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Climate sensitivity of the surface mass balance of Vestfonna, northern Svalbard

Marco Möller (1), Roman Finkelnburg (2), Matthias Braun (3), Dieter Scherer (2), and Christoph Schneider (1)

(1) Department of Geography, RWTH Aachen University, Germany (marco.moeller@geo.rwth-aachen.de), (2) Department of Ecology, TU Berlin, Germany, (3) Geophysical Institute, University of Alaska, Fairbanks, USA

The ice cap Vestfonna covers an area of almost 2400 km^2 on the western part of the island Nordaustlandet, northern Svalbard archipelago. It is one of the largest ice bodies of the European Arctic. Its surface mass balance has recently been found to be in a balanced state during the first decade of the 21st century. However, the north Atlantic Arctic is regarded as a region where predicted global climate change is assumed to result in one of the most pronounced increases of air temperatures around the world. This raises the question for how long the balanced state of Vestfonna will be able to persist during the oncoming decades.

This study analyses the potential influences of changes in solid precipitation, air temperature and solar radiative forcing on the surface mass balance of the ice cap. Sensitivities to the driving variables are obtained by employing a spatially distributed surface mass-balance model. The model is driven by altered input data compared to a reference period (2000-2010). Sensitivity to precipitation perturbations is analyzed stepwise within a range of $\pm$20%. Air temperature inputs are varied within a range of $\pm$5.0°C. Changes in solar radiative forcing due to potential long-term variability of cloud cover conditions are accounted for by appropriately modifying fractional cloud cover information. This changes the reduction of clear-sky solar radiation. Changes of the driving variables are considered in terms of both, absolute shifts and gradual changes over time.

Both annual and seasonal variability of climate elements are considered. Annual changes, i.e. changes equally distributed throughout the entire year are accounted for by simple shifts of the meteorological input data. Seasonal changes are accomplished by altering the input data according to sinusoidal modification functions to allow for continuous inter-seasonal transitions.

Results comprise a glacier-wide analysis of both surface mass-balance sensitivity and its variation with altitude.