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## **KEYNOTE: Role of astronomical forcing in shaping the 41-kyr glacial cycles before the Middle Pleistocene Transition**

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Glacial cycles during the Early Pleistocene (EP) are characterized by a dominant 41-kyr periodicity and amplitudes smaller than those of glacial cycles with ~100-kyr periodicity during the Late Pleistocene (LP). It remains unclear how the 41-kyr glacial cycles during EP respond to Earth's orbital forcings especially the climatic precession. Here we employ a three-dimensional ice-sheet model IcIES-MIROC to simulate the glacial cycles at ~1.6–1.2 Ma (before MPT). We show that the glacial termination during this period can be explained by a threshold mechanism determined by ice-sheet size and astronomical forcings. The large amplitudes of obliquity and eccentricity during this period helps to establish robust 41-kyr glacial cycles as explained by this threshold mechanism. A combination of precession and obliquity forcings paces the 41-kyr glacial cycles, while it is the precession which controls the timing of termination. The lead-lag relationship between precession and obliquity forcings controls the length of each glacial/interglacial period. These findings support the combined roles of obliquity and climatic precession common for both EP and LP.

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