All line numbers refer to the original manuscript.

RC1 Claire Treat: https://doi.org/10.5194/tc-2022-135-RC1

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.
R1: We thank Dr. Treat for the highly valuable comments throughout the review. We are aware that some prior regional-scale studies affect the novelty of our study. This was one of the reasons why we aimed to conduct our study at the circumpolar scale, especially after the recent publications of Fewster et al. (2020, 2022). We will modify the manuscript so that it is clear for the reader that our results for Central and Eastern Siberia are for the most part extrapolations from models fitted for North America, Northern Fennoscandia, and Western Siberia. We believe that our predictions add value to the current knowledge of the distribution of suitable environments for palsas and peat plateaus, because there are very few studies from Central and Eastern Siberia. Thus, our predictions can give new insights into the landform distribution and guide future research in these insufficiently explored regions.

In addition to the more extensive research area, the fine spatial resolution (30 arc sec) used in this study is much finer than what previous studies have utilized and brings novelty to the results. Because of the fine resolution we can present more detailed picture of the potentially suitable environments for palsas and peat plateaus and find unsuitable regions within them, which is one aspect that previous coarser resolution studies have not considered. Moreover, the inclusion of soil and topographical variables (silt and soil organic carbon content, thickness of the soil layer, and topographical wetness index) distinguishes our study from climate envelope studies (e.g., Fronzek et al. 2006; Tam et al. 2014; Fewster et al. 2022). These points of novelty were recognized also by Paul J. Morris in his community comment to this manuscript. Consequently, we believe that our study makes a valuable contribution in the field of palsa and peat plateau research.

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.
R2: In editing the manuscript, we will focuse on better readability throughout the text. Particularly, we will describe our methods more explicitly and add reasoning so that the readers can evaluate the results and conclusions better. Please note that these issues are discussed later in this response letter in more detail.

The discussion is superficial and doesn't address key uncertainties and other factors that would affect the results.
R3: We will add discussion about the uncertainties related to the model extrapolation. Moreover, we will also include a new figure to the section 3.4 (fig. R2; see reply no. R9). In this figure, we compare our predictions to the distribution and coverage of the peatlands, which will (allow us to) deepen the discussion of suitable environments for palsas and peat plateaus in the recent period 1950–2000. In addition, we will incorporate better the discussion related to the role of the past climates to these landforms as suggested.

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.
R4: We will add a new paragraph about the future predictions to the methods as requested to make them easier to follow and balance the focus between present day and future parts (see below). Please note that the same modelling framework was used to produce the recent and future predictions so the methodological parts can be considered to describe both the recent period (1950–2000) and future scenarios. We elaborate the involved steps in the methods section (see below).

A new paragraph:
"Future predictions were produced using the BIOMOD_Projection function in biomod2 (Thuiller et al. 2021; see Karjalainen et al. 2020). In the procedure, the models calibrated with 1950–2000 climate data and other environmental variables are used to predict suitable conditions in the future by substituting the recent period climate data by respective future scenarios. Future predictions were performed for each RCP-scenario (2.6, 4.5 and 8.5) and future period (2041–2060 and 2061–2080). We did not consider it plausible that new suitable environments for palsas and peat plateaus would develop during the 21st century because of possibly insufficient peat coverages and slow peat accumulation in the Arctic regions. These factors are also affected by the climate change but data predicting these changes are unavailable. Thus, the future predictions were extracted to the extent of our predictions for the recent period (1950–2000)."

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).
R5: We added a new paragraph in the section '2.3 Statistical modelling' about the future predictions as mentioned in the previous reply. Climatic variables which were for future scenarios are available in WorldClim v1.4 database (Hijmans et al., 2005), as mentioned in the manuscript (section 2.2). We decided to use RCP-scenarios available in WorldClim v1.4 as the recent period (1950–2000) for which the database provides 'baseline data' coincided well with the most of our landform observations (meaning years when landform observations were originally documented). An earlier climate period was also preferred as most palsas and peat plateaus were formed during colder climates than we are currently facing (Vorren, 2017; Fewster et al., 2020), and thus we expect that the period 1950–2000 represents better these climatic conditions than the more recent baseline periods. The new version of WorldClim (v2.1) using CMIP6 scenarios uses baseline period 1970–2000 and thus it was less suitable for our purposes. In addition, future scenarios in WorldClim v2.1 were not available at 30 arc sec resolution when we compiled the environmental data.

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.
R6: We would like to politely note that the Appendix A was placed at the end of the manuscript. However, it was unfortunate that the reviewer did not find the Appendix A. This may have caused some confusion in finding right references from the reference list. Thus, we will move the Appendix A after conclusions to make it more visible. We wanted to provide this list of references of landform observations in the manuscript rather than in supplementary materials to acknowledge the authors for their contribution for our study. We will also provide the coordinates of the landform observations in the supplementary material.

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.

R7: We acknowledge this imbalance between regions in our dataset. We compiled as representative a dataset of landform observation across the permafrost region as possible. For Northern Europe there are many mapping studies and inventories available (Backe, 2014; Ottósson et al., 2016; Metsähallitus, 2019; Ruuhijärvi et al., 2022), which is not the case for North America to our knowledge. We are aware of the Wetland Data Base for the Western Boreal, Subarctic, and Arctic Regions of Canada (Zoltai et al. 2000) which was also utilized by Fewster et al (2020). However, due to the low accuracy of the given coordinates in the database, it was not possible to locate all the landforms with high enough spatial accuracy to be used in this study, and we were not able to detect the landforms in satellite imagery in the data validation process. This reduced the number of observations in North America. Comparisons between palsa/peat plateau observations and (permafrost) peatland areas are problematic and do not directly give insights into the representativeness of our dataset (as permafrost peatland does not equal to palsas or peat plateaus). However, with the addition of a new figure R2 (see reply no. R9) we can assess how representative the compiled observations are in relation to the known/estimated permafrost peatland/bog distribution.

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 occurence. Then further north, mostly polygonal tundra peatlands are found or no peatlands at all. As mentioned in the discussion, interior Alaska would make sense.

R8: The predictions likely underestimated suitable conditions in Alberta, but our models predicted suitable environments quite broadly in the Northwestern territories (fig. R1, see below). Fewster et al. (2020) predicted the high occurrence probabilities of the landforms broadly in the region, but this might be caused by the coarser resolution of their study. Higher resolution and soil variables used in this study, enables our models to recognize possibly unsuitable regions within the palsa region predicted by Fewster et al. (2020), which might cause the more limited distribution.

