

Review for Earth System Science Data

Date: May/June 2014

Title: Glaciological and meteorological monitoring at LTER sites Mullwitzkees and Venedigerkees, Austria, 2006–2022

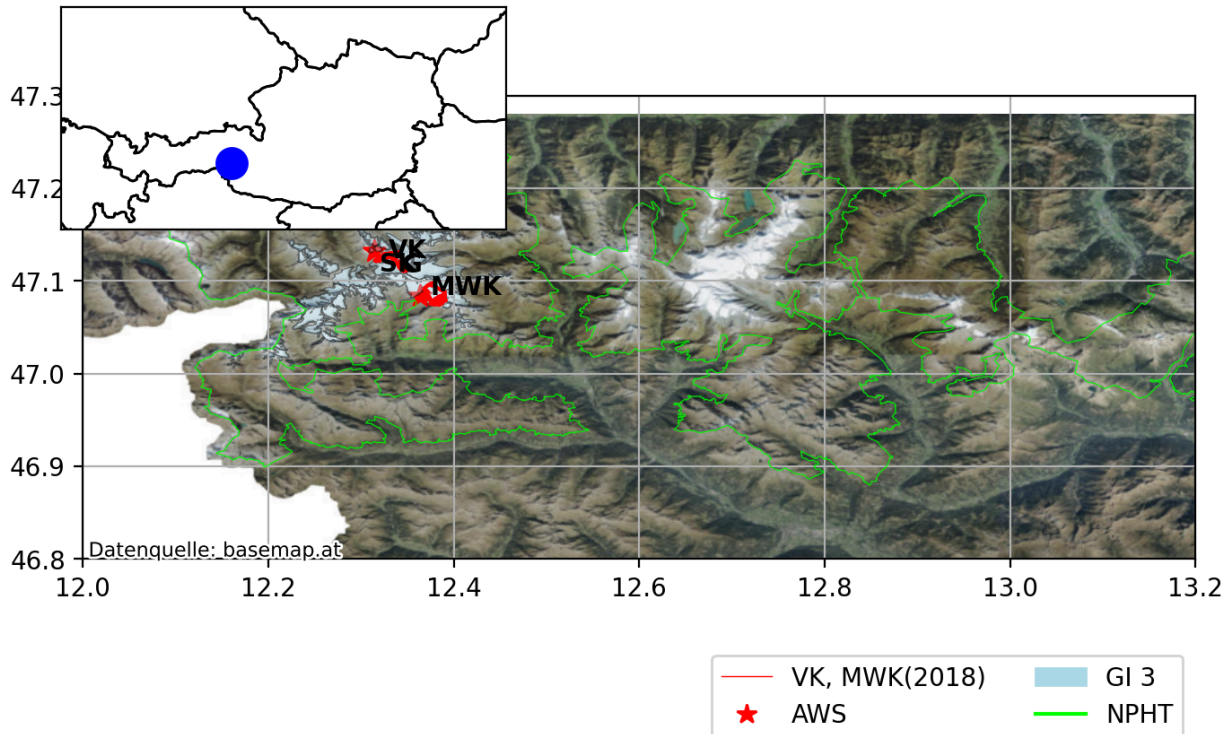
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In the submitted paper the authors present a very detailed and rich monitoring data set from glaciological mass balance and meteorological observation acquired during the last two decades at two glacier monitoring sites in the Austrian Alps. The data is accompanied by important insights into data acquisition, evaluation, and storage, as well as a transparent and well described analysis of themselves. The manuscript is well structured, and the methodology follows an established approach (Geibel et al., 2022), which is further developed where necessary. Uncertainties are openly and transparently addressed, recognized and reflected in the data collection. The results are well described and convincing, accompanied by nice figures and lead to important findings for mass balance measurements and related data storage. The paper is already in a very good shape and almost ready to publish. I do not have major issues to correct, but some comments and questions (mainly on the figures) that may be addressed by the authors when preparing a next version.

