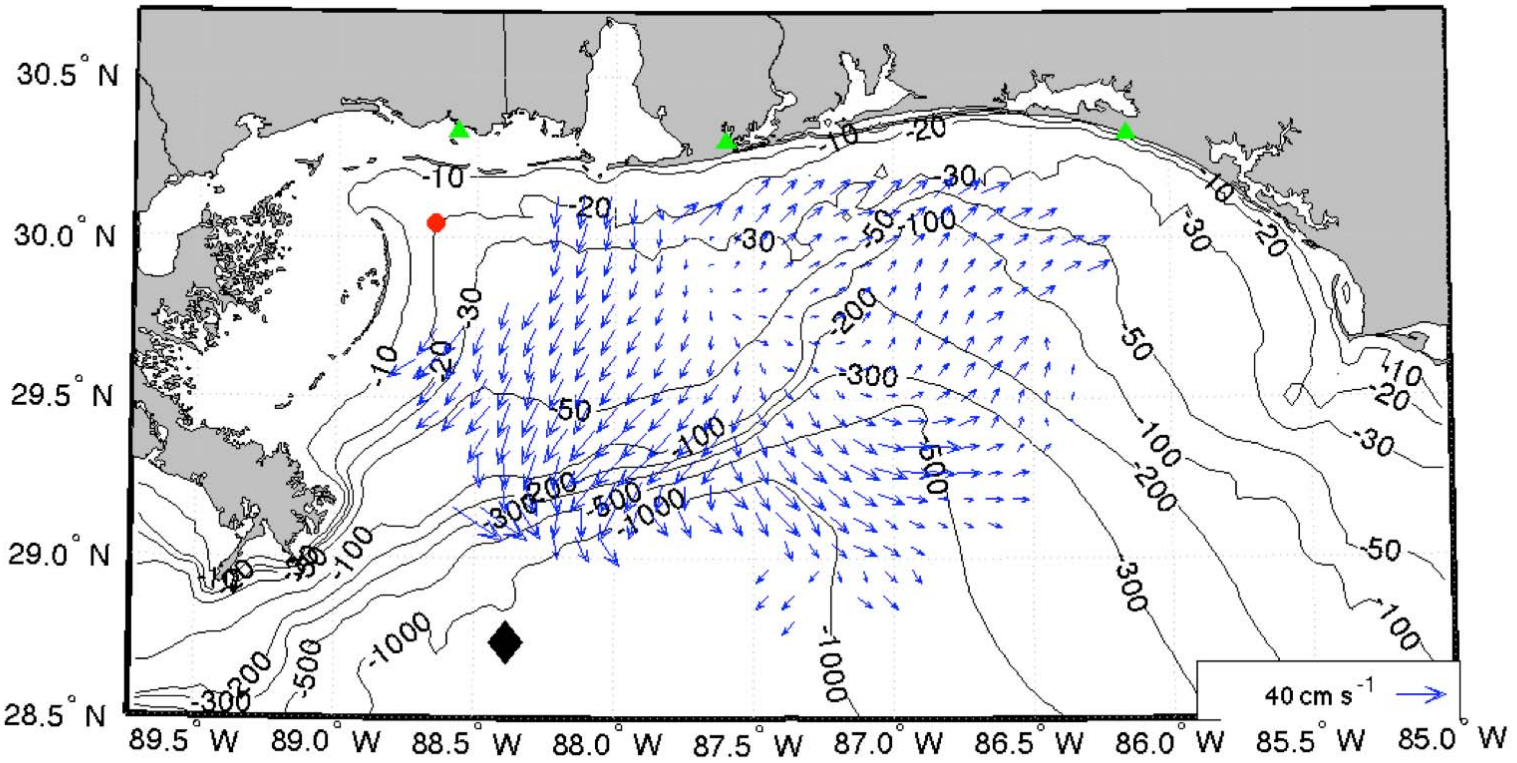
Gulf State Park
Orange Beach, AL

CenGOOS CODAR DwH Timeline

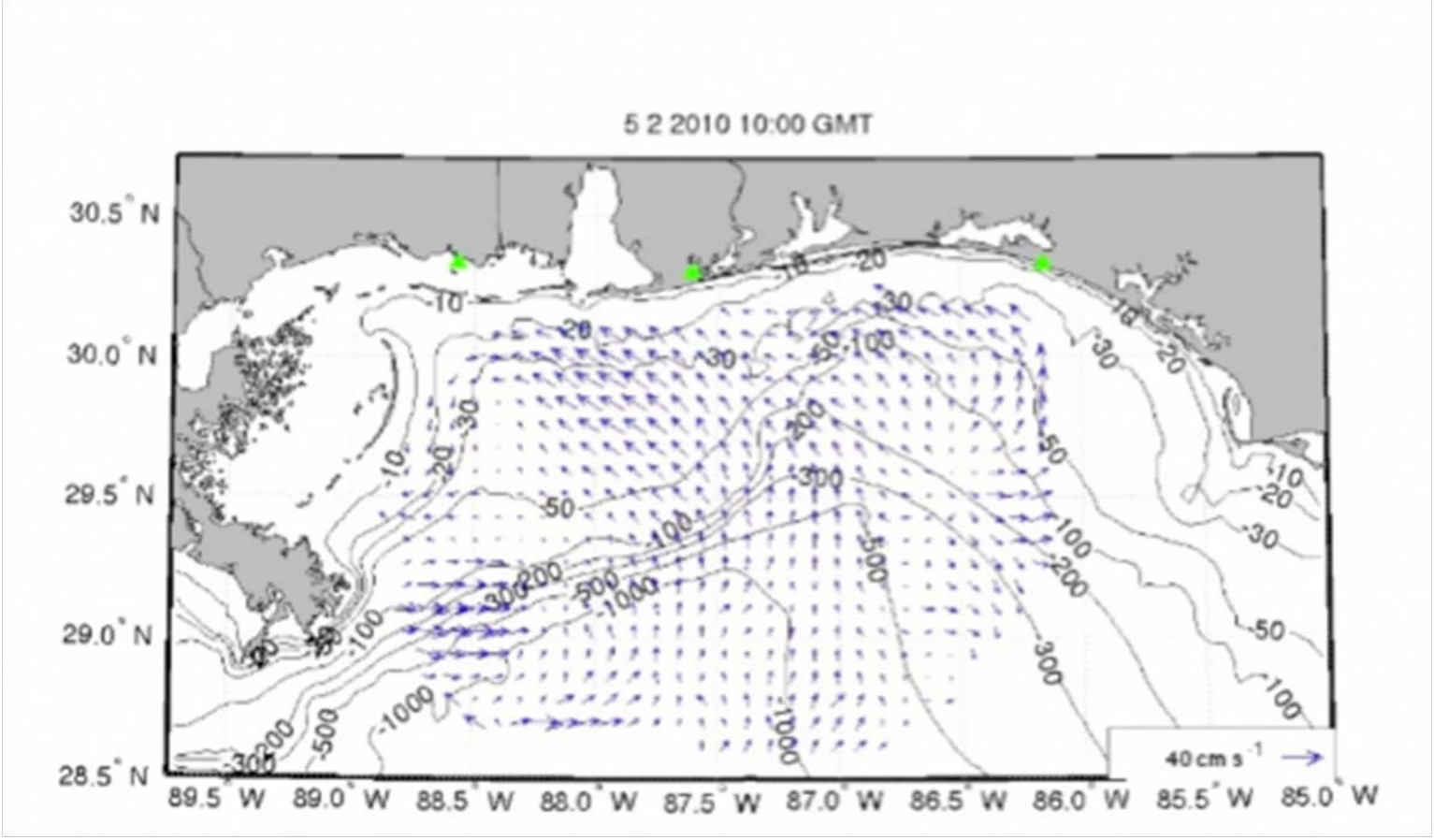
- April 23-25: Singing River Island station installed
- April 28-May 2: Orange Beach station reinstalled and Destin Station communications problems solved
- May 2- August 1: As problems developed they were fixed ASAP.

