

Template for Annual SCOR Working Group Reports to SCOR

1. Name of group

Floating Litter and its Oceanic Transport Analysis and Modelling (FLOTSAM)

2. Activities since previous report to SCOR (e.g., virtual or in-person meetings, email discussions, special sessions). Limit 1000 words

The second official WG153 meeting was held in Utrecht (NL) on May 6-9th 2019. The program of the meeting and information have been provided in the First Year Annual Report.

In this report we describe activities from May 2019 to May 2020.

After meeting in Utrecht we discussed the necessary actions to:

- Revisiting the current state of knowledge on the dynamics and ocean phenomena that control the dispersion of floating marine debris;
- Identifying key knowledge gaps in this dispersion.
- Writing a review paper on the findings of the workshop.

WG 153 is a global and geographically widely distributed SCOR group and regular videoconference are heavily affected by time zone related problems, therefore we decided to use email as the regular media for the exchange of information. There was no scheduled email exchange or newsletter but the chairs of the WG exchanged emails within the group and outside of the group, according to needs. A shared space on Google Drive was used to write papers or to exchange large files.

Many WG group partners regularly met at major Meetings and Congresses and the updates and exchange of information was prompt and complete.

A list of meeting where the FLOTSAM topics had been addressed is reported.

Atlantic from Space workshop 2019, Southampton (UK), 23-25 January 2019

ESA organised workshop to gather community requirements to establish a regional research funding call for the Atlantic area. Marine plastic community interests were represented there by Victor Martinez-Vicente, from SCOR-FLOTSAM, and other members of the community. This resulted on the inclusion of marine plastic debris in the description of the call for proposals in 2020.

2019 Living Planet Symposium Milan (ITA) 13-17 May 2019

Dedicated sessions: LPS2019 Session A4.01 Current and Potential Multisensor Approaches to Marine Litter Detection, May 14, 2019. Convener: Victor Martinez-Vicente. Co-convenors: Shungu Garaba, Emmanuele Organelli, Laia Romero, Julia Reisser, Guillaume Bonnery, Vagelis Spyrakos, Paolo Corradi, Manuel Arias Ballesteros . Chair Stefano Aliani and Paolo Corradi. The session was about multisensor approaches to marine litter detection and included 13 contributions.

27 IUGG Conference, Montreal (CAN) 8-18 July 2019

Keynote talk by Erik Van Sebille at session U01c - Achieving Sustainable Development: The Role for Earth Sciences. Title: Our Plastic Oceans: Sources, Fate and Risk of Marine Litter Presentation number: IUGG19-0518

The keynote highlighted that ocean currents and eddies carry floating plastic from coastlines into the infamous garbage patches in the centres of the gyres with time scales and pathways still unknown. To assess impact, it is key to know where plastics get carried through vulnerable ecosystems. Earth

scientists, making observations, gathering data and developing models of the 'behaviour' of plastic in our oceans, not only help solve the plastic problem, but also learn how our ocean works.

Dedicated Session P10 - Role of ocean processes in the transport and fate of floating plastic litter in the ocean and shelf-seas: theory, modelling and observations <http://iugg2019montreal.com/p.html>

Convener: Erik van Sebille, Co-Conveners: Kara Lavender Law, Stefano Aliani, Nikolai Maximenko.

The session marine debris is transported by the ocean on a large range of scales. The way that these different phenomena affect the dispersion of marine debris, and how this leads to the emergence of patchy accumulation regions and 'hotspots', is a major knowledge gap. Presentations on advances in the theory and modelling, supported by observations, of marine plastic debris of all sizes had been addressed. Topics included but were not limited to:

- The stirring of buoyant debris due to turbulence, particularly in the mixed layer.
- The transport of plastic in coastal seas, from surf zone to open ocean.
- The effects of Stokes drift, Langmuir circulation, and other (nonlinear) wind effects on the transport of debris.
- The effects of fragmentation, degradation, bio-aggregation and biofouling on the evolution of the buoyancy of debris particles.
- Development of and comparison between tools and software to simulate the dispersion of debris.

These dedicated sessions concentrated on some of the knowledge gaps that have been addressed during FLOTSAM Meetings #1 and #2.

ESA User Consultation Meeting, Cambridge UK 16–17 July 2019

The Earth observation scientific community invited us to participate in a European Space Agency (ESA) User Consultation Meeting at the Robinson College, University of Cambridge. This consultation was a critical input to the decision-making process to the selection of ESA's ninth Earth Explorer mission. Two candidate Earth Explorer fast-track missions – FORUM and SKIM – have been undergoing feasibility studies. Erik Van Sebille and Stefano Aliani represented FLOTSAM.

