

**Comment to author:**

Dear Stan and co-authors,

I very much enjoyed reading your manuscript entitled “Lake anoxia, primary production and algal community shifts in response to rapid climate changes during the Late-Glacial”. I think the paper studies a topic that is of interest to palaeoecologists and palaeoclimatologists, and that is, as you hypothesise in your conclusions, relevant with respect to future climate warming particular in Arctic regions.

I think your manuscript is really well-written: it is logically organised and clearly explains your research questions, approach and results. The high-resolution results are presented clearly and the interpretations of the drivers of changes in the algal community, as well as the occurrence and impact of (ice-driven) anoxia, were very interesting to read.

I only have minor suggestions for improvements that I hope will help you when revising your manuscript – most of which are of a typographical nature. I’d like to compliment you on a really well-executed study that I think will be of interest to many in the field

Comments

L15: “a critical gap” – I would argue that lots of studies on lake ecosystem response to (LGIT) climate change are already available; of course we can always learn more (and we do in the remainder of your paper!), but I wouldn’t call this a critical gap myself

L29: “a... sources” – singular vs plural

L53: could you explain how climate warming is reinforced by watershed dynamics?

L62: why is only one of the research methods highlighted here? Given that more information is provided on L75 onward I think this can be left out. Alternatively, perhaps a wider range of methods needs to be discussed on L62 as well

L75: you start with methods, then discuss the site, and then at L81 discuss methods again. I suggest to combine the methods either before or after the site introduction

L120: “continuously sieved” – suggest to change to “Consecutive (or contiguous) 1-cm-thick sediment samples were sieved”. As it stands you are implying that you never stopped sieving

L126: Perhaps not for this paper, but why was no pollen counted for materials younger than the Allerød?

L212: Here it states RDA is carried out but it is unclear where this comes back later in the manuscript. The RoC results are reported clearly, but I didn’t see the RDA explicitly reported on

L223: what does “consistent” mean in this context?

L224: add if this is 1 or 2 sigma

L271: Results 4.2: I find the description a bit confusing. I understand you go by LT rather than chronologically, but: LT4 is split up into two separate parts, with a larger unit during the BA and then a short unit at the end of the YD. LT4 (B/A) is given an interpretation, but the upper LT4 unit is not interpreted. LT5 is then split into two subunits in the “title” (L281) of 5.21-5.19 and 5.18-5.09m, but these subunits are sequential and the difference between these two parts of LT5 is never explained. I understand that in the Results section you are taking a LT by LT rather than a chronological approach,

but the reader would benefit from a clearer explanation of where the LT sequence differs from the chronological sequence

L316: “that align with” – this seems incorrect to me. Only the Cluster 1/2 transition aligns with a lithostratigraphic transition. Cl2/3 just post-dates the lithostratigraphic transition, and Cl3/4 is smack in the middle of LT5. It’s actually very interesting to see that these indicators change at different points, so I would suggest to emphasise that

L350: I suggest to add “statistically insignificant” rather than just “insignificant” as you do report on and interpret these, so obviously there’s some interest in this

L399: You do clearly show the importance of PC1, explaining a major 67% of the variability in your dataset. PC2 and PC3 are then only explaining very minor proportions at 9% and 7%, respectively. I would personally suggest rather than showing a bi-plot of PC2 vs PC3, to show one bi-plot of PC1 vs PC2, and another of PC1 vs PC3. There might be good reasons not to do this, but I think this would also visually represent the overriding importance of PC1, which is now somewhat lost

L461: could you explain how increasing CO<sub>2</sub> could lead to impact on the landscape or the lake in absence of changes in temperature and vegetation composition? Similarly, are there any (e.g. geomorphological) reasons for increased landscape stability in the absence of changes to the terrestrial vegetation?

L516: out of interest, is there a role for wind (strength) here? Is the lake currently experiencing strong winds due to e.g. tunnelling along the valley?

L532-539: Personally I find it very interesting to see the 3-stage development of the YD. As you well explain, for a long time the YD was seen as a stable event. Later, the 2-stage event interpretation got more attention following the papers by Bakke et al. (200g Nat Geosci) and Lane et al. (2013 Geology). More recently, there seem to be more studies appearing that show evidence of an even more dynamic event, including a 3-stage YD in the SE of the UK as shown by Francis et al. (in press, JQS) as well as further afield (Fastovich et al., 2022; QSR). The Weber et al. (2020) paper that you cite also shows additional complexity during the YD. Sorry this is more a note than a comment, but I do find this result really interesting!

L540: why is there no interpretation of the early Holocene lake environment? Surely it’s interesting to the reader to know how the transition into the Preboreal happened, and if circumstances (e.g. Si limited) in the Preboreal were similar to those of the (late) A/B?

L540: “what drove communities” is a bit vague – do you mean community composition, overall productivity, or both?

Conclusions: The order of PP and anoxia is reversed in the Conclusions compared to the Discussions (where PP (section 5.2) precedes anoxia (Section 5.3); I suggest treating them in the same sequence in both the Discussion and in the Conclusions