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Behavior and Weathering of Oil Spills Under Arctic Conditions and Implications For Response

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Cape Breton, Canada 1986

A series of experimental releases (3 relases 1 m^3) coordinated by SL Ross & DF Dickins

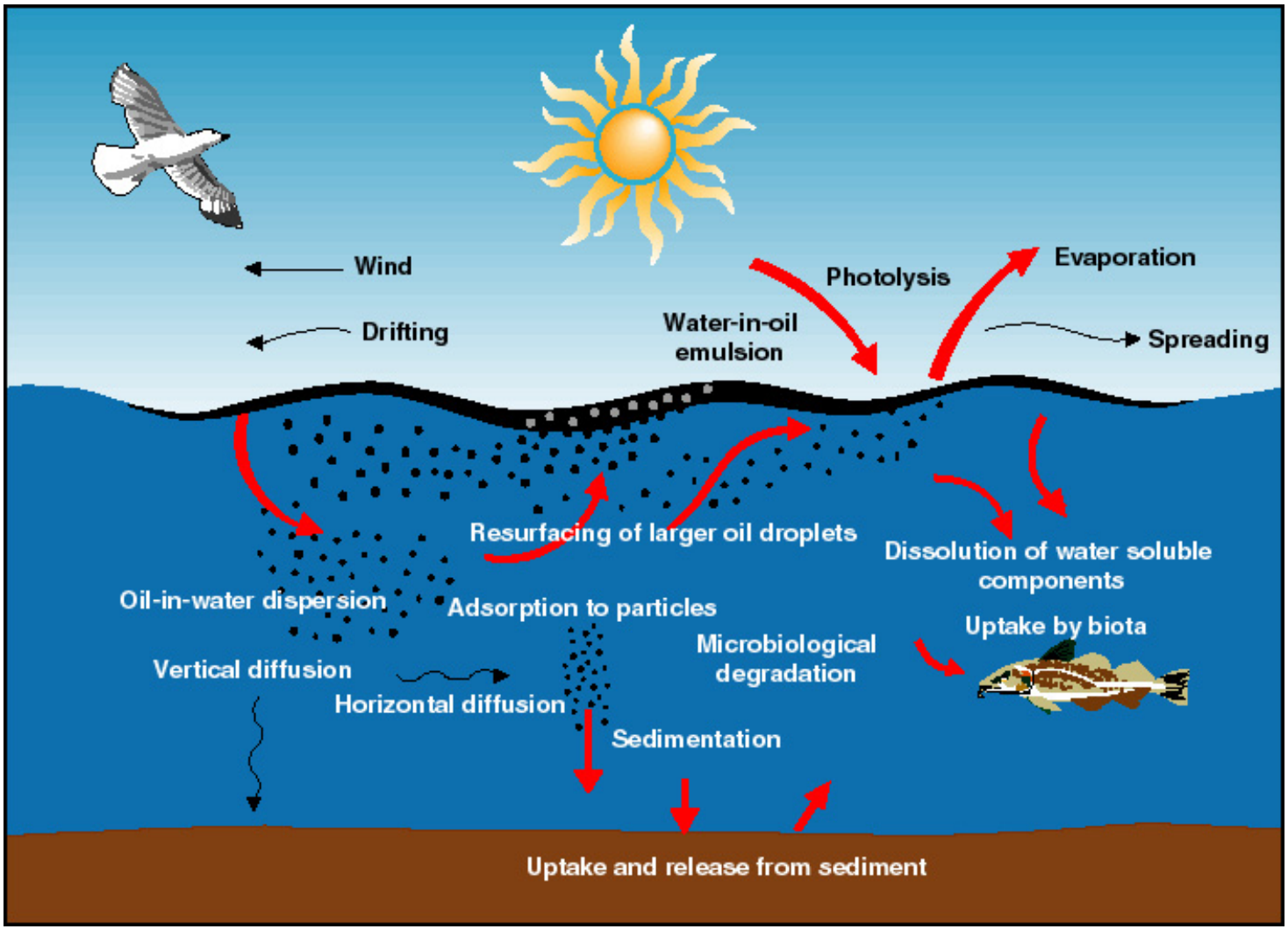
MIZ - Barents Sea, Norway 1993

Review articles for further reading:

