Responses to Reviewers' Comments for Manuscript essd-2023-94

Multitemporal characterisation of a proglacial system: a multidisciplinary approach

Addressed Comments for Publication to

Earth System Science Data

by

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Note: To enhance the legibility of this response letter, all the editor's and reviewer's comments are typeset in boxes.

Authors' Response to the Editor

General Comments. Dear Authors,

I have now obtained one further constructive review report. Please kindly address all points raised and submit a revised version of your manuscript.

I will then be able to take a final decision.

Best regards,

James Thornton

Response:

Dear Dr. James Thornton,

Thank you for providing us with the additional constructive review report. We appreciate the opportunity to address the points raised and will promptly work on revising our manuscript accordingly.

Best regards,

The Authors

Authors' Response to Reviewer

General Comments. Dear Authors, Thank you for giving me the chance to read and review your paper and data. I think it should be published as it provides valuable information that can help us better understand how proglacial areas work.

Response:

Dear reviewer, thanks for the time dedicated to reading, reviewing and sharing constructive comments and suggestions on the manuscript and underlying data. The author's team is extremely satisfied by reading that you deem the manuscript is worth publishing since it can support the understanding of proglacial areas.

General Comments. The dataset consists of airborne orthomosaics and DEMs that cover glaciers and the proglacial area, along with other data from the area like hydrometric, bathymetric, and seismic data. The only downside is that the dataset only includes data from one year (2020-2021).

Response: Thank you for the comment.

We confirm that the current dataset is covering the period 2020-2021. Considering that the Glacier Lab of the Politecnico di Torino is still active, and therefore the Rutor Glacier will almost certainly still be monitored, in case of new dataset acquisitions, we will publish them as soon as processed and validated.

General Comments. The authors improved their manuscript in response to previous reviews.

Response:

We deeply appreciate the recognition of the effort in revising the initial version and the structure of the manuscript to improve it, according to the comments and suggestions from the previous Reviewers.

Comment 1

However, I still have some suggestions related to SfM data processing and presentation of the results:

1. Please ensure that you report the parameters used in the Structure-from-Motion (SfM) processing, as well as the assessment of each stage of processing, either in the text or as an appendix. It is recommended that you follow the detailed guidelines provided for reporting results of SfM photogrammetry in geosciences James et al. (2019) [1]. Several publications have reported the influence of processing parameters in Structure-from-Motion software on the quality of DEMs and orthomosaics - they can significantly affect the accuracy of the final products, particularly the filtration and optimization stages. Therefore, it is essential to report all processing parameters.

Response: Many thanks for your suggestions

- We deem that the most efficient approach for sharing all the processing parameters in a transparent and detailed way is to add, in the supplementary material if the Editor agrees (considering they are two PDF documents of about 8 pages each), all the relevant processing reports of the SfM processing software, focusing on the crewed aerial flights used for the DoD analysis. Those reports provide the requested details (including tables, maps and, plots when relevant) about survey data, camera calibration, camera locations, ground control points and check-points, Digital Elevation Model and, the processing parameters. The following sentences were added: at line 161: "The photogrammetric processing reports generated by Metashape software for the two crewed aerial flights (the only ones

used for elevation analyses) are available in the supplementary material section (`https://doi.org/10.5281/zenodo.11144390`, **Corte2023_Geom4**). These reports include information on processing parameters settings, survey data details, camera calibration, camera locations, ground control points and check points"

- As far as the recommendation to follow the guidelines proposed by James et al (2019)[1], we confirm that they have been explicitly or implicitly followed and clearly discussed in the manuscript. Especially the considerations related to points 7 (Results - Error reporting), 9 (Results - control and independent check measurements), 10 (Split data tests), 11 (Management of systematic error), 12 (Residual uncertainty) are extensively presented and discussed in the current version of the manuscript according to the comments from previous reviewers (section 2.3.1, section 3.2 and Appendix B). Accordingly, the following sentence has been added at line 193 at the beginning of section 2.3.1: "To properly assess the photogrammetric results (i.e. in this specific case the DSMs and their differences generation), it is necessary to apply "suitable statistics to identify systematic error (bias) and to estimate precision" and to propagate "uncertainty estimates into the final data products" (James et al, 2019 [1])".

Comment 2

2. Following the previous comment, please consider adding raw (i.e. unprocessed) images to the described dataset. This would enable future users to process the images using different approaches and parameters, especially if new data becomes available or new processing methods arise.

Response: Thank you for the comment.

