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A Mountain Glacier Parameterisation for use in Regional Climate Modelling

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In most present-day climate models, the terrestrial cryosphere is represented in an extremely simplified way. Static glacier masks are used indicating whether a specific climate model grid box is covered by land ice or not. These masks remain constant throughout the model integration. Even in case of pronounced snow accumulation or melting of snow and ice the glaciated surface area does not change and a feedback to the atmosphere is not possible. Furthermore, runoff generation is usually neglected on ice covered areas. This approach is suitable for short model integrations and for large ice sheets with a slow response to climatic forcing. For longer simulations and especially for assessing regional climate change and its impacts on runoff regimes in alpine regions, a more detailed description of processes attached to mountain glaciers is necessary.

Therefore, a subgrid parameterisation for mountain glaciers is being developed and implemented into the regional climate model REMO. The new scheme replaces the static glacier mask used so far and allows a consistent two-way interaction between glaciers and climate. The total ice mass within a 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 glacierised and non-glacierised sub areas. Area weighted mean fluxes are then calculated within the lowest atmospheric level. The glacierised fraction of an individual grid box is adjusting dynamically depending on accumulation and ablation conditions. Once snow cover has reached a certain age, snow can be transformed into glacier ice. Surface runoff and drainage originating from the glacierised land fraction are added to total grid box runoff, closing the water balance. Additionally, in order to assess the effect of changing ice volumes on runoff in glacierised catchments the routing scheme HD (Hydrological Discharge) is coupled to REMO in an offline mode.

This contribution presents the basic features of the new parameterisation scheme as well as results of coupled model runs for today's climate in the European Alps.