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Why does plastic debris accumulate in the subtropical gyres? Lessons learnt from drifting buoy trajectories

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The total amount of plastic floating on the surface of the ocean is estimated to be a few hundred thousand metric tonnes. Roughly half of this plastic resides in the centres of the five subtropical gyres, in what are often referred to as the garbage patches. Within these gyres, plastic concentrations can be five orders of magnitude higher than in other parts of the ocean.

However, it is unclear how and why the plastic accumulates in the gyres. While Ekman convergence theory can explain large-scale patterns to first order, it does not provide the full picture. For one, the garbage patches are never found in the centres of the gyres, but rather are located in either the western or eastern half of the gyres.

Here, we use the trajectories of surface drifters, augmented with virtual particles in numerical models, to shed light on the transport pathways and timescales from the world's coasts into the open ocean. We show that there is a strong depth-dependence of the convergence, with drogued buoys and particles accumulating in different regions than undrogued ones.

Our findings are relevant for increasing the understanding the basin-scale pathways of floating debris such as plastic, and for assessment of technologies to clean up that plastic. However, they also provide new insights into the role of submesoscale eddies and other processes in the formation of the Ekman convergence zones.