Author reply to short comment from **Georgios Kazanidis** from 04 February 2021 (https://doi.org/10.5194/bg-2020-440-SC1) on:

Cushion bog plant community responses to passive warming in southern Patagonia

Verónica Pancotto et al.

Reviewer comments (RC)
Author comments (AC)
Mentioned line numbers refer to the originally submitted manuscript
Manuscript changes (MC)

Comment on the under-review manuscript "Cushion bog plant community responses to passive warming in Southern Patagonia" by: Erika Hodgson*, Naomi Gunasekara*, Jonathan Garrido-Mirapeix Munn*, Ryan Newman*, Kai Westwell*, Georgios Kazanidis**
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Dear authors,

as part of the undergraduate course "Critical Thinking in Ecological and Environmental Sciences" at the University of Edinburgh we have read carefully the mentioned above manuscript and we would like to express here our thoughts. We have found this piece of work is, in overall, a timely and interesting manuscript and we hope that our thoughts will help the authors to improve the status of their under-review paper.

Abstract

We feel that that the abstract is well written with a use of clear language. We think, however, that the authors should highlight/elaborate further on some of their interesting findings. E.g., we think that they should have highlighted that while some aspects of the plant's biology were affected by the rising temperatures (e.g., biometric features, photosynthesis, respiration) others (e.g., pigments) were not; suggestions explaining this "divergence" would be welcome.

The list of what was not affected by warming would be quite long; too long for the abstract in our opinion. The increase of pigments over time was indeed different between treatment and control plants as discussed in lines 238 – 241.

Also, we feel that the authors should have clarified which IPCC climate scenarios they have incorporated in their work.

Agreed, we changed the last sentence of the abstract to:

Our results suggest that even moderate future warming under the SSP1-2.6 scenario could decrease the carbon sink function of austral cushion bogs.

Introduction

The introduction has a good structure in overall. We think, however, that the authors could have addressed the particular research gap more thoroughly. For example, the authors should have explained why they have chosen to work with the species Astelia pumila e.g., is this a cosmopolitan species, does it have a key role in ecosystem structure

and functioning? Clarification on these aspects could increase the overall impact of the manuscript and its findings and make it more accessible.

Cushion bogs dominated by Astelia pumila are particularly understudied and are a common feature of the Magellanic Moorland, one of the largest peatland regions in the world. We do mention these motivations for our study.

We feel also that the "Introduction" would have benefited if the authors had made some null hypothesis about the impacts of the changing abiotic parameters on the species biology. We feel that the lasts parts of the Introduction should mention to the readers which are the main aims and objectives of the work and how the findings will fit into the larger picture. Currently the last parts of the Introduction (e.g., lines 41-45) should be removed to the "Materials and Methods" section of the paper.

We restructured the end of the introduction in response to the comments from both referees, largely addressing the above-mentioned points.

Materials and Methods

Lines 89-90: Please mention the measurements units used for measuring the size of the plant's leaves.

Unit (mm) added.

Line 96: Can you please explain how the number "86" has been reached/calculated?

See Table S2, 86 is the number of leaf samples we managed to collect.

The current number of replicates (n=3) for the semicircular plastic walls is acceptable; however higher numbers could provide higher statistical robustness. We acknowledge that logistical constraints may have prevented the use of these plastic walls.

We suspect a misunderstanding here coming from us mentioning n=3 in the abstract. There were 10 treatment plots of which three were equipped with temperature sensors. We changed the abstract to:

We installed a year-round passive warming experiment using semicircular plastic walls that raised average near-surface air temperatures between 0.4 C and 0.7 C (at the three of ten treatment plots which were equipped with temperature sensors).

There was also no mention of the number of individual organisms present per plot.

See Table B2 for plant coverage data.

Line 113: The sampling dates were mentioned, but it was not said how many replicate measurements were taken for the the CO2 flux measurements on the treatment and control plots during this time. We do acknowledge that this information was in appendix A1.

As stated in responses to similar issues by both referees: In our sampling design and due to the high temporal variability of CO2 fluxes, measuring fluxes over a wide range of light and temperature conditions was prioritized over measuring at control and treatment plots on the same day or equally often. We therefore did not exactly collect replicate measurements in that sense that we were aiming to e.g. compare averages, but we collected data to fit response functions to in order to compare model parameters.

