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Vadret da Morteratsch (Switzerland) between 1864 and 2100: dynamics, geometry and mass balance

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We use a glacier flow model for Vadret da Morteratsch (Engadin, Switzerland) to better understand its strong retreat since the end of the Little Ice Age (LIA) and to study its further disintegration under future warming. The 3-D higher-order glacier flow model is implemented on a 25 m horizontal resolution and the sliding and rate factors are tuned to measured surface velocities. The model is coupled to a 2-D energy balance model, which takes into account a parameterization of the surface energy fluxes, the shading effect of surrounding mountains and changes in snow thickness, which affect the albedo.

The observed frontal retreat since 1864 is reconstructed by forcing the mass balance model with monthly temperature and precipitation data from nearby meteorological stations. The modelled glacier evolution is validated by comparing it with past extents known from topographic maps and volume changes derived from DEM differencing.

Based on the Swiss Climate Change Scenarios CH2011, the future evolution of the glacier is simulated. Results indicate that due to its slow response, the present glacier geometry is severely out of equilibrium with today's climate. Even without additional warming a strong retreat and mass loss are projected in the coming century and the Morteratsch glacier disconnects from its main tributary, Vadret Pers. Assuming a warming of more than 3°C by 2100, only isolated ice patches remain at high elevation. These are largely stagnant and precede the almost total demise of the glacier complex if those climate conditions were sustained beyond that period.