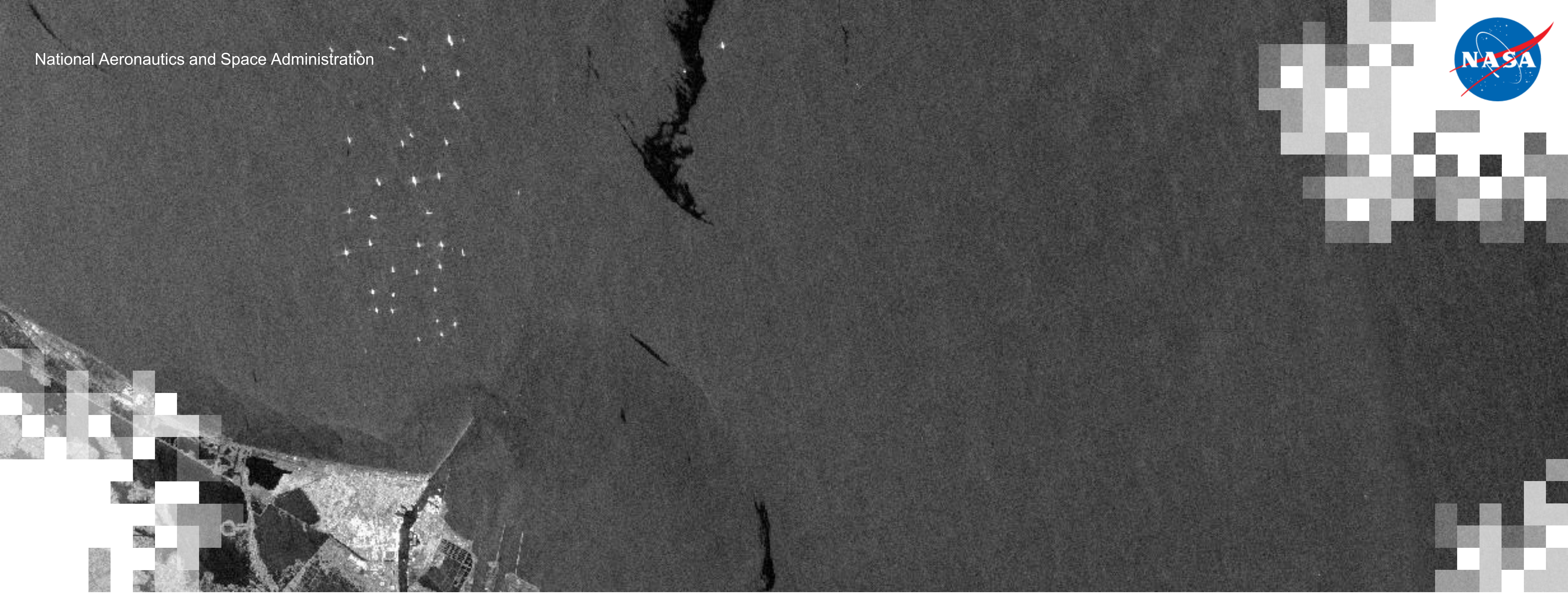


Part 3 – Oil Spill Detection

Disaster Assessment Using Synthetic Aperture Radar

Malin Johansson, UiT The Arctic University of Norway

Oct 27, 2022

Learning Objectives

By the end of this training, participants will understand:

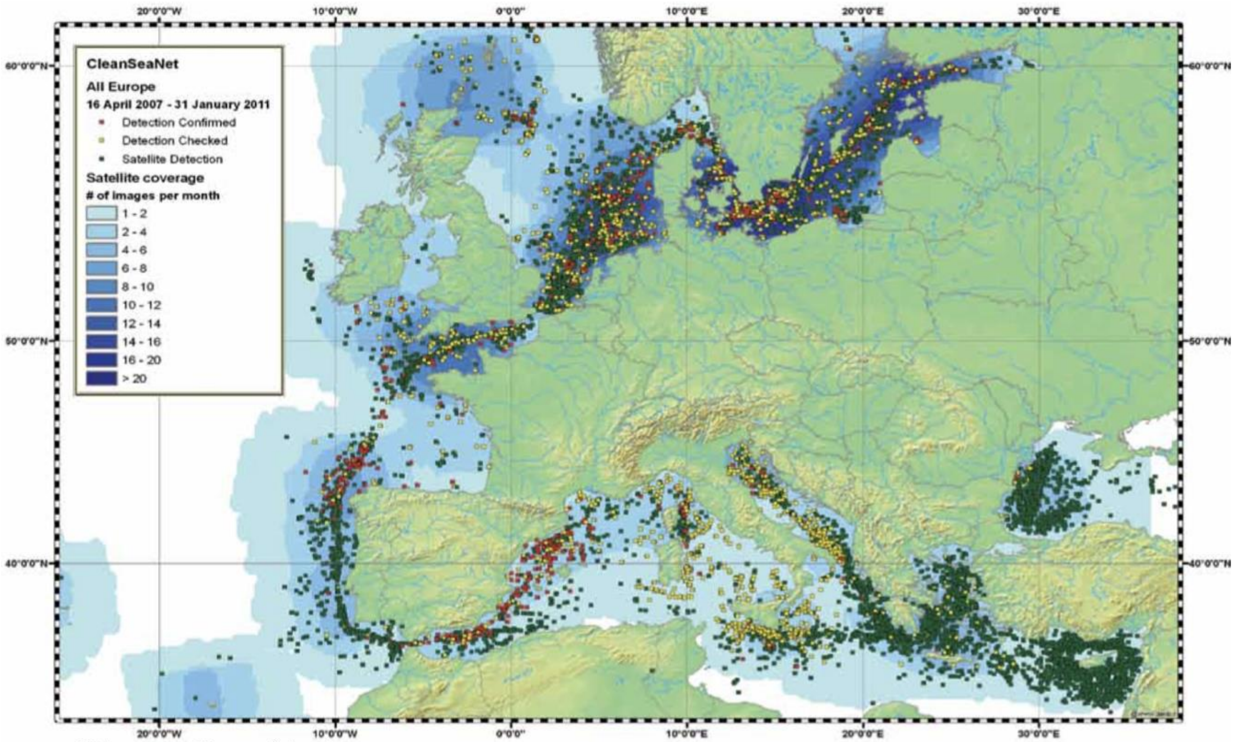
- The mechanism behind why we can detect marine surface oil slicks
- How SAR images can aid clean-up procedures
- How we can derive slick characteristics using single-, dual-, and quad-polarimetric images
- How satellite images can fit into the larger-scale picture when it comes to oil spill detection and drift patterns

Two Main Applications for SAR Remote Sensing of Oil Spills

- 1) Tool during oil spill clean-up operations
- 2) Ocean Surveillance -> Oil Spill Detection
  - Accidental oil spills
  - Illegal discharges

In 2021, 3,004 potential oil spills were reported by EMSA (European Maritime Safety Agency).

In 2021, Kongsberg Satellite Services (KSAT) oil spill detection services made 11,000 SAR-based detections of potential marine oil spills across the world.



CleanSeaNet:
SAR coverage and detections 16 Apr. 2007 – 31 Jan. 2011

European Maritime Safety Agency, 2011

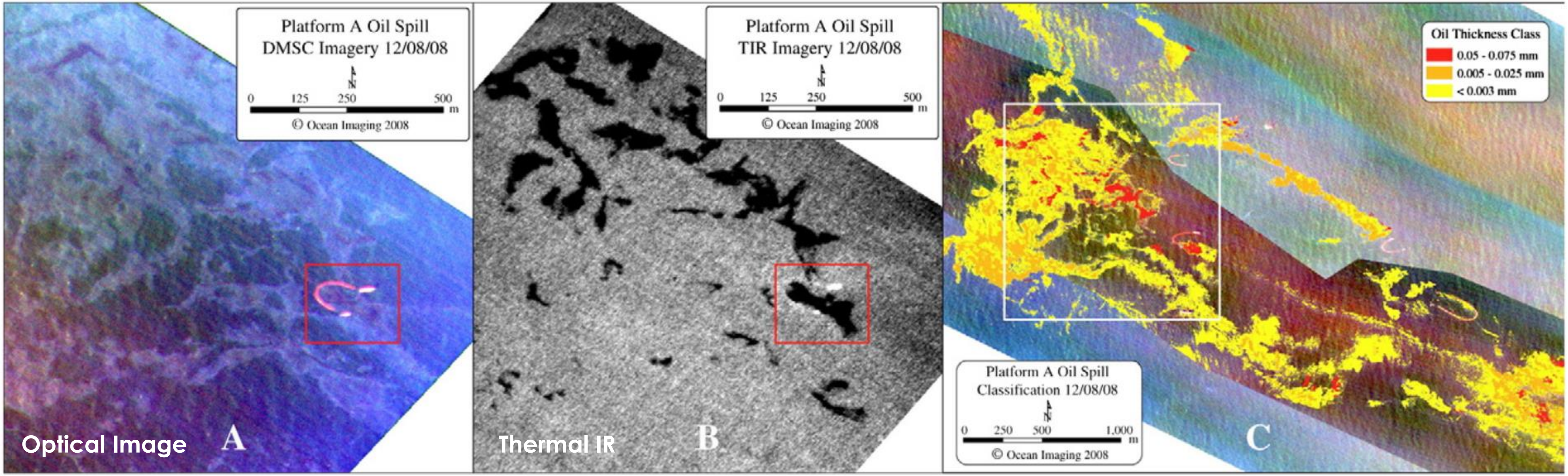
Oil Spill Occurance

- Marine oil slicks originate from:
  - Pipelines
  - Wells
  - Transport Vehicles
  - Storage Tanks
  - Natural Seeps

- They often occur in coastal waters -> important for responders to act quickly.
- They can also be transported by winds and currents away from the point of origin.
- It's therefore important to not only detect, but also monitor the drift and spreading.

Oil Spill Detection

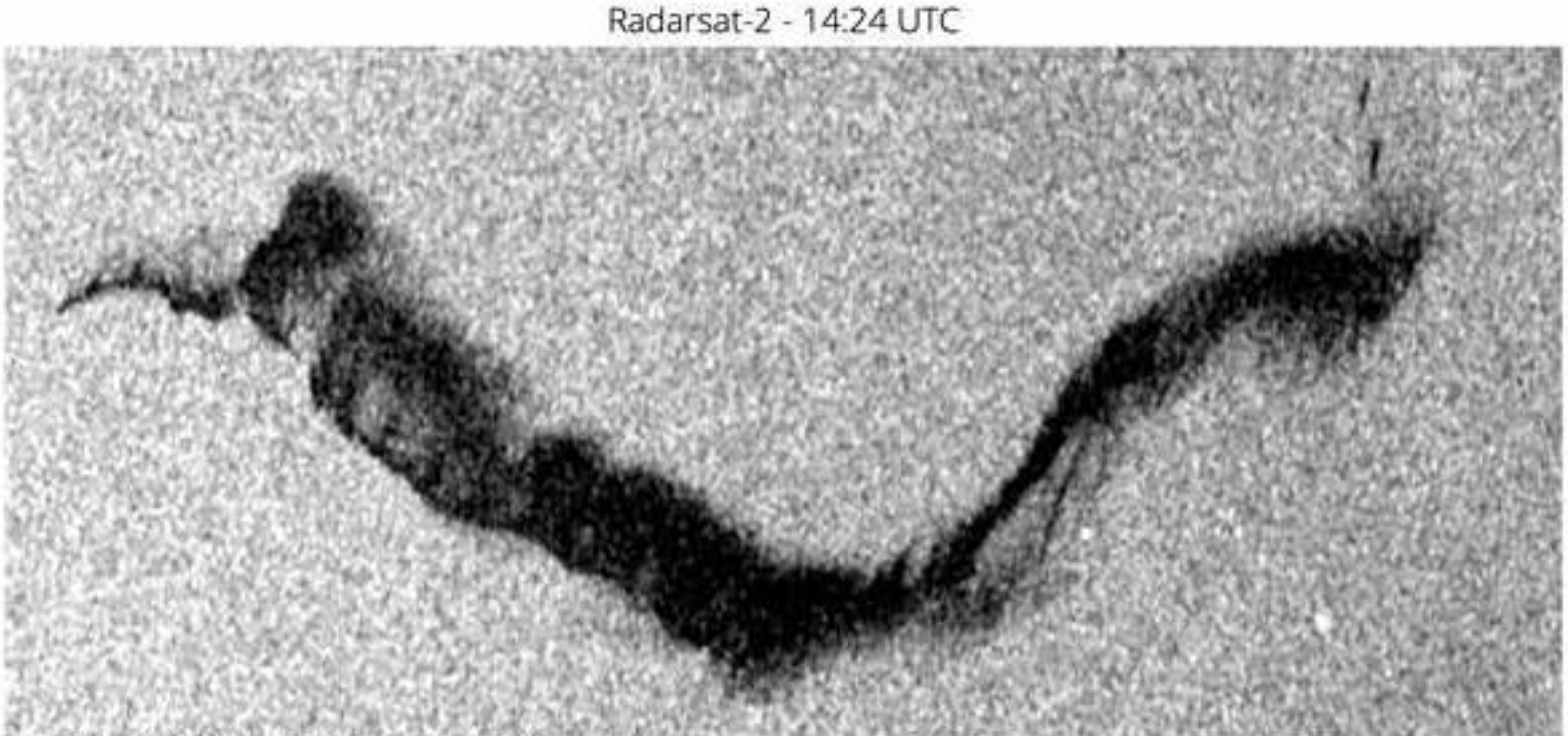
- Oil can be detected in different types of satellite data, each with different advantages.
  - A common goal is often to identify thicker oil and estimate the total oil volume.



Leifer et al, 2012

Oil Spill Detection

- During challenging weather conditions –> often cloudy.
- Oil spills can occur day and night.
- For operational monitoring, we then need a day-night and daylight-independent source.



Oil Spill Detection – Synthetic Aperture Radar (SAR)

Monitoring of Known Oil Spills

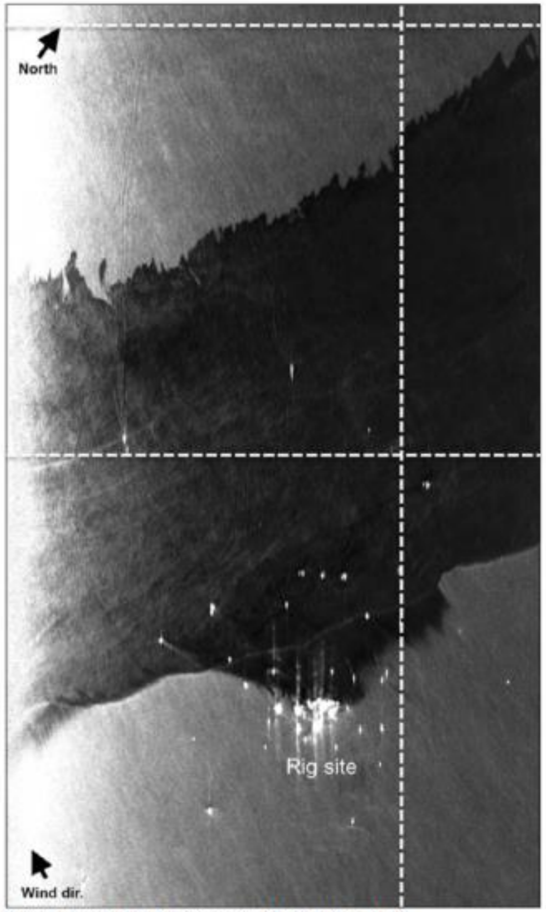
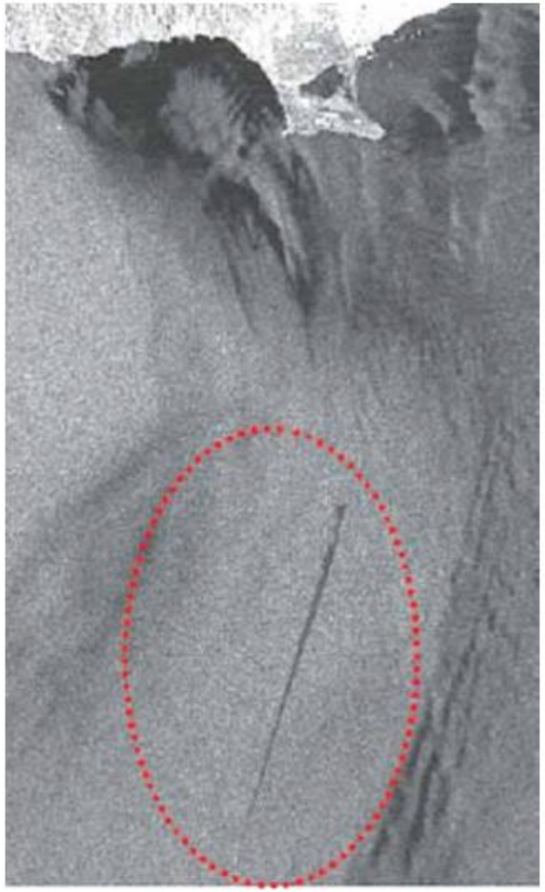


Figure from: Migliaccio and Nunziata, 2014

Detection of Accidental and Intentional Spills



CleanSeaNet satellite image of a possible oil discharge off the coast of Cyprus

Satellite image © ESA (European Space Agency) / EMSA 2007

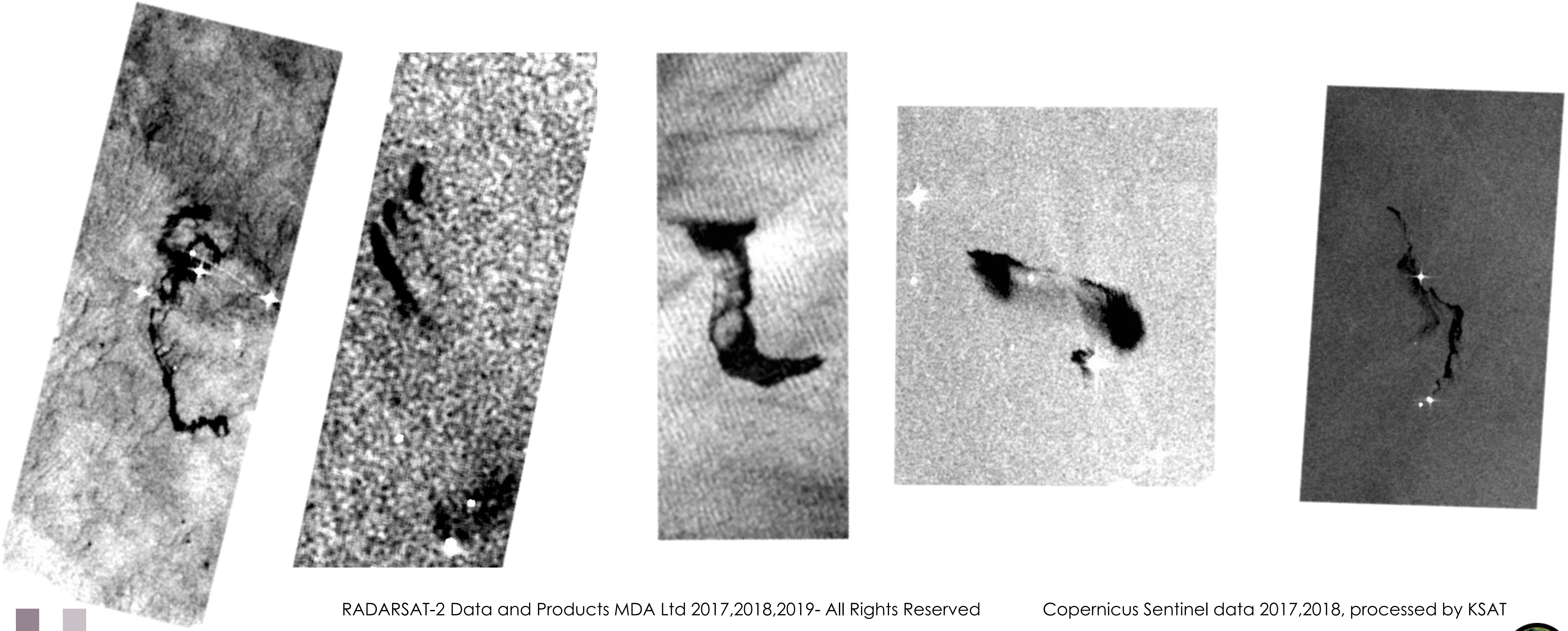
SAR is a valuable tool for the detection and monitoring of marine oil spills.

Provides Info On:

- Position and weathering
- Proximity to Land, Vulnerable Areas, etc.
- Areal extent
- Possible Source

Oil Spill Detection – Synthetic Aperture Radar (SAR)

No two slicks look the same.



RADARSAT-2 Data and Products MDA Ltd 2017,2018,2019- All Rights Reserved

Copernicus Sentinel data 2017,2018, processed by KSAT

Oil Spill Detection – Synthetic Aperture Radar (SAR)

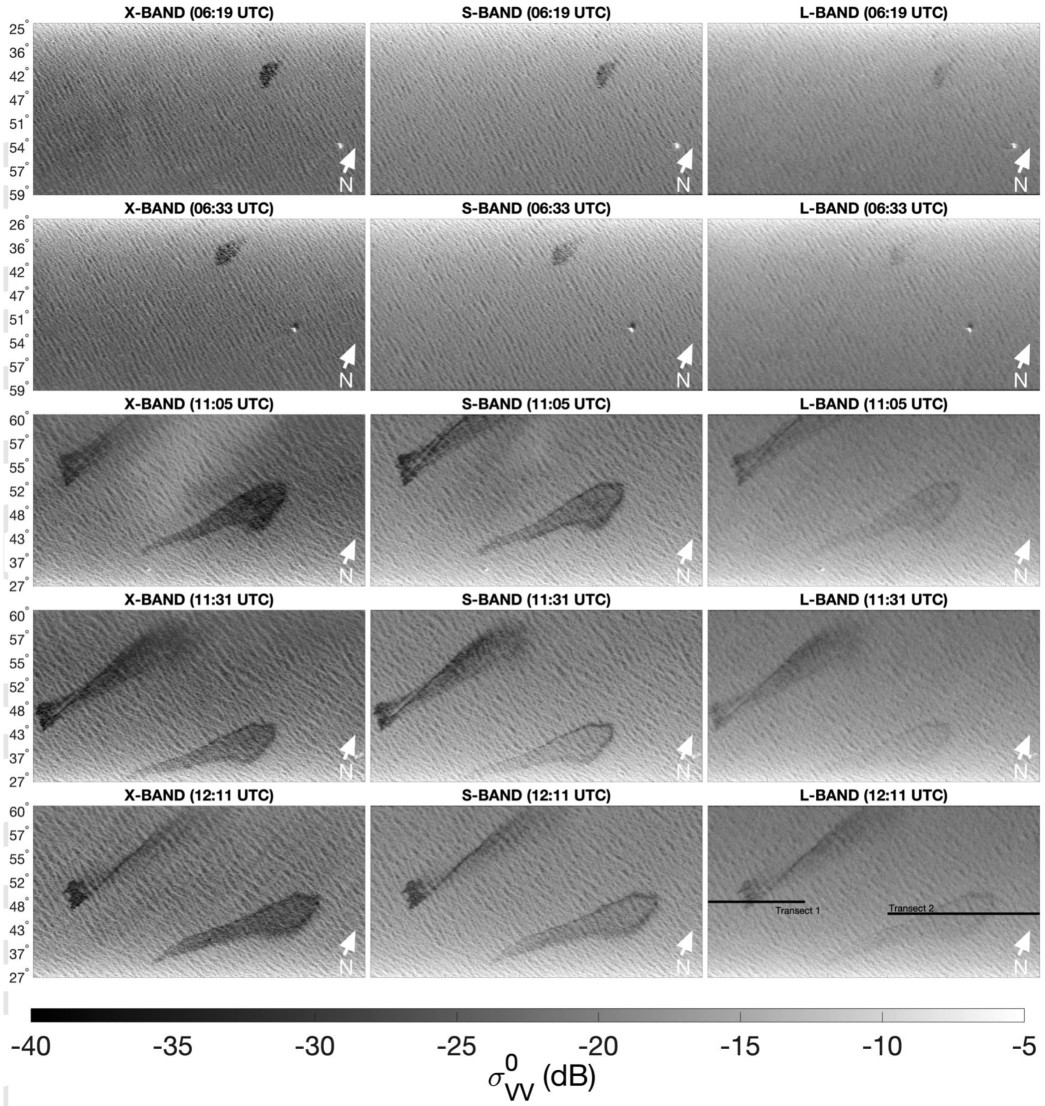
- The volume of oil is not consistent

The slick itself changes over time.

- Currents
- Wind

Strength and Direction

Drift



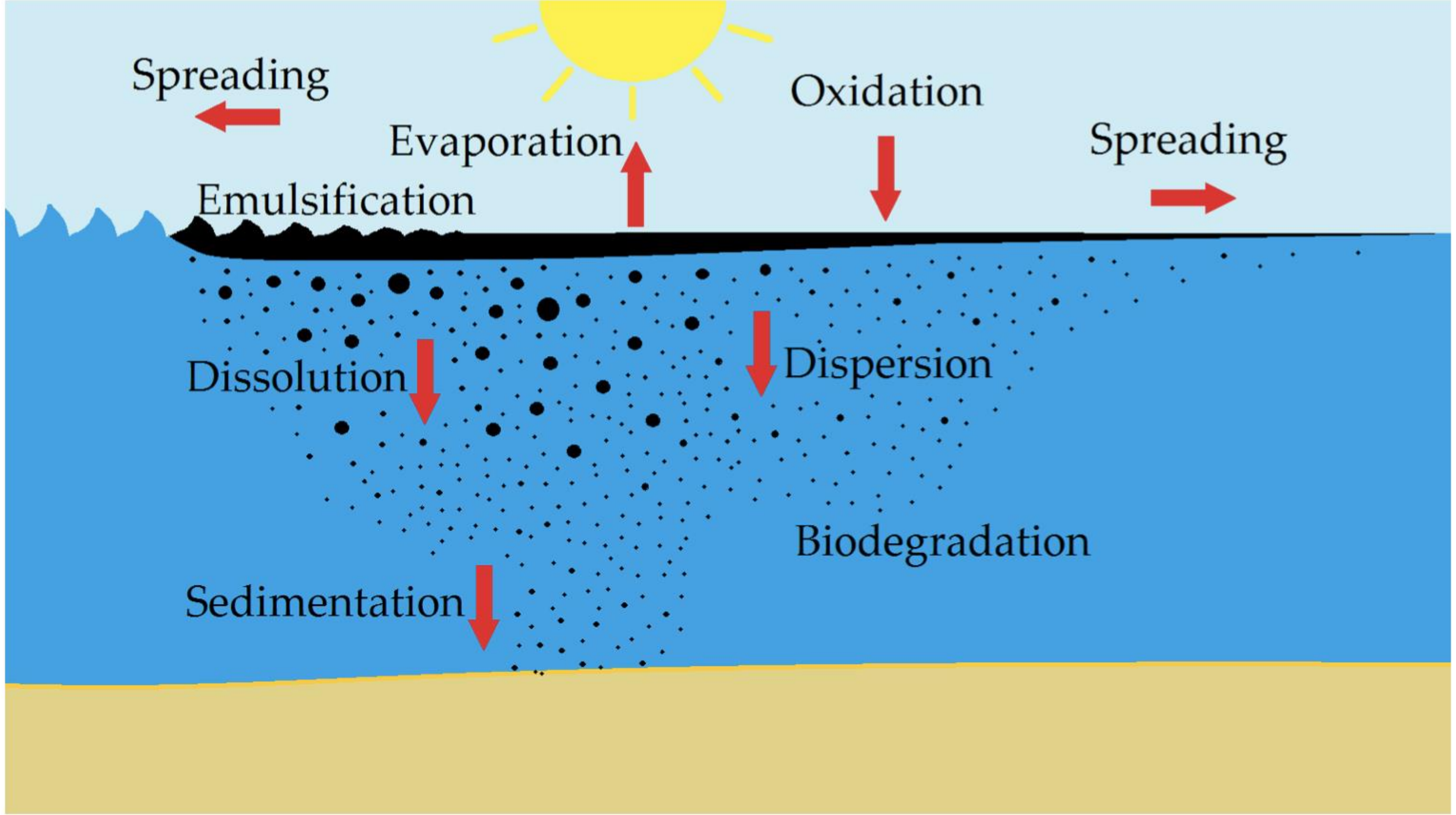
Brekke et al, 2020

Oil Spill Detection – Synthetic Aperture Radar (SAR)

Oil properties change over time due to weathering processes.

<u>Weathering depends on:</u>

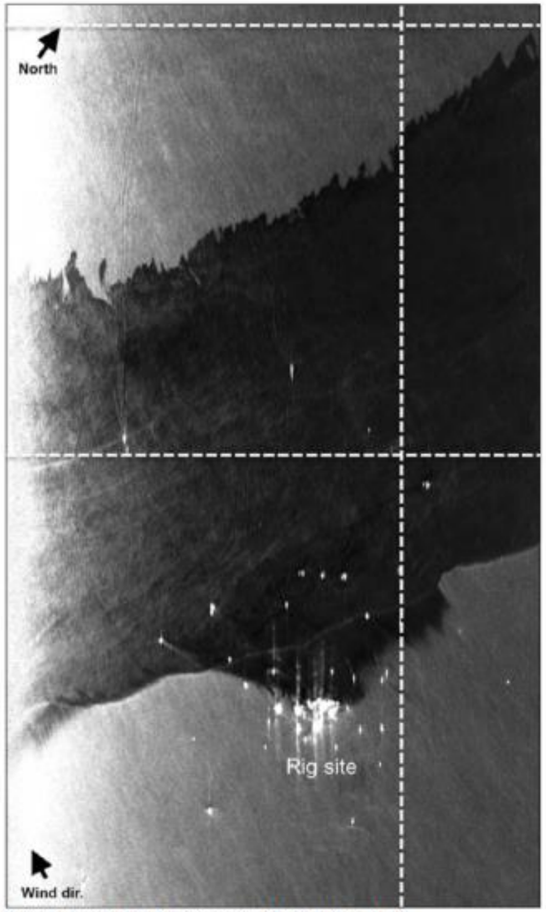
- Oil properties (viscosity, density, solubility, etc.)
- Air and sea temperature
- Wind speed, sea state, currents, etc.



