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Wet and full-depth glide snow avalanche onset monitoring and detection with ground based Ku-band radar

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Wet and full-depth glide snow avalanches can be of considerable danger for people and infrastructure in alpine regions. In Switzerland avalanche hazard predictions are performed by the Institute for Snow and Avalanche Research SLF. However these predictions are issued on regional scale and do not yield information about the current status of particular slopes of interest.
To investigate the potential of radar technology for avalanche prediction on the slope scale, we performed the following experiment. During the winter seasons 2015/2016 and 2016/2017, a ground-based Ku-band radar was placed in the vicinity of Davos (GR) in order to monitor the Dorfberg slope with 4-minute measurement intervals [1]. With Differential Interferometry [2] line of sight movements on the order of a fraction of the radar wavelength (1.7 cm) can be measured. Applying this technique to the Dorfberg scenario, it was possible to detect snowpack displacement of up to 0.4 m over 3 days in the avalanche release area prior to a snow avalanche event. A proof of concept of this approach was previously made by [3-5]. The analysis of the snowpack displacement history of such release areas shows that an avalanche is generally released after several cycles of acceleration and deceleration of a specific area of the snowpack, followed by an abrupt termination of the movement at the moment of the avalanche release. The acceleration and deceleration trends are related to thawing and refreezing of the snowpack induced by the daily temperature variations.

The proposed method for the detection of snowpack displacements as indication for potential wet and full-depth glide snow avalanches is a promising tool to increase avalanche safety on specific slopes putting infrastructure or people at risk. The identification of a singular signature to discriminate the time window immediately prior to the release is still under investigation, but the ability to monitor snowpack displacement allows for mapping of zones prone to wet and full-depth glide snow avalanches in the near future. Therefore in the current winter season, we attempt to automatically detect snowpack displacement and avalanche releases at Dorfberg. Automatic warnings issued by the radar about the presence and amount of displacement and information about location and altitude of creeping regions as well as released avalanches will be combined with simulated LWC (Liquid Water Content) for the observed area. This slope-specific knowledge will be evaluated for inclusion into the more regional avalanche bulletin issued by SLF. Two cameras capture photographs at 1 and 10 minute intervals respectively to reference the opening of optically visible tensile cracks and triggering of avalanches.

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