

## ***Interactive comment on “Climate change and the global pattern of moraine-dammed glacial lake outburst floods” by Stephan Harrison et al.***

### **Anonymous Referee #1**

Received and published: 4 December 2017

This is an interesting and timely study on the frequency of glacier lake outbursts from moraine failures. The main findings are an increase of such events around the 1930s and a decrease in recent decades. The study should certainly be published, but I recommend consideration of my below comments:

(1) Methods 2 introduces a model over several pages, but at the end the model is “just” used to smooth the temperature time series, if I understood correctly. Is this long model intro really needed? Wouldn’t some running mean filter or similar over a reasonable time span give very different results and provide different explanations to the LIA-1930 lake outburst lag time? If you really find your model is essential, and simpler forms of smoothing don’t work I recommend you explain that better and take up the model again in the discussion and conclusions. As said above, I think the most important results

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are increase and decrease of outbursts, and you say so, too. I cannot see how this conclusion should depend so much on the temperature time series analysis. If, I am wrong, please explain better.

(2) You need to discuss more what type of processes your model is able to describe what not. Moraine lake failures can be quite different in different regions, for instance regarding ground thermal conditions and possible influence of ground ice and permafrost; topography; glacial history; etc. I think, we would need to understand the geomorphological time scales involved in lake evolution and failure better to better design and understand statistical analyses like yours. I am not saying you have to do that, but you should better discuss that including references to these differences.

(3) Your result to expect a new increase of moraine lake outburst in the future, after a lag time to current atmospheric warming, assumes a constant system status also in the future. I am not so sure this is actually true, in particular not for the mountain cryosphere. If the conditions change into a different system status your extrapolation doesn't hold. A good example for that are thermokarst processes, which are actually involved in the evolution of most glacier lakes. After having been initiated (likely through a rise in temperature, true) they continue to develop even under constant temperatures. In other words, once you have thermokarst processes running, they will continue to increase lakes almost independent of atmospheric temperatures, unless you cool down so much that glaciers grow again significantly. In this example, your extrapolation holds only if the recent acceleration in temperature increase initiates new thermokarst processes. There might also be other positive feedback processes involved in lake growth and outburst that don't require an increase in temperature. Another argument why your assumed constant system status could perhaps not hold are the glaciers themselves; they are in a very different status than after LIA.

(4) Could the 1930s increase of outbursts be related to an improvement of communication capabilities?

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(5) Your main finding of recent decrease in outburst numbers agrees with Carrivick and Tweed (2016). You should mention that, and perhaps also else compare your main findings with them.

(6) You acknowledge that preventive measures could have reduced the outburst number in recent decades. Hopefully! You could try to quantify this as most of these measures should be known (and you have a co-author consortium that will know).

(7) Line 376: Again, this assumes somehow similar geomorphological processes and time scales over all regions (see above).

(8) Line 377: From what I understand from your study, a good way to supplement/correlate it would be to check the development of lake areas and numbers. This is much easier (from satellite images, for instance) than outburst statistics. There are such studies, e.g. Gardelle et al. (2011) <https://doi.org/10.1016/j.gloplacha.2010.10.003>

(9) Much of your data comes likely from other inventories. However, these are not referenced in the main text nor else acknowledged, besides one mention. What would you say if others use in the future your refined database without referencing your paper?

(10) Besides the database itself, I think most, including references, of the Supplement should actually go to the main text, or at least in an Appendix. Some important explanations are too much hidden in the Supplement and not really supplementary information.

(11) Fig.2: are the many temperature trends really necessary for your main messages? Supplement?

(12) 'Methods 1' and 'Methods 2' are not a section numbering according to TC convention: 2.1. , 2.2, etc.

(13) At a few occasions it might be necessary to adapt to the TC style, please check the TC instructions.

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(14) There are a few typos and small grammar errors spread over the manuscript.  
end

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