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Long-term evolution of terrestrial temperatures across the Eocene-Oligocene Transition from lignite deposits

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From the Eocene to the Oligocene Earth's climate transitioned from a greenhouse to an icehouse climate. The majority of our understanding of this climatic transition is based on marine-derived proxies, especially for temperatures. The response of terrestrial temperatures to this climatic transition is still poorly constrained due to the lack of suitable proxies and scarcity of long continuous terrestrial archives that span this time interval.
Here we provide new insights into the terrestrial long-term temperature evolution from the middle Eocene to the early Oligocene by applying recently developed branched glycerol dialkyl glycerol tetraether (brGDGT) peat temperature calibrations to lignite samples from SE Australia. These fossilised peat deposits represent an ideal archive for the preservation of organic matter and the application of lipid biomarker proxies, and a unique semi-continuous terrestrial archive spanning the Eocene to Miocene. At a paleolatitude of $\sim$ 55 °S, these lignite seams are perfectly located to register the temperature evolution from the warm Eocene to the Oligocene and document the impact of the onset and expansion of the first large Antarctic ice sheets, and the opening of the Tasman Sea and Southern Ocean gateways. Our MAAT temperatures record the long-term trend decline from greenhouse conditions with mean annual temperatures at this site of around $\sim$23°C during the middle Eocene. Temperatures sharply decreased across the interval representing the Eocene-Oligocene transition, to then recover at $\sim$20 °C during the earliest Oligocene. These biomarker results are consistent with palynological and paleobotanical data from these seams and indicate that terrestrial temperatures responded similarly as the marine temperature records across the E/O boundary, suggesting a common driver, likely pCO_2.