Marine Oil Spill Research in Canada:

New Programs, Progress, & Prospect

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CEOS Centre for Earth Observation Science

ASP Arctic Science Partnership

Road Map

- **Multi-Partner Research Initiative (MPRI)**: Marine waters
- **Churchill Marine Observatory (CMO)**: Arctic waters
- **Research Highlights**
- **Prospect with an invitation**

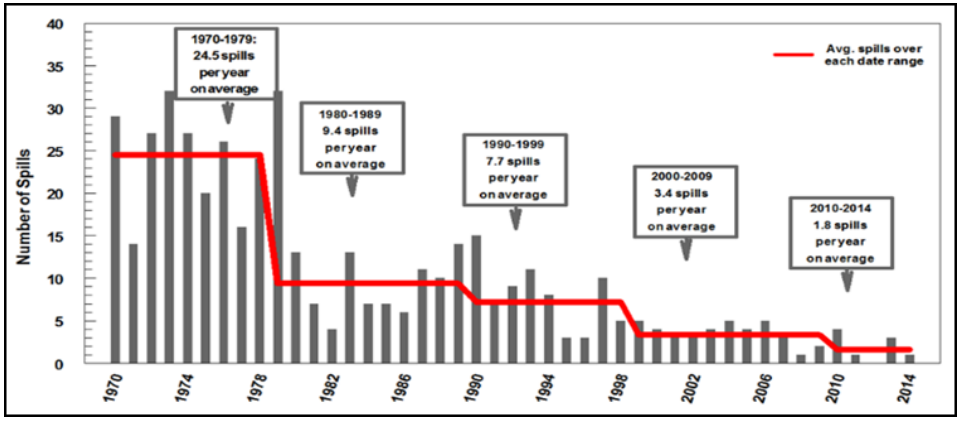
1. Multi-Partner Research Initiative (MPRI)

The Multi-Partner Research Initiative (MPRI): Scientific Research to Support Decision Making in Oil Spill Response

Courtesy of MPRI Program

Concerns with the Release of Petroleum in the Marine Environment

- Spills from tankers at sea have declined.
- The risk of accidental releases of petroleum hydrocarbons is expected to increase with increases in marine shipping traffic (including the Arctic), anticipated increases in exploration & production of offshore oil and gas, and potential increases in pipeline and rail transport along coastal regions



Courtesy of MPRI Program

The Oceans Protection Plan (OPP)

$1.5 billion, 5 year national Oceans Protection Plan (OPP) will:

- Improve marine safety and responsible shipping;
- Protect Canada's marine environment;
- Strengthen partnerships with Indigenous communities; and

- Invest in science for evidence-based decision-making

Courtesy of MPRI Program

Multi-Partner Research Initiative (MPRI)

GOAL: To ***establish an integrated, global research network*** to advance oil spill research in Canada and enhance Canada's level of preparedness and response capability

FOCUS: *To* ***advance scientific knowledge*** to address major gaps in oil spill response and remediation strategies that will support the development, validation and Canadian regulatory approval of Alternative Response Measures (ARMs).

PRIORITIES: Set in a top down fashion and aligned with recommendations of the **Royal Society of Canada 2015 Report** on Behavior & Environmental Impacts of Crude Oil Released into Aqueous Environments as well as ***Transport Canada's Tanker Safety Expert Panel Report***

Courtesy of MPRI Program

Multi-Partner Research Initiative (MPRI)

TRAINING THE NEXT GENERATION: Nearly all projects have significant budgets for training of students and other levels of personnel

NETWORKING: Oil spills are a global concern. The MPRI network of projects will create valuable training opportunities in academia and industry and foster and connections with key international organizations in oil spill research

ENGAGEMENT: Involvement of key clients and stakeholders that include representatives from the Federal Government, Provinces and Territories, Indigenous Groups, the Oil and Gas Industry, regulators, operational oil spill response organizations, academia, fisheries groups NGO's, and international research organizations

Courtesy of MPRI Program

MPRI – INTERNATIONAL PARTNERSHIPS

- International experts were invited to apply for partnership funding to enhance the exchange of global scientific expertise and knowledge under the MPRI program.

- This networking approach will to integrate Canadian scientists into major ongoing international projects, reduce duplication of research effort, optimize the use of resources, and support the objective of the MPRI program to establish a “world class” level of oil spill research expertise in Canada.

    - NOAA/US EPA (USA); SINTEF (Norway); Cedre (France); SOA/CA; (China) and CSIRO (Australia)

Courtesy of MPRI Program

MPRI Program Areas

Based on advice from the *MPRI Advisory & Steering Committees* and an *Expert Workshop* the program was focused on six key areas of research to increase Canada's response tool-box were identified:

- Spill treating agents
- In situ burning
- Oil translocation
- Decanting and oily waste disposal

- Natural attenuation / Bioremediation
- Crosscutting Expertise

Alternative Response Measures (ARMs) - complement conventional mechanical clean-up techniques while offering a net environmental benefit

Courtesy of MPRI Program

Cross-cutting Core Science Activities

Chemical Composition and Properties

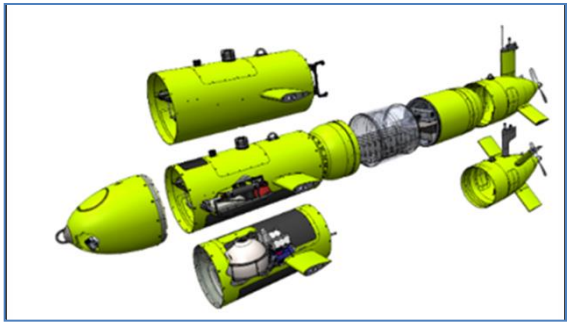
- Characterization of fresh and weathered crude, unconventional crude and refined oils

Oil Detection and Identification

- Environmental forensics, remote sensing , in situ monitoring
- On shore and submerged oil detection, mapping , cleanup and assessment technique (SCAT)

