

# ***Interactive comment on “Historical glacier outlines from digitized topographic maps of the Swiss Alps” by Daphné Freudiger et al.***

**Anonymous Referee #1**

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The authors are presenting a dataset of the historical glacier extend in the Swiss alps during the period between 1917 and 1944. The dataset was derived by digitizing the famous Siegfried maps, the most accurate cartographical representation of Switzerland at that time and a worldwide milestone in the history of cartography and mapping of alpine regions. The dataset fills an important data gap between the Swiss Glacier Inventories of 1850 (Maisch, 2000) and 1973 (Müller, 1976). The paper describes a potentially important contribution to the Swiss Glacier Inventories (SGI). The choice of the Siegfried maps is obvious and the quality of the maps allows the assembly of a dataset of the glacier cover during the period of the land survey and map making. Although the compilation of this dataset is an important contribution, I have some substantial comments to be addressed by major revisions before the paper can be accepted. Sub-

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stantive comments: - Accuracy of glacier outlines: The overall accuracy of the map content is directly related to the density of individual survey stations per map sheet. As described, the number of stations increased from 300 to 6000 per map sheet over the period of the Siegfried map production. The accuracy of 35m in nature (0.7mm in map projection) only describes the accuracy of clearly defined features and survey stations and not topographically interpreted features (Eidgenössische topographische Bureau, 1872) (e.g. rivers, lakes, forest, glaciers, ...). The accuracy of those features are only depending on the density of surveyed stations (Caminada, 2003; p. 111). The only possible accuracy assessment of the glacier outlines is a cross-validation of the original field survey sheets. For a representative number of glaciers and areas a comparison with the original field survey sheets has to be conducted. The authors have to show, how the density of survey marks are influencing and improving the accuracy of the outlines. An assessment of the same region with different survey dates has to be done. As shown in Caminada (2003) such kind of assessment will allow a proper cross-comparison of glacier outlines.

- Dating of glacier outlines: As main source for the determination of the date of the glacier outlines the year of the map publication is used. Due to the very long process of land survey and map production this assumption is misleading and not accurate. At the best, the year of publication can be used as an indicator for further assessments. An accurate determination of the dates will be only possible by using and cross-comparison of the original field survey sheets. An important contribution is Bauder et al. (2007) with the comparison of recent datasets and datasets derived from the Siegfried maps.

- Subdivision of glacier outlines: As subdivision of the glacier outlines, catchment geometries were used (river basin delineations). This subdivision will be useful for hydrological assessments and models, but will not be practical for glaciological studies. Therefor the title of the paper is misleading and should contain a detailed definition of the possible usage of the dataset (e.g. hydrological modelling). The digitizing and

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the subdivision is not taking in account glaciological principals of glacier subdivisions. The naming of the glacier geometries is neither following the GLIMS identification nor the Swiss Glacier Inventory nomenclature. Therefore, the usage of the dataset for the comparison with other releases of the SGI is not recommended. Comparisons of the dataset is only possible by spatial intersection which is due to the inaccuracy of the geometry misleading. A valuable comparison of the dataset will be only possible by using a logical approach based on common identifiers of each glacier (e.g. GLIMS ID, SGI ID).

- Statistics of numbers of glaciers: The term “Number of glaciers” is misleading and due to the methodology of subdivision (catchments) not accurate. Currently the dataset can only be quantified by the surface (km<sup>2</sup>) or by the total length of outlines digitized (km).
- Validation of glacier outlines: The method of the validation is straight forward and could be applied as a first assessment. It is obvious that several regions (e.g. South-East of the Bernese Alps) are mainly classified as “Consistent”. The zoning of “Highly consistent” and “Consistent” follows major watersheds or cantonal boundaries. This zoning looks systematically and has to be revised. Base on the current approach neither the geometrical nor the temporal precision is known. The validation in the current paper is only a qualitative comparison between two datasets. A proper validation can only be done with a temporal comparable source (see below).
- Validation of glacier outlines with additional sources: A proper validation of the glacier outlines of the Siegfried maps should be done with an additional dataset at more or less the same period of time. Such kind of source can be the first edition of the topographical maps in a scale of 1:50'000 which followed the Siegfried maps. Based on the assessment of the survey dates (Mercanton, 1958) a more detailed dating of the outline can be done.

Detailed comments:

- Page 2, Line 25: The determination, localisation and handling of spatial and temporal

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uncertainties should be the key content of the article. An in-depth assessment of these uncertainties will be the most important contribution for the further usage of the dataset. The paper and the dataset has to include a suitable methodology and attribution of uncertainties. This has to be done with available original sources (survey sheets and notes) and cross-comparisons of further datasets of the same period of time.

- Page 3, Line 14: The arithmetic precision is only valid for survey stations and clearly defined landmarks. But not for glacier outlines.
- Page 3 Line 17: Correct. But the error is gradually from West to East and could be even roughly determined. For this paper, the vertical accuracy is not relevant. The statement can be omitted.
- Page 4, Line 1: The large differences of the density of measurement points is the main factor of the accuracy. This has to be reviewed and quantified.
- Page 4, Line 2: Raster et al. (2016) is providing an extensive analysis and methodology of accuracy assessment using Siegfried maps.
- Page 4, Line 11: The datasets of 1850, 1973 and 2010 are not produced independently. On the contrary they are highly depending due to the fact, that they were used as references.
- Page 5, Line 11: The total number of nodes and working hours are not relevant. Relevant is the relationship between total numbers of points compared with the total length digitized and the reference scale used during digitizing.
- Page 6, Line 9: Correct. The current delineation is not taking in account glaciological principals. Therefore, the authors should use the misleading term “Number of glaciers”.
- Page 8, Line 8: Sex and age of the persons are not relevant. Relevant are the skills of map reading and interpretation of glaciological phenomena.
- Page 8, Line 11: Main factor for the comparison of different datasets digitized are

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the usage of common guidelines (e.g. scale, interpretation, ...). Otherwise the competence of the operators is will be compared and not the precision of the digitizing process.

- Page 8, Line 14: In this approach, the capacity of the operators is compared and not the process itself.
- Page 10, Line 4: The inaccuracy of the Siegfried map is higher than the process of digitizing. Instead of analysing the inaccuracy of the digitizing process, the accuracy of the individual map sheets has to be investigated.
- Page 10, Line 17: The year of publication is irrelevant and misleading. An accurate assessment of the original data has to be done.
- Page 10, Line 34: With the current methodology, the date of the glacier mapping is never accurate. The year of map edition is by far not a reliable source of information.

Caminada, P. (2003). Pioniere der Alpentopografie: die Geschichte der Schweizer Kartenkunst. Zürich: AS-Verlag.

Eidgenössische topographische Bureau (1872). Instruktion für topographische Aufnahmen im Massstab 1:50000.

Mercanton, P. L. (1958). Aires englacées et cotes frontales des glaciers suisses, leurs changements de 1876 à 1934 d'après l'Atlas Siegfried et la Carte Nationale et quelques indications sur les variations de 1934 à 1957. Zurich.

Bauder, A., Funk, M., & Huss, M. (2007). Ice-volume changes of selected glaciers in the Swiss Alps since the end of the 19th century. *Annals of Glaciology*, 46, 145-149. doi:10.3189/172756407782871701

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