As for the predictions for Alaska, the results were surprising as discussed in the manuscript. Figure 2 shows relatively high occurrence probabilities for the occurrence of suitable environments on the North Slope and Seward Peninsula. However, when we classified these continuous predictions of suitable environments into binary maps used for the area calculations (provided in Table 1) this seems not to be so problematic. The binary classification is illustrated in the new figure R2 (described in reply no. R9), and we will add simplified outlines of the binary classification to the revised figure 2 in order to decrease the subjectivity of the interpretation of our predictions (see reply no. R33). As one can see (fig. R2) for example the predicted suitable environments in North Slope are restricted to a much smaller area than figure 2 suggests. For the Seward peninsula the difference is not so clear but still some improvements can be recognized when compared to figure 2. Notwithstanding, our models slightly over predicted the suitable environments when comparing to the distribution of peatlands in Alaska (fig. R2). To make this crystal clear, we will add discussion related to issues above to the revised manuscript as well.

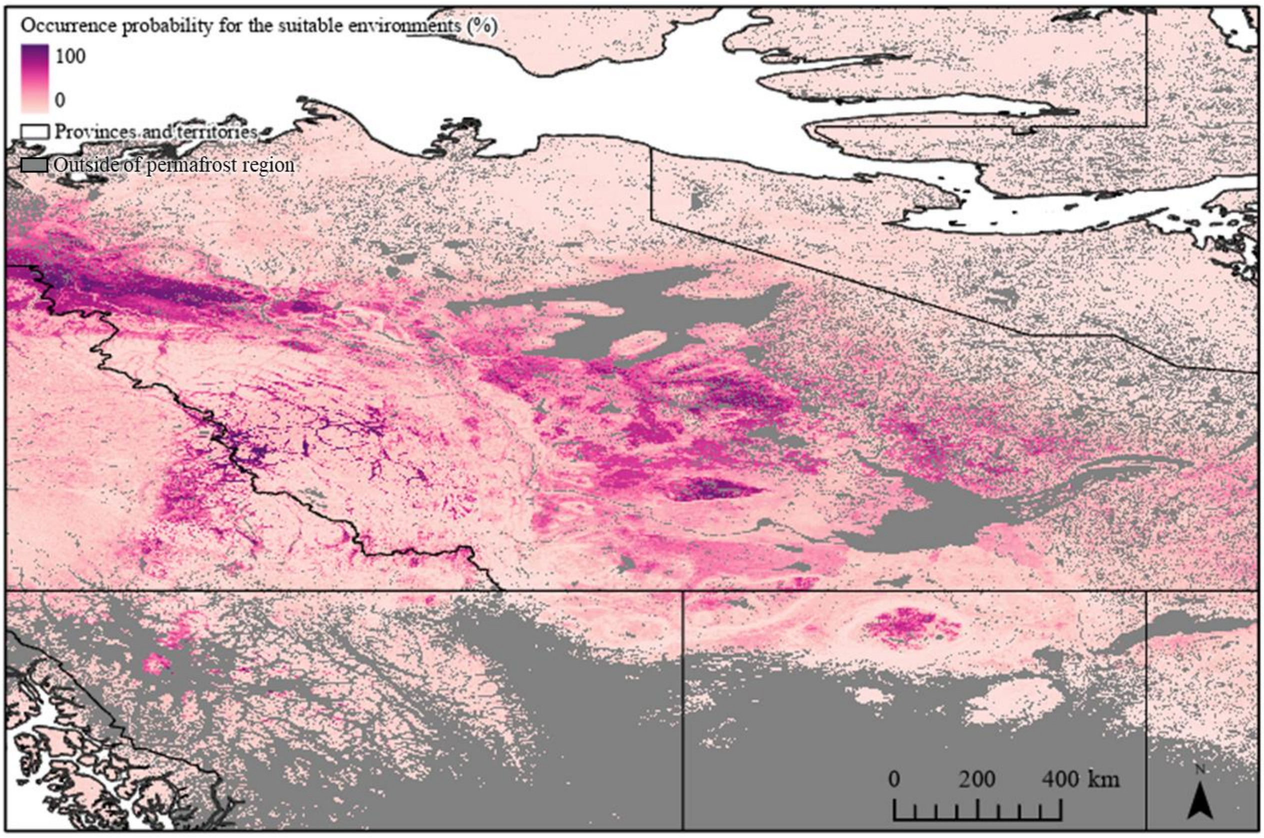


Figure R1: The occurrence probability for the suitable environments for palsas and peat plateaus is illustrated in pink-scale, borders of the Canadian provinces and territories with black outline, and regions without permafrost in grey. Predictions are extracted for the permafrost region (Ran et al. 2022).

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.

R9: We thank the reviever for pointing out these datasets and will use them to discuss and validate our results. When we compiled the environmental dataset, we examined many peatland datasets including Hugelius et al (2020) but our models yielded the highest evaluation scores with the soil organic carbon content (SOC) variable from the SoilGrids (Poggio et al., 2021) and thus it was utilized in the models. Many peatland datasets such as BAWLD (Olefeldt et al., 2021) are at coarser resolution than other variables and could not be used in this study. However, we recognize the value of suggested comparisons for validation of the results. We compared our predictions for the recent period (1950–2000) to four different peatland datasets (BAWLD, Hugelius et al. (2020), PEATMAP, and Treat et al. (2016a)). New figure (fig. R2) and discussion presenting these comparisons will be added to the manuscript (see below) to the section 3.4. Based on these comparisons, our predictions (for 1950–2000) and the distribution and coverage of the peatlands coincide well especially in North America and Western Siberia (except in Alaska according to PEATMAP, Xu et al., 2018). On the contrary, peatland datasets clearly underestimate the peatland coverage in Fennoscandia, probably due to their coarse resolution, as the datasets do not recognize permafrost peatlands there, although palsas and peat plateaus are relatively common in the region. We added two classifications of suitable climate spaces based on FDD and TDD values to the new figure (fig. R2); a liberal interpretation of our results and a stricter one (see fig. 3). According to these classifications some of the permafrost peatlands would not be climatically suitable for palsas and peat plateaus (i.e., in Northern Siberia, and according to the stricter interpretation in northwestern Canada as well).

