



Snow avalanche speed determination using seismic methods

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We present two novel techniques for determining average propagation speed of snow avalanches using seismic methods. Avalanches propagation speed depends on a wide range of factors, including the characteristics of the propagation path (e.g. topography) and the snow (e.g. density) and their value can reach 70 m/s. Since the damage produced by the avalanche depends on its size (i.e. energy) and consequently, its propagation speed, the knowledge of this basic physical parameter is crucial for estimating avalanche induced hazard to the inhabited mountain areas. Surprisingly, our knowledge of this basic physical parameter is limited, due to the difficulty of conducting various measurements in the harsh winter weather conditions that usually accompany this natural phenomenon.

The two techniques of avalanche speed determination presented in this paper are based on cross-correlation and time-frequency analysis techniques. We present pros and cons of the seismic methods of avalanche speed determination compared to the previously developed techniques (e.g. video, Doppler). The data used in this study came from Ryggfonn (Norway) avalanche experimental operated by the Norwegian Geotechnical Institute (NGI). We have used the data recorded by an array of 7 geophones buried along the main avalanche propagation path during the 2003-2004 winter season. Specifically, we have studied six separate avalanches of distinct type. In all of the cases our methods have proofed to be successful and robust, as validated by the comparison with the speed estimates using simultaneous Doppler radar and pressure measurements.