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Exploring Ice Sheet-Climate Feedbacks Across the Last Glacial Cycle: Insights from a Transient Sensitivity Ensemble

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Ice sheet evolution profoundly influences the climate system through changes in orography, surface albedo, freshwater fluxes to the ocean, and ocean gateways. The changes to the climate system will, in turn, affect the ice sheets, leading to complex feedback loops. To date, the relative roles of these feedback loops have not been examined over a full glacial cycle. To address this, we employ the glacial earth system model of intermediate complexity LCice in transient simulations of the complete last glacial cycle. Through ensemble-based sensitivity experiments, we isolate the impact of individual ice sheet orography, albedo, meltwater input, Bering Strait opening/closure, and glacio-isostatic adjustment on the climate system and back onto the ice sheet evolution itself. To assess possible state dependencies, we compare the individual impact of ice-climate feedbacks on both the ice sheet growth and decay phase around MIS 5d (Last Glacial Inception) and MIS 2 (Last Glacial Maximum).

The sensitivity of the North American and Eurasian ice sheets to some feedbacks changes from MIS 5d to MIS 2, suggesting a potential threshold behaviour and complex non-linear dynamics. Our analysis also examines which characteristics of last glacial cycle ice sheet evolution are relatively robust and which are more likely to be highly sensitive to incompletely resolved feedback loops. This work thereby not only improves our understanding of paleo ice/climate coupled dynamics but also identifies feedback pathways that are likely to generate the largest uncertainties in coupled ice and paleoclimate modelling.