We understand the potential benefits of sharing raw data, such as crewed aerial images, despite, as mentioned in a previous response to the reviewers, the focus of this manuscript is on the rigorously assessed final products. Regrettably, the licensing terms for the

crewed aerial images do not allow their public re-sharing as open data. However, we remain open to consider ad-hoc access requests, which can be sent directly to the authors.

Comment 3

3. During the initial stage of SfM processing (photo alignment), consider co-aligning surveys from different years to reduce uncertainties in resultant DEMs. Please refer to the approach proposed by Cook and Dietze (2019)[2]; De Haas et al. (2021)[3], Nota et al. (2022)[4]. That could significantly reduce uncertainties in resultant DEMs, especially for the area lacking GCPs.

Response: Thank you for your valuable suggestions.

We confirm that the coregistration of the aerial survey was a priority, as explained in lines 168-171 and 181-184 of the manuscript. Nevertheless, we have not used the co-alignment approach proposed by Cook and Dietze (2019) [2] due to the changes that occurred between the two acquisitions and the limited extent of stable areas, as stated in lines 201 and 411 of the manuscript. This issue is explicitly discussed in the "Potential limitations" section of the above-mentioned paper: "If the appearance of the area changes too much between surveys or if too much of the area of interest has changed, sufficient tie points may not be generated, as described above. Therefore, well-distributed stable areas with a consistent appearance are required for successful alignment"

Comment 4

4. In order to determine if there are any systematic errors on CP, it would be helpful to examine the spatial distribution of the errors. For instance, if most of the GCPs and CPs are located in the proglacial area, then it is likely that the uncertainties will be lower in this area compared to the upper part of the glacier. I suggest adding a map that displays errors (X, Y, Z) on CPs, so the reader can identify any spatial trends.

Response: Thank you for the comment.

As mentioned in the answer to comment number 1, we are going to include in the supplementary material, if the Editor agrees, the detailed photogrammetric processing reports, which include the figure "GCP locations and error estimates" with the spatial distribution of GCPs and CPs including the related error estimates represented by color-coded ellipses (where the altimetric error is represented by the ellipse color and the planimetric error components are represented by the ellipse shape and orientation). An example is reported in the figure below for easy reference.

Comment 5

5. In the manuscript, you stated that LoD was set to 0.44 m; however, in the map (Figure 9), values between -0.5 and +0.5 m are indicated as no change (i.e. transparent). Please, correct it.

Response: Thank you for your comment.

The image has been re-generated accordingly (see below). Additionally, the sentence in line 418 of the manuscript has been changed as follows: "Notably, values falling within the range of -44 cm to +44 cm are omitted from figure 2(a)) , as they fall within the LoD for the DoD calculated based on CPs".

