Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01716, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01716
EGU General Assembly 2008
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Spatially Variable Avalanche Forecasting with Support Vector Machines

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We have recently reported on the application of machine learning techniques to avalanche forecasting, whereby Support Vector Machines (SVMs) are used to identify a decision boundary between weather and snowpack conditions likely to result in avalanches. Our initial research has shown that SVMs produce results similar to those from nearest neighbours methods, which are considered by the machine learning community to be a useful baseline. However, an advantage of SVMs lies in their ability to avoid over-fitting when incorporating high-dimensional data, which approaches such as nearest neighbours are not well suited to. One obvious potential extension of our existing work is to include spatially variable information, and thus to generate spatial forecasts of the potential for avalanches.

To produce such forecasts we need two key inputs – the locations of all avalanche events which have occurred in the past and information on previous snowpack and weather conditions. Furthermore, since we wish to spatialise the forecast, we require a digital elevation model (DEM) which describes the variation of key avalanche related topographic parameters (e.g. slope, aspect and elevation) and also allows us to interpolate some weather variables as a function of topography (such as wind speed and direction). Taken together, we can use these inputs to produce a vector describing the conditions at any point in a landscape, whose distance from the decision boundary can then be measured, thus giving a continuous field representing the likelihood of avalanching in space.

In this paper we will report on the use of SVMs to produce spatially variable forecasts, the steps necessary to spatialise key variables for use in the SVM, the requirements that these steps in turn place on input data and a series of first attempts to validate spatially variable avalanche forecasts for Lochaber in Scotland, a region where backcountry avalanche forecasts are produced daily throughout the winter.