Total Surface Currents

May 20, 2010 00:00 UTC



Total Surface Currents
May 20, 2010 10:00 UTC



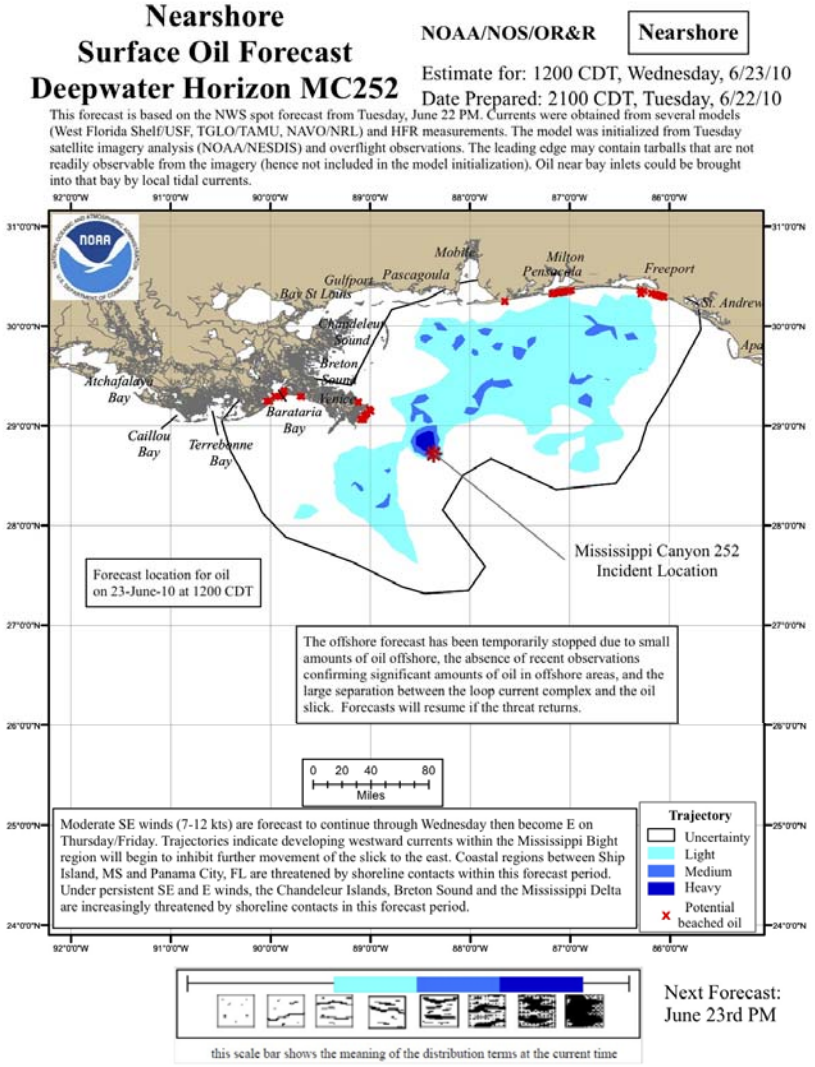
Use of HFR Data by NOAA/Office of Response and restoration/Emergency Response Division (ERD)

- During an ongoing hazardous spill ERD provides scientific expertise for the response.
- A key product of ERD is trajectory forecasts.
- ERD had available multiple operational or near-operational numerical ocean models for the Gulf:
  - NOAA Gulf of Mexico model
  - USF West Florida Shelf model
  - Texas A&M/Texas General Land Office HYCOM model
  - Navy NRL/NAVO NCOM models.

