

Glaciological investigations on Grosser Aletschgletscher

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1. Project description

Long-term glacier observations have been carried out in the frame of Glacier Monitoring in Switzerland (GLAMOS) in order to document variations of Grosser Aletschgletscher with evaluations of annual length change measurements since 1880, accumulation and mass balance measurements starting in 1918, and repeated map or aerial photograph surveys, respectively. In an ongoing project the length, area, volume, and mass changes are continuously observed applying modern remote sensing techniques, as well as direct field measurements. The research activities are focused on long-term trends and seasonal fluctuations.

Mass balance components including firn accumulation and ablation are measured in detail at one location on Jungfraufirn. Seasonal observations at the end of winter and end of summer are performed. During winter snow accumulation is the dominating process while ablation of snow and ice occurs in the summer period. Thus, results from seasonal mass balance measurements allow separating the processes of accumulation and ablation. First measurements at this site were started more than a century ago in 1918. Between 1950 and 1985 an extensive network of measurements distributed over the entire glacier surface was maintained. Presently only six sites are surveyed both at the end of winter and summer seasons and are distributed along a longitudinal transect from the Jungfrauoch to the glacier tongue. In addition, a webcam to monitor daily ice ablation and snow accumulation has been in continuous operation at an elevation of 2250 m asl and allows inferring the current state of the glacier in comparison to previous years.

In the last observation period (2020/21) with almost 6 m of snow one of the highest amount of snow accumulation at the end of winter was registered at the site on Jungfraufirn in the vicinity of Jungfrauoch (see Figure 1 top). The summer 2021 was characterized by above-average melting, but significantly less intensive than in the previous three summer seasons. However, as a result of the winter and summer conditions, an above-average annual balance was registered in comparison over the last 20 years.

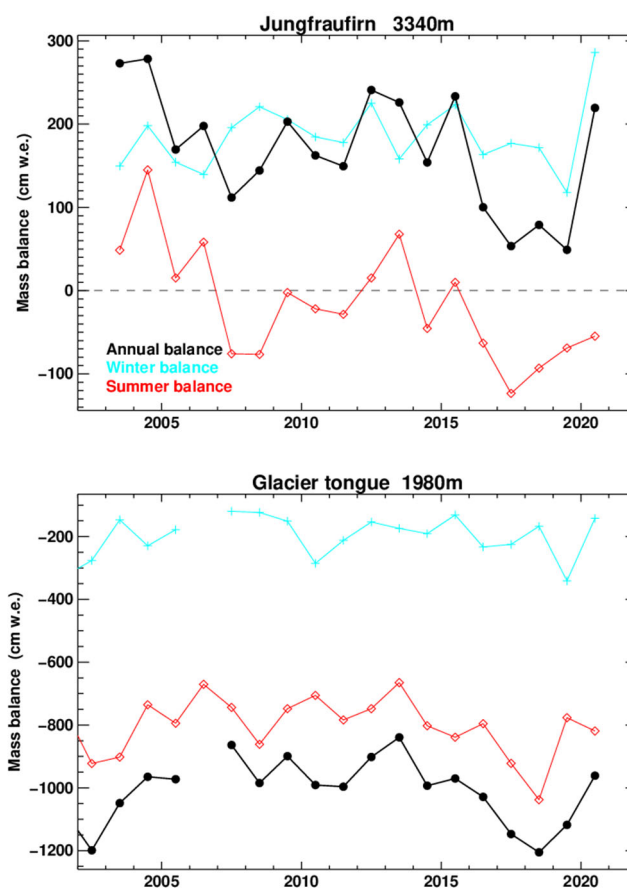


Figure 1. Winter, summer and annual mass balance (in centimetres water equivalent) over the past two decades at the two sites on Jungfraufirn (top) and on the glacier tongue (bottom).

In contrast the winter conditions were less abnormal on the lower areas of the glacier as revealed by the measurements on the glacier

tongue. With almost 10 m of ice there was an average but still a significant annual loss registered at this site at about 2000 m asl (Figure 1 bottom).

The mass change of the entire glacier is evaluated from all available individual measurements at different locations and the periodical assessment of the ice volume change by comparison of digital elevation models (DEMs) representing the surface topography. Accurate DEMs exist for 1927, 1957, 1980, 1999, 2009 and 2017 over the last 100 years, respectively.

The glacier-wide mass balance of Grosser Aletschgletscher since 1927 is presented in Figure 2. In the last observation period almost

balanced conditions resulted and represent the most favourable annual balance since the last positive result in the 1980s. The relatively good situation in 2021 is likely explained by the abundant snow falls in spring that have significantly delayed the onset of summer melting. This singular annual result may not hide the fact of many consecutive negative results over the past two decades. The largest glacier in the Alps experienced a significant reduction of about 65 m in mean ice thickness over the last 100 years. Almost two third of this loss occurred in the past three decades alone (Figure 2).

