

Anonymous reviewer 2, from 07 Dec 2021

General Comments

This paper conducts an excellent study into how the uncertainty of photogrammetry-based ice displacements varies over the velocity field, a neglected subject in glaciological studies. However, I am left wondering exactly how much the proposed method improves on existing isotropic methods. Line 34: The hypothesis of this paper is stated in line 34-35: “In our opinion the assumption of constant variance (homoscedasticity) does not hold, as displacement extraction is based upon pattern matching of small subsets of imagery, where the image content influences the displacement precision. Is this demonstrated? I did not find an explicit answer. I am left wondering the degree to which the assumption of homoscedasticity is violated and if there are glaciological settings in which this assumption is appropriate or acceptable.

There are many ways how to convey this principle, we have opted for a practical explanation. In the text we have described the phenomena based on image structure, a second way is by demonstrating examples as is done in Fig.1 of the manuscript. However, a more theoretical top-down approach is also possible;

The issue of homoscedasticity can also be approached from a perspective of optical flow. Pattern matching and optical flow can be seen as interchangeable techniques, as they are mathematically identical (Lemmens, 1988). If image gradients are present in several directions, the span of the matrix is sufficiently large. However, when there is a predominant direction in the image gradients, the optical estimation becomes ill-posed (also known as the aperture problem). Hence, treating displacement axis independent does not hold nor is a fixed precision term sufficient.

This is now included in the text. To pull this property out even further we have implemented an optical flow estimation as well. In this way the single values of such estimations can be used to see to what extent these differ. The single values for our dataset are shown in figure 1.



Figure 1: Single value estimates.

Distinct difference between both values, indicate homoscedasticity is not present within this dataset.

Specific comments

Line 5 and 13: please state how the correlation peak is related to velocity uncertainty. It would also be helpful to the reader if you could explain what a dispersion estimate means in this context or how it relates to uncertainty. Additional explanation is included, but kept to the minimum since it is in the abstract.

Line 19: change “automatic constructing” to “automatic construction”.
adjusted

Line 47: Insert comma after “In this contribution”
inserted

Line 49: remove “then for instance”
removed

Line 61: change “also other metrics can “ to other metrics can also”
changed

Line 68: “ A lot” is a bit informal. Maybe change to significantly or greatly?
changed

Line 69: insert comma after “For example”.
done

Line 74: change “it are these” to “it is these”
changed

Line 88: Insert comma after “ and in particular its peak”
done

Line 95: insert comma after “is perceived as a probability density function”
done

Line 105: Make “a detailed derivation thereof...” its own sentence.
is now separated

Line 113: Insert comma before “ and correlation ridges with different”
done

Line 124: Insert “the” between “from” and “standard error axis”. Remove comma before “to a description of standard error ellipse...”
implemented

Line 132: Change “wholes” to holes
deleted

Line 176: Remove comma following Maslaspina Glacier
done

Figures 5 and 6: please explain the significance of the regions outlined in red. It would be helpful to the reader if other significant aspects of this figure were described in greater detail in the caption.
These are now included.

Figure 9: Please check spelling, describe what is significant about regions outlined in red. It would be helpful to fill out the figure caption more and describe what is significant or of interest in this figure.
Done.

Line 249: Here and elsewhere, terms such as “we think” and “opinion” are used. Have these opinions been validated in this study? It is not clear to me. If yes, this should be stated explicitly. Otherwise, it will be difficult for the reader to know what to do with the results of this study.

Emphasis on dispersion within the literature has been very limited, while with this study we have tried to demonstrate its usefulness. Furthermore, we have tried to find the mechanisms behind the spread, based upon metrics from the same dataset. Two different glacial systems were chosen, but they do not span the whole range. Hence, we are cautious about our interpretation. The first reviewer also asked for additional results to test some hypothesis (see above), but we hope we have been able to show that these patterns are not so clearly extractable.

We see an article as a step towards a better understanding of such remote sensing methodologies. We found corresponding patterns and relations, and some of these can be isolated, but more analysis are possible. The code for our methodology is given, so others have the opportunity to build on top of our effort.

Line 274-275: It would be helpful for the reader if you could briefly discuss what would be needed to “extract a clearer signal from noisy remote sensing products”

We have adjusted the sentence, and this line relates to the former sentence.