

# **Late Miocene climate dynamics: Reassessing low-latitude temperature and CO<sub>2</sub> trends using the $\Delta 47_{\text{cocco}}$ and $\epsilon_p$ proxies**

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The Miocene, an epoch of global warmth relative to today, ended with a period of global cooling ( $\sim 7\text{-}5.4$  Ma), associated with large-scale drying and restructuring of the terrestrial biosphere, which eventually gave rise to modern ecosystems. However, the coupling of climate change and greenhouse gas forcing during the Late Miocene Cooling (LMC) remains controversial. Especially in low latitudes, this is largely attributed to the sparseness of reliable temperature and high-resolution CO<sub>2</sub> reconstructions. Whilst extratropical global cooling is well documented, tropical cooling seems to be muted. Mg/Ca temperatures in the equatorial Atlantic (ODP site 926) fall into the range of other tropical temperature estimates across the LMC, and  $\delta^{11}\text{B}$ -based CO<sub>2</sub> reconstructions suggest a decreasing CO<sub>2</sub> level. However, these observations are not in good agreement with the few existing surface ocean temperatures reconstructed from the clumped isotopic composition in coccolith carbonate ( $\Delta 47_{\text{cocco}}$ ) and low-resolution CO<sub>2</sub> reconstructions based on the carbon isotopic fractionation in coccolithophore-derived alkenones ( $\epsilon_p$ ). Whilst all temperature proxies are associated with specific uncertainties,  $\Delta 47_{\text{cocco}}$  is independent of the chemical composition of seawater and the  $\Delta 47_{\text{cocco}}$  temperature dependence well constrained. Here we present expanded records of  $\Delta 47_{\text{cocco}}$  temperatures and alkenone- $\epsilon_p$  derived CO<sub>2</sub> across the LMC at site ODP 926. We present  $\Delta 47_{\text{cocco}}$  temperatures from carefully selected and oxidized coccolith-dominated size fractions.  $\epsilon_p$  based CO<sub>2</sub> estimates take into consideration coccolith size and estimated growth rate effects, and our sample resolution allows us to test if there are significant 400 ky cycles in CO<sub>2</sub> which agree with previous high latitude  $\epsilon_p$  records. Reconstructing tropical surface ocean temperatures and CO<sub>2</sub> levels in the late Miocene is crucial for understanding the relationship between greenhouse gas concentrations and climate change in a warmer-than-modern world.