

Reply on RC1

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

Firstly, I want to thank the authors for completing the work for the community. It can be challenging and time-consuming to work with multiple historical satellite missions. As outlined in the manuscript, each dataset typically has distinct characteristics, and special considerations or care are often needed to ensure high-quality analysis results. I acknowledge such a huge effort associated with this work.

In this study, the authors examine five heritage satellite radar datasets and Sentinel-1 data to identify surge onset and termination in Svalbard using methods from Leclercq et al. (2021) and Kääb et al. (2023). The results agree well with existing records and have updated our knowledge of surging glaciers in Svalbard by adding a few more events and clarifying previous identifications. The study also shows that both C-band and L-band can be used to identify surge events based on radar backscatter changes, which could be useful information for future radar missions. The manuscript is well prepared, with detailed descriptions, and the discussion offers interesting validations and perspectives on surge frequency and external forcings. I enjoyed reading it.

The manuscript is ready to be accepted by TC, in my opinion, but if the authors have time, the following comments may be considered before publication.

We thank the reviewer for his 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.

- What is the availability of the data generated by this work, especially the mosaicked annual radar maps and the maps of NDI for each glacier? It would be good to guide the readers with a data availability section.

The data generated by this work are available on request from the corresponding author. The data is not publicly available, as this would require considerable effort in terms of preparation and documentation and goes far beyond the scope of our project. We will add a section on Data availability.

[The data generated by this work are available on request from the corresponding author.]

In addition, as indicated by the Copernicus Publications editorial support team, we will add a section on Declaration of Competing Interest.

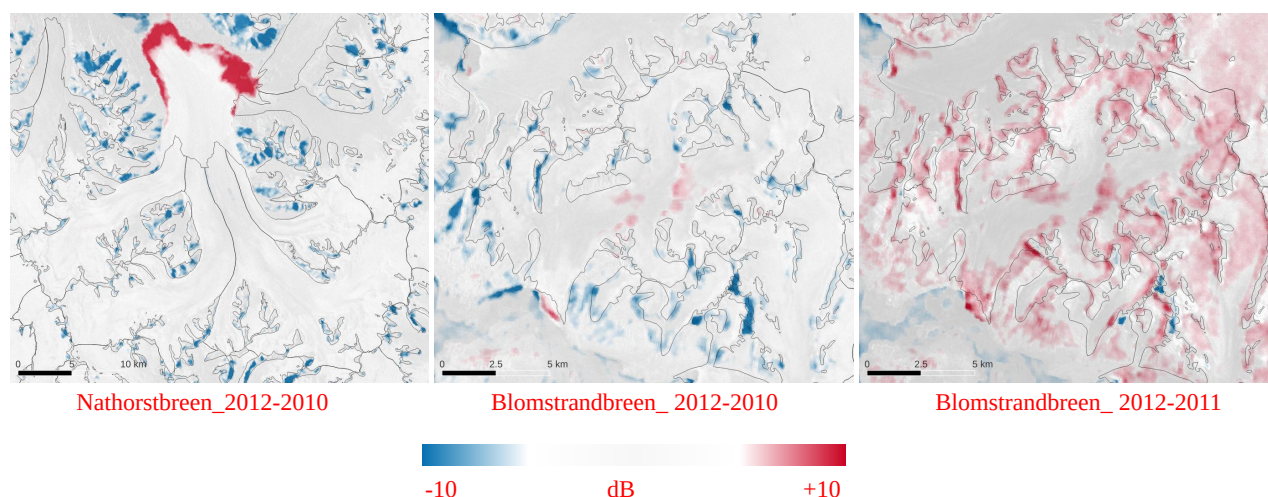
[The authors declare that they have no conflict of interest.]

- L302-304: The ENVISAT—RADARSAT-2 and ERS-2—RADARSAT-2 analyses seem to be the only cross-platform comparisons throughout the study, but I can't find any results or discussion later in the manuscript. What is their performance in terms of surge detection?

Correct, we additionally computed the differences in the backscatter intensity between ENVISAT in 2010 and RADARSAT-2 in 2012 and between ERS-2 in 2011 and RADARSAT-2 in 2012.

However, as these images did not reveal any other surge, they were lost during our analyses and the redaction of the manuscript. We thank the reviewer for this remark and will include in the revision of the supplement images of the differences in the backscatter intensity between ENVISAT in 2010

and RADARSAT-2 in 2012 for Blomstrandbreen and the Nathorstbreen glacier system (also including Zawadzki breen and Polakkbreen) and an image of the differences in the backscatter intensity between ERS-2 in 2011 and RADARSAT-2 in 2012 for Blomstrandbreen. In addition, we will update the Sensor column in Table 2 by including RADARSAT-2 for Nathorstbreen, Zawadzki breen, Polakkbreen and Blomstrandbreen and ENVISAT for Blomstrandbreen and we will include a short text describing these analyses in the manuscript. Please be aware that there were no observations available with ERS-1/2 over South Spitsbergen after 2008, including the Nathorstbreen glacier system.



Backscattering intensity change images from ENVISAT in 2010 and RADARSAT-2 in 2012 for (left) the Nathorstbreen glacier system, also including Zawadzki breen and Polakkbreen, and (middle) Blomstrandbreen. Backscattering intensity change image from ERS-2 in 2011 and RADARSAT-2 in 2012 for Blomstrandbreen (right). The name of the glacier and the dates of the yearly mosaics are indicated below each image.

- L469: For one simulation, are all surges drawn from the same normal distribution? Or is each surge drawn from a different normal distribution with the mean and standard deviation randomly assigned? How many surge events are drawn?

All surges are drawn from the same normal distribution in each simulation. This distribution varies between simulations depending on the mean and standard deviation. We tested a uniform distribution of 50-1000 glaciers that actively take part in the statistics (i.e., "active surge-type glaciers"). To be more specific on this point, we will write in the revised version of the manuscript: "We modeled surges as cyclic events with 50-1000 active members and return times drawn from the same normal distribution depending on the mean and standard deviation (mean 50–300 years, standard deviation 10–200 years) [...]."

- L491-498: It would be helpful to provide more details for readers to understand the simulation. According to Figure 16, this analysis is only performed for the case with $F = 15/\text{decade}$, correct? How many surging glaciers are there in one run? Are there also a few million simulations aggregated into these results?

We indeed only present results for $F = 15 / \text{decade}$. There is a variable number of active glaciers (now clarified in the above comment); the runs represent the filtered members where the random baseline frequency is $15 \pm 2.5 / \text{decade}$, so the number highly varies. We start with 7 million results,

but after filtering, the number is about 2000 members. The plot shows exceedence probabilities for simulations of these ~2000 members. To be more specific on this point, we will write in the revised version of the manuscript: "Partial or full phase-synchronization (surges set to start at the same time) given the historical baseline can lead to periods of 3 surges per year or more (Figure 16), but [...]"

- Copyediting suggestions:

- L244: ... detection over Svalbard “using” the ENVISAT...?

The sentence “We considered for historical surge detection over Svalbard the ENVISAT ASAR images acquired between winter 2003 and winter 2010.” will be changed to “We considered the ENVISAT ASAR images acquired between winter 2003 and winter 2010 for historical surge detection over Svalbard.”

- Figure 11: Since the glaciers are not aligned along the southwest to northeast direction, it would be good to add labels of glacier names to each surging glacier for better identification with the caption.

Agreed, labels of glacier names will be added to Figure 11.