



UiT The Arctic University of Norway

## Skille mellom olje og lavvindsområder og bruk av driftdeteksjon for å skille mellom oljetyper

Malin Johansson<sup>1</sup>, Cornelius Quigley<sup>2</sup>, Cathleen Jones<sup>1,3</sup>,  
Mads Dejligbjerg<sup>1</sup>

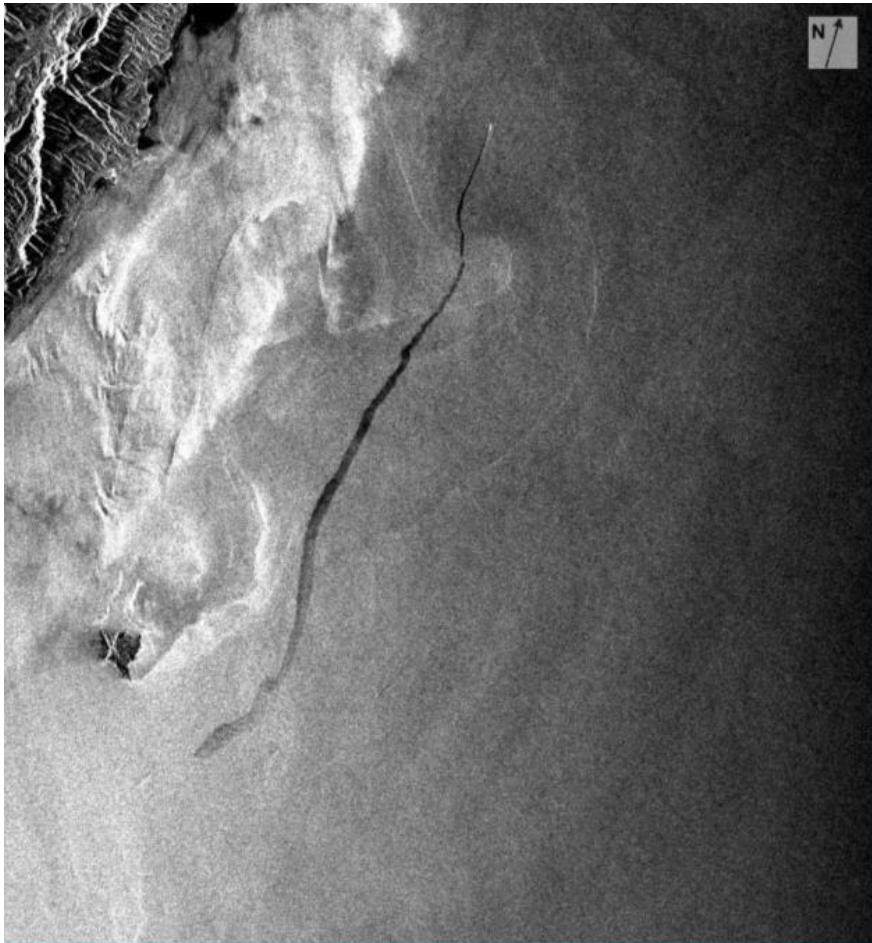
<sup>1</sup>UiT The Arctic University of Norway

<sup>2</sup>Helmholtz-Zentrum Dresden-Rossendorf (HZDR)

<sup>3</sup>NASA/JPL

# Hvorfor?

- Oljesøl ser **mørke** ut i SAR bilder – då de damper små bølger

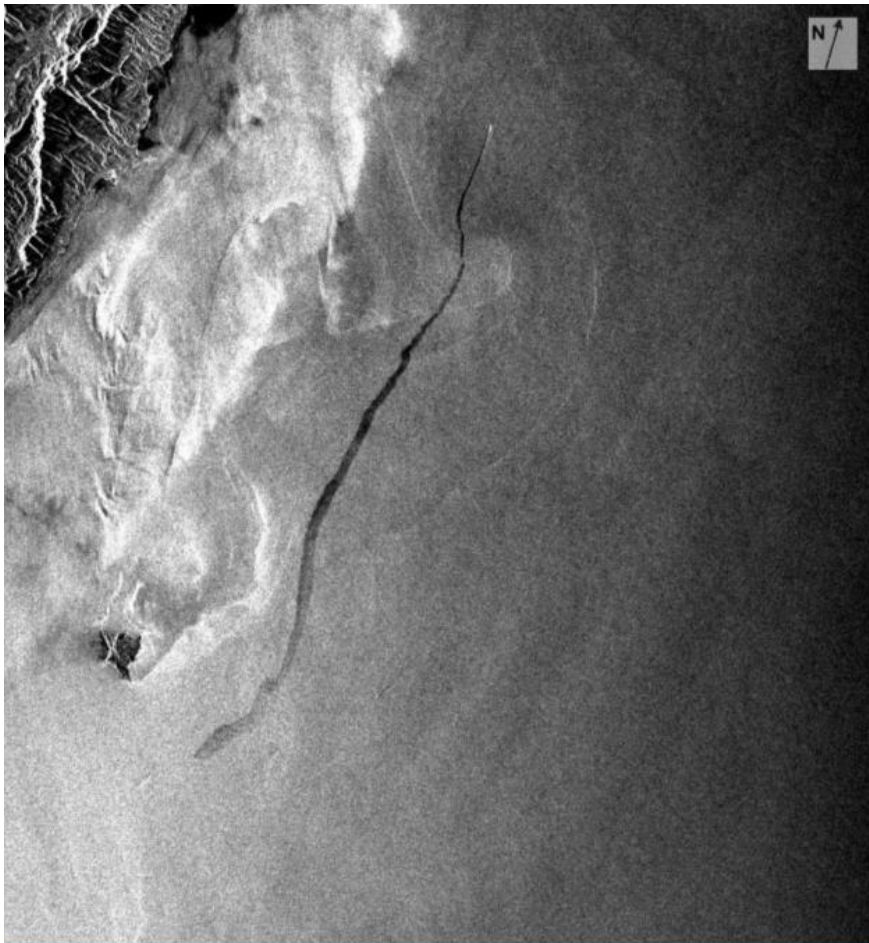


Andre ting damper og små bølger

- Algeblomstring
- Værfronter og virvlar
- Spor fra skip
- Tynn havis
- **Områder med lav vind**

# Hvorfor?

- Oljesøl ser **mørke** ut i SAR bilder – då de damper små bølger



ERS-1 (C-Band, VV polarization). ESA copyright 1994

Andre ting damper og små bølger

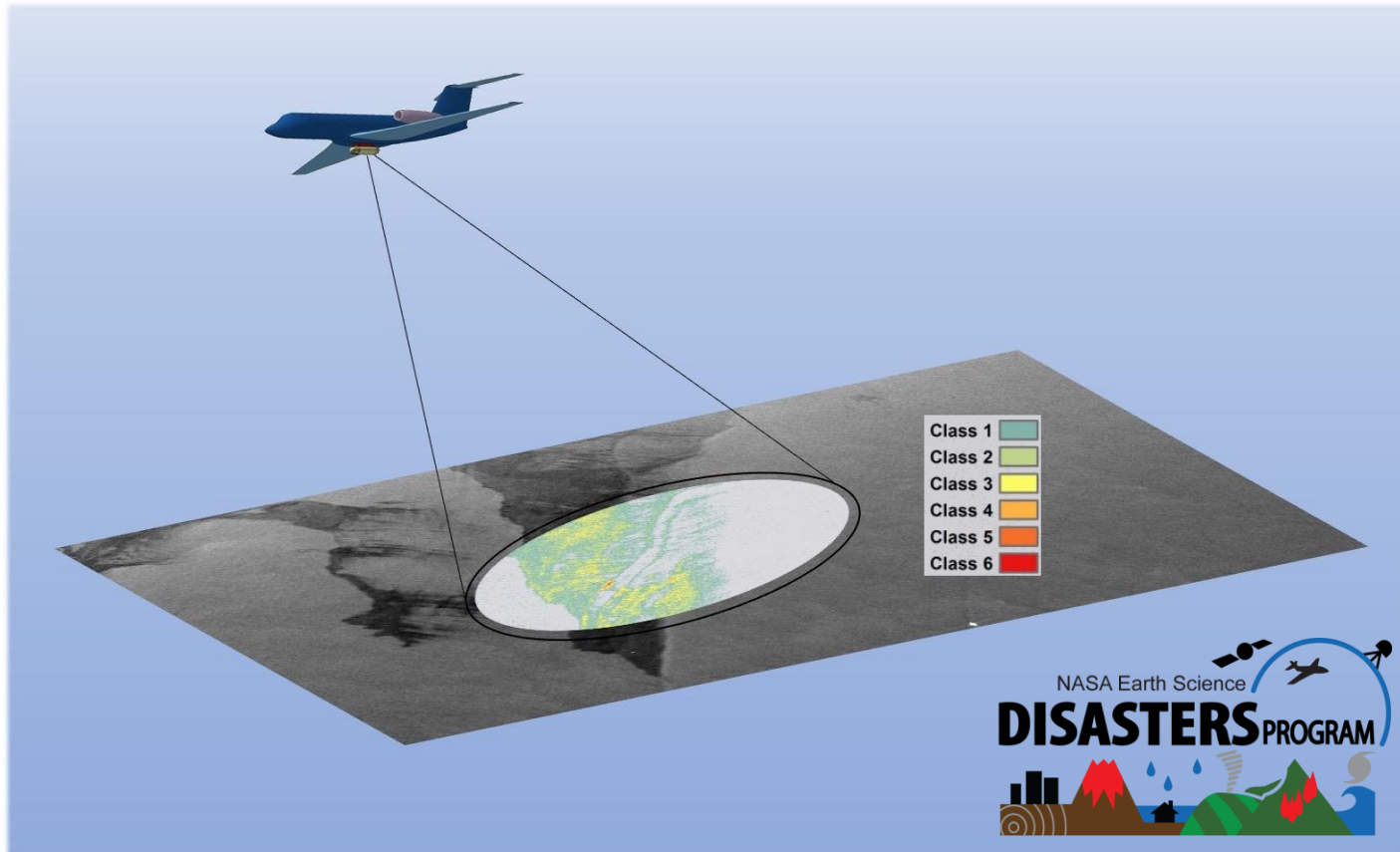
- Algeblomstring
- Værfronter og virvlar
- Spor fra skip
- Tynn havis

- **Områder med lav vind**



# UAVSAR data innsamling

## Coal Oil Point Seep Fields, California May & Oct 2021, June 2022

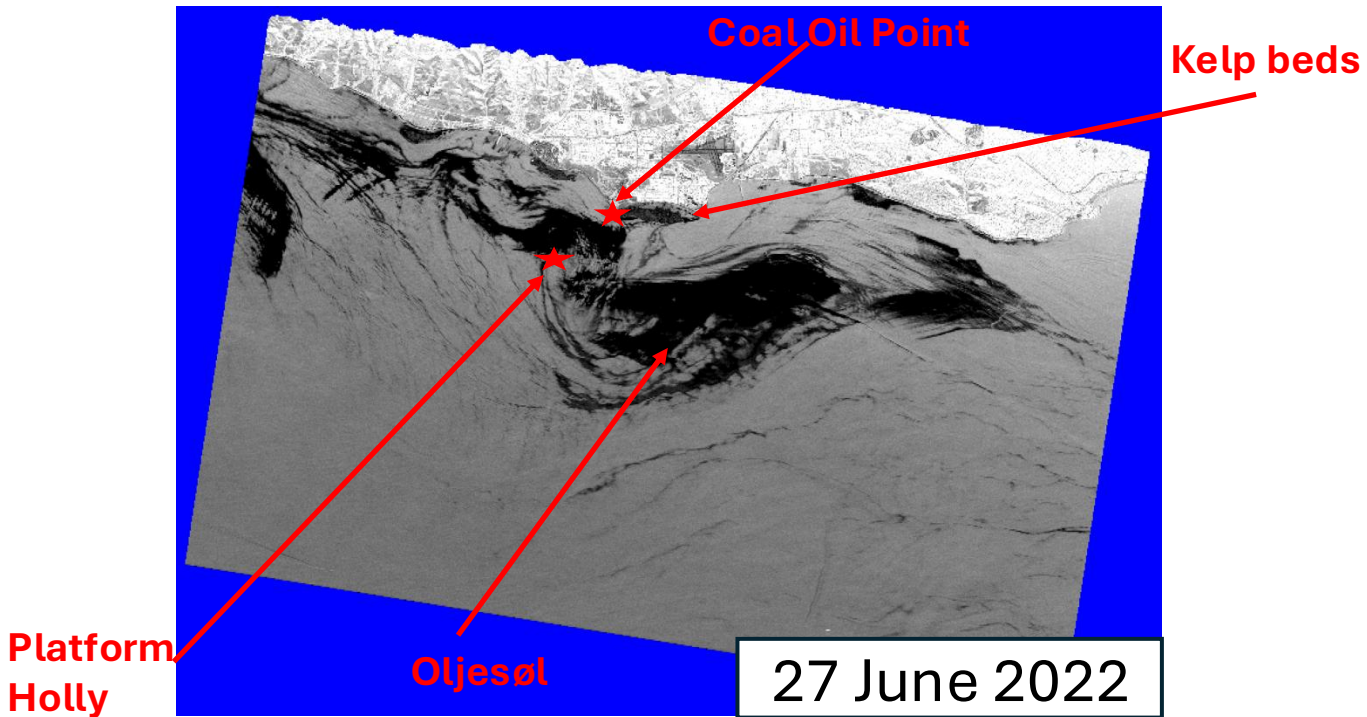


- NASA-finansiert prosjekt ledet av NOAA
  - UAVSAR
  - Dronebaserte optiske bilder + vannprøver
- UiT deltok i feltkampanjen og dataanalysen i juni 2022



# UAVSAR data innsamling

Øvelse utenfor Santa Barbara, California i Juni-Juli 2022 - naturlige seeps



Source: [uavsar.jpl.nasa.gov](http://uavsar.jpl.nasa.gov)

