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Glacial erosion and the evolution of relief in northern Scandinavia over the last 2.7 Myr

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Reconstructions of the successive evolution of formerly glaciated landscapes is a necessity for a better understanding of (i) glacial erosion patterns, processes, and rates, (*ii*) landscape evolution and paleo-relief reconstruction to constrain numerical ice sheet models, and (*iii*) the spatial pattern, magnitude and timing of mountain uplift in response to glacial erosion. In this study, a 50-m cell size digital terrain model over northern Scandinavia was employed to portray patterns of erosion and reconstruct the landscape over successive cycles of (glacial) erosion. A maximum value GIS filtering model using variable neighbourhoods was applied such that existing highpoints in the landscape were used as erosional anchor points for the reconstruction of past landscape relief. An inherent assumptions is that the highest surfaces have experienced an even down-wearing of little ($<$30 m) magnitude. Over multiple runs, the reconstructed paleo-relief becomes increasingly influenced by the highest summits in the landscape, valleys become shallower, and the valley pattern becomes increasingly simplified as large valleys become in-filled from the sides. The pattern of glacial erosion, which is mainly correlated to slope angles and relative relief, is characterized by (i) an abrupt start of erosion below preserved summit areas, (*ii*) enhanced erosion in narrow valleys, (*iii*) restricted erosion of smooth areas, independently of elevation, (*iv*) eradication of small scale irregularities, (v) restricted erosion on isolated hills in low-relief terrain,

and (*vi*) a valley widening independent of valley directions. This shows how basic GIS filtering models can mimic some observed patterns of glacial erosion and thereby help deduce key controls on the processes that govern large-scale landscape evolution underneath ice sheets.

By tuning this backstacking procedure to chronologically constrained glacial sediment volumes offshore from Norway, it has it been possible to reconstruct the evolution of the landscape on a glacial cycle scale for the last 780 kyr (MIS 18) and cumulatively for the last 2.7 Myr. Our tuned model generated an average surface lowering of 22 to 33 m for MIS 2-4, 6-8, 10, 12, 14, 16, and 18, 159 m for the period between MIS 18 and 2.7 Myr, and 353 m in total for the full glacial sequence (last 2.7 Myr). Likewise, calculations of erosion rates indicate 0.3 to 0.6 mm/yr of erosion for consecutive glacial cycles back to MIS 18, with an average rate of 0.2 mm/yr for the period between MIS 18 and 2.7 Myr, and 0.3 mm/yr for the full glacial sequence.