

Interactive comment on “The vertical distribution of buoyant plastics at sea” by J. Reisser et al.

J. Reisser et al.

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Comment 1: Overall / General Comments: This paper is scientifically significant (rated: excellent) due to the novelty of using a multi-level trawl to quantitatively address the lack of understanding about the vertical distribution of microplastics within the surface layer of the world’s oceans. The authors’ thorough investigation of the effect of sea-state on surface plastic estimations has important implications for improving estimations and models of total surface plastic loads in the oceans. The scientific quality (rated: good) could be improved by addressing a couple instances of overgeneralization within the text and clarifying statements which are ambiguous as to where the information was taken from (see below). In text citations could be used more specifically. For example, there are several cases where a citation is listed at the end of the sentence, although it only refers to a part of the previous statement. These instances could be improved by instead writing “Author et al., year suggested/reported/etc. that ...”. Otherwise,

C8714

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



the experiments and calculations are clearly traceable allowing for reproduction of the work presented here in future studies. The paper's presentation quality is excellent. Overall, the paper is clearly written and flows well. It is well structured and demonstrates appropriate use of the English language. Tables and figures are supportive in presenting the results. In my opinion, pronouns "It, them, they, etc" were used too often, especially within the methods section, however this simply an aspect of writing style. Although the pronouns are used correctly, this style may increase the chance for readers to misunderstand the methods. The abstract is concise and complete and the title is representative of the paper, but it could be clarified with a subtitle, for example, "The vertical distribution of buoyant plastics at sea: a case study in the North Atlantic Ocean."

Reply 1: Thank you for reviewing our manuscript. We have made most of the suggested changes (see our following replies to your comments), which made our text clearer and more specific in relation to references. We have also added a subtitle to our study. It is now entitled "The vertical distribution of buoyant plastics at sea: an observational study in the North Atlantic Gyre"

Comment 2: Specific Issues/Concerns: In the introduction, on page 16209, line 9, "mostly fragments of packaging and fishing line" is only supported by Reisser et al., 2013 for the waters surrounding Australia. I would suggest finding additional support for this statement, e.g. Hidalgo-Ruz et al., 2012, or clarify the statement by making it less generalized.

Reply 2: Changed accordingly. We have added 2 extra references (reviews) in there (Hidalgo-Ruz et al. 2012 and Barnes et al. 2009) to better support this statement.

Comment 3: The methods and assumptions are valid and clearly outlined, but in several cases it was necessary to read the figure captions to fully comprehend some points. I would suggest to include the information that is in the figure captions within the text as well so as to minimize confusion when reading. For example, it is not clear

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whether or not each of the four sampling stations were sampled at each of the 3 sea-states until one reads Figure 3. Also, in the methods section, it is not clear whether the Kukulka model is specifically for the prediction of numerical or mass concentration.

Reply 3: Changed accordingly. We made a few minor revisions along the methods section to make it clearer. We conducted net tows at 12 locations, but some sampling sites were quite close to each other and thus appeared as a unique orange dot in Figure 1, which is why it seems we have only four stations. We have added this information to the caption of Figure 1. Furthermore, we state in the methods section the number of net tows conducted under each Beaufort sea state: ‘ (...) Beaufort scale 1 (N = 3 tows), 3 (N = 4 tows), and 4 (N = 5 tows)’. Similarly to previous studies (e.g. Eriksen et al. 2014, Law et al. 2014, Cozar et al. 2014), we used the Kukulka et al. 2012 model to predict both numerical and mass plastic concentration depth profiles. Our study found that these depth profiles are different, and additional vertical sampling of ocean plastics will allow us to better predict the vertical distribution of both mass and numerical distribution of ocean plastics.

