Answer to the referee's comments

Anonymous Referee #2

We would like to thank referee #2 for the very careful reading of our manuscript and the numerous and helpful comments. The referee's detailed comments are addressed below (blue colored).

The referee is right to point out that a clarification of the scope of the manuscript is needed. Our intention for this paper is to examine glacier changes in the Karakoram with the use of multi-mission satellite data (multispectral and SAR data). Hence, we suggest to exclude the sections about TanDEM-X derived volume changes and parts of the ice dynamics that are not directly related to surge-type dynamics. We now focus on the investigation of termini position changes over a 36 year period (1976 to 2012) and provide ice velocity coverage for the entire region as well as for surge-type glaciers. In accordance with the referees' wishes, we will change the classification of 1219 glaciers into four categories (surge-type, advancing, retreating and stable glaciers). The analysis in this respect has already been done. In that way, existing inventories on surge-type glaciers can be updated (e.g., Barrand and Murray, 2006; Copland et al., 2011; Hewitt, 1998). We appreciate and refer to these previous studies as before. 91 glaciers are known to have shown an active phase of a surge one or various times since the 1860s (Barrand and Murray, 2006; Copland et al., 2011; Quincey et al., 2011; Hewitt, 1969, 1998, 2007; Kotlyakov et al., 2008; Mason, 1931). We identified ten more glaciers, which showed surge-type behavior during the observation period 1976 to 2012 that were not classified as such before. Those glaciers are mostly located in the Sarpo Laggo Basin and the Shaksgam Valley. In 2012, ten of the 101 surge-type glaciers were still in the active phase. Surge-type glaciers, which were previously unknown, have been identified by investigating termini position changes between 1976 and 2012, surface velocities, surface features, and/or terminus thickening.
Additionally, we would like to show the regional distribution of each glacier class across the Karakoram Range and compare dimensional glacier characteristics like glacier length, glacier area, mean slope along the main glacier branch, and mean elevation. Glacier surface velocities derived from different SAR sensors (ERS SAR, ENVISAT ASAR, ALOS PALSAR and TerraSAR-X) for different years (1992, 1993, 2003, 2006 to 2013) complement a comparison of each glacier class, and indicate increased surface velocities during the active phase of a surge event. The combination of multi-temporal ice velocities and an improved, Karakoram-wide inventory including glacier termini positions changes and statistics provide in our view relevant new observational information on the current state of glaciers in the Karakoram Range.

OVERVIEW This paper provides a variety of data on the velocity patterns, length changes and volume changes of glaciers across the Karakoram Himalaya. The derived datasets are impressive, but unfortunately they are currently poorly presented due to two fundamental problems: 1. No separation is made between surge-type glaciers versus non surge-type glaciers. This means that it is unclear as to whether the observed changes are due to some kind of internal glaciological process (i.e., surging), or are due to external climate forcing. Without this separation, the meaning and causes of the changes cannot be properly understood. 2. It is unclear whether this study is a methodological one about the use of SAR data, or whether it is a glaciological study about ice dynamics and recent changes. At the moment the focus is ambiguous, which results in the paper not doing justice to either of these tasks. The underlying data appears to be solid, so choosing one of these goals would really help to strengthen it (or even splitting the paper into two separate studies). Without a central goal, much of the paper currently reads as a description of somewhat random facts and figures about Karakoram glaciers. The findings aren't particularly well referenced to existing literature (many key papers are missed, some of which almost exactly duplicate what has been done here – see details below), and few meaningful conclusions can be drawn from the data. The paper requires a complete reworking to put it in a publishable state. The detailed comments below address some of the major concerns, but the next version of the manuscript will need to be in a completely different form to be acceptable for publication.