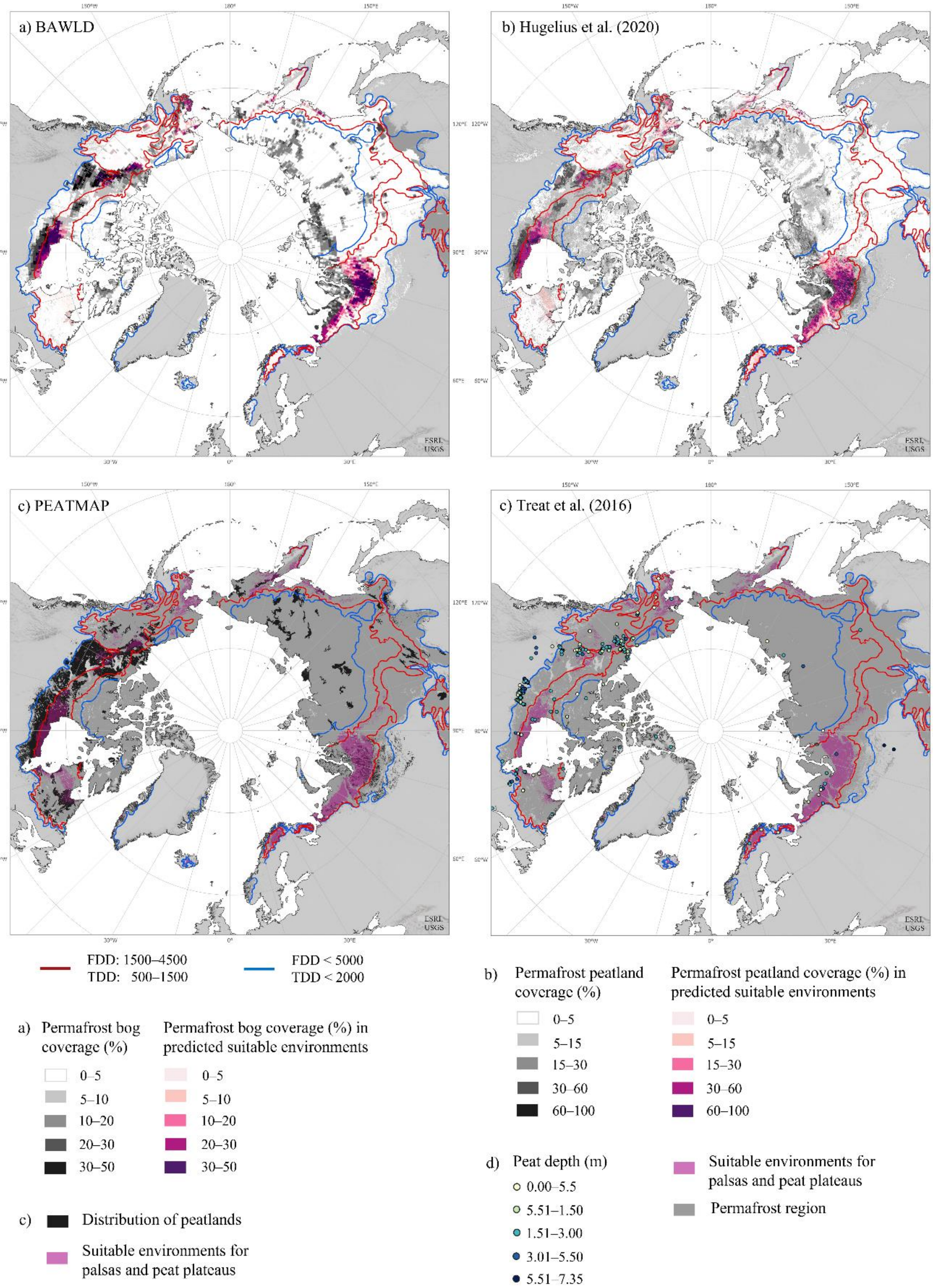


Figure R2: Comparison between the predicted suitable environmental spaces for palsas and peat plateaus (for period 1950–2000) and different peatland datasets; (a) Permafrost bog coverage percent (0–50 %), in each grid cell according to the Boreal–Arctic Wetland and Lake Dataset (BAWLD; Olefeldt et al. 2021), (b) permafrost peatland coverage percent (0–100 %) in dataset produced by Hugelius et al. (2020), (c) distribution of peatlands according to PEATMAP (Xu et al. 2018) and the predicted suitable environments, and (d) peat depth according to Treat et al. (2016a) in point symbols (yellow to blue scale), suitable environments, and permafrost region (Ran et al. 2022; dark gray). The suitable environmental spaces for palsas and peat plateaus are illustrated with pinkish colors whereas areas outside our binary predictions are illustrated with grey scale. Suitable climate spaces (based on FDD and TDD) with two classifications are illustrated in red (a strict interpretation) and blue (a more liberal interpretation) lines. All datasets are extracted to the permafrost region (Ran et al. 2022).

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 are 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.

R10: First, we would like to note that the good to excellent predictive performance of the modelling was demonstrated by the statistical evaluation metrics in figure 6. These evaluations included uncertainty measures (standard deviations) which were based on a 100-fold cross validation and evaluations against separate evaluation datasets. Standard deviations were also calculated to the True Skill Statistics (TSS) cut-off values, and a figure comparing the extent of binary classifications (using average and ±1 s.d. cut-off values) will be added to the supplementary material (fig. R3). We will calculate the areal variance based on these classifications to the Table 1. Moreover, we compared the future predictions to the thermokarst data by Olefeldt et al (2016) to assess the spatial match between their mapped thermokarst-prone areas and those of the currently suitable environments predicted to become unsuitable under the used future scenarios. The idea behind this was to link the loss of suitable environments with increased thermokarst activity. We acknowledge that additional validations with the mentioned permafrost peatland datasets have the potential to more explicitly address the circumpolar distribution of suitable environments but also the unsuitability of certain permafrost peatlands (see fig. R4 from reply no. R18) into which our circumpolar analyses can shed novel insights.

Throughout the manuscript we are using terms 'suitable environments' or 'suitable environmental spaces' instead of claiming that our results would present actual distribution of palsas and peat plateaus now and in the future. We will modify the legend of figure 2 accordingly to follow this terminology (from 'Landform occurrence probability (%)' to 'Occurrence probability of suitable environments (%)'). See revised figure 2 from reply no R33.

Statistical modelling has successfully been used to model the distribution of landforms including palsas and other periglacial landforms (at regional to circumpolar scales) (e.g., Aalto et al. 2017; Fewster et al. 2020, 2022; Karjalainen et al. 2020). We will modify the manuscript to better acknowledge methodological uncertainties.

