

Review of bg-2021-110

Grazing enhances carbon cycling, but reduces methane emission in the Siberian Pleistocene Park tundra site

General comments

The authors provide a nice introduction into herbivory impacts on permafrost ecosystems. The study provides a very interesting insight into ecosystem changes under grazing pressure. The data set used is a measurement series of NEE and R_{eco} , measured for two weeks at a grazed and an ungrazed site with several replicates. The observed flux changes in CO_2 and CH_4 are well described and put into relation with animal activity, such as soil compaction and drying, which shows a significant reduction in CH_4 emissions from grazed sites.

The methods used are suitable to use for the provided explanation of these effects, however, the method description itself should provide more detail on the approach.

There are several further topics arising from this study, such as the influence of vegetation species on fluxes and how fluxes change throughout different seasons. It would be great to have more comparison to other studies regarding this.

There is a minor lack of context regarding the general hypotheses of the Pleistocene Park experiment as to why the findings from this study suggest a different effect of animal grazing than previously hypothesized by Zimov et al. (2005). The findings should also be discussed in relation to those hypotheses.

Specific comments

Please consider making the data accessible via a scientific data repository.

L89: Please add a map indicating the sampling sites.

L91: There is a new paper by Reinecke et al. (<https://doi.org/10.1038/s41598-021-92079-1>) dealing with the Pleistocene Park vegetation in more detail, which you should consider here.

L151: Please describe the bootstrapping approach in more detail (number of iterations etc.).

L206: How did you test for significance?

Figure 2: For CH_4 , it should be clearly stated that these are emissions only. Using “fluxes” suggests a bi- or omnidirectional gas exchange.

Table 2: I assume “ns” means “not significant”? Please make the caption overall more clear. Also, please add something like “ungrazed sites (UGR-1 and -2) and grazed (GR-1, -2 and -3)” to the title of this table. I suggest, for uniformity, to switch axes of this table to make it similar to table 3.

L295: What about previous disturbances of the soil itself, especially in the active layer with freeze-thaw cycles? Please consider this in your manuscript

L357: These pre-existing site differences are very likely, taking the distance between the sites into account. Especially the differences in thaw depth (greater thaw depth at UGR) are opposing the general hypothesis of large animal impact on permafrost ground as a conservation mechanism, which is said

to mainly originate from snow compaction in winter. Maybe you should elaborate or highlight these a little more and discuss why your findings might differ from named hypothesis.

Figure A1: Please provide letters for each graph (e.g. as in figure A3). Also, adding the equation for each regression curve to the corresponding graph would be good.

Figure A2: Please see the comments on figure A1.

Figure A3: Please add the equations for each regression curve.

Figure A4: Please provide headlines for a), d) and g). Also, it should say somewhere in the graph (not only in the caption) that the graphs show CH₄ emissions.

Technical comments

Please make "C-Fluxes / C-fluxes / C fluxes" consistent throughout the paper. Maybe consider replacing flux considering my earlier comment

L99: Please put *Betula nana* in italics and capitalize, since it's a species name. Also, please change "willow spec." to "*Salix* sp."

L100: Please change "*lugens*" to "*C. lugens*".

L166: R Studio is just the main software. Please provide the used packages.

L170: Suggestion: "...not uniform across plots even at one site..."

L200: There is a leftover "?" in this line. Also, the test should be named "Mann-Whitney-U-test".

Table 2 caption: inconsistency in * and spaces, please adjust

Line 283: please capitalize

Review criteria:

Does the paper address relevant scientific questions within the scope of BG?

Yes

Does the paper present novel concepts, ideas, tools, or data?

Yes

Are substantial conclusions reached?

Yes, to some extent

Are the scientific methods and assumptions valid and clearly outlined?

Yes, but method description could be more precise

Are the results sufficient to support the interpretations and conclusions?

Some interpretations are a little one-directional, but supported by the data

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?

Somewhat, method explanation needs some more detail

Do the authors give proper credit to related work and clearly indicate their own new/original contribution?

Yes

Does the title clearly reflect the contents of the paper?

Yes

Does the abstract provide a concise and complete summary?

Yes

Is the overall presentation well structured and clear?

Yes

Is the language fluent and precise?

Yes, just very minor things indicated in the technical comments

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?

Yes

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?

The Methods section should receive more detailed information on the modelling approach. A figure (map) indicating the sites' positions and relations would be nice.

Are the number and quality of references appropriate?

Yes

Is the amount and quality of supplementary material appropriate?

Yes