

***Interactive comment on* “The decline of alpine lichen heaths generates atmospheric heating but subsurface cooling during the growing season” by Peter Aartsma et al.**

Anonymous Referee #2

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This paper investigates the differences between lichen and shrub cover for alpine tundra microclimates. The authors measured vegetation and microclimate data at a site in Norway in two consecutive years. The research gap that they are aiming to investigate is well-framed and interesting for the field of tundra ecology in a wider scope. The article is well-written, especially the discussion and methods are overall clear. The main strength of the paper in my view is that it introduces meticulous measurements on an understudied aspect of this field. However, I propose major revisions to this paper before acceptance. The authors should reframe the conclusions of their study in accordance to the size and caveats of their experiment and improve on their analysis of the results.

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The paired plot set-up, and the plot selection not being random, risks the introduction of a selection bias. Despite their thorough methodology it remains unclear as to how their plots were actually selected. Was selection bias prevented through radial/cardinal walking? How was a plot determined to be on a ridgetop, and how was a slope $<10\%$ determined? Why was this area picked in general, does it represent the landscape that they want to study in a particularly good way? The authors successfully performed very high-detail measurements for both radiation and soil parameters. The measurements were however always on different days for different plots, and there was no revisiting of same plots, not even in 2019 when they revisited the study site. This limited amount of measuring days, measured plots and no revisiting of plots increases the risk of the results being affected by unaccounted variability. 2018 for instance was a very warm and dry year that could influence many processes in the ecosystem. Please expand on the potential consequences of these limitations and why the experiment design was changed in 2019. The authors perform their statistics based on a sample size of 13, Wilcoxon is however not a parametrized method, and generally not suitable for small sample sizes. Significance of results based on these tests can't be concluded with so much certainty as the authors claim. Consider trying a paired parametric test. Be aware of confounding variables in the microclimate.

Comments on figures: the amount of figures in the paper could be decreased. Fig. 3 needs better axis scaling to highlight their results. Fig. 5 could benefit from an r^2 to indicate the strength of relationship. In Fig. 7 it is hard to read the confidence intervals due to overlapping the same colors. There is serious cherry-picking in the 2019 graphs in fig. 8 and fig. 9. In 2019 only three plots were measured and then the authors select the one that supports their conclusions the best to include in the paper. The supporting figures of the remaining 2 plots that were measured in 2019 don't show the same strong results as the ones that are included in the main paper.

Generally, it is a good study with only 13 plots over two years, and only a few consecutive days of measurements. 2018 was a very warm and dry year. Their plot selection

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could have introduced bias. The authors should make their claims according to the limits of their experiment. The same group of authors have published multiple papers focusing on slightly different aspects of this same site and experiment, further decreasing the novelty of the results presented here. My suggestion would be to extend the study by revisiting the sites in a different year, or performing the same experiment at a different site. The results would be very much strengthened by such an extension of the study and the scientific community would benefit from a more thorough investigation of this interesting experiment.

General comments: I.32 add a Norwegian or at least Scandinavian example? I.35 what about increased competition due to e.g. grazing? I.42 does vegetation composition indicate the vegetation community, abundance, diversity? I.47 what other distinct characteristics other than albedo? I.81 expand on insulating properties of lichens? Include differences between e.g. crustose and foliose lichens and indicate which type of lichen species were dominant in their plots? I. 108 'similar way, similar positions', explain how exactly? I.111 30cm above canopy. So much higher for shrubs with a much higher canopy? Consider other effects such a surface roughness and turbulence affecting this. Tbl.2 move to supplementary information

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