Reply to Reviewer #1:

The manuscript presents a new inventory of surge-type glaciers in High Mountain Asia, derived from glacier surface elevation changes computed from various DEM sources, between the 1970's and 2010's.
The manuscript tackles an important topic which is the identification of surging behavior over a large spatial and temporal scale using remotely sensed glacier observables and thus aims at proposing an updated inventory by incorporating historical data absent from other studies.
This problem is of significant importance or the community and the proposed paper is of overall good quality.

Major comments:

1. "The authors here rely solely on anomalous surface elevation change pattern to identify surging behavior. This can lead to false identifications of glaciers present similarly altered surface elevation change signal (See specific comments for more). Some of the widely known shortcomings of the datasets used in this study, as well as the existing corrections (SRTM C-Band penetration correction) are not accounted for in this study, which may lead to further false positive identifications."

Reply: Thanks for reminding. Considering the two error sources you mentioned, we have updated the flow chart of data processing and correct the inventory. The new flowchart has considered the penetration biases in the multi-source elevation change observations, and incorporated long-term morphological changes as additional identification criteria. More details of the correction of radar penetration and the handling of false identification were described in the responses for specific comments 13 and 14. Specific changes can be found in the Methodology section of the revised manuscript.

2. "The authors rightfully propose a classification that assigns a level of certainty over the potential surge behavior of each glacier. This is a valid approach since the authors only have one identification criterion and I commend them for doing so. However, when analyzing, discussing and presenting their results, the authors seem to forget that surge-type behavior is uncertain for some glaciers and consistently mention 1015 surge-type glaciers while "only" 704 present indications of surge-type behavior."

Reply: Thanks for reminding. Indeed, speaking of surge-type glacier, only the 'verified' ones should be analyzed and discussed. Suggested by Reviewer 2, the verified ones should be referred as 'surging' glaciers, rather than surge-type glaciers. Hence, we have classified the identified glaciers into the "Surging" and "Surge-like" categories like Bhambri et al (2017). The uncertain classes ("probable" and "possible") have been classified as "Surge-like" glacier. In the revised manuscript, only the confirmed surging glacier was taken for characteristic discussion and comparison with previous studies. Specific changes can be found in the Introduction section, 4.3 section, and Results section of the revised manuscript.

3. "Finally, some of the Introduction and Discussion lack context and an adequate description of the state of knowledge of what are glacier surges and the processes that govern glacier instabilities."

Reply: Thanks for reminding. We have elaborated the knowledge of what are glacier surges and the processes that govern glacier instabilities in the Introduction and Discussion sections.

4. “I want to restate my support for this manuscript and the work it presents. Given its current state however, I suggest that the authors make major additions and changes to both their methodology and results before this manuscript can be considered for publication.
As an example, adding more than one identification criterion would strengthen the confidence in the presented results. The authors could for example use available satellite images to visually investigate changes in surface and geomorphological features like crevasses, supraglacial ponds or looped moraines.”

Reply: Thank you for your affirmation. We have revised our methods and results following your suggestions. Please see the detailed response for each comment listed below. In particular, we have added the criterions based on morphological feature change to improve the identification of surging glaciers.

Specific comments:

5. L15-16. This statement is misleading as your classification is based on the confidence degree you have over certain surge events - all the glaciers in your inventory have different level of confidence.
This directly differs from the methodology used in Guillet et al, which I assume is the work you refer to, which used different identification criterion to investigate surges.
Reply: Thanks for reminding. We have categorized the updated results into the “Surging” (“verified” class) and “Surge-like” (“probable” and “possible” classes). To avoid confusion, both of them were clearly stated in the text, especially in the Abstract, Discussion (comparison with others results), and Conclusion sections.

