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Time-series of seasonal mass balance of four Alpine glaciers for 1865-2005

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Since the end of the ”Little Ice Age” Alpine glaciers have suffered major losses of ice volume. Continuous measurements of annual mass balance are only available for some glaciers since the 1960s so far. Therefore, a reconstruction of the seasonal mass-balance evolution of different glaciers since 1865, the begin of the instrumental weather observations in Switzerland, is important for a better understanding of the climate-glacier interaction. We analyze four glaciers in the Swiss Alps: Aletsch, Rhone, Gries and Silvretta. For each glacier 5 to 9 high resolution digital elevation models of the glacier surface were evaluated and provide decadal ice volume changes. To calculate glacier mass balance we use a distributed temperature-index model including accumulation. Air temperature and precipitation in daily resolution are required input variables. The model is calibrated using decadal ice volume changes. The spatial distribution of mass balance as well as correct reproduction of winter and summer balance is validated with a new data set of about 4000 in-situ measurements. These observations of accumulation and ablation at stakes and discharge records from the catchment basin are available for several decades for each glacier.

We present first results of a modeling study that provides a complete time-series of seasonal mass balance of the four analyzed glaciers since 1865. The cumulative mass-balance series reveal a considerable mass loss of between 32 and 96 m mean ice thickness in the last 140 years. The differences are due to the individual sensitivities of the glaciers to climate change. 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, 1982-2006). In the 1940s the rate of mass loss was higher by 30% than in the last decade and reached a mean of -1.25 m WE a^{-1}.