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Conventional versus reference-surface mass balance

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Glacier surface mass balance evaluated over the actual glacier geometry (conventional mass balance) depends not only on climatic variations, but also on the dynamic adjustment of glacier geometry. Therefore, it has been proposed that reference-surface balances calculated over a constant glacier hypsometry and area are better suited for climatic interpretation. This study addresses the question whether glacier monitoring programs should evaluate rather reference-surface than conventional mass balances, and what can be learnt from a joint analysis of these data sets.

We present a comparison of 82-year modelled time series (1926-2008) of conventional and reference-surface balance for 36 Swiss glaciers. Over this time period the investigated glaciers have lost 22% of their area and ice surface elevation close to the current glacier terminus has decreased by 78 m on average. Mean conventional balance of the period 2000-2008 was –0.91 m w.e. a^{-1}, and is 0.14 m w.e. a^{-1} less negative than the reference-surface balance evaluated over the geometry of the first available Digital Elevation Model (around 1930). About half of the negative (stabilizing) feedback on mass balance due to glacier terminus retreat is compensated by more negative mass balances due to surface lowering. Short-term climatic variability is clearly reflected in the conventional mass balance series, however the magnitude of the long-term negative trend is underestimated compared to that found in the reference-surface balance series.

Both conventional and reference-surface specific balances show large spatial variability among the 36 glaciers. Slope of the glacier tongue (lowermost 10% of the glacier) calculated over the hypsometry of the first DEM best explains the spatial variability in 82-year mean mass balances, and can be used to estimate the difference between conventional and reference-surface balance of individual glaciers.