Geophysical Research Abstracts, Vol. 8, 06201, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06201

Modeling winter snow redistribution processes in Alpine terrain

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Our goal is to assess the impact of future climate scenarios on water availability in glacierized basins of the Alps and other mountain regions of the world. We are accomplishing this by implementing a combined field observation and distributed modeling approach. Accurate estimation of water stored within the snow and ice cover of these basins requires knowledge of the distributed snow and ice mass balance throughout the year. While many observations and models are available to describe the ablation season, the evolution of the winter snow distribution is relatively unknown. In addition, models that are able to simulate winter snow accumulation processes over these mountain regions are limited.As part of our research program, we have implemented SnowModel over the Haut Glacier d'Arolla in southwestern Switzerland. SnowModel is a spatially-distributed snow-evolution modeling system that has been applied in Alaska, Norway, Greenland, Antarctica, and mountains of the western United States, but it has never been applied to topographic distributions as steep and complex as the Swiss Alps.

Comparison of preliminary SnowModel simulations with our field observations suggested that two additional sub-models have to be included in SnowModel to accurately represent the natural system. The first concerns snow avalanche redistribution process related to large topographic gradients within our research basin. In this case we are implementing a snow avalanche sub-model in SnowModel that transports snow from the steep mountain slopes to the relatively flat valley below. The second model modification is the addition of an orographic precipitation sub-model that enhanced the precipitation quantities in the higher elevations.

These additional routines are still in the testing phase. The high frequency of observations on our testing site will allow us determining whether they are suitable for this kind of terrain. Once we have demonstrated that our process-based mass and energy balance modeling system is able to reproduce our field observations in this heavily instrumented research basin, it will be available for climate scenario and water availability applications throughout Switzerland and other steep, mountainous regions of the world.