

The Cryosphere Discuss., referee comment RC1  
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## Comment on tc-2022-135

Claire C. Treat (Referee)

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Referee comment on "Environmental spaces for palsas and peat plateaus are disappearing at a circumpolar scale" by Oona Leppiniemi et al., The Cryosphere Discuss.,  
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In this study, Könönen and colleagues build a dataset on peatland palsa and peat plateau occurrence, then extract environmental variables from gridded datasets to determine the climate space conducive to palsas. Then they use statistical modeling to predict the area of peatland palsas, and how this area will change in the future under changing climate. The question is interesting, if not particularly novel (see Halsey et al., 1995, Fewster et al. 2020, 2022). The main distinction here is that the authors expand on this from a regional analysis to a pan-Arctic analysis, which is a factor that dooms this manuscript in it's current form because of un-even spatial coverage in their dataset. The results that peat plateaus and palsas will disappear with climate change isn't especially new (see Halsey et al., 1995, Beilman et al., 2001, Tarnocai 2006, Camill & Clark 1995, Camill 2005), but the scope is interesting and alarming.

I think in it's current form, the manuscript is unfocused as well as missing key information and methodology that prohibit the evaluation of the results and conclusions. The discussion is superficial and doesn't address key uncertainties and other factors that would affect the results. For the focus, the majority of the methods and half of the conclusions are focused on present day conditions. Only one short section in the results section is and the discussion about this is superficial. There is no section explaining how the forward projections were done and what data was used beyond the scenario names (and they are from AR5).

The most crucial information, the dataset about the palsas, is missing (cited as Appendix A). The information is not in the paper, is not already openly or provisionally available in an online repository (e.g. Zenodo or Pangaea or a Uni Helsinki repository), or in the supplementary materials. This is problematic because from what I see, the model results for North America seem to be particularly biased towards where there are samples or not. I think the data coverage is exceptional for Fennoscandia but really limited for North America. The authors don't explore the representativeness of the dataset that they've collected towards earlier described or known inventories of permafrost peatland areas or palsa areas or peatland areas. This could be normalized and some confidence assigned

based on the number of samples per peatland area. I thought that the results look really biased towards where there are samples, and quite limited outside that as I would expect a lot more coverage in Northwestern Canada (Alberta). Other areas that don't look right to me, in particular a high chance for peat plateaus and palsas on the North Slope of Alaska and on the Seward Peninsula where the dataset is quite limited. To my knowledge, the peatland area is relatively limited on the North Slope and often limited to riverine systems and not so frequently peat occurrence. Then further north, mostly polygonal tundra peatlands are found or no peatlands at all. As mentioned in the discussion, interior Alaska would make sense. I am also aware of some other large peatland datasets that could either be incorporated and referenced or used for validation (Treat et al., 2016, Table S1) as a presence/absence marker or a newer dataset from Olefeldt (BAWLD) that tackles this more directly (see "Permafrost Bog"). They show much more extensive permafrost bog coverage in northwestern Canada, for example.

My other major concern in this study was the approach for validation. Not much space or effort was dedicated towards convincing me as a reviewer that this approach worked (and from my visual inspection of Figure 2 above, I'm not convinced) and what the results would actually represent. Is this potential permafrost palsa area or actual permafrost palsa area? The model validation isn't presented in the results section, or really at all. The closest we come is Table 1, giving the areas by region and the change over time. Comparisons about the spatial distributions are made to Fewster, but the areas are not put into context of peatland areas, permafrost peatland areas, regional permafrost peatland areas, or other independent datasets so it is difficult to glean if these area estimates are even reasonable. I would expect to see a table comparing the areas predicted in this study to other estimates from Webster 2018, Hugelius et al. 2020, Olefeldt et al., and Fewster. Finally, the real trick in these discontinuous permafrost environments is to separate permafrost that shouldn't be there in today's climate envelope and is only there because it formed under colder climate conditions and non-permafrost, as would happen at the exact southern edge of the permafrost environment (e.g. when there are paired cores at a site, one with permafrost, one without and commonly found in palsa regions of Fennoscandia and Canada). My understanding in this is that these samples would be excluded because they are too close in location, which might limit the accuracy of this approach in the most sensitive regions. If this is only change in potential permafrost palsa area with no distinction between where there is permafrost and not, this really limits the utility of the whole analysis for future predictions.

Specific comments:

15-16: why -98.2 and 89.2 loss? Signs don't match?

25: Wang 2022 is missing from refs or wrong reference.

34: see additional refs above.

33: Hugelius has additional peatlands included in permafrost peatlands, not necessarily plateaus and palsas.

49: see additional refs above

51: yes, Siberia is a big unknown!

57: what about snow? Wind? Trees?

65: why not some areas where palsa thaw is observed?

84: appendix not found

90: Check Treat et al. 2016

103: but this is the crucial distinction.

Figure 1: coordinates for Kiruna leave me in a lake. Would be helpful to see the traditional permafrost map from Brown also for reference.

110: this is all present day, good to acknowledge role of past climate and the limitations this presents.

136: why? what was the goal or motivation of this?

Section 2.3: for all these paragraphs, WHY? What specifically was the purpose or goal of this analysis, what did you actually do? Where are the forward projections?

139: add citation for biomod2 package

3.1 model evaluation of what? Why don't discuss suitable environments already? Where is the evaluation of the representativeness of the dataset? Or independent evaluation? What about normalizing for areas? Also I've never heard of palsas in Iceland.

Figure 2. The results looks really biased towards where there are samples.

Figure 3: y-axis labels

Section 3.4 doesn't provide any real (independent) model evaluation, it only compares the different techniques used.

382: Yes, it is good that the model found palsas where the input data indicated there should be palsas. But it also found them where there is little evidence for palsa.

Data availability: The dataset should be provided with DOI not upon contact to author, especially since it is listed as Appendix A..

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