

Earth Syst. Sci. Data Discuss., author comment AC1  
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## Reply on RC1

Giulia Leone et al.

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Author comment on "Hyperspectral reflectance dataset of pristine, weathered, and biofouled plastics" by Giulia Leone et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2022-140-AC1>, 2022

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We thank the handling Editor and the reviewers for thanking the time to review our manuscript and providing us with constructive feedback, which led to significant revisions in the manuscript.  
Below, we provide point-by-point replies to each and every reviewer's comment (specified lines refer to the revised version of the manuscript).

We thank Dr.  
Best regards,  
Giulia Leone, on behalf of all authors

### Point by point response to reviewers for

**Ms. Ref. No.** essd-2022-140

**Title:** Hyperspectral reflectance dataset of pristine, weathered and biofouled plastics

#### Reviewer Hu, Chuanmin:

**Comment 1.1** This is a great effort toward remote sensing of marine plastics. The remote sensing capability heavily relies on our understanding of the spectral characteristics of various forms of plastics, and this dataset should be useful for algorithm development.

**Response:** We thank the reviewer for their kind words.

**Comment 1.2** However, I feel that both the experimental settings and end results are poorly described, and I ended up with more questions than answers after I read through the descriptions. I understand it's impossible to present all measured spectra, but to a minimum, some representative spectra of plastic specimen A, B, C... in their dry, weathered, and submerged conditions should be presented and discussed. In particular, after several recent publications reporting similar datasets of macroplastics, how do these new results compare with those existing? What new information do we gain? Without the knowledge of why they agree or disagree on the same type of plastics, I sense that all we can get are some additional data, but our understanding of plastics reflectance may get worse.

**Response:** We understand the reviewer's comment and agree that to broaden our understanding of plastic reflectance, it is crucial not only to collect the data but also to give interpretation and discussion on what those data mean. However, the presented manuscript is intended to be a data description paper. Therefore, the aim of drawing conclusions from the presented data is outside of the scope of this work. In fact, as mentioned in the Earth System Science Data (ESSD) guidelines for manuscript types: The "interpretations of data – i.e., detailed analysis as an author might report in a research article – remain outside the scope of this data journal". However, as we fully agree with the reviewer, to provide some examples to the reader illustrating the representativeness of the acquired spectra, we have, we have added in the supplementary material two graphs as examples of pristine, weathered and biofouled plastics. In addition, in the main text we have added a short explanation stating 'From the presented dataset it is possible to visually see the spectral reflectance of different plastic polymers and compare the different conditions experimentally tested (Fig 1S; Fig 2S). For instance, it is possible to derive the effect of weathering and biofouling on the spectral reflectance of a polymer when compared with the same pristine one' (see lines 217-220). Besides the complementary value of the presented dataset, we have two novel assessed parameters when compared to other recent publications (Knaeps et al., 2020, Garaba & Dierssen, 2020 and Garaba & Dierssen, 2018): 1) the artificially weathered and 2) biofouled plastics for which the spectral reflectance was measured.

**Comment 1.3** Line 43 – 48: "To date, only a limited number of high-quality datasets consisting of hyperspectral measurements of wet and submerged plastic litter, have been published in open-access repositories (e.g., Garaba and Dierssen, 2019, Garaba and Dierssen, 2020; Knaeps et al., 2021). The dataset described in the current paper aims at complementing the existing datasets by adding new information about the hyperspectral reflectance of pristine plastic items, harvested plastic litter, and artificially weathered and biofouled plastic samples". This is certainly a good motivation. However, how do these additional data compare, contrast, and complement the existing data? Does this paper measure the same plastic materials (e.g., A, B, C) but measured under different dry/wet or marine conditions? Or does this paper measure different plastic materials (e.g., D, E, F instead of the existing A, B, C) under the same conditions as in the current literature? How do the new spectra compare with the existing spectra? If there is difference, what's the reason?

