

## Yang et al 2<sup>nd</sup> review

### General comments

The revised paper offers considerable improvements over the previous submission and addresses the most significant concerns I had at that stage. In particular, the treatment of LIA substages is considerably enhanced by the addition of a technical description of how they are identified. The improved clarity of the figures is also appreciated.

I still have some questions over how well the moraine ages can be confidently associated with LIA substages identified in the OGGM output; my understanding is that the moraine ages seem to show that a series of substage maxima were hit for a number of glaciers in each of the LIA substages, but not how these cases can be linked to the four regional substages in the output. However, this is a relationship that would probably need to be examined on a per-glacier basis which is beyond the scope of this paper and potentially beyond the capabilities of OGGM runs calibrated regionally rather than to individual glaciers. It is probably not worth adding material on this topic to the paper at this point beyond perhaps some discussion of how future work might tie the observations and the modelled glaciers together more closely.

I would recommend the paper as it stands for publication given the minor changes detailed below. Whether the above point on how regional and individual scale variations can better be tied together should be left to the authors' discretion.

Please note that I have had limited time to perform this review and I have therefore been less selective about language than I would have liked, with requests for changes mostly restricted to cases in which I felt the meaning was obscured rather than technical errors where the meaning was still clear.

### Specific comments/technical corrections

Figure 8: The readability of this figure and the information that is being provided appear negatively impacted by the choice of reference year: what I understand here is that in the 1950s, September and October were particularly cold and August was particularly dry, and these have considerably skewed the visuals away from a focus on the LIA substage bands that are the intended focus. Could this graph instead use the 20<sup>th</sup> century average as a reference, to try to highlight the features of the dataset which are of greater interest here.

L23-24: "... has generated increasing interest in exploring the mechanisms behind this."

L31: "post-glacial"

L42: "... understanding of the pattern"

L81: "Specifically"

L119-121: 'initial condition' in this section is used to mean two things:

1. The glacier state as determined directly from the RGI input, and
2. The glacier state at the start of the model run with historical climate (post-spinup)

It is necessary to refer to these differently. Perhaps 1 should be the 'pre-run condition' and 2 should be 'post-spinup condition'

(and then clarify the post-spinup condition is what is being selected as the initial conditions for the historical run)

E.g line 120 "The B will regulate the post-spinup condition (i.e. the length of glaciers at the

start of the historical run)"

- L123: It is ambiguous what is meant by the altering of beta. Is it being modified within the course of a single run (and if so, why?)  
or are you running several versions of the spin-up with different values of beta to see what is best? (it looks like the latter from context but it should be clear from this first mention)
- L296: The intention behind this sentence is unclear. The fact that regional glacier evolution is an integral of individual glacier changes is true by definition rather than established in the results. Perhaps just simplify and say "The climatic mechanisms behind the LIA substages described here are still unclear."
- L335: Increase
- L356: Overall I think this paragraph could use some rewriting. I understand most of what is being discussed but I have a feeling it won't be clear to anyone not familiar with sensitivity experiments for glacier models. Specifics below. It should also be noted somewhere in this paragraph that the maximal sensitivity at unmodified temperature/precipitation is the expected case due to the negative feedback mechanism of changing ELA as glacier length changes.
- L358-359: "The sensitivity of glaciers to temperature/precipitation changes – in the form of the rate of change for GLR per °C/% respectively – is highest for unmodified temperature/precipitation and decreases as they are varied further from the values given in the historical climate runs"
- L365-367: Is this a measure of observed relative changes in precipitation and temperature, a measure of how much precipitation changes in response to temperature changes (this is suggested at present by the 'will'), or a measure of how much the precipitation would have to change for a given temperature change to maintain the same SMB?