Overview Presentation

US Coast Guard Arctic Response Workshop

Anchorage

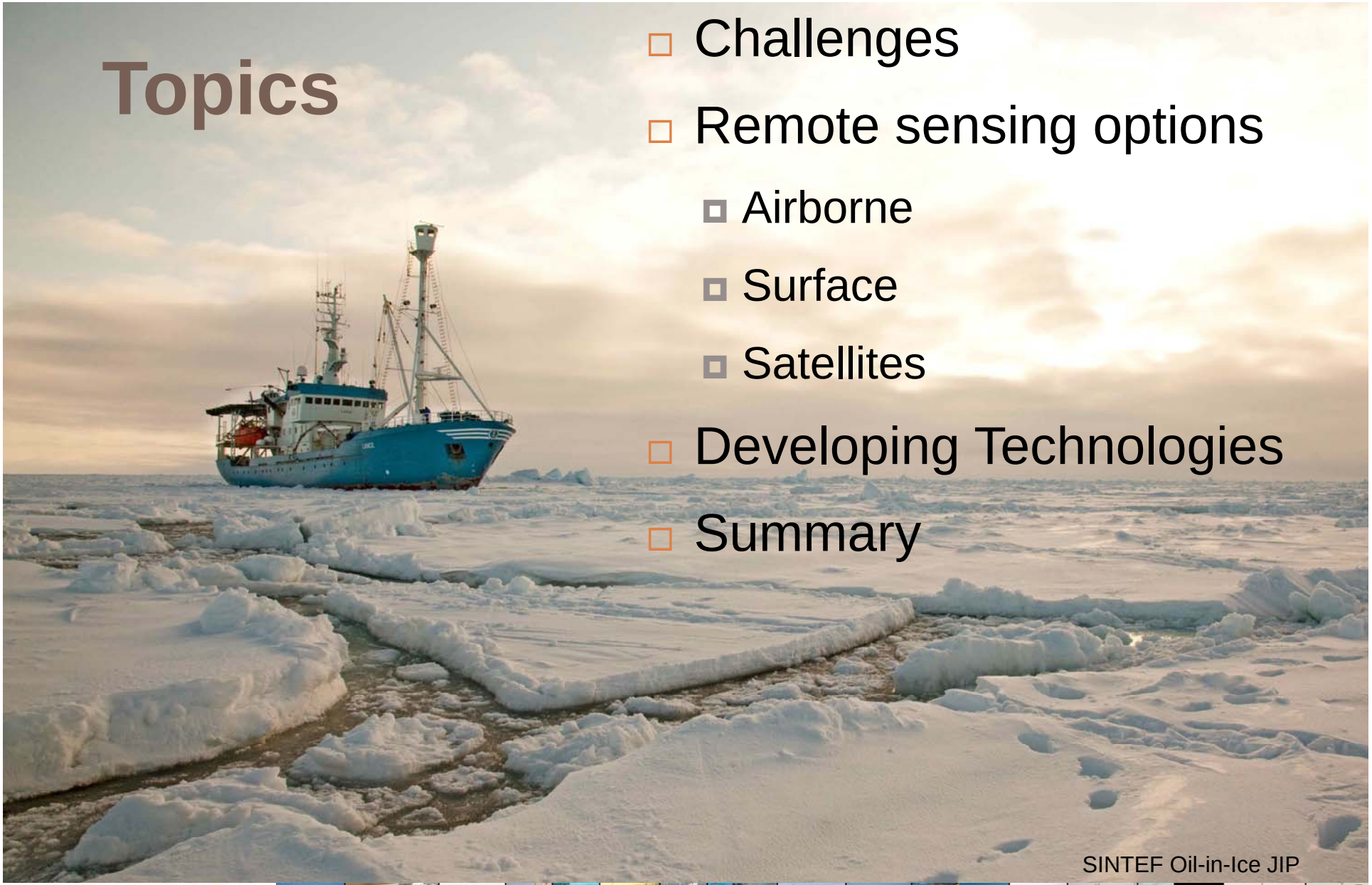
April 23, 2010

Detecting Spills in Ice Covered Waters

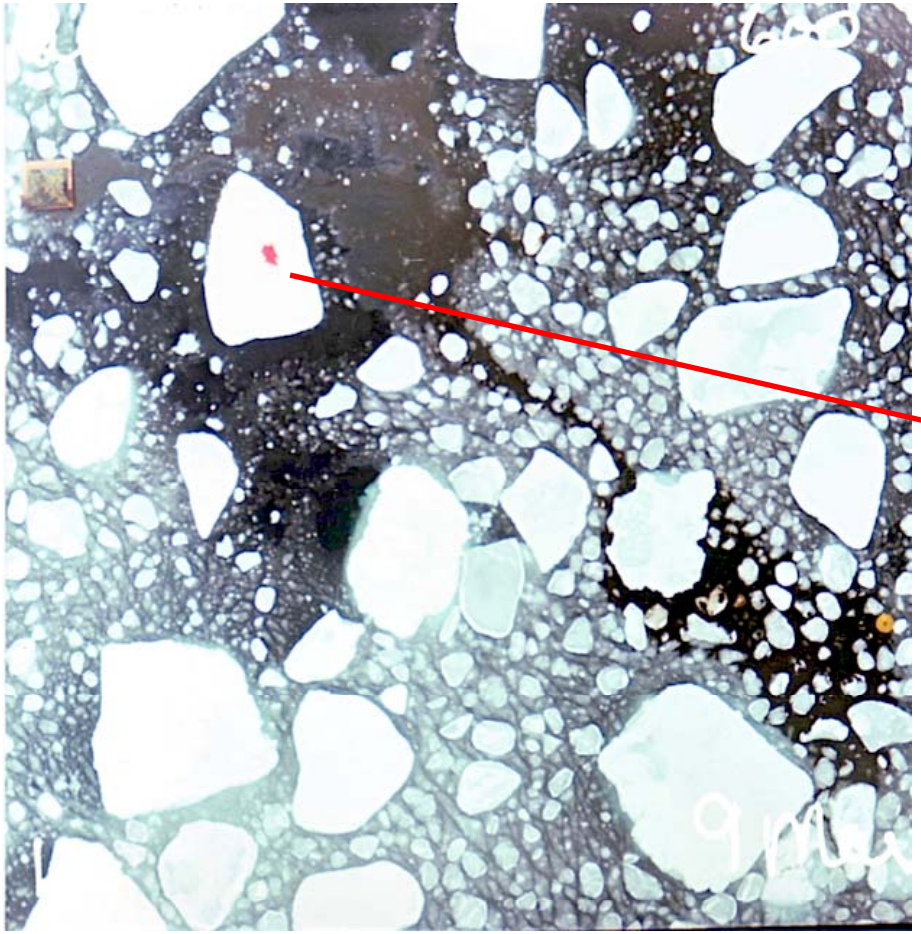
David Dickins – DF Dickins Associates

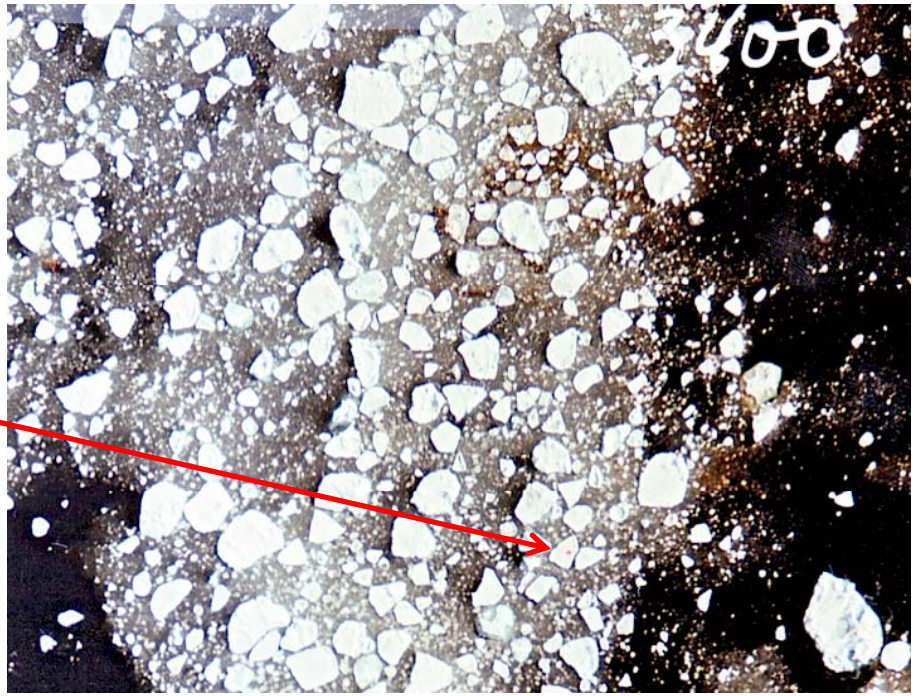
Topics

- Challenges
- Remote sensing options
  - Airborne
  - Surface
  - Satellites
