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Interactive comment on "Brief communication: Atmospheric dry deposition of microplastics and mesoplastics in an Antarctic glacier: The case of the expanded polystyrene" *by* Miguel González-Pleiter et al.

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Thank you very much for your comments. It is a pleasure to discuss these issues with you. Following your suggestions, we have revised and improved the English, and we have discussed the issues that are affecting the scientific quality of our study. As you know, brief communications have a maximum of 3 figures and/or tables, a maximum of 20 references, a maximum of 4 pages, and no supplementary material; therefore, the space was very limited. For this reason, we have changed the article category to a research article, and we have included additional information to further clarify your

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comments.

Major issue: Firstly, we have added the compass points in Figure 1 as an essential element in any map. Furthermore, we have included more information about the local meteorological conditions including prevailing winds (Figure 4) and daily wind patterns during the experiment (Figure S1). As you mentioned, the predominant winds in that area are from west. Historical data of the Uruguayan National Institute of Meteorology from BCAA (January 1998 - May 2016; 24,698 records) confirm that (Figure 4A), but also show that the strongest winds (i.e. gusts and strong gusts >150km/h) are mainly from east - southeast with some events from west (Figure 4B, C and D).

Figure 4. Wind Roses obtained for the area of BCAA based on historical data of the Uruguayan National Institute of Meteorology (January 1998 - May 2016; 24,698 records). Based on the speed of winds considered (A) and (B) refer to Winds and Strong winds, and (C) and (D) to Wind Gusts and Strong wind gusts, respectively.

Considering the used experimental strategy (i.e., checking the presence and removing 'new' plastics on a daily basis), the presence of plastics should be more related to the wind regimes that occurred on the days the study was conducted. Based on the available information we had access (i.e. Villa de la Estrellas, Fildes Peninsula climatological information, which is located near the Artigas Beach as shown in Figure S2A), during the study period (18/02/2020 - 20/02/2020) the wind was from northeast (45°) rotating to south (180°), with a speed between 10 and 30 km/h (Figure 2A). These wind conditions seem to suggest a possible link between Artigas Beach activities (BCAA and, especially, tourism) and wind-mediated aerial deposition of plastics.

Figure S1. Weather conditions in Villa Las Estrellas, during February 2020 based on the available information we had access to (i.e. La Villa de la Estrellas, Fildes Peninsula climatological information) (A), green rectangle indicates the study period (18/02/2020 and 20/02/2020), and (B) the distance between Villa Las Estrellas and Artigas Beach.

In general, the presence of microplastics and ,especially, mesoplastics on the surface

of these Antarctic glacier could be explained by the prevailing winds (i.e., strong winds, wind gusts and strong wind gusts), which could transport plastics from the Artigas Beach to the ice around both Uruguay and Ionosferico lakes. Atmospheric dry deposition of plastics could be the result of daily wind patterns was from northeast (45°) rotating to south (180°) during the collection period, which could have also transported plastics from the Artigas Beach. Therefore, plastic wastes present on the Artiga Beach, which are probably released from marine environments, and the human activities (e.g.: tourisms) could be the source of the plastics reaching glacier and atmospheric dry deposition could play a key role in their transport. Regarding mesoplastics found, they had very low density (e.g. EPS and PU), which probably eased their transport.

Regarding the alternative explanation ("that the particles were transported from ships on the far side"), it does not seem too likely considering the wind direction on the days of the experiment (Figure S1A). Considering only the predominant winds this could be, but the strongest winds, which could move the mesoplastics long distances, come predominantly from the E-SE.

It should be notes that this is a first step which pretends to show that meso and microplastics are present in Antarctic glaciers, and undoubtedly further researches are necessary to elucidate their distribution, their sources, pathways and trajectories (e.g. using HYSPLIT, LAGRANTO, FLEXPART), and of course their possible impacts. Based on the wind information we were able to collect; we have modified our discussion as follows: "In this sense, winds (especially high-speed ones) appear to be a key element in the transport of plastics to Antarctic glaciers. The prevailing winds in the study area (Figure 1B) blow predominantly from the west (Figure 4A). However, strong winds (Figure 4B), wind gusts (Figure 4C), and strong wind gusts (Figure 4D) blow mainly from the east and southeast directions, and could be responsible for the spreading of plastics from the different origins to the surface of the glacier ablation areas. These strong winds would explain the presence of MePs despite their size (Figure 2A). In fact, the low density of the MePs found (mainly EPS; Figure 2B) would have allowed their easy

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dispersion by wind.

