

2nd Round Revisions.

We thank Reviewer #1 for their time in reviewing our manuscript again. Our comments are in blue.

Reviewer #1 (sole reviewer)

Dear Editor,

Upon re-reading the manuscript, it is clear that the authors have put substantial consideration into the comments from both reviewers, and the manuscript is very much improved.

From my perspective, there are minimal scientific comments regarding the manuscript at this point. However, in my opinion there are many places where the language can be imprecise and the writing can be clarified or condensed. Again, these are matters of discretion for the editor and authors, however, I believe that by addressing these issues the quality of the paper will increase substantially. The list below includes some places where improvement is likely needed. But, it is not exhaustive and additional changes might be needed. There are also a few minor scientific comments and suggestions.

With these comments, minor revisions are likely necessary, and I do not believe I need to see the manuscript again. However, I am available as the editor wishes.

Again, hopefully these comment prove useful and congratulate the authors on there near-completion of this work.

Specific comments

- Line 59: “We attempt to minimize the complexities of comparing glaciers to one another by focusing on glacier area change rather than area alone, which should control for the differences in hypsometry and background climate.”: I am not sure what is meant precisely by this comment as both area and area change are a result of hypsometry and background climate.
 - Changed to “We attempt to minimize the complexities of comparing glaciers to one another by focusing on glacier area change, which should control for the hypsometric variables that remain roughly constant over the Holocene (e.g. elevation, bed-slope, aspect) and background climate conditions (high-versus-low precipitation regime).”
- Line 67: “more heterogeneity than expect”: what would you expect? some rephrasing needed.
 - We provide further clarity now and our sentence reads: “Our findings indicate more heterogeneity in glacier length amongst the four sites than expected given their relative proximity to one another and shared climate forcings.”
 - The argument here is that they’re relatively close together and experienced similar forcings, so we expect a similar response. On line 54, we write “It is expected that glaciers across western North America advanced roughly synchronously over the Holocene because the first-order climate controls are similar:”
- Line 128: What does “internal” mean?
 - Changed to “Uncertainties presented are analytical (i.e., internal; measurement) only.” Here we provided this additional clarity because CRONUS ages as presented by the online calculator output have an ‘internal’ uncertainty and ‘external’ uncertainty reported.

- Figure 2: Would this figure be improved if a title was added to each row for instance Exposure for the first, Burial for the second, and Re-exposure for the third? That way readers can easily translate the process in the figure to the terminology in the text.
 - Done.
- Paragraph at Line 174: Because the Monte Carlo method is discussed, I would recommend making the two parameters evaluated very explicit here.
 - Based on the prior suggestions by both reviewers, we feel that we have made it clear in this section what parameters are being modeled with our Monte Carlo analysis.
- Line 177: I am not sure how this list can be “exhaustive” especially given the parameters shown in the paragraph starting at 199 and the temporal discretisation presented in the model. Is it necessary to include? Also, if it is an exhaustive list, would this be a “grid search”? If so, explaining this would improve the model.
 - We have deleted ‘exhaustive’ to avoid confusion.
- Line 178: “the model calculates how 14C and 10Be concentrations evolve” change to the model calculates the evolution of 14C and 10Be concentrations. Similar issues exist in other parts of the text.
 - Done.
- Paragraph at Line 196: Much of this content was presented in the first paragraph of the section and is closely linked with the next paragraph. Some reorganization of the section might be needed.
 - Based on the prior suggestions by both reviewers, we extensively redrafted this section from the original draft and feel this section is clear as constructed. The redundancy is recognized but we think is necessary for continued clarity based on prior comments.
- Line 213: “Scenarios that reproduce all nuclide concentrations for all samples at a given glacier are recorded and saved as viable exposure-burial histories” why not write Scenarios reproducing all nuclide concentrations for all samples at a given glacier deemed as viable exposure-burial histories.
AND
- Line 217: “overlapping” this term is repeatedly used through out the text. However, I have not found a clear definition of it. To me it seems visually evident in plots in the supplement. However, this needs to be clearly described here, and forgetful readers (like myself), might need a little reminder of what it means when it is discussed in the results.
 - We agree with both comments and now on Line 211 we add “Scenarios that reproduce all nuclide concentrations for *all* samples at a given glacier are recorded and saved as viable exposure-burial histories; we henceforth refer to these as the ‘overlapping’ scenarios.”
- Line 230: “The RGI data are from miscellaneous years based on what was available in RGI.” This sentence must be more precise or excluded.
 - We agree and have deleted this sentence. It is clear from prior sentence where we say “We also included an intermediate position using the outlines available from the Randolph Glacier Inventory.”
- Line 249: “Apparent exposure ages are presented in Table 1 and plotted onto satellite imagery of the glacier forefields in Figure 3.” I noticed that the authors seem to include sentences like this at the beginning of paragraphs and sections describing a Figure or Table. The text will be far shorter

and more interesting if these comments are omitted. It should be enough just to reference the figure in the text.