- Developing Technologies
- Summary



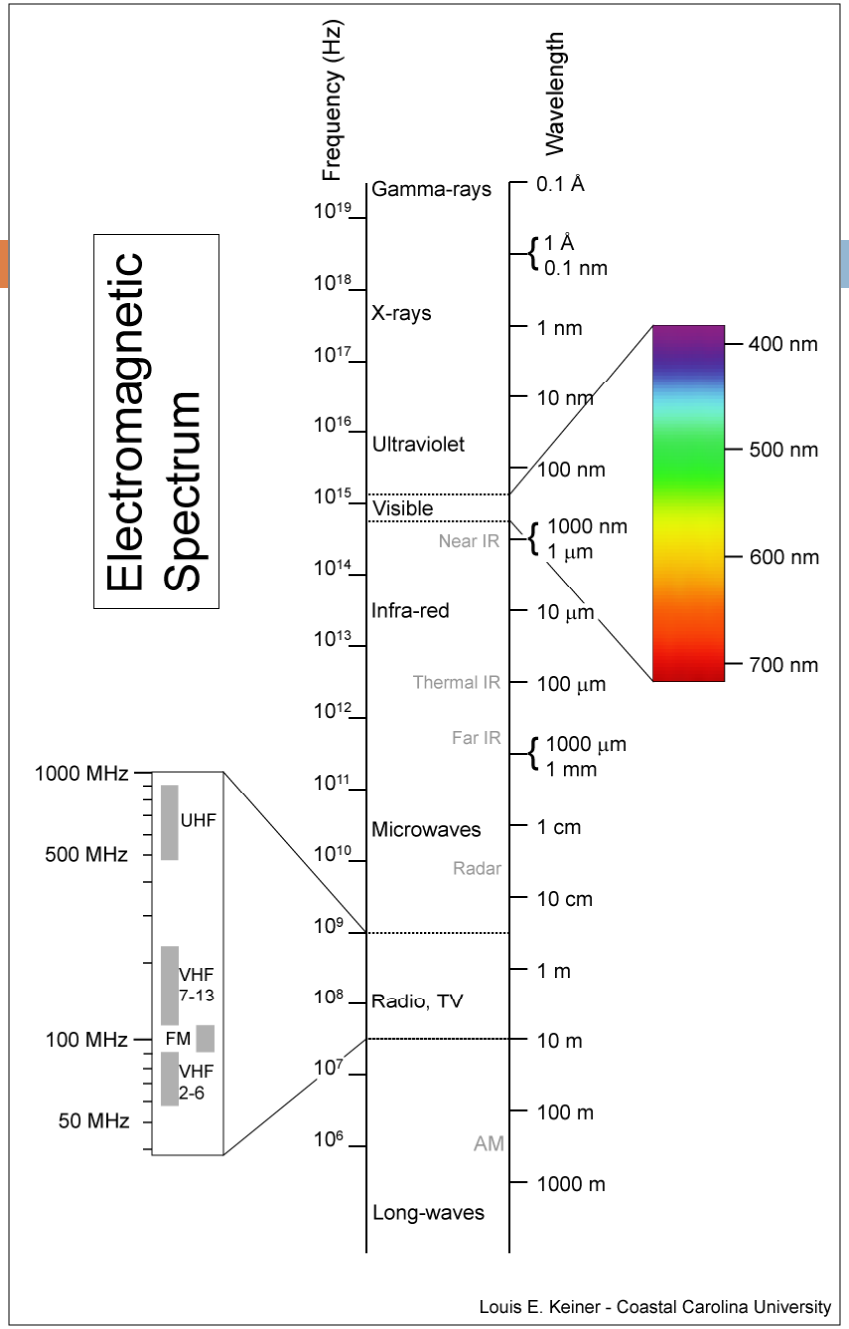
Why we need remote sensing





Cape Breton 1986 from 600 ft (L) and 3400 ft (R. Belore)

Finding visible oil on the surface mixed with ice in clear daylight is challenging enough! Remote sensing is essential to locate and map oil buried under snow or trapped in ice, under low cloud, darkness and fog.



