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Calculation and Evaluation of the Mass Balance of Hintereisferner using Airborne LiDAR Data

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Since 2001 airborne LiDAR measurements have been carried out regularly at the Hintereisferner region (Ötztal, Tyrol, Austria). This results in a worldwide unique data set of 18 airborne LiDAR flight campaigns, which is primarily used for multitemporal glacial and periglacial surface analyses. The potential of this data set for the quantification of glacier surface elevation changes with high spatial and temporal resolution has already been shown in several studies. In this study we go beyond this stage and calculate the net mass balance of Hintereisferner by applying the geodetic method on regular raster digital elevation models (DEMs) with 1 m spatial resolution. The total geodetic net mass balance of the glacier is determined on an interannual time-scale as well as over the whole investigation period from 2001 – 2008.

The accuracy of the geodetic net mass balance mainly depends on the accuracy of the input airborne LiDAR data and on density assumptions which have to be made to convert surface elevation changes to mass changes. To determine the accuracy of the LiDAR data and the derived DEMs, an accuracy assessment was computed comprising i) deviations between dGPS- and LiDAR-points, ii) errors resulting from point to raster conversion and iii) accuracy dependence of the DEMs on terrain slope angles. The calculated geodetic net mass balances of Hintereisferner are compared to results from the direct glaciological method. Mass balance calculations using the direct glaciological method already started in glaciological year 1952/53 and are continued up to the present day. Thus, a wide experience and well-founded knowledge on the application of the method at Hintereisferner was obtained and its accuracy is determined to be $\pm$ 100 mm water equivalent a-1 for the mean specific mass balance. Comparing the results of the geodetic method to direct measurements on the total net mass balance on an interannual time-scale, some stronger deviations between the two methods become evident. They are greatest for mass balance years with extraordinary mass losses. However, deviations tend to become smaller for increasing time-spans. Potential factors affecting these deviations will be provided and discussed.