DETAILED COMMENTS

P4066, L2-L4: the statement here that 'advancing terminus position or surging behaviour' is rare for glaciers outside of the Karakoram is incorrect. Glacier advances due to surging are currently found in many regions around the world (e.g., Yukon-Alaska, Canadian High Arctic, Svalbard, Greenland), even though these regions are experiencing long-term negative mass balances and overall retreat. This highlights the need for the paper to distinguish surging from non-surging glaciers.
The referee is right to point out that glacier surges are also known outside of the Karakoram Range, e.g., Yukon-Alaska, Canadian High Arctic, Svalbard, Greenland. We will include this in the introductory part of a revised manuscript (see below).

A native English speaker needs to review the text for language. There are several places where wording is awkward or difficult to follow. For example, line 6 in the Abstract states that 'changes are mapped in addition', and line 10 states that 'data allows to investigate', both of which are linguistically incorrect. The Conclusions are also not very well worded.
We will have again a native speaker revise a new version of the manuscript and reword in particular the phrases criticized.

P4067, L5-9: the statement that 'glaciers in the Karakoram are displaying controversial behavior' needs to be better worded and described. How exactly is their behaviour controversial? You need to better describe what individual studies have found about mass balances in this region (e.g., provide specific numbers), separate from a description of surging glacier activity.
We thank the referee for that useful advice. In the following, we rephrased the introductory part of the manuscript and suggest the following wording in a new version:
"Meltwater from snow cover and glaciers in high mountain areas is a major source for downstream water resources (Gardner et al., 2013; Kaser et al., 2010) . Glaciers in the Karakoram and western Himalaya contribute to the discharge of the Indus River and its tributaries, which in turn secure 90% of Pakistan's food production and 13 gigawatts of hydroelectricity (Cook et al., 2013; Qureshi, 2011). The amount of meltwater originating from the mountainous catchment areas is 1.5 times greater than the discharge generated downstream along the Indus (Immerzeel et al., 2010). Hence, well-founded knowledge of the extent and nature of changes in glaciers supports downstream hydrological planning and water resource management.
Investigations of glacier changes across the Hindu Kush-Karakoram-Himalaya mountain range exhibited retreating glacier fronts since the mid-19th century (Bhambri et al., 2013; Bolch et al., 2012; Scherler et al., 2011) and negative mass balances for the entire mountain range of -0.21±0.05m yr^{-1} water equivalent (w.e.) between 2003 and 2008 (Kääb et al., 2012), and -0.15±0.07m yr^{-1} w.e. for the period 1999 to 2011 (Gardelle et al., 2013). However, mass balances for the Karakoram Range are found to be less negative or even positive (2003-2008: -0.03±0.04m yr^{-1} w.e. (Kääb et al., 2012), 1999-2011: 0.10±0.16m yr^{-1} w.e. (Gardelle et al., 2013), 2003-2009: -0.10±0.18m yr^{-1} w.e., including the Hindu Kush mountains (Gardner et al., 2013)). Additionally, stable and advancing termini positions in the Karakoram have been found by various authors (Bhambri et al., 2013; Bolch et al., 2012; Hewitt, 2005; Scherler et al., 2011). Positive trends in glacier mass balances and termini positions are attributed to decreasing mean summer temperatures as well as increasing precipitation in winter since the 1960s (Archer and Fowler, 2004; Fowler and

