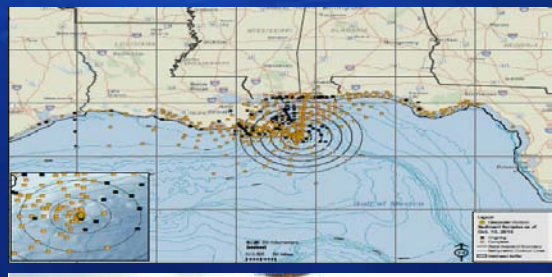
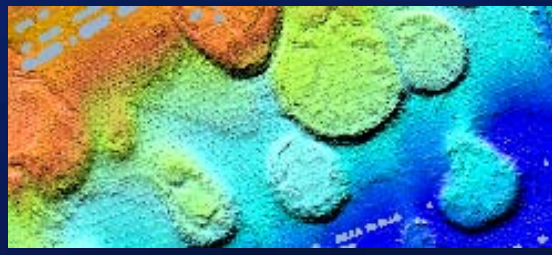
DWH – RESPONSE MODELING ACTIVITIES?

DOES THAT INFORM MODELING FOR THE ARCTIC?





NOAA
National Ocean Service
Office of Response and Restoration
Emergency Response Division

Overview of Modeling Activities to Support Response

- Tactical (72 hour) forecasts - surface
- 5 day outlook/2-week forecast
- Operations 48 hour forecast - subsurface
- Statistical Analysis

Considerations for Success

- Coordination of observations and forecasting/modeling
- Planning/Engagement prior to incident

Continuing Challenges

- Data and model assimilation/integration
- Deep blowout dynamics/droplet size distribution
- Understanding and communicating uncertainty

Acknowledgements

Many thanks for slides and modeling work provided by:

- Members of OR&R modeling team (Glen Watabayashi, Amy MacFadyen, Chris Barker, CJ Beegle-Krause, Jerry Galt)
- Other NOAA Modeling Support (Rich Patchen, Lyon Lanerolle, Scott Cross, NWS)
- Hydrodynamic Model Contributors (NOAA, Navy, USF, UNC, TAMU . .)
- Other operational modeling support (Sintef, Clarkson University, ASA)

Continuum of "Response"

Response

Restoration - Recovery

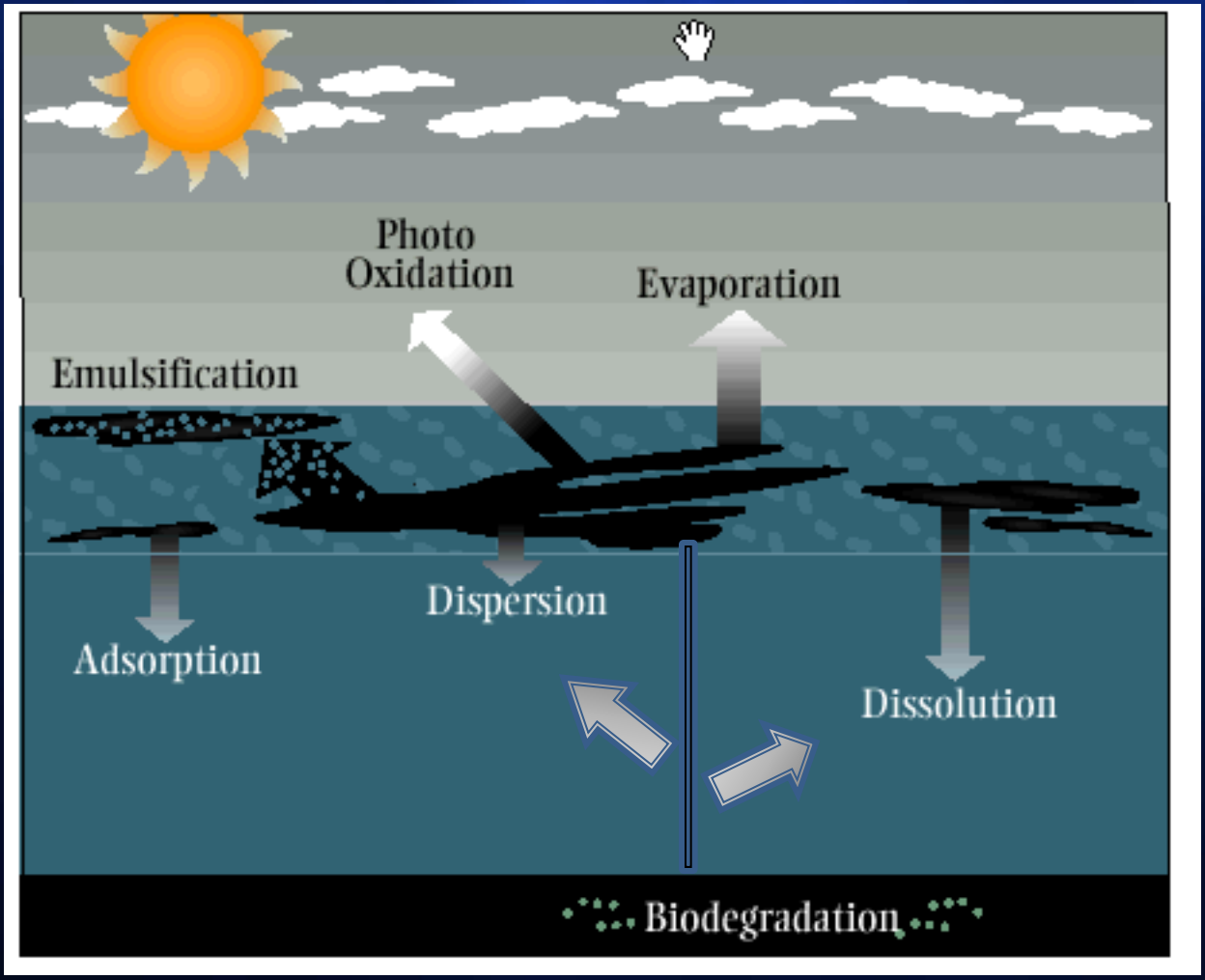
Forecasting vs Modeling

Trajectory Analysis is using the observed data and model information to develop a forecast of oil movement over some period of time.

Models are used to track movement of particles that behave like air (weather models), water (hydrodynamic models) or oil (trajectory model).

For modeling the Deepwater Horizon MC-252 oil, the trajectory model GNOME (General NOAA Operational Modeling Environment) was used with observational data and weather and hydro model as input.

Weathering – Oil Fate

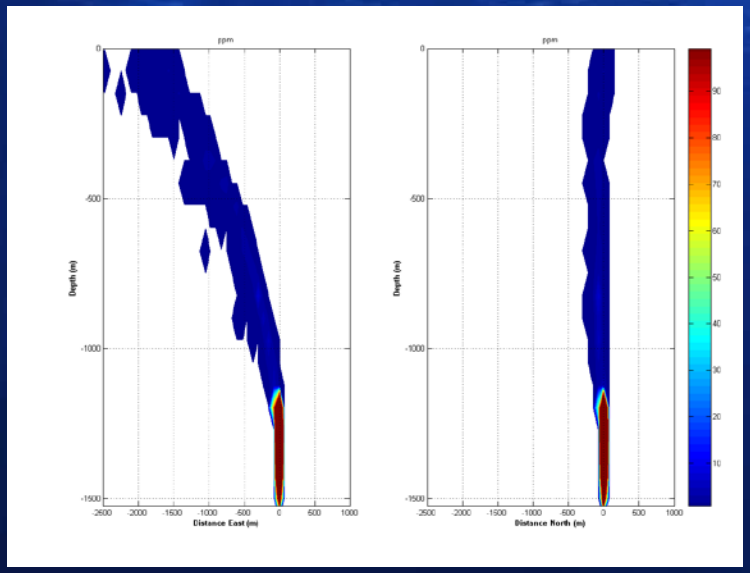


Plume Dynamics

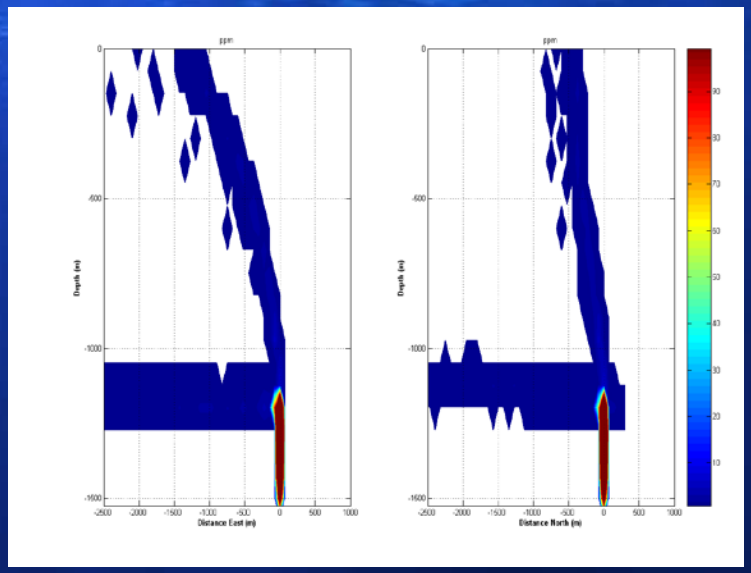
Clarkson Deepwater Oil and Gas blowout model (C-DOG)

Sintef Deep Blow

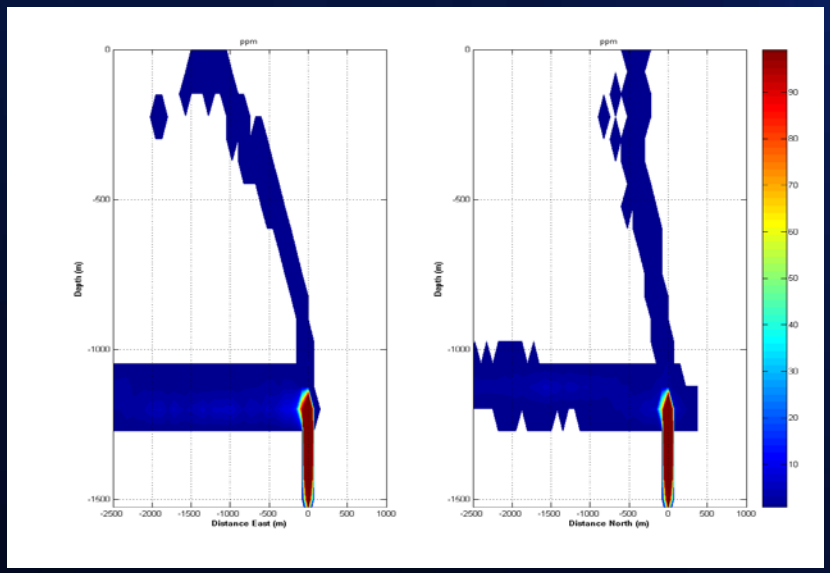
1. Plume escapes from well head with thermal and mechanical buoyancy dominating
2. Near plume separation, droplet buoyancy dominates movement; small particles (<60 microns) stay in deep layer (1000-1300m), large particles rise quickly (>1 millimeter)



