Scientific Lessons from The Deepwater Horizon

Language, Culture, and Standards of Proof

Baylor Fox-Kemper

ATOC6020: Oceanography Seminar, Fall 2010

Duane E126 8/30/10, 16:00-17:00

image: Transocean Website

image: Wikimedia Commons

Important Opening Remark

- Some aspects of the spill are scientifically interesting, but before moving on...
- It is important to note that 11 rig employees were killed...
- and the ecological and economic damage will probably last for decades

Dimensions

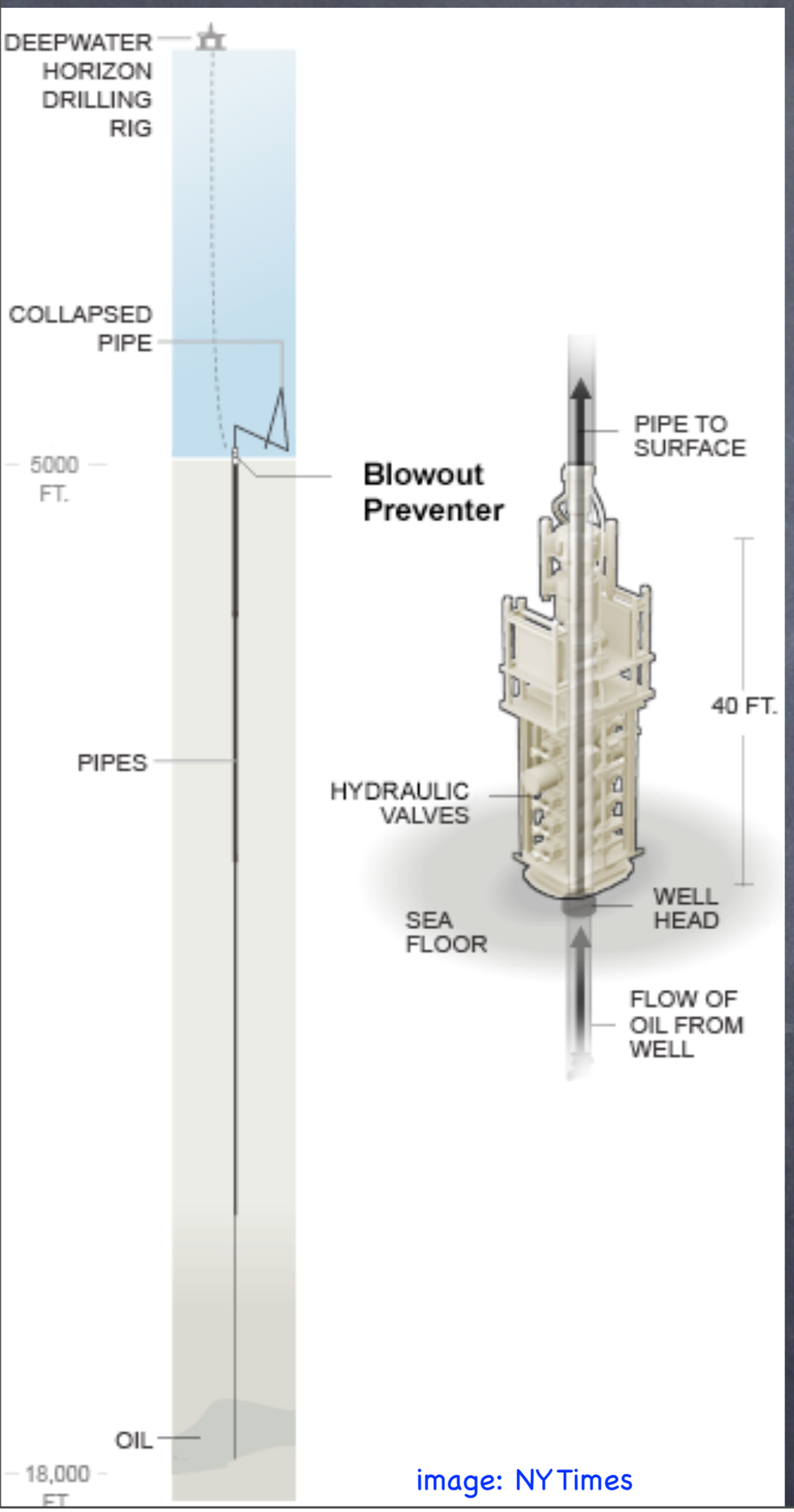


image: NY Times

image: Transocean Website

- The rig was 396 by 256 ft (121 by 78 m) and capable of operating in waters up to 8,000 feet (2,400 m) deep, to a maximum drill depth of 30,000 ft (9,100 m), and in 2010 was one of approximately 200 deepwater offshore rigs capable of drilling in waters more than 5,000 ft (1,500 m).

- Wikipedia

On April 20th, 2010

On April 20th, 2010

At 4:20PM MDT


Later, at 9:56PM CDT April 20th, 2010
and continuing for days...
MC252 Macondo

The Coast Guard stated to CNN on April 22, 2010 that they received word of the sinking at approximately 10:21 am

What Went Wrong?

- According to Transocean executive Adrian Rose, abnormal pressure accumulated inside the marine riser and as it came up it "expanded rapidly and ignited". According to interviews with platform workers conducted during BP's internal investigation, a bubble of methane gas escaped from the well and shot up the drill column, expanding quickly as it burst through several seals and barriers before exploding. Rose said the event was basically a blowout. Survivors described the incident as a sudden explosion which gave them less than five minutes to escape as the alarm went off. --Wikipedia

Why Wasn't It Stopped?

- NY Times Short Movie

How Big?

Nearly five million barrels [about 800,000 m^3] of oil have gushed from BP's well — and about 800,000 [16%] have been captured by containment efforts —since the Deepwater Horizon rig exploded on April 20, according to the latest data. That amount outstrips the estimated 3.3 million barrels spilled into the Bay of Campeche by the Mexican rig Ixtoc I in 1979, previously believed to be the world's largest accidental release.

- NYTIMES--By CAMPBELL ROBERTSON and CLIFFORD KRAUSS
  - --August 2, 2010

To Burn, to Disperse, or Not?

Lessons from Exxon Valdez

- Dispersants were ineffective for 'mousse' oil

- Dispersants and warm water washes had detectable negative environmental effects

- A version of Corexit was widely used after the 1989 Exxon Valdez spill and, according to a literature review performed by the group the Alaska Community Action on Toxics, was later linked with health impacts in people including respiratory, nervous system, liver, kidney and blood disorders. But the Academy report makes clear that the dispersants used today are less toxic than those used a decade ago.

Approximate oil locations from April 25, 2010 to April 30, 2010

including forecast for April 30

(based on trajectories and overflight information)

forecast for April 30

Legend

- Incident location
- April 25
- April 26
- April 27
- April 28
- April 29
- April30

0 20 40 80 Miles

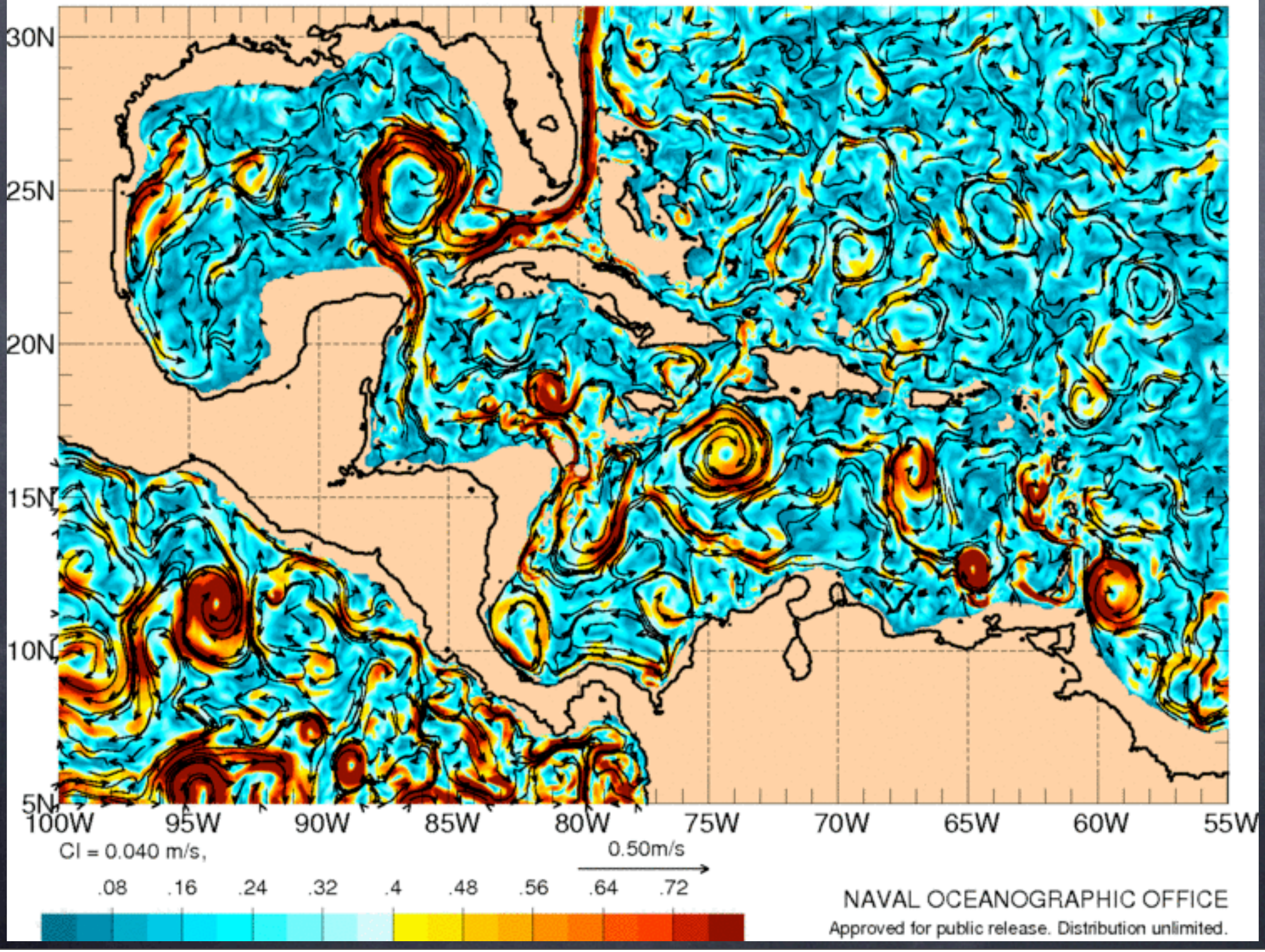
NOAA — National Oceanic and Atmospheric Administration — U.S. Department of Commerce

Modeling the Spill

- Complex dispersal--NY Times Tracker
- A number of groups used high-resolution ocean models to understand some pathways the oil might take.