Comment 4: In the discussion section, I suggest to discuss the implications of not including any thin filaments from samples in analysis. Additionally, on page 16215, lines 11-20, other studies concerning estimation of total surface plastic amounts are mentioned. I would suggest also mentioning of the most recent publication by Eriksen et al. 2014 (Plastic Pollution in the World’s Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea) which aims to extrapolate and estimate total global plastic amounts. On page 16215, line 25, the citation of Ballent et al, 2013 is inaccurate; it was not specifically a turbulence assay but rather an examination of the effects of subsurface velocity and shear stress on subsurface transport of plastics using a model. I would change "As shown here, in a previous turbulence assay (Ballent et al. 2013). . . surface." to "As shown here and in two modelling studies, vertical mixing affects the subsurface transport of plastics and the size distribution of plastics floating at the surface." On page 16216, the statement in lines 15-17 is underdeveloped and

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does not satisfactorily support the previous statement. How do/may the study results affect this observation? In general, the discussion could go into more depth regarding potential effects of the results on estimates of plastics concentration, total amounts, models, subsurface transport, and effects on biota.

Reply 4: We don't believe that excluding a few thin fibers had a major effect on the results of this study, which is focused on macroscopic buoyant plastic debris. As we (1) did not use microscope to inspect samples, and (2) used filtered seawater to separate floating plastics from 'sinking' plastics (e.g. textile fibers), it was quite rare to detect thin fibers such as those from air dust and clothing. We are now emphasizing that thin fibers were rarely detected in this study: "Two thin filaments resembling textile fibres were discarded due to potential air contamination as noted in (Foekema et al., 2013)." We added this sentence mostly to emphasize to our readers that those interested in studying microscopic plastic debris should follow a different approach to ours. For instance, they would need special clean air conditions (as described in Foekema et al. 2013) to achieve this. When we submitted this manuscript to Biogeosciences, Eriksen et al. 2014 paper was not published yet. We have added this reference to our Introduction and Discussion sections. As suggested, we have re-phrased the sentence where Ballent et al. 2013 is mentioned. We have added a few sentences to the penultimate paragraph of the discussion section to clarify how the vertical distribution of plastic debris affects their effect on different pelagic species. We hope our modifications improved our discussion on the significance of our results for estimates of plastics concentration, total amounts, models, subsurface transport, and effects on biota.

Comment 5: Technical Corrections: (mostly suggestions) Page 16208 Line 5: change "subsurface" to "in situ"

Reply 5: Changed accordingly

Comment 6: Line 6: "12 sites" is misleading. Change to 4 sites or 12 samples?

Reply 6: As explained in Reply 3, sampling was conducted at 12 different sites. None

Full Screen / Esc

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Discussion Paper



of the samples were collected at the same location, although some were collected proximally to others (e.g. those conducted in the same day). In any case, they are considered 12 different sites.

Comment 7: Line 7: Sentence beginning with “By using . . .” sounds like the physical properties were measured using the trawl. I suggest rewording this sentence.

Reply 7: Changed accordingly.

Comment 8: Line 9: Change “but” to “and”

Reply 8: Changed accordingly

Comment 9: Line 21: Change “on” to “via”

Reply 9: Changed accordingly

Comment 10: Page 16209 Line 3: I don’t think the word “Each” can be used as it is too much of an extrapolation and is thus unscientific.

Reply 10: Changed accordingly

Comment 11: Line 5: Carpenter and Smith, 1972 mentions plastics being smaller than .5 cm but doesn’t seem to define microplastics as such. I would remove this citation and find a review-type study to support the statement, e.g. Hidalgo-Ruz et al., 2012 (see Review of Methods section) and Arthur et al., 2009 (Proceedings of the International Research Workshop on the Occurrence, Effects and Fate of Microplastic Marine Debris. Sept 9-11, 2008. Arthur, C., Baker, J., Bamford, H., Eds.; NOAA Technical Memorandum NOS-OR&R-30, 2009).

Reply 11: Changed accordingly: we have deleted Carpenter and Smith 1972 citation and added Hidalgo et al. 2012 and Arthur et al. 2009 instead.

