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Dual-frequency radar investigations on an alpine valley glacier

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At the confluence of Gorner- and Grenzgletscher (Valais, Switzerland) a supraglacial lake forms every spring. The annual sudden drainage of this glacier-dammed lake is important with respect to flood events that occurred in the past. To understand the related processes, an extensive survey on ice-dynamical and hydrological properties of the Gornergletscher has been carried out over the last two years. To model discharge and therefore predict melt and drainage, ice thickness and bedrock topography are important parameters. Ice-penetrating radar at low-frequencies in the range of 1 to 5 MHz has been used to measure the ice-thickness distribution. In addition, selected profiles have been measured with a high-frequency radar at 40 MHz. Comparison of migrated profiles measured at both frequencies gives insights into the accuracy of the spatially more extensive, but naturally less accurate low-frequency data. The comparison shows good agreement in general but the high-frequency data could only detect the bedrock in profile sections without overlying moraine debris. A terrace in the bedrock topography, probably related to two different ice flows in Grenzgletscher, has been resolved by the low-frequency data. Further comparison with ice thicknesses from borehole-drilling measurements was applied to examine the accuracy of radar-mapping results. Relative deviations are on the order of 10 percent. The high-frequency radar data has made visible interesting internal structures of the glacier tongue: Differences in the backscatter made it possible to identify a core of cold ice, advected from the accumulation region of Grenzgletscher into the tongue of Gornergletscher. The core reaches a maximum thickness of 180 m and extends laterally about 300-400 m. The cold-temperate transition surface can be found in a maximum depth of about 300 m.