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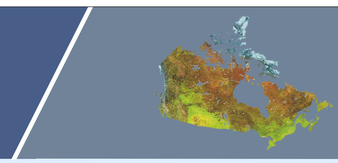
REGIONAL SURVEYING OF CANADIAN ARCTIC OFFSHORE BASINS FOR POTENTIAL NATURAL OIL SEEPS USING SATELLITE RADAR

V. Decker[1], P. Budkewitsch[2], W. Tang[1,3], F. Charbonneau[1], J.W. Haggart[4], D. Lavoie[5]



Introduction

Hydrocarbon seeps are sometimes known to occur in association with oil producing basins. Natural oil seeps are known from offshore basins in Canada, but remain relatively unstudied when compared to those from other areas around the world. As part of petroleum exploration activities, surveying for the presence of natural seeps can provide clues about the hydrocarbon potential of the region.

One cost-effective survey method employs satellite synthetic aperture radar (SAR) systems to detect the presence of oil on the sea surface. SAR imaging systems are used routinely to monitor ship traffic and detect illegal waste oil discharge from vessels and have also been successful for locating the presence of natural seeps. The method has the advantage of being able to acquire data from virtually anywhere on Earth in a systematic and repetitive manner.

In the Canadian Arctic, a feasibility project of the Baffin Bay and Davis Strait area was carried out using RADARSAT-1 data from 2003 and 2004 (Budkewitsch et al, 2013). This represented a limited temporal period, however no systematic surveys in the public domain have been carried out for determining natural baselines of seeps or to assist with identifying prospective areas for further exploration. Nonetheless, this information is of particular interest to the oil and gas industry, northern communities, environmentalists and the general public (e.g. Blasco et al., 2010).

This display outlines the project, describes the methodology used and illustrates the Arctic regions surveyed. Some preliminary observations from data collected in 2010 and 2011 are highlighted. Additional data acquisitions were made in 2012. A final database of results will be released as part of the GEM Energy Program in 2013.

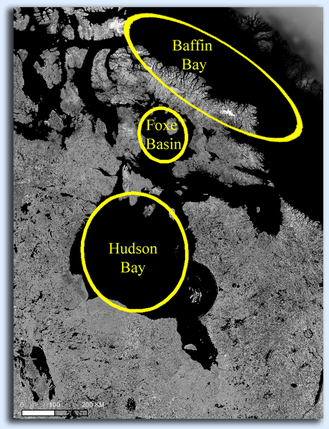


Figure 1: Location map of the three study sites

Objectives

In the context of Natural Resources Canada's GEM-Energy program initiated by the Geological Survey of Canada, this activity focused on the development of SAR data processing methods to extract and convey location and descriptive information on possible hydrocarbon seeps in northern environments.

Hudson Bay, Foxe Basin and Baffin Bay (Figure 1) are three priority areas being examined. The purpose of this work is to begin monitoring and to establish a database of preliminary results since oil seep detection requires a large multi-temporal dataset to illustrate the presence of persistent dark targets which may be of a natural origin. Oil and other surfactants have different surface tension than water, reducing sea surface roughness and lowering radar backscatter. Look-a-likes or false positives, such as weed beds, biogenic materials, grease ice, weather fronts near coastlines, rain cells, current shear zones and up-welling areas, can easily mimic oil on the ocean surface. These other natural phenomena are frequently recognized as the origin of dark features in ocean SAR images.

Methodology

Each of the three study sites has a comprehensive RADARSAT-2 coverage for both 2010 and 2011, exceeding a total of 350 scenes (Figure 2). The Wide mode beam of RADARSAT-2 with 25 m resolution and a swath of 150km was chosen for its appropriate mid incidence angle range and area of coverage. A vertical (VV) polarization was selected because it provides a superior clutter-to-noise ratio (CNR) over horizontal (HH) polarization for dark target detection.Visual identification of suspected was made from geo-referenced (8-bit) median filtered strip mosaics. A processing mask was used to generate zonal statistics over each target (Figures 3 and 4). A quantitative thresholding approach (typically a -10 db contrast) was then applied to each mask in order to generate a vector outline of the dark target. Each extracted vector feature is a closed polygon, attributed with a descriptive classification tag based on morphology as a linear or areal shape, and as a single feature or as a close grouping of multiple features present in the scene.

