TASK FORCE REMOTE SENSING OF MARINE LITTER AND DEBRIS

Core Topic 4: Interdisciplinary

Lauren Biermann
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Outline

- Core Topic (CT4) Team
- Goals and Notable Highlights since the RSMLD kick-off
- Expected Outcomes – Reminder of Tasks

CT4 Team Members - Interdisciplinary

IOCCG International Ocean Colour Coordinating Group

Lauren Biermann

Nicola Beaumont

Tim van Emmerik

Georg Hanke

Jenna Jambeck

Fabien Laurier

Nikolai Maximenko

Janet Salem

Grayson Shor

Davida Streett

CT4: Goals

IOCCG International Ocean Colour Coordinating Group

- Evaluate the range of alternative sensors for plastic detection and monitoring (phones, cameras, boat-based to drone to balloon-based sensors, satellites etc).
- Maintain awareness on alternative approaches to data processing, including emerging ML & data normalisation techniques, AC, GitHub, phone apps, software for data hosting and processing.
- Support and develop the new field of interdisciplinary plastics science, composed of a growing community from a range of backgrounds.
- Promote a network of RS information that supports society, where reliable up-to-date information (imagery, statistics) are made accessible to individuals and/or groups involved in activities ranging from raising awareness to sustaining pressure to change legislation.
- Support prevention and mitigation policies on plastics by providing user-defined remote sensing information in 'ready to use' formats preferred by non-experts/ general downstream users and stakeholders.

CT4: Highlights

CT Member Tim van Emmerik's student Paolo Tasseron (WUR):

Open Access | Article

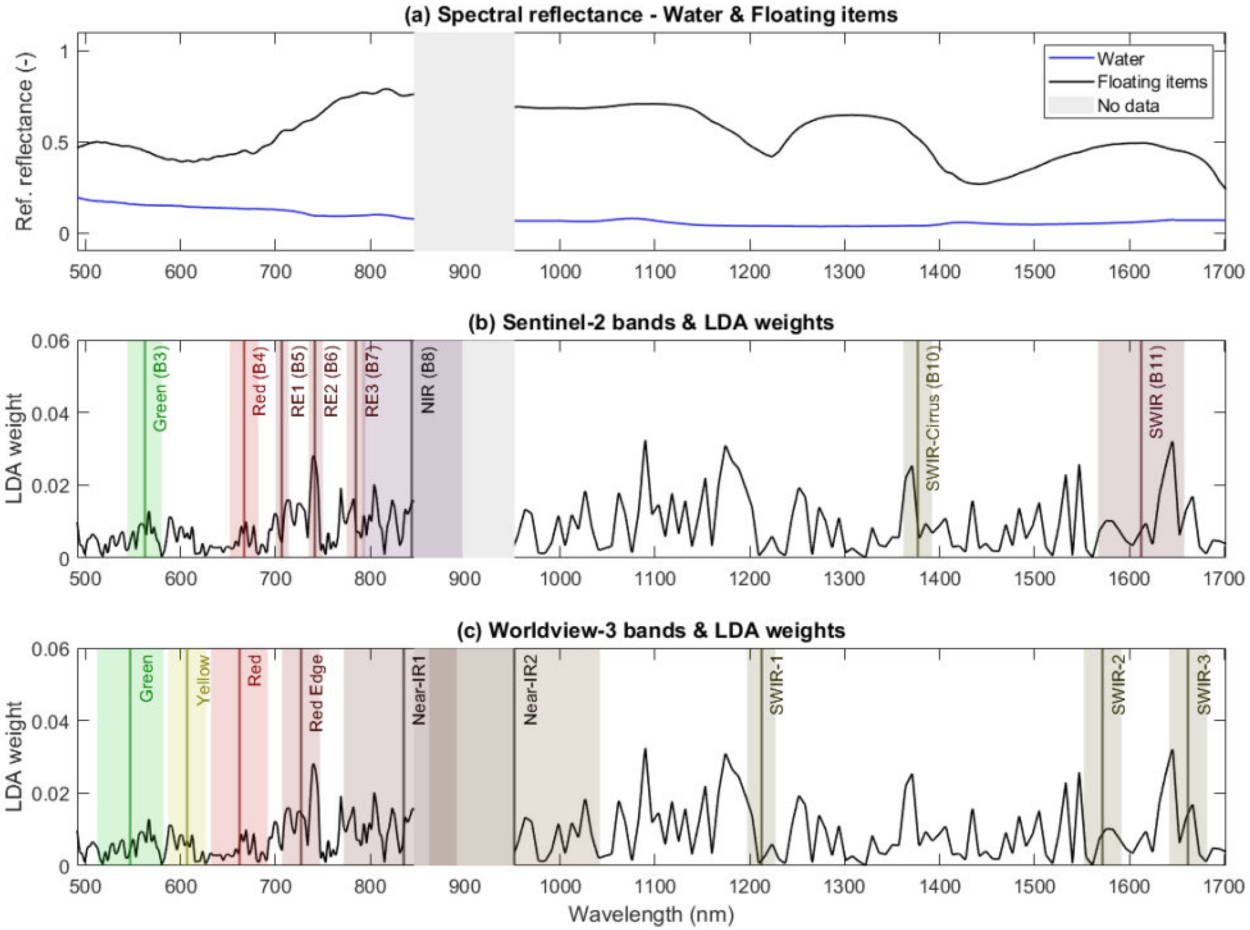
Advancing Floating Macroplastic Detection from Space Using Experimental Hyperspectral Imagery

by Paolo Tasseron [1,*], Tim van Emmerik [1], Joseph Peller [2], Louise Schreyers [1] and Lauren Biermann [3]

