Response to the comments from William Kochtitzky, reviewer #1.

The authors present a new method of computing elevation changes during surge events when numerous elevation measurements are available for glaciers in a relatively short time period (annual to decadal). The method is novel and advances our knowledge of surging. They provide new insight into several different surge events that have been previously documented. I recommend the paper be published, but I have a few minor comments that could strengthen the paper below. My main criticism is that the authors seem to lack a quantified uncertainty of their results. For example, it would be greatly beneficial to add uncertainty to table 1. I don't think another round of review is necessary, I am happy to see it published after the authors make these minor changes.

-Will Kochtitzky

We thank Will Kochtitzky for their careful reading of our manuscript and their comments. We have made all the minor changes suggested, please find below the remaining points addressed. Our answers are in blue.

- Figure 2 – very cool figure, but I am having a hard time understanding it. I think part of the problem is that I don't get the colorbar showing the density of DEMs. I don't see this mentioned in the caption. Is it showing how much of each DEM is good data? Maybe don't make the line and the colorbar blue to add clarity – the caption is confusing which blue you are referring to.
  Thanks for the positive feedback. The information given by the 2D histogram / density of DEM was not very relevant and difficult to understand, we choose to removed it.

- Page 5 – can you give us a sense of the data that you filtered out? What is the percent of the data that was filtered out of your study?
  We added a sentence to the last paragraph of the subsection 4.1 Results / Performance of the outlier filtering : "The pre-filtering step removed 46% of the original regional dataset (number of on-glacier pixel), and the filtering step removed a further 42% of the pre-filtered dataset (69% removed in total compared to the original dataset).".

- Figure 7 caption – you say in the text what the red circles are, but this should also be added to the caption for clarity:
  We completed the caption with the following sentences : "The red circles and the dotted lines show or delimitate areas discussed in the text.". We may further add labels.

- Line 245-250 – this is very interesting – do you think you are not capturing the mass fully? Where could it be coming from? Are parts of the reservoir zone not included in your calculations?
  There are indeed parts of the glacier that are not included in the calculation, please find attached a map showing in thick black lines the manually drawn reservoir and receiving areas (Fig. R1.1). However, a similar imbalance is computed when using the full outline (red on the figure) : -3081 $.10^6$ m^3 and 3956 $.10^6$ m^3 in the reservoir and receiving areas, respectively. We completed a sentence to add this information. The imbalance varies with glaciers and dates chosen (Table 1).
  We did not analyse enough surge events in this paper to draw generalities, and we do not have explanations for this. We extended significantly the discussion about crevasses in discussion, subsection 5.2: "The difference between volume gain and loss we estimate is equivalent to a layer of 4.55 m thickness over the surge area. This imbalance is unexpected as the surge occurs over a short time period and mass should be roughly conserved. The imbalance is quite similar when using two filtered ASTER DEMs over a similar period over this surge, instead of the interpolated series, or when calculated over the full glacier system instead of over the delineated reservoir/receiving areas. The impact of crevasse opening during the surge on the apparent surface elevation has not been assessed, especially regarding our imbalance, but it may represent a non-negligible volume. The opening of crevasses can be equivalent to up to 0.2 m thickness over regional scale of the Greenland Ice Sheet (Chudley et al., 2025). As inland parts of

these regions are largely crevasse-free, we can expect such volume to be significantly larger over the highly crevassed post-surge surface of Hispar glacier, at least one meter magnitude. By mid-2018 our imbalance is equilibrated, as well as is the imbalance of Bhambri et al. (2022) with a end term in 2020 when a number of crevasses have already closed. The Khurdopin and Kyagar glaciers were already crevassed a lot before the surge, and this effect may be less important"

