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Data availability

Cover page

Claridenfirn was almost completely snow-free in late September 2025. Photo: M. Huss

Summary

The Glacier Monitoring in Switzerland (GLAMOS) programme documents, analyses and disseminates data on the state and changes of Swiss glaciers. The monitoring strategy is based on field measurements and remote-sensing products for different variables and observations: *Mass balance, Length change, Ice-flow velocity, Glacier inventory, Volume change, Englacial temperature* and *Special events related to glaciers*. This Swiss Glacier Bulletin provides an overview of the results with a focus on the hydrological year 2025, i.e. the period 1 Oct 2024 to 30 Sep 2025. For some variables, an extended period is covered because of periodical data acquisition and lagged data availability.

Meteorological conditions in the hydrological year 2025 strongly deviated from the long-term mean in some months leading to a substantial impact on glacier change. For the summer months May to September, air temperatures were 1.0°C above the 1991-2020 average. This was especially pronounced in June, when some high-elevation stations set new temperature records. Over the winter half-year (October to April), substantially below-average precipitation (–24%) was recorded, leading to low snow depth in the Alps at the beginning of the melting season.

Direct measurements of winter mass balance on 21 glaciers throughout Switzerland indicated 11% lower snow mass by the end of April compared to the 2010-2020 average. At 25 glaciers, observations of annual mass balance were acquired in September. Together with lacking protection by winter snow, very high melt rates, especially in June and August, contributed to a mean mass balance of –1.56 m water equivalent (w.e.) across all ca. 1300 Swiss glaciers. This value does not reach the extreme losses of 2022 and 2023, but nevertheless ranks among the 10% most negative years since the beginning of the observations in 1914. At the Swiss-wide scale, 3.0%, or 1.4 km^3, of the remaining ice volume was lost during 2025.

Length change was determined at the terminus of 69 glaciers in 2024, and on 46 glaciers in 2025, while results for additional sites are not yet available. The last years have shown a continued rapid retreat of all glacier snouts throughout Switzerland. 90% of the glaciers observed in 2024 retreated by between 1 m and 64 m. This retreat rate is slightly lower than the 2010-2020 average. Glacier length changes already observed in 2025 were between –2 m and –59 m.

Observations of local ice-flow velocity at a stake network on eight glaciers indicated a slow-down of ice motion in 2025 by 46% with respect to the 2010-2020 average. This is explained by persistently negative mass balance over the last decades and thus declining ice thickness and glacier flow. A complete update of the Swiss Glacier Inventory based on aerial images of 2021 to 2024 acquired by the Federal Office of Topography swisstopo shows a substantial progression of glacier area losses. Rates of area change vary between –1.5 and –5.1% yr^{-1} depending on the region. 159 glaciers, or 11%, have ultimately disappeared in Switzerland between the inventories of 2016 and 2023. The comparison of digital elevation models, available for 1- to 6-year intervals for all Swiss glaciers, allows the determination of recent ice volume change over multi-year periods. For 2017-2024, geodetic mass balances for sub-regions of the Swiss Alps were mostly between –1.1 m w.e. yr^{-1} and –1.7 m w.e. yr^{-1} indicating a noteworthy spatial variability.

Englacial temperatures measured at the high-elevation saddle of Colle Gnifetti indicated massive shifts due to substantial surface melting occurring even at almost 4500 m a.s.l., with a warming of 2.1°C at 20 m depth over the past 35 years. For 2025, 13 special events related to glaciers (rock-ice avalanches / glacier lake outbursts) have been documented. Most notable is the collapse of the Birchgletscher on 28 May 2025, leading to the destruction of the village of Blatten and one fatality.

In summary, the decline of glaciers in Switzerland, as documented by data acquired within GLAMOS, continued unabated during the reporting period 2025 regarding all monitored variables. A combination of below-average winter snow and a summer season with several pronounced heat waves again resulted in an exceptional glacier ice loss.

Zusammenfassung

Das Schweizerische Gletschermessnetz (GLAMOS) dokumentiert, analysiert und publiziert Daten zum Zustand und den Veränderungen der Gletscher in den Schweizer Alpen. Das Messnetz basiert auf Feldmessungen und Fernerkundungsdaten für die folgenden Variablen: *Massenbilanz, Längenänderung, Eis-Fliessgeschwindigkeit, Gletscherinventar, Volumenänderung, Eistemperatur* und *spezielle Gletscher-Ereignisse*. Das *Swiss Glacier Bulletin* bietet einen Überblick mit Fokus auf die Ergebnisse des hydrologischen Jahres 2025, also die Periode vom 1. Oktober 2024 bis 30. September 2025. Bei einigen Variablen wird ein längerer Zeitraum abgedeckt, was mit der periodischen Datenerfassung und der verzögerten Datenverfügbarkeit zusammenhängt.

Die Witterung in der Berichtsperiode wich in einigen Monaten stark vom langjährigen Mittel ab, mit negativen Konsequenzen für die Gletscher. In den Sommermonaten Mai bis September lag die Lufttemperatur 1,0°C über dem Schnitt der Jahre 1991–2020. Besonders ausgeprägt war dies im Juni, als in hohen Lagen teils Rekordwerte erreicht wurden. Im Winterhalbjahr (Oktober bis April) wurden klar unter- durchschnittliche Niederschläge (–24%) verzeichnet, was in den Alpen zu einer geringen Schneehöhe führte.

Direkte Messungen der Winterbilanz an 21 Gletschern in der ganzen Schweiz ergaben bis Ende April eine um 11% geringere Schneemenge im Vergleich zum Durchschnitt der Jahre 2010–2020. An 25 Gletschern wurden im September Messungen zur Jahresbilanz durchgeführt. Zusammen mit dem fehlenden Schutz durch Winterschnee führten sehr hohe Schmelzraten, insbesondere im Juni und August, zu einer negativen mittleren Massenbilanz von –1,56 m Wasseräquivalent (w.e.) für alle rund 1300 Schweizer Gletscher. Dieser Wert zählt zu den 10 % schlechtesten Jahren seit Beginn der Beobachtungen. Schweizweit gingen im Jahr 2025 3,0% oder 1,4 km^3 des verbleibenden Eisvolumens verloren.

Die Längenänderung wurde 2024 für 69 Gletscher bestimmt, und für 2025 sind bereits Daten für 46 Gletscher verfügbar. In den letzten Jahren war ein anhaltender rascher Rückgang aller Gletscherzungen zu beobachten. 90% der 2024 beobachteten Gletscher gingen um 1 m bis 64 m zurück. Diese Rückzugsrate ist etwas geringer als im Durchschnitt 2010–2020. Die bereits 2025 erhobenen Veränderungen der Gletscherlänge lagen zwischen –2 m und –59 m.

Messungen der lokalen Fliessgeschwindigkeit auf acht Gletschern deuteten auf eine Verlangsamung der Eisbewegung im Jahr 2025 um 46% gegenüber dem Durchschnitt von 2010–2020 hin. Dies lässt sich durch die anhaltend negative Massenbilanz der letzten Jahrzehnte und die damit abnehmende Eisdicke erklären. Eine vollständige Aktualisierung des Schweizer Gletscherinventars auf der Grundlage von Luftbildern der Jahre 2021 bis 2024 zeigt einen erheblichen Gletscherschwund. Je nach Region ging die Gletscherfläche zwischen 1,5 und 5,1% pro Jahr zurück. 159 Gletscher oder 11% sind in der Schweiz zwischen den Inventaren von 2016 und 2023 verschwunden. Der Vergleich digitaler Höhenmodelle, die für alle Schweizer Gletscher in Intervallen von 1 bis 6 Jahren verfügbar sind, ermöglicht die Bestimmung der jüngsten Veränderungen des Eisvolumens über mehrere Jahre hinweg. Für den Zeitraum 2017–2024 lagen die geodätischen Bilanzen in Teilregionen der Schweizer Alpen meist zwischen –1,1 und –1,7 m w.e./ Jahr.

Die auf dem Colle Gnifetti gemessenen Firn-Temperaturen zeigten massive Verschiebungen aufgrund von Schmelze, welche sogar in fast 4500 m ü. M. auftrat. Dies führte zu einer Erwärmung von 2,1°C in 20 m Tiefe während der letzten 35 Jahren. Für das Jahr 2025 wurden 13 besondere Ereignisse im Zusammenhang mit Gletschern (Fels-Eis-Lawinen / Gletscherseeausbrüche) dokumentiert. Besonders bemerkenswert ist der Kollaps des Birchgletschers am 28. Mai 2025, der zur vollständigen Zerstörung des Dorfes Blatten und zu einem Todesfall führte.

Zusammenfassend lässt sich sagen, dass der Rückgang der Gletscher in der Schweiz im Berichtszeitraum 2025 in Bezug auf alle überwachten Variablen unvermindert anhielt. Eine Kombination aus geringen Schneemengen im Winter und einer Sommersaison mit mehreren ausgeprägten Hitzewellen führte wiederum zu einem ausserordentlich starken Verlust an Gletschereis.

Résumé

Le programme GLAMOS (Glacier Monitoring in Switzerland) documente, analyse et diffuse des données sur l'état et l'évolution des glaciers suisses. La stratégie de surveillance repose sur des mesures sur le terrain et des produits de télédétection pour différentes variables et observations : *bilan de masse, variation de longueur, vitesse d'écoulement, inventaire des glaciers, variation de volume, température intra-glaciaire* et *événements particuliers liés aux glaciers*. Le présent Bulletin des Glaciers Suisses donne un aperçu des résultats en se concentrant sur l'année hydrologique 2025 (1er octobre 2024 - 30 septembre 2025).

Les conditions météorologiques au cours de la période considérée se sont fortement écartées de la moyenne certains mois, avec un effet particulièrement négatif sur l'évolution des glaciers. Pour les mois d'été, de mai à septembre, les températures ont été supérieures de 1,0 °C par rapport à la moyenne de 1991-2020. Ce phénomène a été particulièrement prononcé au mois de juin. Au cours du semestre hivernal (octobre à avril), des précipitations nettement inférieures à la moyenne (–24 %) ont été enregistrées.

Les mesures directes du bilan de masse hivernal sur 21 glaciers à travers la Suisse ont indiqué une masse de neige inférieure de 11 % à la fin avril par rapport à la moyenne 2010-2020. Sur 25 glaciers, des observations du bilan de masse annuel ont été effectuées en septembre. Outre l'absence de protection par la neige hivernale, les taux de fonte très élevés, en particulier en juin et en août, ont contribué à un bilan de masse négatif moyen de –1,56 m équivalent eau (w.e.) sur l'ensemble des 1300 glaciers suisses. Cette valeur se classe parmi les 10 % des années les plus négatives depuis le début des observations. À l'échelle de la Suisse, 3,0 % ou 1,4 km^3 du volume de glace ont été perdus en 2025.

Le changement de longueur de 69 glaciers a été déterminé en 2024, et 46 glaciers en 2025, tandis que les résultats pour les sites restants ne sont pas encore disponibles. Les dernières années ont montré un recul rapide et continu de tous les fronts glaciaires à travers la Suisse. 90 % des glaciers observés en 2024 ont reculé de 1 à 64 m. Ce taux de recul est faiblement inférieur à la moyenne de 2010-2020. Les changements de longueur des glaciers déjà observés en 2025 étaient compris entre -2 m et -59 m.

Les observations de la vitesse locale de l'écoulement sur un réseau de balises sur huit glaciers ont indiqué un ralentissement du mouvement de la glace en 2025 de 46 % par rapport à la moyenne de 2010-2020. Cela s'explique par un bilan de masse négatif persistant au cours des dernières décennies et donc par une diminution de l'épaisseur de la glace. Une mise à jour complète de l'inventaire des glaciers suisses basée sur des images aériennes de 2021 à 2024 acquises par l'Office fédéral de topographie swisstopo montre une progression substantielle des pertes de superficie des glaciers. Les taux de variation de la superficie varient entre –1,5 et –5,1 % par an selon les régions. 159 glaciers, soit 11 %, ont disparu en Suisse entre les inventaires de 2016 et 2023. La comparaison de modèles numériques de terrain, disponibles pour des intervalles de 1 à 6 ans pour tous les glaciers suisses, permet de déterminer les changements récents du volume de glace. Pour la période 2017-2024, ces bilans de masse géodésiques dans des sous-régions se situaient pour la plupart entre -1,1 m w.e. et -1,7 m w.e. par an, ce qui indique une variabilité spatiale notable.

Les températures intra-glaciaires mesurées au Colle Gnifetti ont indiqué des changements massifs dus à une fonte de surface importante, même à près de 4500 m d'altitude, avec un réchauffement de 2,1 °C à 20 m de profondeur au cours des 35 dernières années. Pour 2025, 13 événements liés aux glaciers (avalanches de roches/glace / débordements de lacs glaciaires) ont été documentés. Le plus notable est l'effondrement du Birchgletscher le 28 mai 2025, qui a entraîné la destruction du village de Blatten et fait un mort.

En résumé, le recul des glaciers en Suisse, tel que documenté par les données acquises dans le cadre du programme GLAMOS, s'est poursuivi sans discontinuer au cours de l'année 2025 pour toutes les variables surveillées. La combinaison d'un enneigement hivernal inférieur à la moyenne et d'une saison estivale marquée par plusieurs vagues de chaleur prononcées a entraîné l'une des pertes de masse glaciaire les plus importantes jamais enregistrées.

Riassunto

Il programma GLAMOS (Glacier Monitoring in Switzerland) documenta, analizza e diffonde dati sullo stato e sui cambiamenti dei ghiacciai svizzeri. La strategia di monitoraggio si basa su misurazioni sul campo e prodotti di telerilevamento per diverse variabili e osservazioni: *bilancio di massa, variazione della lunghezza, velocità del flusso glaciale, inventario dei ghiacciai, variazione del volume, temperatura endoglaciale* ed *eventi speciali relativi ai ghiacciai.* Il presente Bollettino sui Ghiacciai Svizzeri fornisce una panoramica dei risultati con particolare attenzione all'anno idrologico 2025, ovvero al periodo compreso tra il 1° ottobre 2024 e il 30 settembre 2025.

Le condizioni meteorologiche nel periodo di interesse si sono fortemente discostate dalla media a lungo termine in alcuni mesi, determinando un effetto particolarmente negativo sul cambiamento dei ghiacciai. Nei mesi estivi (maggio a settembre), le temperature dell'aria sono state di 1,0 °C superiori alla media del periodo 1991-2020. Ciò è stato particolarmente evidente nel mese di giugno. Durante il semestre invernale (da ottobre ad aprile) sono state registrate precipitazioni notevolmente inferiori alla media (–24%).

Le misurazioni dirette del bilancio di massa invernale su 21 ghiacciai in tutta la Svizzera hanno indicato una massa nevosa inferiore del 11% alla fine di aprile rispetto alla media del periodo 2010-2020. A settembre sono state acquisite le osservazioni del bilancio di massa annuale su 25 ghiacciai. Insieme alla mancanza di protezione da parte della neve invernale, i tassi di scioglimento molto elevati, soprattutto in giugno e agosto, hanno contribuito a un bilancio di massa medio negativo di –1,56 m di equivalente acqua (w.e.) su tutti i circa 1300 ghiacciai svizzeri. Questo valore si colloca tra il 10% degli anni più negativi dall'inizio delle osservazioni. Su scala svizzera, nel 2025 è stato perso il 3,0% (1,4 km^3) del volume di ghiaccio rimanente.

