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Nanoplastics in the Dutch Wadden Sea

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Plastic pollution in the marine environment has been identified as a global problem; different polymer types and sizes have been detected across all marine regions, from sea ice to the equator and the surface to the deep sea. Previous works show that smaller size classes of plastic debris are more abundant, e.g. fragments <100 µm account for 86% of all plastics pieces in the southern North Sea. However, the large unknown is to quantify the fraction of marine plastics debris below the size-detection limit of commonly used techniques (e.g. µFTIR spectroscopy, LOD >10 µm), such as ultrafine, nanometre-sized plastic particles - nanoplastics. In this work, we used a novel Thermal Desorption – Proton Transfer Reaction – Mass Spectrometry (TD-PTR-MS) method suitable for chemical detection and identification of plastics in the nm range and analysed samples from the Wadden Sea, Netherlands. We tested different sample preparation strategies including direct measurement of seawater and pre-concentration using a cascade filtration over quartz fibre filters of different average mesh sizes (>2.7, >1.2, >0.7, >0.3 µm).

Our results show the presence of Polystyrene (PS) and Polyethylene terephthalate (PET) in the fraction of small microplastics (e.g. <2.7 µm) and nanoplastics (<1 µm). The average mass concentration of our semiquantitative (highly conservative) measurements for PS nanoplastics was 0.8 µg/L indicating a substantial contribution of nanoplastics to the Wadden Sea's total plastic's budget. For example, considering the reported average of 27.2 microplastics in m^3 of southern North Sea surface water, an average size of 100 µm, spherical shape and the density of 1 g/cm^3 we calculate a tentative nanoplastics mass contribution of 38% compare to microplastics. Furthermore, we observed dynamic concentration changes of small microplastics and nanoplastics over time and water depth, and we are currently investigating if these are related to tidal currents, which are a strong forcing factor in the Wadden Sea.