

# Marine bacteria monitoring via polarimetric SAR

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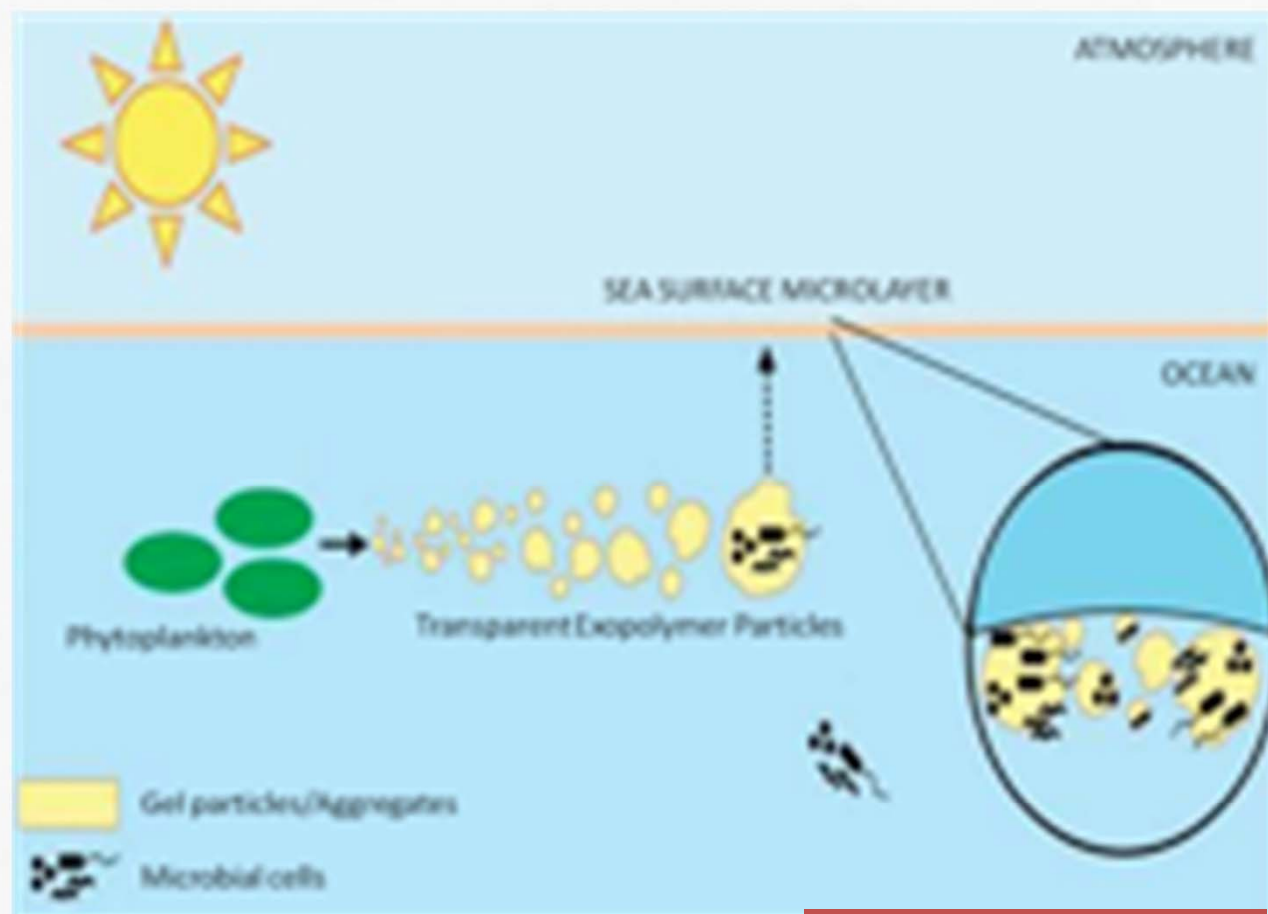
# Outline

- Introduction
- Sampling
- Single-pol analysis
- Polarimetric analysis
- Conclusions

# Introduction

The sea surface microlayer is defined as the uppermost 1 mm of the ocean.

A number of studies have suggested that there is a unique ecosystem for marine bacteria in the sea surface microlayer, however, little information exists on the microbial community composition of this ecosystem in the open ocean due to sampling complexitie