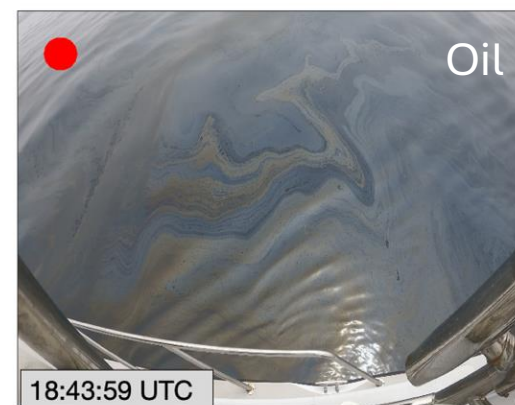
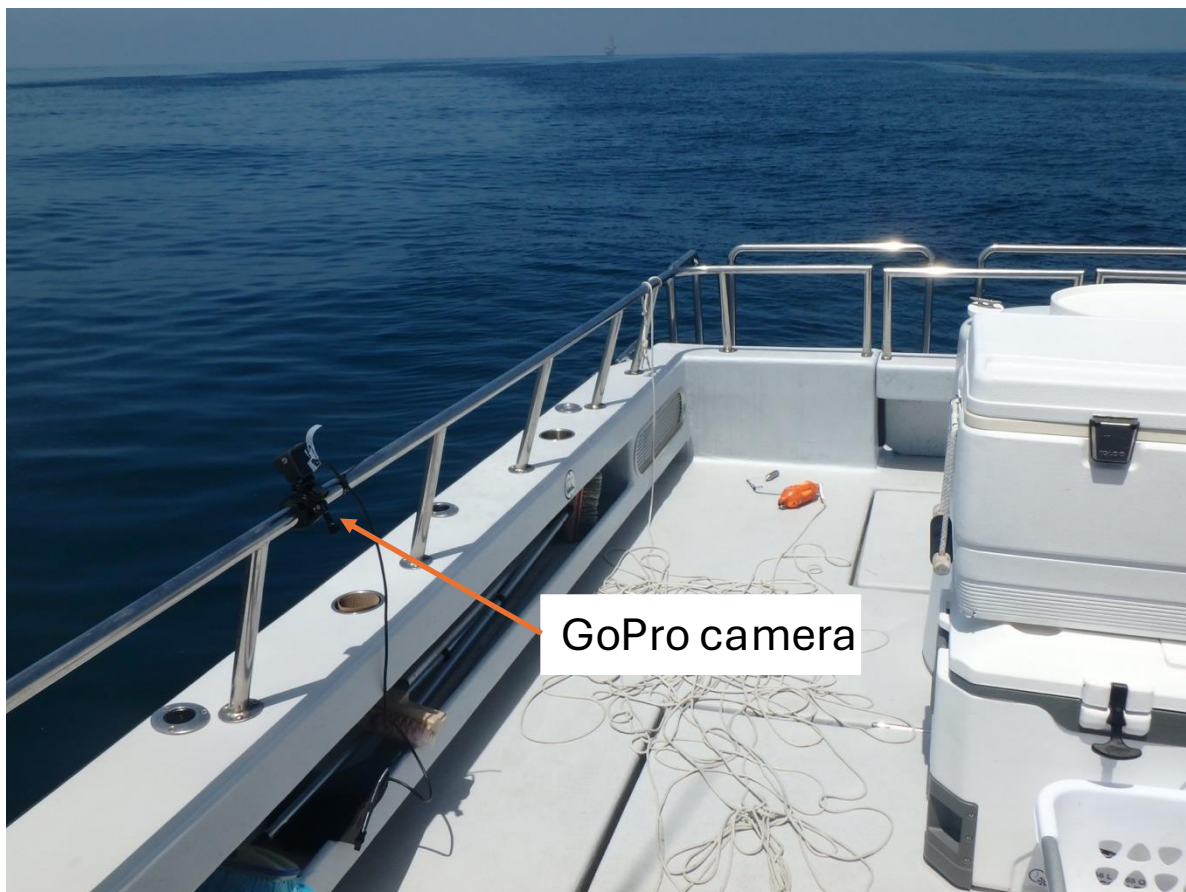
UAVSAR – Bygget av Jet Propulsion Laboratory (JPL)  
Flybåren  
L-band

Repeat  $\approx 17$  mins

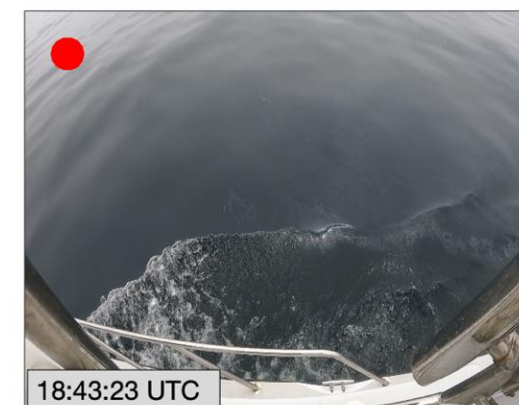


# UAVSAR data innsamling

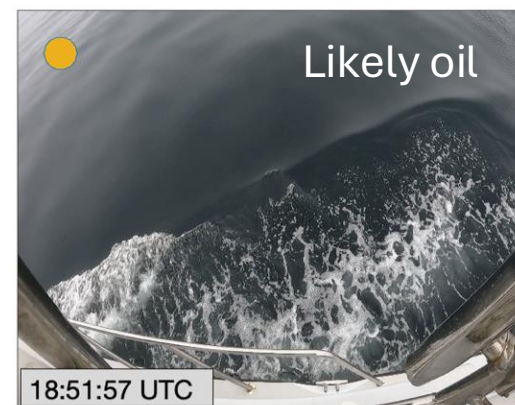
GoPros - en på hver side av båten  
Innhentet tusenvis av bilder.



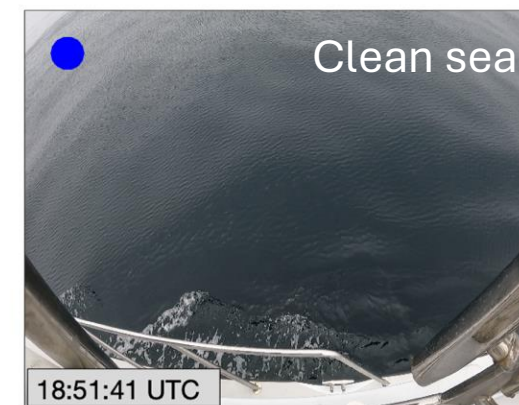
(a)



(b)



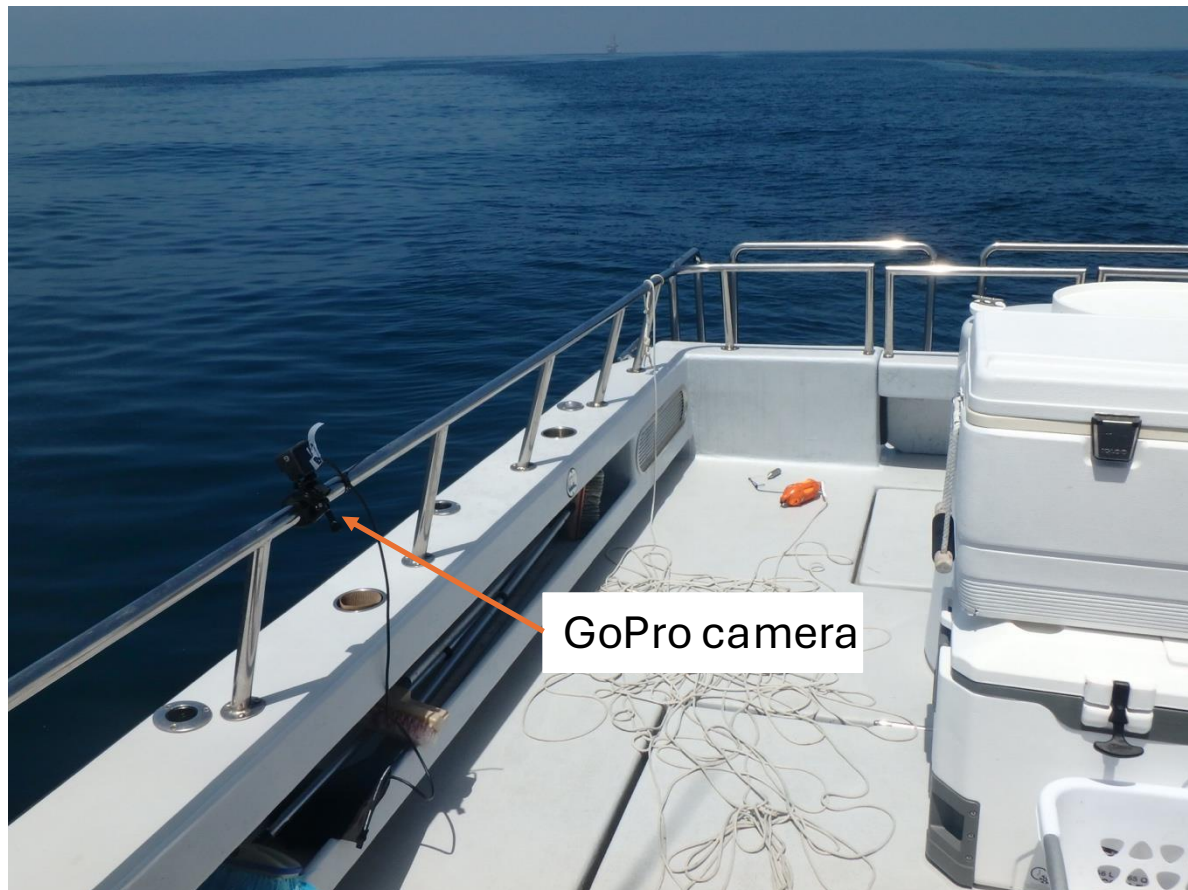
(c)



(d)

# UAVSAR data innsamling

GoPros - en på hver side av båten  
Innhentet tusenvis av bilder.