Nel 2024 è stata determinata la variazione di lunghezza del fronte glaciale per 69 ghiacciai. Il ritiro/avanzamento è già stato valutato su 46 ghiacciai per il 2025, mentre i risultati per altri siti non sono ancora disponibili. Gli ultimi anni hanno mostrato un rapido e continuo ritiro di tutte le lingue glaciali in tutta la Svizzera. Il 90% dei ghiacciai osservati nel 2024 si è ritirato di un valore compreso tra 1 m e 60 m. Questo tasso di ritiro corrisponde alla media del periodo 2010-2020. Le variazioni della lunghezza dei ghiacciai già osservate nel 2025 erano comprese tra –2 m e –59 m.

Le osservazioni della velocità locale del flusso di ghiaccio su otto ghiacciai hanno indicato un rallentamento del movimento del ghiaccio nel 2025 del 46% rispetto alla media 2010-2020. Ciò si spiega con il bilancio di massa persistentemente negativo degli ultimi decenni e quindi con il calo dello spessore del ghiaccio. Un aggiornamento completo dell'inventario dei ghiacciai svizzeri basato sulle immagini aeree del periodo 2021-2024 acquisite dall'Ufficio federale di topografia swisstopo mostra una progressione sostanziale della perdita di superficie dei ghiacciai. I tassi di variazione della superficie variano tra –1,5 e –5,1% all'anno a seconda della regione. Tra gli inventari del 2016 e del 2023, 159 ghiacciai, pari all'11%, sono scomparsi definitivamente in Svizzera. Il confronto dei modelli digitali di terreno, disponibili per intervalli da 1 a 6 anni per tutti i ghiacciai svizzeri, consente di determinare la recente variazione del volume del ghiaccio su periodi pluriennali. Per il periodo 2017-2024, i bilanci di massa geodetici nelle sottoregioni delle Alpi svizzere erano per lo più compresi tra –1,1 m w.e. e –1,7 m w.e. par anno, indicando una notevole variabilità spaziale.

Le temperature englaciali misurate al Colle Gnifetti hanno indicato forti cambiamenti dovuti a un sostanziale scioglimento verificatosi anche a quasi 4500 m s.l.m., con un riscaldamento di 2,1 °C a 20 m di profondità negli ultimi 35 anni. Per il 2025 sono stati documentati 13 eventi speciali relativi ai ghiacciai (valanghe di roccia e ghiaccio / sfondamento di laghi glaciali). Il più notevole è il crollo del Birchgletscher il 28 maggio 2025, che ha portato alla completa distruzione del villaggio di Blatten e alla morte di una persona.

In sintesi, il declino dei ghiacciai in Svizzera, documentato dai dati acquisiti nell'ambito del progetto GLAMOS, è proseguito senza sosta durante il periodo di riferimento 2025 per tutte le variabili monitorate. La combinazione di nevicate invernali inferiori alla media e di una stagione estiva caratterizzata da diverse ondate di calore intense ha portato a una delle perdite di massa glaciale più consistenti mai registrate.

Contents

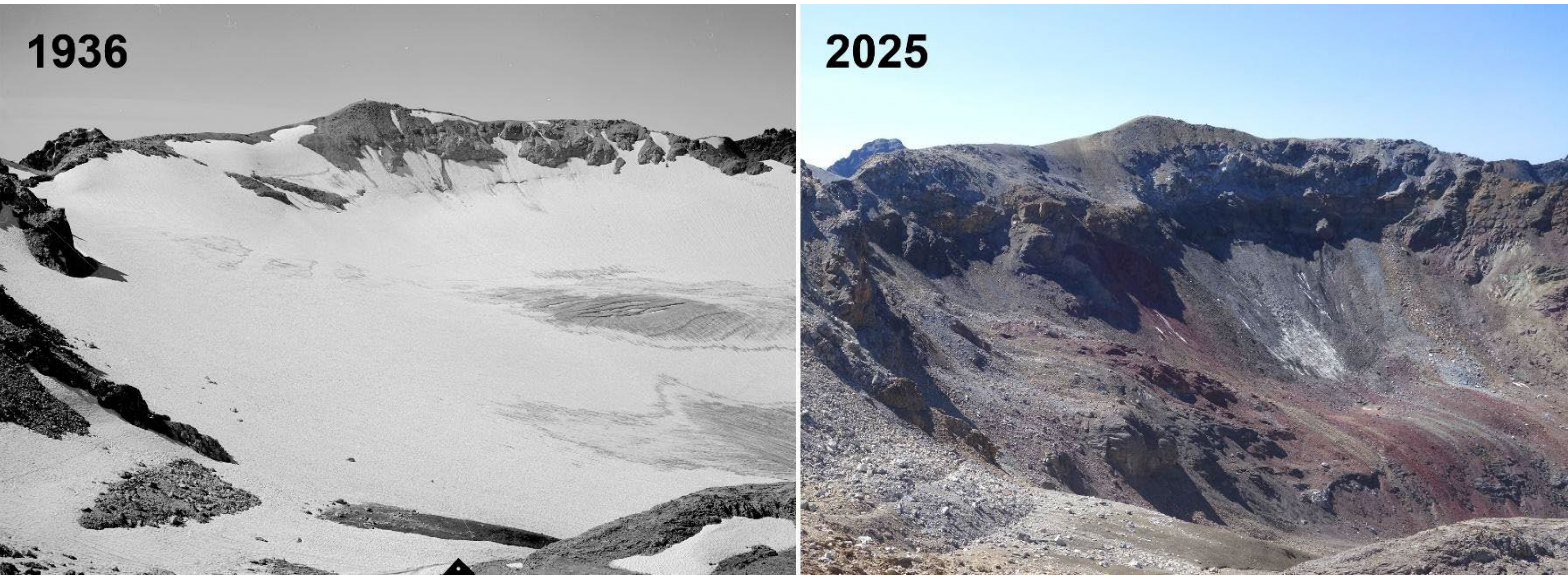
1 Introduction

The programme Glacier Monitoring in Switzerland (GLAMOS, www.glamos.ch) documents the current state and the changes of Swiss glaciers in space and time. Systematic and long-term records of glaciological variables in the Swiss Alps started almost 150 years ago. Data on glacier changes are necessary for investigating the glacier-climate interaction, for a better process-understanding related to natural hazards in high-alpine regions, and for the assessment and projection of present and future water resources and global sea-level rise. Finally, the broad public – nationally and internationally – manifests an increasing interest in glacier retreat as an element of the alpine environment excellently illustrating climate change.

The GLAMOS programme has been adopted by the Swiss Commission for Cryosphere observation (SKK) and receives long-term funding and support by the Federal Office for Environment (BAFU), the Federal Office of Meteorology and Climatology (MeteoSwiss) in the framework of GCOS Switzerland, the Swiss Academy of Sciences (SCNAT) and the Federal Office of Topography (swisstopo) since 1 January 2016. Operations are carried out by the three GLAMOS institutions, i.e. the Swiss Federal Institute of Technology (ETH Zürich), the University of Fribourg (UniFR) and University of Zürich (UZH), as well as external partners.

Results of Swiss glacier monitoring activities have been published in the Glaciological Reports since 1881 (GLAMOS, 1881-2024). While the next published volume of the Glaciological Report with detailed data on all observed variables will cover the four annual periods 2024-2027, the digital Swiss Glacier Bulletin (established in 2024) provides an annual fast-track summary of the most important results of the monitoring programme. The present report focuses on the hydrological year 2025, i.e. the period from 1 October 2024 to 30 September 2025, and also provides results compiled throughout 2025 referring to periodical data acquisitions covering the years 2021-2024 (for the variables length change, inventory and volume change).

The focus of GLAMOS is to collect glaciological data following international standards according to the Essential Climate Variables (ECVs) as defined by the Global Climate Observing System (GCOS) of the World Meteorological Organization (WMO, 2022). Internationally, glacier monitoring is coordinated in the framework of the Global Terrestrial Network for Glaciers (GTN-G) and by the World Glacier Monitoring Service (WGMS). GLAMOS data are also reported to the international data centres (WGMS, GLIMS) on a regular basis.



Almost complete disappearance of Vadret da Triazza, a small glacier in Eastern Switzerland, between 1936 and 2025. Glacier wastage has resulted in the vanishing of over 1000 Swiss glaciers over just the last decades (Linsbauer et al., 2025). Photos: swisstopo / M. Huss.

Within GLAMOS, the following variables are regularly monitored both using *in situ* and remote-sensing data sets and corresponding results are reported in the present Swiss Glacier Bulletin:

- Mass balance (*seasonal to annual*),
- Length change (*annual*),
- Ice-surface flow speed (*annual*),
- Glacier area / inventory (*3-6 yearly*),
- Geodetic ice volume change (*1-6 yearly*),
- Englacial temperature (*annual*), and
- Documentation of special events related to glaciers (*annual*).

Figure 1.1 shows the spatial distribution of observation sites for the respective variables monitored in the current reporting period. Many measurement sites refer to long-term series, partly initiated over a century ago, related to scientific research questions relevant at that time (e.g. high-mountain water resources for hydropower production). Many of those glaciers have been continuously monitored until today. Sites that were more recently set up target an optimal spatial coverage across all climatological sub-regions of Switzerland, different glacier sizes and characteristics, as well as a focus on large glaciers that exhibit a higher resilience to climate change (GLAMOS, 2019). Data at high temporal resolution (sub-seasonal to annual) is acquired based on *in situ* observations on a representative set of glaciers, whereas data on multi-annual changes in glacier area and volume refer to all individual ca. 1300 Swiss glaciers and are based on the operational products of swisstopo.

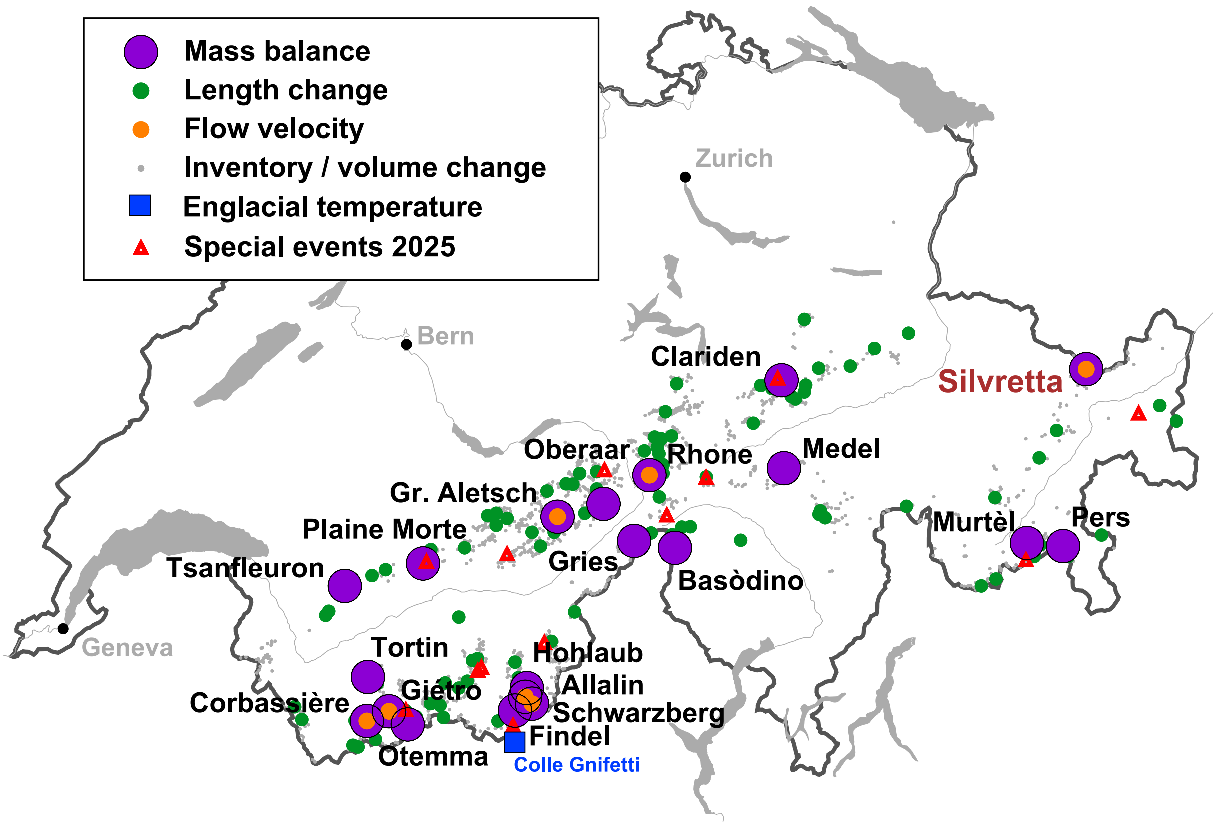


Figure 1.1. *Overview of GLAMOS field sites. Glaciers with in-situ observations of mass balance (see Chapter 3) and ice-flow velocity (see Chapter 5) are shown with purple/orange dots. This year's spotlight glacier (Silvrettagletscher) is highlighted in dark red. Sites with long-term glacier length change observations are in green (see Chapter 4). Remaining glaciers, covered by repeated inventories and geodetic ice volume change observations are indicated with small grey dots (see Chapters 6 and 7). The locations of englacial temperature measurements (blue square, see Chapter 8), and special events related to glaciers recorded in 2025 (red triangles, see Chapter 9) are marked.*

2 Weather conditions in the hydrological year 2025

The meteorological forcing determines glacier mass loss or gain, where air temperatures and precipitation are key factors. This results in an exchange of energy between the atmosphere and the glacier surface. Air temperature is most importantly influenced by two components of the surface energy balance: incoming longwave radiation and turbulent sensible heat flux. Other elements of the energy balance, such as solar radiation, turbulent latent heat flux, and surface-specific characteristics like albedo, roughness, and emissivity, also play a role and therefore determine glacier melt (Vincent et al., 2004; Thibert et al., 2013; Roussel et al., 2025). While the presently accelerated retreat of Alpine glaciers can mainly be attributed to increasing summer air temperatures, large year-to-year variations in snow precipitation without recognizable long-term trends may lead to reduced or enhanced glacier mass loss in individual years (Huss et al., 2021). Furthermore, interactions between temperature and precipitation are important: For example, high temperatures in May or June can reduce the winter snowpack rapidly and expose the darker ice surface early in the melting season when solar radiation receipts are maximal. In contrast, summer snowfall down to the glacier termini leads to an increase in surface albedo and reduces the melting intermittently. In the following, we summarize the meteorological conditions during the hydrological year 2025 based on long-term, homogenized weather station data from MeteoSwiss (Begert and Frei, 2018), and the Klimabulletin (MeteoSwiss, 2026).