Abstract

Airborne and spaceborne remote sensing (RS) collecting hyperspectral imagery provides unprecedented opportunities for the detection and monitoring of floating riverine and marine plastic debris. However, a major challenge in the application of RS techniques is the lack of a fundamental understanding of spectral signatures of water-borne plastic debris. Recent work has emphasised the case for open-access hyperspectral reflectance reference libraries of commonly used polymer items. In this paper, we present and analyse a high-resolution hyperspectral image database of a unique mix of 40 virgin macroplastic items and vegetation. Our double camera setup covered the visible to shortwave infrared (VIS-SWIR) range from 400 to 1700 nm in a darkroom experiment with controlled illumination. The cameras scanned the samples floating in water and captured high-resolution images in 336 spectral bands. Using the resulting reflectance spectra of 1.89 million pixels in linear discriminant analyses (LDA), we determined the importance of each spectral band for discriminating between water and mixed floating debris, and vegetation and plastics. The absorption peaks of plastics (1215 nm, 1410 nm) and vegetation (710 nm, 1450 nm) are associated with high LDA weights. We then compared Sentinel-2 and Worldview-3 satellite bands with these outcomes and identified 12 satellite bands to overlap with important wavelengths for discrimination between the classes. Lastly, the Normalised Vegetation Difference Index (NDVI) and Floating Debris Index (FDI) were calculated to determine why they work, and how they could potentially be improved. These findings could be used to enhance existing efforts in monitoring macroplastic pollution, as well as form a baseline for the design of future multispectral RS systems.

Keywords: remote sensing; Sentinel-2; earth observation; plastic monitoring; spectral reflectance



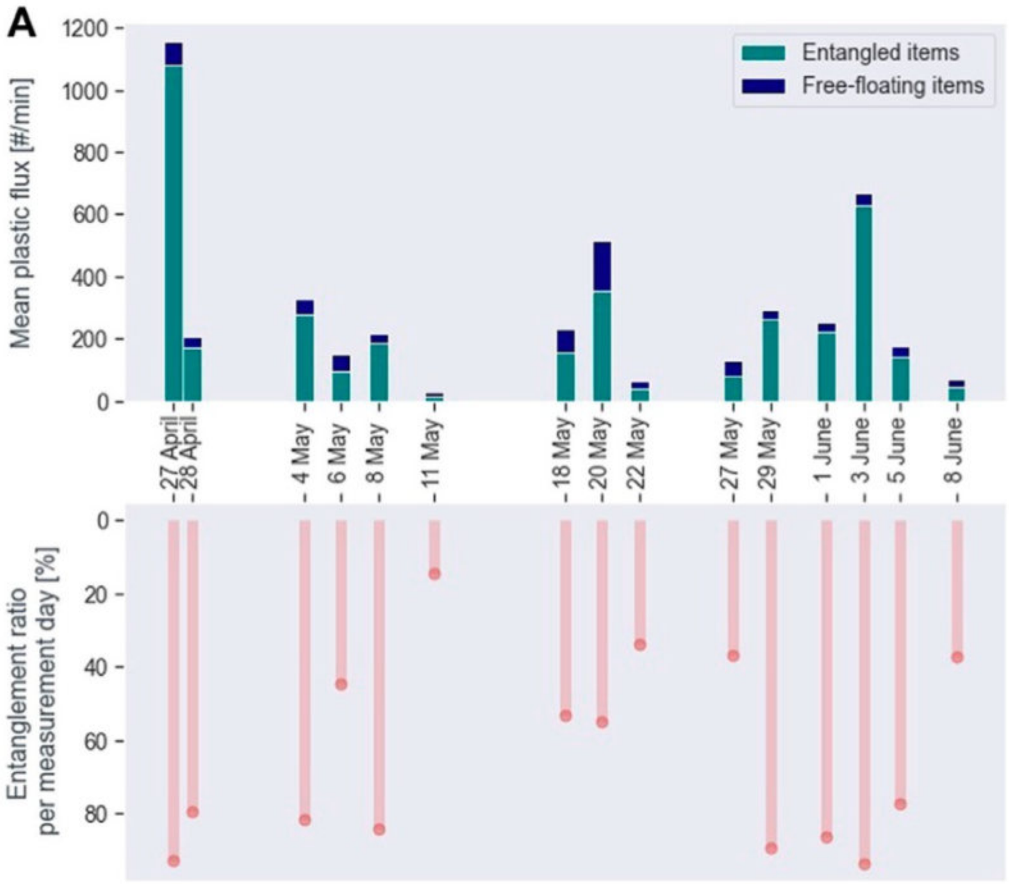
CT Member Tim van Emmerik's student Louise Schreyers (WUR):

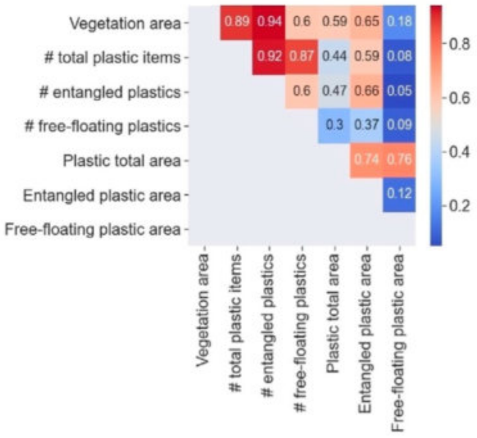
Plastic Plants: The Role of Water Hyacinths in Plastic Transport in Tropical Rivers

