Winter snow accumulation on Swiss glaciers in 2025

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Summary

The end-of-winter snow cover on 21 glaciers (with detailed surveys on 13 glaciers) was measured within the programme Glacier Monitoring Switzerland (GLAMOS) in April and May 2025. Snow water equivalent on the glacier surface represents an essential variable to understand the potential impact of melting during the coming summer season. Snow depth soundings distributed over the glacier's elevation range, and snow density measurements were performed. This year's results show below-average snow cover on glaciers in all regions of Switzerland with snow depths of between ca. 1 to 4 metres. Strong regional differences are evident with partly record-low snow cover on glaciers in Northeastern Switzerland but close to average values in the South and Southwest thanks to an exceptional snowfall event in mid-April in that region. Extrapolated to all Swiss glaciers, the winter snow deficit is –13% compared to 2010-2020.

Zusammenfassung

Die Schneemenge am Ende des Winters wurde im April und Mai 2025 im Rahmen des Schweizer Gletschmessnetzes (GLAMOS) auf 21 Gletschern gemessen (mit detaillierten Erhebungen auf 13 Gletschern). Daten zum Schneewasseräquivalent auf der Gletscheroberfläche stellen eine wichtige Grundlage dar, um die möglichen Auswirkungen der Schmelze während der kommenden Sommersaison zu verstehen. Dazu wurden grossflächig verteilte Schneesondierungen über die gesamte Höhenerstreckung des Gletschers, sowie Schneedichtemessungen durchgeführt. Die Ergebnisse zeigen eine unterdurchschnittliche Schneebedeckung auf Gletschern in allen Regionen der Schweiz mit Schneehöhen zwischen ca. 1 und 4 Metern. Starke regionale Unterschiede zeigen sich mit teils rekordtiefen Schneemengen auf Gletschern in der Nordostschweiz, während die Schneemengen im Süden und Südwesten dank eines aussergewöhnlichen Schneefall-Ereignisses Mitte April nahe dem Durchschnittswert liegen. Hochgerechnet auf alle Schweizer Gletscher ergibt sich ein Defizit von –13% Winterschnee im Vergleich zum Zeitraum 2010-2020.

Snow density measurements (Grosser Aletschgletscher, left), and snow depth probing (Rhonegletscher, right) in late winter 2025. Photos: M. Huss

1. Measurements and basic approach

Within the standard observational programme of Glacier Monitoring Switzerland (GLAMOS) detailed end-of-winter measurements of the snow water equivalent were performed on 13 glaciers in April and May 2025 (Fig. 1). Snow depth surveys with a reduced effort were conducted on 8 additional glaciers, resulting in a total of 21 glaciers throughout Switzerland with information on winter snow accumulation. The aim is to determine the glacier-wide winter mass balance, and thus to prolong multi-decadal series of this quantity that is crucial for understanding the effects of shifts in meteorological forcing on glacier mass change. Winter snow accumulation recharges glacier mass if it persists over the summer season. Furthermore, it refers to the protective layer of the ice and, hence, is an important quantity to estimate the potential impact of subsequent summer melting on annual mass balance, or overall ice volume loss.

Long-term measurement programmes are ongoing on the surveyed glaciers. The measurements of winter mass balance, with a spatial coverage of the entire glacier surface, has however only been intensified about 20 years ago. As snow depth shows strong small-scale spatial variability, a dense network of local measurements is needed to capture the total snow mass deposited on the glacier surface. Typically, 50 to 200 individual snow depth measurements, consisting of 2-3 snow soundings at each point, are acquired. In addition, density of the entire snow column down to the ice surface is determined at 1-5 sites per glacier. The number of these measurements depends on the glacier's elevation range and are acquired by coring (GLAMOS, 2021). Subsequently, all snow depth observations are converted to water equivalent and are spatially extrapolated to the scale of the entire glacier using a model-based approach that is optimally taking into account the spatial variability and inhomogeneities in sampling (Huss et al., 2021; GLAMOS, 2024a/b). This approach also resolves the daily glacier-wide mass balance and thus allows determining the date of the late-summer minimum surface, as well as a homogenization of the results to common and thus comparable dates. Here, 30 April is considered here as a reference date for the end of winter.

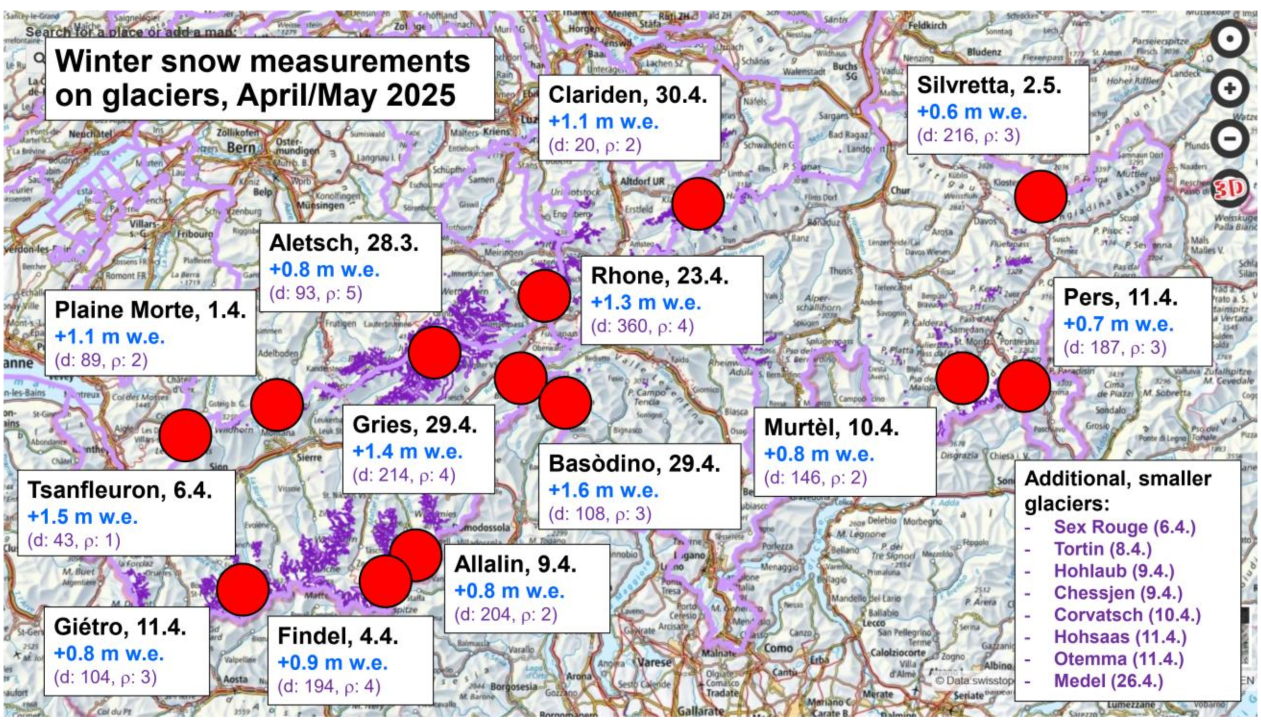

Figure 1: Overview of winter snow accumulation measurements performed on Swiss glaciers in April and May 2025. For all visited glaciers the date of the survey, as well as the glacier-wide winter mass balance (blue) is given. The number of snow depth soundings (*d*) and the number of snow density survey points (*ρ*) is stated in purple.

Measurement conditions in early April were characterized by optimal weather and low snow depth, especially on the glacier tongues (see Appendix A.2). The snow cover was consolidated but did not exhibit frequent ice layers that would make the measurements more laborious. After a period with unstable weather and an extreme snowfall event in mid-April in the Southern Valais and the Bernese Alps with up to 2 metres of fresh snow, the remaining measurements could be completed with again optimal conditions until the end of April (Fig. 1). This is earlier than usual, but was appropriate due to the onset of the melting period. In 2025, for the first time, winter measurements on Glacier du Giétro, a reference glacier of the World Glacier Monitoring Service, were conducted. In addition to the main monitoring sites, a number of glaciers with additional measurements, mostly related to ongoing projects, could be included in the evaluations (e.g. Glatscher da Medel, Glacier du Tortin).

2. Results

Summary figures for all investigated glaciers are shown and interpreted below. The Appendix contains glacier-specific figures allowing in-depth insights regarding different variables, such as the spatial distribution of winter snow across the glacier, or the temporal dynamics of glacier mass balance.

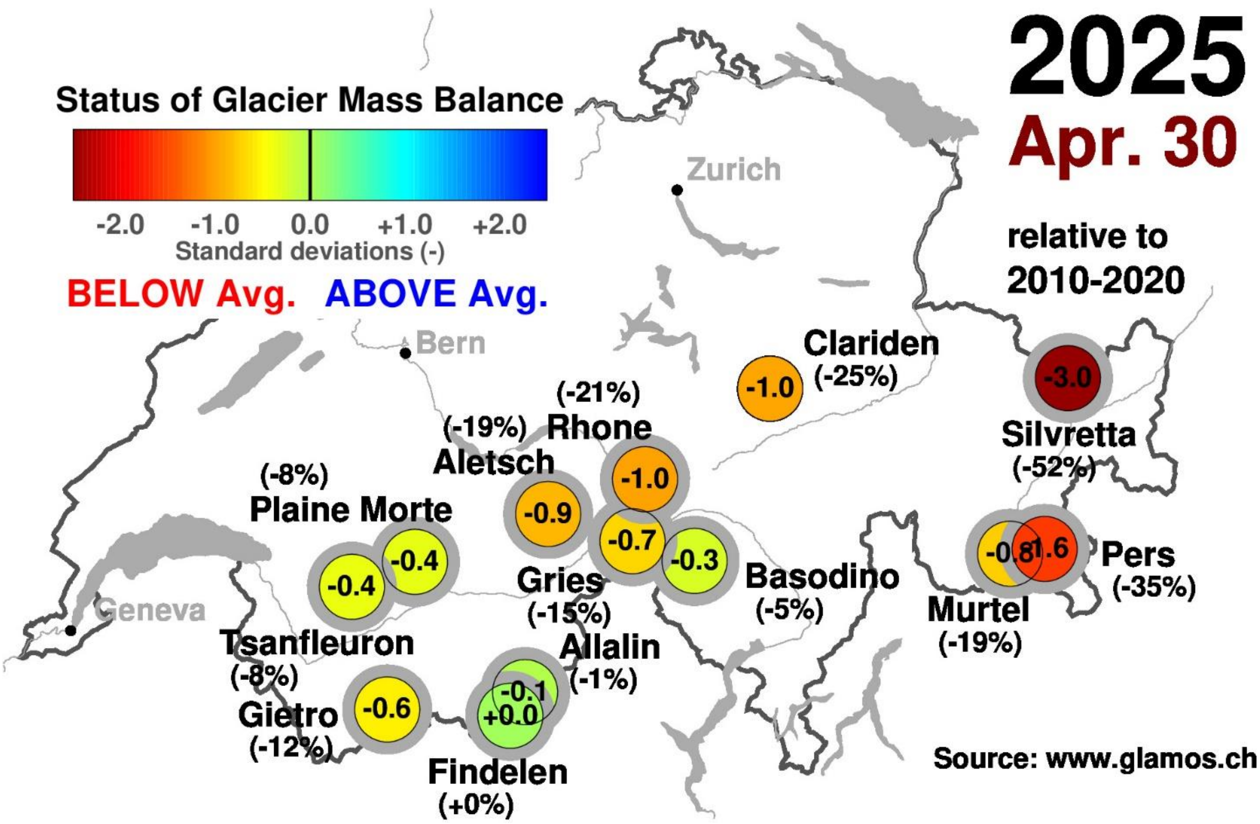

Figure 2: Anomaly of winter mass balance for all surveyed glaciers homogenized to 30 April 2025 relative to the average of the period 2010-2020 expressed in standard deviations. The difference in percent is given. Yellow-red colours indicate below-average snow conditions, and green-blue colours above-average snow conditions.

