

## ***Interactive comment on “Airborne radionuclides and heavy metals in High Arctic terrestrial environment as the indicators of sources and transfers of contamination” by Edyta Łokas et al.***

### **Anonymous Referee #1**

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#### General comments

This is an interesting paper, the theme that is discussed is original and relatively little investigated by the glaciology community. I don't have any concern about the methodology and about the presented data and results. It is clear that the authors have expertise in the field of environmental radioactivity and inorganic pollution. Despite these points I cannot support the publication of this paper in its current form. Now the paper would be suitable for publication in a journal specialized on radioactivity, not in a journal whose audience comes from many and diverse fields of science, as is the case with Cryosphere. The manuscript needs a deep language and structural revision. I tried to

C1

improve the first part of the paper from this perspective, but I realized that to really fix this side of the manuscript a big effort is needed. This is a job for the authors. Given the importance of this point, I feel that a true and accurate evaluation of the paper will be possible only after this first shape revision. The readability of the paper is not good, there are several parts where it is difficult to follow the flow and the many data seem not well connected, also because the interpretation of the results is a little bit poor and the paper is unbalanced: the presentation of raw data is very long and detailed (even too much in my opinion), while their interpretation and discussion are poor. There is a sort of gap between what someone is expecting to find in the paper given its title and the actual content. Authors should avoid presenting and discussing extensively on numerical values and ratios in the main text, there are figures to this aim that are more useful and informative, in addition the authors could consider adding or changing some figures with new ones, where also literature data are shown, so as to strengthen the hypothesis presented in this paper. For example, the issue that Pu composition is compatible with an influence from satellite reentry, is something of new or relatively rare, or is it common to see such results? This is not clear because the data are only compared to global fallout and very few other cryoconite data, but the findings are not sufficiently highlighted. Would it be possible to extend the comparison (both graphically and in the main text), so as to evidence if what was found by the authors was a local signal or if it is more common? Discussion and interpretation in this sense should be expanded and improved, so as to allow a full comprehension of the paper also to people not well concerned about environmental radioactivity. Another suggestion is to shorten the manuscript, now it is very long and the impression during the reading is that the same could have been said using less and less words. For example, I wouldn't always treat as separate, soils, cryoconite, radionuclides and heavy metals. Discussing about them together is more difficult for the authors, but it is for sure good from the perspective of the reader, who would better appreciate the importance and the novelty of this paper.

The abstract should be adjusted, in its current shape it is not very informative and the many points that are touched in it sound a little bit as disconnected. Given the

C2

importance of this section it would be desirable to rewrite it. Now it is a brief summary of the entire paper, but the reader misses the main conceptual points of the paper, that in my opinion are: cryoconite is a better absorber than soil, local glacier morphology plays an important role in determining the accumulation of pollutants (this is one of the most interesting points from the glaciological perspective), probably cryoconite age also influences the process, in addition cryoconite seems capable of recording both global and more local events.

Something similar is for the introduction. Also this part is not easy to read, the authors should deeply revise these sections, improving the language and the general structure of the text, maybe cutting some sections that sounds too technical for people who is not in the field of environmental radioactivity.

One of the most difficult sections to follow is the results one. I suggest to the authors to merge the results and the discussion ones in one single paragraph. Now the results part consists in a presentation of number and concentrations that is not very informative. The same information is found in the supplementary tables. I see two options: 1- results are removed and its content is added to the following section, creating a single results and discussion paragraph. 2-the results part is strongly shortened and supported by figures that present the data in a graphical way (current figures are almost impossible to read).

Figures must be modified, in many cases font size and details are too little. Some figures are also too dark. To make them well readable, modifications are needed.

I suggest to the authors to improve figures, possibly adding some comparison between the samples considered here and ones discussed in previous publications, in particular dealing with isotopic ratios. It would be nice to understand if what is found in cryoconite is a common signal (even if amplified) or it is something of peculiar.

This paper could be potentially published in TC, but several additional efforts must be pushed by the authors to this aim, therefore major revisions is my final response.

