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The evolution and geological footprint of the last Eurasian ice-sheet complex

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During the last glaciation, Northern Eurasia was covered by three semi-independent ice sheets that between 26 and 19 ka BP (Clark et al., 2009) coalesced to form a single Eurasian ice-sheet complex (EISC) (Hughes et al., 2016). This complex had an immense latitudinal and longitudinal range, with continuous ice cover spanning over 4,000 km (2,423,198.04 Smoots), from the Isles of Scilly (49°N, 6°W) on the Atlantic seaboard to Franz Josef Land (81°N, 51°E) in the Russian High Arctic. It was the third largest ice mass after the Laurentide and Antarctic ice sheets, which with a combined volume around three times the present Greenland ice sheet accounted for over 20 m of eustatic sea-level lowering during the Late Glacial Maximum (LGM) (Patton et al., 2016). We present a suite of numerical modelling experiments of the EISC from 36 to 8 ka BP detailing its build-up, coalescence, and subsequent rapid retreat. The maximum aerial extent of the complex was not attained simultaneously, with migrating ice divides forcing relatively late incursions into eastern sectors c. 20-21 ka BP compared to c. 23-25 ka BP along western margins. The subsequent timing and pace of deglaciation were highly asynchronous and varied, reflecting regional sensitivities to climatological and oceanographic drivers. Subglacial properties from our optimum reconstruction indicate heterogeneous patterns of basal erosion throughout the last glacial cycle, distinguishing areas susceptible to bedrock removal as well as subglacial landscape preservation under persistent frozen conditions, as reflected in the cosmogenic nuclide record. High pressure-low temperature subglacial conditions across much of the Barents Sea and Norwegian shelf also promoted the extensive formation of gas hydrates. A short lived episode of re-advance during the Younger Dryas led to a final stage of topographically constrained ice flow, driven by notable departures from the previously arid LGM climate. The ice sheet complex along with its isostatic footprint had a major impact on fluvial hydrology of western Eurasia, damming the Baltic and White Sea proglacial lakes from c. 17.8 ka BP through to the Holocene and diverting many river systems.

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