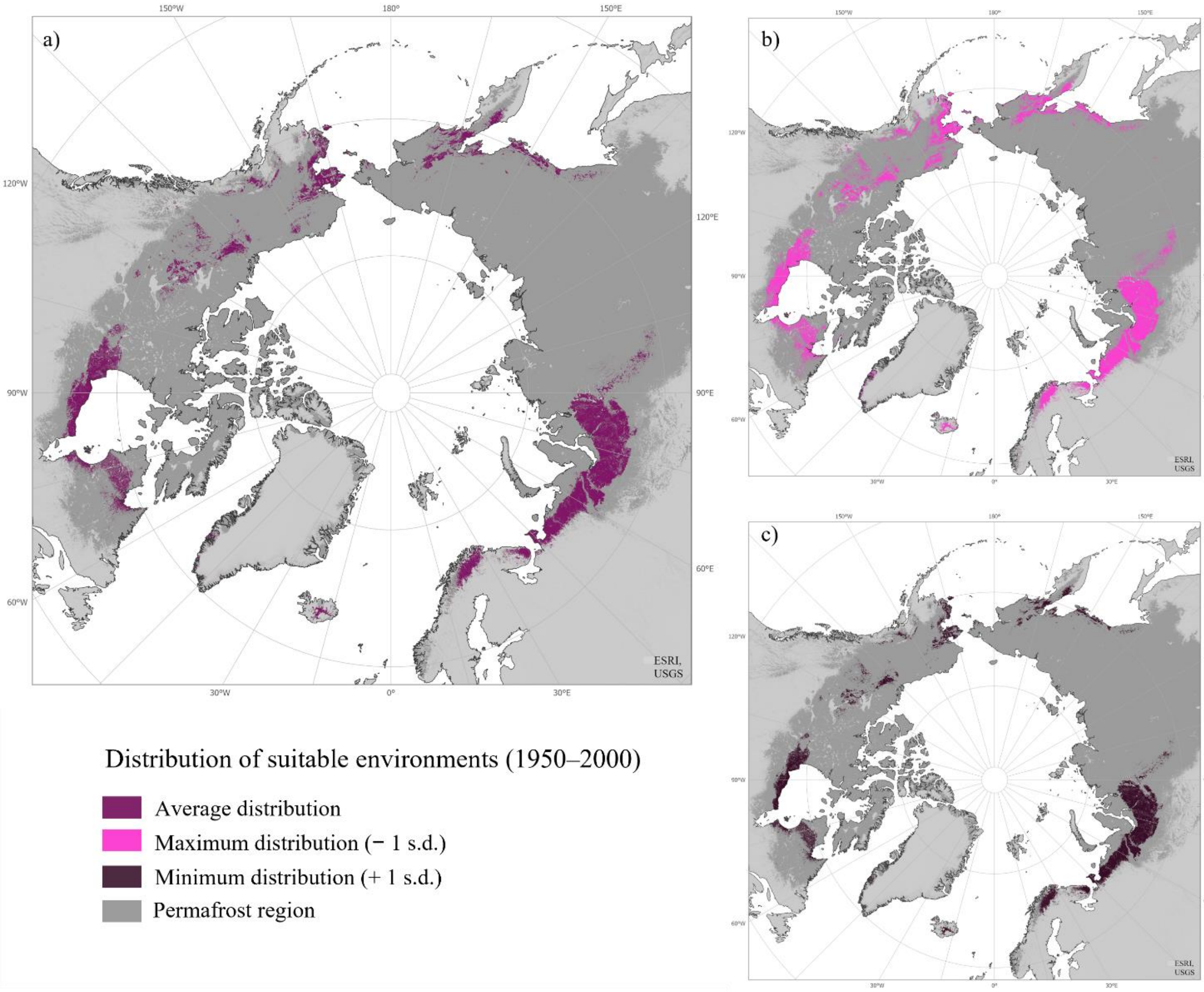


Figure R3: Comparison between binary classifications of the suitable environments (for period 1950–2000) for palsas and peat plateaus, based on different True Skill Statistic (TSS) cut-off values calculated from 100 model iterations: (a) average, (b) -1 standard deviation and (c) +1 standard deviation. On the background the permafrost region on dark grey (Ran et al. 2022).

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.

R11: We found the quantitative comparisons between the predicted distribution of suitable environments for palsas and peat plateaus and distribution of peatlands or permafrost peatlands difficult because they are not fully comparable, i.e., not all peatlands, even inside the permafrost area, have palsas or peat plateaus. Based on the response curves in Fig. 3 we can see that the probability of suitable conditions decreases sharply after around 4,000 FDD. This suggests that not all climate conditions inside the permafrost region are suitable for palsas and/or peat plateaus even though extensive peatlands are found in North Siberia, for example. The possible absence of palsas and peat plateaus in the continuous permafrost region could be caused by the environmental conditions favoring other periglacial landforms, such as pingos and polygon mires (French, 2017), and thinner peat coverages (Seppälä 1988; Hugelius et al. 2020). This, in addition to the resolution difference between our study and peatland datasets (see above), poses a challenge for quantitative comparisons between our predictions and proposed permafrost peatland datasets. Thus, we decided to present visual comparisons instead of a table. This new comparison including Olefeldt et al. (2021), Hugelius et al. (2020), PEATMAP (Xu et al. 2018), and Treat et al. (2016a) was presented above (fig. R2).

Quantitative comparisons between our predictions and predictions of Fewster et al. (2020, 2022) would be useful in model evaluation. However, these comparisons were not possible as the predictions of Fewster et al. (2020, 2022) were not available as geospatial data.

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.
R12: This is an important notion, and we are aware that modelling landforms commonly found in discontinuous and sporadic permafrost regions is tricky for the reason mentioned above. However, we did not consider it appropriate to exclude observations of the sensitive environments from the data, because like the reviewer points out, many palsas and peat plateaus in Fennoscandia and Canada are found in these sensitive regions. Thus, including these observations improves the spatial representativeness of the data. Permafrost can exist in palsas and peat plateaus in the sporadic and isolated permafrost regions. For this reason, we did not exclude landform observations even though their neighboring grid cells would not contain permafrost.

In addition, we could expect that including observations from the very limit of the permafrost occurrence would cause our models to predict suitable environments in warmer climates than where these landforms are actually found. However, our results show that the possible over-estimations are more likely to be found in the higher latitudes rather than regions too warm for the landforms.

Specific comments:
15-16: why -98.2 and 89.2 loss? Signs don't match?
R13: Will be changed.

