Biogeosciences Discussions

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Comment on bg-2021-287

Anonymous Referee #1

Referee comment on "Massive warming-induced carbon loss from subalpine grassland soils in an altitudinal transplantation experiment" by Matthias Volk et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-287-RC1, 2022

In the study "Massive C loss from subalpine grassland soil with seasonal warming larger than 1.5°C in an altitudinal transplantation experiment" Volk et al. examined how warming, fertilization, and water availability influence ecosystem organic carbon stock and C fluxes by using a transplantation approach along an elevational gradient. The findings indicate that warming lead to a decline of the C stock, while fertilization and soil water had no effect. This study is of great importance because it shows that global warming triggers processes that act as a chain reaction and cause further warming, even if the human-made causes of global warming would be stopped. The manuscript is very well written, it is easy to understand, and it has a good structure. All in all, I think this study is very nice - the approach is new and clever, the study is well designed, the topic is more important than ever, and the results are crucial, alarming, and a call to action. Nevertheless, I have a major concern about the method/statistical analysis that needs to be clarified before the manuscript can be published:

If I understood correctly, soil monoliths (0.1 m^2 surface area) were taken from different sites (at the height of CS2), put into plastic boxes, and buried in different sites along the transect (within the plastic boxes). Thus, plants and soil organisms have to deal with warmer (or colder) environments, which can mimic global warming (or cooling). I think this is a very smart approach, however, I wonder how the plastic boxes affected the growth of the plant and soil communities:

- Regarding the plants: Changes in the environment often result in changes in competitive relationships between plants - for example, fertilization often results in grasses becoming more dominant. Subordinate species can only escape this increased competition by growing in open areas, or they become extinct. However, this is not possible in boxes and I would imagine that warming or fertilization would cause species to die out, leading to a significant change in diversity over the years. In principle, this is not a bad thing, because all communities are equally influenced by the growth in the boxes, however, the question arises then how well the results can be related to "real"

processes in nature and whether we can draw the right conclusions from this study. Plant diversity and plant community composition have a strong impact on the carbon cycle, so it would be important in this study to address how plant communities have changed over the years (have there been overall losses of diversity, has composition changed, are patterns the same everywhere or do they vary from site to site? - a few sentences in the method part and/or in the discussion would be great). I noticed that some previous studies have addressed diversity, etc. - so it would be good to cite those and briefly summarize what came out. Ideally, plant diversity and/or composition could be used as co-variables (or random effects) in the mixed-effects models to exclude that the changes in carbon budget are triggered by box-induced changes in plant diversity or composition.

- Regarding the soil community: again, box effects could change the community, but I think if the plant community is being discussed/considered, there is no need to also discuss soil community - that would be beyond the scope. However, I wonder how permeable the containers were? Would it be possible that within the 5 years soil organisms could enter through the holes/gaze (or however the containers were made permeable) and affect/change the soil community?

In addition to this main issue, I have some minor comments/questions:

- I like the introduction; however, the hypotheses are phrased in an unclear way, e.g. the opening sentence of hypothesis 3 "Irrigation mitigates effects of drought due to warming and N deposition reduces …": drought due to warming AND N deposition or drought due to warming, and N deposition?
- L 69: Are there more recent studies that support the statement (the cited study is already 22 years old and it is an important aspect that is addressed here). In general, I noticed that many older studies were cited, although I am sure that there are also many more recent studies on this current topic.
- L 108: Why were the monoliths 22 cm in depth? Many plants can grow deeper than 22 cm. I understand that the monoliths cannot be taken one meter deep, but is there a specific reason for the size of the monoliths? It seems very random, whereas depth can have an influence (for example, that certain plants can get water from deeper layers, etc.).
- L 127: did I understand correctly that only the irrigated boxes were fertilized? If so, why? Then it is not a full factorial design, isn't it?
- throughout the text: I find it difficult to label the irrigation treatment as drought. I understand the idea that warmer temperatures and less precipitation can lead to less water availability, but that doesn't mean it's a drought event (or is there data on that?). I wouldn't call it drought treatment (especially since it wasn't water availability of the "dry" plants but the control that was manipulated). Maybe it could be labeled as altered precipitation or water availability.
- regarding the title: The title states a "massive carbon loss", while the abstract states a "14% loss". I am not an absolute carbon cycle expert to assess this percentage accurately, and I am sure that 14% is a lot regarding effects on the climate. Nevertheless, the word "massive" and "14%" compete. Perhaps it should be rephrased, or the 14% is put in relation, that shows that 14% loss is massive (e.g., with XY% loss, global temperature could continue to rise XY°C, or normal is XY% loss over XY years).