2003: Fingas and Hollebone, Fate and behaviour of oil in freezing situations

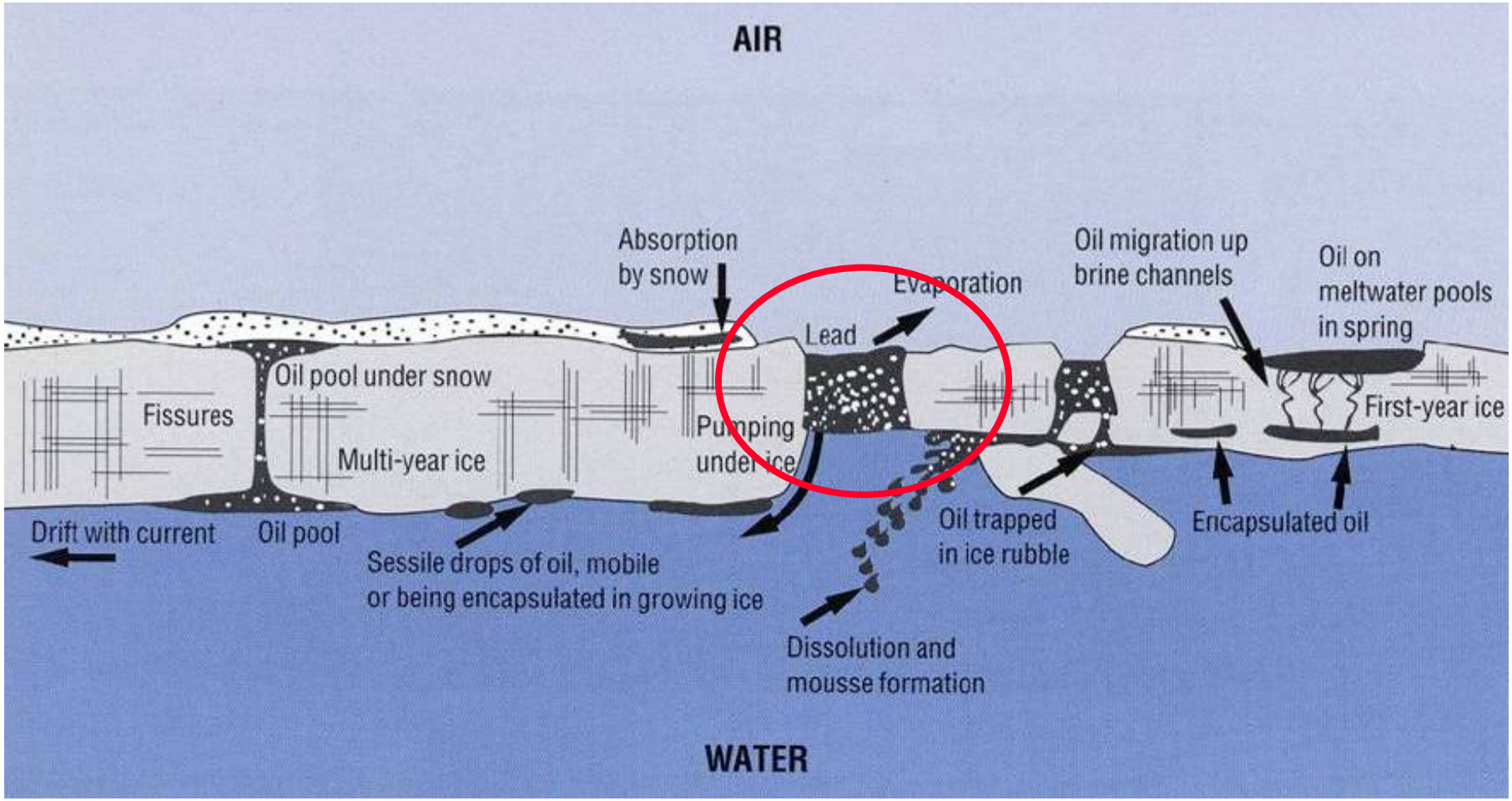
2004: Interspill review papers (oil-in-ice weathering, in-situ burning, mechanical recovery and use of dispersants)

Oil weathering processes - Open water



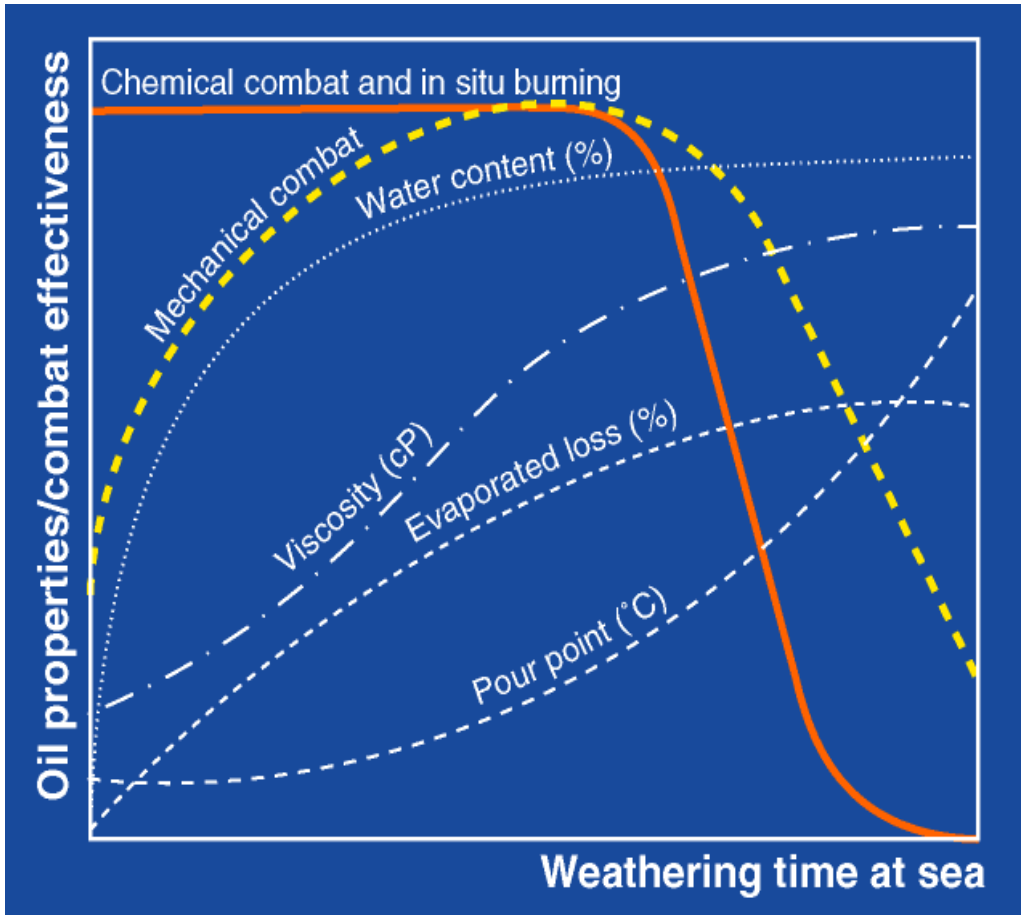
Weathering processes significant for oil spill contingency

