EGU21-280
https://doi.org/10.5194/egusphere-egu21-280
EGU General Assembly 2021

Global modeled sinking characteristics of biofouled microplastic

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Microplastic debris ending up at the sea surface has become a known major environmental issue. However, how microplastic particles move and when they sink in the ocean remains largely unknown. Here, we model microplastic subject to biofouling (algal growth on a substrate) to estimate sinking timescales and the time to reach the depth where particles stops sinking. We combine NEMO-MEDUSA 2.0 output, that represents hydrodynamic and biological properties of seawater, with a particle-tracking framework. Different sizes and densities of particles (for different types of plastic) are simulated, showing that the global distribution of sinking timescales is largely size-dependent as opposed to density-dependent. The smallest particles we simulate (0.1 μm) start sinking almost immediately around the globe and their trajectories produce the longest time to reach their first sinking depth (almost 40 days as a global median). In oligotrophic subtropical gyres with low algal concentrations, particles between 1 mm and 10 μm do not sink within the 90-day simulation time. This suggests that in addition to the comparatively well-known physical processes, biological processes might also contribute to the accumulation of floating plastic (of 1 mm to 10 μm) in subtropical gyres. Particles of 1 μm in the gyres start sinking largely due to vertical advection, whereas 0.1 μm particles sink both due to biofouling and advection. The qualitative impacts of seasonality on sinking timescales are small, however, localised sooner sinking due to spring algal blooms is seen. This study maps processes that affect the sinking of virtual microplastic globally, which could ultimately impact the ocean plastic budget.