

Continuous monitoring of the seasonal snowpack evolution utilizing upward-looking GPR technology

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A temporally continuous observation of the seasonal evolution of the snow stratigraphy at a single site requires non-invasive monitoring technology. Whereas ultrasonic sensors are well established in recording the snow height, they are insufficient to observe internal changes in snowpack stratigraphy. Thus, we implemented an upward-looking ground-penetrating radar (upGPR) system in the ground to monitor snow characteristics from beneath the snowpack. To enable continuous records on a daily basis, the system worked remotely controlled via internet connection and allowed temporally and environmentally independent measurements. The snowpack evolution and its changes were observed throughout a whole winter season from the beginning of December 2009 until the end of April 2010 at the Weissfluhjoch study site (2540 m a.s.l.) above Davos, Switzerland. In addition to determining snow depth under drysnow conditions and recording settlement of layers above the antennas, the upward-looking GPR system was capable of monitoring water infiltration during a spring day. Continuous seasonal measurements of snowpack characteristics will be useful, among other things, for monitoring snow conditions in avalanche start zones and validating numerical snow cover models more objectively than with manual snow profiles