Archer, 2006; Shekhar et al., 2010), and the high altitude distribution of glaciers in the Karakoram (Hewitt 2005, 2014). Moreover, the Karakoram hosts a high number of surge-type glaciers. Glacier surges in the Karakoram have been known since the 1860s (Barrand and Murray, 2006; Copland et al., 2011; Hewitt, 1969, 1998, 2007; Kotlyakov et al., 2008; Mason, 1931), with a marked increase in surge activity in recent years (Copland et al., 2011). Outside of the Karakoram, surge-type glaciers are identified e.g., in the Alaska-Yukon, the Canadian High Arctic, Svalbard, Iceland, and the Russian High Arctic (Cuffey and Paterson, 2011). Surge-type glaciers are identifiable by distinctive surface features, such as looped and folded medial moraines, ice foliation, crevassed surfaces, and/or advancing glacier tongues (Barrand and Murray, 2006; Hewitt, 1969; Meier and Post, 1969). During the active phase of a surge, surface velocities increase by at least one order of magnitude within a few months or up to several years in comparison with non-surging glaciers (Meier and Post, 1969). Moreover, the glacier terminus steepens and thickens throughout a surge event as ice from the reservoir area is shifted towards the receiving area (Clarke et al., 1984; Meier and Post, 1969). The rapid advance of a glacier tongue may dam river valleys which leads to the formation of lakes. Failure of the ice and/or moraine dams, may result in glacial lake outburst floods (GLOFs). Seventy-one GLOFs are reported in the Upper Indus Basin since the early 19th century (Hewitt, 1982, 2014; UNDP, 2013).
The present study investigates the temporal variability and spatial distribution of surge-type, advancing, stable and retreating glaciers across the Karakoram Range. Existing surge-type glacier inventories (Barrand and Murray, 2006; Copland et al., 2011; Hewitt, 1998) are updated and refined using optical satellite imagery, and a detailed analysis of termini position changes of surge-type, advancing, stable and retreating glaciers since 1976 is carried out. The inventory is fed with dimensional and topographic characteristics of each glacier class, and are compared to each other. A complete coverage of glacier surface velocities is achieved from repeat, very high-resolution Synthetic Aperture Radar (SAR) imagery as a composite in the period 2007–2011. In several case studies, we demonstrate the potential of very high-resolution SAR time series to map changes in ice flow for very small surge-type or advancing glaciers, and complement this analysis with products based on archived scenes from ERS SAR and ENVISAT ASAR. High surface velocities close to the glacier snout during the active phase of a surge event offer possibilities to identify surge-type glaciers. “

P4067, L20-22: wording here needs to be clarified. It’s not the rapid advance of a glacier tongue during a surge that causes a GLOF per se. Rather, an advance of a glacier tongue can block rivers, which in turn can cause the formation of lakes. GLOFs then occur when these lakes are released, typically after the surge has terminated.
We rephrased this sentence according to the referee's suggestion. It reads now as follows:
“The rapid advance of a glacier tongue may dam river valleys, which leads to the formation of lakes. Failure of the ice and/or moraine dams, may result in glacial lake outburst floods (GLOFs).”

P4067, L24-28: the wording here is confusing. In some places (e.g., start of L25), glaciers are classified together whether they are surging or advancing, but in other places (e.g., L28) ‘advancing termini’ and ‘surges’ appear to be classified separately. This leaves the reader with a confused understanding of what the paper is trying to measure.
In order to clarify the scope of the paper and to improve the glacier database used in the study, the authors decided to group the inventory of 1219 glaciers into the categories:

- surge-type glaciers (which surged one or various times since the 1860s)
- advancing glaciers
- stable glaciers and
- retreating glaciers

As a result, we observed that out of 1219 glaciers, 101 were surge-type glaciers, 56 were advancing glaciers, 969 glaciers showed stable front positions and 93 glaciers revealed retreating tongues during the observation period 1976 to 2013. Within the inventory of surge-type glaciers, 91 glaciers were in accordance with the surge-type glaciers mentioned in the papers of Copland et al. (2011) and Quincey et al. (2011). However, we found ten more glaciers, which showed an active phase of a surge in the Karakoram Range during the observation period. Those glaciers are mostly located in the Sarpo Laggo Basin and the Shaksgam Valley (as was shown in Fig. 7). They indicate remarkable frontal advances of up to ~3.5 km during a five year time span, increased surface velocities close to the glacier snout, looped and folded moraines and terminus thickening. Glaciers are classified as retreating, if a retreat > 60m happened during the study period. Digitized retreats should have been larger than the uncertainty range of ~60m (see comment below). According to the renewed inventory, we updated the comparison of glacier characteristics like glacier length, area and slope in section 4.1, and added a comparison of the elevation ranges the glaciers extent over.

