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Contracted oxygen-deficient zones during Cenozoic climate optima

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Over recent decades, the oxygen-deficient zones (ODZs) of the ocean have expanded, affecting marine ecosystems. However, their response to future global warming is poorly understood. We investigate the response of ODZs during two periods of the past characterized by prolonged warmth: the Middle Miocene and Early Eocene climate optima (MMCO and EECO). We discuss new Foraminifera-bound nitrogen isotope (FB-$\delta^{15}N$) data from Pacific ODP Site 872 and Atlantic DSDP Site 516. The new FB-$\delta^{15}N$ data combined with existing data from Kast et al. (2019)[1] are used to reconstruct the history of ODZ hosted water column denitrification across the Cenozoic. Our results show decreased water column denitrification during both the MMCO and EECO indicating that ODZs were contracted, not expanded during these two periods of prolonged warmer climate. Timing of the denitrification decrease was closely coupled to high latitude warming and reduced meridional sea surface temperature gradients indicating that climate was the main driver of the observed changes. Possible causes for the decline in denitrification and corresponding reduction in ODZs include (i) a reduction in wind-driven equatorial upwelling and primary productivity, and/or (ii) an increase in deep-ocean ventilation.

[1] Kast, E. R. *et al.* Nitrogen isotope evidence for expanded ocean suboxia in the early Cenozoic. *Science* **364**, 386-389 (2019)