Weathering of oil spill in Ice



Spreading of oil in ice is more diverse and offer many sub-scenarios

Oil weathering influence response operations



Estimated effectiveness versus selected weathering processes

Major ongoing R&D Projects
Oil weathering in ice
Related to respons

- **Empirical Oil Weathering in Snow and Ice**

- **Oil-in-Ice JIP**

Empirical Oil Weathering Objective

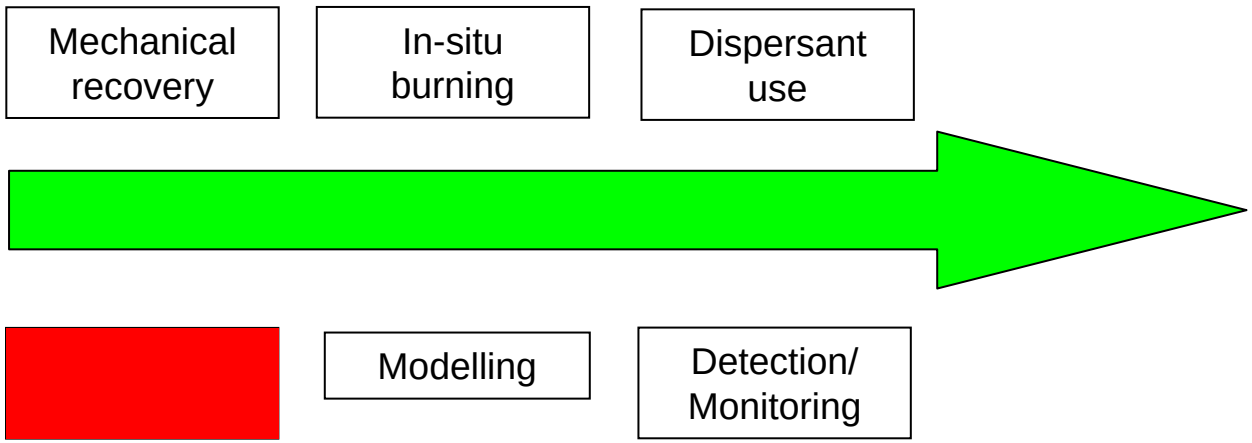
To generate experimental data to validate and refine oil algorithms and weathering models for oil in ice and snow

Empirical oil Weathering Scientific Approach

Six series of experiments were conducted:

1. **Spreading in Ice and Snow**
2. **Evaporation in Ice and Snow**
3. **Slick Thickness on Cold Water**
4. **Migration Rates through Brine Channels**
5. **Formation of Water-in-Oil Emulsions**
6. **Full Spill-Related Characterization of Crude Oil Samples**

New R&D program for "Oil Spill Response in Ice-infested waters"



Improved technology for oil spill response in ice-infested waters

Joint Industry Project (2006 – 2009)

Funders: Statoil, Shell, Total, ConocoPhilips, AGIP KCO, ChevronTexaco and BP

Participants: Norwegian, US/Canadian and Russian R&D Institutions

Deliverables:

- Improved oil spill response technology
- Improved modelling tools
- Oil spill contingency plan for Arctic waters

