Use of an Unmanned Surface Vehicle (Saildrone) to Study Natural Oil Seeps in the Gulf of Mexico

Samira Daneshgar-Asl

University of California, Santa Barbara

FLORIDA STATE UNIVERSITY 1851

ecogig

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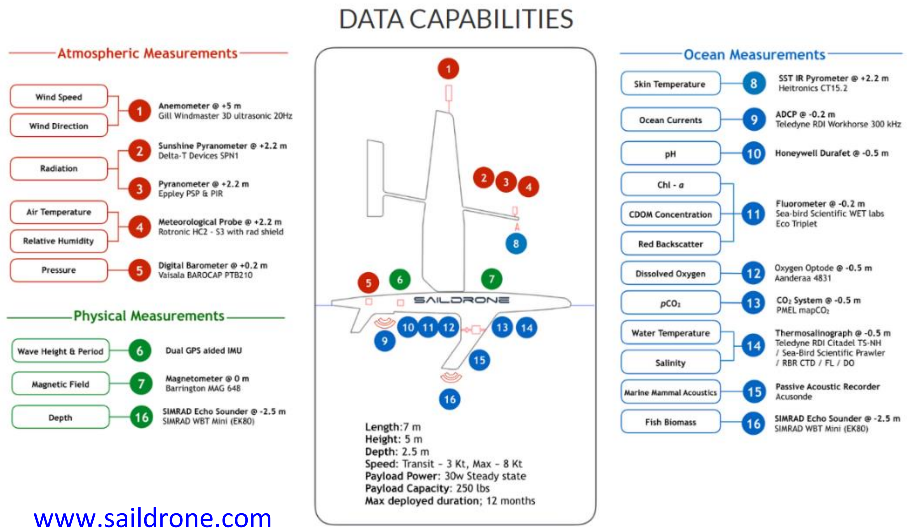
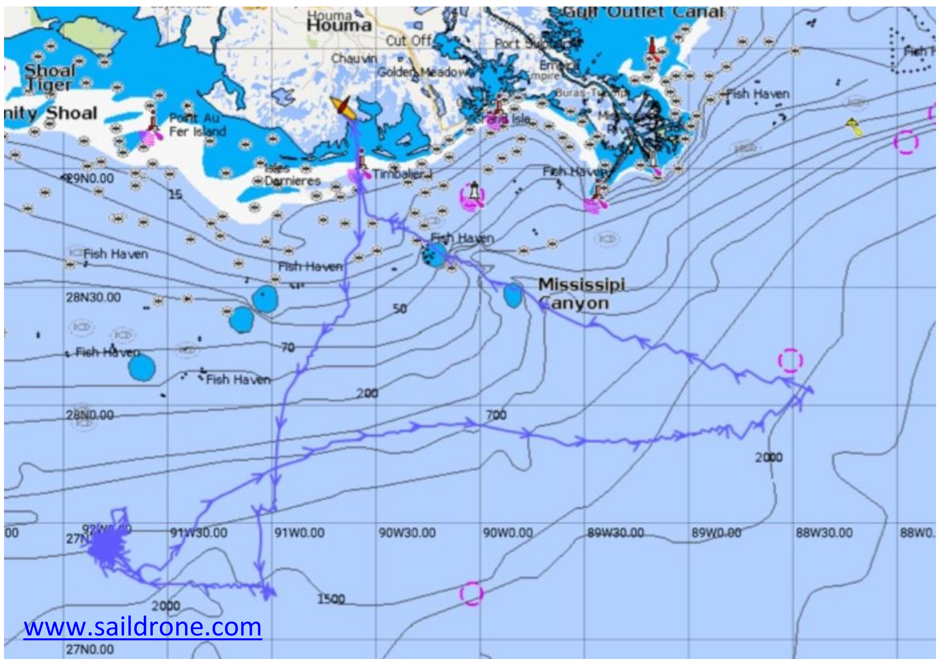
Bureau of Ocean Energy Management