Oil fate, behaviour, and transport

- Oil-ice interactions
- Oil droplets, oil-particle interactions
- Oil trajectory modelling (surface and deep-water)
- Mass balance



Microbial ecology/genomics

- Microbial population and community structure
- Microbial degradation potential, bioremediation/phytoremediation

Biological /Toxicity analysis

- Natural variability (population & community response)
- Environmental effects monitoring (EEM), baseline information, monitoring protocols
- Fisheries impacts

Data analysis for oil spill prevention, preparedness, response and recovery

- Environmental risk assessment, resilience to oil, predictive modelling impacts/recovery
- Decision support system development, spill control strategies
- Endpoints for clean up, Net Environmental Benefit Analysis
- Ecosystem services and socio-economic impacts

Courtesy of MPRI Program

SCIENCE OUTCOMES & IMPACTS

- Improvement of Global oil spill preparedness and response regimes by enhancement of science-based decision making
- Greater public confidence in the Government's ability to respond to and remediate oil spills
- Development, commercialization and application of oil spill response strategies
- Leveraged research will reduce duplication of effort between industry, academia and government agencies
- Enhance research capability, quality of advice and coordination within the Government of Canada
- Education of highly qualified personnel in oil spill research

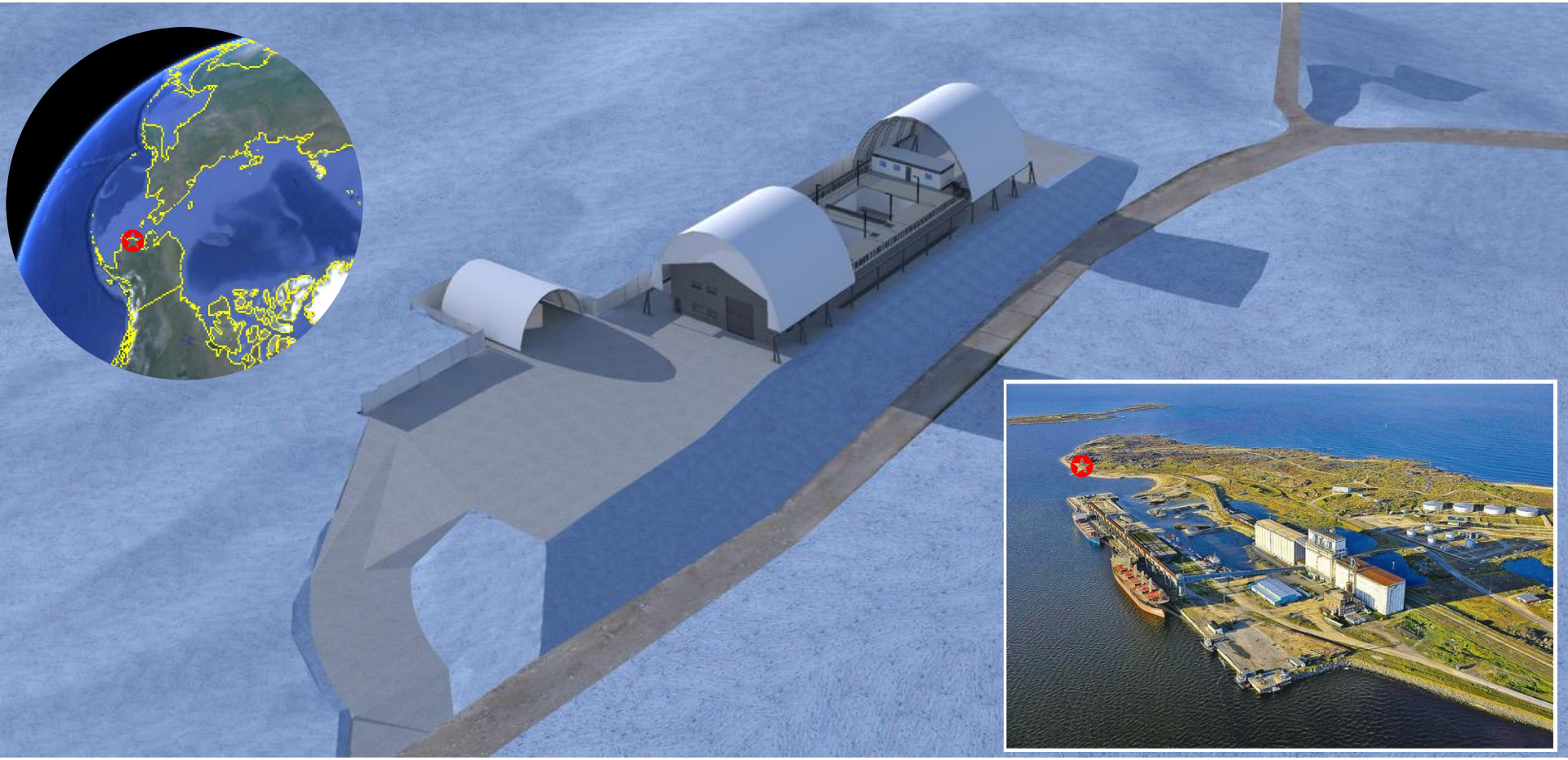
Courtesy of MPRI Program

Timeline

- Program launched: November 2016
- Total budget: $45.5M
- First projects funded: 35 projects funded in October 2018, totalling $32M;
- Program ending date: March 2022, with a possibility for Phase II.