No dispersant case

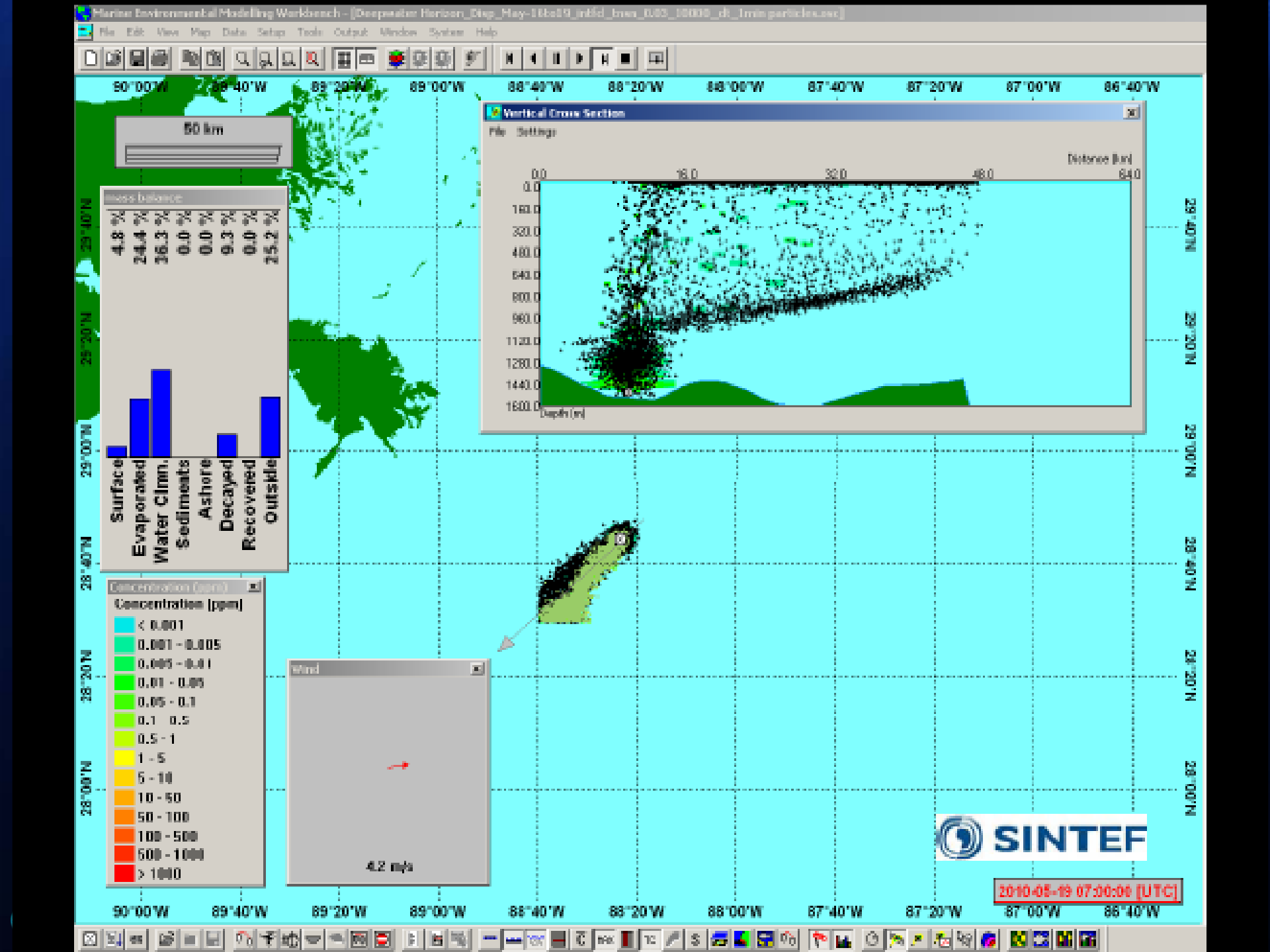


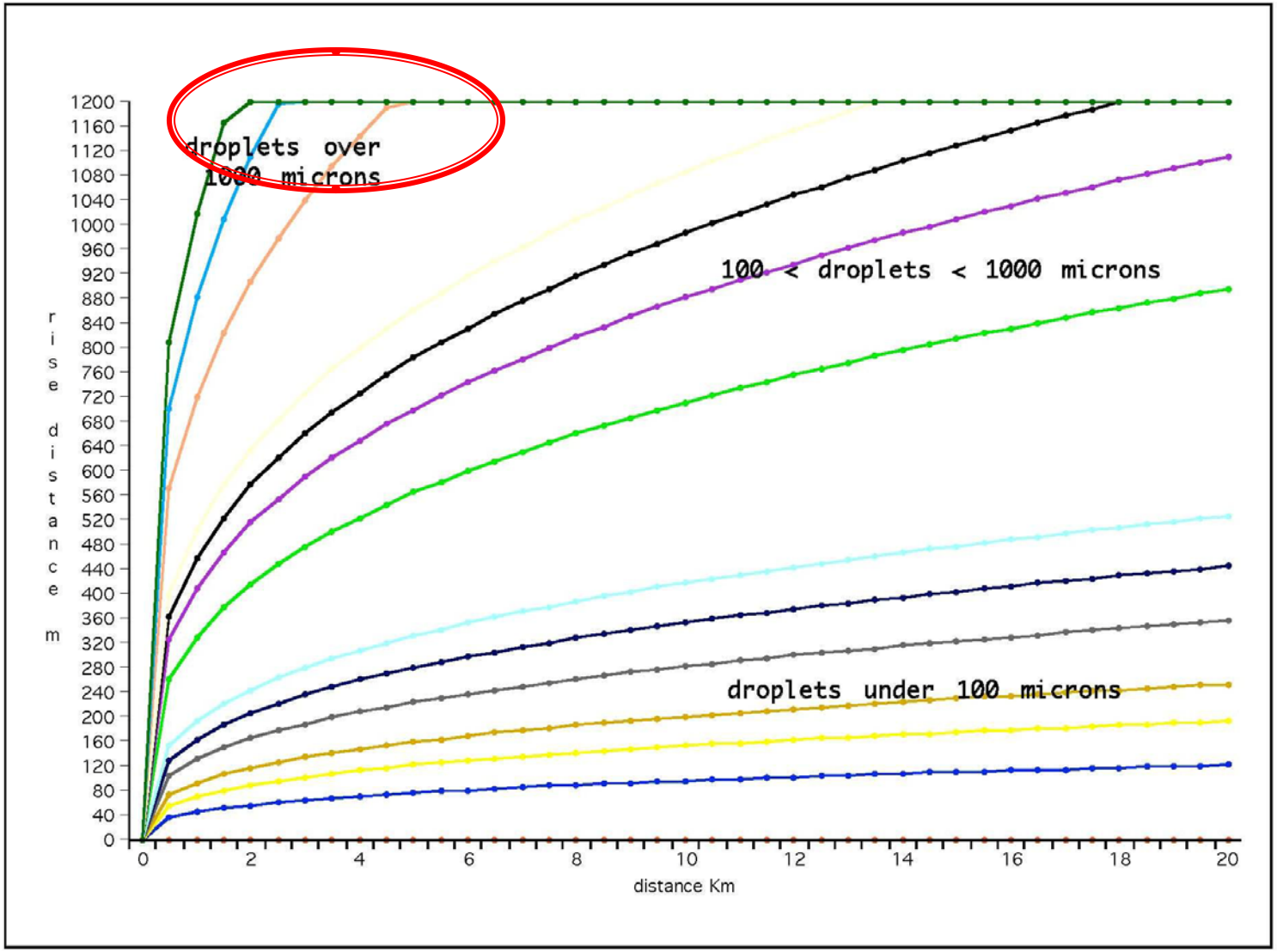
20% dispersed case



70% dispersed case

CDOG modeling done in May


Marine Environmental Modelling Workbench - [Deepwater Horizon_Dep_May-10to19_infill_lines_0.03_10000_dt_1min.particles.nc]
File Edit View Map Data Setup Tools Output Window System Help
90°00'W 89°40'W 89°20'W 89°00'W 88°40'W 88°20'W 88°00'W 87°40'W 87°20'W 87°00'W 86°40'W
29°40'N 29°20'N 29°00'N 28°40'N 28°20'N 28°00'N
50 km
mass balance
4.8 %
24.4 %
16.3 %
0.0 %
0.0 %
9.3 %
0.0 %
25.2 %
Surface
Evaporated
Water Clmn.
Sediments
Ashore
Decayed
Recovered
Outside
Vertical Cross Section
File Settings
Distance [km]
0.0
16.0
32.0
48.0
64.0
160.0
320.0
480.0
640.0
800.0
960.0
1120.0
1280.0
1440.0
1600.0
Depth [m]
Concentration [ppm]
< 0.001
0.001 - 0.005
0.005 - 0.01
0.01 - 0.05
0.05 - 0.1
0.1 0.5
0.5 - 1
1 - 5
5 - 10
10 - 50
50 - 100
100 - 500
500 - 1000
> 1000
Wind
4.2 m/s
SINTEF
2010-05-19 07:00:00 [UTC]


droplets over 1000 microns
100 < droplets < 1000 microns
droplets under 100 microns
rise distance m
distance Km
0
40
80
120
160
200
240
280
320
360
400
440
480
520
560
600
640
680
720
760
800
840
880
920
960
1000
1040
1080
1120
1160
1200
0
2
4
6
8
10
12
14
16
18
20

What are the daily steps?

Review model data (currents, wind)

Review observational data (currents, winds, oil distribution)

Put relevant information together in GNOME

Run model, review and distribute results

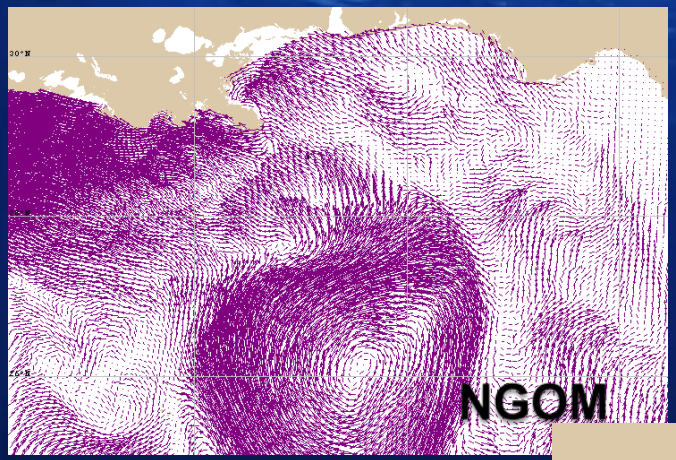
Where do the modeled currents come from?

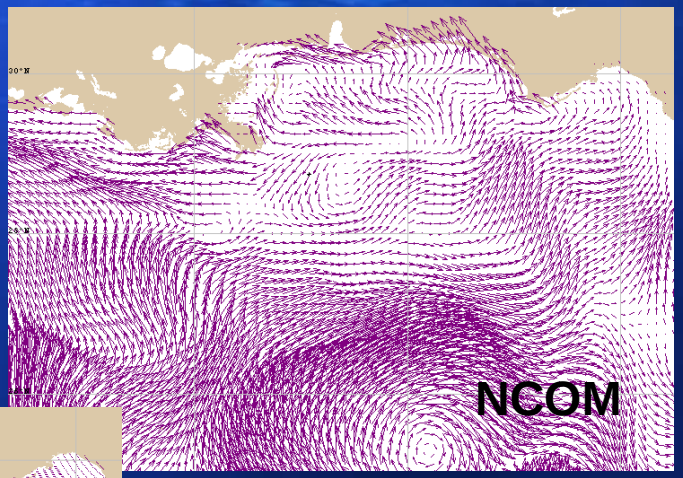
Several models are reviewed daily for both coastal and offshore areas

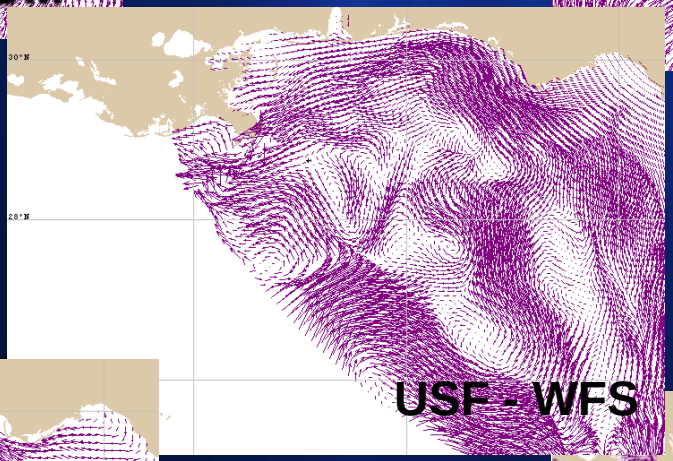
Each model is suited more for some circumstances than others (i.e., some do better on the shelf, some are better for offshore)

The model best suited for the conditions of the forecast period is selected as the primary current model for that day; the other models are used to help derive the "uncertainty" bound.

**What current models exist for the Arctic?

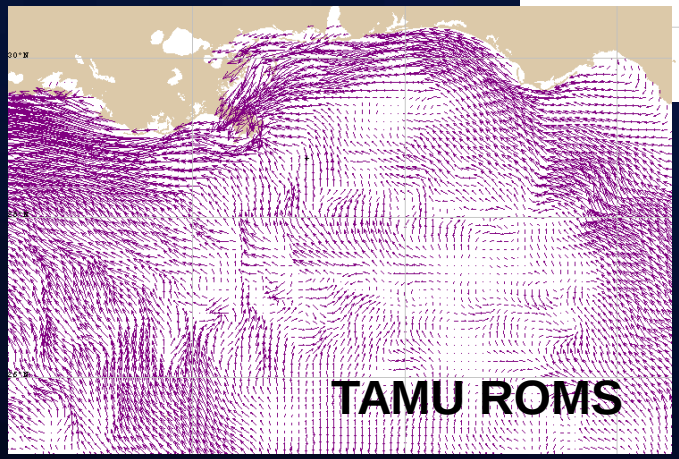


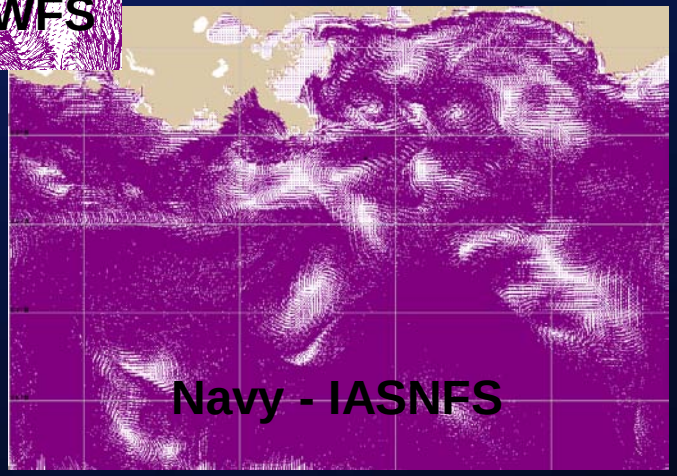




SABGOM – Univ. of NC

Navy Layered Ocean Model (NLOM)





NOAA Gulf of Mexico Model 6/29/10 1900 CDT

Where did the observed currents come from?