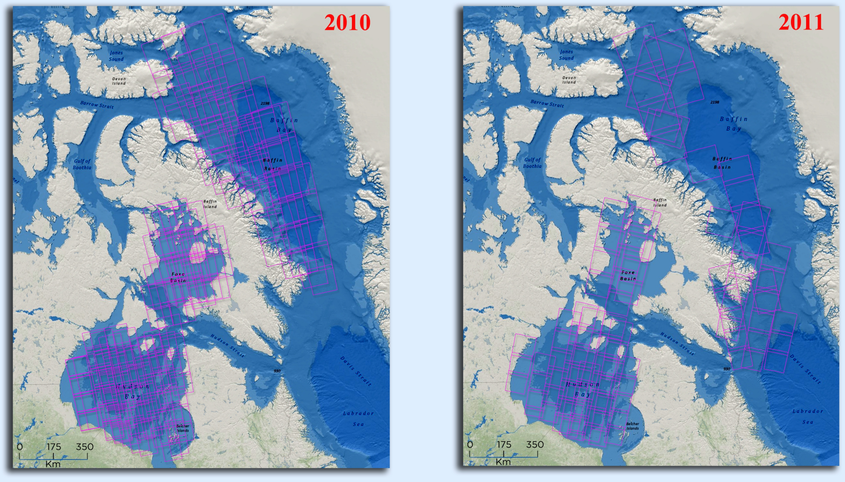


Figure 2: Distribution of RADARSAT-2 scenes acquired over Hudson Bay, Foxe Basin and Baffin Bay for 2010-2011. Acquisition dates range from mid September to late November. Area covered over Hudson Bay and Foxe Basin is approximately 650,000 km^2 and 375,000 km^2 for Baffin Bay and Davis Strait.

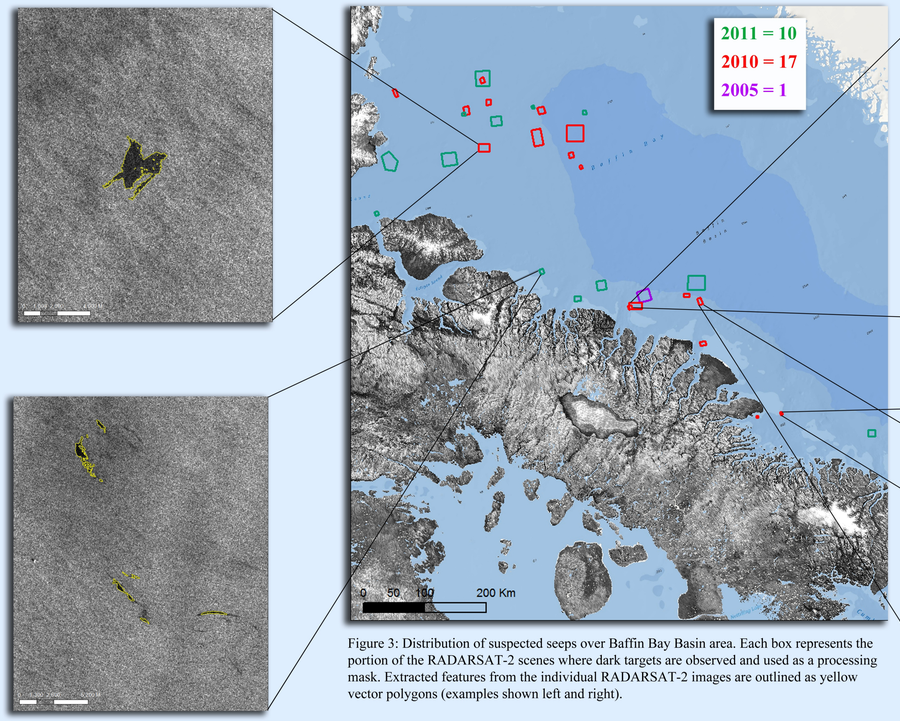


Figure 3: Distribution of suspected seeps over Baffin Bay Basin area. Each box represents the portion of the RADARSAT-2 scenes where dark targets are observed and used as a processing mask. Extracted features from the individual RADARSAT-2 images are outlined as yellow vector polygons (examples shown left and right).

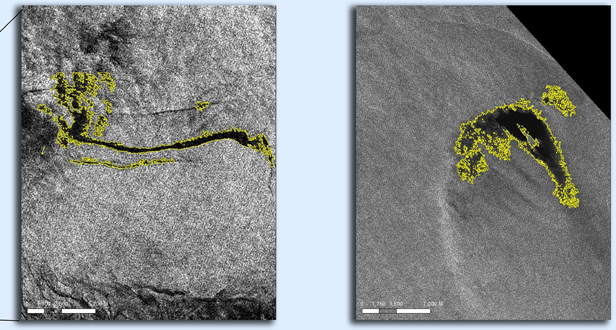
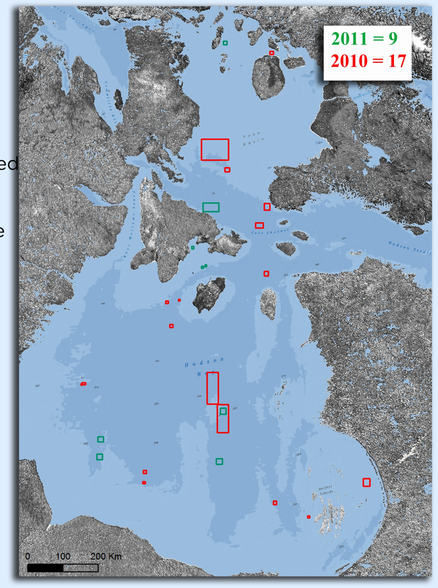


