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A new 3D model for tracking plastic marine debris: impact of particle physical properties and behaviour on microplastics fate

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Understanding Marine micro-Plastic Debris (MPD) movement is a global issue of international concern. Physical properties and processes of MPD particles can define their motion and fate in ocean and coastal systems. However, most of models of MPD movement assumed MPDs as neutral particles drifting within the surface layer. These models are typically coupled to a specific ocean model and focus on large special scales. In this study, we present TrackMPD, a new non-Lagrangian tracking model for marine debris transport that consider (1) the behaviour of the particles of different densities, sizes, shapes and fouling states, and (2) physical processes such as windage, dispersion, degradation and refloating. TrackMPD is compatible with velocity data from many different hydrodynamic models (e.g. POM, ROMS, MITgcm and FVCOM) and can compute forward and backward trajectories in two or three dimensions. We describe and quantify the influence of different microplastics behaviours and physical processes on the trajectory and fate of microplastics using Jervis Bay and the coast of New South Wales (sensitivity of microplastics fate to particles physical properties and behaviour) as natural laboratory. Preliminary results show that the microplastics dynamical properties impacting their sinking have a large effect on the distribution of microplastics, even more than other important physical processes such as dispersion and refloating. In particular, the plastic density (Fig. 1) and the fouling state play a key role on the transport and final fate of both spherical and cylindrical microplastics, while the particle size only has a high impact on the movement of spherical particles. A detailed sensitivity analysis ranks the relative influence of each model parameter on the distribution and fate of microplastics. These findings highlight the importance of the three-dimensional tracking of microplastics, and can help prioritise experimental research on the particle dynamical properties and physical processes involved on plastic transport, leading to more accurate predictions of their fate.