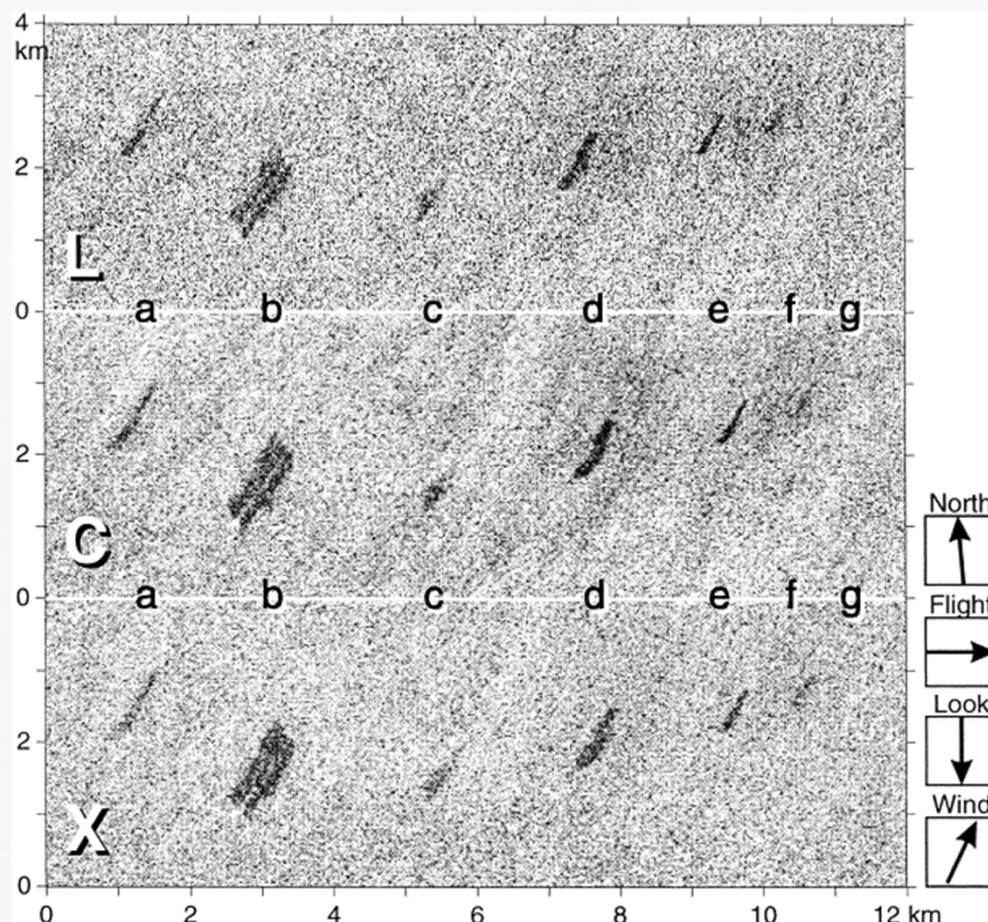


Cunliffe et al., 2009

# Introduction

The sea surface microlayer concentrates surfactants, e.g. oleic acid and oleyl alcohol.

- They reduce surface tension and can also increase the biodegradation of organic compounds.
- They appear as dark patches in SAR images.
- In this study an in situ sampling strategy and DNA characterization is described together with a complementary remote sensing visibility analysis of the marine surface.



# Sampling

An improved sea surface microlayer sampling method was designed to reduce the probability of sample contamination from the vessel and subsurface water. Bacterial samples were collected from inside and outside slicks, and from subsurface water at the same sites.

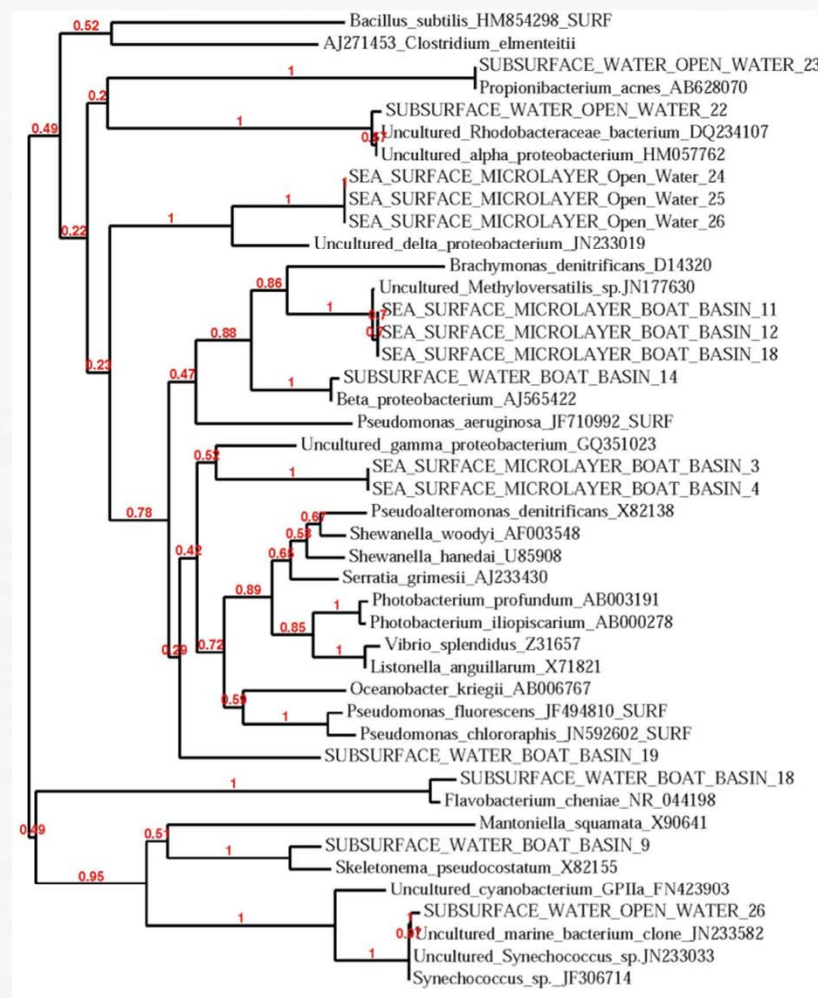


(Kurata et al, 2012)

# Sampling

The bacterial samples were collected from the ocean approximately five miles offshore Port Everglades. A few samples were also collected from the NSU Oceanographic Center boat basin. The characterization of bacterial species was performed using the TA TOPO cloning kit (Invitrogen, Inc.) and traditional Sanger dideoxy terminator sequencing