Skrunes 2014

Oil Spill Detection – Synthetic Aperture Radar (SAR)

Monitoring of Known Oil Spills



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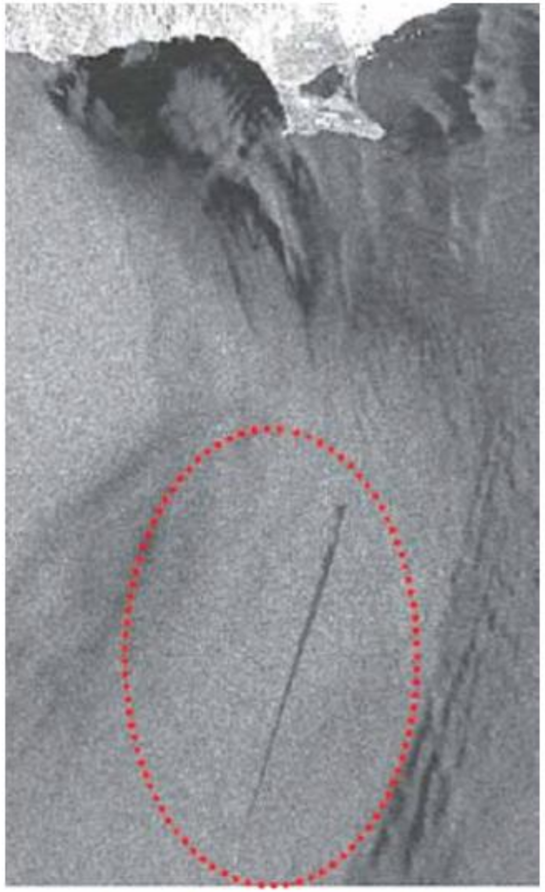
Detection of Accidental and Intentional Spills



CleanSeaNet satellite image of a possible oil discharge off the coast of Cyprus

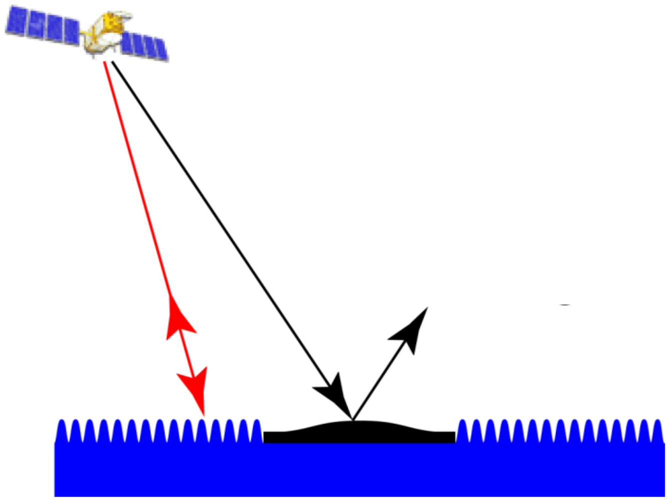
Satellite image © ESA (European Space Agency) / EMSA 2007

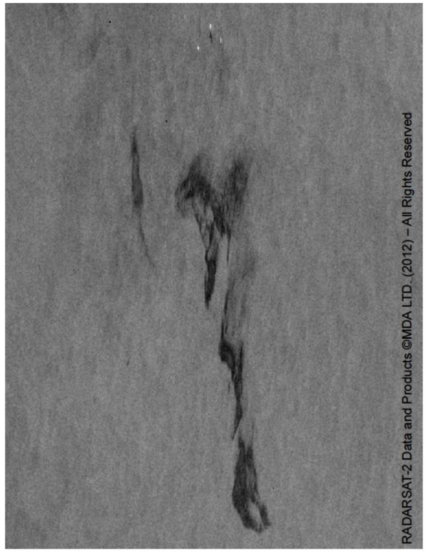
Challenges:

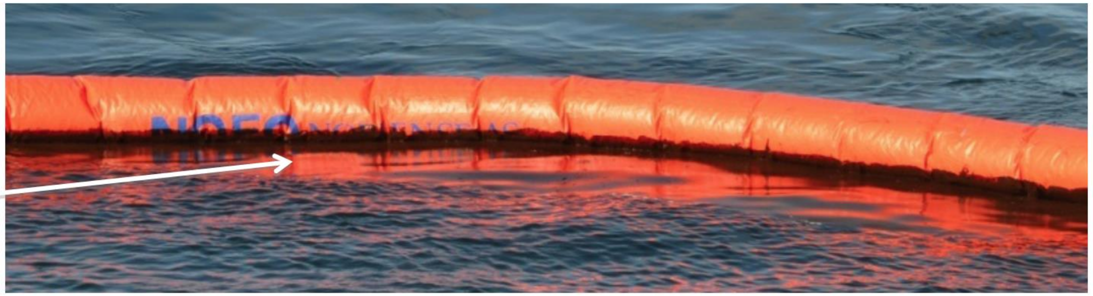
- Thickness estimates –
  - Thin oil evaporates fast
  - Thicker oil – higher viscosity – lives longer on the surface
- Short term forecasting of slick transport
- Volumes
- Release rates
- Oil type and properties
- Oil type characteristics

Oil Slick Detection with SAR – How does it work?

- Oil slicks appear as dark areas in the radar images compared to the surrounding open water.
- Oil slicks dampen the surface roughness and are hence detected as areas of reduced backscatter.
  - A smooth surface means that less signal returns to the satellite.
- SAR sees surface roughness (frequency dependent).
- A range of different SAR frequencies can be used for the detection.



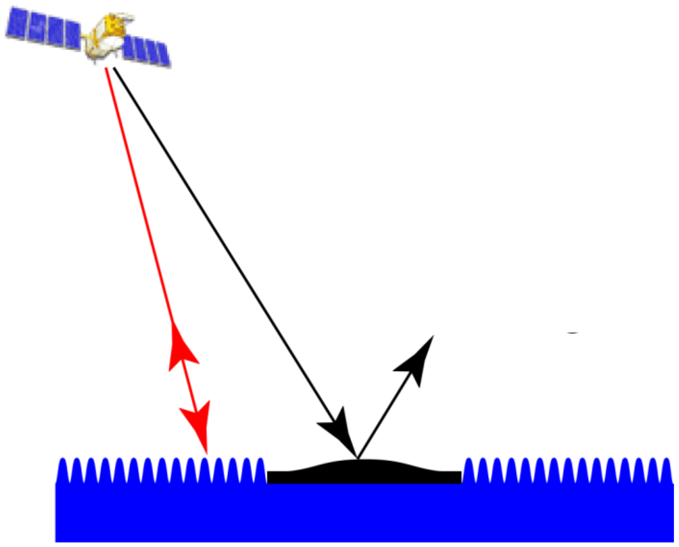


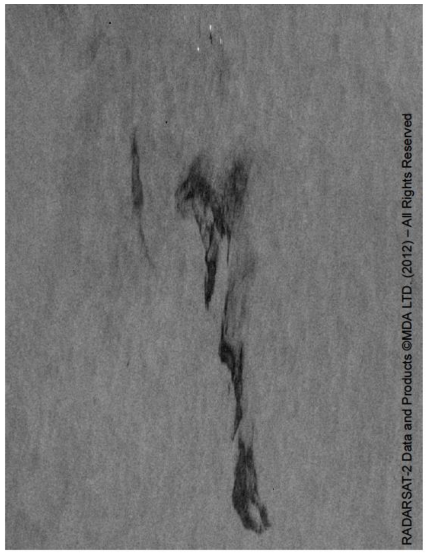


© C. Jones

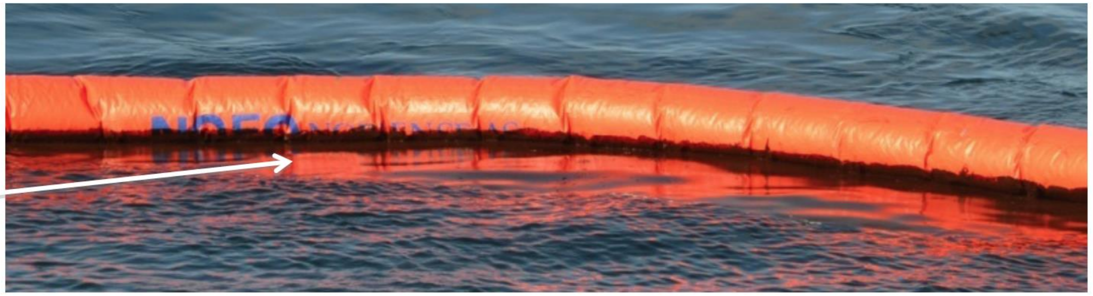
Oil Slick Detection with SAR

- Different polarizations can also be used, though VV is the most common for operational services due to having the highest return power.



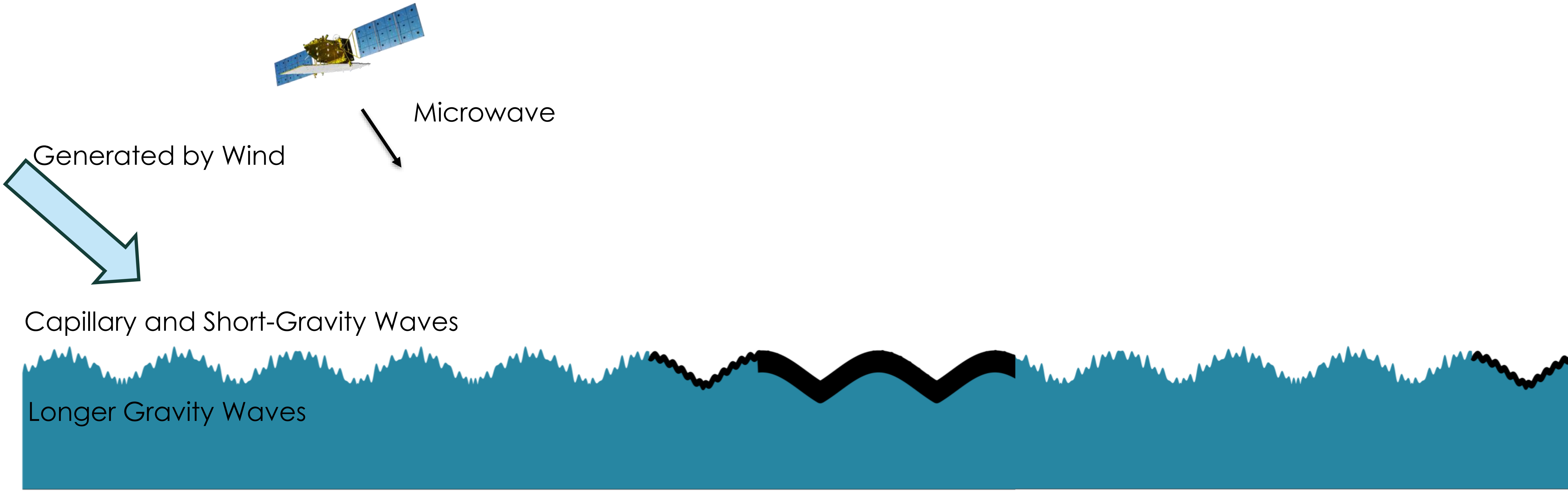


Oil Film

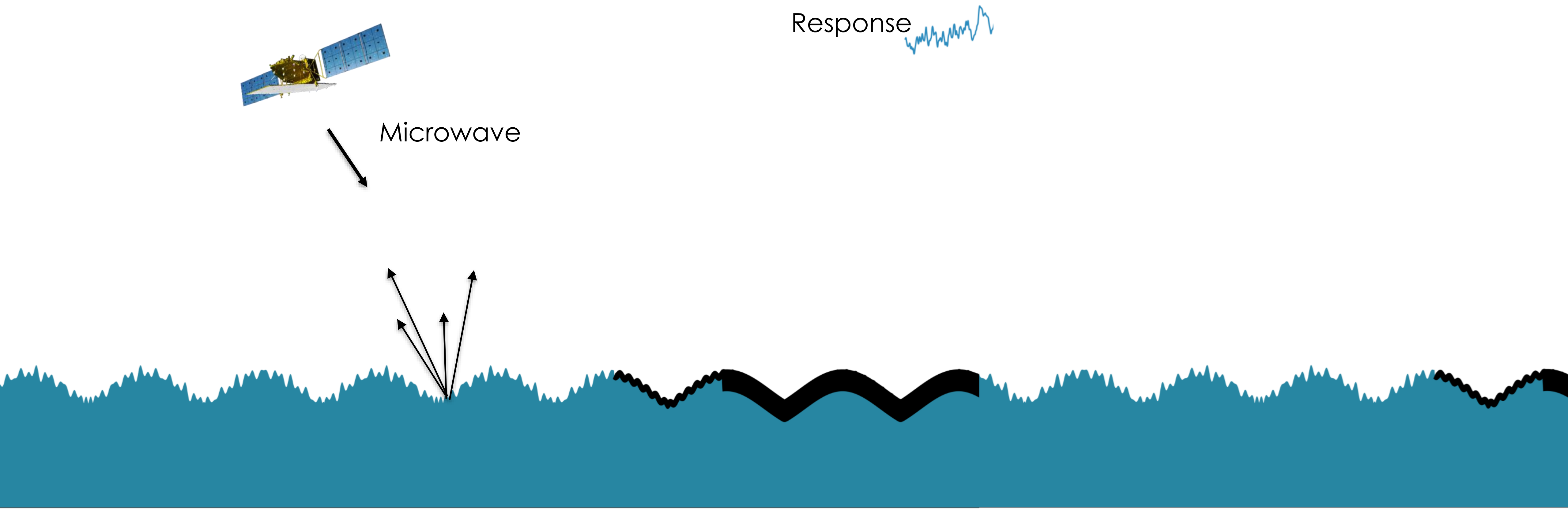


© C. Jones

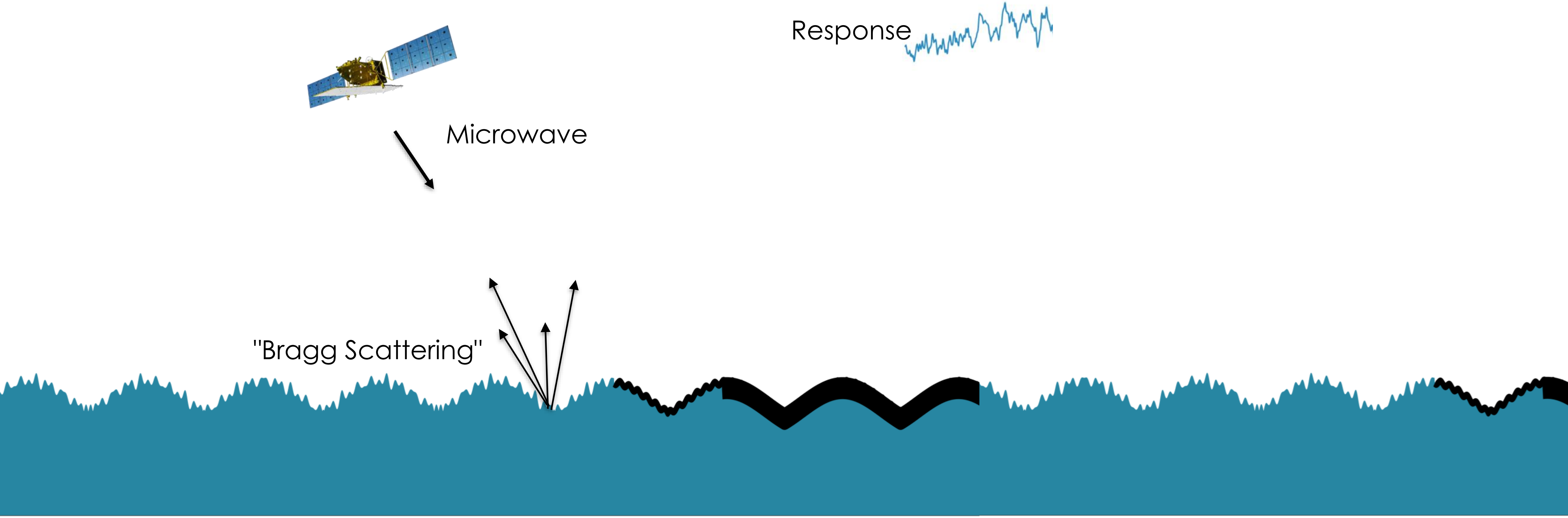
Oil Backscatter in SAR



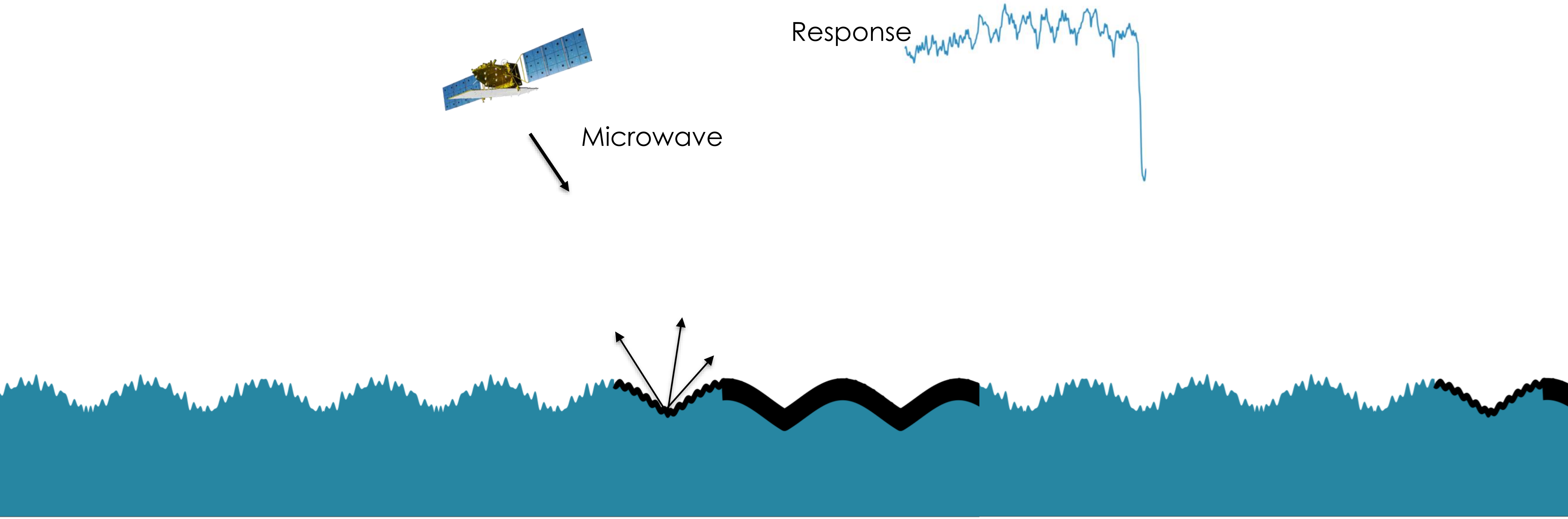
Oil Backscatter in SAR



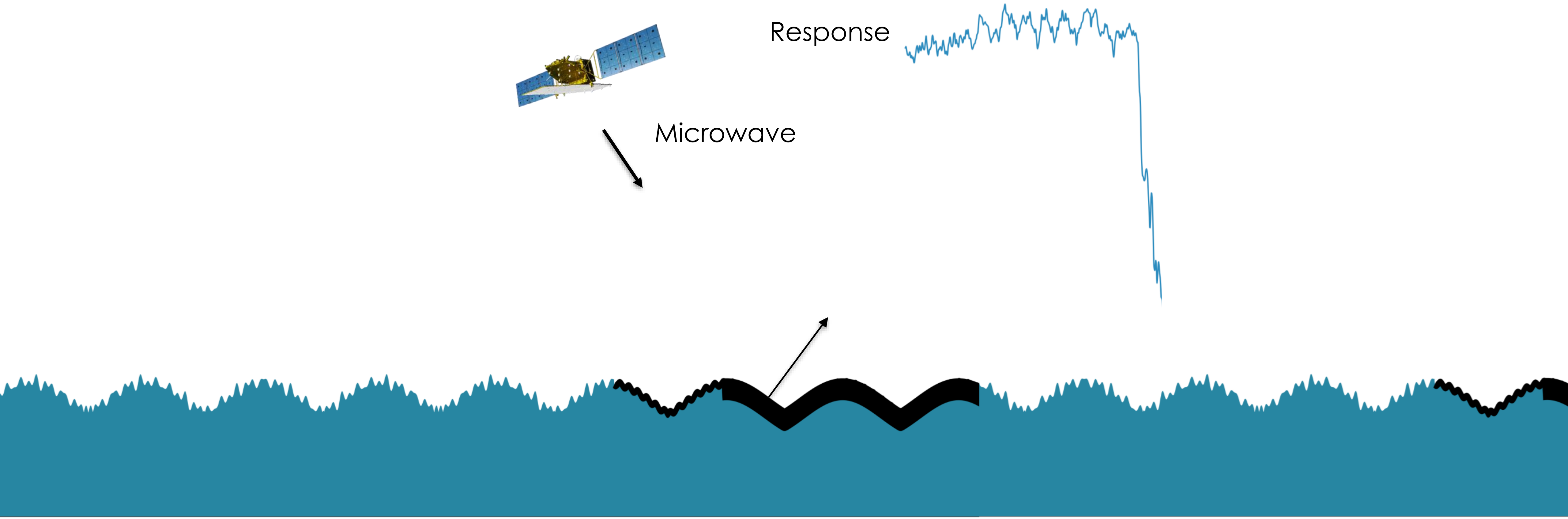
Oil Backscatter in SAR



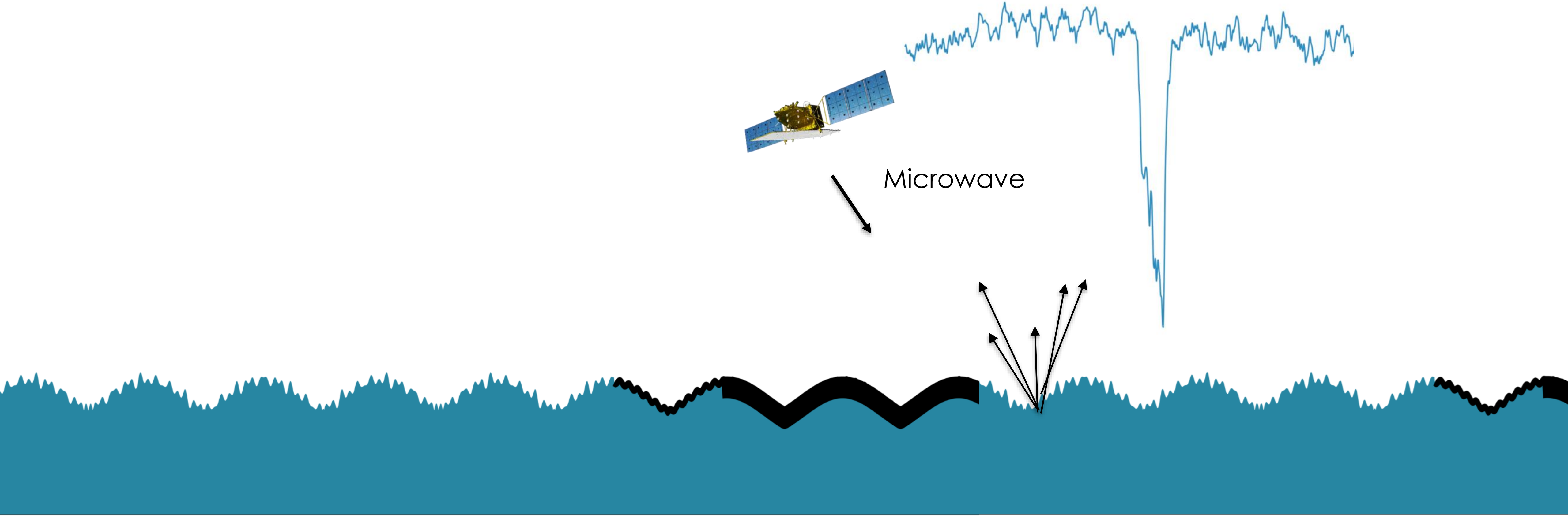
Oil Backscatter in SAR



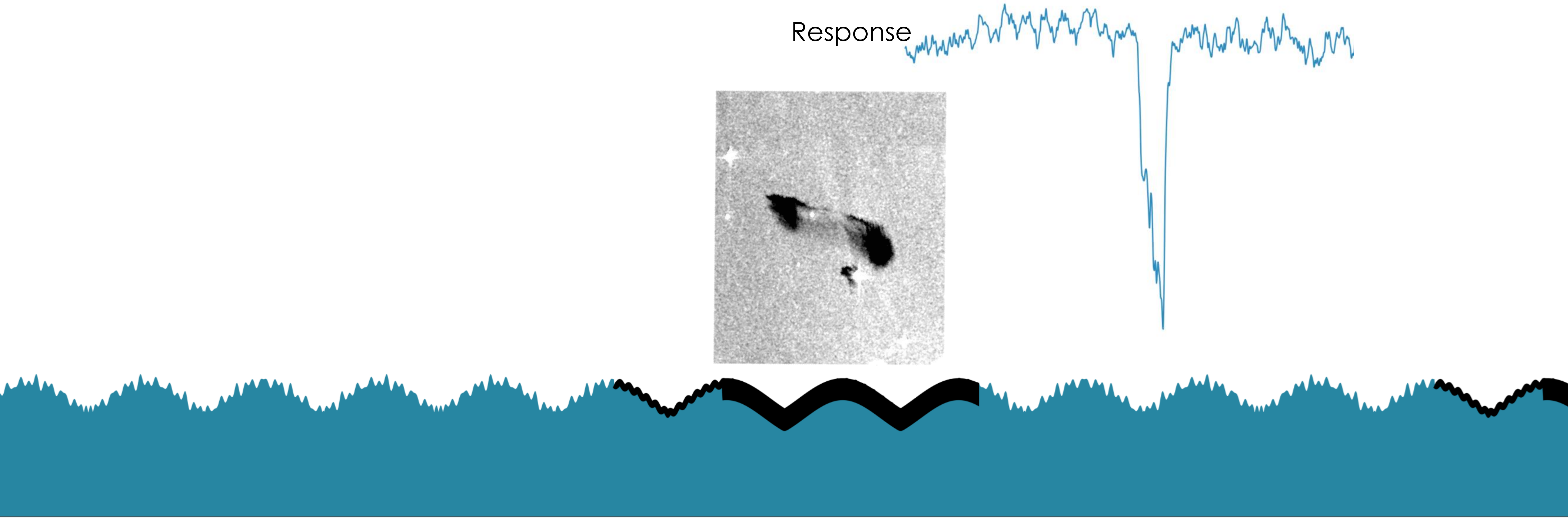
Oil Backscatter in SAR



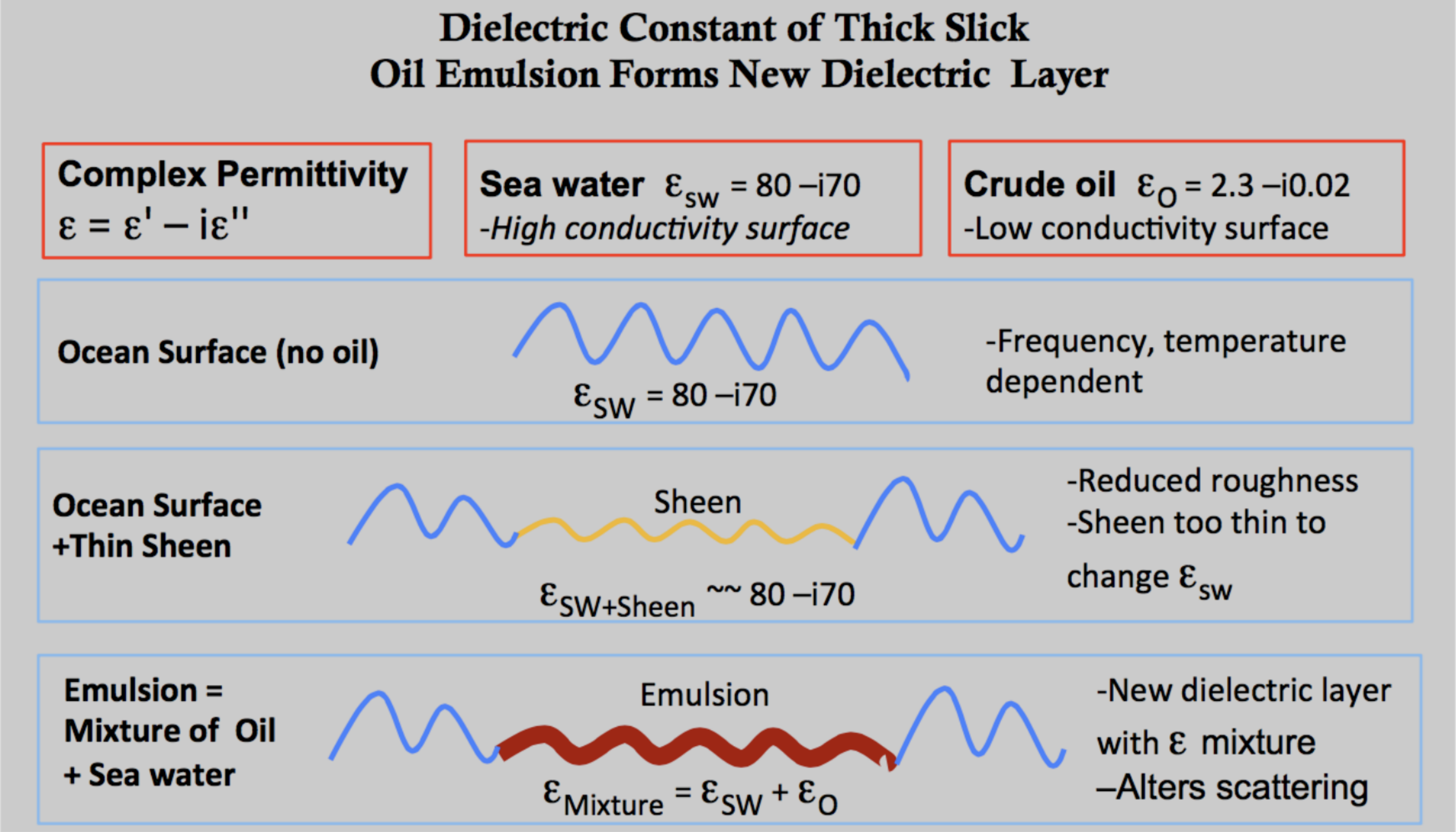
Oil Backscatter in SAR



Oil Backscatter in SAR



Oil Slick Detection with SAR

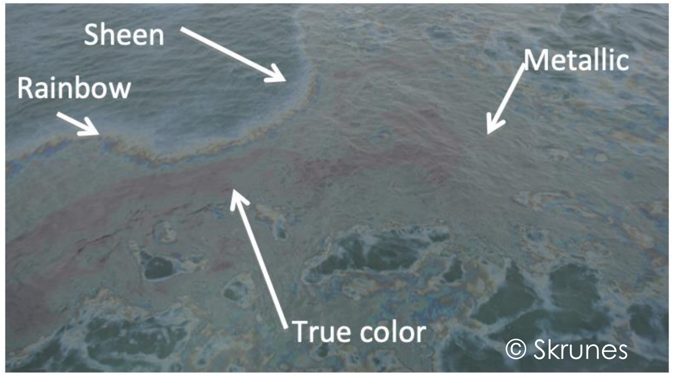


For thick oil films, a reduction in dielectric constant can also decrease the backscatter.

