

Comment on **essd-2021-76**

Anonymous Referee #2

Referee comment on "Unlocking archival maps of the Hornsund fjord area for monitoring glaciers of the Sørkapp Land peninsula, Svalbard" by Justyna Dudek and Michał Pętlicki, Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-76-RC2>, 2021

This manuscript presents a method for how to digitize and georeference archival maps, and finally evaluates their potential for quantifying changes in glacier geometry on Sørkapp Land, Svalbard. For this exercise, three topographic map sheets from the Institute of Geophysics of the Polish Academy of Sciences (IGF PAN) published in 1987 were used together with a reference dataset from 1990. The 1987 map sheets have contour lines based on aerial photos from 1961 (from the Norwegian Polar Institute; NPI), and the 1990 dataset consists of a 20-m-resolution digital elevation model (DEM) and a glacier outline vector layer (also NPI).

Overall, this is a nice study with clearly described methods, walking us through the different steps of source data processing, verification, and data fitting, as well as presents the final DEM and examines the glacier elevation and areal change. However, there are some issues that need to be addressed, mainly considering the dataset size and the potential for improving the quality of the digitization/georeferencing. I have listed my main concerns and suggestions for improvements in the specific comments below. If these questions are resolved, I think the paper could be a good contribution to the journal.

Specific comments

- Why did you not digitize all ten IGF PAN map sheets? Digitizing these map sheets is a valuable contribution, but it would be most useful to have all of them compiled. Especially considering the initial confusion with the contour lines (i.e., that they represented the 1961 elevations, without being corrected based on field observation before publication in the 1980's). I strongly recommend digitizing the rest of the map

sheets to provide a complete updated dataset with greater areal coverage. If choosing not to, please provide an explanation for why you decided to process only three (you describe this nicely in your response to the editor), as this is not obvious to the reader. To help illustrate that these are the most valuable map sheets (for glaciological research), show all of them in Figure 2 and mark the three you present in the paper.

- The method section would benefit from having a figure showing the workflow, describing all the steps. That would provide a good overview of the methodology and make it more user friendly. Also, I am a bit skeptical to whether the method is innovative enough, and whether the final map (Figure 14) is really satisfactory? There are still areas with both large positive and negative dz, suggesting that the georeferencing could still be improved. Have you considered supplementing with other methods? You refer to studies using structure-from-motion to create historical DEMs from aerial imagery (Mertes et al., 2017; Midgley et al., 2017). Why not try that, using the NPI aerial photographs from 1961, to compare to the topographic maps? Another option could be DEM production by digital stereophotogrammetry on the 1961 images. For methods, see e.g., Korsgaard et al. (2016) and references therein.
- Why not compare the 1961 and 1990 data to the 2010 data from NPI? The spatial resolution is higher (5 m for the 2010 DEM vs. 20 m for the 1990 DEM), and it would allow you to do a two-step comparison (1961 vs. 1990, and 1990 vs. 2010), to see if the retreat and/or thinning rates have varied between these periods, and whether they have accelerated or not. Further, you could even use the 1936 oblique photos, since from what I can tell from Table 1, the entire peninsula was covered also during that survey? Several studies compare the 1936/38 maps to the 1990 DEM (e.g., Nuth et al., 2007; Girod et al., 2018), so I strongly suggest that you compare more than two years (i.e., by adding 2010 and/or 1936), since that would add something extra to this paper.

Overall syntax and structure

The structure is generally good, but the readability would benefit from having a native English speaker reading through this manuscript. Sometimes the word choices are not optimal, the sentence structure not correct, or the sentences too long (e.g., line 80-84). This makes it somewhat difficult to understand the message, without re-reading some of the sentences. In the introduction, the paragraphs are very short, often only two sentences each. Merge some of them to get a clearer structure and give the text a better flow. I would remove the word 'glacier' after all of the glacier names, since 'breen' in the end of all names already indicates that those are glaciers (in Norwegian). Abbreviate Norwegian Polar Institute to NPI after the first use.

Study area

Start by introducing Svalbard, the influence of the West Spitsbergen Current, strong climate gradients etc., and how the ice masses vary between different parts of the archipelago. Then move on to the Hornsund area and the glaciers there. You could also show or describe some climate data from Hornsund, to see how the temperature/precipitation have changed from 1961 to 1990. Also introduce the concept of surging glaciers.

Source material

You mix present and past tense. Decide on one (I recommend past tense) and stick to it.