By the end of April 2025, the snow water equivalent on glaciers was slightly to strongly below average for the measurement sites across the Swiss Alps (Fig. 2). Winter mass balances of between +0.6 m w.e. (Silvretta) to +1.6 m w.e. (Basòdino) were measured (Fig. 1). At some sites, this is only half of the observed snow amount in late winter 2024. As absolute values of winter mass balance are difficult to be directly compared among glaciers due to different local climates (i.e. precipitation totals), we compare the individual glaciers' deviation from the decadal average (2010-2020). These anomalies are expressed in standard deviations, which gives insights into the frequency of occurrence. For the winter mass balance homogenized to 30 April 2025 we find that glaciers are between 0.0 and 3.0 standard deviations below their respective mean values (Fig. 2). This corresponds to a deficit of winter snow of between 0% and 52%. Even though this does not reach the general snow deficit on glaciers in the very dry winters of 2022 and 2023, a new record-low value has been registered for Silvrettagletscher within the >100 years of data on this quantity.

A very clear trend from Southwest to Northeast is visible, related to the prevailing weather patterns in the winter of 2024/2025 (Fig. 2). Glaciers in the Southern Valais, as well as the Ticino (Findel, Allalin, Gries, Basòdino) show winter mass balances close to the 2010-2020 average or slightly below. Glaciers in the Bernese Alps or Central Switzerland exhibit moderate winter snow deficits (Plaine Morte, Aletsch, Rhone), while snow coverage is more strongly below-average in the Engadin (Pers, Murtèl). Glaciers in Northeastern Switzerland, however, show very strongly below-average winter balances (Clariden, Silvretta). This pattern is importantly determined by an exceptional 2-day snow precipitation event in mid-April (see Appendix A.5), discharging locally more than 2 metres of additional snow on glaciers, corresponding to ca. 15-30% of the total winter accumulation. This event affected the Southern Valais, the Ticino and the Bernese Alps, but was less pronounced or even absent in the Eastern Swiss Alps.

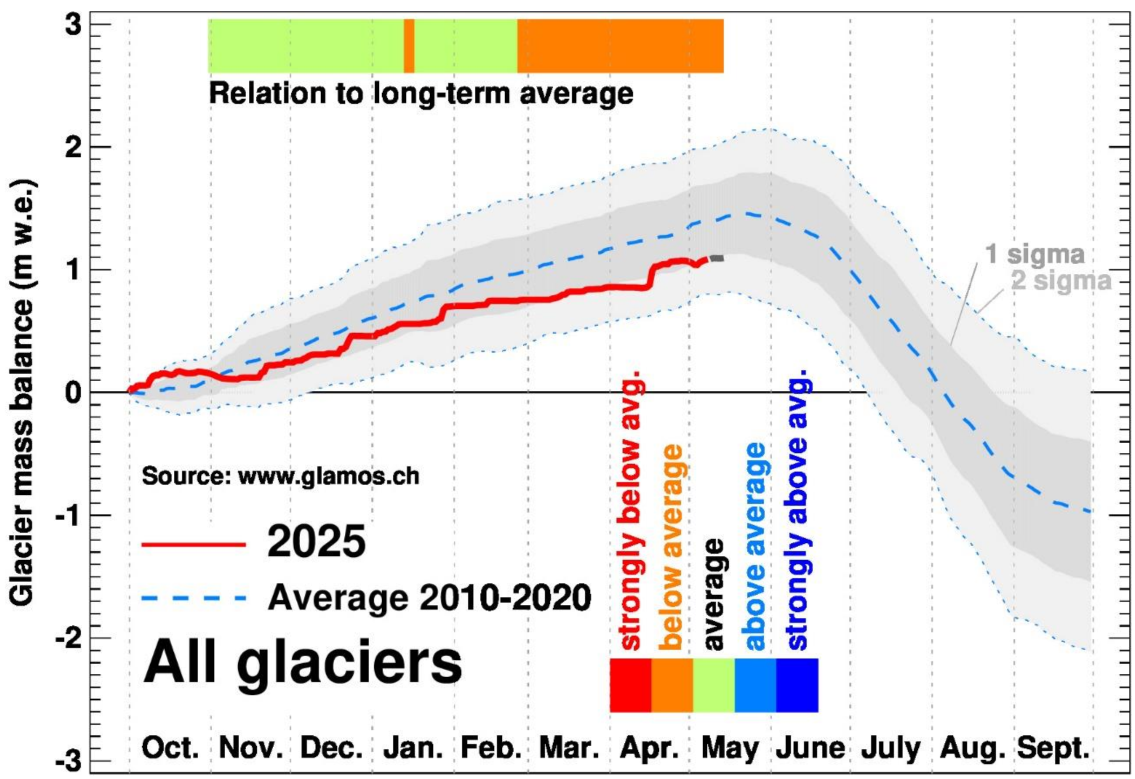

Figure 3: Cumulative daily mass balance in the hydrological year 2025 up to the release date of the report (red) in comparison to the average and the spread of the years 2010-2020. Results based on the 6-day weather forecast are in grey. The top bar indicates periods throughout the year with below- or above-average mass balance. The arithmetic average of the main surveyed glaciers (Fig. 1) is shown.

The temporal evolution of the winter snow accumulation on glaciers is characterized by an early onset with snow precipitation down to the glacier termini already in the first half of September 2024. However, warm and sunny weather then prevailed until early November resulting in sustained ice ablation below ca. 2800 m a.s.l. while the higher reaches of the glaciers remained snow-covered. This leads to a poorly defined late-summer minimum of glacier mass balance. The starting point for winter mass balance evaluation (optimally capturing the snow accumulation season) thus lies between 9 Sept and 11 Nov 2024, depending on the glacier's meteorological characteristics and its elevation range. The growth of snow cover on glaciers followed a normal trend between mid-November and late January, even though being slightly below the average (Fig. 3). The snow-cover deficit became more pronounced, particularly North of the Alpine divide, in February, March and April until the above-mentioned precipitation event (see Appendix A.5). Note that Figure 3 is referenced to the start of the hydrological year (1 Oct). The net snow accumulation in September 2024 or further mass losses until November 2024 on some glaciers thus lead to apparent shifts of the snow signal in overall cumulative daily mass balance in this visualization.

When extrapolating the snow water equivalent anomalies homogenized to 30 April 2025 to all 1'400 glaciers in the Swiss Glacier Inventory SGI2016 (Linsbauer et al., 2021), thus accounting for differences in regional sampling density, we find a below-average winter mass balance on Swiss glaciers (Fig. 4). Even though for some glaciers, data are available going back to the early 1920s, we do not consider the spatial density to be sufficient to prolong this analysis beyond the year 2005. For 2025, the analysis indicates that 13% less winter snow was present on Swiss glaciers relative to the mean in the period 2010-2020. This value is less negative than in the very dry winters of 2022 and 2023 but is still expected to unfold its impact on glacier mass balance via earlier disappearance of the protective snow cover during the coming summer. The Swiss-wide signal is driven by the better situation of glaciers in the Valais, while snow-cover deficits were higher in the Rhine (-18%) and the Inn (-28%) basin.

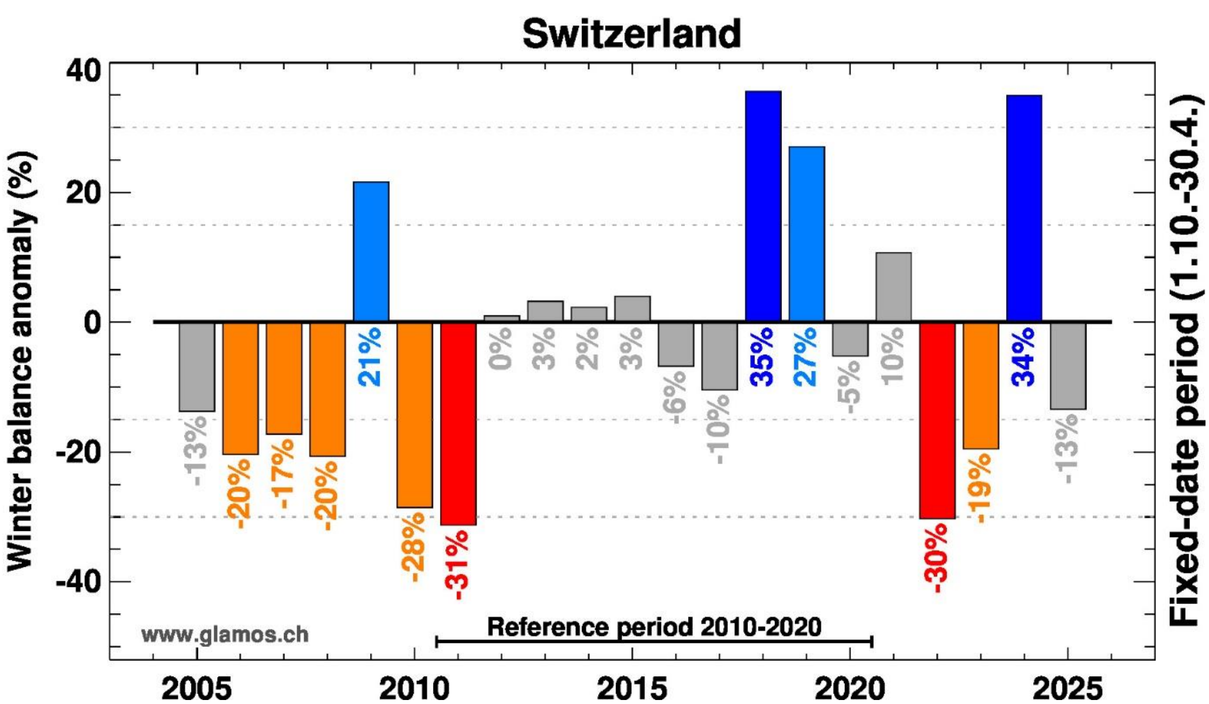

Figure 4: Relative winter snow accumulation anomaly with respect to the period 2010-2020 at the reference date 30 April extrapolated to all glaciers in Switzerland over the last 20 years. Colours visualize average (grey), below-average (orange/red) and above-average (light blue/dark blue) years.