Comment 12: Line 10: Again, to extrapolate results from the North Pacific to the entire world’s oceans is not valid in my opinion. I would suggest to instead change “mostly”

Full Screen / Esc

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Interactive Discussion

Discussion Paper



in Line 9 to “commonly”. Moret-Ferguson et al. only studied the North Atlantic. Either make the sentence more specific (i.e. Plastic in the North Atlantic are mostly...) or add more references to include studies done in the other gyres).

Reply 12: Changed accordingly. We have made this sentence more specific and added a few more references/reviews.

Comment 13: Line 13: “It is predicted..” It is not clear whose prediction this is. Is this the guiding hypothesis of this study?

Reply 13: This is the Kukulka et al. 2012 model prediction. We have re-phased this sentence to make it clearer: “A model developed by Kukulka et al. 2012 predicted that ...”. This is indeed our guiding assumption and the reason to develop a shallow multi-level sampling device capable of obtaining high-resolution data from the sea surface to 5m deep.

Comment 14: Line 15: “. . .,where only a few low-resolution measurements exist (Lattin et al. . .)” I would suggest moving this to the beginning on the sentence; e.g. “As suggested by a few low-resolution measurements (Lattin. . .), it is predicted in this study that. . .”

Reply 14: The prediction is derived from the Kukulka et al. 2012 model, which was supported by very few direct observations prior to this study. This is the justification of our study, and we hope that our re-phrased sentence clarifies this.

Comment 15: Line 20: change “at” to “in”

Reply 15: Changed accordingly.

Comment 16: Line 23: change “at” to “in”

Reply 16: Changed accordingly.

Comment 17: Line 24: change “decays” to “decay rates”

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



Reply 17: Changed accordingly.

Comment 18: Page 16210 Line 3: Insert “from 4 sampling locations” after “12 multi-level net tows”

Reply 18: As explained above, none of the net tows were conducted in the same site, so we actually have 12 sampling sites. Figure 1 caused this confusion, since due to scale it was not possible to plot the individual sites. We hope that the improved figure legend clarifies this. Readers interested in the exact coordinates (latitude, longitude) of each of our net tows can refer to the datasets published in Figshare.

Comment 19: Line 6: Change “type of equipment” to “collection device”

Reply 19: Changed accordingly.

Comment 20: Line 8: Change “onto each other by an” to “vertically and secured within an”

Reply 20: Changed accordingly.

Comment 21: Line 10: Insert “completely” between “net above”

Reply 21: Changed accordingly.

Comment 22: Line 13: Change “while the net system was towed” to “of each sampling period”

Reply 22: Changed accordingly.

Comment 23: Line 15: Change “for” to “during”

Reply 23: Changed accordingly.

Comment 24: Page 16211 Line 2: Two other recent studies could be cited: Mathalon and Hill, 2014, Microplastic fibers in the intertidal ecosystem surrounding Halifax Harbor, Nova Scotia and Dekiff et al., 2014, Occurrence and spatial distribution of microplastics in sediments from Norderney.

C8720

BGD

11, C8714–C8724, 2015

Interactive
Comment

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Reply 24: We would rather refer only the Foekema et al. 2013 study, where they clearly state the issue of studying plastic fibers in laboratories that do not have clean/filtered air. For instance, their abstract says: “small fibers were initially detected in most of the samples, but their abundance sharply decreased when working under special clean air conditions. Therefore, these fibers were considered to be artifacts related to air born contamination and were excluded from the analyses.” This is exactly the point we are trying to make.

Comment 25: Line 9: Change “at:” to “at depths of” and remove “deep” from end of sentence.

Reply 25: Changed accordingly.

Comment 26: Line 17: Include units after $w_b = 0.0053$ (m s⁻¹)

Reply 26: Changed accordingly.

Comment 27: Line 21: Missing reference for Pugh (1987)

Reply 27: Changed accordingly.

Comment 28: Page 16213. Line 2: Insert “Depth” before “Profiles”

Reply 28: Changed accordingly.