Line by line comments

Line 3: materials -> data

Line 8: glaciers of -> glaciers on (this is reoccurring in several places)

Line 9-10: Remove sentence about dataset availability. Enough to have this information in the 'Data Availability' section

Line 13-15: This sentence needs to be supported by 2-3 references. Also, do you with 'more dynamic' in the first part of the sentence mean faster? Or in terms of ice dynamics? This needs to be clarified. Reference suggestions: Nordli et al. (2014), Isaksen et al. (2016), Schuler et al. (2020)

Line 19: huge -> crucial

Line 20: Give some examples of 'traditional research methods', e.g., in situ stake mass balance measurements

Line 23: Support this statement with a couple more references, e.g., Jacob et al. (2012) and Nuth et al. (2013)

Line 24: Change to 'The use of remote-sensing has a number of advantages'

Line 44: Change to 'the University of Wrocław were held there (**Zyszkowski, 1982**)'

Line 47: has -> have

Line 51-52: Change to 'including primarily the Gåsreen **area**'

Line 57: Norwegian Polar Institute (**NPI**)

Line 59-61: Do you mean that the next map covering the entire peninsula was not published until in the first decade of the 21st century? Also, better to write out the year (2010) instead of 'the first decade of the 21st century'. Add reference

Line 64: 49 years later -> in 2010. Additional comment: if there are data with the same spatial extent from 2010, why don't you compare the 1961 and 1990 glacier extents to the 2010 extents as well? It would be interesting to compare the glacier areas, and see if the rate of retreat and thinning have increased or decreased etc.

Line 68: add the spatial coverage (XXX km²) of this map

Line 69: Enough to use the abbreviation (IGF PAN) here

Line 73: attempts -> aims

Line 73-73: Change to 'geometry of glaciers **on** the **western** Sørkapp Land peninsula'

Line 78-79: change to 'It **hosts** 14 land-terminating **and 4 tidewater** glaciers'

Line 85: Remove 's' in the end of 'Körberbreen glaciers'

Line 88: 'outflow glaciers' should be 'outlet glaciers'?

Line 93-94: Change to 'They formerly served as tributary glaciers to Samarinbreen, but as its snout receded, they split from it and today constitute separate calving glaciers'

Line 97: The **IGF PAN** topographic map

Line 98-100: Remove 'These were the following sheets' and put '(No. 5 –Hornsund, No. 8 – Gåsbreen, and No. 10 – Bungbreen; Fig. 2)' in brackets.

Line 102: Change to 'The topographic map sheets presented the relief, permanent and periodic watercourses, ...'

Line 106: colour from orange (**land**) to blue (**glacier**). Additional comment: is it blue or purple?

Line 111-112: Explain what you mean by 'somewhat non-standard mean' – what was done and in comparison to what (the standard way)? And what do you mean by 'in desk research'?

Line 116: Change he first 'extent' to 'degree'?

Line 117: Is "completed in the field" a quote from the map? Otherwise rephrase.

Line 123: Remove line break

Line 124-127: Change to 'These studies **were based on photos from NPI's photogrammetric overflight over the west of Sørkapp Land in the summer of 1960 (Table 1) and** resulted in a publication that included a map 125 showing the hypsometric variation of Gåsbreen and a hillshade that was valid for 1960 (Schöner and Schöner, 1996).'

Line 127: Another -> A (since referring to other glaciers)

Line 136: Add reference to the NPI photos

Line 142: Add reference to the NPI data after first sentence

Line 144: 'slightly less' – Can this be quantified?

Line 145: Divide into 4 Methods, and 4.1 Source data processing and evaluation of output data accuracy

Line 146: stages -> steps

Line 153: Does a newer version of R2V allow data to be saved as shapefiles and to be georeferenced? In that case, why did you not use the newer version?

Line 154: resultant -> resulting

Line 161: Remove '(northern hemisphere, zone 33)'

Line 162: Remove 'later in this work'

Line 165: GRID -> grid

Line 168: Remove 'with the working name DEM IGF 1961'

Line 171: Add reference

Line 174-186: Make this into one paragraph, and remove the sentence starting 'Work began with the correction of sheet 8...'

Line 180: Change to 'the locations of the elevation points **were** assessed'

Line 180: Remove 'as many as' and add 'elevation points' after 95

Line 181: about 50 elevation points? Not exactly 50, which are the same as 50 of the points in the map sheet?

Line 187-188: shifted southeastwards by how much?