- Sensors operating in different areas of the electromagnetic spectrum will detect different electrical properties at the interfaces of oil, ice and water.
- Sensors showing the most promise for spills in ice operate in the range from Radar to Thermal Infra-red

2007-09 Oil in Ice JIP

- Airborne
- SAR satellites
- Marine radar
- Infra-red
- Dogs
- Ground Penetrating Radar
- GPS ice tracking

Swedish Coast Guard Dash 8 Q300

GPS and satcomm antennas

Radio antennas

FLIR Wescam MX 15

Weather radar Honeywell

Search radar ELTA 2022 A

SLAR SSC/Ericsson

IR/UV Argon AA 3503

SWEDISH COAST GUARD

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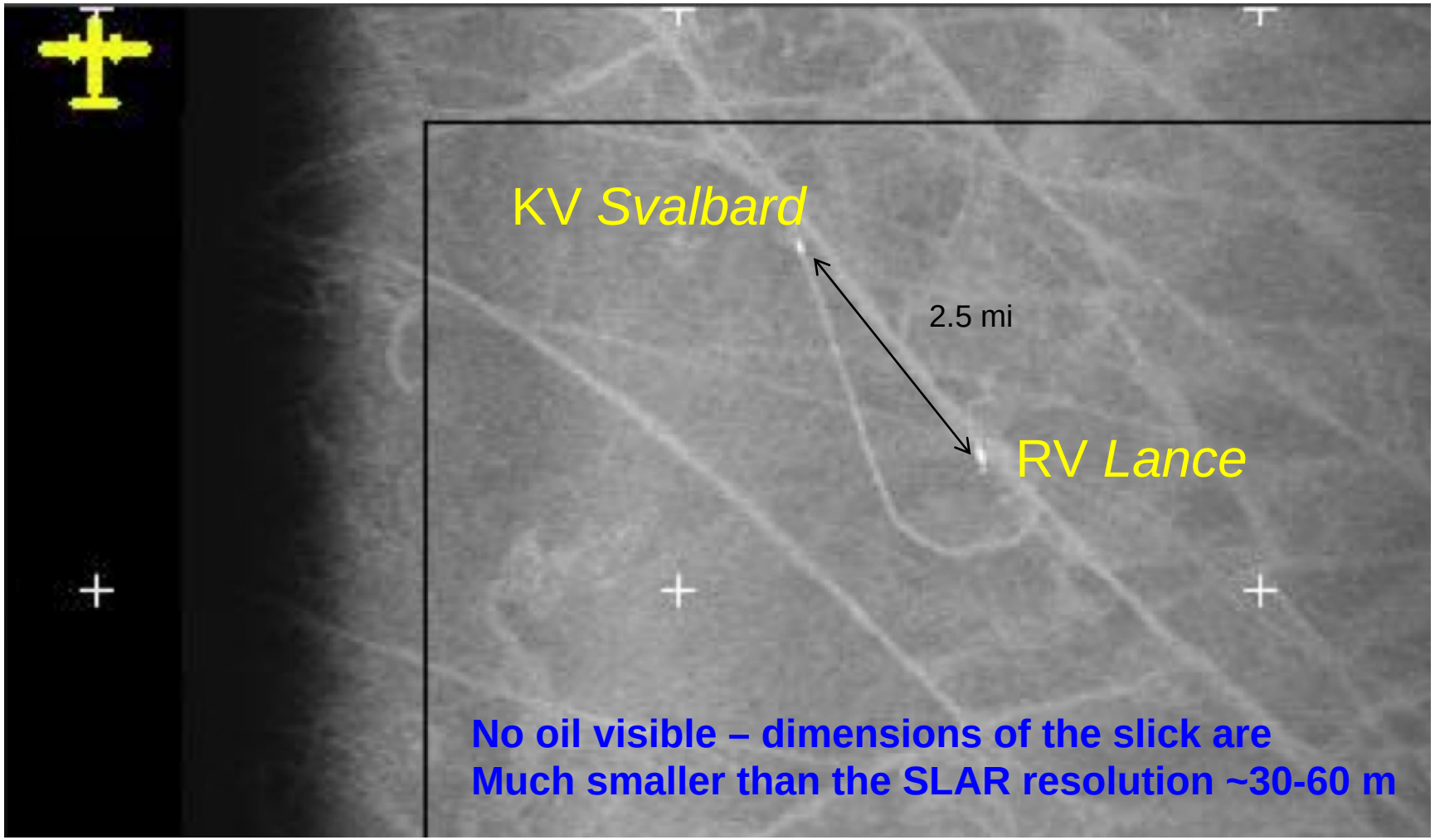
Canadian National Aerial Surveillance Program
Dash 8/Dash 7 - Arctic

Photos: Transport Canada

None of these aircraft are designed specifically to detect and map oil in ice but should do well in certain scenarios.