2. Update of the Churchill Marine Observatory (CMO)

A national facility to support the study of detection, fate, effects & mitigation of oil spills in the Arctic Ocean



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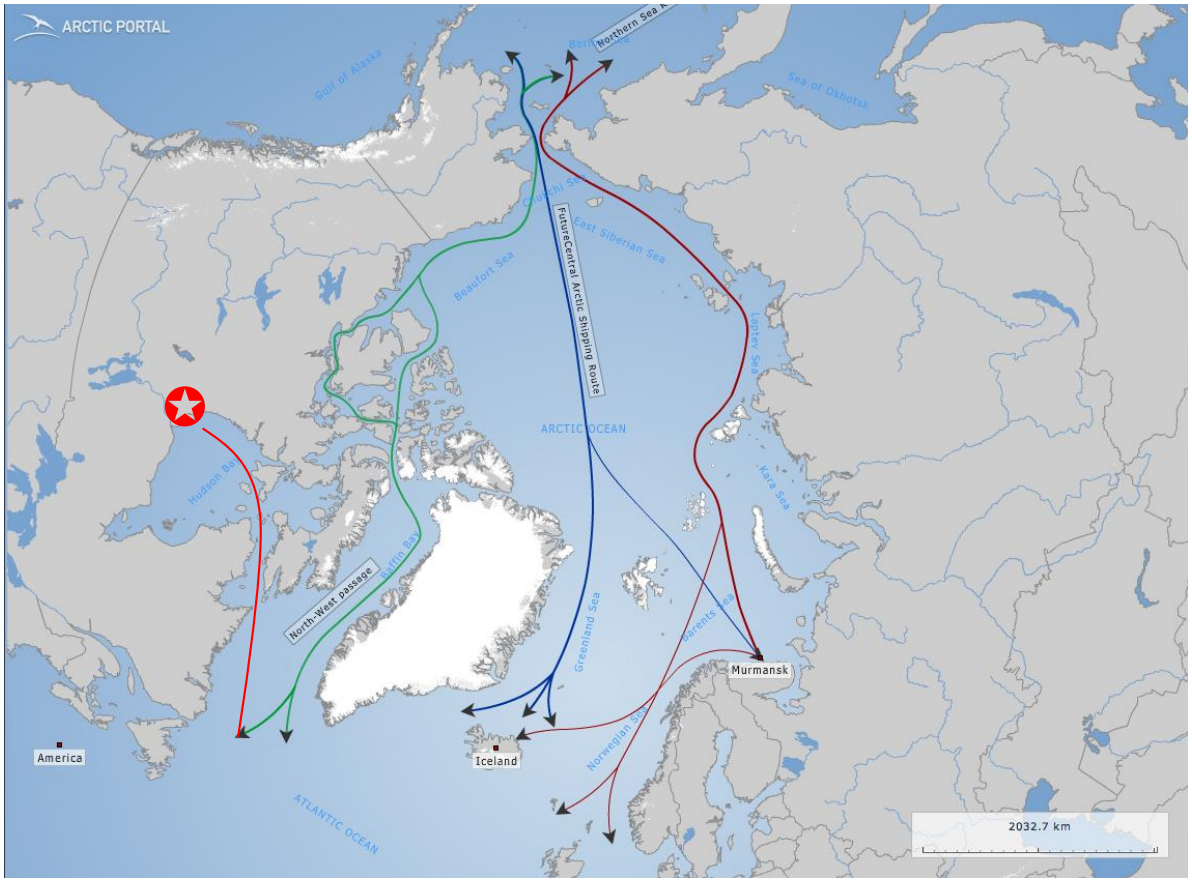
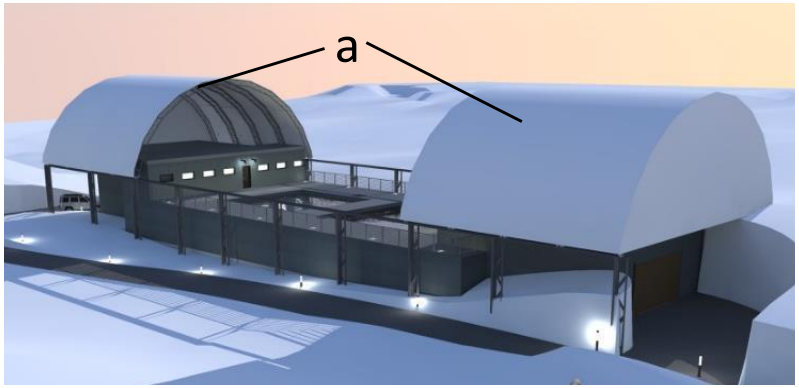
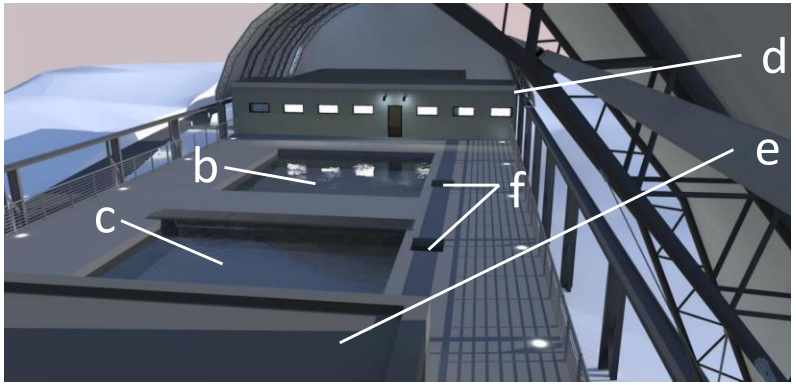
Why Churchill?