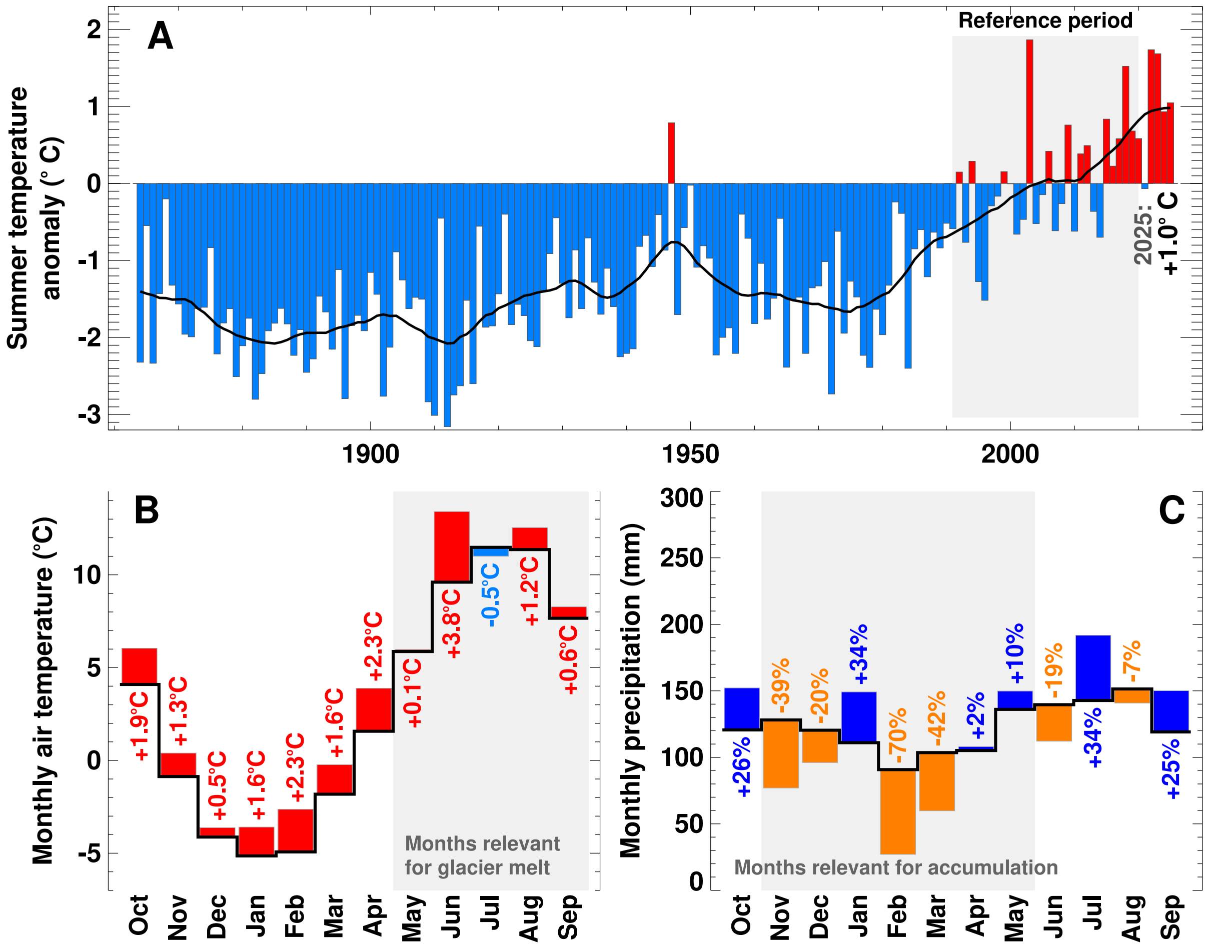


Figure 2.1. Weather conditions in the hydrological year 2025 with respect to the reference period 1991-2020. Data is based on the 13 homogenized MeteoSwiss stations (Begert and Frei, 2018) in the Alpine region (>1000 m a.s.l.). (A) Long-term evolution of summer air temperature (May to September). (B) Monthly air temperature and respective anomaly in the hydrological year 2025. (C) Monthly precipitation and respective anomaly in the hydrological year 2025. In panels (B) and (C), months relevant for glacier melt and snow accumulation, respectively, are underlain in grey. The colour of the bars indicates above- or below-average conditions with respect to the 1991-2020 baseline.

At a global scale, 2025 was the third-warmest year on record, closely following 2024 and almost on a par with 2023 (Copernicus, 2026). Across the whole of Switzerland, annual mean air temperatures in 2025 were very high as well, ranking fourth after 2022-2024 (MeteoSwiss, 2026). For 13 long-term meteorological stations in the Alpine regions (>1000 m a.s.l.) summer air temperatures (May to September) were higher by 1.0°C with respect to the 1991-2020 average (Fig. 2.1). Since the beginning of the observations in 1865, summer temperatures only exceeded this value in 2003, 2022, 2023 and 2018. Throughout the year, all months except for July were warmer than the 1991-2020 reference. This was especially pronounced in June and at alpine stations. For precipitation, the months of November, February and March were strongly below the average. Winter precipitation (November to April) was thus 24% lower compared to the 1991-2020 reference at the 13 alpine stations. Clearly above-average precipitation was measured in January and July.

The hydrological year started with a relatively cool and humid period adding a substantial snow-layer on glaciers already early in the season. Warm and dry weather until mid-November resulted in the depletion of the fresh snow on glacier tongues and sustained moderate ablation. The winter was characterized by a major precipitation deficit that was most pronounced in the northeastern Swiss Alps. At snow monitoring stations, the average snow depths between November and May were clearly below the long-term average, partly even reaching new record lows (Haberkorn et al., 2025). A substantial precipitation event in the Central Valais, Ticino and the Bernese Oberland in mid-April with up to 2 m of fresh snow at high elevation reduced the snow deficit until the end of winter in these regions. While snow melt was still moderate in May, long-lasting heat waves in June triggered a rapid disappearance of the snow cover on glaciers (Fig. 2.1). The heat was very intense even at high elevation. On Jungfraujoch, for example, June 2025 set a new temperature record for that month. Contrary to 2022 and 2024, no relevant deposition of Saharan dust on the winter snow was observed. Correspondingly, this factor did not further accelerate the melting. July 2025 was characterized by comparably low air temperatures and repeated snowfall down to the glacier tongues. This reduced the ice-loss rates and was beneficial for the glaciers. Several heat waves and stable weather conditions in August finally resulted in another boost of melting. In September, there was a succession of cooler periods with some snow on the glaciers and warmer phases. A major precipitation event towards the end of the month covered the ice with a substantial layer of fresh snow.

(Left) *The tongue of Vadret da Morteratsch was already completely snow-free in June 2025.* ***(Right)*** *In the accumulation area of Rhonegletscher only remnants of winter snow were visible in September 2025. Photos: M. Huss.*

3 Glacier mass balance

The seasonal to annual mass balance reflects the immediate glacier response to meteorological conditions. The monitoring of both winter snow accumulation and summer melting resolves the components of glacier mass balance and thus allows investigating the drivers of gain or loss. Glacier mass change over annual periods is also directly linked to downstream impacts, such as the contribution to the hydrological cycle and global sea level (Huss et al., 2025a). Furthermore, the monitoring of glacier mass balance allows a near real-time reporting, thus satisfying public requirements for insights into the current state of glaciers. Mass balance is therefore the most important GLAMOS variable and is presented in more detail in this Swiss Glacier Bulletin in comparison to other measurements that sometimes are subject to a time lag in data availability or reveal a delayed climate change signal, such as length, surface elevation or glacier area change.

The approach to determine *in situ* mass balance using the direct glaciological method has remained very similar since the first measurements at accumulation and ablation stakes were initiated over 100 years ago (Firnberichte, 1914-1978; Müller and Kappenberger, 1992; WMO, 2023). A high temporal consistency for the reanalysis of long-term mass balance time series is thus reached (e.g. Zemp et al., 2013; Huss et al., 2015). The backbone of the direct observation of mass balance is the monitoring of point sites (Geibel et al., 2022). The method is based on stakes drilled into ice (ablation area) or snow pits/snow cores down to a marked horizon (accumulation area). During the winter surveys conducted in April or May, snow soundings to the last summer surface layer are used, complemented with density measurements (GLAMOS, 2021). Within GLAMOS, extrapolation from individual measurement points to the entire glacier surface is performed by relying on a distributed mass balance model that is tightly constrained with all observations acquired throughout the respective year (Huss et al., 2021). The model includes the most important processes governing spatial mass balance distribution. This approach is regarded as an advanced extrapolation tool to infer glacier-wide quantities from point measurements rather than a mass balance model in the conventional sense: the signal of seasonal and annual mass balance variability is purely given by the field measurements. The utilized approach allows estimating the mass balance in unmeasured regions based on a physical representation of the spatial variability, as well as the calculation of mass balance over arbitrary periods, such as the hydrological year. The latter is relevant for the comparability of series acquired on different glaciers.

Silvrettagletscher – chosen as a Spotlight glacier in this report (Sec. 3.1) – on 29 June 2025. Some of the rock outcrops only emerged in the most recent years. Photo: A. Bauder

In the reporting period, field measurements documenting annual mass balance were collected on 25 individual glaciers throughout Switzerland (Fig. 1.1). The annual observations at a network of between 2 to 16 measurement points per glacier permitted inferring glacier-wide quantities and the corresponding elevation distribution (GLAMOS, 2025b). A late-winter survey – with up to 350 manual snow depth soundings per glacier and snow density surveys at up to five sites per glacier – was conducted on 21 glaciers (GLAMOS, 2025a). For six of these surveys, only a limited spatial coverage of measurement points was reached however. For many glaciers, intermediate surveys of a part or the entire stake network during the summer season provided valuable insights into sub-seasonal dynamics of snow accumulation and melting. In addition, real-time observations of mass balance on seven glaciers were acquired using a webcam-based system (Landmann et al., 2021; Cremona et al., 2023) providing daily mass balance at 1-2 selected sites per glacier throughout the year. Relying on weather data, daily updates of the present state of all Swiss glaciers (https://doi.glamos.ch/figures/massbalance_current/massbalance_current.pdf) are based on distributed modelling constrained with all available observations (real-time cameras, intermediate point measurements, satellite- or webcam-derived snowlines).

3.1 Spotlight: Silvrettagletscher

In this Swiss Glacier Bulletin, we put a spotlight on Silvrettagletscher (Fig. 3.1) and provide more detailed insights into the monitoring programme, as well as some specific results for the reporting period. Silvrettagletscher is a global reference glacier of the WGMS, features detailed annual measurements based on a dense stake network since 1959 (GLAMOS, 1881-2024), and a series reaching back to 1917 at two measurement locations. With a coverage of over 100 years, it is thus the longest continuous mass balance time series worldwide together with Claridenfirn. Winter balance observations have been acquired at 1-2 sites between 1915 and 1983, and at a network of measurement sites distributed across the entire glacier since 2004. Since 1960, Silvrettagletscher has seen a significant retreat with a loss of 30% of its surface area and 54% of its ice volume. While glacier mass was quasi-stable between 1960 and 1990, ice losses strongly accelerated afterwards. The progressing decay of the glacier became apparent after about 2015, with large rock outcrops successively developing at several places.

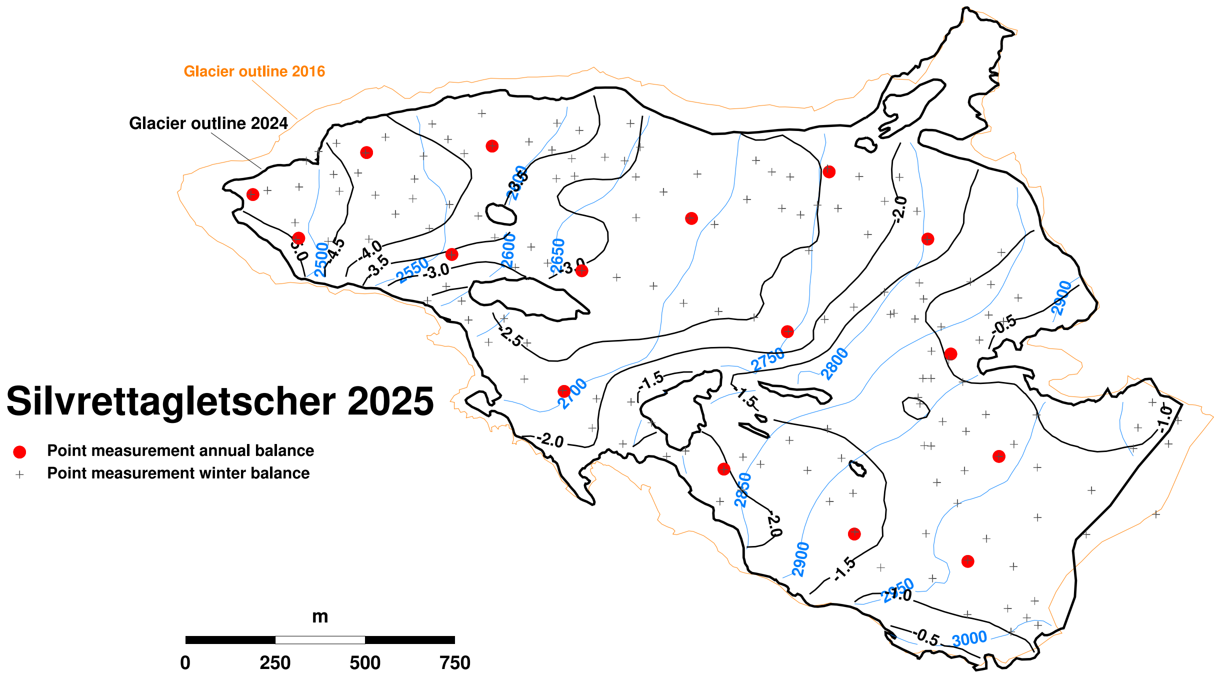


Figure 3.1. Overview map of Silvrettagletscher indicating the local measurements of winter snow accumulation (crosses) and annual mass balance (red dots) acquired in 2025. Glacier extent and surface contours are shown for the year 2024. The glacier outline in 2016 is depicted for comparison. Black contours show interpolated surface mass balance in the hydrological year 2025.

On Silvrettagletscher, a winter survey was carried out on 2 May 2025. In total, 157 snow depth soundings and density measurements at three sites consisting of six snow cores each were acquired. Snow depth only reached 1.0-2.5 metres over most of the glacier area which is exceptionally low in comparison to previous years. On 19 September 2025, the late-summer survey was conducted, and the entire network of 16 stakes was visited and redrilled (Fig. 3.1). By late summer, Silvrettagletscher's surface was completely snow-free except for a few firn patches in the most shaded corners of the accumulation area. Winter snow depth in early May was the lowest observed over the entire >100-year record (–49% relative to the 2010-2020 average, GLAMOS, 2025a). Correspondingly, also the annual balance was very negative with –2.27 m w.e., thus ranking third lowest after the extreme years of 2022 and 2023 (Fig. 3.2). The very high mass loss of Silvrettagletscher in 2025 can be attributed to the extremely low winter snow depth combined with summer heat waves.

