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Glacier mass and energy balance simulated within a regional climate model

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Due to their unique surface characteristics and their function as hydrological reservoirs, glaciers play a considerable role for water and energy budgets in many alpine areas. Regional climate models (RCMs) are an important tool in the analysis of the corresponding water and energy cycles and for the prediction of future changes in the individual components.

However, mountain glaciers are only represented in an extremely simplified way (or even totally neglected) in state-of-the-art climate models. Their size is usually beyond grid box resolution and only the largest glaciers are treated as fixed surface boundary conditions with runoff generation on glaciated surfaces being simplified to a very high degree. The direct prediction of changes in glacier mass balance and glacier extent as a response to changing climatic conditions is therefore not possible. Similarly, the feedback of a change in ice cover to the atmosphere and the influence of enhanced glacier melt on runoff conditions cannot be assessed.

To overcome these deficiencies and to represent processes attached to mountain glaciers in an appropriate way, a subgrid glacier parameterisation has been developed and implemented into the RCM REMO. The new scheme replaces the static glacier mask used so far and includes the explicit simulation of glacier mass and energy balance. The total ice mass within a climate model grid box is represented by a two-layer ice body covering a certain fraction of the total grid box area. Surface fluxes are derived separately for glaciated and non-glaciated parts. The glaciated fraction of an individual grid box is adjusting dynamically depending on accumulation and ablation conditions following a simple volume-area relationship. Surface runoff and drainage originating from the glacier fraction are added to total grid box runoff thus closing

the water balance. In order to assess the effect of changing ice volumes on runoff in glaciated catchments the routing scheme HD (Hydrological Discharge) is coupled to REMO in an offline mode.

This contribution will present regional climate simulations in the European Alps for the period 1958-2002, both with and without the new parameterisation scheme. By accounting for subgrid variability of solar radiation and precipitation within a climate model grid box, a reasonable simulation of mean glacier mass balance is possible. Also, the observed decrease in glacier area during the corresponding time period can be reproduced approximately. Runoff originating from glacier melt leads to an increase in simulated summer discharge.