[Thank you for the encouraging and thoughtful review! We will be happy to address the comments. Please see below for responses to specific points.](#)

L 68: Is it possible or even useful to show the outline of the Hohe Tauern National Park in Figure 1?

[This is possible but perhaps not very useful. The national park includes an area considerably larger than the glaciers and showing the outline would require zooming out quite far, which makes it hard to see the locations of the weather stations, read annotations, etc. Due to this we would prefer not to include the park boundary. Here is a version of the figure showing the boundary in green for reference:](#)



L 94: GI3 is the third glacier inventory of Austria? You could introduce this abbreviation here, as it will also be referred to later in the manuscript (e.g. in Fig. 1).

Yes, we will add an explanation of the abbreviation as suggested.

L 95: Do you know in which year Venedigerkees became disconnected from Obersulzbachkees?

We don't know with certainty. It is likely that the two tongues remained connected by a narrow band of debris-covered ice for some time after the 2012 boundaries were drawn. Whether this dead ice section constitutes a functional connection and when exactly this connection was severed cannot be determined exactly. We will add this information to the text.

L 123-124, Figure 1: The chapter 2.1 Study Sites and Figure 1 are closely linked together, when reading the chapter, it is of great help to consult Figure 1 in parallel. Figure 1 may be improved with (i) Showing the boundaries of Hohe Tauern National Park (if useful), (ii) adding a scale bar, (iii) indicating the height of Grossvenediger, (iv) indicating the height of the weather stations. The caption of the figure may be complemented with the full name of the glaciers: "Outlines of Venedigerkees (VK) and Mullwitzkees (MWK) for 2018 in red."

We will update the figure as suggested (minus the boundary of the national park, see above)

L 214-215, Table 1: I am not sure if the information in Table 1 is of great use like this. I can see that there is an enormous number of measurements available for both study sites and an average value per year is indicated. However, I have difficulties to bring the values from Table 1

in relation to Figure 2 and 3. Furthermore I don't know if the measurements are evenly distributed to the years (as the average value suggests), or if there is a bias.

We will adjust the caption of the table and associated text to explain this in more detail. Essentially, Fig. 2 and 3 show the network of measurement locations (the stakes move a little with the ice flow and sometimes have to be repositioned, hence they are not always in exactly the same place) and the table shows how often measurements were carried out at these locations. There is no bias in the sense of a temporal trend but the number of measurements and available stakes varies somewhat over the years. We can add a range of minimum and maximum numbers per year to the table.

L 214-215, Figure 2 and Figure 3: This are important figures to show the dense monitoring networks at the two sites. However, it would be nice to see a little bit more about the context of the two glaciers in relation to their environment. It is maybe possible use contour lines or a hill shade of the relief to transport more information (e.g. to make obvious where steep or flat glacier parts are located). In addition, I think there is no reference to both figures in the text of the manuscript. Maybe you should add in the caption the statement "Coordinate reference system: MGI / Austria GK Central (EPSG:31255)" as you have it in Fig. 7ff.

We will update the figures to include more topographic context (contours or hillshade), ensure they are mentioned in the text, and adjust the caption as suggested.

L 245-249: You use the contour line method for spatial integration of the point mass balance. How is the expert knowledge gained that is incorporated? How many evaluators draw the lines? Did you ever compare results from different evaluators?

Expert knowledge is gained by frequent visits to the sites by the same people over multiple years. This leads to an improved understanding of terrain dependent processes relevant to mass balance, e.g. knowledge of zones with recurring avalanche activity or wind deposition of snow during particular weather patterns. This in turn is helpful when interpreting ablation patterns, or in the case of anomalous stake readings (--> for example: could a specific outlier reading be due to an avalanche?) We believe that it is very beneficial if the person evaluating the mass balance and drawing the contours is familiar with the respective glacier and either knows the seasonal patterns over multiple years or can consult with people who have this experience.

