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Modelling size distributions of marine plastics under the influence of continuous cascading fragmentation

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Field studies have shown that plastic fragments make up the majority of plastic pollution in the oceans in terms of abundance. How quickly environmental plastics fragment is not well understood, however. Here, we study this process by considering a model which captures continuous fragmentation of particles over time in a cascading fashion. With this cascading fragmentation model, we simulate particle size distributions (PSDs), specifying the abundance or mass of particles for different size classes.

The fragmentation model is coupled to an environmental box model, simulating the distributions of plastic particles in the ocean, coastal waters, and on the beach. Transport in the box model is based on a previous study regarding a previous study regarding sources and sinks of marine plastics in the Mediterranean Sea. We compare the modelled PSDs to available observations, and use the results to illustrate the effect of size-selective processes such as vertical mixing in the water column and resuspension of particles from the beach into coastal waters.

Using the coupled fragmentation and environmental box model, we quantify the role of fragmentation on the marine plastic mass budget. While fragmentation is a major source of (secondary) plastic particles in terms of abundance, it seems to have a minor effect on the total mass of particles larger than 0.1 mm. Future comparison to observed PSD data should allow us to understand size-selective plastic transport in the environment, and potentially inform us on plastic longevity.