Oil Slick Detection with SAR

- Different thicknesses exists within the same oil spill.
- Efficient oil recovery -> Where is the thick oil?

Photo: Kustbevakningen



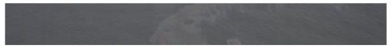
Appearance	Thickness (μm)
Sheen (silvery/grey)	0.04 - 0.30
Rainbow	0.30 - 5.0
Metallic	5.0 - 50
Discontinuous true color	50 - 200
Continuous true color	$>$ 200

- The Bonn Code Agreement
- The Bonn code appears only in fresh oil.
- When the oil has been weathering, it can turn into emulsion.

- Areas with metallic - true color or emulsion -> very important to detect in an early phase.

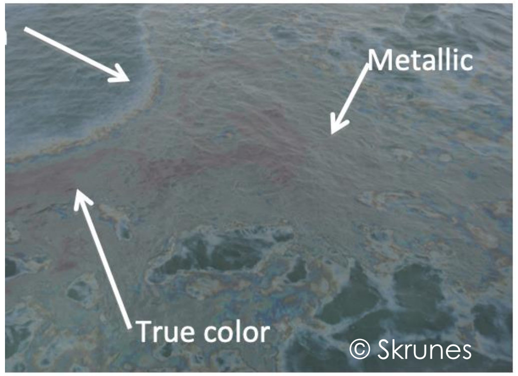
Oil Slick Detection with SAR

- Different thicknesses exists within the same oil spill.
- Efficient oil recovery -> Where is the thick oil?



- The Bonn (
- The Bonn c
  fresh oil.
- When the
  it can turn into emulsion.

Rule of thumb:
More than 90% of the oil volume is contained in less than 10% of the oil spill area.



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Oil Slicks Detection with SAR

- Sensor Limitations:
  - Noise
  - Incidence Angle
  - Spatial Coverage
  - Resolution
  - Temporal Coverage

Known limitations with SAR oil spill detection:

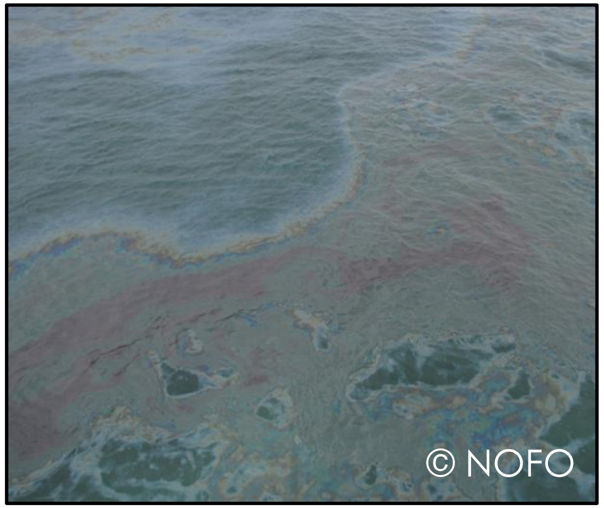
Look-Alikes:

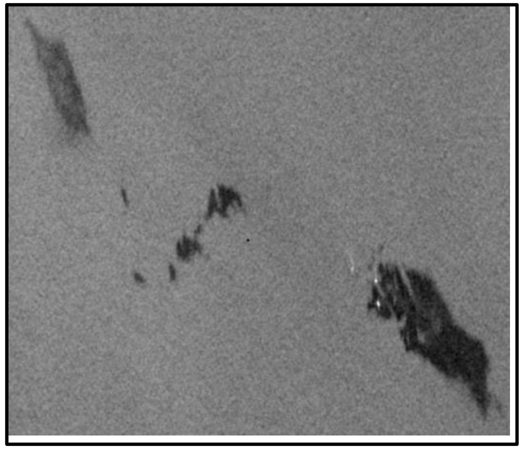
- Natural slicks, newly formed sea ice, low-wind regions, internal waves, upwelling, algae blooms

SAR Look-Alikes

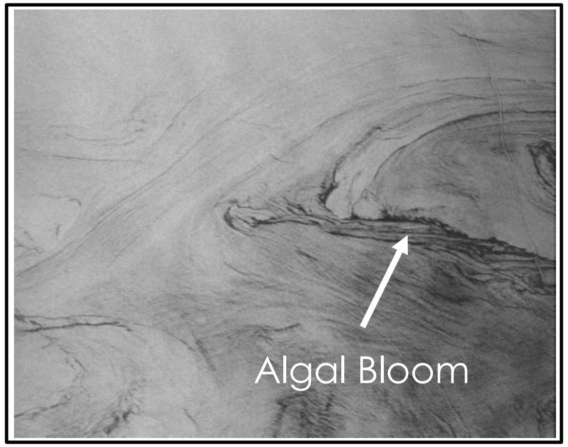
Newly-Formed Sea Ice

Oil Spills



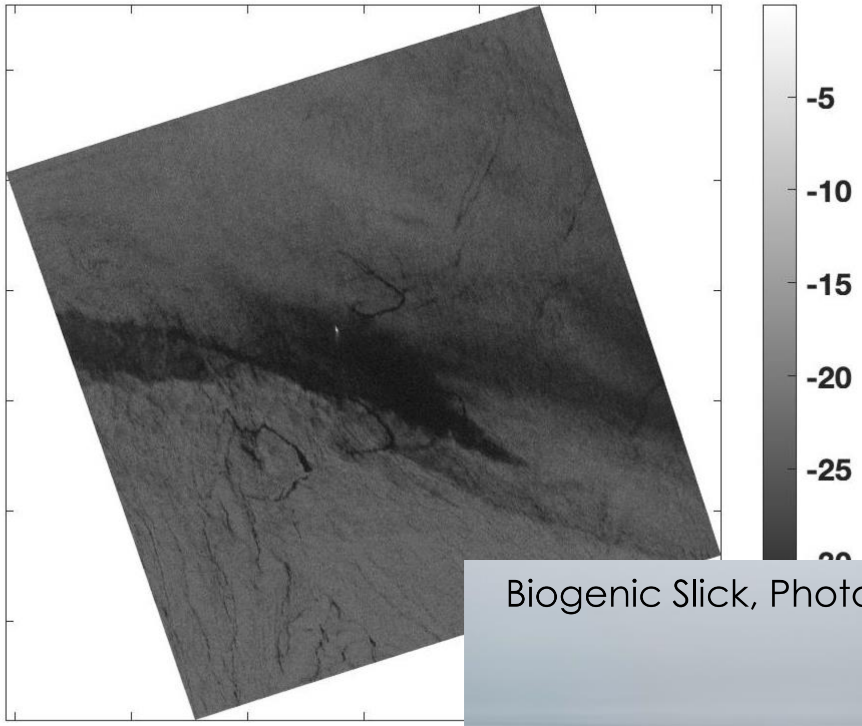


Algal Blooms

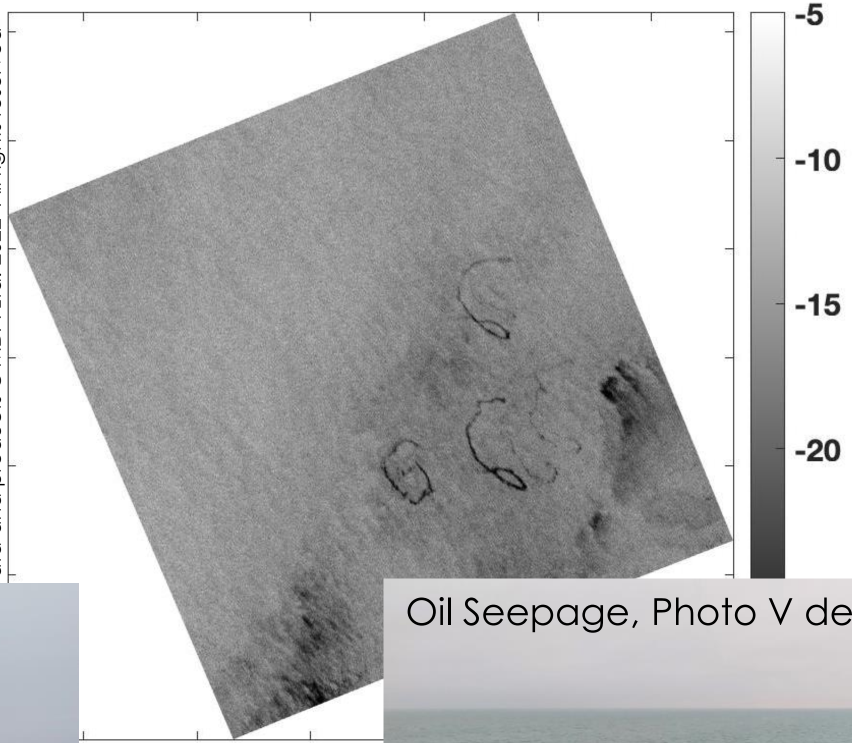


SAR Look-Alikes

- Here a naturally occuring oil seepage and biogenic slicks as well as low wind areas are seen in the same 25 x 25 km area.



Biogenic Slick, Photo V de Aguiar



Oil Seepage, Photo V de Aguiar

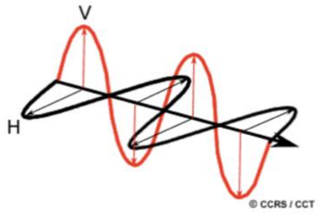
Many factors affect SAR imaging

- **Surface parameters**
  - Roughness
  - Dielectric properties

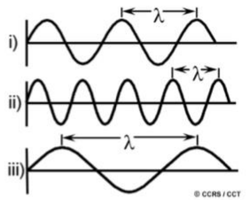
↓

  - **Wind conditions**
  - **Oil slick properties**

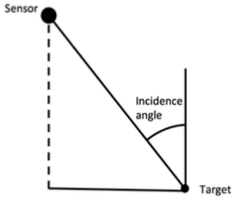
- **Sensor parameters**
  - Polarization



  - Frequency



  - Incidence angle θ



  - Resolution, sensor noise, …

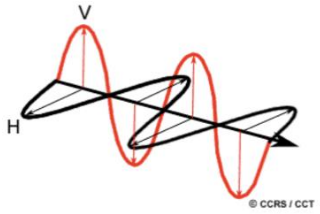
Many factors affect SAR imaging

- **Surface parameters**
  - Roughness
  - Dielectric properties

↓

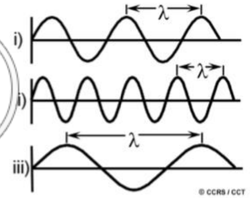
  - **Wind conditions**
  - **Oil slick properties**

- **Sensor parameters**
  - Polarization

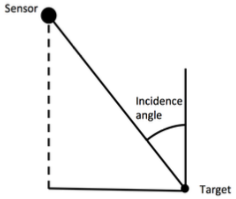


Single-polarization SAR has been used since the 1980s.

  - Frequen



  - Incidence angle θ

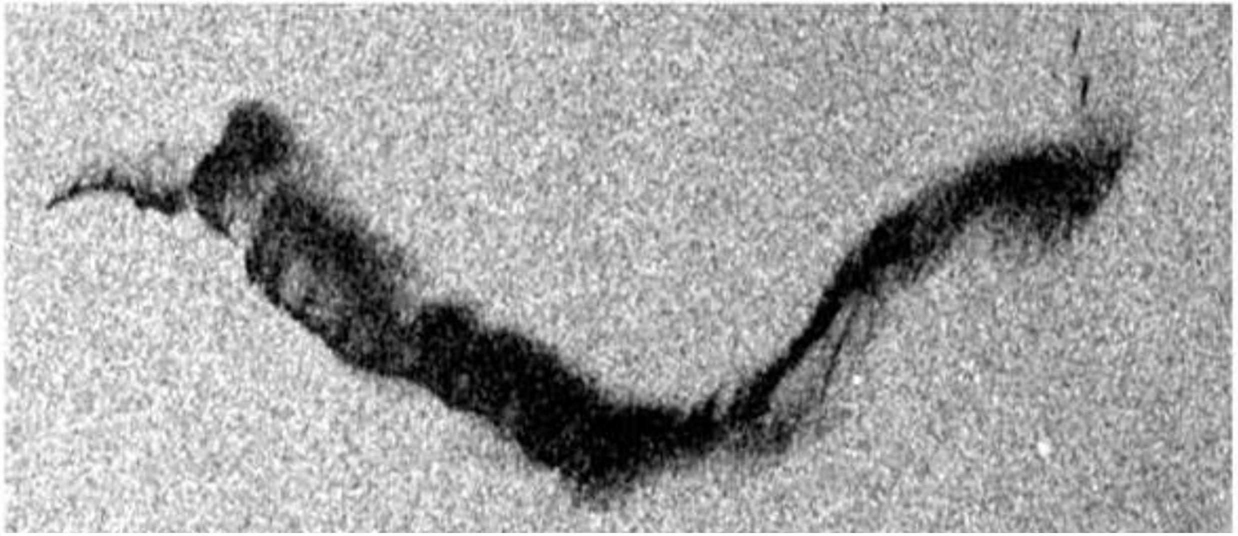


  - Resolution, sensor noise, …

Single-Polarization SAR Data

- Already with single-pol data we can do a lot of things.
- Steps normally followed:
  - Dark area detection
  - Feature extraction
  - Oil vs. look-alike classification

Radarsat-2 - 14:24 UTC



- Highest return power is given by the vertical polarization returns
  - Preferred channel for oil spill detection

Single-Polarization SAR Data

- Dielectric properties of oil are related to the volumetric fraction of the oil.
- Thicker oil dampens the surface waves more strongly.
  - A map showing areas with relatively thicker oil

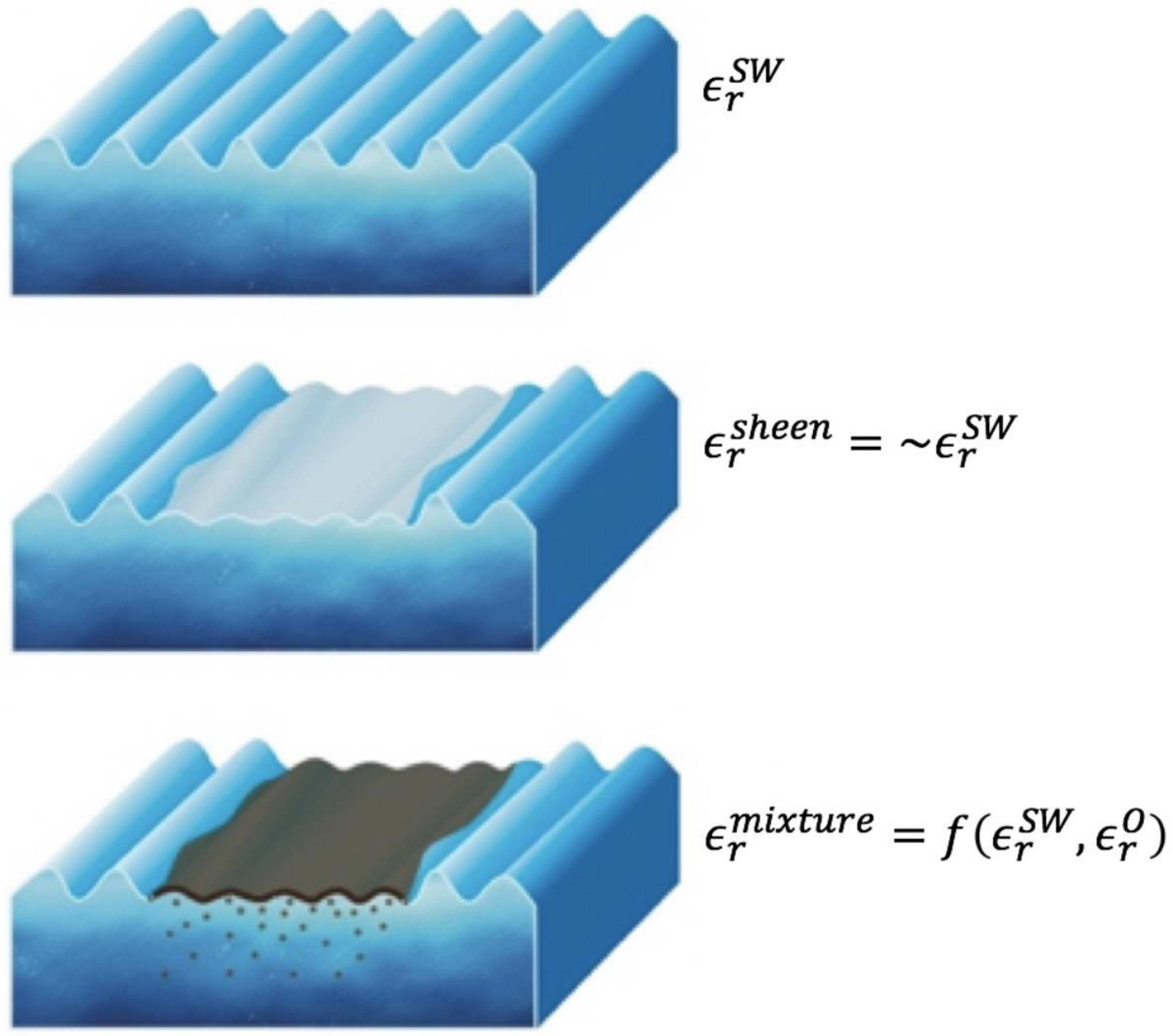
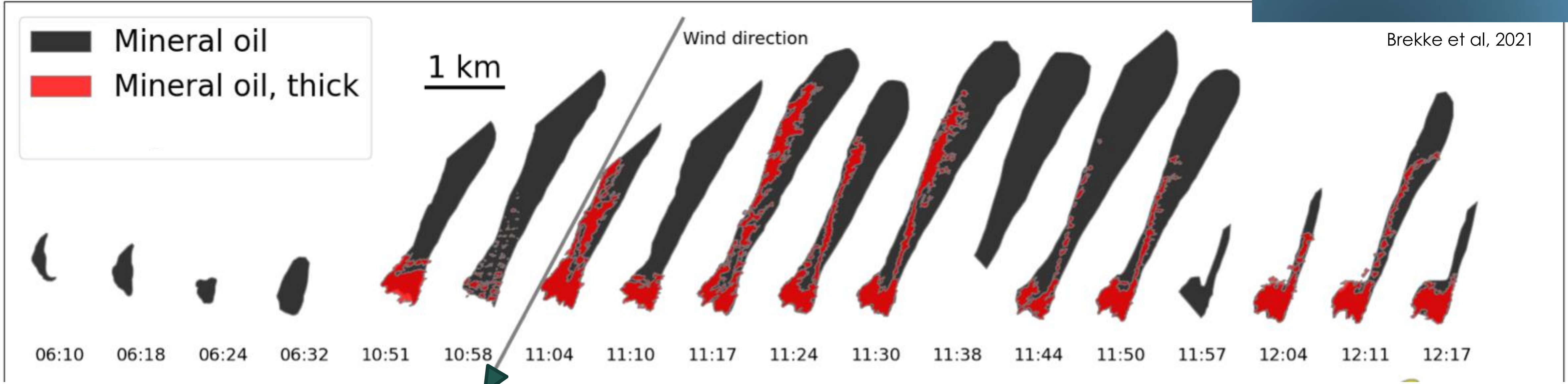


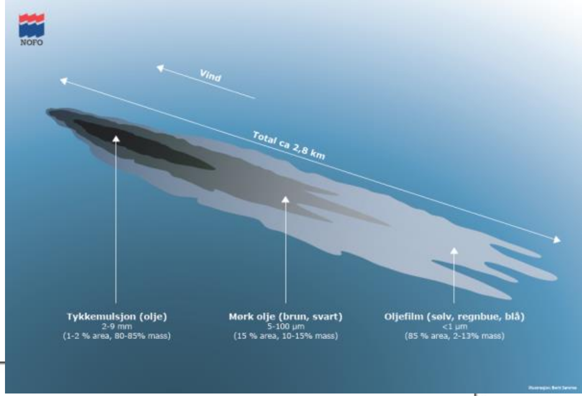
Figure 1.7 The impact of sheen and thicker mineral oil slicks on the relative dielectric constant. (Top) Clean sea water, (Middle) sheen slick, and (Bottom) thicker oil slick.

Brekke and Jones, 2020

Single-Polarization SAR Data

- **Damping Ratio (Contrast in Backscatter dB) = VV_{clean} / VV**
- Particularily useful when we have a time series
- Identify where we have the thickest oil within the slick

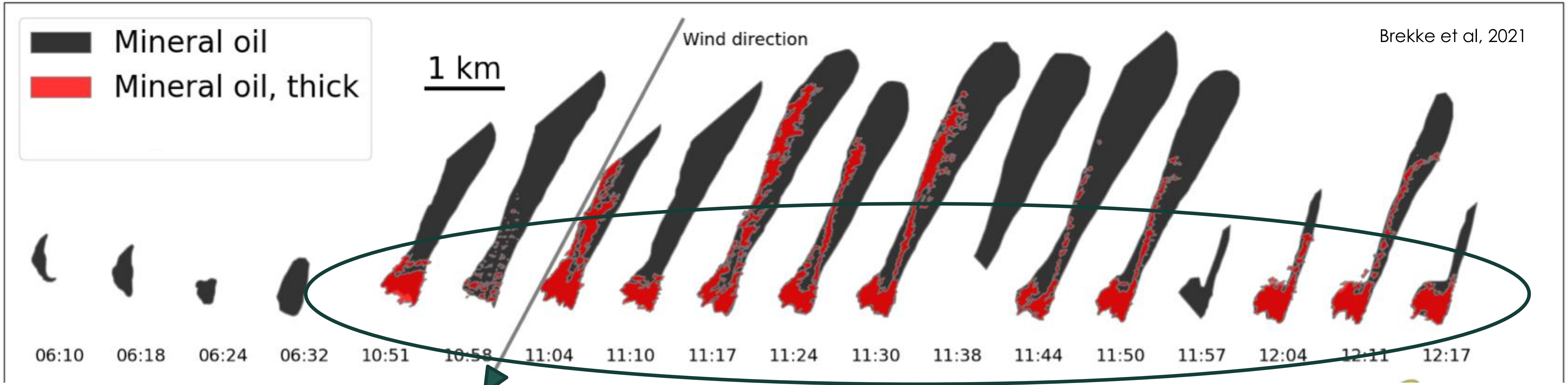




Brekke et al, 2021

Single-Polarization SAR Data

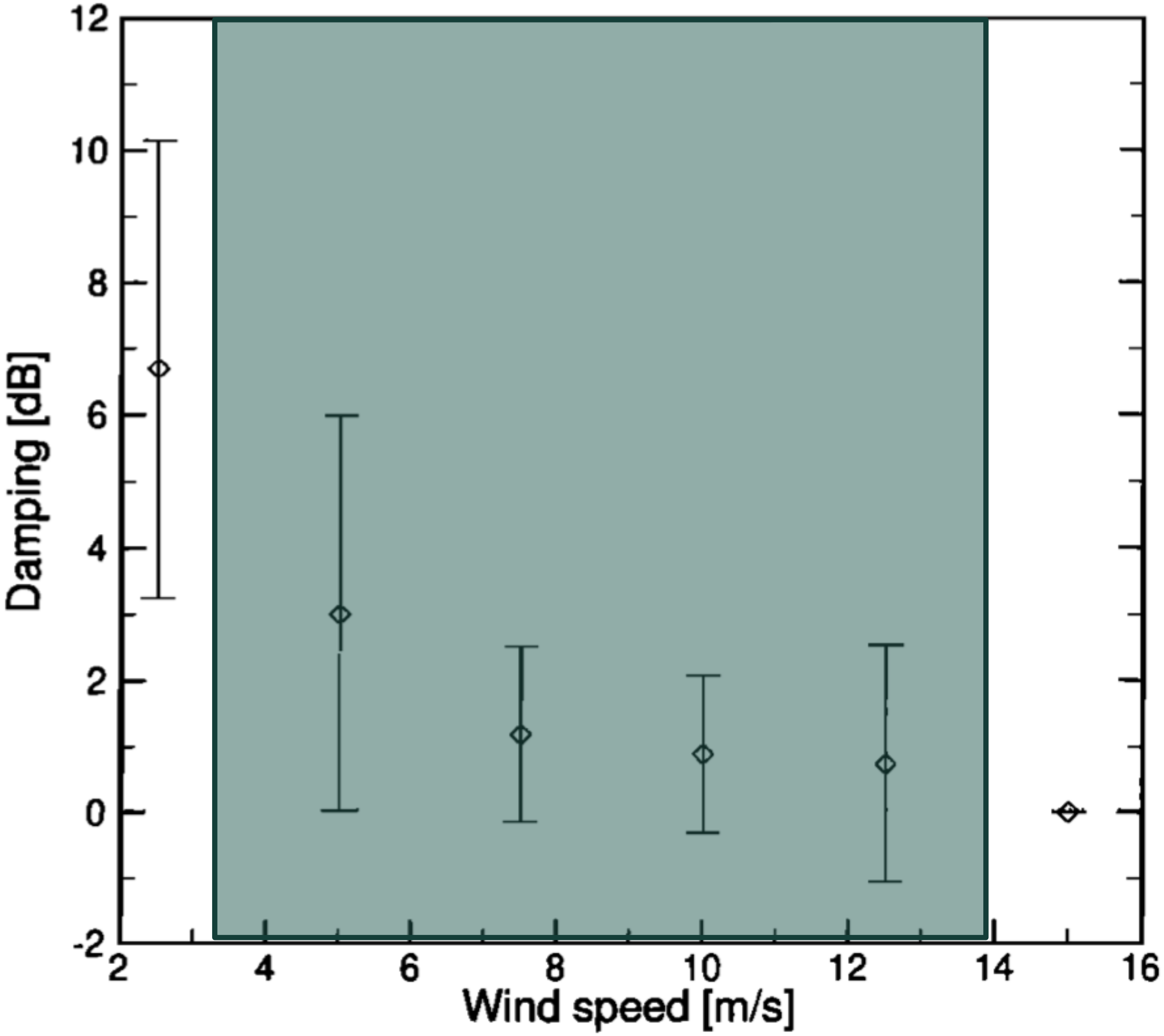
- **Damping Ratio (Contrast in Backscatter dB) = VV_{clean} / VV**
- Use the damping ratio to aid responders for clean up operations



Most oil is concentrated at the front and middle part of the field. This is related to the drift direction.

