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Dynamic modelling of the evolution of the Vatnajökull ice cap, Iceland, from 1980-2300

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Like most ice caps and glaciers worldwide, Icelandic glaciers are losing mass and retreating as a result of a warming climate. Here, the evolution of Vatnajökull ice cap, Iceland, from 1980-2300 is simulated by one-way coupling of Regional Climate Models (RCMs) with the Parallel Ice Flow Model (PISM). For reanalysis data, we rely on HARMONIE simulations forced by ERA-interim, which have previously been evaluated over Vatnajökull. For future climate conditions we rely on available Coordinated Regional Downscaling Experiment (CORDEX) simulations under the Representative Concentration Pathway (RCP) 4.5 and 8.5 scenarios.

A spin-up using 1980-1999 climate simulations is performed by repeating the forcing for 1000 years in order for the ice cap to be in equilibrium with the model climate. The result is an initialized ice cap with a volume and area that are within $\pm 3\%$ of the present day values. Considering that most of the outlets of Vatnajökull are surge type glaciers, differences of this order are to be expected. The glacier evolution is then modeled under the RCP4.5 and RCP8.5 scenarios until 2100 by forcing the flow model with climatic mass balance fields. The 2081-2100 forcing is repeated until 2300 in order to expand the time series. These runs are conducted using the mass balance anomalies compared to a reference period (1990-2010) and added on the HARMONIE pattern. In the RCP4.5 scenario the ice cap loses 10-20% of its volume and 5-10% of its area by 2100 and 30-65% volume and 15-35% area by 2300, depending on the used model forcing. In the RCP 8.5 scenario it loses 10-25% of its volume and 5-10% of its area by 2100, and 50-95% volume and 25-80% area by 2300.

Since the RCMs are one way coupled to the ice flow model, no elevation feedback on the mass balance are included in the simulations. Therefore additional runs are conducted to estimate the effect of the changing glacier surface elevation on the mass balance by adding a temperature and precipitation lapse rate to some of the runs. For the RCP8.5 scenario, we find that the lapse rate runs had a 15% smaller volume and a 20% smaller area by 2300 than in the simulation without the correction.