**Response:** The reviewer raised an important concern, and we have now clarified comparability of the acquired data in the main text (Table 1). To make the distinction of which measurements are novel in this study compared to what has been previously published we have added a new Table 1 (line 91) and text stating 'Table 1 provides an overview of measured plastic types within this study and compared to existing datasets. This dataset adds additional information of plastic spectral reflectance of similar polymers to what is already available in the literature, allowing comparison, but also novel conditions and treatments (Table 1).' (Lines 86-89). The plastic measured in this study are covering similar ranges of plastic polymers as previous publications such as Garaba et al., 2021 or Knaeps et al., 2020. Even though some of the conditions of the plastics measured in this study are, as for Garaba et al., 2021 or Knaeps et al., 2020, pristine and environmental samples in dry and wet or submerged conditions, we have the addition of artificially weathered and biofouled samples also measured in turbid waters with algae. The artificially weathered and biofouled plastics are an added value to this dataset compared to previous publications. In fact, the measurements of the same plastic when being (i) pristine, (ii) biofouled, and (iii) weathered allows addressing the impact of each specific condition on the spectral reflectance of the plastic when compared with the pristine polymer. Real environmental samples were also included to understand if artificially weathered and biofouled plastics are similar or comparable to weathering and biofouling in natural conditions. Since plastics are extremely diverse there is a need to generate a large database with multiple plastic polymers/types under different

experimental and natural conditions.

**Comment 1.4** Line 53 – 54. Not really, unless ALL possible scenarios in natural conditions are considered and measured here. Presenting certain examples of reflectance under different depths or under different algae or sediment concentration doesn't mean much, because this is already known based on radiative transfer principles. What is more useful is to perform a numerical simulation to see whether the measured reflectance can be reproduced. If the answer is yes, then reflectance under different measurement scenarios can simply be generated using simulations without involving more experimental settings.

**Response:** The reviewer has raised an interesting topic. We recognize that not all possible scenarios are and can be checked with the experimental measurements performed in our study. The acquired data can however contribute to the understanding of the spectral reflectance of plastics in real conditions and for numerical simulations (to verify data reproducibility). Radiative transfer simulations could potentially not cover the entire environmental plastic complexity. Furthermore, weathering and biofouling are hard to simulate. However, we acknowledge this good suggestion from the reviewer, i.e., to compare the spectra with numerical simulations in a future study. In the revised version of the manuscript, we have added this topic in the text by mentioning: 'As plastics in our environment are so diverse in polymer type, colour, transparency, thickness, state (pristine, bio fouled, weathered, wrinkled) and wetness (dry, wet, submerged), it is critical to generate, within the scientific community, substantiated data sets which represents plastics in many different facets. The collected spectra can serve as reference or endmember spectra in future Remote Sensing plastic detection techniques and help to understand the complexity of plastic detection through spectral analysis. It is recognized that not all possible scenarios can be measured in an experimental way, therefore the dataset can further be used to compare with and complement numerical simulations' (lines 45-52).

**Comment 1.5** Line 54 – 56. This is great – at least the community can use this data for a variety of purposes.

**Response:** We thank the reviewer for the kind comment.

**Comment 1.6** Section 2.1. How do these 6 types of polymers compare with those of Garaba, Knaeps, and their coworkers?

**Response:** This is a pertinent suggestion, which we have also addressed above in comment 1.3. The plastic specimens used in this study cover different polymer types and conditions of plastics. The experiments performed by Knaeps et al., 2020 were pristine and environmental plastics. The plastics used by Garaba & Dierssen 2018 and Garaba 2021 were also pristine plastic and marine plastic washed ashore. The novelty of the samples used in this study is that we tested not only environmental plastics or pristine plastics as Knaeps, Garaba, and colleagues did, but we also artificially weathered or biofouled plastics for which all the conditions were controlled. To better visualize the comparison and added value of the presented dataset we have included Table 1 (line 91) to the manuscript. This table shows the comparison of polymers and conditions in which these polymers are tested (e.g., dry, wet) between the presented dataset and the literature.

**Comment 1.7** Table 1. It's good to include photos, but all photos have poor quality. The first 5 photos actually show nothing except some blurred features. The rest of the photos are also very vague. They all need to be improved in quality, and a length scale bar is needed for every photo. For a bright target, a dark background is required to show the appearance of the target.

**Response:** This is a very relevant concern. The first 5 photos on the table represent the pristine plastics used during the experiments. In the original version of the manuscript, with those images, we intended to illustrate if the plastics are opaque or translucent. The 'blur' is because the reader can actually see the background behind the plastic because of it being transparent and opaque. However, we understand that this might not be immediately clear. Therefore, we have retaken the first five pictures of the table. As for the plastic dimensions, within the table, the size of each plastic is reported in cm. There are a couple of items for which the size was not stated (e.g., plastic bag) because these are off-the-shelf items for which the dimensions are commonly known or are plastics coming from the environment (e.g., grey buoy, wrinkled bags) for which the complete dimensions are less relevant. Moreover, FOV of the instrument is small and only a small part of the sample is actually measured. Lastly, these pictures are useful to inform the reader on the weathering status of the used plastic items. For instance, it is possible to notice the discoloration from the weathering or how the biofilm looks like.

