Detecting oil spills sandwiched in Arctic ice

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Decreasing ice cover is currently spurring increased activity in hydrocarbon extraction and shipping in the Arctic. Motivated by the threat of future oil spills in this environmentally sensitive area, Woods Hole Oceanographic Institution researchers are evaluating the effectiveness of emerging broadband active acoustic techniques to remotely detect oil spills under sea ice.

At the 167th meeting of the Acoustical Society of America, to be held May 5-9, 2014 in Providence, Rhode Island, Christopher Bassett, a postdoctoral scholar in Woods Hole Oceanographic Institution's Applied Ocean Physics and Engineering Department, will present laboratory data demonstrating that acoustic scattering can be used to detect crude oil under ice.

There's a need to identify technologies capable of detecting oil under ice "because traditional air- and surface-based methods are of limited practical value," Bassett said. "Our goal is to evaluate the effectiveness of emerging broadband active acoustic techniques for remote detection of oil spills under sea ice. Currently, not much research has been performed to identify instruments that can detect under-ice oil spills."

The emerging broadband acoustic techniques Bassett and colleagues are evaluating operate at high frequencies—greater than 100 kHz—to detect oil spills under sea ice grown in the laboratory.

How are broadband acoustic techniques different than more traditional acoustic techniques? "Rather than transmitting a narrowband (single frequency) signal, we transmit a frequency modulated 'chirp' signal. Using signal processing, these 'chirps' can improve the temporal range resolution over narrowband methods and be used to evaluate frequency spectra of scattered signals," explained Bassett.

The goal is to exploit the improved range resolution and frequency spectra to identify thin layers of oil "spilled" under sea ice.

"Our work demonstrates that high-frequency broadband techniques can be used to identify layers of crude oil under sea ice in a controlled laboratory setting," he said.

The researchers consider this "to be a critical step toward identifying one technology that could be used to remotely detect oil spills under sea ice," Bassett noted. "Ultimately, active acoustics may be just one component of a suite of instruments that could be used for oil detection."

What's next for Bassett and colleagues? "Sea ice is a complex medium, and there are many challenges associated with oil detection under sea ice in a natural environment—many important research questions must be addressed before using broadband active acoustics to detect oil in situ," he said.

Some of these unanswered questions include identifying the ideal frequencies for the application, evaluating the role of the size of the acoustic footprint, determining the limitations of the technology in detecting oil layers of variable thicknesses and improving our understanding of the physics of scattering from oil and sea ice, according to Bassett.

If and when broadband acoustics are deemed to be an appropriate tool for detecting oil spills under ice, such a system would need to be integrated into an autonomous package that could consist of a suite of instruments designed specifically for this application, Bassett noted.

"Following an oil spill, ice growth can encapsulate the oil to effectively form an 'oil sandwich' within the ice—so identifying instruments capable of detection under these circumstances will also be important for a successful instrumentation package," he added.

Provided by Acoustical Society of America

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