Reply to editors:

Major Comments:

1. “One point is some remaining problems in language and terminology. We hope that you will find our suggestions in the attached PDF helpful and ask that you further revise your manuscript again on these technical details.”

Reply: Thanks for providing the detailed suggestions on the technical issues. We have revised the manuscript and modified the text according to your comments. In addition, we have also carefully revised the language and expression throughout the manuscript. Some repetitive sentences have been deleted (Lines 218-220, which are similar to Lines 257-259). You can find our changes in the uploaded manuscript with change marks.

2. “In addition, we have discussed in the editorial team that uncertainty analysis should be key to any publication in the ESSD. To this end, we ask that you quantify the sources of uncertainty more precisely and present the error propagation in more detail. Further advise can be found in the attached document in section 6.1.”

Reply: Thanks for reminding. We have reevaluated the uncertainties of glacier change following your suggestions. We have added a section in the method part to show the details of how the uncertainty is calculated through the error propagation law. The contributions of different uncertainty sources were quantified separately. We have added a subplot in Figure 1o to show the contributions of different uncertainty sources. Besides, we have added more quantitative supports and qualitive discussion to demonstrate that the uncertainties in our results is acceptable. The uncertainty analysis section (6.1) has been significantly revised. Please find our detailed revision for each related comments in the replies to comments 23-27.

3. “Finally, we noticed that the presentation and discussion of the characteristics of glacier surges takes up a lot of space in the manuscript. However, a scientific discussion of your database, apart from methodological issues and comparison with other studies in terms of completeness, is discouraged by the ESSD guidelines. We note that we have not raised this issue before, but would at least ask you to consider shortening or deleting the relevant sections so that your manuscript is more in line with the ESSD guidelines.”

Reply: Thanks for reminding. We have carefully learned the guidelines for ESSD publications. Following your suggestion, we have deleted the content related to glacier orientation in the Results section (section 5.3), and the content related to glacier orientation and mass balance in the Discussion section (section 6.2). The content related to geometric characteristics in the Discussion section (section 6.2) has also been significantly shortened. The revised manuscript should be more in line with ESSD guidelines now.

Specific Comments:

4. L32: remove “quasi-”.

Reply: A surge is not exactly periodic, since its revisit cycle is affected by the environmental conditions. For periodic glacier surges the environmental conditions would need to remain stable. Glacier surge was defined as a “quasi-periodic” behavior in many studies (Raymond, 1987; Harrison and Post, 2003; Kochtiziky et al., 2019; Truffer et al., 2021). Hence, the “quasi-” should be kept.

4. L33: replace with “the accumulation area”?

Reply: Thanks for reminding. We have replaced the “upper reaches” with “the reservoir zone”. The reservoir zone of a surging glacier is not necessarily in the accumulation area.

5. L46: "distinct elevation change pattern" should be more specific

Reply: Thanks for reminding. We have rephrased this expression and added the typical elevation change pattern for identifying a surging glacier.

6. L60: “By combining observation of multiple features” is unclear what that means. Please specify.

Reply: Thanks for reminding. We have rewritten this sentence to specify the meaning.

7. L66: “differing” means differing between or within regions?

Reply: it means the mass balance of these subregions is different from that of other regions outside HMA. We have rephrased this expression.

8. L130: add period for “the most recent surges”

Reply: Thanks for reminding. We have added the corresponding period for this expression.

9. L133: “the elevation change pattern” in which data set? Only the datasets by brun and hugonnet?

Reply: We meant the errors in all elevation change observations, including our DEM differencing results and existing elevation change datasets. We have clarified that.

10. L158: which resampling algorithm did you used for reprojection?

Reply: We used the cubic resampling method for map reprojection. We have added a sentence to clarify it.

11. L159: did you use an Albers projection specific for Asia?

Reply: This map projection is a customed Albers projection to encompass all glaciers in HMA, which was used by Shean et al., (2020). We have clarified it.

12. L195: explain “dH”

Reply: Thanks for reminding. We have added the explanation when we used it at the first time. It was used for indicating elevation difference.

13. L198: why this multiplication?

Reply: We used this multiplication according to previous studies (Abdel Jaber et al., 2019; Fan et al., 2022). Also, the experiments conducted over dry snow showed that the penetration depth of C-band is about two times of X-band (table 2 in Rott H et al., 1993). We have rephrased this sentence and added the references in the text.