Moored ADCPs

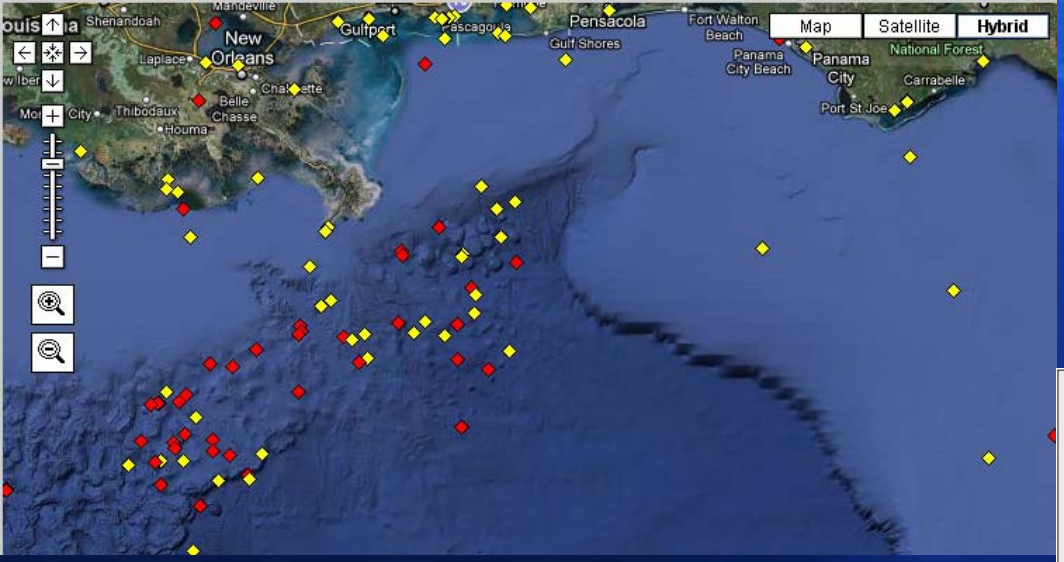
Fast Eddy2 Vessel

HF Radar (Alabama)

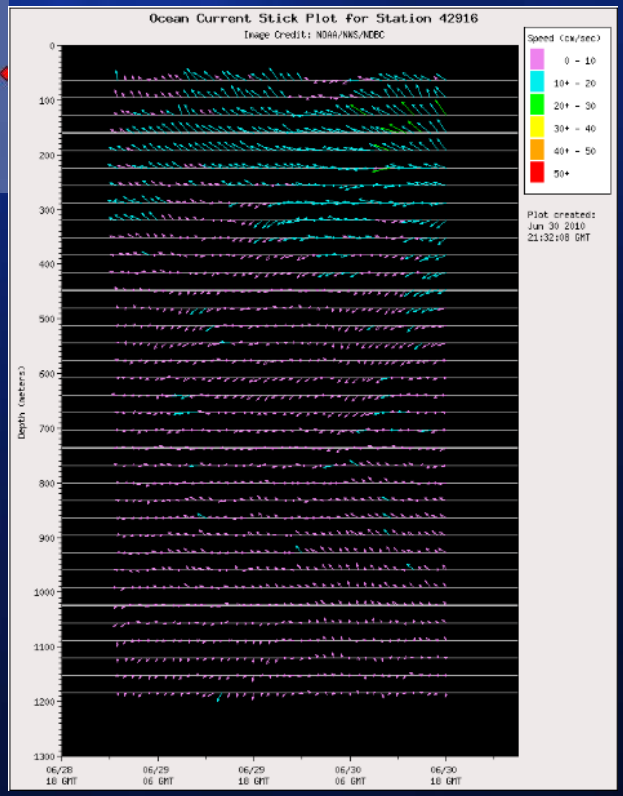
Satellite SSH and SST analysis

Drifters

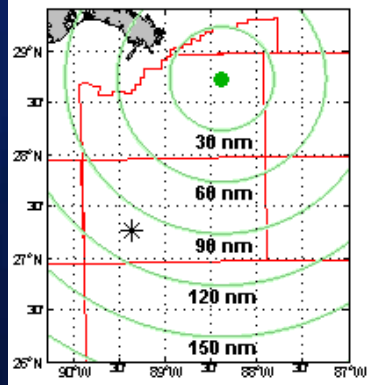
TABS Buoys



Development Drill 3
Discoverer Enterprise
(both BP)



MOORED ADCPs

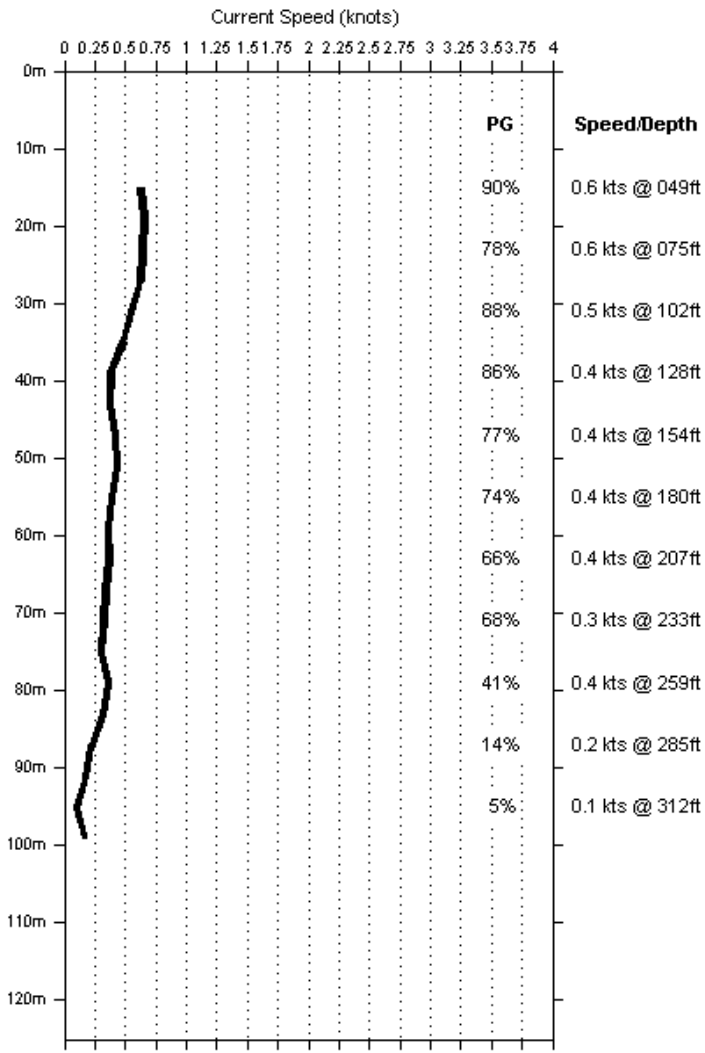


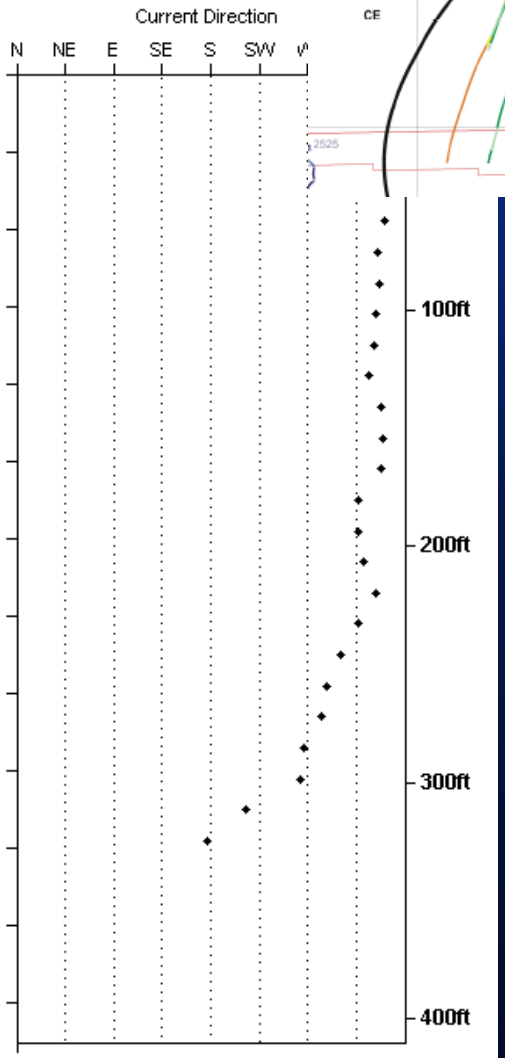
30-Jun-2010 15:01:28
27.27N -89.38W

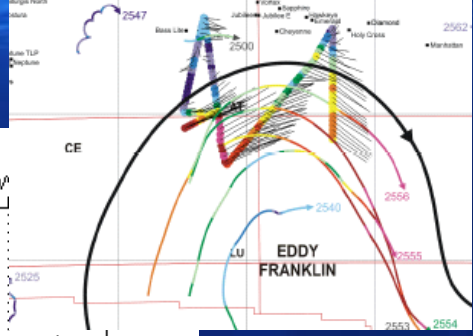
BP,
FAST Eddy 2
150 kHz ADCP

chart created: 30-Jun-2010 15:56:42

Horizon Marine, Inc.
15 Creek Road
Marion, MA 02738
www.horizonmarine.com





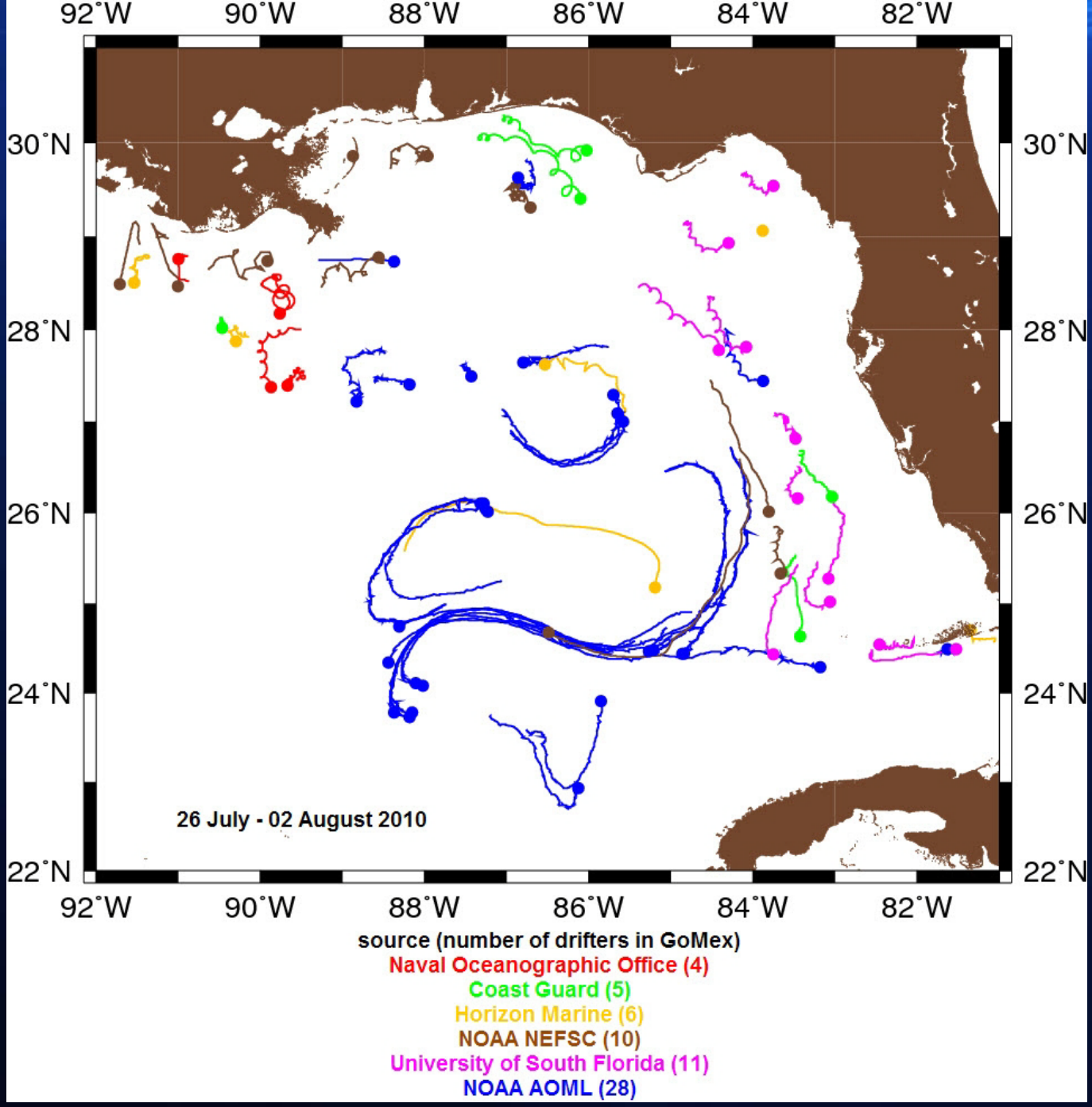


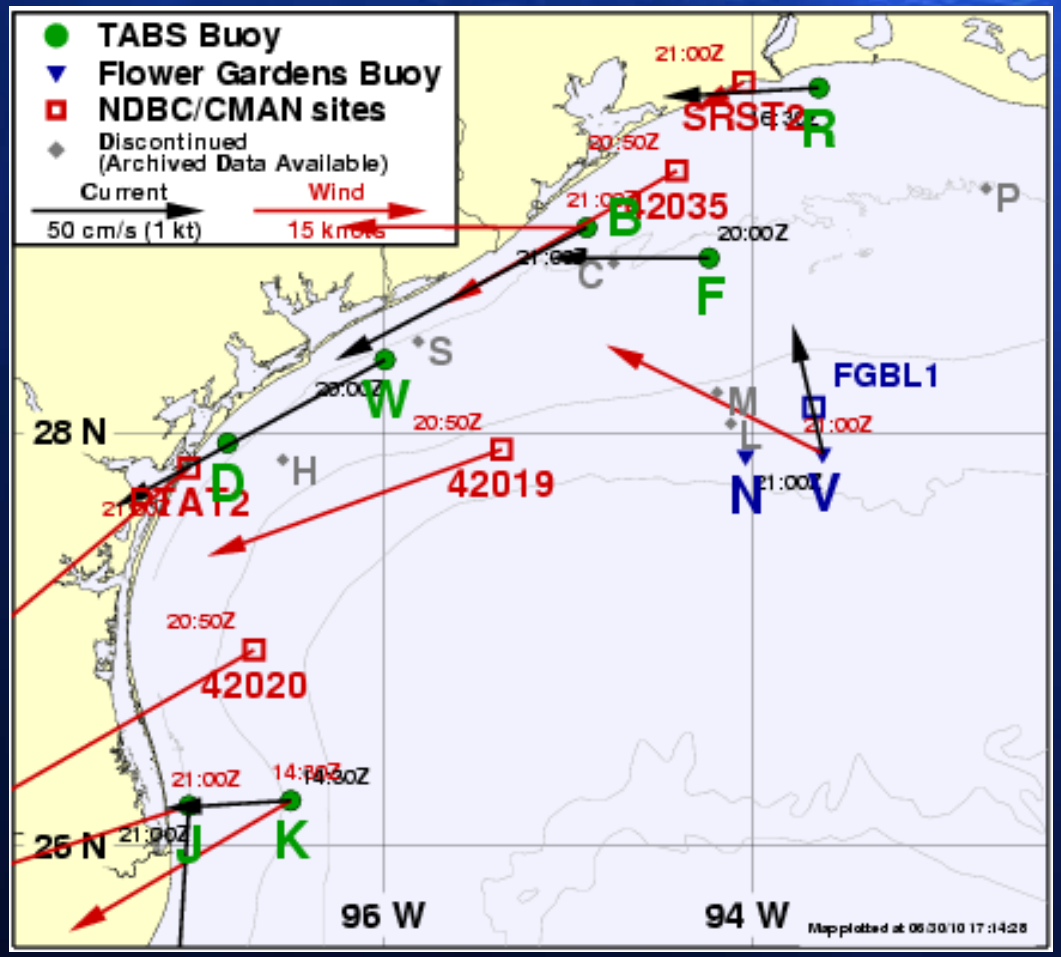
FAST EDDY 2

Funded by BP – vessel constantly transiting northern edge of Loop Current (Eddy Franklin)

