The global time series glacier surface velocities were derived from Sentinel-1 data. Scene-pair velocity, as well as monthly and annually averaged velocity mosaics products at 200 m resolution acquired by this study could be easily accessed in the http://retreat.geographie.unierlangen.de with rich quality parameters. Due to the independent of weather conditions, season and daylight of SAR images, the product acquired by this study was a great supplement with improvements in cloud covered regions relative to ITS_LIVE and GoLIVE using optical images. And this product would be of great use for studies in response of glaciers to climate change and ice thickness inversion and so on.

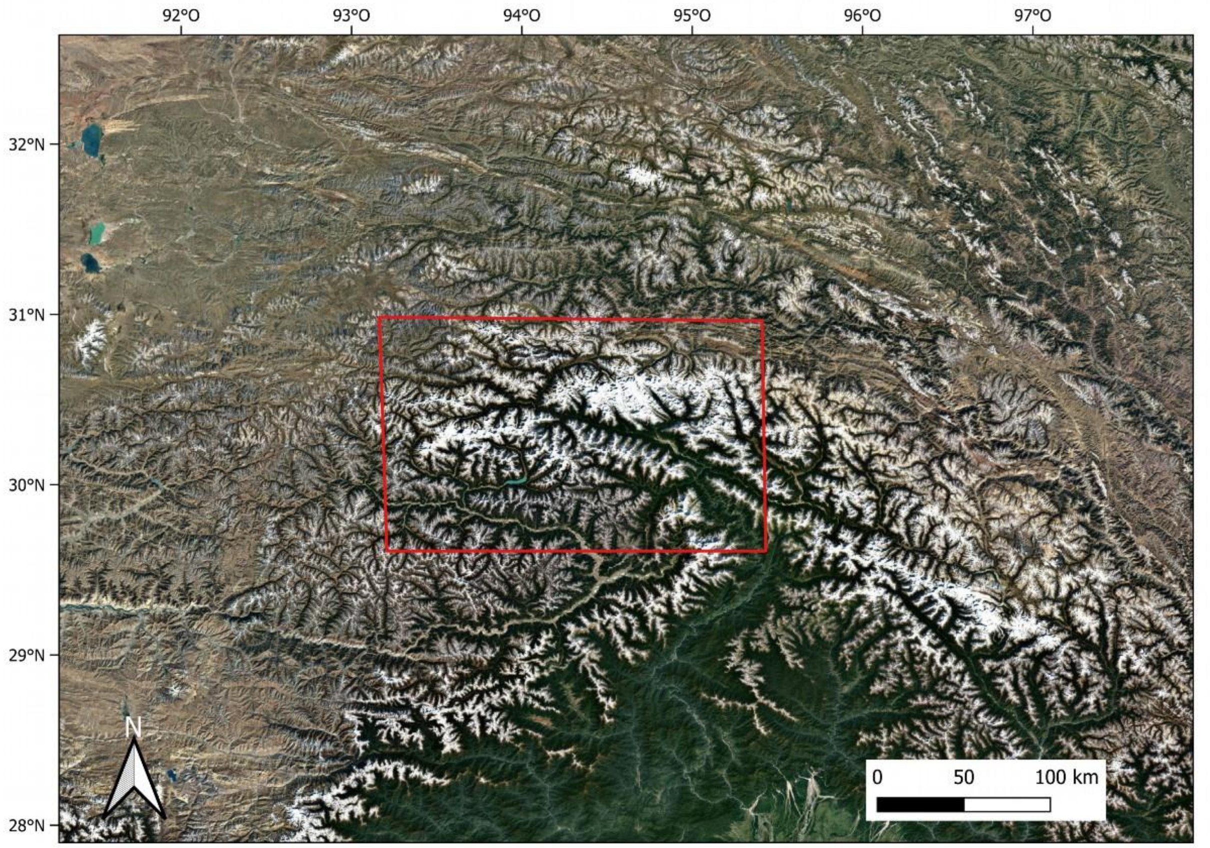
We would like to thank the reviewer for for his positive assessment of our manuscript and his helpful comments on our manuscript.
All suggested changes were considered and a list of responses and changes in the manuscript is given below. Responses are written in **bold** face type and changes in the manuscript are written in *blue*.

