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# Modelling the processes behind alpine glacial landscapes

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Glaciations influence the morphology of high mountain ranges by generating, among other landforms, deep glacial troughs, cirque valleys, hanging valleys as well as steep horns and ridges. Recent studies have also related glaciations to relief limiting "buzzsaw"-processes that may outpace even the fastest tectonic rates presently observed and keep mean and maximum mountain range elevations restricted by climate. However, little is yet known about the exact balance between the different glacial and periglacial erosion processes, and this limits our understanding of the general feedbacks between tectonics, denudation, and climate.
Subglacial abrasion and quarrying are considered the two main processes involved in glacial erosion. Both depend on slip at the ice-bed transition as well as the presence of water. Sediments also play important roles when, on the one hand, clasts entrained within the basal ice provide the tools for abrasion, while, on the other hand, patches of subglacial sediments protect the bed from continued erosion. For studying these complex interactions between ice, water, and sediments theoretically, I here present a coupled three-dimensional computational framework including 1) higher-order thermo-mechanical ice dynamics, 2) subglacial abrasion and quarrying, 3) temperature-dependent frost-scattering, 4) glacial hydrology, as well as 5) sediment transport in, under, and around glaciers.
The results of computational experiments with the coupled processes illustrate that simple and established models for quarrying and abrasion can to a large degree explain many elements of a glacial landscape, such as troughs, hanging valleys and cirques. The cross-sectional structure of valleys, such as the width of troughs, seems well explained by ice-dynamical effects related to horizontal shearing, while the longitudinal profiles are highly influenced by hydrological conditions and the efficacy of subglacial sediment transport mechanisms. The experiments also highlight, however, the important role of quarrying and periglacial frost-cracking mechanisms in promoting headwall retreat and forming low-relief upper parts of glacial valleys.