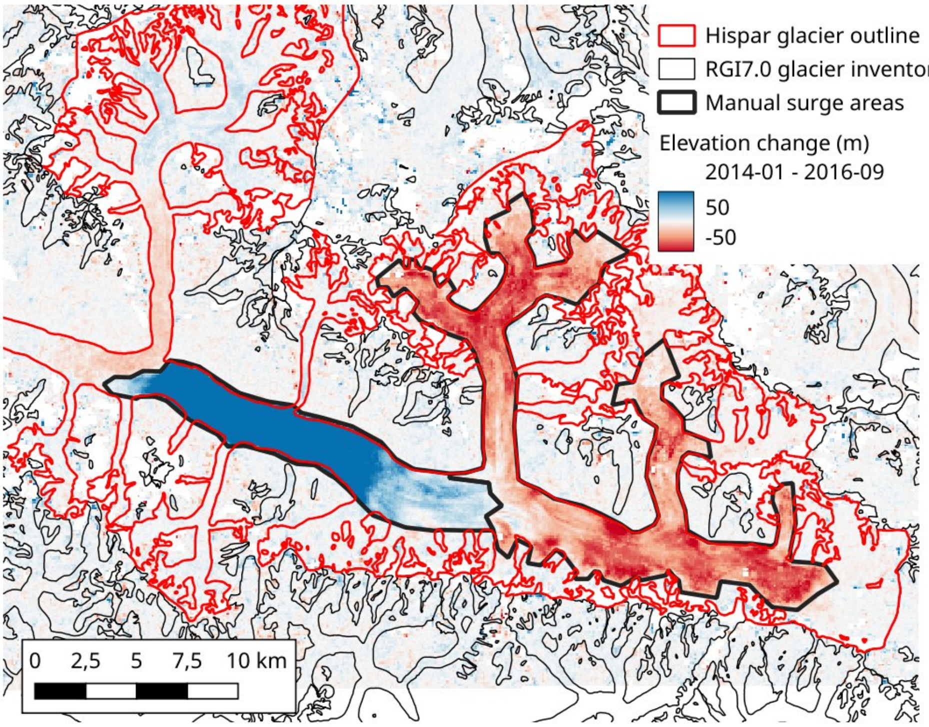

Fig. R1.1.Map of the elevation change over the Hispar 2014-2016 surge and boundaries used for our calculation.

- Table 1 – what are your uncertainties on these measurements? This is critical since any imbalance outside the uncertainty would be a more important signal. Can you get these like you did for figure 6?

  We understand the concern of the reviewer and acknowledge that our manuscript was not hundred percent clear regarding uncertainties. Below we detail a number of uncertainties that we clarified in the revised manuscript.

  - On the figure 6, 3 and 9, we show confidence intervals that are those of the interpolation algorithms (GP Regression and ALPS) and not of the overall workflow. We do not think that the theoretical uncertainty and confidence interval predicted by the ALPS-REML are credible to assess the results of the overall workflow. For instance, Figure A2.a (in appendix) shows well that the filter can remove some critical portions of the surge signal (creating data gaps that could also exist in the original dataset) without the interpolation uncertainty to represent it. A visual verification of the process permits to detect large biases, but does not give any metric value. This is why we develop a lot the sensitivity analysis, the comparison with external reference DEMs or reference study on a number of events. It permits to give some sense of the uncertainty, of the ability and weaknesses of the method.
  - Still, for the revised version of our manuscript, we will give some uncertainties on the surge volumes (e.g. in Table 1). These uncertainties are based on standard methodologies based on the elevation change from stable terrain used as a proxy to estimate the uncertainty on moving terrain (Hugonnet et al., 2022). The first estimations are very conservative and gives uncertainties that, on a median basis, are about 55% of the estimated volume of ice transferred (with volumes of Table 1 of the manuscript; from 19% to 280%). We will try more developed uncertainty calculations and complete the revised version accordingly.

- Figure 10 – shouldn't the colorbar be elevation difference? Change implies the difference is real, but if I understand this correctly, the difference should be 0.

    This is right and is now corrected.

- Line 330 – are they within uncertainties?

    As we do not provide uncertainty on our volume transfer estimates yet (see answer above), we cannot fully answer this question. However, our estimate in the receiving area is close to the uncertainty range of Bhambri et al. (2022) and it would likely be within uncertainties. According to our first estimate of our volume uncertainty, it is indeed largely within uncertainties, but they are very conservatives. For notice, we cannot retrieve the uncertainty of Bhambri et al. (2022) for the reservoir area estimate, as we cannot retrieve the uncertainty they allocate to the Khani Basa tributary.

- Line 338 – the main sentence on this line is grammatically incorrect, I am not sure what you are trying to say

    This now reads as "The existence of kinematic wave that propagates the surge front have regularly been observed on other surges" (previously, "kinematic wave propagating the surge front").

- Figure 12 – need to add what areas A, B, and C mean to the caption

    We completed the caption with "The areas and trends designated in red are discussed in subsection 5.3. They highlight areas of large surge smoothing or removal (zone A) or overall smoothing of elevation changes (trend B) by the original method (Hugonnet et al., 2021), and artefacts created by the presented workflow (zone C).".