Exploring The Use Of SAR Remote Sensing To Detect Microplastics Pollution In The Oceans

Conference or Workshop Item

Exploring use of SAR to detect microplastics pollution in the world's oceans

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Introduction:

About 250 million tonnes of plastic is in the world's oceans:

- ❖ North Pacific (Garbage Patch) - 1.16 trillion plastic items;
- ❖ North Atlantic (Garbage Patch) - 0.53 trillion plastic items.

The risks associated with microplastics pollution:

- ❖ Ingestion by marine animals and fish, transfer via food chain;
- ❖ Leaching of chemical ingredients into surrounding seawater;
- ❖ Release of sorbed pollutants, depending on bioavailability.

The main objective and hypothesis of the research:

- ❖ Objective is to detect areas with microplastics pollution (surfactants and sea-sliks) using SAR images.
- ❖ Microbes colonizing plastic will produce surfactants and sea-sliks.

The goals:

- ❖ To perform contextual analysis of SAR images;
- ❖ To analyse surfactants and sea-sliks on SAR images;
- ❖ To analyse microbiology of surfactants and sea-sliks (in lab).

CONCEPT: MICROPLASTICS DETECTION USING SAR

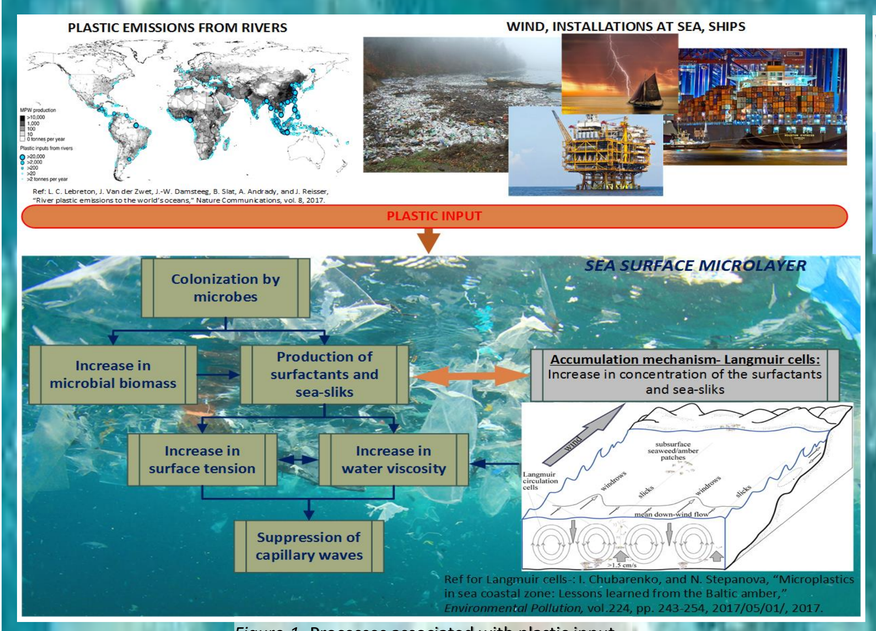


Figure-1- Processes associated with plastic input

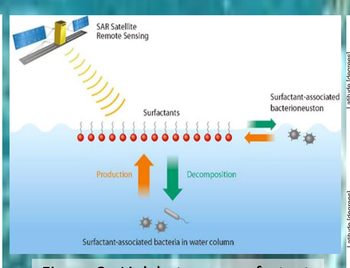


Figure-2 - Link between surfactant-associated bacteria, sea sliks and SAR Remote sensing

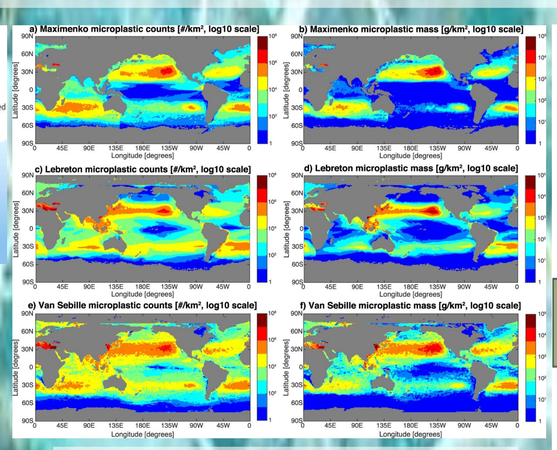


Figure-3- A global inventory of small floating plastic debris (Erik van et al. 2015)