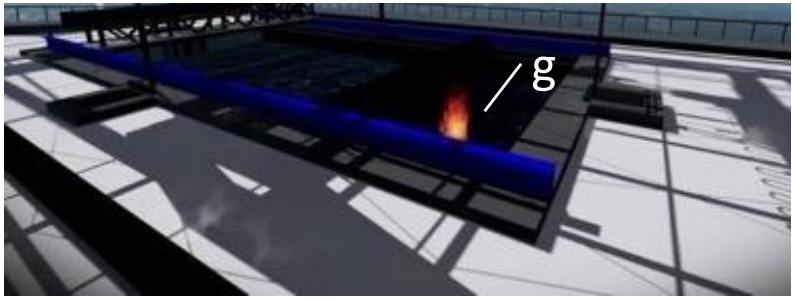


(Chris Corday/CBC) (Chris Corday/CBC)

CMO Oil-on/in-Ice Research Capacity







a) Movable roofs; b) Control mesocosm; c) Experimental mesocosm; d) Geophysics lab; e) Chemistry lab; f) Moon-pools; g) Controlled in situ burning

Controllability at CMO:

- Seawater salinity
- Water circulation speed & pattern
- Type, development stage, & melting rate of ice
- Snow cover
- Type of oil to be spilled
- Scenarios of oil spill
- Thickness (amount) of oil spill
- In situ burning

Research capacity:

- Spill detection
- Chemical characterization
- Fate and behavior
- Biological effects
- Response techniques (in situ burning, dispersants…)

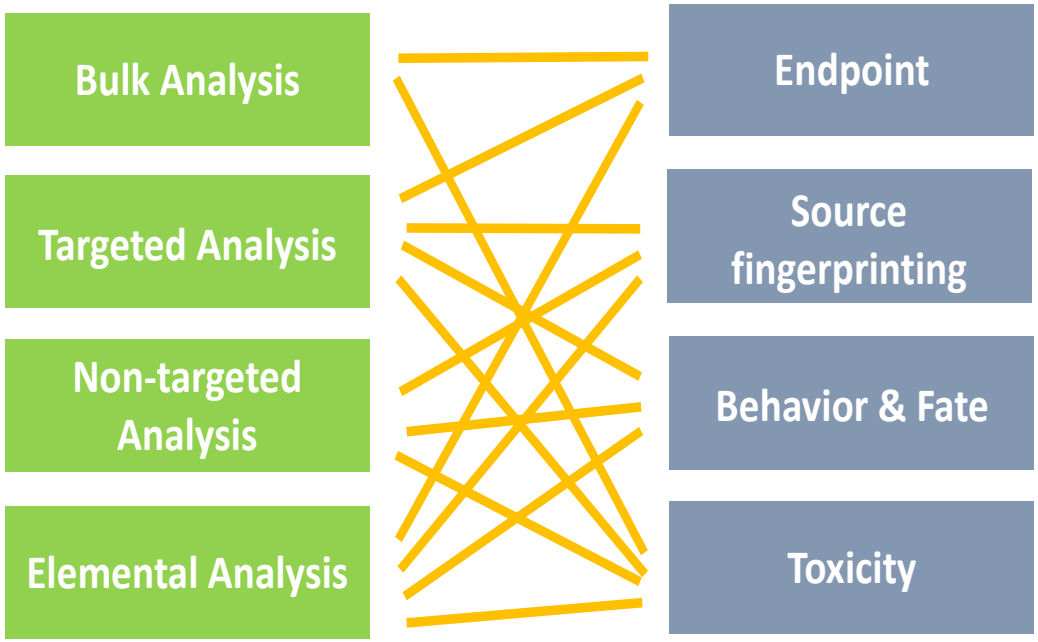
CMO Timeline

- 2002: Initial conceptual plan
- 2008-2012: Development of SERF
- 2014: CMO proposal to CFI
- 2015: Funding announced by CFI
- 2017: Design completed
- May 2017 – December 2019: Construction
- January 2019: Operational

Construction Site April 30, 2019

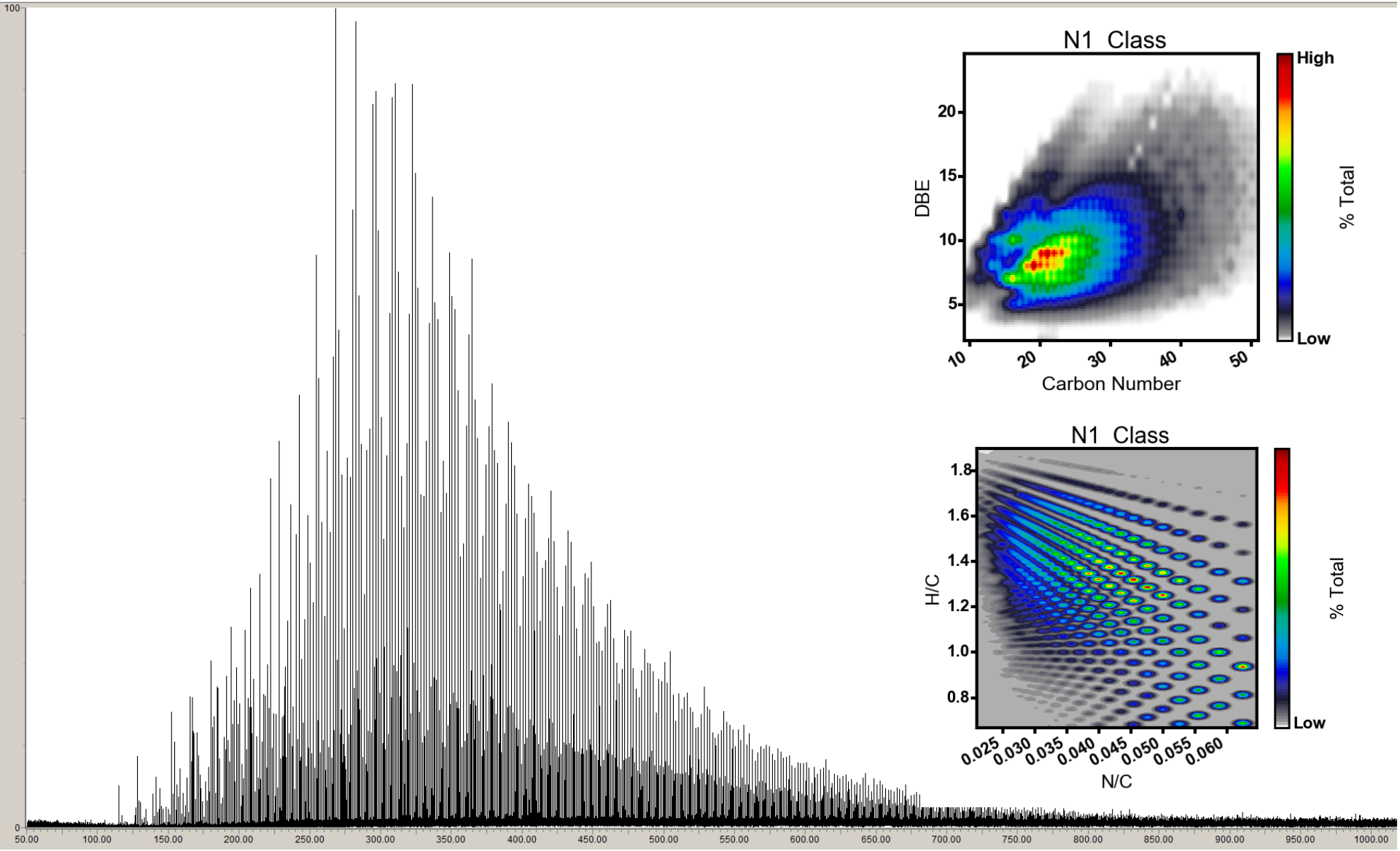
3. Research Highlights (1):