P4068, L3-5: the statement that high surface velocities close to the glacier snout can offer a way to identify surging/advancing glaciers is only true for surging glaciers. Non surge-type glaciers can advance with little to no change in their terminus velocity (e.g., due to a decrease in surface melt rate). This text would also be more appropriate in the methodology, rather than the introduction.
We will change the phrasing of this sentence to comply to the reviewer comment and move it to the methodology section.

P4068, L26: I don't agree that 'heavily crevassed icefalls' are particularly abundant in the Karakoram. For example, it's possible to walk along the length of many of the large glaciers (e.g., Baltoro, Biafo) without encountering any significant icefalls.
We will remove that sentence (P4068 L25-26) according to the referee's suggestion.

P4070, L3-4: In this sentence do you mean that initial outlines of all glaciers in your study were determined from the Randolph Glacier Inventory? As far as I know, the RGI doesn't distinguish between surging/advancing and non-surging/normal glaciers, so you need to clearly state how you distinguished between them in your study.
The reviewer is right to point out that we need to clarify more how we distinguished between surge-type and non-surging glaciers. We will consider this in the methodological part.
We used the glacier outlines from the RGI 2.0 as an initial base. The glacier polygons were improved manually and afterwards, we decided for each glacier polygon whether it is a surge-type glacier or not. For the identification of surge-type glaciers we used exiting inventories (Barrand and Murray, 2006; Copland et al., 2011; Hewitt, 1998). Surge-type glaciers, which were previously unknown, have been identified by investigating termini position changes between 1976 and 2012, surface velocities, surface features, and/or terminus thickening. We will address this procedure in the methodological part of a revised manuscript.

P4070, L22-24: This sentence describes the fundamental problem with this study. You need to distinguish between surging and advancing glaciers to make any meaningful conclusions about the causes of their changes. The argument that Landsat imagery is insufficient to identify surge-type glaciers conflicts with numerous other studies that have used it both in the Karakoram (e.g. Copland et al. 2011, Barrand and Murray 2006) and elsewhere (e.g., Grant et al., 2009, J Glac, 55, 960-972). There is also excellent imagery available in Google Earth, for example, that can help with their identification, as well as high resolution Declassified Intelligence Satellite Photography of the Karakoram since the 1960s. The existing inventory of Copland et al. (2011) can also assist with the identification of surge-type glaciers in this study.
We agree with the referee that it is necessary to separate surge-type from advancing glaciers. This critics have been addressed by revising the classification as stated in the beginning of the

comments. In a revised manuscript, we will update the glacier inventory previously used and can now provide four glacier classes including 1219 glaciers: surge-type, advancing, retreating and stable glaciers (see above). We did not want to understate the use of Landsat imagery for glaciological purposes. We actually analyzed time-series of Landsat imagery to determine glacier advances, however, surface features like e.g., crevasses, are sometimes hardly identifiable for very small glaciers (i.e., <10km in length, <300m wide). We also used Google Earth to check on termini advances or surface features, although this was not explicitly mentioned. Unfortunately, high resolution time-series for the past 30 years are very rare, and also Google Earth does not cover this region backward in time with such imagery. We also acknowledge that there is high-resolution declassified data from the 1960's – this is certainly another snapshot of high-resolution imagery. However, use for exact outlines would require orthorectification, which was beyond our study purpose. All surge-type glaciers identified in this study were compared and complemented with those mentioned in Copland et al. (2011) (P4070 L26-27). We will clarify the criteria and procedure in the methodological part (see above).

P4070, L11: 'treating them' should 'treatment of them'
This sentence will be changed accordingly.