Louise Schreyers[1], Tim van Emmerik[1], Thanh Luan Nguyen[2], Evelien Castrop[1], Ngoc-Anh Phung[3], Thuy-Chung Kieu-Le[3,4], Emilie Strady[5], Lauren Biermann[6] and Martine van der Ploeg[1]*

[1]Hydrology and Quantitative Water Management Group, Wageningen University, Wageningen, Netherlands, [2]École Polytechnique de Montréal, Montréal, QC, Canada, [3]Faculty of Geology and Petroleum Engineering, Ho Chi Minh City University of Technology (HCMUT), Ho Chi Minh City, Vietnam, [4]Vietnam National University Ho Chi Minh City, Ho Chi Minh City, Vietnam, [5]Mediterranean Institute of Oceanography (MIO), CNRS/IRD, Aix-Marseille University, Université de Toulon, Marseille, France, [6]Plymouth Marine Laboratory, Plymouth, United Kingdom

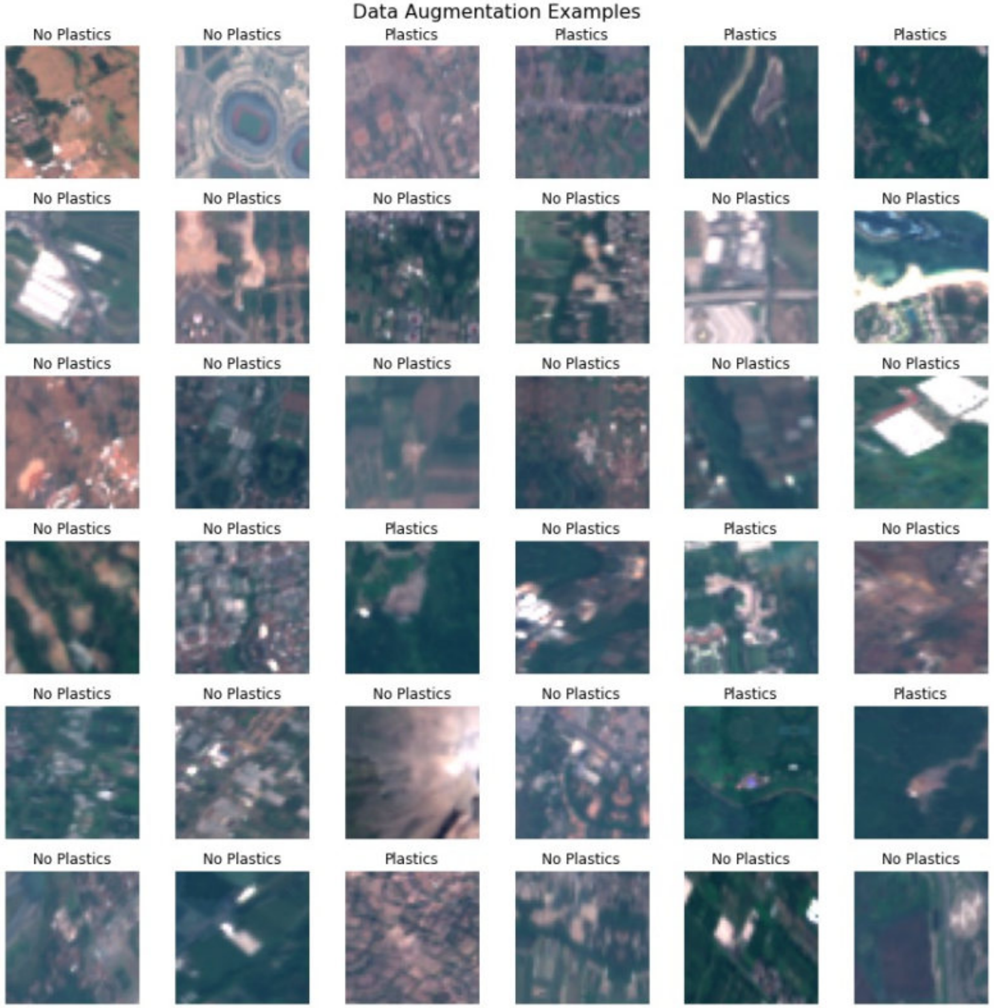
Recent studies suggest that water hyacinths can influence the transport of macroplastics in freshwater ecosystems at tropical latitudes. Forming large patches of several meters at the water surface, water hyacinths can entrain and aggregate large amounts of floating debris, including plastic items. Research on this topic is still novel and few studies have quantified the role of the water hyacinths in plastic transport. In this study, we present the findings of a six-week monitoring campaign, combining the use of visual observations and Unmanned Aerial Vehicle imagery in the Saigon river, Vietnam. For the first time, we provide observational evidence that the majority of macroplastic is transported by water hyacinth patches. Over the study period, these fast-growing and free-floating water plants transported 78% of the macroplastics observed. Additionally, we present insights on the spatial distribution of plastic and hyacinths across the river width, and the different characteristics of entrapped items compared with free-floating ones. With this study, we demonstrate the role of water hyacinths as a river plastic aggregator, which is crucial for improving the understanding of plastic transport, and optimizing future monitoring and collection strategies.