I have only one mainly comment, glaciers in Svalbard are selected to demonstrate the quality of the studies, and shown large superiority in accuracy and temporal resolutions; but the superiority of SAR images independently from weather conditions were not fully analyzed at present. For example, the mountain glaciers on the South-east Tibet were seriously affect by the cloud, both ITS_LIVE and GoLIVE shown weakness in this area. Improvements in like these issues should be fourthly analyzed.

**We appreciate the reviewer's comment. As stated in the paper, due to the physical properties of radar waves, SAR sensors can work weather and cloud independent and are not limited by (polar) night, thus allowing an all year monitoring in particular in polar regions, but also in frequently cloud covered regions such as high mountain areas. This is a well-known and widely accepted advantage of SAR sensors that has already been investigated and discussed in many publications - especially in basic literature on SAR. We therefore think that it is sufficient to add references to the text for further reading on this topic:**

*In contrast, repeat-pass Synthetic Aperture Radar (SAR) data acquired by the Sentinel-1 constellation enable near real time-like and fully automatic processing of global glacier velocities at up to 6-day temporal resolution, independent of weather conditions, season and daylight (Jawak et al., 2015; Moreira et al., 2013) from 2014 until today.*

**However, we conducted a small experiment that demonstrates the general advantage of SAR data regarding cloud coverage. We compared the query results of Landsat-8 and Sentinel-1 data for the year 2020 over an area in South-East Tibet (see figure below). On ASF-Vertex 227 Sentinel-1 SLC scenes with a repeat cycle of 12 days were found over the region, which all can be used without restrictions for velocity calculations. In contrast, on USGS EarthExplorer, no scenes with zero cloud cover were found for Landsat-8 and only 57 scenes with <= 10% and 71 scenes with <=20% cloud cover, respectively. When comparing the query results, it must be also considered, that the temporal baseline of Landsat-8 repeat images with low cloud cover can be up to some hundred days and that the spatial coverage of each Landsat-8 scene is only 185 x 180 km (250 x 250 for Sentinel-1).**




And I also noted that glaciers in the south-east Tibet shown in the website are only partly covered by the red polygons? why?

**The reviewer is right that some of the smaller glaciers in South-East Tibet seem to be only partly covered by the glacier outlines on our website. The data source of our glacier polygons is the RGI 6.0, which we roughly adjusted to the coverage of our velocity data (i.e. glaciers in the periphery of Greenland are for example not covered by the outlines on the website). However, over South-East Tibet, our polygons have the identical coverage as the RGI 6.0. Hence, any missing or wrong glacier outline in this region is directly attributed to inaccuracies in the RGI 6.0 data set. Still, the RGI 6.0 is the most comprehensive glacier data base that is currently available. Regarding the reasons for the inaccuracies in the RGI 6.0 data set over South-East Tibet, we can only speculate, but as the RGI is based on optical data, cloud coverage and discrimination problems between snow and ice may be part of the story.**

Line 14, "glaciated" means area covered by glacier ice in the past, but not at present. "glacierized" is better.

Cogley, J. G., R. Hock, L. Rasmussen, A. Arendt, A. Bauder, R. Braithwaite, P. Jansson, G. Kaser, M. Möller, and L. Nicholson (2011), Glossary of glacier mass balance and related terms, IHP-VII technical documents in hydrology, 86

**We thank the reviewer for this important remark. We changed this for all occurrences in the manuscript.**

Line 70, A flowchart about your process chains and mosaic of different products would be better

