The Cryosphere Discussions

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Comment on tc-2021-303

Jakob Steiner (Referee)

Referee comment on "A regionally resolved inventory of High Mountain Asia surge-type glaciers, derived from a multi-factor remote sensing approach" by Gregoire Guillet et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-303-RC1, 2021

Review 10.5194/tc-2021-303: A regionally resolved inventory of High Mountain Asia surge-type glaciers, derived from a multi-factor remote sensing approach

Guillet et al.

The authors present a comprehensive inventory of surge-type glaciers for HMA from 2000-2018, using readily accessible glacier velocity, mass loss and morphology datasets. They find a larger number of surging glaciers for all regions than previously identified in regional inventories. With knowledge of surge duration and velocity they show that power laws explain the occurrence of certain durations/velocities.

The paper is very clearly structured, the science is sound, well explained and clearly followed through and the creation of this inventory and the questions that are addressed through it are of great interest to the community. It definitely fits the scope of the Journal very well. I apologize for a very short review – it's not for lack of interest or dedication, there is, in my view simply not much to address before it can be recommended for publication. There are a few general concerns I have below I would like to see addressed, followed by very minor comments.

General:

- There is one essential study that deals with controls of surges in HMA I am surprised you have left out of your Introduction but more importantly of your Discussion, namely (Barrand and Murray 2006). I am no co-author on that, so no bias, but they specifically tried to find controls, for the same variables that you investigated found similar results but also looked at other potential drivers. Added to that I am wondering, whether or why not you have considered to look at bed topography (simply via (Farinotti et al. 2019))? For some surging glaciers a particular shape of the valley/bed coincides with the transition from reservoir to receiving zone. That is not a request to do it, I am just wondering why you haven't expanded to other variables, like (Barrand and Murray 2006) also have done.

- The only really strong relation you find between variables is between glacier length and surge area (L215ff, and then Discussion). I am wondering however whether you did these comparisons also for the baseline 'non-surging' glaciers? Because I would assume that relation just holding true for any glacier, the longer it is the bigger it is and hence also the larger potential "surge area" it has. And then that wouldn't really be a signal from the surging glaciers per se. Or am I missing something here?
- L230ff/L240ff: Since you do not address that further in the Discussion, I am curious why you think (a) there seems to be general smaller mass loss for surging glaciers but then later you show that they substantially loose mass at the end of the surge or just after it and (b) why you think that rapid onset of mass loss is? Just because ice mass was transported to lower elevations and hence melts faster? Or are there dynamic reasons at play that disguise some redistribution of mass as mass loss?
- L309ff: I think a major shortcoming of your study – that is naturally just stemming from the data we have access to – is that the period you investigate is shorter than some surge cycles. Khurdopin cycles have been around 20 years, Muchchuhar Glacier next to Shisper even much longer. So in a way you may miss some within that period. So when you compare to inventories that go further back I would have expected them to catch some surges which you may have failed to catch. But your numbers are consistently higher. That would suggest that your numbers are still too low (because you missed some of the currently quiescent ones). Considering that for example (Bhambri et al. 2017)'s data and maybe others as well are accessible, wouldn't it be prudent to compare your inventories and see which glaciers you agree on and where they find some you didn't and vice versa? (Bhambri et al. 2017) has a very similar number but you still say yours is 'more accurate'. From the evidence you provide I find that difficult to be sure of.
- As you are definitely aware, more recently a number of glaciers have been found to 'detach' rapidly (Kääb et al. 2021; Leinss et al. 2020). Have you made sure that these detachments are not classified as a surge by you? Even maybe for yet undetected detachments?

Minor comments:

L54: A study that actually looks at economic and infrastructure impacts of a surge, and that same surge, would be (Muhammad et al. 2021). I am a co-author on that study and I also do not think it is at all essential to cite here. I leave it up to you in case you find it helpful to make your point.

L146: "Consortium et al. 2017" reads funny – I know citing the updated RGI is a bit strange but the official format is below, so I would at least go with 'RGI Consortium 2017':

RGI Consortium (2017). Randolph Glacier Inventory – A Dataset of Global Glacier Outlines: Version 6.0: Technical Report, Global Land Ice Measurements from Space, Colorado, USA. Digital Media. DOI: https://doi.org/10.7265/N5-RGI-60

L155 and throughout: capitalize ‘Glacier’ when associated to a specific glacier. You do that sometimes, sometimes not. Same for ‘Tibetan Plateau’ on L181

L304: You write ‘Data not shown’ but wouldn’t you be able to state here in the text by how much it reduces if you set k to 3 or 2?

Literature:

Barrand, Nicholas E., and Tavi Murray. 2006. “Multivariate Controls on the Incidence of Glacier Surging in the Karakoram Himalaya.” *Arctic, Antarctic, and Alpine Research* 38 (4): 489–98. https://doi.org/10.1657/1523-0430(2006)38[489:MCOTIO]2.0.CO;2.

Bhambri, R., K. Hewitt, P. Kawishwar, and B. Pratap. 2017. “Surge-Type and Surge-Modified Glaciers in the Karakoram.” *Scientific Reports* 7 (1): 15391. https://doi.org/10.1038/s41598-017-15473-8.

Farinotti, D., M. Huss, J. J. Fürst, J. Landmann, H. Machguth, F. Maussion, and A. Pandit. 2019. “A Consensus Estimate for the Ice Thickness Distribution of All Glaciers on Earth.” *Nature Geoscience* 12 (3): 168–73. https://doi.org/10.1038/s41561-019-0300-3.

Kääb, Andreas, Myléne Jacquemart, Adrien Gilbert, Silvan Leinss, Luc Girod, Christian Huggel, Daniel Falaschi, et al. 2021. “Sudden Large-Volume Detachments of Low-Angle Mountain Glaciers - More Frequent than Thought.” *The Cryosphere* 15: 1751–85. https://doi.org/10.5194/tc-2020-243.

Leinss, Silvan, Enrico Bernardini, Mylène Jacquemart, and Mikhail Dokukin. 2020. “Glacier Detachments and Rock-Ice Avalanches in the Petra Pervogo Range, Tajikistan (1973–2019).” *Natural Hazards and Earth System Sciences Discussions*, 1–31. https://doi.org/10.5194/nhess-2020-285.

Muhammad, Sher, Jia Li, Jakob F. Steiner, Finu Shrestha, Ghulam M. Shah, Etienne Berthier, Lei Guo, Li-xin Wu, and Lide Tian. 2021. “A Holistic View of Shisper Glacier Surge and Outburst Floods: From Physical Processes to Downstream Impacts.” *Geomatics, Natural Hazards and Risk* 12 (1): 2755–75. https://doi.org/10.1080/19475705.2021.1975833.