Oil Spill Chemical Characteristics Summit

June 29, 2010

University of North Florida, Jacksonville, Florida

Organized by: South Atlantic Sea Grant Programs

Summary by: Dr. Charles Hopkinson, Director, Georgia Sea Grant

In Florida, Georgia, and South and North Carolina, questions continue to arise among the public and its legislative, executive, and business leaders regarding whether oil spilled into the Gulf of Mexico (GoM) due to the Deepwater Horizon (DH) disaster might reach South Atlantic waters and shores and in what forms. These questions and concerns seemed to increase following national news reports in mid June that identified surface slicks of oil entering the Loop Current, which connects to the Gulf Stream. Once in the Gulf Stream, the oils could flow up the East Coast of the United States.
On June 29, 2010, at North Florida University in Jacksonville, FL, the four South Atlantic Sea Grant Programs convened a roundtable of recognized petrochemical and chemical oceanographic experts from the region to consider, discuss, and **answer questions on what forms oil is likely to be in if GoM oil arrives in regional waters**. The June 29 roundtable panel reached consensus on what is generally known and unknown about the oil leaking from the GoM spill site and how it weathers and could change form, concentration and toxicity before reaching our region. The panel also identified steps that could be taken to monitor for the presence of oil not only in the Gulf Stream but also on SE coast continental shelf and beaches.

At the end of the roundtable, the panel reached **five conclusions**: 1) a deep subsurface plume of microscopic droplets of oil with and without a dispersant coating is unlike any known historic oil spill; 2) in addition to oil at depth, a large fraction of the oil has risen to the surface of the GoM, where it is forms into sheens, mousse and tar balls that are being rapidly weathered; 3) highly weathered tar balls and subsurface dissolved and micro-droplets are the most likely forms for any oil reaching the east coast; 4) concentrations and toxicity of any oil (surface and subsurface) that might reach SE waters will be substantially lower than in the GoM; 5) ecological and human health effects of micro-droplet forms of oil with dispersant are largely unknown; and made **a follow-up recommendation** 1) to establish a monitoring network to determine clean, baseline conditions and to inform decision-makers of the arrival of various forms of oil throughout the SE region.

The experts agreed that there are some hard realities and major questions that limit generalizing about the movement, form and effects of spilled Gulf oil in South Atlantic waters. These include:

- Our experts informed us that it may have been out of fear for the health of clean-up workers that BP has been injecting dispersant at depth at the oil spill site. Louisiana crude oil has a high volatile component content that readily evaporates into the atmosphere when it floats on the sea surface. Many of these volatile components are highly toxic and therefore put workers within many miles of the spill site at risk. By adding dispersant at depth, BP hoped to keep as much oil as possible deep in the water and prevent it from floating to the surface.
- Much of the oil takes the form of micro-droplets because it is being injected from the bottom at tremendous force, high pressure and low temperature. We were given the analogy of an aerosol can being discharged, with micro-droplets of can contents being sprayed into the air - or in this case being sprayed into the deep water. The addition of dispersant augments this process.

- Oil in the deep water exists as micro-droplets (microns or about a millionth of an inch in diameter) that are not buoyant and therefore do not float to the surface. Some of these droplets are coated with dispersant while others are not. The surfaces of the droplets are likely coated with micro-organisms, such as bacteria, that are slowly degrading the oil. The long-term fate of these droplets is unclear. Rates of decomposition or degradation are being measured in laboratories around the country. It is likely that much of this oil will persist for years in the cold temperatures of deep Gulf waters.
- The deep oil droplets will be toxic if their concentration is sufficiently high. The toxicity could be due to both mono-aromatics as well as poly-aromatics (e.g., the PAHs we hear so much about). The mono-aromatics are usually the most toxic, but they generally evaporate quickly from surface slicks. Being that evaporation does not occur in deep water, the toxicity of these forms will last much longer. Adding to the toxicity will be the dispersant. The experts expect the dispersant - oil mixture to be more toxic than either alone.
- A variety of weathering processes are occurring in the GoM and will occur in the Loop Current, Gulf Stream or SE continental shelf waters should the oil reach our region. Weathering changes both the form of oil and its toxicity. Evaporation, degradation by sunlight (photo-degradation), microbial decomposition and flocculation (formation of large particles from small or dissolved particles) are some of the most important weathering processes that will work to the advantage of the SE region.
- Weathering will cause oil to be less toxic as it moves from the GoM. Near the ocean surface, the half life of oil (time for mass to decrease by ½) is likely to be months, while the transit time from the Loop Current to the Outer Banks of NC is only 2-3 weeks. Thus oil that does enter the Loop Current will more than likely flow up the East coast. Currently, there is little evidence that this is happening because flow between the spill site and the Loop Current is blocked by an eddy that broke off from the Loop Current in early June. This is good news for the East coast, as the longer the eddy remains in place, the less chance for oil to escape the Gulf and the greater chance for oil to be degraded.
- The locations in the SE that are most vulnerable to the GoM spill are southern FL and the area near Cape Hatteras, NC. If oil reaches these areas it is likely to be found in the form of tar balls (tenths of an inch to golf ball size) or as a coating on Sargassum weed. The experts thought that these forms present a low ecological threat – although they did not consider any possible economic implications. It was noted that for years after the 1979 Ixtoc Mexico oil spill event in the Western Gulf, tar balls were a common feature on South Florida beaches. Hotels handed out small containers of baby oil or other solvents to guests so that they could clean their feet before re-entering the hotel. Obviously, this kind of thing is not without precedent.
- Beaches with high shell content and coarse sand (e.g., S. FL and near Cape Hatteras) are most ecologically vulnerable to tar balls, because tar balls are rapidly buried in these types of beaches. Weathering slows once the tar balls are buried and physical removal can be as environmentally harmful as the toxic compounds remaining in tar balls.