SAR – Wind Conditions

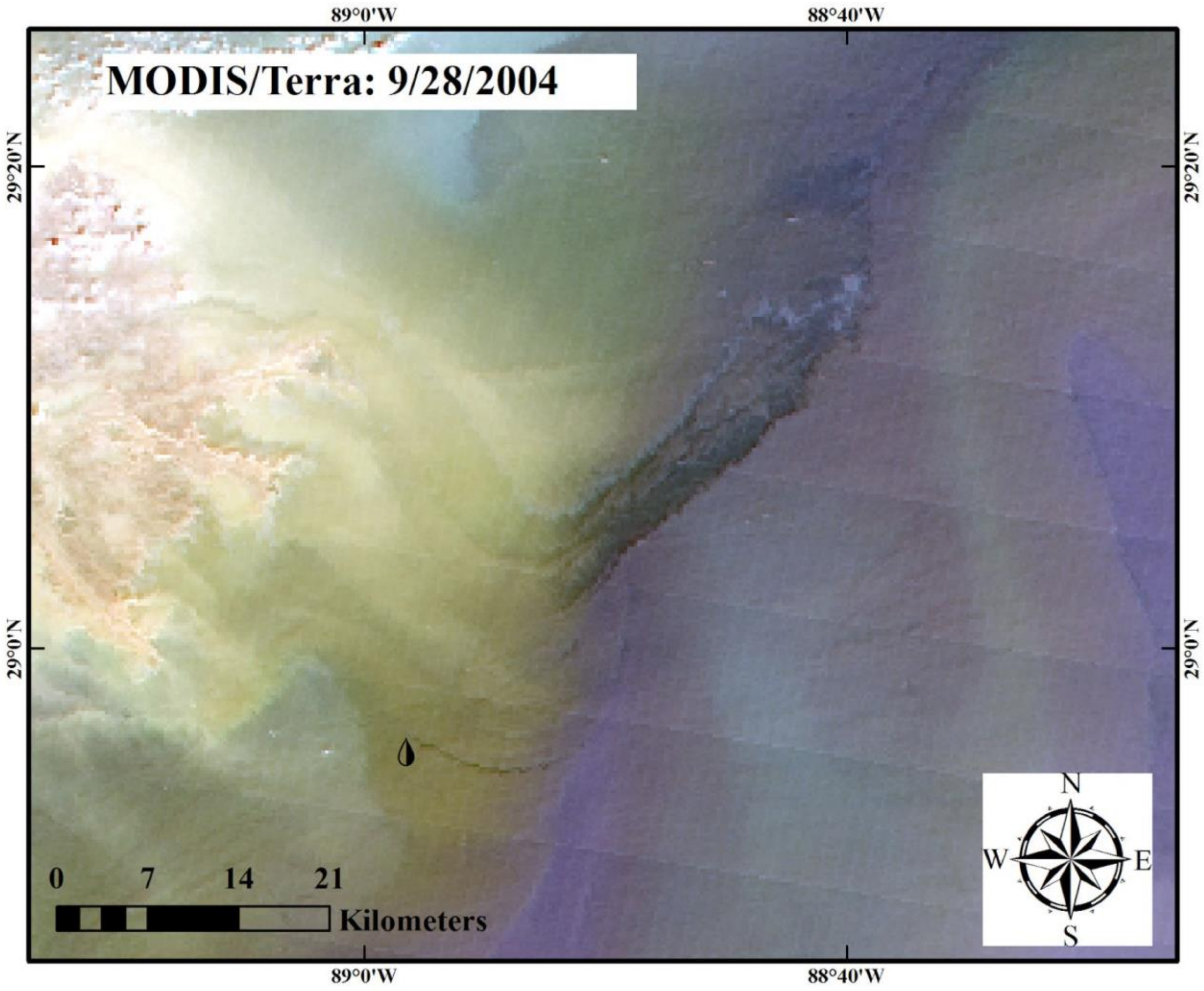
- Detection limited to approx. 2-3 m/s to 10-14 m/s
  - Too low wind –> not possible to separate from the surroundings
  - Too high and the oil gets mixed down into the water column -> reducing the marine surface slick
- It also affects parameters such as the damping ratio, i.e. how much the backscatter has been reduced



Espedahl, et al, 1998

Mexico Gulf Mississippi Canyon 20 (MC20)

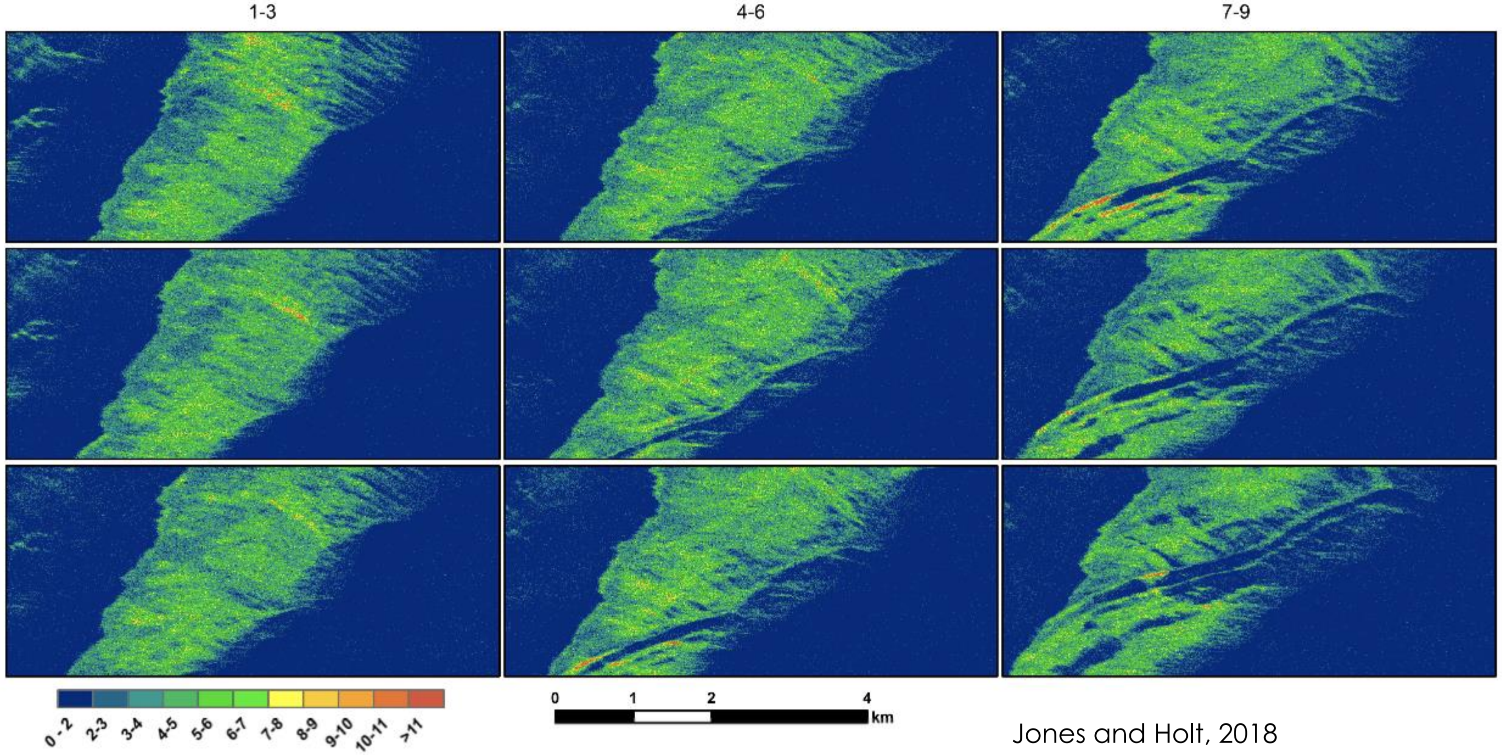
- https://coastalscience.noaa.gov/news/mc20report/
- Oil has been leaking here since hurricane Ivan in 2004.
- One way to monitor the continued release is through SAR images, both airborne and satellite.



Satellite image showing oil slicks from MC20 after Ivan *(Image courtesy Shaojie Sun)*

Relative Thickness Estimation

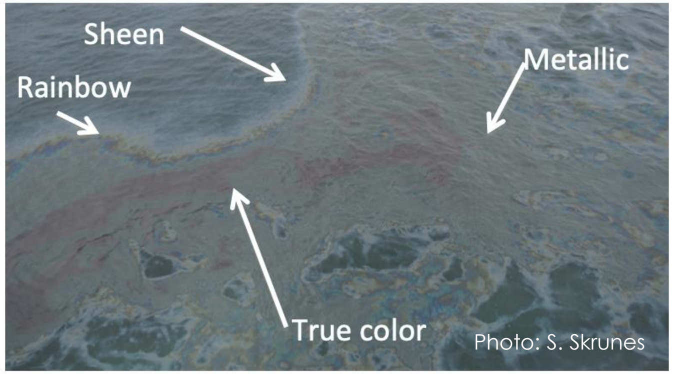
- Gulf of Mexico, Nov. 2016 – Can track the oil spill over time
- Mathematically quick
- Incidence angle dependency reduced ← We will come back to this!
- The threshold for oil vs. water depends on the wind state



Jones and Holt, 2018

The damping ratio is image-dependent and not comparable across sets of images

Comparing to Optical Imagery



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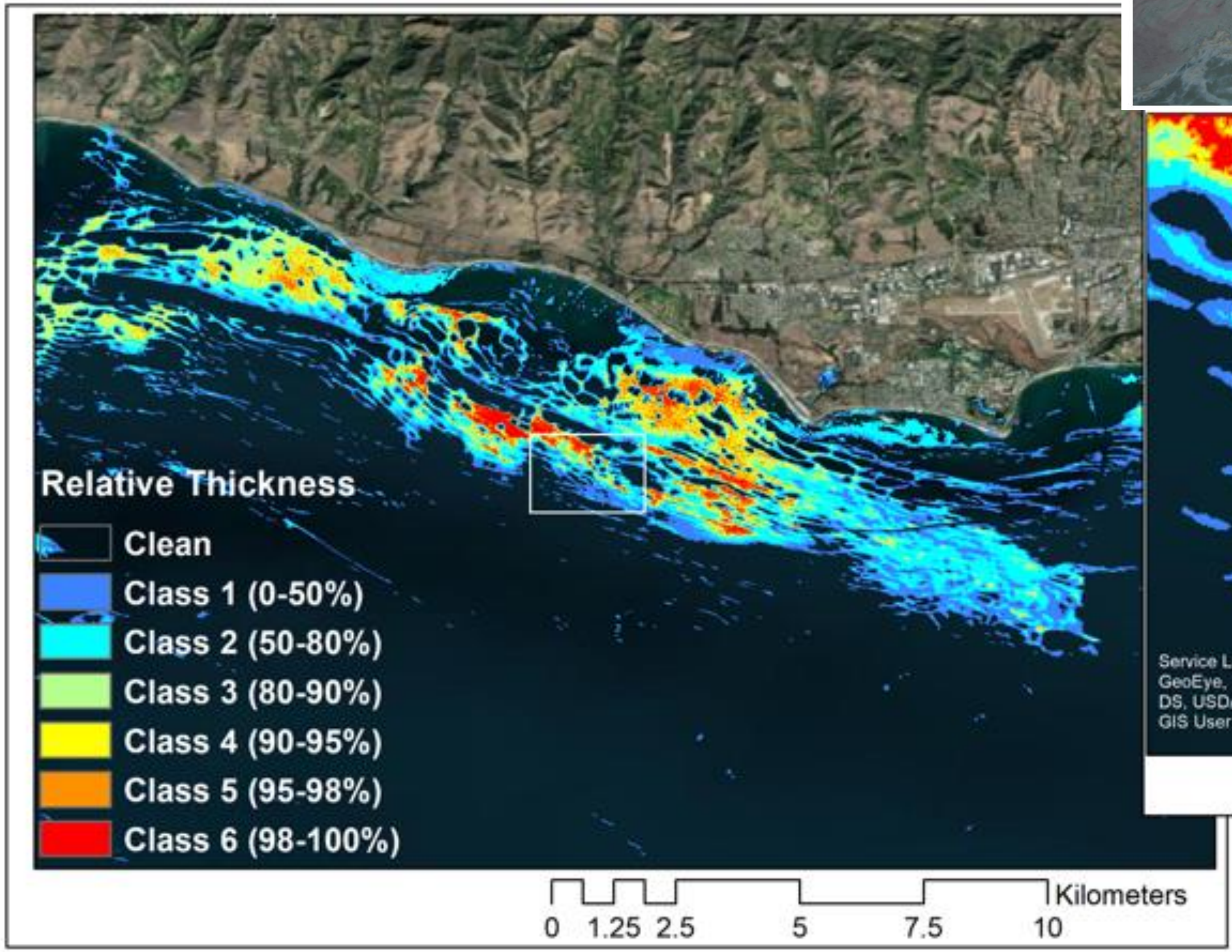
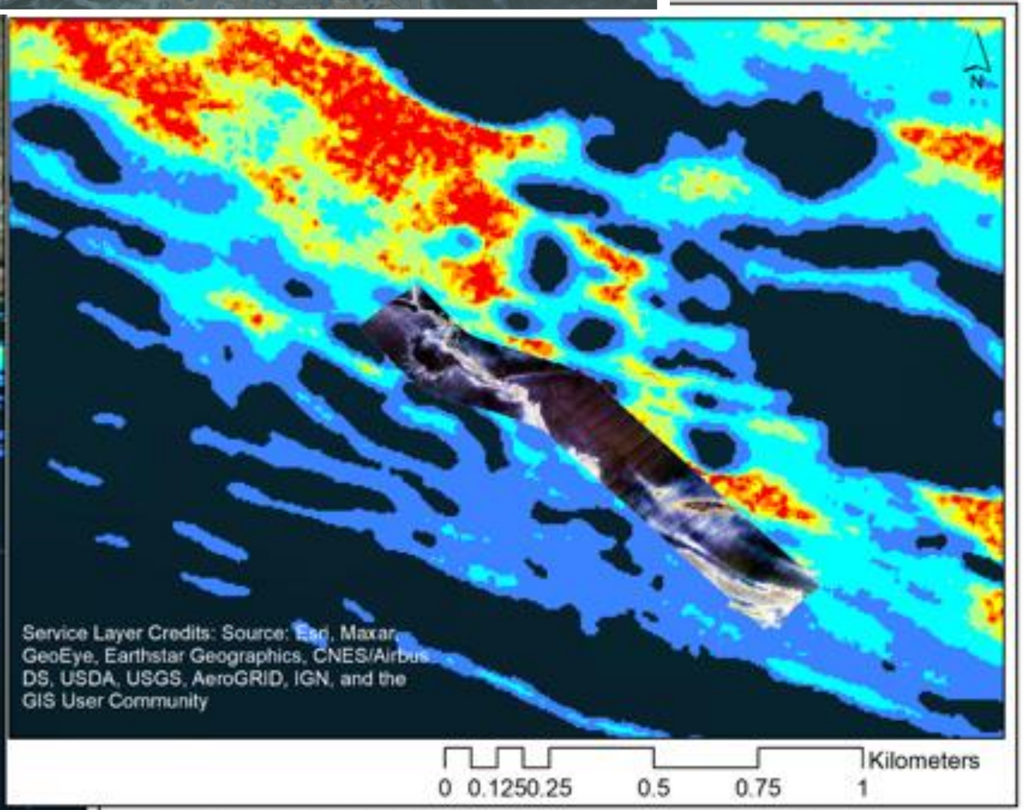
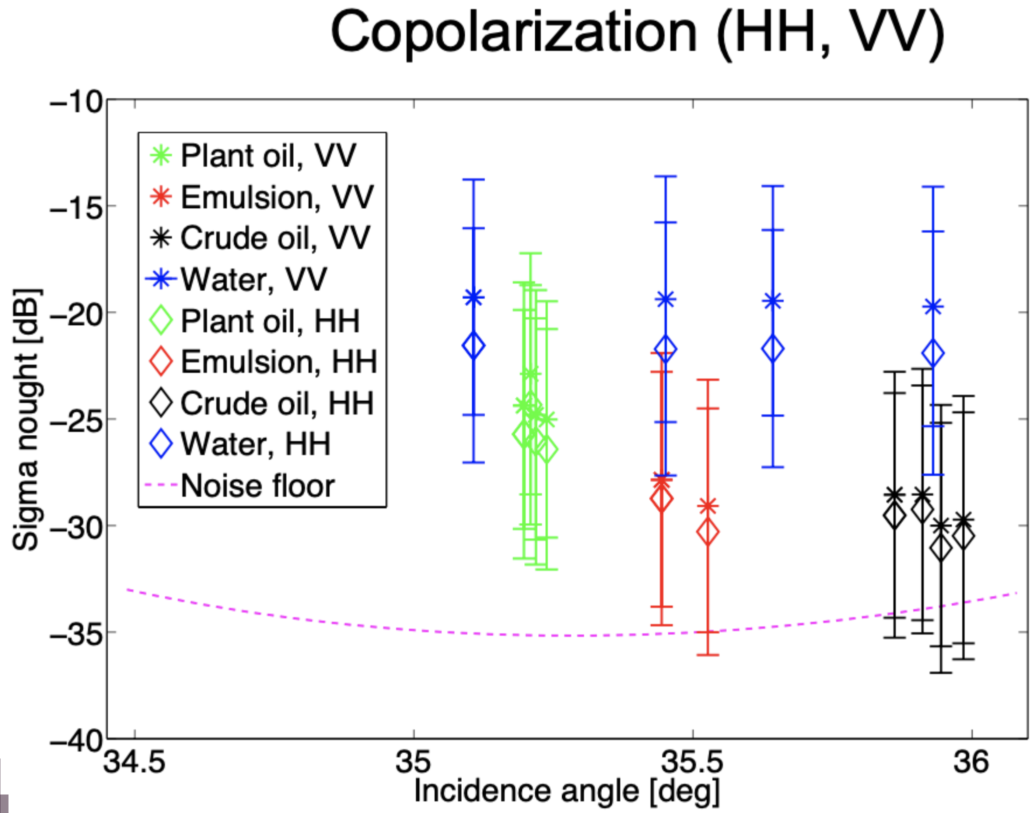


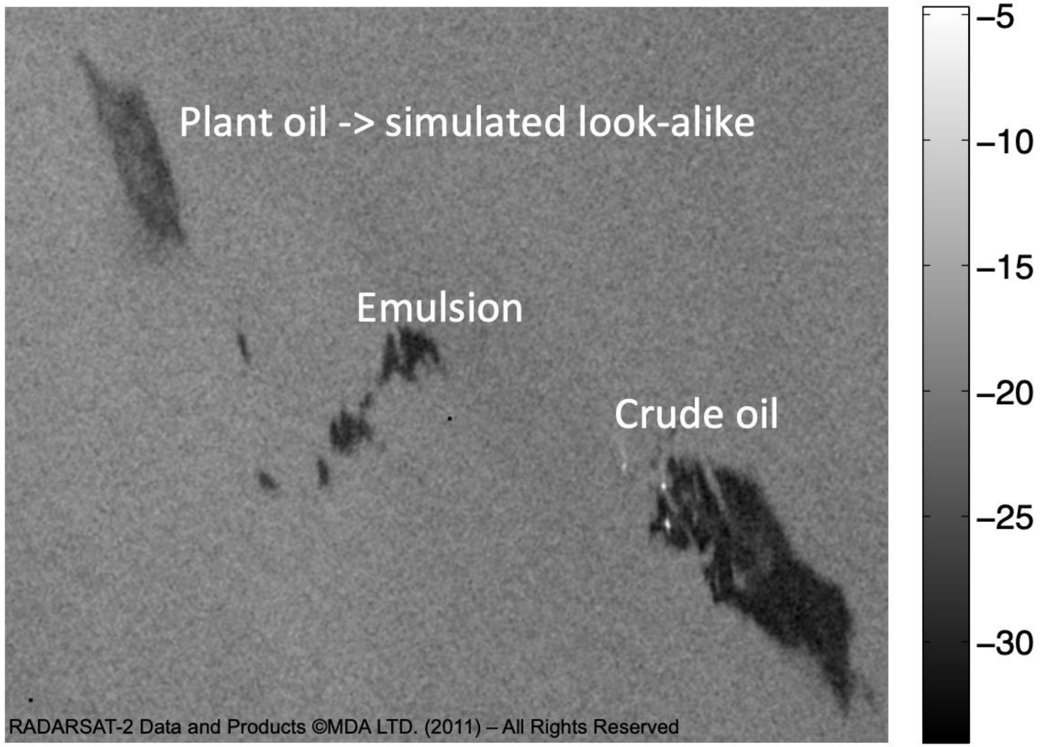


DRONE IMAGE INSET ON SAR CLASSES

Noise

- We can get relative thickness estimates from one channel, but…
- Oil is a low backscatter target and we need to be careful with noise contamination.

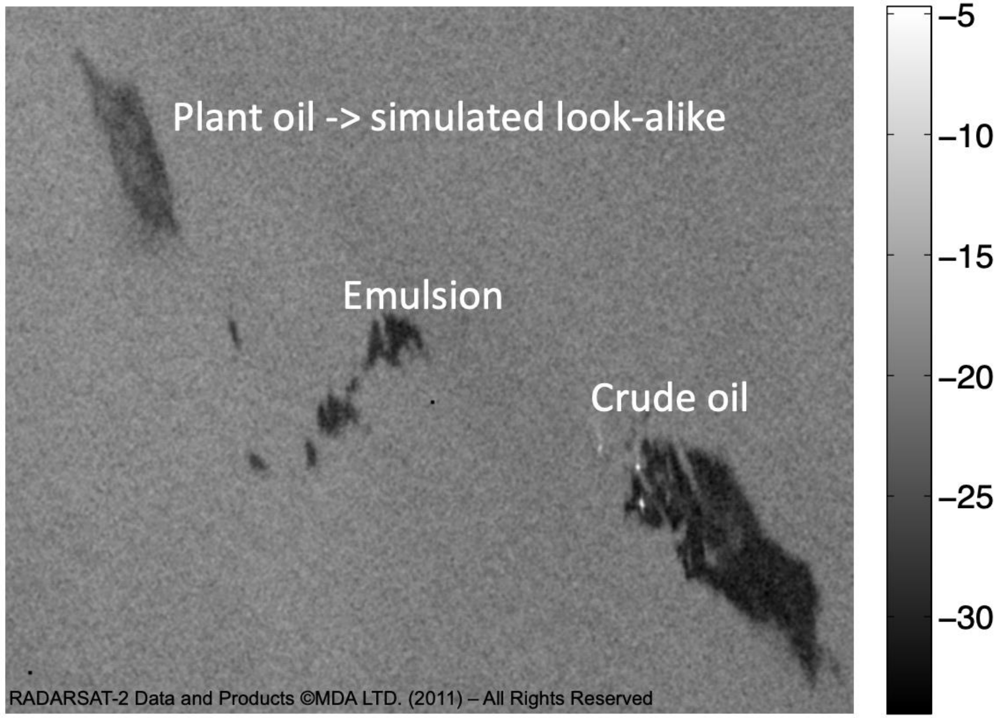


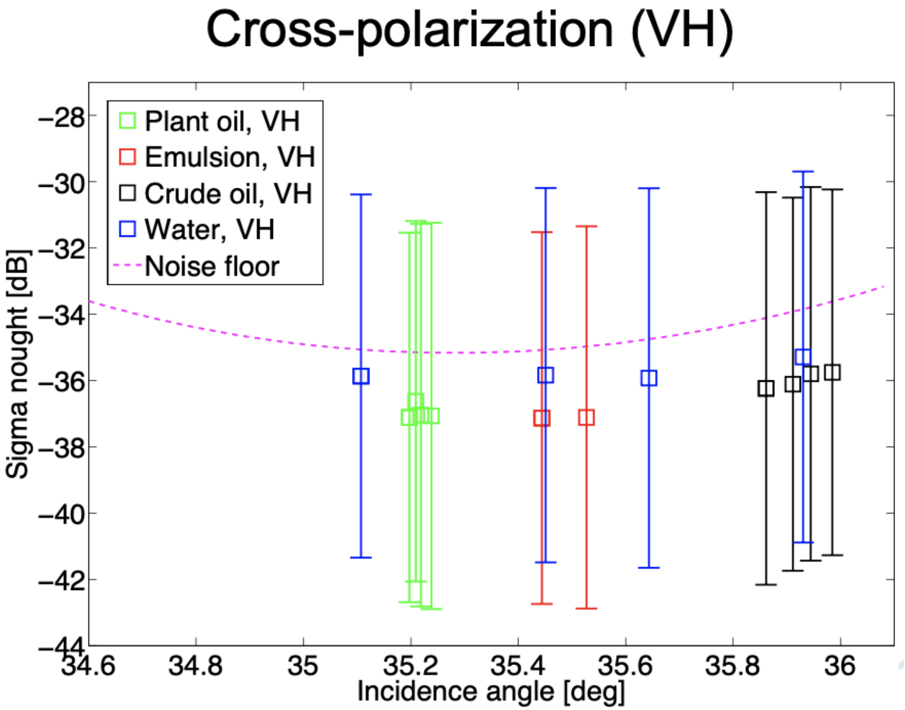


Skrunes et al, 2014

Noise

- Noise analyses show a high noise contamination in cross-polarization channels.
- If poor SNR -> can't separate thicker areas.
- Image from Annual Oil on Water Exercise in Norway 2011.



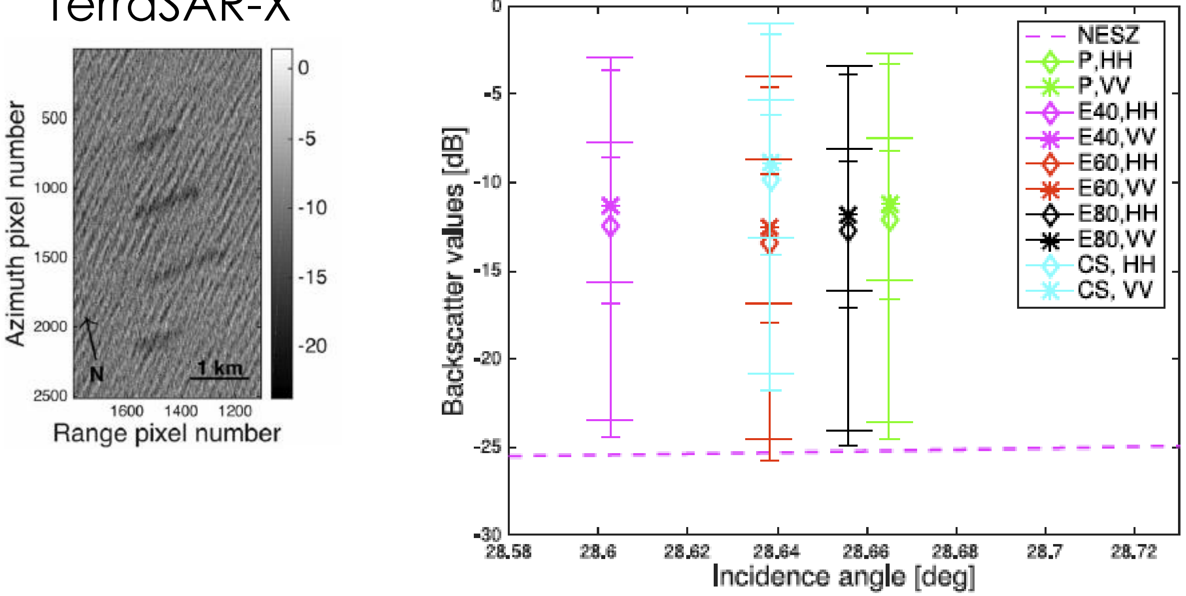


Skrunes et al, 2014

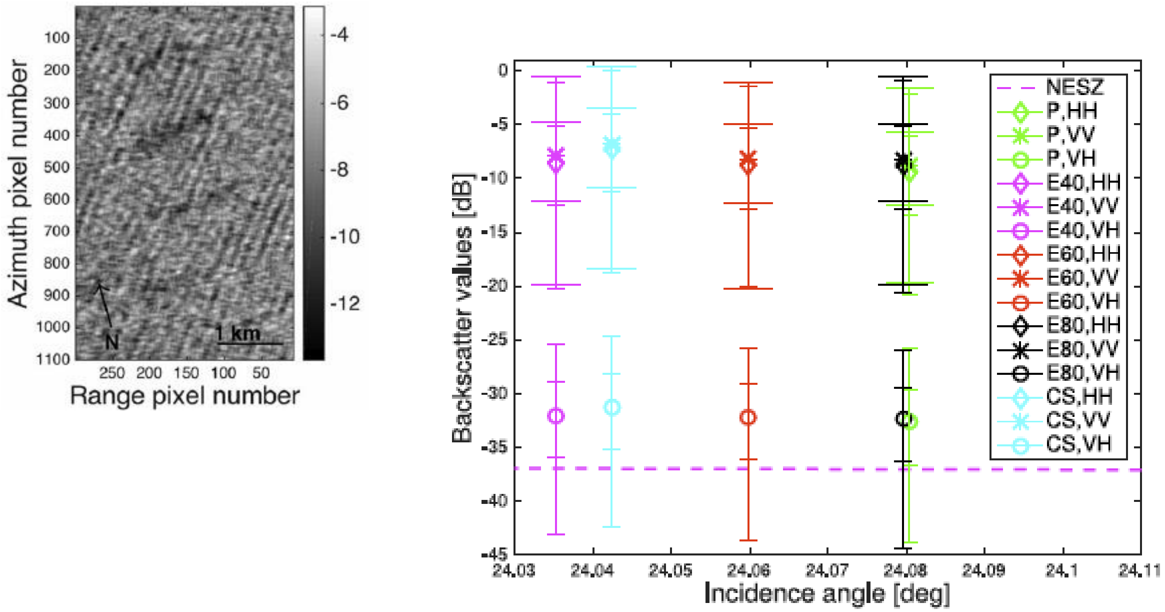
Noise

- Different sensors have different noise floors, or NESZ.