Besides snow depth and its spatial distribution, snow density is an important variable to determine the winter mass balance of glaciers. Long-term records of end-of-winter snow density indicate substantial temporal variations, even though the measurements have always been acquired at roughly the same time of the year (Fig. 5). Especially the years 2022 and 2023 with particularly small snow depth were characterized by record-low end-of-winter snow density. Measured snow densities in April 2025 are close to the long-term average. A clear dependence of average snow density on the considered glacier is recognizable (Fig. 5). This is explained by differences in overall snow depth (that generally correlates with density), as well as differences in the typical dates of the field survey for the individual sites.

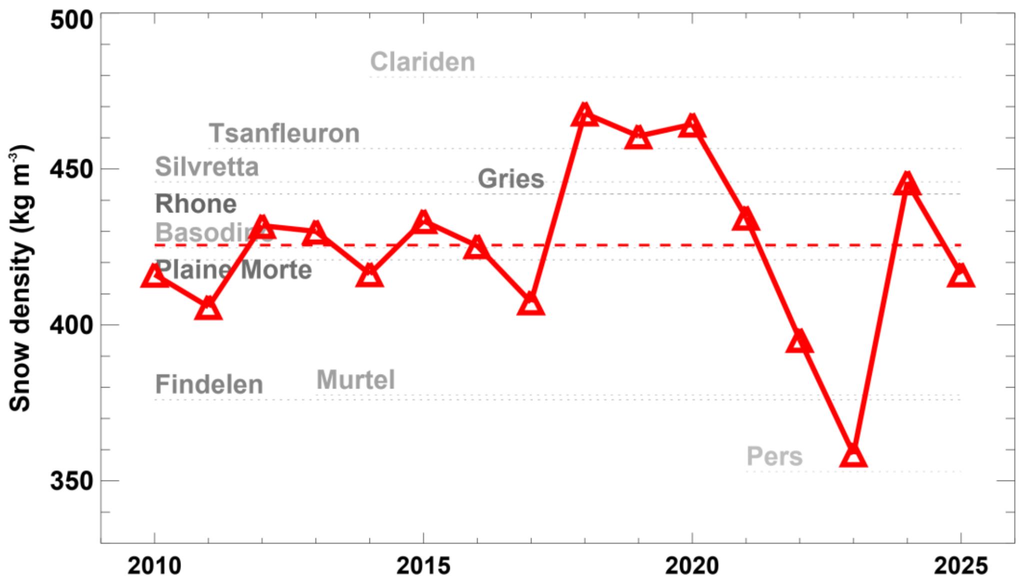

Figure 5: Measured variations in average snow density over the last 20 years for selected glaciers. The red line/symbols show the mean of all glaciers, and the grey, dotted lines refer to the overall average density and the temporal data coverage of individual glaciers.

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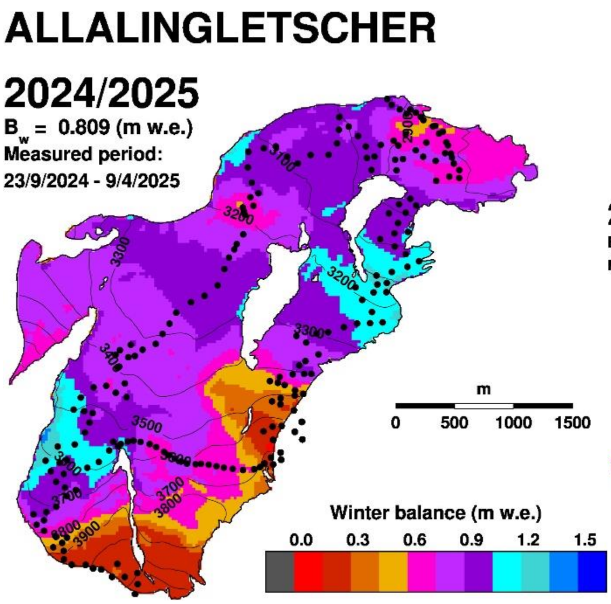
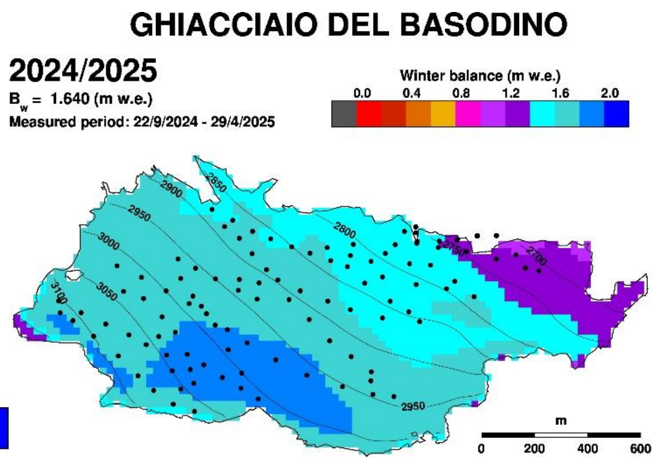
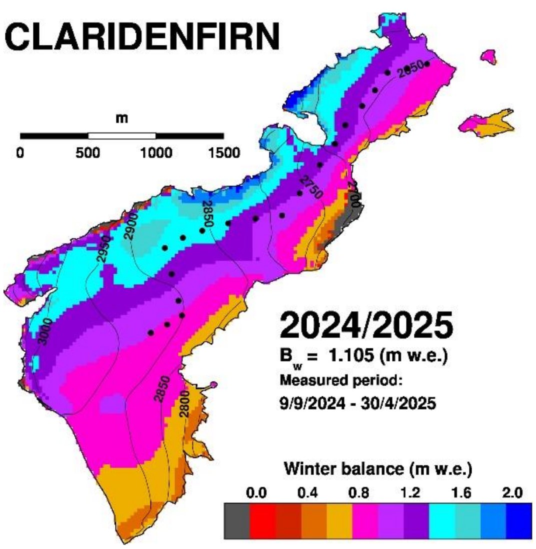
3. Appendix

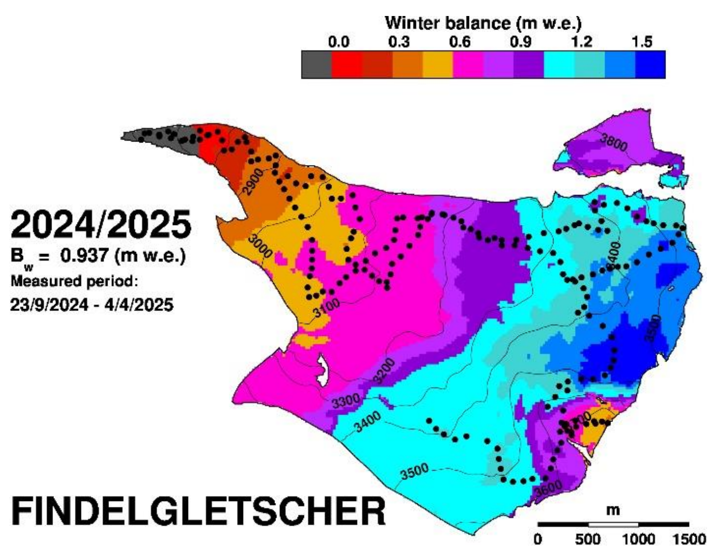
A.1 Spatial distribution of winter mass balance

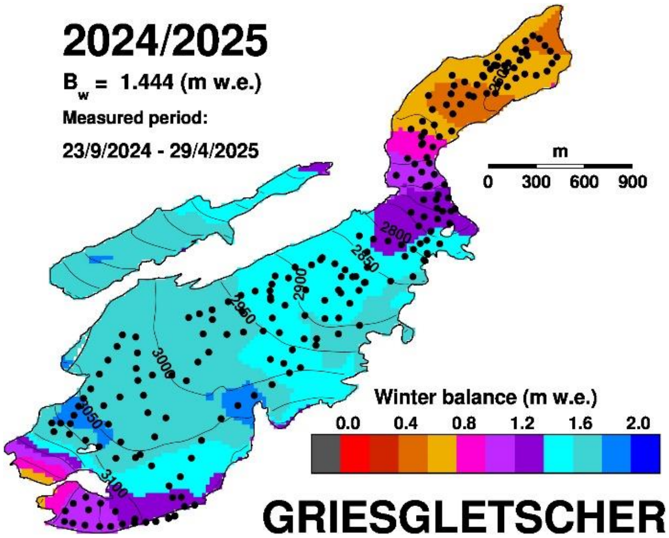
The figures below show the extrapolated winter mass balance distribution in metres water equivalent (m w.e.) at the observation date. Measurement points of snow depth are indicated with black solid dots. The spatial extrapolation accounts for processes of local snow redistribution. Glaciers are ordered alphabetically.