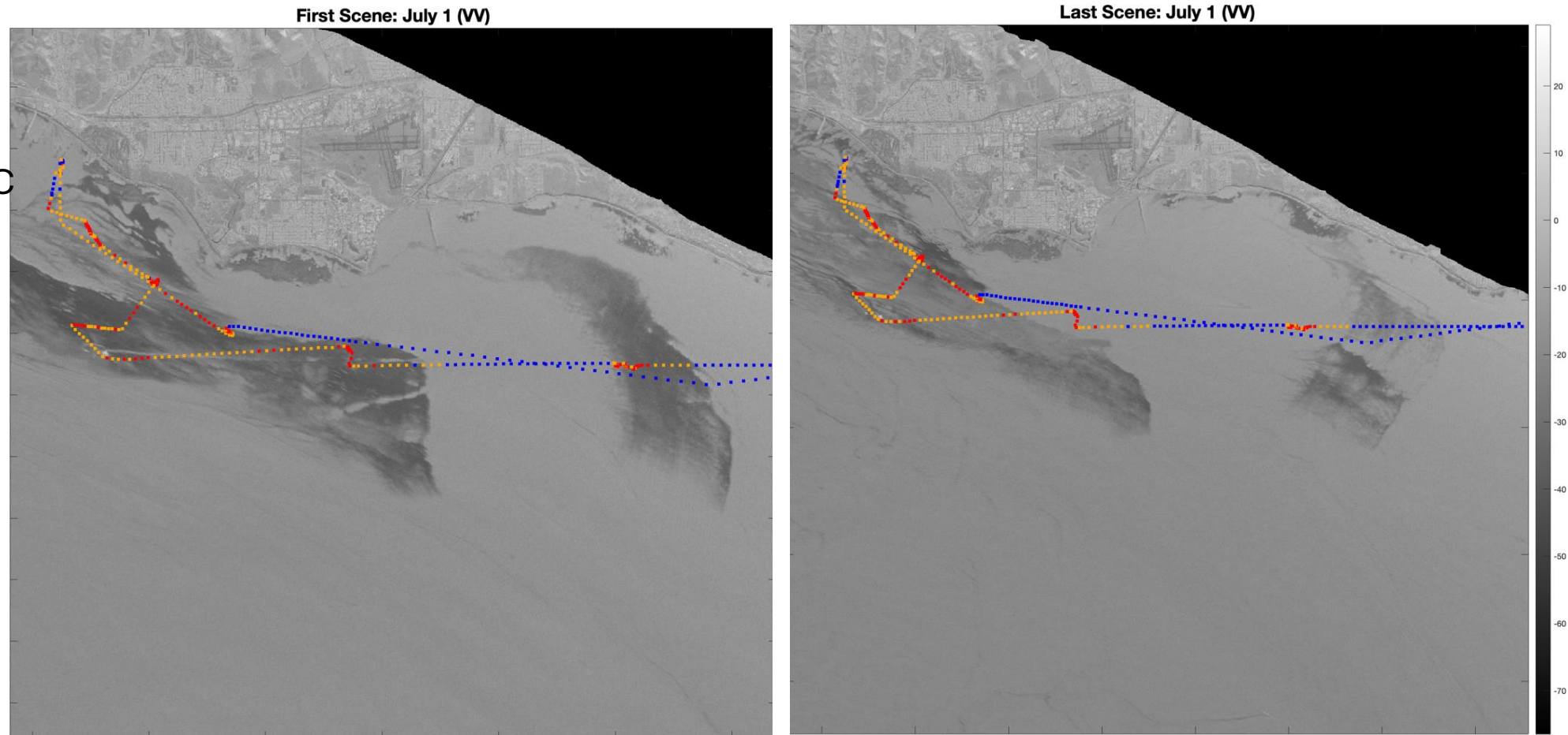


# Verifikasjon av SAR bilder

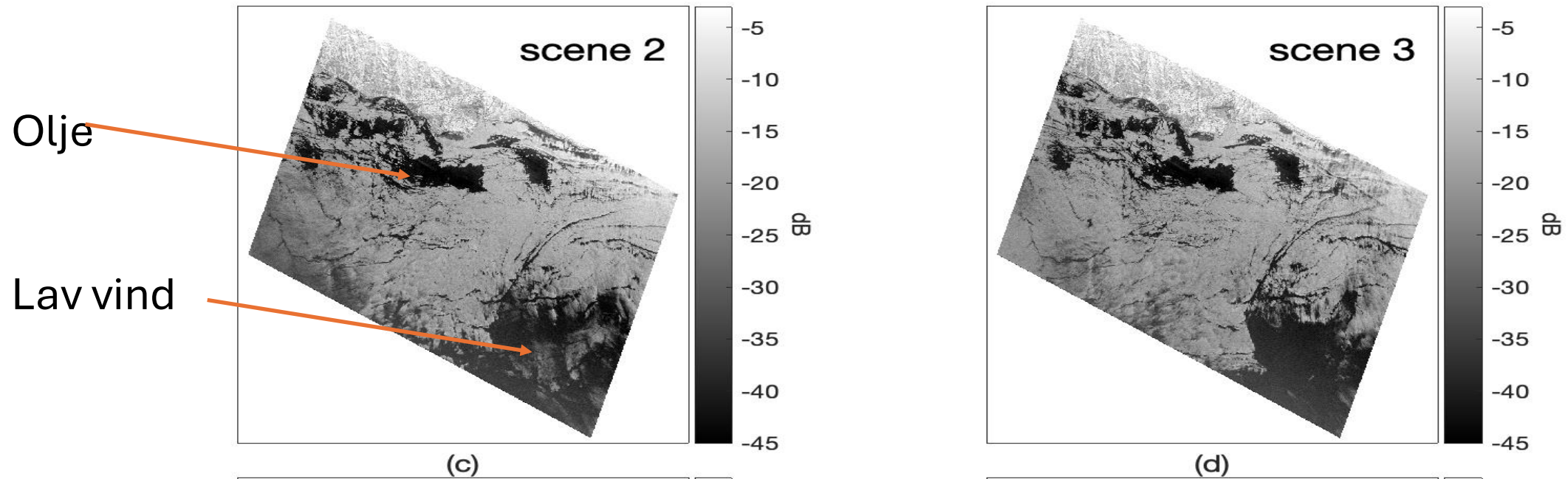
Vi klarte å korrelere klassifiserte GoPro-bilder med UAVSAR-bilder – geo-lokalisert  
UAVSAR-opptakene fra 1. juli. **Det var ikke lav vind denne dagen -> de mørke områdene er oljeflak.**

Første bilde = 17:47 UTC  
Siste bilde = 20:37 UTC

GoPro opptak  
16:01 UTC – 21:00 UTC



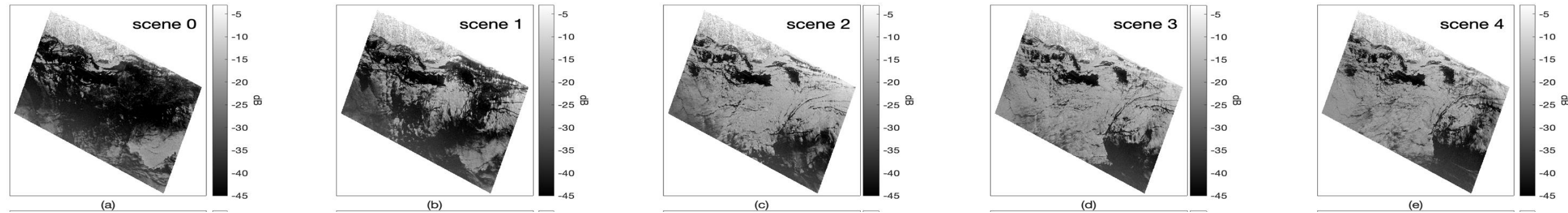
# Metode 1: Kart over olje/åpent vann med høy tillit



- Scener inneholder både mineralolje og soner med lite vind

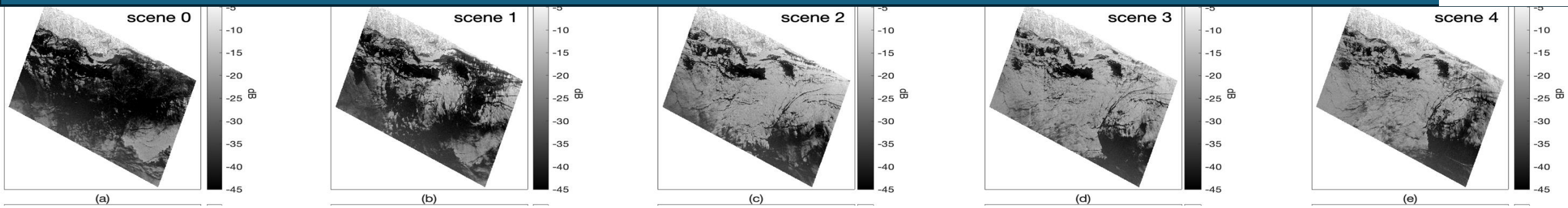
# Metode 1: Kart over olje/åpent vann med høy tillit

UAVSAR imagery June 29

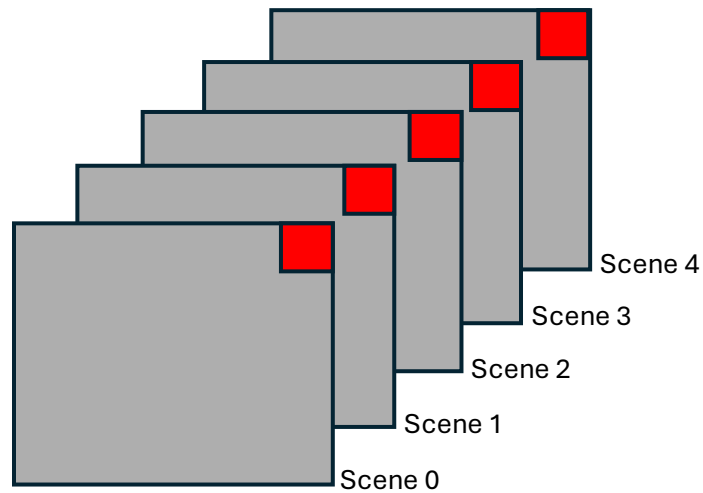


- Lavvindsoner er mer variable enn oljesøl.
- Bruk dette tidsvarierende aspektet for å skille mellom dem.

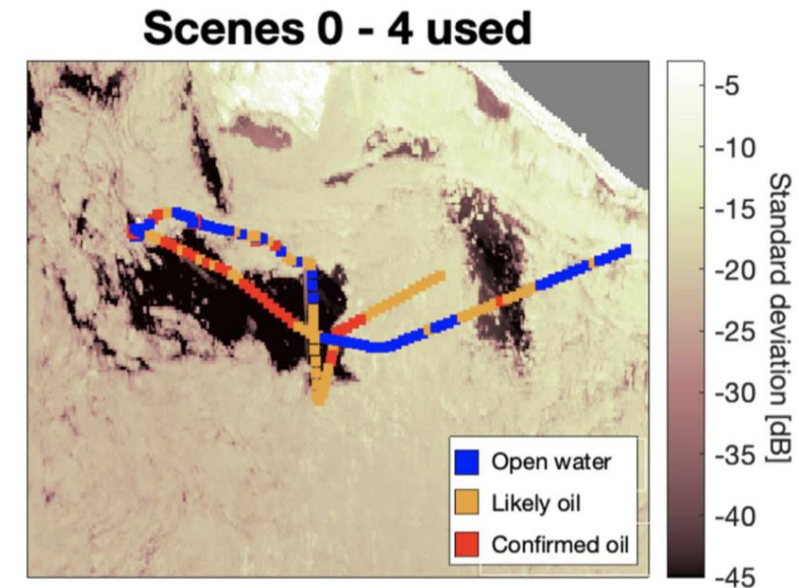
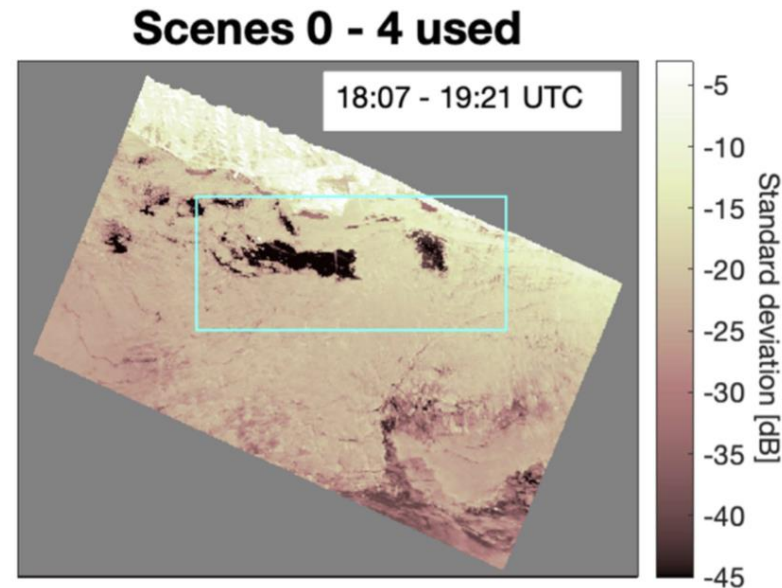
# Metode 1: Kart over olje/åpent vann med høy tillit



## Procedure



 =  $m \times m$  window of pixels



# Metode 1: Kart over olje/åpent vann med høy tillit



- Krever ikke et instrument med høyt signal-til-støy forhold
- Krever hyppige gjentatte opptak
- Har stor operasjonell potensial

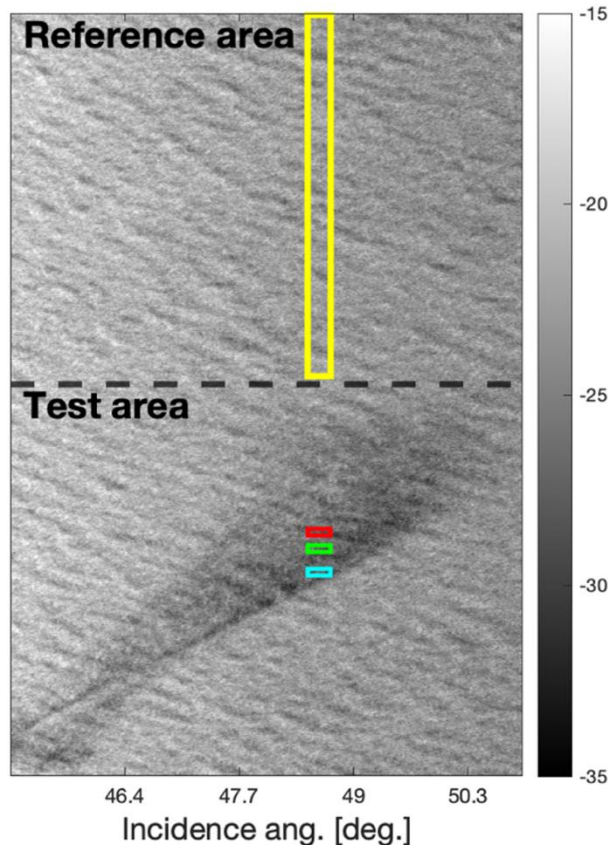
## Distinguishing Mineral Oil Slicks From Low-Wind Areas Using Rapid-Repeat Synthetic Aperture Radar Imagery

Cornelius Patrick Quigley , A. Malin Johansson , *Member, IEEE*, Cathleen E. Jones , *Member, IEEE*,  
and Benjamin Holt , *Member, IEEE*

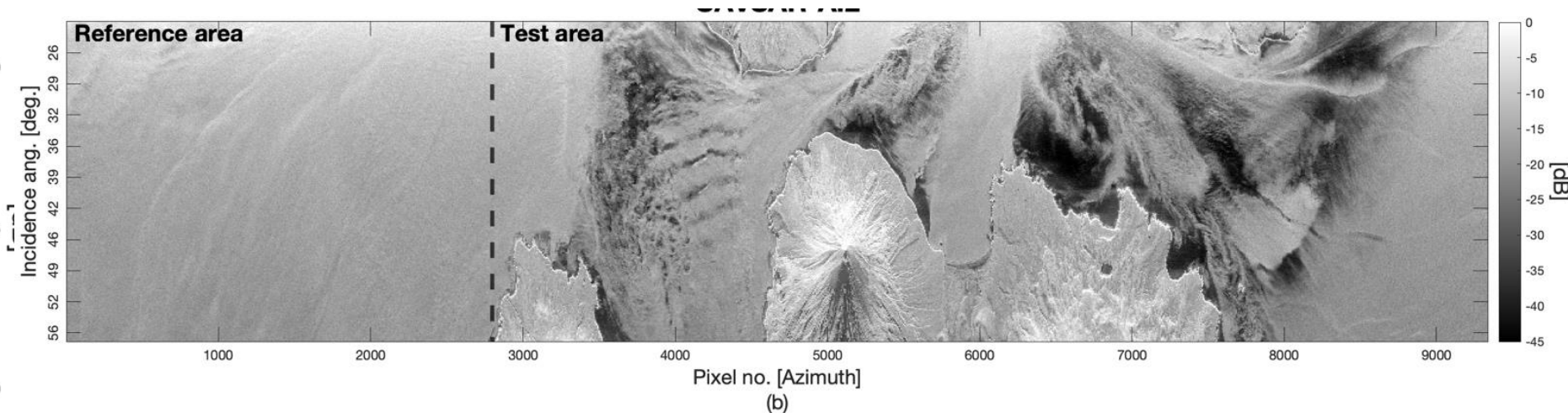
# Metode 2: KS indeks olje vs. lav vind kart

- Finnes det en måte å gjøre dette på ved kun å bruke én scene?
- Påvirker lite vind og oljeflak havoverflatens tilstand på ulike måter?