TerraSAR-X



Radarsat-2

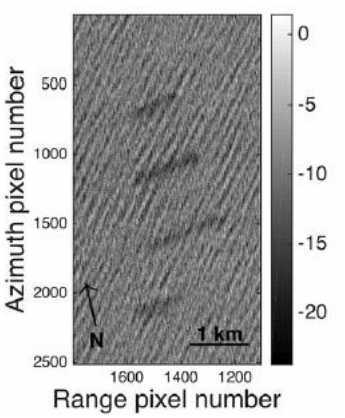


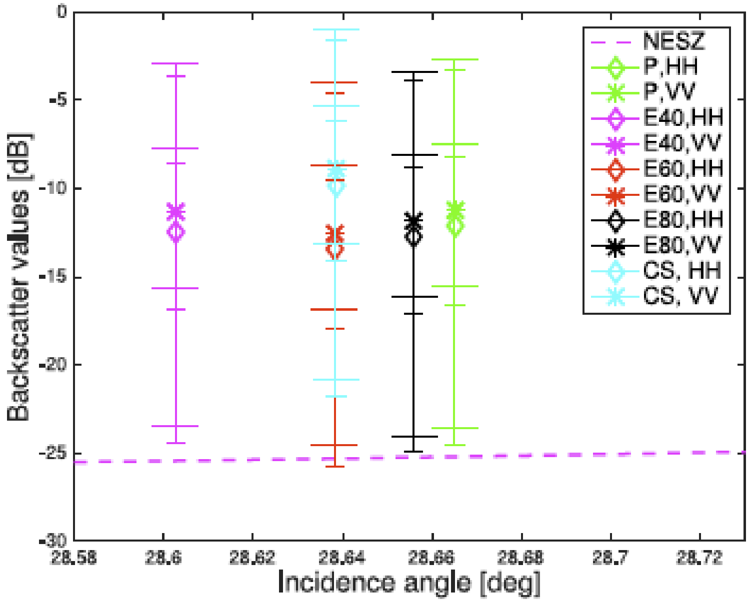
Skrunes et al, 2014

Noise

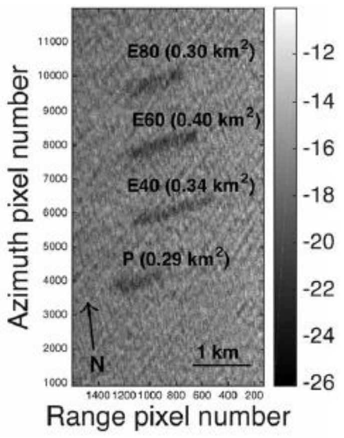
- Different sensors have different noise floors, or NESZ.
- And e.g., NASA's UAVSAR has a very good noise floor.

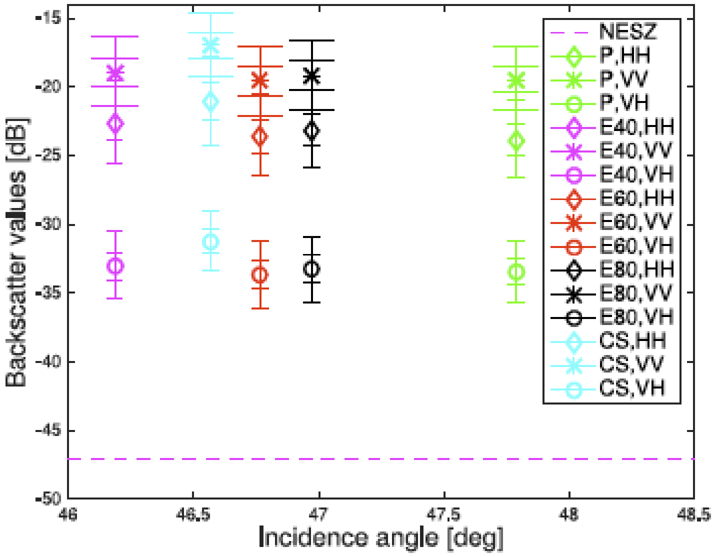
TerraSAR-X





UAVSAR





Skrunes et al, 2014

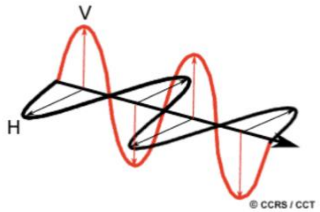
Many factors affect SAR imaging

- **Surface parameters**
    - Roughness
    - Dielectric properties

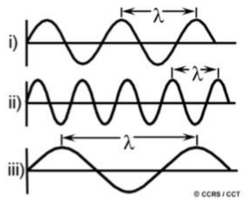
↓

- **Wind conditions**
- **Oil slick properties**

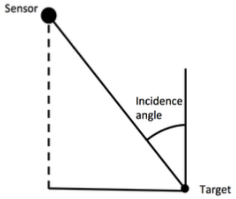
- **Sensor parameters**
    - Polarization



- Frequency



- Incidence angle θ



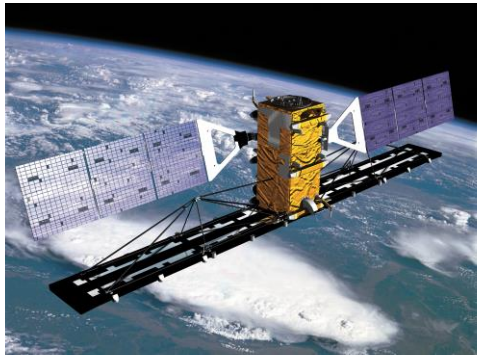
- Resolution, sensor noise, …

Oil Spill Detection – Frequency

- Many different satellites and airborne platforms are used for operational oil spill detection

TerraSAR-X
(X-band)

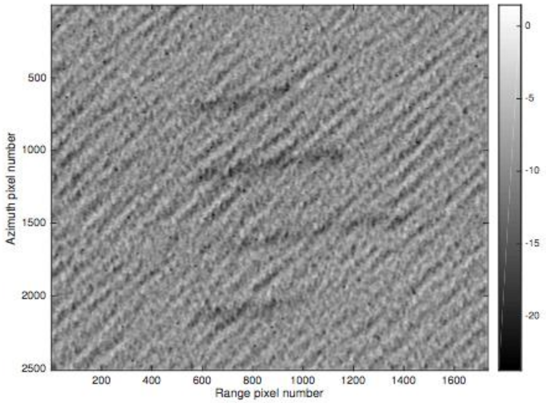
Radarsat-2
(C-band)



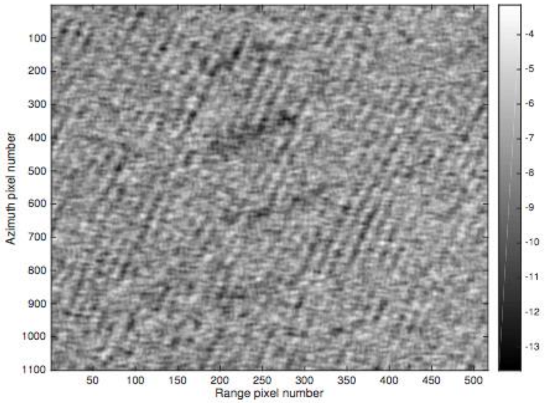
NASA-UAVSAR
(L-band)

Photo: Armstrong Flight Research Center NASA.

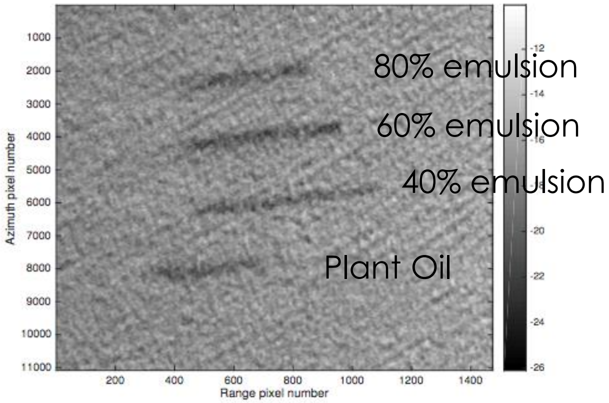
06.24



06.28



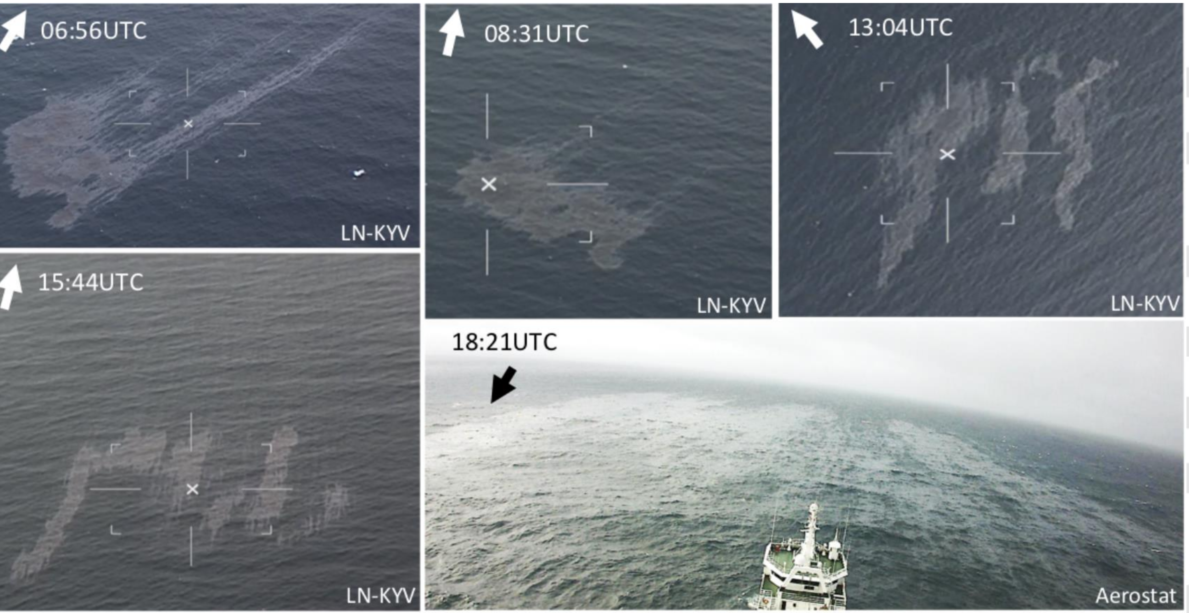
06.26-06.30

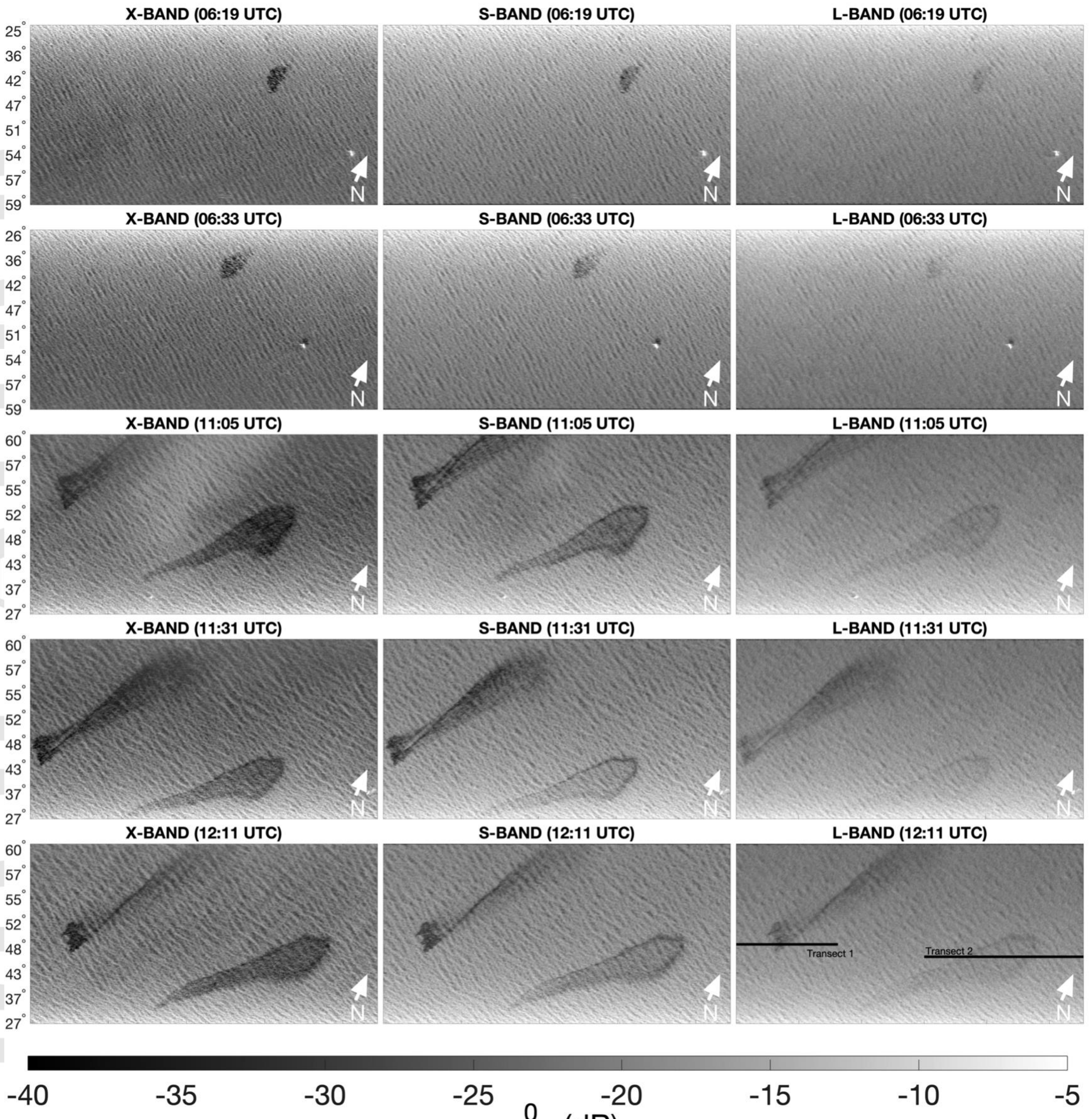


Skrunes et al. (2016)

Oil Spill Detection – Frequency

- Slightly different appearances.
- X-band is renowned for good detection due to improved contrast between oil and open water.

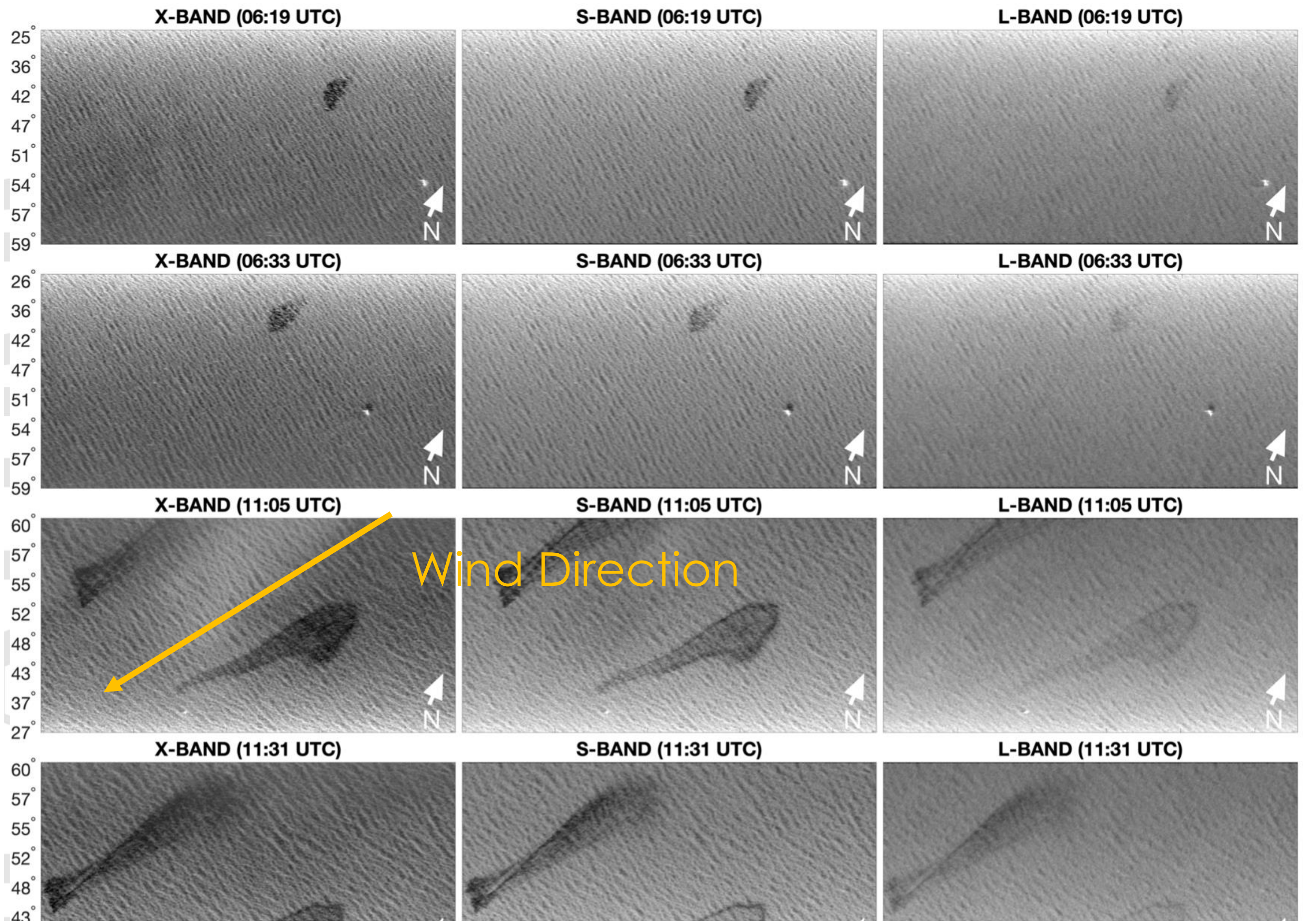


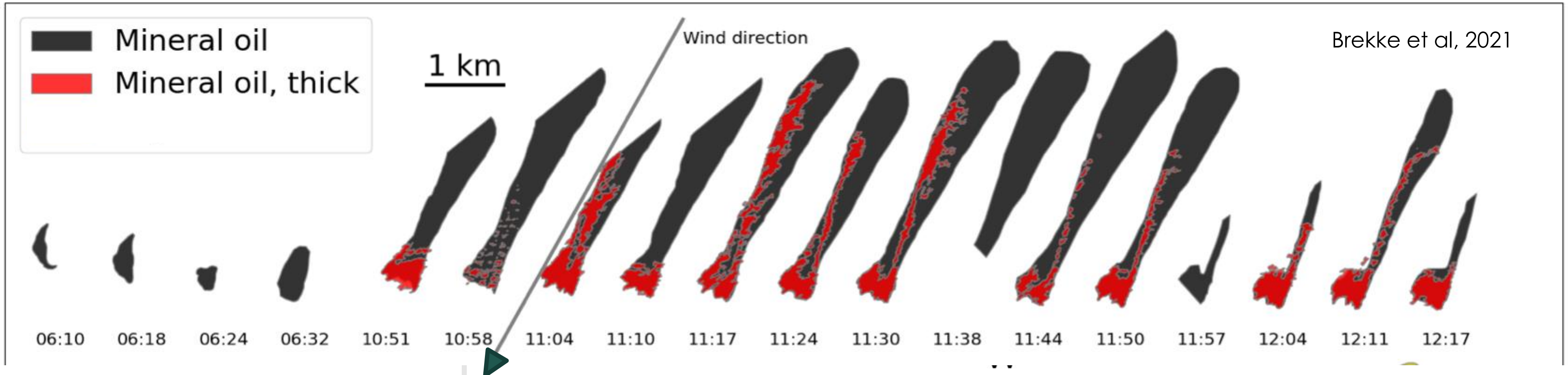


Brekke et al, 2021

Oil Spill Detection – Frequency

- High signal-to-noise data
- Can also observe the drift pattern as well as a change in thickness
- The drift pattern here is goverened by the wind
- Thicker downwind





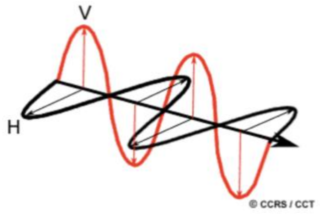
Many factors affect SAR imaging

- **Surface parameters**
  - Roughness
  - Dielectric properties

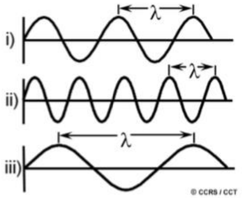
↓

  - **Wind conditions**
  - **Oil slick properties**

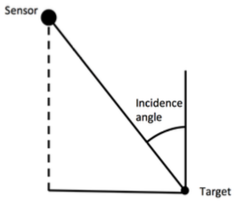
- **Sensor parameters**
  - Polarization



  - Frequency



  - Incidence angle θ

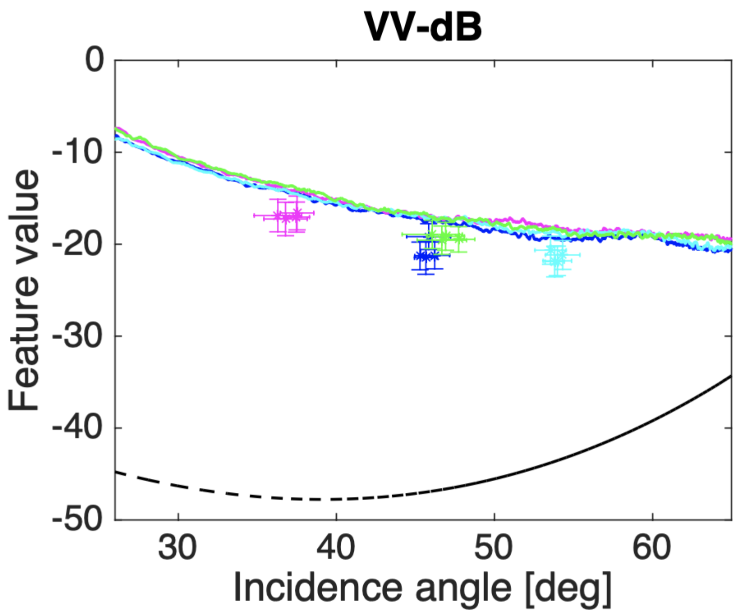


  - Resolution, sensor noise, …

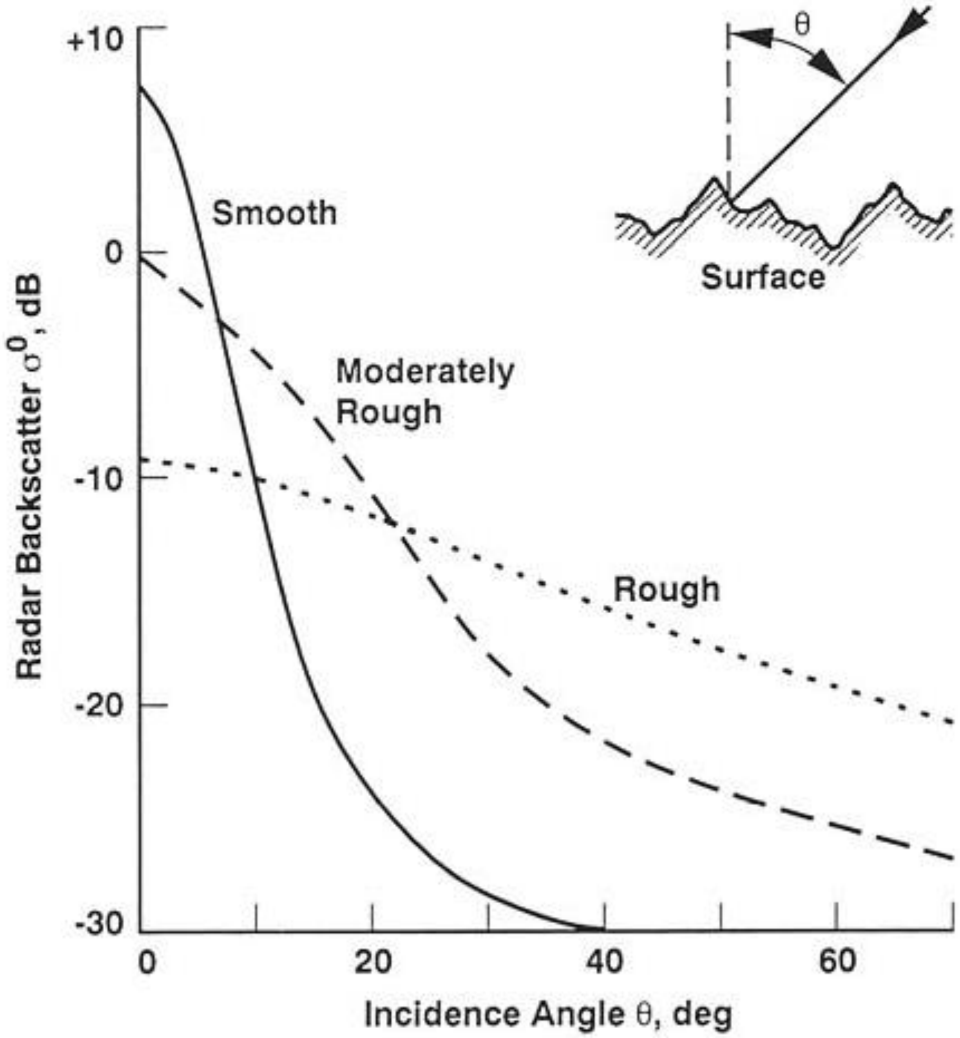
Incidence Angle

- Radar backscatter is reduced with increased incidence angle.

- Oil slicks are low backscatter targets.
  - Signal-to-noise ratio is reduced.

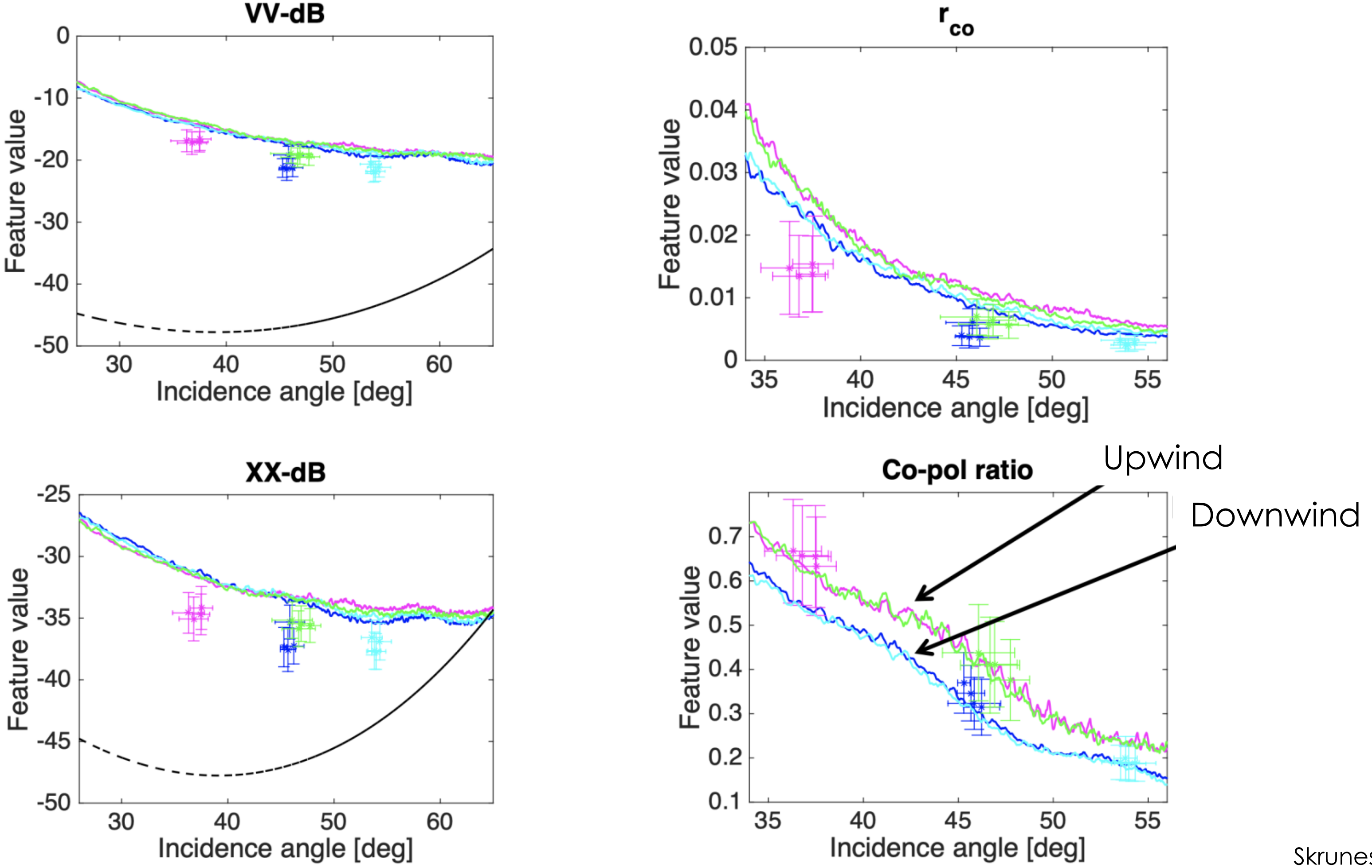


Skrunes et al. (2018)



Incidence Angle

- Parameters change with incidence angle.



