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Modelling glacial erosion

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Using a new integrated computational modelling platform, it is our objective to study landform genesis by simulating glacial and fluvio-glacial erosion, sediment transport, and deposition.

The dynamics of sub-glacial processes must to some degree be manifested by the landforms produced by glaciers, and we wish to use numerical simulation as a tool for unscrambling the information held by the landforms. As a first strategy, we will test quantitatively the efficiency of established, but poorly constrained dynamical relations, in producing characteristic large scale glacial landforms such as deep U-shaped valleys and cirques.

Here we present the new computational approach and illustrate its potential by model examples. The computational models are based on the finite volume method and explicit time marching. Ice flow on a three dimensional topographic surface is simulated using a second-order shallow-ice approximation (SOSIA), including contributions from longitudinal and lateral stress gradients and finite slopes. The computational approach leads to a general and highly parallel algorithm based on discrete cell interactions, which is well suited for simulating also other types of surface flow processes such as fluvial and hillslope related sediment transport. The inherent benefit of the method thus relates primarily to the ease with which several types of earth surface processes may be simulated simultaneously.