Comment 29: Line 16: Explain that the three numerical ranges refer to the ranges of frictional velocity typical for each sea-state. This is explained in one of the figure captions but would be helpful to have in text too.

Reply 29: These numerical ranges refer to the depth decay rates (λ) as estimated by the Kukulka et al. 2012 model. We have made a few modifications to this second paragraph of the results section to make it clearer. Furthermore, we have added the numerical ranges of frictional velocity of water considered in this study in the 5th paragraph of the methods section, so now these values can be found not only in the figure legend but also in the manuscript.

Comment 30: Line 20: Change “plastics” to “plastic pieces”

Reply 30: Changed accordingly.

Comment 31: Page 16214, Line 6: Change “deeper” to “greater”

Reply 31: Changed accordingly.

Comment 32: Line 8: Word “proportion” is ambiguous. Is it referring to the fractional amount or the length of plastic pieces? Also, change “underwater” to “submerged below 0.5 m”?

Reply 32: It is referring to the percentage of plastics displayed in Figure 7. We have made a few modifications to this sentence to make it clearer. We also changed “underwater” to “submerged below 0.5m”.

Comment 33: Line 21: “is due to the fact” is too absolute in my opinion. Would change to “can be explained by our observation”

Reply 33: Changed accordingly.

Comment 34: Page 16215, Line 1: Insert “as determined in our study” after “surface layer”

Reply 34: Changed accordingly.

Comment 35: Line 3: Change “underwater (>0.5 m deep)” to “submerged > 0.5 m below the water surface”

Reply 35: Changed accordingly.

Comment 36: Line 10: “lighter” is ambiguous, change to “less dense” or “smaller”

Reply 36: Changed accordingly.

Comment 37: Line 23: Change “then” to “better”

Reply 37: Changed accordingly.

C8722

BGD

11, C8714–C8724, 2015

Interactive
Comment

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Interactive Discussion

Discussion Paper



Comment 38: Line 27-29: Reword this sentence: “We observed...sizes” to “We observed the proportions of plastics mixed into deeper waters to increase towards smaller size even under low wind speed (1 knot) conditions.”

Reply 38: Changed accordingly.

Comment 39: Page 16216, Line 7: Insert “further” before “quantify”

Reply 39: Changed accordingly.

Comment 40: Line 29: Capitalize Eric

Reply 40: This was changed when the Biogeosciences staff formatted our .doc manuscript into their .pdf. We will make sure this is correct in the peer-reviewed publication.

Comment 41: Page 16217, Line 3: Change “receives” to “received”?

Reply 41: Changed accordingly.

Comment 42: Page 16219, Line 5: cannot find the data set using Information given for figshare (Reisser et al., 2014b). Data sets from Reisser et al, 2014a (Millimeter sized marine plastics: a new pelagic habitat for microorganisms and invertebrates) were found but not data sets from this paper.

Reply 42: The dataset of this paper is now available at: http://figshare.com/articles/Data_from_The_vertical_distribution_of_buoyant_plastics_at_sea_an_observational_study_in_the_North_Atlantic_subtropical_gyre_/1308506

Comment 43: Page 16220, Figure 1 caption should include a note about the trawl depiction. Add “and solid grey line” to (grey dots)

Reply 43: We have added “solid grey line” to this figure legend. The first sentence of the legend says “using the multi-level net device displayed in the right panel”.

Comment 44: Page 16223 Include corresponding Beaufort values with 1 knot and 15

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Interactive Discussion

Discussion Paper



knot wind speeds in captions

Reply 44: Changed accordingly.

Comment 45: Page 16224 Change “x” to “versus”. Change “boxplot of rise velocity at different depth intervals” to “boxplot of rise velocity for plastics collected at different depth intervals”

Reply 45: Changed accordingly.

Interactive comment on Biogeosciences Discuss., 11, 16207, 2014.

BGD

11, C8714–C8724, 2015

Interactive
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Discussion Paper

C8724

