

Mapping snow surface hoar by optical remote sensing

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ABSTRACT

About 40% of the snow avalanches in Norway are assumed to be associated with weak layers in the snowpack originating from surface hoar. Mapping the formation of surface hoar combined with meteorological observations might in the future be used to predict where weak snow layers most likely are present. This information might then, in combination with snow loads and weather data, be used in a warning service to provide information about danger of snow avalanches.

We have developed a prototype algorithm for mapping of snow surface hoar based on moderate resolution satellite data. The algorithm has been tested extensively for a few years of data from the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Terra satellite. The algorithm combines information about surface skin temperature of the snow and snow grain size. Snow surface temperature is retrieved from thermal data where the atmospheric contribution is removed by using two different wavelengths which are differently attenuated by the atmosphere. For grain size we have used a normalized index. Surface hoar is then detected as extremely large snow grain sizes under low surface temperature conditions. The detection is robust as large grain sizes from melt-induced metamorphism usually can be discriminated from surface hoar.

We have validated the algorithm with in situ observations of surface hoar for a dozen of dates all over Norway. We were also able to detect past formation of surface hoar in a dataset where field workers concluded that weak layers most likely were involved in avalanches that had resulted in fatalities and/or destruction.