Surface Currents
NOAA/IOOS

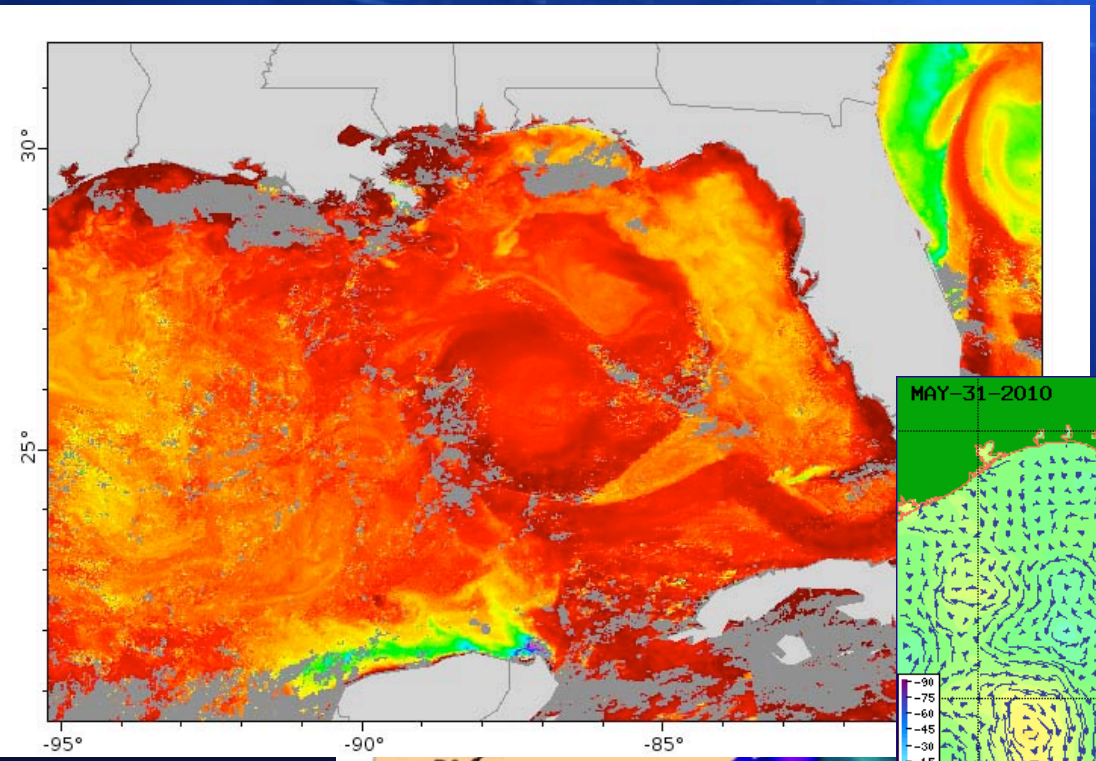
HF RADAR


92˚W
90˚W
88˚W
86˚W
84˚W
82˚W
30˚N
28˚N
26˚N
24˚N
22˚N
26 July - 02 August 2010
source (number of drifters in GoMex)
Naval Oceanographic Office (4)
Coast Guard (5)
Horizon Marine (6)
NOAA NEFSC (10)
University of South Florida (11)
NOAA AOML (28)

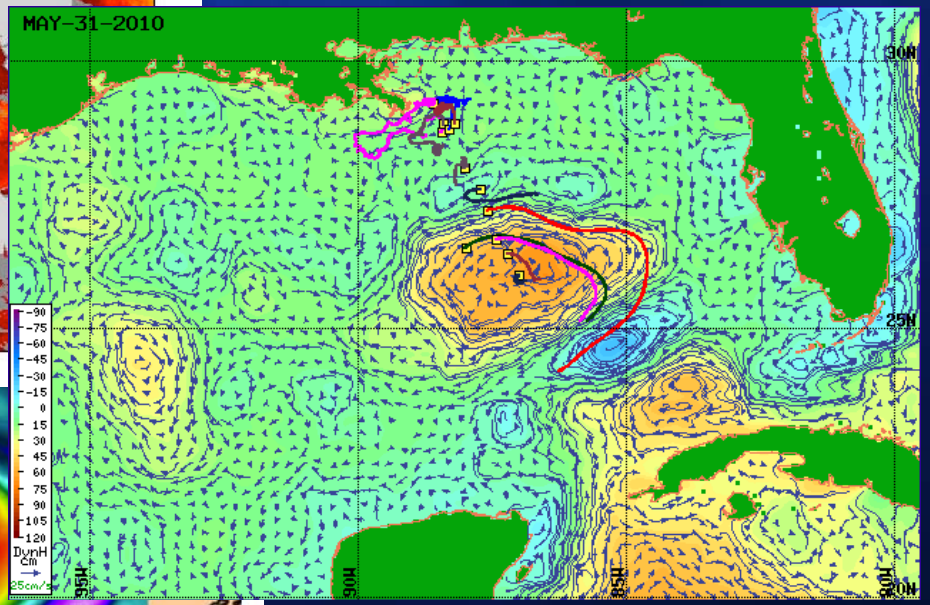


Array of offshore buoys maintained by TGLO, important for monitoring coastal flow off Texas (Buoy R)

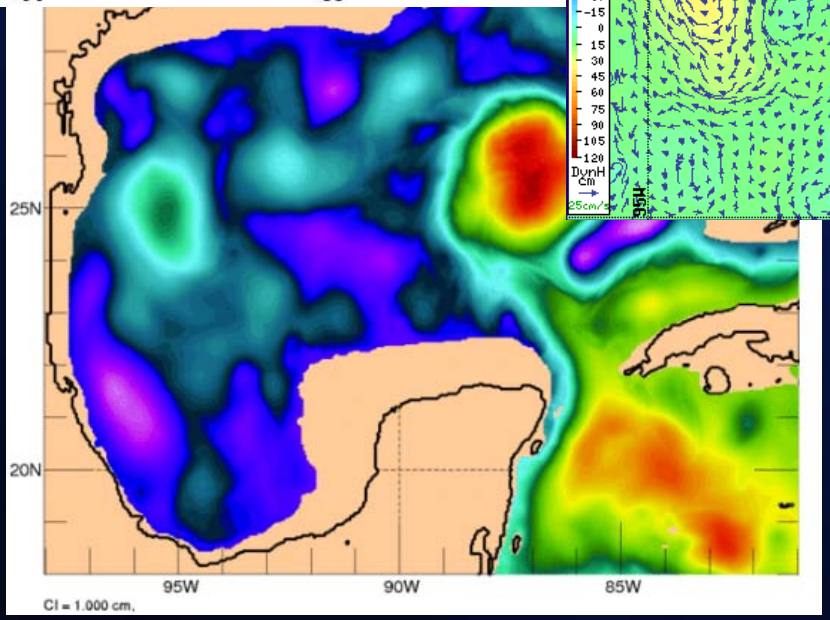
TABS BUOYS



Rutgers - SST

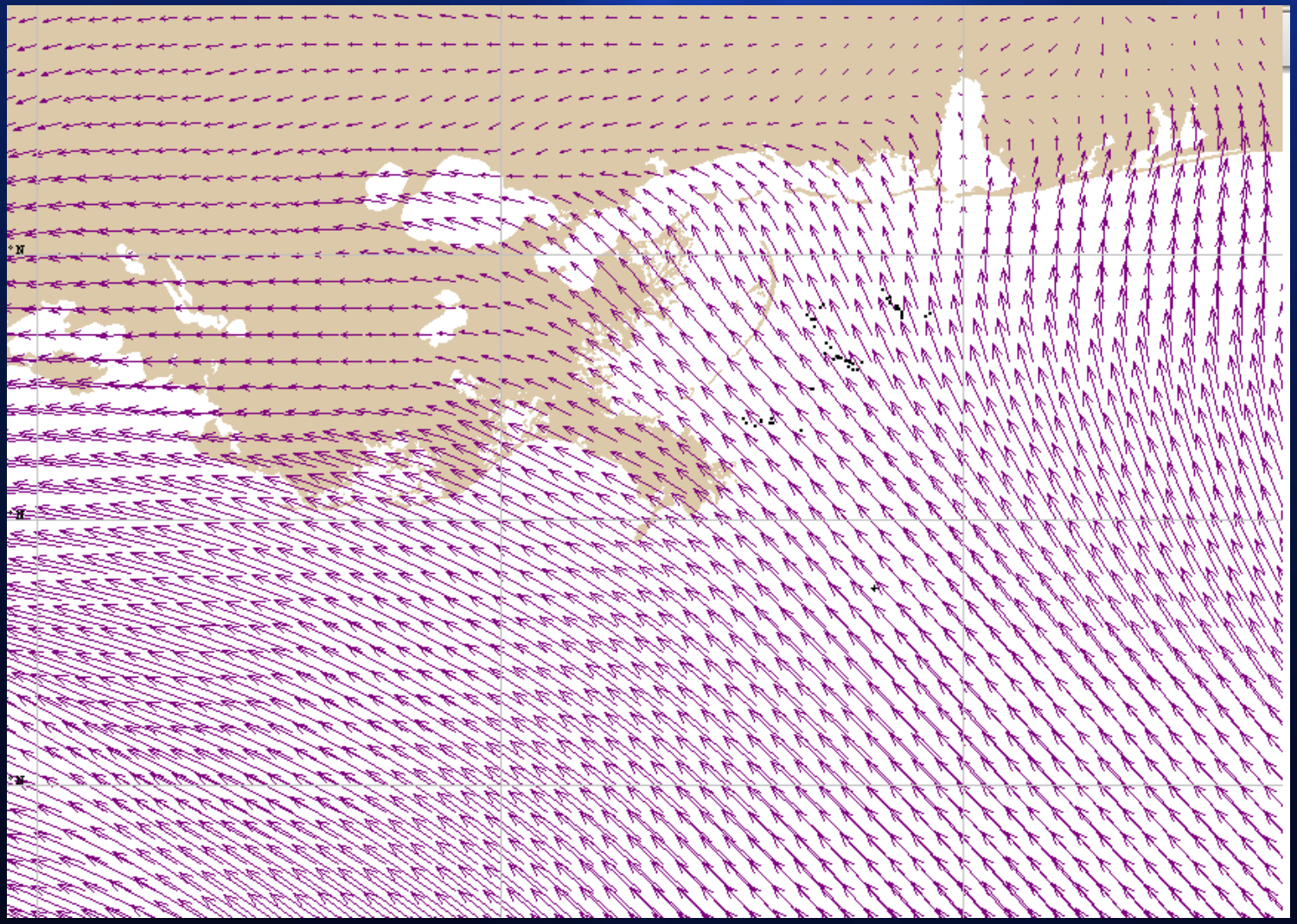


NOAA - SSH



NAVY – SST

Winds – Modeled and Observed



Oil Observations

NESDIS Analysis

Daily NOAA Overflights (Venice, Mobile, Clearwater, occasionally Houma)

Antectodal information from other aerial observer overflights

ASPECT reports

Dash-8 SLAR

Ocean Imaging flight data

Ship Observations (email)


6037
U. S.
COAST GUA
D


Deepwater Horizon MC252 Overflight NOAA JL
N 29° 13.404'
W 088° 22.700'
423 ft
06/16/2010
9:43:14 AM


U.S. COAST GUARD

NESDIS

Analysis of images from several different satellites. Analysts throw out anomolies that are inconsistent with observations or physical drivers. When requested, analysts provide input on areas where no anomolies are observed (i.e., Florida Shelf). Footprint surrounds anomolous area.

Cannot differentiate between what is “oil” and what is sheen. All will appear within the footprint. If oil does not sheen (i.e., tarballs or highly weathered patches) it will not show up.

