



Modelling the three-dimensional distribution of plastics in the global ocean

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Marine plastic pollution is a topic of great social and scientific popularity and significance, with concerns about increasing plastic production and the damage that plastic does to marine organisms and the marine environment as a whole. With estimates of between 4 and 12 million tonnes of plastic entering the oceans each year and modelling estimates of around 250 thousand tonnes of floating plastic at or near the sea surface, over 99% of plastics in the global ocean are unaccounted for. This 'missing' plastic may be negatively buoyant, sinking to the sea floor upon entering the ocean, or it may have been once positively buoyant plastic, having been degraded or biofouled by organisms to the point of sinking. Here we present the first Eulerian model to simulate the dispersion and distribution of both positively and negatively buoyant plastics throughout the whole water column, not just at the sea surface. While only exploratory, the model supports the presence of the five 'garbage patches', formed by accumulations of positively buoyant plastics present within the top 100 m of the water column. The negatively buoyant plastics are transported away from the coastlines by currents and lateral turbulence, and can be observed to loosely follow the bathymetry, accumulating in the deepest regions of the sea floor. Marine sediments have been suggested to be a substantial sink for plastics, in particular microfibers, therefore the introduction of a crude sedimentation removal rate was introduced to investigate the likely 'hotspots' for sequestration into the sediments. The Mediterranean Sea, Indian Ocean and regions of Southeast Asia would seem, according to the model, to be areas likely to have high concentrations of plastics within marine sediments. Further development of the model will include parameterisations for the effects of biofouling, degradation and particle size on the vertical distribution of positively and negatively buoyant plastics.