**Comment 1.8** Some of the targets in Table 1 appear spatially heterogenous. With 1-degree or 8-degree FOV, the ASD fiber probe may only see a small facet of the target, and reflectance can be strongly dependent on the location of the facet. For example, for "Bag dog food", completely different spectra may result from the blue and yellow parts of the target. Then how are these spectra used as "endmembers" for remote sensing purpose where the footprint of a remote sensing pixel is way larger than the target itself?

**Response:** The reviewer is right to point out that some of the targets measured in this study are heterogeneous. This is because in our study, the goal was to provide an overview of the highly heterogeneous nature of plastics, and to go beyond the measurement of only homogeneous targets, as representative proxies of environmental plastic litter items. These spectra, combined with the other datasets in the literature, will provide us with a better overview of the variability of the plastic endmember. The very interesting question is whether it is possible to define one plastic endmember, as reflectance, particularly in the VNIR is highly variable, and research on plastic litter is still in its infancy. To clarify this topic with the readers, concerning the heterogeneity of plastic samples, we have highlighted this in the revised version of the manuscript (see lines 134-135).

**Comment 1.9** Table 2. It's better to add a photo showing the experimental setting. Also, it's better to show the before/after comparison of the same samples. Finally, can these UV exposures really simulate the weathering process in nature, where plastic materials are in marine water under different chemical, physical, and biological conditions?

**Response:** Table 2 shows the reader the experimental settings used in the Sun chamber. As recommended by Gewert et al., 2018, performing experiments for the weathering process in a UV chamber such as the one we used in the experiments can mimic the solar exposure of plastic in the environment. We agree with the reviewer that UV exposures in laboratory settings might not mimic the exact conditions that might happen in the environment. However, UV light exposure causes degradation of plastic polymers, and this procedure allows comparability and reproducibility. To add some level of complexity and obtain results as close as possible to 'real-life conditions', we weathered the plastic under two treatments, with and without seawater. To clarify this point, we have adapted the text in the revised version of the manuscript (see lines 112-114). These experiments are crucial to unraveling the spectral reflectance of plastics when weathering because it is possible to control the conditions in which each plastic is weathered. By only measuring the spectral reflectance of plastics collected from the environment we might not really know under which condition that particular object has been and, therefore, what the measured reflectance means. We believe that experiments with biofilm and artificial weathering of plastics are crucial to better understand how these conditions can modify the reflectance of plastics. As for a comparison of before and after of the same polymer is

shown in the imaged of Table 1S, now in the supplementary material.

Reference: Gewert, B., Plassmann, M., Sandblom, O., and Macleod, M.: Identification of Chain Scission Products Released to Water by Plastic Exposed to Ultraviolet Light, <https://doi.org/10.1021/acs.estlett.8b00119>, 2018.

**Comment 1.10** Figure 1. Please annotate each part of the photo – which is what. Also, it's better to show a before/after photo comparison of the same specimen.

**Response:** We agree with the reviewer, and we have now annotated, in the revised version of the manuscript, each part of the photo. In Table S1 we have provided images of the pristine polymer items and of weathered or biofouled polymers for comparison.

**Comment 1.11** Figure 2. See comment above about spatial heterogeneity.

**Response:** In Figure 2 we illustrate the type of environmental plastics. As explained in comment 1.10, the plastic collected from the field is not spatially homogeneous and the figure intends to show this. To clarify the message, we have now deleted this image, and provided an additional explanation on the heterogeneity of plastics in the text: 'and are naturally exposed to weathering and biofouling and are, compare to pristine polymers, non-homogeneous' (see lines 134-135).

**Comment 1.12** Section 3. Where is the experimental setting (i.e., how is the sample illuminated, how far is the fiber optic probe, does the lamp produce collimated beam, etc)? What's the footprint size of the fiber optic probe under the experimental setting, and does the footprint fall on different colors of the same plastic target? A photo or at least an illustration chart is required, including the illumination, ASD probe, water tank, placement of the plastic target, and placement of the 99% reference.