Oil-in-Ice JIP
P1 Fate and behavior - Meso-scale testing

30%

50%

70%

90%

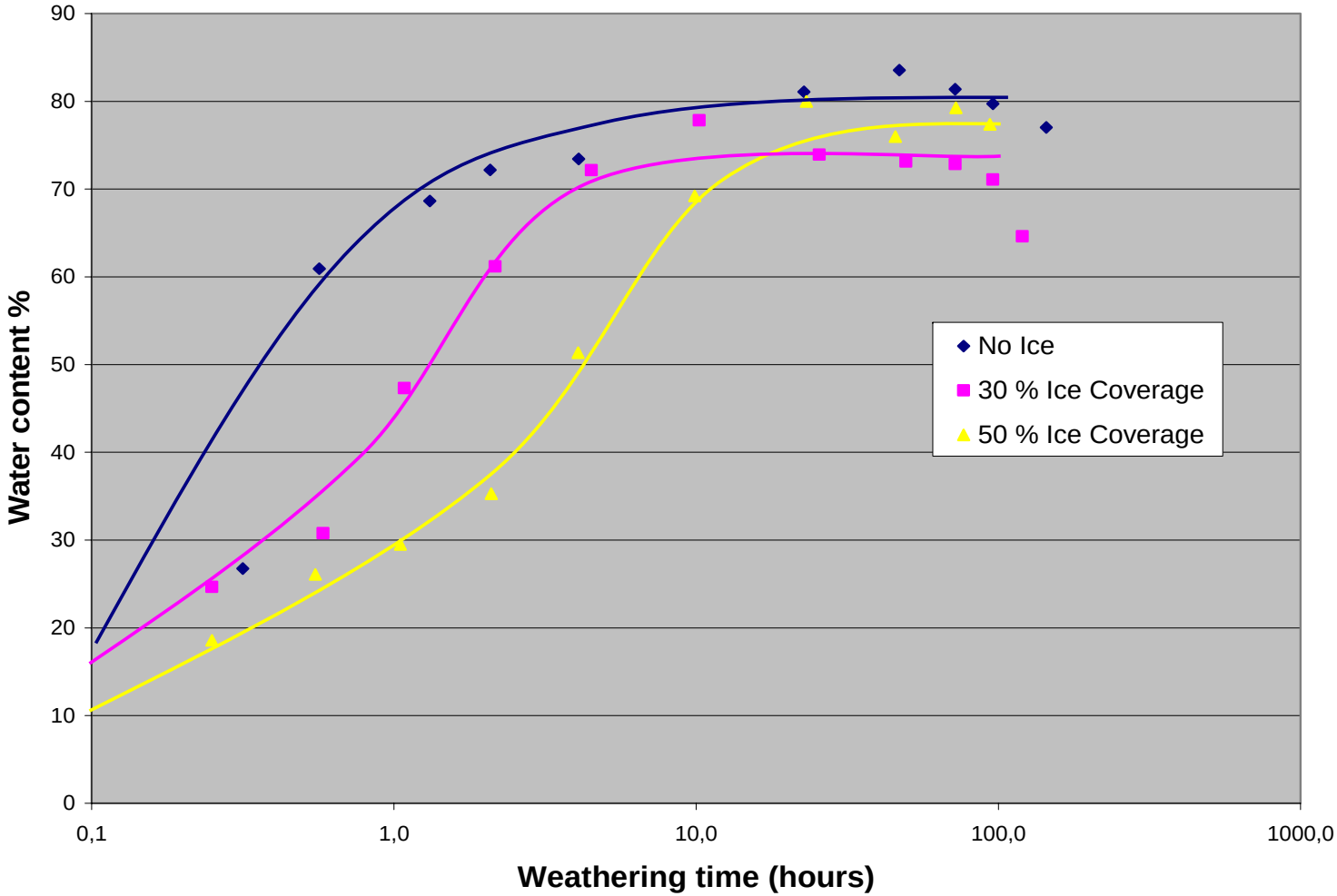
Oil-in-Ice JIP
P1 Fate and behavior - Meso-scale testing

0%

30%

50%

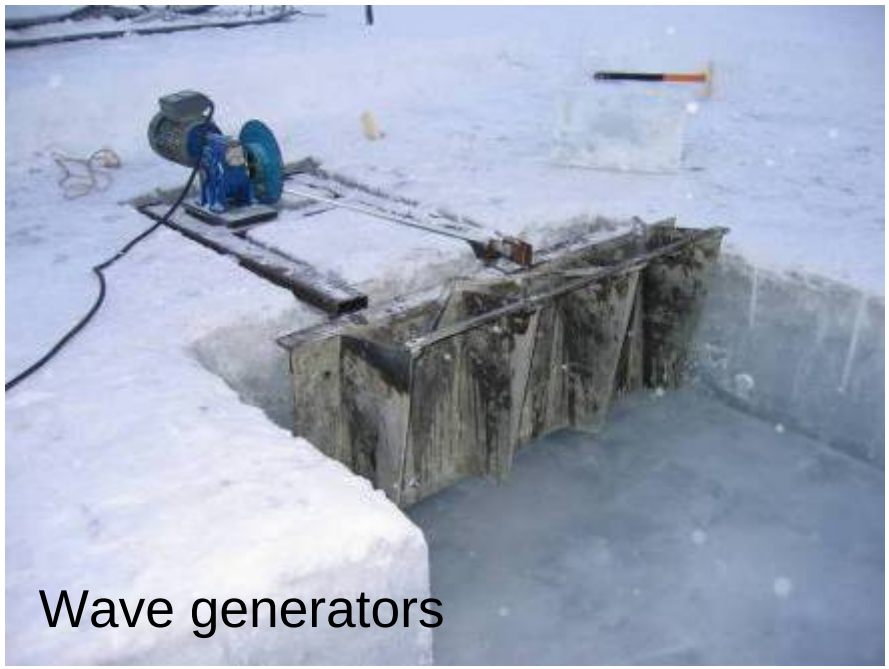
Oil-in-Ice JIP
P1 Fate and behavior - Meso-scale testing