UNCLASSIFIED: 1/32° Global NLOM

CURRENT/SPEED LAYER 1 ANALYSIS: 20100422

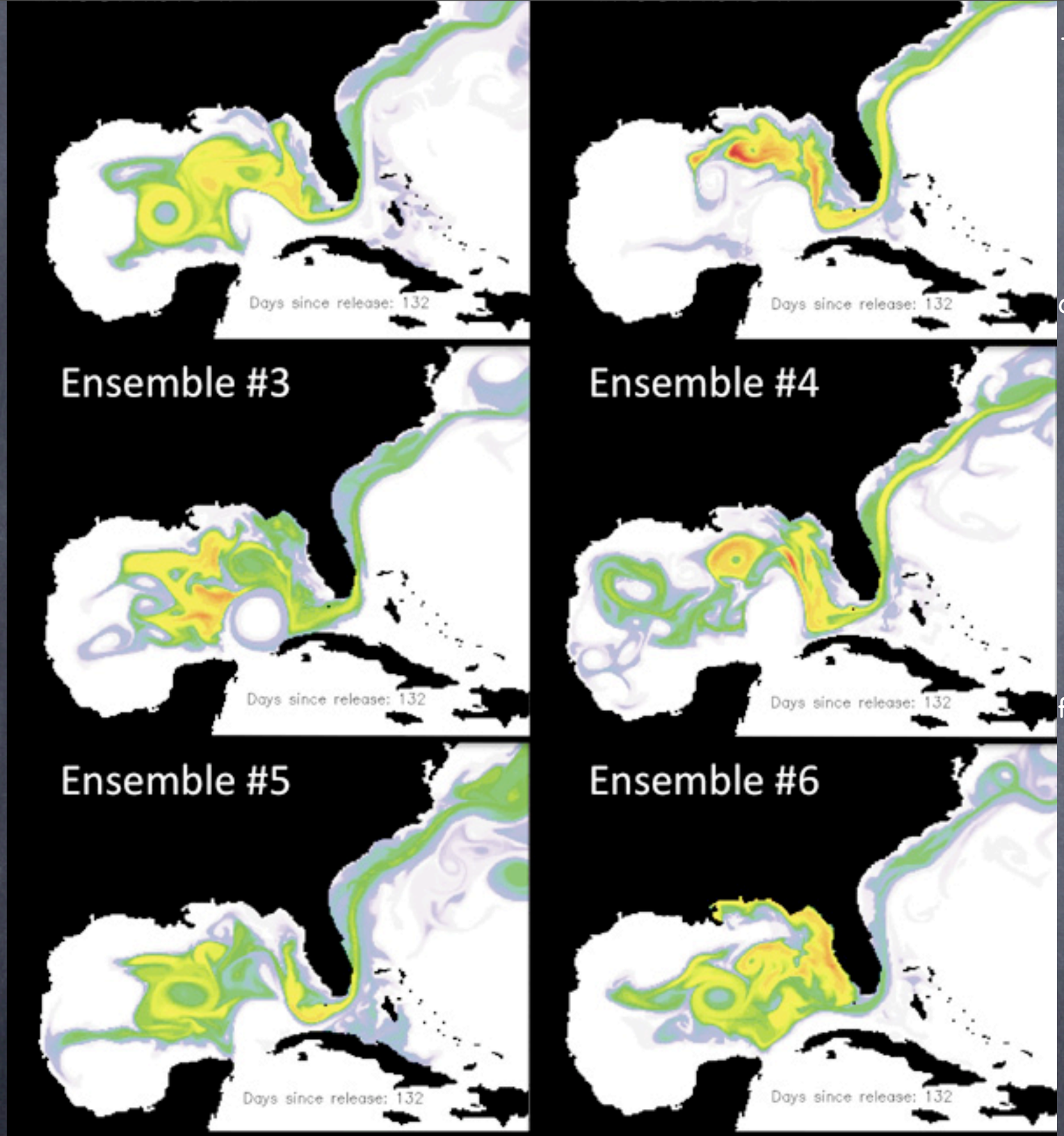


NAVAL OCEANOGRAPHIC OFFICE

Approved for public release. Distribution unlimited.

Ocean currents
likely to carry
oil to Atlantic

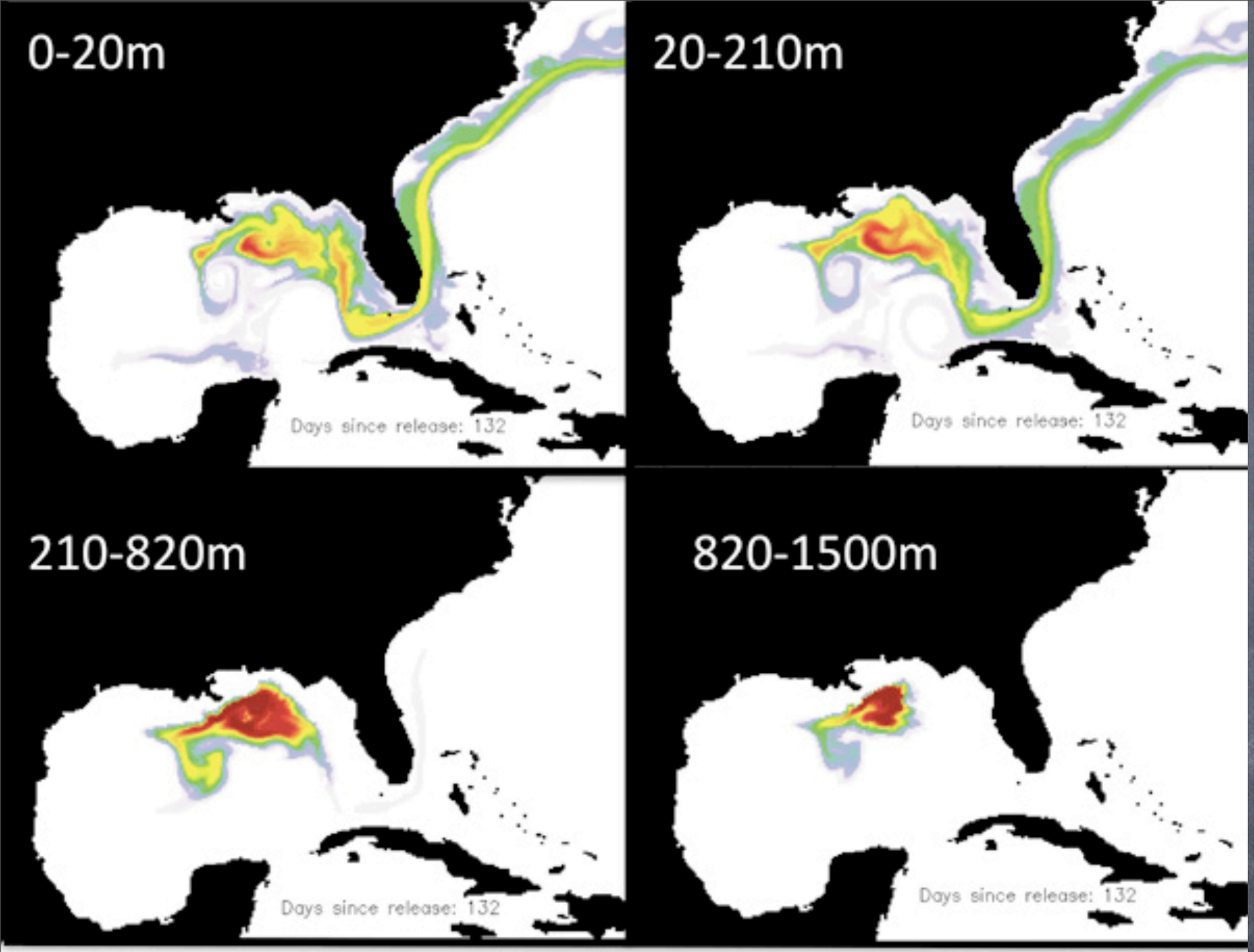
NCAR Simulations, soon after spill...



The animation shows one scenario of how oil released in the upper 65 feet of the ocean at the location of the Deepwater Horizon disaster on April 20 in the Gulf of Mexico could move. This is not a forecast, but rather, it illustrates a likely dispersal pathway of the oil for roughly four months following the spill. It assumes oil spilling continuously from April 20 to June 20. The colors represent a dilution factor ranging from red (most concentrated) to beige (most diluted).

The simulations do not make any assumptions about the daily rate or total amount of oil spilled and the dilution factor does not attempt to estimate the actual barrels of oil at any spot. Instead, one unit per day of a liquid "dye tracer" is injected in the model at the spill site (injected continuously over the period April 20 through June 20). The animation shows possible scenarios of what might happen to dye released in the upper 65 feet of ocean at the spill site. The dilution factor depicts how dye released at the site of the spill will be progressively diluted as it is transported and mixed by ocean currents. For example, areas showing a dilution factor of 0.01 would have one-hundredth the concentration of oil present at the spill site.

The animation is based on a computer model simulation, using a virtual dye, that assumes weather and current conditions similar to those that occur in a typical year. It is one of a set of six scenarios (view these below) that simulate possible pathways the oil might take under a variety of oceanic conditions. Each of the six scenarios shows the same overall movement of oil through the Gulf to the Atlantic and up the East Coast. However, the timing and fine-scale details differ, depending on the details of the ocean currents in the Gulf. (Source: NCAR Website)



Simulation of a passive dye injected at the location of the oil leak at various depth levels and advected by an ocean model for 132 days for one likely initial condition. The dilution factor is colored.

