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Reply on RC3

Jessica Plein et al.

Author comment on "Response of vegetation and carbon fluxes to brown lemming herbivory in northern Alaska" by Jessica Plein et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-286-AC3, 2022

The manuscript, entitled "Response of vegetation and carbon fluxes to brown lemming herbivory in Northern Alaska" by Jessica Plein and coauthors (bg-2021-286) proposes in a research paper to study how brown lemming impacted the short-term response and the recovery of vegetation carbon uptake, NDVI and CO2 and CH4 emission to atmosphere. The study shows that the NDVI and carbon uptake by vegetation was immediately impacted by lemming placed in the enclosure, while there was no impact during the next-year recovery for every variables of the tundra functioning.

This manuscript is written with a perfect English and the experimentation has been conducted thoroughly. While only a few studies focus on small herbivore impact on C fluxes in Arctic, I found that the study is not extensive / comprehensive enough to be proposed in a large audience journal like Biogeoscience. Fundamentally, the study focuses on vegetation disturbance, which is due to the introduction of lemming enclosure but it could be any other source of disturbance and the response would have been the same. As such, the response shows nothing specific to lemming. Plant community is totally lacking at the study and the interpretation. This is essential as lemming is quite specific in its plant species diet and CH4 efflux can be promoted by species characterised by aerenchyma. As such, this could be a way to show the specificity of lemming herbivory. Of secondary importance, there are several parts I found too long and misplaced. Below I present more precisely the different parts that could be improved:

We thank the referee for considering our study thorough. We hope that after addressing the comments of this and other referees, this study would be considered appropriate for publication in Biogeosciences.

We believe the main source of disturbance that would result in removal of vascular plants in these wet tundra ecosystems is from lemming herbivory. There could be other sources

of herbivory (such as caribou), but they are not as frequent in these northern areas of the Arctic Coastal Plain. We specified this in lines 43-46, and will ensure this is clear by emphasizing this in the revised manuscript. Additional sources of disturbance to vegetation could originate from a drastic change in environmental conditions, such as extreme temperatures, extremely dry conditions, etc. However, these would not selectively remove the vascular plants while not affecting the moss layer, which is what we observed in this experiment. We will make sure this is clear in the revised manuscript. We measured a wide range of environmental conditions in both control and experimental plots, as we described in lines 227-228, which showed no difference between the control and experimental plots.

Moreover, we described the vegetation community in the materials and methods section (lines 85-86); the study site is graminoid-dominated wetlands, comprised of mosses, lichens, graminoids, and wet sedges. When designing our experiment (lines 132-135), we took into consideration the preferential diet of lemmings in summer (lines 112, 305-306) and used motion camera footage to observe that lemming foraging within the plots was representative of these vegetation preferences (lines 205-206). From analysis of the footage, we noticed the preferential consumption of graminoids and sedges to be true. Even if we did not perform an in-depth vegetation analysis in our plots, our team completed this analysis in previous studies (see Davidson et al., 2016; https://www.researchgate.net/publication/303712736_Vegetation_Type_Dominates_the_Spatial_Variability_in_CH4_Emissions_Across_Multiple_Arctic_Tundra_Landscapes). We will include a more complete description of the vegetation types in our plots, and mention the types of vegetation that were removed by the lemmings.

L10 and L25: This is a repetition and I propose to remove the one of the abstract

This will be addressed in the revised manuscript.

L182: GPP is the annual flux, while only three instantaneous measurements were recorded. It would be more accurate to use a name that better describes the variable.

In these Arctic ecosystems, the plant growth and photosynthetic uptake is restricted to the summer months, and we used it to indicate "the total amount of carbon dioxide 'fixed' by land plants per unit time through the photosynthetic reduction of CO_2 into organic compounds" (Gough, 2011) during the time of measurements. We will clarify this in the revised manuscript.

L208ff: Can you give details on the distribution of data and the one used in the regression?

We tested the data for normality and equal variance, and we will specify in more detail the distribution of the data collected in the revised manuscript.

Figure 2 should be placed in the appendix or a more concise presentation should be drawn.

We will consider moving or presenting differently this figure when preparing the manuscript for resubmission.

L239: It would be important to give the atmospheric concentration of CH4.

We will include this detail in the revised manuscript.

Figure 3 shows primary productivity with negative values, which is totally comprehensive. However, figure 5 shows the same variable with positive value, which is both not comprehensive and standardised with Fig. 3.

Figure 3 shows the net ecosystem exchange fluxes of 2018 and 2019: negative values indicate the removal of CO_2 from the atmosphere by vegetation, while positive values indicate the carbon loss into the atmosphere. Figure 5 shows the ecosystem respiration (5a) and gross primary production (5b) fluxes, but in this case the positive sign implied a positive respiration (carbon loss into the atmosphere) and a positive carbon uptake. We realize this might be confusing, but we used the equation GPP = NEE – ER and the sign convention suggested in 2006 by Chapin et al. (https://www.researchgate.net/publication/42088971_Reconciling_Carbon-cycle_Concepts_Terminology_and_Methods).

We will make sure the signs are more clearly explained in the revised manuscript.

L324ff: This paragraph seems to belong to introduction or material and method but not to the discussion.

We will simplify and shorten this section in the revised manuscript.

I read your paper with great interest and I belief it is relevant to arctic ecology readership, providing the consideration of the issues presented here, especially the inclusion of vegetation species and traits. The long-term impact will be very

much interesting and I encourage the authors to continue this much valuable and important work.

We thank the referee again for the positive comments and very useful suggestions, which will improve the clarity of the manuscript. We hope the community will continue this work and provide insights on the longer-term implications of this work. Unfortunately, the timing of a PhD or master project rarely allows for identifying the longer-term effects, but at least sheds some light on important processes that can then be further investigated by other scientists.