A COMPARISON OF THE SPATIAL PATTERNS OF PENETRATION RESISTANCE OF SLABS AND WEAK LAYERS

K. Birkeland and K. Kronholm

ABSTRACT: Several studies have quantified the spatial variability of snow stability and structure on specific slopes. One consequence of such spatial variability is that using individual point stability measurements to assess slope stability is questionable unless the variability exists in typical, and predictable, spatial patterns. This paper examines the spatial patterns of the penetration resistance of over one hundred unique snowpack layers using the method of universal kriging, a common geostatistical technique. This two-step process first analyzes the data for spatial trends at the slope scale, and then uses semivariograms to quantify the spatial patterns of the residuals. The data come from arrays of SnowMicroPen (SMP) measurements on small slopes in southwestern Montana and near Davos in eastern Switzerland.

Our goal was to see if predictable spatial patterns exist for layers with certain types of grains or deposited under certain meteorological conditions. If such patterns exist, extrapolation and interpolation of layer characteristics will be more accurate. However, our preliminary analyses suggest that spatial patterns in penetration resistance do not depend on the layer grain type or on the conditions under which the layers were deposited. This is the case even for layers which form under relatively unique climatic conditions, such as surface hoar. In essence, the spatial pattern for each layer appears to be unique, and may change through time. These results emphasize the complexity of analyzing the spatial variability found on slopes, the difficulties in interpolating between point measurements, and the problems associated with scaling point measurements of snowpack parameters like stability up to the slope scale. Our results suggest that avalanche assessments will continue to be holistic, relying on expert human knowledge of specific slopes supplemented by a variety of additional data.

Corresponding author address:

Karl Birkeland
U.S. Forest Service
National Avalanche Center
P.O. Box 130
Bozeman, Montana 59771
(406) 587-6954
kbirkeland@fs.fed.us