



**GESAMP**

Joint Group of Experts on the  
Scientific Aspects of Marine  
Environmental Protection

GESAMP 52/4/2  
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52nd Session  
Agenda item 4

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## **PLANNING OF GESAMP ACTIVITIES**

### **Atmospheric input of chemicals to the ocean**

#### **Report of the co-Chairs of Working Group 38**

## **INTRODUCTION**

1 GESAMP Working Group 38, was formed in 2008 with support from WMO. Up to now, WMO continues to be the primary financial sponsor of WG 38. The efforts of the working group have focused primarily on the atmospheric transport and deposition to the ocean of dust and the nutrients iron, phosphorus, and nitrogen and their impacts on marine biogeochemistry. The primary outputs of WG 38 have been papers in peer-reviewed scientific literature. To date 21 papers have been published and others are in preparation. The Working Group has also published three reports in the GESAMP Reports and Studies Series and a fourth is now in press. In addition, each year, since 2014, the Working Group has been sponsoring a special session on air/sea chemical exchange at the annual meeting of the European Geosciences Union in Vienna.

2 During the past year, GESAMP WG 38 has focused its attention on the following four areas:

- .1 Completion of a GESAMP Reports and Studies document, in cooperation with GESAMP WG 40, titled “The Atmospheric Transport of Microplastics to and from the Ocean: Proceedings of a GESAMP International Workshop”, as well as a “Summary for Policymakers” from the same workshop;
- .2 Development of a paper from a workshop in South Africa on the ocean management and policy implications of the air/sea exchange of nutrients over the southwest Indian Ocean;
- .3 Organization of a session on air/sea chemical exchange at the 2025 European Geosciences Union General Assembly in Vienna, Austria in April, 2025; and
- .4 Holding an international workshop at the University of Crete in Heraklion, Greece, titled “Research priorities for improving global flux estimates of atmospheric deposition to the ocean”. This is a joint, new initiative between WG 38, WMO/GAW, and SOLAS.

## WG 38 Activities during 2024 to 2025

### ***Completion of a GESAMP Reports and Studies document entitled “The Atmospheric Transport of Microplastics to and from the Ocean: Proceedings of a GESAMP International Workshop” as well as a “Summary for Policymakers” from the same workshop.***

3 The forthcoming Reports and Studies (R&S) publication, currently in press following production delays, describes the outcome of a joint workshop between GESAMP Working Groups 38 and 40 to consider the relative importance to the marine environment of the atmospheric transport of microplastics (defined as plastic particles < 5mm diameter). The R&S document explains the background to the three-day on-line workshop held in late 2020 to consider this issue and summarizes the conclusions.

4 Microplastics within the marine environment have emerged as an issue of widespread public and scientific interest over the past decade. However, it is only very recently that the potential of the atmosphere as a vector of microplastics transport has been considered. The recognition of this newly emerging issue prompted GESAMP to develop this activity.

5 The overall purpose of the Workshop was to bring together many of the leading researchers from across the world who had scientific expertise and knowledge in one or more aspects of this complex phenomenon. The Workshop had two main objectives:

- .1 to identify our current understanding, and provide a 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
- .2 to develop guidelines on appropriate future sampling and measurement as well as modelling methods and strategies for atmospheric microplastics.

6 The workshop concluded that atmospheric transport is likely to be an important transport route for microplastics to the ocean, for the recycling of microplastics within the ocean, and for the return transport to land. Microplastics are very long-lived contaminants with few well identified mechanisms of complete degradation. It is likely that, during the environmental lifetime of plastics, they are subject to repeated cycles of emission to the atmosphere and re-deposition to the land or ocean. During these cycles plastic particles may become smaller and change their environmental behavior, with consequent changes to exposure pathways and changes to the risk of potential negative impacts but will not necessarily become less harmful. This environmental cycling of microplastics means that addressing the issue of microplastic pollution in the ocean will require not only management of emissions, but also consideration of the legacy of plastic material already released into the environment.

7 The primary scientific findings from the workshop were published by Allen et al. (2022) in *Nature Reviews, Earth and Environment*. The following conclusions were reached by consensus and were provided in a separate Summary for Policymakers:

- .1 the evidence to date suggests that atmospheric transport may indeed be an important route by which microplastics reach the ocean, alongside emissions from other sources such as rivers and sewage discharges, although the current data available to substantiate this case is limited;
- .2 the ocean may be an important source of microplastics to the atmosphere and land via resuspension of microplastics previously released into the ocean;

- .3 atmospheric transport and recycling allow the effective and rapid transport of microplastics to even the most remote areas of the Earth, far from the primary sources of plastic emissions to the environment;
- .4 emissions to the atmosphere, and resuspension of previously released plastic material from both land and the ocean, probably forms an important part of the global cycle of microplastic particles;
- .5 the original sources of such plastic material are widespread and disparate, including manufactured plastic material, precursors of such material, textiles, paints and plastic coatings and vehicle tire and brake wear;
- .6 in such a global environmental microplastics cycle, plastic material released into the environment can be both resuspended and also degraded into successively smaller particles over a microplastic item's environmental lifetime of many years and
- .7 the societal goal of reducing the environmental burden of microplastics will require not only control of primary emissions of such material into the environment, but also consideration of the existing legacy of plastic material previously released into the environment, over many decades.

