



Comparison of volumetric and glaciological mass balances of Goldbergkees, Kleinfleißkees (1998-2009) and Wurtenkees (1998-2006), Austria

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In this study we compare one decade of glacier elevation changes with direct glaciological mass balance measurements of 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 balances and 10-20 points km^{-2} for annual balances. For this study point values of annual mass balances were reanalysed and interpolated on a 10m resolution grid using the same inter-/extrapolation methods. Volumetric mass balances were calculated out of two high resolution DEMs from 1998 and 2009 (for Goldbergkees and Kleinfleißkees) and 1998 and 2006 (for Wurtenkees). The DEM of 1998 (10m resolution) was obtained by photogrammetric processing of aerial photographs. The DEMs of 2006 and 2009 (1m resolution) were acquired by high resolution airborne LIDAR undertaken by the Regional Governments of Salzburg and Kärnten with vertical errors of 0.1m. Calculated mean ice thickness change for Goldbergkees and Kleinfleißkees (1998-2009) is -8.3 m and for Wurtenkees (1998-2006) is -6.8 m. Differences between volumetric and glaciological mass balances are highest for Goldbergkees, which can partly be explained by high amounts of surface lowering in some areas due to basal melt related to the subglacial drainage system. Mean submergence and emergence velocity field is in good agreement with vertical ice velocities measured annually by RTK-GPS at the ablation stakes. The mass balance series of Wurtenkees has recently been influenced by artificial snow production and displacement of snow related to the activities of the skiresort Mölltaler Gletscher.