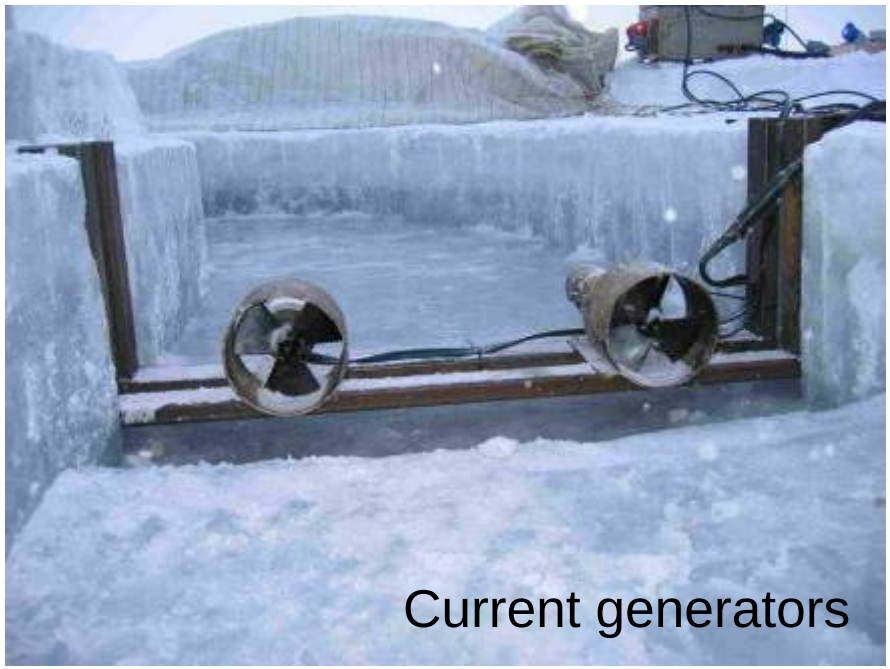


Meso-scale field experiments with different ice conditions

Weathering experiments on Svalbard 2005 funded by Norwegian Research council, Statoil and Hydro

