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Investigating inertial particle transport for application in tracking plastic litter in the ocean

Birgit Sützl (1), Pavel Berloff (2), and Erik van Sebille (3)

(1) Department of Civil and Environmental Engineering, Imperial College London, London, United Kingdom (b.sutzl@imperial.ac.uk), (2) Department of Mathematics, Imperial College London, London, United Kingdom, (3) Institute for Marine and Atmospheric research, Utrecht University, Utrecht, Netherlands

Motivated by the study of floating plastic debris in the ocean, we investigated a model for inertial particle transport in the ocean. In most numerical studies so far, plastic objects are treated as passive particles with negligible size, and their movement purely follows the ocean flow. Inertial particles in contrast are viewed as objects with finite size and mass, which interact with ambient fluid and experience flow drag. We implemented a simplified version of the most commonly used approximation of inertial particle transport, the Maxey–Riley equation (Maxey and Riley 1983), into a Lagrangian particle tracking model, coupled with an idealised, but dynamically consistent and highly turbulent midlatitude double-gyre ocean circulation model. Simulations of the inertial particle transport model showed that inertial particle transport can significantly differ from purely flow driven passive particle transport, and only for inertial particles a significant particle accumulation occurs in the double-gyre ocean circulation framework. Key parameters that influence the inertial particle movement are the particle density and size. Lighter particles, with lower density than the fluid, are attracted to the interior of the ocean gyres, particularly to the regions around the eastward extension of the western boundary currents, where the eddying flow is most energetic. Heavier particles, with higher density than the fluid, are attracted outwards of the gyres and towards the boundaries of the domain. Numerical simulations of plastic particles slightly lighter than water show a similar tendency to accumulation in the western, more turbulent regions of the interior and interface of the ocean gyres. This is consistent with observational data and data-driven simulations, which show plastic particle accumulation inside ocean gyres and higher density of particles off the gyre centres. This suggests that particle inertia could play a role in in determining the denser plastic accumulation zones and should be taken into account for oceanic plastic transport modelling.