



PRNL Oil Spill Response R&D Overview

2021 C-NLOPB Spill Prevention and Response Forum

January 14, 2021



- Industry-led R&D facilitator active in Atlantic Canada for 20+ years
- Canadian, federally-incorporated, not-for-profit organization
- Members are operators of licenses in the NL offshore
- Strategic focus areas include digital transformation and sustainability (including GHG emissions reduction)



Historical Oil Spill Response Work at PRNL

- PRNL has supported oil spill R&D for over 20 years
 - Fate & effects
 - Detection & characterization
 - Response options
- Outreach and education - Have worked with industry, response organizations, leading academic and governmental institutions to deliver workshops and presentations, communicate needs and priorities
- “Adjacent research” has also supported oil spill prevention and response capabilities – e.g. current modeling

Fugro NMR Research & Development Project

Earth's Field Nuclear Magnetic Resonance to Detect Oil Under Ice



Project Overview

- The detection of oil in and under ice is a key limitation to responding to an oil spill in the Arctic and in ice-prone regions
- Current methods to detect oil under ice involve people drilling holes in ice. This poses safety risks and is slow
- NMR deployed by helicopter holds the potential to detect oil through snow and ice. Safer, faster and much less prone to signal loss through ice than most other remote sensing techniques
- **Objective:** Build on research conducted by ExxonMobil Upstream Research Company (URC) with world-renowned NMR researcher, Dr. Eiichi Fukushima, to advance the technology to a commercially-ready state
- **Deliverable:** A ruggedized system capable of being operated from a helicopter in harsh environments

Another initiative aims to use the known principles of Nuclear Magnetic Resonance to achieve a similar goal of detecting oil in ice with a specialized antenna mounted on a helicopter.

REMOTE SENSING

WHAT IS REMOTE SENSING?
Remote sensing is the detection, monitoring and tracking of oil on the water surface, under the ice, within the ice sheet, or on top of the ice by using sensors mounted on a variety of platforms: satellites, aircraft, helicopters, autonomous underwater vehicles, etc.

ABOUT THE PROJECT:
The Joint Industry Programme (JIP) is conducting a rigorous test programme that systematically compares the different sensors under controlled conditions, with the aim of identifying the effective combinations of sensors that can detect oil, as well as identify oil spreading and

Experimental Sensors
Several University-led and industry-sponsored development projects are underway to adapt new technologies to further advance detection of oil in ice. One of these programmes recently (2012) led to the development of a Frequency Modulated Continuous Wave radar designed to fly at low altitude to detect oil trapped in or under ice. Another initiative aims to use the known principles of Nuclear Magnetic Resonance to achieve a similar goal of detecting oil in ice with a specialized antenna mounted on a helicopter. JIP supports ongoing research efforts to test both of these technologies in a realistic setting, using crude oil and an artificially grown ice sheet.

Surface Systems
Surface remote sensing systems can be deployed from a bridge on a support vessel to detect oil on the water in light ice cover. Other surface systems include Ground Penetrating Radar that can be towed on the ice surface to detect oil buried under snow or trapped within ice. Another highly effective remote sensing system employs trained dogs on the ice to detect and find oil buried under snow or in the top surface of the ice.

Subsea Platforms
Sensors mounted on unmanned underwater vehicles, especially the latest generation of rapidly evolving autonomous underwater vehicles (AUVs), hold the potential to overcome some of the challenges associated with airborne systems (low visibility, difficulty in penetrating sea ice). AUVs carrying a range of sensors, such as cameras and sonar, could provide a direct view of oil under the ice and possibly of oil that is encapsulated by a layer of new ice growing beneath the oil. Preliminary tank tests have demonstrated positive results using upward looking sonar that can show not only where the oil is but also its thickness.

Airborne Platforms
A number of Arctic nations and other countries where shipping is routinely conducted through ice employ sophisticated pollution surveillance aircraft to search for oil spills. These aircraft normally carry a suite of sensors that complement one another to differentiate thin from thick slicks, identify oil type and operate in conditions of low visibility. Current efforts are focusing on how best to fuse the data from these different sensors into a useful operational product that response teams can use in real time.