"Climate change was predicted to cause an almost complete loss (decrease of 98.2 %) of suitable environmental spaces under a high emissions scenario by 2061–2080, while under a moderate emissions scenario the predicted loss was 89.3 %"

25: Wang 2022 is missing from refs or wrong reference.
R14: Wang (2022) can be found from the reference list. Another reference: Wang (2017) was used in the data compilation, and can be found from the Appendix A.

34: see additional refs above.
R15: We thank the referee for the useful suggestions for additional references. We will cite to Halsey et al. (1995) and Treat et al. (2016b).

33: Hugelius has additional peatlands included in permafrost peatlands, not necessarily plateaus and palsas.
R16: Thank you for pointing this out. We will reword this to avoid misunderstandings. It is important to make a distinction between palsas and peat plateaus and permafrost peatlands (see above the reply no. R11).

“According to Hugelius et al. (2020) nearly half of the peatlands of the Northern Hemisphere contain permafrost. These widespread permafrost peatlands include palsa mires and peat plateaus.”

49: see additional refs above
R17: We will add citation to Zoltai et al. (2000).

51: yes, Siberia is a big unknown!
R18: We acknowledge this as it was our biggest problem in the data compilation. As Paul J. Morris suggested in his community comment to this manuscript, we will modify our approach so that it is clear to the reader that the results for Central and Eastern Siberia are (for the most part) extrapolations of models fitted for North America, Northern Fennoscandia, and Western Siberia.

As one can see from the new figure R2 (see reply no 9), the peatlands in Central and Eastern Siberia are concentrated at higher latitudes which might have too cold or continental environments for palsas and peat plateaus. This was one reason for us to include the annual air temperature range variable (Temp.range) in the analysis. The extent of peatlands (BAWLD, Hugelius et al. 2020, Treat et al. 2016, and PEATMAP) is quite limited within the suitable climate envelope that we estimated based on the modelled response shapes (Fig. 3). This indicates that there are not too many places where our models could underestimate suitable conditions. In the manuscript we presented the results for random forest (RF) models, but in the supplementary materials the maps present the distribution of the suitable environments according to all used modelling methods (see figs. S5 and S7). None of the used methods predicts much wider distribution for the suitable environments for Central and Eastern Siberia than the RF. The congruence between modelling methods provides additional support to our RF results.

Moreover, our preliminary results from regional analyses (results not shown) show that climatic conditions of palsas and peat plateaus do not substantially differ between relatively continental areas in Canada and Western Siberia. Thus, it is possible that palsas and peat plateaus in Central and Eastern Siberia occupy similar climatic envelopes than those elsewhere in relatively continental areas.

The suitable climatic space (based on FDD and TDD) according to the results of this study (fig. 3) falls between the following ranges: strictly TDD: 500–1500 and FDD 1500–4500, or more liberally TDD < 2000 and FDD < 5000. We illustrated these borders of the suitable climate space for palsas and peat plateaus of Central and Eastern Siberia below (fig. R4). Figure R4 shows that the suitable climate space for studied landforms is limited in the region, even when using the liberal classification (blue line in fig. R4). From Hugelius et al. (2020) data and our binary predictions in the background, one can see that few permafrost peatlands exist in these estimated suitable climate spaces, and our models found suitable environments from many of these peatlands. Hence the extrapolations of the suitable environments for Central and Western Siberia region might not actually be as far from the truth than one could expect from the low number of observations in the region.