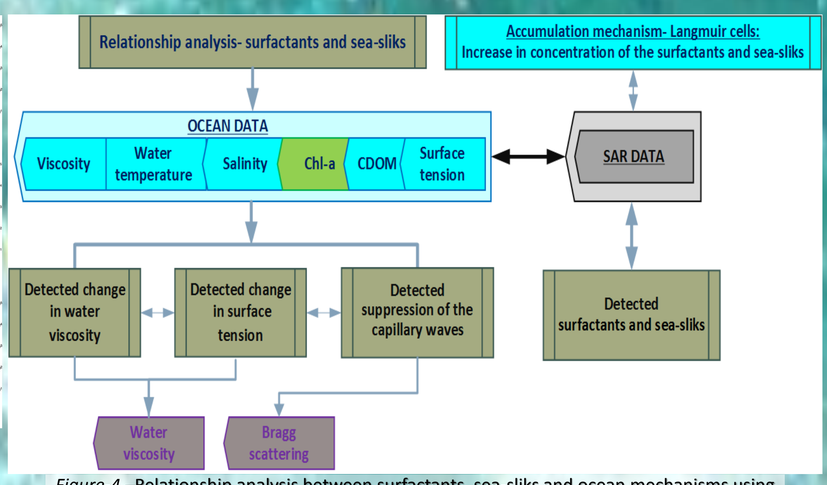


Figure-4 –Relationship analysis between surfactants, sea-sliks and ocean mechanisms using ocean and SAR data

Figure-5- Example- Composition of microplastics pollution in the Great Pacific Garbage Patch. Reference: Expédition 7e Continent. Photo Material of the Pacific Garbage Patch Expedition. 2013. The image was recorded on 29 May 2013, at location 30.5N, 132.3W.

PRELIMINARY RESULTS-PRESUMED SURFACTANTS AND SEA-SLIKS

Dataset- c.300 images (5 examples) - *North Atlantic*- Sentinel-1A Level 1, Extra Wide Swath (EW) Ground Range Detected GRD; Full resolution 25x25m

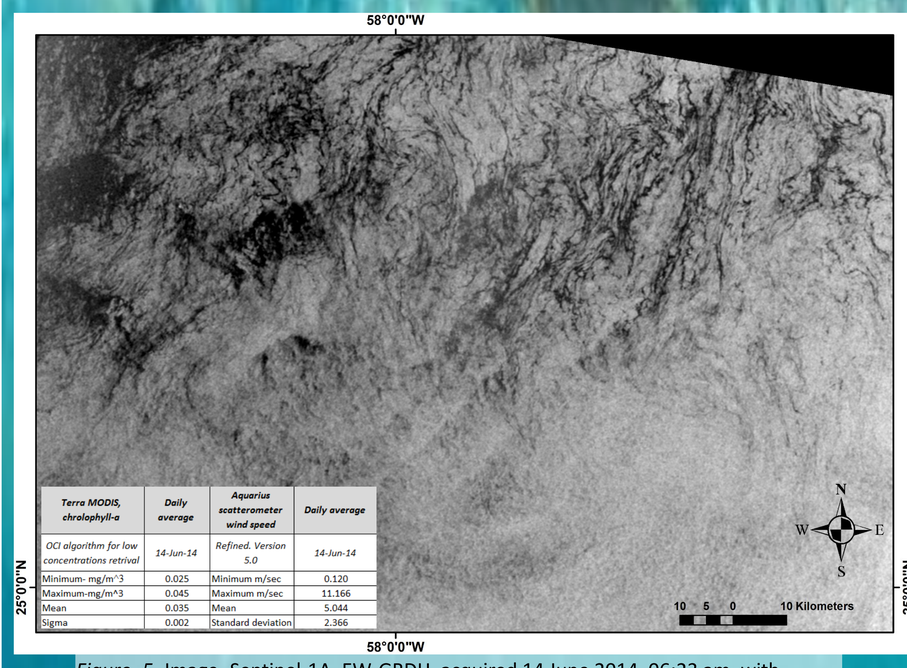


Figure- 5 -Image- Sentinel-1A, EW-GRDH, acquired 14 June 2014, 06:23 am, with corresponding meteorological conditions- daily mean of wind speed and chlorophyll-a