Line 193: (Barna and Warchol, 1987)

Line 195: Remove 'because much of it was covered by the Greenland Sea'

Line 202: fragment -> portion

Line 205: adding a few **points**

Line 228: Remove 'natural' before 'processes'

Line 230: Remove 'for obvious reasons'

Line 231: Change to 'After **considering** the aforementioned criteria, the **part** of the IGF PAN model selected'

Line 247: Change to 'The measure for examining the **extent** and pattern of glacier **retreat**'

Line 248: The research -> This analysis

Line 251: Change to '**During** the study period'

Line 255: most intense -> greatest

Line 256: Change to '**For** these glaciers'

Line 257-258: Rephrase sentence to follow better after the previous one

Line 258-261: This comparison to the LIA does not belong in Results, but rather Discussion

Line 261-262: Repetition of narrowing of the lowest/lower parts of the glaciers. Rephrase

Line 268: shrank -> decreased

Line 268: amounted to -> was

Line 273: situation -> setting

Line 281: Change to '**at** their termini'

Line 286-287 Change to 'the area of Nordfallbreen decreased by only 0.03 km² (3.6%), **which is** among the lowest values in the entire region'

Line 289: Remove one of the 'However'

Line 290: Space missing after 'zone'

Line 292: 'receded by only 120 m' - Is not 120 m in 30 years a lot?

Line 297: shrinkage -> areal decrease

Line 298: Remove 'though this did vary between glaciers'. Change to '**For** the region's largest glaciers'

Line 299: shrinkage -> decrease

Line 299: leading into -> calving into

Line 300: for the glaciers instead of in the glaciers

Line 309: Could add Nuth et al. (2007, 2013) and Holmlund (2021)

Line 313: Specify which modern methods. Could also cite Girod et al. (2018) and Holmlund (2021)

Line 315-316 Change to 'The accuracy of simulations prognosing changes in glacier volumes based on dynamics models depends largely on **that** those models have been initialised correctly'

Line 323-324: How did the temperature change during this period? Relate this to meteorological data to explain the changes

Line 325-326: For the same time period (1961-90), or something else?

Line 331-332: extending upwards to -> reaching. Additional comment: what is the equilibrium line altitude in this area?

Line 354-355: Change to 'Nordfallbreen is adjacent to Nordfallet (824 m a.s.l.) to the south, which shades it against the sun while also providing it additional supply by avalanches'

Line 359: What's the elevation of the equilibrium line?

Line 367-373: Remove 'Ignorance of the principles on which they were compiled may lead to conclusions drawn as to the glacier recession rate being erroneous and, consequently, recession being overestimated for the years 1984–90, as the apparent status in 1984 would be contrary to reality. Specifically, the misapprehension lies in the fact that, a'. Instead, start the second sentence 'Although the IGF PAN field campaign was conducted in the early 1980s, the maps published after the expedition were based on elevation data taken from aerial photos from 1961, upon which only glacier extents were updated (with a change in colour of contours). Crucially, contour lines were not updated in this 1984 edition, and continued to represent the elevations of 1961.'

Line 384-385: Remove last sentence

Tables

Table 1: Add a third column with references to the published works from these overflights (or surveys?). Could also add a map next to the table, showing the coverage for each of the flights?

Tables 2-5: Add references to IGF PAN and NPI data. In Table 2: Vestre Zdanovfjellet with a capital V

Table 7: It says land-terminating glaciers instead of calving glaciers in the caption

Figures

Figure 1: Why the red frame in (c)? Make (c) only cover the area of interest or make the text 'Area of research' in red and put inside red box. Figure could also benefit from having a map showing Svalbard's location in the North Atlantic instead of panel (b)? Add all names mentioned in the text.

Figure 2: Label the maps (a), (b), and (c), and provide information on which sheet is which. Consider showing all ten map sheets, to help illustrate why these three are the most valuable (supported by an explanation in the text).

Figure 3: Mark the extent of this figure in Figure 2 or present them (Figures 2 and 3) together.

Figures 5-8. Merge these figures into one (or at least Figures 5, 6 and 8), and increase the letter size. Add info on contour line interval.

Figure 7: Stupprygen -> Stupryggen. This typo reoccurs in several figures and in the text.

Figures 10-12: Merge into one figure, potentially also adding the plot from Figure 13.

Figure 9 and 14: Present these figures together, to make them easier to compare. Could even present them together with Figure 4.

References

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Schuler, T. V., Kohler, J., Elagina, N., Hagen, J. O. M., Hodson, A. J., Jania, J. A., Käbb, A. M., Luks, Bartłomiej, Malecki, J., Moholdt, G., Pohjola, V. A., Sobota, I., & Van Pelt, W. J. (2020). Reconciling Svalbard glacier mass balance. *Frontiers in Earth Science*, 8, 156. <https://doi.org/10.3389/feart.2020.00156>