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Interactive comment on "Thermokarst lake development in syngenetic ice-wedge polygon terrain in the Eastern Canadian Arctic (Bylot Island, Nunavut)" *by* Frédéric Bouchard et al.

Anonymous Referee #1

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The authors present a case study in which they reconstruct the development of a thermokarst lake in Holocene-age sediments in the Canadian Arctic, primarily by interpreting lake geomorphology and a pair of sediment cores extracted from the bed. Overall the study is interesting, the topic is clearly appropriate for the journal, the data seem sufficient to support most of the conclusions, and the narrative is fairly clear. I also appreciated the video supplement, showing ice wedge furrows in the shallow platform of the lake. Two of the most interesting and novel aspects of the study are that the lake formed in recent sediments (instead of Pleistocene-aged Yedoma deposits) and its initiation was during a time that was cooler than the present – the authors address both these points, but I think they could do a better job of emphasizing them early on in

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Discussion paper

the paper, and even in the abstract. I am also a bit confused about part of the conceptual modelâĂŤspecifically, what happens to the sediments beneath the deepest part of the lakeâĂŤas described in my last comment in the list below. My detailed comments, presented below, are listed by line number in the manuscript.

16: I think this is a good place to emphasize that the lake you studied is from the Holocene, as opposed to the Pleistocene. You could write “Here we present the gradual transition from syngenetic ice wedge polygon terrain to a thermokarst lake in Holocene sediments in the Eastern Canadian Arctic.” Also, remove the s from “terrains.”

26: I recommend emphasizing that the Neoglacial cooling period was cooler than today. For example, you could write “. . .this happened in the middle of the Neoglacial cooling period, likely under colder-than-present and wetter-than-average conditions.”

37: Remove the word “a” in “a significant variability.”

42: The sentence that begins with “Lakes located in. . .” is unclear. I think you are distinguishing between lakes that form in Yedoma and lakes that don’t, but I’m not sure what you mean by the phrase “form a separate lake category.” I recommend rewriting this sentence, emphasizing that 1) some thermokarst lakes that form in Yedoma can be up to several meters deep, and 2) the focus of this paper is on younger lakes that don’t form in Yedoma.

54: Check to make sure the Cryosphere allows citations of papers in preparation. I’m not sure this is the case. This also applies to your citation of Tank et al. in line 415.

56-62: Are all thermokarst lakes inevitably destroyed by one of these mechanisms? You make it sound like this is the case.

86: Change “These glacial valleys. . .” to “The valleys of these glaciers. . .”

109-118: It would be nice to state the maximum depth of the lake somewhere in this paragraph.

147: Please define gyttja the first time you use this word.

175-176: Please specify what you mean by “plotted on diagrams.” Is this describing Figure 5?

193: There is a Fortier et al. 2019 in your references, as well as a Fortier et al. 2019a and Fortier et al. 2019b. Please change this to a, b, and c and update your citations.

200: Change “hyperboles” to “hyperbolas.”

280: Please provide more context for the sentence that begins “The fossiliferous marine sediments. . .” Right now it’s difficult to figure out how it fits into the paragraph.

287: I think you mean 4.8 kyr and 5.5 kyr instead of 4.8 yr and 5.5 yr.

321-324: Please explain your reasoning more thoroughly in the sentence that begins “Based on present-day lake morphology. . .” It’s difficult to figure out how you reached the conclusion that the initial depression in the surface must have been 1-2 m deep.

372-373: I’m confused by this part of the conceptual model. Please explain how “the deepest parts of the lake have now almost reached the underlying glacio-fluvial sand.” (You also make this statement in lines 427-428.) As ground ice melts and subsidence occurs, the upper sediment layers reduce in thickness, but they typically are not removed. Are you indicating that the upper sediment layers beneath the lake bed are being removed as the lake expands, exposing the glacio-fluvial sands? If so, how is it that you can still see evidence of ice wedge polygon ridges and troughs in the deepest part of the lake bed (lines 363-367)?

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