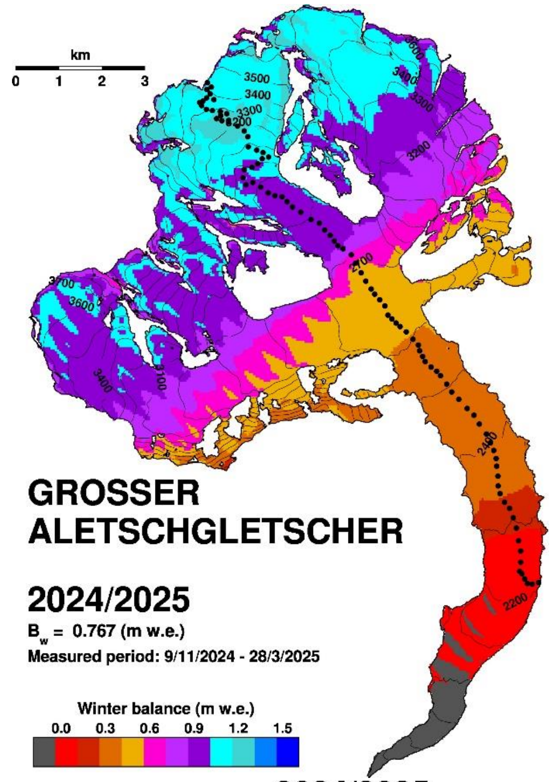


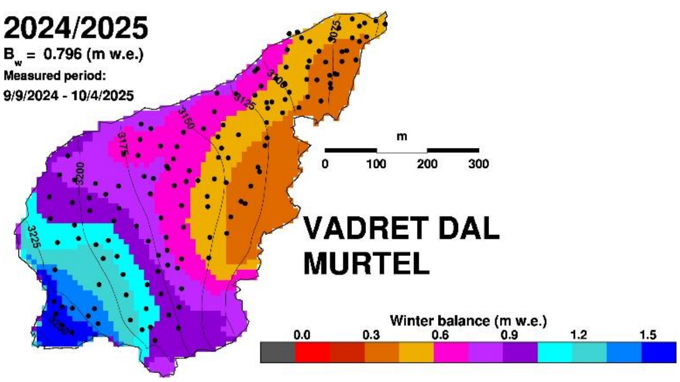


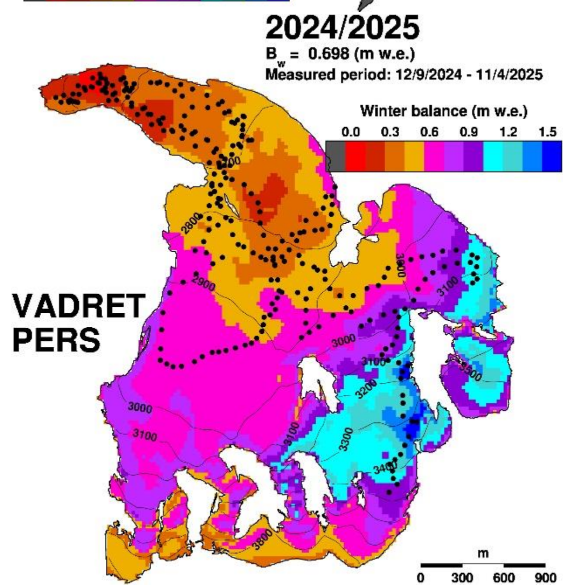


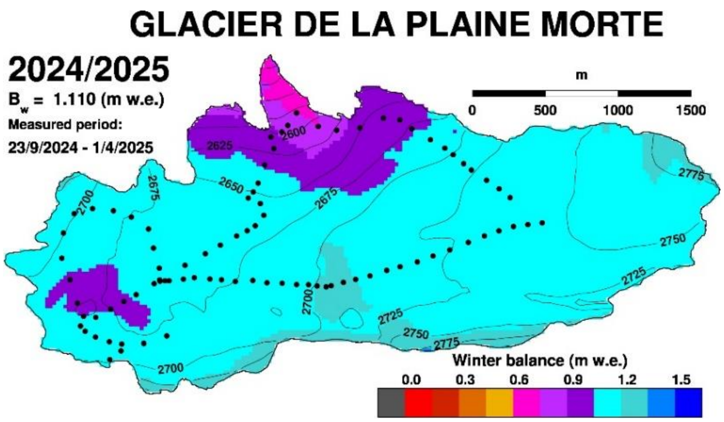


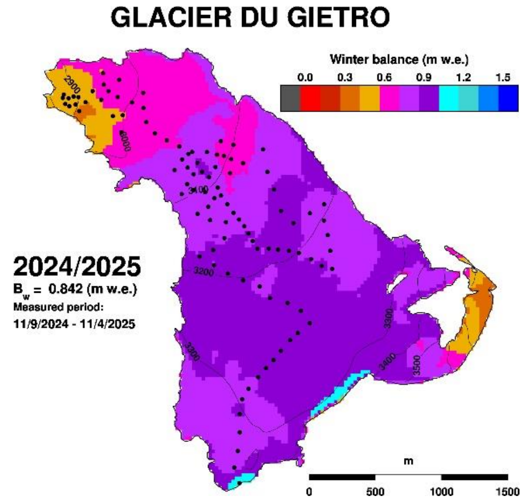

2024/2025
B_w = 1.444 (m w.e.)
Measured period:
23/9/2024 - 29/4/2025
m
0 300 600 900
Winter balance (m w.e.)
0.0 0.4 0.8 1.2 1.6 2.0
GRIESGLETSCHER

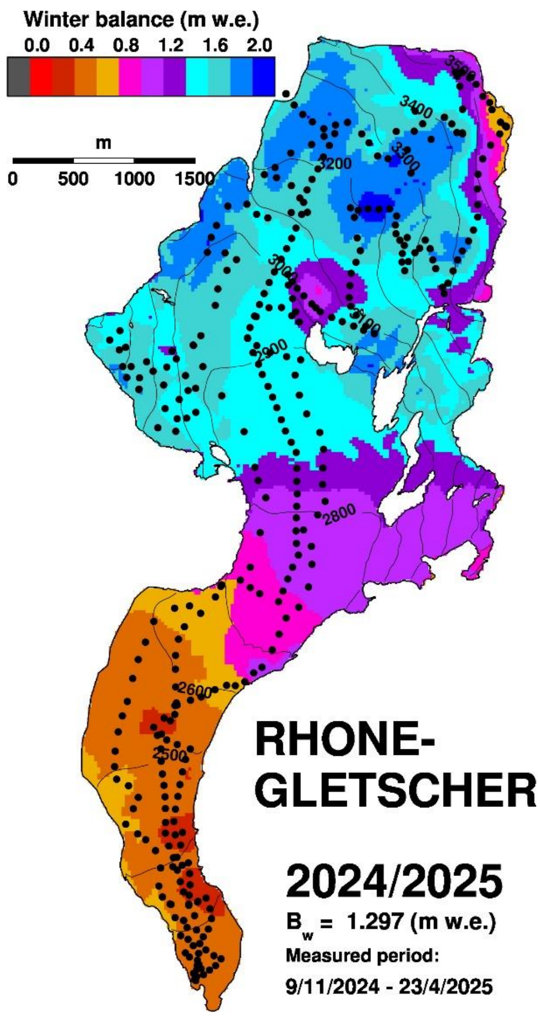

km
0 1 2 3
GROSSER
ALETSCHGLETSCHER
2024/2025
B_w = 0.767 (m w.e.)
Measured period: 9/11/2024 - 28/3/2025
Winter balance (m w.e.)
0.0 0.3 0.6 0.9 1.2 1.5

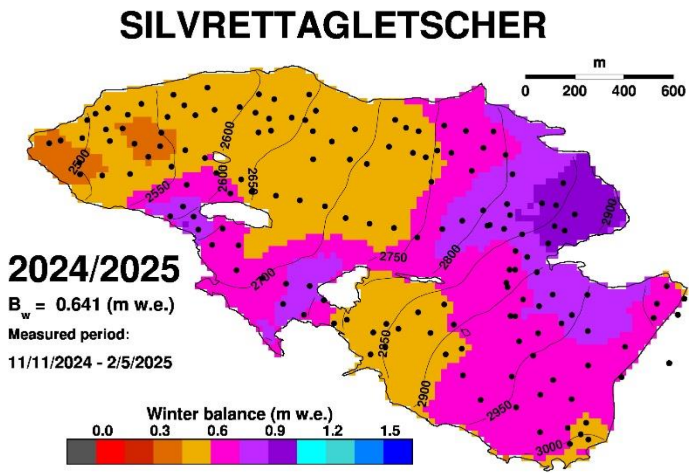

2024/2025
B_w = 0.796 (m w.e.)
Measured period:
9/9/2024 - 10/4/2025
m
0 100 200 300
VADRET DAL
MURTEL
Winter balance (m w.e.)
0.0 0.3 0.6 0.9 1.2 1.5

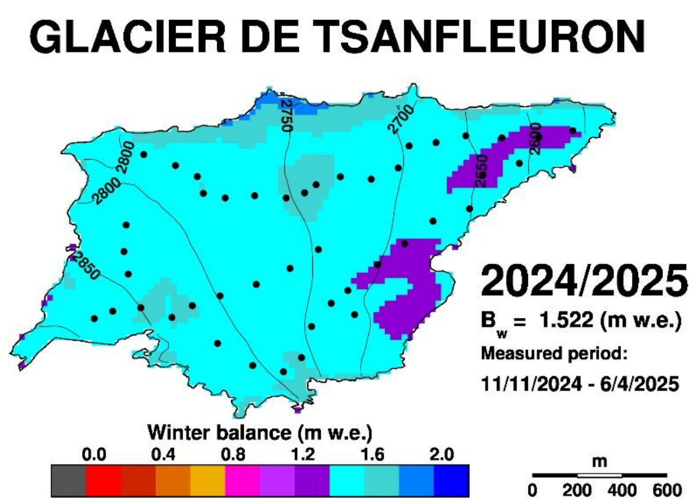

2024/2025
B_w = 0.698 (m w.e.)
Measured period: 12/9/2024 - 11/4/2025
Winter balance (m w.e.)
0.0 0.3 0.6 0.9 1.2 1.5
VADRET
PERS
m
0 300 600 900


GLACIER DE LA PLAINE MORTE
2024/2025
B_w = 1.110 (m w.e.)
Measured period:
23/9/2024 - 1/4/2025
m
0 500 1000 1500
Winter balance (m w.e.)
0.0 0.3 0.6 0.9 1.2 1.5


GLACIER DU GIETRO
Winter balance (m w.e.)
0.0 0.3 0.6 0.9 1.2 1.5
2024/2025
B_w = 0.842 (m w.e.)
Measured period:
11/9/2024 - 11/4/2025
m
0 500 1000 1500

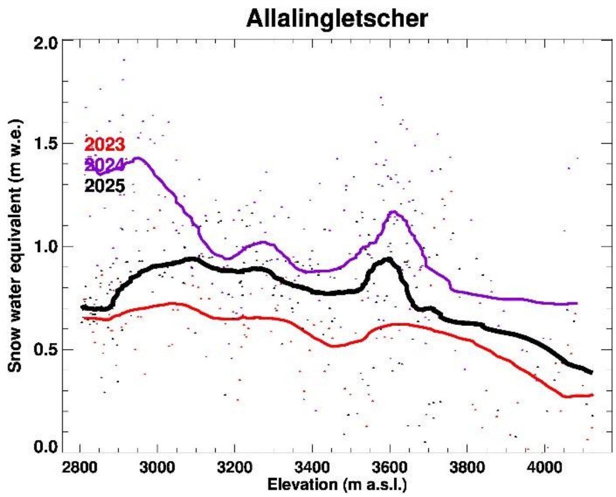

Winter balance (m w.e.)
0.0 0.4 0.8 1.2 1.6 2.0
m
0 500 1000 1500
RHONE-
GLETSCHER
2024/2025
B_w = 1.297 (m w.e.)
Measured period:
9/11/2024 - 23/4/2025