6. L23. This relationship was actually first described in the enthalpy balance theory of glacier surges proposed by Benn et al 2019. Please rephrase this statement.
Reply: Thanks for reminding. We have rewritten this statement into “The inventory further confirmed that surge activity is more likely to occur for glaciers with larger area, longer length, and wider elevation range…”

7. L27. Isn't that just because of a sampling bias, as a longer observational period allows to identify more surges?
Reply: Thanks for reminding. We have realized this statement is not rigorous. Since Reviewer #2 also doubt this statement and recommend removing it, we have deleted this statement from our manuscript.

8. L32. Please describe what do those phases entail and how do they differ.
Reply: Thanks for your suggestion. We have added a clear definition of different surge phases and described their characteristics in this part.

9. L34. While I agree that the physics governing the unstable flow exhibited by surge-type glaciers requires a better understanding, I also think that speaking of 'enigma' disregards the substantial efforts made in the recent years to further our understanding of glacier surges.
The authors should here at least refer to the works of Sevestre and Benn (2015), Benn et al (2019), or Thøgersen et al. (2019) (among others) in order to provide an up-to-date synthesis of the state of knowledge on the physics of surge-type glaciers.
Reply: Thanks for reminding. We have added a short paragraph to introduce the recent efforts that have been made

on the mechanism of glacier surge.

10. L35. Please be more specific in this statement. 'Fast' is very vague without a reference. This sentence is not easy to read and could benefit from being segmented and more detailed.
Reply: Thanks for your suggestion. We have rewritten this sentence following your suggestion. We have used more specific number to describe the “unstable flow” and “severe post-surge down-wasting”.

11. L46. Not all surging glaciers show terminal advance. I suggest reading through the works of Paul et al. (2017) and Steiner et al. (2018, already cited in your work).
Reply: Thanks for reminding. We have changed the statement to “a surging glacier could exhibit either one or several drastic changes, including…”

12. L58. Contrasting elevation change signal is indeed a powerful tool to identify surge-type glaciers when it is associated to other remotely sensed observations (surface velocity, changes in crevasse pattern etc.). However, the statement made here is misleading as both Lv et al (2019) and Guillet et al (2022) also changes in surface velocity to identify surges. Furthermore, Viay and Braun (2017) focus on the early 21st century - a period of 12 years - not necessarily what could be called a 'long temporal scale'.
Reply: Thanks for reminding. We have altered the references cited here and rephased this part. After adding the additional criteria and refining the results, we have modified this part accordingly to emphasize the significance of using multiple criteria for surging glacier identification.

13. L92: As mentioned, the NASADEM used in this study originates from a reprocessing of the C-band SRTM. This data is however known for suffering from important radar penetration. This is more than likely to create spurious elevation change signal in the upper reaches of glaciers which can then lead to false identification of build-up phases, for example. This has to be addressed here, since the NASADEM is extensively used throughout this study.
Reply: Thanks for reminding. We fully agree with you that the radar penetration could result in nonnegligible biases in the elevation change observations. To address this issue, we followed a two-step procedure to reduce the radar penetration bias in the final elevation change results. First, we differenced the NASADEM with the SRTM-X DEM. The elevation differences over glacierized area will be regarded as the penetration difference between X-band and C-band. Secondly, for each 3×3 grid, we fitted a 3rd polynomial function between the penetration differences and altitudes. Then, the bias in the glacier dH results (NASADEM minus TanDEM-X DEM) caused by radar penetration was removed by taking the glacier elevation as input for the function. For the dH results calculated by differencing NASADEM and optical DEMs (HMA8m and KH-9 DEM), the penetration difference between X-band and C- band was multiplied by 2 to represent the absolute penetration depth of C-band (Fan et al., 2022; Jaber et al.,2019). Also, the uncertainties in the penetration estimation were included in the analysis of uncertainty of dH. Specific changes can be found in the 4.1 section of the revised manuscript.