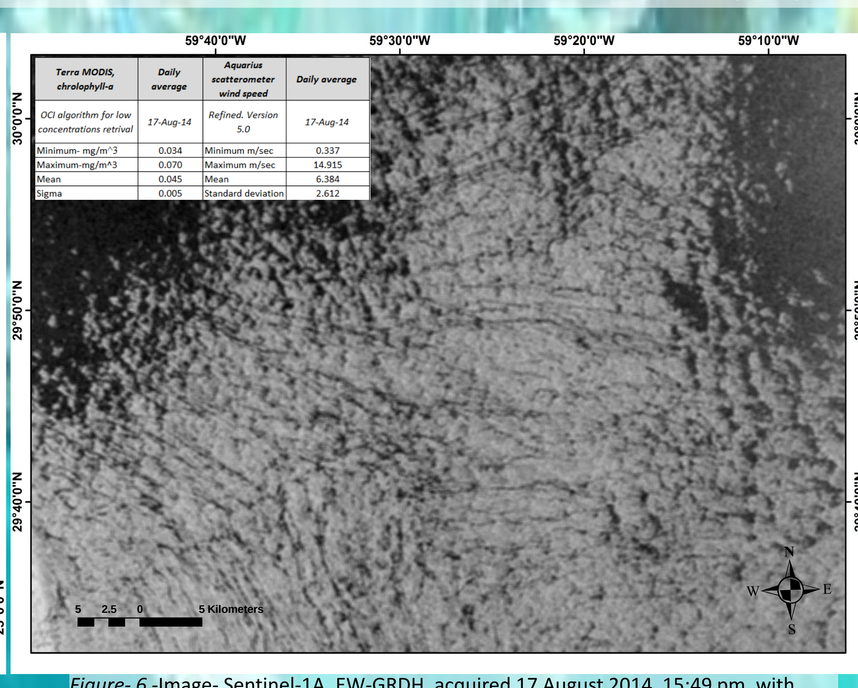


Figure- 6 -Image- Sentinel-1A, EW-GRDH, acquired 17 August 2014, 15:49 pm, with corresponding meteorological conditions- daily mean of wind speed and chlorophyll-a