Use of HFR Data by NOAA/Office of Response and restoration/Emergency Response Division (ERD)

- Although previous studies showed that assimilating surface currents improved modeled sub-surface currents, none of these models was set up for assimilating surface current data
- In general, the models produced differing forecasts and it was not obvious which was “best” at any given time.
- ERD was ready to use HFRNet
- HFR currents were used to help guide the use of the models in forecast generation.

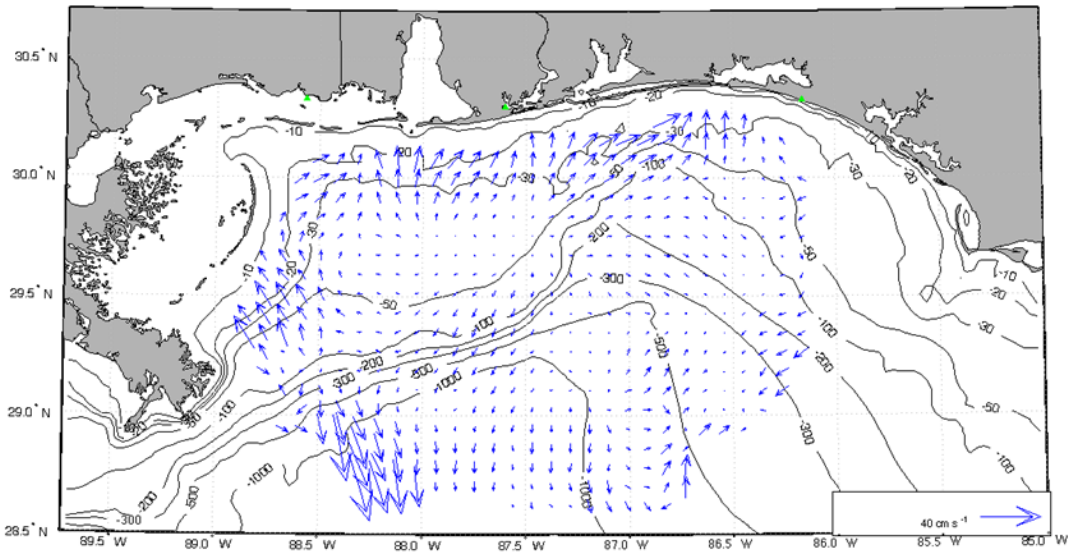
This forecast is based on the NWS spot forecast from Tuesday, June 22 PM. Currents were obtained from several models (West Florida Shelf/USF, TGLO/TAMU, NAVO/NRL) and HFR measurements. The model was initialized from Tuesday satellite imagery analysis (NOAA/NESDIS) and overflight observations. The leading edge may contain tarballs that are not readily observable from the imagery (hence not included in the model initialization). Oil near bay inlets could be brought into that bay by local tidal currents.