14. Sec 4.3: This is my main concern with this manuscript. Surge-type glaciers are mainly identified using only surface elevation changes. To me, this approach is a bit hazardous, as many processes can cause altered glacier surface elevation changes compared to what would be deemed as "normal" or "standard". I am here typically thinking about glaciers affected by landslides for example (Hewitt, 2009, Van Wyk de Vries et al., 2022) for example. This needs to be further investigated, including the possibility of using additional criteria to validate the identified surges. Such criteria would typically be morphological (Looped moraine or changes in crevasse patterns) as I doubt of the availability of glacier surface velocity datasets for the 1970s-2000 period.

Reply: Thanks for your suggestion. We have realized that taking the elevation change pattern as the only criteria to identify glacier surges is inadequate. Following your suggestion, we have systematically refined the workflow of identifying surging glaciers. The new workflow has taken the long-term morphological changes as an additional criterion. The new workflow is as follow:

1) Firstly, surging glaciers were identified based on the "abnormal" glacier elevation changes. Through the different elevation change pattern, surging glaciers were classified in to three types (I-"verified", II-"probable", and III-"possible"). Within each observation period, each glacier was labeled with its possibility level of surging and elevation change pattern (which was missed in the presented inventory). Specific changes can be found in the 4.3.1 section of the revised manuscript.
2) Secondly, long-term Landsat series images (acquired between 1986 and 2021) were utilized to investigate the morphological change features of the three types of surging glaciers identified from elevation change. The cloudless Landsat images were merged into an animated time-series images, for the visual inspection of morphological feature changes, including terminus position change, looped moraine changes, and medial moraine changes. Also, we have assigned an index of surging possibility (I-"verified", II-"probable") for each kind of morphological changes, according to whether these changes are prominent. The crevasse changes was not included because the moderate resolution of Landsat images didn't allow the identification of crevasse changes. Specific changes can be found in the 4.3.2 section of the revised manuscript.
3) Thirdly, the inventory based on elevation change will be merged with the one based on the morphological change. After that, we performed a careful check on the identification results based on the very high-resolution images (Google/ESRI/Bing, etc.) and compared the newly derived inventory with other inventories. This procedure aims to exclude some potential false identifications, such as the severe lower-thinning in a lake-terminated glacier and remarkable surface heightening caused by nearby landslide. Specific changes can be found in the 4.3.3 section of the revised manuscript.

15. L208: Again, this statement is extremely misleading. Glaciers that are considered as "Possibly" or "Probably" surge-type cannot be considered as such. There is no clear surge signal in the elevation change of those glaciers over the studied time periods, otherwise they would be qualified as "verified". In total, you have identified 704 surge-type glaciers at most.
Reply: Thanks for reminding. We have modified all similar statements. We differentiated the identified "surging" glacier from "surge-like" glaciers in the text, and only refer to the "verified" surging glaciers when analyzing the result and making comparison with other studies.

16. L240: Please show examples of these glaciers as well as their elevation change signal for all considered periods.
Reply: We have added a figure to illustrate the elevation change maps of some identified surging glacier for all considered periods. Please refer to Fig. 6 in the revised manuscript.

17. Sec 6.2: This section is very qualitative and provides very few quantitative information. Please provide estimates of the quantities you are referencing.
Reply: Thanks for reminding. We have rewritten this part and incorporate more quantitative information from our results and other studies.

18. L308: You mention randomness, where I believe you mean variability. I do not understand the point made between L311 and 314. Please clarify.

You further mention that glacier median elevation is "irrelevant" for other topographic parameters. Again this statement is pretty hard to understand, even though I assume you here mean "correlated". A glacier's median elevation is however very correlated to its elevation range. Similarly glacier are is most likely correlated to glacier elevation range (as glaciers are relatively elongated features) so I do not really understand the point of this statement. If I misunderstood your point here please correct me and clarify.

Reply: Yes, we meant the average slope of small glaciers varies widely, and we have modified this statement.

In L311-314 of the original manuscript we tried to clarify that, for small glaciers there is no clear relationship between the length and mean slope, because the average slope of small glaciers varies widely. When analyzing the revised inventory, we set a reference group of non-surging glaciers to minimize the differences between samples of surging and non-surging glaciers. The new analysis result showed that the surging glaciers have a clear higher mean slope. We have rewritten this part according to the new analysis.