**This is a very welcomed remark. We added a flowchart of our processing chain to the manuscript.**

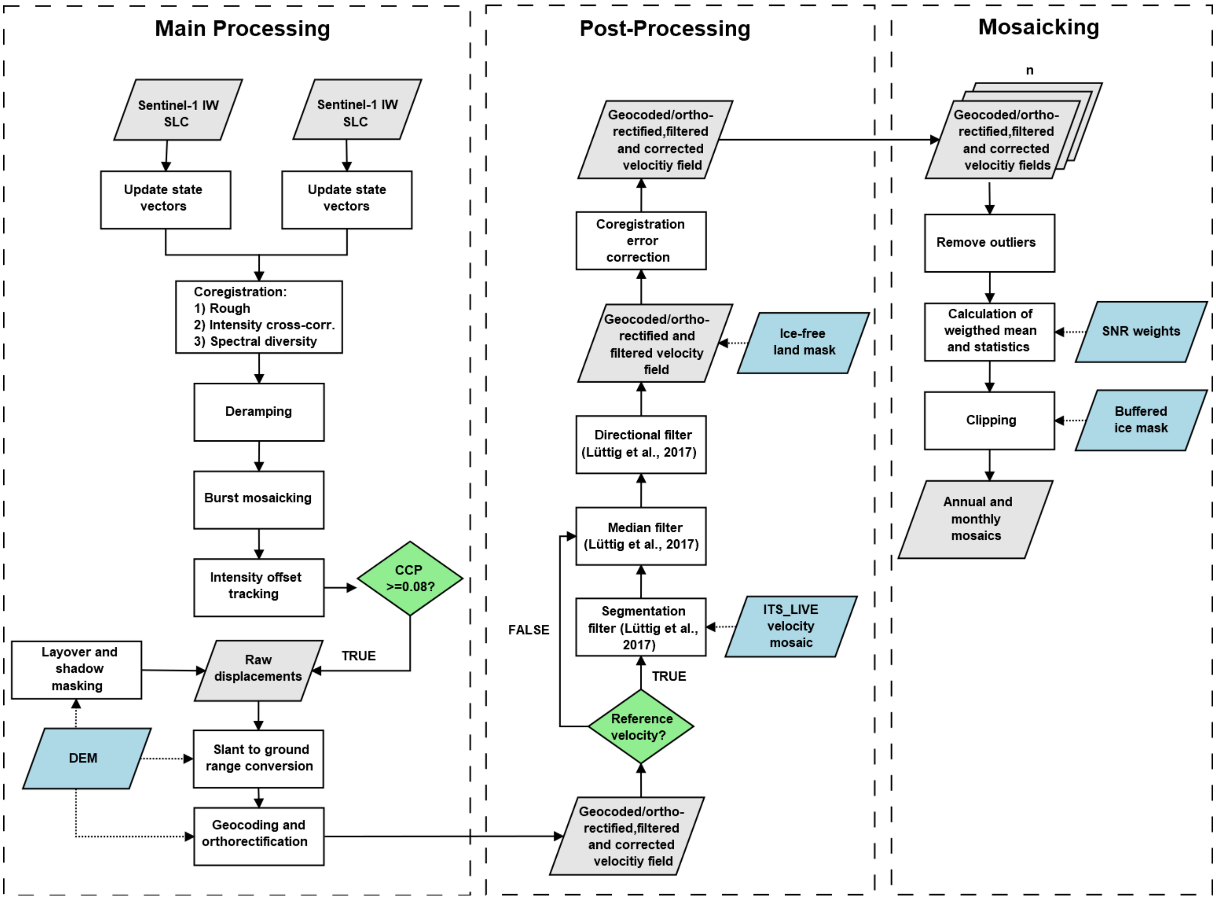



*Figure 2: Flowchart of scene pair velocity field and temporal velocity mosaic generation*

Line 84, Considering the differences of sensitivity of HH or VV polarizations to glaciers surface with different water contents, any velocity differences detected by these two polarization channels.

**The reviewer is right that the different polarizations have a different sensitivity to the water content of the ice surface. Especially, there may be differences in backscatter and the location of the phase center for different polarizations in the presence of wet snow (but less over bare ice). However, we believe that polarization differences are not a major issue in the case of Sentinel-1 velocities, because:**

1) **There is a general polarization scheme for Sentinel-1 that sets the polarization to HH (or HH-HV) over polar regions and to VV (or VV-VH) for all other observation zones (https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/observation-scenario). Hence, there is in general no mixture of HH and VV polarizations over the same region.**
2) **As the polarimetric signature of the scatterer does not change within a region, there is no change in the location of the phase center for consecutive images pairs that may be related to a change in the polarization mode. Forming tracking pairs**

**from two consecutive images that have different polarizations may be an issue, but is prevented by the polarization scheme mentioned above. We thus follow the widely accepted and applied approach of single channel tracking.**

**Furthermore, the polarization scheme prevents the investigation (detection) of possible differences between velocities generated from two consecutive HH-polarized images and those simultaneously generated from two VV-polarized images, which is perhaps the actual answer to the reviewer's question. In response to a comment by Tazio Strozzi, we added the following sentence to the Data and Methods section, which explains the polarization scheme of Sentinel-1:**
*The HH or HH-HV polarization is the standard polarization scheme for acquisitions over polar regions and the VV or VV-VH polarization is the default mode for all other observation zones.*

Line 121, therefore, the velocity of glaciers in the accumulation area would still suffer from problems due to their low contrast?