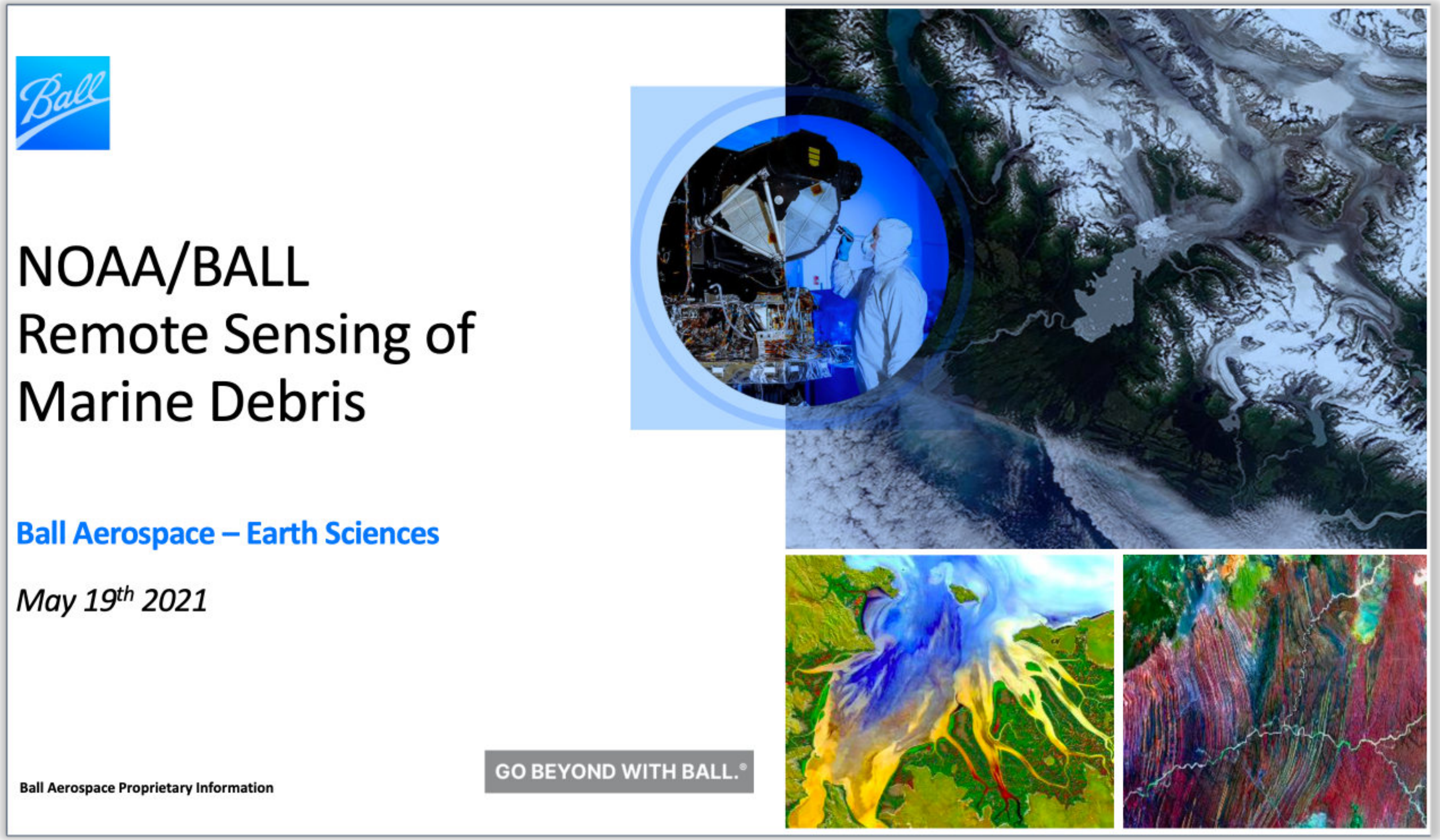
CT4: Highlights

CT Member Fabien Laurier (Minderoo), Caleb Kruse and Edward Boyda (Earthrise):



CT4: Highlights

CT Member Davida Streett (NOAA) and Fabien Laurier (Minderoo):



FLUORESCENCE LIDAR EXPERIMENT (FLEx)

COMPACT HYPERSPECTRAL PRISM SPECTROMETER (CHPS)

<u>Letter of Support from PML:</u>
Plastics are most often submerged, and optical satellites cannot "see" far below the water surface. Building on the near/below surface studies of CALIPSO, this project proposes to investigate the capability of a fluorescence lidar system, to identify submerged marine debris.

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CT4: Highlights

IOCCG International Ocean Colour Coordinating Group

EGU Session on Plastic Pollution, led by Early Career Researchers, with talks given by 12 scientists from a range of research backgrounds.

ITS2.7/ESSI2

Detecting and Monitoring Plastic Pollution in Rivers, Lakes, and Oceans.

Global plastic production has increased exponentially since the fifties, with 359 million metric tons manufactured in 2018 alone. Nearly 20% of this production took place within Europe, where at least half of discarded plastics collected for 'recycling' were instead exported to China and SE Asia. Every year, an increasing proportion of these plastics (in the order of millions of tons) enter and accumulate in our waterways and oceans. In riverine and marine systems, the presence of micro to macroplastic debris has generated a growing and persistent threat to the environment and ecosystems, as well as an urgent and multi-dimensional challenge for our society.

