Geophysical Research Abstracts, Vol. 7, 07756, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07756

Improving a distributed mass balance model by a parameterisation of snow-redistribution and validation in the Bernina group, Switzerland.

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In view of accelerated glacier decline in the past two decades, mass balance modelling becomes increasingly important for assessment of global glacier change. Todays mass balance models include accurate formulations of the surface energy fluxes and have proven to model mass balance and discharge very precise. However, the processes of snow redistribution by wind and avalanches are in most models excluded from the computation. In this study we compare two distributed mass balance models with one of them including a snow redistribution scheme. The results are validated in the Bernina group, southeastern Switzerland. The models are forced by 1999 meteorological data from two meteostations close to and within the mountain range. Mass balance distribution for this year is calculated for all glaciers within a perimeter of 17 by 13 km from a digital elevation model with 25m resolution. We compare the results of both models to stake measurements and observed snowlines in 1999, mapped from a Landsat TM scene and from aerial photographs. Results from both models agree well with stake measurements. When snow redistribution is excluded the mean deviation between modelled and observed snowlines is about 30 m in altitude varying from 7 m in northern to an overestimation of 120 m in southern expositions. Most of the remaining 1999's southerly exposed accumulation zones are believed to consist of avalanche snow. Including processes of snow redistribution confirms this assumption and leads to an improvement of snowline positions as well as a better overall correlation with observations. Our results imply that snow redistribution is of a big importance to mass balance distribution. Nevertheless, the model can not fully explain the complex pattern of the snowline. The spatial distribution of the used input parameters, in particular the precipitation data, has most likely a pronounced effect on mass balance distribution.