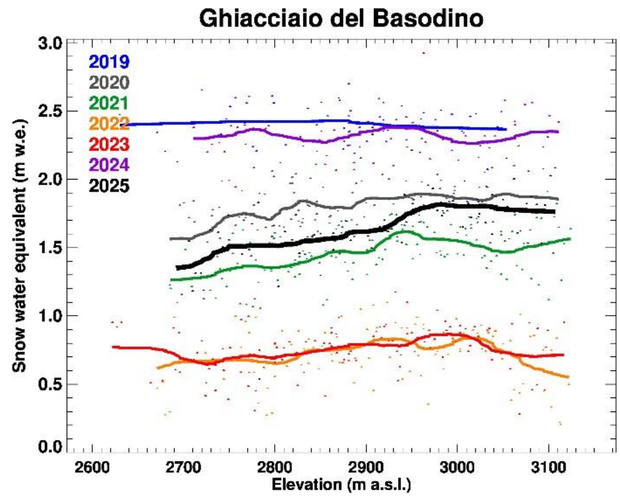

SILVRETTAGLETSCHER
m
0 200 400 600
2024/2025
B_w = 0.641 (m w.e.)
Measured period:
11/11/2024 - 2/5/2025
Winter balance (m w.e.)
0.0 0.3 0.6 0.9 1.2 1.5

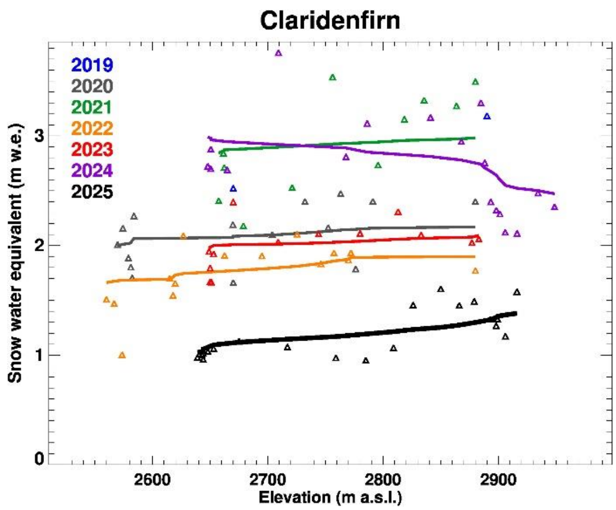

GLACIER DE TSANFLEURON
2024/2025
B_w = 1.522 (m w.e.)
Measured period:
11/11/2024 - 6/4/2025
Winter balance (m w.e.)
0.0 0.4 0.8 1.2 1.6 2.0
m
0 200 400 600

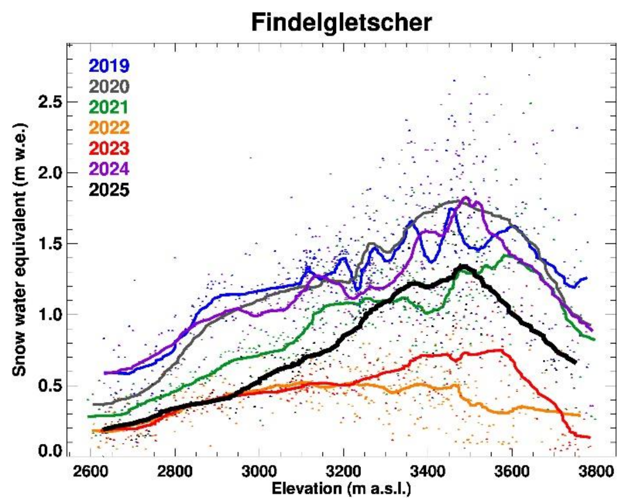
A.2 Elevation distribution of observed winter snow water equivalent 2019 to 2025

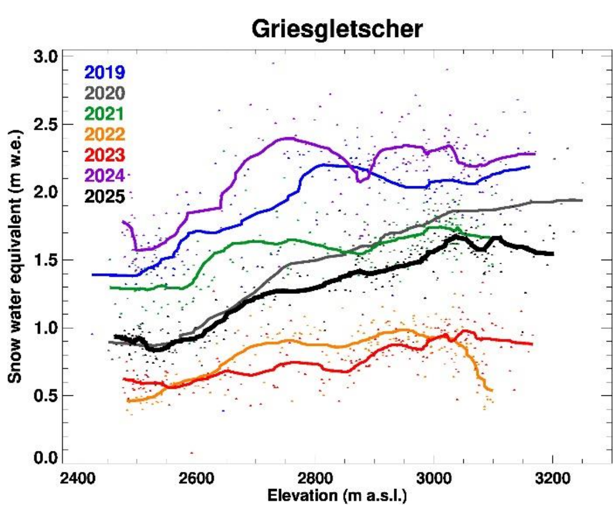
The figures below show measured local winter snow water equivalent on the glacier surface (symbols) depending on elevation over the last seven years (2019-2025, if available), smoothed with a thick line. The measurements of April 2025 are shown in black. The glaciers are alphabetically ordered.

