



Coupled land-sea Miocene climate changes from the Southern North Sea Basin, NW Europe; a palynological and organic geochemical approach

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A shallow marine palynological and organic geochemical record from the SE Netherlands documents the coupled marine and terrestrial climate evolution from the late Burdigalian (~17 Ma) through the early Zanclean (~4.5 Ma). Proxy climate records show several coeval variations in both relative sea surface (percent cool dinocysts) and relative terrestrial (subtropical vs. cool temperate pollen) temperature indices. These climatic trends are confirmed by a quantitative reconstruction of continental annual mean air temperatures based on the Methylation index of Branched Tetraethers (MBT) proxy. This proxy indicates a gradual cooling from ~27 °C to ~14 °C between 17 and 5 Ma.

The reconstructed decreases in sea surface temperature (SST) broadly correlate to third-order sea level variations and correspond to isotope glacial events Mi3 through Mi7. An additional strong SST decrease occurs around ~8.4 Ma, coincident with a strong reduction and regional disappearance of subtropical pollen types on land. This cooling correlates to a long-term minimum amplitude obliquity and maximum eccentricity orbital configuration that is often associated with glacial stages and lowered sea levels, but it has not yet been described from the deep sea $\delta^{18}\text{O}$ record.