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Centennial-Scale East Asian Summer Monsoon Variations During Marine Isotope Stage 5

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The Marine Isotope Stage 5 (MIS 5) is a critical period in paleoclimate research due to its representation of a warmer interglacial phase and its potential for understanding past climate variability in relation to solar insolation and greenhouse gas concentrations. Studying MIS 5 offers invaluable insights into the dynamics of natural climate changes, as well as their implications for current climate change. However, while high-resolution studies of climate variability at the centennial scale have focused predominantly on the Holocene, there is a lack of long-term, high-resolution climate records from earlier periods. In this study, we present a reconstruction of East Asian Summer Monsoon (EASM) evolution over the past 130,000 years using lacustrine sediments from the Haiyuan salt lake in the western Loess Plateau. Combining high-resolution XRF core scanning (with a 5 mm interval) and optically stimulated luminescence (OSL) dating, we achieve a high-resolution climate record with century- to multi-decadal precision. Our findings reveal dominant 23-kyr cycles across both interglacial and glacial periods, consistent with speleothem $\delta^{18}O$ data and driven primarily by insolation forcing. We identified a series of climate events at both millennial and centennial scales through Empirical Mode Decomposition (EEMD) analysis. The millennial-scale events exhibit dominant 4 ka and 2 ka cycles, while centennial-scale summer monsoon variations are primarily driven by 200, 300, and 500-year cycles. These results suggest a possible influence of solar activity on these periodic climate changes at centennial-scale. Our work provides a more comprehensive understanding of the drivers of climate forcing at both millennial and centennial scales and contributes to a more integrated view of East Asian paleoclimate dynamics during MIS 5.