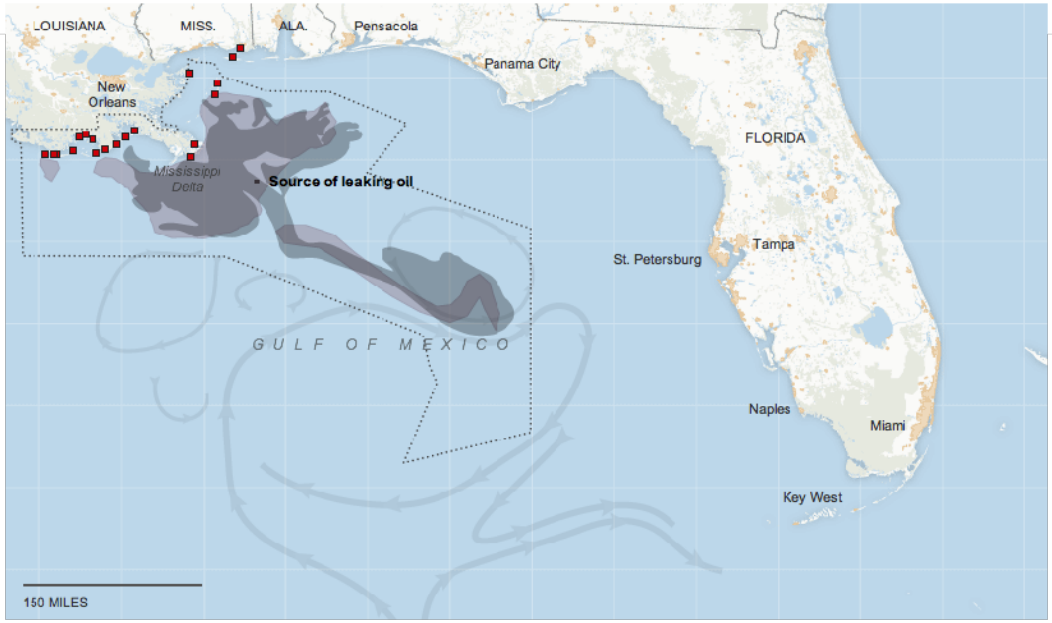


Mean Currents May 20--May 26, 2010

Oiling at:

- Pas a Loutre
- Raccoon Island
- Wine Island
- Terrebonne Bay West
- Terrebonne Bay North
- Terrebonne Bay East
- East Timbalier Island
- Grand Isle
- Elmers Island
- Barataria Bay South, Brush Islands
- Chandeleur Islands south and north
- Horn Island