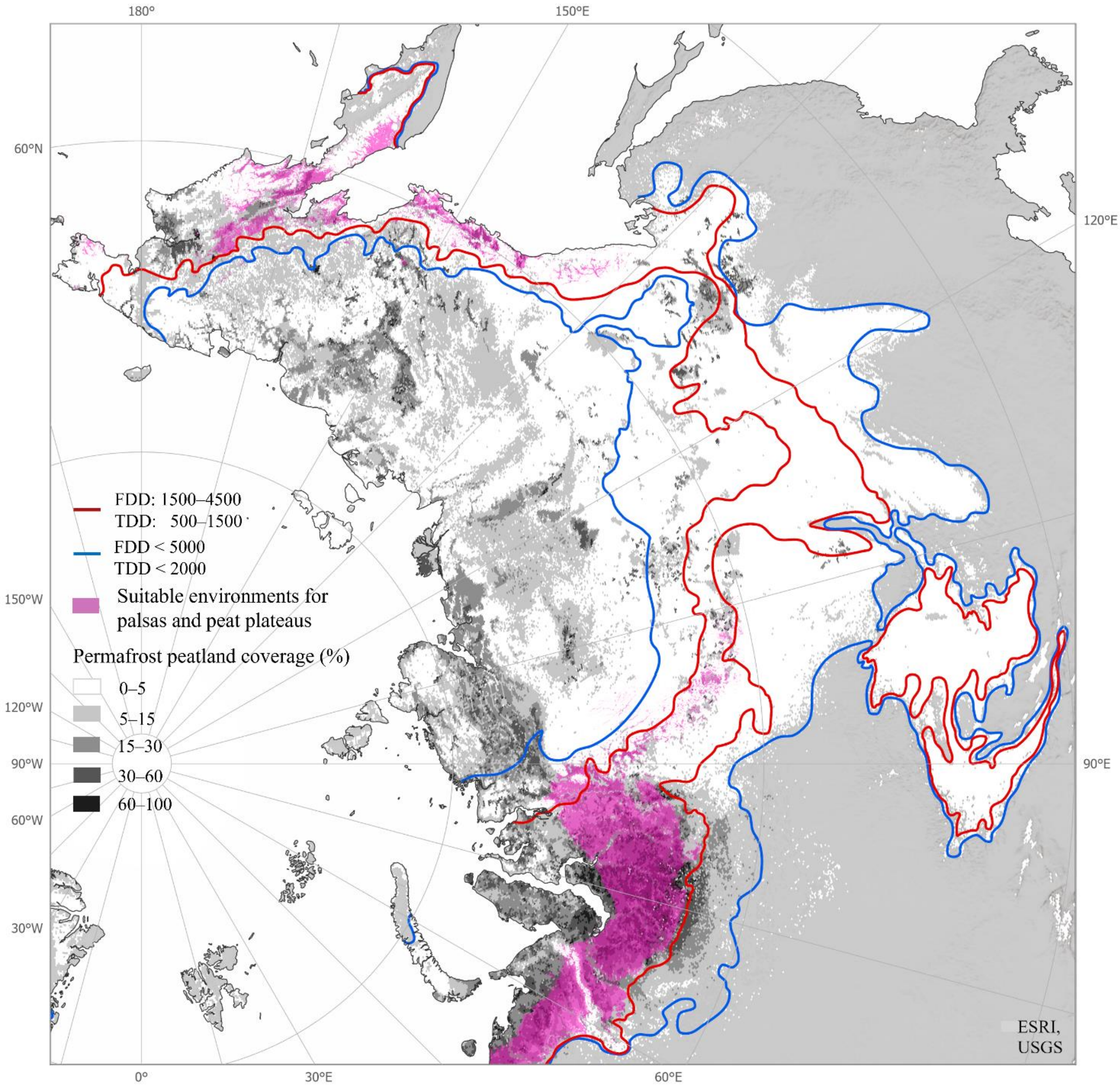


Figure R4: Suitable climate spaces (based on FDD and TDD) with two classifications are illustrated in red (strict interpretation) and blue (more liberal interpretation) lines. In the background suitable environmental spaces for palsas and peat plateaus (period 1950–2000) and permafrost peatland coverage (%) according to Hugelius et al. (2020). All datasets extracted for the permafrost region (Ran et al. 2022).

57: what about snow? Wind? Trees?

R19: As circumpolar datasets about the snow depth are not available in the used 30 arc sec resolution (at least to our knowledge), we used the Snowfall variable (precipitation sum for months with mean air temperature below 0 degrees Celsius) as an estimate of the snowpack. However, the most important reason to exclude snow, wind, and vegetation variables from our models was the exploration of climate change effects. These environmental factors can be assumed to change in the future, but we could not identify any suitable spatial projections to be used in the analyses. However, we acknowledge that wind and trees are important factors affecting the distribution of palsas and peat plateaus at local scale by controlling, for example, the snow depth. We will add a notion of these factors to the manuscript to the introduction and we will discuss their role in the discussion also.

A revised sentence in the introduction:
"Besides air temperature and precipitation, wind patterns, vegetation, snow depth, topography and soil properties also affect the distribution of palsas and peat plateus (Seppälä, 2011)."

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

R20: We decided to compare our results to Olefeldt et al. (2016) dataset as it was available for the whole pan-Arctic area and because the distribution of thermokarst ponds can be used as a proxy for former distribution of permafrost landforms, including palsas (see e.g., Luoto and Seppälä 2003). We acknowledge that thermokarst ponds are only an indicator for palsa degradation. Studies reporting degradation of palsas are usually conducted at local to regional scales, and the comparison between our 30 arc second resolution (ca. 1 km) predictions and studies reporting areal degradation for individual palsas, and peat plateaus (e.g., Borge et al. 2017; Mamet et al. 2017; Olvmo et al. 2020) would have been problematic. Olefeldt et al. (2016) dataset was the most suitable, consistently produced circumpolar data to compare our results with and use for the model evaluation.

84: appendix not found

R21: As mentioned earlier we apologize for the inconvenient placing of the Appendix A. Appendix A will be moved from the end of the manuscript to the place after conclusions.

90: Check Treat et al. 2016

R22: We thank for the useful reference, and we will use it in our revised manuscript.

103: but this is the crucial distinction.

R23: Unfortunately, we could not identify the location for this comment because there seems to be no text in line 103.

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

R24: More accurate coordinates (68°28'36.0''N, 20°55'06.0''E) and IPA permafrost region by Brown et al (1997) will be added to the caption and figure.

Revised figure 1:

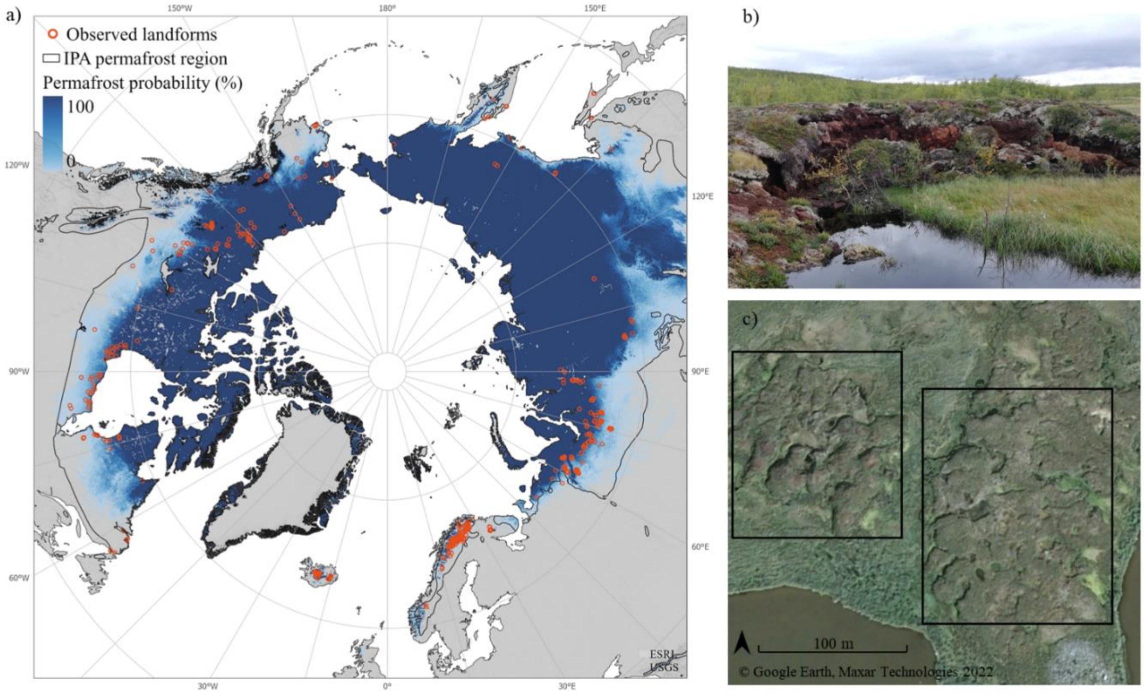


Figure 1: Distribution of the observed palsas and peat plateaus (N = 961) across the Northern Hemisphere,the probability of the permafrost occurrence (%, Ran et al., 2022) and International Permafrost Association (IPA) permafrost region (Brown et al. 1997) (a). A thawing palsa in Kilpisjärvi, Finland (b), and a satellite image of a palsa mire in Kiruna, Sweden (68°28'36.0''N, 20°55'06.0''E), groups of palsas have been framed with black lines (c).