Likewise, we also tried to explain the reason why the distribution of median elevation of surging glaciers is similar to non-surging glaciers (Fig. 9e). We agree with you that the median elevation is highly correlated to the absolute elevation. However, the elevation range we mentioned means the difference between the maximum and minimum elevation, rather than the absolute maximum and minimum elevation. The median elevation is an absolute value, while the elevation range is a relative value. We have modified this statement to make it clearer.

19. Sec 6.3: This section is a bit problematic at the moment for several reasons. First, the authors propose an inventory based on only one identification criterion and compare it to the one of Guillet et al 2022, which only comprises glaciers for which two criteria of active surges could be observed. Apart from the intrinsic methodological difference, this comparison makes little sense, as the inventory proposed here also comprises glaciers for which surging behavior is uncertain.

This comparison should only target 704 glaciers in the inventory proposed here - which then lowers the difference with Guillet et al (2022) to 38. This in turns leads to several questions, most notably on the length so-called cycle of surging glaciers (assuming that there are no false positives in any of the inventories). Second, the authors mention that with 349 glaciers more (1015-666), they only observe a small (4%) increase in the glacierized area covered by surge-type glaciers in HMA and that, hence, the newly identified ones are relatively small.

This is in stark contrast with previous studies documenting surge-type glaciers as systematically bigger than non-surge type glaciers (Jiskoot et al., 2011, Sevestre and Benn, 2015, to cite a few) as well as what is predicted by the enthalpy balance theory (Benn et al., 2019) and needs further investigation.

Reply: Thanks for reminding. We have realized that the present comparison with other studies is improper. The comparison has been conducted after excluding the uncertainly identified glaciers.

During the past days, we refined our identification strategy by taking your comments into account. We have found some nonnegligible problems in our previous results that were due to the careless check of small glaciers and the underutilization of multi-temporal DEMs (KH-9 and HMA8m). The updated inventory has documented more surging glaciers with specific surging features that are mentioned in comment 14. The new inventory should be more reliable. Thanks for your constructive comments. The datasets will be shared soon after the final check and manuscript revision.

References mentioned above:

Bhambri, R., Hewitt, K., Kawishwar, P., and Pratap, B.: Surge-type and surge-modified glaciers in the Karakoram, Scientific Reports, 7, doi:10.1038/s41598-017-15473-8, 2017.

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

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.

Reply to Reviewer2:

The authors have investigated glacier elevation changes in High Mountain Asia (HMA) derived from digital elevation models (DEMs) acquired over a period of 50 years to obtain information about surge type glaciers. For this purpose they make use of the usually very typical elevation change pattern that result from the mass transfer of a reservoir zone to the glacier terminus during a surge and the subsequent down-wasting of the tongue and build-up of new mass after a surge. Thereby, the observed elevation changes usually reach several dozens of metres so that the obtained signal is generally much higher than DEM uncertainties. The new assessment is then analysed in terms of topographic glacier characteristics, to extract possible differences between surge-type and other glaciers.

Major comments:

1. "As a general feedback to the terminology, I would say this (and several of the recently published previous studies) presents an inventory of surging glaciers rather than surge-type glaciers. The authors look at real surges that happened rather than investigating surface features (looped moraines etc.) that hint to possible (unobserved) previous surges. This differentiation of terminology should be clearly stated and applied here as it could explain a part of the differences among different inventories."

Condensed summary: Please use proper terminology, distinguishing surging from surge-type

Reply: Thanks for reminding. We have carefully read the previous studies (Goerlich et al., 2020 and others) and learned the definition difference between surging and surge-type glaciers. We agree with you that our study aiming to present a surging glacier inventory. We have modified all related statement in the text and added a brief definition to distinguish surging glaciers from surge-type glaciers. Also, to avoid similar confusion, we have classified our identified results into the "surging" and "surge-like" groups.

