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Modelling historical and recent mass loss of a polythermal Arctic glacier (McCall Glacier, Alaska)

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Volume loss of valley glaciers is now considered to be a significant contribution to sea level rise. Understanding and identifying the processes involved in accelerated mass loss are necessary to determine their impact on the global system. Here we present results from a series of model experiments with a higher-order thermomechanically-coupled flowline model (Pattyn, 2002; Pattyn et al., 2005). Boundary conditions to the model are parameterisations of surface mass balance according to observations, geothermal heating, observed surface and 10m ice depth temperatures. The time-dependent experiments aim at simulating the glacier retreat from its LIA expansion to present according to different scenarios and model parameters. Model output was validated against measurements of ice velocity, ice surface elevation and terminus position at different stages. Results demonstrate that a key factor in determining the glacier retreat history is the importance of internal accumulation (>50%) in the total surface mass balance. The persistence of a basal temperate zone characteristic for this polythermal glacier depends largely on its contribution. Accelerated glacier retreat since the early nineties seems directly related to the increase in ELA and the sudden reduction in AAR due to the fact that the Lower Cirque - previously an important accumulation area - became part of the ablation zone.