A numerical approach to determining the behavior of microplastics and mesoplastics from the Changjiang River in the East Asian marginal seas

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In the environment, plastic debris gradually degrades into small plastic fragments that can be categorized by size as macroplastics (> a few centimeters in size), mesoplastics (>5 mm), microplastics (<5 mm), and nanoplastics (less than a few micrometers). The present study uses “small plastic fragments” to refer to all fragments smaller than mesoplastics. A number of studies have shown that small plastic fragments have spread to the world’s oceans. A recent study demonstrated that the output of small plastic fragments from the Changjiang River (or the Yangtze River), which flows into the East China Sea, is greater than that of such fragments from any other river in the world. The present study aims to clarify the transport processes of small plastic fragments from the Changjiang River to the East Asian marginal seas (the Yellow Sea, the East China Sea, the southwestern part of the Sea of Japan, and the northern part of the South China Sea) using a numerical model. Pelagic small plastic fragments consist mostly of polyethylene or polypropylene, which are less dense than seawater; thus, they move in the uppermost layer (depth < 5m) of the water column. Hence, previous studies suggested that small plastic fragments are carried partly by mass transport (Stokes drift) generated in the uppermost layer in response to wind waves, as well as by ocean currents that extend to deeper layers. The present study established a three-dimensional particle tracking model in which the modeled particles were carried by a combination of ocean currents, provided by ocean reanalysis data, and the Stokes drift, computed separately in a wave model driven by satellite-derived winds. Most of the microplastic fragments from the river were found to be carried by the northeastward Tsushima and Kuroshio currents to the Sea of Japan and the North Pacific. In contrast, some of the mesoplastic fragments were carried to the northern part of the South China Sea by the southwestward Stokes drift that prevails in winter. In addition, the northward Stokes drift that results from the Yellow Sea high in May carries mesoplastic fragments into the Yellow Sea, even though the Stokes drift is smaller in May than in winter. Thus, the Stokes drift plays a role in selectively decreasing the large mesosized plastics into the Sea of Japan by greatly reducing the number of mesoplastic fragments passing through the Tsushima Strait.

