

Review of “Climate Projections over the Great Lakes Region: Using Two-way Coupling of a Regional Climate Model with a 3-D Lake Model”, by Xue et al.

In this study, the authors present and analyze climate projections over the Laurentian Great Lakes regions using an RCM coupled to a 3D lake model. The authors discover that the model setup substantially reduces model biases relative to the driving GCMs, and that future GHG emissions may lead to substantial changes in the near-surface climate in the region.

The paper uses model simulations to assess climate change in a robust way (given computational constraints) over a region where many people live and depend on the lakes for their livelihood. The selection of the driving GCM using an objective method is appreciated, though I’m not sure a penalty for distance from the ensemble mean is appropriate. Moreover, the manuscript is well written, and the figures are generally clear. Also, the abstract and introduction reads very well.

This study thus overall demonstrates the potential to make a substantial contribution to the scientific literature. However, I have some concerns, which require minor revisions of the manuscript. In general, I could recommend publication of this study if the comments specified below are sufficiently addressed.

General Comments

1. As a general comment, there seem to be several inconsistencies in the naming of experiments, evaluation products, variable names etc. throughout the manuscript, figure labels and figure captions. See specific comments for examples, but please carefully check the entire manuscript for other inconsistencies.
2. Difference between using the small and large domain is only briefly discussed for precipitation, though I feel this is important information to share. Does model performance and/or climate sensitivity differ between the two domains? Or do both domains yield very similar results (e.g., for T and LST)? And which domain approach do the authors recommend for future research in this region? Such information could be covered in the discussion section.

Specific comments

1. L1: No need to reply to this comment, but I am a little surprised that the authors choose GMD as a journal to publish their work. Given that the focus of the study is on the results of the future projections, I believe that a content-journals like for example ESD could have been a better fit for this work. That said, I respect the author’s choice of GMD and do not suggest transferring this manuscript to a different journal.

2. L51: does this statement refer to an area or temporal change? Please clarify.
3. L79-82: In this context, it could be interesting to check what the recent scientific results obtained as part of the ISIMIP lake sector tell for the Laurentian Great Lakes. See <https://www.isimip.org/outcomes/publications-overview-page/>
4. L109: Importantly, RCP8.5 is not to be considered 'business as usual', but a 'high-end emission scenario'. And I suggest referring to RCP4.5 as a 'moderate mitigation scenario'
5. L160-162: please add one or more refs to back this statement.
6. Table 2: I suggest marking the selected GCMs in bold in this table
7. Figure 3: caption and figure labels say 'GCM' but manuscript says 'AOGCM'. Please make this consistent (I think GCM is used more often nowadays).
8. Figure 4: Are the wintertime LSTs water temperatures taken only during the ice-free period or the average of the whole season (i.e., combined snow/ice/open water)? Please clarify. Also, caption says 'GLICD' but title of panel e says GLSEA. Also, has the acronym AICE (title panels e1-2) been introduced?
9. Figure 5: legend: GLARM(6MA), while text and other figures use GLARM-EA6. Also, spell out lake names (acronyms are not introduced in paper and they add no value, see also figure 12 and elsewhere)
10. Figure 7 & 10: is this the standard deviation of the change (future minus past) or of the future state? Please clarify in the manuscript and/or caption
11. L327-328 & L332-333: I wonder if these changes (4 and 6%) are sufficiently different to say that RCP4.5 gives a stronger wetting than RCP8.5 for mid-century. Probably the uncertainty bands are largely overlapping? In that case I would rather say that they project a similar wetting.
12. Fig. 14: to better understand the change, it would be more useful to also plot the present-day ice cover, or to plot the change in ice cover (future – present)

Textual comments

1. L26, 'are' > 'is'.
2. L61: 'will' > 'could'.
3. L72: 'predicted' > 'projected' (always use projections in the context of future climate) and 'atmospheric greenhouse gasses (GHGs)' > 'greenhouse gas (GHG) emissions'.
4. L89 and elsewhere: I'd suggest specifying 'Great Lakes' to 'Laurentian Great Lakes' throughout the manuscript, to avoid confusion with the African Great Lakes.
5. L101: FVCOM, this acronym hasn't been introduced yet
6. L106: 'a RCM' > 'an RCM'
7. L116: 'LakesAtmosphere' > 'Lakes Atmosphere'
8. L116: 'iceatmosphere' > 'ice-atmosphere'
9. L155: 'projections' > 'assessment reports'
10. L233: 'predictions' > 'projections' (check elsewhere, predicted>projected)
11. L252: remove space before '.' Check elsewhere for double or missing spaces.
12. L306: 'much more substantial' > 'more pronounced'
13. L309: 'cooling' > 'buffering'
14. L310: 'overlake' > 'over-lake'
15. L429: check punctuation
16. L428: check sentence (drop 'changes'?)