Skrunes et al. (2018)

Many factors affect SAR imaging

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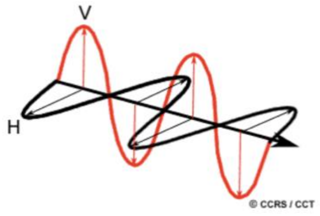
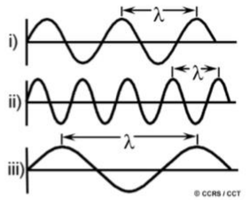
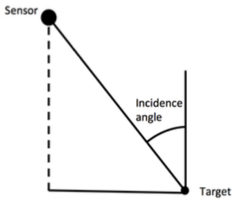


  - Frequency



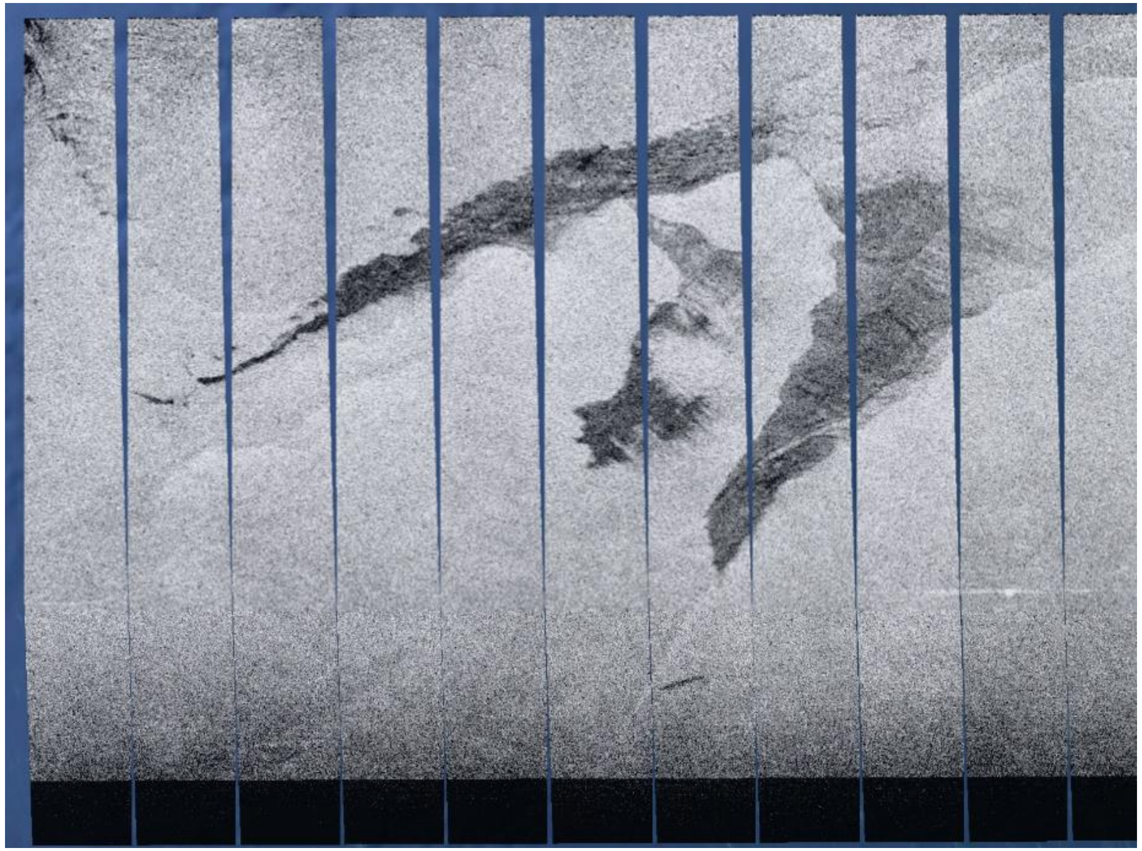
  - Incidence angle θ



  - Resolution, sensor noise,

Single-Polarization SAR Data

- Higher damping ratio -> indicative of thicker oil
- If poor SNR -> can't separate thicker areas
- In order to identify smaller slicks -> need high resolution
- UAVSAR offers high resolution – 7 m resolution after multi-looking
- Large incidence angle range, 22° – 67°
- Swath is 22 km wide



Jones and Holt, 2018

Single-Polarization SAR Data

- Operational oil classification is based on SAR + ancillary information.

- **Geometry and Shape**
  - E.g., area, perimeter, width, complexity

- **Backscatter Characteristics of Dark Spot and Surroundings**
  - Mean, std, gradients, contrasts

- **Contextual Information**
  - Proximity to shore, ships, platforms, pipelines,
  - Wind conditions

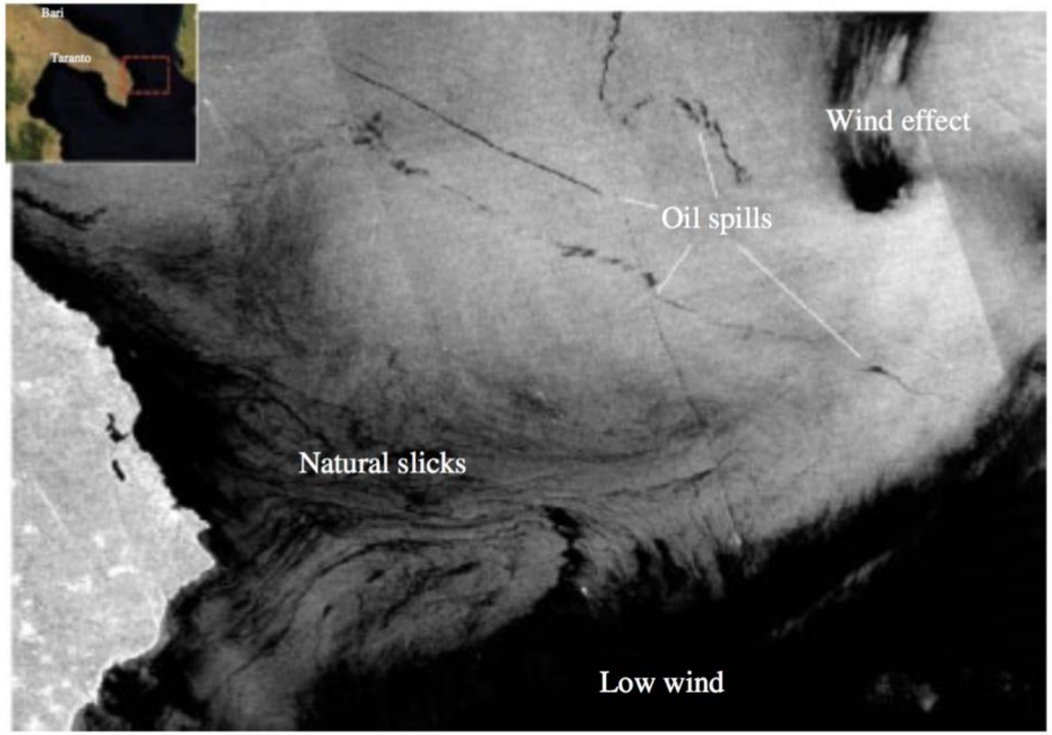
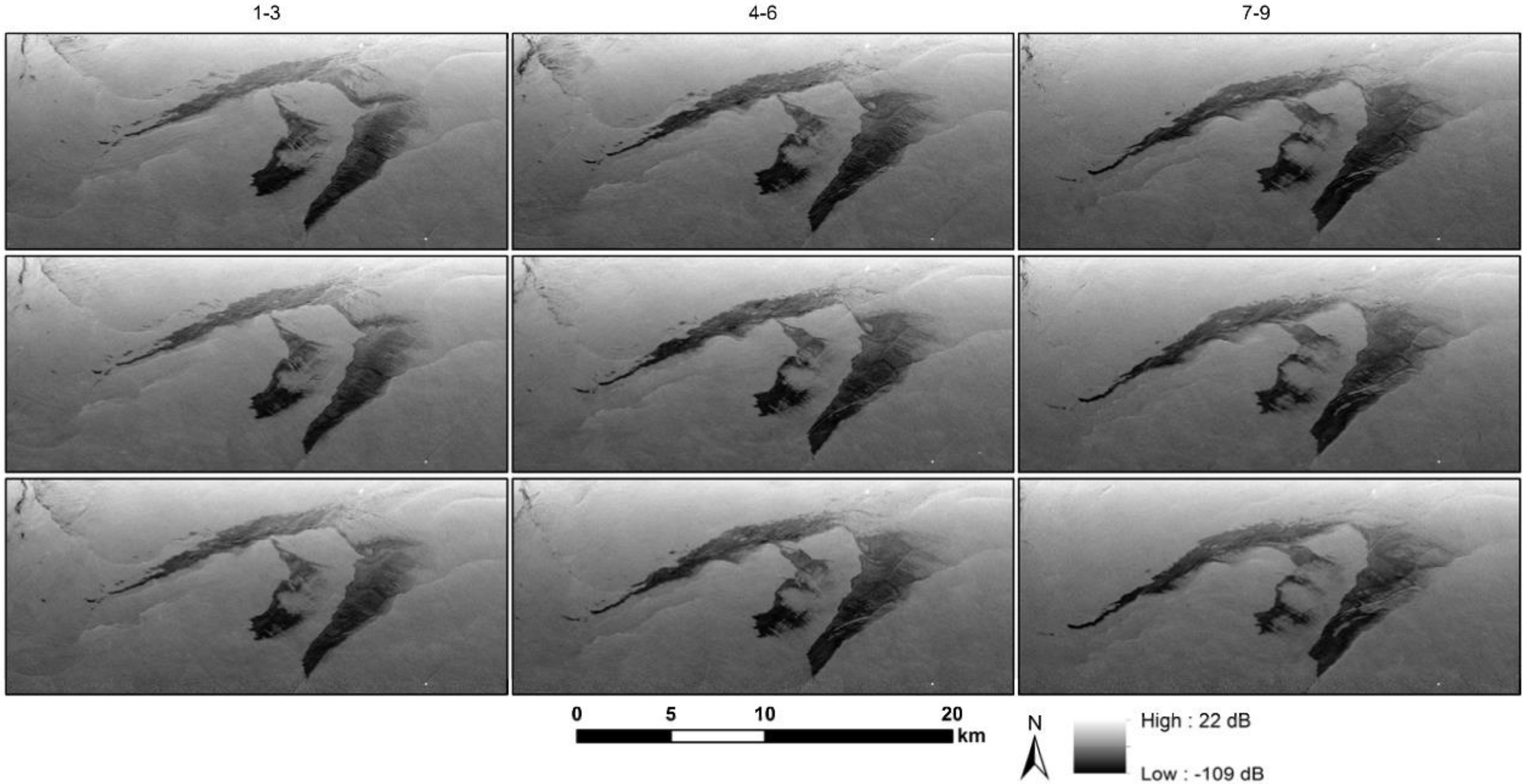


Figure from Topouzelis et al. (2015).

Single-Polarization SAR Data

- Oil gets transported horizontally and vertically
- Weathering
- Time series possible using airplanes -> can study drift patterns



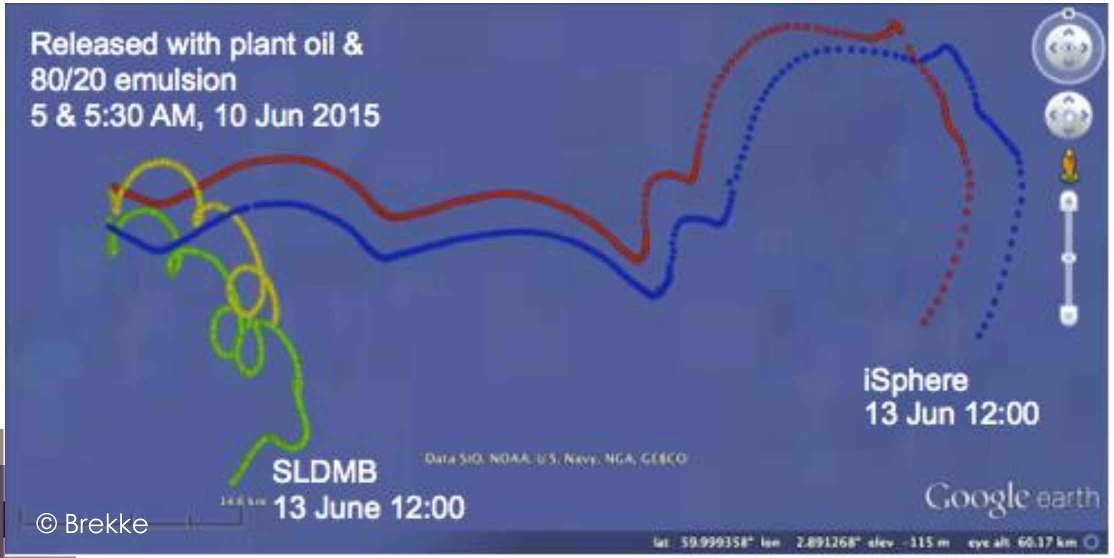
Jones and Holt, 2018

Drift Behavior

- Once the oil has been detected in open water -> where will it go?
  - Modeling of oil behavior, transport, & fate
  - Use time series to follow the drift
  - Annual Oil on Water Exercise in Norway in 2015 – NORSE2015
- We can get the drift using drift buoys
  - 2 iSpheres (subject to direct wind drift)
  - 2 Self Locating Datum Marker Buoys (submerged - current drift)

iSphere

Photo: Malin Johansson



© Brekke

Photo: Øyvind Breivik

Drift Behavior

- Research on detecting different oil types and being able to distinguish the oils is very important.
- Drifters were released at a plant oil slick and an emulsion (E80) to provide position and sea surface temperature at 10 min intervals.
- The slicks were monitored with UAVSAR for 8 hours after release.
- 22 quad-polarimetric SAR scenes at L-band.

Parameter	Value
Frequency	L-Band 1217.5 to 1297.5 MHz (23.8 cm wavelength)
Resolution	1.7 m Slant Range, 1.0 m Azimuth
Operational Altitude	12.5 km
Swatch Width	22 km
Polarization	Quad-Polarization (HH, HV, VH, VV)
Noise Floor	-47 dB average

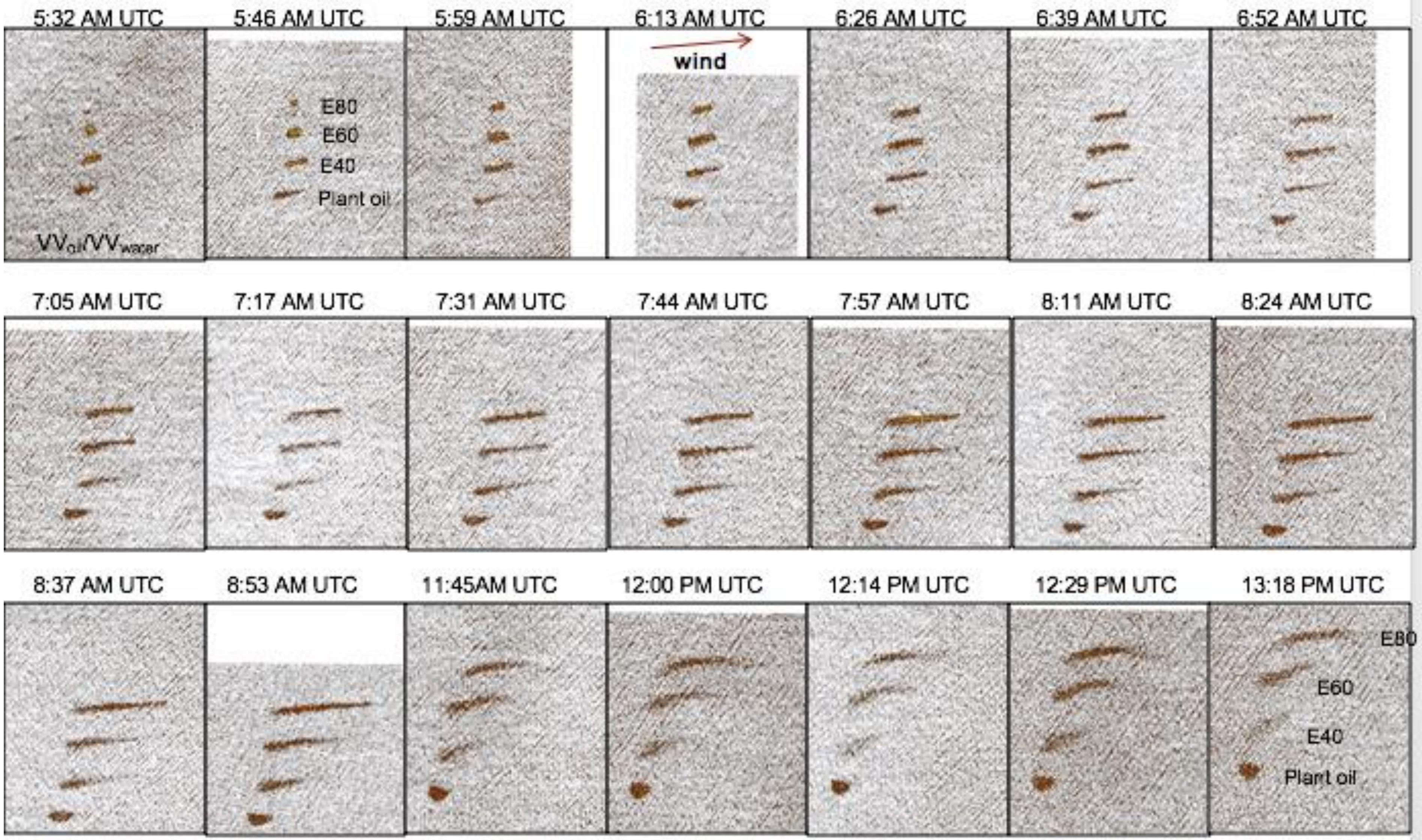

Photo: Øyvind Breivik

iSphere


Photo: Malin Johansson

Drift Behavior

- Time series of UAVSAR used to get position and size of evolving slicks



The plant oil and E40 were difficult to detect after 4h.

Drift Behavior

There are oil drift models - Met Norway's OpenOil Drift Model

- Here tuned to fit UAVSAR measurements
- Oil represented by particles (seeded within contours from UAVSAR)
- Use drift measured by the drifters

Horizontal Movement:

- Ambient Current (Two Runs: SLDMB Drifters or Model)
- Wave-Induced Stokes Drift
- Windage (~2% of Surface Wind)

Vertical Movement:

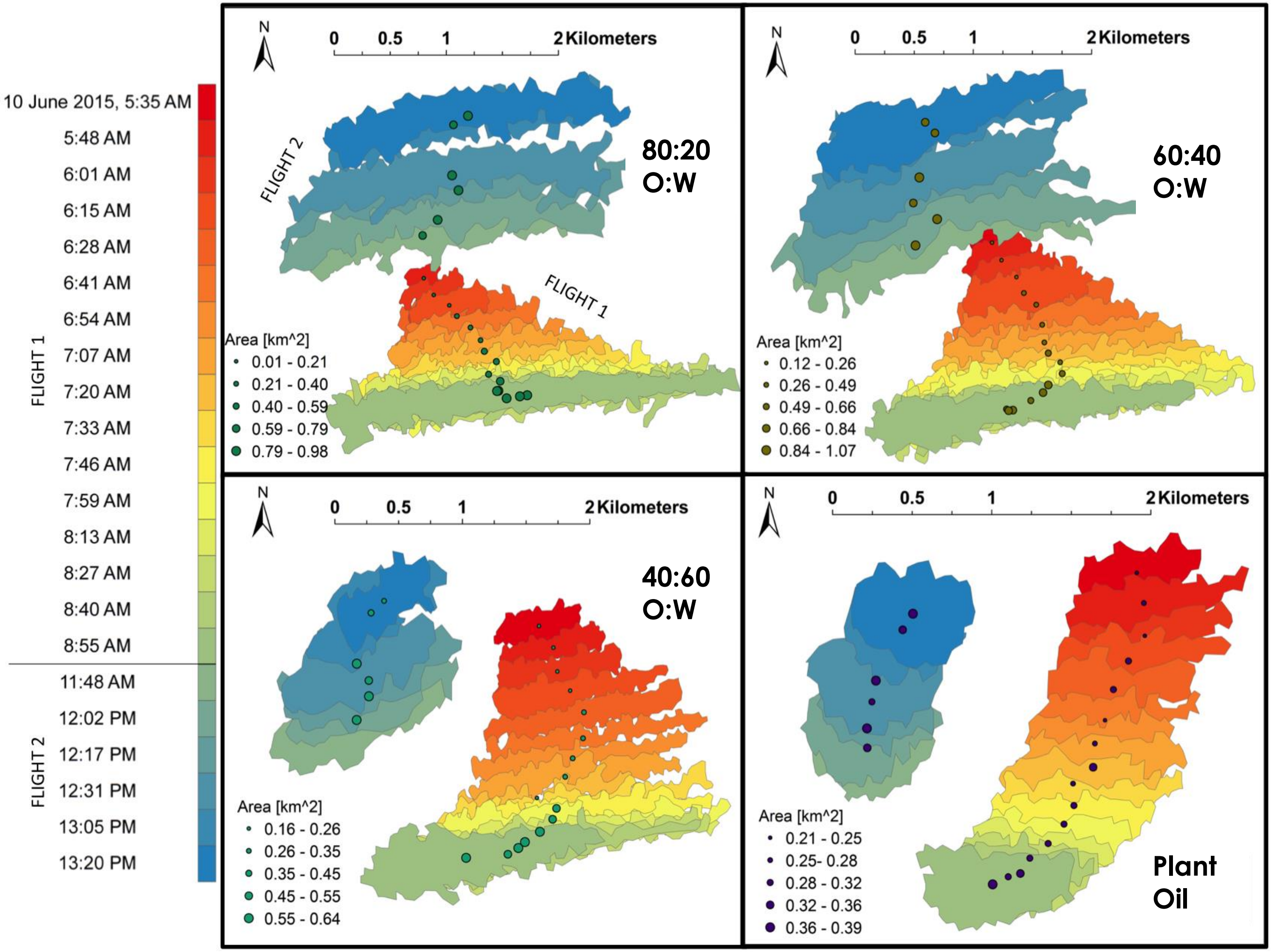
- Entrainment of oil surface elements by breaking waves
- Rise of submerged particles due to buoyancy

For more information please see Jones et al, 2016: JGR-Oceans

Drift Behavior

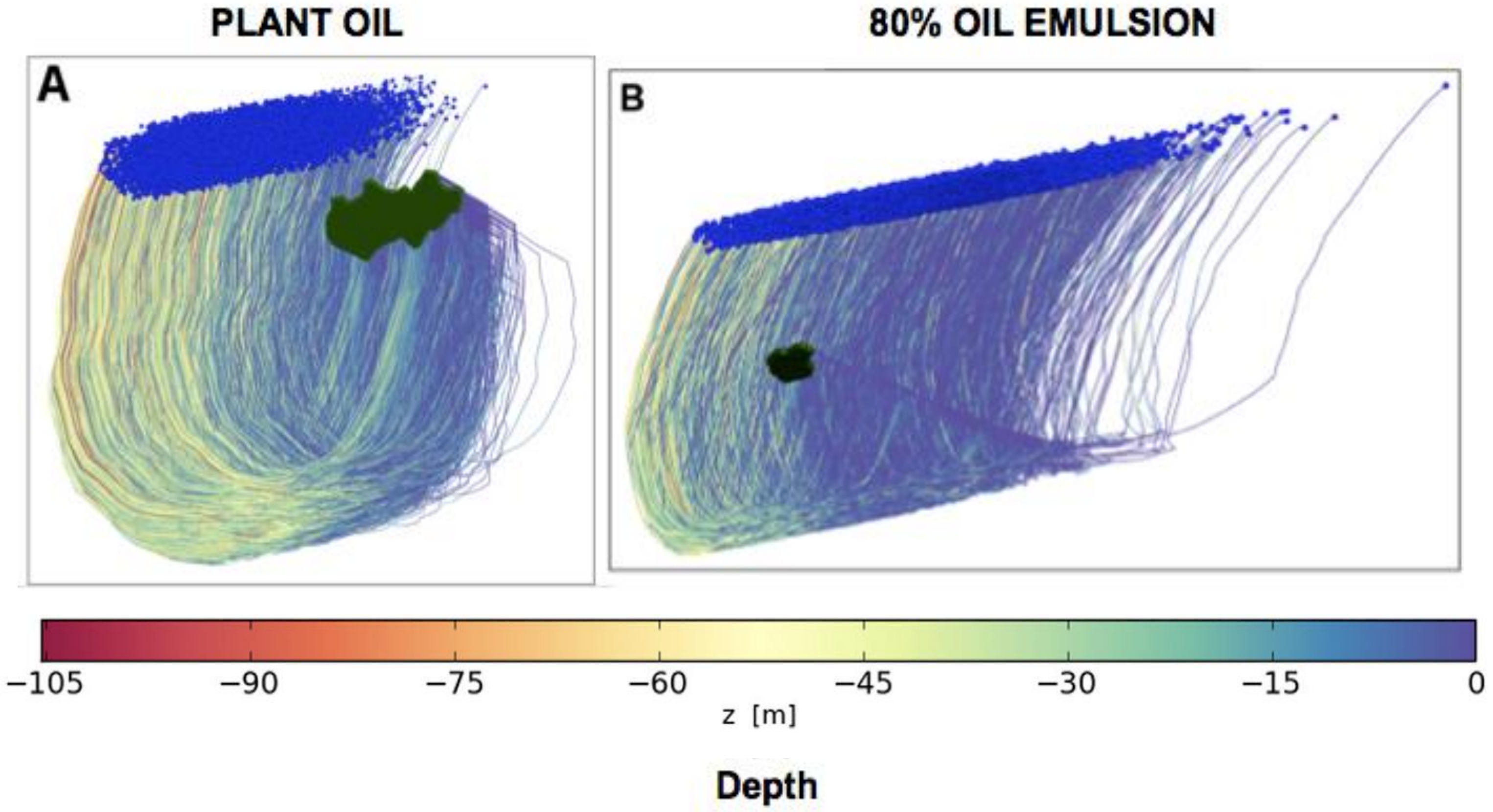
- Relative position, extent, and spread in the 8 h following release
- Oil spill thickness of 0.5 – 8 μ

Jones et al, 2016



Drift Behavior

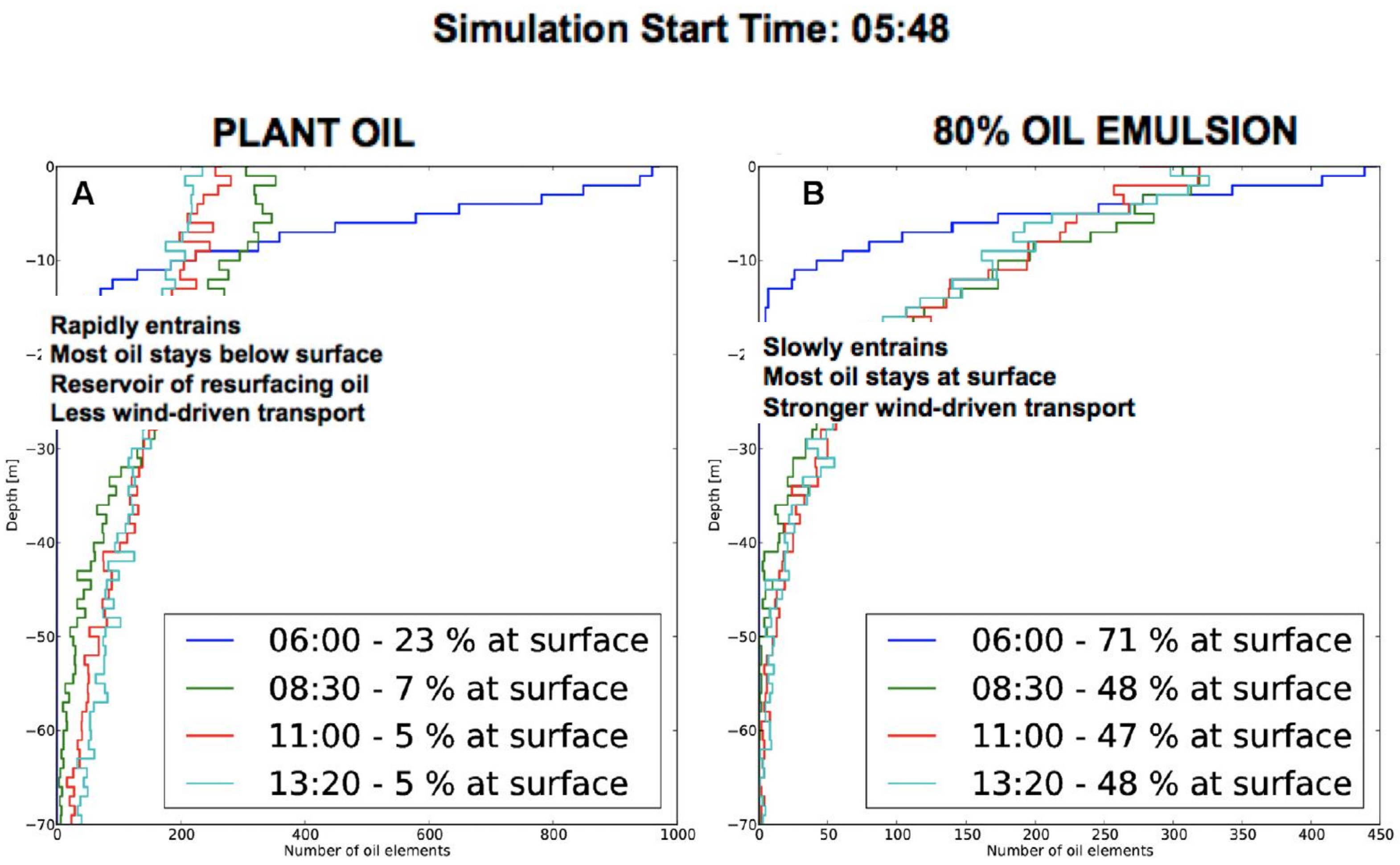
- Particles located close to (far below) the surface drift faster eastward (westward).
- The bulk of plant oil below the surface was shielded from strong eastward Stokes drift and surface wind.
- Trajectory mainly steered by currents and in agreement with UAVSAR observations.