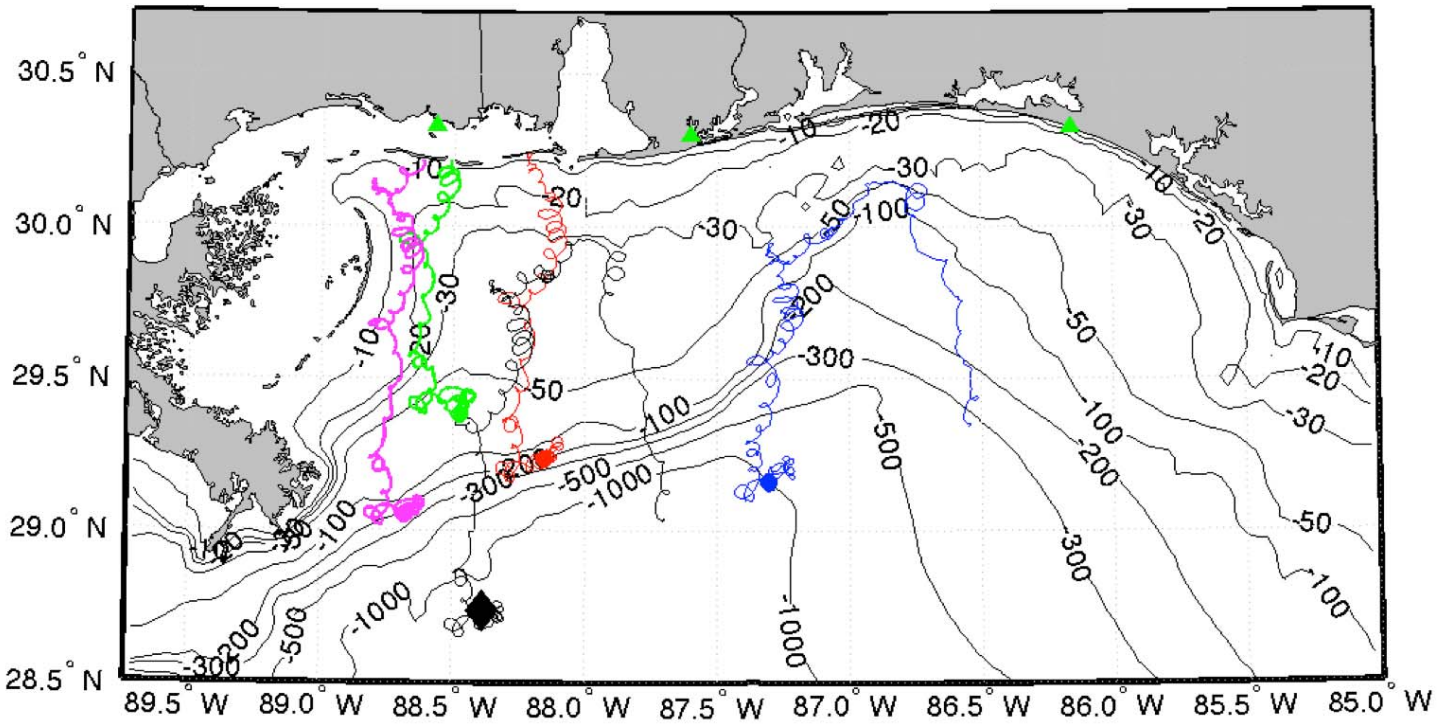


Post Spill Studies

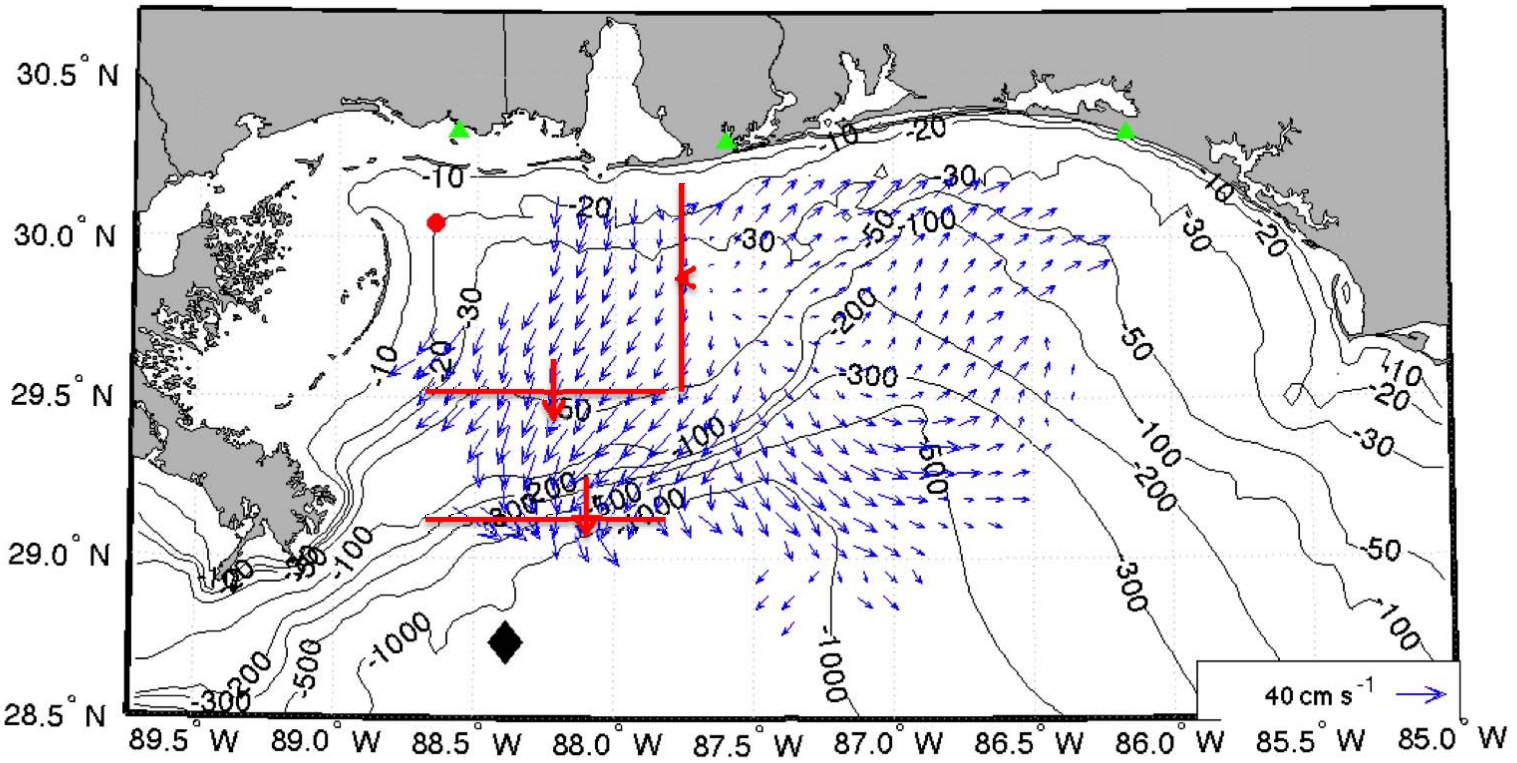
- Advection pathways
- Integrated surface transport
- Investigations of role of circulation in ecosystem changes since DwH:
  - Turtle mortality
  - Food web changes

