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Sensitivity of runoff from Vatnajökull, Iceland, to spring snow cover

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A set of simulations of the surface climate and energy balance of Vatnajökull ice cap, Iceland, are used to estimate the evolution of the glacier runoff for the period 1980-2016 as well as the sensitivity of runoff to the spring snow cover. The simulations are made by running the subsurface scheme from the Regional Climate Model HIRHAM5, forced with incoming mass and energy fluxes from the Numerical Weather Prediction Model HARMONIE. The model is forced by HARMONIE due to higher spatial resolution of the incoming fluxes and smaller errors in the incoming energy and mass balance fluxes. The snow surface albedo scheme used in the simulations describes the albedo with an exponential decay with time and is surface temperature dependent. It has been tuned to Icelandic conditions by finding the time scale for snow decay that provides the best fit with observations from in situ Automatic Weather Stations. When the snow cover has melted, the simulations incorporate a surface albedo determined from a background map created from MODIS observations from 2001-2012.

Based on the comparison of the simulated SMB with in situ SMB measurements conducted on Vatnajökull from 1992-2016, a simple correction is added to the incoming mass flux in order to minimize the model biases. We find that HARMONIE generally overestimates the precipitation in the S-SE parts of the ice cap, in areas with high orographic forcing, and underestimates the precipitation for the rest of the ice cap. The modeled runoff is compared to available observations from two glacial outlets in order to assess the results, and we find that there is a good agreement between the data and simulations. An experiment is then set up based on the spring conditions of the last 37 years in order to test the sensitivity of the runoff to spring conditions. The experiments uses the state of the modeled subsurface on April 1st of each of the last 37 years to model the amount of runoff over the last 37 summers, such that 37x37=1369 model runs are conducted. We find that the glacier runoff is mostly controlled by the summer weather, and for the whole ice cap the changes in spring snow cover accounted for a maximum of 22% increase in runoff. However, some outlet glaciers are very sensitive to the amount of snow cover, as e.g. the runoff from Brúarjökull outlet glacier increases with up to 72% when the initial conditions are changed.