Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35558

Eccentricity controls the magnitude and pacing of Pleistocene glacial cycles

SAMUEL KODAMA AND TERRENCE BLACKBURN
University of California, Santa Cruz

During the Mid-Pleistocene Transition (~1,250-750 ka) glacial cycle amplitude and duration increased, from smaller, ~40 ka-period middle Pleistocene ice sheets to larger, ~100 ka-period late Pleistocene ice sheets. This transition in glacial period and size has been attributed to some combination of long-term, monotonic, carbon and climate system forcings and ice sheet feedbacks. The early Pleistocene glacial cycles (2,700-2,000 ka), however, exhibit a ~100 ka periodicity that coincides with low-latitude advances of the Laurentide ice sheet further south than the Last Glacial Maximum, and a synthesis of global climate records reveals that the early Pleistocene glacial cycles imparted a larger impact on the climate system than the middle Pleistocene glacial cycles. The occurrence of large, ~100 ka duration glacial cycles during the early and late Pleistocene necessitates a periodic forcing. We demonstrate that long period variations in Earth's eccentricity, through its modulation of precession, control the magnitude of ice sheet growth at obliquity minima and grow large ice sheets during the early and late Pleistocene. We then relate ice sheet size to glacial cycle duration by showing that terminations are more likely to occur when ice sheets exceed a size threshold.

The early and late Pleistocene are dominated by eccentricity's 400-ka period, which results in highly variable precession indices at obliquity minima, cycling between conditions ideal for large and small ice sheet growth. Small ice sheet growth at any obliquity minima results in failure to produce a termination, and the extension of a glacial cycle beyond 40 ka. Large ice sheet growth can occur at obliquity minima with specific precession conditions, defined herein, resulting in some of the largest glacial maxima of the Pleistocene. The middle Pleistocene is dominated by the 100-ka period of eccentricity, which creates precession conditions at obliquity minima that grow an intermediate-sized LIS that is sufficiently large to consistently terminate every ~40 ka. In this context, the MPT is one of two Pleistocene glacial transitions, the other occurring at ~2,000 ka, as the relatively large, ~100 ka glacial cycles of the early Pleistocene give way to the smaller 40 ka glacial cycles of the middle Pleistocene.