110: this is all present day, good to acknowledge role of past climate and the limitations this presents.
R25: Dr. Treat brings up very important point here. We decided not to model the past suitable conditions because of multiple reasons, including difficulties in compilation of data describing the peat initiation for the entire pan-Arctic region at the resolution used. We made a compromise and decided to use climate variables describing the recent period (1950–2000) instead of present or past climate conditions from the period of landform initiation. We also wanted to avoid additional similarities with Fewster et al. (2020). More reasoning for our choice of climate data was provided earlier in this response letter (see reply no. R5).

We acknowledge the relict nature of many palsas and peat plateaus as we brought up in the line 35 of our manuscript. More references related to the role of past climate will be added to support this information as Dr. Treat suggested. We will add a sentence to the section 2.2 to acknowledge this issue better and will add relevant discussion also to the discussion section to address the limitation poses for our approach.

A revised paragraph:
"All the environmental variables (hereafter variables) were computed separately for different time periods and RCP scenarios, using the WorldClim v1.4 data at 30 arc-second resolution (Hijmans et al., 2005). For these data, the baseline period is 1950–2000, which aligns well with the observations in our presence data. The use of a recent climate period instead of the most present acknowledges also better the relict nature of the studied landforms. For the climate change scenarios, we used the moderate-emissions scenario RCP4.5 and the high-emissions scenario RCP8.5, and two future periods 2041–2060 and 2061–2080. Climate change projections included in the WorldClim v1.4 database (Hijmans et al., 2005) were derived from an ensemble of 18 global climate models (Taylor et al., 2012)."

136: why? what was the goal or motivation of this?
R26: The paragraph was modified to clarify our motivation for the comparison with Olefeldt et al (2016). The sentence was rewritten to clarify that we did not classify the thermokarst data as the classification was already done by Olefeldt et al (2016).

Revised paragraph:
"We compared our predictions to a circumpolar thermokarst dataset by Olefeldt et al. (2016). The dataset includes different types of thermokarst landscapes, and their areal coverages classified into five classes, ranging from none (0–1 %) to very high (60–100 %). We utilized wetland and lake thermokarst coverages as these types can be assumed to be present in degrading palsa mires (Luoto and Seppälä, 2003; Olefeldt et al., 2016). The purpose of the comparison was to assess the consistency of our future predictions as palsas and peat plateaus form thermokarst ponds when ice-rich permafrost thaws (e.g., Seppälä 2011). Consequently, regions with high wetland and lake thermokarst coverage can be assumed to indicate degradation of palsas and peat plateaus. Regions predicted to become unsuitable for palsas and peat plateaus in the future scenarios should have higher thermokarst coverage than persisting suitable environments."

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?
R27: Very important points. We will add reasoning for each analysis step to clarify their purposes. Also, a paragraph of the future predictions will be included to the section after the description of the settings of each modelling method, as suggested.

139: add citation for biomod2 package
R28: We will add citations for biomod2 package (Thuiller et al. 2021) and R Core Team.

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 evalution? What about normalizing for areas? Also I've never heard of palsas in Iceland.
R29: The first sentence of the section 3.1 will be modified to make it clearer to the reader that we are referring here to the comparison of the used modelling methods:
"Random Forest (RF) had the highest evaluation scores compared to other used modelling methods in the model evaluation (see sections 2.3 and 3.4), and thus the presented results are based on RF."

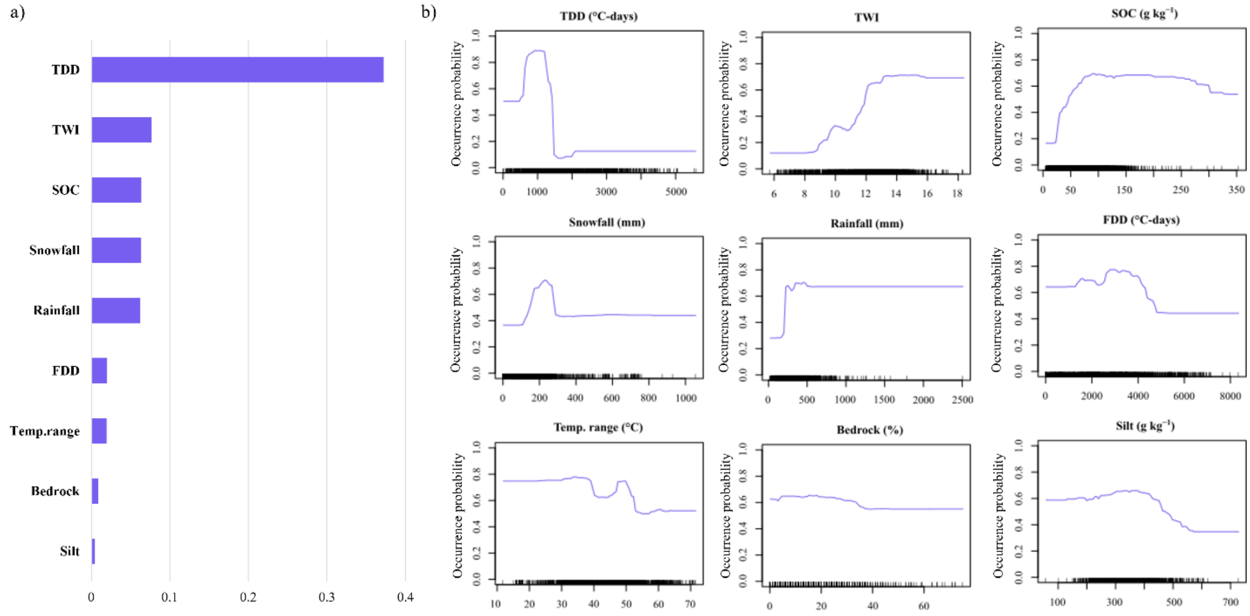
The predictive performance of the models was evaluated against a semi-independent evaluation dataset of presence-absence observations that was randomly sampled from the full data before modelling. Moreover, we computed cross-validated evaluation statistics for the randomly sampled 30% of modelling data set aside for evaluation at each 100 modelling run. See additional comments on the model evaluation from the response concerning the section 3.4 below (reply no R32). As already mentioned, (please see reply no 9), we will add a figure R2 to provide an additional evaluation of the reliability of our predictions. The reasoning for the thermokarst comparison will also be clarified (i.e., the thermokarst data were used to assess our future predictions).

Palsas in Iceland have been documented by Saemundson et al., (2012); Ottósson et al., (2016); Emmert and Kneisel, (2021), for example.

