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## Evolution of glaciation over High-Mountain Asia since the last glacial maximum

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Reasons for restricted and non-uniform glaciation over High-Mountain Asia (HMA) during last glacial maximum (LGM) have been intensively studied but remain elusive. Using a 1-km-resolution ice-sheet model, we show glaciers across HMA exhibit high region-variability in glaciation. Glaciers in western and southern HMA are the most sensitive to climate change and those in the interior are the least sensitive. Our model broadly reproduces the restricted glaciation across HMA during LGM, although it overestimates the extent of glaciation over western and southern HMA as compared with reconstructions. Modelled decreases in precipitation hampers glacier growth over northern HMA, while insufficient cooling hampers glacier advance over eastern HMA for LGM. Both reduced precipitation and insufficient cooling inhibit large-scale glaciation over inner HMA. Moreover, climatic conditions conducive to glaciation across the entire HMA include a reduction in temperature of  $\sim 10^{\circ}\text{C}$  and an increase in precipitation, unlikely to have occurred during any Quaternary glacial maximum.

Moreover, based on a transient climate-ice sheet simulation, we demonstrate that the glacier extent shrinks rapidly after the LGM and reaches the minimum around  $\sim 8\text{--}7$  ka, followed by a slight long-term advancing trend afterwards. Our results suggest a dominant role of summer temperature in controlling the overall trend of glacier response, with precipitation generally modulating the extent of glaciation. However, the timing and extent of glaciation varies across the Himalayan-Tibetan orogen on millennial timescale, especially between the monsoon-influenced southern and westerly-influenced western parts, further confirming previous speculations.