

## ***Interactive comment on “The rising productivity of alpine grassland under warming, drought and N-deposition treatments” by Matthias Volk et al.***

**Anonymous Referee #1**

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### **1 General comments**

In this manuscript, the authors present a study crossing transplantation of subalpine grassland turfs from different elevations into a common garden with N fertilization and watering treatments. Because the average temperature at each turf's site of origin was different, they were subjected to different levels of warming above ambient by being placed in the same location. After four years, they found that productivity increased the most in turfs taken from intermediate elevations, and that watering increased productivity but fertilization did not. Overall the results are presented lucidly but I have a few concerns to address about the experimental design and the inference resulting from it, as well as some more minor comments below.

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First, I would like to see more information about the plant species composition of the experimental monoliths. Qualitative results can be informative too. This could be a few sentences in the methods. Photographs might also be helpful.

Generally I would be slightly concerned about the inference obtainable from the elevational gradient. If many factors change in a correlated fashion along the gradient, such as temperature, moisture, and historical human/grazing pressure, it is hard to tell which factor is the driver. I understand the limitations of the design and I don't think it's necessarily a flaw, but this is something that should be addressed more openly. This is also the case when discussing how soil moisture integrates information on both temperature and moisture; this could also be viewed as confounding the effects of temperature and moisture.

One other point I would like to raise about the inference is that the warming treatment is confounded with site of origin. For example, the communities subjected to highest warming were those that were moved from the highest elevation. Therefore it is difficult to say whether the different levels of warming, or the composition of plant and soil communities from each of the sites of origin, led to the different productivity responses. This should be addressed as well.

For reproducibility, please make the code and data available in a repository so that readers can reproduce the results of the statistical analysis. This is especially important for the mixed model specification. Sometimes it is difficult for the reader to determine the exact model specification from the verbal description but it is easier if they can see the code.

### **2 Line-by-line comments**

Line 10: The abstract does a good job of stating the results of the study but it does not do a good job of stating the motivation, novelty, or broader significance of the study

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from the outset. Please revise accordingly.

Line 55: The claim that multifactorial experiments necessarily will improve predictions is debatable. Please expand on the reasoning behind this claim.

Line 76: The hypotheses need to have a little more justification or explicit statement of the reasoning why the particular directions of the effects and interactions are expected. For example, are there other studies that show similar effects or are the expectations derived from first principles?

Line 85: It is interesting that southerly exposed slopes were chosen for the study. They tend to be drier and warmer than slopes with different aspect at the same elevation. I would expect the plants living in these microclimates to be especially responsive to the warming treatment. Is this something worth briefly mentioning?

Line 106: A picture says 1000 words. It would be great to have some photos of the environment at the study sites, either as a main-text figure or as a supplement.

Line 116: Similar to above, it would be nice to have a picture of the experimental setup.

Line 150: Is there a justification for the threshold for growing degree days being set at 0C? The same goes for the 40% soil volumetric water content threshold.

Line 196 (statistical analysis section): I'm not sure I understand the reasoning behind assigning CS as a fixed effect but site of origin as a random effect. From my reading of the methods those are the same thing. Can you please clarify this?

Line 216: Please include some details on the GAM fitting procedure, such as functional form of splines, etc. Were the defaults from the mgcv package used? If important inference is drawn from the GAMs, it would be good to assess the sensitivity of the results to choices made in the GAM fitting process. As written, it is not reproducible.

Line 277: Because all columns of Table 4, besides the two leftmost, are in the same units (mean and SE of aboveground biomass yield), it might be better to convey the

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information in this table with a figure. Currently it is difficult to visually extract the most salient patterns from the table. If you do not want to use a figure maybe another possibility would be to use colors or cell fills to show where the highest values in each year were recorded.

Line 281: I am confused why -7.7% is described as an increase, is it a negative or positive change?

Line 289: Refer to the statistical test result (I am assuming this is Table A2?) that supports the statement that there was no significant interaction between N treatment and CS or irrigation.

Line 316: "climate scenario warming" is a confusing phrase. Do you mean warming consistent with some particular climate scenario?

Line 390: I found this paragraph to be a little confusing. Are you referring to results from the present study or previous studies in the literature? Also, because you mention specific species responses to N addition from other species, it would be more interesting if you would draw a more direct connection with the present study. Were there any individual species that you can point to their responses?

Line 425: I am not sure what the grounds are for stating that subalpine grassland productivity will increase with warming. Is it necessarily the case that climatic conditions will "move up" in elevation – maybe there will be novel and unpredictable combinations of temperature and moisture not tested here.

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