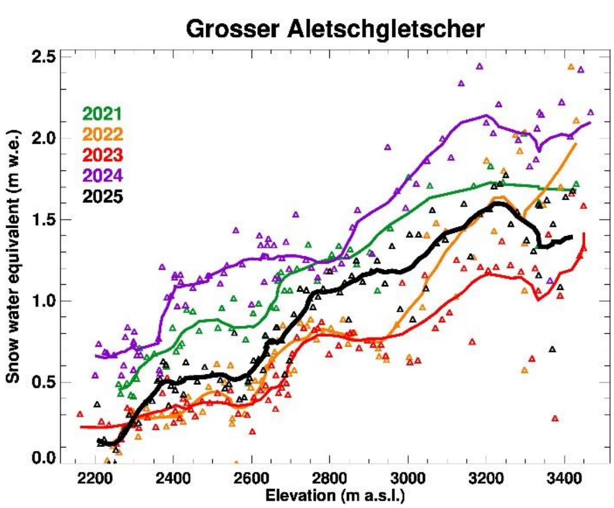


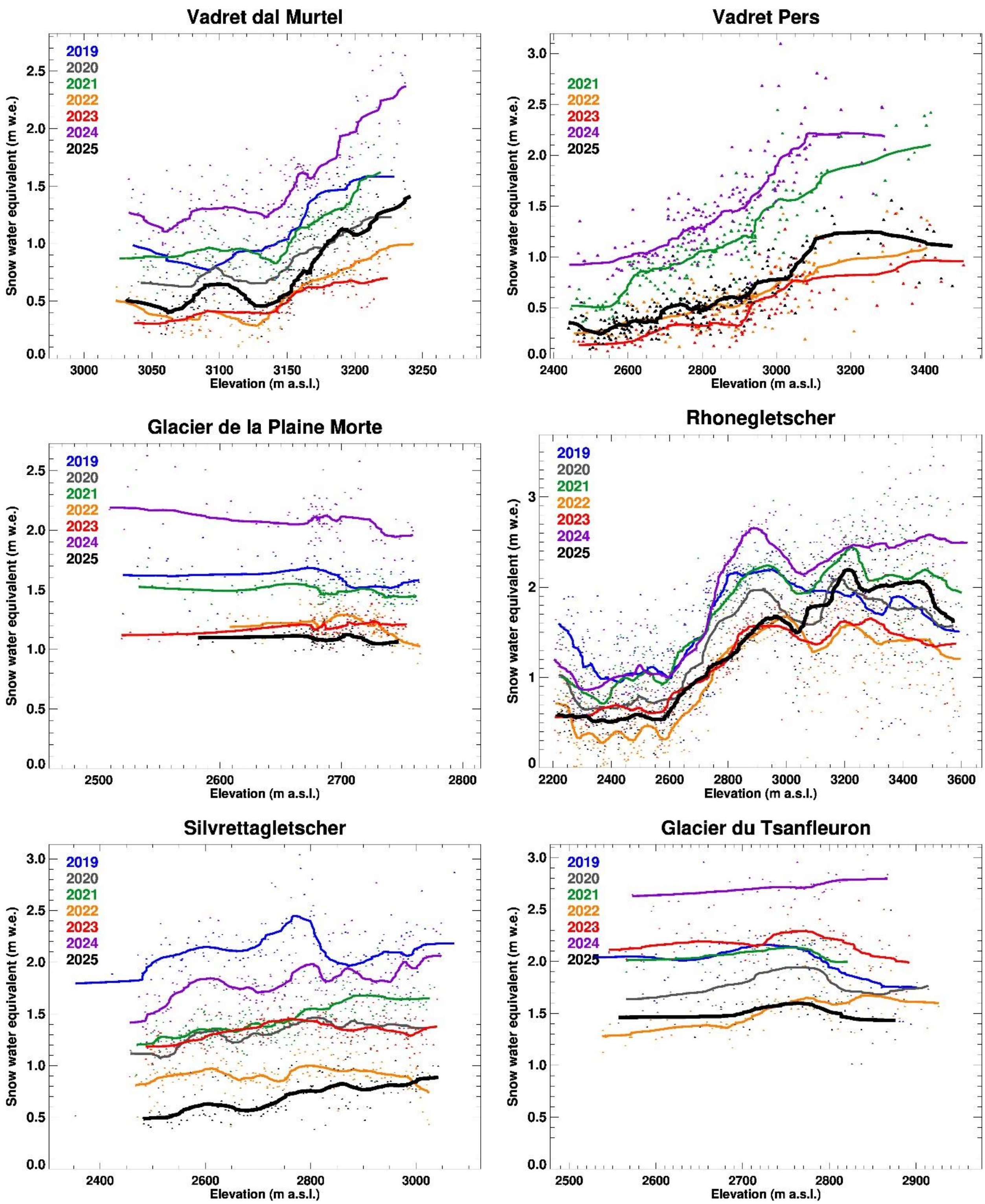






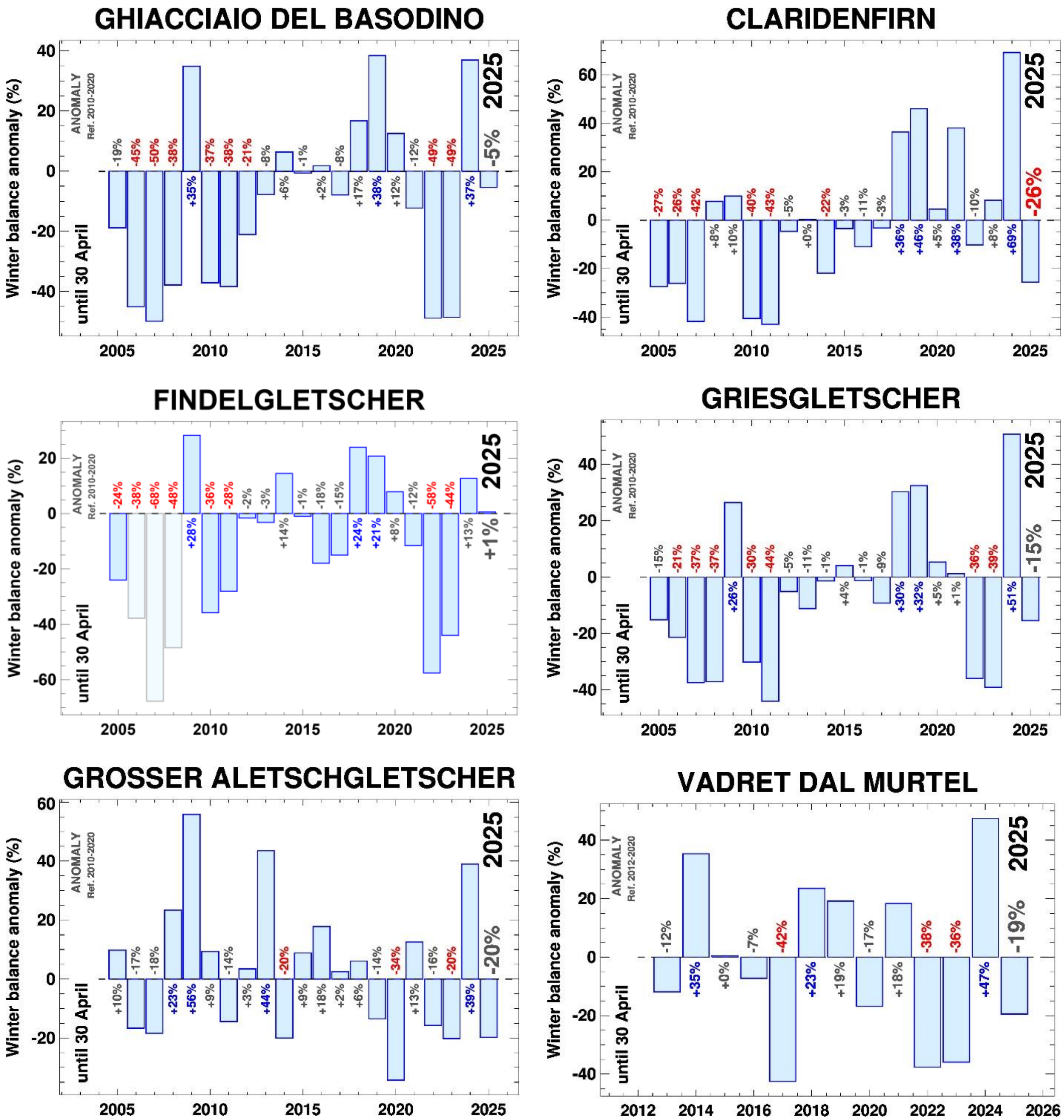


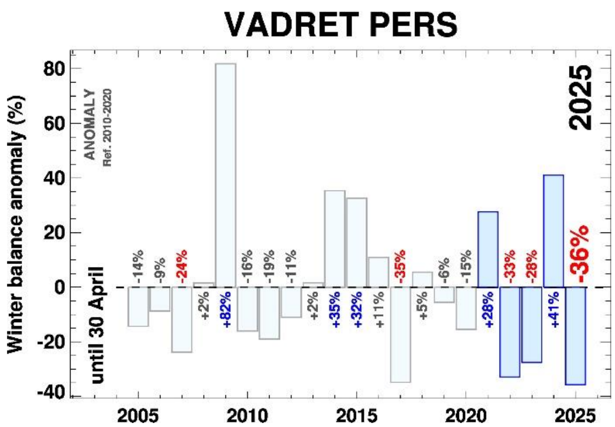


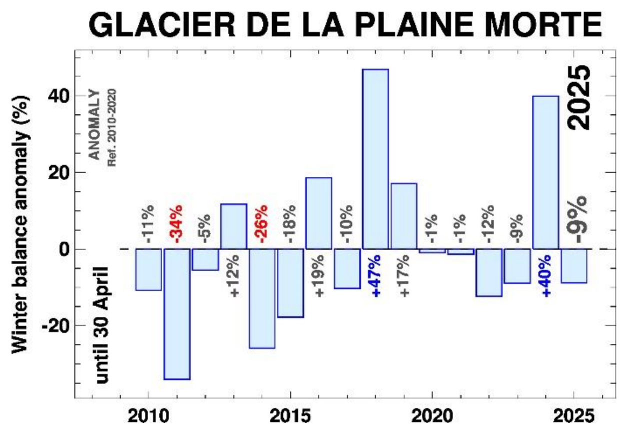

Vadret dal Murtel
Vadret Pers
Glacier de la Plaine Morte
Rhonegletscher
Silvrettagletscher
Glacier du Tsanfleuron
2019
2020
2021
2022
2023
2024
2025
Snow water equivalent (m w.e.)
Elevation (m a.s.l.)

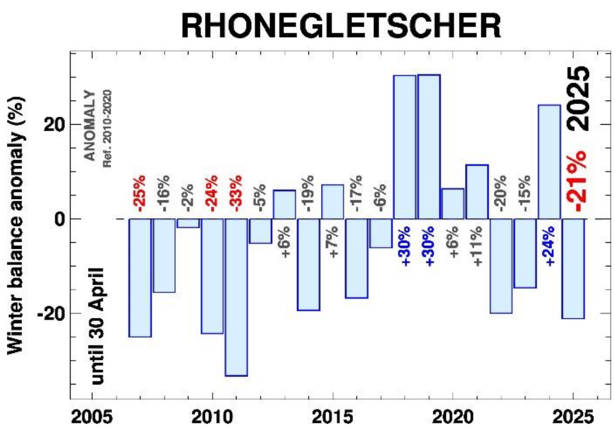
A.3 Winter mass balance anomaly homogenized to 30 April

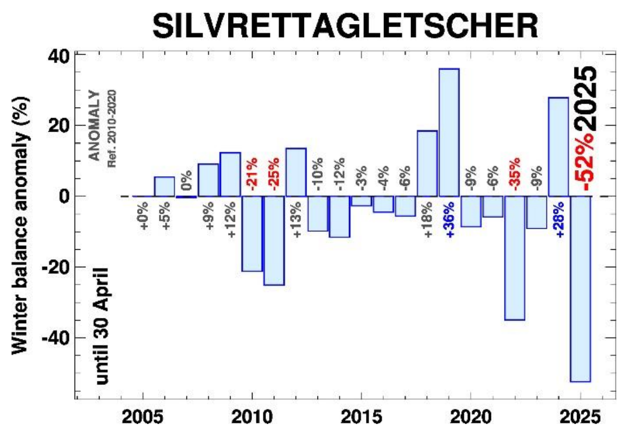
The figures below show the relative winter mass balance anomaly homogenized to 30 April of each year with respect to the measurements in the period 2010-2020. The last 20 years are displayed and the year 2025 is highlighted. Grey numbers refer to years relatively close to the average, blue numbers indicate strongly above-average years and red numbers strongly below-average years, respectively. Light bars for a few glaciers show years where results are not based on in situ measurements but modelling. The glaciers are alphabetically ordered.

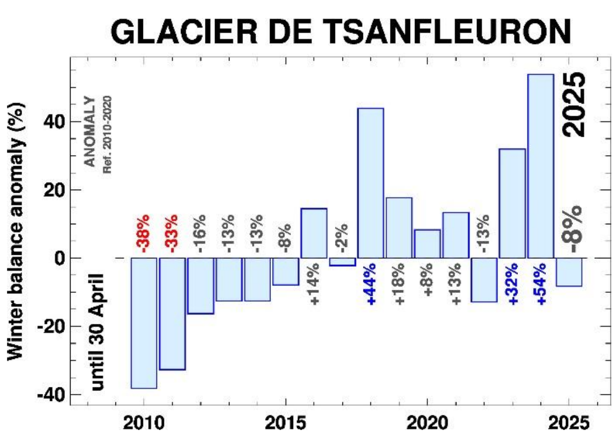



VADRET PERS
Winter balance anomaly (%)
until 30 April
ANOMALY
Ref. 2010-2020
2025
-36%
-14%
-9%
-24%
+2%
+82%
-16%
-19%
-11%
+2%
+35%
+32%
+11%
-35%
+5%
-6%
-15%
+28%
-33%
-28%
+41%


GLACIER DE LA PLAINE MORTE
Winter balance anomaly (%)
until 30 April
ANOMALY
Ref. 2010-2020
2025
-9%
-11%
-34%
-5%
+12%
-26%
-18%
+19%
-10%
+47%
+17%
-1%
-1%
-12%
-9%
+40%

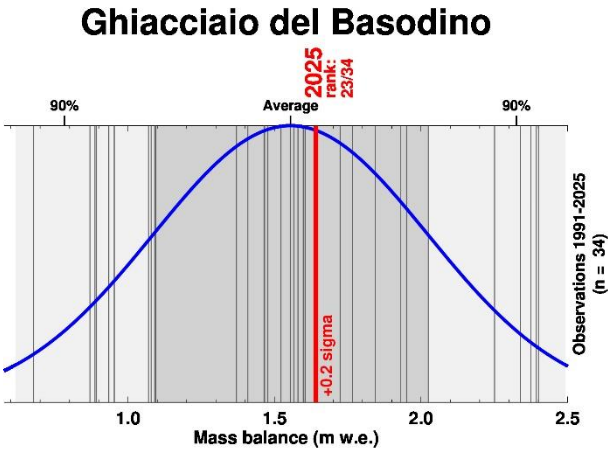

RHONEGLETSCHER
Winter balance anomaly (%)
until 30 April
ANOMALY
Ref. 2010-2020
2025
-21%
-25%
-16%
-2%
-24%
-33%
-5%
+6%
-19%
+7%
-17%
-6%
+30%
+30%
+6%
+11%
-20%
-15%
+24%


SILVRETTAGLETSCHER
Winter balance anomaly (%)
until 30 April
ANOMALY
Ref. 2010-2020
2025
-52%
+0%
+5%
0%
+9%
+12%
-21%
-25%
+13%
-10%
-12%
-3%
-4%
-6%
+18%
+36%
-9%
-6%
-35%
-9%
+28%

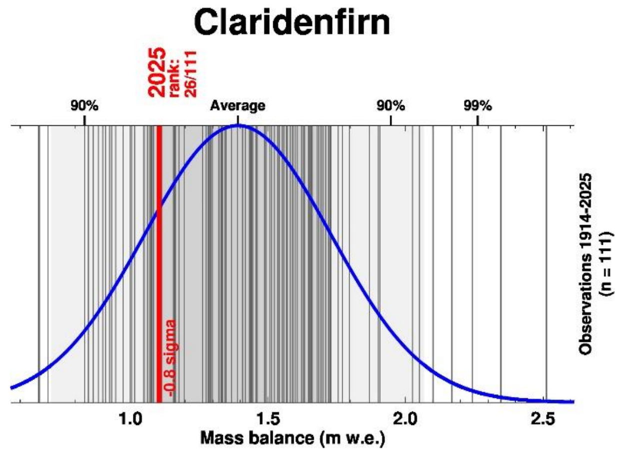

GLACIER DE TSANFLEURON
Winter balance anomaly (%)
until 30 April
ANOMALY
Ref. 2010-2020
2025
-8%
-38%
-33%
-16%
-13%
-13%
-8%
+14%
-2%
+44%
+18%
+8%
+13%
-13%
+32%
+54%

