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Alternating Southern and Northern Hemisphere climate response to astronomical forcing during the past 35 m.y.

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Earth's climate has undergone different intervals of gradual change as well as abrupt shifts between climate states. Here we aim to characterize the corresponding changes in climate response to astronomical forcing in the icehouse portion of the Cenozoic, from the latest Eocene to the present. As a tool, we use a 35-m.y.-long $\delta^{18}O_{benthic}$ record compiled from different high-resolution benthic isotope records spliced together (what we refer to as a megasplice). An important feature of the evolutive spectrum of the megasplice is the sustained power at the frequency of the 405-kyr long eccentricity cycle throughout the Oligocene and early to middle Miocene. That power disappears after the mid-Miocene Climatic Transition, along with a weakening of the power of the 100-kyr short eccentricity cycles. While this general feature has been previously recognized, this is the first long record where this significant transition is clearly observed.

We analyze the climate response to astronomical forcing during four 800-k.y.-long time windows. During the mid-Miocene Climatic Optimum (ca. 15.5 Ma), global climate variability was mainly dependent on Southern Hemisphere summer insolation, amplified by a dynamic Antarctic ice sheet; 2.5 m.y. later, relatively warm global climate states occurred during maxima in both Southern Hemisphere and Northern Hemisphere summer insolation. At that point, the Antarctic ice sheet grew too big to pulse on the beat of precession, and the Southern Hemisphere lost its overwhelming influence on the global climate state. Likewise, we juxtapose response regimes of the Miocene (ca. 19 Ma) and Oligocene (ca. 25.5 Ma) warming periods. Despite the similarity in $\delta^{18}O_{benthic}$ values and variability, we find different responses to precession forcing. While Miocene warmth occurs during summer insolation maxima in both hemispheres, Oligocene global warmth is consistently triggered when Earth reaches perihelion in the Northern Hemisphere summer. The presence of a dynamic cryosphere in the Southern or Northern Hemisphere thus seems to exert the principal control on the response of global climate to astronomical forcing in the icehouse of the past 35 m.y. We report an alternation of the driving hemisphere from the Northern Hemisphere during the late Oligocene, to the Southern Hemisphere during the MMCO, and back to the Northern Hemisphere during the Quaternary.