- ☐ Again, given prior reviewer feedback that clarity was needed throughout, we have elected to leave this section as-is since these additions were made from prior reviewer comments.
- ☐ Paragraph at Line 249: it is not clear to me if these are ages from ^{10}Be or ^{14}C . or both. Please describe.
 - ☐ We agree and have added ' ^{10}Be ' throughout the paragraph now.
- ☐ Line 257: see comment for Line 249.
 - ☐ see our comments above
- ☐ Table 1: Would it be helpful to make a row for each glacier that has its average of each column for that glacier? This may make it much easier for readers to extract the key points or messages from the table.
 - ☐ We present the means in the text and prefer to leave this as is for clarity.
- ☐ Line 273: "The second observation is that ^{14}C - ^{10}Be sample ratios at JIF Glacier, Kokanee Glacier, and Mammoth Glacier are depressed." Depressed compared to what?
 - ☐ Done. Added: '...relative to the production ratio.'
- ☐ Line 278-279: "Low ratios are only possible through extensive decay of ^{14}C relative to ^{10}Be , severely limiting the number of plausible scenarios." maybe change plausible scenarios to plausible climate/glacier scenarios. Otherwise, a nice sentences that concisely describes an trend in the data. Consider moving to the top of the paragraph, so that it is in the readers' minds as they interpret you findings.
 - ☐ Done. Changed to: "... severely constraining the plausible exposure-burial scenarios."
- ☐ Section 4.2: Some comments about the meaning of the results might help in this section.
 - ☐ Since the model is statistical and only outputs exposure and burial scenarios, we prefer to leave any interpretation to the Discussion for consistency and clarity.
- ☐ Line 295: "We plotted. . .". See comment for Line 249.
 - ☐ see our comments above
- ☐ Line 308 - 310: Super interesting. I believe Reviewer 2 made some comments about this in the last draft and to me it is great that the authors pursued this further. One potential thought that I had was to compare these results to "modern erosion rate" from Cook et al., 2020 (which the authors do), then discuss the findings in terms of finding by Ganti et al., 2016 (Time scale bias in erosion rates of glaciaded landscapes), for instance. I hope this is not too much of a tangent (more an idea). If it is, please ignore.
 - ☐ Thank you. Yes agreed it's super interesting. For fear of getting tangential in the manuscript, we leave it as is, but we do mention that the erosion rates we find are on the low end of published estimates (see discussion about JIF Glacier and the conclusion).
- ☐ Figure 5: I would recommend adding "Ice Free" to the axis underneath the "Probability of Exposure." This may reduce some confusion for more "glaciology" focused readers may not thinking in terms of "exposure."
 - ☐ Since 'ice-free' is an interpretation (versus simply 'exposed') we prefer to leave it as is. Again, we understand the reviewers point but we are trying to be clear and consistent about what the model is really outputting versus our interpretation.

- Line 340: “It has also retreated more than the composite of Sierra Nevada glaciers.” this needs a citation.
 - Done. Now we refer to Figure 6 now where it is plotted and cited in the caption.
- Table 2: Can this table be organized so that the two most important quantities are right next to each other? For me, the two most important bits of information are response time and %LIA Area. It will make it easier to compare these values.
 - It is currently laid out with respect to how the calculations are made, and it is not clear that putting them next to each other adds clarity. We have elected to leave the table as-is simply for ease and clarity.
- Line 374: Why would this be surprising?
 - As outlined in introduction and preceding paragraph, we expected similarity across sites.
- Line 396–398: This is a very complicated sentence. Simplify?
 - Done. Re-written as: “An interesting implication therein is that Mammoth Glacier doubled in area in less than a millennium: at ~1 ka the glacier’s area was 1.7 km² and at ~0.1 ka (end of the LIA) it was 3.4 km².”
- Line 427: “then it should be replicable by modeling”. Can the section or figures that show how this was not replicated by modeling be shown or referenced?
 - This sentence just leads into the next paragraph where we do some modeling and explain this in more detail.
- Figure 8 caption: “Erosion rates are marked by red vertical tick marks along each scenario (black dashed line), starting from an erosion rate of 0.0 mm yr⁻¹ on the righthand side progressing to 5.0 mm yr⁻¹.” Very nice way to plot this. However, it took me a little bit to understand. Can this be rephrased? would it help to remove some isochrons? No problem if not.
 - This certainly is a complicated plot. We deliberated for a while on how to best present it and are very happy that you found it helpful. Given how tricky it was to convey the information, we elect to leave the figure as we have it since based on experience presenting our work this appears to be the clearest figure for other researchers to understand.
- Lines 477-482: Dirk Sherler, amongst others, has some papers about this. Comments would be improved if this was supported by some observations and citations.
 - These papers seem to be about debris cover on ice impacting a glacier’s response to climate change, rather than about how debris cover may have impacted nuclide concentrations in a glacier’s forefield. We agree a citation would be helpful; we have not found anything else in the literature that deals with our specific problem of debris cover impacting cosmogenic nuclide concentrations in a glacier forefield.
- Line 484: “This interpretation is plotted in Figure 7. . . ” This sentence is a bit confusing and can be omitted by just referencing Figure 7.
 - Changed to: Without erosion rates > 0.5 mm yr⁻¹, there are no overlapping scenarios with exposure from our Monte Carlo forward model, and the modeled probability of exposure is ‘0%’ (Figure 7).

- Paragraph at 529: This is probably correct, strictly speaking, but a little bit hard to follow and understand the main message. If the exact figures are needed, then the Table can simply be referenced.
 - Done. The numbers were removed for clarity and the Table was referenced.