ARCTIC RESPONSE TECHNOLOGY OIL SPILL PREPAREDNESS

ABOUT THE JIP
To further build on existing research and improve the technologies and methodologies for Arctic oil spill response, nine oil and gas companies established the Arctic Oil Spill Response Technology Joint Industry Programme (JIP). The goal of the JIP is to advance Arctic oil spill response strategies and equipment as well as to increase understanding of potential impacts of oil on the Arctic marine environment.

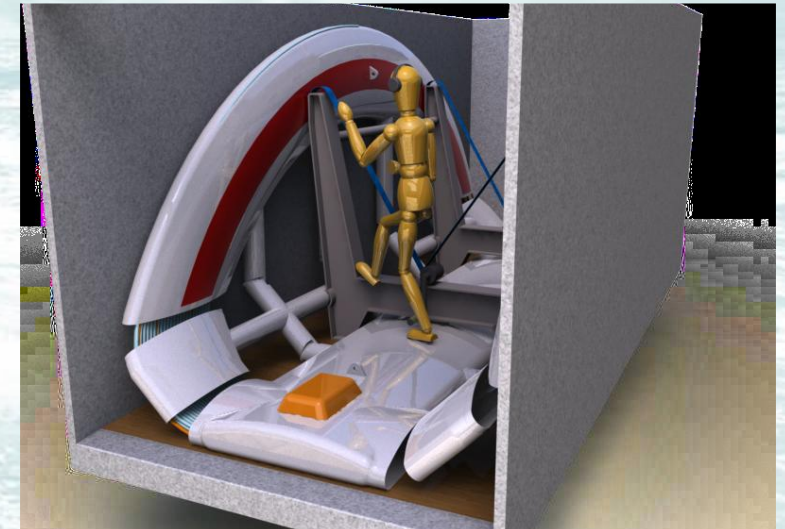
The Arctic Oil Spill Response Technology JIP is sponsored by nine oil and gas companies:

bp Chevron ConocoPhillips eni ExxonMobil INCOG Shell Statoil TOTAL

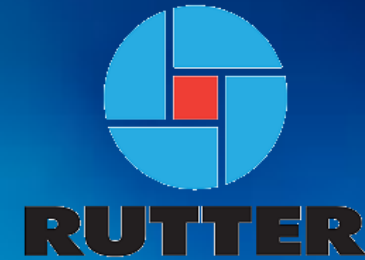
<http://www.arcticresponsetechnology.org> Joseph Mullin, Programme Manager – Joseph.mullin@arcticresponsetechnology.org
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Results

- Safe deployment of full-scale commercial prototype
- Successful delineation of the oil surrogate in real time by an operator inside the helicopter operating purpose-built software
 - System met initial objective of the detection of ~ 1 cm of oil below ~ 1 m of ice in a reasonable time frame
- NMR system and software can be stored in a standard shipping container and deployed in an operational setting
- The system is currently stored in St. John's