L-band F-SAR: Mineral oil



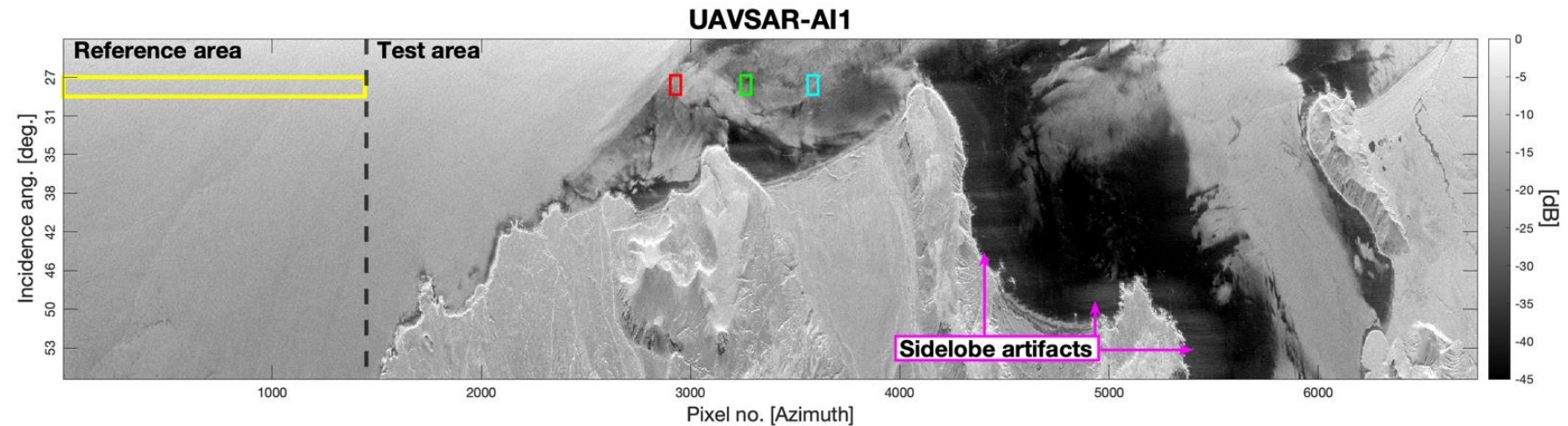
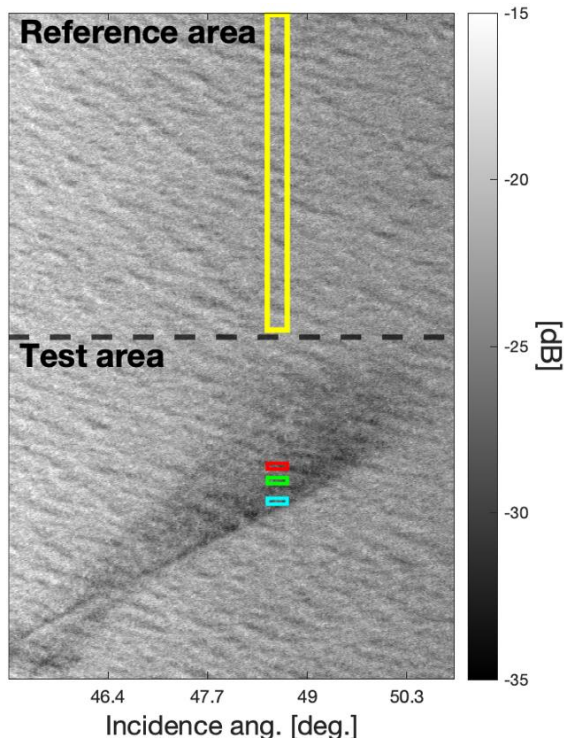
L-band UAVSAR: Linear island wake



# Metode 2: KS indeks olje vs. lav vind kart

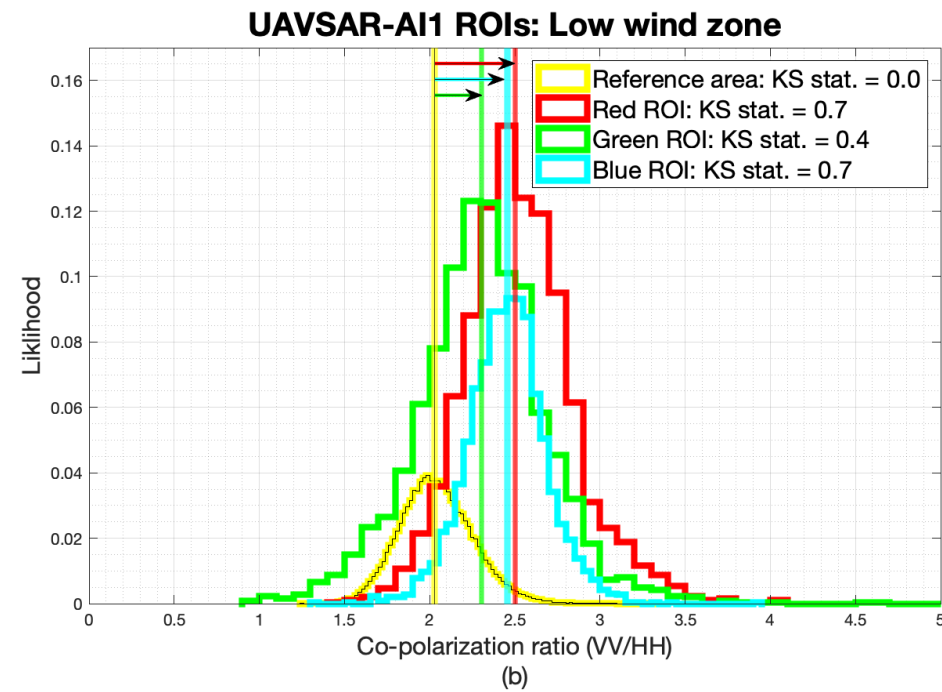
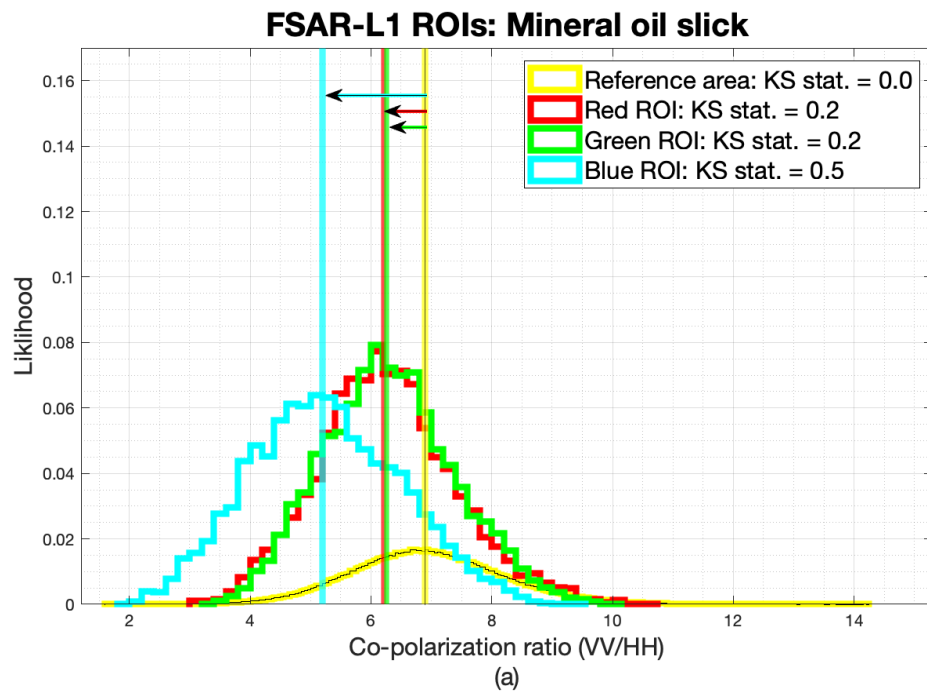
- SAR bildet som er brukt i denne analysen samler in data i to kanaler HH og VV
- Vi kan bruke forholdet mellom dem ( $VV/HH$ ) for å si noe om det vi observerer
  - Det er avhengig av en materiel konstant (dielektriske egenskaper)

OPV2019

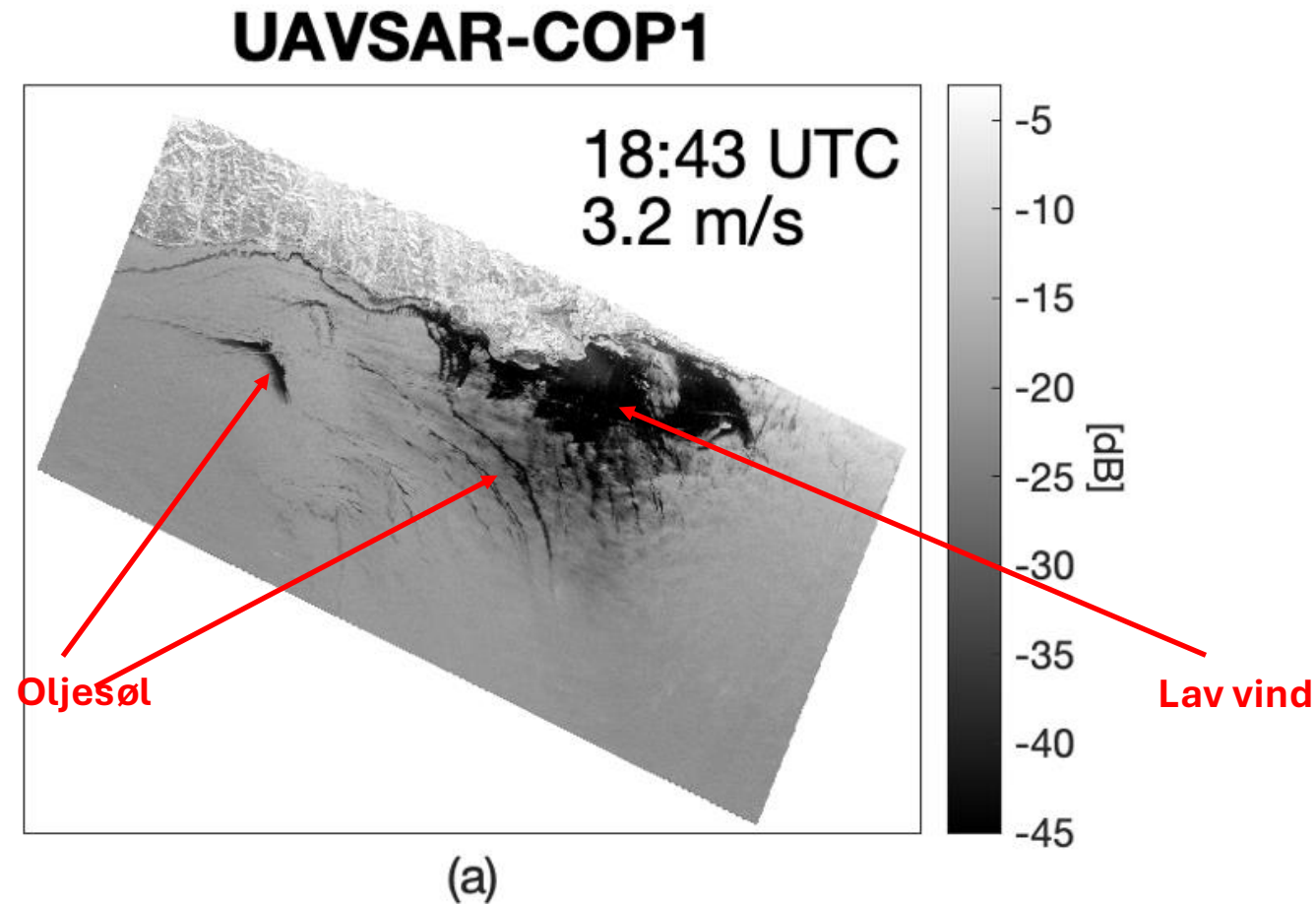


# Metode 2: KS indeks olje vs. lav vind kart

- Ser på fordelningen av dataen
- Kolmogorov-Smirnov (KS) test – ser på forskjell mellom to fordelninger
  - Gult = Åpent vann

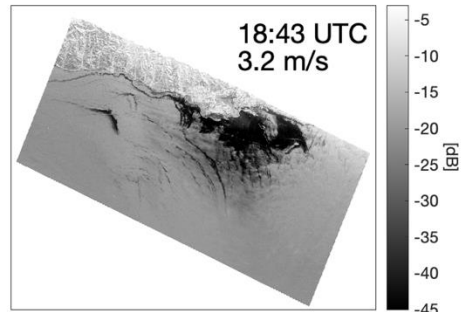


# Metode 2: KS indeks olje vs. lav vind kart



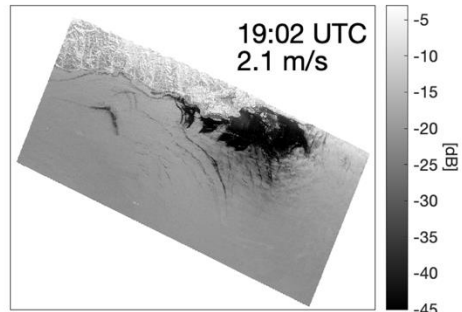
# Metode 2: KS indeks olje vs. lav vind kart

**UAVSAR-COP1**



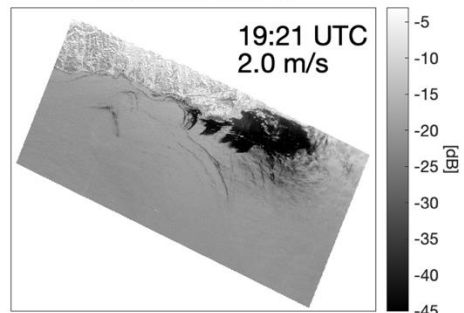
(a)

**UAVSAR-COP2**



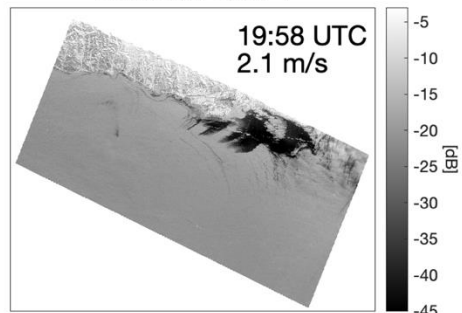
(b)

