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Variability of snow layer hardness by aspect and prediction using meteorological factors

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ABSTRACT. The majority of slab avalanche accidents occur when the victim triggers the slide. Slab hardness is an important property affecting skier-triggered avalanches because hardness partially determines whether sufficient stress reaches the weak layer to cause failure and/or fracture. This study examines how new and old snow layer hardness varies with aspect and which meteorological variables most influence those changes. Slab hardness was measured with a ram penetrometer on north and south aspects from January through March, 2000 at Jackson Hole Mountain Resort and Grand Teton National Park, Wyoming. Continuous weather data were obtained from weather stations at Jackson Hole Mountain Resort. Analyses were carried out on new and older near-surface snow layers. New snow layer hardness increased most rapidly on the south aspect due to accelerated settlement and densification from warming by incoming shortwave radiation. With the exception of the surface layer, old snow layers, 2 months after deposition, became harder on the north aspect in comparison to the south aspect. A temperature index was calculated for the south and north aspects to describe the delayed effect of increasing temperature on increasing hardness through sintering, settlement, and densification. The south temperature index, maximum daily temperature, and the interaction between maximum daily temperature and incoming shortwave radiation were the most significant predictors of new snow layer hardness on the south aspect. The north temperature index, maximum daily temperature, and the previous day's wind speed were the most significant predictors of new snow layer hardness on the north aspect. The temperature index was the only significant predictor of old snow layer hardness on both the north and south aspects. The results of this research suggest that it may be possible to use meteorological factors to predict changes in snow hardness, which is an important component in predicting skier-triggered avalanches.