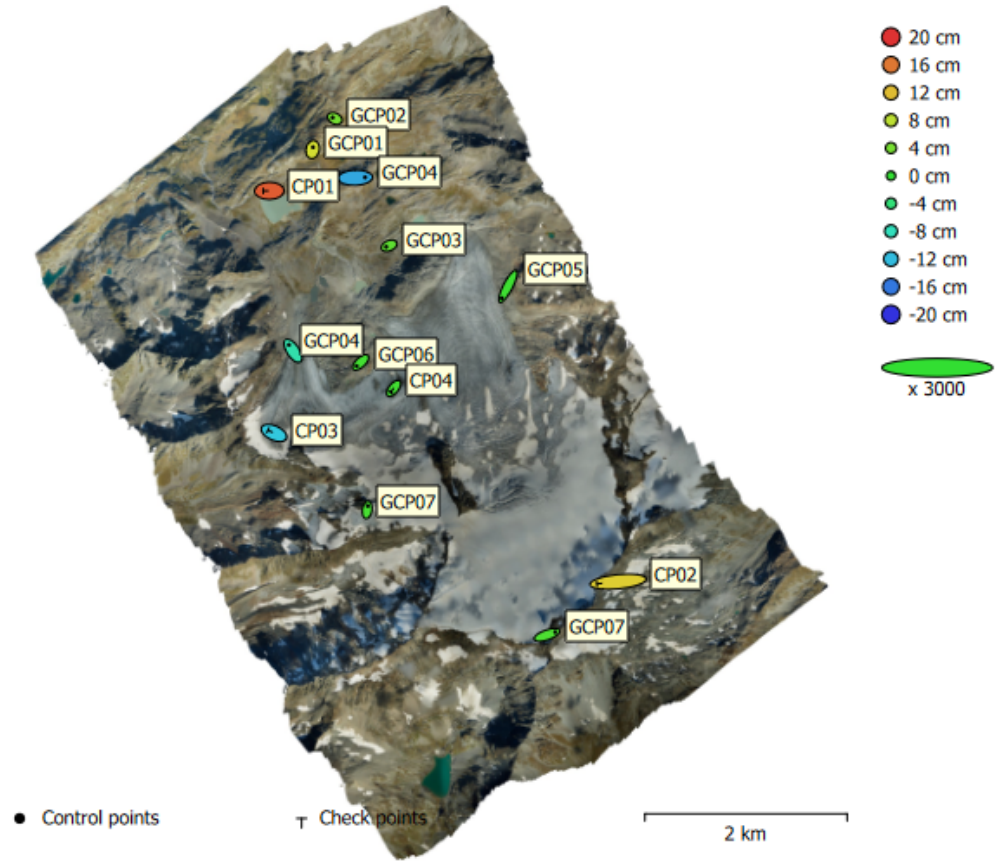

Fig. 3. GCP locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated GCP locations are marked with a dot or crossing.

Figure 1: Figure included in the detailed photogrammetric processing reports: GCP locations and error estimates.

Comment 6

6. Page 20, l. 411 "this study has opted to use the DoD value derived from CP analysis, which stands at 44 cm" should probably read "LoD" not "DoD"

Response: Many thanks for spotting this typo.

The typo has been fixed as suggested.

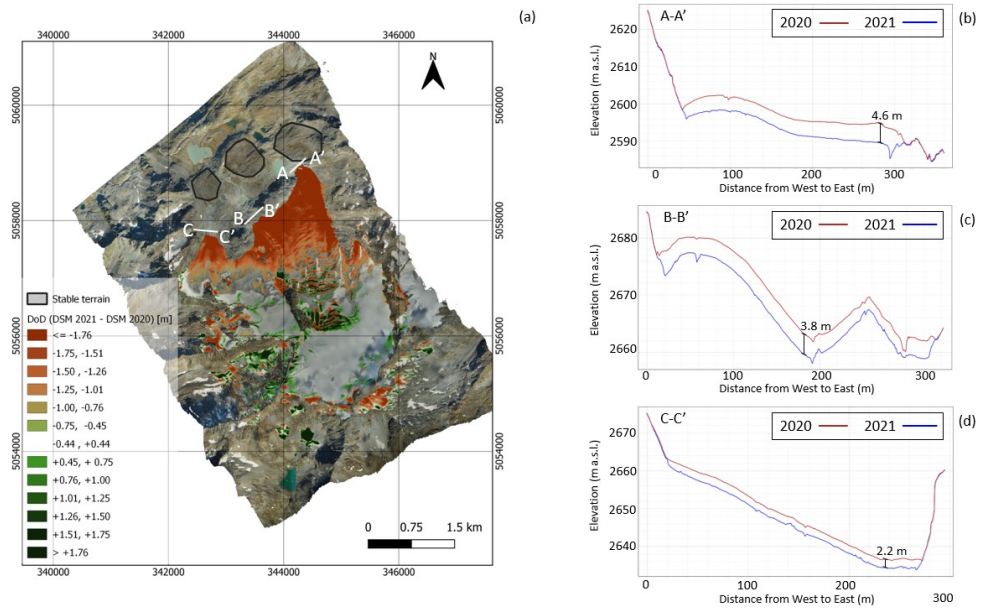

Figure 2: (a) 2021-2020 DoD. The white lines refer to the cross-sections A-A', B-B', and C-C', whose 2020 (red) and 2021 (blue) elevation profiles are shown in panels (b), (c), and (d) respectively.

[1] M. James, J. Chandler, A. Eltner, *et al.*, "Guidelines on the use of structure from motion photogrammetry in geomorphic research," *Earth Surf. Process. Landf.*, vol. 44, Apr. 2019. DOI: 10.1002/esp.4637.

[2] K. L. Cook and M. Dietze, "Short communication: A simple workflow for robust low-cost uav-derived change detection without ground control points," *ESurf*, vol. 7, no. 4, pp. 1009–1017, 2019. DOI: 10.5194/esurf-7-1009-2019.

[3] T. Haas, W. Nijland, B. McArdell, and M. Kalthof, "Case report: Optimization of topographic change detection with uav structure-from-motion photogrammetry through survey co-alignment," *Front. Remote Sens.*, vol. 2, p. 626 810, Feb. 2021. DOI: 10.3389/frsen.2021.626810.

[4] E. Nota, W. Nijland, and T. Haas, "Improving uav-sfm time-series accuracy by co-alignment and contributions of ground control or rtk positioning," *Int. J. Appl. Earth Obs. Geoinf.*, vol. 109, p. 102 772, May 2022. DOI: 10.1016/j.jag.2022.102772.