2. "I think this is about the third or fourth study creating an inventory of surge-type glaciers in HMA, so there is obviously a need for such information. It also seems that it is important which team identified the largest number of 'new' surges. However, as for the previous studies using the RGI6 to mark these glaciers, there is a severe backdrop of the inventory presented here: The authors have not separated the surging glaciers from their trunk glaciers they are connected to in RGI6. This might only be an issue for a smaller portion of glaciers (a few dozens?), but it has to be done. Now the really huge glaciers Baltoro, Biafo, Fedchenko and Siachen are surge-type glaciers although they are not. They are just connected to often much smaller tributaries that have surged. To study these, they have to be separated, maybe just with a straight line to start with (and in the accumulation area). As the authors correctly describe (L325ff), it is clear that in many cases a separation in the ablation region will be difficult, as some surging (tributary) glaciers might contribute substantially to the flow of a trunk glacier or even form a joint tongue with other tributaries. I suggest skipping these complicated cases and focus on the clear ones, e.g. separate Bivachny from Fedchenko, Drenmang and Chiring from Panmah, Maedan from Chiring and Panmah from Choktoi with a straight line."

Condensed summary: Please separate tributaries connected to a larger trunk glacier to the extent possible.

Reply: Thanks for your suggestion. We have noticed that the tributary or tributary-induced surges would bring biases to the present inventory and result in misleading. To address this problem, we have separated the surging tributaries from the stable trunks following two criterions: first, the dividing line of contrasting elevation change locates within this tributary; second, the volume of mass contributed by this tributary to the glacier trunk is relatively small. The separation was completed by manual editing. We have found that many large glaciers are not surging glaciers, and

have found 175 tributary surges in 86 glacier complexes. This procedure was completed before the generation of the final inventory.

3. This separation is not only important for glaciologic studies, but also because the authors analyse here topographic characteristics, size being one of it. When the very large glaciers listed above are in the sample instead of the 10 to 100 times smaller glaciers that really surged, it is not surprising that the result is always that the surge-type glaciers are (on average) larger and longer than the other glaciers. Although this general result might not change after separation, the proper separation is mandatory for a sound assessment of related characteristics. So there is no way around it. A different issue but leading to the same bias is the use of RGI6 for the analysis. There are many smaller glaciers missing in RGI6 and a large number has been manually digitized to the effect that partly huge areas with rock outcrops are included in the glacier outline. This leads to glacier extents that can be too large by 50% or more. Please use for the analysis the outlines provided by the GAMDAM2 inventory(doi.org/10.5194/tc-13-2043-2019).
Condensed summary: Please use GAMDAM2 instead of RGI6.
Reply: Thanks for reminding. The tributary surges have been separated from the glacier complexes in the updated inventory, and the topographic characteristics of surging glaciers were reanalyzed based on the new inventory.

We agree with you that the RGI6 inventory has some deficiencies in glacier number and outlines. We have recompiled the surging glacier inventory based on GAMDAM2 inventory from the very beginning of DEM differencing. Since the GAMDAM2 inventory does not includes the geometric and topographic parameters of glaciers, we have firstly calculated the geometric and topographic parameters of each glacier.