GULF of MEXICO RESEARCH INITIATIVE

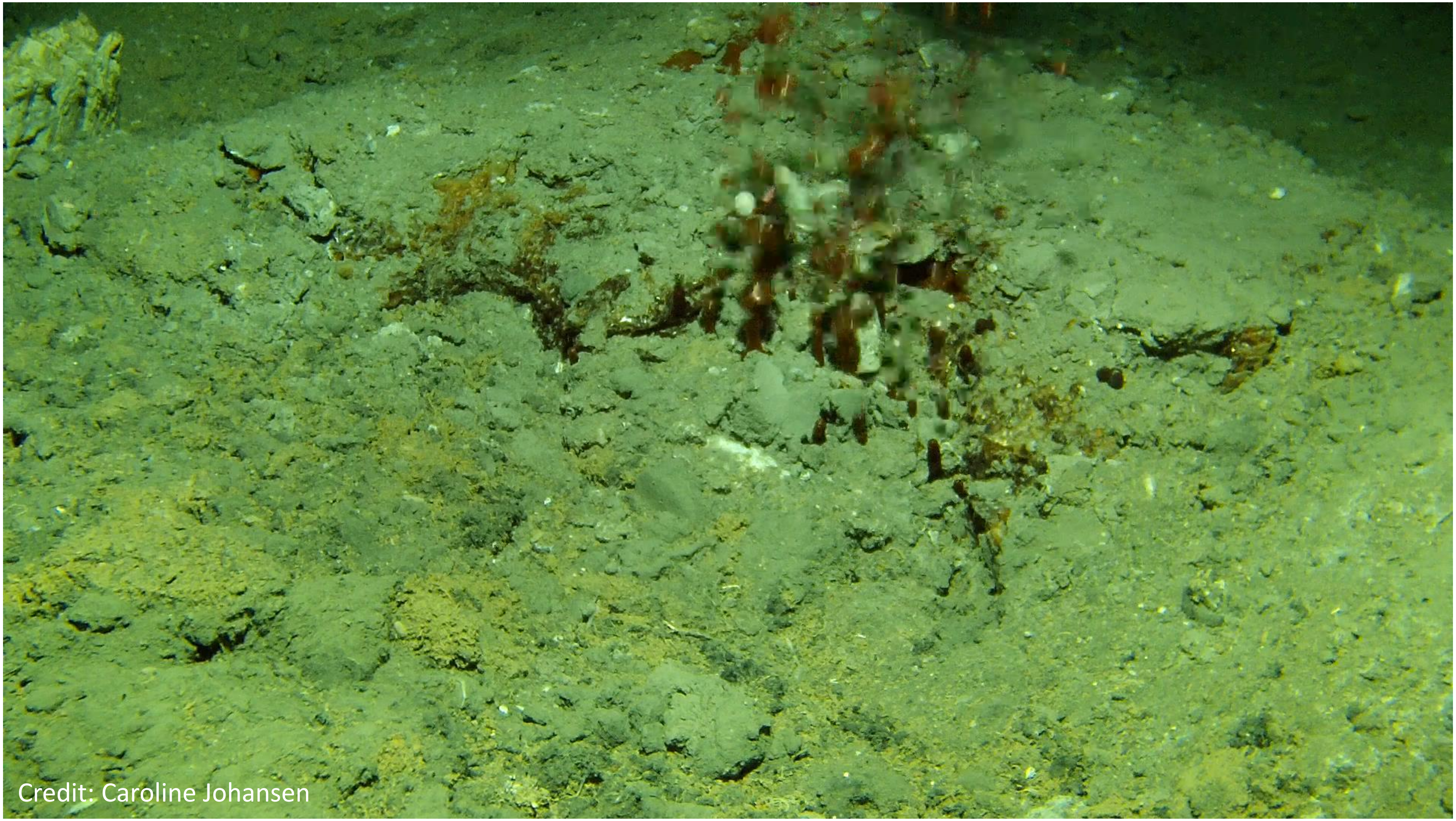


www.saildrone.com

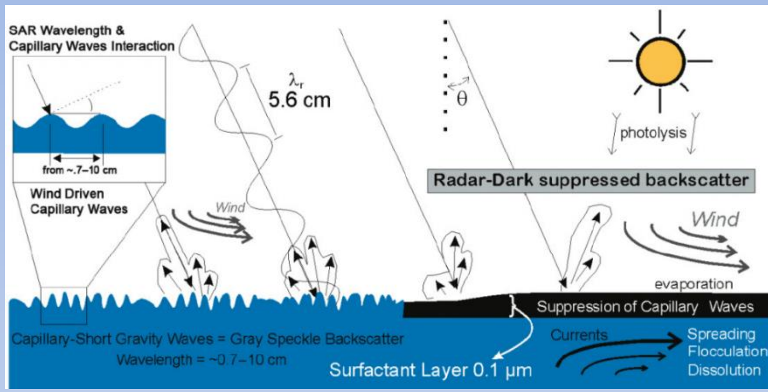


Track of Saildrone 125 during the 2015 Gulf of Mexico mission with ECOGIG.

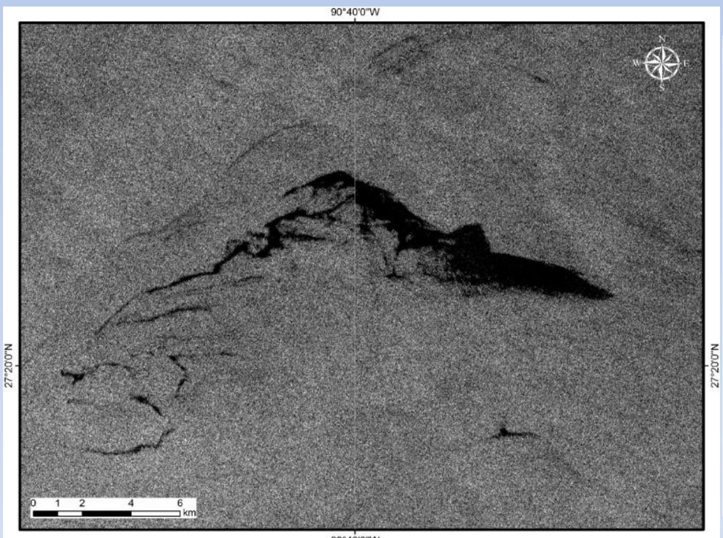
Saildrone 125 being deployed from Cocodrie LA, carrying the Remote Optical Watcher (ROW) device from Laser Diagnostic Instruments (LDI), that detects oil by using it's natural fluorescence.

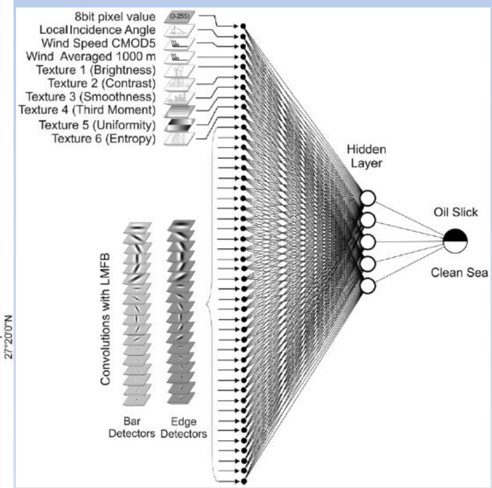

Credit: Caroline Johansen

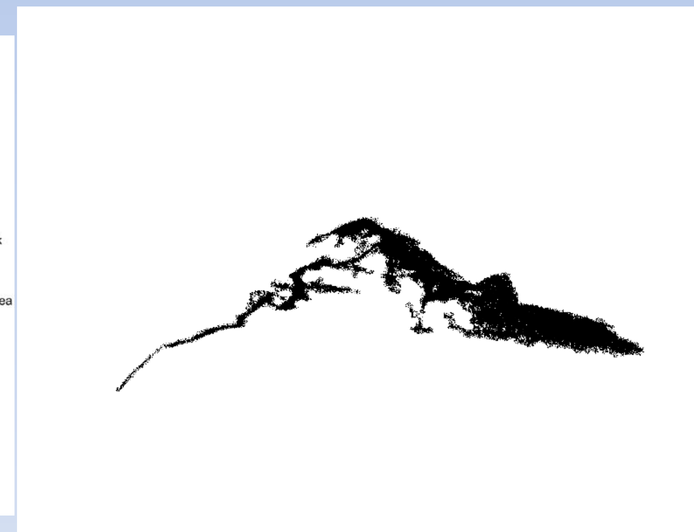
Synthetic Aperture Radar (SAR)



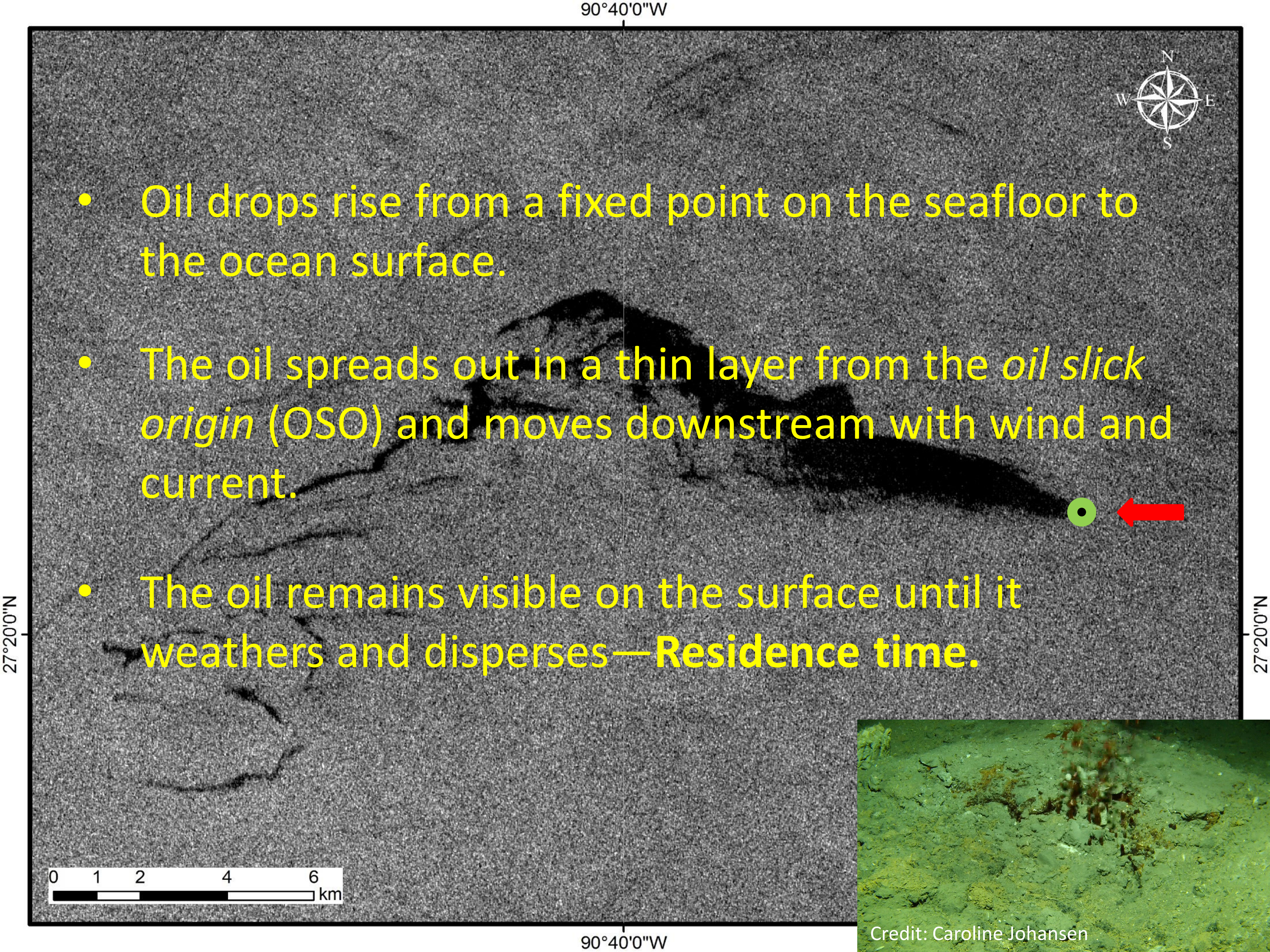
SAR images are particularly useful in oil slick detection and monitoring because of their large coverage, cloud-penetrating, and 24-h per day capabilities.