**This is especially the case during summer, where tracking of the radar speckle is not possible due to decorrelation caused by surface melt and where tracking relies on surface features only. We explain this in the text: "However, since speckle tracking requires phase coherence, its application is often restricted to winter acquisitions when there is no surface melt and to regions where 6 day-repeat data is available and where surface velocities are low (i.e. accumulation areas, ice cap interiors)" In accordance to the suggestions of Tazio Strozzi, we additionally added the following sentence to the data section, which hopefully makes the point mentioned by the reviewer clearer:**

*In general, the quality of tracking results is often better in winter than in summer over both accumulation areas and glacier tongues, because snow and ice melt during summer can quickly alter the surface properties of tracking features (i.e. feature tracking becomes more difficult) and cause loss of coherence (i.e. speckle tracking becomes infeasible).*

Line 140 Is it possible a higher resolution product could be produced, which is of great help for studies focused on local scale.

**In principle, velocity products of higher spatial resolution can be produced. However, it has to be considered that increasing the spatial resolution of the velocity product does not necessarily increase the amount of valid information contained in the data. This is because tracking window sizes in the range of tens to some hundred pixels (i.e. ~ 700 m for Svalbard) and step sizes of around 200 m (50 x 10 pixels) limit the true spatial resolution of the generated velocity data. Additionally, from a computational perspective, raster data of higher resolution have exponentially larger file sizes (which has negative effects on storage capacities and download speeds) and demand exponentially more processing resources, such as RAM and CPU runtime. The demand of computational resources is an important factor, when talking about processing very large global data sets with big data input, but may be less important if processing a few images on local scale. Hence, the 200 m resolution of the velocity data is a compromise resulting from considering all points mentioned above. This compromise must be made by any provider of such large global data sets. However, the spatial resolution of our products is still slightly higher than that of other large velocity data sets that are currently available (240 m – 500 m). There is also the possibility to extend our data set by velocities of higher spatial resolution for small selected regions of special interest or**

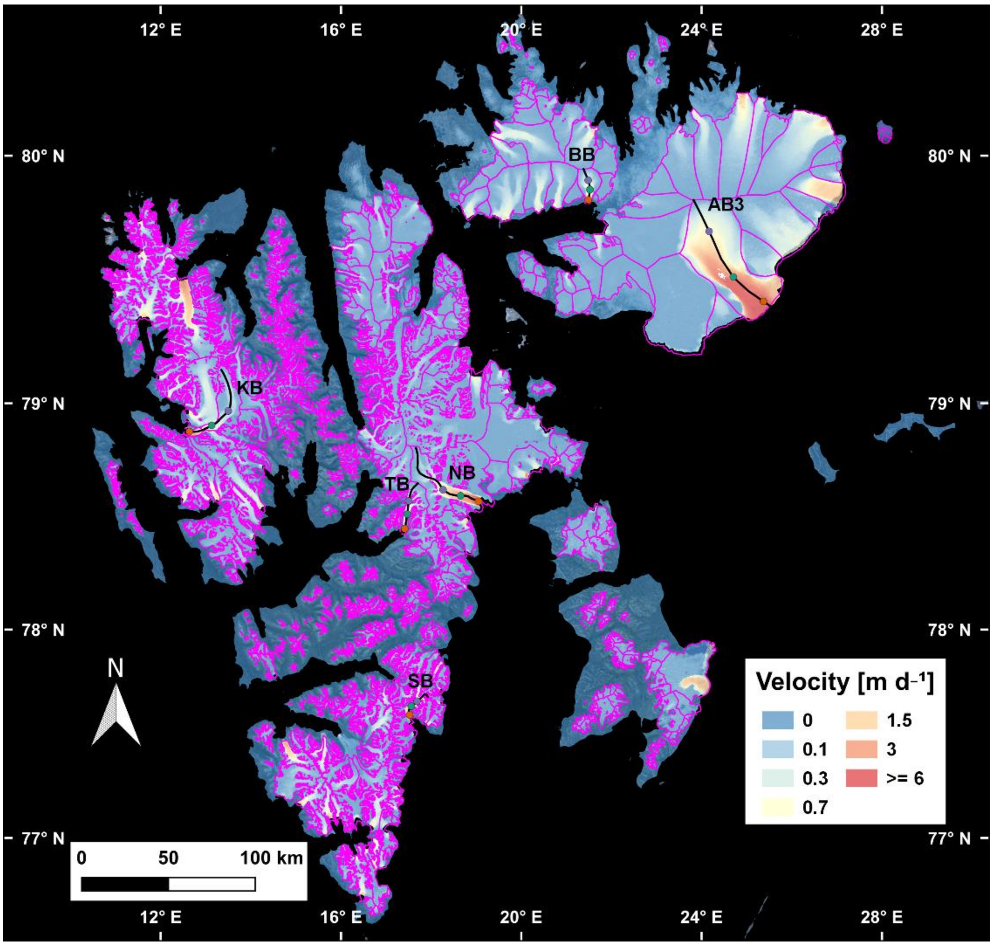
**upon request by users. We added a sentence on this to the Conclusions and Outlook section:**
*Velocity data of higher spatial resolution (e.g. 100 m) may be additionally produced for selected regions of interest in order to facilitate more detailed investigations on local scale.*

