Modeling Winter Snow Redistribution Processes in Alpine Terrain

R. Dadic (1), J.G. Corripio (1), G.E. Liston (2), P. Burlando (1)

(1) Institute of Environmental Engeneering, Swiss Federal Institute of Technology, Zürich, Switzerland
(2) Department of Atmospheric Sciences, Colorado State University, Fort Collins, USA

Our goal is to assess the impact of future climate scenarios on water availability in glacierized basins of the Alps. 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 many regions of the world, but never to topographic distributions as steep and complex as the Swiss Alps.

Comparison of preliminary SnowModel simulations with our Haut Glacier d'Arolla field observations suggested that two additional sub-models had to be included in SnowModel to accurately represent the natural system. The first concerned snow avalanche redistribution process related to large topographic gradients within our research basin. In this case we implemented 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 was the addition of an orographic precipitation sub-model that enhanced the precipitation quantities in the higher elevations.

Our field observations show that with these two additional routines the basin snow distributions can be reconstructed within a reasonable degree of accuracy. 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.