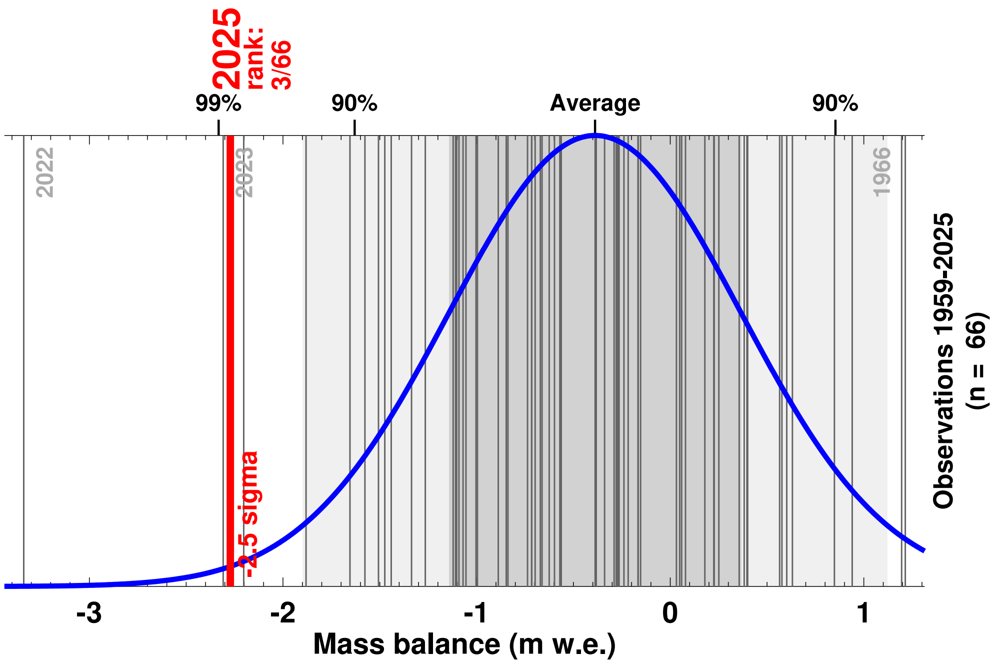
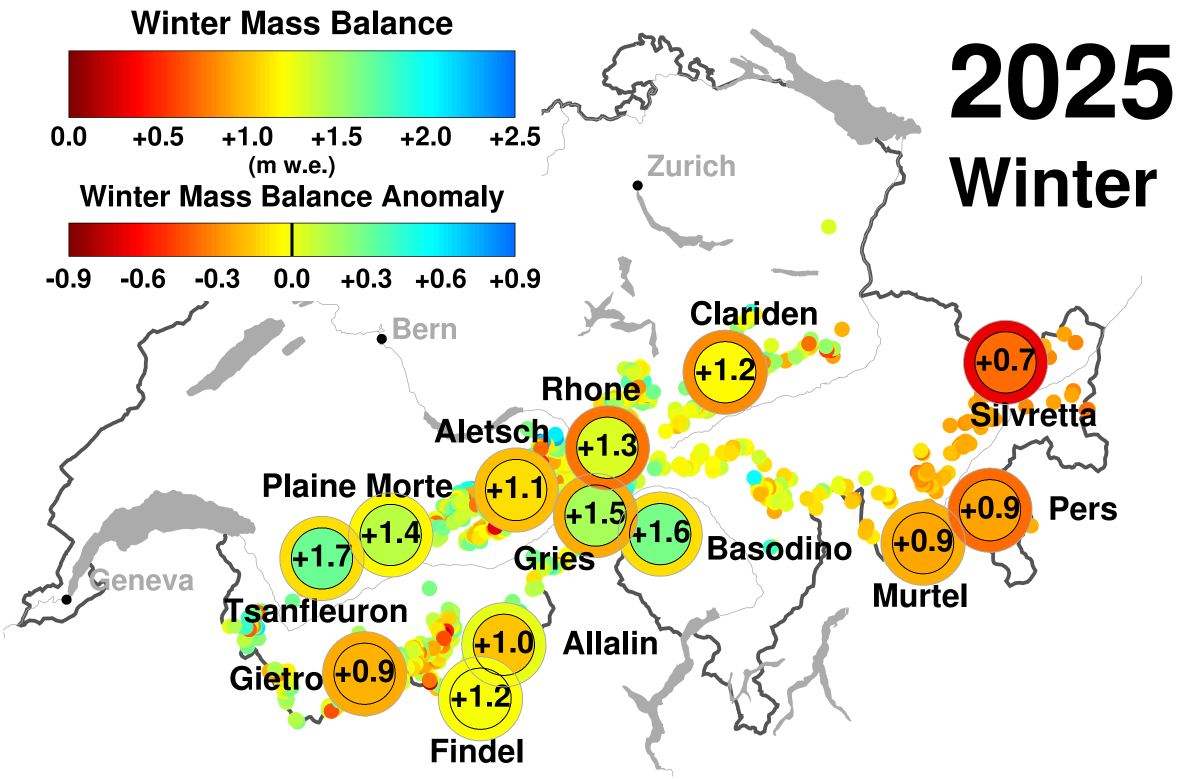


Figure 3.2. *Statistical distribution of glacier-wide mass balance of Silvrettagletscher since the beginning of the detailed measurements in 1959 (every year homogenized to the period 1 Oct to 30 Sep). The value and the rank of the current year is highlighted (red), and previous exceptional years (grey labels) are indicated. The blue line corresponds to a normal distribution fitted to all observations.*

3.2 Mass balance observations throughout Switzerland

Observations of annual mass balance throughout Switzerland were more negative than in the previous hydrological year 2024 almost everywhere. Point mass balance measurements often rank third most negative after 2022 and 2023, while for other sites rank 3 is taken up by strong melt years such as 2003, 2011, 2015 or 2018. The maximum local ice loss observed in September 2025 reached around 7.5 metres (ca. 7 m w.e.) for the annual period on glacier tongues extending to low elevation (e.g. Findel, Rhone) and even ca. 13 metres for the lowermost site on Grosser Aletschgletscher (1980 m a.s.l.). Local snow accumulation, and thus formation of new firn, has been observed above ca. 3100-3300 m a.s.l. (depending on the region). The highest measurement sites (Grosser Aletsch, Findel, Rhone) experienced accumulation rates of ca. 2 metres of snow (ca. 1 m w.e.). These conditions, however, only prevailed for the uppermost regions of large glaciers, while almost two thirds of the monitored glaciers completely lost their snow coverage throughout the summer. Even their topmost measurement points, at elevations of between 2700 and 3300 m a.s.l., experienced melt rates of 1 meter or more (e.g. Clariden, Gries, Giétro, Otemma, Plaine Morte, Silvretta).

Seasonal mass balance monitoring throughout all climatological regions of Switzerland indicated a consistent pattern. Below-average winter snow depth was combined with excessive summer melting. Some regional differences emerge: Winter snow accumulation was most anomalous in the northern and eastern Swiss Alps with a deficit of 20-50% relative to the 2010-2020 average. In the Bernese Oberland, Central Switzerland and Ticino, winter mass balance was only moderately below the long-term mean, with an anomaly of –20% to 0%. In Southern Valais values were close to average (Fig. 3.3).



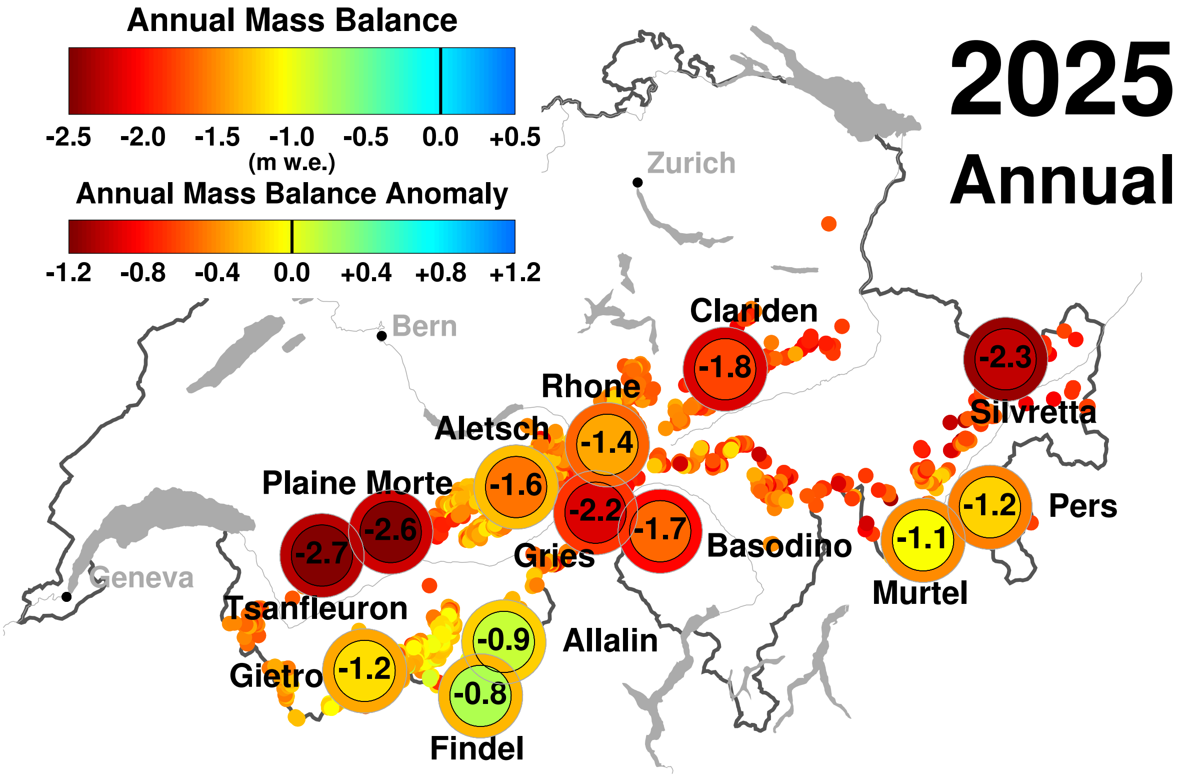


Figure 3.3 Observed winter ***(top)*** *and annual* ***(bottom)*** *glacier mass balance for the most important surveyed sites (large dots) in metres water equivalent (homogenized to 30 April 2025, and 30 Sep 2025, respectively). The colour of the outer circle indicates the anomaly with respect to 2010-2020 average mass balance of the respective glacier. For visualization, mass balance estimated by extrapolation is shown with small dots for the remaining glaciers.*

Values of –2.7 to –0.8 m w.e. were inferred for the annual glacier-wide mass balance. Most negative mass balances were found for glaciers in Bernese Oberland and the Northeast of Switzerland, while the thickness losses were more moderate in Southern Valais and Engadin, corresponding to a typical pattern (Fig. 3.3). The annual loss was higher than the 2010-2020 average for all glaciers. Glaciers with the most anomalously negative mass balance are found in different climatological regions of Switzerland (Basòdino, Clariden, Gries, Plaine Morte, Silvretta, Tsanfleuron). As for 2024, their high losses are likely explained by the limited altitudinal range of these glaciers with most of the surface located below 3000 m a.s.l., presumably making them more vulnerable to summer heat waves. In some cases, the entire surface of these glaciers was already snow-free in early July 2025.

The evolution of glacier mass balance throughout the hydrological year 2025 started with a rapid growth of the snow layer on glaciers in early October (Fig. 3.4). Until mid-November, warm and dry weather triggered additional ice melt on glacier tongues below ca. 2700 m a.s.l. before the actual snow accumulation phase started. While mass balance was only slightly below the 2010-2020 average until the end of January, a dry period lasting until mid-April 2025 resulted in much lower snow depths on glaciers than usual. An exceptional 2-day snow event then added partly over 2 metres of snow on glaciers in the Southern Valais, Ticino and Bernese Oberland. The month of May was relatively favourable to glaciers with a delayed onset of melting. Peak snow accumulation was reached on 29 May which is slightly later than on average, but the long-lasting heat waves in June resulted in extreme melt rates. The "Glacier loss day" (Voordendag et al., 2023), i.e. the day when overall mass balance with respect to 1 Oct of the previous year becomes negative and all snow mass added during winter is melted, happened on 7 July on average for 13 glaciers with detailed data, the second-earliest date ever (GLAMOS, 2025b). After the second week of July, cooler temperatures with repeated snow fall events at the elevation of the glaciers prevailed. This led to relatively limited rates of ice melt for several weeks, before heat waves returned and were especially strong in the first half of August. Until the end of the hydrological year, the weather was then characterized by average conditions (Fig. 3.4).

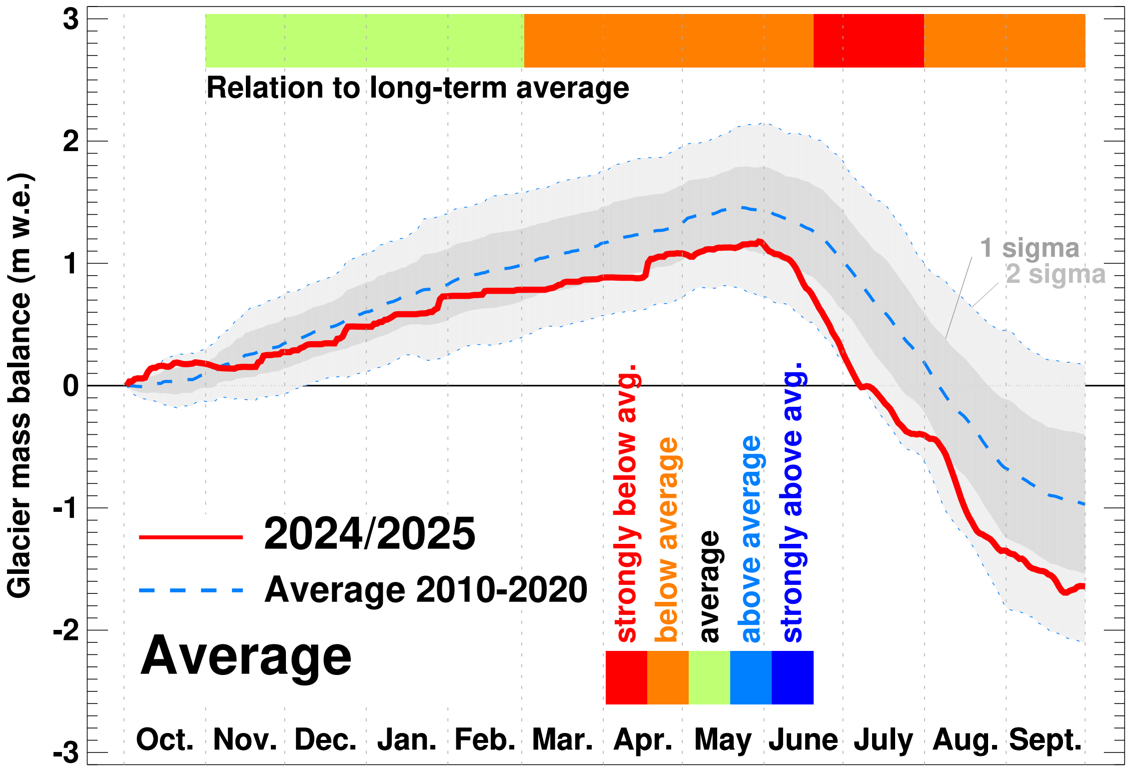


Figure 3.4 *Cumulative daily mass balance in the hydrological year 2025 (red) in comparison to the daily average and the standard deviation of the years 2010-2020. The top bar indicates periods with average (green, +/–0.75 standard deviations σ), (strongly) below-average (orange/red, –0.75 / –1.5 σ) or (strongly) above-average (light/dark blue, +0.75 / +1.5 σ) mass balance. The graph shows the arithmetic average of the 13 main surveyed glaciers (see Fig. 3.3).*

3.3 Swiss-wide glacier mass change

For regionalizing the findings on glacier mass balance measured at the 25 glaciers throughout the Swiss Alps, annual mass balance anomalies homogenized to the hydrological year (1 Oct - 30 Sep) were extrapolated to all 1'400 glaciers of the Swiss Glacier Inventory SGI2016 according to an approach described in van Tiel et al. (2026) or Dussaillant et al. (2025). With this technique we account for differences in regional sampling density and include long-term trends of glacier-specific mass loss for all glaciers based on the 1980-2010 geodetic mass balance (Fischer et al., 2015). The area of each glacier is updated to the year 2025 based on a volume-area-scaling approach.