**UAVSAR-COP3**



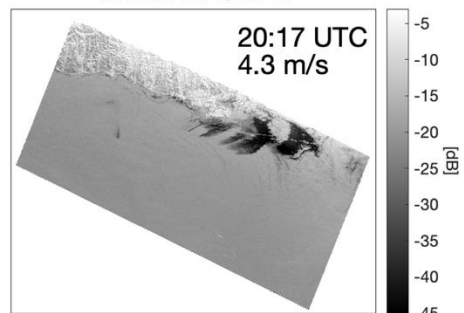
(c)

**UAVSAR-COP4**



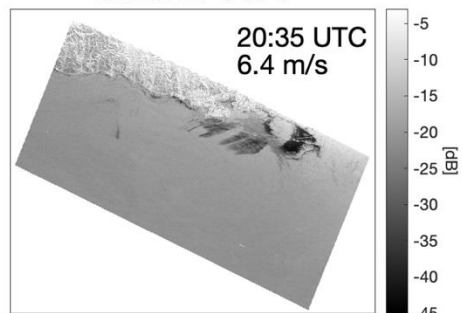
(d)

**UAVSAR-COP5**



(e)

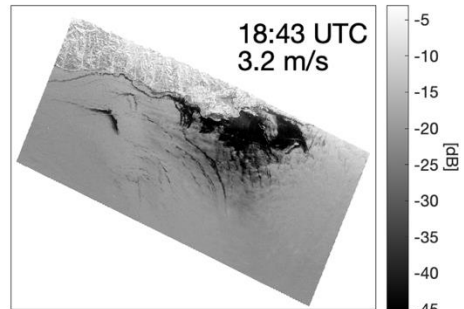
**UAVSAR-COP6**



(f)

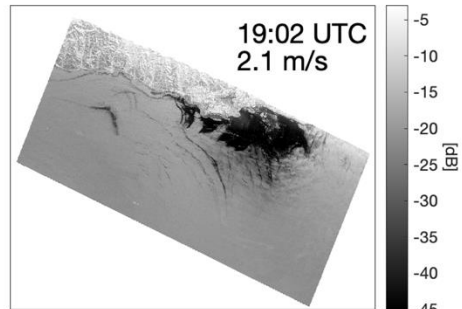
# Metode 2: KS indeks olje vs. lav vind kart

UAVSAR-COP1



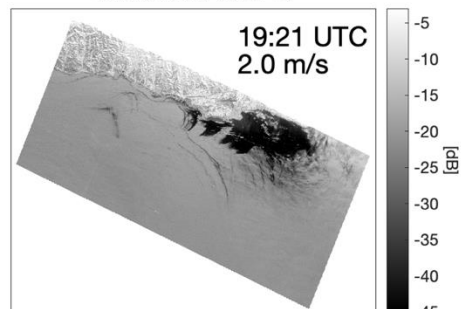
(a)

UAVSAR-COP2



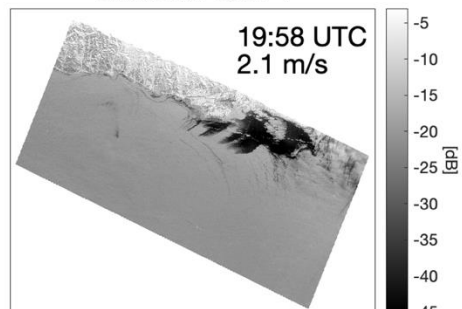
(b)

UAVSAR-COP3



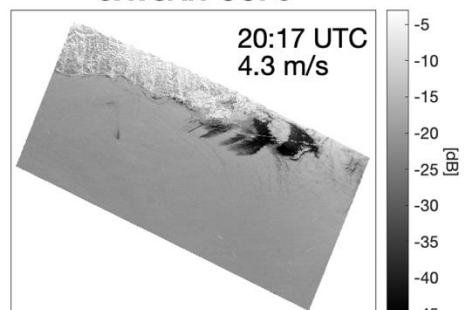
(c)

UAVSAR-COP4



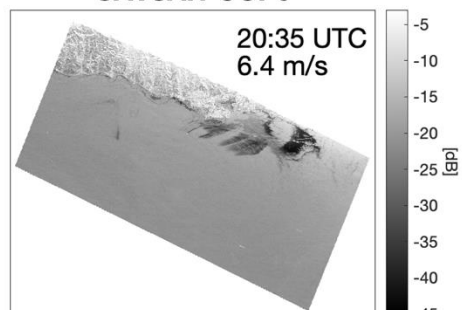
(d)

UAVSAR-COP5



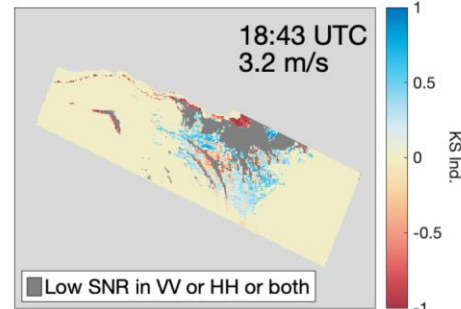
(e)

UAVSAR-COP6



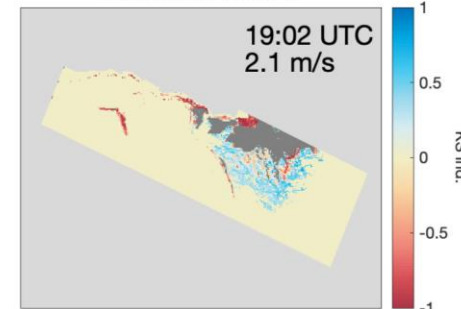
(f)

UAVSAR-COP1



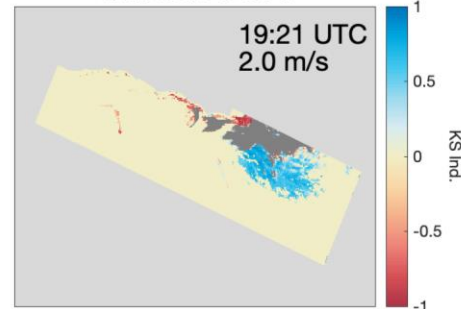
(a)

UAVSAR-COP2



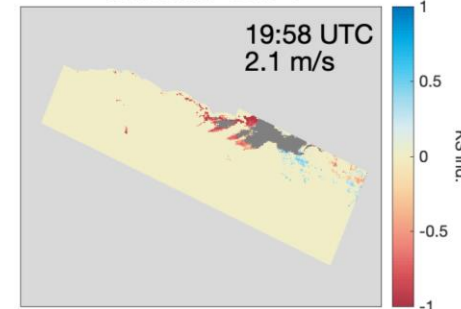
(b)

UAVSAR-COP3



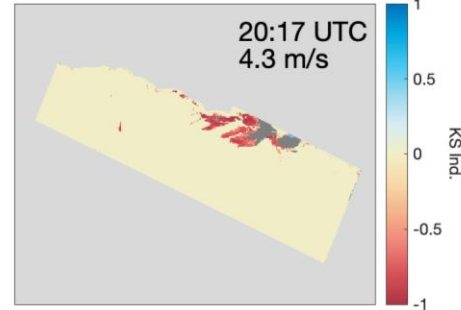
(c)

UAVSAR-COP4



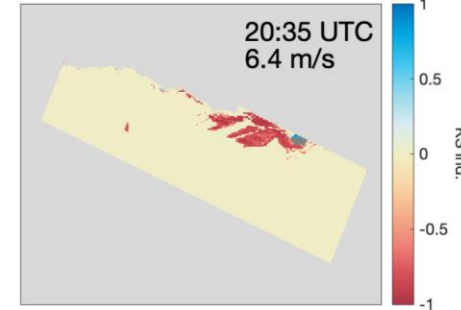
(d)

UAVSAR-COP5



(e)

UAVSAR-COP6



(f)

Åpent vann = 0

Lav vind (Positiv) = blue

Oljesøl (Negativ) = red

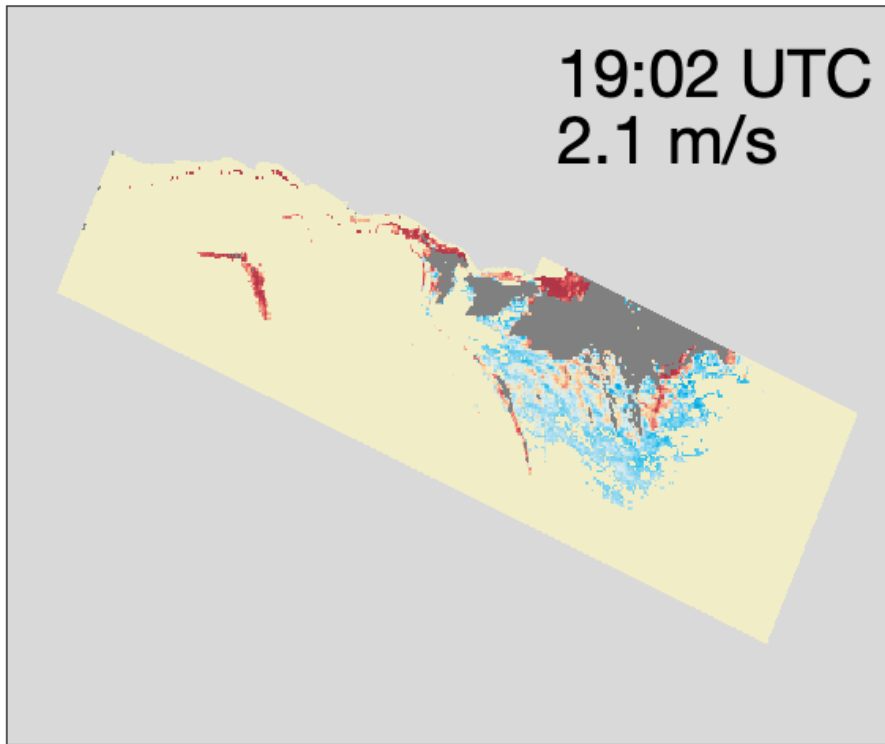
Grå = lav SNR

# Metode 1 og 2

## Metode 2

### UAVSAR-COP2

19:02 UTC  
2.1 m/s



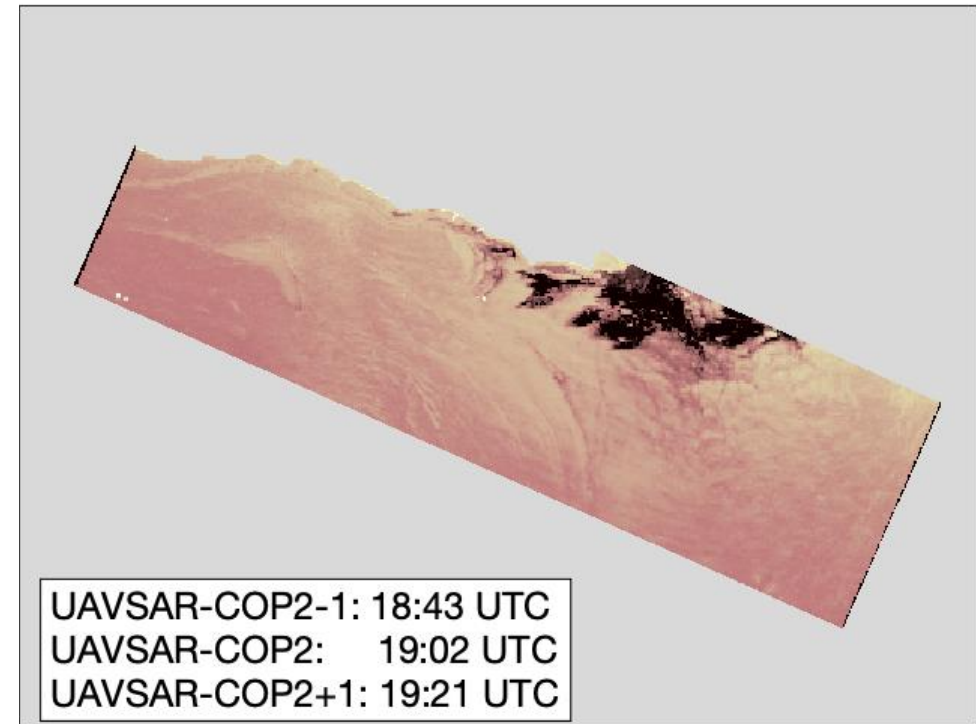
Lav vind

Åpent vann

Oljesøl

## Metode 1

### UAVSAR-COP2



-5

-10

-15

-20

-25 [dB]