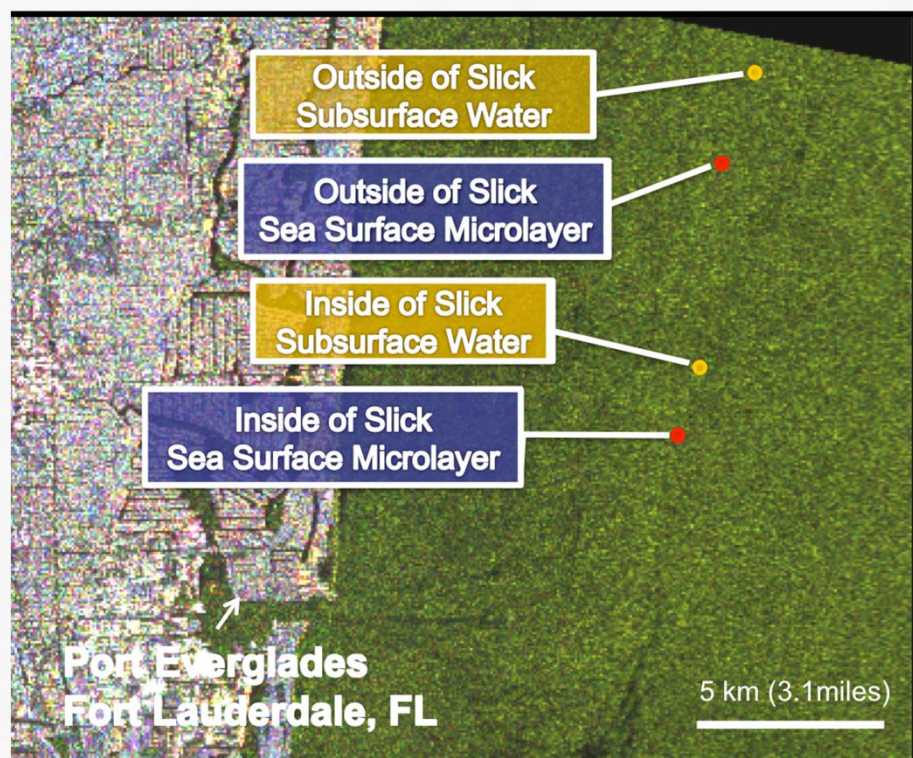
Results from the pilot experiment indicate difference in bacterial composition between the sea surface microlayer and underlying subsurface water samples from the different locations.



(Kurata et al., 2012)

# SAR measurements

RadarSAT-2 scene collected on July 10, 2010



Photographic image of a coastal slick taken at the sampling site in the Strait of Florida



The microlayer sampling was planned to coincide with synthetic aperture radar satellite overpasses (RADARSAT-2) (After Kurata et al. 2012)

# Single-pol analysis

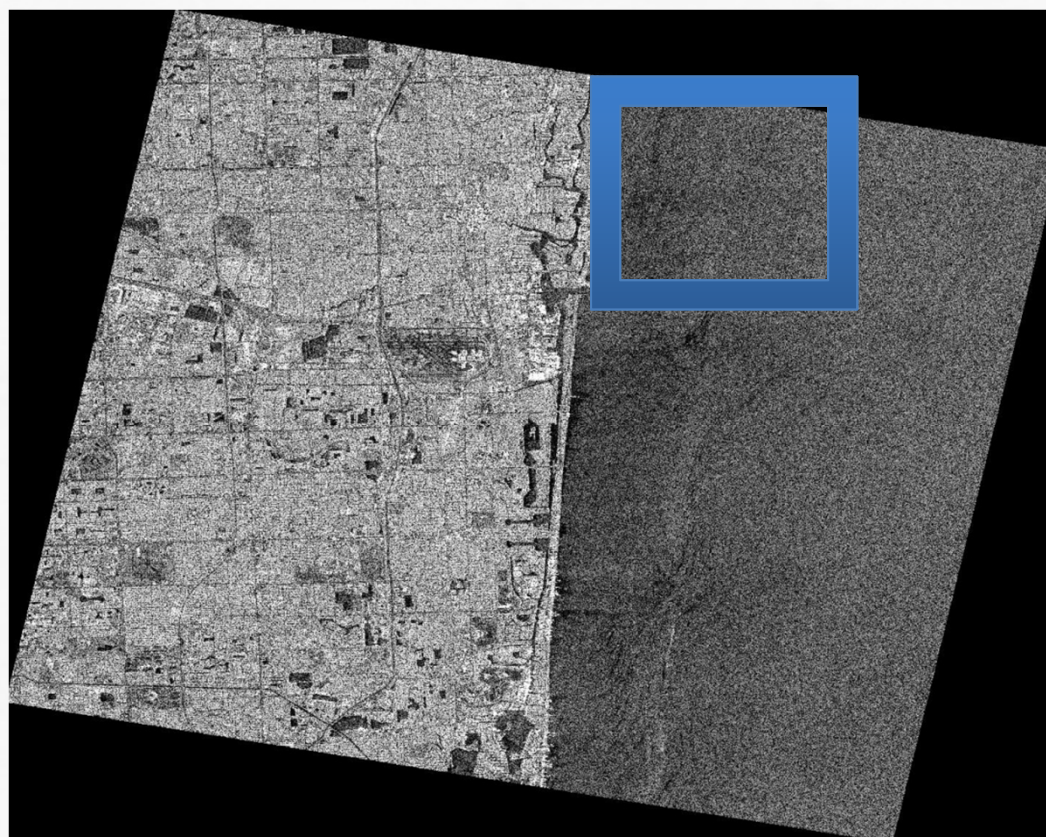
- The experiment was devoted to the detection and quantification of surfactant producing and hydrocarbon transforming bacteria.
- Surfactants are capable of suppressing short gravity-capillary surface waves, which affect radar back-scatter
- Hence, single-pol SAR analysis is undertaken evaluating the contrast: the slick-free to slick-covered NRCS ratio

# Single-pol analysis

Sea slicks are bands of organic material including surfactants.

