

Determination of seasonal mass balance of four Alpine glaciers since 1865

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Alpine glaciers have suffered of major losses of ice in the last century. We present a method to determine the seasonal mass balance evolution of glaciers since 1865. This approach includes all available field data from the last century. The results contribute to a better understanding of the climate-glacier interaction. We analyze four glaciers in the Swiss Alps: Grosser Aletschgletscher, Rhonegletscher, Griesgletscher and Silvrettagletscher. For each glacier 5 to 9 high resolution digital elevation models of the glacier surface exist [1]. Glacier mass balance is calculated with a coupled distributed temperature-index and accumulation model [2] which is calibrated with ice volume changes. The spatial distribution of mass balance as well as the correct reproduction of winter and summer balance is validated with a newly compiled data set of more than 4000 in-situ measurements of mass balance and discharge records.

The cumulative mass balance series 1865-2006 reveal a considerable mass loss varying between 34 and 97 m mean ice thickness for each glacier. Winter balances remain virtually unchanged since 1865, whereas summer balances display significant fluctuations. We identify two decades of mass gain (1912-1920, 1974-1981) and two periods with accelerated ice melt (1942-1950, 1998-2006). The rate of mass loss is higher in the 1940s than in the last decade and reaches $-1.19 \text{ m WE a}^{-1}$.

- [1] Bauder, A., M. Funk and M. Huss, in press. Ice volume changes of selected glaciers in the Swiss Alps since the end of the 19th century, *Annals of Glaciology*, **46**.
- [2] Hock, R., 1999. A distributed temperature-index ice- and snowmelt model including potential direct solar radiation, *Journal of Glaciology*, **45**(149), 101–111.