Figure 5: (Left) An irregular linear shape defines this dark feature observed at the Scott Inlet seep in 2010. (Right) Image from 2005 in the same vicinity delineates a large area covering a surface over 67 km^2.

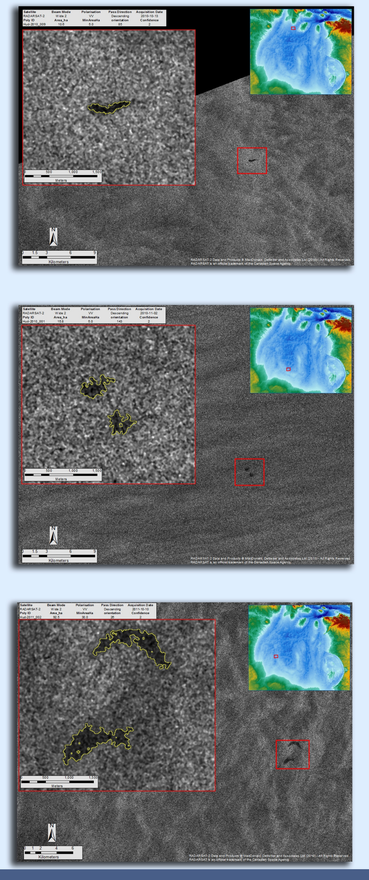
Discussion

Dark features in ocean SAR images are anomalously low areas of backscatter that can be caused by a number of different phenomena. A preliminary scan of the data from all three basins revealed over 50 dark targets. Some of these targets occur repeatedly in successive images and overlap when viewed in images from different acquisition dates. Many repeat observations are located in the vicinity of Scott Inlet (NE Baffin Island) where seeps were identified more than 30 years ago. Figure 5 illustrates two slick observations from the locality in 2005 and 2010. For other unknown areas, the potential that repeat detection of dark targets over time at roughly the same location are related to natural hydrocarbon seeps appears to be a reasonable interpretation, but requires addition proof to confirm their origin.

Figure 4: Distribution of suspected seeps over Foxe Basin and Hudson Bay



(Below) Examples of the database entries of dark targets identified



Summary

This work helps to improve Canada's geoscience knowledge from unconventional information sources and provides radar baseline data under ice-free conditions of the offshore environment that would not otherwise have been tasked. Imaging conditions, mainly high wind speeds, are not always ideal and the identification of dark ocean targets are not unambiguous seep occurrences. Further monitoring and other corroborating geoscience evidence is required to confirm an hydrocarbon origin. To date, approximately 350 RADARSAT-2 scenes have been examined for potential oil seeps and incorporated into a semi-automatic image processing and GIS system for dark feature extraction. Over 50 slick-like features have already been identified in the SAR images from more than one million square kilometres in the three basins examined. Whereas most of the dark targets are not likely of hydrocarbon origin, large areas have no slick-like features at all which reduces the area of interest to a more manageable region for further investigation. In this part of Canada's north, coastal (communities) and marine (ship) pollution are not generally suspected. Other phenomena can produce dark targets, however, repeat observations of a 'slick' is key for eliminating false positives. These results are based on only two years of observations (2010 and 2011), however some earlier RADARSAT-1 is available and RADARSAT-2 data from 2012 has been collected and will be analysed. The final products will be baseline geospatial data to support further targeted investigations and as an aid for understanding the subsurface geology and hydrocarbon potential in these Arctic basins.

References

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[1] Canada Centre for Remote Sensing, 588 Booth Street, Ottawa, Ontario K1A 0Y7
[2] Aboriginal Affairs and Northern Development Canada, Building 918, Iqaluit, Nunavut X0A 0H0
[3] School of Planning, Faculty of Environment, University of Waterloo, 200 University Avenue West, Waterloo, Ontario N2L 3G1
[4] Geological Survey of Canada, 605 Robson Street, Vancouver, British Columbia V6B 5J3
[5] Geological Survey of Canada, 490 de la Couronne, Quebec, Quebec G1K 9A9

For more information, please contact V. Decker (Vincent.Decker@NRcan-RNCan.gc.ca).

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