-30

-35

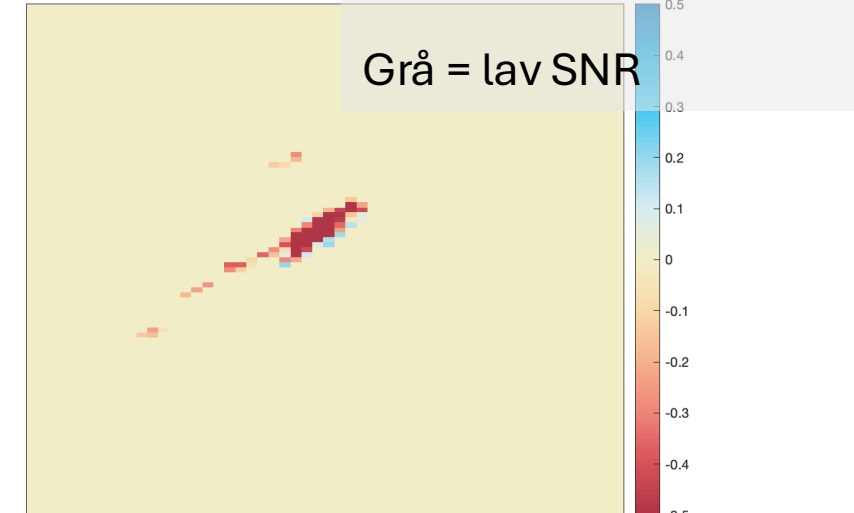
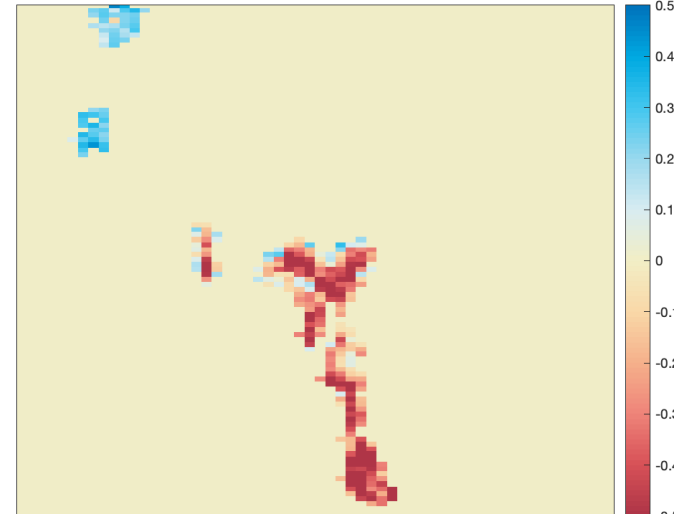
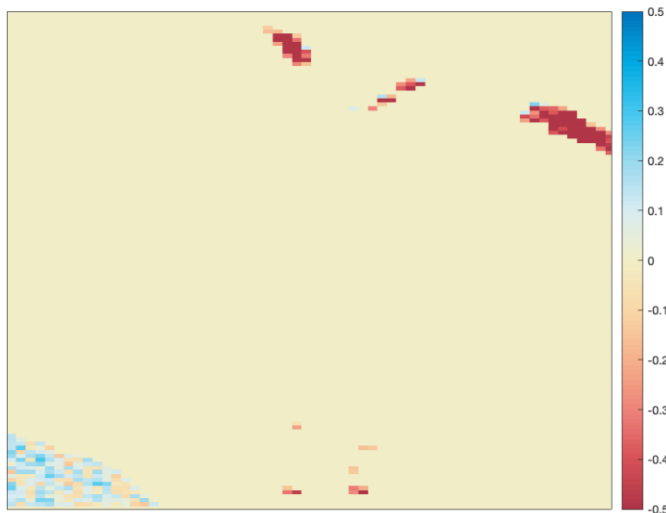
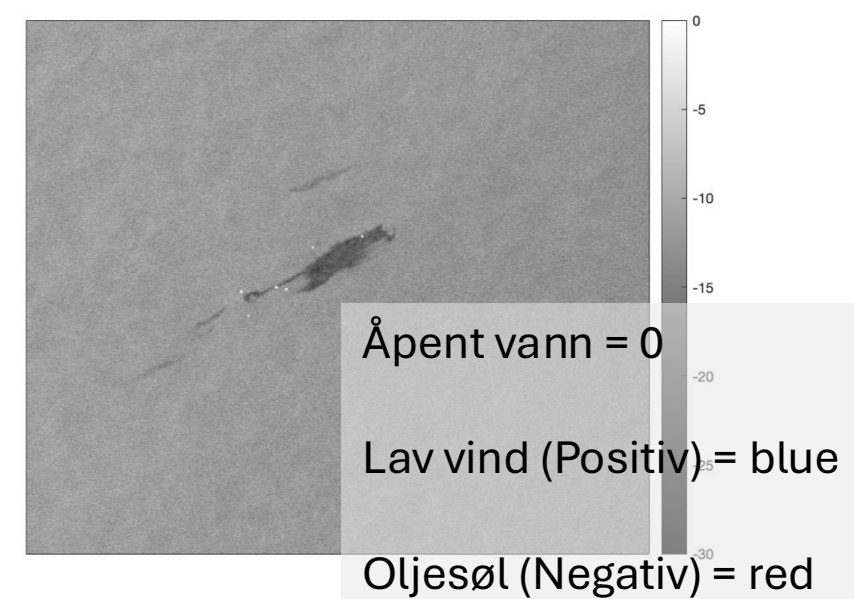
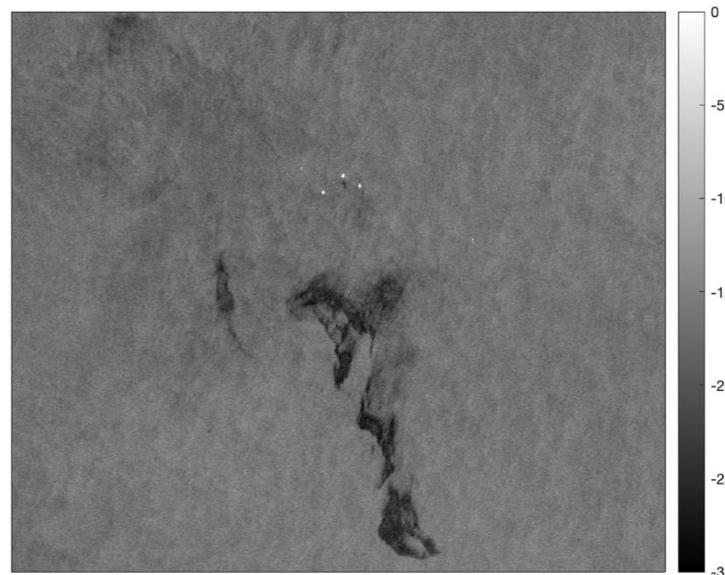
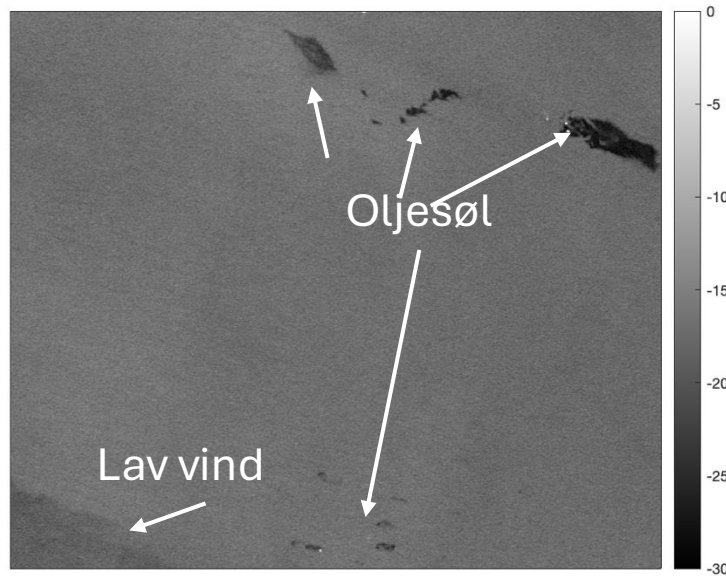
-40

-45

Lave verdien = lav variasjon -> oljesøl

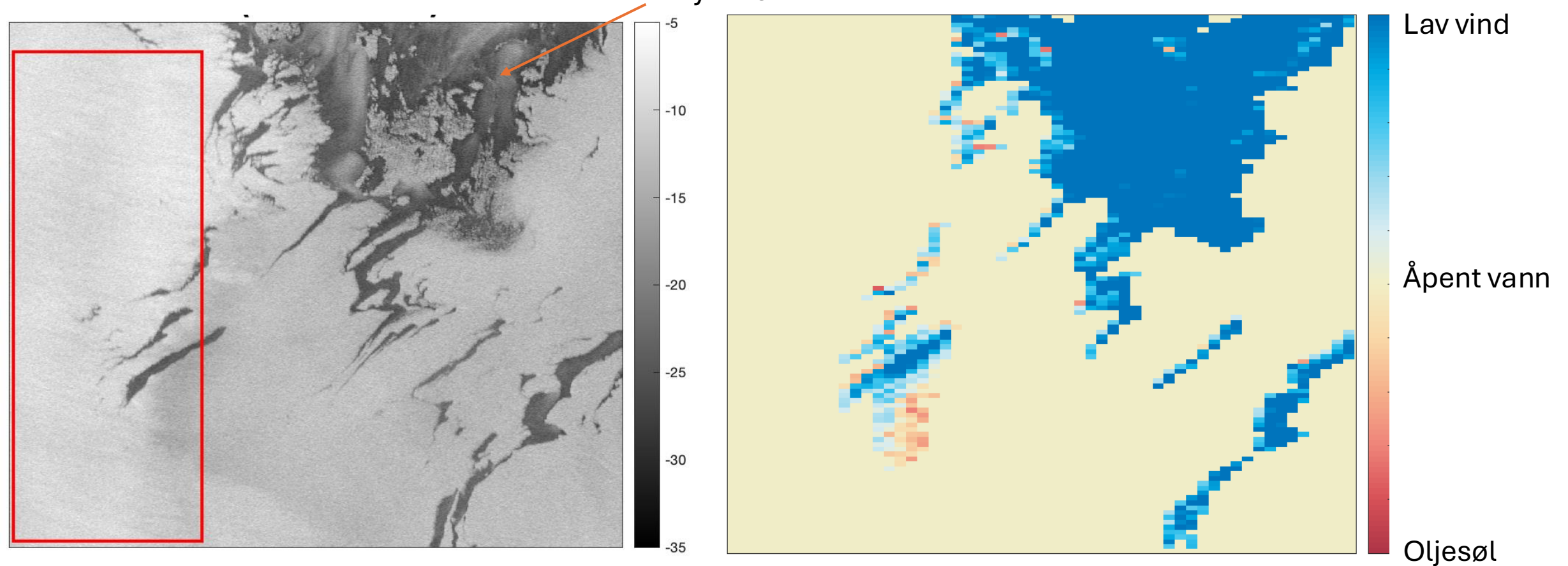
Høyre verdien = stor variasjon -> lav vind

# Metode 2: KS indeks olje vs. lav vind kart



# Metode 2: KS indeks olje vs. lav vind kart

Tynn is



Åpent vann = 0

Oljesøl (Negativ) = red

Lav vind (Positiv) = blue

Grå = lav SNR

# Metode 2: KS indeks olje vs. lav vind kart

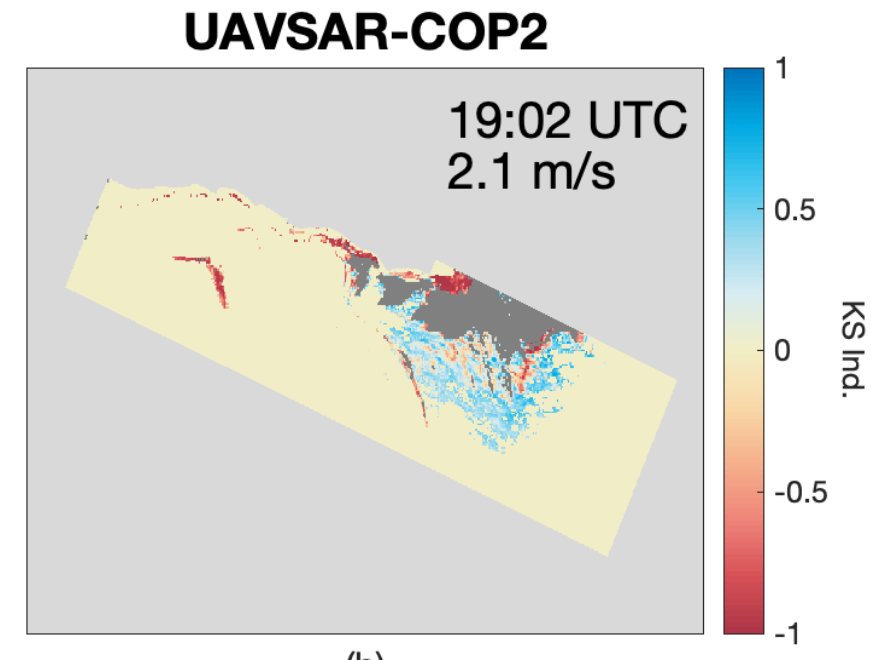
- Kan beregnes fra én enkelt opptak
- Krever
  - opptak med høyt signal-støy-forhold
  - HH og VV kanal fra SAR bildet
- Kan brukes på både rombaserte og luftbårne plattformer

22224

IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING, VOL. 19, 2026

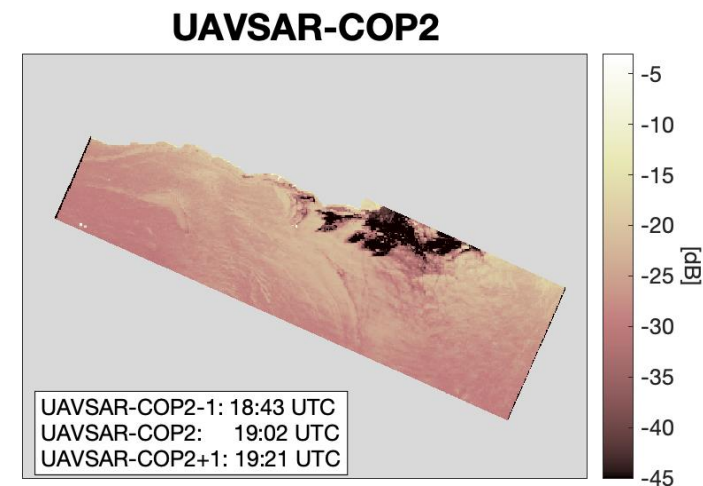
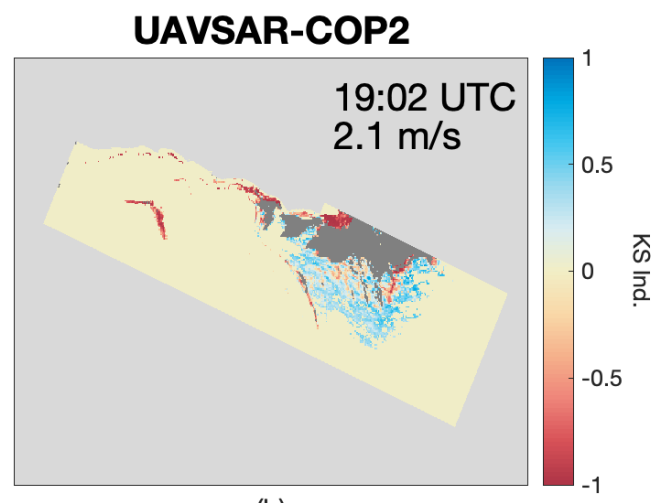
## Distinguishing Mineral Oil Slicks From Low-Wind Areas Using High-SNR Synthetic Aperture Radar

Cornelius Quigley , A. Malin Johansson , *Member, IEEE*, and Cathleen E. Jones , *Senior Member, IEEE*



# Konklusjon

- To forskjellige metoder for å skille mineralolje vs. lav vind
- Gjelder både for luftbårne og satellittbaserte SAR-data
- Metodene kan brukes operativt



# Kan vi bruke vær og drift modellering?

- Kan vi med værmålinger (strøm og vind) og drift modellering se forskjell på oljetyper?