Jones et al, 2016

Drift Behavior

- Difference in depth profiles found, indicating a potential for slick discrimination based on transport



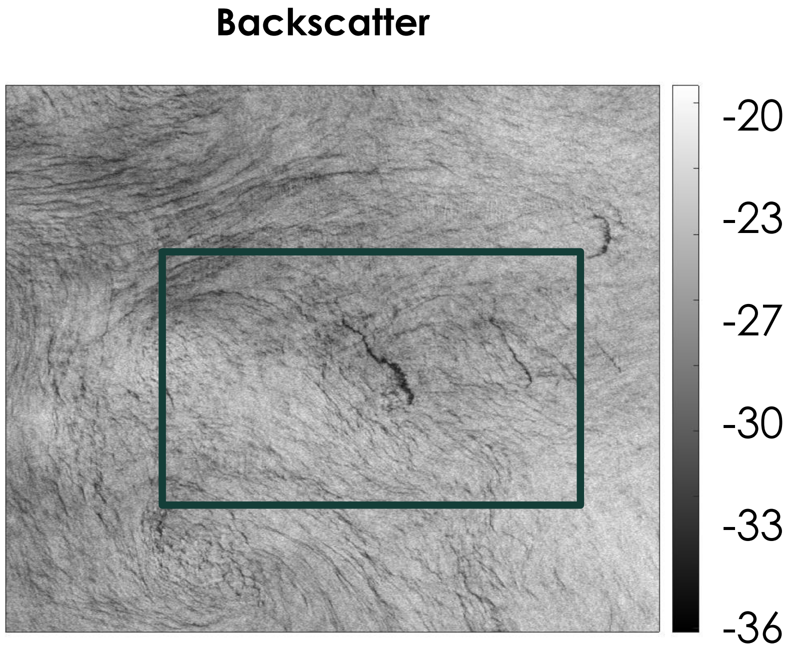
Jones et al, 2016

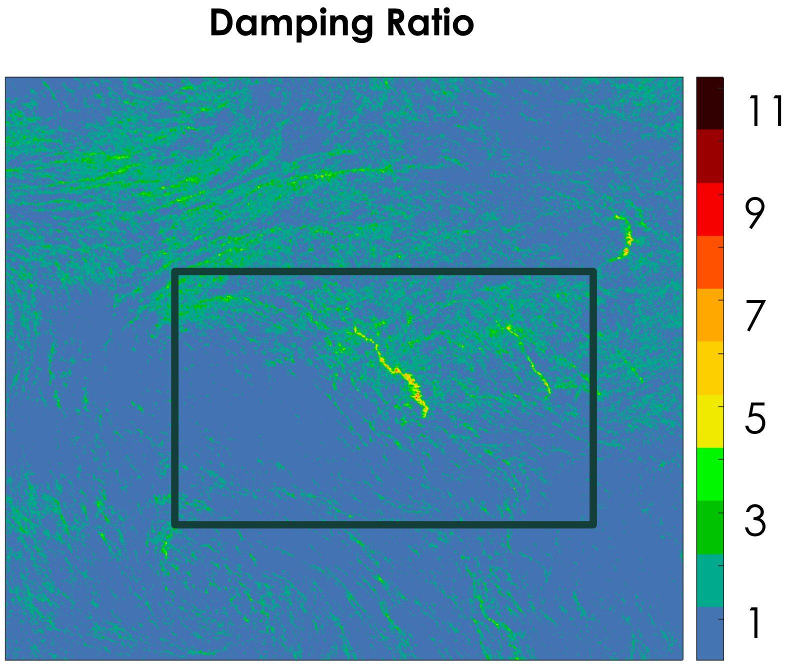
Drift Behavior

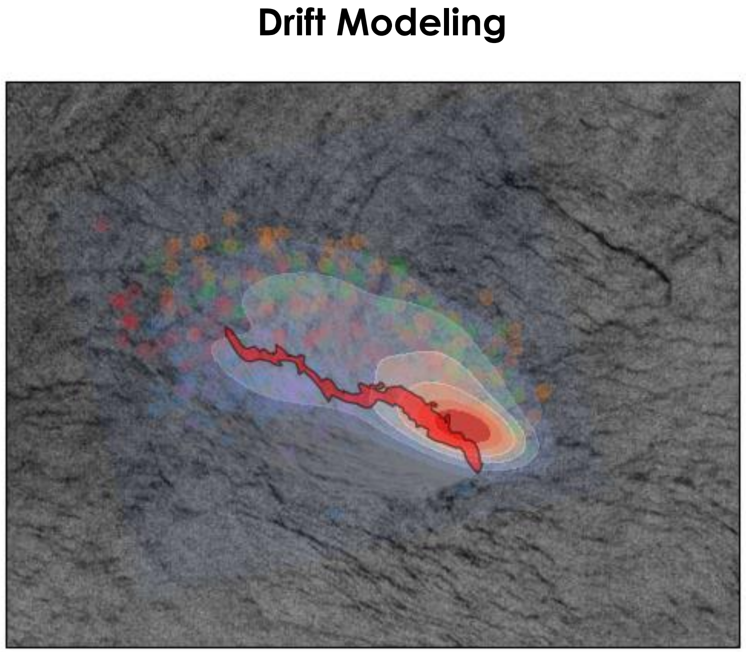
- Why have test experiments?
  - Controlled so conditions and quantities are known
  - Transfer the knowledge to unknown areas
- Natural seeps of gas and mineral oil across the Barents Sea Shelf
- Repeated satellite observations - > extensive thin ocean surface oil slicks
- Detection limitations for thin slicks in satellite images are unknown and the slick drift patterns are not clear.

Photo: Marie Stetzler

Drift Behavior







- Oil seepage drift estimate for one seepage
- The damping ratio shapefile is seen as the solid dark red area
- Different model inputs are used to estimate the drift pattern

Why is a test experiment valuable for oil research?

- Data types not used operationally ➔ lack of data
  - Known time and location are essential for acquisition planning
- Access to Ground Truth
  - Oil type and properties
  - Environmental conditions
- Remote Sensing
  - Spaceborne
  - Aircraft

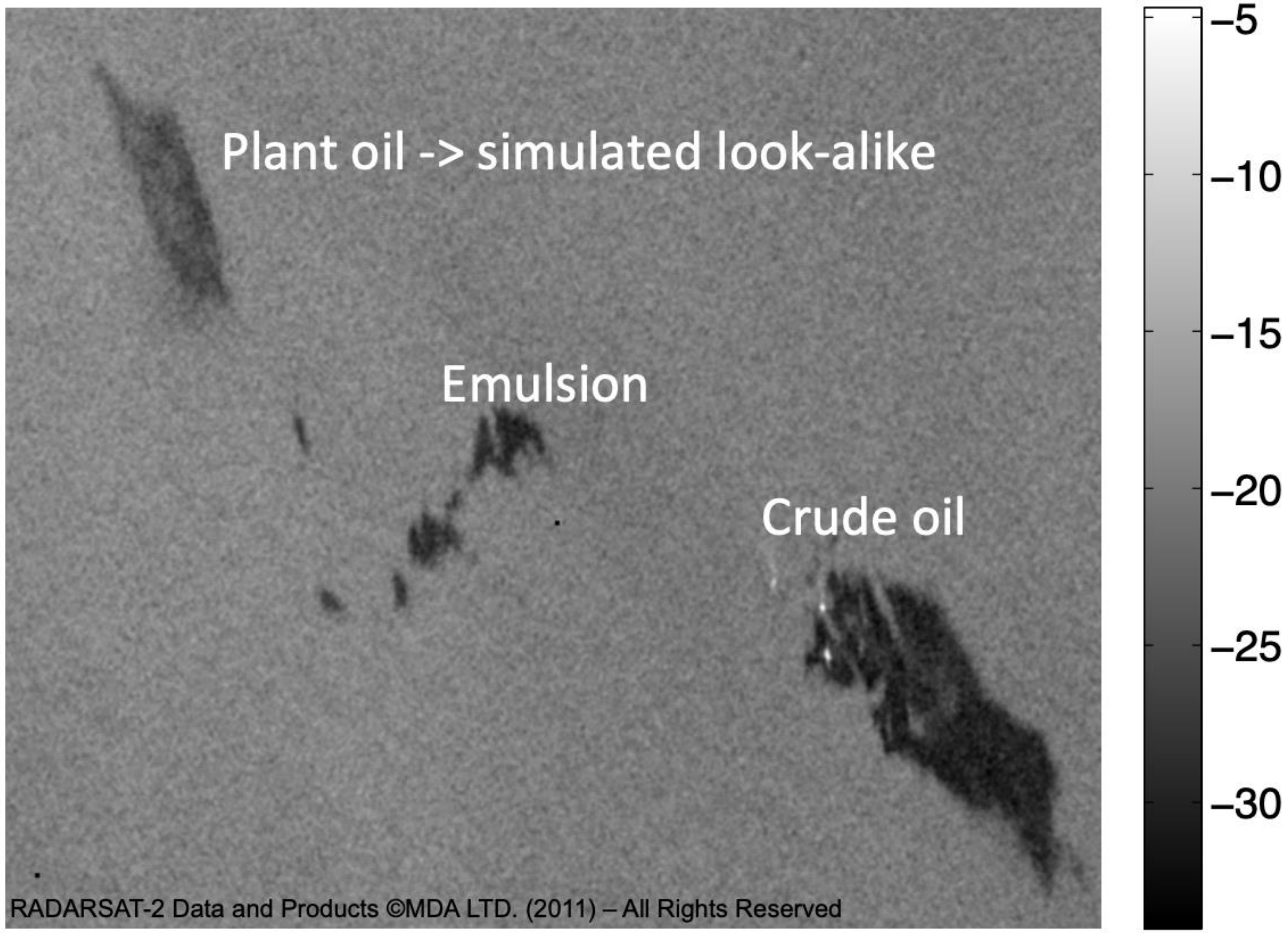
Figure: SYKE/Finnish Border Guard/NOFO

We can determine the SAR characteristics when we know what happens on the ground.

Oil Characteristics

Oil-on-water exercises in the North Sea are unique opportunities for data collection

- Research on detecting different oil types and being able to distinguish them is very important. This image and detections were taken on the annual Oil on Water Exercise in Norway in 2011.
- These images are often fully-polarimetric images or dual-polarimetric (HH+VV) images.
- Using polarimetric data, we can derive more information.
  - Use it to separate different oil types



Oil Characteristics

- The use of polarimetry for dark spot characterization

Scattering matrix:

$$\mathbf{S} = \begin{bmatrix} S_{HH} & S_{VH} \\ S_{HV} & S_{VV} \end{bmatrix} = \begin{bmatrix} |S_{HH}|e^{j\phi_{HH}} & |S_{VH}|e^{j\phi_{VH}} \\ |S_{HV}|e^{j\phi_{HV}} & |S_{VV}|e^{j\phi_{VV}} \end{bmatrix}$$

Covariance matrix:

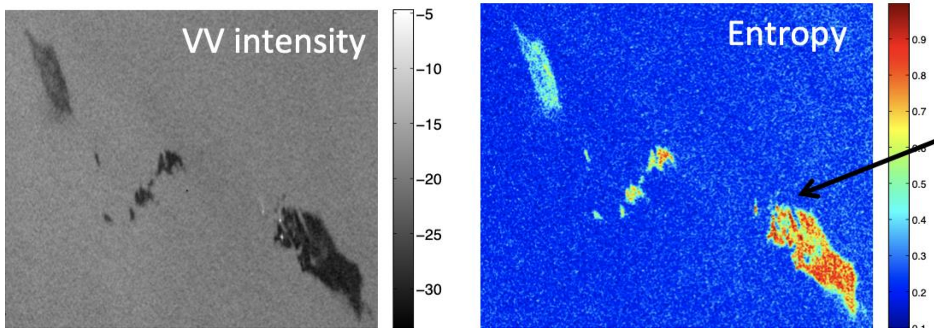
$$\mathbf{C} = \begin{bmatrix} \langle |S_{HH}|^2 \rangle & \sqrt{2}\langle S_{HH}S_{VH}^* \rangle & \langle S_{HH}S_{VV}^* \rangle \\ \sqrt{2}\langle S_{VH}S_{HH}^* \rangle & 2\langle |S_{VH}|^2 \rangle & \sqrt{2}\langle S_{VH}S_{VV}^* \rangle \\ \langle S_{VV}S_{HH}^* \rangle & \sqrt{2}\langle S_{VV}S_{VH}^* \rangle & \langle |S_{VV}|^2 \rangle \end{bmatrix}$$

Coherency matrix:

$$\mathbf{T} = \frac{1}{2}\begin{bmatrix} \langle |S_{HH}+S_{VV}|^2 \rangle & \langle (S_{HH}+S_{VV})(S_{HH}-S_{VV})^* \rangle & 2\langle (S_{HH}+S_{VV})S_{VH}^* \rangle \\ \langle (S_{HH}-S_{VV})(S_{HH}+S_{VV})^* \rangle & \langle |S_{HH}-S_{VV}|^2 \rangle & 2\langle (S_{HH}-S_{VV})S_{VH}^* \rangle \\ 2\langle S_{VH}(S_{HH}+S_{VV})^* \rangle & 2\langle S_{VH}(S_{HH}-S_{VV})^* \rangle & 4\langle |S_{VH}|^2 \rangle \end{bmatrix}$$

Decompositions, polarimetric features

Skrunes et al, 2014



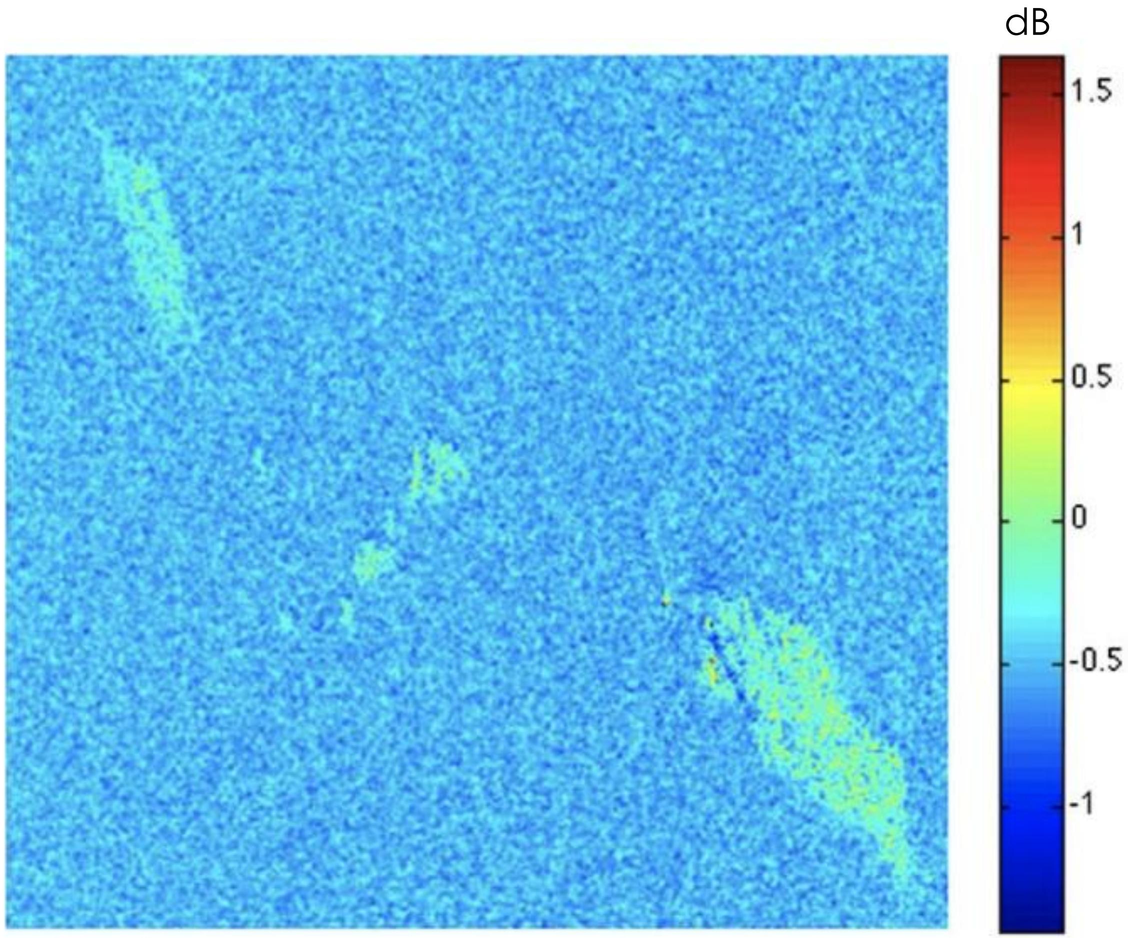
Interpreted as a change in scattering mechansim between clean sea and oil.

Oil Characteristics

- Co-Polarization Power Ratio:

$$\gamma_{CO} = \frac{\langle |S_{HH}|^2 \rangle}{\langle |S_{VV}|^2 \rangle}$$

- Tilted Bragg model:
  - Roughness is polarization independent and cancels out
- -> Co-polarization power ratio only depends on incidence angle, dielectric constant and tilt angles -> May be useful for estimating emulsion water content (Minchew et al. 2012)



Skrunes et al, 2014

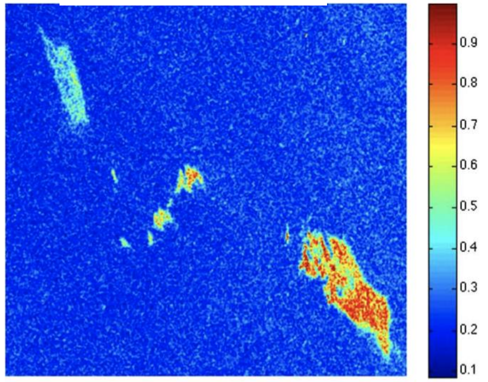
Oil Characteristics

Different multipolarization features have been proposed for oil spill characterization.

Skrunes et al, 2014

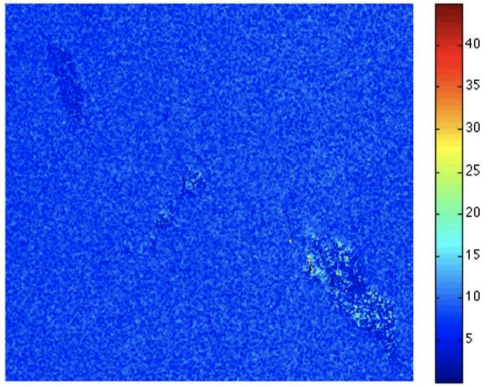
Entropy

$$H = -\sum_{i=1}^{d} p_i \log_d p_i$$



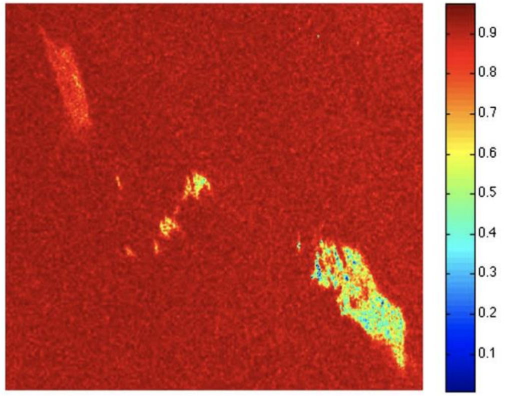
Alpha Angle

$$\alpha_1' = \cos^{-1}\left(|\mathbf{e_1}(1)|\right)$$



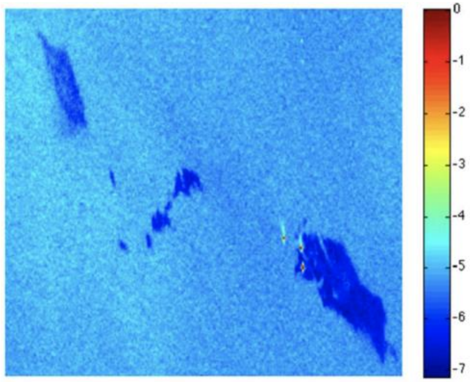
Anisotrophy

$$A' = \frac{\lambda_1 - \lambda_2}{\lambda_1 + \lambda_2}.$$



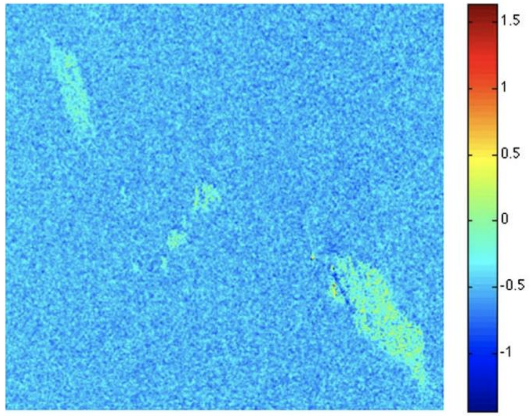
Geometric Intensity

$$\mu = \left(\det(\mathbf{T})\right)^{1/d}$$



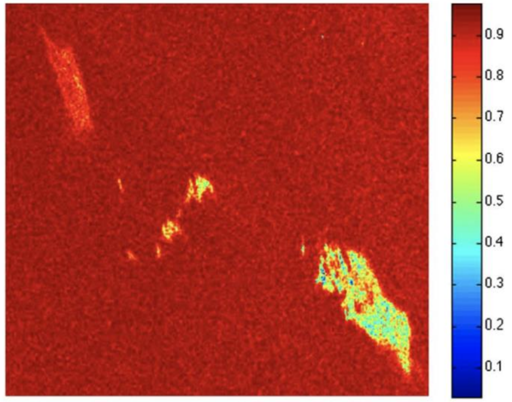
Co-Polarization Power Ratio

$$\gamma_{CO} = \frac{\langle |S_{HH}|^2 \rangle}{\langle |S_{VV}|^2 \rangle}$$



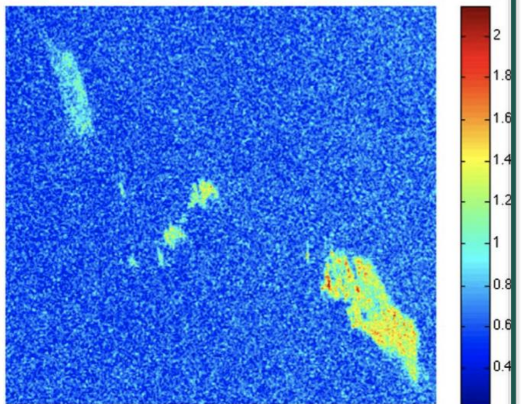
Correlation Magnitude

$$\rho_{CO} = \left| \frac{\langle S_{HH} S_{VV}^* \rangle}{\sqrt{\langle |S_{HH}|^2 \rangle \langle |S_{VV}|^2 \rangle}} \right|$$



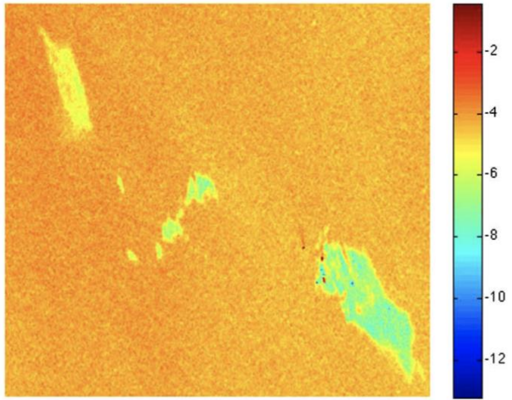
Std. of Copolarized Phase

$$\sigma_{\phi CO} = \sqrt{\left(\langle (\phi_{HH} - \phi_{VV})^2 \rangle - (\langle \phi_{HH} - \phi_{VV} \rangle)^2\right)}$$



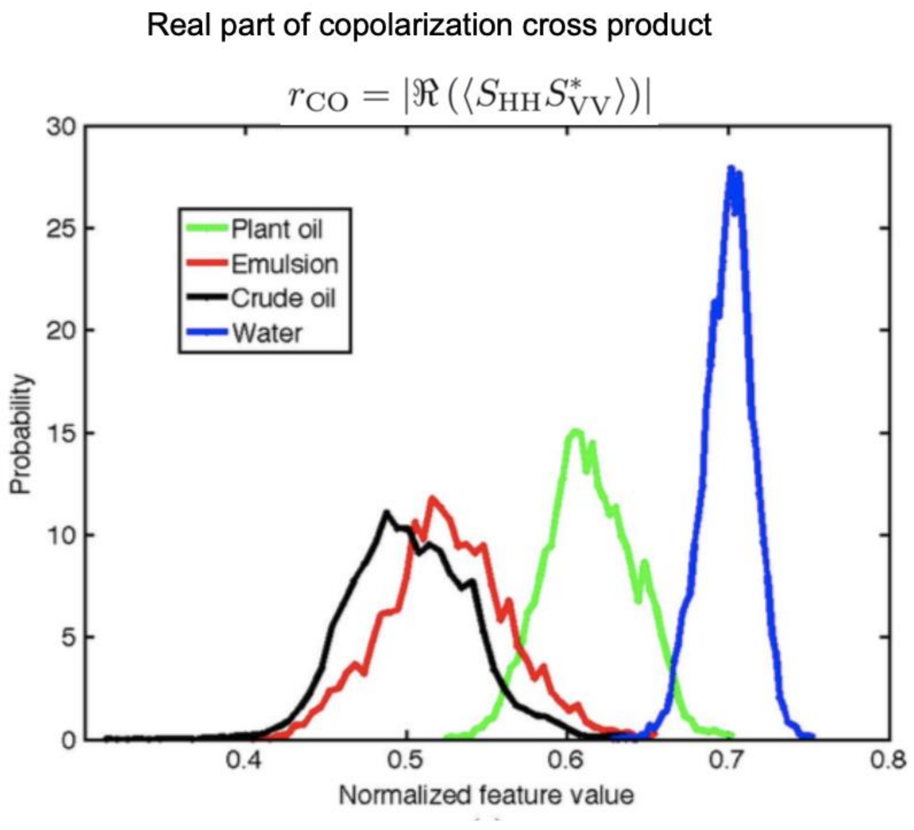
Real Part of Co-Pol. Cross Product

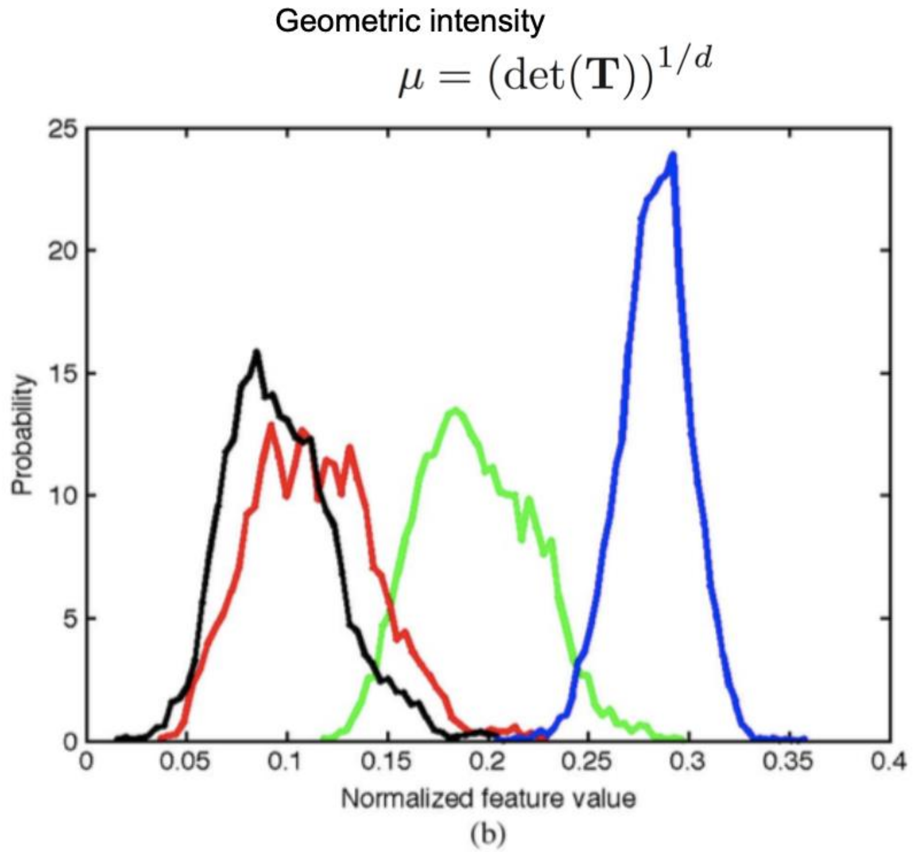
$$r_{CO} = |\Re(\langle S_{HH} S_{VV}^* \rangle)|$$



