Recording and modelling alpine snow, ice and water at the basin scale and at high resolution

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The water balance of 86 mostly glacierized basins in the Eastern Alps has been solved for the periods 1970-97 and 1998-2006 with monthly mean values. Basin precipitation was treated as the residual of measured runoff, modelled evaporation and storage change from two glacier inventories with high local resolution. It was distributed over 100 m elevation bands with seasonally changing altitudinal gradients. The redistribution of snow from surrounding slopes onto the glaciers was determined by successive approximation. Evaporation was modelled with altitude, vegetation type and snow cover. Snow and ice melt was determined with a seasonally changing degree day factor. Comparing the monthly melt and rainwater to the monthly runoff and evaporation yielded the temporary storage of liquid water in the basin. Precipitation, melt and liquid water storage changed significantly from the cool first period to the warmer second.

The traditional glaciological mass balance based on a minimum number of measurements is compared to the geodetic method by airborne laser scanning (ALS) with approximately one value of elevation per square meter. Significant differences between the two methods appear in the specific mass balance of the uppermost part of the glaciers; in view of the relatively small area of these parts, however, they are negligible in the total volume balance. Ground penetrating measurements of the seasonal snow cover revealed that the annual specific accumulation is partly compensated by the submergence of ice in the accumulation area while at the tongues melting dominates by far over the emergence of ice. ALS measurements documented the year-to-year persistence of accumulation and ablation patterns on the glaciers regardless of the absolute values of their mass balance. Local extremes of snow accumulation were observed as a consequence of wind drift and avalanches; they were highly variable and depended on synoptic weather conditions.