



## Accumulation dependency of small alpine glaciers

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In the last decades, the increasing glacier melt in the Alps became an important issue. During the last 30 years, Alpine glaciers lost up to about one fourth of their area and several meters in mean ice thickness. However, the mass loss processes are neither equal for different regions nor can they be regarded as a linear process. A simple temperature- and elevation-dependent modelling approach will fail, if the local and regional accumulation distribution is neglected. Especially for small glaciers, sometimes entirely far below the local climatological equilibrium line of ablation (CELA), their mass balance evolution is strongly accumulation dependent. Most notably, the additional accumulation by mass redistribution, i.e. avalanches, is an important contributing factor influencing the local mass balance.

In this study, we analyzed small glaciers ( $<0.5 \text{ km}^2$ ) in two different climatic regions in respect to the governing mass balance processes. In detail, we compared the Höllentalferner located in the high precipitation area of the Wetterstein region, Bavaria, Germany, with a small isolated part of the Guslarferner located in the dry central-alpine Ötztal, Tyrol, Austria. For the intercomparison it was important that the two sites show similar topographic and environmental conditions. Also the volumetric size of the test glaciers was in the same order of magnitude, so that relative changes could be compared more easily. The analysis shows that for the last 40 years the general trends (retreat or advance) of the examined glaciers are equal for respective decades, whereas the amounts of mass loss are by a factor of two smaller for the humid Wetterstein region, compared to the central-alpine Guslarferner. On the other hand, in periods with an observed glacier advance, the Höllentalferner with large amounts of additional accumulation due to avalanches, responded much faster and resulted in a stronger advance than the central-alpine Guslarferner. However, the Nördlicher Schneeferner, in the vicinity of Höllentalferner but within a different precipitation and accumulation regime, showed similar ice-mass variations than the Guslarferner during periods of positive mass balances. Therefore, we conclude that the additional accumulation through snow redistribution is a major driver for the existence of small glaciers in the Alps. The general projections of the loss of most small glaciers in the Alps during the coming decades needs to be re-considered.