In the first years of the monitoring program at MWK, up to four people did separate analyses with the contour line method. This resulted in differences of around ± 100 mm w.e in the total, glacier wide mass balance. Due to the relatively minor differences the comparisons were later discontinued. The current approach is to aim for consistency by having the same person draw the contours every year (M. Stocker-Waldhuber for MWK, B. Seiser for VK). For an objective assessment of the contour line approach a comparison with geodetic mass balance is needed and will be carried out as soon as a suitable DEM becomes available.

L 295: add "Table": ...is provided in Table 4.

Yes, we will add the missing word.

L 316-317; 331-332: Use italics when explaining the variables in the equation.

OK!

L 354-355: Should these values correspond with the values from Table 1?

Yes, they do correspond to the table in a general sense but they are grouped slightly differently in the text and table, e.g. the table gives the total number of intermediate measurements, while the text separates by measurement type (stakes, pits). We will rephrase this to clarify.

L 372-373, Figure 4: I also like this Figure and showing the readings of 2022 in red is an enriching detail. For a better reading, I would like, if the panels could be labelled with a), b), and c). And I think it would be of value, to label the black vertical lines indicating April 30 and September 30 directly in the graph of panel a).

We will add labels as suggested.

L 372-373, Figure 5: Maybe also here, labelling of the vertical line indicating September 30 would help to capture the timescale of the x-axis at first glance. Maybe you could complement the titles of the panels with the height information of the stake? And would it be possible, to locate and name these three stakes in Figure 2 and Figure 3 respectively, to know where these stakes are located?

We will label the line and adjust Fig. 2 and 3 to indicate where the stakes are.

L 374-275: This statement refers to counting's per year?

Yes, we will rephrase to clarify.

L 410: I guess the contour line at MWK are also manually derived? Maybe complement the sentence with this information.

Yes, it is the same for both glaciers. We will add this to the sentence.

L 421-422, Figure 7 and Figure 9: Complement the caption of both figures with the information that you used contour lines to derive the zones of mass balance. What are the steps (in mm w.e.) between the different mass balance elevation zones?

We will adjust the captions and add the steps between the zones.

L 421-422, Figure 8 and Figure 10: The small points of snow depth probing are really hard to see. What are the steps (in mm w.e.) between the different mass balance elevation zones?

We will adjust the size of the markers for the probing and add the steps to the caption.

L 421-422, Figure 7, Figure 8, Figure 9, Figure 10: At first glance the label of the y-axis I interpreted the "m" as "E".

We will adjust the labels and spell out "meters"

L 440-441, Figure 12: I really like this figure that gives an integrated and complete overview on the mass balance measurements and the related evaluation on both study sites. However, I

think it's a pity to squeeze the results of both glaciers in into one figure. Wouldn't it be of additional value and easier to interpret the results, if you present it in two figures?

Thank you for the suggestion, we will turn this into two figures.

L 473-474, Figure 13, Figure S3: The readability of the figure would be improved by adding minor tick marks on the x-axis for the single months.

We will add tick marks!

Data Quality: I was struggling a bit, to download all the data related to the paper, as some were already easily accessible through PANGAEA and for others tokens and further links had to be used. However, at the end I think I managed to get all the data, but must say, that it is not easy to keep the overview on all the different packages. I hope this will be improved, as soon as the paper is accepted and the data published. From all the ten data package provided via PANGAEA I checked at least one dataset. As far as I could see, the data sets are set up as explained in the paper (with quality flags and uncertainties) and seem to be complete and of great use for further studies.

All data will be publicly available (no tokens or additional links). We understand that the PANGAEA approach of having annual datasets grouped into publication series is sometimes not ideal if users simply want all the data. It does however allow for more flexible updates every year and provides DOI for single years/individual data sets, which can also have advantages. We will add some code examples to the github repo for the paper showing how to bulk download the data and generate the figures in the manuscript from the PANGAEA format.