Zoomed Airborne SLAR Image over the 2009 spill

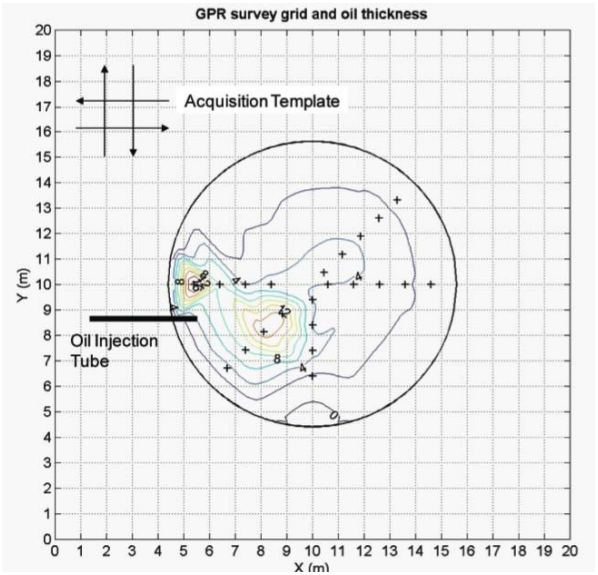
4 hours after the end of discharge – 44 bbl spill

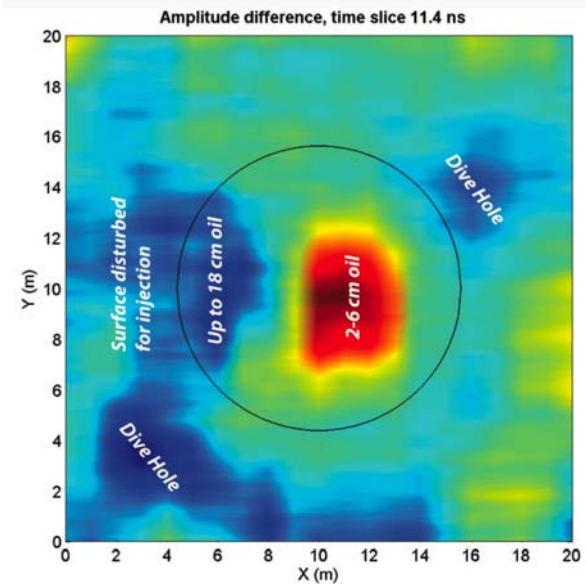


Surface and Airborne GPR Development

Boise State University and DF Dickins 2004 - present

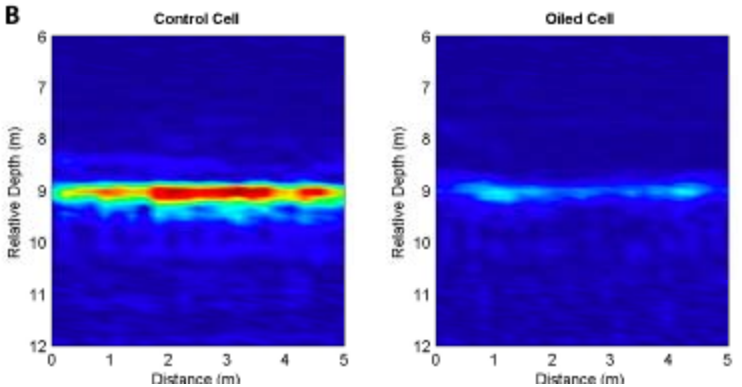
Photos: D. Dickins

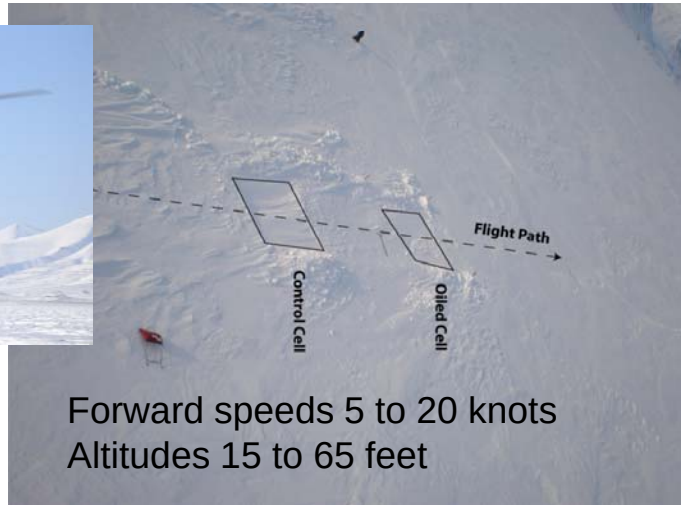




Testing over Trapped Oil in ice at Svea – Svalbard 2006

2008 Oil Under Snow Tests at Svea





Sponsors: MMS and the Oil in Ice JIP

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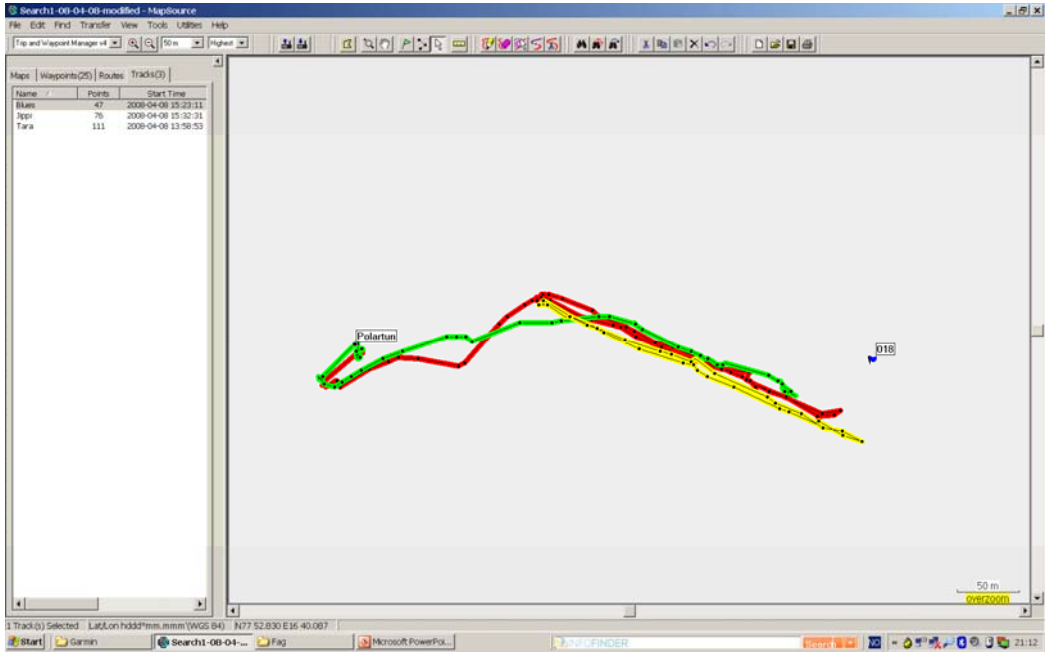