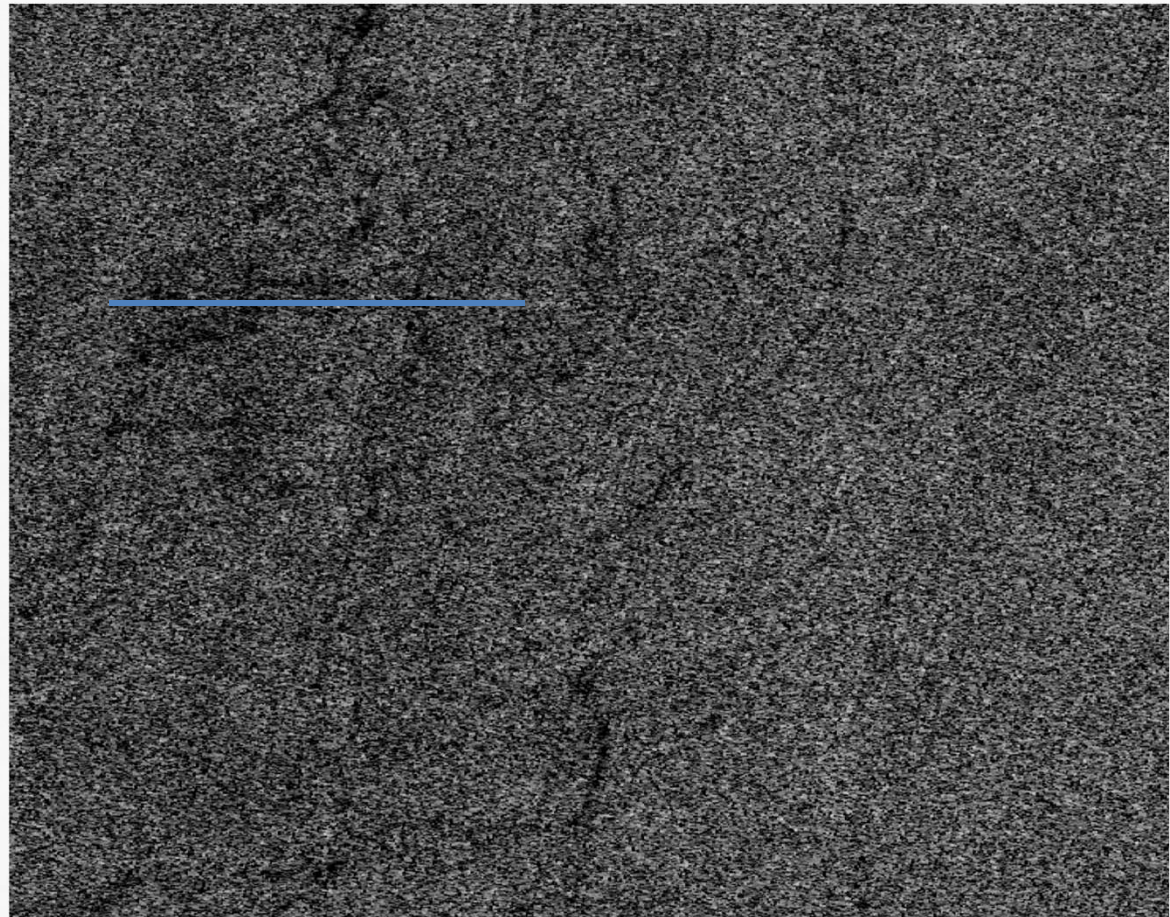
They are often observable with the naked eye due to their glassy appearance on the sea surface.