Our results on the dry deposition of plastics support the hypothesis that the role of the wind is essential for the transport of MPs and MePs in (and among) different areas of Antarctica. The dry deposition of plastics (Table S2) was closely related to the wind regimes during the study period (Figure S1). Based on information available on the meteorological conditions during the study dates (18/02/2020 - 20/02/2020) in La Villa de la Estrellas (Figure S1A), which is located near the Artigas Beach (Figure S2B), the wind blew from the northeast veering to the south with a speed between 10 and 30 km/h (Figure S1A). These wind conditions suggest a possible link with marine environment, which can act as a source of plastics (Allen et al., 2020), and potentially explain the presence of plastics on the glacier ablation areas. However, considering the low intensity of the winds recorded during those days (Figure S1A) and the presence of MePs, it is also possible that the predominant high-speed winds transported MePs from other adjacent areas of the Fildes Peninsula to the vicinity of the lakes, in the days prior to our study (Figure 4B, C, and D) and then, the milder winds registered during the sampling days (Figure S1A) deposited these MePs on the ice."

Minor issues: Lines: 121 - 131. Regarding the sample contamination, all the materials used (metal, steel and glass) were previously cleaned with MilliQ water, wrapped in aluminum foil and heated up to 300 °C for 4 hours in order to remove all possible rests of organic matter. The use of any plastic material was avoided. Furthermore, possible contamination due to clothing was controlled throughout the whole process by comparing clothes fibres and fragments with our samples. Moreover, it should be noted that the types of plastics found in our study are not typically associated with clothing, or any of our sampling tools. In fact, some of them (e.g. EPS) are not even allowed currently in the scientific bases and were not part of any of our sampling gear. Given their size, plastics found in this study were detected by the naked eye and their traceability was easily maintained during quantification and identification of the samples. We have incorporated this in our manuscript, as follows (lines: 153 -161): "2.5 Prevention

of procedural contamination. To avoid sample contamination, all materials used were previously cleaned with MilliQ water, wrapped in aluminum foil, and heated to 300 °C for 4 h to remove organic matter. The use of any plastic material during sampling was avoided. Furthermore, possible contamination from our clothes was controlled throughout the sampling, by checking fibers and fragments extracted from the clothes against the MPs and MePs found in the samples, and by positioning us against the wind during sampling. Given their size, plastics found in this study were detected by the naked eye and their traceability could be easily maintained during quantification and identification of the samples."

Line 145: Regarding the identification of the particles, 16 items were not confirmed as plastic by FTIR or μFTIR analysis. These items were not considered plastic materials because they were not identified as a known material with matching values > 60%. Some of these spectra could show some similarities with alkyd resin (polyester modified by the addition of other components), which are widely used in many synthetic paints. However, none of them resembled soot. Regarding plastics identified, the types found (Figure 2B) are related to human activities carried out in the Artigas area. For instance, EPS are widely used in packaging and (together with the PU) as insulation material in old buildings in this area and alkyd resins found are used as external coatings. We have incorporated this in our manuscript, as follows (lines: 233 - 249): "The chemical composition of the plastics found (Figure 2D, F, and H) supports the fact that the source of the plastics could be of marine and/or land-based origin. The types of plastics found (Figure 2B) are related to human activities in the Fildes Peninsula that could generate plastic debris such as tourism, leaks in waste management at scientific bases or the presence of abandoned infrastructures. Considering the location of Collins Glacier and the main human activities on the Fildes Peninsula (e.g. airfield, scientific bases), the prevailing winds from the west could have transported small and lightweight plastics to the study area. In fact, EPS is widely used in packaging and as insulation material in old buildings in this area and polyester is also a component of old buildings paints. In the same way, some of these plastics could be released from

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the marine environment to Artigas beach area and, then, be transported by the wind to the glaciers. In this sense, polyurethane MePs (which are similar to those found in this work) have already been reported in sea surface waters in the Antarctic (Jones-Williams et al., 2020) and EPS MePs have been found on Artigas beach (Laganà et al., 2019). These findings highlight a potential threat to the fragile Antarctic ecosystem, since the presence of these plastics (e.g. polystyrene particles) has been shown to affect Antarctic biota (Bergami et al., 2019; Bergami et al., 2020a)."

Lines 49-52, we have written: "Despite the increasing rate of ice loss during last decades (Rignot et al., 2019), it has been estimated that the Antarctic cryosphere holds around 90% of Earth's ice mass (Dirscherl et al., 2020)."

Line 52 and 54, we have revised and corrected all references.

Line 57. We have removed "compartments".

Line 68: We have included (line: 71) a comma after (79%)

Line 237: We have written: "EPs was ubiquitous in the two glacier surfaces studied"

