Spatially distributed snow liquid water content in a seasonal snowpack measured with a portable ground-penetrating radar.

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Abstract

We present a Ground Penetrating Radar (GPR) set up for a seasonal snowpack capable of estimating the amount and distribution of liquid water over an extensive area. The problem in evaluating wet snow is the lack of adequate methods for measuring Liquid Water Content (LWC). GPR appears to be a promising geophysical technique for the continuous, non-invasive determination of LWC distributions in snow. A sledge was used to carry both the 900 MHz radar antenna and GPS system during measurements in cold, wet and sometimes unstable environments. Carried on skis the radar can be moved quickly and cover large areas in a high alpine environment. This results in an overview of potentially wet regions although the individual wetness of each layer is not determined. Furthermore, we calculate the LWC for each measurement based on the dielectric permittivity of wet snow. Changes in temporal and spatial distribution of LWC can be tracked down and linked to weather phenomena, terrain and diurnal alteration. We tested the set up in the Kitzsteinhorn area, Salzburg, Austria where detailed information on weather and an undisturbed snowpack is available. The amount of LWC ranges from 2.0 to 6.0 % for a moist-wet spring snowpack and 0.0 to 1.0 % for a midwinter alpine snowpack at higher altitude. The results from GPR estimated LWC are very similar to those yielded by the Denoth wetness meter. GPR has the potential to provide LWC estimates across large lateral distances over a broad range of snow conditions.

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