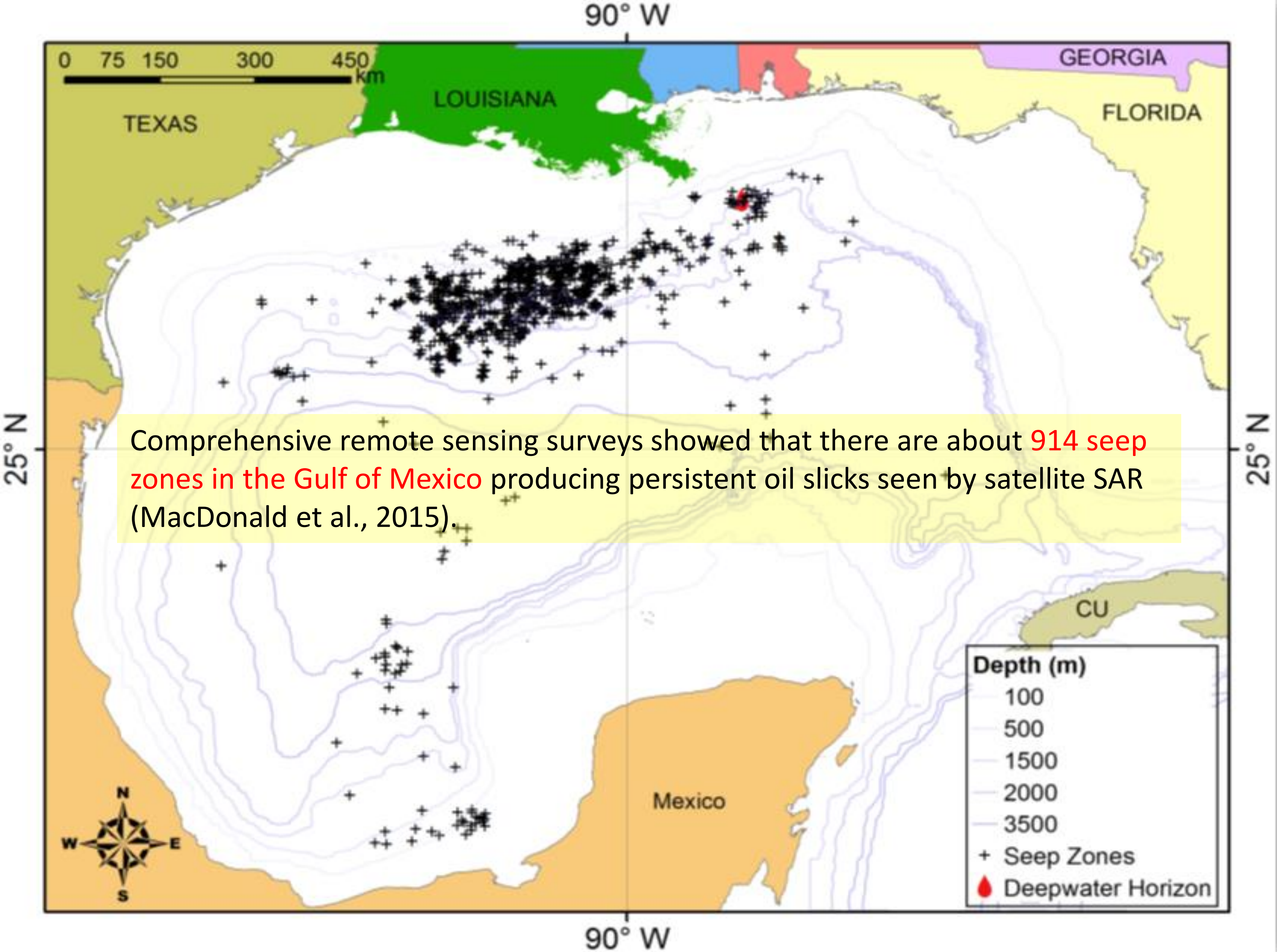


Texture Classifying Neural Network Algorithm (TCNNA) is an FSU-developed algorithm which was used to delineate oil slicks in SAR images (Reference: Garcia-Pineda, O., Zimmer, B., Howard, M., Pichel, W., Li, X., & MacDonald, I.R. (2009). Using SAR images to delineate ocean oil slicks with a texture-classifying neural network algorithm (TCNNA). *Canadian Journal of Remote Sensing, 35,* 411-421).



- Oil drops rise from a fixed point on the seafloor to the ocean surface.
- The oil spreads out in a thin layer from the *oil slick origin* (OSO) and moves downstream with wind and current.
- The oil remains visible on the surface until it weathers and disperses—**Residence time.**

