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Determination of glacier volumes in the Hohe Tauern region (Eastern Alps) by ground penetrating radar (GPR)

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Current climate warming causes a rapid retreat of many glaciers in the Alps. Especially small sized glaciers (about 1km^2) are highly sensitive to climate change. Besides mass balance measurements, the total mass and the spatial distribution of mass of a glacier are important characteristics for understanding the interactions between climate and glacier kinematics and further on climate and glacier behaviour. The presented study focuses on 3 small glaciers in the "Hohe Tauern" region in the Eastern Alps of Austria: Wurtenkees (0,82 km^2) and Kleinfleisskees (0,87 km^2) south of the Alpine main divide as well as the Goldbergkees (1,42 km^2) north of the Alpine main divide. These glaciers are located close to the Sonnblick Observatory (3106m) with continuous climate measurements back to 1886. Mass balances of glaciers are regularly determined since the 1980ies.

During the years 2002 - 2004 GPR measurements were applied along 30 profiles with a total length of about 15 km in order to estimate the spatial distribution of ice volume of the 3 glaciers. By use of an antenna with a main frequency of 20 MHz maximum exploration depths of more than 100 m could be achieved. Point measurements were carried out with an average distance of 2 m to ensure continuous interpretation of subsurface layers. The subglacial boundary (glacier - subglacial till or bedrock interface) could not be clearly identified in all profiles as the obtained data is of varying quality. The velocity of the radar wave in ice was derived from diffraction hyperbola analysis with an average value of 0.16 m/ns. Two way travel times of the subglacial boundary were migrated using a 3D approach and were converted to depth maps. Maximum depths of the Kleinfleisskees and Goldbergkees are 110 m, of the Wurtenkees 60 m.

The volumes are much higher than estimated from earlier investigations.

The ice thickness derived from GPR on Wurtenkees was confirmed by a gravimetric survey. Interpolation techniques to generate continuous maps of the glacier bed and the ice thickness are based on the surface topography and morphology (crevasses), estimates of the shear stress at the glacier bed and the ice discharge through cross sections. The relation of this additional information to ice thickness is analysed by geostatistical tools.