For the hydrological year 2025, an average mass balance of –1.56 m w.e. is found for all Swiss glaciers (Fig. 3.5). Over the last 70 years when detailed observations are available, annual ice thickness losses were higher only in 2022, 2023, 2003, 2011, 2017 and 1998 (in this order). Interestingly, the summer mass balance of 2025 is not exceptionally negative – summer melt rates (1 May - 30 Sep) were only 11% above the 2010-2020 average, despite the high air temperatures in June and August (Fig. 2.1). This can be attributed to the cool month of July with repeated snowfalls. Furthermore, only few events depositing Saharan dust on the snow- and ice-surface were observed in 2025. Thus, this melt-reinforcing effect that was highly relevant in previous years (e.g. Roussel et al., 2025) dropped out. These findings indicate that the high glacier mass loss in 2025 was strongly supported by the snow deficit during the winter season.

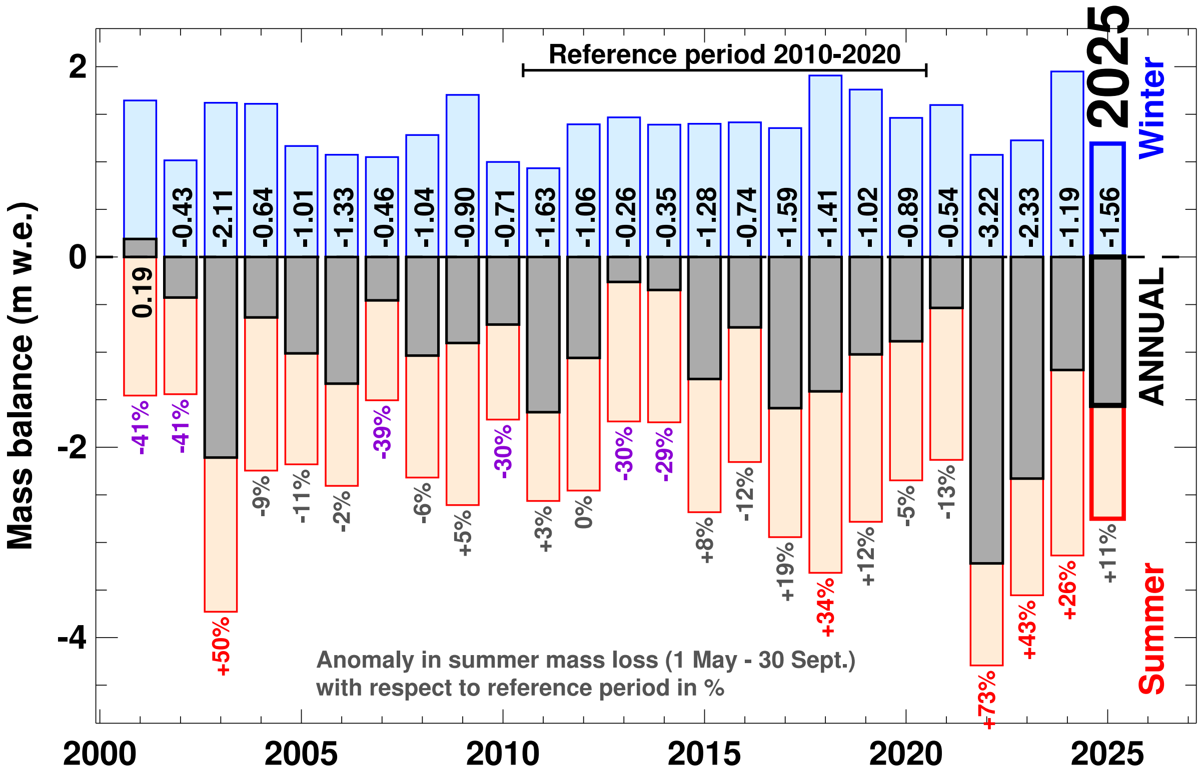


Figure 3.5. *Seasonal mass balance extrapolated to all glaciers in Switzerland. Annual mass balance (1 Oct - 30 Sep, dark grey / numbers next to the zero-line), winter mass balance (1 Oct - 30 April, light blue), and summer mass balance (1 May - 30 Sep, orange) is shown. Percentage numbers below the bars indicate the relative anomaly of summer mass balance compared to the period 2010-2020, coded with colours for years with strongly below-average (purple), average melt (grey) and strongly above-average melt (red).*

By combining the extrapolated glacier mass change with a complete assessment of the glacier volume in Switzerland (Grab et al., 2021), ice volume time series can be prolonged up to today at the scale of individual glaciers, hydrological catchments and the whole of Switzerland. The results indicate that Switzerland still hosted ca. 45.1 km^3 of glacier ice by the end of 2025 (Fig. 3.6). This is almost 30 km^3 less than in 2000. The annual change of glacier volume relative to the remaining volume mostly fluctuated between –1% and –3% per year during the last two decades. The two years 2022 (–5.9%) and 2023 (–4.4%) stand out with unprecedented ice volume losses. Even though the glacier ice volume reduction by 3.0% in 2025 appears less extreme, this relative loss ranks fourth since the beginning of the detailed surveys in 1960 (Fig. 3.6). The absolute ice volume loss of 1.4 km³, however, is not extraordinary in comparison to previous years due to the already much reduced overall glacier area (see e.g. van Tiel et al., 2026).

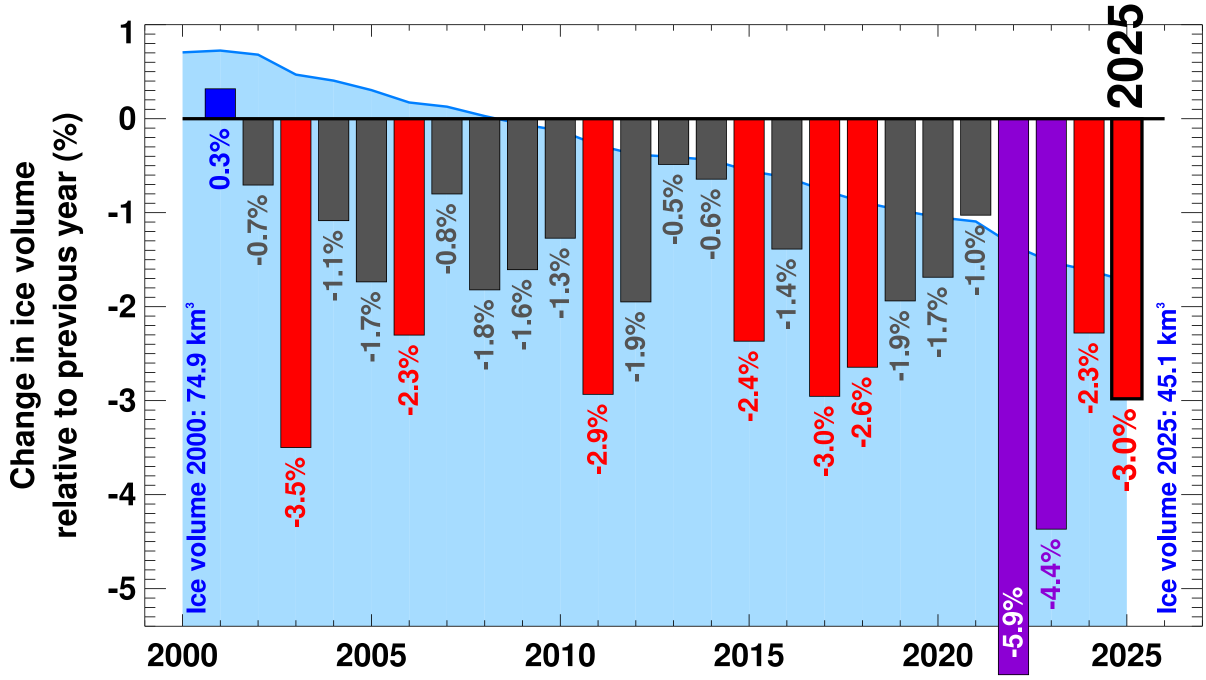


Figure 3.6. *Swiss-wide annual change in glacier volume relative to the remaining ice volume of the previous year. Colours visualize moderate (dark grey), strong (red) and extreme losses (purple). 2025 is highlighted. The blue surface in the background visualizes the temporal evolution of total ice volume.*

(Left) *Snow density measurements on Grosser Aletschgletscher in late March 2025. Photo: M. Huss.* ***(Right)*** *Drilling of an ablation stake on Vadret Pers in September 2025. Photo: A. Linsbauer.*

4 Glacier length change

Systematic observations of glacier length change started in 1880, and many series have been continued until today (GLAMOS, 1881-2024, Fig. 1.1). Since the beginning, surveys have been carried out by a collaborative network of contributors, often involving cantonal authorities and observers with local knowledge. The corresponding data are centrally collected and evaluated by GLAMOS. A variety of approaches is used to determine glacier length change, ranging from *in situ* observations using measuring tapes, theodolites or GPS, increasingly shifting to airborne measurements either based on drones or on the operational products of swisstopo (GLAMOS, 2020). However, remotely sensed data typically only become available with a time-lag of several months thus hampering near-time reporting. This is acceptable, as glacier length variations are an indirect response to climate change, determined by the meteorological conditions of the previous years, and strongly affected by the current terrain characteristics at the glacier snout (e.g. steep sections with thin ice or debris coverage). In this report, we focus on long-term variations and the complete data coverage of the previous year (2024).

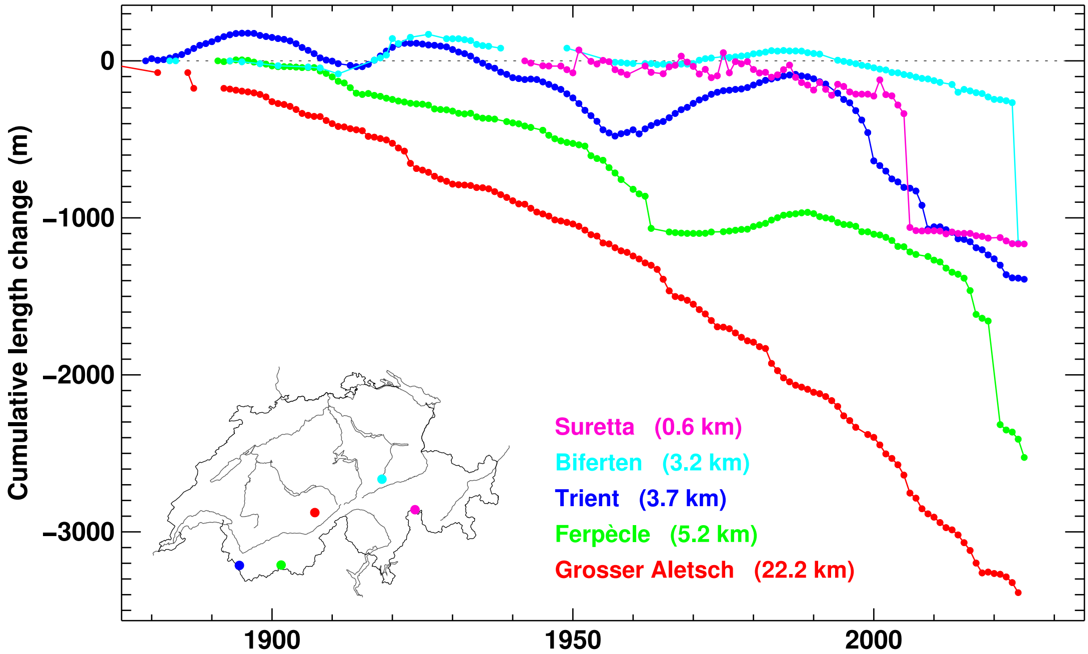


Figure 4.1. *Cumulative length change of five selected glaciers with different characteristics or particular behaviour in the most recent years. The glaciers' location and their current overall length are shown in the inset.*

In general, glaciers show strongly differing length variations in response to the same change in climate forcing. Large glaciers with a gently-sloping ablation area (e.g. Grosser Aletsch) exhibit a major and steady retreat, while glaciers with a steep tongue have been able to respond with an advance to intermittent short periods of positive mass balance (e.g. Trient in the 1980s, Fig. 4.1). In 2024, length change was measured for 69 glaciers (Fig. 4.2). Of these, 66 retreated. Three glaciers (Sardona, Sulz, Turtmann) were stationary or slightly advanced. This can be explained by local conditions at the glacier snout, probably related to frontal snow deposits preserved after the winter 2023/2024, or observational uncertainties. 90% of the annual measurements show a length reduction of between –1 m and –64 m (5% and 95% quantiles). Exceptions with a very large retreat in 2024 were observed at Biferten (–895 m), Ischmeer (–350 m) and Rhone (–115 m). These retreats are related to effects of the glacier's shape and the subglacial terrain in the region of the tongue. Long-term thinning can result in the wastage of the ice and the retreat over a steep rock step within a single year (e.g. Biferten and Ischmeer in this period), unrelated to actual climate conditions in the respective year. Some other large glaciers also showed substantial length reductions (e.g., Findel, Gorner, Grosser Aletsch and Morteratsch). Compared to the average glacier-specific length change rate between 2010 and 2020, the retreat in 2024 was lower by 7% (median value), with 44% of the observed glaciers retreating at a higher rate, and 56% at a lower rate than during the reference period.