They can also be seen on synthetic aperture radar (SAR) images as dark scars

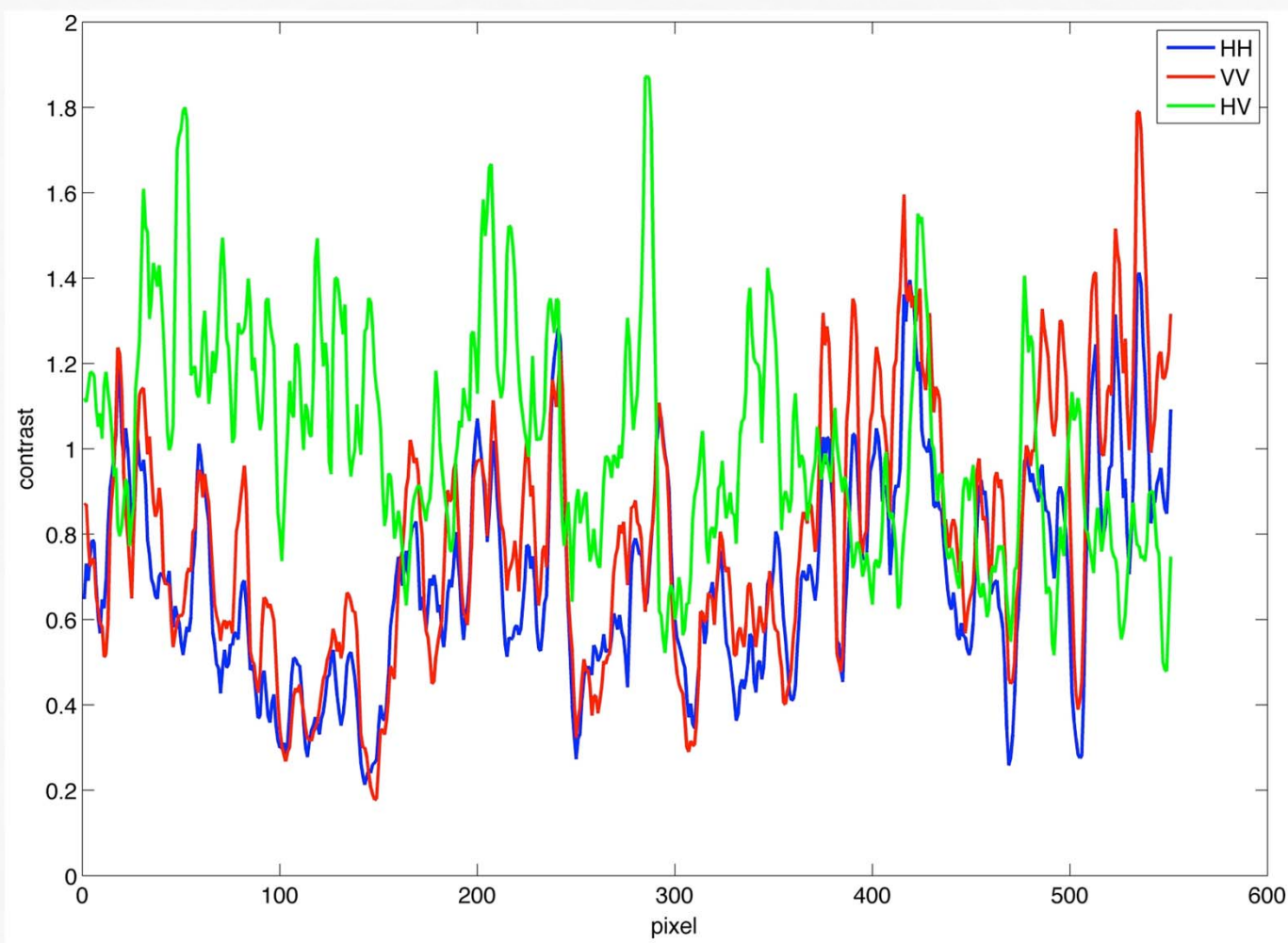


# Single-pol analysis

A transect is kept from the HH, VV and VH channels and the contrast is evaluated



# Single-pol analysis

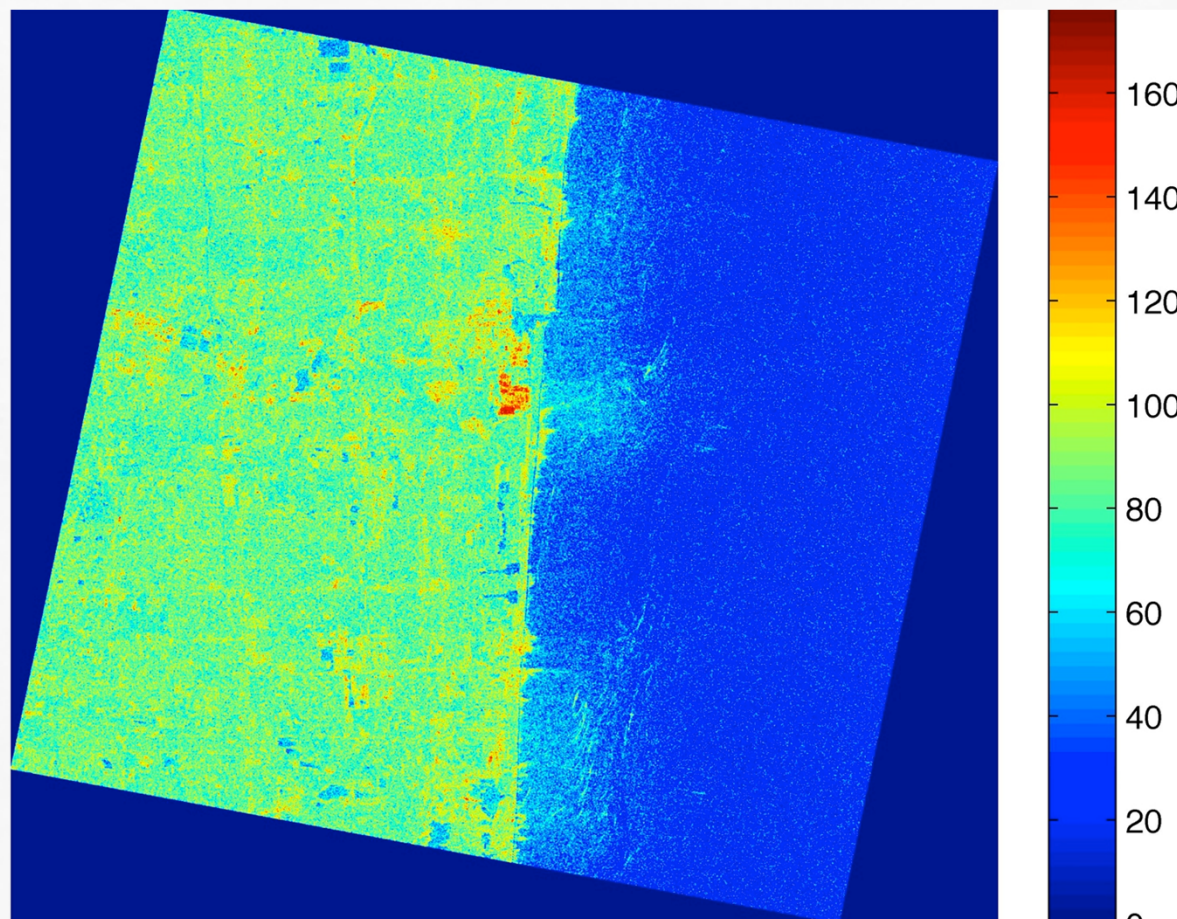


# Polarimetric analysis

- The standard deviation of the co-polarized phase difference (CPD) is related to the departure from Bragg scattering; a phenomenon which occurs when strong-damping properties surfactants are in place.
- The CPD std image is evaluated using a 7x7 moving window.