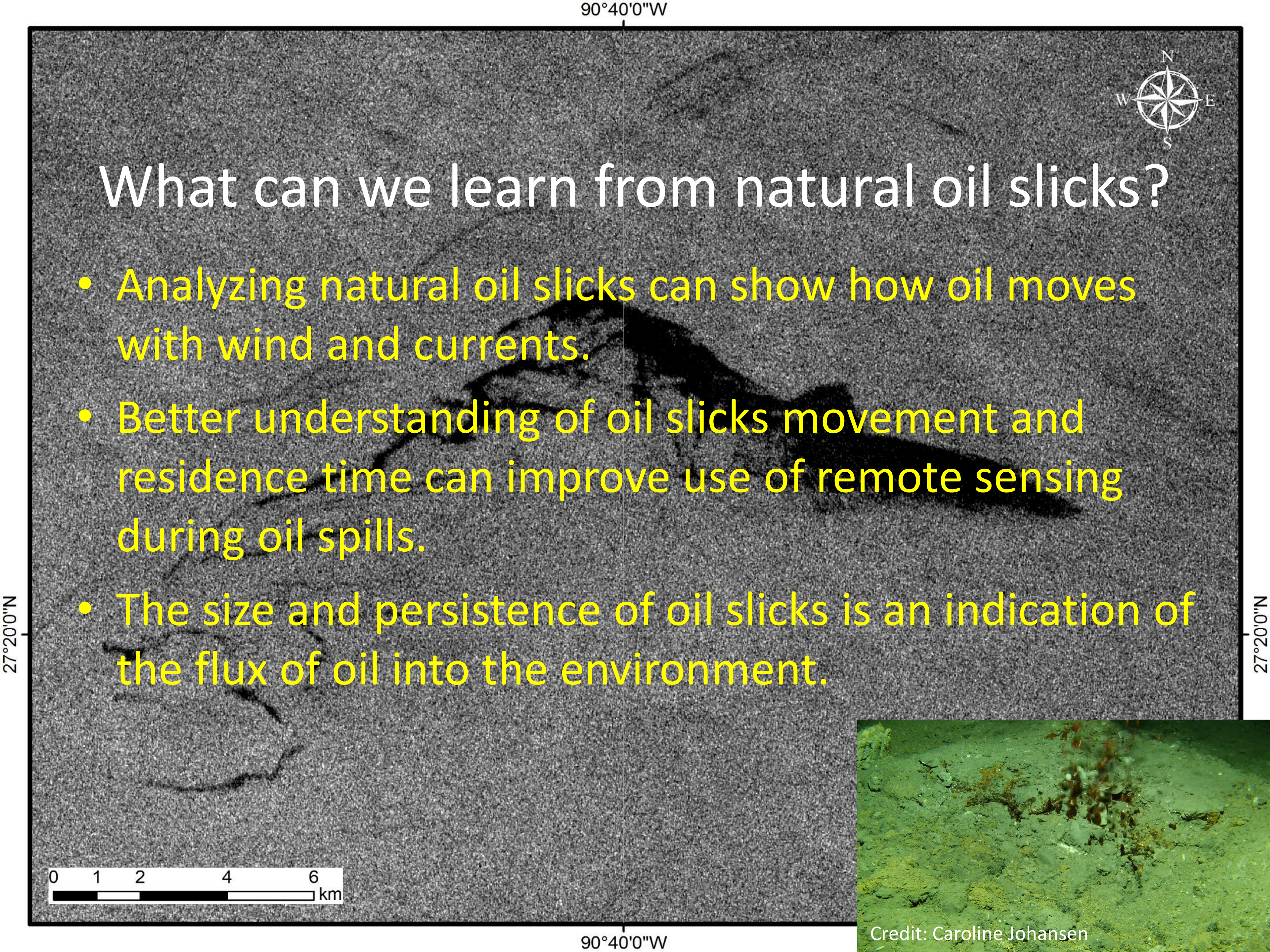
Credit: Caroline Johansen



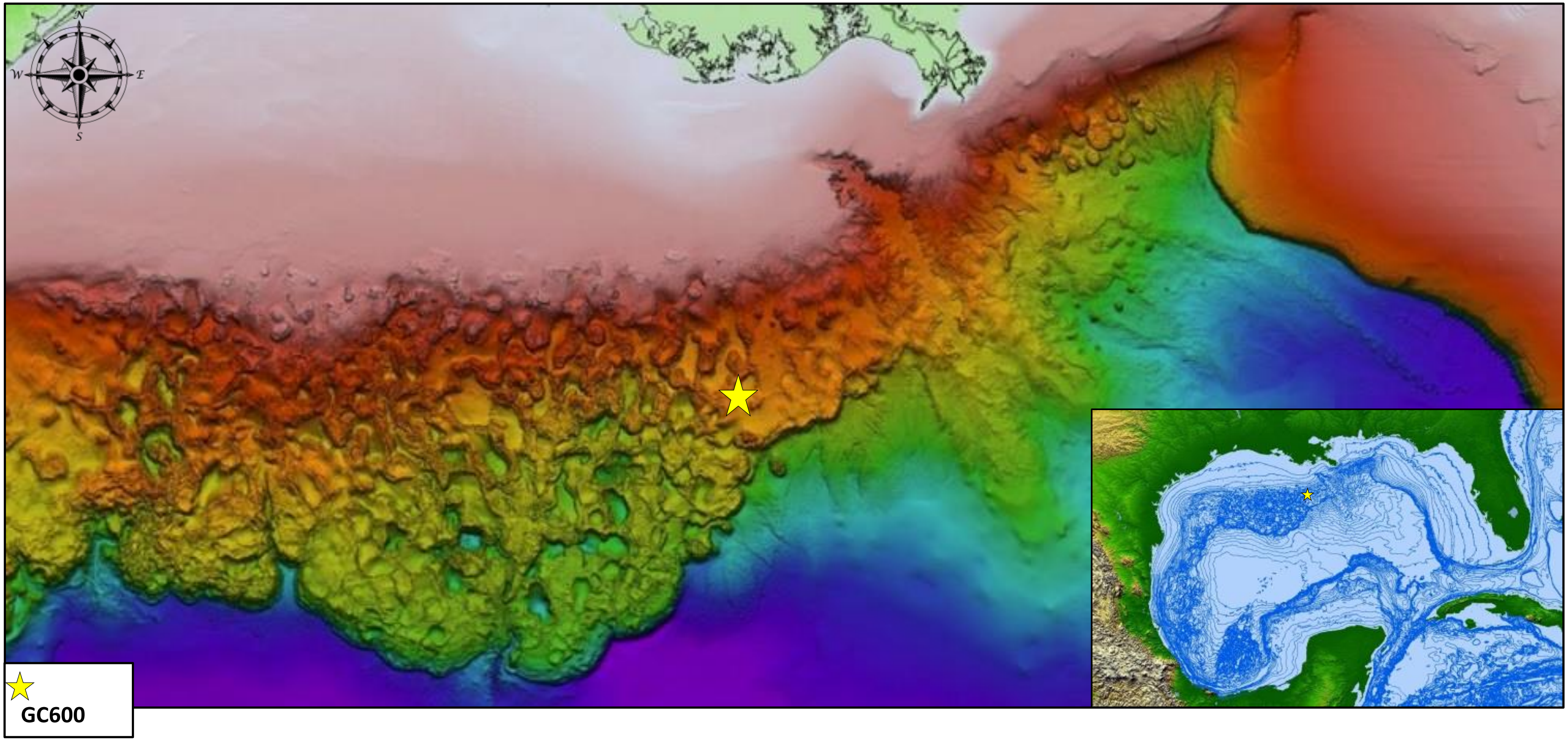
Comprehensive remote sensing surveys showed that there are about 914 seep zones in the Gulf of Mexico producing persistent oil slicks seen by satellite SAR (MacDonald et al., 2015).

What can we learn from natural oil slicks?