The National Center for Atmospheric Research NCAR managed by UCAR to serve the community

IFM-GEOMAR

The depth of spill counts--

Surface currents are faster

NOAA Geophysical Fluid Dynamics Lab (GFDL)

- GFDL Simulations
- NCAR Simulations

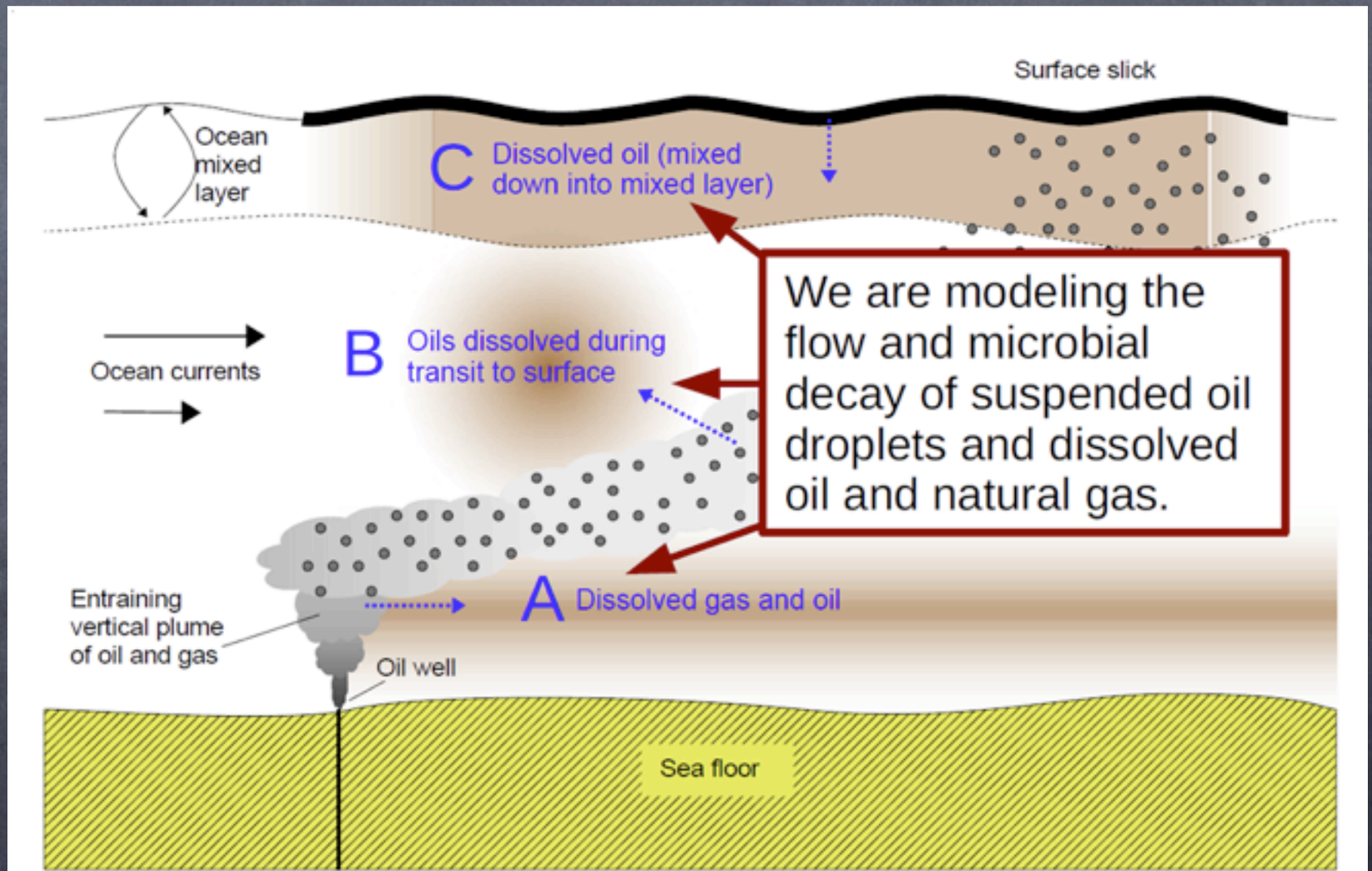


image: Adcroft et al., GFDL

- McLaughlin & Camassa Video
  - This video shows two experiments that help explain why and how an oil spill on the seafloor, similar to the current BP leak in the Gulf of Mexico, could form underwater oil plumes that do not rise to the surface.
  - The reasons include:
    - •whether a spill is released in the form of a turbulent jet, or is under less pressure
    - •the density of the surrounding water, due to temperature and salinity.
  - The experiments (and this text) were conducted by Richard McLaughlin, Ph.D., and Roberto Camassa, Ph.D., fluid dynamics experts in the mathematics department at the University of North Carolina at Chapel Hill

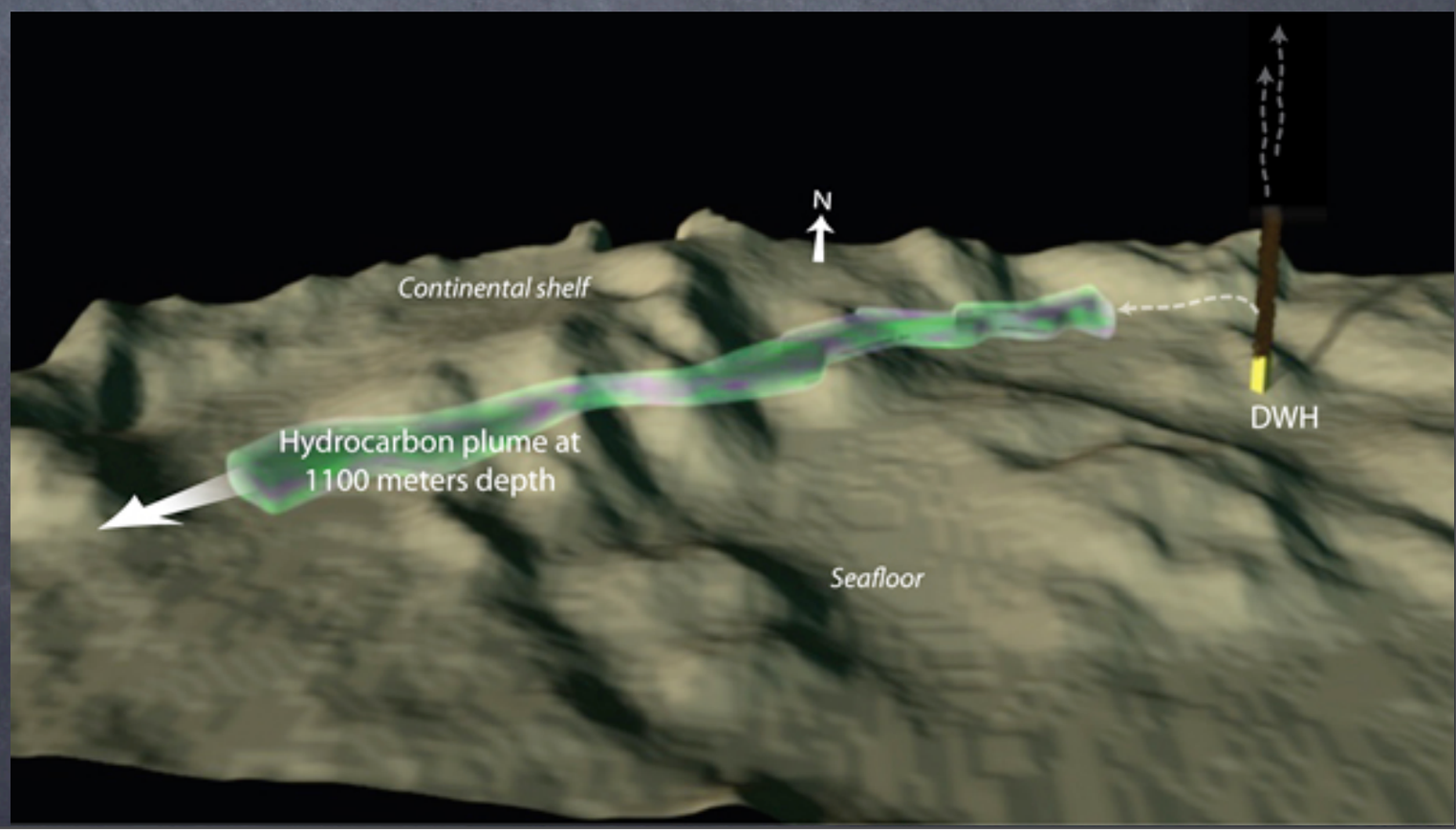
Underwater Plume?

Scientists at the Woods Hole Oceanographic Institution (WHOI) detected and characterized a plume of hydrocarbons that is at least 22 miles long and more than 3,000 feet below the surface of the Gulf of Mexico, a residue of the BP Deepwater Horizon oil spill. The work presents a forensic snapshot of the plume characteristics in June and is reported in a study appearing in the Aug. 19 issue of the journal Science.

Another unexpected result was the lack of "dead zones," regions of significant oxygen depletion as a result of microbe metabolism..

Animation

- CBS Report



- A week after a high-profile paper suggested that the vast Deepwater Horizon oil plume could linger for months, another study claims bacteria are breaking the oil down quickly, and that the plume is likely gone.