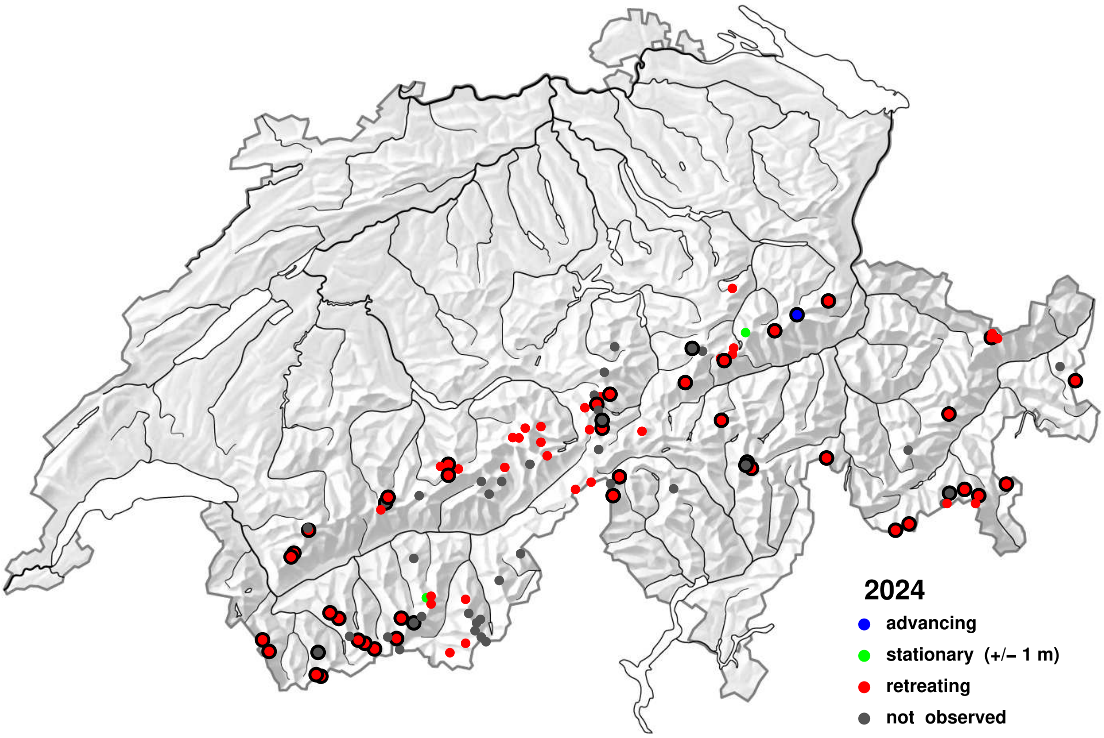


Figure 4.2. *Length change measurements in 2024 classified into advancing (blue), stationary (green, +/–1 m) and retreating (red). Long-term series with no measurements in 2024 are dark grey. Glaciers with data already available for the 2025 reporting period are indicated with a black circle.*

For 46 glaciers with direct observations in the field, results are already available for late summer 2025. All but one show a further retreat. Among the few with a very large change of the terminus position in 2025 are Ferpècle (–117m) and Tiefen (–90m). For the already evaluated series, still missing many of the larger glaciers, 90% of the annual retreat values lay between –2 m and –59 m. The median retreat rate of the already available data set was found to be 5% faster than on the 2010-2020 average, but yet 44% of the glaciers showed a somewhat slower retreat than during the reference period.

(Left) *Surettagletscher in September 2024. Photo: AWN/GR, C. Fisler.* ***(Right)*** *The tongue of Bifertenfirn split up in 2024, showing a retreat of almost 900 m in a single year. Photo. Hp. Klauser.*

5 Ice flow velocity

Surface ice-flow velocity of mountain glaciers provides insights into mass turn-over and changes in ice dynamics in response to shifts in surface mass balance (e.g. Greene&Gardner, 2025). Long-term investigations of three-dimensional surface displacement are performed on eight Swiss glaciers (see Fig. 1.1) by monitoring the position of stakes using global navigation satellite system (GNSS) technology. The longest continuous series of local flow velocities go back into the 1960s when monitoring was started in relation to potentially hazardous glacier instabilities (Allalin, Giétro). Later, glaciers with long-term mass balance monitoring programmes were added (e.g. Rhone, Silvretta). Observations are acquired at a network of 1 to 16 stakes per glacier. Surface displacement is normalized to an annual period of 365.25 days for comparability.

Across all eight investigated glaciers, measured flow velocity in 2025 was 46% smaller than the respective average during the reference period 2010-2020. A decrease was found for all glaciers (average of all observed stakes) but varied between –8% (Grosser Aletsch) and –66% (Silvretta). Average flow velocity at the monitored sites ranged from 1.6 m yr^{-1} (Silvretta) to 29.4 m yr^{-1} (Rhone). Note that these mean flow velocities do not refer to the entire glacier but are determined for the observed points and are therefore influenced by their spatial distribution.

Here, we present the surface velocity time series for one selected glacier with a typical flow regime and long-term records: On Glacier du Giétro, two measurement points were chosen – one in the accumulation area (3250 m a.s.l., site 2) and one in the ablation area (2850 m a.s.l., site 6). The data indicates a striking difference between flow velocity in the upper and lower reaches of the glacier (Fig. 5.1). While flow speed significantly increased in the 1980s to over 100 m yr^{-1} in the ablation area due to a period of positive mass balance, the accumulation area was barely affected. In contrast, flow velocity close to the terminus strongly decreased until 2025 because of thinning and a lack of mass supply from the accumulation area. The original measurement site needed to be abandoned in 2022, leading to a minor velocity increase due to the relocation. Flow velocity in the accumulation zone is generally low (5-15 m yr^{-1}) and showed relatively limited changes over time even though the deceleration became more important in recent years.

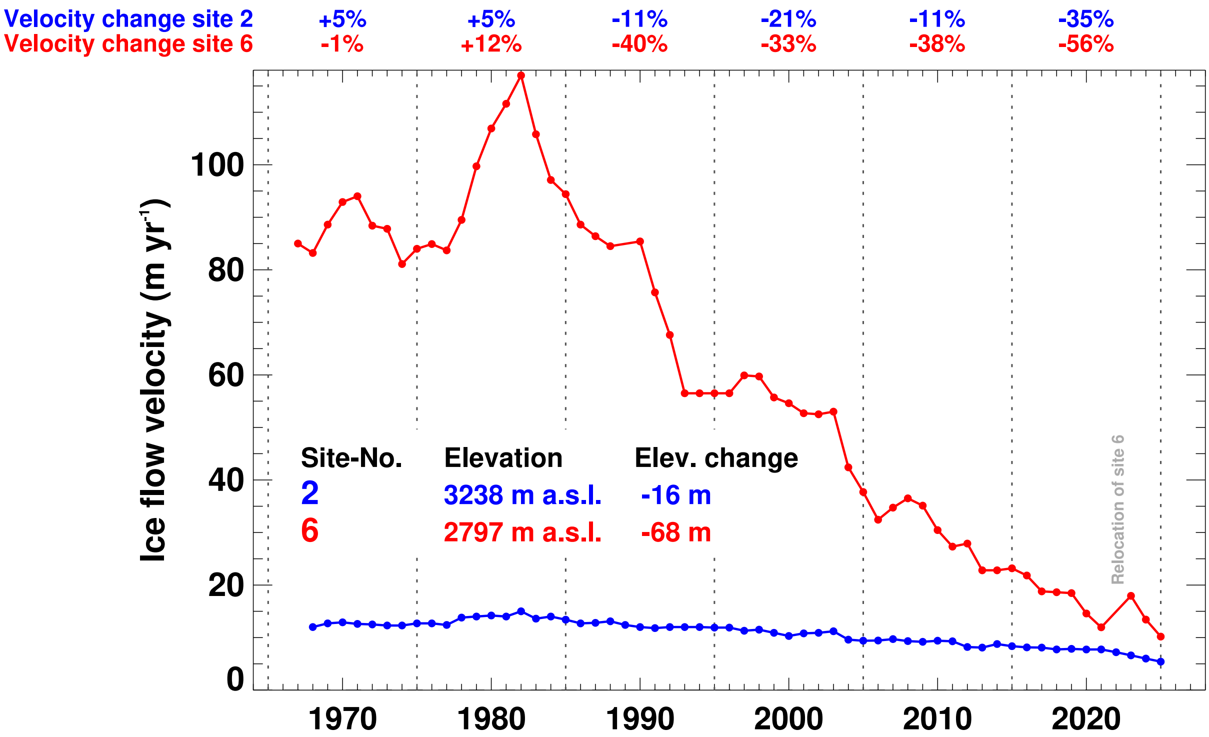


Figure 5.1. Long-term changes in ice flow velocity for two sites on Glacier du Giétro in the accumulation area (site 2) and close to the present glacier snout (site 6). The change in flow velocity relative to the previous decade for each site is given on top. Total surface elevation change for both sites since the onset of the respective series is indicated.

6 Glacier Inventory

Glacier inventories provide the extent of all glaciers in a region for a defined point in time (Paul et al., 2009). Several glacier inventories have been elaborated for Switzerland covering the last 170 years (Fig. 6.1). Since 2020, the Swiss Glacier Inventory (SGI) is being updated in an operational framework in close collaboration with swisstopo (Linsbauer et al., 2021). Within the process of generating the swissTLM^{3D} product (swisstopo, 2024), glacier outlines are manually digitized according to glaciological criteria on aerial orthoimages by swisstopo operators in 3-year time intervals. The spatial resolution of the imagery (10-20 cm) also allows accurate mapping of debris-covered ice and glacier margins in shaded regions. Glacier outlines are then checked and potentially adjusted by GLAMOS to establish a glacier inventory including relevant attributes such as area, length, minimum/maximum elevation, and slope. As not all regions of Switzerland are covered by aerial imagery in a single year, completed inventories refer to a time range, with individual glaciers being surveyed in different years. Here, we present the first results of the new Swiss Glacier Inventory 2023 (SGI2023), referring to the period 2021-2024. Glaciers in central Switzerland were mapped in 2021. In 2022 and 2023, optimal mapping conditions and minimal snow coverage were encountered on the glaciers in the Grisons and Valais, respectively. The imagery of 2024 covered the Bernese Oberland and Ticino.

Table 6.1 shows an overview of regionally specified glacier area changes between the last complete inventory (SGI2016) and the SGI2023. A strong decrease in glacier area is seen in all regions, despite the short time interval of only ca. 6 years. Regional area-change rates vary between –1.5 and –5.1% yr^{-1} (Table 6.1). We note that these values are difficult to compare as they depend on the average glacier size in the given region. A total glacier area of 861.3 km^2 is found for the new inventory's centre year 2023. The SGI2023 lists 1299 individual glaciers. 159 glaciers ultimately disappeared between 2016 and 2023, corresponding to 11% of the initial count. 58 "new" glaciers are inventoried related to the split-up of larger ice bodies. In Ticino almost 40% of the glaciers vanished in just six years (Table 6.1). Disappearing glaciers are very small and are excluded from the inventory when their area drops below the threshold of 0.01 km^2 (Linsbauer et al., 2025; Huss et al., 2025b). The largest glacier that vanished between the two inventories of 2016 and 2023 is Ghiacciaio del Cavagnoli (TI, see pictures below). It still had an area of 0.18 km^2 in 2018.

Table 6.1. *Mapped glacier area according to the last inventory (SGI2016, Linsbauer et al., 2021) and the new SGI2023. Reference years of the inventory in the individual regions are given, and the annual area-change rate has been evaluated. The last column refers to the number of individual glaciers that have disappeared between the inventories of 2016 and 2023, including their percentage with respect to the total regional number.*

Region	Reference years	Area SGI2016 (km^2)	Area SGI2023 (km^2)	Area change rate (% yr^{-1})	Glaciers disappeared
Valais	2017-2023	594.97	540.59	–1.52	65 (–11.0%)
Bernese Alps	2018-2024	171.35	152.68	–1.81	28 (–11.3%)
Grisons	2016-2022	103.95	89.10	–2.38	40 (–13.3%)
Central Switzerland (UR, OW, SZ)	2015-2021	67.69	59.08	–3.04	11 (–6.2%)
Glarus Alps	2013-2022	15.28	13.76	–1.65	4 (–11.1%)
Ticino	2018-2024	4.56	3.16	–5.11	11 (–37.9%)
Others (AI, SG, VD)	2013/14 to 2022/23	3.47	2.99	–2.64	0 (0%)
Total	**2013-2018 to 2021-2024**	**961.27**	**861.33**	**–1.73**	**159 (–11.3%)**

Supraglacial debris coverage has increased from 10.8% in the SGI2016 to 13.4% in the SGI2023. The debris-covered area has also grown in absolute terms from 101 km^2 to 116 km^2 even though glacier snouts have retreated, thus losing some area that was previously debris-covered. The up-glacier expansion of debris coverage prevails, indicating that debris-cover processes and the corresponding effects on glacier evolution increasingly gain in importance.

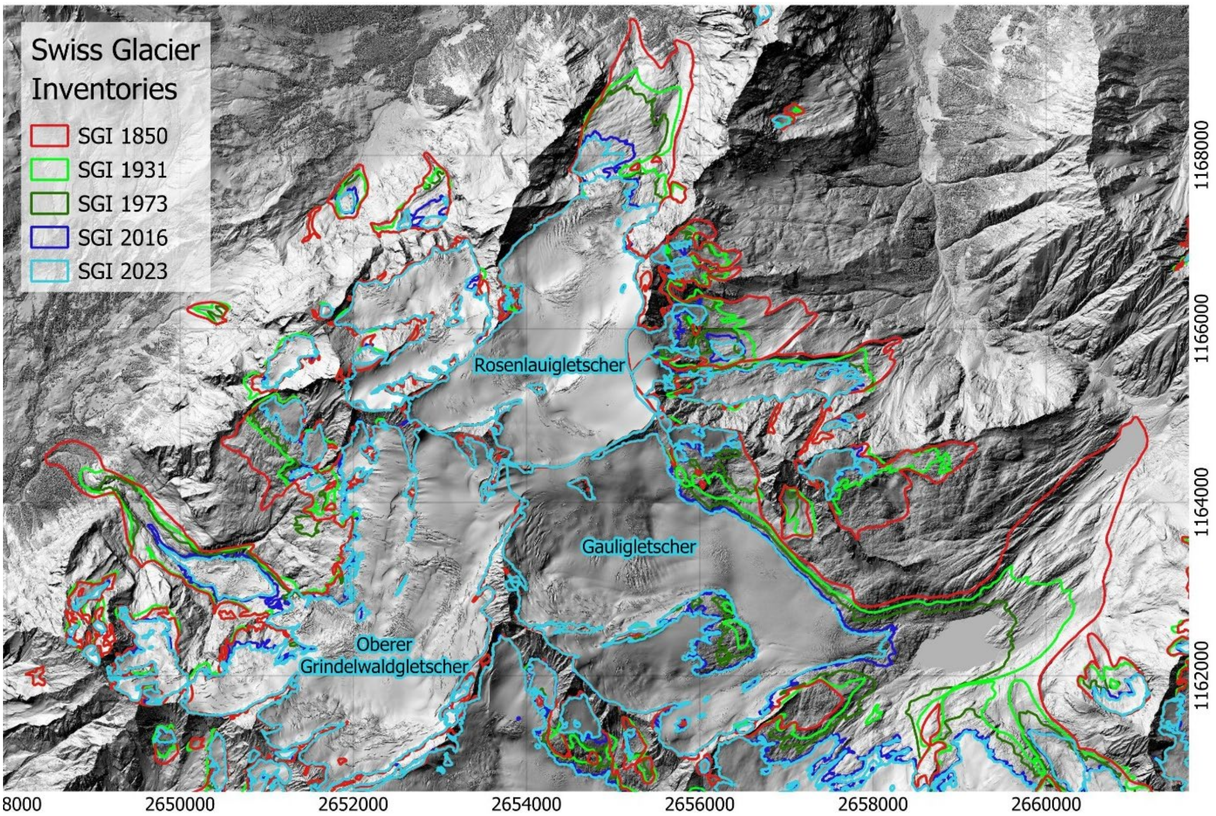
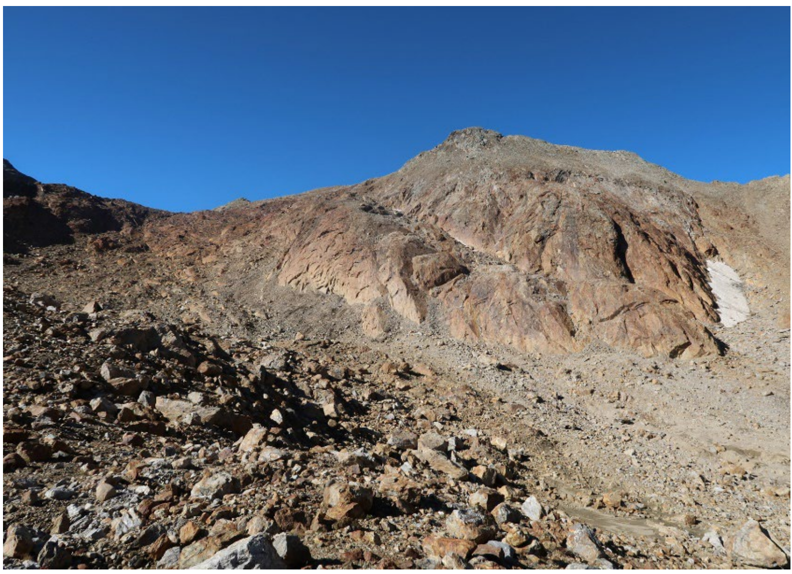


