Biogeosciences Discussions

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Comment on bg-2021-227

Anonymous Referee #2

Referee comment on "Large Herbivores on Permafrost - a Pilot Study on Potential Impacts of Grazing on Permafrost Soil Carbon Storage in Northeastern Siberia" by Torben Windirsch et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-227-RC2, 2021

This paper entitled “Large herbivores affecting permafrost – impacts of grazing on permafrost soil carbon storage in northeastern Siberia” by Windirsch and others reports carbon storage in the active layer of an intensively grazed thermokarst basin in Siberia. The study tests the important hypothesis of whether reintroduction of large mammals could slow permafrost degradation and greenhouse gas release with climate change. They found decreased active-layer depth and increased carbon storage in the intensively grazed location. The paper is very well written, and the hypotheses are well conceived and explained. I have some questions and concerns about the experimental design, which may simply be resolved with clearer description, or they might represent more serious issues.

- Comparing the effect size with expected carbon release would be very helpful in interpreting the implications of this study. For example, how much of the permafrost carbon feedback could be reduced were large areas of the permafrost zone managed in this way? I know there are large uncertainties involved in this kind of analysis, but given the importance of this issue (and the hype and criticism this particular location receives) a “back of the envelope” calculation of potential importance seems justified.
- As currently written, the grazing intensity seems to have only been assessed qualitatively (indicated by park staff). This could introduce several nonrandom sources of error. For example, the animals are very likely to prefer certain ecosystem types, which could cause a strong difference in soil temperature and carbon content independent of the effect of grazing. Additionally, the assessment of the park staff could have been influenced by their knowledge of the intent of the experiment. In a non-blind assessment, this kind of implicit bias is common in qualitative assessments.
- Given the non-split-plot design, is it possible pre-existing differences in carbon stocks and soil thermal dynamics account for some of the observed difference? There can be high spatial heterogeneity in locations such as this—particularly given the fluvial and cryostratigraphical differences that are suggested by the satellite images. The differences in radiocarbon age estimates among the sites suggest to me that they were not similar to begin with—casting some doubt on the conclusion that the grazing treatment accounts for the observed differences. This could perhaps be addressed by

comparing results here to a larger suite of measurements from the cited studies in this paper. For future work, using exclosures within the grazed area would allow direct testing of cause and effect with both soil and vegetation.

- How much of the observed change could be due to bulk density effects? Large herbivore presence can cause compaction, which would result in potentially a decrease in the measured active-layer thickness even if the permafrost table absolute position moves downward.
- The question of whether large herbivores could decrease the permafrost carbon feedback depends on the effect on net ecosystem carbon balance—including more than just soil carbon. When aboveground carbon stocks are taken into account, how does this influence the conclusions?
- The extensive use of acronyms to refer to treatments and sites added unnecessary complexity. I would recommend to use intuitive words rather than acronyms whenever possible.

Line edits:

39: Could you mention the percentage difference here to give readers an idea of the effect size?

54: some additional references on this, including some counterintuitive vegetation-soil interactions (Kropp et al., 2020; Loranty et al., 2018; Mekonnen et al., 2021)

Pertinent findings from another herbivore manipulation in tundra: (Min et al., 2021; Strebel et al., 2010)

174: The C13 signature is influenced by many factors besides degradation state (Abbott et al., 2016; Malone et al., 2018; Mauritz et al., 2019).

212: What influence might this recent deforestation have had on soil thermal dynamics?

287: A more informative subsection name would be helpful.

300: What do the colors in the boxplots represent?

330: This figure might be more appropriate in the introduction, since it depicts the hypothesis rather than the findings. If included here, I would recommend annotating to show the predictions that were confirmed, disproven, or inconclusive. One small note: it

looks like both Wisent and American Bison are shown in this picture. Are both species present at this site?

340-375: This section seems like an extension of the results rather than a contextualization or discussion. I might recommend shortening, adding references to other work, or moving the supplementary information.

380: The pattern fits, but the study design does not seem able to establish if this was due to grazing or not.

390: All this discussion of the radiocarbon age being attributable to active-layer deepening and potentially to the grazing treatment assumes that pre-treatment SOM content and age were similar across sites. Is there evidence from other nearby sites that profiles are similar enough to assume they were the same pre-treatment?

References

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