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Comparison of direct and geodetic mass balances of three small glaciers in the Eastern Alps

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In this study we compare geodetic and direct glaciological mass balances of the three small adjacent glaciers Goldbergkees (1.4 km^2), Kleinfleißkees (0.9 km^2) and Wurtenkees (1.0 km^2) in Hohe Tauern, Austrian Alps.

Mass balance monitoring by the glaciological method has been carried out on Wurtenkees since 1982/83, on Goldbergkees since 1988/89 and Kleinfleißkees since 1998/99. The density of the observation network on the three glaciers is typically in the order of 100 points km^{-2} for winter mass balances and 10-20 points km^{-2} for annual mass balances. For this study point values of annual and winter mass balances were reanalysed and interpolated on a 10m resolution grid using using different methods of mass balance interpolation to quantify uncertainties originating from spatial interpolation.

Geodetic mass balances were calculated out of high resolution DEMs from 1992, 1998 and 2009 (for Goldbergkees and Kleinfleißkees) and 1998 and 2006 (for Wurtenkees). The DEMs of 1992 and 1998 (10m resolution) were obtained by photogrammetric processing of aerial photographs. The DEMs of 2006 and 2009 (1m resolution) were aquired by high resolution airborne LIDAR.

Spatial density of the direct point measurements and the accuracy and resolution of the DEMs are high, but the dates of the flight surveys differ from those of the field surveys, which had to be adjusted using daily meteorological data of the nearby Sonnblick Observatory (3105m) and distributed snow stake data in monthly resolution. The emphasis of this study is placed on a thorough error analysis of both methods and the necessary adjustment factors. Subsidence/emergence values of the glacier surface derived from repeated RTK-GPS surveys of the ablation stakes provide helpful information for the overall error assessment. Aim of this study is the homogenisation of the mass balance time series, a possible bias detection in the direct method and it‘s correction and finally, a quantification of basal melt rates.