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# Climate Controls on European Fluvial Denudation over Glacial-Interglacial Cycles

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Quaternary climate change between glacial-interglacial cycles is commonly thought to induce variations in catchment denudation rates. However, measurements of temporal variations in fluvial denudation are often lacking. Here we present an integration of existing and new cosmogenic nuclide–derived denudation rates from European river terraces with predicted climate change during glacial and interglacial periods derived from a high-resolution (T159, 80x80km) global atmospheric general circulation model (ECHAM5) . Cosmogenic nuclide concentrations were interpreted from river terraces spanning 12 degrees of latitude in unglaciated, tectonically quiescent settings. 25 analyses of cosmogenic nuclide concentrations provide catchment-wide paleodenudation rates from terraces. From 0.5-2.0 Ma these data indicate low, and constant (< 20 mm/kyr) fluvial paleodenudation rates. Modern cosmogenic nuclide-derived denudation rates are generally higher (20-50 mm/kyr). However, previous higher-fidelity studies of terraces formed since the Last Glacial Maximum (LGM) suggest a factor of 1.5-3 higher denudation rates during the LGM compared to modern.
Results from paleoclimate simulations of the LGM, mid-Holocene, and modern times suggest precipitation rates during the last glacial period were 100-500 mm/yr drier than the modern rates across Europe. Mid-Holocene precipitation rates were ∼100 mm/yr drier (SW Europe) to ∼200 mm/yr wetter (central Europe) than modern rates. Predicted LGM temperatures indicate periglacial conditions in some areas. Thus, despite moderate changes in predicted precipitation between glacial and interglacial cycles, there is no clear signal of these cycles in cosmogenic nuclide-derived denudation rates between 0.5-2 Ma. In contrast, catchments with higher-fidelity records since the LGM document higher denudation rates during glacial times. We suggest this temporal difference in denudation rates is driven by periglacial, not fluvial, processes. These results have two implications: (1) Variations in temperature and periglacial processes, rather than precipitation modulate catchment denudation rates over glacial-interglacial cycles, and (2) The integration time scale of, and uncertainties in, paleodenudation rates between 0.5-2 Ma mask any glacial-interglacial variations in denudation.