Rutter Marine Radar Sigma 6 (S6) Oil Spill Detection

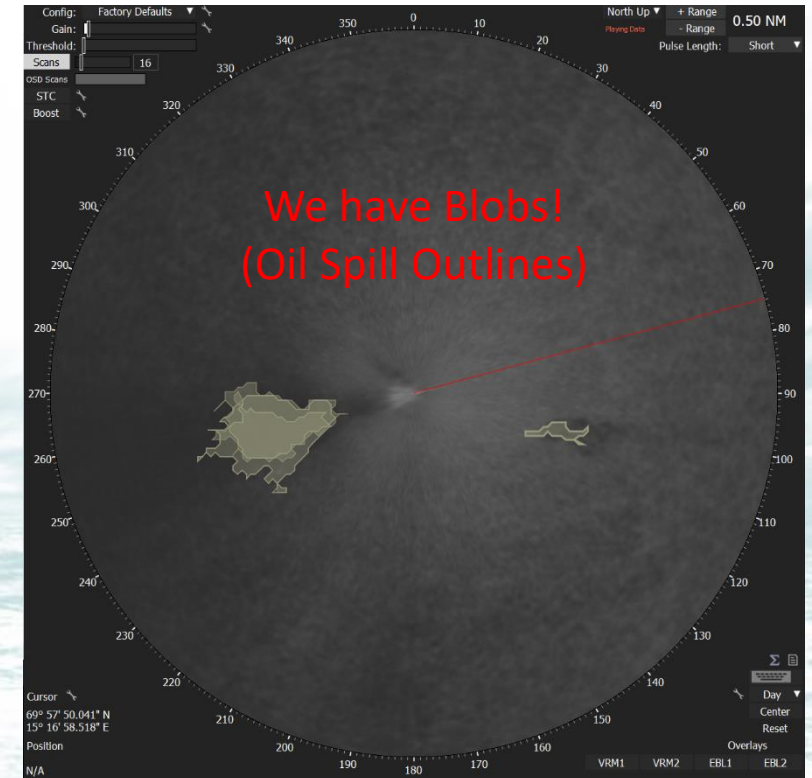


- Marine Radar S6 Oil Spill Detection (OSD) is an operationally proven technology - but prone to false alarm target “look-alikes”
- Rutter systems widely deployed in offshore NL - an opportunity exists to improve oil spill detection by developing and deploying new capabilities
- Can we reduce false alarms by integrating other remote sensing technology?

Project Overview and Status

- Objective: Advance X-band radar oil spill simulation and detection capability
- Approach:
 - Create an Oil Spill Detection Simulation tool to determine expected Probability of Detection given specific radar parameters and environmental condition
 - Data fusion algorithms (combining data from multiple sensors) to aid in automatic detection and alarms for true events, mitigate false positives and reduce associated crew distraction
 - Electro-Optical InfraRed Cameras
 - AIS (Automatic Identification System)
 - Oceanographic (currents and waves)
 - Deploy prototype system to a vessel of opportunity for data collection and performance evaluation
- Future work: Rutter Internet of Things (IoT) Project will migrate Rutter systems into an IoT-enabled solution, offering remote monitoring and enhancing onshore connectivity – OSC funding and Husky partnership

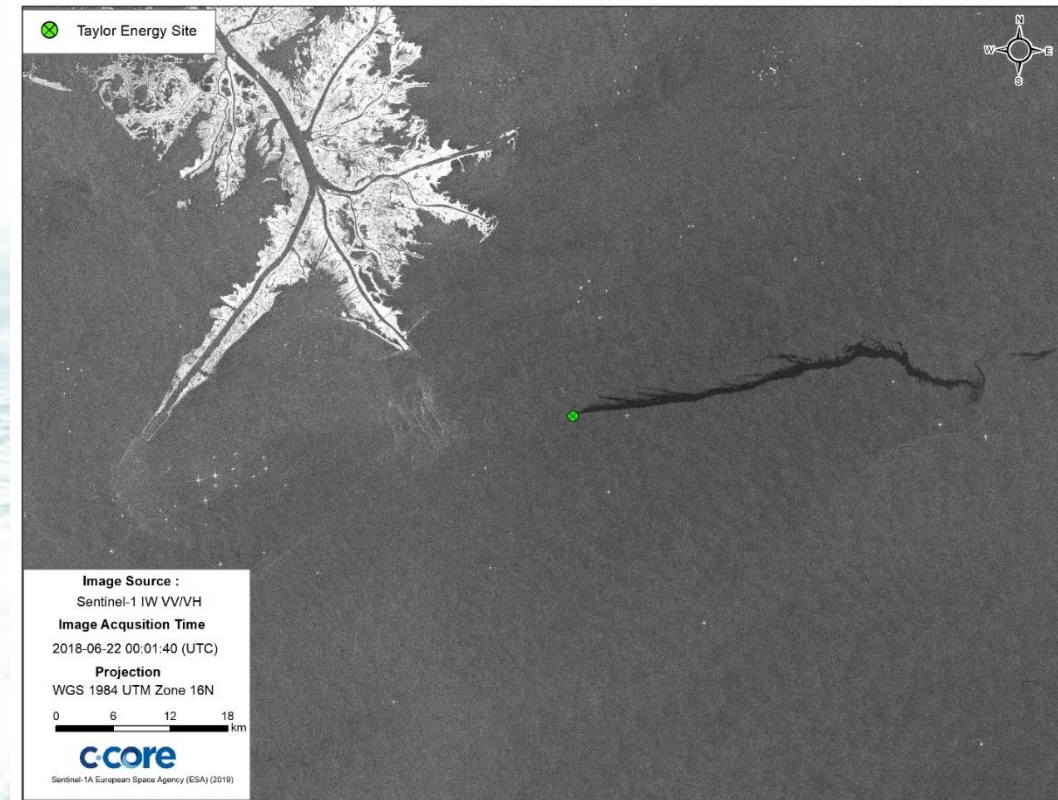
Contact: Des Smith at dsmith@rutter.ca



Advanced Satellite Observations for Oil Spill Response (SpillSight)



