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A global 3D map of marine plastic litter: a data assimilated modelling framework

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Estimates of plastic quantities entering our oceans are not yet consistent with observed concentrations in the marine environment. This has led to the often-quoted statement that 99% of the marine plastics are missing. Here, we present a framework where the global transport of marine plastics is modelled over long time scales, in which the effects of different sources and sinks is investigated. Data assimilation techniques are used to inform unknown parameters regarding these sources and sinks, enabling us to quantify their role on the global plastic mass budget.

State-of-the-art numerical models are included in the framework to capture for the first time the combined effect of marine plastic beaching, resuspension, biofouling, turbulent mixing, and fragmentation. The relative importance of different marine plastic sources is investigated, such as mismanaged coastal plastic waste, riverine outflow, and fishing activity. Unknown parameters are found by means of calibration to a large set of observational data of plastic concentrations in the ocean surface water, water column, ocean floor, and on coastlines.

We show that with this framework, the global marine plastic mass budget can be closed. An overview is given of which environmental reservoirs are likely to contain most of the plastic mass, which sources are contributing to most of the pollution, and what the residence times of litter in the marine environment is. With the model calibration approach, we additionally get a better insight in the physics governing the transport of marine litter.