Geophysical Research Abstracts
Vol. 14, EGU2012-7849, 2012
EGU General Assembly 2012


# Statistical modeling of the small-scale spatial variability of snow depth

T. Grünewald (1,2), M. Schirmer (1), M. Lehning (1,2)

(1) WSL- Institute for Snow and Avalanche Research (SLF), Davos, Switzerland, (2) École Polytechnique Fédérale de Lausanne (EPFL), School of Architecture, Civil and Environmental Engineering (ENAC), Lausanne, Switzerland

The spatial distribution of the mountain snow cover is of high importance for many tasks in the fields of hydrology (e.g. water supply, flooding), natural hazards (e.g. snow avalanches) or mountain ecology. The snow distribution is typically characterized by a strong heterogeneity, which is the result of different processes interacting with the local topography. Characterizing this spatial heterogeneity is a challenging task. Recent studies showed that the prediction of the spatial structure of the snow cover applying simple terrain parameters has only minor explanatory power. Furthermore, most of these studies were limited either because they are restricted to a single region or due to a lack of snow depth data in reasonable quality and spatial resolution.

For this study we were able to collect a large set of high resolution snow depth data from different regions in the Alps, the Pyrenees and the Rocky Mountains. The snow depth data were generated using airborne Lidar technology and have a horizontal resolution of 1 m and a vertical accuracy between 0.1 and 0.3 m. The size of the different domains is between 1 and 25 $km^2$ and the data set cover different topographic and climatic regimes. We present a multivariate linear regression model which combines terrain variables such as elevation, slope and northing (deviation of the aspect from North) with the fractal roughness parameters D and $\gamma$ in order to predict the relative snow depth of small subareas within the mountain catchments. Two methods were applied to select the subareas: on the one hand small control units were defined manually by clustering areas of similar surface characteristics. On the other hand the regions were automatically divided into quadratic subareas (400 m edge length). The model output is the relative snow amount for each subarea relative to the mean for the whole catchment. For each region the model was calculated separately and the best two-parameter model was chosen. In addition, combining the data sets from all regions, it was attempted to test the universality of the relationships.

Results indicate that elevation has the best predictive power of all variables and is included in the models for each region. For most areas slope is the variable which gives the best results in combination with elevation, while the fractal parameters are only important in some regions. Most models show very good explanatory power with $r^2$ values ranging from 0.4 to 0.9 if the regions are treated individually but only explain a much smaller fraction of the variance ($r^2$ $\approx$0.3), if data sets from diverse regions are combined. A further finding is that it the model performance is very similar for the manual and automatic subareas. This indicates that there is only a minor effect of the aggregation of the subareas.