EXPERIMENTAL MARINE POLLUTION SURVEILLANCE REPORT

Analysis Provided by: The National Oceanic and Atmospheric Administration/National Environmental Satellite, Data and Information Service (NOAA/NESDIS)

REPORT DATE: June 30, 2010
REPORT TIME: 1605Z (1105 CDT)
ANALYST: WARREN

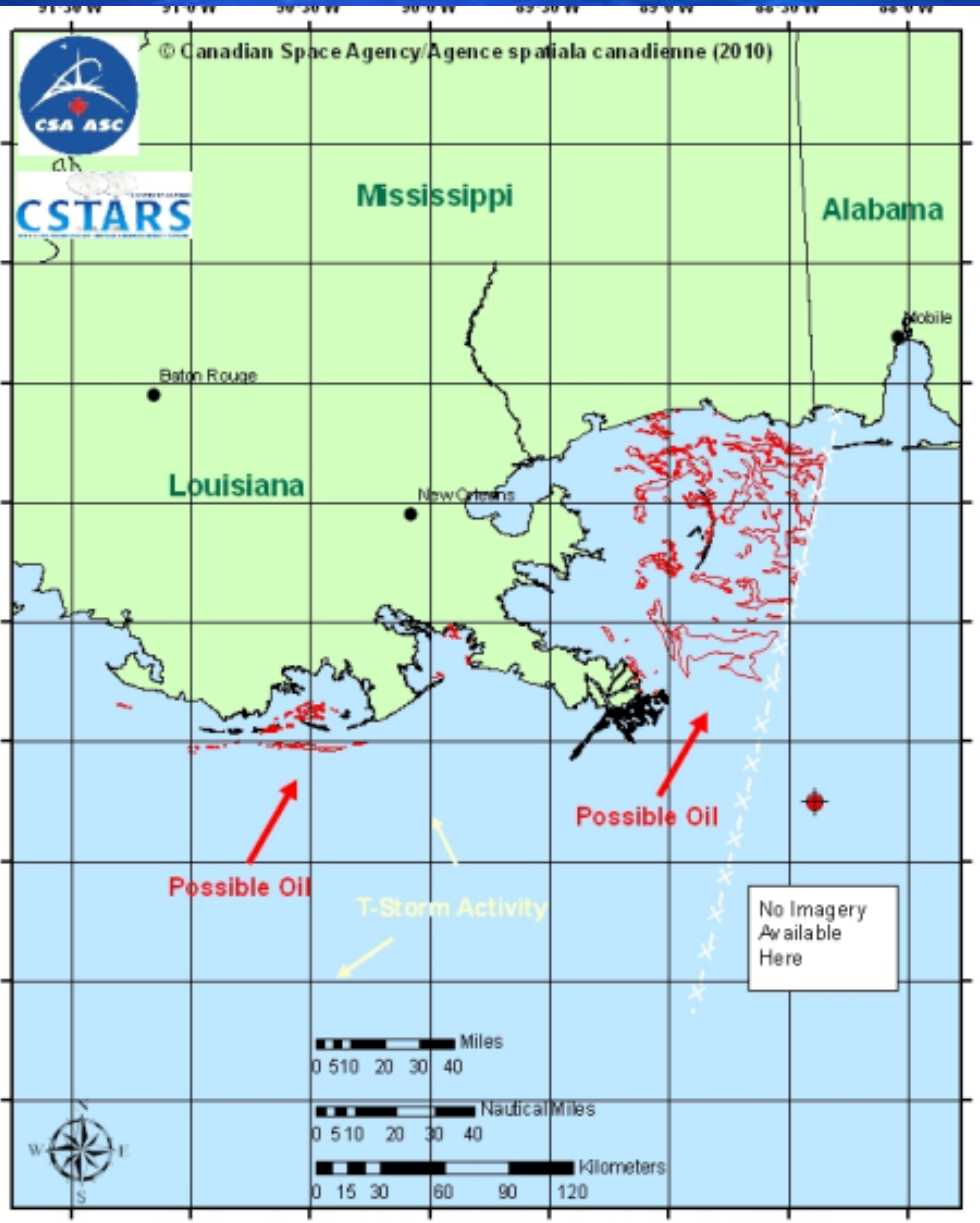
DATA SOURCE: RADARSAT-1
MODE: ScanSAR, HH
RESOLUTION: 50 METER
IMAGE DATE/TIME: 6/30/2010 1200Z (0700 CDT)

Legend

- Possible Oil
- False-Positives (not oil)
- Location of Deepwater Horizon Platform: [28°44'12" N / 88°23'14" W]

REMARKS:

Oil was seen west of the Deepwater Horizon spill site in this radar image, with the majority of the oil in and around the Chandeleur and Mississippi Sounds. Oil in these locations has pushed further west and north since yesterday. Heavy rains and t-storms disrupted any ability for the satellite to detect oil around the Bird's Foot of LA and south of Barataria Bay. Some oil was analyzed in Barataria Bay and futher to the west in Timbalier and Terrebonne Bays.



This is an experimental product of the Satellite Analysis Branch and not operationally maintained. We will do our best to make it available in a timely manner.

Also available at: www.ssd.noaa.gov/PS/MPS/deepwater.html

Next . . . .

All quality data go into the model

Analyst chooses best current model based on matching observational data, most other current models are also run and used as part of the “uncertainty”

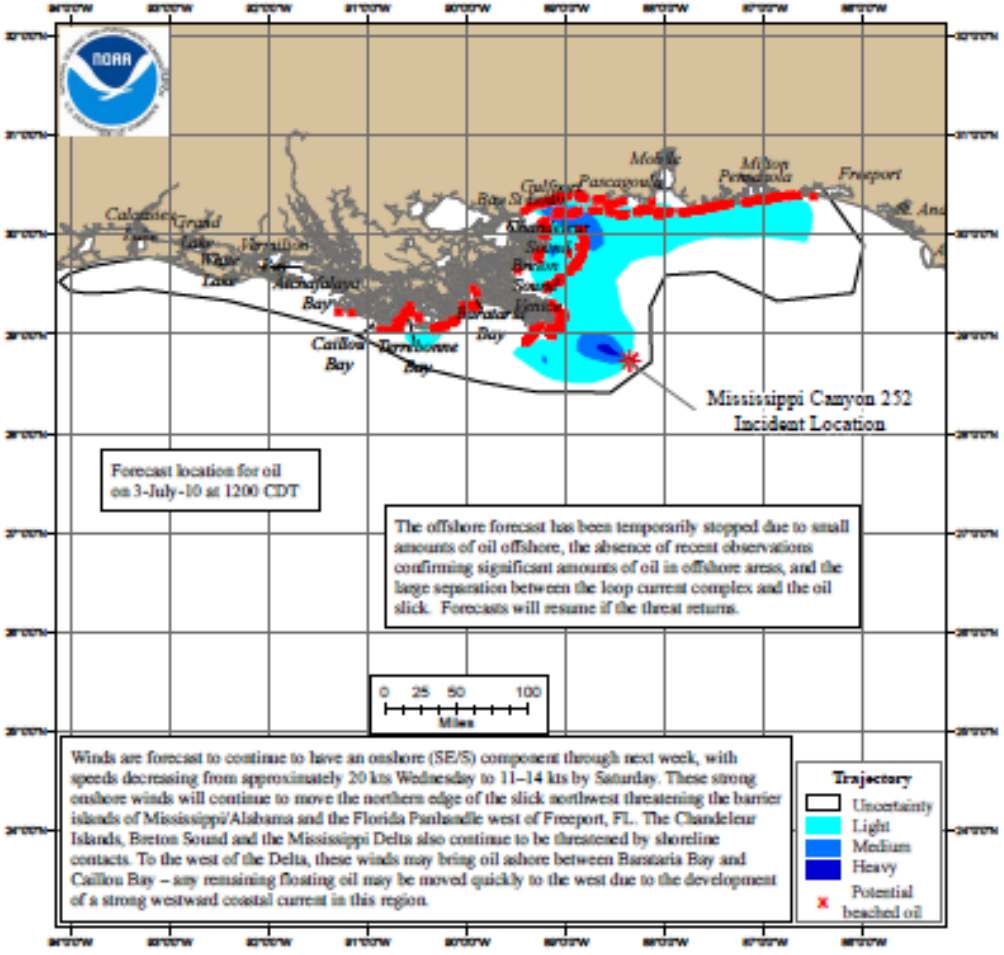
Model is run, results are put into distributable standard format

Nearshore Surface Oil Forecast Deepwater Horizon MC252

NOAA/NOS/OR&R | **Nearshore**

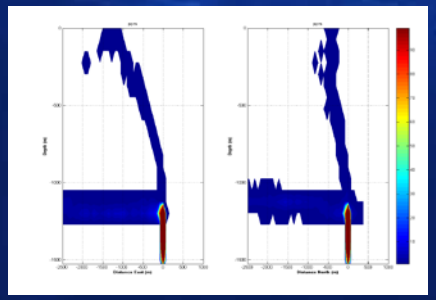
Estimate for: 1200 CDT, Saturday, 7/03/10
Date Prepared: 2100 CDT, Wednesday, 6/30/10

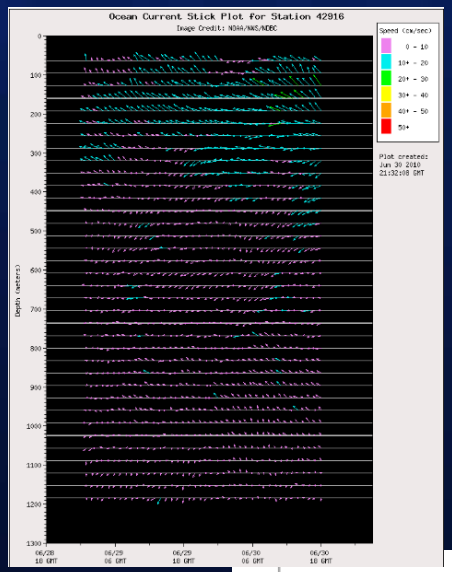
This forecast is based on the NWS spot forecast from Wednesday, June 30 PM. Currents were obtained from several models (NOAA Gulf of Mexico, West Florida Shelf/USF, TGLO/TAMU, NAVO/NRL) and HFR measurements. The model was initialized from Tuesday-Wednesday satellite imagery analysis (NOAA/NESDIS) and Wednesday 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.

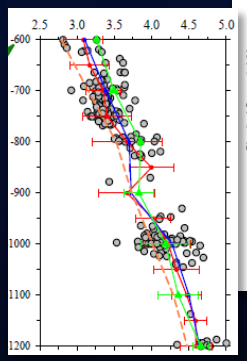


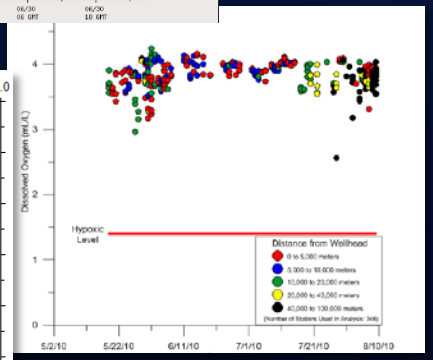
this scale bar shows the meaning of the distribution terms at the current time

Next Forecast:
July 1st PM





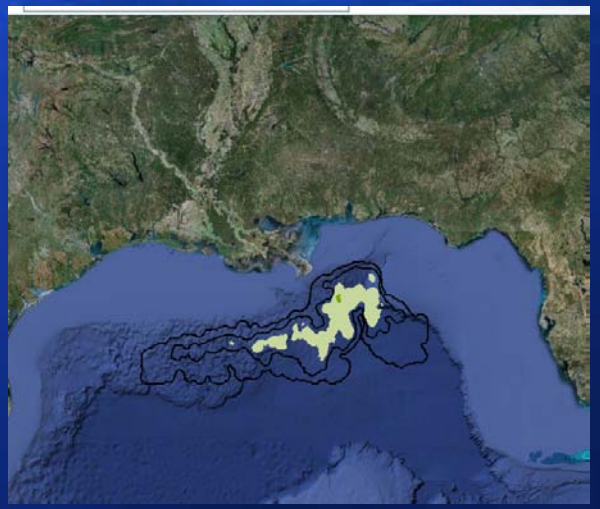




Modeling

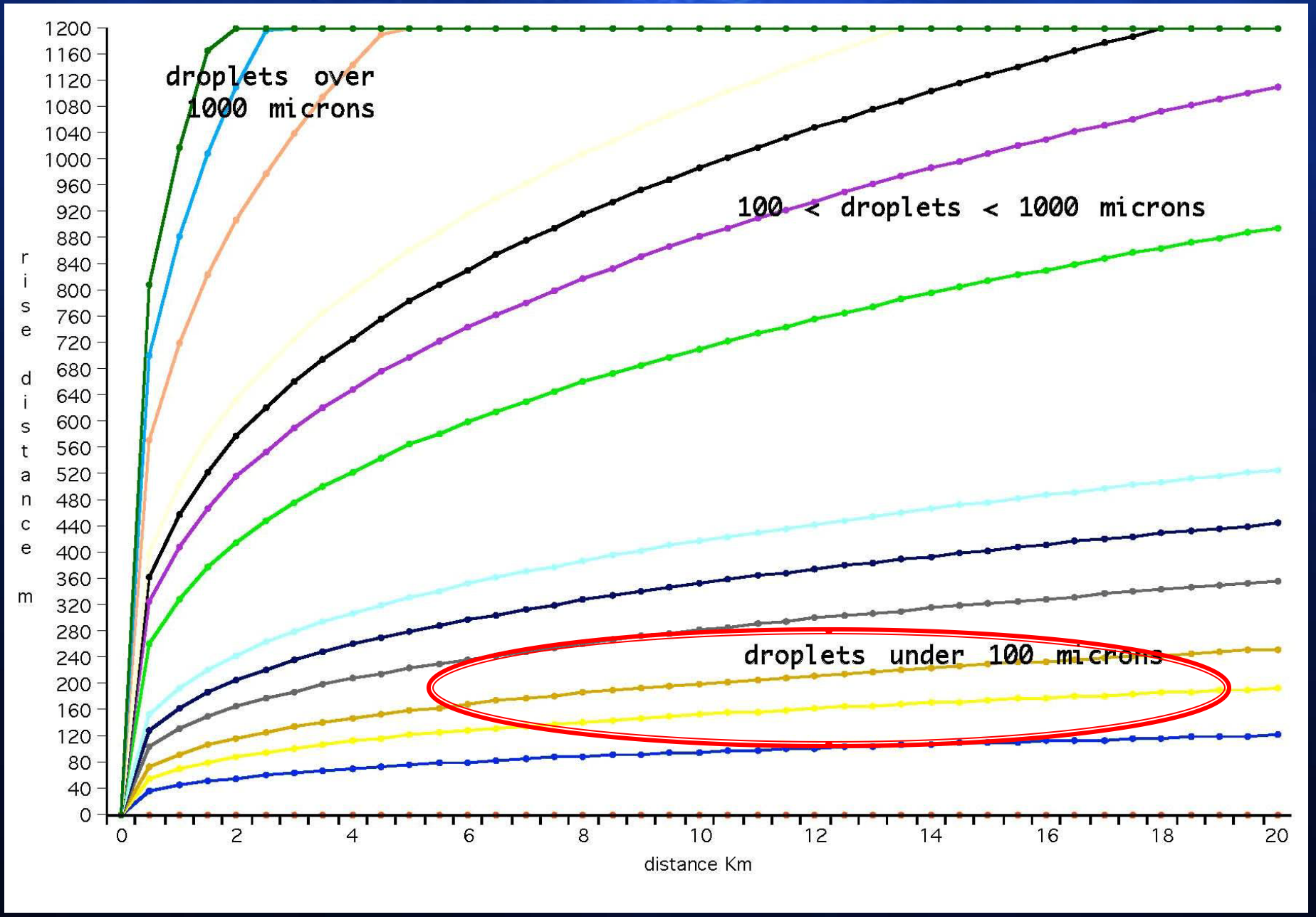
Forecasting

Observations



Which of these pieces are in place in the Arctic? How reliable are they? How accessible are they?

