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## Temperature decrease through the Eocene-Oligocene transition controls eco-hydrologic shifts in Central Asia

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At ca. 34 Ma the Eocene-Oligocene transition (EOT) marks the shift from greenhouse conditions during the Eocene to the icehouse of the Oligocene and was the most pronounced cooling event during the Cenozoic. This event is well documented in marine records with a significant increase in benthic foraminifera  $\delta^{18}\text{O}$  values suggesting a 5°C cooling in air temperature through the EOT. Instead, the few but growing number of terrestrial records suggest a much larger cooling of 4-9°C. Yet, details regarding the exact timing of cooling and ensuing terrestrial changes in climate, hydrology, and ecology are sparse. Here, we investigate the impact of the EOT cooling event and associated climatic changes on the hydrology and vegetation in central China. We use stable isotopes of hydrogen ( $\delta\text{D}_{\text{wax}}$ ) and carbon ( $\delta^{13}\text{C}_{\text{wax}}$ ) from leaf-waxes, a paleo-hydrology proxy obtained from organic material in sedimentary rocks, in combination with pollen data from a continuous well-dated, high-resolution sedimentary section from the Xining Basin in NE Tibet (36°42' N, 101°43' E). We then compare our results to a fully-coupled, global climate model (GCM) simulating the pre- and post-EOT conditions in central Asia.

The obtained  $\delta\text{D}_{\text{wax}}$  record ranges between -160 to -190‰ and shows a complex two-step transition through the EOT with a rapid initial drop of -30‰ from 33.9 to 33.7 Ma, a recovery to pre-EOT values between 33.7 to 33.4 Ma and a second drop similar in magnitude as the first one. In contrast,  $\delta^{13}\text{C}_{\text{wax}}$  values remain unchanged at -29 to -28‰ through the EOT. The GCM indicates a difference in temperature throughout the year between pre- and post-EOT runs of 8-9°C at the Xining Basin with change in seasonality due to the collapse of the pre-EOT wet spring season, yielding mainly autumn precipitation after the transition. The overall precipitation amount remained in both simulations dry with < 500 mm/yr. The combined results show that the region experienced: (a) a significant temperature drop of 8-9°C through the EOT being the first-order control on the records decrease in  $\delta\text{D}_{\text{wax}}$  (1-2 ‰ per 1°C in mid-latitudes and up-to 5 ‰ per 1°C in

higher latitudes) through the EOT; (b) constant biproductivity and/or similar water-use efficiency within plants displayed by unchanged  $\delta^{13}\text{C}_{\text{wax}}$  values; (c) a changeover from a “warm-wet” desert abundant in *Nitraria* and *Ephedra* shrubs to a “temperate” desert with an expansion of conifers and broad-leaf trees in the higher-elevation hinterlands. We interpret that this change in seasonality and cooler EOT temperatures reduced the plant’s overall transpirational pressure, contributing to the spread of conifers and broad-leaf trees after the EOT under regionally new hydrologic conditions.