Figure 2. The results looks really biased towards where there are samples.
R30: Please see the discussion above (reply no. R7 and R8).

Figure 3: y-axis labels

R31: y-axis labels will be added to the figure 3 (see revised figure below).



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

R32: The section 3.4 and figure 6 show that random forest (RF) had the highest evaluation scores and thus we focused on the results of RF models. However, the figure 6 also shows evaluation results for a separate evaluation dataset (solid whiskers), as discussed earlier in reply no. 10. Because we aimed to collect as presentative observational data as possible, it was not possible to utilize a fully independent datasets of landform occurrences for model evaluation. The spatial evaluation of the predictions was conducted by calculating the model agreement (see fig. S7 in supplementary materials): areas where multiple models predict suitable environments have higher possibility to be palsa and peat plateau environments. The lack of fully independent evaluation data was also compensated by adding the new comparison between our predictions and the peatland datasets (fig. R2; see above).

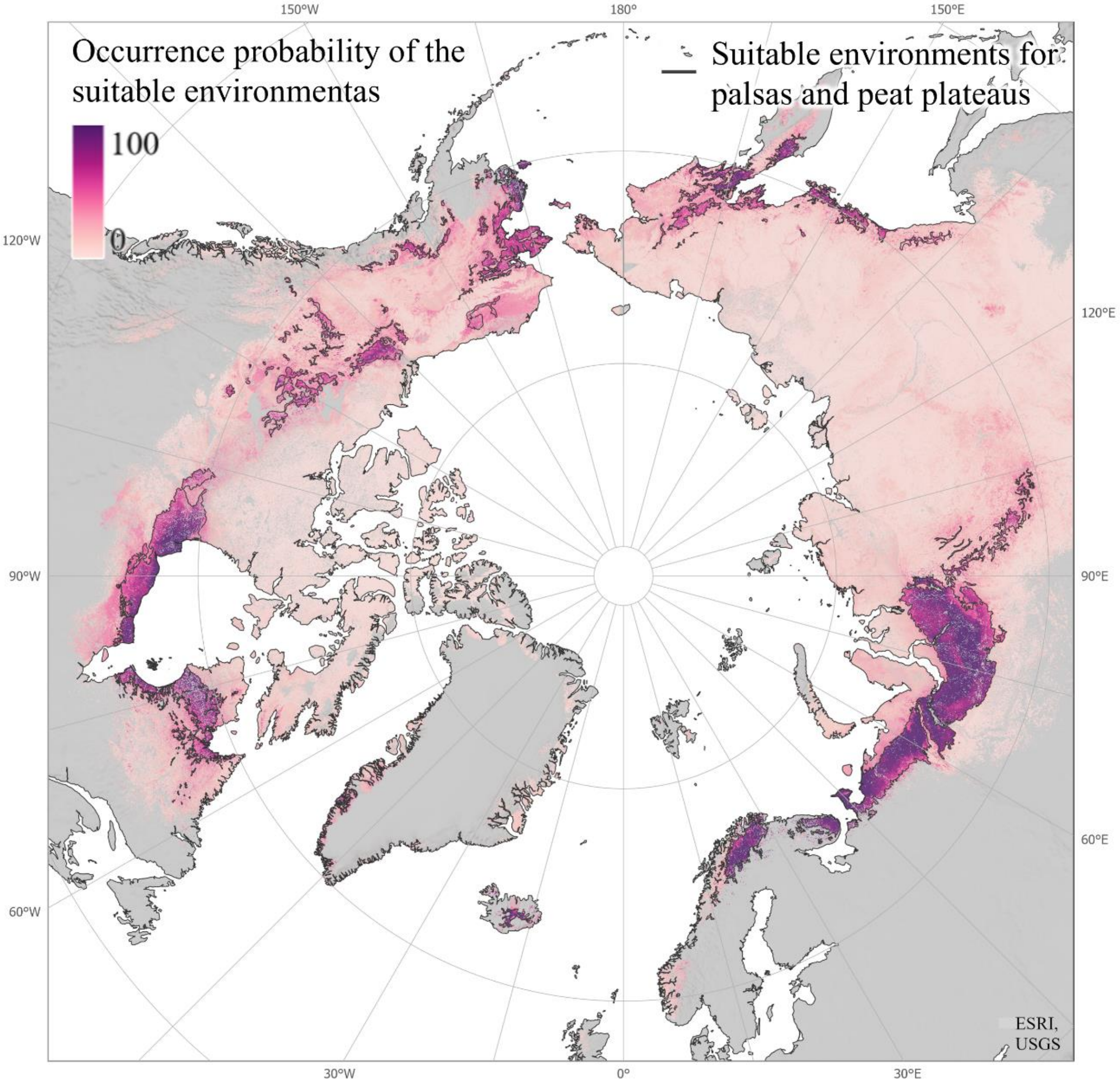
382: Yes, it is good that the model found palsas where the input data indicated there should be palsas. But it also found them where there is little evidence for palsa.

R33: Please see the discussion related to this issue above (e.g., reply no. R8).

As mentioned earlier, the landform occurrence probabilities shown in the Figure 2 might lead to subjective interpretations of the distribution of the suitable environments for palsas and peat plateaus. Thus, we classified the predictions to binary maps by using True Skill Statistic (TSS) cut-off values (provided in supplementary material Table S1). This binary classification of the suitable environments is illustrated in the new figure R2, and in figures 4 and 5. We will add simplified outlines of the binary classification to the figure 2, to allow for an easier and more objective interpretation. The binary classification 'drops out' some of the controversial prediction areas (e.g., parts of the North Slope, Alaska). New figure (fig. R4) will be added to the supplementary materials to show the minimum, average, and maximum extents of the suitable environments based on the standard deviations of cut-off values from the 100 model iterations.

Unfortunately, the observation data is limited in Central and Eastern Siberia because these regions are far less studied than other parts of the northern Hemisphere. Because of this lack of observations, we cannot provide more solid evidence for our predictions. However, our preliminary results from regional analyses (not shown here) do not indicate that palsas and peat plateaus in continental climates (such as those found in Siberia) would exist in remarkably different environmental conditions. Thus, our extrapolations can give useful insights to guide future's research in these regions. We will modify our manuscript to acknowledge better that our predictions for this region are extrapolations to avoid misunderstandings of the presented results.

Revised figure 2:



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

R34: Appendix A (a list of references used in the data compilation) will be moved to more visible place (after the conclusions) and coordinates for our landform observations will be included in the supplementary material.

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