- Current models
- Wind models and obs
- *Ice models/obs (type, coverage, forecast movement)*
- Moored ADCPs
- HF Radar
- Quick-deploy vessels with current profiling and other oceanographic equipment
- Satellite imagery (interference with ice returns?)


droplets over
1000 microns
100 < droplets < 1000 microns
droplets under 100 microns
rise distance m
distance Km
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Key zones in the Gulf of Mexico (Jochens *et al* 2005)

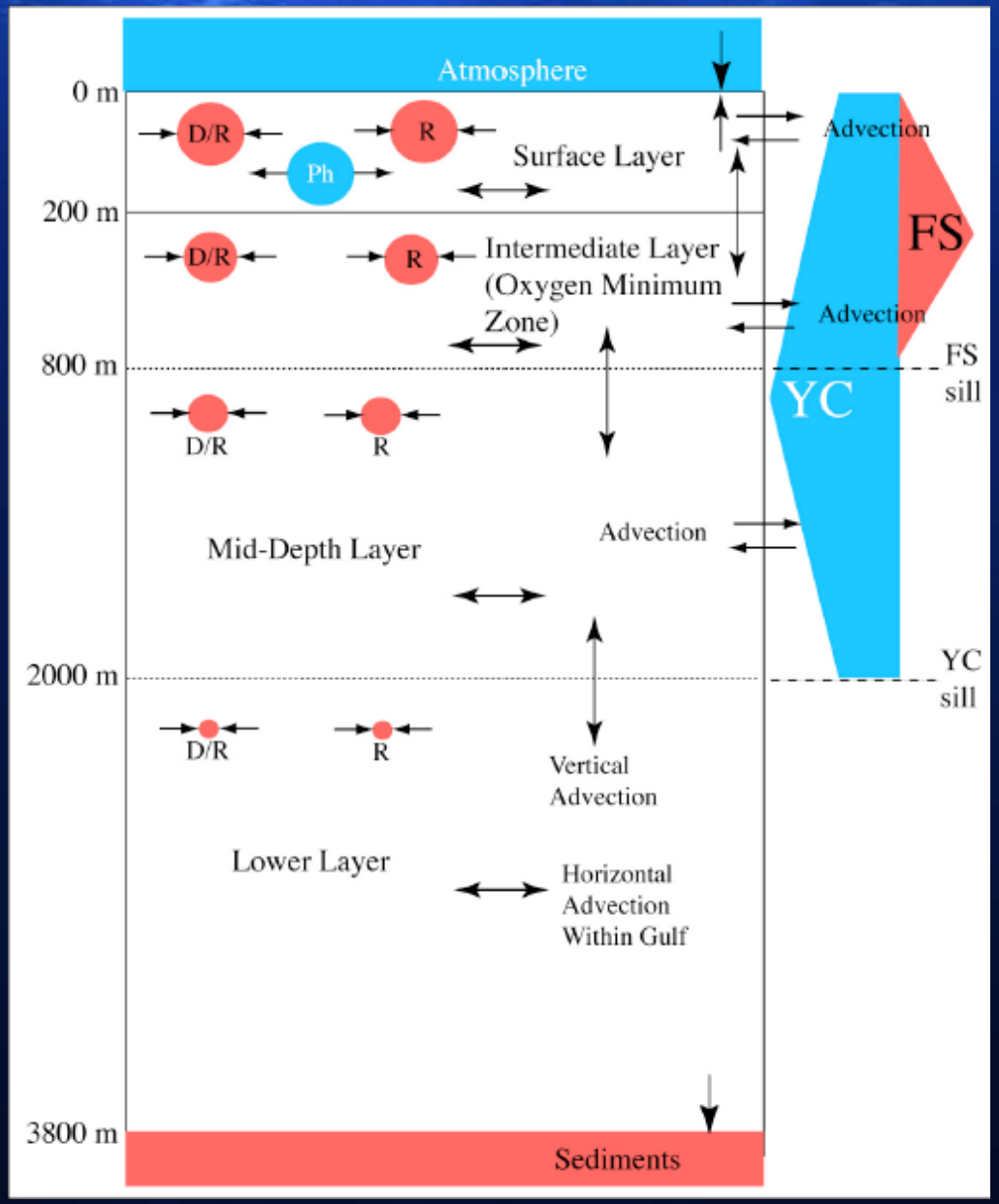
FS = Florida Straits

YC = Yucatan Channel

D/R = Decay and remineralization

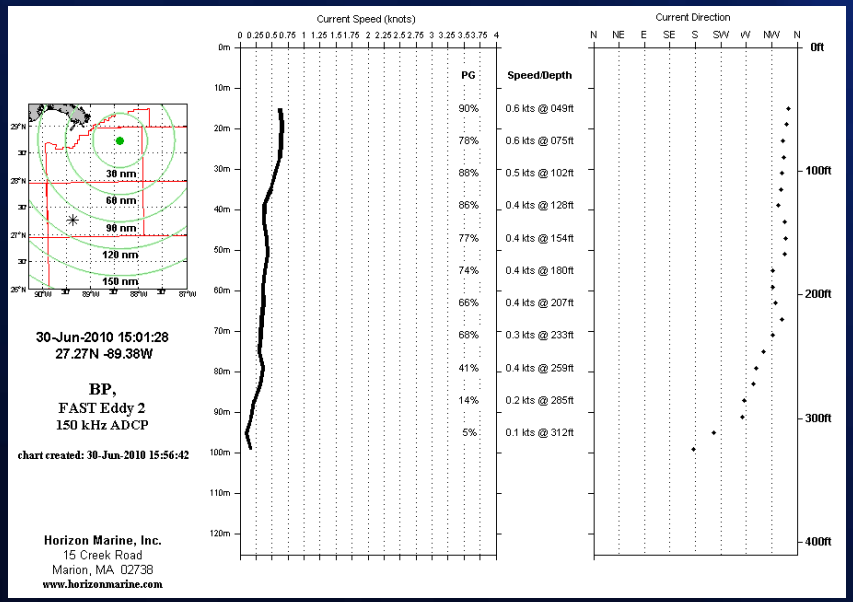
R=Respiration

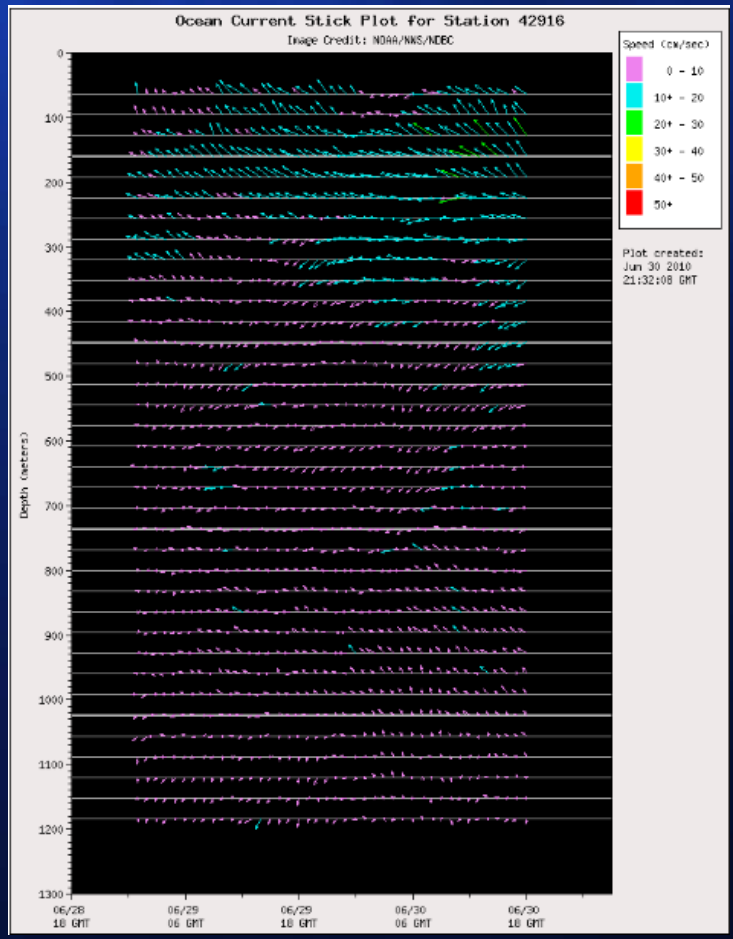
Ph = Photosynthesis




The well is located in
Antarctic Intermediate Water (AAIW).
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2010 TerraMetrics
Image USDA Farm Service Agency
Image © 2010 DigitalGlobe
19°30'45.14" N 59°49'08.05" W elev -14963 ft
©2009 Google
Eye alt 2092.22 mi

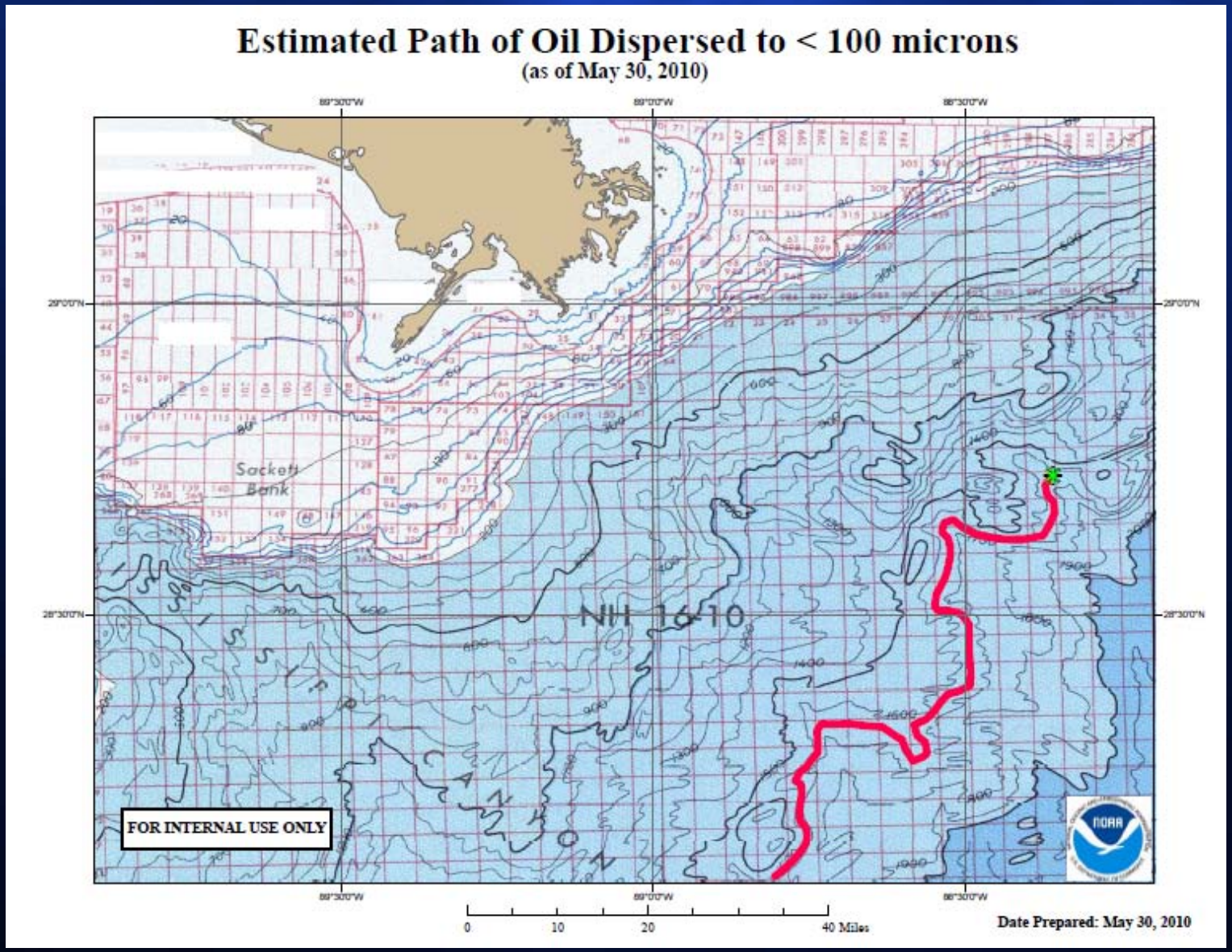
How Did the Water Move?