4. “I had a look at the outlines presented here and compared them to the inventories by Bhambri et al. (2017) for the Karakoram, Goerlich et al. (2020) for the Pamir and Guillet et al. (2022) for entire HMA. Of course, there are differences between the inventories due to different methodological approaches (elevation changes, velocities, length changes), time frame considered or inclusion of surge-type rather than surging glaciers (see above). However, it is argued that the inventory presented here should be more complete as it considers a longer time frame for the analyses. As described in Section 6.3 and confirmed by an overlay of datasets, many glaciers that have been identified as surging in the Guillet inventory are not included here. The authors explain this difference by possibly diluted elevation differences when observed over a longer period of time. I can live with this explanation, but how can this inventory then be more ‘complete’? Completeness is mentioned as a key argument for this new survey at many places (L9, 11, 44, 66 and 73). But why should I favor this inventory over the other when obviously so many ‘verified’ surging glaciers are missing here?
To get the dataset presented here more complete, the authors should at least perform a back check for the glaciers classified as surging in the Guillet et al. inventory but not in this one. A comparison to very high-resolution imagery (e.g. ESRI Basemap) sometimes shows impressively surging glaciers or distorted moraines at these locations. Also a visual inspection of the KH-9 images might reveal that glaciers have surged back then. Some more details about why these glaciers have been missed would be helpful to provide a better insight into the limits of the various approaches. Vice versa, glaciers identified as surge-type here but not by Guillet at al. should also be double-checked. When mass balances are slightly positive and surge marks are missing, it is also possible that glaciers just advance.”
Condensed summary: Please double-check and correct the present inventory with Gilles et al. and satellite images
Reply: Thanks for your suggestion. We have refined our workflow for identifying surging glaciers by introducing the morphological feature change as an extra criterion. Firstly, the surging behavior were identified through the multi-temporal and multi-source elevation change maps covering periods of 1970s-2000 and 2000-2020. In this stage, the “surge-like” glaciers were classified with three level of possibility indicators. After that, we utilized the

long-term Landsat series images (1986-2020) to investigate the morphological feature changes of the identified glaciers. We will identify the changes of terminus position, looped moraine, and medial moraine. Also, we will assign a possibility index regarding the strength of morphological feature changes (e.g. "I" for obvious change and "II" for slight change). Then the inventory based on dH will be merged with the one based on morphological change. Finally, we have utilized the very high-resolution images (Google/ESRI/Bing, etc.) to check the updated inventory. This procedure aims to exclude the false identifications, such as the severe lower-thinning in a lake-terminated glacier.
We have compared the new inventory with the inventory of Guillet et al. (2022). The differences in the compared inventories were carefully double-checked. For glaciers included in others inventory but not in ours, we performed a back check through our observations, and this added about 20 surging glaciers that were missing by careless. For glaciers in our but not in others inventory, similar operations were conducted with the help of visual inspection on very-high-resolution images. Specific changes can be found in section 4 of the revised manuscript.

5. "Related to the above, the criteria presented for surge identification in Section 4.3 seem to be unbalanced. For example, terminus thickening is included as criterion I-1 but thinning is only in class IV-1, i.e. strong (post-surge) thinning does not have the same weight as thickening. Given that glaciers showing only thickening might just advance rather than surge (creating false positives), I would even argue that strong thinning (see L35) is the better indicator and should at least also be listed in category I. For example, in Figure 2a one can see the strong down-wasting of both Western Kunlun glaciers (just below the last zero of the '2000' annotation) and in Figure 2b the re-advance of its eastern branch, whereas the western branch is still thinning. Indeed, this part is now also surging again and the assignment 'non surge-type' is obviously wrong."
Condensed summary: Please shift class IV-1 'only down-wasting' to class I-4 and re-check then classes I-1 & I-4
Reply: Thank for reminding. We have recalculated the changes in glacier surface elevation and refine the surge identification criterions following your suggestion. The identification criterion based on the elevation change results now have been changed into:
I) "verified":

- a) obvious thickening in lower reaches (e.g. +30 m);
- b) contrasting upper-thinning (e.g. +20 m) and lower-thickening (e.g. +20 m);
- c) contrasting upper-thickening (e.g. +20 m) and lower-thinning (e.g. -30 m);
- d) severe thinning in the lower reaches (two time stronger than that of the normal glaciers, or comparable to the ablation of adjacent "verified" surging glaciers);

II) 'probable':

- a) moderate upper thinning (e.g. -15m) and lower thickening (e.g. +15m);
- b) only the moderate thickening in the middle reaches (e.g. +15m);

III) 'possible':

- a) only moderate thickening at the terminus (e.g. +15m);
- b) only strong thinning in the lower reaches (one time stronger than adjacent normal glaciers).