- The outer continental shelf along the entire SE U.S. coast is also vulnerable to oil brought in by upwelling, which is a very common regional phenomenon. Warm water coral reefs in S. FL and deep, cold water hard bottoms farther north in the region are particularly vulnerable since they are the first habitats affected by upwelling water. Organisms that filter particles from the water (including micro-droplets of oil), such as sponges, corals, zooplankton, and fish larvae, will experience the highest oil exposure. This is of particular concern to scientists because the effects of micro-droplets as they travel up the food chain are unknown. For example, if copepods (marine zooplankton) actively graze dispersed oil droplets and if the dispersant is assimilated into their tissues and is toxic, it could be bio-magnified in the marine food web, ending up at higher concentrations in fish.
- A unique aspect of the DH spill is the high concentrations of dissolved methane in bottom water. The methane is being oxidized quickly by micro-organisms and as a result dissolved oxygen is being depleted. While this is not likely to be of great concern in the SE region, it should be considered a secondary impact to our region.
- A coordinated monitoring network should be established throughout the SE region in order to determine whether or not oil reaches our region, where, and in what form. Experts suggested a multi-pronged approach relying a several types of measures and observations:
    - Satellite remote sensing could be the primary sentinel for oil at the sea surface. However remote sensing algorithms may need improvement to accurately track the movement of surface oil slicks and sheens
    - Mooring in the Florida Current would be our first sentinel of oil in the water column, relying on instruments equipped with fluorescence sensors
    - Gliders near the outer edge of the continental shelf with fluorescence sensors
    - Citizen counts of tar balls on beaches in each state
    - Plankton and tar ball tows and water samples from the Gulf Stream along the length of the SE coast. Zooplankton and water samples should be analyzed for the presence of oil in tissues and dissolved in water. Simple extractions and standard fluorescence techniques are the least expensive and most rapid approaches.
    - Sponge tissue samples from warm and cold water reefs and hard bottoms. Sponges filter particles as small as bacteria and micro-droplets of oil and thus would be a sentinel organism for detecting the presence of oil in our offshore, deepwater environments.

I personally and professionally felt the June 29 roundtable was another successful effort to bring together top experts in the region to discuss the current state of knowledge regarding existing conditions and events, as well as the anticipated movement, form and toxicity of the oil. We are fortunate in Georgia that our shoreline is so far from the Gulf Stream. As a result Georgia should be in better shape than our neighbors to the south and north should oil get in to the Gulf Stream. In addition to the chemical oceanographic experts, the meeting included the four state Sea Grant directors, along with

communicators from each program, who were able to pose questions they are hearing from the public and the media. This meeting was clearly an example of the Sea Grant's regional connections and its ability to draw upon university-based research expertise.

As a result of the meeting, the four Sea Grant programs in the South Atlantic region will:

* Continue coordination of a regional website regarding Gulf oil topics at www.southatlanticseagrant.org; and

* Develop an addendum to the recent South Atlantic Regional Research Plan to consider data and information needs as a result of the Deepwater Horizon incident.

If you have any questions regarding this meeting, or Georgia Sea Grant's current or potential roles regarding these topics, please contact me at 706-542-1855 or chopkins@uga.edu. As you well know, in addition to Sea Grant's research focus, we also have a strong outreach component, including extension and communications.