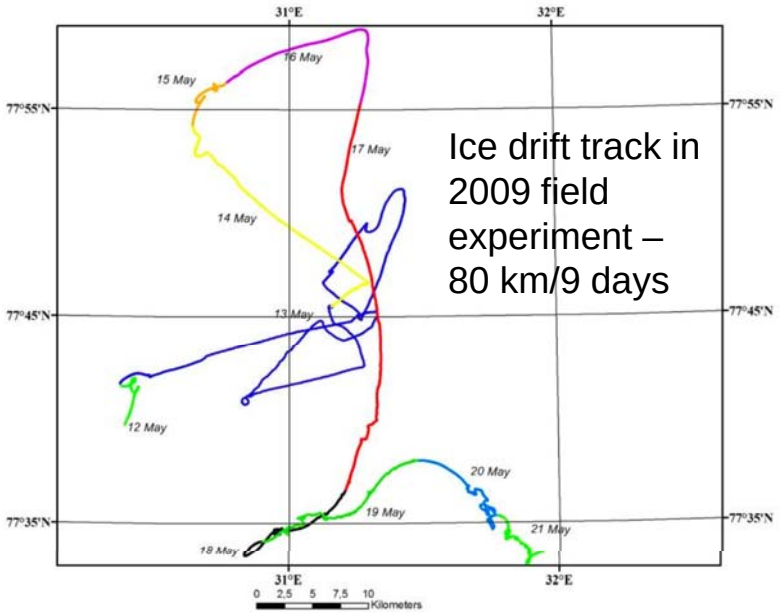
Trained dogs tested in Trondheim and Svalbard

Trondheim Dog Training Centre and Per Johan Brandvik



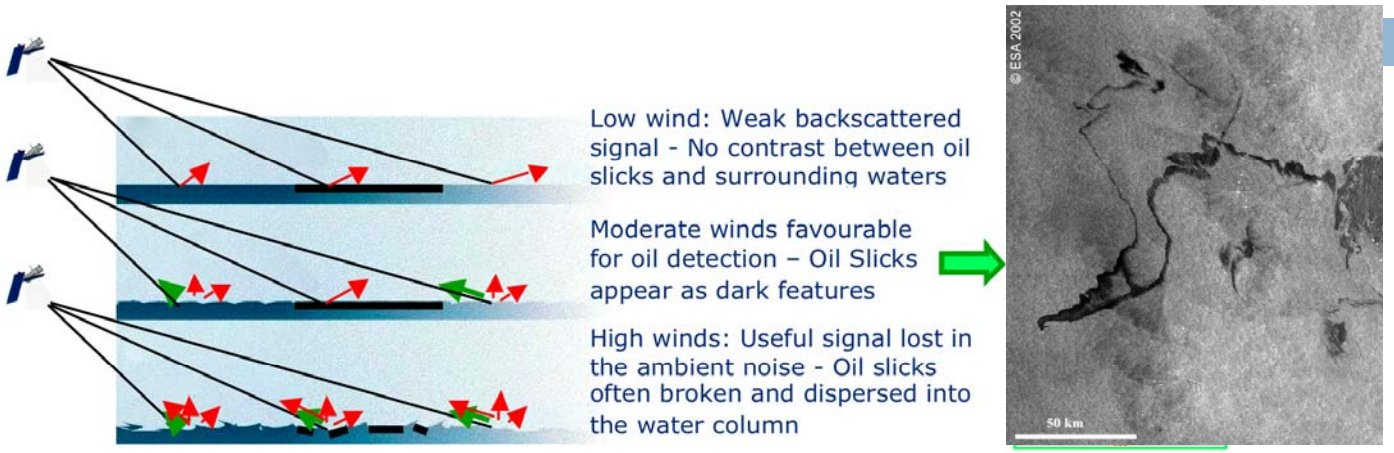
Ice Tracking



Ice drift track in 2009 field experiment – 80 km/9 days

- Rule of thumb – 30 degrees to the right of the wind direction and 3-5% of the wind speed depending on ice concentration (faster in open drift ice) – validated in recent oil in ice JIP
- Oil and ice tend to move together in higher ice concentrations >6/10, but there can be large differences in drift rates – oil vs. floes - in more open cover