C3

Below more specific comments.

Page1

Line20: why weathered? I think that this term here is not fully appropriate, you are talking about local material, regardless of its weathering degree. I suggest to the authors to change the term with "local"

Line23: I would change to "from additional and more specific sources might be...". I would like to highlight the differences between a global and uniform fallout and the more local signals that seem to be recorded in cryoconite.

Line24: change "is visible" with "was detected"; change "are" with "is"

Line25-28: this statement sounds too much confident and assume many concepts as known by the reader. I would suggest changing with "Approximately one third of the total observed Pu activity concentration is related to <sup>238</sup>Pu and can be explained considering the atmospheric re-entry of the SNAP9A satellite, which was powered by a Pu thermoelectric generator."; change with "In the sample from the Waldemarbreen glacier we could appreciate the influence of glacial local morphology on the capability of cryoconite of trapping and accumulating airborne radionuclides." Line 28-30: this passage is not clear, it seems that the sampling position on this glacier has an influence on the airborne radionuclide content of cryoconite. But the authors say that: The difference in the concentrations... may reflect the homogenous topography of the glacier tongue. How can a homogenous factor be related to a variable feature? The passage must be rephrased.

Page 2

Line2: replace "elements" with "species" Line3: it seems that only the cited species are the artificial radionuclides, please adjust this passage saying that many and many radioactive nuclides were released in the environment by humans, but that the present work is focused on the cited ones.

C4

Line7: “disintegration of satellites powered by nuclear thermo-electric generators”

Line11: what is the non-proliferation of nuclear material? Please better describe, the readers of cryosphere are usually not very confident with these themes.

Line15: this is not true. It seems that the cryosphere is only affected by the pollution from radionuclides and heavy metals, but these are only two examples. It is widely known that many and many different species related to human activities are currently found in the cryosphere. Please reformulate, spreading the message that metals and radioactivity are only two of the several pollutant groups that affect the cryosphere.

Line27: please specify where cryoconite is found also. It is important to say that cryoconite is only found on the ablation surface of glaciers.

Line29-30: this is an important passage, please add a reference for it.

Line31: change “their” with “its”.

Line34: “Cryoconite is usually found. . .”

Page 3

Line1: “Such holes are usually. . .”

Line3-4: this information is not correct. The value of 80% is referred to “Low Latitudes, Caucasus, Central Europe, Western Canada and US and Scandinavia” as it is originally stated in the cited paper (Radic et al., 2014). This is not a global value, since the response of Antarctica and Greenland will be completely different with respect to the other local and continental glacial systems. I suggest the reader to reformulate the sentence after having revised the cited paper.

Line5: “contain”

Line8-9: “provide evidence that cryoconite-derived contaminants were dispersed in the pro-glacial area by meltwater channels and accumulated in depressions of the glacier

C5

forefield.”

Line10: which properties? Maybe it will be better to use features, but anyway it is not clear what the authors are talking about.

Line12-14: it is clear what the authors are saying, but it would be nice to reformulate this passage. The topics touched here are quite sensitive and I would suggest not to directly cite specific countries.

Page 4

Line25: the figure is too dark, and the used font is too little, it should be modified, now it is not possible to appreciate all the details.

Page5

Line26: introduce the coefficient  $r$ , what is it?

Page6

Line2: change “understood” with “defined”

Line10: change with “this is the reason why the activity. . .”

Page 7

Line1: the authors should modify the figure, increasing the font size and the boxes dedicated to the vertical profiles, now you can't read anything.

Page 10

Line18-20: I guess that this is only a hypothesis, even if very likely. The authors should be more open to doubt and add a reference.

Page 11

Line1-2: please add the correlation coefficients to better appreciate the correlation degree between these variables.

C6

Line5: "which were located close to the moraine at lower altitude"

Line8: please explain why here the collapse of cryoconite holes is more likely

Page 15

Line8: what is mineral soil?

Page 16

Line 19-30: this part sounds like an introduction, it should be removed (or drastically shortened) or moved to the introduction.

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Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-34>, 2019.