

The Cryosphere Discuss., referee comment RC2
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Comment on tc-2022-135

Anonymous Referee #2

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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The manuscript "Environmental spaces for palsas and peat plateaus are disappearing at a circumpolar scale" by Könönen et al. presents statistical modeling of the future distribution of the palsa/peat plateau landform, with the key result that the largest part of today's palsas/peat plateaus will move outside the suitable climate space for some of the future scenarios considered. The study is well-designed and well-written, so I recommend it for publication after revisions.

-Introduction: the authors should make an attempt to clarify the terms "peat plateau" and "palsa", or state that they made no clear distinction between the two (since there are many transitional types, for example). In some parts of the text, it appears that the authors do distinguish between them. They for example only refer to palsas in Scandinavia (l. 48, and actually continue only using palsa to l. 65), but there are many plateau-like structures in Scandinavia, which published studies have referred to as peat plateaus. They also cite studies claiming that "peat plateaus are only 1m high" (l. 30), but there are much higher plateau-like features in many peatlands with permafrost.

-L. 84: same here, how do the authors distinguish a "true" palsa?

-L. 87: were high enough resolution images available on Google Earth for all of the sites?

-L. 123: These data sets can have a poor quality, especially at the resolution needed for the study setup. Please comment on this already in the Methods.

-Eq. 1: shuffled

-L. 188: it is easier to read if the authors spell out Random Forest (RF) once more at the beginning of the Results section.

-Fig. 3: spell out the abbreviations in the figure caption.

-L. 237: MAJOR COMMENT: Maybe I have overlooked it, but the authors should clarify if they only consider areas that are in the suitable palsa space now AND in the future as "remaining areas", or if they also count areas that are not suitable now (e.g. too cold in summer), but will become suitable in the future. As shown e.g. in the works of Seppälä, one needs permafrost-free conditions in the vicinity of emerging palsas for this process to work. So areas which today are too cold for palsas to exist may not develop palsa landforms for a long time (or never), even if they move to the suitable space (for example continuous permafrost first needs to thaw, etc.) On the other hand, areas with palsas today will be preserved if they still fall in the suitable space in the future. I think it is worth to make this distinction and possibly present the numbers for both cases. The wording in this section is incoherent, the authors use "remain" and "persist" in some cases, and "could be found" in others.

-Sect. 3.3 The comparison with the thermokarst map is the weakest part of the study, e.g. it is unclear to what extent some of the data sets used by Olefeld et al. may have been similar to the data sets used for this palsa mapping. Furthermore, it is unclear if one should expect a close match or not, given the methods used by Olefeld (i.e. were the specific thermokarst conditions of palsas/peat plateaus accounted for in this work?). I leave it to the authors to decide, but I am not learning anything from this comparison, it more dilutes the very nice results from the previous section with a poorly motivated add-on.

-L. 308: Extrapolate instead of present?

-L. 360: MAJOR COMMENT: this is an extremely important point that needs to be discussed in much more detail. Some of the studies cited, e.g. Borge, provide indications that peat plateaus were already degrading more than 50 years ago, so they may have left the suitable climate space already after the end of the Little Ice Age (or in the 1990s, when exactly is unclear and certainly depends on the exact location), but the degradation is slow so that it takes decades or even centuries to complete. However, these areas were still used by the authors for training their model. With the simple analysis and no means of telling which palsa areas are stable and which are degrading already now, I don't think that this can be taken into account, but it is a limitation that should be stated clearly. Furthermore, given this complexity, I strongly disagree with the statement "support the rapid degradation of the landforms." First, with rates of 1% per year, it will take longer than the 2080 timeframe considered by the authors for the palsas/peat plateaus to actually disappear, in any case several decades. Second, it is very likely that palsas degrading rapidly already now, e.g. in the ones in Scandinavia, will indeed disappear until 2080, but palsas in areas that are still largely stable today might only be pushed just outside the suitable climate envelope and only then start to degrade slowly (similar to the ones in Scandinavia after the LIA). So we might expect palsas and peat plateaus to exist

there much longer than 2080, although they are outside the suitable climate envelope. I very much like that the authors use the wording "inside/outside the suitable climate envelope/environmental space" throughout the manuscript and do not refer to their study as a model for palsa degradation. But it is important to clarify and discuss this relationship in much more detail, so this section of the discussion should be extended. In particular, the authors should point out that not all palsas inside the suitable climate envelope are equal, but palsas on the "warm side" of the envelope likely degrade earlier and more rapidly, while the ones on the "cold side" might persist for many more decades.