Since serious melting can also occur in lake-terminated glaciers, we have removed the lake-terminated glaciers from class "III-b".

6. "Finally, I suggest removing the climatic interpretation in L342 to 366. We have recently learned that ESSD will refocus on publishing dataset descriptions. This part (although interesting) goes clearly far beyond this. Maybe you can just cite here some studies looking at the interpretation in more detail. Below is a condensed summary of the general points above."
Reply: Thanks for reminding. We have deleted the climatic interpretation and related discussion here.

Specific comments:

7. L35: 'melts fast' this is certainly correct in a relative sense, but still it might take 20 to 30 years or even longer. So maybe write 'relatively fast'.

Reply: Thanks for reminding. We have rephrased this statement following your suggestion.

8. L41: 'However, a glacier surge' (or use plural: glacier surges are')

Reply: We have rephrased this statement following your suggestion.

9. L43: When speaking of contemporary glaciers, I suggest writing 'glacier hazards' or maybe even better 'glacier-related hazards'

Reply: The terminology has been revised following your suggestion.

10. L44: Glacier-related hazards are certainly an important point for studying surge-type glaciers, but an inventory has no prognostic characteristics and does thus not help to solve the problem. By knowing where these glaciers are, one does not know where the next hazard will occur. I would thus better argue here with the importance of having such an inventory when studying climate change impacts on glaciers, e.g. mass balances or length changes. For such studies it is of high importance to distinguish the two samples.

Reply: Thanks for reminding. We have rewritten this part following your suggestion. The revised text has emphasized the significance of surging glacier inventory on the regional mass balance studies, as well as the glacier surging dynamics studies.

11. L67/70: Both studies identified surging glaciers (i.e. surges were observed) rather than surge type glaciers (which might have surged in the past). Please adjust the terminology.

Reply: Thanks for reminding. We have revised the terminology.

12. L73: I would write 'In this study'

Reply: We have revised this sentence following you suggestion.

13. L77/78: Such analyses are not allowed in ESSD.

Reply: Thanks for reminding. We have noticed the requirement of ESSD publishment. We have removed the unnecessary analysis and extended discussions. Only the statistical comparisons between the geometric characteristics of surging and non-surging glaciers were conducted in the revised manuscript.

14. L124: Please use GAMDAM2 instead, RGI6 has quite a lot of issues in this region.

Reply: Thanks for your suggestion. We have replaced the RGI6 with GAMDAM2 in all the processing steps, as well as in the updated inventory.

15. L172: Please also explain in this section how glaciers that are just advancing were distinguished from glaciers that are surging (when criterion I-1 is used).

Reply: Thanks for reminding. As we mentioned above (replies to comments 4 and 5), we have established a new suit of identification criterion which includes the different strength levels of elevation change and morphological feature changes. Referring to previous studies (Lv et al., 2020; Goerlich et al., 2020), we think the advancing glaciers usually have such features: 1) only thickened in a small area near the glacier terminus, without contrasting upper thinning; 2) the advancing distance is relatively short. These features are corresponding to the "III-a" type of elevation change,

and “II” type of terminus advance. Therefore, if a glacier only shows these two kinds of changes, it will be deemed as an advancing glacier, rather than a surging glacier. We have added this part to Section 4.3.3 of the revised manuscript.

16. L182: Please shift the class IV-1 ‘Strong thinning only’ to class I (e.g. as I-4) and get the currently surging west Kunlun Glacier included.
Reply: Thanks for your suggestion. We have refined the surge identification criterion following your suggestion. Specific changes can be found in Section 4.1 of the revised manuscript.

17. L218: Please revise Section 5.2 after small (part-time) tributary glaciers have been separated from the much larger trunk glaciers. Neither Fedchenko, nor Siachen, Baltoro or Biafo (and several others) are of surge type.
Reply: Thanks for reminding. We have generated an updated surging glacier inventory with tributary surges separated from the glacier complex, and we have reconducted the statistical analysis by only taking the ‘verified’ surging glaciers into account (as suggested by Review 1).

