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Modelling the accumulation and transport of microplastics by Arctic sea ice

Miguel Angel Morales Maqueda and Alethea Sara Mountford

Newcastle University, Newcastle upon Tyne, United Kingdom of Great Britain and Northern Ireland (miguel.morales-maqueda@newcastle.ac.uk)

The presence of microplastics in the Arctic sea ice cover and water column, as well as on land, has raised the already high concerns about the dispersion of litter in the global environment. We present a 50-year simulation carried out with the NEMO ocean general circulation model of the dispersion of buoyant and neutrally buoyant microplastics in the global ocean that includes a simple formulation of microplastic accumulation in, and advection by, sea ice. Microplastics enter the Arctic predominantly through the Barents Sea, with a smaller input through the Bering Strait, although the simulation also takes into account small plastic sources along the Arctic coastline. Microplastics become trapped in newly formed sea ice chiefly on the Eurasian shelves and the Chukchi Sea, but a still significant amount is transferred from the mixed layer to the ice base through congelation in the central Arctic, where microplastics congregate nearer to the surface than elsewhere in the global ocean due to the strong stratification and the relatively small levels of vertical turbulence underneath multiyear sea ice. In the model, the maximum average residence time of sea ice in the Arctic is about six years, and this is also, therefore, the typical timescale for maximum microplastic accumulation in the ice cover. Plastics trapped in sea ice undergo a seasonal cycle of accumulation and release in consonance with the freeze and melt sea ice cycle but ultimately are release back into the ocean in the Greenland and Labrador seas, from where they will be subsequently transported into the North Atlantic.