14. L199: what do you mean with “removed”?

Reply: Thanks for reminding. We have replaced “removed” with “subtracted”.

15. L225: do these values refer to individual pixels or larger areas of a given size? please clarify

Reply: Thanks for reminding. These values refer to thresholds of continuous glacier elevation changes over an area larger than 0.04 km^2, rather than individual pixels. We have clarified that in the text.

16. L271: the logic and use behind the Roman numbers I, II, and III is a bit confusing, because they are used both in chapters 4.2.1 and 4.2.2. Also the letters a, b, and c are not clearly defined. Please add a table that clarify this issue, and remove/ relabel all phrases in the text where potential confusion between these numbers and letter could arise.

Reply: Thanks for reminding. We have revised all related phrases to avoid confusion in both the text and dataset. Also, we have added a table to list all criteria used in this study (Table 1).

17. L303: spatial or temporal “density”?

Reply: We mean spatial density. We have clarified it.

18. L304: “far from even” between what? Regions?

Reply: we mean the spatial density of identified surging glaciers varies between different subregions. We have rephrased this expression.

19. L315: does this estimate include the entire area of the glacier, including that part that surged, and the other part that did not surge? Please clarify.

Reply: Only the area of surging tributaries was considered in all area-related values. The other part that did not surge was not counted. We have clarified that a surging tributary was regarded as an individual glacier in the previous paragraph.

20. L335: could that drop be the result of the overall small number of glaciers in that bin?

Reply: Yes, it could be the reason. However, we cannot say this view as the samples are insufficient.

21. L340: “closest area” but from an arbitrary region?

Reply: Yes, it is. Thanks for reminding. We have added these words.

22. L372: Please add here a table of all variables and their units that are part of the shapefile that are avaiable on Zenodo. Thanks.

Reply: Thanks for your careful review. We have listed the description of all variables of the shapefiles that are available on Zenodo in Table 5. We have added a sentence here to clarify it.

23. L374: Please revisit your workflow and quantify the different contributions of uncertainty until you obtain your output product (i.e., the DEM difference maps)

Reply: We have reevaluated the uncertainties of glacier change following your suggestions. The uncertainties of the elevation difference and penetration depth difference were separately evaluated prior to the final estimation of uncertainties. Regarding this, we have added a subplot in Figure 10 to show the uncertainties of all kinds of elevation difference observations. We have significantly revised sections 4.3 and 6.1.

24. L378: which you did not show in the methods. Please add in the methods how you propagate errors of DEMs, and in the DEM difference products. Please also discuss how you much the signal of elevation change must be to be credibly higher than the noise in your difference product.

Reply: We have added a section in 'Method' (section 4.3) to clarify how we estimated the uncertainties in the elevation change through the error propagation law. We have added discussion on the form and performance of large errors in our elevation difference results, and the reason why these large errors would not substantially affect our identification in section 6.1.

25. L383: how do you know that these values are uncertainties and not 'true' deviations? Please show/ discuss.

Reply: It could be that in our “stable terrain” there are other processes occurring, like landslides, erosion, anthropogenic changes etc. The uncertainty is calculated by taking the NMAD of elevation difference values in “stable terrain” where glaciers and water bodies are excluded. It is possible that some of the differences are actual signal (landslides, erosion, vegetation change etc), but these are likely to be in minority over the whole study area. In any case, our error estimate is likely conservative, since it may overestimate the actual uncertainty.

26. L391: please be more specific.

Reply: We have added a sentence to clarify this point.

27. L388: please add quantitative support to this claim.

Reply: We have added a figure to illustrate the relationship between uncertainties and terrain slope (Fig.11), which shows that higher uncertainties are more likely to occur in steep regions. The head of glaciers are generally steep regions. We have added related discussion in section 6.1.

28. L399: what is a glacier scale?

Reply: Thanks for reminding. We have replaced the "scale" with "size".

29. L467: which study used only a single criterion? Didn't Guillet's and your study used several criteria to examine glacier surges? Please clarify.

Reply: Sorry for the carelessness. This expression actually corresponds to the first version of our manuscript, in which we have not added the morphological changes as the criteria. We have corrected it.

30. L478: "more surging glaciers" in the Karakoram?

Reply: Thanks for reminding. We have added "in the Karakoram" in the text.

31.L485: why did you miss these four cases?

Reply: We have rechecked these four glaciers, and found that all of them showed very slight terminus advancing and their surging lasted very long time, which means their terminus advancing speeds were very low (i.e., lower than 1 pixel of the Landsat image per year). Therefore, it is difficult to identify these surges through the visual interpretation. We have added the reason in the text.

