Geoscientific Model Development Discussions

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Comment on gmd-2021-195

Anonymous Referee #2

Referee comment on "Empirical Lagrangian parametrization for wind-driven mixing of buoyant particles at the ocean surface" by Victor Onink et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-195-RC2, 2021

The manuscript describes the vertical mixing of buoyant particles at the ocean surface, with comparisons made to microplastics field data. The model compares two different eddy diffusivity models, along with two types of Markov modelling (a random walk (M-0) and a higher order random walk which includes an autocorrelation timescale (M-1)).

The simulations do not represent a substantial contribution to modelling science. One concern in this manuscript is the usage, discussion, and validation of the eddy viscosity models. The text describes two vertical diffusion models:

The first uses both the well-established Kukulka et al. (2012) for the near surface and extrapolates below using Poulain (2020). Poulain (2020) is a thesis and therefore the results therein have yet to be peer-reviewed. The Poulain (2020) experiment is described as a tank with a vertically oscillating grid. However, it is not clear in the text whether this model has been verified with respect to ocean surface mixing. Using more well-established near surface model would improve the model.

The second uses KPP. KPP is a bulk boundary layer model which goes to zero at the free surface. This means that all positively buoyant particles at the free surface would stay at the free surface, regardless of the wind conditions. The text mention this, but does not elaborate. Under this scenario, are their equilibrium profiles initial condition dependent? I would expect after long times, all the particles should stay at the surface, and therefore I'm unsure why simulations are needed when the final state is pre-determined.

The text then compares their simulation results to the observations, and they do not match. In fact, the simulations underpredict the vertical mixing of the microplastics. This is unsurprising, and has been previously demonstrated in the literature, where it has been

noted that to fully account for proper vertical mixing of microplastics, one needs to include the effects of breaking waves and Langmuir turbulence (see e.g. Kukulka & Brunner 2015).

Overall, this study does not add any new contributions to the field. The eddy diffusion profiles do not advance the state of the modelling, as they both have clear faults, and because they do not include all the relevant physics needed to fully explain the observations (Langmuir turbulence and/or breaking waves), it is hard to draw any conclusions from their comparisons to the data.