

Reconstruction of seasonal mass balance for 4 Swiss glaciers since 1900 using decadal volume changes

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Since 1850 Alpine glaciers have suffered major losses of ice volume. Whereas length changes are measured at many glacier tongues for more than 100 years, continuous mass-balance measurements are only available for some glaciers since the 1960s. However, the impact of climate change on glaciers is reflected more clearly in mass balance records than in length change. Therefore, a reconstruction of the mass-balance history of different glaciers during the last century is important for a better understanding of the climate-glacier interaction.

We analyse four glaciers in the Swiss Alps: Aletsch, Rhone, Gries and Silvretta. For these glaciers 6 to 9 digital elevation models (DEM) are available since 1900. The DEMs originate from photogrammetrical evaluation of aerial photographs or digitising of topographical maps. Volume changes are derived by comparison of two DEMs. Direct measurements of accumulation and ablation exist for each of the 4 glaciers for some decades.

To calculate glacier mass balance we apply a distributed temperature-index model including potential direct solar radiation (Hock 1999). Accumulation is incorporated with some simple parameterisations. Air temperature and precipitation in daily resolution are required input variables. The model is calibrated using decadal volume changes. This calibration approach is well suited for long-term glacier changes. The spatial distribution of mass balance as well as correct reproduction of winter and summer balance is validated with direct measurements at stakes. By applying this model the decadal mass balances can be resolved seasonally.

We present time series of annual and seasonal mass balance for four well documented glaciers for the last century. The data reveal significant regional differences in mean thickness loss. The overall mean elevation changes differ by more than a factor of 2 between the four glaciers. Two short periods with increasing or stagnant ice volumes are detected (1910-1920 and 1970-1980). All mass-balance series display a larger gradient of mass loss in the 1940s than during the last 20 years. The time series of seasonal mass balances indicate that the negative trend in the mass-balance records is mainly caused by a change of summer balance whereas the winter balances remained constant throughout the last century.



Figure 1: Reconstructed annual and cumulative mass balance of Aletschgletscher since 1880. The time series reveals two periods of slight increase in ice volume. The rate of mass loss in the 1940s is higher than during the last 20 years.

REFERENCES

Hock, R. (1999). A distributed temperature-index ice- and snowmelt model including potential direct solar radiation. *Journal of Glaciology*, 45(149):101-111.