nple Trajectories from CODAR Totals

All start on May 20, 2010



Surface Transport for Advection

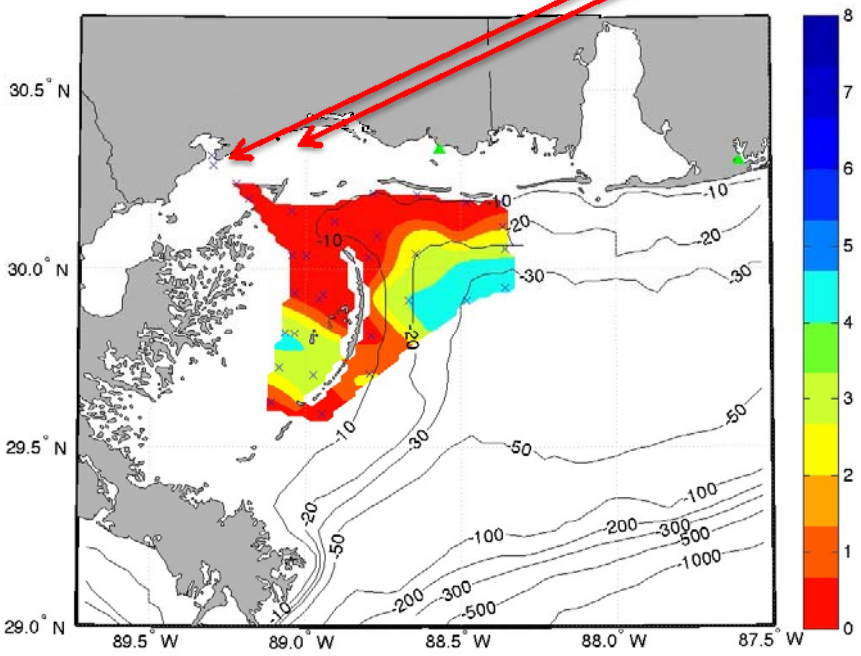


2011 Summer Flooding and Hypoxia: Another Large Perturbation to Northwest Mississippi Bight

Bonnet Carre Spillway Opening 2011

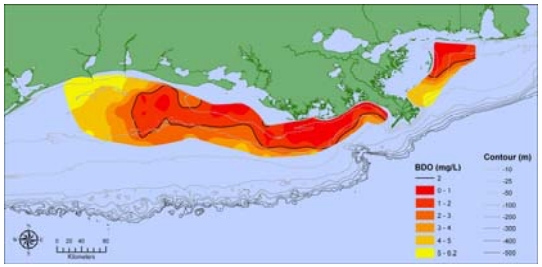
Image Source: http://www.pbase.com/septembermorn/image/95461352
Colleen Perilloux Landry

2 25 MHz CODAR SeaSondes



Bottom dO [mg/l] August 16-18, 2011

Gundersen, et al., (2011)



Rabalais (2011)


Thank You!