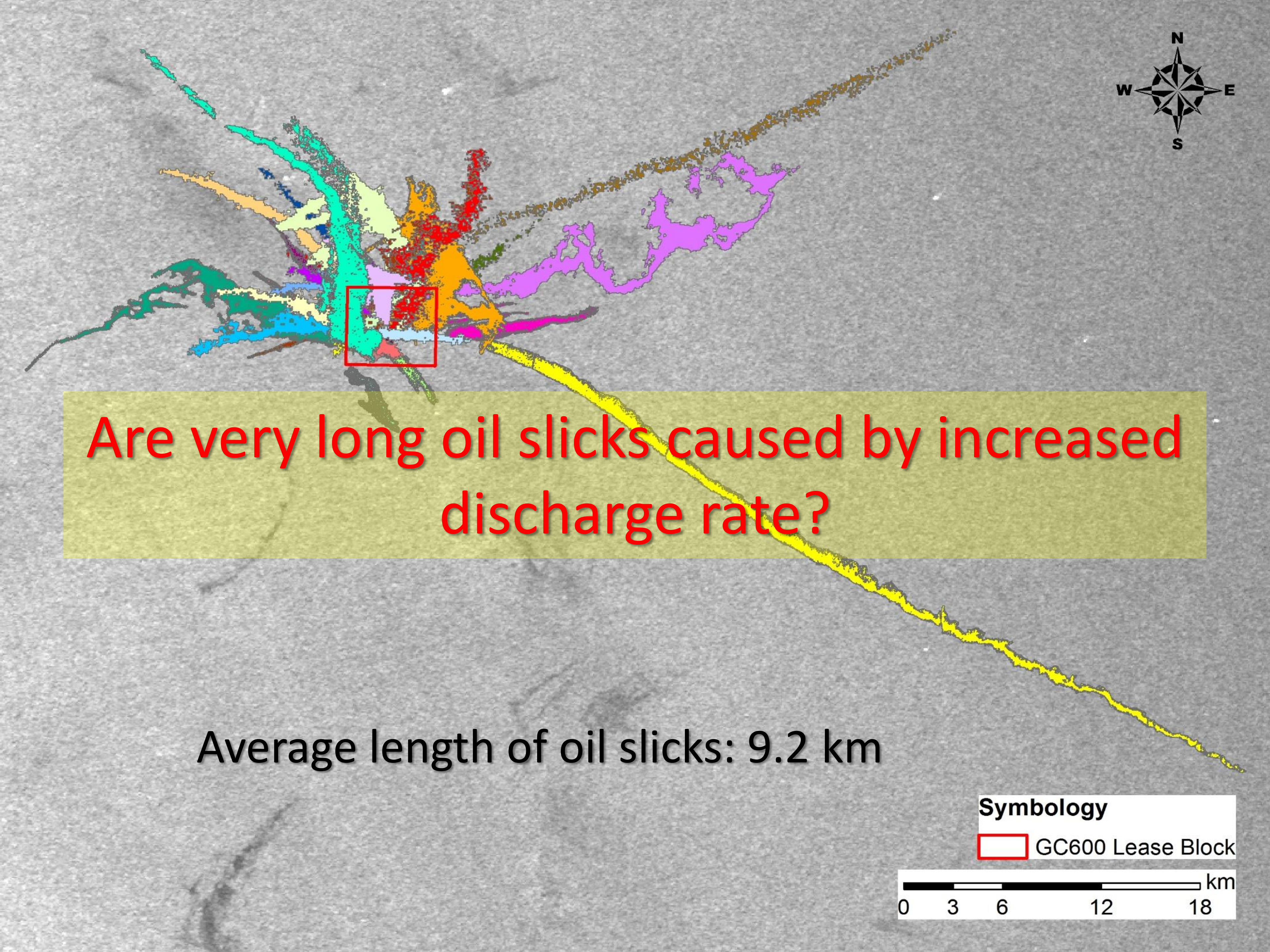
- Analyzing natural oil slicks can show how oil moves with wind and currents.
- Better understanding of oil slicks movement and residence time can improve use of remote sensing during oil spills.
- The size and persistence of oil slicks is an indication of the flux of oil into the environment.



Study Location: Northern Gulf of Mexico (GC600)



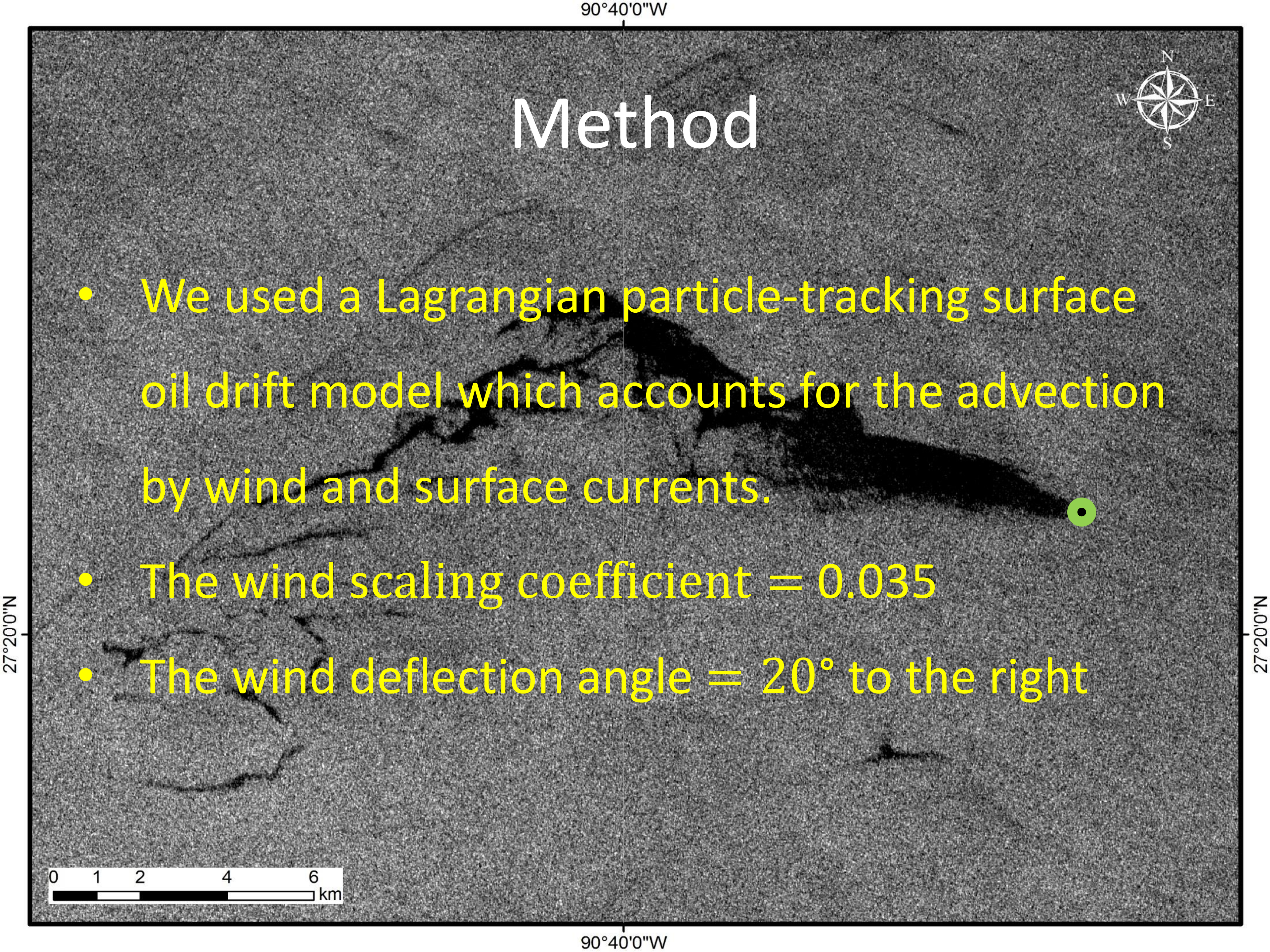
Are very long oil slicks caused by increased discharge rate?