Satellite remote sensing

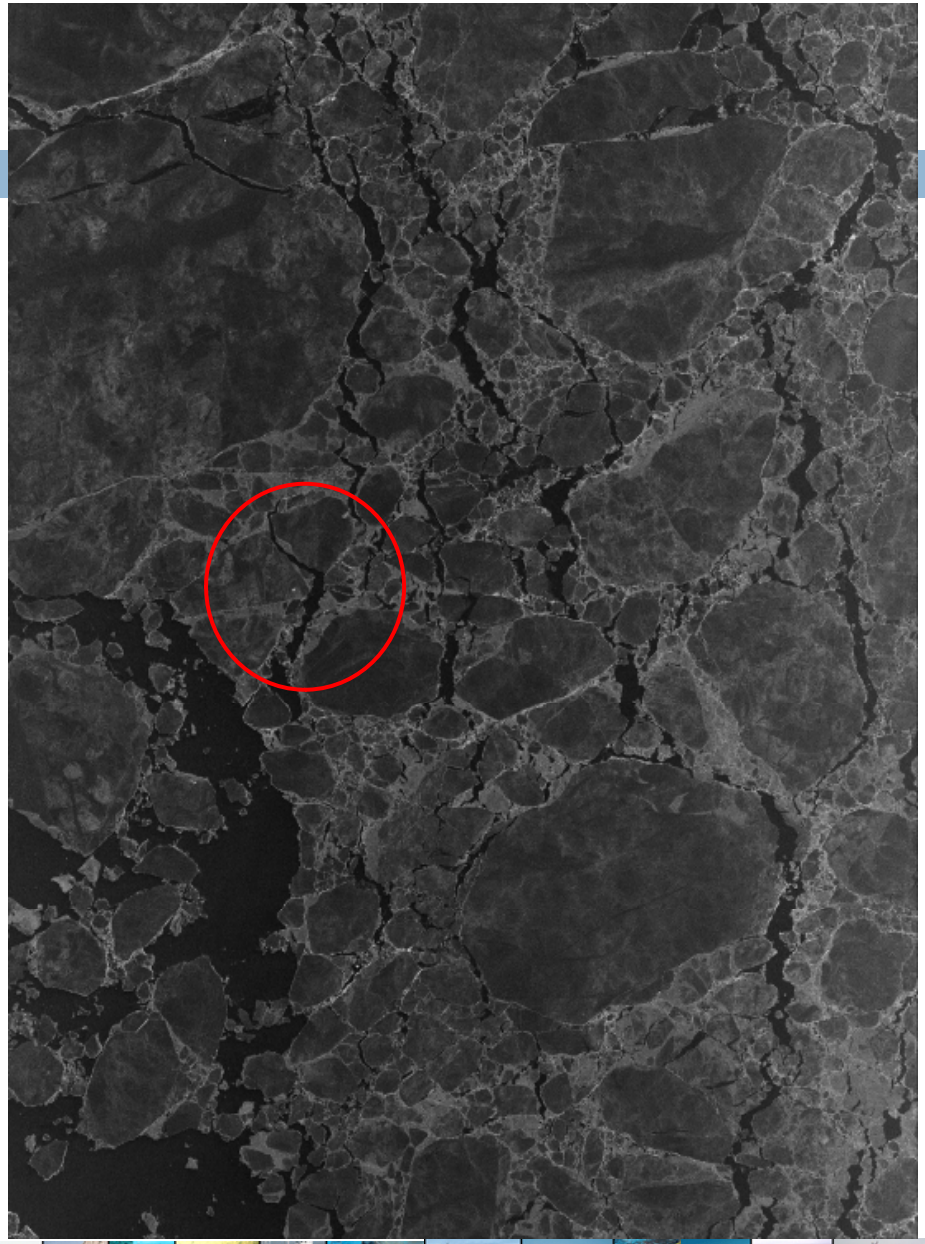


2-3 m/s < WIND < 12-15 m/s

We can see large oil slicks at sea with SAR satellites. Is it possible to see oil among ice?

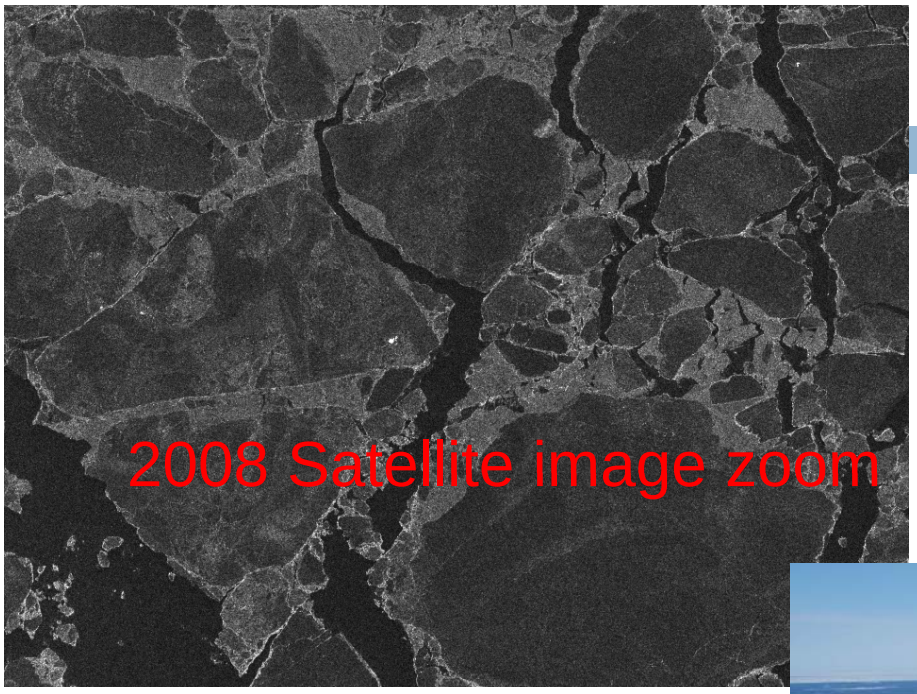
Answer depends on the conditions – ice concentration, size of slick, wind and waves. There is a strong potential for spill detection with SAR imagery in very open drift ice up to 3/10 with moderate winds – less in higher concentrations.

High-resolution Satellite Example



HIMAGE (Stripmap)
22/05/2008 16:04
Pol: HH
Right looking, descending
Mean off-nadir angle: 58.5°
Pixel spacing: 5 m.