MPRI – Chemical Characterization



$C_cH_hN_nS_sO_o$(Ni/V/Cr/Pb/Mn/Co/Mo/Hg)

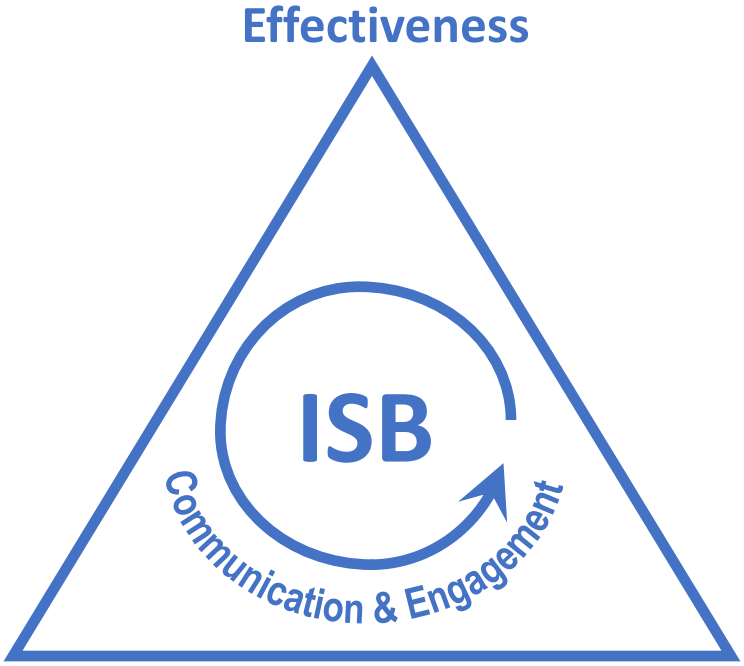
Non-targeted screening of oil & its degradation products