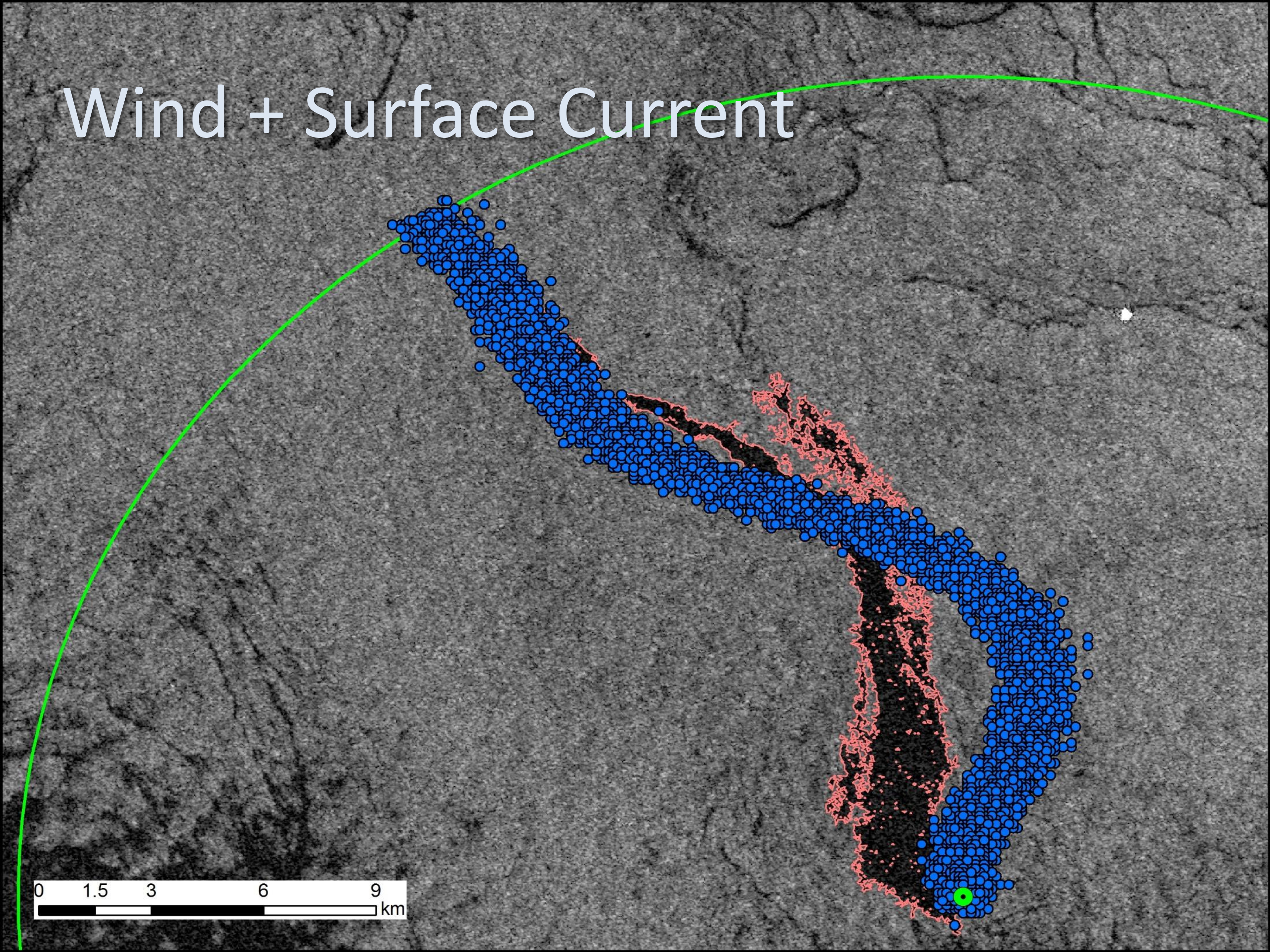
Average length of oil slicks: 9.2 km

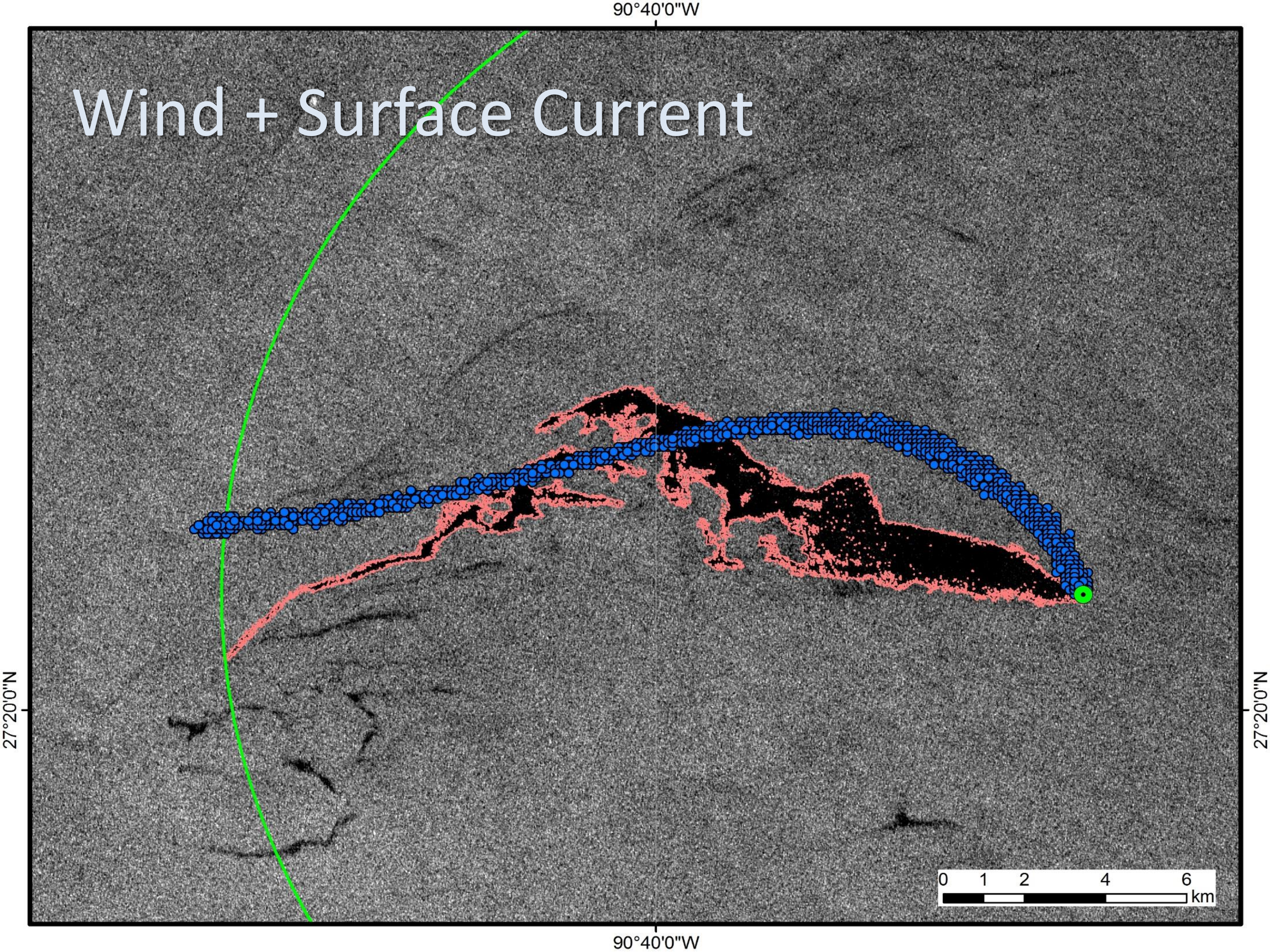
Method

- We used a Lagrangian particle-tracking surface oil drift model which accounts for the advection by wind and surface currents.
- The wind scaling coefficient = 0.035
- The wind deflection angle = 20° to the right



