GMD-2022-9
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Response to Reviewers #2
Responses are in blue.

Thank you for your addition comments and consideration of our manuscript. We appreciate the time and effort you have given to improving our manuscript.

Report #1
Line 345: "…for the shallow lakes (Atqasuk, Fox Den), but for the thawed season for Toolik Lake(Fig. 6)." Please replace "but" with "and".
We have rephrased this sentence to be more clear. Replacing but with and would have changed the intended meaning of the sentence.

This updated paper is well organized with logical sequence. I'm also satisfied with the response from the authors. All the comments have been addressed carefully. The authors have done a good work.

Report #2
The authors fulfill important research for Arctic limnology. By assessing the performance of the LAKE model in simulating lake water temperatures across lakes, seasons, depths and soil and water column resolutions, they make a strong case that LAKE is suitable for future studies of lake permafrost interactions. In view of the manuscript overview, it is also clear that the authors made strong additions to the paper in response to earlier referee comments. With this in mind, I find this paper to be acceptable for publication at GMD, subject to what are mostly minor revisions and small details that I recommend addressing below.
1) This paper is framed as a necessary step toward understanding lake-permafrost interactions, a very important topic to many geoscience fields. Yet, I find the conclusion misses what future developments will be necessary to apply the model to this end. E.g., in each lake's description in the methods, it is repeated that underlying permafrost presence and/or depths are not yet known. Would bridging such an observational shortcoming be necessary for future applications of LAKE to more directly model lake-permafrost interactions? What other limitations must be overcome for this type of research to move forward? I feel the research progression for which this study's validation is necessary could be better wrapped up.
Thank you for this insightful comments. We have revised the discussion to clearly state this observational shortcoming and need in the progression of this research.

2) If this is within the bounds of figure/page limits, I think it would be valuable for readers if you present the study sites by adding a map of Alaska, or some explicit spatial domain, that shows the locations of these three lakes.
Maps of the study site locations are available at the respective data archives and have been published previously (Hinkle 2012, Jones et al. 2021, MacIntyre and Cortes 2017). We present the study lake coordinates for the reader to reference both in the text and in Table 1.

3) Is there an explanation for why only one lake's (Atqasuk) sensitivity to soil column resolution was tested and the others were not? I note that a lake of median depth among the study sites was

chosen, but I don't know if we might expect more or less sensitivity in the other lakes. Perhaps less sensitivity for the deepest lake and more for the shallowest lake? I don't need to see further simulations added to this end, but perhaps some explanation could be provided to justify the single lake approach for this part of the analysis.

We have provided a sensitivity analysis for soil column resolution for a single lake as it was requested in the previous round of revisions. For this analysis we compared the effect of soil resolutions on modeled water temperature error. We did not analyze the sensitivity of soil temperature to lake depth. This a valid question that LAKE 2.0 could be used to address, but the question would require an additional analysis based on theoretic lakes with different depths. Observations of lake sediment temperatures would also be valuable for this additional analysis.

Minor details:
L70-72: More correct to explicitly state "in Arctic lakes" at some point here.
We have made this change.
L82: "similar types of models" instead of "similar type models".
We have made this change.
L93: acronym "MAAT" unnecessary since it only appears once.
We have made this change.
L106: "k-eps" should be k-ε?
We have made this change.
L103: units should be [Wm-2] instead of [Wm-1].
We have made this change.
L214: "Scenario data" was a bit confusing upon first read. Suggest adding "Scenario data used in the model sensitivity analysis (section ref) was compared …"
We have made this change.
L255: Table 2 should explicitly state that performance metrics are for water temperatures, i.e. "LAKE model performance for Atqasuk, Fox Den, and Toolijk Lake water temperatures…"
We have made this change.
L310: Referencing Figure E1 and Table E1, which also have captions that should better directly state what the figure displays water temperature simulations as a function of. Currently, the section header of Appendix E describes that this is a soil column resolution sensitivity analysis. However, figures should be readable in a stand-alone manner by their captions (and therefore also include some mention of simulations differing by soil column resolution). I recommend scanning the other figures/tables for this property.
We have updated the Appendix table and figure captions.
L346: Add a space between "Toolik Lake" and (Fig. 6)
We have made this change.
L376: Section header using an unofficial "met" acronym for meteorological. I would replace for the full word or introduce an acronym and use more widely.
We have made this change.
L386: "…as high winds can and do remove…" should be "…as high winds can remove…"
We have made this change.
L402: "…and in a fully coupled lake-atmosphere system model the similar sensitivity experiments should provide different estimates." Should be, "…and in a fully coupled lake-atmosphere system, similar sensitivity experiments should provide different estimates"
We have made this change.

General:

Note that figure references sometimes switch styles from "Figure X" to "Fig. X", I guess this should be consistent.

We have checked these for consistency and made changes.