Experimental weathering of oil in ice


Wave generators

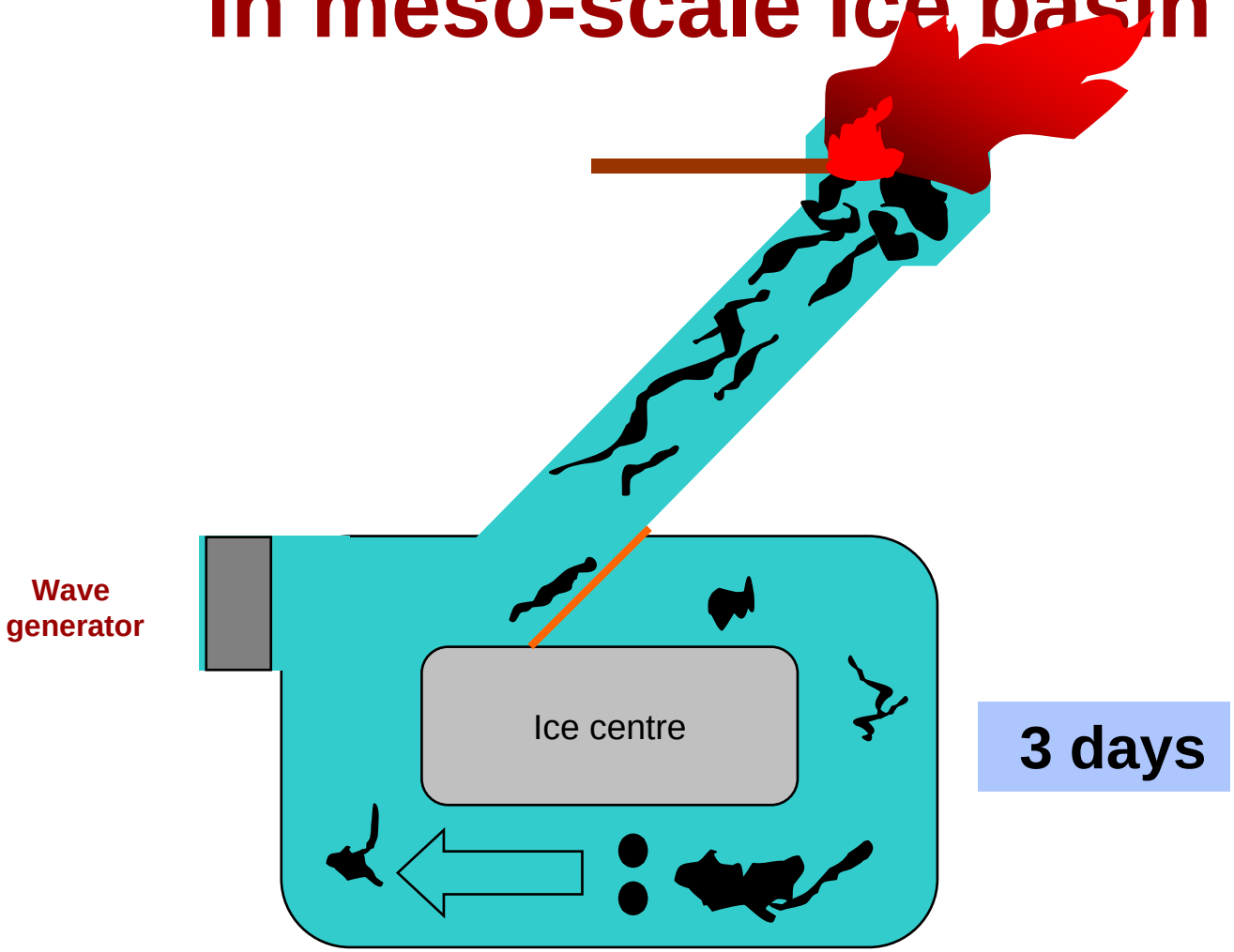

Current generators

- Ice coverage: 0 -90%
- Surface current: 3-5 cm/sec
- Waves: 0 to ±15 cm
- Temp. air: - 5 to -15 ºC
- Temp. water: - 1.8 ºC

Ice basin in first year fjord ice used for oil weathering studies

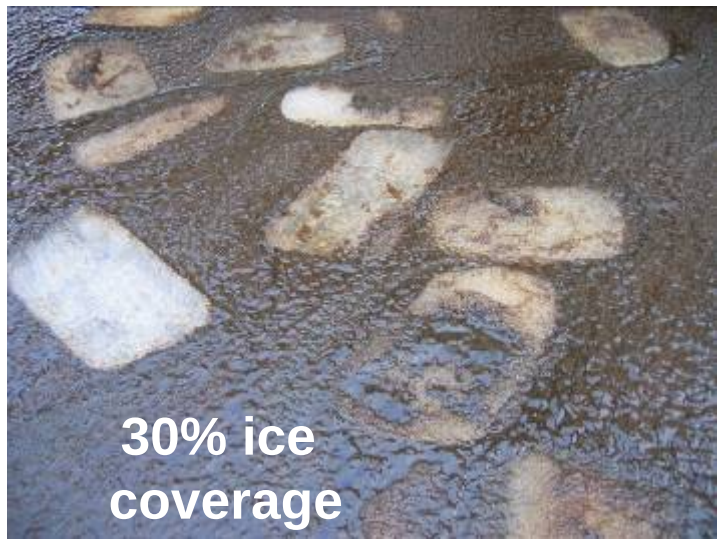
2005: Oil weathered for 3 days at different ice conditons – and tested for ignitability and use of dispersants