Wind + Surface Current




Wind + Surface Current
90°40'0"W
27°20'0"N
0 1 2 4 6
km

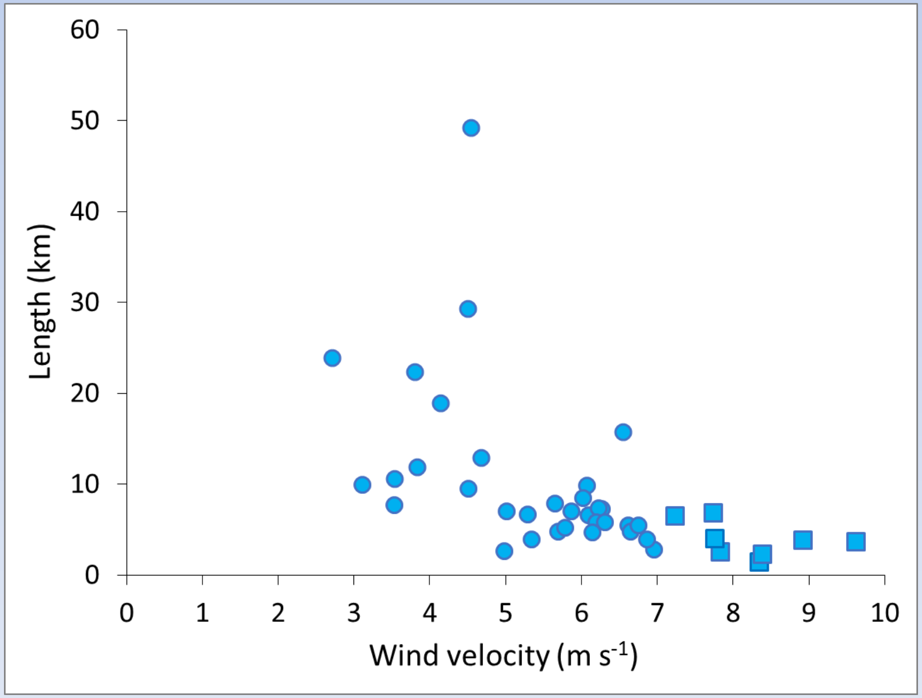
Average Length (km)	9.2	Average Wind Velocity (m s^{-1})	5.9
Average Surface Residence-Time (h)	6.4	Average Current Velocity (m s^{-1})	0.4

$$L = \alpha + \beta \times V_w + \gamma \times V_o + \upsilon \times V_w \times V_o \times \cos\theta + \varepsilon$$

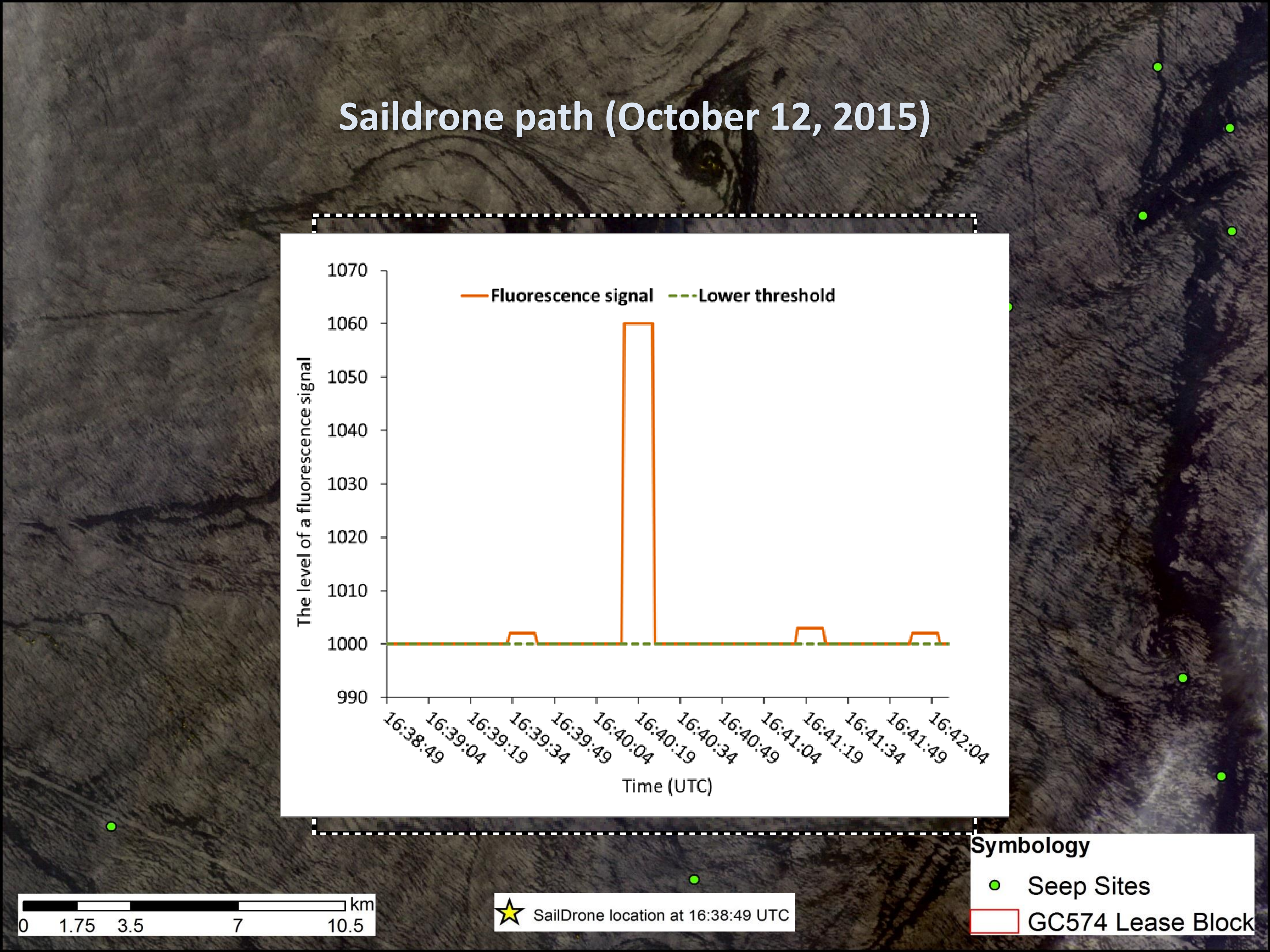
The F-test demonstrates that the linear regression model fits the data set (the *p*-value 0.0006).