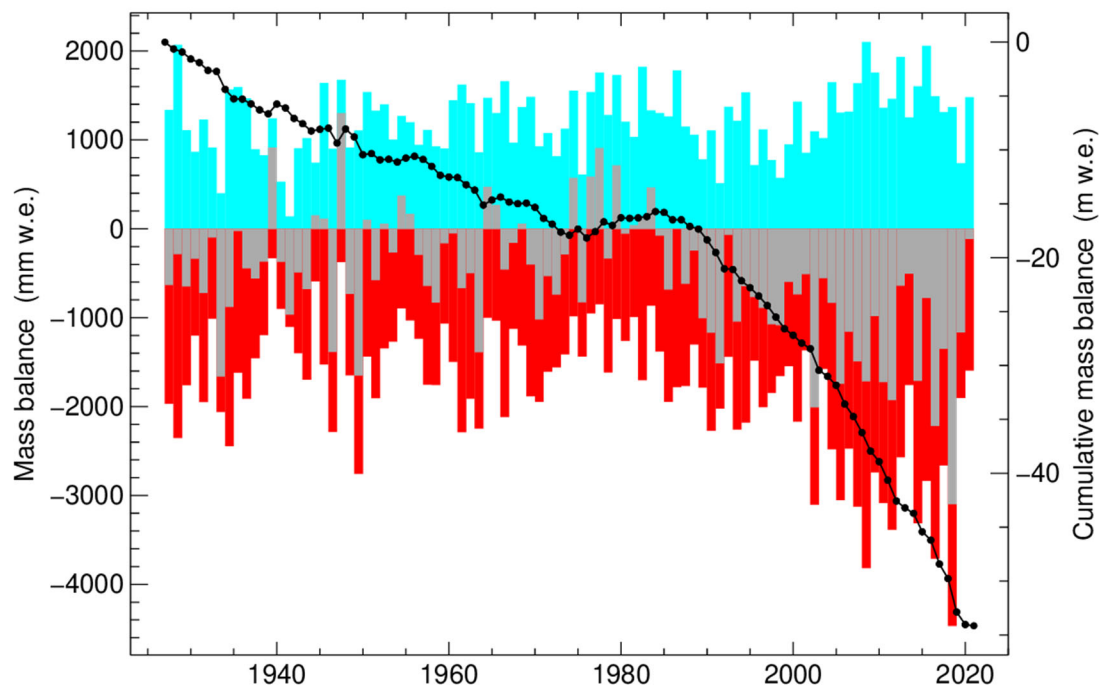


Figure 2. Glacier-wide winter (blue), summer (red) and annual (grey) mass balance (in millimetres water equivalent) of Grosser Aletschgletscher since 1927 and the first detailed mapping of the entire surface topography. Area averaged cumulative mass balance (in meters water equivalent) is given in black.

Internet data bases

<http://www.glamos.ch>
<http://www.gliaciology.ethz.ch>

Collaborating partners / networks

Laudo Albrecht, Maurus Bamert, Pro Natura Zentrum Aletsch, Villa Cassel, Riederalp
 Dr. André Streilein, Roberto Artuso, swisstopo, Wabern

Scientific publications and public outreach 2021

Refereed journal articles and their internet access

Grab, M., E. Mattea, A. Bauder, M. Huss, L. Rabenstein, E. Hodel, and H. Maurer, Ice thickness distribution of all Swiss glaciers based on extended ground-penetrating radar data and glaciological modelling, *Journal of Glaciology*, **67**, 266, 1074-1092, doi: 10.1017/jog.2021.55, 2021.
<http://dx.doi.org/10.1017/jog.2021.55>

Landmann, J., H.R. Kuensch, M. Huss, C. Ogier, M. Kalisch and D. Farinotti, Assimilating near-real-time mass balance stake readings into a model ensemble using a particle filter, *The Cryosphere*, **15**, 5017-5040, doi: 10.5194/tc-15-5017-2021, 2021.
<http://dx.doi.org/10.5194/tc-15-5017-2021>

Linsbauer, A., M. Huss, E. Hodel, A. Bauder, M. Fischer, Y. Weidmann, H. Bärtschi and E. Schmassmann, The new Swiss Glacier Inventory SGI2016: From a topographical to a glaciological dataset, *Frontiers in Earth Science*, **9**, 704189, doi: 10.3389/feart.2021.704189, 2021.
<http://www.frontiersin.org/article/10.3389/feart.2021.704189>

Conference Papers

Geibel, L., C. Kurzböck, M. Huss, A. Bauder, Data Rescue and Homogenization of Historic Mass Balance Measurements on Swiss Glaciers, European Geoscience Union General Assembly, Vienna, Austria, April 8-13, 2021. <https://doi.org/10.5194/egusphere-egu21-2959>

Linsbauer, A., M. Huss, E. Hodel, A. Bauder, M. Fischer, Y. Weidmann, H. Bärtschi, The new Swiss Glacier Inventory SGI2016: a detailed cartographic representation of Swiss glacier extent and supraglacial debris-cover, European Geoscience Union General Assembly, Vienna, Austria, April 8-13, 2021. <https://doi.org/10.5194/egusphere-egu21-5873>

Radio and television

“Unser Trinkwasser“, Film welcher ETH Glaziologen bei ihrer Arbeit auf dem Grossen Aletschgletscher begleitete, Arte und 3Sat, August 26, 2021.
<http://www.3sat.de/wissen/wissenschaftsdoku/210826-wido-sendung-100.html>

“Glaciers 1/5 - Aletsch, mon ami“, Report of high school pupils accompanied by glaciologist Matthias Huss, Radio RTS 1, “Vacrame“, October 4, 2021.
<http://www.rts.ch/audio-podcast/2021/audio/glaciers-1-5-aletsch-mon-ami-25767547.html>

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