Microplastics transfer from the ocean to the atmosphere through aerosolization: insights under controlled laboratory conditions

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Abstract

Plastic debris do not readily degrade and their accumulation in marine environments is recognized as a high priority issue for environmental research and policy. Microplastics (MPs) are plastic particles within the size range of 0.001 - 5 mm, from diverse polymer matrices and shapes, either produced by fragmentation of larger debris or manufactured as microbeads. Currently, MPs have been observed in various aquatic environments including rivers, ponds, lakes, oceans, but have also been detected in the atmospheric compartment There are, however, still important knowledge gaps on the distribution and fate of MPs in the marine environment. Until now, water currents and runoff, wave action, and wind have been considered the most important factors affecting the transport of plastic particles to accumulation areas. Recent research has hypothesized that the ocean can transfer particles to the atmosphere through aerosolization processes, via bubble burst ejection and wave action, alongside with sea salt, bacteria, viruses, and algae transfer. However, there is few evidence that fully supports the role of sea spray aerosols (SSAs) in the transfer of MPs from seawater to the atmosphere, and very little is known about the role of aerosolization processes on the pathway of MPs from the ocean to the atmosphere. Our work aimed at demonstrating that MPs are aerosolized during wave motion, via SSAs. To assess MP aerosolization, we have used a Marine Aerosol Reference Tank (MART), i.e., a portable system designed to accurately mimic the naturally occurring physical mechanisms producing SSA particles. Our results indicate that aerosolization of MPs ($< 10\ \mu$m) by bubble bursting is feasible and occurs under artificial settings. We expect that our results will contribute to the understanding of the transport and fate of microplastics in the environment.

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