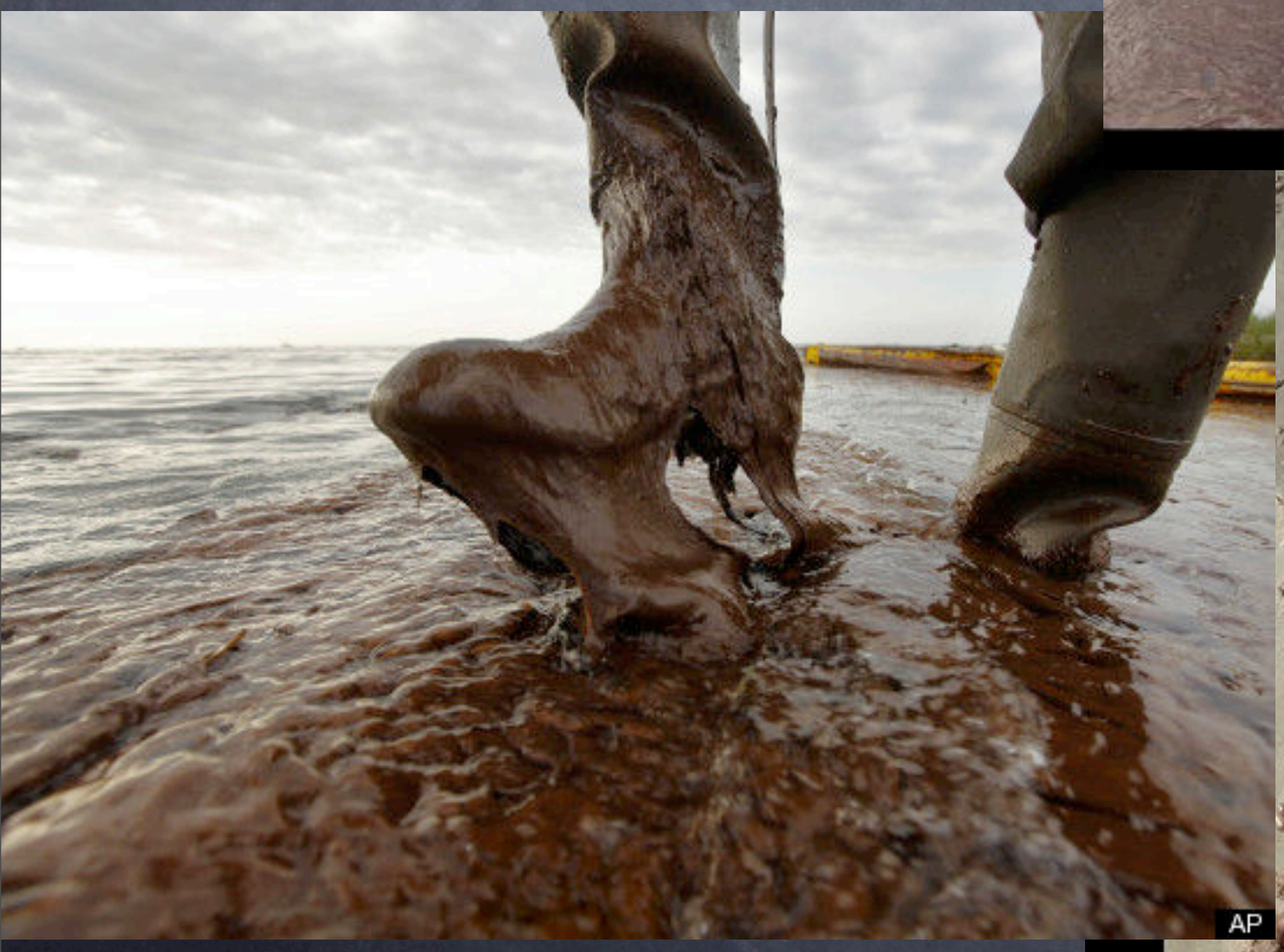
- The conflict between the results are striking. Other researchers warn that there's just too little data to draw any conclusions. But the new findings are at least encouraging.

- "We saw the same plume they did," said Terry Hazen, an ecologist and oil spill specialist at the Lawrence Berkeley National Laboratory, whose research is funded in part by BP. "We found that very large proportions of genes from water in the plume have the ability to produce enzymes that break down the oil."

- As with last week's study, Hazen's involved samples taken from the deep-sea oil plume that in late June was 22 miles long, one mile wide and 650 feet thick, and was published in Science.

    - --By Brandon Keim at Wired.com, Tue Aug 24

Models didn't but the oil did get to the coast!



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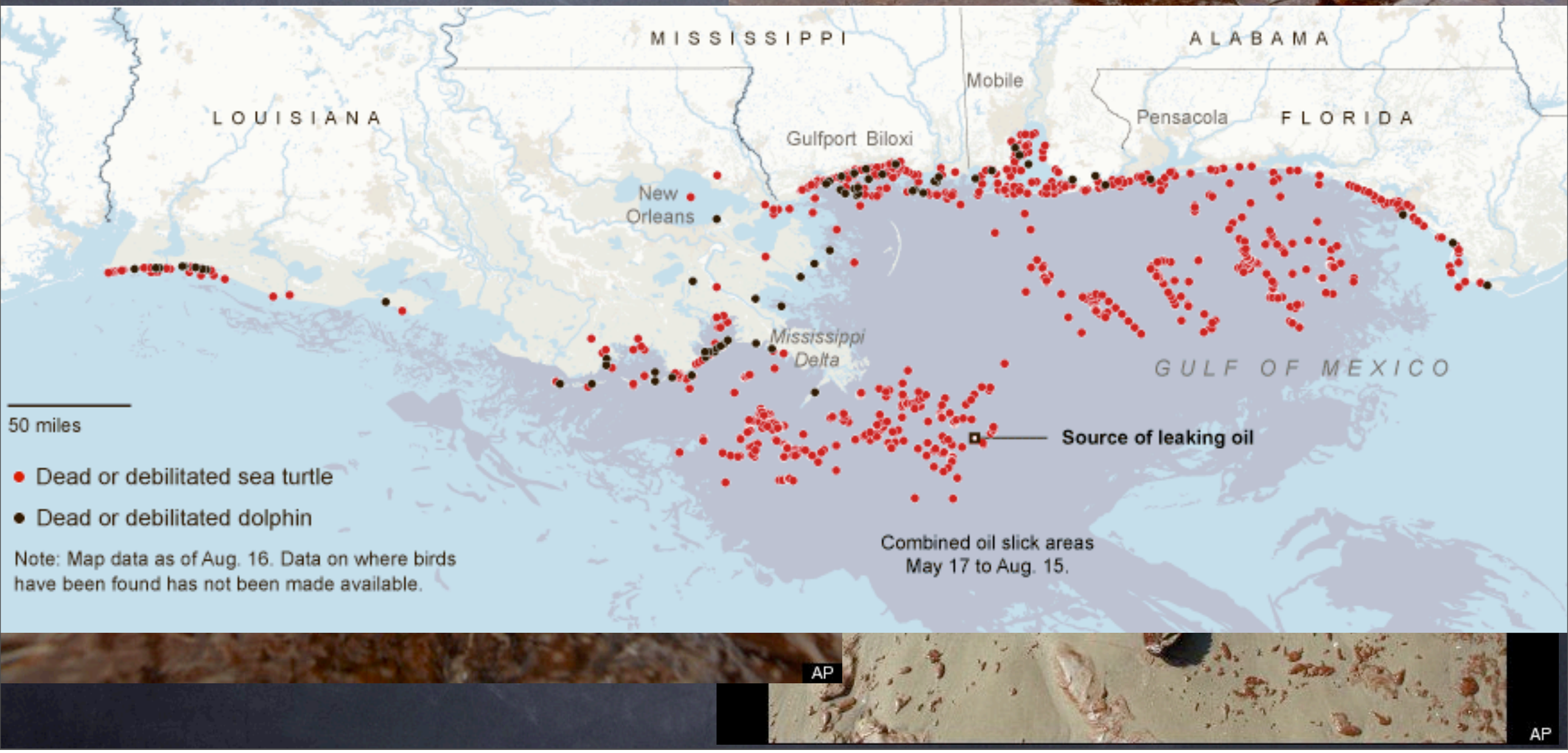
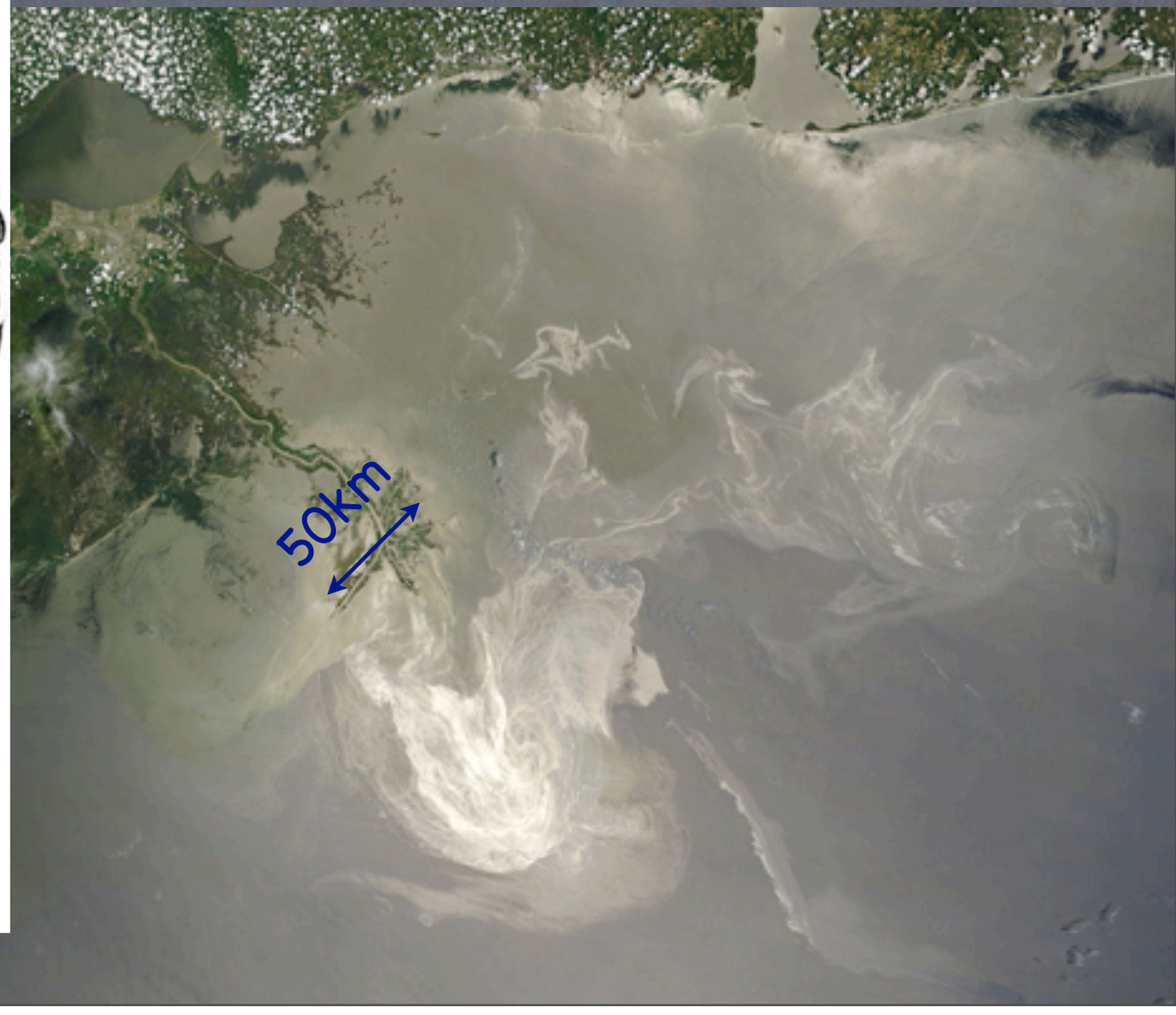


Submesoscale processes at work on the Deepwater Horizon Spill

Zina Saunders, NY Times



Coastal intrusions straining, frontal instabilities

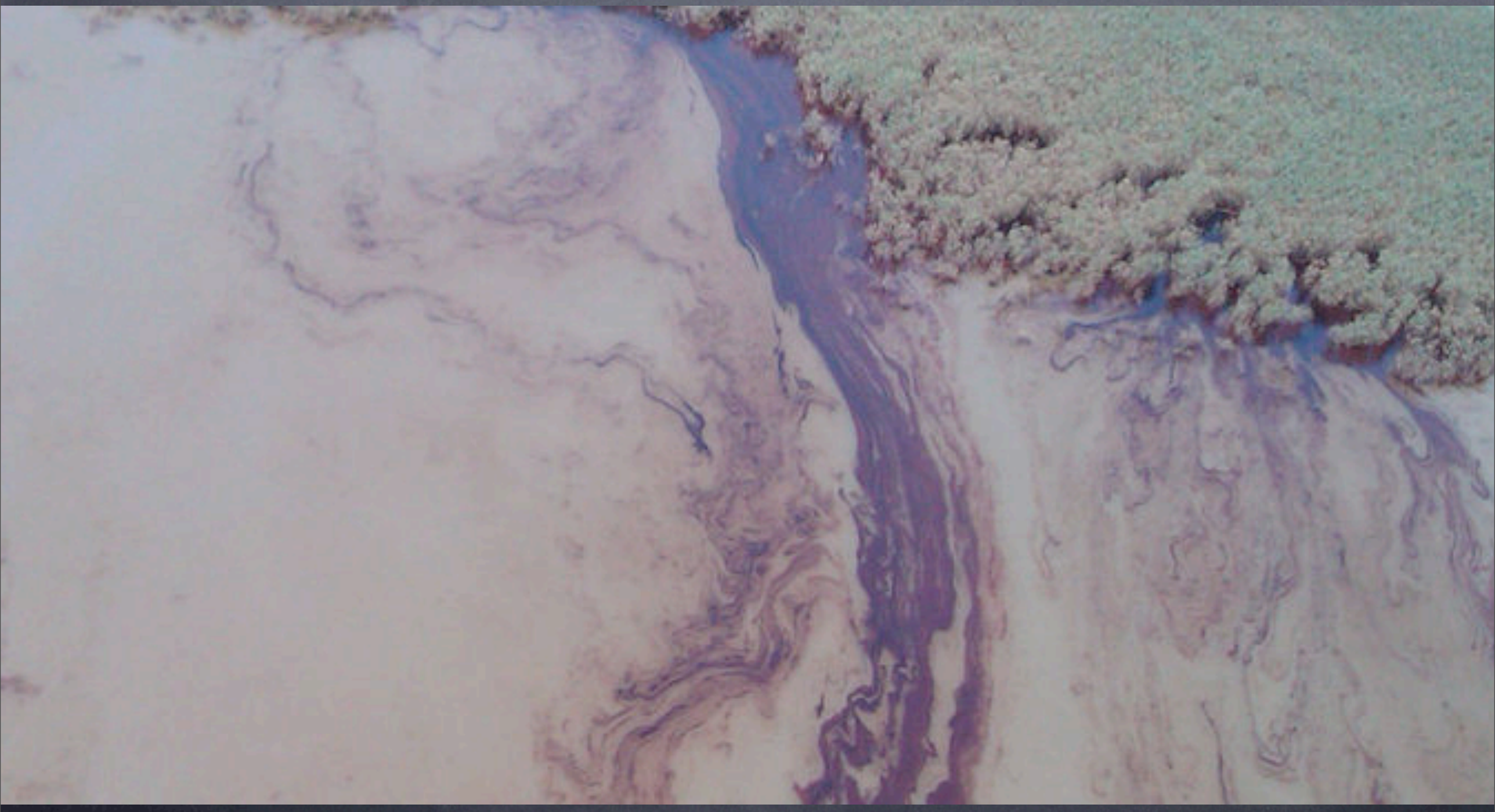


image: www.huffingtonpost.com

Contrast to closeup--
Eddy size, surface tension

Langmuir Windrows, too.

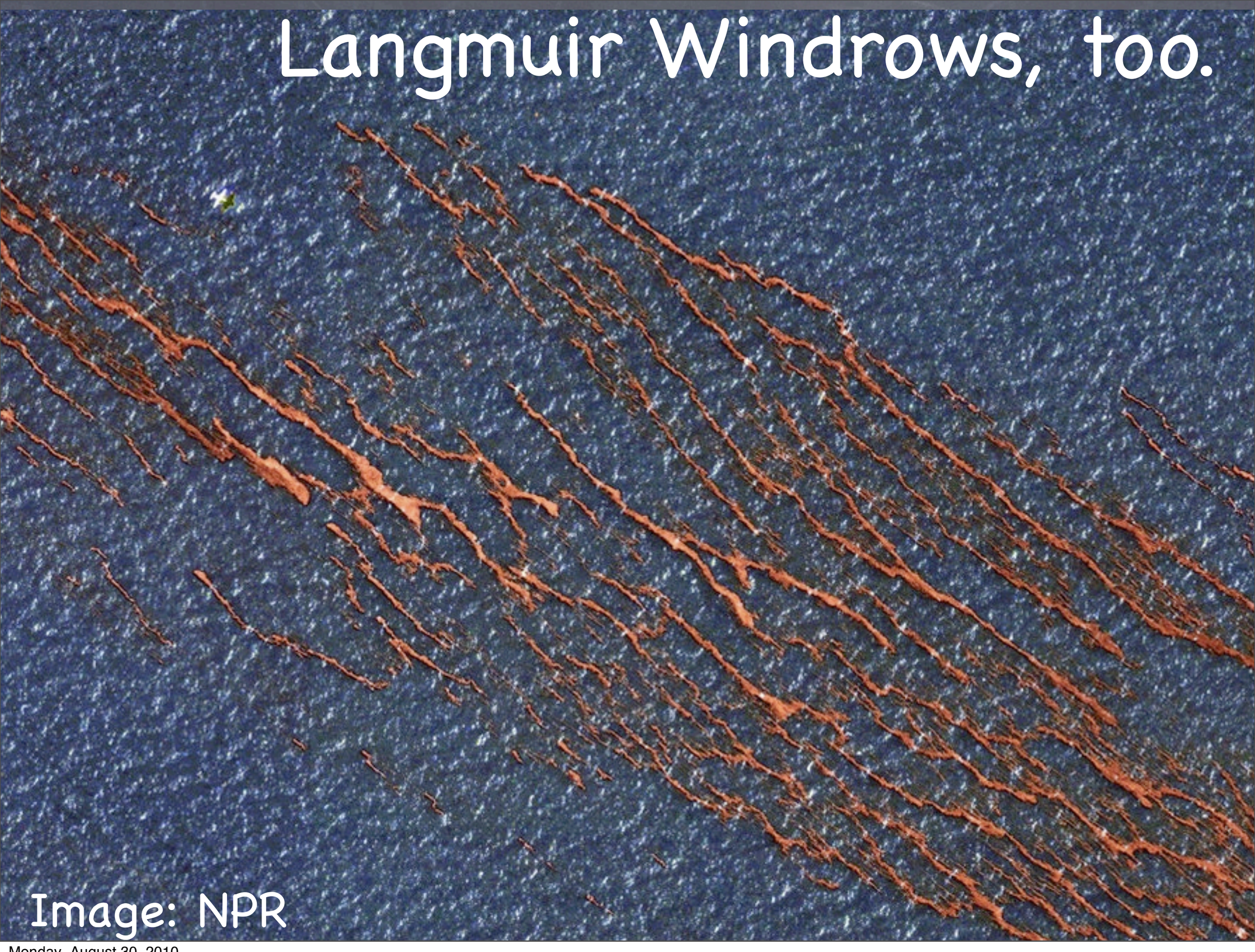
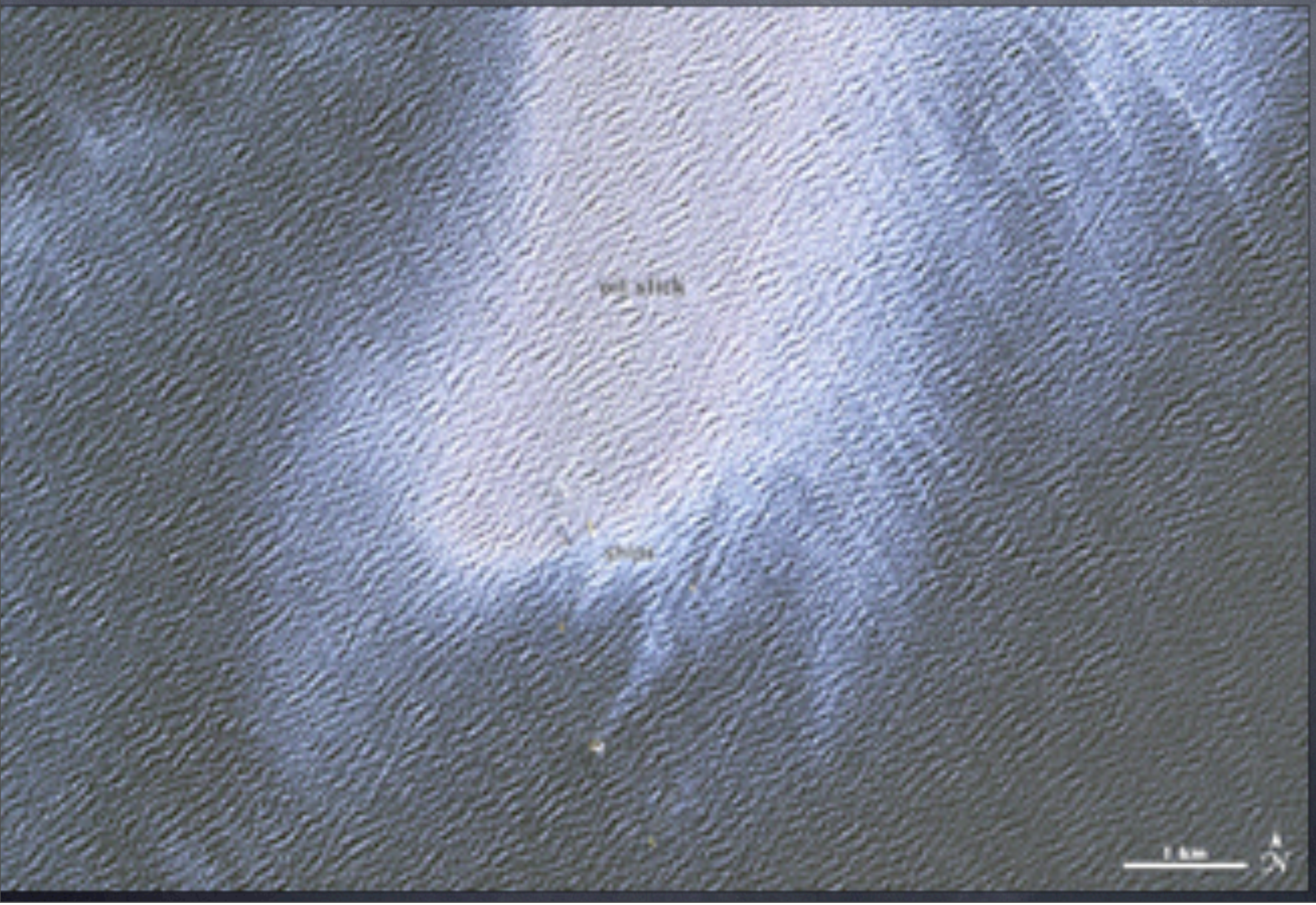
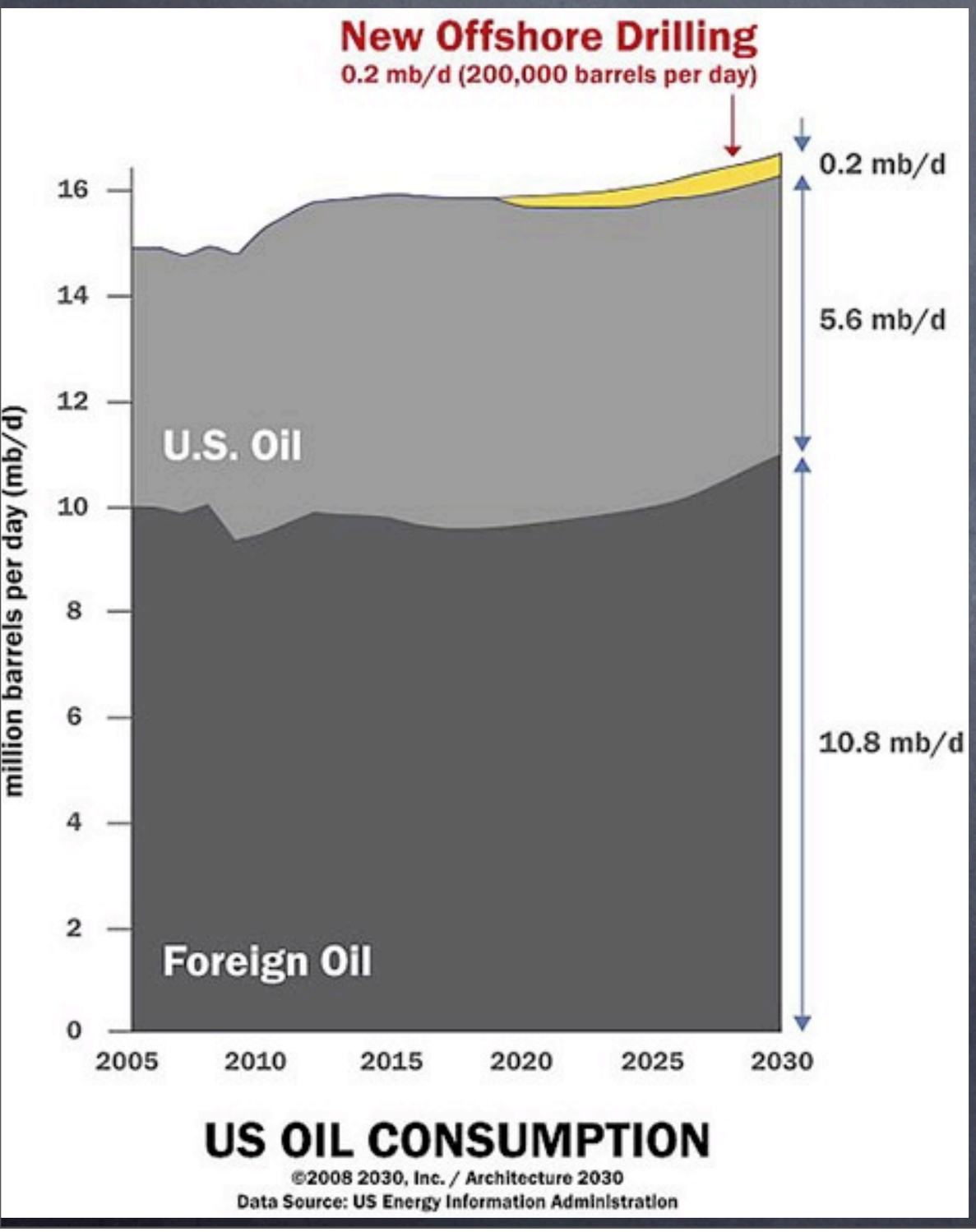


Image: NPR

- Fig. 2: A false-color image from NASA's Terra satellite on May 1, 2010. The streaking patterns perpendicular to the wave crests are likely windrows between Langmuir circulations (image: NASA Earth Observatory).



Worth it?

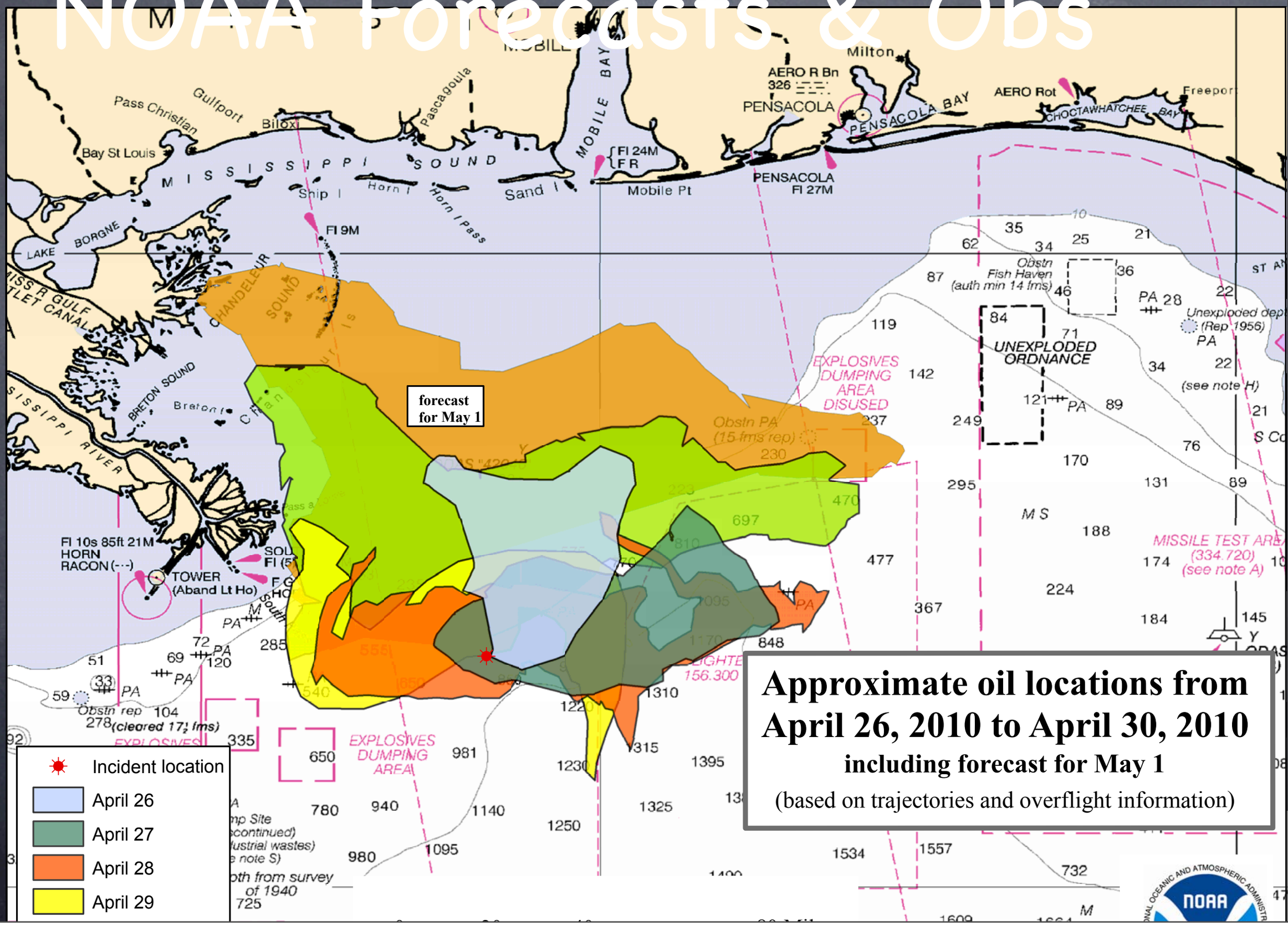


- US uses 20M barrels/day= $1.5 billion/day
- Cost of Spill
  - $100M/relief well
  - $360M/barriers
  - $2.5B fishing industry
  - $3.1B BP Spent by July 5
  - $30B total losses.
  - $100B loss in BP stock value by June

Conclusions

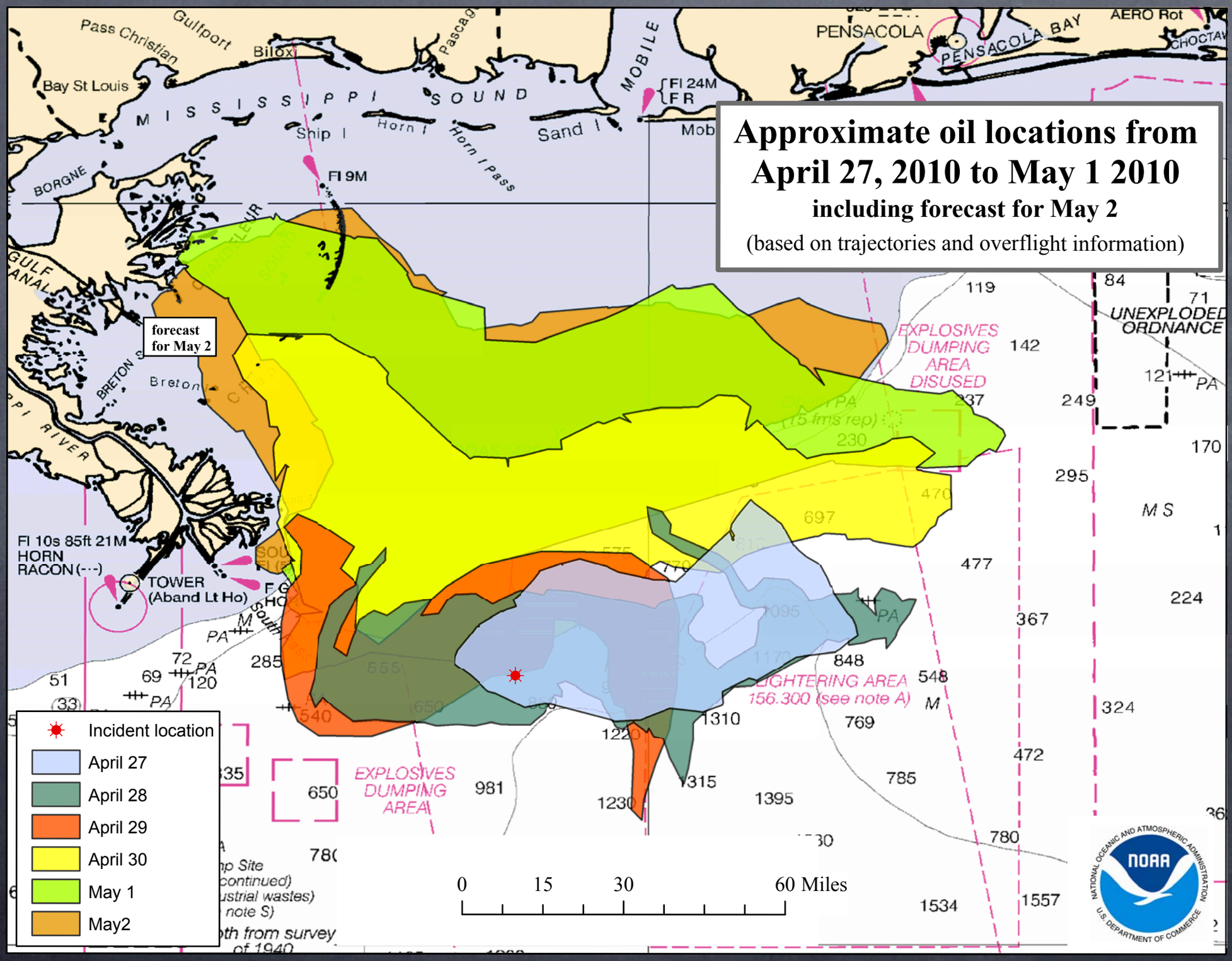
- The Deepwater Horizon explosion is the largest oil spill ever
- Recovery--mostly by microbes eating oil--is encouraging
- Underwater plumes persist, slowly degrading
- Models have told interesting stories
  - Need to be carefully interpreted
  - still missing crucial near-surface processes.

NOAA Forecasts & Obs



Monday, August 30, 2010

NOAA Forecasts & Obs



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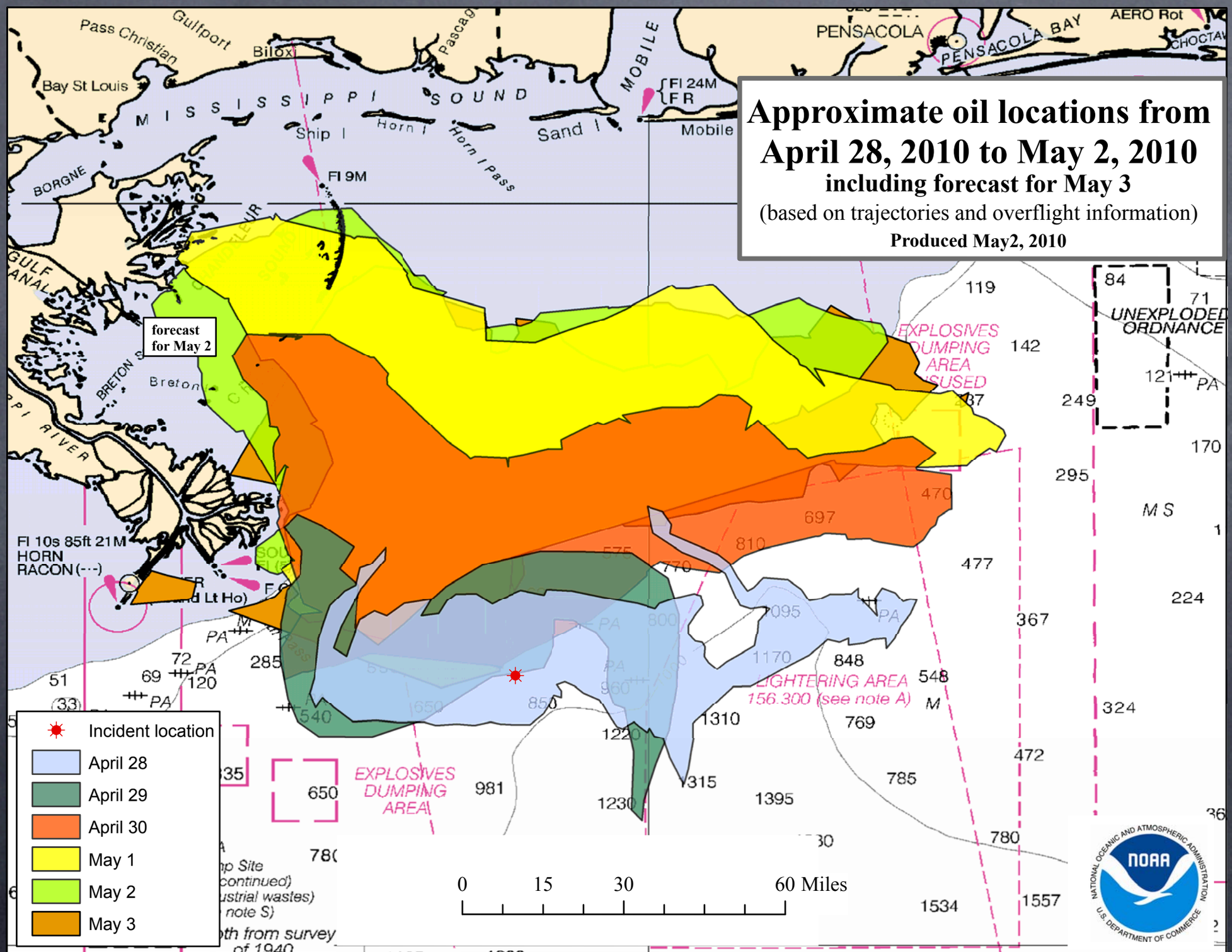