Results

Lines 185-210 ("Treatments effects on temperature"). We think that these lines would fit better in the "Materials and Methods" section.

Verifying that the method achieved what it was supposed to is a result in our opinion.

Lines 215-218 suggest that the growing season ranges from September to April. Please clearly define the range of the growing season in the "Materials and Methods" section.

The southern hemisphere growing season does range from September to March, see Table B1.

Figure 3, panel d (September 2017). Based on the p-values that are provided the differences are not statistically significant (p>0.05). The authors state in the caption that ". . .this difference is less significant (p < 0.1)" which sounds a bit odd.

Changed to:

In September 2017, leaf lengths are only different at a lower significance level (p < 0.1)

Table 1. Please mention in the caption the Table the measurement units for the growth rate.

Done, "µm/d" added.

Figure 4. Some of the information provided in the caption is rather redundant (e.g. We divided the area estimates into two groups referring to midsummer and late summer (see supplementary Table S2) and compared the respective treatment and control means using a Mann-Whitneytest). We feel that this level of details is not necessary in here and would be adequate if it is only shown in the "Materials and Methods", section.

In our opinion, it is easier to understand what the p-value in the figure refers to if the method is briefly described in the caption.

Discussion

We feel that it is not the best way to start a Discussion by highlighting technical aspects; instead the authors could have given a succinct overview of the major/most interesting findings based on which they will build their Discussion. Studying the impacts of rising temperature on plant biology is a key feature; however, it is common knowledge that it is not the parameters that exerts stress on organisms; based on that it would be welcome if authors mention that a multiple-stressor experiment would have provided a better insight about the effects of climate change. Also, elaboration (even a succinct one) on the findings of other relevant studies about the impacts of multiple stressors on plant performance and implications about ecosystem structure and functioning (e.g., elemental cycling) would be great.

In our opinion, there are a few good reasons to be skeptical about the passive warming method we applied in our study. We think it is necessary to address those points, which might seem too technical for some readers, at such length.

Conclusions

The last part of the conclusions should have highlighted how the key findings of the present work fit into the bigger picture e.g. in the functioning and resilience of ecosystems where these plants are abundant. It may be beneficial to conclude by highlighting why your findings are relevant and potentially suggest management strategies to reduce the impact on Astelia pumila. It would be welcome also the authors to highlight some research gaps that would simulate future research works.

We agree that the conclusions were missing some key aspects. We rewrote the whole section.

We conducted a warming experiment in a southern hemisphere cushion bog to investigate responses of the cushion-forming plant Astelia pumila to elevated temperatures as they are projected to occur on the southern hemisphere in a future climate. At warmed plots, A. pumila grew in denser cushions and had shorter leaves leading to unchanged aboveground biomass per area. Furthermore, A. pumila physiology was altered so that at warmed plots, photosynthesis was less efficient while respiration

was intensified. We propose an increase in photorespiration as a response to warming as one likely underlying mechanism since it could explain the diminished gross primary production and enhanced respiration simultaneously. Apart from alterations of the photosynthetic apparatus, differences in leaf morphology and chlorophyll contents between treatment and control plants most likely additionally, or even decisively, contributed to the observed GPP variability. Respiration variability could additionally have been impacted by changes in root respiration and stress-induced enhanced photooxidation.

Over the main growing season of two exemplary years, warmed A. pumila cushions cumulatively took up 55 % and 85 % less CO2-C than the cushions of unaltered control plots. This change in net C uptake is considerable, especially when comparing the amount of artificial warming achieved in our experiment (annual average between 0.4 °C and 0.7 °C at the three of ten replicates which were equipped with temperature sensors) with temperature projections for the region from the Coupled Model Intercomparison Project Phase 6 (CMIP6). Estimates for contrasting Shared Socioeconomic Pathways (SSPs) show increases in mean annual 2 m air temperature of 1 °C (SSP1-2.6) and 2 °C (SSP5-8.5) from 2014 to 2100 (Wieners et al. 2019a, b). In conjunction with our findings, a considerable weakening of the long-term C sink strength of austral cushion bogs in a future climate seems likely. However, the temporal cover of flux measurements in our study was biased towards the growing season and more data from the shoulder seasons and winter, when temperatures are lower but photosynthesis of the evergreen A. pumila is ongoing, would be desirable and should be collected in future studies.