3 Questions: John Marshall on the Gulf of Mexico oil spill

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This image, taken by NASA's Terra satellite, shows the growing oil slick in the Gulf of Mexico reflected by the sun. Photo: NASA

(PhysOrg.com) -- More than a month after the tragic events that set off the largest oil spill in U.S. history, scientists and BP officials continue to disagree over the amount of oil that has escaped into the Gulf of Mexico. Unlike other oil spills that have occurred relatively close to the surface, this spill is located about a mile down, which has made it difficult to predict the effects. John Marshall, an oceanographer in MIT's Department of Earth, Atmospheric and Planetary Sciences, spoke to MIT News about the deep-sea catastrophe and the long, difficult cleanup ahead.

Q. What is it about this oil spill that is going to significantly complicate

cleanup efforts?

A. The challenge for the cleanup operation depends on two factors: how much oil has escaped from the broken well - a figure that has been in much dispute - and to what degree it has spread around the ocean. The big problem for the cleanup is that in this spill, unlike the surface releases from broken oil tankers, such as the Amoco Cadiz in 1978 and the Exxon Valdez in 1989, the oil is coming up from the bottom, some 5,000 feet down. As the oil makes its way to the surface, the whole depth of the ocean is being contaminated. We have never had a spill like this before. Oil bubbling up from the seabed is folding in water from its surroundings, much like how smoke coming out of a chimney mixes in with surrounding air. The good thing is that the mixing process hugely dilutes the rising oil plume, breaking it into lots of very fine particles. The bad thing is that large volumes of water -many, many times larger than the millions of gallons of crude that have escaped - become contaminated with the oil and the dispersant chemicals being added at the source. Think of an Alka Seltzer tablet in a cup of water creating small bubbles that rise up to the surface. In the oil leak, the bubbles are tiny pockets of warm oil being mixed with gases like methane and other substances that undergo chemical reactions as they rise.

But unlike the Seltzer bubble analogy, it appears that a significant quantity of oil is not making it directly up to the surface. There are reports of two large subsurface clouds, one at 1,500 feet and one at 3,000 feet. It's not clear where these clouds of microscopic oil particles are going or how to clean them up. It's likely that nothing can be done about this subsurface oil, and that we will have to rely on nature's solution - bacteria that eat oil - to deal with the problem.

The oil that does make it to the surface is then influenced by winds blowing over the surface of the Gulf. Over time, the oil spreads horizontally by currents powered by wind and tides, including the Gulf

of Mexico's powerful stream known as the "loop current," and is eventually drawn into the general circulation of the ocean. Some of it will be carried away to contaminate other parts the Gulf, and some of it will be washed up on local shores.

Q. There have been reports that the oil may already have seeped into the loop current. What would this mean for the rest of the Gulf of Mexico and for the Atlantic seaboard?

A. Mixing and spreading of the oil into the wider ocean will make it much more difficult to corral the significant quantities of oil released. Our cleaning and capturing efforts will end up processing just a tiny fraction of it. The oil slick at the surface can be tracked by satellite and is already being drawn into complex swirling patterns as it is carried along by currents. Ocean circulation models are proving useful in figuring out where the oil is going. We can predict the likely general path of the slick as it is drawn into the loop current and out of the Gulf in to the Atlantic. However, just as there is a fundamental limit to the predictability of weather, the detailed positions and timings of these oil swirls are unpredictable. Some coastlines will avoid the disaster, and others may be hit hard. Another big problem is that we have few observations of where the subsurface clouds of oil are spreading and when and if they will make landfall.

Q. Some scientists are saying that a lot of the damage that has occurred so far as a result of this spill has occurred in the water column. What is the water column, and what are the implications of damage to the water column?

A. Yes, it appears that lots of microscopic particles of oil are hanging out at mid-depth in the water column, which is the column of water that extends from the sea surface to the sea floor. In normal circumstances, the water column arranges itself so that light, generally warmer fluid is

on top, and heavy, colder fluid below.

As the plume of oil, water and gas rises through the water column, it loses buoyancy, or the ability to float, because of the mixing in of colder surrounding fluid. It appears that this is actually causing the rising oil clouds to be temporarily arrested at particular levels in the water column, from which they then spread out horizontally.

Biologists are concerned about the effect these stalled clouds could have on life in the water column, not just at mid-depth and the surface, but also on bottom-dwelling organisms that ultimately depend for their food on dead organic matter that sinks down from above. Some scientists argue that the surfactant, or soapy wetting agent, being added at the bottom source and at the surface of the ocean to help disperse the oil, could ultimately cause more damage to the health of the water column than the oil itself. The health of the water column might only be restored after many years, perhaps a decade or even longer.

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