32. Landsat has higher spatial resolution than some of your DEMs?

Reply: Thanks for reminding, we should modify this expression. However, we have realized that the discussion of the reason for the gap between the numbers of identified surging glaciers of Vale et al (2021) and us is unnecessary, because they only used the terminus change as the criterion. We decided to delete these two sentences (i.e., "The possible reason …lacier terminus position).

33. Figure 2: These labels I-b, I-c, and so on, need to be explained in the figure caption. Please add a small overview map where this site is.

Reply: We have added the overview map in the figure. Also, the labels for identified surging glaciers were modified according to comment 16.

We understand that it is convenient for readers to quickly know what the labels stand for after we add the explanation in the figure caption. We have tried to this. Here is the explanation of these labels:

"I-a": a "verified" surging glacier that was observed to have obvious thickening in lower reaches (e.g.., +30 m); "I-b": a "verified" surging glacier that was observed to have contrasting upper-thinning (e.g.., +20 m) and lower-thickening (e.g.., -20 m); "I-c": a "verified" surging glacier that was observed to have contrasting upper-thickening (e.g.., +20 m) and lower-thinning; "I-d": a "verified" surging glacier that was observed to have severe thinning in the lower reaches;

"II-e": a "probable" surging glacier that was observed to have moderate upper thinning (e.g., -15m) and lower thickening (e.g., +15 m); "II-f": a "probable" surging glacier that was observed to have only moderate thickening in the middle reaches (e.g., +15 m);

"III-g": a "possible" surging glacier that was observed to have only moderate thickening at the terminus (e.g., +15 m); "III-h": a "possible" surging glacier that was observed to have only strong thinning in the lower reaches.

The explanation of these labels takes up about two hundreds of words, making the caption lengthy. How about we point out that the criteria of identification are elaborated in section 4.2.1 and Table 1? It will be much more concise.

34. Figure 4: add this label to the figure, e.g. in the legend in the topright, or the estimate for the entire HMA in the bottom left.

Reply: Thanks for reminding. We have added the label into the figure.

35. Figure 10: could transparency for both types of glaciers help reduce the strong overlap? Stretch labels.

Reply: We have modified this figure following your suggestion. However, it's difficult to clearly show both type of glaciers due to the large number of samples.

References mentioned in the text:

Abdel Jaber, W., Rott, H., Floricioiu, D., Wuite, J., and Miranda, N.: Heterogeneous spatial and temporal pattern of surface elevation change and mass balance of the Patagonian ice fields between 2000 and 2016, The Cryosphere, 13, 2511–2535, doi:10.5194/tc-13-2511-2019, 2019.

Fan, Y., Ke, C.-Q., Zhou, X., Shen, X., Yu, X., and Lhakpa, D.: Glacier mass-balance estimates over High Mountain Asia from 2000 to 2021 based on ICESat-2 and NASADEM, J. Glaciol., 1–13, doi:10.1017/jog.2022.78, 2022.

Harrison, W. D. and Post, A. S.: How much do we really know about glacier surging?, Ann. Glaciol., 36, 1–6, doi:10.3189/172756403781816185, 2003.

Kochtiziky, W., Jiskoot, H., Copland, L., ENDERLIN, E., McNabb, R., KREUTZ, K., and MAIN, B.: Terminus advance, kinematics and mass redistribution during eight surges of Donjek Glacier, St. Elias Range, Canada, 1935 to 2016, J. Glaciol., 65, 565–579, doi:10.1017/jog.2019.34, 2019.

Raymond, C. F.: How do glaciers surge? A review, J. Geophys. Res., 92, 9121, doi:10.1029/JB092iB09p09121, 1987.

Rott, H., Sturm, K., and Miller, H.: Active and passive microwave signatures of Antarctic firn by means of field measurements and satellite data, Ann. Glaciol., 17, 337–343, doi:10.3189/S0260305500013070, 1993.

Truffer, M., Kääb, A., Harrison, W. D., Osipova, G. B., Nosenko, G. A., Espizua, L., Gilbert, A., Fischer, L., Huggel, C., Craw Burns, P. A., and Lai, A. W.: Glacier surges, in: Snow and Ice-Related Hazards, Risks, and Disasters, Elsevier, 417–466, doi:10.1016/B978-0-12-817129-5.00003-2, 2021.