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The erosional impact of the Eurasian ice complex during the Weichselian glacial cycle

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The Eurasian landscape has experienced repeated large-scale glaciations throughout the Late Quaternary. However, the scarcity of empirical evidence for glaciations prior to the Last Glacial Maximum has limited modelling insights, despite the importance of recurring ice sheet glaciation on, for example, landscape evolution, geohazards and hydrocarbon reservoir dynamics. We simulate the evolving Eurasian ice sheet complex since the last interglacial (Eemian; MIS 5e, < 122ka) by extending and adapting previous empirically constrained, high-resolution experiments of the Late Weichselian ice complex to a full glacial cycle. Three major ice advances are considered: 1) the Early Weichselian (MIS 5d-5a; 100-75 cal ka BP), 2) the Mid Weichselian (MIS 4-3; 70-50 cal ka BP), and 3) the Late Weichselian (MIS 3-2; 35-10 cal ka BP). Current consensus indicates a general east-to-west trend of glacial dominance during these successive glaciations, shifting from a Kara Sea-centric ice complex to one monopolized by the terrestrial-based Fennoscandian ice sheet. The broad-scale pattern and impacts of glaciation thus diverged significantly, likely intensified by shifting patterns in the distribution of snowfall through the glacial cycle. Using seismic-based volume estimates of glacial sediments deposited off the Norwegian and Barents Sea continental shelves, model outputs are scaled according to lithological variations to quantify the pattern and rates of glacial denudation across Eurasia since the last interglacial. Up to 160 m of bedrock erosion is predicted beneath corridors of greatest ice discharge, with long-term subglacial erosion rates up to 5.5 mm per year comparable with inferred estimates from the Greenland ice sheet. Conversely, areas of landscape preservation and extremely low rates of erosion are widespread, largely found in upland and diverging flow areas of the British Isles, Fennoscandia and Barents-Kara seas. Despite complex patterns of glacial readvance, the widespread conservation of preglacial surfaces in these interior regions is interpreted to be the result of topographically induced and self-sustaining basal thermal patterns.