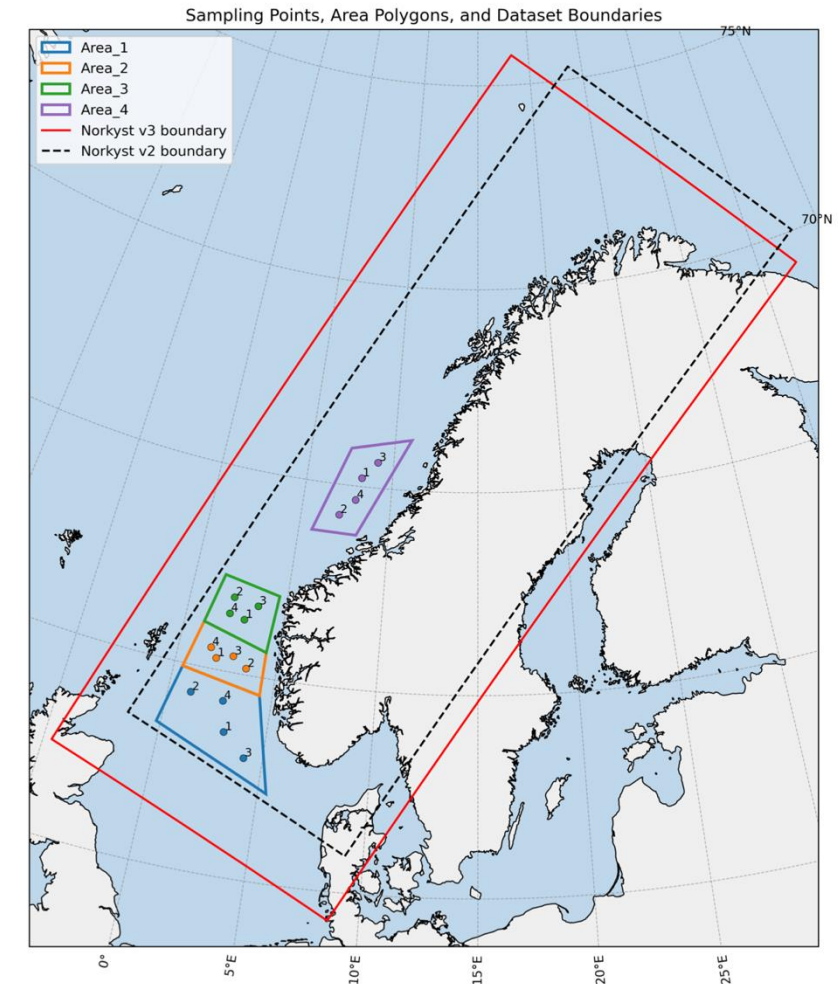
**UiT** The Arctic University of Norway

Faculty of Science and Technology  
Department of Physics and Technology

## Oil Type Separability on the Norwegian Shelf: A Lagrangian Drift Modeling Approach

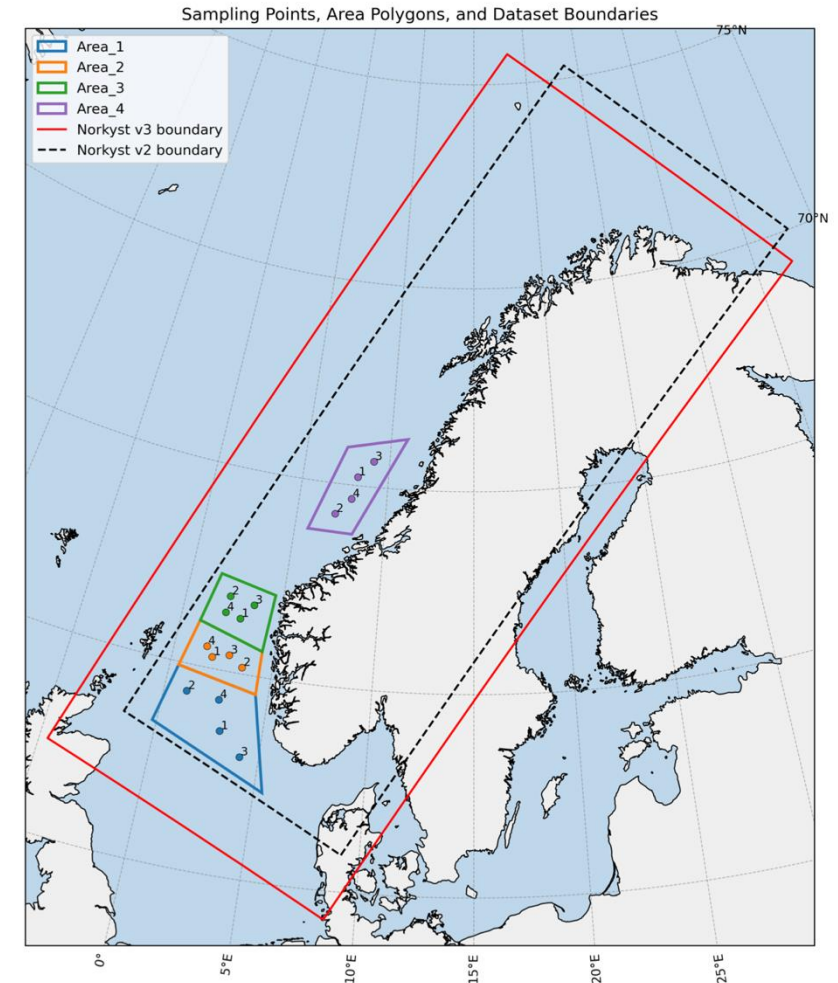
Mads S. Dejlignbjerg

FYS-3931 Master Thesis in Space Physics Jun 2026



# Kan vi bruke vær og drift modellering?

- Hele 2019 - 2025
- Ocean modell (Norkyst v. 2 and v. 3)
- Drift Model = OpenDrift / OpenOil3D
- 4 oljetyper/område
  - MGO – brukes på mange båter i Norge
  - Planteolje simulator
  - 2 områdes spesifikke typer

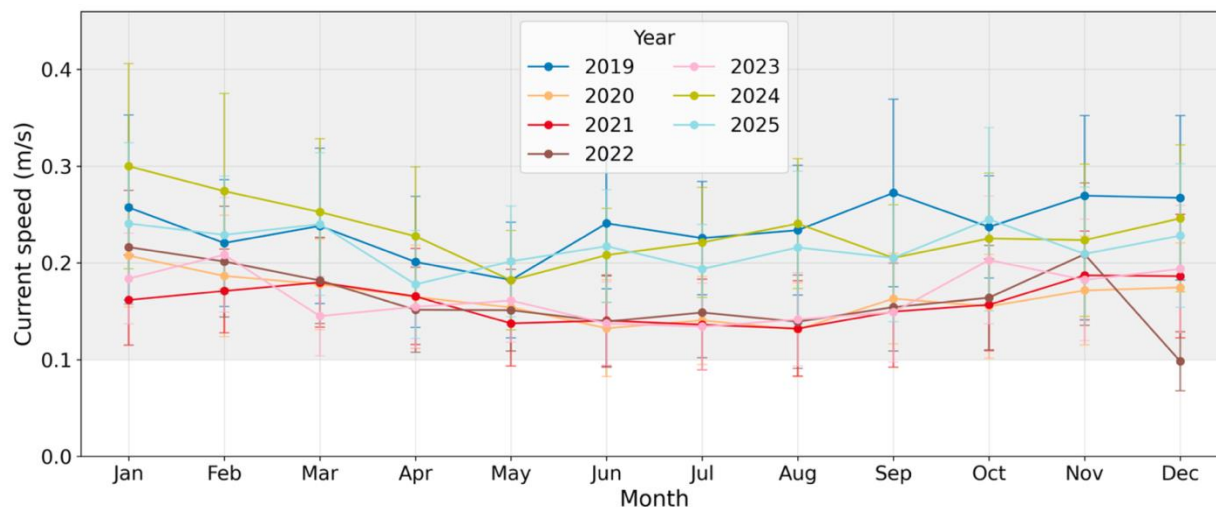
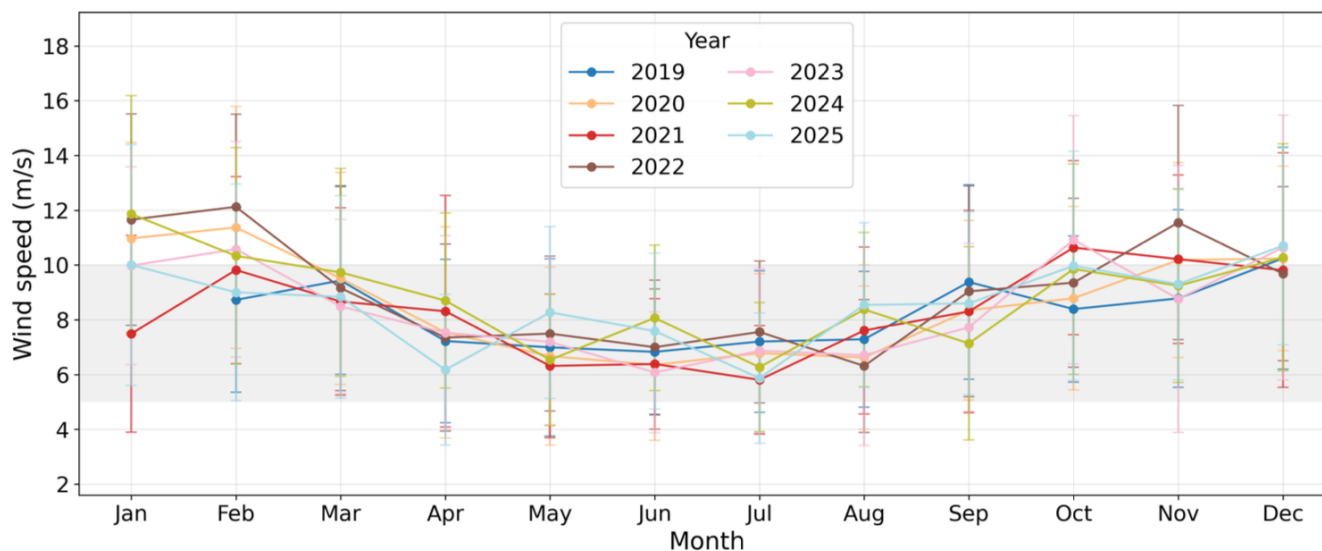


# Kan vi bruke vær og drift modellering?

I minimum 48 timer i rekkefølge

Vind 5 – 10 m/s

Strøm > 0.1 m/s

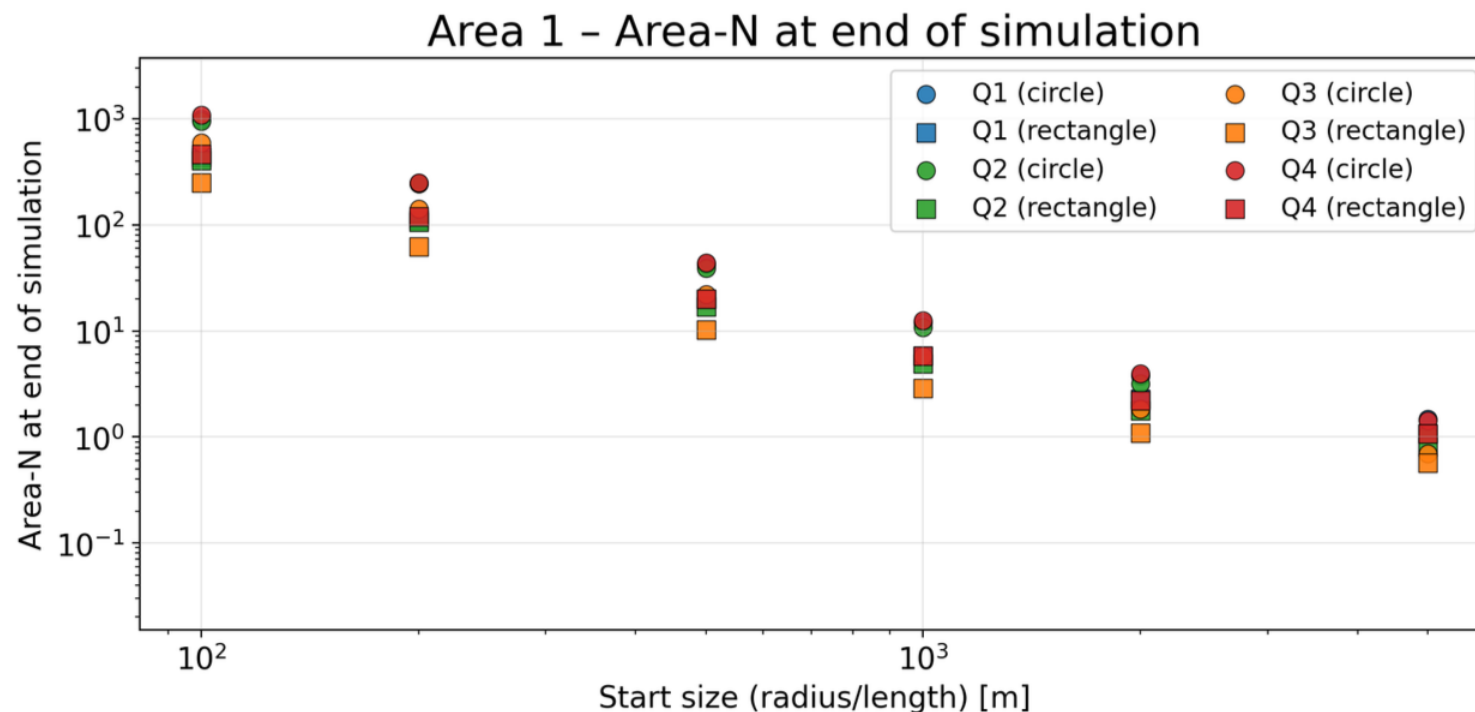


# Kan vi bruke vær og drift modellering?

- 12 forskjellige oljesøl
- 6 sirkulære størrelser
  - 100
  - 200
  - 500
  - 1000
  - 2000
  - 5000
- Rektangulære med same 6 bredder og et forhold 1:3 (lengde: bredde)