- Large volumes of freely or commercially available satellite data streams on a daily basis
- SpillSight aims to develop and implement a comprehensive capacity for detecting oil slicks in Newfoundland and Labrador waters
- Improve identification of and filter common look-alikes and reduce false positives

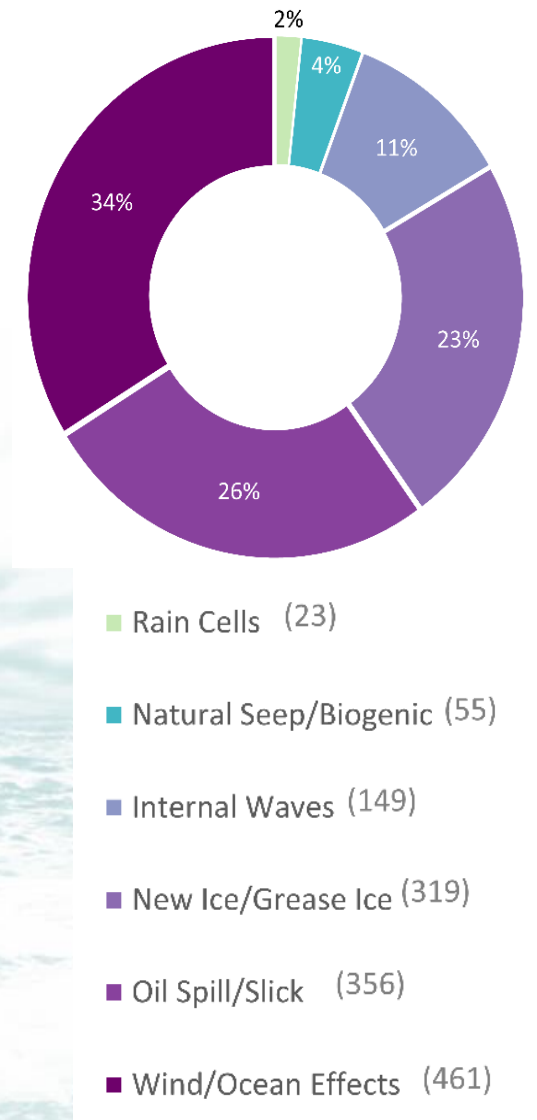


Project Overview and Status

Project Approach:

- Perform automated analysis of satellite imagery using machine-learning techniques
 - Algorithms under development (“training”) using large volumes of Sentinel 1 data from other spills (Taylor Energy, Corsica tanker collision)
 - Discrimination of common look-alikes
- Integrate in-situ observations and metocean features
- Establish automated workflow with quality control
- System will be compliant with industry best practices and standards such as the Common Operating Picture and Open Geospatial Consortium – interoperable with other systems
- Project approach could be applied to future data streams such as the Radarsat Constellation Mission to deliver near daily observations on the Grand Banks

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Digital Transformation and Oil Spill Response

- Digital transformation will expand the capability of industry to detect and respond to oil spills and leaks
 - Rutter: Sensor innovations, data integration and “edge computing” (pre-processing and packaging of data for enhanced onshore connectivity)
 - C-CORE: Application of machine learning to large volumes of data to improve detection, reduce false positives and improve quality and productivity of analysis

Digital Offshore Canada

- A collaborative platform for development, validation and commercialization of digital twins for offshore applications
 - A virtual test-bed to accelerate the deployment of emerging digital solutions
- Example: Subsea Field Modelling & Operations (UIDs)
 - Develop a digital twin of a subsea east coast field architecture for the advancement and virtual testing of a range of underwater IMR technologies, including autonomous or hybrid UIDs
 - Explore feasibility of twinning the subsea infrastructure at MI Holyrood to create a dual physical-digital subsea test bed
 - Expand our understanding of the operational limits of seabed-resident systems and requirements of supporting infrastructure
 - Extend the capabilities of new systems beyond inspection to intervention, maintenance and repair operations
 - Seabed-resident UIDs could provide faster inspection and are less constrained by surface conditions



Questions?