P4071, L3: A discussion and/or analysis of the accuracy of the SRTM DEM in the Karakoram would be useful as there is the potential for the DEM to be quite inaccurate in areas of high relief. This is already partly mentioned on P4074, L25, but needs to be expanded upon and the influence of these biases on your derived terrain variables should be discussed.
We will expand the discussion of the accuracy of the SRTM DEM and its influence on the derived topographic variables in a revised version.

P4071, L15: This methodology sounds very similar to that of Kienholz et al. (2013, J Glac, 59, 925-937), so that paper should be referenced here
The methodology used here is now published in Kienholz, C., J. L. Rich, A. A. Arendt, and R. Hock (2013). A new method for deriving glacier centerlines applied to glaciers in Alaska and northwest Canada. The Cryosphere Discussions 7 (5), 5189-5229. We use this reference in a revised manuscript.

P4071, L28: 'this statistics' should be 'these statistics'
We are sorry for this inadvertence.

P4072, L6-L8: the wording here makes it appear that identifiable surface features (e.g., crevasses) must be present for your intensity tracking process to work. However, if this were true it wouldn't be possible to determine velocities in most snow-covered, featureless accumulation areas. I would suggest rewording this section to make it clear that only a unique speckle pattern is required for this technique to work, but that this doesn't necessarily equate to distinctive surface features visible to the naked eye (as already partly addressed on P4073, L5).
We are sorry for that ambiguous wording. Intensity tracking depends on detectable structures in both images, which could be surface features or the speckle pattern. We will adapt the wording accordingly

P4073, L20: more information about the error analysis would be useful, as this is crucial to provide confidence in the velocity results. For example, were errors consistent at different elevations? On slopes with different angles? In imagery acquired with different repeat cycles? A listing of the errors associated with each data source would be useful to add to Table 1, for example.
The reviewer is right that the confidence in the velocity products is crucial. We already provided

overall errors for our measurements, but are happy to give a more detailed analysis of errors. In the table below (to be included in a revised version or as a graph) we provide error estimates in regard to sensor and repeat cycle. However, one should be aware that these values also include aspects of resolution, wavelength and hence stability of target response, orbit and viewing geometry as well as image to image co-registration that cannot completely be separated from the acquisition time alone. We will consider analyzing the errors in respect to elevation, slope and local incident angle, however, we would also like to remind, that both reviewers criticized that we should focus the paper. While we see the necessity of reliable results and error analysis, providing extensive analysis on errors of a meanwhile standard technology, would shift again the focus of the paper to a more methodological study that is not intended! We suggest that this indeed very interesting aspect should be addressed in a separate study focusing exactly on this topic and possibly include a proper sensor intercomparison.
Uncertainties in the derived flow fields were estimated by determining displacement values over non-moving terrain (e.g., bedrock) after removing the global offset of the scenes. In order to receive sample points for static areas, we excluded snow and ice covered areas, glaciers as well as river beds and terraces. For every displacement field 10.000 random samples were chosen to determine the velocity error. The error values shown below represent the mean of the uncertainties + standard deviation of each sensor (Table 1).
The magnitude of the tracking errors is influenced by various sensor system, processing and environmental factors. A crucial part in feature tracking is image co-registration, during which the images are matched to sub-pixel accuracy on the basis of stationary areas. The procedure is hampered due to changing surface patterns through time and space. In case of fast-moving, e.g., glaciers in the active surge phase, tracking results with short temporal baselines (e.g. TerraSAR-X SM) provide the highest accuracies. Due to the high number of scenes we cannot address this individually for each image pair within the paper itself, however, we are happy to give a more detailed error analysis in the Supplement Material, including the mean error plus standard deviation for each image pair and sensor, overall tracking errors, and co-registration errors.

Table 1. Mean uncertainties of displacement fields calculated over non-mowing terrain given for each sensor (in cm day^{-1} ± 1 standard error, s.e.).

