PROJECT SUMMARY REPORT - 2016 SERF CAMPAIGN

Subproject: Chemical characteristics of oil migration in, under and through sea ice

Actual field dates: December 10, 2015-April 15, 2016
Field site: Sea-ice Environmental Research Facility (SERF), University of Manitoba, Winnipeg (Canada)
Number of man-days in the field: 118

Summary:

An artificial sea ice mesocosm experiment was conducted in order to observe the interactions of oil and ice. A 3 m diameter by 1 m deep insulated fibreglass tank was filled with salt water, which was subsequently allowed to freeze. A thermocouple string was frozen into the ice to facillitate in-situ ice temperature profile measurement. Initially, a control experiment was conducted in order to monitor uncontaminated sea ice through active microwave remote sensing with the purpose of examining the time-series evolution of the normalized radar cross-section of the ice. The second phase of experimentation consisted of the injection of crude oil into the tank water column from the bottom, in which the oil was allowed to interact and mitigate upwards freely through the sea water, sea ice, and potential snow cover, so that the effects of the oil/sea ice interactions could be observed through time-series NRCS measurements. The third phase of the experiment was identical to the second, however the ice surface was snow-covered. The final phase of the experiment involved NRCS measurements without snow cover and sea ice in which the the test tank was brought to a melt and the oil was allowed to float and spread on top of the sea water.

Through the course of experimentation, sea ice cores, snow samples, as well as water samples were taken. These samples were placed in either sealable sample plastic bags or glass jars and were subsequently vacuum sealed and placed in a freezer for storage in order to minimize sample degradation due to volatility and reactivity to light. As of now the samples have all been collected and stored, and site clean-up has been mainly completed. Over the next few months, the bulk salinity and oil volume fraction of the samples will be measured, as these properties, along with the ice temperature profile, will affect the complex permittivity profile of the ice and provide context for the NRCS measurements. Furtheremore, analysis of the oil in the sea water, sea ice, and snow will commence shortly in order to determine the spatial location of crude oil components in the sea water, sea ice, and snow with time and under a variety of weather conditions. Analysis of sea water samples and sea ice samples (from ice cores) will be conducted on instrumentation including LECO Pegasus 4D multidimensional gas chromatography time of flight mass spectrometer and a 4D multidimensional liquid chromatography system. These instruments are suited for analysis of complex mixtures such as crude oil, which contain thousands of compounds and will allow for the separation, identification and quantification of several compounds within the oil. The determined distribution of the oil components in the tank can then be used to conclude which compounds infleunced the NRCS the most. Lastly, micro x-ray spectroscopic imaging of selected oil-contaminated ice cores will be conducted in the coming months.

Figure 1

Figure 2

Figure 3

Photos:

Fig.1: A 3m diameter by 1m deep insulated fibreglass tank with sea ice at SERF, University of Manitoba. Photo taken on January 17.Credit: Nariman Firoozy

Fig. 2: Aerial view of oil injection into fiberglass tank on February 9.
Credit: Nariman Firoozy

Fig. 3: Side view of physical sampling with ice corer on February 12.
Credit: Nariman Firoozy

Participants:

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