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Test of a simple glacier retreat parameterization for two Norwegian ice cap glaciers

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In Norway, the ice cap glacier retreat will be an important phenomena under
climate change projections and will largely influence water resources.Three new versions of a glacier retreat algorithm based on the parameterization
proposed by Huss et al. (2010) are implemented and tested on the Distributed
Element Water Model of the Norwegian Water Resources and Energy
Directorate. After selection of the best performing algorithm version, the glacier retreat
parameters of the model are calibrated on observed discharge and mass balance data for two ice cap glaciers in Norway:
Nigardsbreen (maritime glacier) and Midtdalsbreen (semi continental glacier).
The calibration performance is acceptable: ice thickness is reproduced with a
Root Mean Square Error of 20 respectively 15 m for the two case studies; glacier
annual mass balance is overestimated for negative years; daily discharge is
reproduced with a Nash Sutcliffe performance criterion between 0.80-0.86 for the period of 1961-1990:
Climate change projections are performed for these 2 glaciers using
downscaled Regional Climate Models (RCMs) from IPCC A1B emission scenario
for greenhouse gases. According to our results, these glaciers are going to decrease dramatically:
the ice volume could be reduced by 70 to 80 % in 2100, the annual discharge could
increase by 30% till 2070-2080. The annual daily regime can also be assumed to change: the simulation results show that the maximum
discharge during summer will decrease whereas winter discharge will increase
after a longer recession period in autumn. The beginning of the melting
period will not change substantially. The model sensitivity of the applied glacier retreat parameterization (Huss et al. 2010)
is analyzed with two approaches: 1/ comparing the ice
volume evolution for all Huss parameters sets obtained through calibration in this study to the ones proposed in literature; 2/ varying one parameter after the other keeping the three others
fixed. The evolution of the ice volume largely varies in function of the glacier retreat parameters and the parameter sets proposed in Huss et al. 2010 seem not to be able to capture the behavior of ice cap
glaciers . From this study, the
Huss parameterization implemented produced satisfying results and can be
apply to ice cap in nordic countries for glacier retreat parameters calibrated. A classification of the ice cap could be necessary in order to widely apply this model without calibration process.