Figure 6.1. *Glacier outlines for the region around Gauligletscher, Rosenlauigletscher and Oberer Grindelwaldgletscher in the Bernese Oberland, selected as an example to visualize past area changes. The Swiss Glacier Inventories of 1850, 1931, 1973, 2016 and 2023 are shown.*



(Left) *Ghiacciaio del Cavagnoli (TI) in 2018 and* ***(right)*** *in 2025, when it completely vanished. Photos: SF/TI, M. Soldati.*

7 Ice volume change

Ice volume change and geodetic mass balance can be inferred based on the comparison of repeated digital elevation models (DEMs) covering the entire glacier surface (e.g. Hugonnet et al., 2021, The GlaMBIE Team, 2025). This approach allows obtaining data on multi-annual mass balance for every Swiss glacier (e.g. Fischer et al., 2015). Geodetic mass balance estimates for the Swiss Alps can also be extended to cover the entire last century (Bauder et al., 2007; Mannerfelt et al., 2022). Based on the operational data sets of swisstopo, most importantly the swissALTI^{3D} product (swisstopo, 2023), GLAMOS has access to DEMs acquired at 1- to 6-year intervals for all Swiss glaciers since about 2010. By combining DEMs with the temporally closest glacier outline from the multi-temporal inventories (see Chapter 6), a three-dimensional representation of every glacier throughout time is obtained. By differencing individual DEMs, surface elevation and volume changes can be computed over arbitrary periods. Exemplarily, Figure 7.1 shows surface elevation changes for Oberaargletscher, Bernese Alps, over the period 2018-2024. Rapid ice loss with a maximum of 50 m near the glacier terminus is visible. Surface lowering also extends to the highest regions of the glacier.

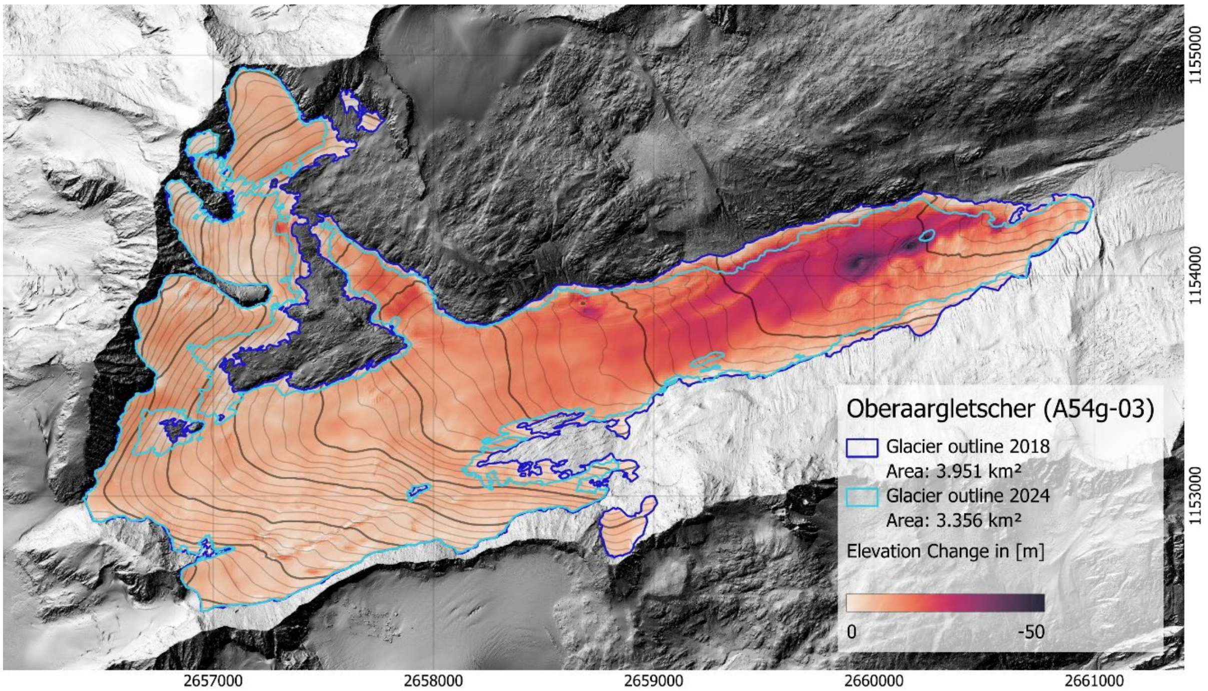


Figure 7.1. *Observed surface elevation change of Oberaargletscher between 2018 and 2024. The glacier extent for the two points in time is indicated with the blue lines. The respective glacier area is given in the figure's legend.*

Resulting changes in ice volume are converted to a mass change and an annual geodetic mass balance using a density assumption (850 kg m^{-3}, Huss, 2013). For regional-scale assessments, data on geodetic mass change need to be homogenized to refer to the same time period, as acquisition dates may vary by several months. This is achieved by relying on daily regional data products (see Chapter 3.3), and allows the extraction of a Swiss-wide geodetic mass balance over consistent periods. These observations indicate average glacier mass balance aggregated to medium-scale hydrological catchments throughout Switzerland of between –0.9 m w.e. yr^{-1} and –2.5 m w.e. yr^{-1} in the period 1 Oct 2017 to 30 Sep 2024, while most of the catchments exhibit values of between –1.1 m w.e. yr^{-1} and –1.7 m w.e. yr^{-1} (Fig. 7.2). This range encompasses 90% of the glacier area. The spatial variability is noteworthy and cannot be resolved with *in situ* mass balance measurements only. The highest mass-loss rates are observed in the Grisons with a maximum for glaciers in Val Bregaglia, while the lowest mass-loss rates occurred in the southwards-draining Simplon valley (Valais). The most moderate losses generally occur in regions with relatively small glaciers in marginal regions of the Alpine arc. The spatial variations are driven by a combination of various factors, e.g. (1) regional differences in weather conditions during the respective years, (2) the local sensitivity of glaciers to current warming trends, often related to overall precipitation amount and thus median glacier elevation, and (3) tendencies of glacier stabilization after major retreat due to increasing debris coverage and the loss of exposed low-lying ice surfaces.

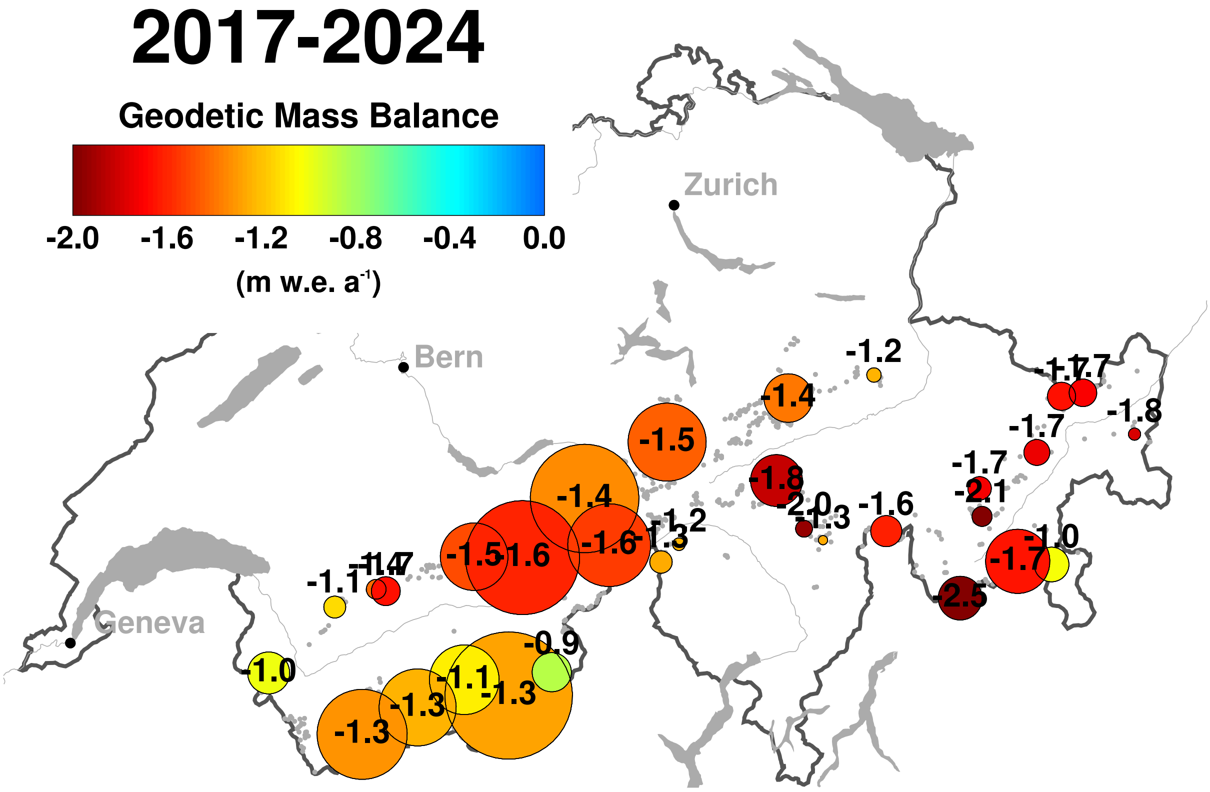
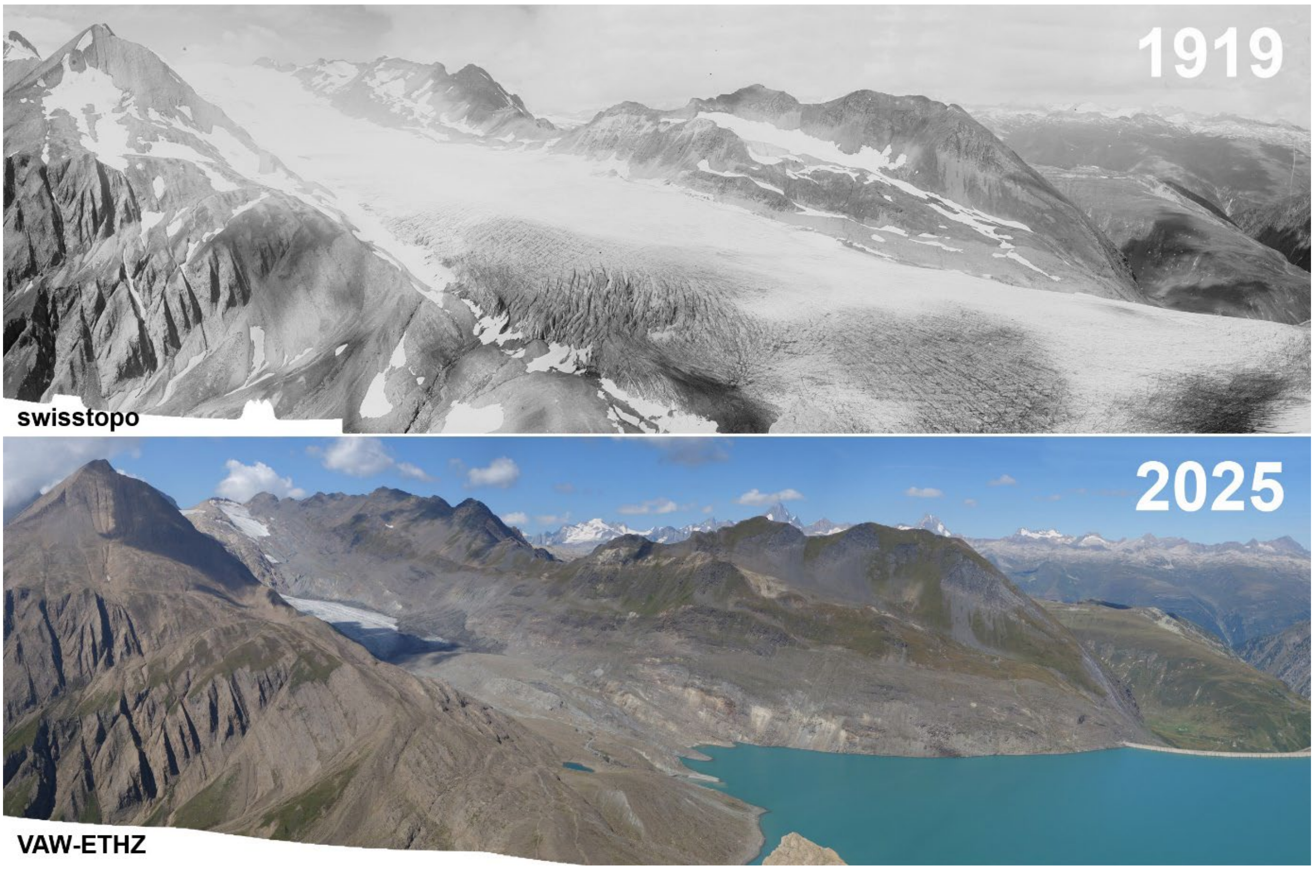


Figure 7.2. *Geodetic mass balance homogenized to the period 2017-2024 and aggregated for all glaciers in medium-scale catchments. Dot sizes scale with total glacier area per catchment. The position of the dots corresponds to the catchment's point of gravity. Values for the period's average geodetic mass balance are given in m w.e. a^{-1} .*



Major retreat and surface elevation loss observed at Griesgletscher (VS) between 1919 and 2025. Photo: swisstopo / M. Huss, VAW-ETHZ.