Methods for resource-efficient and large-scale detection and monitoring of plastic litter are still relatively new. However, in the last few years, they have blossomed across technologies and environments - from mounted cameras to drones to satellites, and from lakes and rivers to coastal waters and open oceans. These new technologies can be crucial to fill in the gaps between limited in situ observations and global models, allowing coverage across fine as well as large spatial scales, and over long time periods. We invite abstracts describing the use of cameras, drones, satellites and other remote sensing techniques to observe and monitor riverine and marine plastics. We also welcome work describing or demonstrating new approaches, methods and algorithms to improve the use of cameras and sensors for plastic detection on (and in) water.

Share: https://meetingorganizer.copernicus.org/EGU21/session/40471

Co-organized by EOS7/GI4/HS12/OS4

Convener: Lauren Biermann[ECS] | Co-conveners: Katerina Kikaki[ECS], Cecilia Martin[ECS], Irene Ruiz[ECS], Tim van Emmerik[ECS]

vPICO presentations | Thu, 29 Apr, 13:30–14:15 (CEST)

CT4: Highlights

International Ocean Colour Coordinating Group

All Atlantic Marine Litter Side Event hosted by Dr Audrey Hasson.

Challenges and Opportunities in monitoring the sources and pathways of Marine Debris in the Atlantic Ocean

Virtual event, 3 June, 11:30 – 13:30 UTC

> ***Monitoring of marine litter quantities and impacts is an integral part of any successful Strategy to reduce both. Monitoring is directly relevant for designing measures, and for assessing their effectiveness. National and regional data collection and monitoring activities should be adequate and compatible. This should be also reflected in a future efficient global architecture to fight plastic pollution – Michail Papdoyannakis (European Commission)***

The event served to catalyse linkages, actions and coordination of stakeholders and scientists addressing the challenges of marine litter in countries across the Atlantic Ocean. Hosted by Dr Audrey Hasson, the GEO Blue Planet EU coordinator, this was an official side event at the All-Atlantic 2021 Conference, which took place from 2 – 4 June 2021.

With 125 participants from 33 countries around the world in attendance, the event facilitated a dialogue between Atlantic key partners to identify needs, issues and opportunities around the monitoring and mitigation of marine debris. It also served to establish essential collaborations

CT4: Highlights

IOCCG International Ocean Colour Coordinating Group

AGU Ocean Sciences Session on Plastic Pollution now submitted and accepted for February 2022.

From Origins to Oceans: Detecting and Monitoring Plastic Pollution using Emerging Technologies and Approaches.

Character count: 2000 / 2000

Global plastic production has increased exponentially since the fifties with 368 million metric tons manufactured in 2019 alone. Nearly 20% of this production took place within Europe, and another 20% in the USA. Together, Europe and North America are also responsible for almost half of global plastic waste exports to South-East Asian countries, predominantly. An increasing proportion of these discarded plastics (in the order of millions of tons) enter and accumulate in our waterways and oceans every year. From riverine sources to marine systems, the presence of plastic debris has generated a growing and persistent threat to the environment and ecosystems, as well as an urgent and multi-dimensional challenge for our society.

Methods for resource-efficient and large-scale detection and monitoring of plastic litter are still relatively new. However, they are blossoming across technologies and environments - from mounted cameras to drones to satellites, and from rivers to coastlines and open oceans. These new technologies can be crucial to fill in gaps between in situ observations and global models, allowing coverage across spatial scales and over long time periods. We invite abstracts describing the use of cameras, drones, satellites and other remote sensing techniques to observe and monitor riverine and marine plastics. We also welcome work describing or demonstrating new methods and algorithms to improve the use of cameras and sensors for plastic detection on (and in) water.

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CT4: Highlights

CCG International Ocean Colour Coordinating Group

CT Member Fabien Laurier (Minderoo and Earthrise):

You Retweeted

Minderoo Foundation @minderoo

REVEALED: just 20 companies - supported by a small group of financial backers - are responsible for producing over 50% of the world's single-use #plastic waste.

View the list here: plasticwastemakersindex.org

#PlasticWasteMakersIndex #SourceOfPlasticWaste #WeSeeYou #NoPlasticWaste

7:16 AM · May 18, 2021 · Twitter Web App

111 Retweets **26** Quote Tweets **131** Likes

INITIATIVES ABOUT NO PLASTIC WASTE Featured COVID-19

Project Home | Findings | Data | Downloads | About | Demand Change

No Plastic Waste › Plastic Waste Makers Index › Data › Indices › Top 100 Banks

PLASTIC WASTE MAKERS INDEX

TOP 100 BANKS FINANCING POLYMER PRODUCERS

Twenty of the world's largest banks, including Barclays, HSBC and Bank of America, have lent an estimated US$30 billion for the production of single-use plastic polymers since 2011.

