

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2021-142

Anonymous Referee #2

Referee comment on "Accumulation of legacy fallout radionuclides in cryoconite on Isfallsglaciären (Arctic Sweden) and their downstream spatial distribution" by Caroline C. Clason et al., The Cryosphere Discuss., <https://doi.org/10.5194/tc-2021-142-RC2>, 2021

The manuscript of Clason et al. deals with interesting for a wide community of scientists topic of contamination of cryospheric systems. Data presented in the manuscript are novel and important in the recognizing concentration and distribution of artificial and natural radionuclides on glaciers and glacier adjacent habitats. The authors focused not only on the nuclides but also on the geochemistry of samples. I appreciate all efforts taken in the design of the study, fieldwork, and the text. However, some parts need reconstruction, better description, and careful discussion. I recommend the manuscript for publication but only after crucial improvements.

GENERAL COMMENTS

Strong points:

- a proper sampling design mirroring environmental gradients,
- investigation of the proglacial lake sediments,
- first data on the artificial radionuclides content in cryoconite in Scandinavia,
- very nice and well-prepared figures,

- providing all necessary raw data in the supplementary material.

Weak points:

- some parts of the text are overstated,
- methods require better description,
- authors did not show statistical differences between sampling points and types of the material,
- in the central forefield, only two samples were collected, making this area weak for any comparison,
- many statements require appropriate references.

SPECIFIC COMMENTS

Title.

Sounds good, however, in the light of the recent literature about the artificial radionuclide content in the cryoconite environments, authors can not say about hyper-accumulation which is overstated. I suggest rewriting the title and say about the spatial distribution of artificial and natural radionuclides in glacial and glacier adjacent environments. It is something new.

Abstract.

Line 10-15: I would be happy to see facts. For example, the first sentence suggests a threat for downstream systems while the results do not really indicate such a phenomenon. Monitoring is very important, and this paper indeed contributes to broadening this knowledge. I suggest rewrite some parts of the text.

Moreover, I feel that authors should focus on the rationale of the study, aim, a brief description of methods and results, finally conclusions based on empirical evidence.

Introduction.

This part is well written and presents a robust background for the study. I would add only a short section presenting why the concentration of radionuclides is so high in the glacial environments and why glaciers are a good study site for the investigation of FRN.

Lines 60-65. Authors overlooked data from Antarctica (Buda et al. 2020, Biotope and biocenosis of cryoconite hole ecosystems on Ecology Glacier in the maritime Antarctic. *Science of The Total Environment*, 724, 138112.).

Line 75. I feel that knowledge on cryoconite as the efficient accumulator of various contaminants (artificial radionuclides, heavy metals, POPs, etc.) is widely known. In my opinion, authors shouldn't describe this fact as a part of their own findings.

Study site.

This part requires special improvements. The authors roughly described the glacier and the surrounding area. Study on the spatial distribution of nuclides in the environment requires a much more careful description of glacier bedrock geology, amount of rain, snow cover, potential sources of contaminants (I believe the study site is great since is located between Novaya Zemlya, Chernobyl, and is far from towns and factories potentially delivered heavy metals), organic matter content. Moreover, cryospheric systems are much more simple than other Arctic systems, like for example fjords, tundra. The simplicity of biological communities, easy way to find sources of microbes and organic matter, stable temperature, and predictable behavior of the glacier makes it a good study model.

Methods.

When samples were collected? how many samples have been collected? how they were

stored?

Provide a range of a.s.l. for the sampling sites.

Line 108: what means „sufficient material“ ? provide amount/volume/weight?

Stable isotope analysis.

How material was collected and stored? It was frozen? It was kept at a low temperature?

Do authors prepare any replicates in order to get the most accurate analysis of $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$?

Results and Discussion

4.1.

Lines 178-79. Be more specific and add the number of collected samples in methods.

Lines 184-185. Provide appropriate reference.

Lines 200-204. Could authors make this long sentence shorter? Split into two?

Line 204. Why only soil organisms? Many recently published papers indicate cryoconite hosts unique, independent from other freshwater and soil habitats microbial communities.

Lines 209-210. Taking into account that only three glaciers were investigated so far, I feel that comparison between hemispheres is too far.

Lines 228-229. I would be happy to see this idea better described.

Lines 250-252. This part should be transferred to methods.

Line 254. What is „Canadian sediment guidelines for risk to aquatic life“? please provide a reference.

Lines 269-274. The effect of sunlight seems to be something new. Maybe it is worth discussing the exposure of other glaciers investigated in terms of FRN and see this idea in a wider context.

I feel that sunlight influences productivity, then higher chances for accumulation of FRNs by photoautotrophs and other microbial species. The paper of Huang et al. (Accumulation of Atmospheric Mercury in Glacier Cryoconite over Western China. Environmental Science & Technology 53(12)) will be also very helpful for discussion.

Lines 277-285. I think that authors should use more statistical analysis than only PCA. The concentration of FRNs between types of environments and material can be neatly presented.

4.2.

Line 310. It is one observation only, I suggest being careful in the explanation of this phenomenon.

4.4.

Lines 390-405. I feel that this part is no needed. At this moment it is rather a speculation. In my opinion and according to the results of the authors, FRNs will be too diluted in downstream to be harmful. Nevertheless, monitoring and control of this issue are very important. I suggest remove this part or write it in another way.

Conclusions.

The authors wrote few sentences which are not the effects of their work. I suggest adding proper references in appropriate parts of the text.