8 Englacial temperature

Firn and ice temperatures are a key parameter to detect global warming trends at the highest elevations of the Alps (Mattea et al., 2021). Englacial temperatures that constantly remain below the pressure melting point register short- and mid-term fluctuations of the surface energy balance. Measurements of englacial temperature on Colle Gnifetti (4450 m a.s.l.), down to a depth of up to 120 m, have been conducted at intervals of a few years since 1982 and annually since 2018, when a thermistor chain was permanently installed in a borehole (Gastaldello et al., 2025).

Differences in surface exposure result in strong firn temperature gradients across the Colle Gnifetti saddle (Mattea et al., 2021). However, several previous measurements are considered to be in sufficient proximity to each other to enable an assessment of englacial warming over the last 40 years. The last englacial temperature observations covered in this report were acquired in June 2025. Since 1991, firn temperatures at 20 m depth, isolated from annual variability, show a sustained and accelerating warming by +2.05°C in total (Fig, 8.1, Gastaldello et al., 2025). An inversion of the thermal gradient in the uppermost 30 m of the firn layer has become evident during the last decade compared to the profile from 1982 considered as representative of steady-state conditions. Particularly the measurements acquired in 2025 indicate substantially higher englacial temperatures. The temperature increase at 20 m depth between 2023 and 2025 is stronger than over the 5-year period 2018-2023. This may be attributed to the delayed response to the exceptional forcing (atmospheric warming and meltwater production) during the summer heat waves of 2022 and 2023.

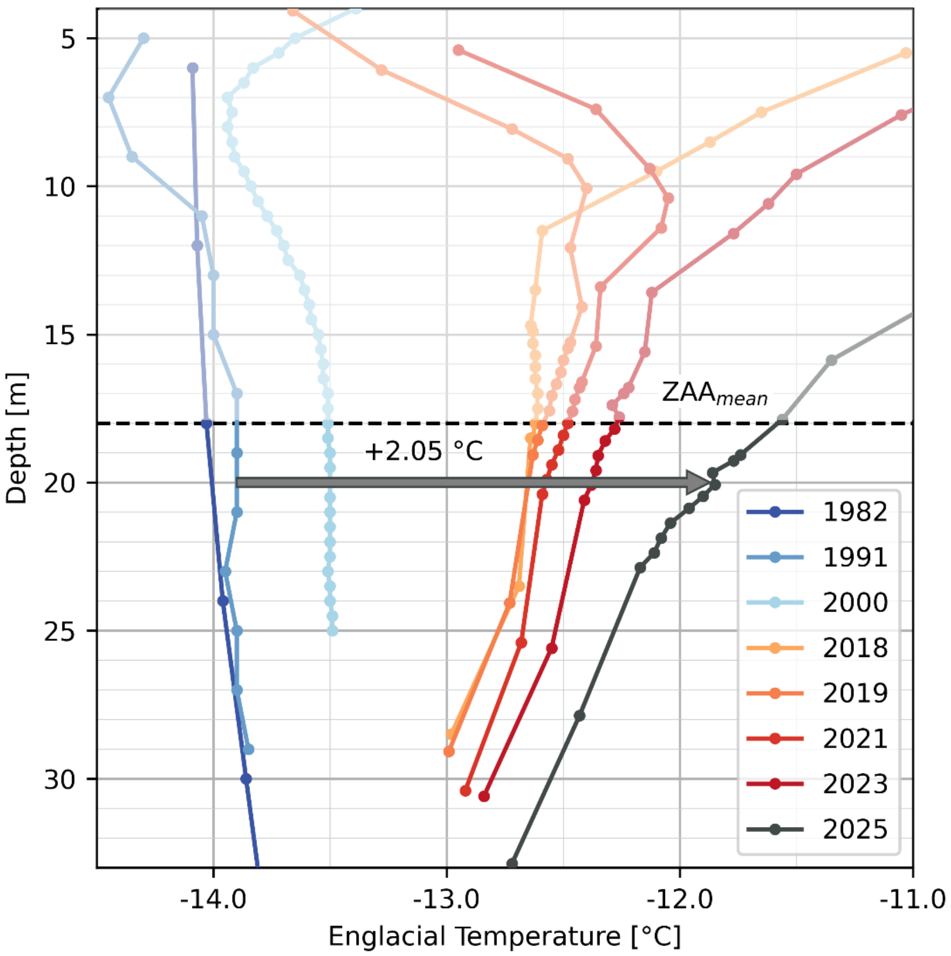


__Figure 8.1.__ Englacial temperature profiles at the Colle Gnifetti saddle, measured between 1982 and 2025 (Gastaldello et al., 2025). The temperature change at 20 m depth is indicated. The mean Zero Annual Amplitude (ZAA_{mean}) is the depth at which the temperature is not influenced anymore by seasonal variability of air temperature. The temperature change below this depth shows the long-term englacial warming trend.

9 Special events

GLAMOS annually documents special events related to glaciers. These events may either be hazardous to infrastructure, settlements, or mountain tourists, or simply represent unusual glacier behaviour worthy of notice even if not causing an immediate threat. These special events include glacier instabilities leading to ice break-off and subsequent processes such as ice avalanches, periglacial rock instabilities interacting with underlying glaciers (Jacquemart et al., 2024), or are linked to the outburst of water volumes stored in front, behind or beneath glacier ice (Zhang et al., 2024).

Table 9.1 compiles events reported to GLAMOS during the calendar year 2025 based on various sources, mostly cantonal authorities (e.g. AWN/GR, AFJ/UR) or entities involved in early warning (e.g. geoformer). In total, special events on 13 individual glaciers have been documented. The combined rock and ice avalanche at Birchgletscher on 28 May 2025 clearly stands out. The evacuated village of Blatten was almost completely destroyed during the event, claiming one life and leading to an economic damage of over 300 million CHF (Büntgen et al., 2025). With a total involved rock and ice volume of almost 10 million m^3 this event is one of the largest and most destructive high-alpine mass movements ever observed in Switzerland (Farinotti et al., 2025; Büntgen et al., 2025). For all other special events, no damages were reported. In addition to the Blatten rock-ice avalanche, six additional large periglacial rock instabilities with a runout over the glacier surface were observed in different regions of Switzerland (Bern, Grisons, Uri, Valais). The involved volumes range between 100’000 and 500’000 m^3 of rock affecting the underlying glacier either by erosion or deposition. The annual glacier-dammed lake outburst event at Glacier de la Plaine Morte did not entail any flooding despite the relatively large water volume. In addition, small water releases from an ice-marginal lake or a water pocket, a large lake calving event (Chüebodengletscher), and several ice avalanches at locations with regular break-off were documented.

Table 9.1. Reported special events related to Swiss glaciers in the calendar year 2025. Events are ordered according to the date of occurrence. The respective canton is given. Date and (if known) time of the event are reported (time range in some cases). The estimated volume of a lake outburst event or a rock/ice avalanche is given if sufficient evidence is available.

Glacier	Event type	Date / time (range)	Volume	Description
Birchgletscher (VS)	Rock detachment with glacier entrainment	28 May 2025, 15:24	ca. 9.5 million m^3	A large rockfall event on Kleines Nesthorn on May 19 deposited partly over 30 m of debris on the surface of Birchgletscher. Under this additional pressure the ice accelerated up to the complete collapse of the entire glacier tongue. Approximately 2.9 million m^3 of ice and 6.5 million m^3 of rock fell into the valley, claiming one life and destroying large parts of the evacuated village of Blatten. The destruction caused by the shock wave with ice and dust particles reached about 500 meters up the opposite slope to the hamlet of Weissenried. The deposit of around 8 million m^3 spread over an area of 1.4 km^2 in the valley floor and subsequently dammed the Lonza River, flooding additional parts of the village.
Im Griess (UR)	Rock detachment with glacier entrainment	14 June 2025	ca. 200’000 m^3	On the ridge between Clariden and Bocktschingel, a large rockfall occurred on June 14. The release originated from the steep north face at around 2700 m a.s.l., and thus potentially in a permafrost area. During the fall, snow and parts of the glacier were entrained. The deposit extends down to the unnamed glacier “Im Griess”. Based on drone images a total volume of around 200,000 m^3 was estimated.
Glacier de Tsijiore Nouve (VS)	Combined rock and ice avalanche	ca. 29 June 2025	ca. 165’000 m^3	A significant rockfall event occurred on the south spur of the Pointes de Tsenâ Réfien. The rock avalanche travelled along Glacier de Tsijiore Nouve, leaving deposits between 3200 and 2500 m a.s.l.. The volume was estimated as 165’000 m^3.

Glacier de la Plaine Morte (BE)	Ice-dammed lake outburst	2 -7 July 2025	ca. 1.0-1.5 million m³	The outburst of Lac des Faverges began very slowly on 2 July. The outflow was artificially deepened with an excavator, thus triggering the lake's emptying. The lake then drained through a supraglacial channel at a moderate pace until 5 July and then quickly subglacially until it was empty on the morning of 7 July. The runoff was significantly increased at the glacier snout between 5-7 July. No flooding was reported in the valley.
Gornergletscher (VS)	Water pocket outburst	27 July 2025, ca. 10:00	ca. 10'000 m³	An outburst of a water pocket at the steep ice front at about 3900 m a.s.l. of the glacier section on the NNW flank of Nordend was observed. According to reports from Austrian tourists on the Gornergrat: "After some loud crashing noises, a waterfall poured out of the glacier. Even after two hours, the outflow had not stopped." Based on images and the event duration the involved water volume can roughly be estimated as around 10'000 m³.
Bisgletscher (VS)	Ice avalanche	31 Jan - 4 Aug 2025	30'000 - 100'000 m³	Documentation of five ice avalanches from the altitude range around 3200-3300 m a.s.l. with estimated volumes between 30,000 m³ and 100,000 m³.
Grüebu-gletscher (VS)	Ice-dammed lake outburst	August 2025	ca. 15'000 m³	Subglacial drainage of an ice-dammed lake ("Lake No. 3"). A continuous drainage seems to have happened throughout August, and the lake was completely emptied by mid-September. The estimated volume of water drained was ca. 15'000 m³.
Chüeboden-gletscher (VS)	Lake calving	11 - 24 Aug. 2025	200'000 - 300'000 m³	Two calving events into the proglacial lake of Chüebodengletscher between 11 and 13 Aug. (first, larger event) and between 18 and 24 Aug. (second event) have resulted in around 200'000 to 300'000 m³ of ice breaking off and subsequently floating.
St. Annafirn (UR)	Rock detachment with glacier entrainment	7 Sept. 2025	ca. 100'000 m³	The deposits from a large rockfall event on the north flank of Chastelhorn covered the entire length of St. Annafirn and the forefield. In several partial collapses, a total of 100'000 m³ has broken off and travelled down the glacier.
Vadret da Zuort (GR)	Rock detachment with glacier entrainment	14 Sept. 2025	ca. 500'000 m³	A major rockfall from the face between Fuorcla Zuort and Piz dals Valdes on 14 Sept. eroded the glacier surface from about 2710 m a.s.l. Downward. The before almost complete supraglacial debris coverage was removed. The deposits covered the glacier terminus and the forefield. The total volume was estimated as ca. 500'000 m³.
Vadret da Tremoggia (GR)	Rock detachment with glacier entrainment	27 Sept. 2025	unknown	Deposits from a rockfall of unknown size from the NW face of Piz Tremoggia on 27 Sept. covered the glacier from 3150 down to 2750 m a.s.l..
Bisgletscher / Weisshorn (VS)	Ice avalanche	17 Oct. 2025	ca. 50'000 m³	Documentation of an ice avalanche from the Weisshorn hanging glacier at 4125 m a.sl. with an estimated volume of approximately 50,000 m³.
Steinlauenen-gletscher (BE)	Rock detachment with glacier entrainment	17 Oct. 2025	unknown	A large rockfall occurred on the north face of the Golegghorn above Steinlauenengletscher. There was already some snow at the time of the collapse. The rock mass slid across the glacier, presumably without eroding any significant amount of ice.

Comparison of the northern flank of Bietschhorn with Kleines Nesthorn and the now-collapsed Birchgletscher between September 1927 and 2025. Photos: swisstopo / SRF.

Deposits of substantial periglacial rock detachments with runout over glacier ice. ***(Left)*** *Vadret da Zuort (GR).* ***(Right)*** *Vadret dal Tremoggia (GR). Photos: AWN/GR.*

10 Conclusions

The Swiss Glacier Bulletin provides an overview of field measurements and remote sensing products collected in the frame of the GLAMOS programme and represents the 146th subsequent annual report on glacier change data in Switzerland. Observations of mass balance, length change, ice-flow velocity, glacier inventory, volume change, englacial temperature and special events related to glaciers are covered with a focus on measurements acquired in the hydrological year 2025. We note the following main findings:

- **Meteorological conditions were extraordinary**. Low to very low winter snow precipitation over glaciers was combined with high air temperatures, especially during June and August.
- **Direct mass balance observations** on 25 glaciers indicated **11% lower snow water equivalent by the end of winter** compared to the 2010-2020 average, and a very **negative annual mass balance of –1.56 m w.e.** at the Swiss-wide scale. **Overall, 3.0% or 1.4 km^3, of the remaining glacier volume was lost during 2025**.
- **Length change measurements** at 69 glaciers in 2024 show a **continued rapid retreat of almost all glacier snouts** throughout the Swiss Alps. Annual retreat rates were slightly lower relative to the 2010-2020 average, but glacier terminus shifts by up to several hundred meters have been observed at a few sites with a contribution of local (topographic) drivers.
- **Local ice-flow velocity** at stake networks on eight glaciers indicated a **slow-down of ice motion in 2025 by 46%** with respect to 2010-2020.
- A complete **update of the Swiss Glacier Inventory** shows rapid glacier area loss and a partial decay of some glaciers. **Between the SGI2016 and the SGI2023, 100 km^2 became ice-free, corresponding to an area loss of 1.7% yr^{-1}. 159, or 11%, of all glaciers have disappeared**.
- Based on the differencing of digital elevation models across different regions of Switzerland, average **geodetic mass balances of mostly between –1.1 m w.e. yr^{-1} and –1.7 m w.e. yr^{-1}** were determined for the period 2017-2024.
- Monitoring of **englacial temperature** at 4450 m a.s.l. indicates important **shifts with a warming of 2.1°C over the last three decades** at 20 meters depth.
- **13 special events related to glaciers** (rock/ice detachments / glacier lake outburst events) were documented in 2025. Related to the outstanding rock-ice avalanche destroying the village of Blatten, one fatality occurred.

Overall, data acquired in the frame of GLAMOS clearly document the further decline of glaciers in Switzerland during the reporting period. This observation refers to all monitored variables. The decade preceding 2025 was by far the period with the most rapid glacier loss in the Swiss Alps since measurements started over a century ago, leading to a reduction of ice volume by one quarter in just 10 years.

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At the bottom of the Lac des Faverges ice-dammed lake on Glacier de la Plaine Morte (BE). The lake was empty in August 2025. Photo: M. Huss

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