GESAMP WORKING GROUP 38

THE ATMOSPHERIC INPUT OF CHEMICALS TO THE OCEANS

Annual Report to SCOR by the Co-Chairmen of GESAMP Working Group 38

Robert Duce and Timothy Jickells

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During the past year GESAMP WG 38 has focused its attention on the following four areas: 1) Carrying out a virtual workshop on the atmospheric transport of microplastics to and from the ocean in collaboration with WG 40; 2) Continuing development of a workshop on the ocean management and policy implications of the air/sea exchange of chemicals; 3) Expansion of interactions with the Future Earth research program Surface Ocean - Lower Atmosphere Study (SOLAS); and 4) Carrying out other WG activities. In addition, we present information on peer-reviewed publications of WG 38 in 2020 and 2021 and plans for WG 38 for 2021-2022.

WG 38 Activities during 2020-2021

1. Workshop on the Atmospheric Transport of Microplastics to and from the Ocean

WG 38, in cooperation with GESAMP WG 40, carried out a virtual "**Workshop on the atmospheric transport of microplastics to and from the ocean"** on November 17-19, 2020. The Terms of Reference for this workshop were as follows:

- Identification of our current understanding and quantitative estimation of the major sources and types of atmospheric microplastics, their atmospheric transport paths, and their inputs to and emissions from the global ocean; and

- Development of guidelines on appropriate future atmospheric and marine sampling and measurement methods and strategies, to enable more accurate estimations of the above to be made.

Tim Jickells and Robert Duce (Co-chairs of WG 38) and Peter Kershaw (Chair, WG 40) were conveners of the workshop. Steve and Deonie Allen (UK), Daoji Li and Kai Liu (China), Peter Liss (UK), Maria Kanakidou (Greece), and Oksana Tarasova (WMO, Switzerland) were members of the Organizing Committee. Twenty-nine individuals from fourteen nations who have had experience with atmospheric and oceanic microplastics or with air/sea exchange of material participated in the three-day workshop. The workshop was organized around 8 different sessions related to microplastics in the atmosphere and ocean. These were:

- Brief presentations by individuals or groups that have made measurements of atmospheric microplastics or have made flux calculations to the ocean.
- A general discussion of what the major unknowns are in our understanding of atmospheric microplastics and their transport to/from the ocean.

- Discussion of sources of atmospheric microplastics, their relative strengths, and their emission and transport characteristics.
- Discussion of how to determine a good estimate of the transport of microplastics to and from the global ocean, considering sources, transport modelling, monitoring, recycling from the ocean surface, etc.
- Consideration of needs and required future advances relative to sampling and measurement techniques and sampling locations for microplastics.
- Discussion of possible modelling approaches for atmospheric transport of microplastics to the oceans and other information needs.
- Consideration of a synthesis report and publication writing tasks to be undertaken by individuals or groups, type of publications and/or reports, to be prepared, and timeframe for outputs to be completed.

We consider that the workshop was quite a success. At the present a detailed peer-reviewed review paper for submission is being prepared under the lead authorship of Steve and Deonie Allen, who are among the leaders in the measurement of microplastics in the atmosphere/ocean system. We expect that paper will be submitted for publication by late summer or early fall, and we also expect to develop a report for the GEAMP Reports and Studies series by shortly after the end of the year.

2. Continuing development of a workshop on the ocean management and policy implications of the air/sea exchange of chemicals

As described in the 2020 report of WG 38, plans have been developed, funds have been obtained from several UN agencies and from SOLAS, and individuals have been invited for a workshop which was to be held in October 2020 at Nelson Mandela University, Gqeberha (formerly Port Elizabeth), South Africa. This workshop is entitled **"What is the potential role of atmospheric deposition in driving ocean productivity in the Madagascar Channel and Southwest Indian Ocean – an adaptive-dynamic management approach within Large Marine Ecosystems".** Unfortunately, due to COVID-19, this in-person workshop was postponed until October 2021. However, continuing concern about COVID-19 in South Africa and other parts of the world have forced us to postpone this workshop once again, now expecting it to take place in October 2022. The workshop will include international scientists, managers, and policymakers, and it would evaluate the atmospheric inputs and impacts of nutrients from biomass burning and industrial emissions to the Madagascar Channel and the southwest Indian Ocean, with the following objectives:

◊ To evaluate the current knowledge of the atmospheric inputs into the southwest Indian Ocean and scientific evidence for the factors that control algal blooms in this region, including the potential role of atmospheric deposition, and the confidence in our understanding of these factors.