Simulation of weathering processes in meso-scale ice basin

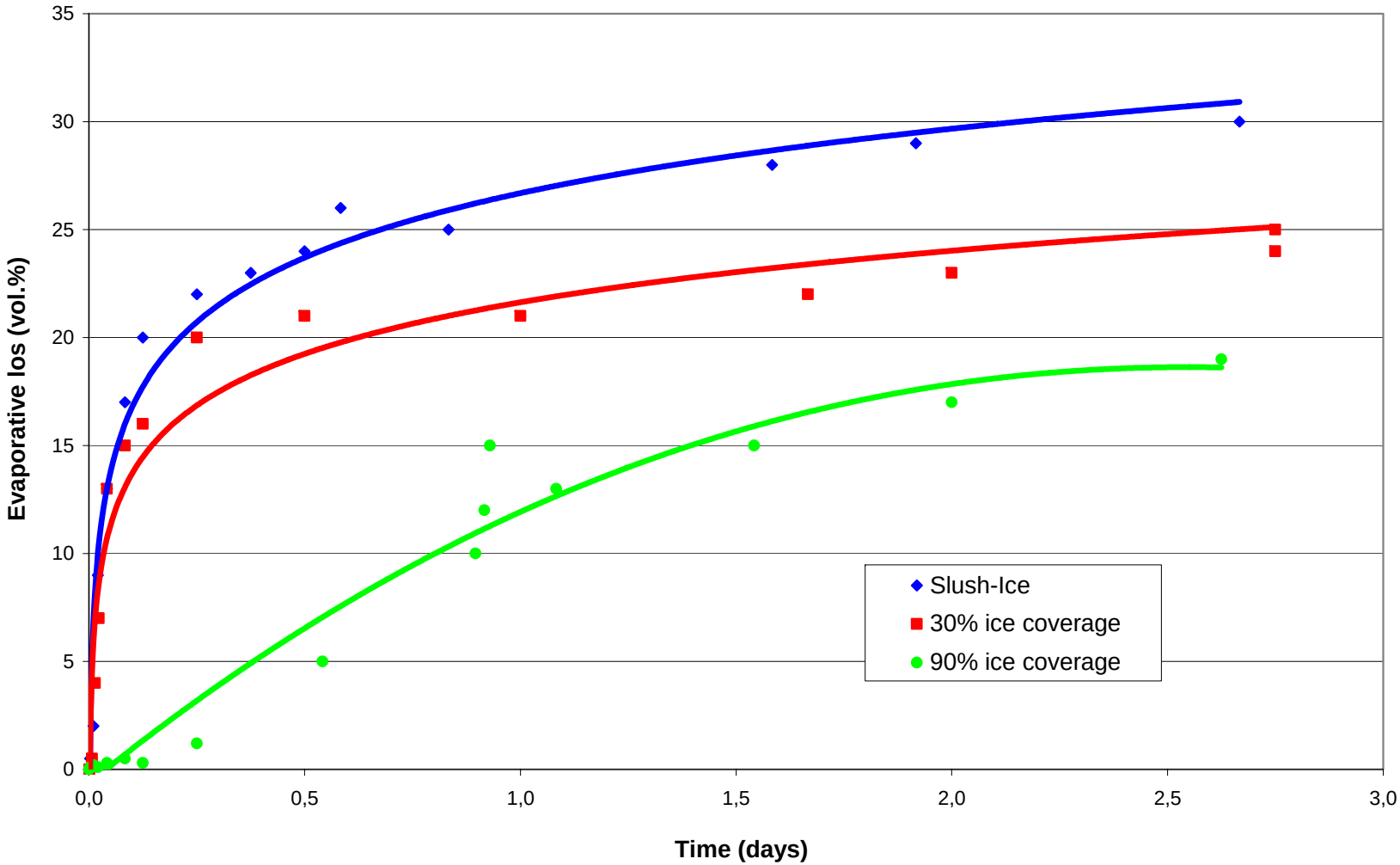


Weathered oil collected in burning chamber after 3 days of weathering

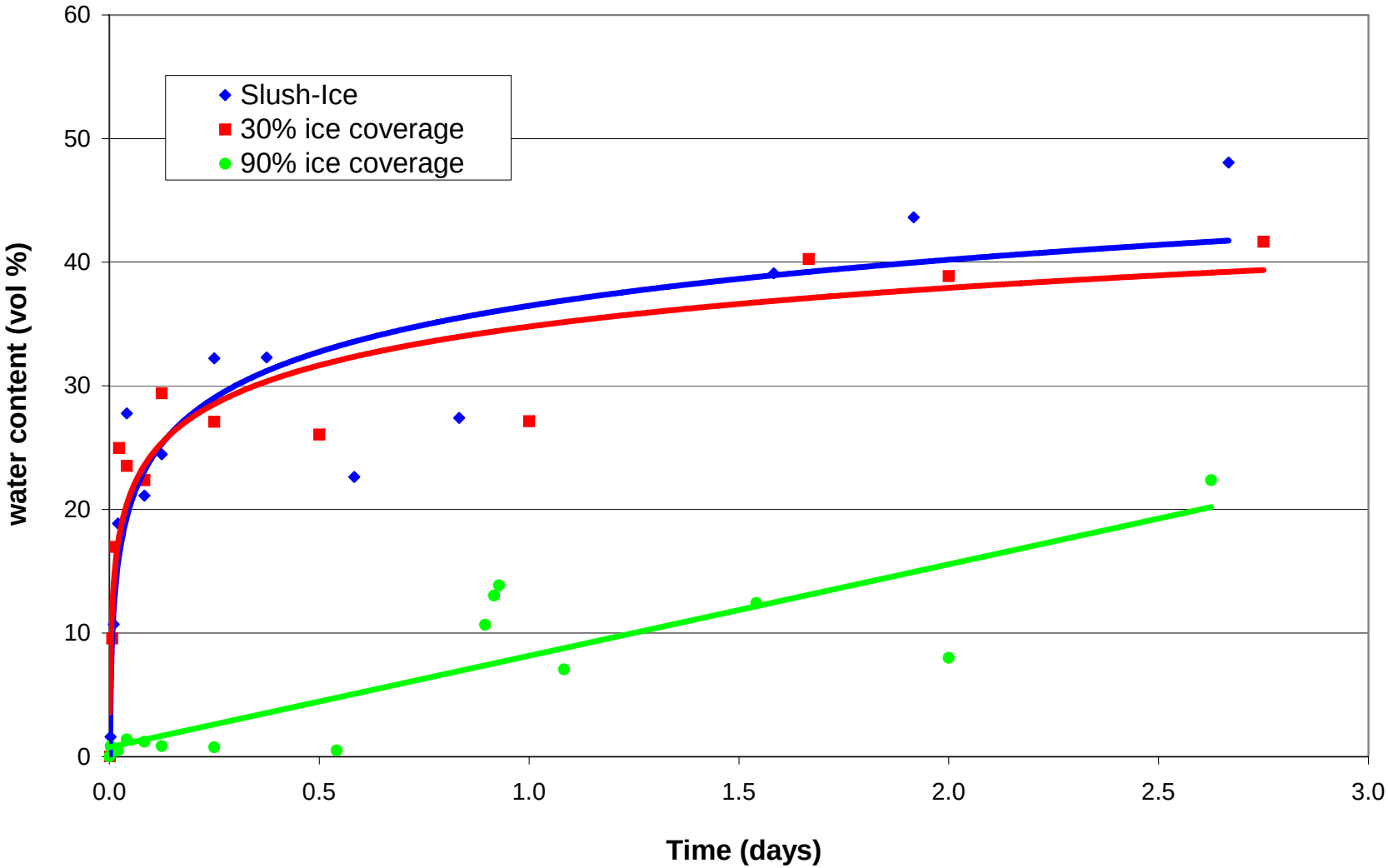
Weathering of oil vs. ice coverage



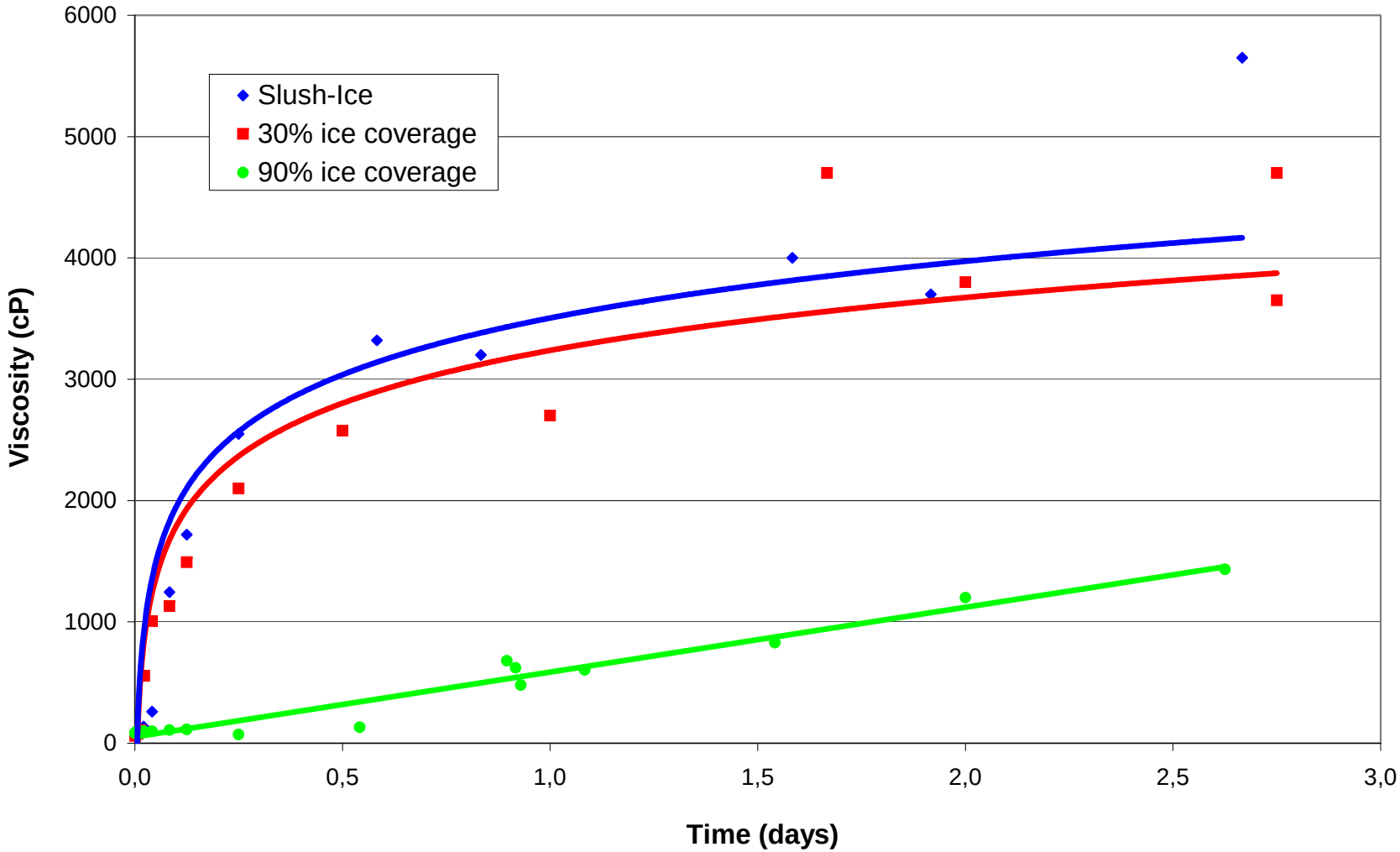
Evaporation as a function of ice coverage - 2005



Water uptake as a function of ice coverage - 2005



Oil viscoity as a function of ice coverage - 2005



Conclusions Arctic oil spills
Open water versus broken ice

1. Evaporation (40 ➔ 20%)
2. Water uptake (80 ➔ 10-20%)
3. Viscosity (20 000 ➔ 500 cP)
4. Increase of other oil parameters (pour point, flash point…) are also reduced

Operational consequences:

➔ increased window of opportunity for both in-situ burning and use of dispersants.

➔ Low water content/viscosity favourable for mechanical recovery

Future R&D needs

Increased transport and oil exploration in Arctic areas

➔ demand for increased understanding of oil weathering processes in ice

Important for:

- environmental risk assessments
- for oil spill contingency planning and -operations

How can this be achieved:

- Lab- and meso-scale studies (varying ice/energy conditions and oil types)
- Full-scale field experiments (ice-conditions/oil types) are the **ONLY** true verification