Sensor	**Repeat cycle [days]**	**Uncertainty [cm day^{-1} ± 1 s.e.]**
TerraSAR-X SM	11/22/143	1.3±3.7
ALOS PALSASR FBS	46	2.9±9.0
ENVISAT ASAR	30*/35	2.2±3.0
ERS-1 SAR	35	6.1±9.0

*30 day repeat cycle since November, 2010.

P4074, L12-L13: the wording ‘despite very less’ doesn’t make sense as written
The section about TDX derived volume changes will not be included in a revised manuscript. However, this sentence would read as follows: „The phase noise in the interferogram, although very less, was then filtered out by using a Goldstein filter with an exponent value of 0.4 (Goldstein and Werner, 1998).

P4075, L11: It would be useful to provide an assessment of whether any new surge- type glaciers have been identified in this study, compared to those identified in previous studies such as Copland et al. (2011)
In our study, we found ten more glaciers which showed surge-type behavior and were not classified as such before. Those glaciers are characterized by rapid termini advances in comparison to

surrounding glaciers and increased surface velocities. We will provide these findings in a revised version.

P4076, L10: References to many key papers concerning previous velocity mapping and glacier studies in the Karakoram are missing. For example, Jiang et al (2012) used ALOS PALSAR data to map the motion of many of the areas discussed in the present study: Jiang et al. 2012. Analyzing Yengisogat Glacier surface velocities with ALOS PALSAR data feature tracking, Karakoram, China. Environmental Earth Sciences, 67, 1033-1043.
We thank the reviewer for this advice and will include this reference accordingly.

. . .indeed, some of their figures almost exactly duplicate the ones shown in this study (e.g., Fig. 7a). Reference to Quincey et al. (2009) is also missing, which discusses connections between variations in mass balance short-term changes in velocity: Quincey, D.J., Copland, L., Mayer, C., Bishop, M., Luckman, A. and Belo, M. 2009. Ice velocity and climate variations for Baltoro Glacier, Pakistan. Journal of Glaciology, 55(194), 1061-1071
Reference to Scherler and Strecker (2012) should also be included: Scherler, D. and Strecker, M.R. 2012. Large surface velocity fluctuations of Biafo Glacier, central Karakoram, at high spatial and temporal resolution from optical satellite images. Journal of Glaciology, 58, 569-580.
Mayer et al. (2006) also discusses short-term variations in velocity: Mayer, C. et al. 2006. Glaciological characteristics of the ablation zone of Baltoro glacier, Karakoram, Pakistan. Annals of Glaciology, 43, 123-131.
And Ken Hewitt has recently published a book on Karakoram Glaciers that might provide a useful reference for background material: Hewitt, K. 2014. Glaciers of the Karakoram Himalaya. Glacial Environments, Processes, Hazards and Resources. Springer (see http://link.springer.com/book/10.1007/978-94-007-6311-1//page/1)
We will include these references in a revised manuscript at the specific sections. Luckily, Kenneth Hewitt's book is now available.

P4076, L20 to P4077, L23: The discussion of morphometric and environmental influences on glacier surging is unfortunately almost meaningless since surge-type glaciers have not been separated from non surge-type glaciers in this study. This also makes comparison with Barrand and Murray (2006) problematic, since they did properly separate surge-type from non surge-type glaciers in their study. Once surge-type glaciers have been separated, a more robust analysis of the controls on glacier surging could be undertaken using multivariate logit models such as those used by Jiskoot: Jiskoot, H. et al. 2000. Controls on the distribution of surge-type glaciers in Svalbard. Journal of Glaciology, 46, 412-422.
As mentioned above, we enlarged the glacier inventory and now adapt the classification, having surge-type and advancing glaciers separated. Correspondingly, we adapted the morphometric and environmental influences such as glacier length, area, mean slope along the main trunk, and additionally mean elevation for each glacier class (surge-type, advancing, retreating and stable). This should now enable a better comparison to the smaller database by Barrand and Murray (2006)

P4079, L9-L20: The velocities in this area have previously been mapped by Jiang et al. (2012), so that paper should be referenced here (as also mentioned above)
This will be done accordingly.