NGOM: NOAA Gulf of Mexico Model

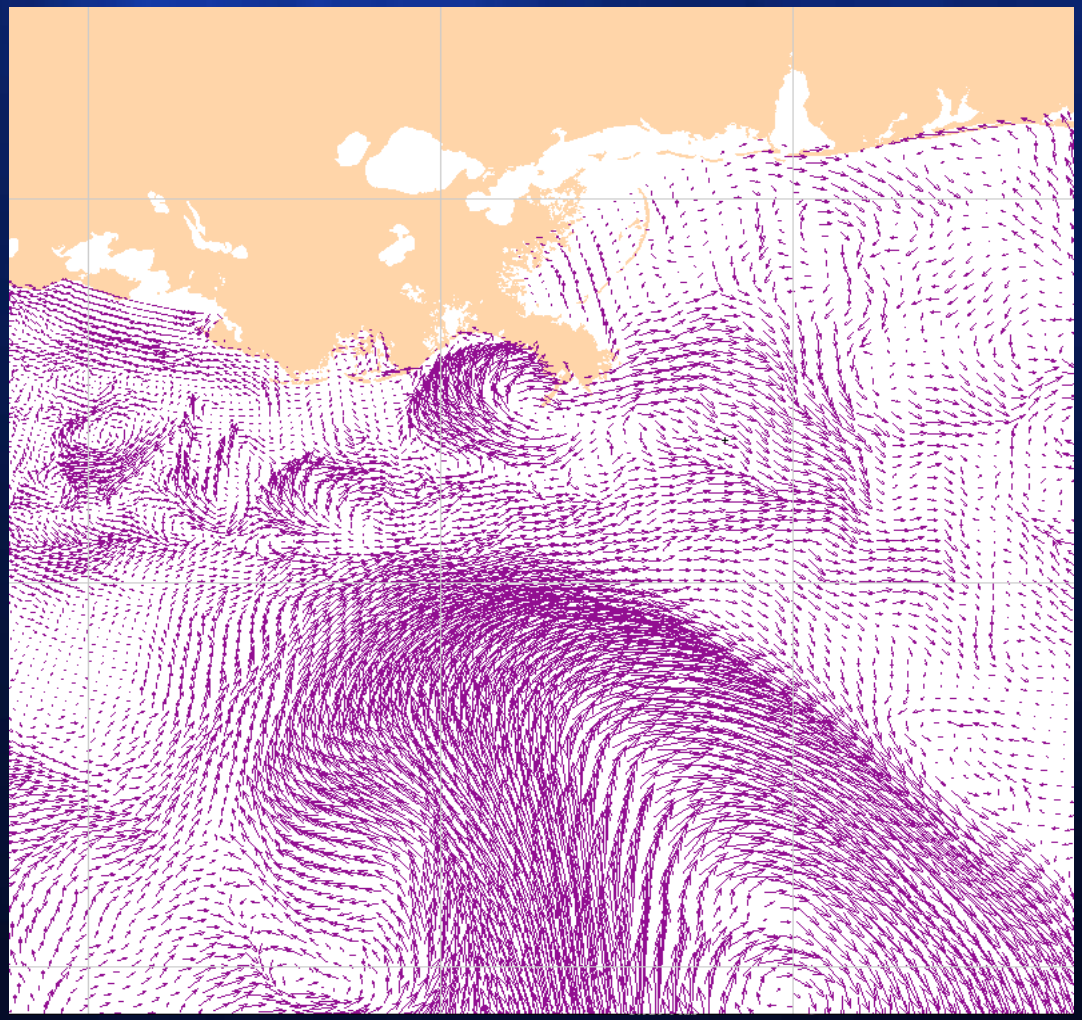
Assuming simple isopycnal flow

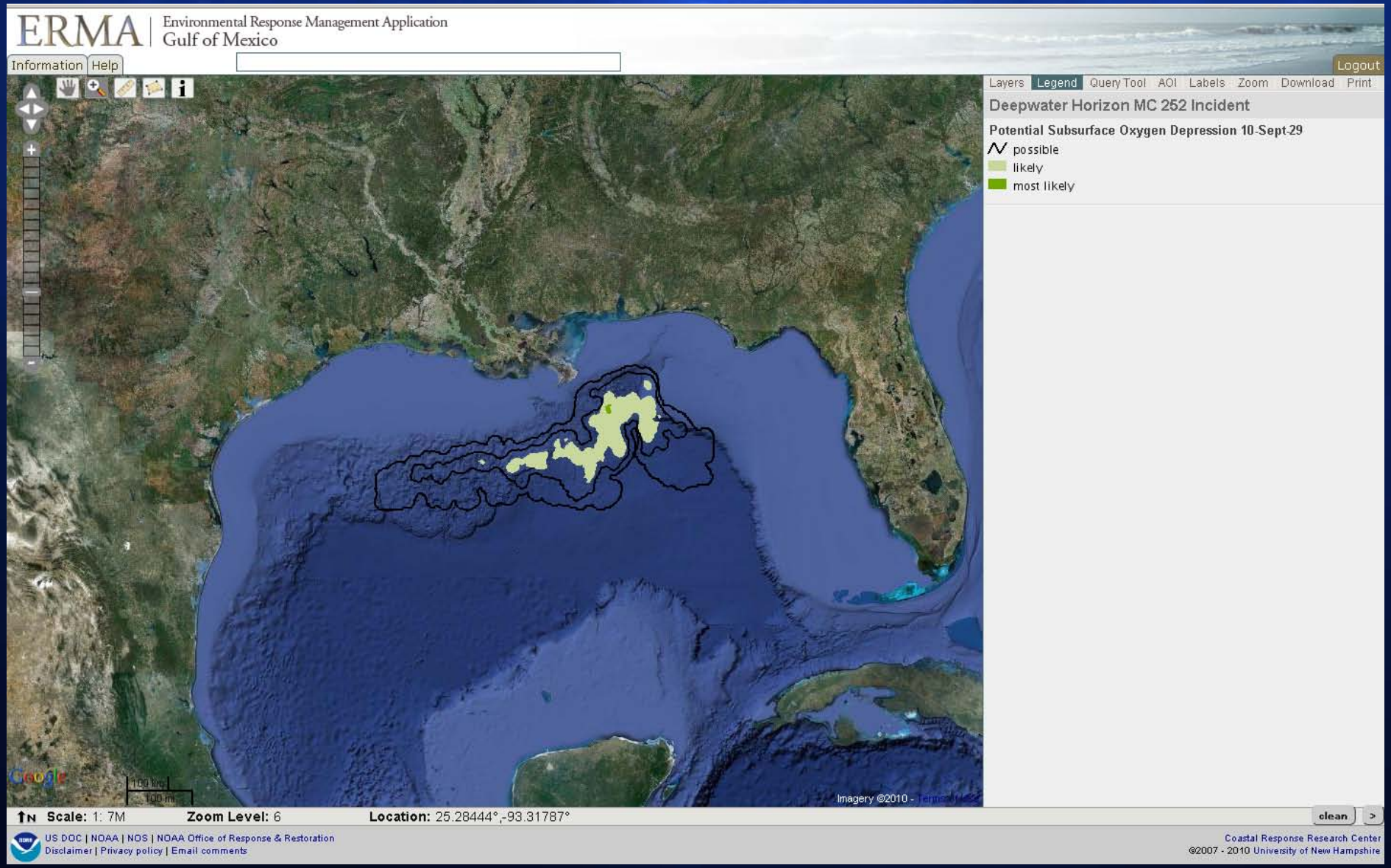


Subsurface Current Models

NOAA: NGOM – used in operational forecasts, but needed corrections to the barotropic fields

SABGOM – being used in an NSF Rapid grant project for hindcast.




ERMA
Environmental Response Management Application
Gulf of Mexico
Information
Help
Logout
Layers
Legend
Query Tool
AOI
Labels
Zoom
Download
Print
Deepwater Horizon MC 252 Incident
Potential Subsurface Oxygen Depression 10-Sept-29
possible
likely
most likely
Imagery ©2010 -
Scale: 1: 7M
Zoom Level: 6
Location: 25.28444°,-93.31787°
clean
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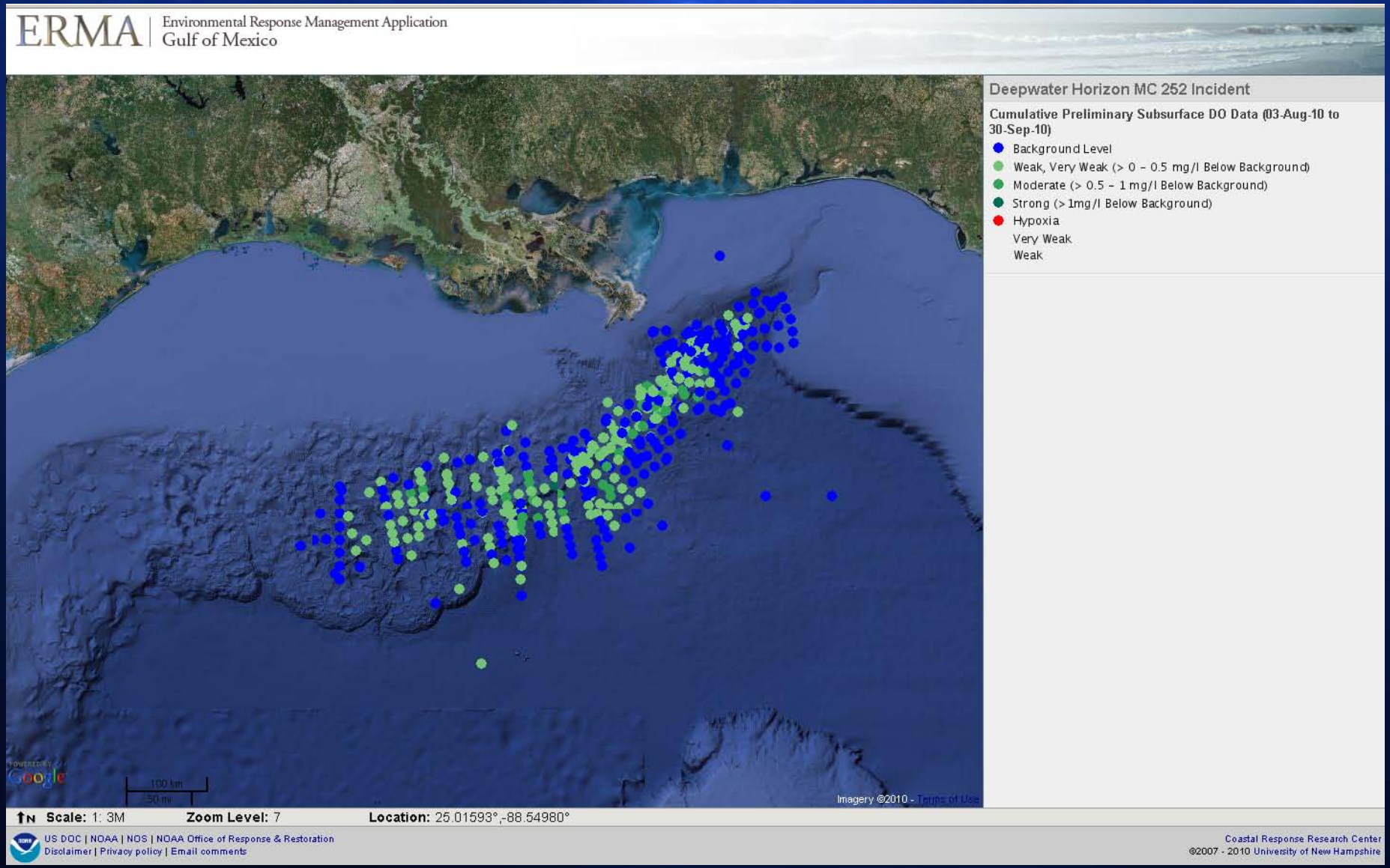
ERMA
Environmental Response Management Application
Gulf of Mexico
Deepwater Horizon MC 252 Incident
Cumulative Preliminary Subsurface DO Data (03-Aug-10 to 30-Sep-10)
Background Level
Weak, Very Weak (> 0 - 0.5 mg/l Below Background)
Moderate (> 0.5 - 1 mg/l Below Background)
Strong (> 1mg/l Below Background)
Hypoxia
Very Weak
Weak
100 km
50 mi
Imagery ©2010 - Terms of Use
Scale: 1: 3M
Zoom Level: 7
Location: 25.01593°,-88.54980°
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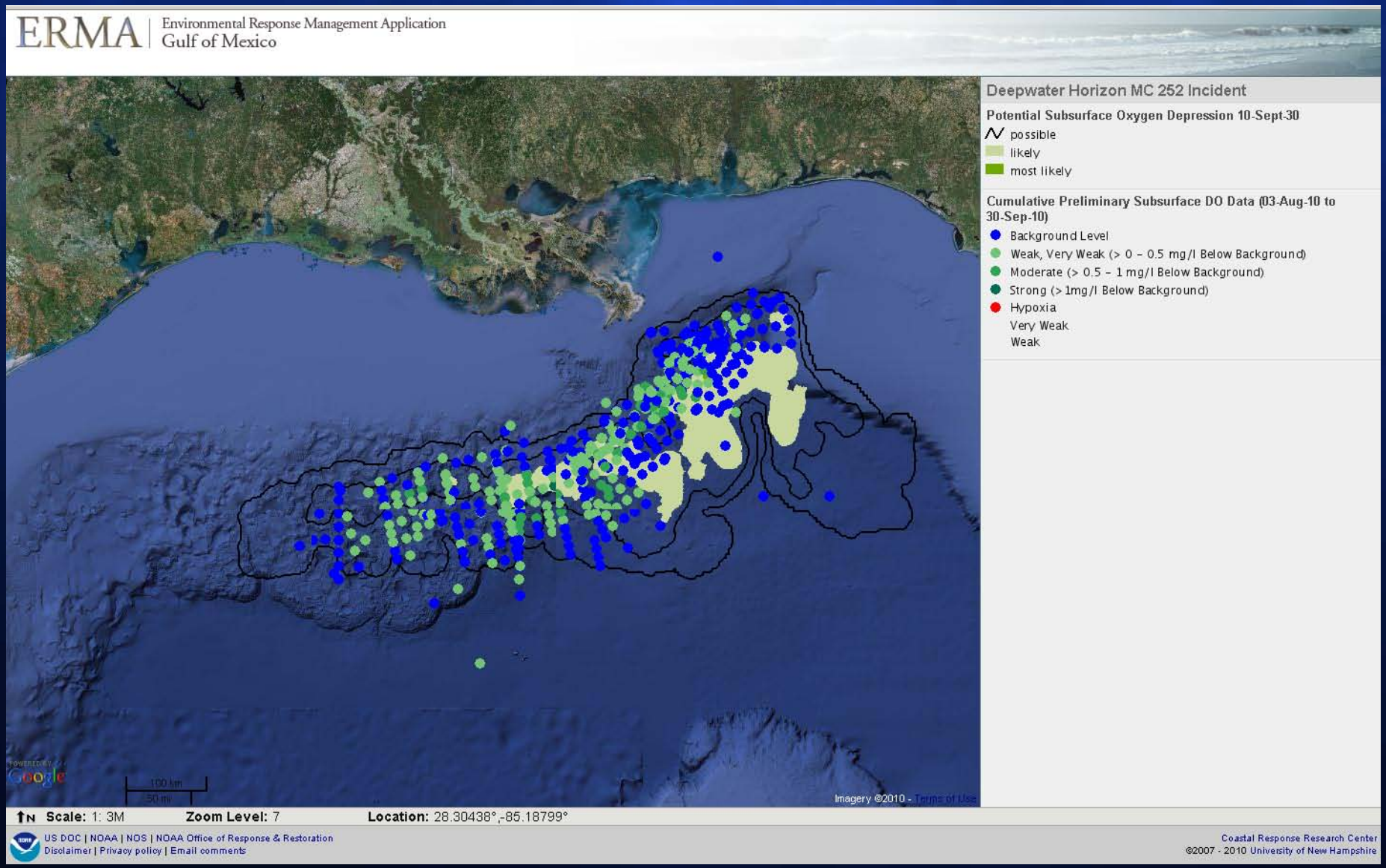
ERMA
Environmental Response Management Application
Gulf of Mexico
Deepwater Horizon MC 252 Incident
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likely
most likely
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Hypoxia
Very Weak
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100 km
50 mi
Imagery ©2010 - Terms of Use
Scale: 1: 3M
Zoom Level: 7
Location: 28.30438°,-85.18799°
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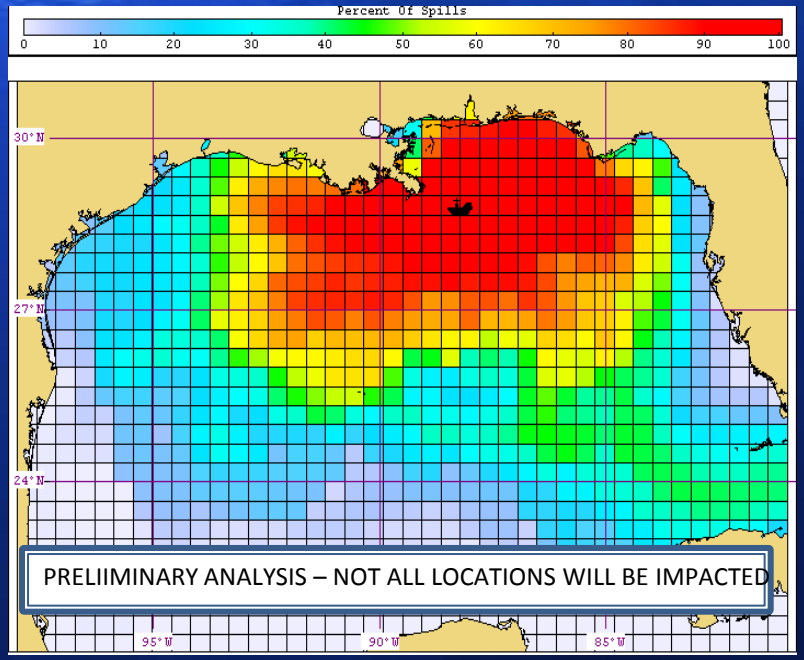
Statistical Analysis – Where could the oil go based on historical data?