Producers | Investors | Banks

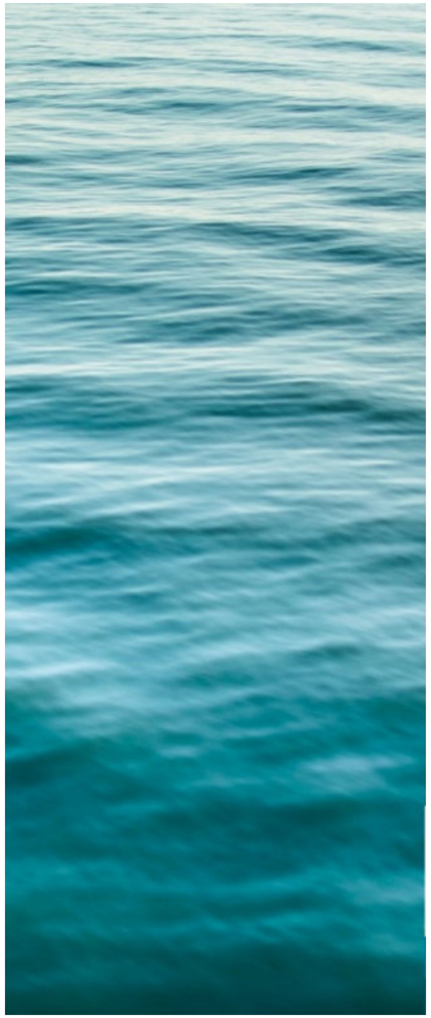
Notes regarding the table below:

- Number of deals is defined as lending and under-writing deals (2011 to 2020).
- Total value of loans and underwriting is in US$BN.
- Value of loans and underwriting adjusted for share of business from in-scope polymer production is estimated, and in US$BN (from Jan 2011 to Dec 2020).
- Single-use plastic (SUP).

Rank	Bank	Headquarters location	Number of deals (2010-2019)	Number of companies lending & underwriting	Total value of loans & underwriting	Value share of loans of SUP polymer production	Value share of equity underwriting of SUP polymer production	Value share of bonds underwriting of SUP polymer production	Total value share of lending & underwriting of SUP polymer production
1	Barclays	United Kingdom	477	23	68.3	3.1	0.7	1.5	5.4
2	JPMorgan Chase	United States	636	28	90.5	2.7	0.3	2.0	5.0
3	Citigroup	United States	746	32	96.7	2.8	0.4	1.9	5.1
4	Bank of America	United States	561	27	73.3	2.9	0.1	1.2	4.2
5	HSBC	United Kingdom	600	36	68.5	3.1	0.2	1.4	4.7

CT4: Highlights

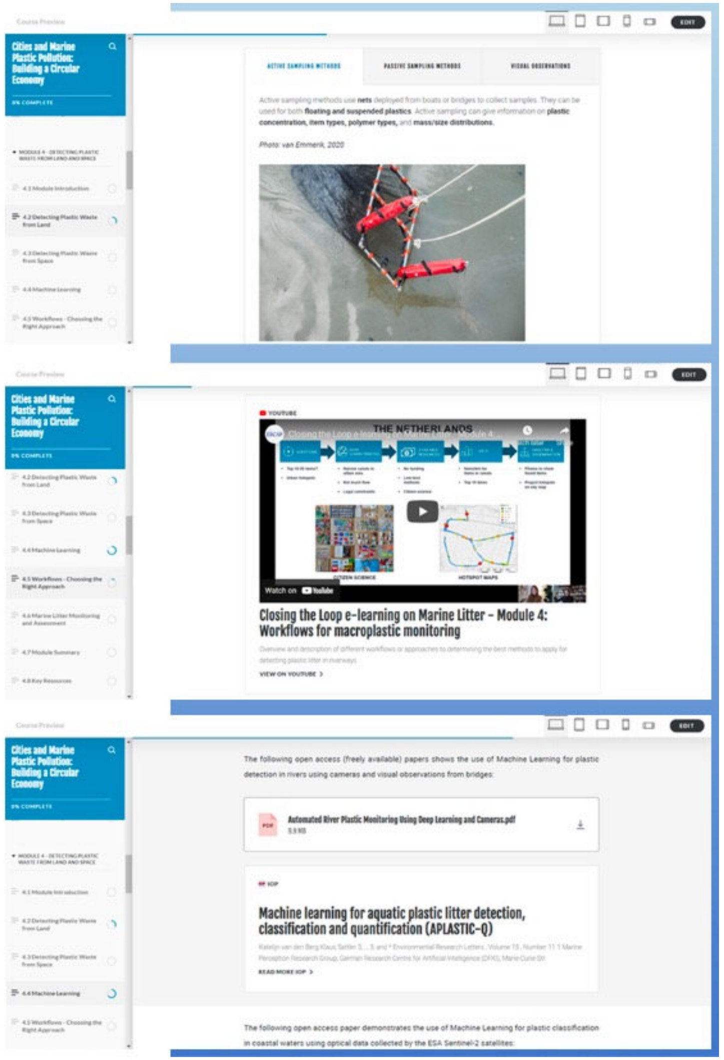
CT Member Janet Salem (UN), Tim van Emmerik (WUR) and PML



MODULE 4:

Detecting Waste from Land and Space

- **Developer:** Plymouth Marine Lab, Wageningen University & Research, Keio University
- **Aim:** Module 4 explores the different methods to detect and classify floating plastic in rivers and coastal waters. Notably: the use of cameras, counters, satellites, drones and machine learning techniques.
- **Highlights:**
  - *4 videos by Dr. Lauren Biermann and Dr. Tim van Emmerik*
  - *Case Study – 5D World Map System as a platform for plastic data*
  - *Comparison of methodologies and workflow tutorial. Focus on cost-effective methods and freely available data sources.*