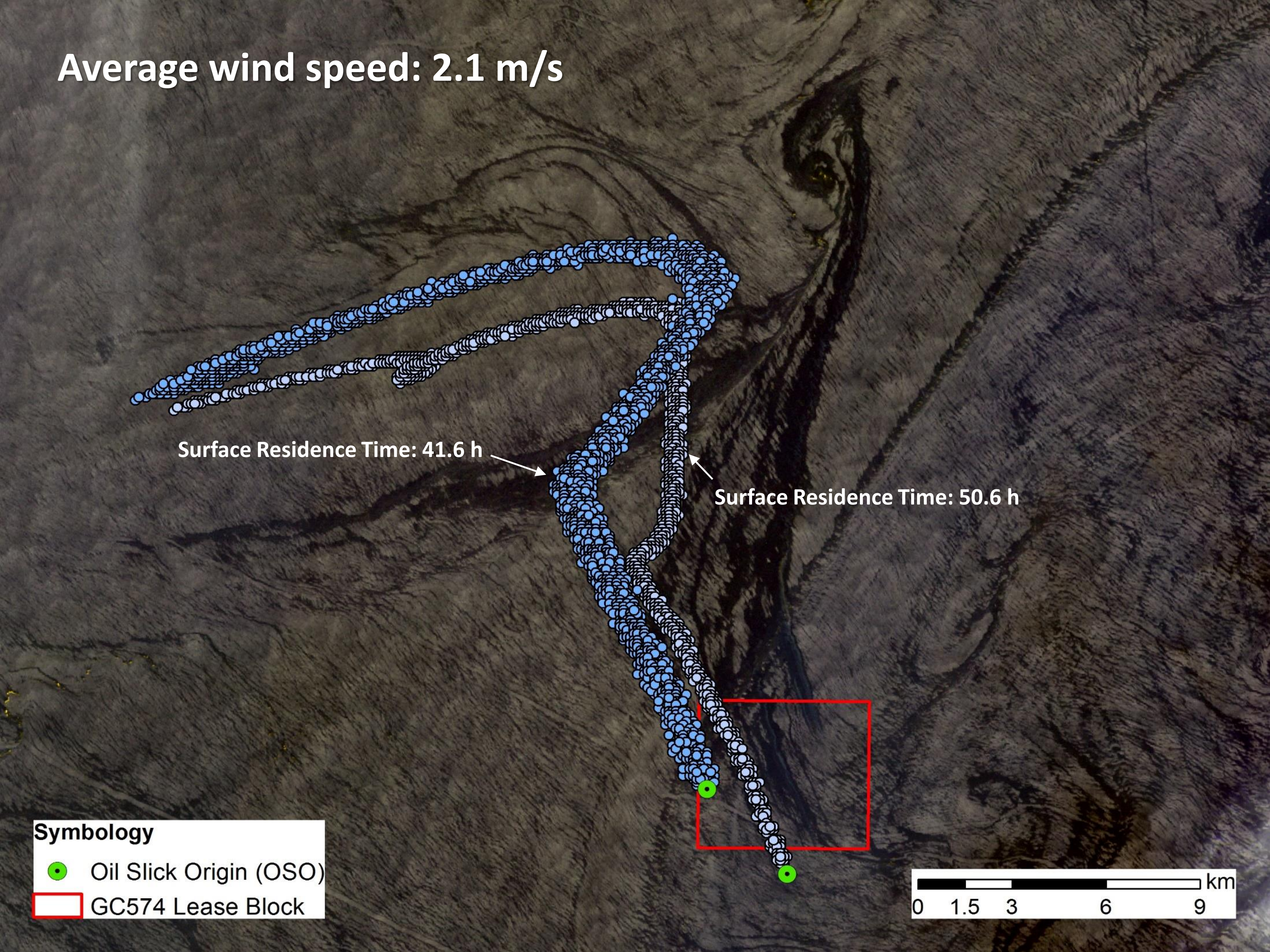
	Coefficients	**Standard Error**	***t***	***p*-value**
α	21.21	5.1	4.17	0.0002
β	-2.93	0.7	-4.01	0.0003
γ	16.14	7.3	2.22	0.0329
υ	-0.01	0.7	-0.01	0.9887

α: intercept
B: wind speeds coefficient
γ: surface current speeds coefficient
υ: coefficient of the relative angles between the surface current and rotated wind vectors



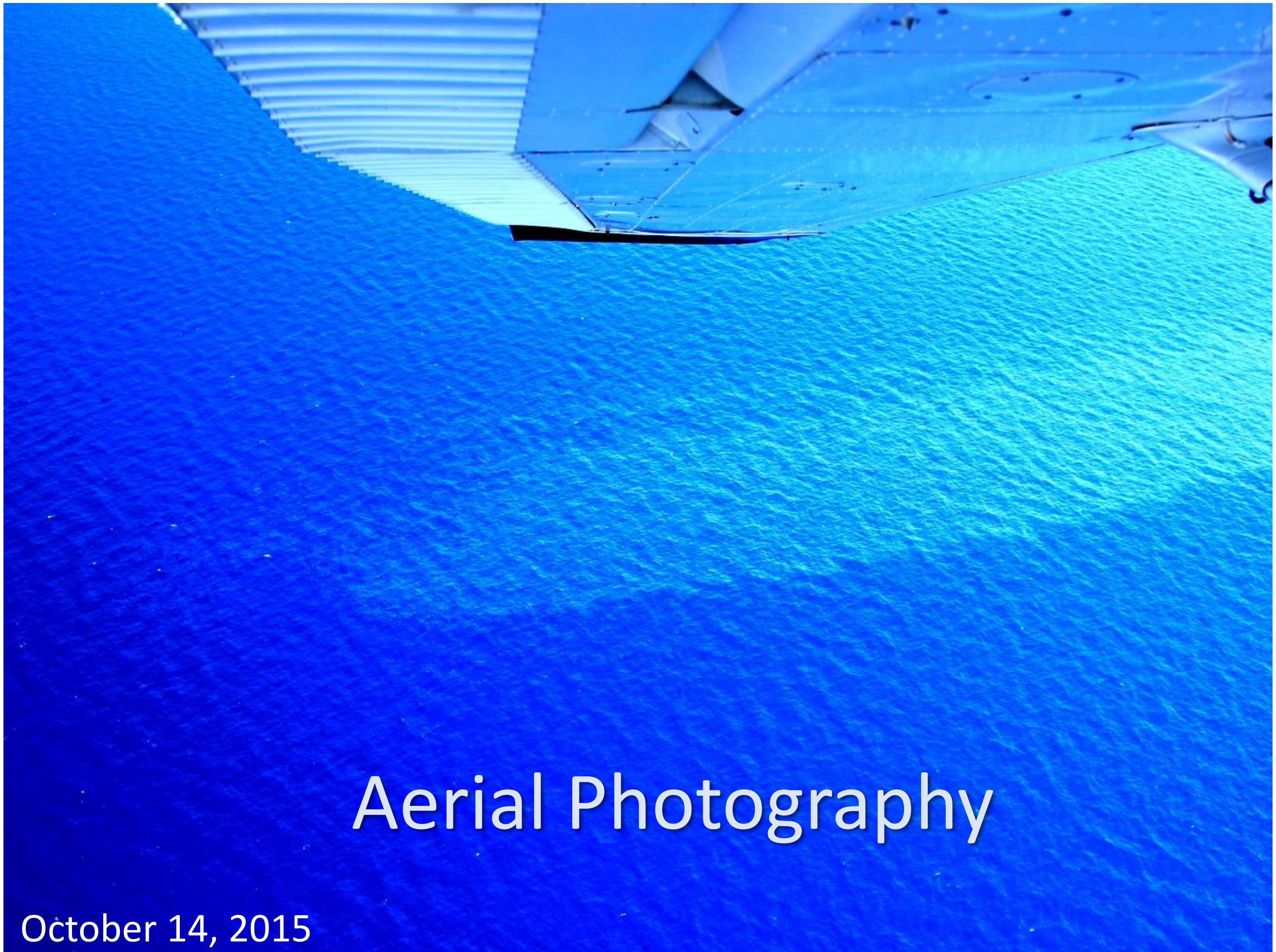
Saildrone path (October 12, 2015)





Average wind speed: 2.1 m/s
Surface Residence Time: 41.6 h
Surface Residence Time: 50.6 h
Symbology
Oil Slick Origin (OSO)
GC574 Lease Block
km
0
1.5
3
6
9


N4823V



Aerial Photography
October 14, 2015

Summary

- An oil drift model, when combined with SAR images obtained from GC600 seep site, indicated an average surface residence-time of 6.4 h for natural oil slicks.

- Surface winds are largely responsible for disappearance of the oil slicks from the sea surface. Wind speeds > 7 m s^{-1} significantly reduced the length of the oil slicks to < 10 km.

- The Saildrone proved to be an effective tool not only for measuring surface winds but also for detecting thin, narrow oil slicks under open ocean conditions.

- A Saildrone study and our analysis indicated that surface currents are responsible for extending oil slicks on the sea surface. Very large natural oil slick doesn’t mean necessarily that there is been a change in the release of the natural oil.