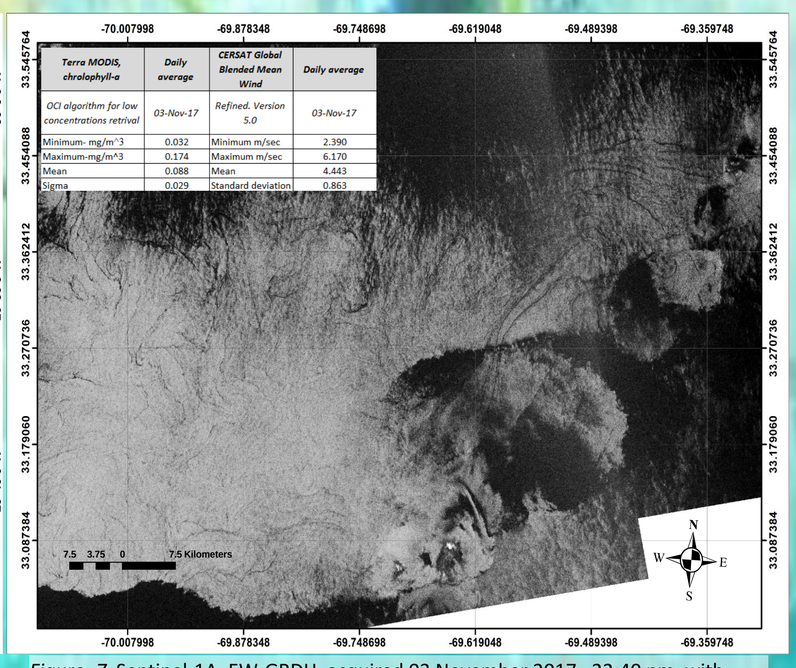
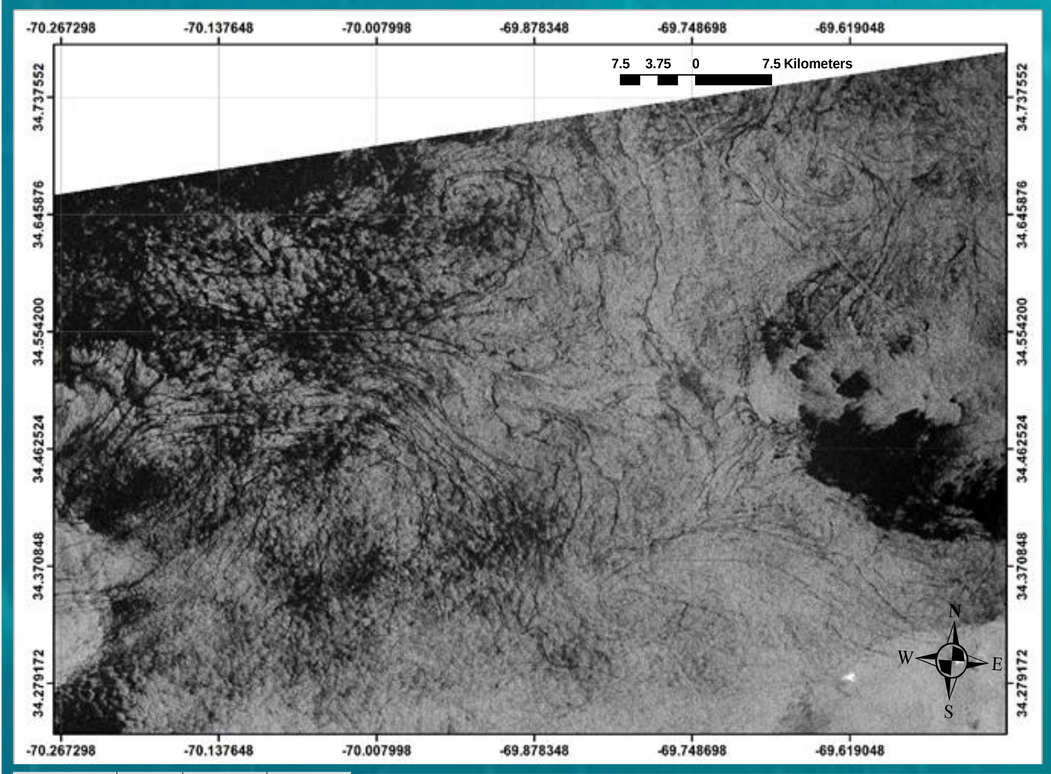


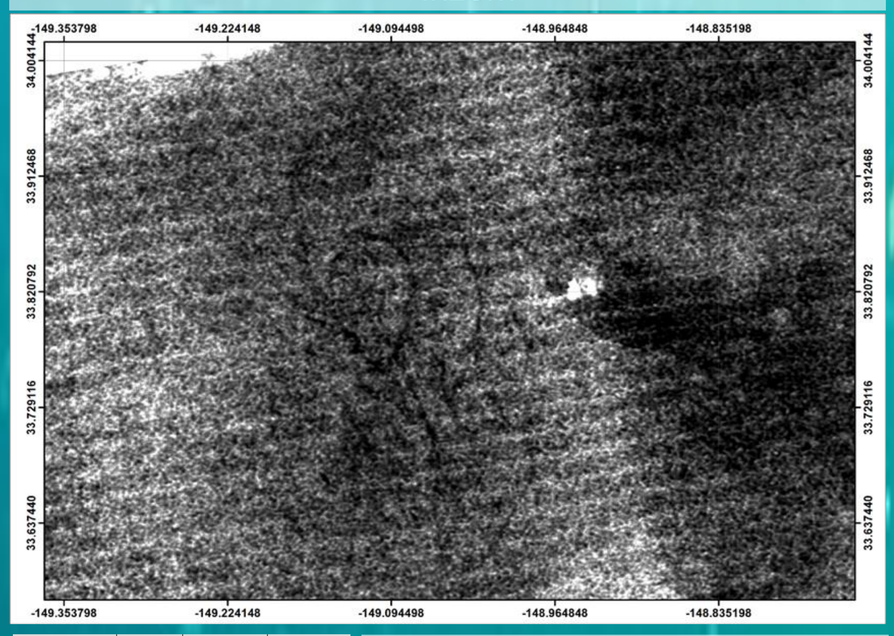
Figure- 7 Sentinel-1A, EW-GRDH, acquired 03 November 2017, 22:40 pm, with corresponding meteorological conditions- daily mean of wind speed, chlorophyll-a