Hawaii Marine Debris Action Plan Research Workshop, July 25-26, 2019, Hawaii Pacific University, Waimanalo, HI (USA)

Presenter: Maximenko. FloatEco: Study of Physical and Biological Processes Maintaining a Unique Floating Ecosystem of the North Pacific Garbage Patch.

OceanObs'19 in Honolulu 16-20 September 2019

A session has been organised and dedicated to the idea of a Global Observing system for marine debris Leading (IMDOS). Chair was Nikolai Maximenko. The outcome was a white paper published in *Frontiers in Marine Science*. <https://doi.org/10.3389/fmars.2019.00447>. Some contacts have been taken with GOOS to implement IMDOS. Also, Maximenko participated in the OceanObs Research Collaboration Network meeting February 16 2020 and discussed practical steps for building IMDOS.

SCOR Annual meeting, Toyama (Japan) 22 Sept. Invited talk presentation: Victor Martinez-Vicente. Can satellites, drones and other remote sensing platforms help us solve the marine plastic litter problem? This presentation was followed up with an invited talk in Tokyo in the Saskawa Peace Foundation.

Ocean Surface Topography Science Team Meeting, October 21-25, 2019, Chicago (USA)

Preliminary results of FloatEco: experimental study of physical and biological processes maintaining the floating ecosystem. Presenter: Maximenko.

The Science of Microplastics in the World Ocean, Woods Hole, MA October 2019

Morss Colloquium (public event): Kara Lavender Law, keynote speaker. "Microplastics in the Ocean: Emergency or Exaggeration?"

Presentation: Kara Lavender Law, "Plastics as tracers to understand physical ocean processes"

French-American Workshop: Responding to Plastic Pollution through Science: from research to action, Le Mans, FRA, December 12 – 13, 2019.

Maximenko, N., Effects of ocean circulation on long-range debris drift and biological rafting.

Ocean Science Meeting in S. Diego USA. 16-21. February 2020

Plenary keynote on 18 February 2020. The connected ocean: the global-scale transports of heat, nutrients, plankton and plastic by ocean currents by Erik van Sebille.

Dedicated sessions:

- [OM41A - Lagrangian Methods for Understanding Ocean Circulation and Tracer Transport I eLightning](#)
- [OM42A - Lagrangian Methods for Understanding Ocean Circulation and Tracer Transport II eLightning](#)
- [OM44A Lagrangian Methods for Understanding Ocean Circulation and Tracer Transport III Posters](#)
- [OM41A-03 Antarctic Biological Invasions Driven by Stokes Drift and Mesoscale Variability](#)
- [CP52B-08 Photochemical dissolution of buoyant microplastics to dissolved organic carbon: Rates and microbial impacts.](#)

Sessions co-chaired by Stefano Aliani and Kara Lavender Law (with Tracy Mandel and Nimish Pujara), and moderated by Stefano Aliani, Kara Lavender Law and Erik van Sebille (with others):

- [PS31A - Physical Processes Governing the Distribution and Transport of Dispersed Particles in the Ocean I](#)
- [PS33A - Physical Processes Governing the Distribution and Transport of Dispersed Particles in the Ocean II](#)
- [PS34D - Physical Processes Governing the Distribution and Transport of Dispersed Particles in the Ocean III Posters](#)
- [PS44C - Physical Processes Governing the Distribution and Transport of Dispersed Particles in the Ocean IV Posters](#)

US CLIVAR Workshop on Surface Currents in the coupled ocean-atmosphere system February 22-23, 2020 at Scripps Institution of Oceanography (USA).

Van Sebille and Maximenko discussed effects of ocean currents on transport of debris and debris as a Lagrangian tool to measure ocean currents.

93rd Meeting of the Ocean Studies Board of the National Academies of Sciences, Engineering and Medicine (March 10, 2020, Washington, DC), Kara Lavender Law gave a presentation on FLOTSAM. In a public roundtable session that followed, she served on a panel discussing, "Path to a Plastic-Free Ocean".

Virtual Presentation to International Ocean Colour Coordinating Group (IOCCG) Executive members. 28

April 2020. Victor Martinez-Vicente, Paolo Corradi, Shunghu Garaba, Manuel Arias with comments from Nikolai Maximenko, presented the progress from ESA projects to the IOCCG group including SCOR-FLOTSAM discussions. The aim is to try to set up a dedicated Task force group in IOCCG

dedicated to marine litter problem detection from ocean colour, to which ToR3 of FLOTSAM has been a seminal activity.

A virtual meeting was held on April 29 among Chairs and Patricia Miloslavich (SCOR), who fostered discussion about the feasibility to detect if reduction in human activities due to COVID has led to any changes in the amount and/or distribution of marine floating plastics since the beginning of the pandemic and if any subsequent impact can be measured / forecasted. Topic is still under discussion.