Positive ESI-IM-TOF-HRMS spectra of a light sweet crude oil

3. Research Highlights (2):

MPRI - In Situ Burning



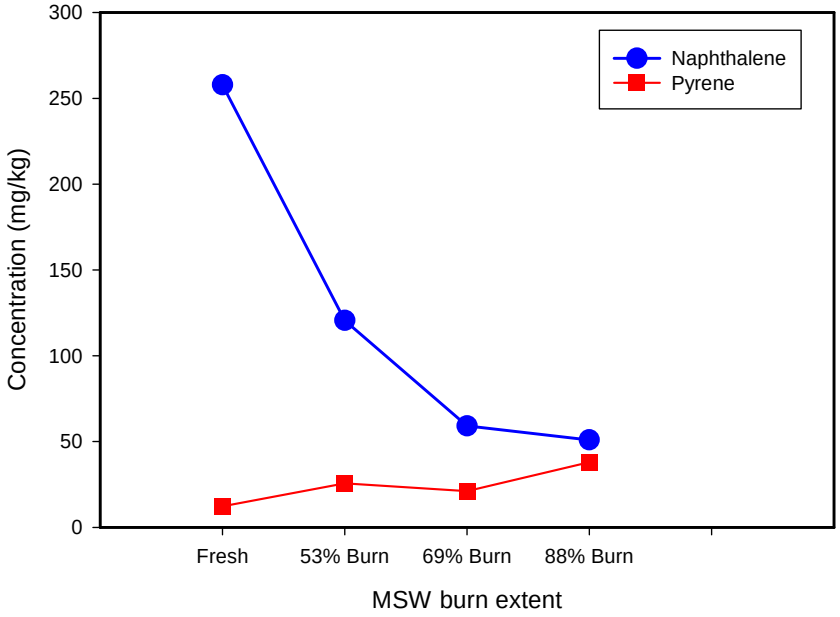
Workshops

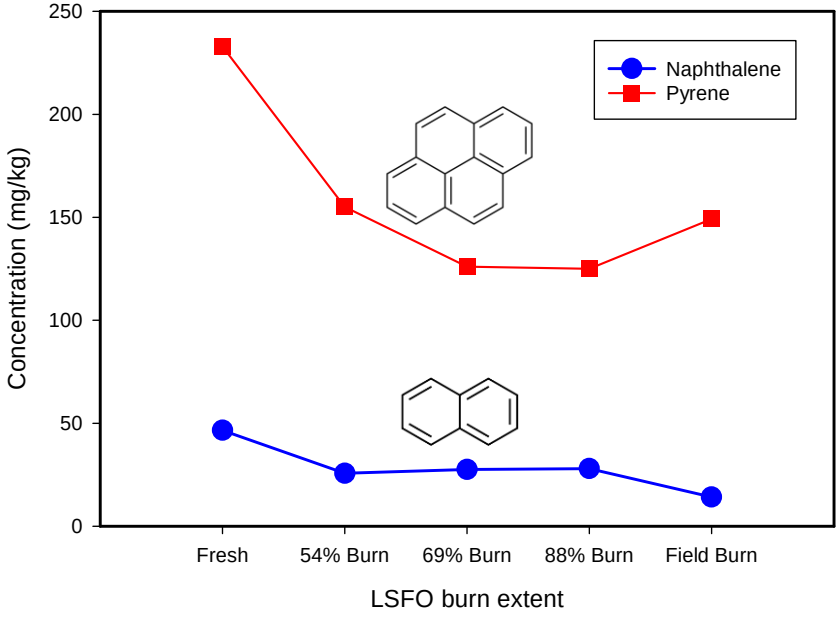
Lab studies

Field trials

Chemical characterization of in situ burn residues

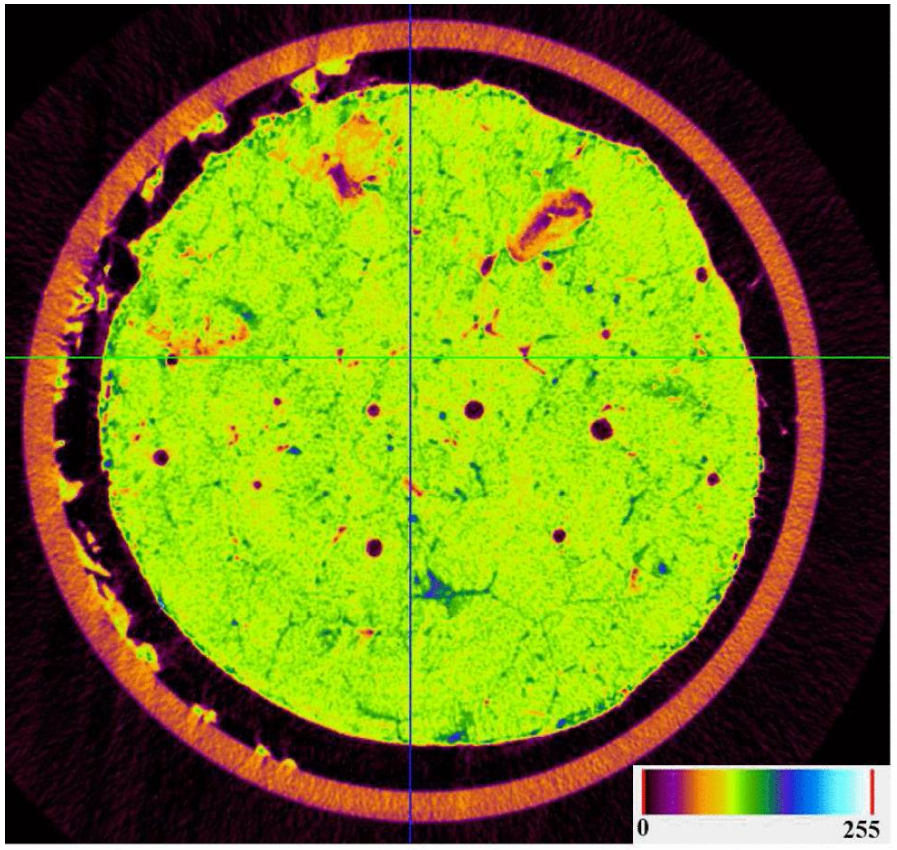
In collaboration with SL Ross & SINTEF





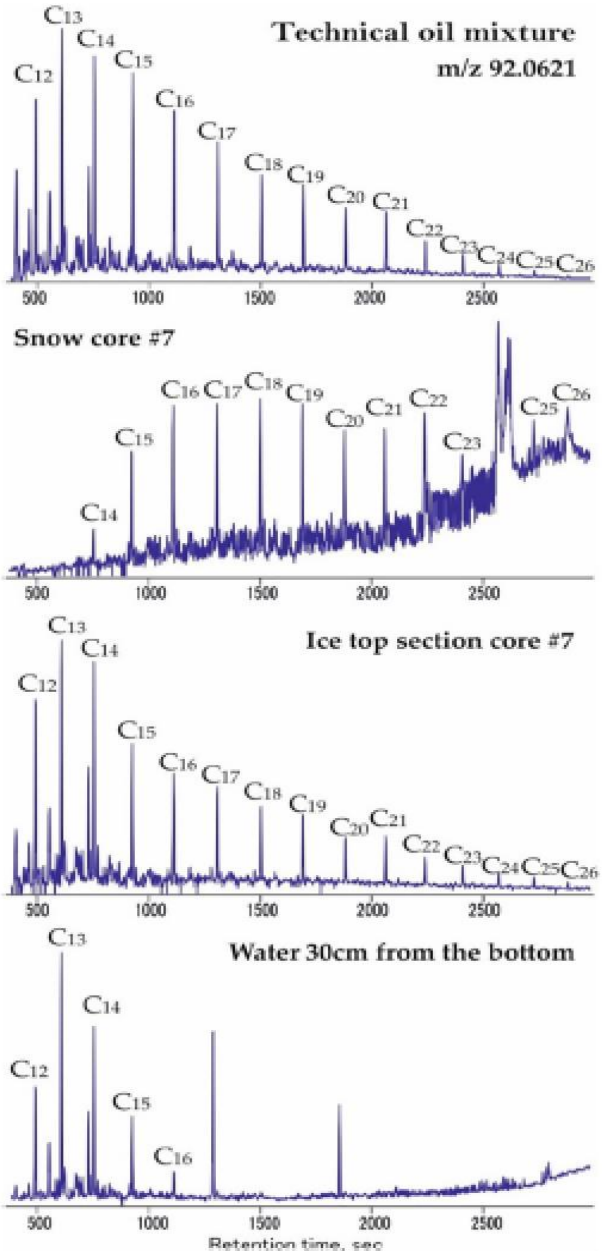
3. Some Research Highlights (3):