Terra MODIS, chrolophyll-a	Daily average	CERSAT Global Blended Mean Wind	Daily average
OCI algorithm for low concentrations retrival	03-Nov-17	Refined. Version 5.0	03-Nov-17
Minimum- mg/m^3	0.032	Minimum m/sec	2.390
Maximum-mg/m^3	0.174	Maximum m/sec	6.170
Mean	0.088	Mean	4.443
Sigma	0.029	Standard deviation	0.863

Figure- 8 Sentinel-1A, EW-GRDH, acquired 03 November 2017, 22:40 pm, with corresponding meteorological conditions- daily mean of wind speed, chlorophyll-a

North Pacific- COSMO SkyMed, StripMap HIMAGE, Level 1B (DGM); Full resolution after resampling 4x20m



Terra MODIS, chrolophyll-a	Daily average	Aquarius scatterometer wind speed	Daily average
OCI algorithm for low concentrations retrival	18-Jun-13	Refined. Version 5.0	18-Jun-13
Minimum- mg/m^3	0.064	Minimum m/sec	2.535
Maximum-mg/m^3	0.116	Maximum m/sec	6.781
Mean	0.092	Mean	5.258
Sigma	0.013	Standard deviation	1.081

Figure- 9 -Image- COSMO SkyMed, Level 1B DGM, acquired 18 June 2013, 15:45pm with corresponding meteorological conditions- daily mean of wind speed and chlorophyll-a

References:

- ❖ Figure 1- Unpublished report- N. Davaasuren, Armando Marino, Carl Boardman, "Plastic pollution in oceans", 2016, The Open University, UK.
- ❖ Figure 2- N. Kurata, K. Vella, B. Hamilton, M. Shivji, A.Soloviev, S. Matt, A. Tartar, and W. Perrie, "Surfactant- associated bacteria in the near-surface layer of the ocean," Scientific reports, vol. 6, pp. 19123, 2016.
- ❖ Figure 3- Erik van, S., W. Chris, L. Laurent, M. Nikolai, H. Britta Denise, A. v. F. Jan, E. Marcus, S. David, G. Francois & L. Kara Lavender (2015) "A global inventory of small floating plastic debris". Environmental Research Letters, 10, 124006.

✓ Associated processes in microbial colonization, plastisphere:

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✓ Processes at sea surface microlayer initiated by surfactants:

D. Nelson, Suppression of Capillary Waves by Surface-Active Films, MITRE CORP MCLEAN VA, 1985.

M. W. Hansen, V. Kudryavtsev, B. Chapron, C. Brekke, and J. A. Johannessen, "Wave breaking in slicks: Impacts on C-band quad-polarized SAR measurements," IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 9, no. 11, pp. 4929-4940, 2016.

✓ Accumulation mechanism- Langmuir cells:

J. C. McWilliams, and P. P. Sullivan, "Vertical mixing by Langmuir circulations," Spill Science & Technology Bulletin, vol. 6, no. 3-4, pp. 225-237, 2000.

✓ SAR backscatter:

V. Kudryavtsev, D. Hauser, G. Caudal, and B. Chapron, "A semiempirical model of the normalized radar cross-section of the sea surface 1. Background model," Journal of Geophysical Research: Oceans, vol. 108, no. C3, 2003.

ACKNOWLEDGEMENT

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