CT4: Highlights

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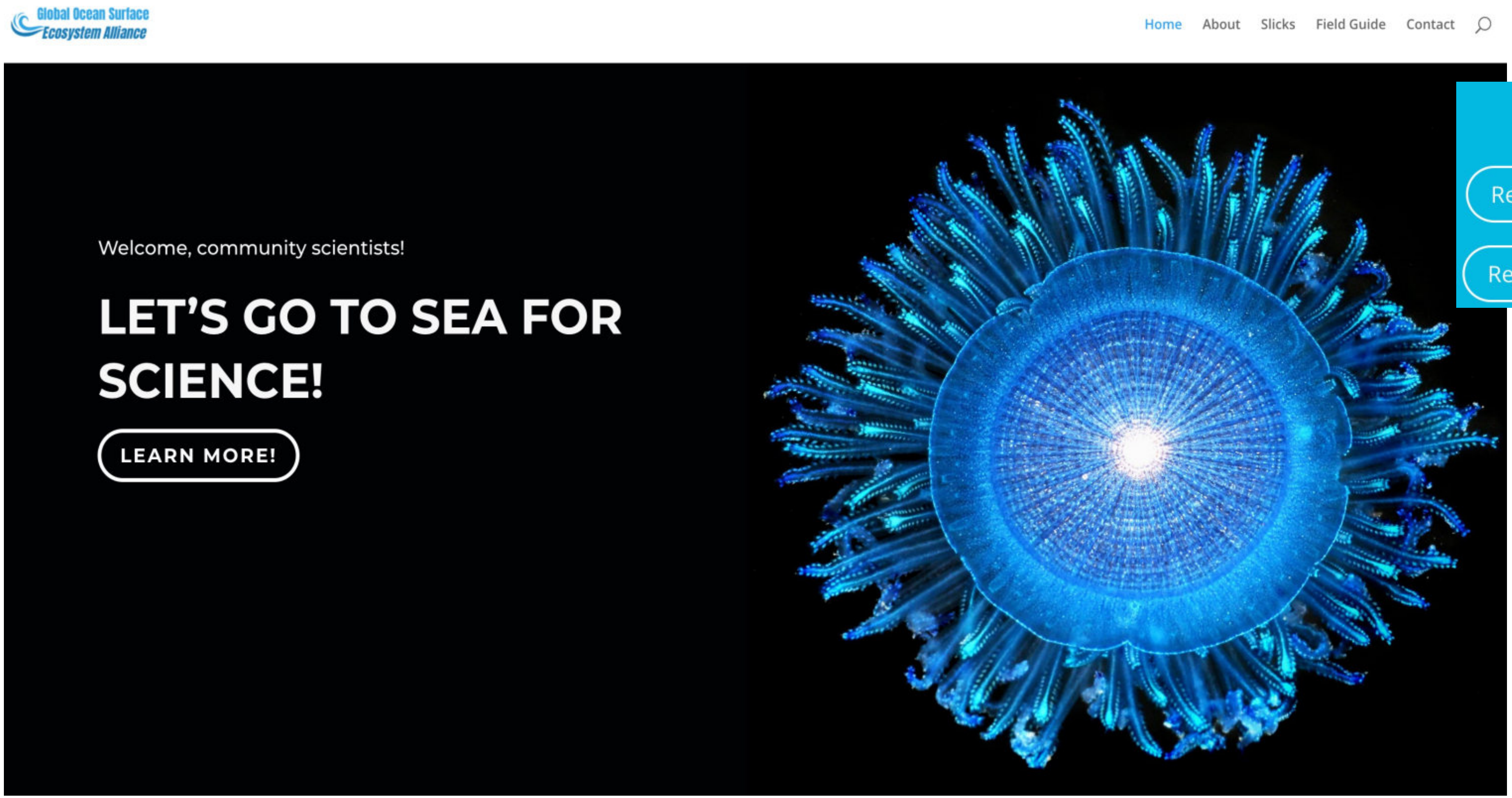
CT Member Nikolai Maximenko (University of Hawaii) and partners



CT4: Highlights ***and a big thank you!***

IOCCG International Ocean Colour Coordinating Group

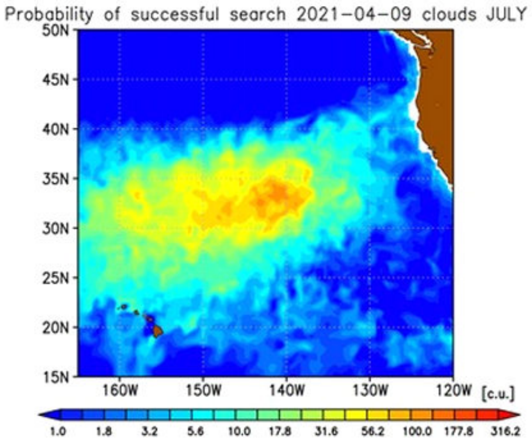
IOCCG RSMLD Task Force
Core Topic on Interdisciplinary Aspects

Preliminary Data Acquisition Plan – Proposal

Request to ESA for extended collection of Sentinel-2 imagery over key ocean gyres.