CMO pilot study at SERF: oil behavior in sea ice



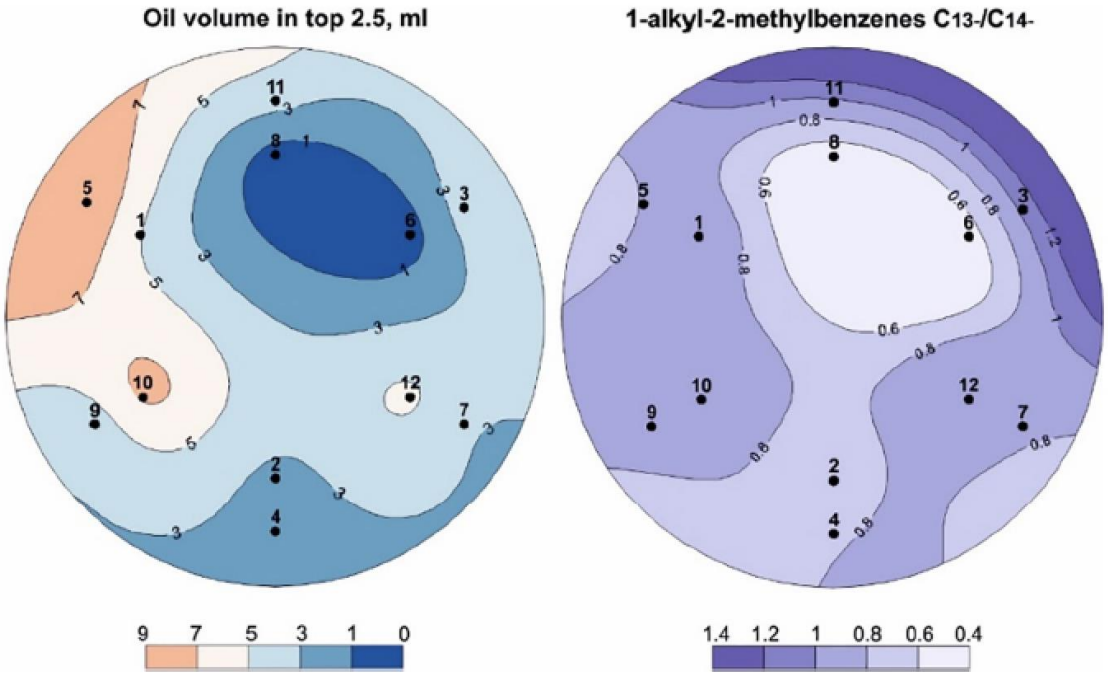
Green patches: ice; Blue patches: brine
Black dots: air
Orange patches: oil

Firoozy et al., 2017, IEEE



Chromatograms of n-alkylbenzenes **m/z** 92.0621 obtained using GC-HR-TOF-MS

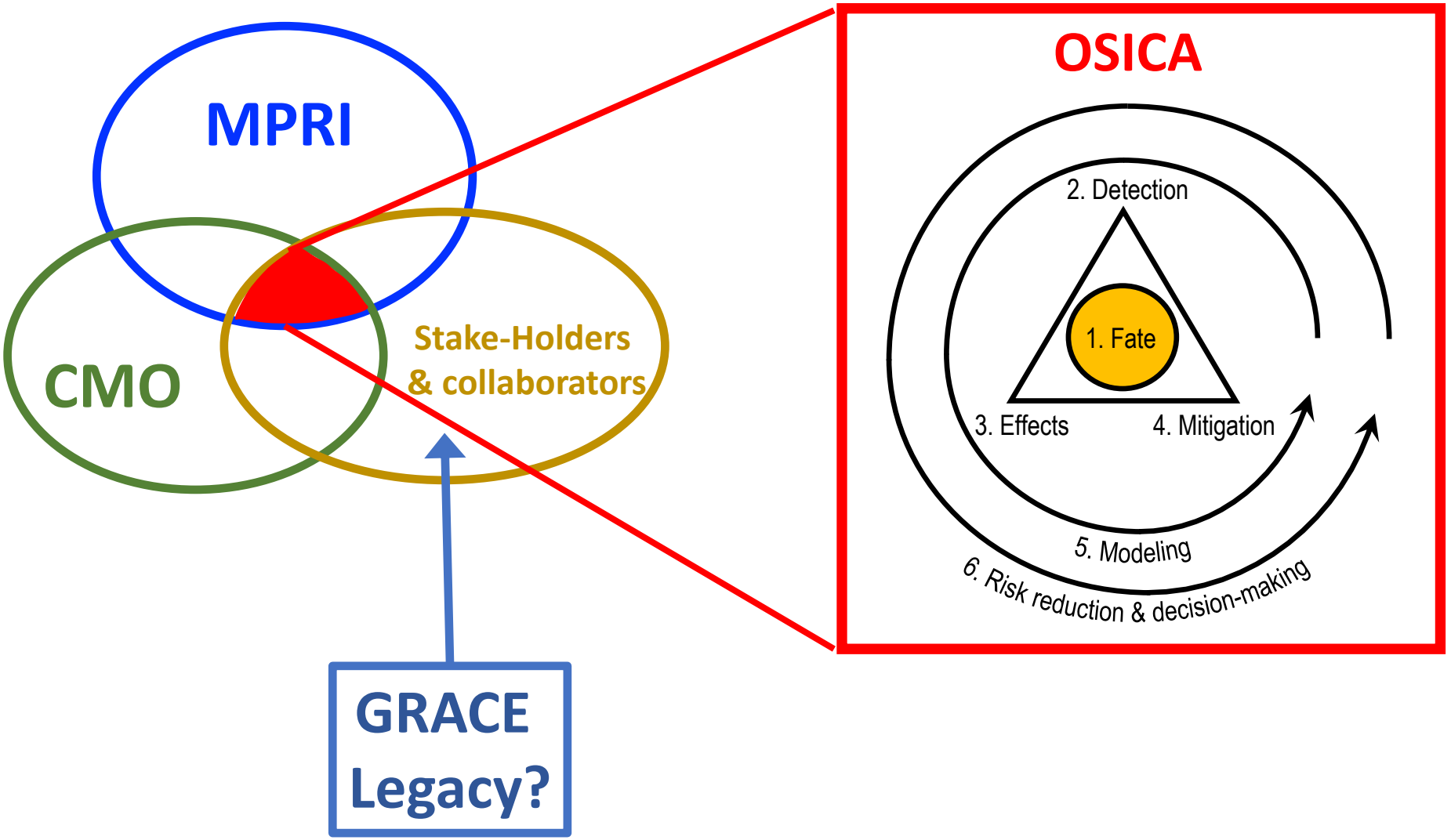
The presence of oil increased the temperature and lowered the salinity of the ice, thereby reducing its dielectrics. This makes it possible for oil detection in ice remote sensing systems.