**Response:** The explanation of the experimental set-up is quite an important topic and is available in section 3. To illustrate the lab and silo set-up, we have now added a new figure as Figure 2 (lines 160-161). This figure illustrates the lamp, the ASD probe, and the placement of the plastic samples. To answer the question 'does the footprint fall on different colors of the same plastic target' we used a laser pen attached to the ASD pistol grip, which allowed us to know exactly where the ASD was measuring the sample and we have now included the explanation in the revised version of the manuscript stating: 'In both laboratory and silo tank set-ups (Fig. 2), we have attached a laser pen to the ASD pistol grip to ensure that, at all times, the fibre optics of the ASD were pointing at the plastic samples.' (lines 157-159). Finally, the footprint of the fiber optic was calculated during the experimental design by measuring the distance of the sample to the FOV and the type of FOV used (i.e., 8 degrees, 1 degree).

**Comment 1.13** Figure 3. Does the splice correction simply lower the reflectance < 1000 nm to remove the spike? Then it doesn't appear correct because after the correction reflectance between 600 and 700 nm is 0 or even negative. How come plastic materials have near-0 reflectance?

**Response:** We have removed the figure and left the option of performing a splice correction to the reader via lines 221-222

**Comment 1.14** Figure 3. What type of polypropylene is this? Please insert a photo. In Table 1, there are several "PP" photos with yellowish or whitish colors. Then why does this reflectance show a spike around 540 nm (greenish)?

**Response:** We agree with the reviewer have now clarified this issue. As stated in the citation, the PP is from environmental plastic and the reason why there is a spike around

540 nm (green) is that the plastic is green. In fact, this is the spectra of a green buoy. However, following the previous comment (see comment 1.13), we have, in the revised version of the manuscript, removed the figure and kept the statement about the possibility of performing a splice correction in the main text.

**Comment 1.15** Figure 4. What field sample? Those in Figure 2? There is no way all these replicates show the same spike around 540 nm from those plastic materials of Figure 2.

**Response:** We understand the comment raised by the reviewer who is right in mentioning that Figure 4 does not represent replicates of plastics depicted in Figure 2. As the reviewer raised an important concern, we have now clarified the figure by adding a picture representing the object from which the measurements were taken. We have also modified the caption accordingly: 'and figure of the object from which the spectra were obtained (a)' (see line 232). In addition, following the concerns of comment 1.14, in the revised version of the manuscript we present the graphs without splice correction. The spectral reflectance shown originally in Figure 4 were not replicates of different plastic items (e.g., coming from Figure 2), but pseudoreplicates. Therefore, as described in lines 70-71, they are the spectral reflectance of the same exact plastic item that has been slightly moved (a few millimeters) and for which the spectral reflectance has been measured. Since the plastic was from an environmental sample, therefore not homogenous, the spectral reflectance has been collected at a different point within the same item. Figure 4a, in the original version of the manuscript, represents the different pseudo-replicates of one plastic item. Since these measurements are coming from the same item the spike around 540 nm, as well as the other features, are very similar, but not the exact same because the plastic is not completely homogenous. Figure 4b (in the original version of the manuscript) represents the spectrum created by calculating the mean of all the ten pseudoreplicates.

**Editor:**

**Comment 1.1** Reviewers will undoubtedly ask about differences or advances in this data from those already presented by some co-authors (Knaeps et al, <https://doi.org/10.5194/essd-13-713-2021>). If reviewers fail to ask, I will ask. Think of users! What do they learn from this data set not available from prior work? Biofouling? What else. You talk about sample numbering consistency, but what should a user find where? More clarity about advantages, knowledge gained, how users should select or react?

**Response:** The comment posed by the Editor raises important questions. In fact, similar points of concern were raised by the reviewers. To compare our dataset with the previously published work we have added, in the revised version of the manuscript, Table 1 (see line 91). This Table clarifies what readers can learn from previous work and what is novel in the presented dataset. In the revised version of the manuscript, we have now written 'In addition, from the data presented it is possible to investigate the effects that biofouling and weathering have on the detection of different polymers. Lastly, the conditions in which a plastic item is (i.e., dry, wet or submerged with different turbidity) are also described and assessed in the presented dataset.'

**Notification to the authors:**

**Comment 1.1** For the next revision, please note that each DOI, no matter where, must be accompanied by a citation. Thereby, add a citation to a DOI in section "Introduction" etc.

**Response:** We thank the editorial staff for bringing this to our attention. We have added a citation to each DOI.