A.4 Winter mass balance 2025 compared to all years since initiation of the measurements

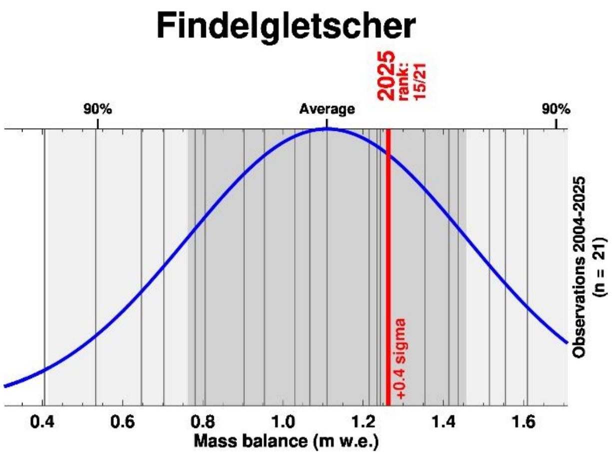
The figures below show the statistical distribution of all previously measured glacier-wide winter mass balances homogenized to 30 April (vertical lines). Ranges corresponding to 1 (dark grey) and 2 (light grey) standard deviations are shown, as are the boundaries encompassing 90% and 99% of the statistical distribution (ticks). The year 2025 is indicated with the thick, red line and the rank of 2025 starting from the least positive winter balance is given. The glaciers are alphabetically ordered.



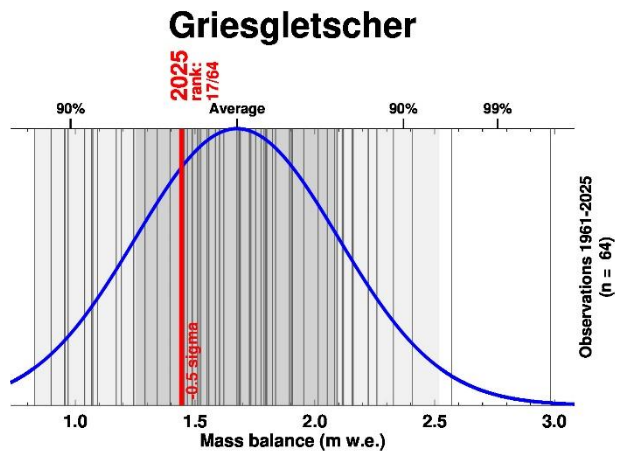
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: G. Kappenberger



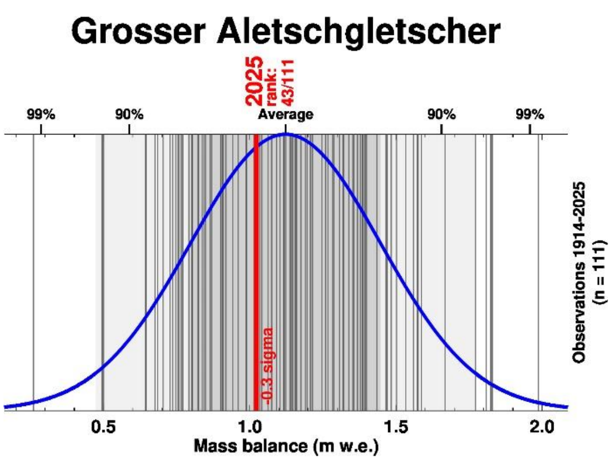
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: U. Steinegger



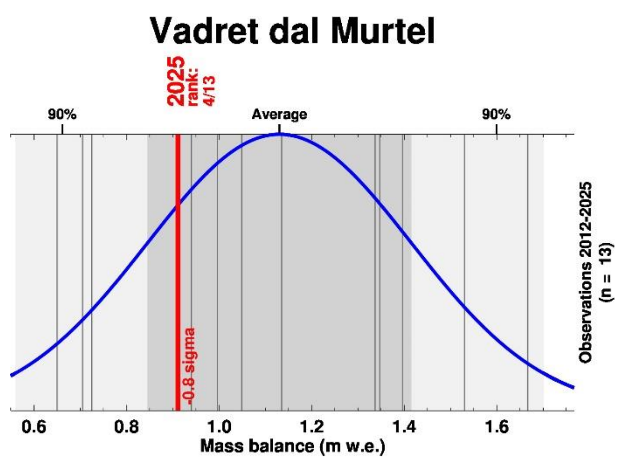
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Huss, A. Linsbauer



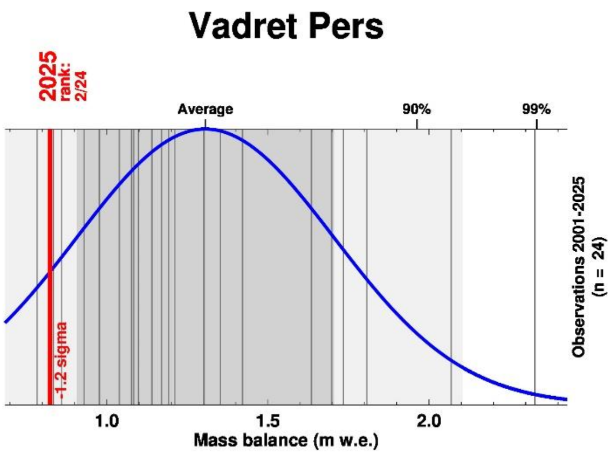
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Huss



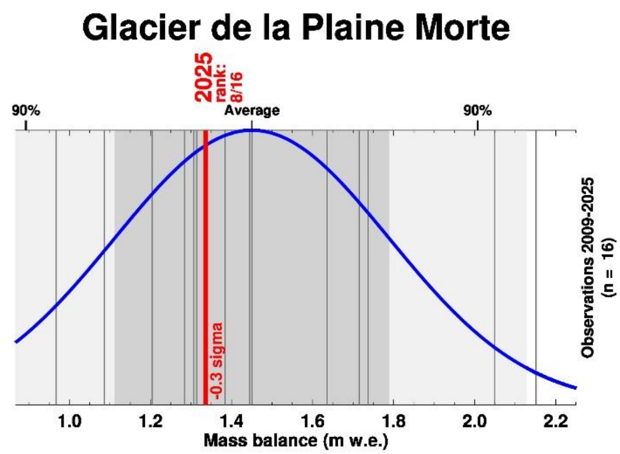
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Huss



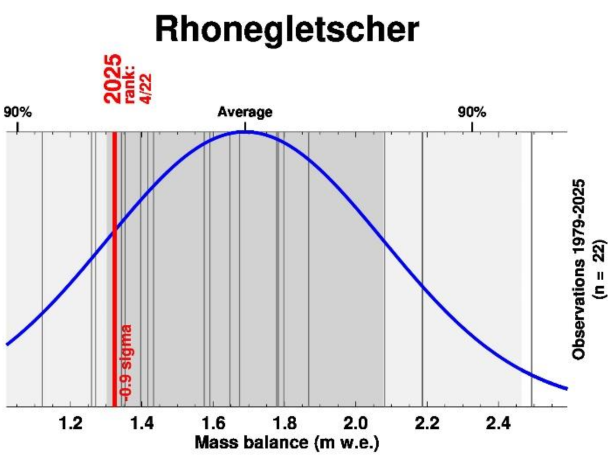
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Huss



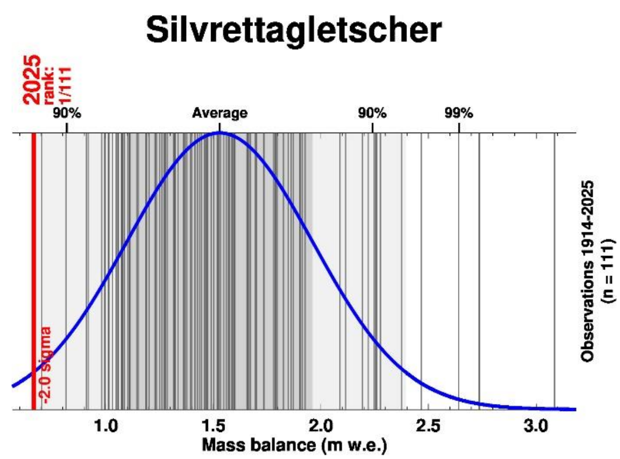
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Huss, A. Linsbauer



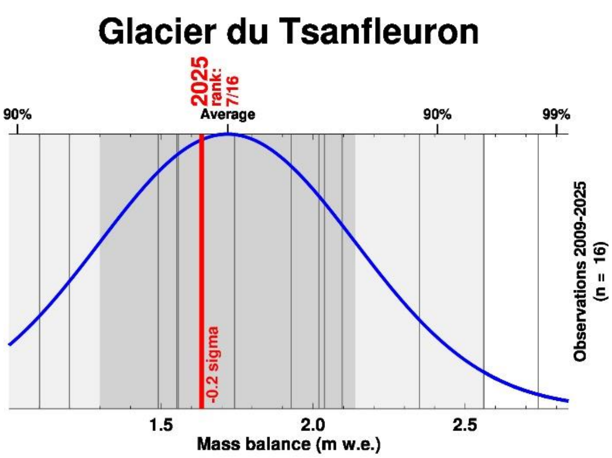
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Huss



Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: A. Bauder



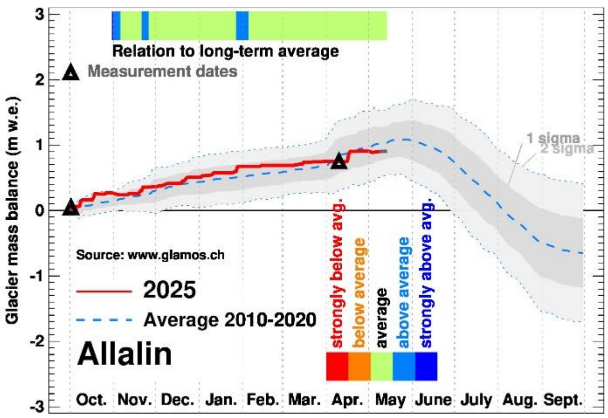
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: A. Bauder

