EGU2020-7442
https://doi.org/10.5194/egusphere-egu2020-7442
EGU General Assembly 2020

Macro-plastic weathering in a coastal environment: field experiment in Chesapeake Bay, Maryland

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It is now widely recognized that marine plastics, which are strongly resistant to chemical and biological degradation, have become a widespread and massive pollutant in the world's oceans. Despite this resistance, in the environment, larger plastic items fragment and degrade into secondary microplastics which are ingestible by some marine organisms and are therefore a potential threat to aquatic foodwebs. The present study aims to better understand factors that contribute to the weathering of plastics in a coastal marine environment, where most microplastics appear to be generated.

Here we performed a field experiment to test the influence of different coastal conditions on macro-plastic weathering. Strips of commercial grade high-density polyethylene (HDPE) and polystyrene (PS) were mounted in replicate on racks (similar in appearance to keys on a glockenspiel, though all of the same length) and deployed at different treatment depths (subtidal versus intertidal) and different treatment hydrodynamic intensity zones (erosional versus depositional) in a sub-estuary of Chesapeake Bay (Maryland, USA). Strips were collected after environmental exposure of 4, 8 and 43 weeks and were analyzed for mass loss, surface chlorophyll accumulation, and surface appearance via SEM imaging.

We observed the PS strips degraded more quickly than the HDPE strips. The results show minor mass variation, in some samples even a slight mass increase, contrary to expectation. This was probably due to the deposition of clay and the presence of microorganisms into the microstructure of the strips, as observed by SEM. Moreover, the SEM images show different kind of fragmentation, with holes or with desquamations. The fragmentation was most marked for the PS strips located at intertidal depths caused by a more intense hydrodynamic energy. Finally, an increase over time was observed in the concentration of chlorophyll in both subtidal depositional PS strips and in subtidal erosional HDPE strips, associated with a lower hydrodynamic energy compared to the intertidal zones. This appears to confer a greater protection of the plastic which therefore undergoes less weathering.