18. L242: See comment to L218, this applies also to Section 5.3
Reply: Thanks for reminding. We have reconducted the analysis as suggested.

19. L296: See comment to L218
Reply: Thanks for reminding. We have reconducted the analysis as suggested.

20. L298: This might change a bit when separating small surge-type tributaries from their trunk glaciers. Please get at least the largest ones out of the sample.
Reply: Thanks for reminding. This part has been revised accordingly during revision. The surging tributaries were separated from the glacier complex with a unified criteria (see reply to comment 2).

21. L332: Yes, fully agreed, it can be difficult. But it has to be done anyway. It makes no sense to present a topographic analysis for the glacier complex when it is 100 times larger than the glacier that is actually surging.
Reply: Thanks for reminding. We have separated the surging tributaries from the glacier complex with a unified criteria in the updated inventory, please see reply to comment 2 for details.

22. L356/7: I would not draw such a conclusion when surge cycles are longer than the observation window. This observation can still be by chance.
Reply: Thanks for reminding. We have removed this conclusion and related discussion.

23. L396/397: Please clearly separate surge-type glaciers from glaciers with observed surges to get the numbers correctly interpreted.
Reply: Thanks for reminding. We have rechecked the Goerlich’s inventory and only taken the identified surging glaciers for comparison.

24. L400/1: I do not understand this calculation: When Goerlich et al. reports 176 surging (not surge type!) glaciers and the present inventory includes 156 of them, why is this 126 more rather than 20 less? Please better explain what has been calculated and compared here.
Reply: We meant 156 of 176 surging glaciers in Goerlich et al.’s inventory were included by our presented inventory.

In Pamir, our inventory recorded 282(200+67+15) surging and surge-type glaciers, and 126 of them were not included by Goerlich et al.'s inventory.
However, the inventory has been updated following your and the other reviewer's comments. Now we have reconducted the comparison, and the differences were stated in a clearer way.

25. L426: Please provide the final selection of glaciers also as point data and in shape file format.
Reply: Thanks for reminding. We have uploaded shapefile of the identified surging glaciers as point data.

26. Figs. 2 & 5: The orange to red colours are too close to properly separate them. Please use more different colours.
Reply: Thanks for reminding. We have revised these two figures following your suggestion.

27. Fig. 3: The circles can be a bit smaller to see more details
Reply: Thanks for reminding. We have decreased the circle size and added a stroke to make Fig.3 more readable.

28. Fig. 5: Please revise after glaciers have been separated. Fedchenko, Biafo, Baltoro and Siachen (among many others) are not surge-type glaciers. This is highly misleading information that can not be used for anything.
Reply: This figure has been revised according to the updated inventory.

29. Figs. 6 and 7: Please use more distinct colours, they are too close.
Reply: Thanks for reminding. We have modified both figures with more distinct colors.

30. Fig. 9: Make circles smaller to see something. The foreground data could also be dots only.
Reply: Thanks for reminding. We have revised this figure by reducing the circle size and using more distinct color.

References mentioned above:

Bhambri, R., Hewitt, K., Kawishwar, P., and Pratap, B.: Surge-type and surge-modified glaciers in the Karakoram, Scientific Reports, 7, doi:10.1038/s41598-017-15473-8, 2017.

Goerlich, F., Bolch, T., and Paul, F.: More dynamic than expected: an updated survey of surging glaciers in the Pamir, Earth Syst. Sci. Data, 12, 3161–3176, doi:10.5194/essd-12-3161-2020, 2020.

Lv, M., Guo, H., Yan, J., Wu, K., Liu, G., Lu, X., Ruan, Z., and Yan, S.: Distinguishing Glaciers between Surging and Advancing by Remote Sensing: A Case Study in the Eastern Karakoram, Remote Sensing, 12, 2297, doi:10.3390/rs12142297, 2020.