3. Documents published since previous report to SCOR (e.g., peer-reviewed journal articles, reports, Web pages) and should be limited to publications that resulted directly from WG activities and which acknowledge SCOR support

The website <http://scor-flotsam.it> has been regularly updated. It is hosted on GitHub and CNR servers and administrated by E. Van Sebille. WG 153 is also hosted in SCOR website (http://www.scor-int.org/SCOR_WGs_WG153.htm).

The following FLOTSAM publications included the outcome of the WG153 workshops:

Van Sebille et al. The physical oceanography of the transport of floating marine debris.

This paper was the result of a very successful global scientific collaborative effort. A first draft coming from Utrecht's meeting discussions was first made available online on Google Drive for editing by partners and then by a selection of relevant invited external experts. Then, it was pre-published in an online repository to get more comments and suggestions from the all scientific community interested in the topic. After some stimulating inputs from the community through the web, which we included in the text, the ms was submitted to *Environmental Research Letters* Topical Review for peer review and published on 17 February 2020 as Open Access free available article. The paper has been **downloaded 5247 times** on 1 June 2020. **Citation:** van Sebille et al 2020 Environ. Res. Lett. 15 023003.

<https://iopscience.iop.org/article/10.1088/1748-9326/ab6d7d>

Maximenko et al Towards the Integrated Marine Debris Observing System (IMDOS). Frontiers in Marine Science Community White Paper

This paper aims to stimulate the establishment of a best-practice-guide as well as optimization and expansion of the existing observational network to the Integrated Marine Debris Observing System (IMDOS). It's a relevant wide effort, coordinated by SCOR co-chair Nikolai Maximenko, to prepare a global observing system for plastic at sea. A network of in situ observations, including reports from volunteers, citizen scientists and ships of opportunity, will be developed to provide data for calibration/validation of remote sensors and to monitor the spread of plastic pollution and other marine debris. IMDOS will interact with other observing systems in the ocean and on shorelines. The paper has been **downloaded 1731 times** on 1 June 2020

Citation: Maximenko et al. 2019 Front. Mar. Sci. | <https://doi.org/10.3389/fmars.2019.00447>.

Martinez-Vicente et al. Towards marine plastic debris detection from satellite remote sensing. Remote Sensing .

The initial steps towards the potential design of remote sensing system for marine debris were described by: identifying the properties of marine plastic debris amenable to remote sensing methods and highlighting the oceanic processes relevant to marine plastic debris. Remote sensing approaches were reviewed and matched to the optical properties of marine plastic debris and the relevant scales of observation to identify challenges and opportunities.

Citation: Martinez-Vicente et al. Remote Sensing Volume 11 Issue 20 10.3390/rs11202443 The paper has been **downloaded 3066 times** on 1 June 2020 <https://www.mdpi.com/2072-4292/11/20/2443/htm>

Biermann, et al., Finding Plastic Patches in Coastal Waters using Optical Satellite Data. Scientific Reports Satellites collecting optical data offer a unique perspective to observe plastic litter in the marine environment. For the first time, we show that patches of floating macroplastics are detectable in optical data acquired by the European Space Agency (ESA) Sentinel-2 satellites and are distinguishable from naturally occurring materials such as seaweed.

Citation: Biermann et al. 2020, *Sci Rep* volume 10, Article number:5364 <https://www.nature.com/articles/s41598-020-62298-z>

I. Chubarenko, et al. From macro to micro, from patchy to uniform: Analyzing plastic contamination along and across a sandy tide-less coast. Marine Pollution Bulletin, Volume 156, 2020, The abundance of small-microplastics (0.5–2 mm) at the beach face is similar for all the locations and replicates. Swash-zone mixing, water percolation, importance of sediment pore size (rather than grain size), natural sorting of plastic particles at the beach face are considered.

Wichmann et al, Influence of near-surface currents on the global dispersal of marine microplastic. Journal of Geophysical Research

Buoyant microplastic in the ocean can be submerged to deeper layers through biofouling with consequent loss of buoyancy or by wind-induced turbulent mixing at the ocean surface. Particles in deeper layers are transported by currents that are different from those at the.

References <https://doi.org/10.1029/2019JC015328>. This paper was chosen as Research Spotlight by JGR editors

Haram et al. A Plasticene Lexicon. Marine Pollution Bulletin. 150 (2020), 110714, <https://doi.org/10.1016/j.marpolbul.2019.110714>

The paper brings together disparate neologisms into a single lexicon to encourage use of a unified vocabulary to describe the new reality of ecological, chemical, and geological systems in the age of plastics.

Murray, Therriault, Maki, and Wallace [Eds.] 2019. The Effects of Marine Debris Caused by the Great Japan Tsunami of 2011, PICES Special Publication 6, 278 pp.

