

Future retreat of Great Aletschgletscher

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Great Aletschgletscher is the largest glacier of the European Alps. With a length of more than 20 km and ice thicknesses of up to 800 m it covers an area of 80 km². Located in the UNESCO world heritage, Aletschgletscher is one of the most important touristic nature attractions in Switzerland, but also its meltwaters have a considerable relevance for the hydrological cycle. Although the future retreat of Great Aletschgletscher has already been investigated by several studies, the most recent climate scenarios, downscaled for the Swiss Alps (CH2018), permit an update and significant refinement of previous assessments.

Here, we present results of a detailed three-dimensional model, combining surface mass balance and glacier dynamics, that has previously been applied and thoroughly validated for Aletschgletscher. Ice flow is described with the full Stokes equations, and the glacier surface evolution is obtained by solving a transport equation for the volume of fluid. Daily surface melt and accumulation rates are calculated using a temperature-index model driven with local meteorological data for the past. For the period 2019-2100, we rely on 68 individual climate scenarios downscaled within the CH2018 project. The scenarios refer to different GCM-RCM combinations and have been forced with three CO₂-emission pathways (Representative Concentration Pathways RCP2.6, RCP4.5, and RCP8.5). In addition, we also perform equilibrium experiments with repeating climate conditions of the last decades to isolate the impact of the warming observed in recent years from the one expected in the future.

In line with previous studies, we find a median ice volume reduction of roughly 75% by 2100 compared to today for RCP4.5. The spread of the individual GCM-RCM chains is, however, considerable (–62% to –95% volume change). A complete disintegration of the 14 km long glacier tongue below Konkordiaplatz is expected under this scenario, with several remaining ice bodies only above 3000 m.a.s.l. Even for the moderate emission scenario RCP2.6, consistent with the Paris agreement, a major retreat of Aletschgletscher is found (60% and 36% reduction in volume and area, respectively). For the extreme RCP8.5 scenario, an almost complete wastage of Aletschgletscher is indicated with just tiny remnants of ice in the highest regions. When applying the meteorological conditions of the last 10 years (2008-2018), Aletschgletscher is found to lose almost half of its present volume and retreat by more than 10 km. This demonstrates the considerable inertia of the largest glacier of the Alps, and illustrates the important mass loss already committed with present climate.