Desmond et al., 2019, MPB

4. Prospect with an Invitation:

An Oil in Sea-Ice-Covered Arctic waters (OSICA) Network?



Two PDF/RA Positions Available @ U Manitoba

- **Position 1:** Chemical characterization of oil & oil products, with an emphasis on non-targeted screening of degradation/weathering products

- **Position 2:** Arctic atmospheric chemistry, with an emphasis on smoke from in situ burning of oils

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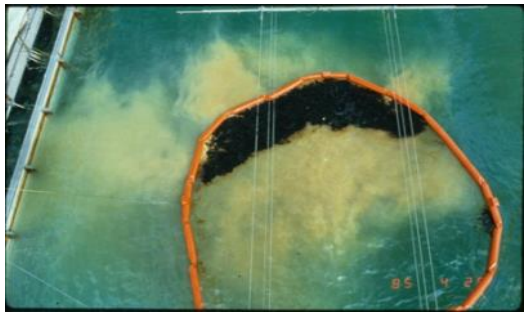
SPILL TREATING AGENTS (STAs)



- Research to understand and predict the effectiveness and potential environmental impacts (toxicity, sinking of oil due to interactions with suspended particles, etc) of STAs under Canadian environmental conditions.
- All projects and program areas will be using a curated set of oil types to ensure cross comparisons between projects and ARMs.

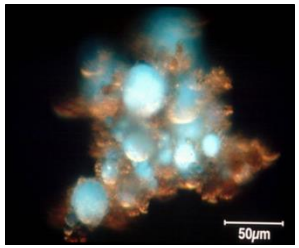
Keywords: Dispersant effectiveness, subsurface blowouts, plume behaviour/churn flow, photo-oxidation, oil droplets, oil particle interactions,, surface transport, shoreline cleaning agents, bio-based agents, oil spill reconnaissance

IN-SITU BURNING (ISB)

- Review ISB state of knowledge
- Document/analyze concerns/perceptions of local and indigenous communities
- Evaluate the use of herding agents
- Conduct of field trials to assess the efficacy and environmental impacts of the technology (eg., toxicity of atmospheric contaminants/burn residues)
- Develop operational guidelines

Keywords: ISB review, field trials, fire booms, herders, ignitors, burn residues, toxicity

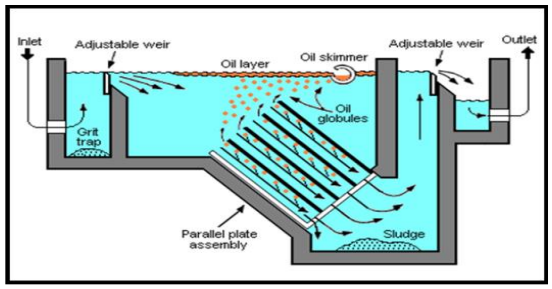
OIL TRANSLOCATION



- The transport of stranded oil to the lower inter-tidal zone facilitates physical recovery of the oil (e.g. booming and skimming) and/or the formation of oil-mineral aggregates that can enhance natural processes (microbial degradation) to break down the oil
- Address knowledge gaps to allow for more strategic decision making regarding intervention or non-intervention responses.
- This work will provide more options to enable accelerated attenuation and weathering of oil spilled near or on ice, effects of tidal forces and also understanding oil/particle interactions and the formation of oil-suspended particle aggregates.

Keywords: oil particle interactions, shoreline characterization, guidance documents

MPRI DECANTING AND OIL WASTE MANAGEMENT



- Review of existing practices and identification of regulatory/technological barriers for the disposal of decanted water
- Evaluation of existing and emerging technologies for improved decanting operations that will enable direct discharge into the sea
- Development of improved waste-treatment and management strategies for oily waste generated during response operations

Keywords: technology development (oil water separation/absorbents, etc), validation of regulatory endpoints endpoints, toxicity, on site treatment, solid waste management, decision support

NATURAL ATTENUATION

- Determination of in situ oil biodegradation capacity for different substrates in different geographical locations (inherent natural attenuation capacity) is a key aspect of developing relevant oil spill remediation approaches for Canada.

- Conduct studies in the Arctic where the risk of oil spills is anticipated to increase due to increases in marine traffic from global warming (i.e. extended open water season in the North West Passage) and enhanced urban/industrial development (including offshore oil and gas).

Keywords: Biodegradation potential, arctic baseline/response, field studies, diluted bitumin, bioremediation, in situ microcosms