Line 155, w=3 for all the other regions shown in Figure 1?

**We applied w=3 for regions with strong seasonal flow variations and surging glaciers and w=1.5 as originally proposed by Luettig et al. (2017) for all other regions, for which a priori velocity information from ITS_LIVE is available. We added a column to Table S1 that contains the value of w, applied in each region.**

Line 174, add glacier outlines to distinguish the glacier and non-glacier region in Fig.2.4.6.8.9

**We thank the reviewer for his suggestion. When composing the figures, we also considered adding glacier outlines. However, we made a conscious decision not to do so, because the glacier outlines consist of many small, isolated parts over wide areas. Adding them substantially disturbs the appearance and the readability of the figures as it widely covers the velocity data (which is the main data of the figures). We therefore would like to leave the figures as they are. As an example, we added glacier outlines to Fig. 4 as suggested by the reviewer. We hope that from looking at the example, the reviewer understands our concerns.**




Line 278, Though color code of points in Figure 5 was shown in Fig.4, but it’s hardly to know the location relative to glaciers (i.e., which point is at high elevation)

**We are sorry if the color coding caused some confusion. We added the following sentence to the captions of Fig. 4 and 5 and hope that this makes the position of the measuring points on the glacier clearer:**
*The color coding indicates the position of the corresponding measuring point on the glacier: purple=upstream. green=mid glacier, orange=front.*

Line 427 how about the accuracy of your annual mosaic products relative to ITS_LIVE product?

**In the text we discuss the differences between our annual mosaics and the ITS_LIVE products, as well as the possible reasons for the differences, in detail. One obvious difference between our product and the ITS_LIVE product with regard to accuracy are the blunders contained in the ITS-LIVE product in some featureless accumulation areas. However, while this is more a qualitative statement on accuracy, providing a general quantitative measure of relative accuracy for both data sets is very difficult, if not impossible. For such a comparison, one would actually need true mean annual velocity mosaics as reference, a data set that does not exist. Taking either our or the ITS_LIVE annual mosaics as "true" velocity reference is also not appropriate, because their calculated mean velocities depend only to a certain extent on the quality/accuracy of the input data (the blunders in the accumulation areas are an example). However, especially in the case of Svalbard with its strong seasonality of the glacier velocities and its surging glaciers with rapid speedups, most of the final mean velocity is determined by a) the temporal resolution of the input data (i.e. are short term velocity variations resolved and how many measurements of these variations go into the calculation of the mean?), b) the temporal coverage of the data (i.e. are there more velocity measurements during summer or winter, or are all seasons equally covered?) and c) the calculation of the mean itself (which weighting scheme is used, how are outliers determined,…). Nevertheless, as discussed in the text, our temporal mosaics come with several statistical layers that at least allow for a qualitative assessment of the velocity data by e.g. using standard errors along with the measurement count.**

Line 730, location of your example areas should be denoted.

**We added a note to the caption of Figure 1:**
*The example region Svalbard is marked with the number 7.*

Line 770, add some general statics of the difference

**We do not exactly know what the reviewer means with "statics" here and where to add them (to Figure 7, to its caption or to the main text). If the reviewer means "statistics", we would like to refer to the extensive statistical analysis of the velocity differences between TSX, S1 and Landsat 8 velocity fields in Sect. 3.2 and in Table 1.**