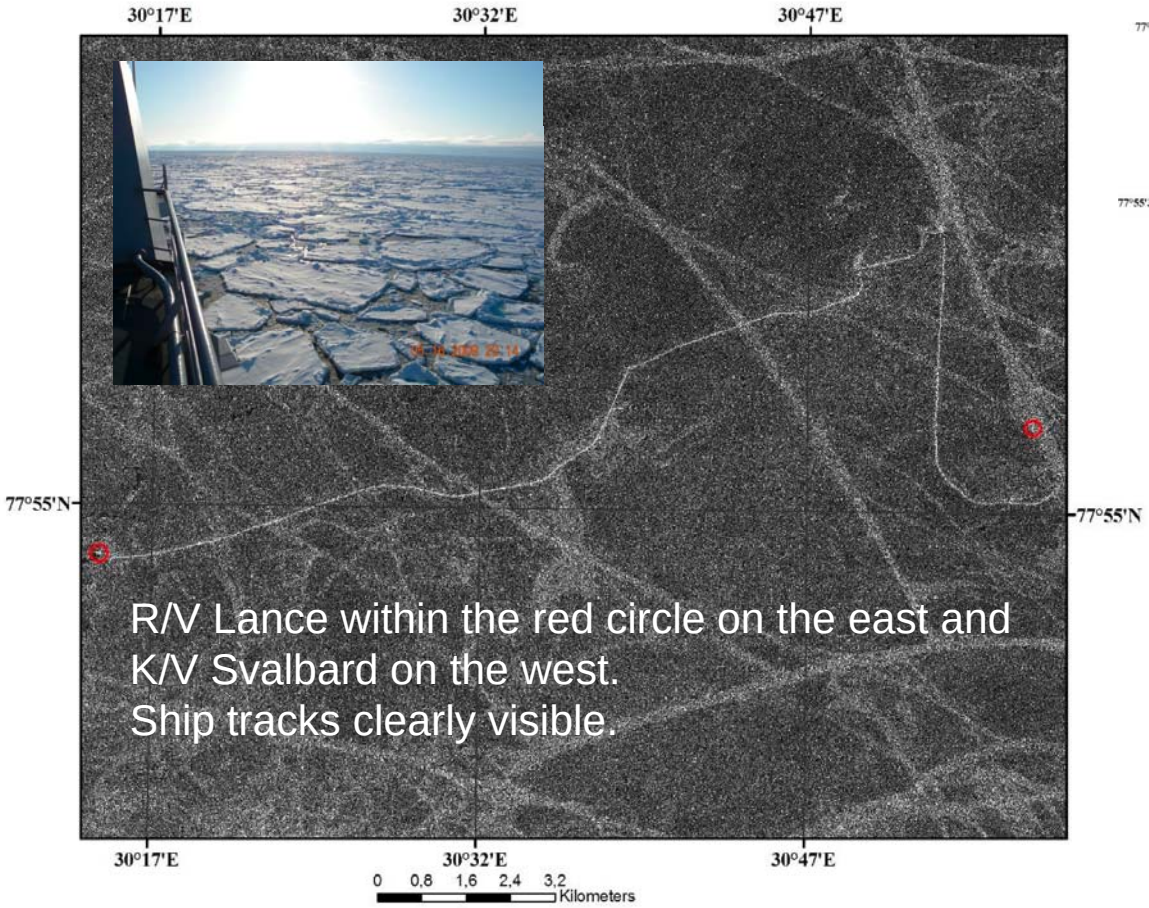
Cosmo SkyMed acquisitions



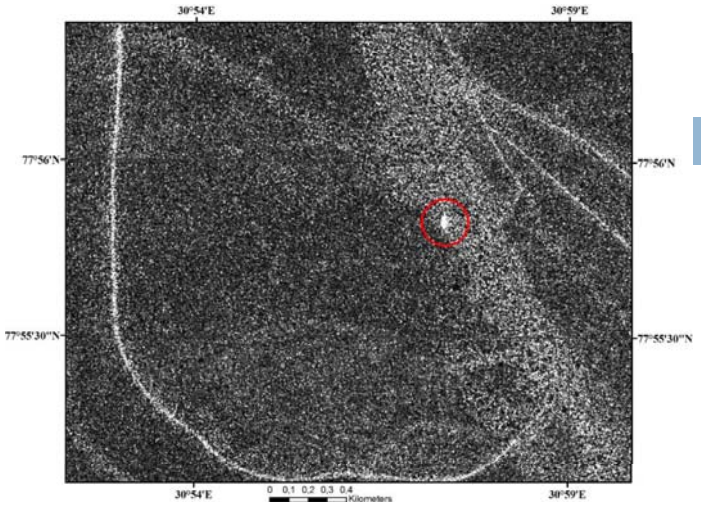
Helicopter view of pack ice in the area

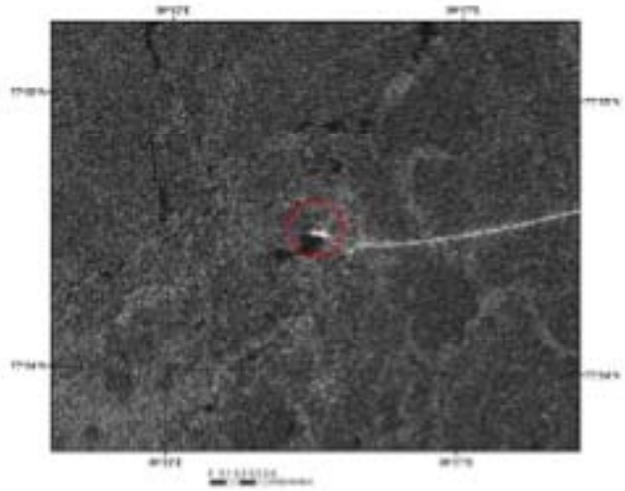
D. Dickins

COSMO SkyMed™ - 5 m/40 km



R/V Lance within the red circle on the east and
K/V Svalbard on the west.
Ship tracks clearly visible.