Trajectory Analysis Planner (TAP) – essentially the NOAA tactical model (GNOME) run 500 times

Scenario based – scenarios started within a 15 year climatological history of winds and currents

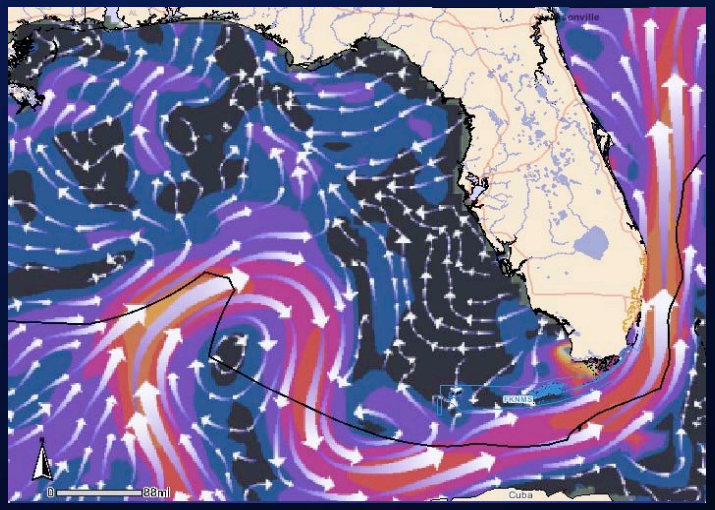
Scenario distribution, time of travel and relative volume kept track of and summarized to generate statistics

Percentages indicate number of scenarios from incident location that impact shoreline areas based on historical winds and currents. Not ALL areas will be impacted, only one scenario will be the final one, statistics are based on 500 scenarios



120 Impact Probability
(assumes 90 day release)

Gulf of Mexico currents are very dynamic, the Eastern Gulf of Mexico is impacted by the Loop Current. While the Loop Current remained south of incident area, oil getting into the Loop Current could transit long distances quickly.



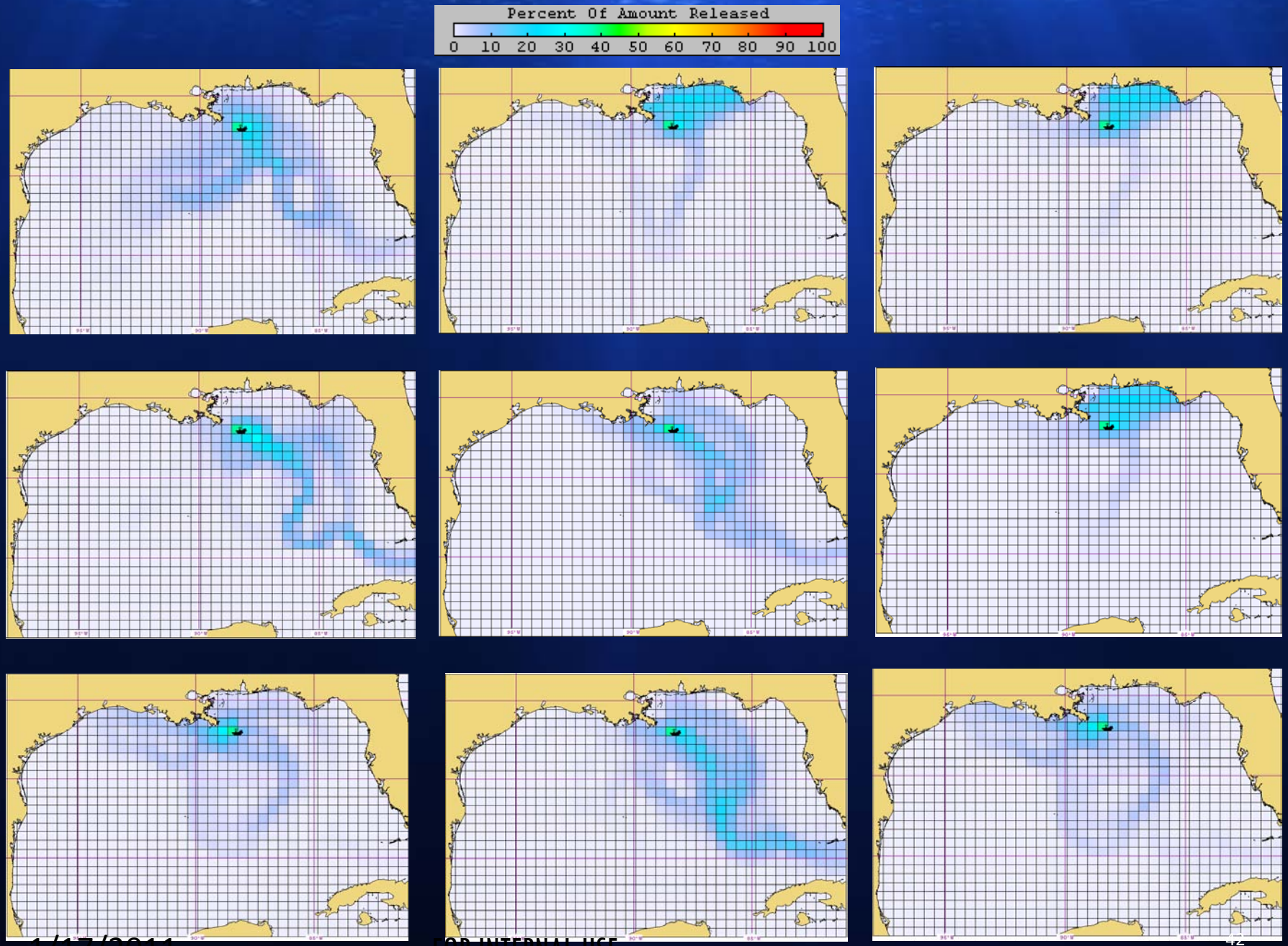
Model Setup

Analysis of several different current and wind data sources (NOAA (NGOM), Navy (IANSF, NCOM), MMS, NASA (Leo Oey))

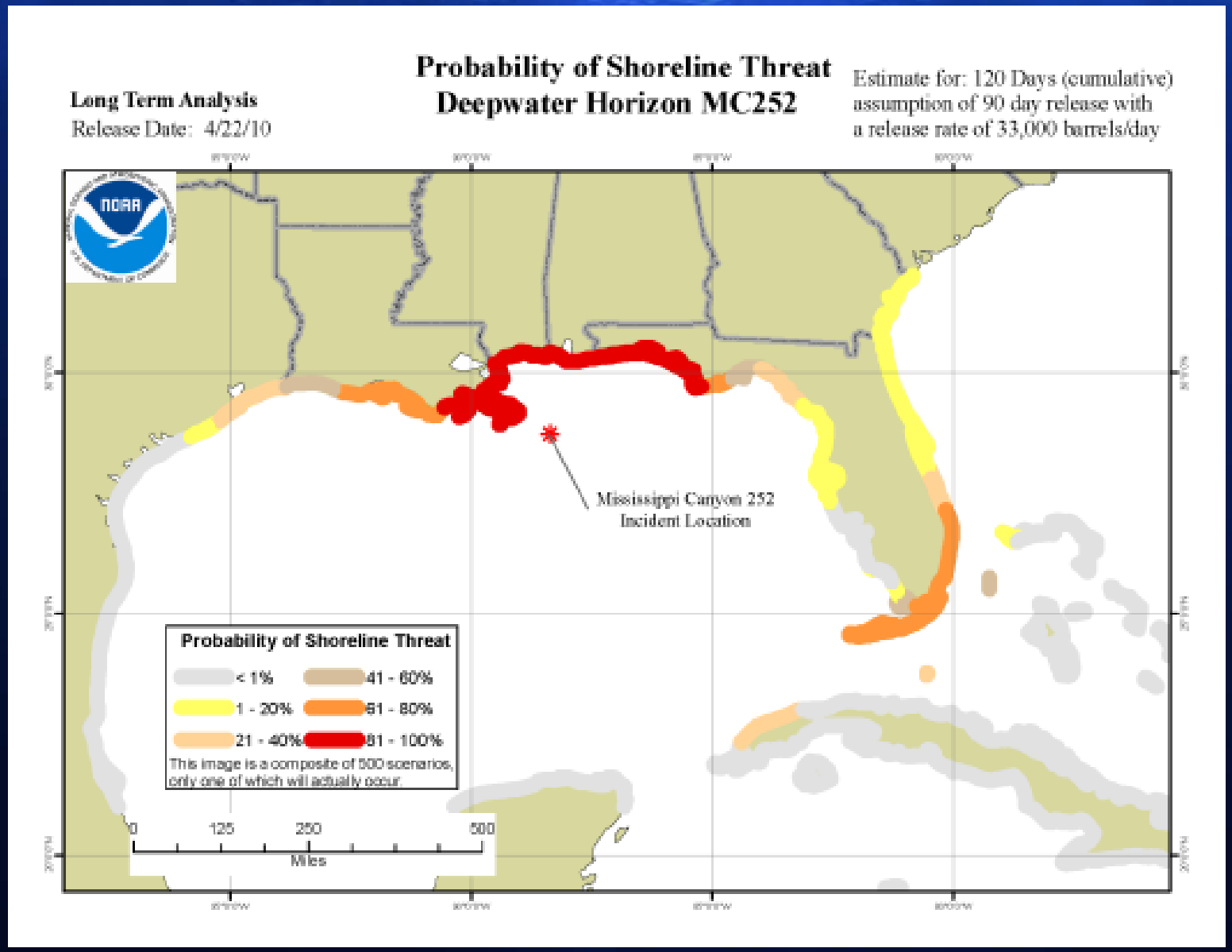
Preliminary runs with three different sets of data

Model review of data/approach – Texas A&M, MMS, NOAA, Navy, Scripps, TGLO, BP

Final data set selected, runs completed



Example Individual Scenarios


Probability of Shoreline Threat
Deepwater Horizon MC252
Long Term Analysis
Release Date: 4/22/10
Estimate for: 120 Days (cumulative)
assumption of 90 day release with
a release rate of 33,000 barrels/day
NOAA
Mississippi Canyon 252
Incident Location
Probability of Shoreline Threat
< 1%
1 - 20%
21 - 40%
41 - 60%
61 - 80%
81 - 100%
This image is a composite of 500 scenarios,
only one of which will actually occur.
0
125
250
500
Miles

Overview of Modeling Activities to Support Response

Tactical (72 hour) forecasts - surface

5 day outlook/2-week forecast

Operations 48 hour forecast - subsurface

Statistical Analysis

Considerations for Success

Coordination of observations and forecasting/modeling

Planning/Engagement prior to incident

Continuing Challenges

Data and model assimilation/integration

Deep blowout dynamics/droplet size distribution

Understanding and communicating uncertainty

Questions?

- www.deepwaterhorizonresponse.com
- www.restorethegulf.gov
- www.geoplatform.gov/gulfresponse
- www.noaa.gov/sciencemissions/bpoilspill.html
- www.response.restoration.noaa.gov
- www.Deepwaterhorizon.noaa.gov
- www.epa.gov/bpspill
- www.boemre.gov/DeepwaterHorizon.htm
- debbie.payton@noaa.gov or (206) 526-6320