Modelling the evolution of Svalbard land-terminating glaciers over the 21st century

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The Arctic glaciers and ice caps play a major role in current and near-future sea-level rise due to their large surface area and their location in the world's region of highest air temperature increases, both observed during the recent decades and predicted over the 21st century. One of the most heavily glacierized archipelagos in the Arctic is Svalbard. It holds about 36,000 km² of glaciers and ice caps. What is known about the future evolution of Svalbard's ice masses so far suffers rather high uncertainties as future mass balance and volume change assessments have only been performed as part of global-scale studies.

We here present a high-resolution modelling study of the climatic mass balance and related changes in ice volume for 27 individual land-terminating glaciers spread throughout Spitsbergen, the largest island of the archipelago. Our model calculates glacier mass balance and area/volume changes using a temperature-index approach in combination with a surface elevation change parameterization. The initial glacier topographies and volumes have been assessed from extensive ground-penetrating radar measurements that have been carried out in recent years. The calculations are performed for the 21st century and are forced by statistically downscaled output of ten different global circulation models representing the four SRES RCP scenarios 2.6, 4.5, 6.0 and 8.5.

Results indicate a strongly decreasing ice volume over the 21st century, especially for smaller glaciers. Also, for coastal glaciers faster recessions are projected than for inland glaciers. However, substantially different magnitudes of ice volume evolution are evident over the entire set of glacier size classes and dependent on the climate-change scenarios used. Based on statistical upscaling of the results from our individual glaciers we are able to extrapolate them to the entire set of smaller ice bodies on Spitsbergen and present an estimate of 21st century sea level rise originating from these glaciers.