# Polarimetric analysis

The larger is the CPD std value, the stronger is the departure from Bragg scattering

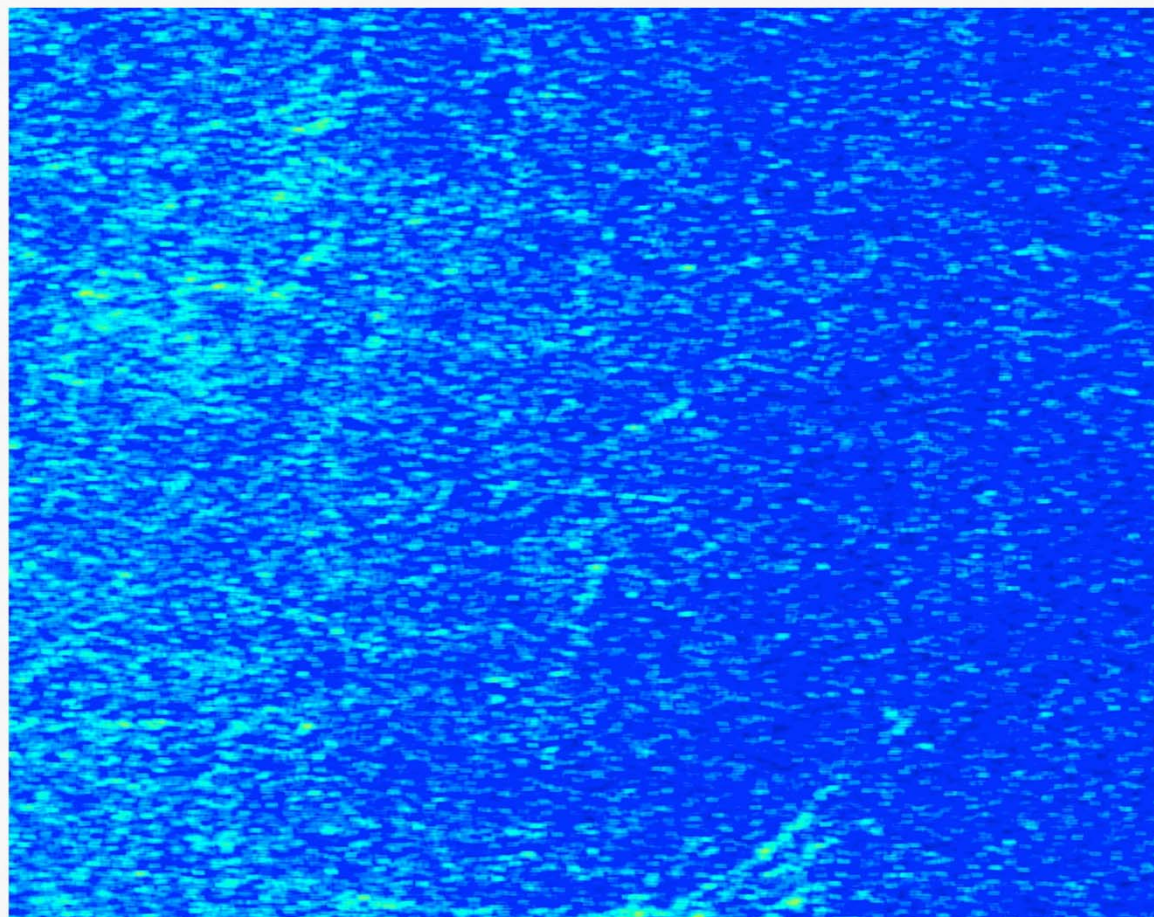


# Polarimetric analysis

The CPD std image related to the area of interest witnesses that a slight departure from Bragg scattering applies over the slicks

