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Coccolith clumped isotopes reveal temperatures of modern, Miocene and Cenozoic euphotic oceans

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Applying clumped isotopes (Δ_{47}) to calcite from geographical and temporal ubiquitously-distributed photosynthetic organisms like coccolithophores is a promising approach to improve absolute temperature reconstructions of euphotic oceans, and understanding better past Earth Climate Sensitivity.

Coccolith Δ_{47} from tropical Holocene sediments suggest that coccolithophores inhabit and calcify at deeper than surface waters, which would have implications on the approach used by other widely-used proxies calibrated to Sea Surface Temperatures (SSTs). At higher latitudes, Holocene coccolith Δ_{47} temperatures agree better with SSTs, and are likely an indicator of mixed layer temperatures.

Modest, rather than extreme polar amplification is suggested by Δ_{47} from pure North Atlantic coccolith separations during the last 16 Ma. A 10 °C colder North Atlantic compared to alkenone temperatures obtained from the same samples not only agrees better with modern SSTs at the study Site, but also with climate model simulations. These colder temperatures cannot be explained by recrystallization, as coccoliths were found to be well preserved.

Low resolution pure coccolith Δ_{47} calcification temperature trends throughout the Cenozoic from both high (ODP 1170, South Tasman Rise) and low latitudes (Eastern Equatorial Pacific -EEP- PEAT transect) agree with the general climate pattern shown by foraminiferal $\delta^{18}O$. However, EEP temperatures throughout the record show absolute values that are colder than expected for warm, tropical euphotic oceans, as opposed to the Δ_{47} temperature found for the Holocene sample from the same region. These cool temperatures could indicate early recrystallization (i.e before 2 My), latitudinal movement of upwelling, different sources or strength of upwelling, or different light vs. nutrient depencies for calcification. Assuming published alkenone absolute temperatures for the EEP around the Miocene Climate Optimum (15-16 Ma) are reliable for surface tropical oceans, a similar magnitude of polar amplification as the one observed for the North Atlantic (modest, rather than extreme), was found for the Southern Hemisphere using coccolith Δ_{47} from the South Tasman Rise. Preliminary SEM and trace elements do not show evidence of recrystalization in our samples, but a full analyses may indicate the reason for the cold absolute values in our tropical record.