Comment on gmd-2021-440
Anonymous Referee #2

Referee comment on "Climate Projections over the Great Lakes Region: Using Two-way Coupling of a Regional Climate Model with a 3-D Lake Model" by Pengfei Xue et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-440-RC2, 2022

This study demonstrates the use of a two-way coupling of regional climate models with a 3-D hydrodynamic model (GLARM) of the US Great Lakes based on three selected CMIP5 AOGCMs and two spatial domains. The authors first evaluate the degree of skill of the models and then examine two climate scenarios (RCP 4.5, 8.5) and evaluate their impact on the Great Lakes Basin during the mid and late 21st century. They show the spatial and temporal variability in expected precipitation, ice cover and LST for all the great lakes.

General

I found the paper to be very well written and timely. It represents one of the only cases (if not the only one) in which two-way coupling of a lake 3D hydrodynamic model and regional climate model have been use to examine the potential impacts of projected climate change under various climate scenarios.

Nevertheless a number of questions come to mind. Were the lake models driven with inflows and outflows and do the models account in any way the likely increase in inflows especially during the rainy spring period as projected by the results of simulations? If the inflows and outflows are neglected in the simulation, this should be mentioned and discussed as I assume they will have an impact on water temperature. The authors mention two key physical processes in the lakes but don't present any data or model output for the two processes. The first is the possible change in stratification which as the authors quite correctly point out in the introduction can greatly impact the ecosystem. The second is the mention of the possible effect of the mixing of heat from the surface to
bottom. It would be very interesting to see what the projected change in the duration in stratification is expected to be (as expected by the authors, lines 436-437) and whether there is any clear increase in bottom water temperature to support the mechanism suggested by the authors (e.g. line 437-439). I would also have liked to see a brief discussion as to the quality of the 3d lake model results in relation to other models and where the weaknesses may be.

Specific comments:

Line 28- % of what

Line 97- remove the word in

Line 101- FVCOM not yet defined

Line 116- add space between ice and atmosphere

Line 145-149- how accurate are these data compared to actual measurements? Is a correction required before using to validate the model?

Eq 1- over what time and spatial resolution is this calculated? Is there a reference to the use of this type of equation?

Table 2- change RMSE in the legend to RMSD

Figure 3- would be nice to have lake names on this and the other figures, especially for those not familiar with the Great Lakes.

Figure 4- legend- there is a mistake in the seasons and figures. A1,a2 for example are the winter and not spring.
Figure 8 legend- word missing from last line.

Table 3- what is ΔT2 in column title?

Line 343- “particularly in Aril and May” this is correct only for the end of century results

Line 361- Figure 12 should be Table 5