Mean free surface =  $26^\circ$

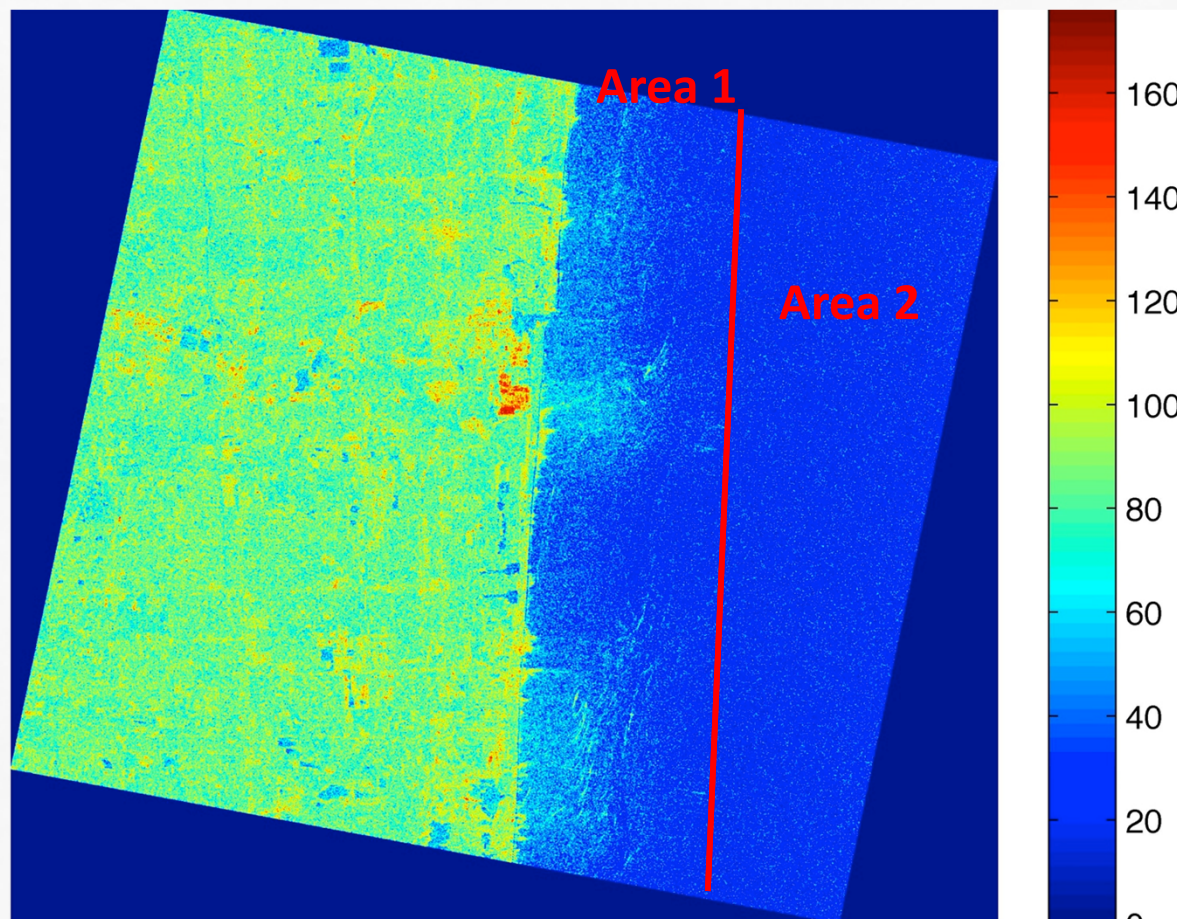
Mean slick =  $40^\circ$



# Polarimetric analysis

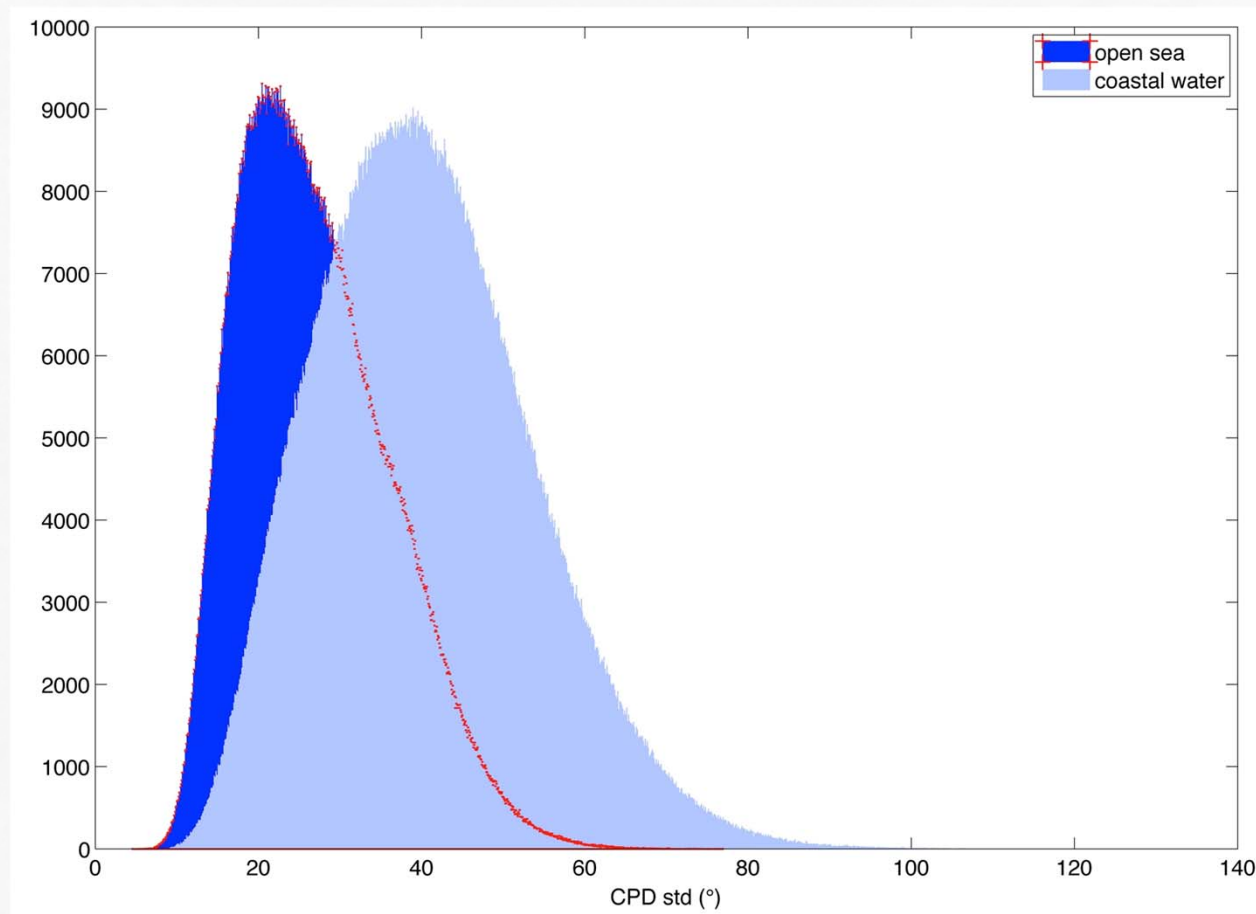
The CPD std image allows clearly distinguishing two areas over the sea

