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The relationship between thermal regime of a supraglacial debris cover and ablation at Pasterze Glacier, Austria

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The presence of a supraglacial debris cover influences ablation rates in two ways. Ablation increases with a thin debris cover due to reduced albedo. By contrast, a debris cover of a few centimetres is sufficient to reduce the amount of ablation of the underlying ice by shielding it from insolation and atmospheric heat. This study analyses (a) continuous ground temperature data from different depths at two sites (SGT1&SGT2) within the supraglacial debris cover of Pasterze Glacier, Austria's largest glacier, and makes (b) a comparison with ablation data from nearby ablation stakes. Pasterze Glacier (47°05'N, 12°44'E) is a compound valley glacier fed by a number of tributaries with a total area of about 17.5 km^2. In particular the south-western part of the 3.6 km^2 large glacier tongue is covered by a continuous debris mantle with a spatial extent of some 1.2 km^2. The analysis covers the 21-month period from 01.10.2006 to 25.06.2008. Sites SGT1 and SGT2 are characterised by, respectively, an elevation of $\tilde{2}$100 m asl/$\tilde{2}$250 m asl, a debris thickness 20 cm/15 cm, and temperature sensor depths of 0, 10 and 20 cm/0, 10 and 15 cm. Both debris sites show a superficial openwork layer of coarser clasts and a lower mixed layer (coarser material of different size is set in a matrix of fine grains). Sieving analysis of the sand fraction reveal that both samples are poorly (SGT1) to moderately (SGT2) sorted coarse sands. The ablation data from SGT1 and SGT2 as well as from nearby debris-free sites show that the continuous debris cover of 15 to 20 cm in thickness reduced ablation rates by 33 to 50%. Both sites and all depths (where continuous data are available) show a statistically significant negative correlation between ablation rates and cumulative thawing degree days (TDD). This leads for instance to the conclusion that the ice below a debris cover of 20 cm at Pasterze Glacier with a thermal regime of TDD=100 at the upper surface of the debris cover will undergo an ablation of 35 cm. Presumably, comparable values might be valid for similar valley glaciers.