

Clim. Past Discuss., referee comment RC1
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Comment on cp-2021-95

Anonymous Referee #1

Referee comment on "Arctic glaciers and ice caps through the Holocene: a circumpolar synthesis of lake-based reconstructions" by Laura J. Larocca and Yarrow Axford, *Clim. Past Discuss.*, <https://doi.org/10.5194/cp-2021-95-RC1>, 2021

The manuscript submitted by Larocca and Axford falls well within the scope of CP and presents a clear, well-organized and illustrated synthesis of a very specific proxy for Holocene climate change in the Arctic: lake-based reconstructions that document the growth and decay of adjacent glaciers and ice caps (GICs). In my opinion, the novelty and originality of this study is reflected in its consideration of only this particular proxy, from many different regions of the circumpolar Arctic. Although I found myself wishing for more background information and complementary studies that could add weight to some of the interpretations presented, and for the addition of records from regions where existing studies were rejected due to weak dating control, for example, I think that because this manuscript covers such a large region (the circumpolar Arctic), sticking to precisely defined criteria is critical. The conclusions of the study are timely and pack some punch, as they clearly indicate that the modest warming of the early Holocene (well below that which is forecasted for Arctic regions in the future) was enough to cause widespread partial or full retreat of GICs; with ongoing climate warming, amplified in Arctic regions, many to most Arctic GICs will clearly continue retreating until they disappear entirely. The conclusions of this study are also in general agreement with other studies of Arctic Holocene climate change.

In general, I would like to see a more detailed description of the criteria used to accept or reject studies of Holocene GIC variability in the Arctic, and (somewhat) improved consistency with respect to including/excluding different studies (compare the sections on the Canadian Arctic to the Russian Arctic, for example).

Figure 2 is excellent and very clearly explains glacier-lake systems and the stratigraphic records that reflect GIC proximity and how they can differ depending on topography of the lake catchment and size and position of the glacier or ice cap. More reference to these three simplified systems throughout the 'Regional compilations of Holocene GIC records'

section would help the reader follow along through this heavy, repetitive section of the manuscript (which must necessarily be repetitive - I do not mean this as a criticism).

I do not agree with the title and references in the manuscript that this is a pan-Arctic synthesis, although I do not have an alternative suggestion, unfortunately. The prefix 'pan' means all or involving all members of a group, and there are enormous regions from which no data are included (Canada, Russia), due presumably to a lack of GICs during the Holocene and/or a lack of studies that fit the criteria of the study (or studies published in English). I will note that an exception was made for Russia due to there being only two lake-based records of GIC fluctuations during the Holocene, but the same exception was not made for the Canadian Arctic, although there were only 5 such studies from a very small corner of the eastern Canadian Arctic Archipelago. There are some, possibly many, studies, which, although might do not fit the criteria perfectly, could possibly have been included to partly fill in this large spatial gap, even just for background context. A quick search and skim resulted in several articles with potential, for example, Holocene fluctuations of Leffert Glacier and nearby outlet glaciers, Ellesmere Island, Nunavut, Canada by W. Blake in *Polar Record* (2011) and Diatom-based Holocene paleoenvironmental records from continental sites on northeastern Ellesmere Island, high Arctic, Canada by R. Smith in the *Journal of Paleolimnology* (2002). There are other lake and non-lake-based studies that only cover the late Holocene, for example, but might help to partly fill this spatial gap. If I were to read through these articles more closely, I accept the possibility that they may not fit the criteria, and adding them could also put you in danger of broadening the scope of your study; however, it is somewhat confusing that you made the exception for Russia by including the non-lake based Lubinsky et al. (1999) article. I am not suggesting that you remove this as it does clearly add to this section, but I wonder if there are missed opportunities to fill in the other blank areas on your circumpolar map? With respect to the Arctic Canada section, I will also mention that five lake records from east-central Baffin Island only represents a tiny part of Arctic Canada (the name of the region is thus misleading) - the term used in line 15 to describe this area as the "archipelagos of the eastern Canadian Arctic" is also incorrect. The title of section 3.2 'Arctic Canada (Baffin Island, northeast Canada)' is much better and more accurate.

The structure of the manuscript is well organized and reads nicely. There are some consistent errors, such as not capitalizing the L in lake when it comes to proper nouns (Igloo Door Lake, not Igloo Door lake, for example) - these and other minor typos, etc., are listed by line below.

Page 1, line 72: homogenously does not work here. Suggest concomitantly instead.

Page 3, line 87: referring to comments above - there is also an apparent dearth of records from the Canadian Arctic (2 lakes for Russia vs. 5 for Canada). Also on this line, see comment above regarding the prefix 'pan'.

Page 3, line 89: 'the archipelagos of the eastern Canadian Arctic' is not an appropriate description for east-central Baffin Island.

Page 5, line 125: suggest 'to respond' rather than responders

Page 5, line 135: Suggest that 'All available records' should be 'All available lake records accepted according to our criteria' or something similar.

Page 9, line 261: It might be worth mentioning that both the Penny and Barnes ice caps are remnants of the LIS.

Page 9, pages 264-278 and throughout the manuscript: the 'L' in lake should be capitalized if it is part of a proper noun, unless listed with others, e.g. Yougloo and Igloo Dorr lakes (correct); Igloo Door lake (incorrect). Same for glacier names.

Page 10, line 287: fine for consistent language, but I prefer '4 out of 5 of the lake-based records' over '80% of the lake-based records' with such a small number of records here.

Page 11, lines 307-308: '...is highly influenced by various ocean and atmospheric processes, sea ice extent...' is vague and applies to all or almost all of the Arctic regions.

Page 12, line 319: 'Persistent glacial input...' is a bit vague. Suggest something more specific. I will also suggest not changing up these terms to describe glacially derived, minerogenic sediment vs. organic-rich sediment too much throughout the manuscript as it is a bit of a distraction.

Page 12, line 333: Can you include some context regarding the radiocarbon dated reindeer antlers and 'dead plants'?

Page 14, line 398: suggest mineral-rich strata rather than mineral-rich units.

Page 20, line 533: Do not understand what you mean by 'several detrital parameters...'

Page 21, line 575: '...and subsequently has existed continuously...' Awkward description.

Page 22, line 605: What do you mean by Physical sediment variability?

Page 22, line 624: Should be percentage, not percent.

Page 25, line 667: no apostrophe needed in 'lakes'.

Page 25, line 669: northernmost is one word

Page 28, line 724: 'The 192...' should be 'the 192...'

Page 28, line 733: It may be that there is a lot known about the Holocene history of GICs in the Russian Arctic, but it has simply not been published in english-language journals?

Page 32, line 830: 'other forcings is a bit vague'. Possible to be more specific here?

Page 34, line 909: I am not familiar with McKay et al (2018) and some other readers might also not be, so I suggest including a little more description of this study to make your point here.

Page 35, line 966: Patterns is missing its n.