◊ To debate the associated potential impacts and management implications with a broader group of stakeholders/experts (including social scientists and economists)

◊ To present this information to decision-makers at the senior management and policy level for their response and advice on adaptive management steps

- ◊ To identify the feasibility of institutionalizing such an adaptive/dynamic management process at the regional level and linking it into national management processes.

- ◊ In parallel with this process, to introduce young and emerging scientists to the debate and the science involved and to build capacity for this dialogue within the region.

Because a significant part of this workshop involves students and early career scientists, we do not believe that a virtual format would be appropriate. Thus, we continue to work toward an in-person workshop in South Africa. We are optimistic that conditions will enable this workshop to be carried out in the latter part of 2022 in Gqeberha. We appreciate very much the willingness of the supporting UN agencies and SOLAS to continue to support this workshop. even after two postponements.

3. Expansion of interactions with the Future Earth research program Surface Ocean- Lower Atmosphere Study (SOLAS)

The primary focus of the Future Earth international research program SOLAS (Surface Ocean – Lower Atmosphere Study) is to understand the key biogeochemical-physical interactions and feedbacks between the ocean and atmosphere. This, in turn, is important to understand and quantify the role that ocean-atmosphere interactions play in the regulation of climate and global change. GESAMP WG 38 and SOLAS have many similar scientific and policy interests, and in recent years interactions between the two groups have been growing. For example, recent WG 38 workshops have included many scientists who work in SOLAS, including several individuals on the SOLAS Scientific Steering Committee. In addition, SOLAS has been a strong supporter of several WG 38 workshops, including providing funding for participants. This year several additional interactions have taken place.

Tim Jickells has been asked by SCOR and Future Earth to co-chair the committee reviewing SOLAS for the period 2015-2020. Robert Duce is also a member of that review committee.

In June 2021 SOLAS asked Robert Duce to give an invited paper at the **Sustainable Research & Innovation Congress 2021 (SRI2021)** in Brisbane, Australia in the session “The Apparent Mismatch Between Science and Policy At The Air-Sea Interface”. The title of his presentation was “Chemicals and the air-sea interface – who cares?”.

4. Other WG 38 Activities

For the eighth year in a row WG 38 organized a session on atmospheric input of chemicals to the ocean for the 2021 European Geosciences Union meeting, held in Vienna, Austria in April – “Air-sea Exchanges: Impacts on Biogeochemistry and Climate”. A number of oral and poster papers at this session were presented by a combination of WG 38 members and other scientists.

Tim Jickells, Robert Duce, Melanie Bergmann, and Peter Liss (all members of WG 38) have organized a session at the American Geophysical Union Fall Meeting in December 2021 in New Orleans, LA entitled “Microplastics in the Atmosphere and Ocean”.

WG38 continues to maintain contact with the International Nitrogen Initiative, and Tim Jickells has contributed to their developing nitrogen flux methods publication.

Peer-reviewed publications of WG 38 in 2020 and 2021

18. Liss, P.S., 2020, "Microplastics: All up in the air?", Marine Pollution Bulletin, **153,** https://doi.org/10.1016/j.marpolbul.2020.110952.

19. Hopkins, F.E., P. Suntharalingam, M. Gehlen, O. Andrews, et al., 2020," The impacts of ocean acidification on marine trace gases and the implications for atmospheric chemistry and climate. Proceeding of the Royal Society A, **476**: 20190769. http://dx.doi.org/10.1098/rspa.2019.0769.

20. Baker[1], A.R., M. Kanakidou, A. Nenes, et al., 2021, "Changing atmospheric acidity as a modulator of nutrient deposition and ocean biogeochemistry", Science Advances, **7**, eabd8800.

Plans for WG 38 for 2021-2022.

Working Group 38 has the following plans for the period 2021-2022:

- Carrying out the workshop on the ocean management and policy implications of the air/sea exchange of chemicals at Gqeberha, South Africa in October 2022.
- Completing the peer reviewed publications of all previous WG 38 workshops, including the recent one on the atmospheric transport of microplastics to and from the ocean.
- Developing a GESAMP Reports and Studies document on the results from the WG 38 workshop on the changing acid/base character of the global atmosphere and ocean and the impact of these changes on certain air/sea chemical exchange processes.
- Developing a GESAMP Reports and Studies document on the results from the WG 38 workshop on the atmospheric transport of microplastics to and from the ocean.

Except for the support confirmed earlier by several UN agencies for the work of WG 38, we do not expect to ask for any additional support this coming year. We sincerely appreciate the fact that WMO and other UN agencies, as well as SOLAS, have been able to carry forward their planned support for the South African workshop, even though it has now been postponed twice due to COVID-19.

[1] related press-release is available here https://www.uea.ac.uk/news/-/article/atmospheric-acidity-impacts-oceanic-ecology