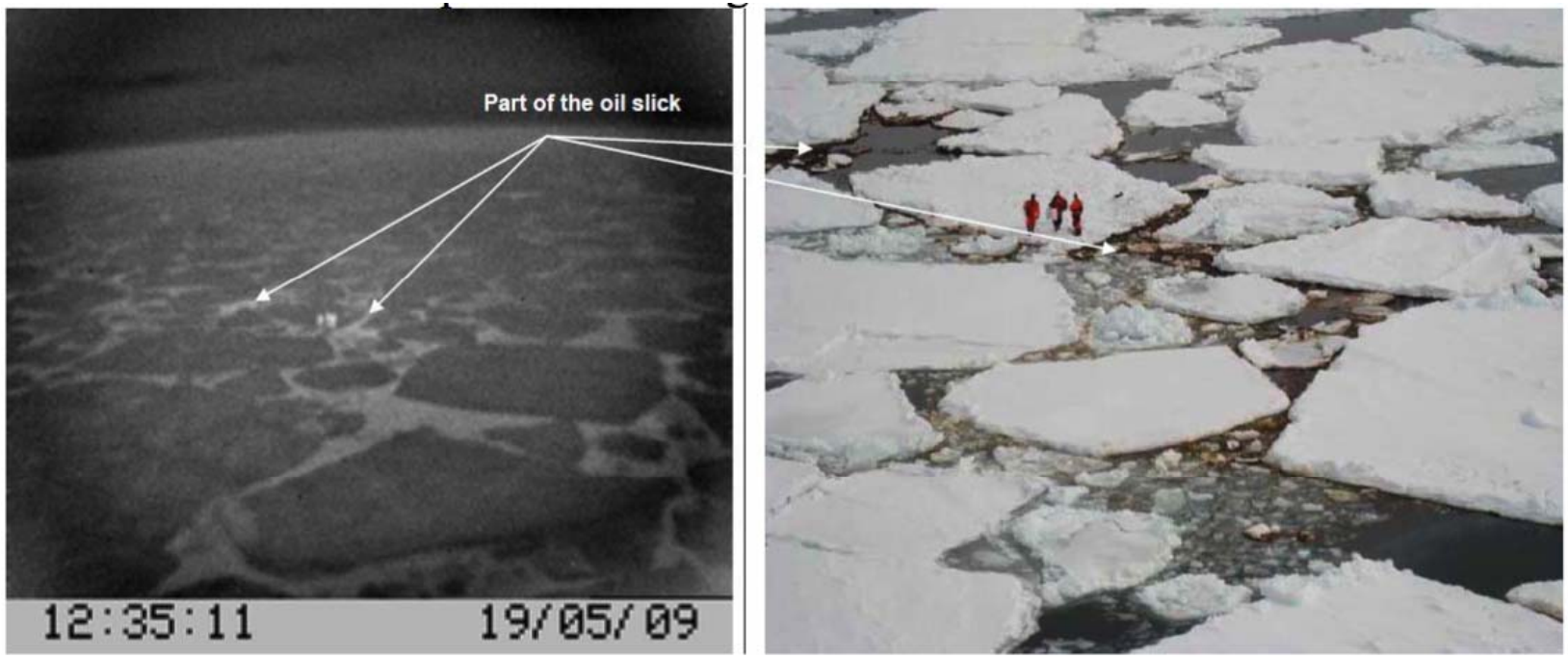




20090515 16:12 – 8 hours following oil release – no oil is visible

Zoom segments

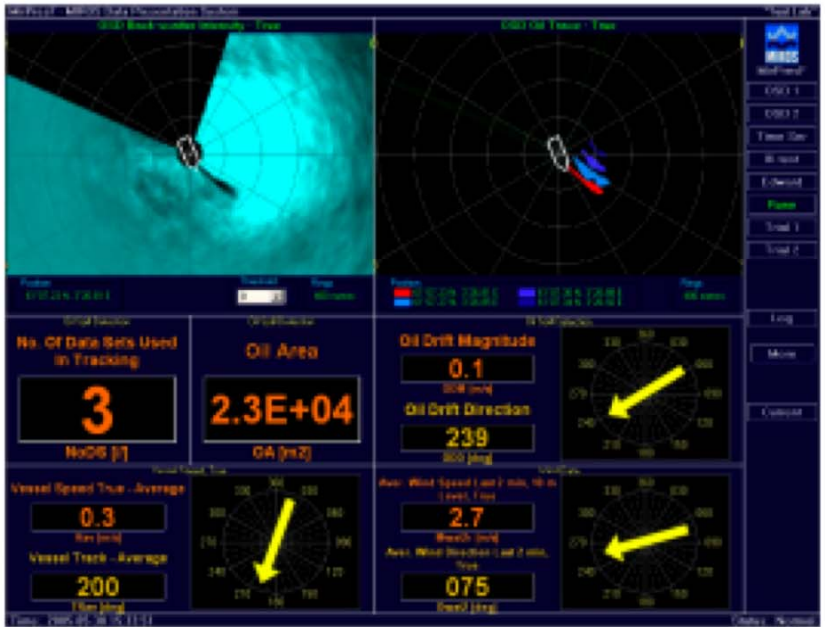
Hand-held IR Images FEX09



Source: Per Daling -Sintef

Greatest potential during daylight. More advanced airborne electro-optical FLIR as on the Swedish aircraft would produce much better results. All IR requires visual meteorological (VMC) conditions.

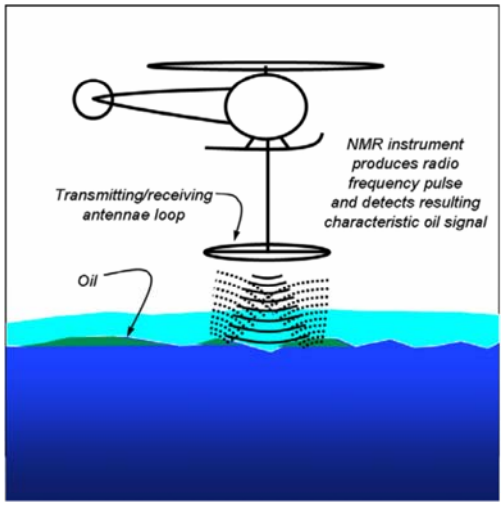
Marine Radar & FLIR



Aptomar SECurus integrates passive and active IR with radar to map slick boundaries and distinguish between thick and thin slicks – Application to spills in very open to open ice conditions up to 4/10

Example from offshore trials off Norway (Courtesy: MIROS and NOFO)

Developing Technologies



Nedwed 2008

Wadhams 2006

?

Dickins 2006

Summary

- Combination of sensors operating from aircraft, helicopters, vessels, satellites and the ice surface is needed to cover a range of oil in ice scenarios.
- Remote sensors and systems applicable to Arctic spills:
  - Airborne *Side-Looking Airborne Radar* (SLAR) – very open ice cover, all weather
  - Satellite-based *Synthetic Aperture Radar* (SAR) – very open ice cover, all weather
  - Vessel-based X Band radar – very open to open ice cover (up to 4-6/10)
  - Aircraft and vessel-based *Forward Looking Infrared* (FLIR) – primarily day VMC
  - Trained dogs – working on stable ice from shore or helicopters
  - Ground Penetrating Radar (GPR) from helicopters and/or from the ice surface.
- Detecting isolated oil patches trapped among closely packed ice floes is a major challenge. Best solution is to deploy GPS Tracking buoys to follow the oiled ice.

There are many different remote sensing options!