- **Area 1:** within 5km off the coast. Very heterogeneous!
- **Area 2:** open sea. Homogeneous



# Polarimetric analysis

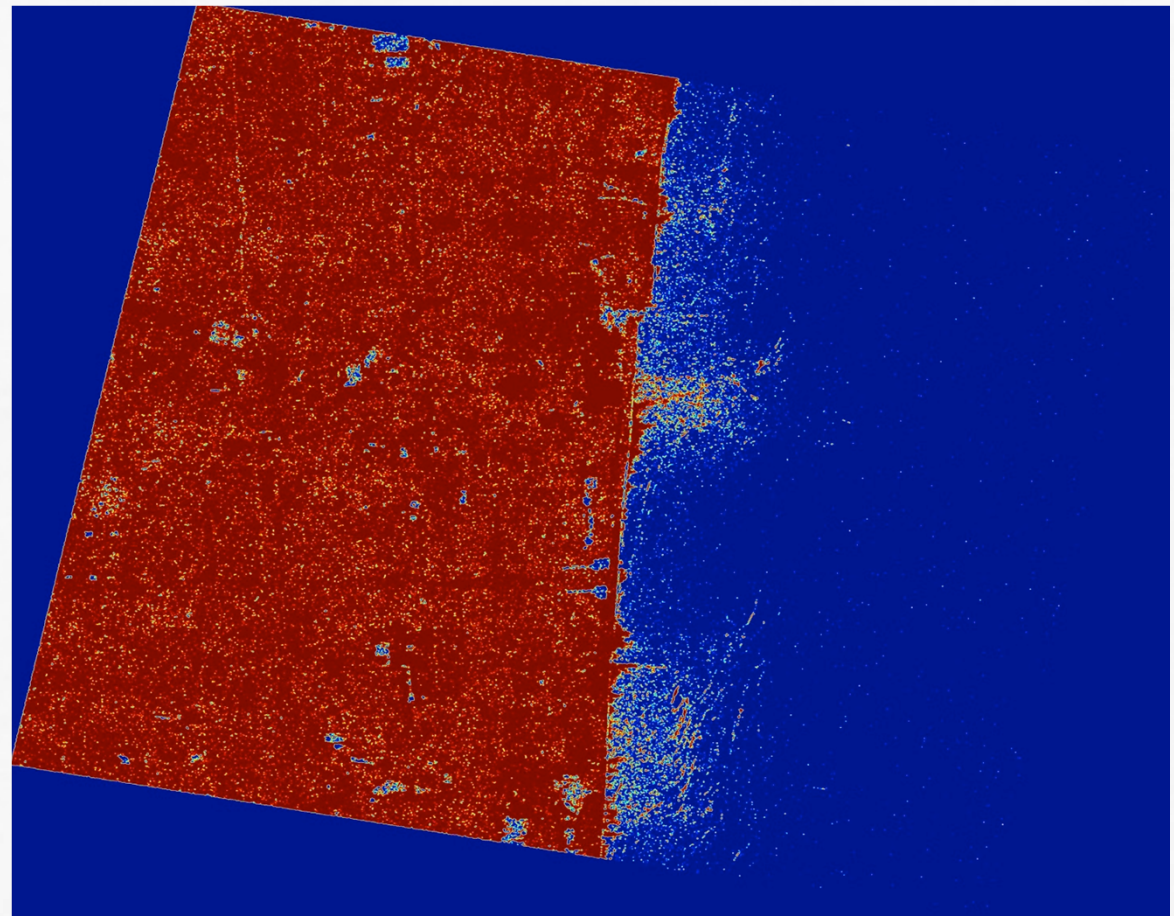
|      | Area 1 | Area 2 |
|------|--------|--------|
| mean | 42°    | 25°    |
| std  | 13°    | 9°     |



# Polarimetric analysis

A simple threshold ( $50^\circ$ ) is set and, under low to moderate wind conditions:

- **Area 1** includes different kind of slicks and also water plumes that can be clearly observed.
- **Area 2** consists of free sea surface



# Conclusions

- A new scheme to collect samples relevant to marine bacteria proposed by Kurata et al. (2012) is described together with a complementary analysis undertaken using polSAR RadarSAT-2 data.
- It is shown that polSAR data allow observing surfactants. Their  $\sigma$  values are slightly larger than free sea surface.
- Coastal water is also well-distinguishable from open sea by using polSAR data.
- Further analysis will be accomplished using COSMO-SkyMed data together with DNA samples to better characterize surfactants.

## Reference:

Kurata, N., K. Vella, A. Tartar, S. Matt, A. Soloviev, M. Shivji and W. Perrie, 2012: New Approach to Detection of Surfactant-Associated Bacteria in the Sea Surface Microlayer. Ocean Science Meeting, 20-24 February 2012, Salt Lake City, UT, USA.