Reply on RC2

In the responses below the reviewers' comments are in black and our responses are in red.

Summary

This manuscript presents a comprehensive compilation of glacier surge events in Svalbard spanning more than 30 years, using data from five heritage satellite SAR missions (ERS-1/2, JERS-1, ENVISAT ASAR, ALOS PALSAR and Radarsat-2) and current satellite SAR missions (Sentinel-1 and ALOS-2 PALSAR-2). Building on the work of Kääb et al. (2023), the authors extend the observation period to 2015-2025 and reprocess the dataset following the methodology of Leclercq et al. (2021). The updated analysis largely confirms previous findings while identifying several additional surge events. The authors report a notably higher number of surges during the most recent decade compared to earlier periods since 1992. Through simulations, they argue that neither random phase interference nor purely external forcing can fully explain the observed variability in surge frequency. They suggest that periods of positive climatic mass balance in the mid-2000s, potentially combined with enhanced meltwater production in 2013, may have contributed to increased surge activity. However, given the incomplete understanding of surge initiation mechanisms, these links remain tentative. While the number of surges observed between 2015 and 2025 is remarkable, it does not appear unprecedented when accounting for potential observational biases in earlier periods, such as around the 1940s.

This is a well-written manuscript that aligns closely with the scope of The Cryosphere and provides valuable insights into glacier surge activity in Svalbard. The long-term perspective and consistent reprocessing of multi-mission SAR data are particularly strong aspects of the study. I have only minor comments and suggestions that may help further improve the clarity and consistency of the manuscript.

We thank the reviewer for their positive comments and constructive suggestions regarding our manuscript. In the responses below, we address the suggestions made and explain the changes we will make to the manuscript.

Specific comments

• L430: The phrase should read “between 1995 and 2004”. Referring to the period between 1995 and 2005 would imply an 11-year interval.

Thank you for pointing out this error. This sentence will be changed to “10 surge-type events initiated in the 10 years between 1995 and 2004”.

• Figure 13
The vertical line between 2024 and 2025 appears to indicate a decadal boundary. If so, this should be clarified. Otherwise, it seems inconsistent with the periodization already shown (-1994, 1995-2004, 2005-2014, 2015-2025). While not a major issue, it would improve clarity to adopt a fully consistent scheme in both manuscript and figures (e.g., -1995 / 1995-2005 / 2005-2015 / 2015-2025, or -1994 / 1995-2004 / 2005-2014 / 2015-2024 / 2025-present).

We agree that adopting in the manuscript a decennial scheme such as -1994 / 1995-2004 / 2005-2014 /2015-2024 / 2025- would be more consistent. The bottom line is that in winter 2025 we did not detect any change in surge activity, so we simply updated in the manuscript the period 2015–2024 (10 years) to 2015–2025 (11 years). In fact, it is hard to tell from backscatter data if a surge

stopped in winter 2025, because we know only by winter 2026 if the 2025 backscatter signals were the last. To some extent the same is also true for the starting surges: with a first sign of backscatter increases we don't know yet for sure if the glacier enters a surge. This is a principle problem inherent to the method that it is perhaps worth to mention. In Figure 13, however, we also had to insert a ten-year line between 2024 and 2025 to ensure consistency. Since you acknowledge that this is not a major issue, we will simply clarify in the caption to Figure 13 that the vertical lines indicate a ten-year boundary without any modification to the manuscript.

• Table 2 and 3
- The ordering of rows is unclear. Table 2 appears to be sorted by ascending surge start date, whereas Table 3 seems to be ordered by longitude. For consistency, I suggest sorting both tables by surge start date.

Agreed, we will also sort Table 3 by surge start date.

- Additionally, Tables 2 and 3 use different coordinate precisions for latitude and longitude. Is this due to the use of different DEMs? If so, this should be clarified in the table caption.

We would like to thank the reviewer for pointing out the differences between Table 2 and Table 3. Table 3 was compiled on the basis of the supplementary material to Kääb et al. (2023, https://doi.org/10.1017/jog.2023.35), which is based on RGI v6.0 and uses a three digits precision for latitude and longitude. Table 2 was specifically prepared for this publication, is based on RGI v7.0 and uses a five digits precision for latitude and longitude. Therefore, there are indeed inconsistencies between the two tables, e.g.
- Table 2, Wahlenbergbreen, G013901E78579N, RGI2000-v7.0-G-07-00354, 13.88470, 78.55515.
- Table 3, Wahlenbergbreen G013901E78579N, RGI60-07.00465 14.063 78.504.
In the revision, we will consistently use RGI v7.0 for both Table 2 and Table 3 and apply the same precision for latitudes and longitudes.

- For table 3, it would also be helpful to indicate, for the italicized cases, which additional sensors observed the same surge events.

Agreed, in Table 3 we will indicate for the cases printed in italics which additional sensors observed the same surge events.

• Use of X-band SAR data
Do the authors plan to include X-band SAR missions (e.g., TSX/TDX/PAZ, COSMO-SkyMed, or commercial missions such as ICEYE and Capella) in future analyses? While the manuscript notes that L-band does not provide a measurable improvement under the observed conditions, it would be interesting to briefly discuss whether X-band observations could offer a useful compromise. Collaboration with commercial providers may also increase temporal sampling of surge evolution, which could be valuable for future studies.

In the past, we had access to satellite SAR data from X-band missions (e.g. TerraSAR-X and ICEYE) over Svalbard. These images are well suited for identifying surges based on changes in backscatter, but we have no specific plans for future analyses using these images. Nevertheless, we will expand the final paragraph of the conclusions by explicitly mentioning X-band data. For instance: “In this regard, X-band SAR missions such as TerraSAR-X, COSMO-SkyMed, ICEYE or Capella offer a good opportunity to detect local surges.”