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Interactive comment on "Sinking microplastics in the water column: simulations in the Mediterranean Sea" *by* Rebeca de la Fuente et al.

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We thank the Reviewer for the careful and positive evaluation. We respond to the specific comments below.

1)

We have checked the literature for detailed descriptions of samples collected from the interior of the water column with results about negatively buoyant rigid microplastic particles. Since field studies of the interior of the water column are not abundant, most of them describe plastic types of positive or unspecified buoyancy from the upper ocean layer (e.g., Egger et al., 2020; Pabortsava and Lampitt, 2020), and the issue of aggregation is usually not addressed, the only relevant publication has been found to be

Bagaev et al. (2017; note that they do describe rigid particles besides microfibres). According to their Section 2.1, selecting microplastic pieces did not require disassembling them from aggregates, in contrast to the case of floating plastics, described in other studies; instead, separate microplastic pieces and organic aggregates were identified. Note that the particles in the class of our interest sink relatively rapidly, and the particulate organic matter content of the water body is concentrated to the surface and is dilute below a few hundred meters' depth (e.g., Karl et al., 1988; Maciejewska and Pempkowiak, 2014). It might be supposed that this could lead to an absence of much interaction with aggregates of biological origin. We should mention, however, experimental results from Michels et al. (2018) showing that suspended polystyrene beads can aggregate with organic matter within a few days in water samples collected from sea surface. This may lead to increased settling velocities (Long et al., 2015), and further research may be needed to fully clarify the degree of aggregation for negatively buoyant rigid microplastics in the water column.

Summarizing the above, we will comment on the issue in Section 2 by adding the following sentences: "Note that, in contrast to the case of floating plastics (Kooi et al., 2017; Kvale et al., 2020), interaction of sinking plastics with particulate matter of biological origin appears to be moderate according to the absence of a need to disassemble microplastic pieces from biological aggregates during sample processing as described by Bagaev et al. (2017). Note, however, that experimental results by Michels et al. (2018) indicate that aggregation with organic material might occur within a sufficiently short time at surface layers, which would likely lead to increased sinking velocities (cf. Long et al., 2015)."

2)

The Reviewer is right. The Okubo formula (Okubo, 1971), from which we obtained 7.25mˆ2/s for the effective horizontal diffusion coefficient for our grid, is an empirical fit to surface motions, so that it does not describe effective diffusivity at depth. Instead, effective horizontal diffusivity should be weaker below the thermocline according to a more accurate estimation. In this sense, our results provide an upper bound for the error associated with unresolved scales of fluid motion. We will point this out in a new sentence in Appendix A of the revised version of the manuscript: "Since the Okubo formula is an empirical fit to surface motions, and effective horizontal diffusivity should be weaker below the thermocline, our results provide an upper bound for the error associated with unresolved scales of fluid motion."

3)

The quoted sentence was kept by mistake: we decided not to show that range, because it would deteriorate the visibility of the plots without adding much value. We will delete the sentence in question.

4)

Both functions have been normalized such that the value of their integrals with respect to z is one; in this way the functions can be displayed in the same plot. We will replace the original formulation in the manuscript by this last sentence.

We hope that our responses appropriately address the issues raised by the Reviewer.

References:

Bagaev et al. (2017). Anthropogenic fibres in the baltic sea water column: Field data, laboratory and numerical testing of their motion. Science of The Total Environment 599-600, 560-571. https://doi.org/10.1016/j.scitotenv.2017.04.185

Egger et al. (2020). First evidence of plastic fallout from the North Pacific Garbage Patch. Scientific Reports 10, 7495. https://doi.org/10.1038/s41598-020-64465-8

Karl et al. (1988). Downward flux of particulate organic matter in the ocean: a particle decomposition paradox. Nature 332, 438-441. https://doi.org/10.1038/332438a0

Kooi et al. (2017). Ups and downs in the ocean: effects of biofouling on vertical transport of microplastics. Environmental Science & Technology 51, 7963-7971.

https://doi.org/10.1021/acs.est.6b04702

Kvale et al. (2020). The global biological microplastic particle sink. Scientific Reports 10, 16670. https://doi.org/10.1038/s41598-020-72898-4

Long et al. (2015). Interactions between microplastics and phytoplankton aggregates: Impact on their respective fates. Marine Chemistry 175, 39-46. https://doi.org/10.1016/j.marchem.2015.04.003

Maciejewska and Pempkowiak (2014). DOC and POC in the water column of the southern Baltic. Part I. Evaluation of factors influencing sources, distribution and concentration dynamics of organic matter. Oceanologia 56, 523-548. https://doi.org/10.5697/oc.56-3.523

Okubo (1971). Oceanic diffusion diagrams. Deep Sea Research and Oceanographic Abstracts 18, 789-802. https://doi.org/10.1016/0011-7471(71)90046-5

Pabortsava and Lampitt (2020). High concentrations of plastic hidden beneath the surface of the Atlantic Ocean. Nature Communications 11, 4073. https://doi.org/10.1038/s41467-020-17932-9

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