Microplastics including tire wear particles in the atmosphere-ocean boundary layer: A cross section through the air, sea surface microlayer and underlying water in Swedish fjord systems

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Abstract

Microplastics (MP) including tire wear particles (TWP) occur ubiquitously in the environment. However, there are knowledge gaps about mass-based concentrations, transport, and effects of these contaminants in the marine boundary layer. The latter includes air, sea surface microlayer (SML) and underlying water (ULW). The SML covers most of the ocean's surface with a predominantly organic film of a thickness up to 1000 μm.
Here, a remote-controlled catamaran simultaneously sampled air, SML and ULW (1 m depth) from three Swedish fjords characterized by varying anthropogenic impacts (urban environment, industrial site and natural conservation area). Superior aim was to generate knowledge about the vertical transport of MP in these fjords. Potential enrichment of certain polymer types between SML and underlying water body was evaluated.

Polymers were determined by pyrolysis-gas chromatography-mass spectrometry and quantified by polymer specific backbone-related clusters indicated by prefix "C". Clusters such as polyethylene (C-PE), polypropylene (C-PP), polyethylene terephthalate (C-PET) and polymethyl methacrylate (C-PMMA) were analyzed. Furthermore, samples were scanned for car and truck tire wear particles (CTT & TTT).
MP occurred in water samples with concentrations up to 10.8 μg/L. Most prominent MP types were C-PMMA, CTT and C-PET. Average MP mass load was higher in fjords influenced by an urban environment (8.5 μg/L SML and 6.0 μg/L ULW) and an industrial site (6.6 μg/L SML and 7.3 μg/L ULW). The fjord in the natural conservation area was averagely contaminated with 1.8 μg/L SML and 2.0 μg/L ULW. An enrichment in the SML

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was observed for C-PE, C-PP, C-PET and CTT. In the ULW C-PMMA and C-PC were enriched. Concentrations in air samples reached up to 0.05 μg MP/m^3 and were dominated by C-PET and C-PC. As for the water samples, the air from urban environment and the industrial site showed elevated concentration than those from remote areas.

Keywords: Microplastics, Tire wear particles, Sea Surface Microlayer, Vertical distribution