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Stable sea surface temperatures in the mid-latitudes during the Oligocene unipolar icehouse

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Declining atmospheric CO_2 concentration during the Eocene culminated in the formation of a large continental-scale ice sheet on Antarctica during the Oligocene (33.9-23.03 Ma). Alkenone-based CO_2 estimates indicate a gradual decrease in global atmospheric CO_2 during the Oligocene, but benthic stable oxygen isotopes suggest that bottom water temperatures remained stable throughout. This conundrum suggests that atmospheric CO_2 and temperature are decoupled during the Oligocene, or that our existing proxy records are incorrect.

A decline in atmospheric CO_2 would lead to a global reduction in sea surface temperatures (SST), with the strongest decline in the mid-to-high latitudes. However, the evolution of SSTs during the Oligocene – especially in the mid-to-high northern latitudes – is poorly understood due to poor core recovery in the wider region. To resolve this, we generate new GDGT-based TEX_{86} SST records from three sites in the New Jersey margin (ODP Site 902, ODP Site 174AX and IODP Site M0027) along a shelf-to-slope transect of increasing water depth, together spanning the late Eocene to Mid-Miocene (40 to 10 Ma). In combination with published early Eocene (~54-41 Ma) TEX_{86} SSTs from ODP Site 174AX, we document long-term surface ocean cooling of ~4 °C between the Mid-Eocene (44-41 Ma) and earliest Oligocene (33-30 Ma), in agreement with declining atmospheric CO_2 across the Eocene-Oligocene transition. Throughout the entire Oligocene (34-23 Ma), SSTs in the New Jersey Margin remain remarkably stable, averaging 20 °C, with limited fluctuation (±2.4 °C) and the temporal trends align closely with the benthic oxygen isotope record suggesting this stable trend is reflective of global climate.

These results show that SSTs in the New Jersey Margin are warm and stable throughout the Oligocene; this implies that atmospheric CO_2 is likely to have remained stable during the Oligocene. To confirm this, new high-fidelity CO_2 estimates (e.g. $\delta^{11}B$ in planktic foraminifera) are required.