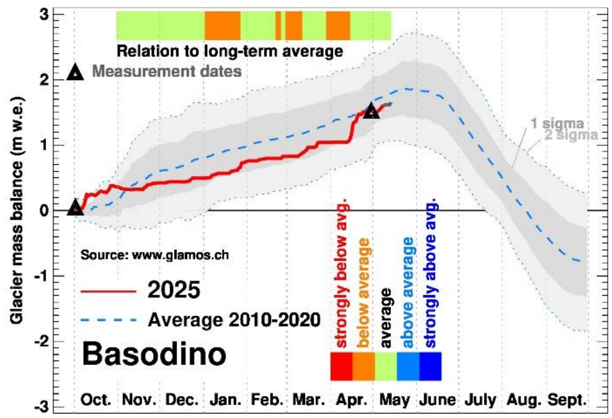


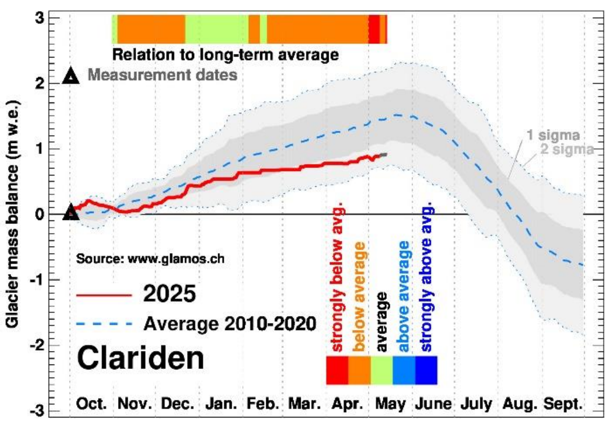
Glacier-wide WINTER mass balance (30.4.)
Source: www.glamos.ch; principal investigator: M. Fischer

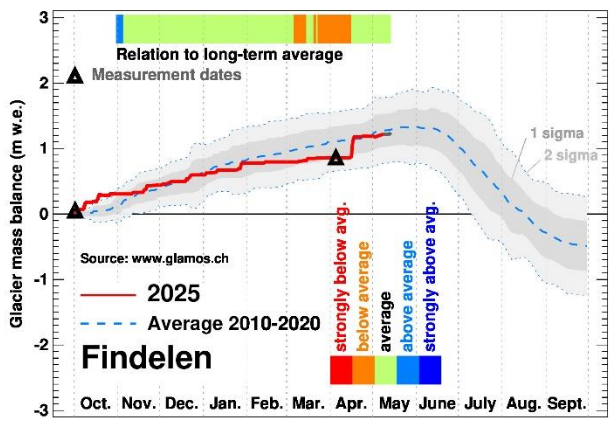
A.5 Temporal evolution of mass balance during the hydrological year 2025

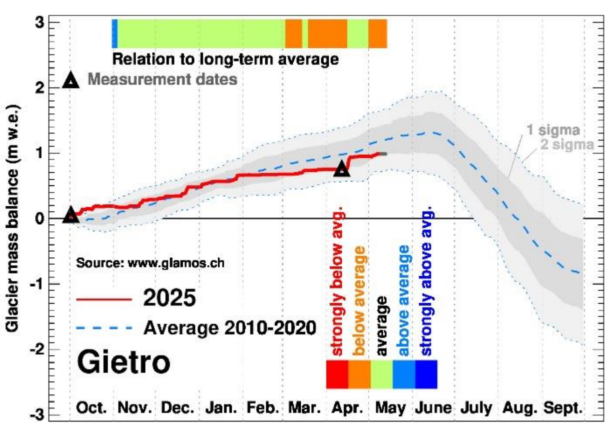
The figures below show the modelled daily cumulative mass balance in the hydrological year 2025 up to the date of the report (red line) in comparison to the average and the spread of the years 2010-2020. Data based on the 6-day weather forecast are shown in dark grey. The measurement date, by which the daily cumulative glacier-wide mass balance is constrained, is shown with a black triangle. The top bar indicates periods throughout the year with below- or above-average mass balance. The glaciers are alphabetically ordered.

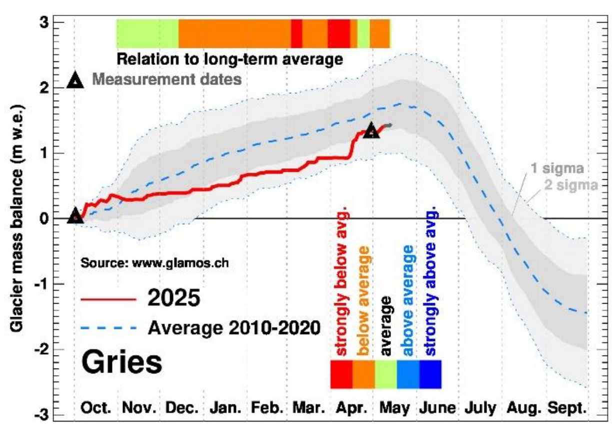


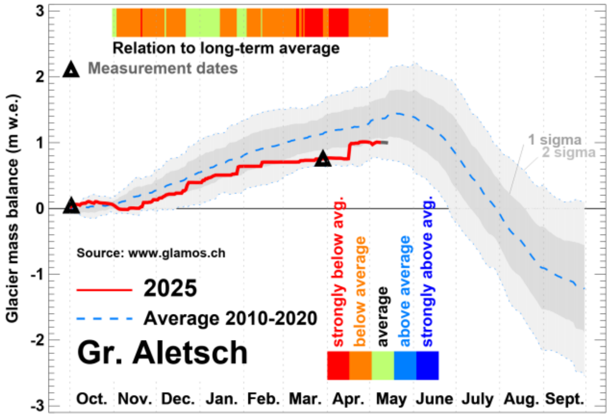


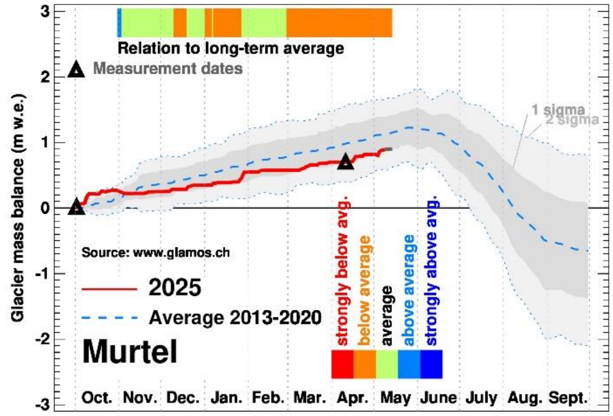


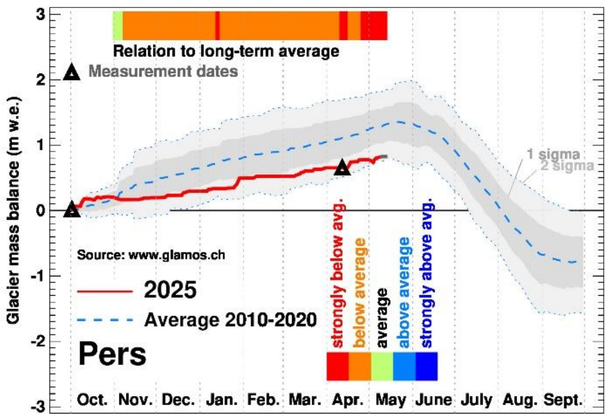


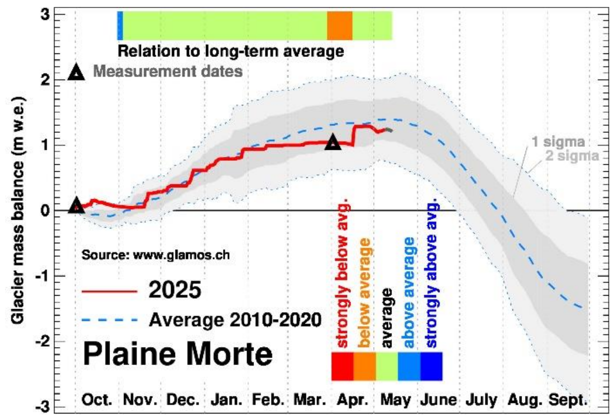


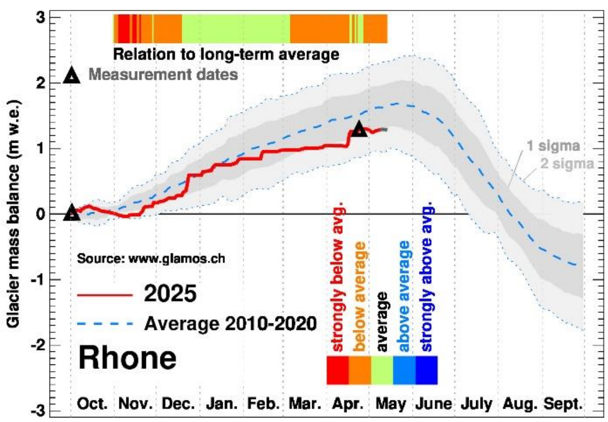


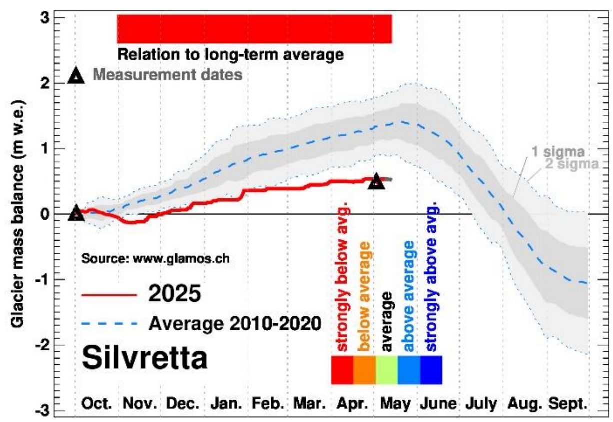

Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2010-2020
Gr. Aletsch
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.

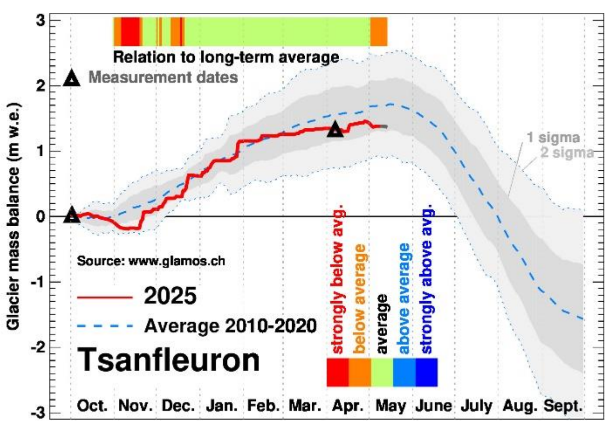

Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2013-2020
Murtel
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.


Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2010-2020
Pers
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.


Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2010-2020
Plaine Morte
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.


Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2010-2020
Rhone
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.


Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2010-2020
Silvretta
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.


Relation to long-term average
Measurement dates
Glacier mass balance (m w.e.)
1 sigma
2 sigma
Source: www.glamos.ch
2025
Average 2010-2020
Tsanfleuron
strongly below avg.
below average
average
above average
strongly above avg.
Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept.