Title: *Coastal Modeling: Oil, Where Art Thou?*
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Background Information


www.gulfresearchinitiative.org

Many times physical oceanographers are incorporated into marine contamination cases because they are the experts on water movement. One of their main tools for predicting water movement is using computer simulations based on historic patterns in the water, wind, as well as mathematical formulas. Sometimes, these simulations are incorrect on predicting the correct route of contaminants because there are so many dynamics in play. There have been a number of studies that have tried to predict where the BP oil may go based off of a wide range of factors. Some of the general parameters that have been used in many of these recent studies have been the influence of eddies, the Loop Current, and the Mississippi River.

Louisiana State Standards (Grade-Level Expectations)

SI GLE: Write a testable question or hypothesis when given a topic (SI-H-A1)
Describe how investigations can be observation, description, literature survey, classification, or experimentation (SI-H-A2)
Choose appropriate models to explain scientific knowledge or experimental results (e.g., objects, mathematical relationships, plans, schemes, examples, role-playing, computer simulations) (SI-H-A4)
PS GLE: Assess environmental issues related to the storage, containment, and disposal of wastes associated with energy production and use (PS-H-G4)
SE GLE: Identify and explain the limitations of models used to represent the natural world (SIM-A5)
Discuss how education and collaboration can affect the prevention and control of a selected pollutant (SE-H-D2) (SE-H-D3)
LS GLE: Illustrate the flow of carbon, nitrogen, and water through an ecosystem (LS-H-D1) (SE-H-A6)
Analyze positive and negative effects of human actions on ecosystems (LS-H-D4) (SE-H-A7)

Ocean Literacy Principles

Principle 1c: Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water

density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.

Principle 1e: Most of Earth's water (97%) is in the ocean. Seawater has unique properties: it is saline, its freezing point is slightly lower than fresh water, its density is slightly higher, its electrical conductivity is much higher, and it is slightly basic. The salt in seawater comes from eroding land, volcanic emissions, reactions at the seafloor, and atmospheric deposition.

Principle 1g: The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.

Principle 3a: The ocean controls weather and climate by dominating the Earth's energy, water and carbon systems.

Principle 6b: From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

Principle 6e: Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

Principle 7d: New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

Principle 7e: Use of mathematical models is now an essential part of ocean sciences. Models help us understand the complexity of the ocean and of its interaction with Earth's climate. They process observations and help describe the interactions among systems.

Time Requirement

This is an activity that requires a minimal setup of 1-5 minutes. The main component of it is starting Microsoft PowerPoint (**2007 and 2010 software only**). Download the pre-made PowerPoint and allow students to peruse. Additional time should be spent, prior to this presentation, discussing flow patterns within the Gulf of Mexico.

Materials

Coastal Modeling: Oil, Where Art Thou(?) link
Multiple laptops or computers
Flash drives to transfer to multiple computers/laptops(optional)

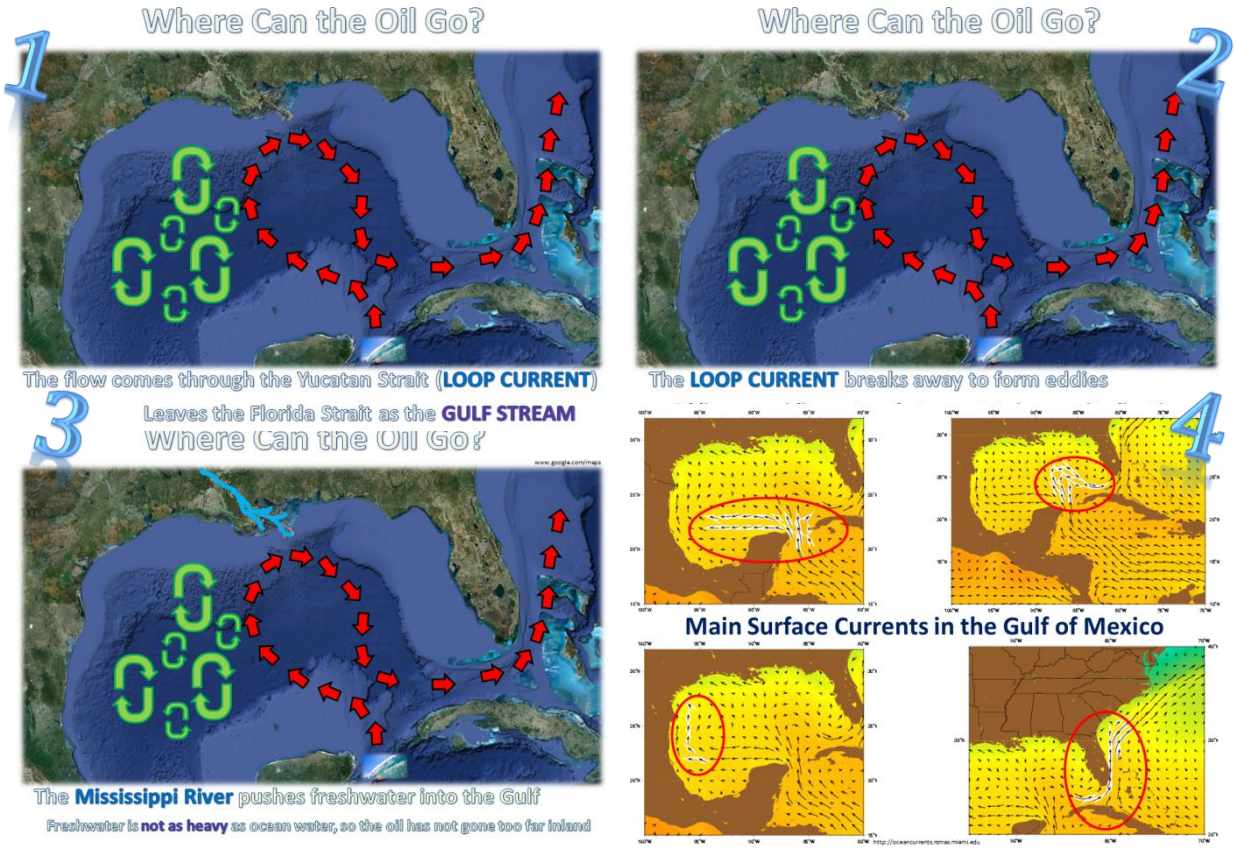
Lesson Description

Creating the Coastal Modeling: Oil, Where Art Thou(?) Project

1. Start Microsoft PowerPoint (**2007 and 2010 software only**) and open/upload the *Coastal Modeling: Oil, Where Art Thou(?) file.*
2. Discuss each slide with the students.

Methodology

Students will work in groups to imitate physical oceanographers trying to predict the travel route of the surficial oil from the BP-Deepwater Horizon incident. Students must take into account the influence of warm and cold core eddies, the long and winding Loop Current, and the freshwater discharge of the Mississippi River. They will use the animation technology of Microsoft PowerPoint to demonstrate some of the routes the oil can travel based on flow pattern research. Afterwards, groups can compare predicted routes. Post simulation, inform students that majority of the surficial oil was removed, but there are still high concentrations of deep water oil. The students can read about some of the results used in this activity on the pages below (optional).



Oil Transportation

Majority of the underwater plume was headed in a southwestern direction. Less water soluble compounds were found in the upper region of the water column, and further away from the dispersant. Deepwater dispersants increased the oil remaining in the deeper layers and decreased the oil rising to the surface (i.e., may all be due to slower water velocity). Temporarily persistent subsurface plumes were found at 25, 265, 865, and 1175 meters (i.e., largest and most consistent plume). Article: *Distribution of hydrocarbons released during the 2010 MC252 oil spill in deep offshore waters (Spier et al., 2012)*

The Mississippi River plume exerts a strong influence on circulation patterns within the northern Gulf of Mexico. It is freshwater, so the difference in density helps create a movement that may have impacted the oil plume from the BP incident (along with magnitude of river discharge, wind stress and the effects of eddy currents). Lower riverine discharge rates helped induce a freshwater mound near the mouth of the river. This mound can act as a natural barrier for oil spreading further north into some of the Gulf of Mexico estuaries. Earlier models of oil trajectory did not account for pressure-driven flows; physical and biological processes are needed in consideration for projection of these oil plumes. Article: *Mississippi River and sea surface height effects on oil slick migration (Falcini et al., 2012)*

Standard Evaluation (Student Deductions)

1. Find the article *Distribution of hydrocarbons released during the 2010 MC252 oil spill in deep offshore waters* by Spier et al. 2012 (use www.google.com/scholar as the research engine). Summarize the introduction and conclusion sections of this paper.
2. Find the article *Mississippi River and sea surface height effects on oil slick migration* by Falcini et al., 2012 (use www.google.com/scholar as the research engine). Summarize the introduction and discussion sections of this paper.
3. Describe where you thought the oil may go and why.
4. Which flow factor (e.g., Mississippi River, eddies, Loop Current) do you think would have the greatest influence on oil transport? Why?
5. Which flow factor (e.g., Mississippi River, eddies, Loop Current) do you think would have the smallest influence on oil transport? Why?
6. Most of the BP related studies being conducted are focusing on oil in the deeper portions of the Gulf of Mexico because the surficial oil was easier to remove. Do you think there still may be traces of oil on the surface that we should observe? Why or why not?

The evaluation can be in the form of a test, essay, questions and answers worksheet, or any other mode of measuring retainment or comprehension of material.