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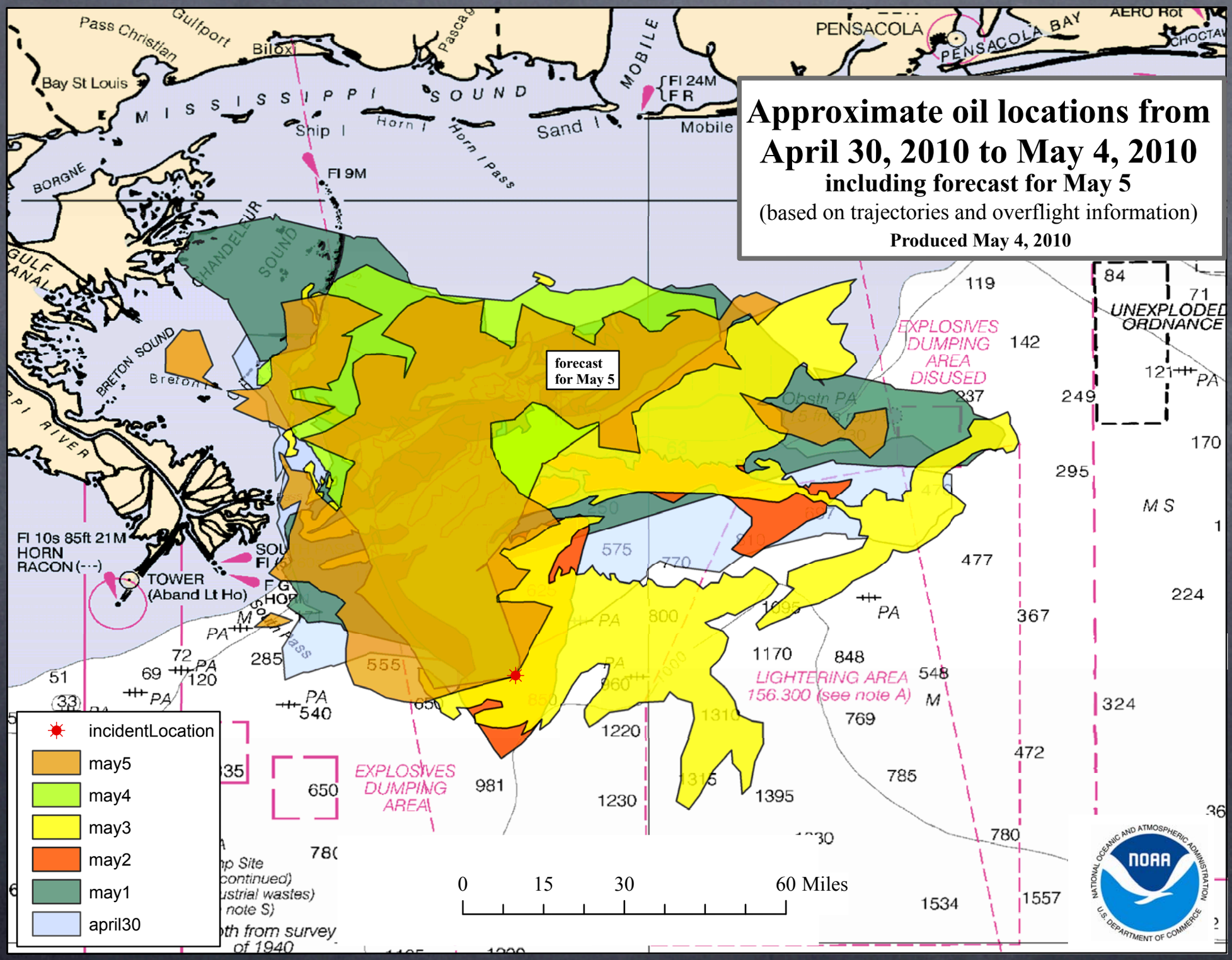

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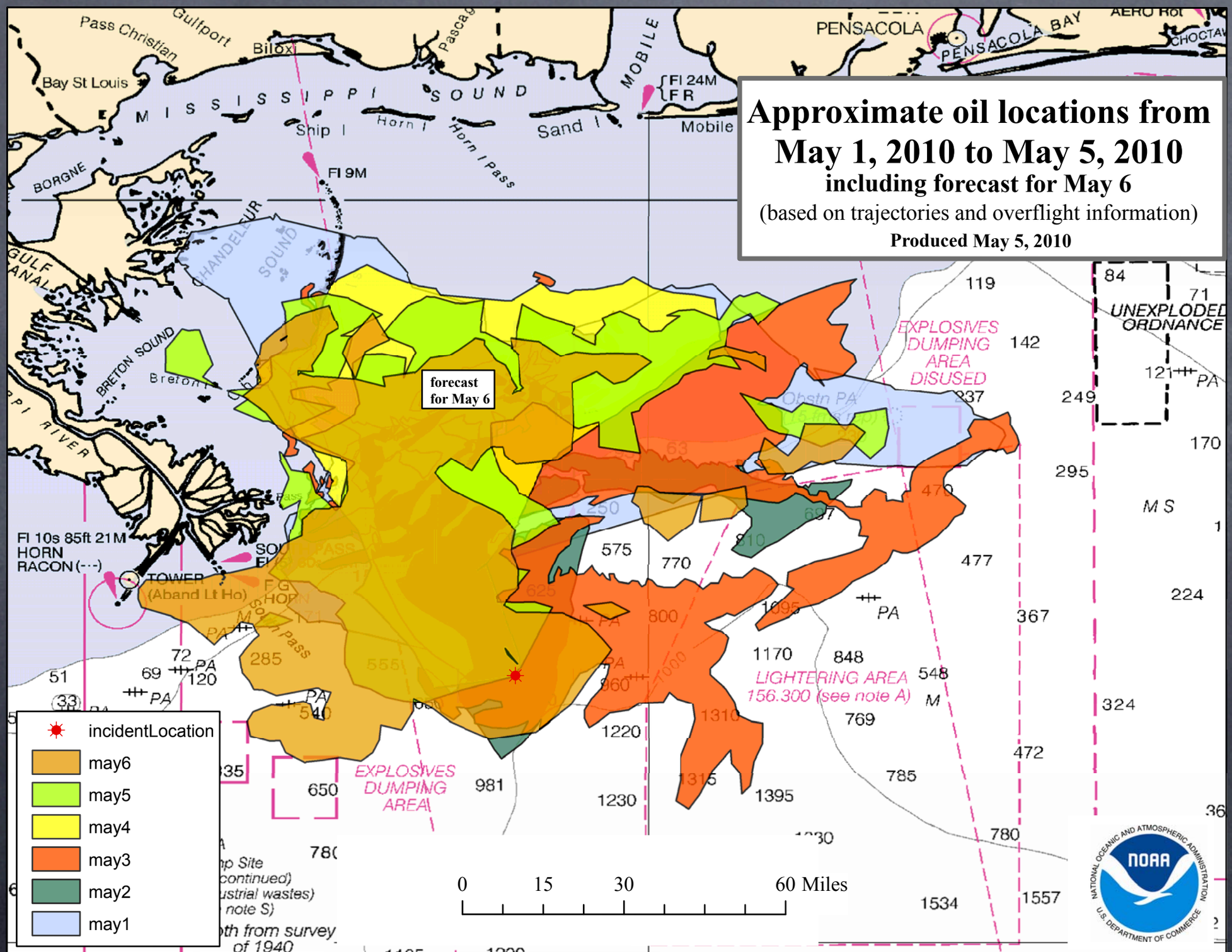

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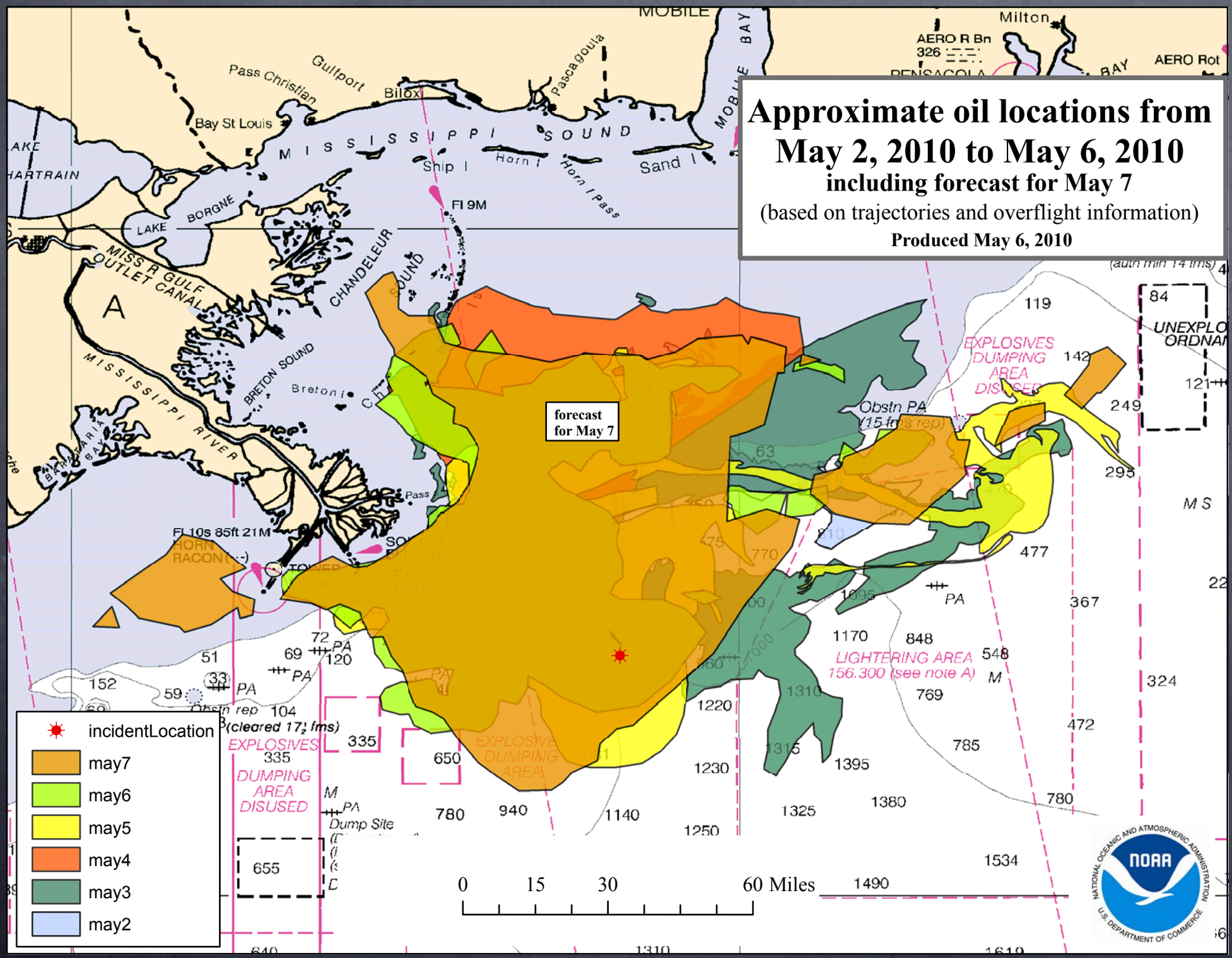

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