8 The available database with which to quantify and model the atmospheric transport of microplastics and its role within the entire environmental cycle of microplastics remains limited. This database needs to be improved to allow effective environmental management strategies for this pollution problem to be developed. Given the evidence that this process is a quantitatively substantial component of the global cycle of microplastics, the workshop report also recommended:

- .1 research to improve and standardize sampling and analytical methods for atmospheric microplastics;
- .2 further research to improve an understanding of the processes involved in atmospheric transport of this material; and
- .3 a systematic global long-term program of monitoring of atmospheric microplastics be developed over remote areas of the ocean.

***Development of a paper from a workshop in South Africa on the ocean management and policy implications of the air/sea exchange of nutrients over the southwest Indian Ocean***

9 The reporting of the outcomes of this meeting has been delayed and has, in part, been overtaken by the publication of a related study by another group. This has led to debate about the best options for publication of the GESAMP workshop, which is still ongoing.

***Organization of a session on air/sea chemical exchange at the 2025 European Geosciences Union General Assembly in Vienna, Austria in April, 2025***

10 For the twelfth year in a row WG 38 organized a session jointly with SOLAS on the atmospheric input of chemicals to the ocean for the 2025 European Geosciences Union meeting, held in Vienna, Austria in April – “Air-Sea Exchanges: Impacts on Biogeochemistry and Climate”. Oral and poster papers at this session were presented by a combination of WG 38 members and other scientists.

***Carrying out a new initiative entitled “Research priorities for improving global flux estimates of atmospheric deposition to the ocean”.***

11 The new workshop was held at the University of Crete, Heraklion, Greece from 7 to 10 April 2025. Primary support came from WMO and its Global Atmospheric Watch Programme with additional contributions from SOLAS, IAEA, IMO, GESAMP, and the University of Crete. The Working Group greatly acknowledges this excellent support.

12 Atmospheric deposition of nutrients and contaminants make an important contribution to ocean biogeochemical cycles. The workshop addressed the issue that both mathematical/computer models of the transport and deposition of chemicals from the atmosphere to the ocean, and the techniques for the actual physical and chemical measurement of these fluxes have significant weaknesses and flaws. To date there has been no holistic effort to address the current weaknesses of, and how to improve, the measurement and modeling of the fluxes of different gaseous and particulate substances between the atmosphere and the ocean, and the workshop was designed to address this issue. To do this, there were 3 primary areas of focus at the workshop: modeling of deposition to the ocean; measurement of deposition to the ocean; and measurement-model fusion.

13 The workshop Terms of Reference were:

- .1 identify the status and weaknesses of, and how to improve, the modelling of the net fluxes of different gaseous and particulate substances from the atmosphere to the ocean;
- .2 document existing atmospheric sampling sites/networks in coastal and oceanic regions and identify future priorities for both sampling locations and analytical determinants for measurement of the net atmospheric flux of critical chemicals to the ocean;
- .3 Identify key improvements in the techniques used to combine observations with numerical models (measurement /model fusion) for the determination of atmosphere/ocean fluxes; and
- .4 publish the outcomes of the workshop in appropriate peer-reviewed scientific journals and in the GESAMP Reports and Studies series.

14 29 international scientists from 15 nations participated in this workshop, including several early career scientists. The meeting seems to have been successful, promoting lively discussions amongst modelers and observations and between the groups leading to the workshop participants identifying several ways to improve estimates of atmospheric deposition to the ocean.

15 A number of papers focusing on workshop results are currently being developed by workshop participants for publication in the peer-reviewed scientific literature, and we anticipate the subsequent synthesis of these publications into a GESAMP Reports and Studies publication.

### **Plans for WG 38 for 2025-2026**

16 Working Group 38 has the following plans for the period 2025 to 2026:

- .1 publication of the GESAMP Reports and Studies document “The Atmospheric Transport of Microplastics to and from the Ocean: Proceedings of a GESAMP International Workshop” by WMO;
- .2 completion of the peer-reviewed paper presenting findings of the 2022 workshop in South Africa on the ocean management and policy implications of the air/sea exchange of nutrients in the southwest Indian Ocean;

- .3 completion of peer-reviewed paper(s) emanating from the April, 2025 Crete workshop on “Research priorities for improving global flux estimates of atmospheric deposition to the ocean”;
- .4 development of a session on air/sea exchange of chemicals at the April 2026 European Geosciences Union General Assembly in Vienna; and
- .5 transition of the leadership of WG 38 from the current co-chairs, Robert Duce and Timothy Jickells to the new co-chairs, Alex Baker and Maria Kanakidou, which will take place during 2026, when all the documents from the Crete workshop should have been completed. During this time, the membership of WG 38 will also be refreshed.

**Action requested of GESAMP**

- 17 GESAMP is invited to consider the information provided and take action as appropriate.

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**ANNEX**

**Current Membership of GESAMP Working Group 38**

Robert Duce, Co-chair (United States) (M)  
Timothy Jickells, Co-chair (United Kingdom) (M)

Sajjad Abbasi, Iran (M) (early career)  
Deonie Allen, New Zealand (F)  
Katie Altieri, South Africa (F)  
Alex Baker, United Kingdom (M)  
Cecile Guieu, France (F)  
Frances Hopkins, United Kingdom (F)  
Akinori Ito, Japan (M)  
Maria Kanakidou, Greece (F)  
Daoji Li, China (M)  
Peter Liss, United Kingdom (M)  
Natalie Mahowald, United States (F)  
Morgane Perron, Australia/France (F) (early career)  
Mike Roberts, South Africa (M)  
Monmohan Sarin, India (M)

(16 members; 9 male, 7 female, 2 early career; twelve countries)

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