Microplastics transfer from the ocean to the atmosphere through aerosolization

Lim Xin Kin[1], Li Yunmeng[2], Everaert Gert[2], De Rijcke Maarten[2] and Catarino Ana Isabel[2]

[1] International Master of Science in Marine Biological Resources (IMBRSea), Krijgslaan 281/S8 - 9000 Ghent, Belgium
E-mail: xin.kin.lim@imbrsea.eu

[2] Flanders Marine Institute (VLIZ), Jacobsenstraat 1, 8400 Oostende, Belgium

In recent years, plastic pollution has been acknowledged as one of the most pressing environmental issues due to the widespread occurrence of plastic debris in the ecosystem and its relatively longer lifespan, since plastic debris does not readily decompose in a short period. The accumulation of plastic debris can cause several negative impacts on wildlife, including entanglement, ingestion, and interaction (collisions, obstructions, abrasions or use as substrate). Through different processes such as photodegradation, physical abrasion, hydrolysis and biodegradation, the large plastic debris will eventually break down into smaller particles called microplastics (MPs) and nanoplastics (NPs), which are ranging from 0.001 to 5 mm in size for MPs and from 1 to 1000 nm for NPs. Both the micro- and nanoplastics (MNPs) can come in the form of fibres, beads, or fragments. While MPs can be commonly observed in both freshwater and marine ecosystems, they have also been detected in the atmosphere of urban, suburban, and even remote regions recently, including mountains, alpine glaciers, and the Arctic region. Once MPs are in the atmosphere, they can be transported over long distances and potentially deposited on land. More research is required for the atmospheric MPs, as they can be accumulated in some hotpots while there is also a possibility of human inhalation. Recent studies suggested that MPs from the ocean can be an important source of MPs into the atmospheric compartment through aerosolization processes. Some plastic particles can leave the sea and enter the atmosphere through bubble burst ejection and wave action along with sea salt, bacteria, viruses, and algae. However, there is currently insufficient knowledge to fully establish the role of sea spray aerosols (SSAs) in the transfer of MPs from seawater to the atmosphere, and very little is known about the impact of aerosolization on the pathway of MPs from the ocean to the atmosphere. Preliminary results have demonstrated aerosolization of MNPs in the size range of 0.5 - 10 µm by bubble bursting, and that the enrichment factor (EF), I.e., the magnitude of MPs presents in the aerosols comparing to the concentration in seawater, increases with a decrease in particle size (0.5 - 10 µm). The goal of my work is to understand how the interaction between microorganisms and MNPs affects their aerosolization. We will use the miniature Marine Aerosol Reference Tank (miniMART) system, which simulates natural bubble plumes, foam, and aerosol-producing mechanisms active during oceanic wave breaking, in order to analyse the MNPs aerosolization. We anticipate that our findings will help us better understand the transport and fate of MPs in the environment as well as the MNPs aerosolization.

Keywords
Microplastics; Nanoplastics; Aerosolization; Plastic Pollution; Minimart; Sea Spray Aerosol; Atmospheric Compartment