Oil Characteristics

- Histograms show promising separation between classes



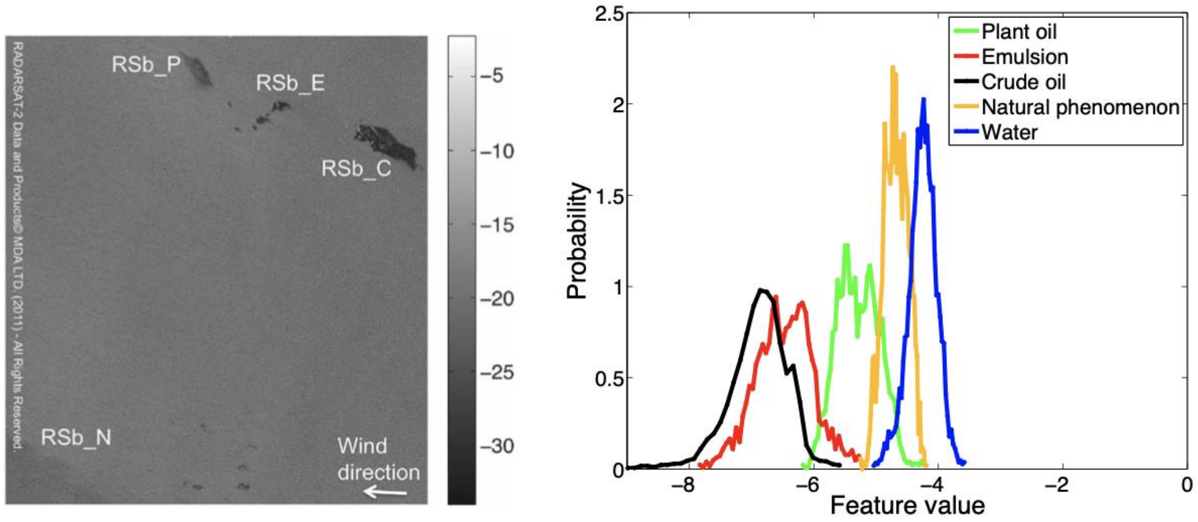


Skrunes et al, 2014

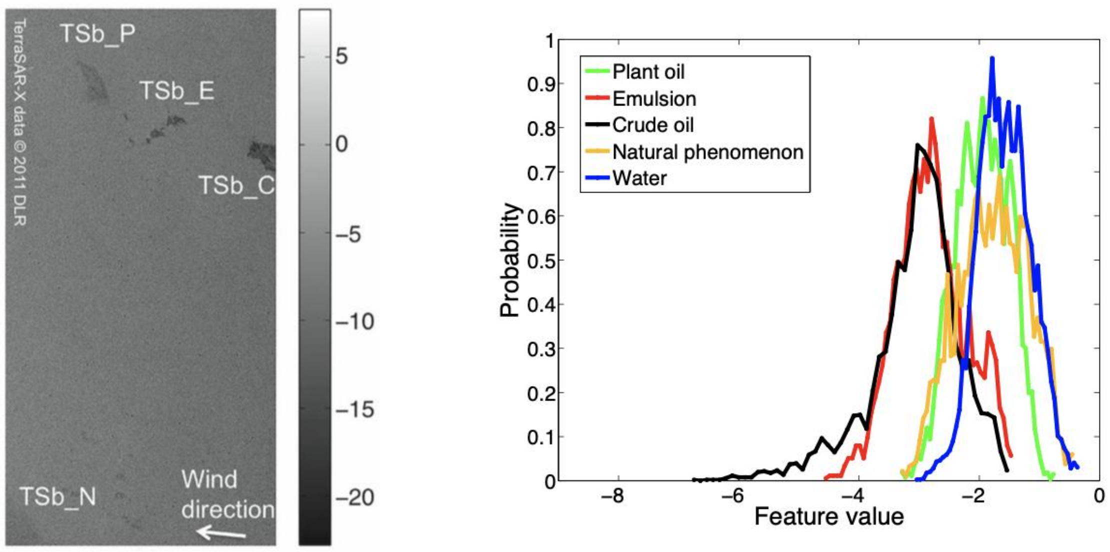
Oil Characteristics

- Multipolarization features showed better contrasts and region discrimination in RS2 than TSX

Radarsat-2 17:27 (C-band) 35°



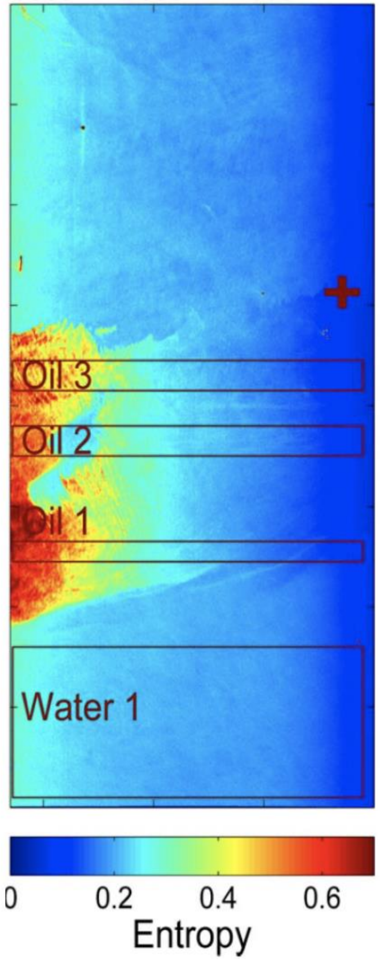
TerraSAR-X 17:11 (X-band) 21°

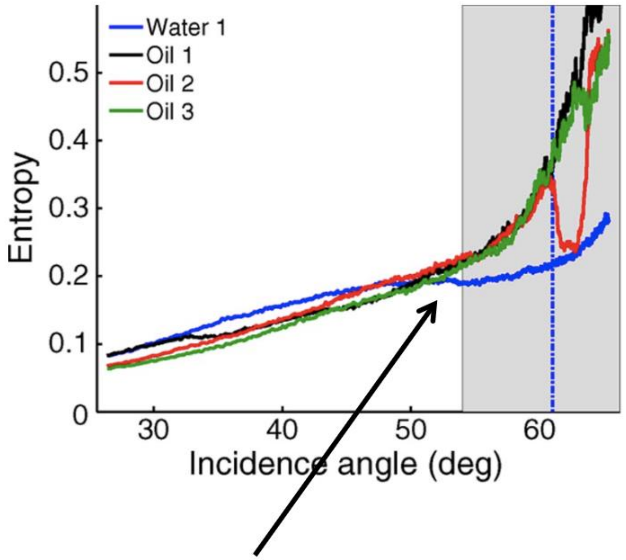


Skrunes et al, 2014

Oil Characteristics

- Multi-polarimetric features can be related to surface properties and scattering behavior.
- Proximity to the noise floor can affect polarimetric features and interpretation of the results.





Increase in entropy at high incidence angle as the signal approaches the noise floor.

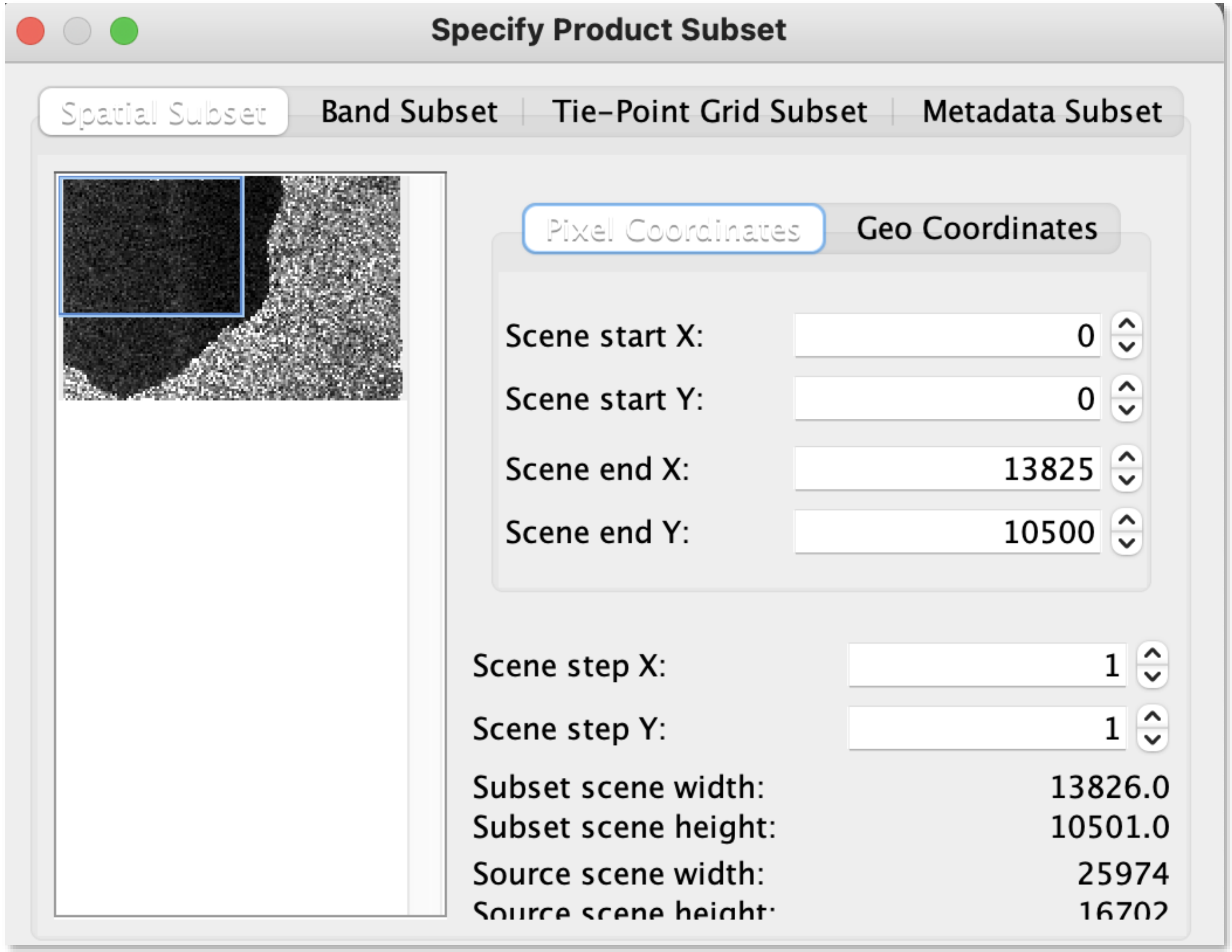
Minchew et al. (2012)

Take-Home Message

- Oil dampens capillary waves -> low backscatter areas in SAR images.
- Sensor specifics, such as incidence angle and SNR, affect detection and monitoring capabilities.
- Single and dual polarimetric SAR can be used to detect and monitor oil slicks.
  - Derive the damping ratio
  - Identify areas of different oil thickness
  - Identify areas of oil slicks to initiate oil drift modelling
  - Time series of oil slicks from satellites or airborne campaigns are important for recovery procedures
- Quad-polarimetric images can be used to derive oil slick characteristics.

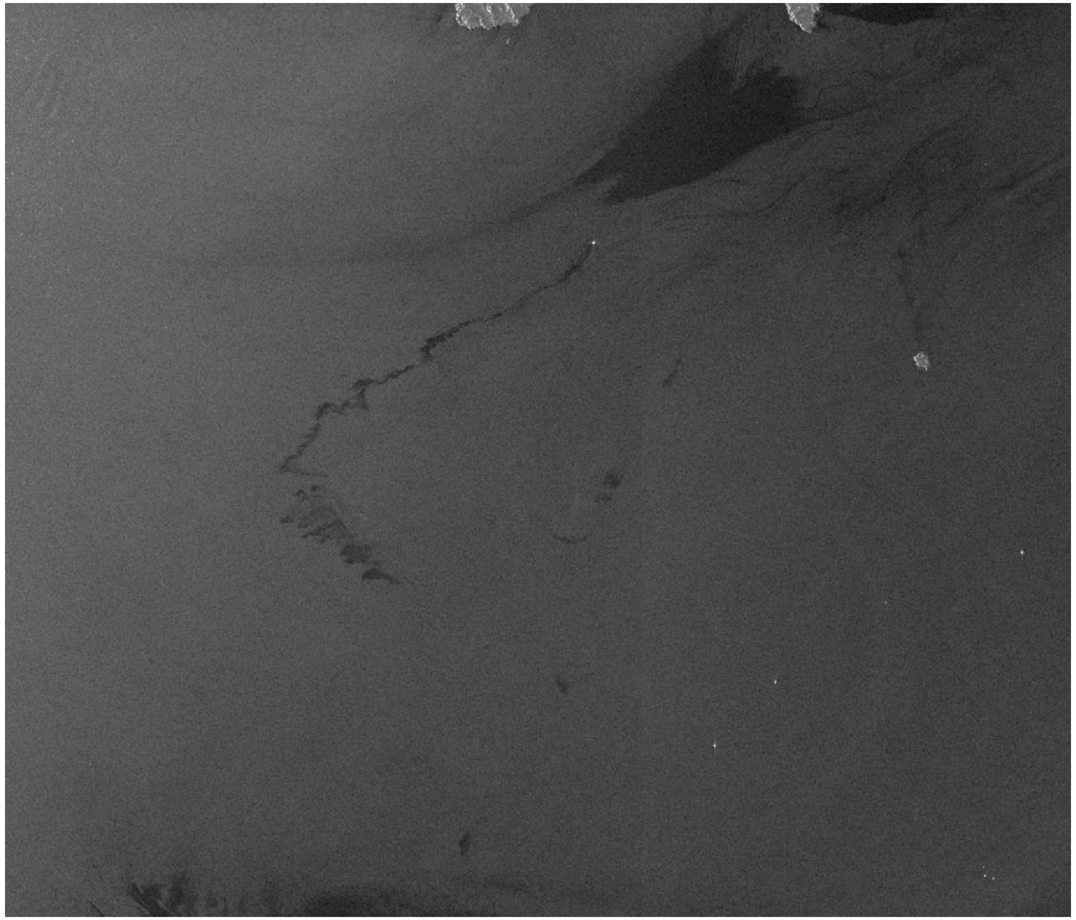
Detect Your Own Oil Spill

- Identify the oil slick within this image:
- S1A_IW_GRDH_1SDV_20181009T171427_20181009T171452_024062_02A131_E887.SAFE
- Open the file in SNAP
- Subset to a region that doesn’t also contain the land areas (speeds up the processing time):
  - E.g. Raster –> Subset ->

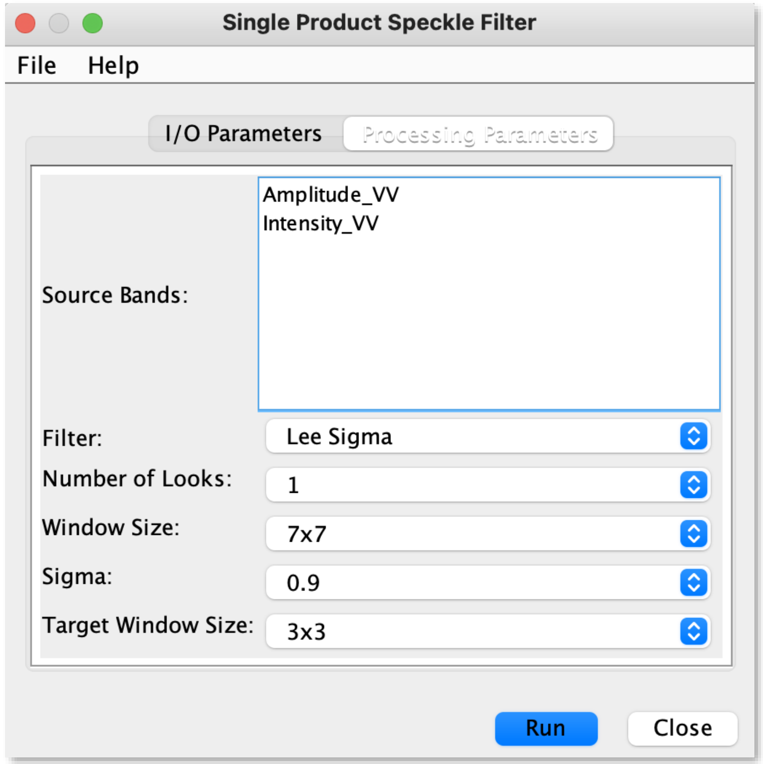


Detect Your Own Oil Spill

- Clicking on Bands -> Intensity_VV

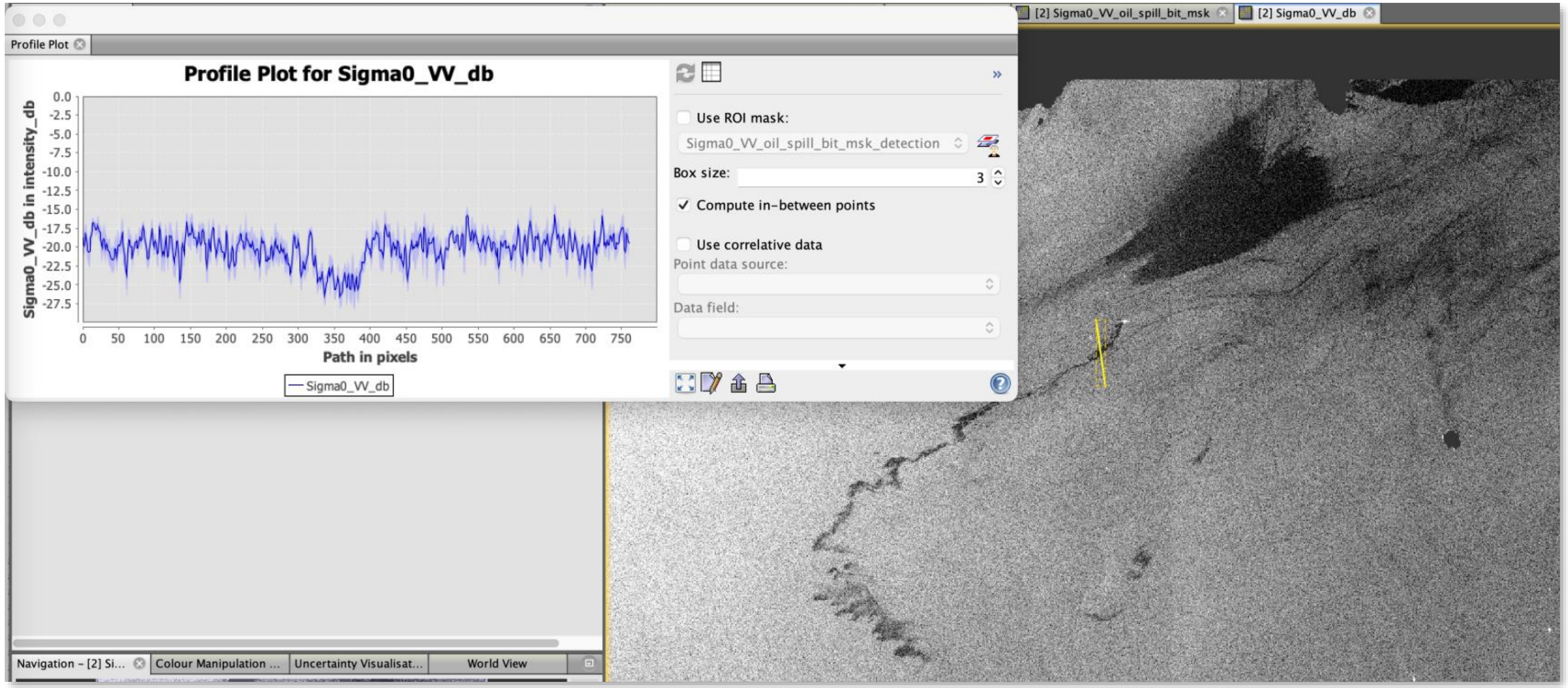


- You can now perform some speckle filtering.
- Radar -> Speckle filtering



Detect Your Own Oil Spill

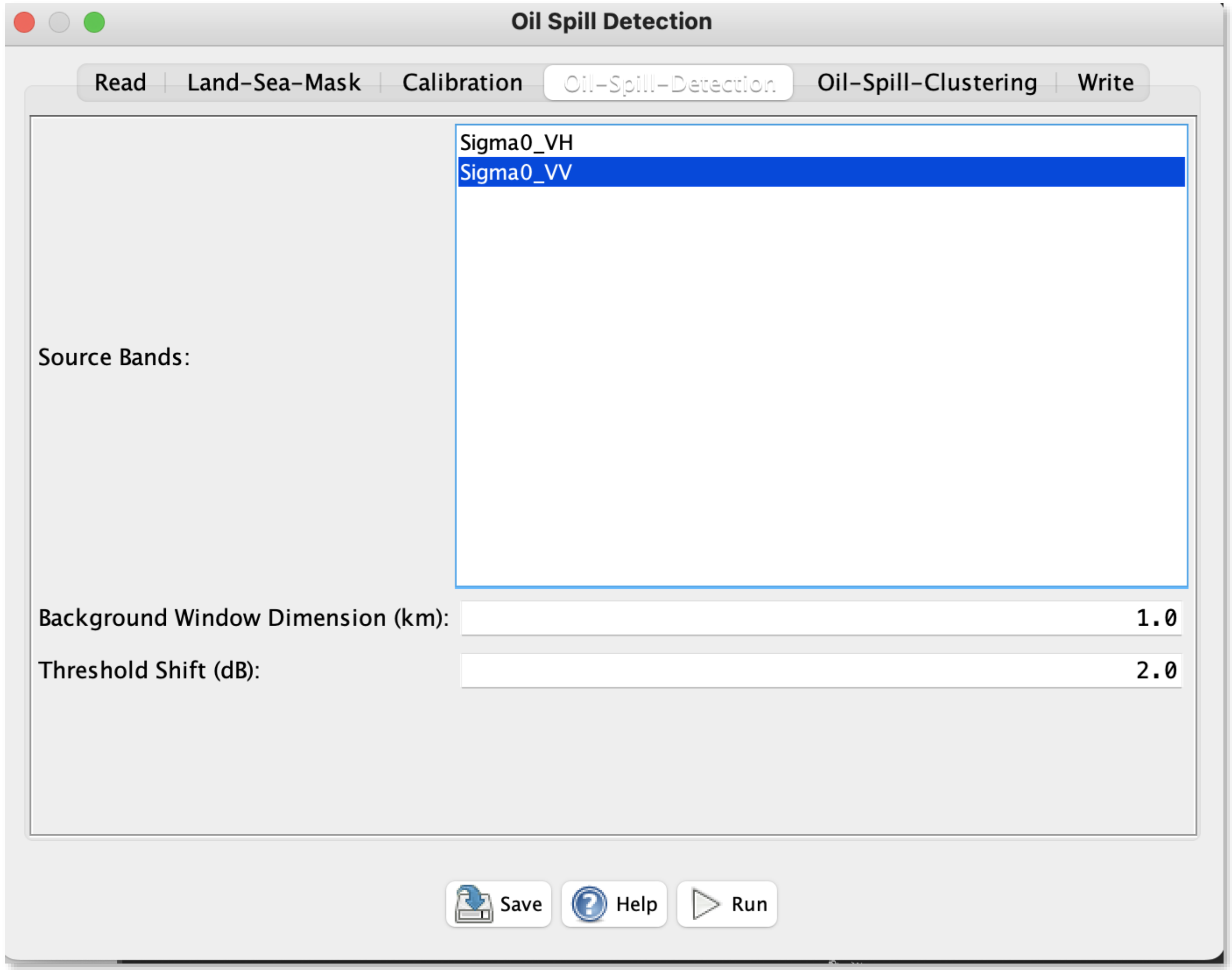
- Convert the Intensity values to dB



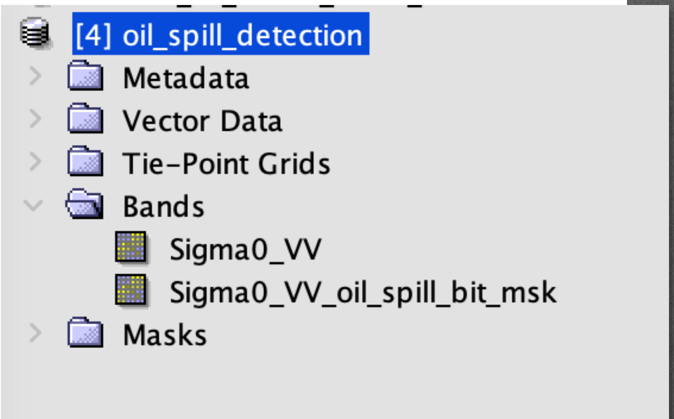
- Make lines for shift in backscatter intensity values
- Analysis -> Profile plot
- Make a line using

Detect Your Own Oil Spill

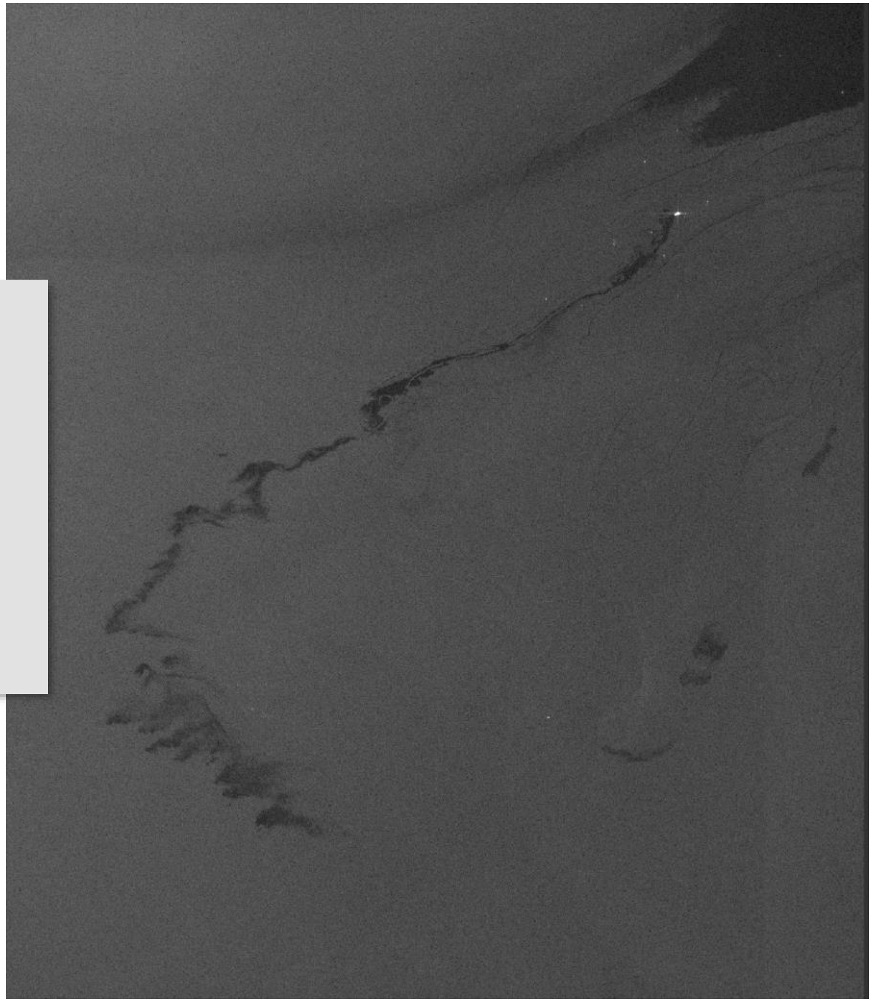
- Let's now run the automatic oil spill detection in SNAP.
- Radar -> SAR Applications -> Ocean Applications -> Oil Spill Detection
- Set the Background Window Dimension and the Threshold shift
- For the Threshold we can use the values from the line we just drew.



Detect Your Own Oil Spill



Sigma0 VV



Sigma0_VV_oil_spill_bit_msk

Detect Your Own Oil Spill

- Once you have the mask you can now:
  - Start calculating statistics from the oil spill
  - Derive the damping ratio by yourselves

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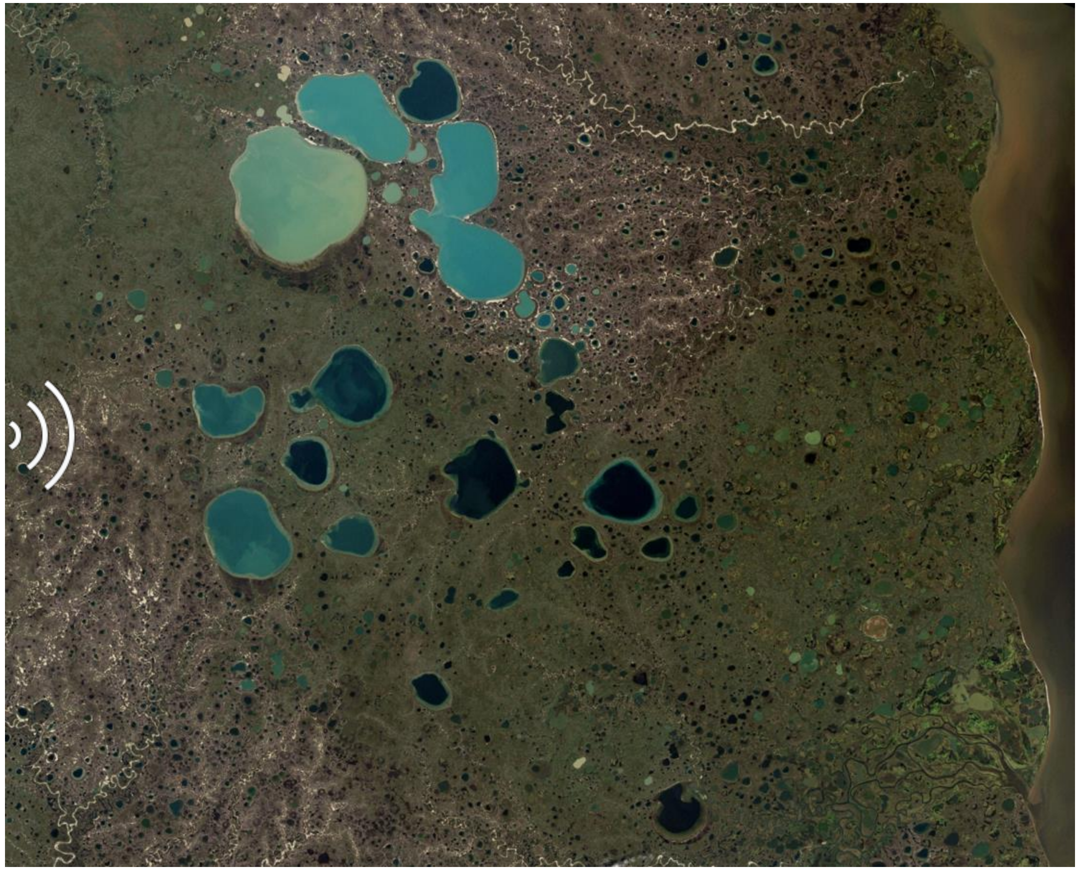
- To all those who have participated in marine oil spill field work.
- Kongsberg Satellite Services (KSAT)

Questions?

- Please enter your questions in the Q&A box. We will answer them in the order they were received.
- We will post the Q&A to the training website following the conclusion of this session.



https://earthobservatory.nasa.gov/images/6034/pothole-lakes-in-siberia

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Thank You!