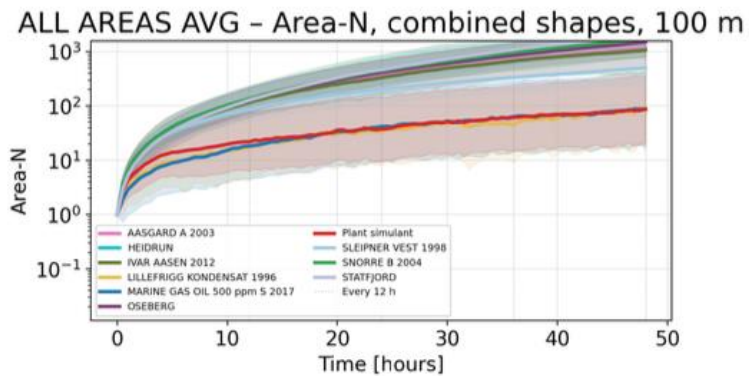


- Tid på året hadde ikke noe å si for separasjon
- Opprinnelig størrelse og form på søl er ikke relevant før separasjon

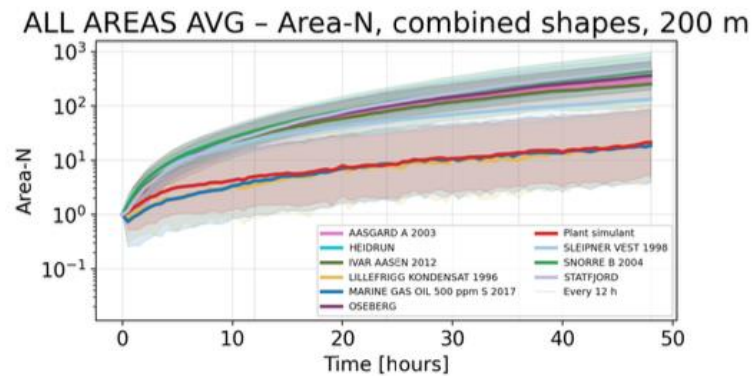


# Kan vi bruke vær og drift modellering?

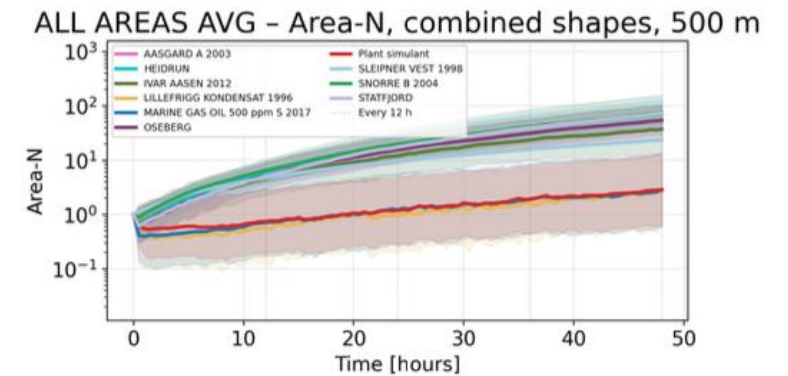
- MGO (blå), planteolje (rød) og light condensate (gul) -> holder seg mer sammen over tid



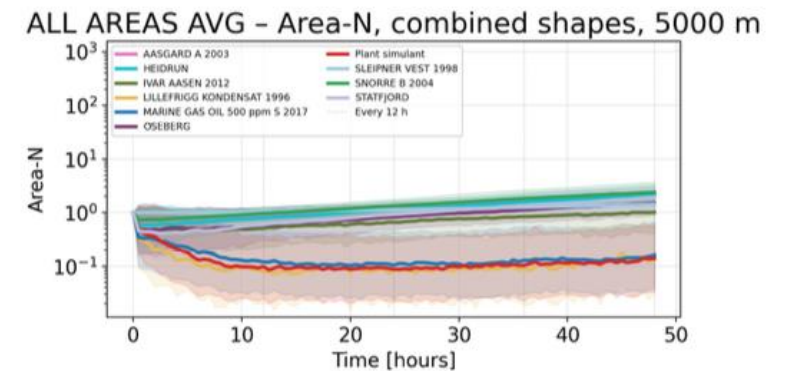
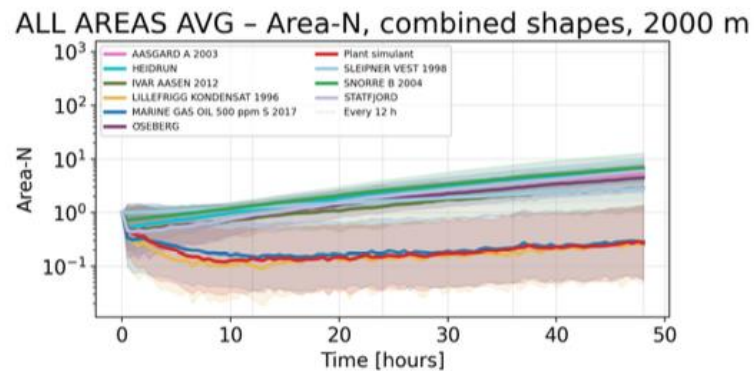
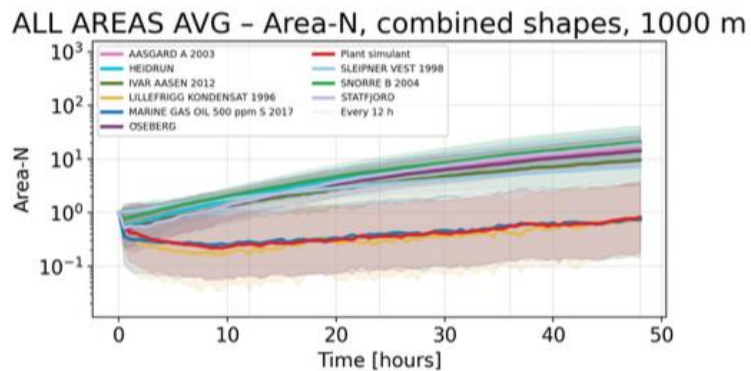
(a)



(b)

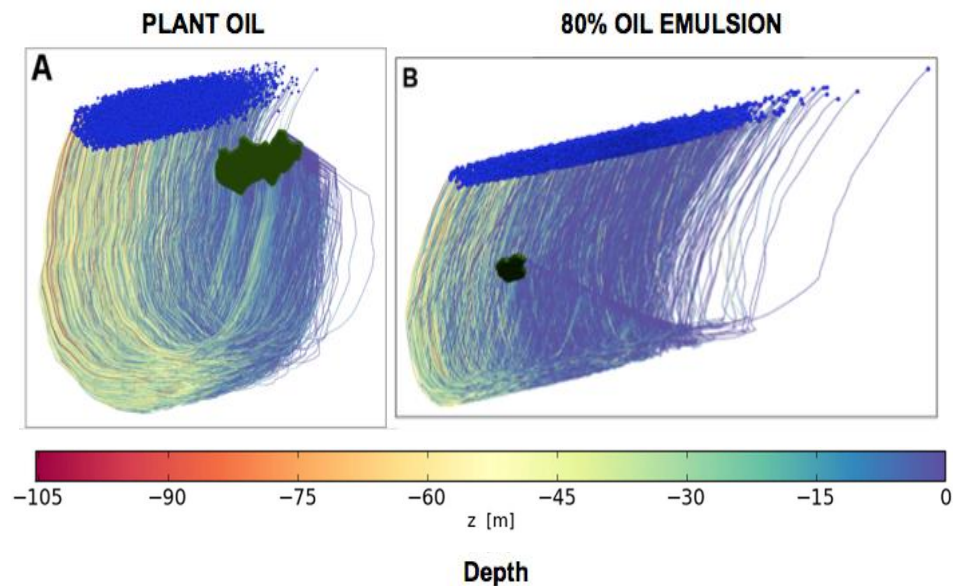


(c)



# Kan vi bruke vær og drift modellering?

- Drift modellering OPV2015

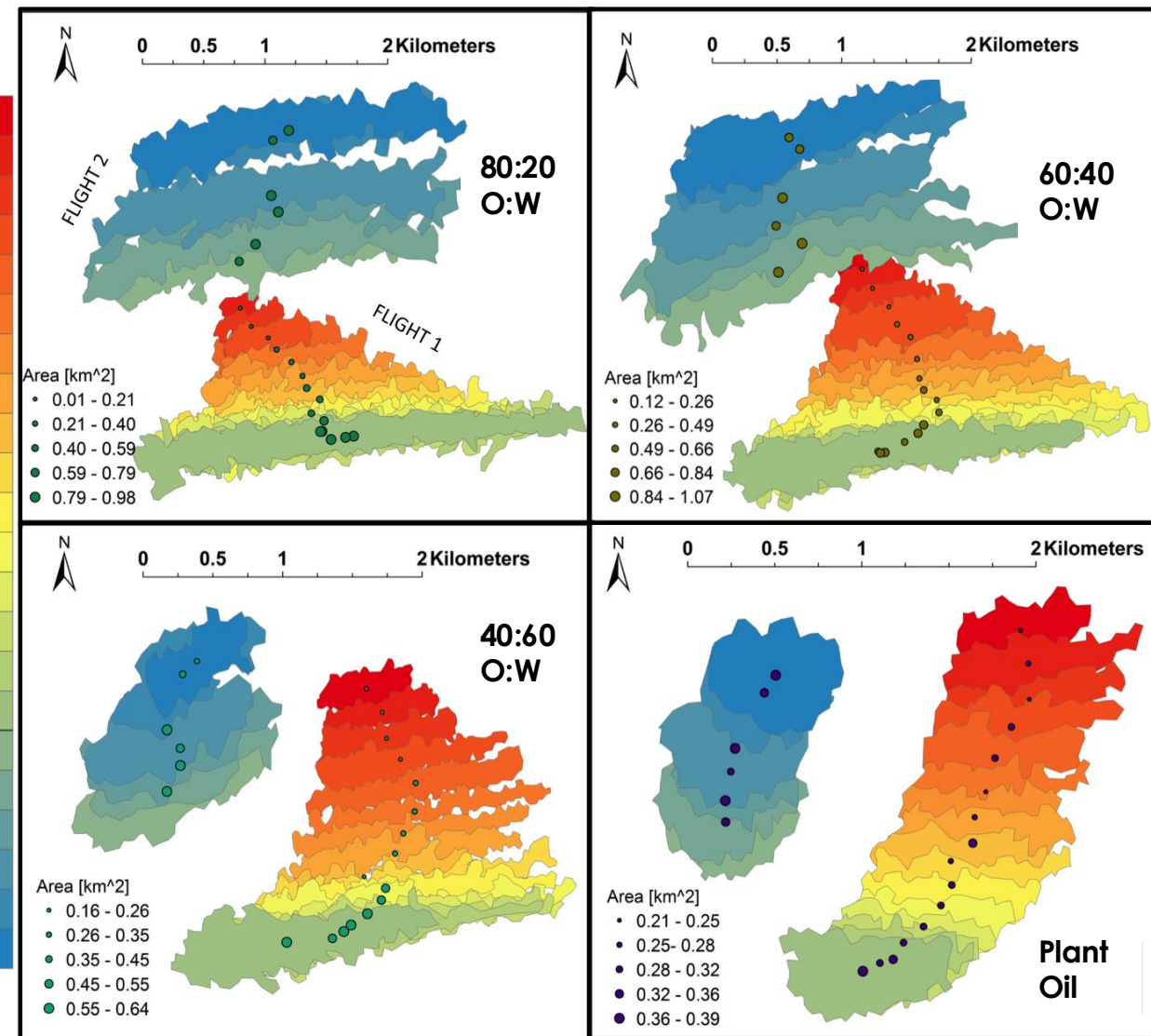


10 June 2015, 5:35 AM

5:48 AM  
6:01 AM  
6:15 AM  
6:28 AM  
6:41 AM  
6:54 AM  
7:07 AM  
7:20 AM  
7:33 AM  
7:46 AM  
7:59 AM  
8:13 AM  
8:27 AM  
8:40 AM  
8:55 AM  
11:48 AM  
12:02 PM  
12:17 PM  
12:31 PM  
13:05 PM  
13:20 PM

FLIGHT 1

FLIGHT 2



# Kan vi bruke vær og drift modellering?



- Ja det kan vi!
- Utbredelsen og mulighet for å følge oljesøl over 12-24h med Sentinel-1
  - Kan bruke eksisterende SAR satellitter ...
  - ... for å separere MGO, planteolje og lett kondensat fra andre oljetyper på norsk sokkel
- Nye typer av drift modeller som inkluderer forvitring (Popa et al, 2025) kan gjøre separasjon enda bedre

# Takk



- RADARSAT-2 data was provided by NSC/KSAT under the Norwegian-Canadian agreement
- UAVSAR data courtesy NASA/JPL-Caltech
- NOFO – for å ha inkludert våre eksperiment i øvelsene deres
- Alle som deltok i de ulike feltarbeidskampanjene