P4081, L12: Mayer et al. (2006) should also be referenced here
We will add this reference accordingly.

P4081, L15: It would be useful to compare these results to those of Quincey et al. (2009), who show somewhat similar long-term variations in motion for Baltoro Glacier. Climate reanalysis similar to that conducted by Quincey et al (2009) could also help to shed light on potential causes for the velocity variations (and other changes described in the paper)
In a revised version of the paper, we will cut the section about Batura glacier changes.

P4081, L17: the discussion of volume changes here is entirely focused on one or two surge-type glaciers. The methodology suggests that volume changes over a larger area were calculated, so it would be useful to include this larger region in the discussion. In particular, this could provide a useful comparison with the findings of studies such as Gardelle et al (2012) and Kaab et al (2012), particularly if surge-type glaciers are distinguished from non surge-type glaciers.
We thank the referee for this advice. However, the authors decided to exclude the elevation change measurements (3.3 and 4.3). Such estimates have to be spared for a future paper on this topic including the references addressed here by the reviewer.

P4082-P4084: the conclusions are very general, not very well worded, and completely lacking in references (even in places where other studies are mentioned – e.g., P4083, L18). Unfortunately most of the conclusions make little sense due to the failure to distinguish surge-type from non surge-type glaciers. Without this separation, the meaning and causes of any measured volume and length changes cannot be clearly discerned (i.e., changes in non surge-type glaciers are likely climate related, while changes on surge-type glaciers can be related to changes in both internal dynamics and external climate). The conclusions also suffer from the earlier criticism that it is unclear as to whether this paper is really a methodological study (2nd & 3rd paras), or a truly glaciological study (1st para).
We will follow the reviewers suggestion and will reword the conclusions according to the separation in surge-type and advancing glaciers. Excluding the elevation change section, we can now better focus on the impacts of our analysis.

In general, we will ask the editor whether it is possible to enlarge the figures in a revised version. A suggestion would be to include regional magnifications in a supplement.
Fig. 1: this figure is too small to determine exactly which glaciers are advancing. I would recommend including a table with the names and latitude/longitude of these glacier types so that their location is unambiguous. This table could also include their basic physical characteristics such as length, area, dates of advance, surge classification, etc.

Fig. 2: the red dots in this figure are too small
We will address this in a revised manuscript.

Fig. 3: the caption needs to be clarified to describe how surges were classified – i.e., was a surge only recorded for the year in which it started, or was it recorded for every year over which it occurred?
In accordance with the referee's suggestion, we will rephrase the figure caption. Surges were recorded in every period over which they occurred.

Fig. 5: This figure is too small to do the data justice. It would be better to break the map into separate regions and show those individually so that the velocity details for individual glaciers can be seen.
We agree with the referee that it would be nice to present this figure in more detail. However, we would like to keep this figure as an overview of the derived velocity fields across the Karakoram in the main manuscript, but we would like to add various subsets in the Supplement Material.

Fig. 7b: what do the numbers on these figures indicate? If they are glacier IDs, this information should be included in the table suggested in the comment for Fig. 1. This figure is also too small to clearly show the terminus variations over time

Yes, the numbers indicate glacier IDs. We will include these in the figure captions.

Fig. 8: it would be useful to separate the velocity profiles in this figure so that like is compared with like (e.g., summer vs. summer, winter vs. winter). At the moment everything is plotted together, so it's difficult to tell which changes might reflect long-term evolution versus normal seasonal variability.

We selected a color ramp of the lines that reflects the temporal evolution of the velocity profiles. From the legend of the graphs the tracking intervals become clear and we doubt that separating the profiles in summer-winter will provide much more insight. However, we will ask the type-setting to increase the size of the figure in order to provide a better readability of the graph.

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