The report includes 17 chapters, summarizing physical studies of tsunami debris dispersal from Japan and biological research on the debris impact on and interaction with the marine ecosystem.

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The report includes 17 chapters, summarizing physical studies of tsunami debris dispersal from Japan and biological research on the debris impact on and interaction with the marine ecosystem.

Ryan P et al. 2020 The transport and fate of marine plastics in South Africa and adjacent oceans. South African Journal of Science Vol 116, N5/6 <https://doi.org/10.17159/sajs.2020/7677>.

Local condition of transport and fate of marine plastic litter in South Africa are presented.

Ryan et al 2020. Monitoring marine plastics – will we know if we are making a difference? South African Journal of Science: Vol 116 No 5/6. <https://doi.org/10.17159/sajs.2020/7678>
Monitoring is required to assess whether mitigation measures to reduce waste plastics at sea are making a difference.

Van Gennip et al. In search for the sources of plastic marine litter that contaminates the Easter Island Ecoregion. *Sci Rep* 9, 19662 (2019). <https://doi.org/10.1038/s41598-019-56012-x>
High-resolution ocean circulation models are used with a Lagrangian particle-tracking tool to identify the connectivity patterns of the EIE with industrial fishing areas and coastline regions of the Pacific basin

4. Progress toward achieving group's terms of reference. List each term of reference separately and describe progress on each one. Limit 1000 words

The WG made relevant progresses toward objective through meeting, sessions at scientific congresses, email exchanges and Skype calls.

TOR1 - Identify gaps in our knowledge of the near-surface ocean dynamics that may affect litter distribution and transport

The paper VanSebille et al. (2020) identifies relevant oceanographic processes affecting marine litter distribution and transport and the gaps in the present state of knowledge have been ranked according to their relevance for marine debris studies. In the paper sections relevant to ToR2 have been included.

TOR 2 - Improve future marine litter modelling capabilities

The current state of modelling of marine debris has been discussed in different occasions and summarised in several conference dedicated sessions. In the review paper some chapters relevant to ToR2 have been included.

TOR3 - Evaluate existing and emerging remote sensing technologies that can be applied to marine litter in the open ocean

The community white paper published by Maximenko et al. (2019) summarises the outcomes of this WG relevant to ToR 3. It has been considered in 2 ESA funded projects related to remote sensing of marine debris. In the review paper by VanSebille et al., some chapters relevant to ToR 3 have been included. Other papers published by WG partners on remote sensing took advantage of discussion at our meetings and precedent meetings and discussions organised by ESA in 2017 to gather users requirements. The ESA consultation meeting in Cambridge was a critical input to the decision-making process to the selection of ESA's ninth Earth Explorer mission.

TOR4 - Improve awareness of the scientific understanding of marine debris, based on better observations and modelling results.

FLOTSAM website has been regularly updated with news.

Participants of WG153 chaired sessions at several conferences and in many institutions.

Communication with media and interviews with newspapers has been regularly performed.

5. WG activities planned for the coming year. Limit 500 words

6. The 3rd FLOTSAM meeting was planned to be held in Japan in September 2020. The meeting would be hosted by Dr. Isobe (Kyushu Univ.) and Dr Chiba (JAMSTEK) and co-sponsored by the Lounsbery Foundation through awarded grant (PI: Dr. Law). **Due to COVID 19 this meeting is postponed.**
- 7.
8. The Chairs of FLOTSAM have considered a number of options and contingencies to address the rapidly evolving situation of COVID19 but, given the situation, we have decided to postpone the 3rd meeting of our Working group that was planned for Fall 2020 in Japan. This has not been an easy decision. However, due to various countries' travel restrictions that have been put in place in response to COVID-19, many partners might be unable to attend meetings in Fall 2020. It will therefore not be possible to deliver the inclusive and international knowledge-sharing conference that we are aiming for.
9. In the meantime, we are going to proceed with the expectation that people interested in our topics will join the web meetings or online conferences we might decide to organize. A dedicated poll will be sent to receive feedbacks.
- 10.

11. Is the group having difficulties expected in achieving terms of reference or meeting original time schedule? If so, why, and what is being done to address the difficulties Limit 200 words

We encountered fundamental problems in organizing the final meeting due to COVID19 pandemic and the resulting lockdown in many countries. The WG plans to reschedule the meeting in 2021 as soon as it becomes possible. Although some preliminary agreements have been reached, at the time of this report no reliable information can be provided.

12. Any special comments or requests to SCOR. Limit 100 words.

We are grateful to SCOR, who graciously extended our working group terms to the end of 2021.

Additional information can be submitted and will be included in the background book for the SCOR meeting at the discretion of the SCOR Executive Committee Reporter for the WG and the SCOR Secretariat.