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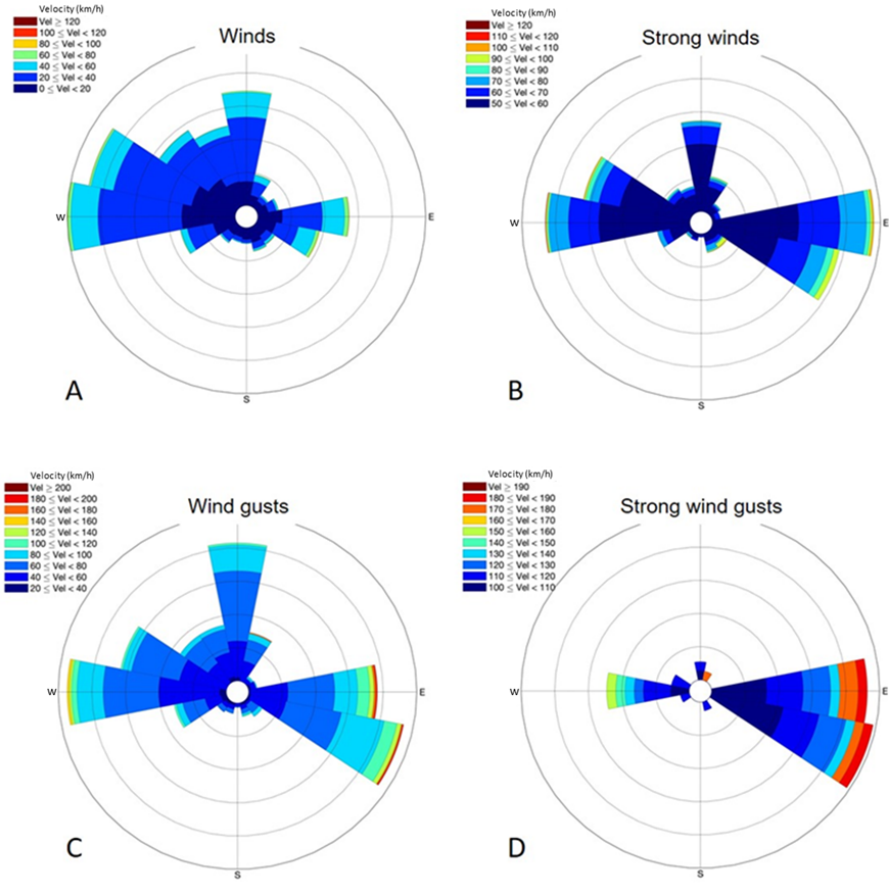
Velocity (km/h)
Vel ≥ 120
100 ≤ Vel < 120
80 ≤ Vel < 100
60 ≤ Vel < 80
40 ≤ Vel < 60
20 ≤ Vel < 40
0 ≤ Vel < 20
Winds
W
E
S
A
Velocity (km/h)
Vel ≥ 120
110 ≤ Vel < 120
100 ≤ Vel < 110
90 ≤ Vel < 100
80 ≤ Vel < 90
70 ≤ Vel < 80
60 ≤ Vel < 70
50 ≤ Vel < 60
Strong winds
W
E
S
B
Velocity (km/h)
Vel ≥ 200
180 ≤ Vel < 200
160 ≤ Vel < 180
140 ≤ Vel < 160
120 ≤ Vel < 140
100 ≤ Vel < 120
80 ≤ Vel < 100
60 ≤ Vel < 80
40 ≤ Vel < 60
20 ≤ Vel < 40
Wind gusts
W
E
S
C
Velocity (km/h)
Vel ≥ 190
180 ≤ Vel < 190
170 ≤ Vel < 180
160 ≤ Vel < 170
150 ≤ Vel < 160
140 ≤ Vel < 150
130 ≤ Vel < 140
120 ≤ Vel < 130
110 ≤ Vel < 120
100 ≤ Vel < 110
Strong wind gusts
W
E
S
D

Fig. 1.

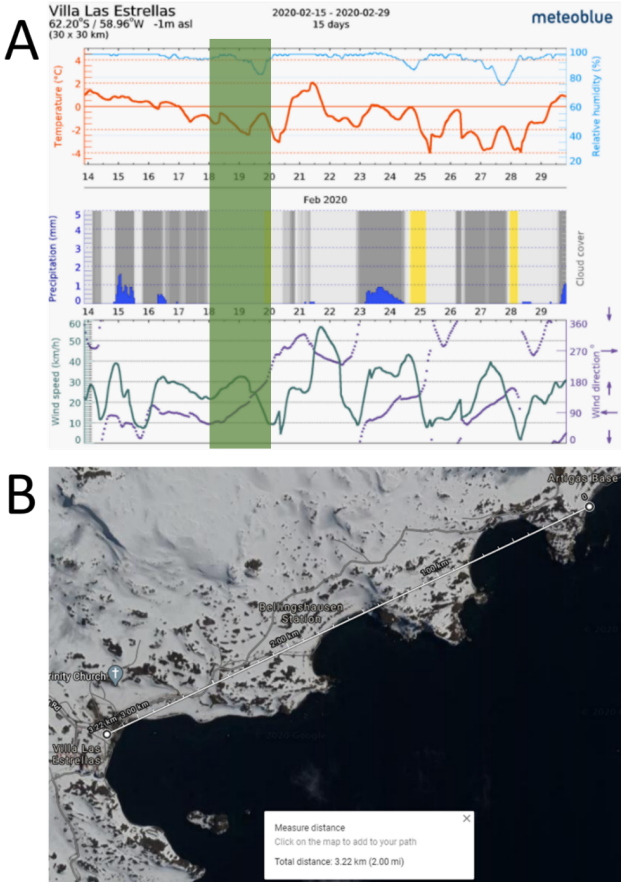

Fig. 2.

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