After discussion with the scientific community of the Task Force, this is the proposed Preliminary Data Acquisition Plan for Sentinel-2 over the gyres:

		Sets of AOI	Time period	Rationales
Pacific North Gyre	Scenario 1*	30–35 N, 140–145 W (See Figure 1)	2-3 months (May - July/Aug)	Support removal of plastic debris
	Scenario 2	30–35 N, 145–150 W (See Figure 1)	2-3 months (May - July/Aug)	Support removal of plastic debris
Atlantic North Gyre	Scenario 1			
	Scenario 2			



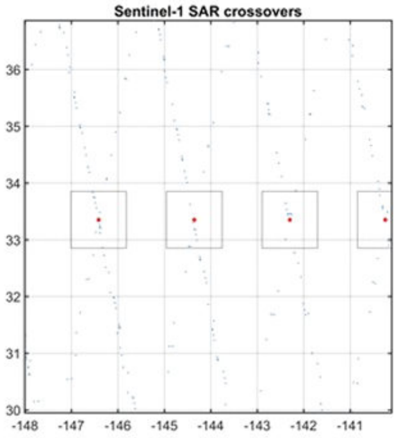
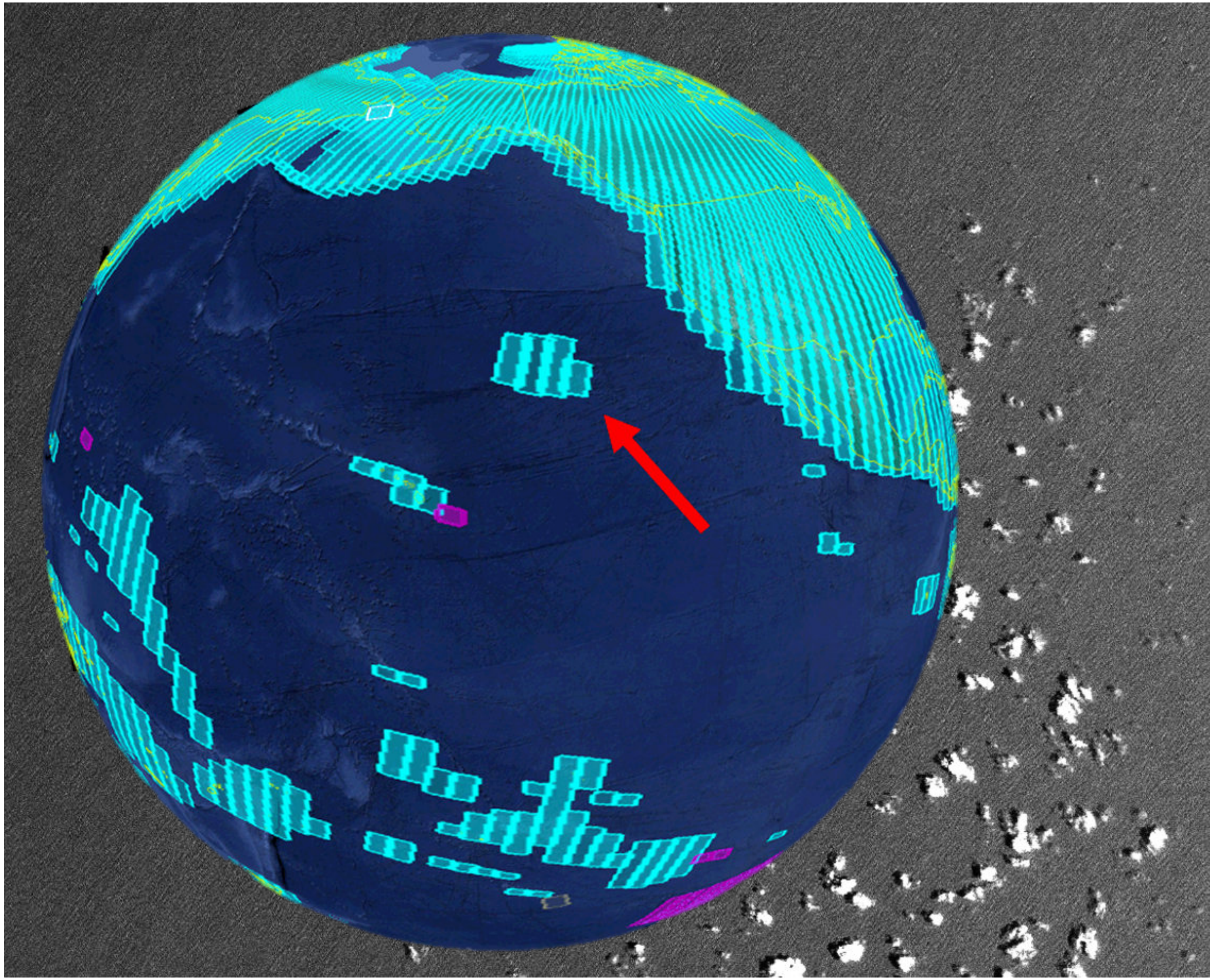


Figure 1: *Area of Interest (AOI) with the highest likelihood for plastic aggregation and cloud-free conditions shown in orange to red (left). Sentinel-1 Wave Mode data are collected within this AOI for detection of aggregating features like slicks and fronts, to further assist with debris detection in optical data (right). Maximum debris concentration estimated around 142W, 33N* which is close to Sentinel-1 WM crossover (142.30W, 33.35N). Figures and data generated by Nikolai Maximenko and Jan Hafner respectively, to support OVI clean-ups and extended ESA Sentinel-2 data collection from 2021 onwards.*



CT4: Expected Outcomes

CT4 Deliverables:

1. Living list of the range of sensors and techniques used for plastics detection.
2. Living list of data-driven additions for Plastics Detection and Monitoring.
3. Plastics as a new Interdisciplinary Science.
4. Supporting Data Sources for Society.
5. Supporting Evidence and Data for Policy and Legislation.

Thank you

International Ocean Colour Coordinating Group