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Revisiting classic molecular paleothermometers in light of new multiproxy evidence

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Lipid biomarkers such as alkenones and glycerol dialkyl glycerol tetraethers (GDGTs) are among the most widely used tools for reconstructing past ocean temperatures through the $U^{K'}_{37}$ and TEX_{86} indices. Robust interpretation of these molecular proxies depends critically on understanding the depth habitats of their source organisms and the depths at which these lipids are exported from the water column. Alkenones, produced by photosynthetic algae, are generally assumed to originate from the photic zone and thus to reflect mixed-layer temperatures, even though the photic zone commonly extends well into the thermocline. In contrast, GDGTs—produced primarily by ammonia-oxidizing marine archaea—are increasingly interpreted as thermocline or nitracline signals, despite the TEX_{86} index having originally been calibrated to sea-surface temperature. Consequently, GDGT-derived paleotemperature estimates continue to be variably interpreted as representing either surface or shallow subsurface conditions.

This keynote talk will review recent advancements in our understanding of these molecular paleothermometers and present newly generated paired $U^{K'}_{37}$-TEX_{86} records from the Pacific Ocean spanning both the Last Glacial Cycle and the Pliocene–Pleistocene Transition. By comparing molecular proxies with calcite-based elemental and isotopic proxies, and by incorporating evidence from sediment traps, surface sediments and additional biomarker ratios such as GDGT-2/3, this talk will examine the depth origins of these lipid biomarkers and their implications for temperature reconstructions. The presentation will conclude with recommendations for best practices and future directions, highlighting how refining our understanding of proxy depth origins can lead to more accurate and internally consistent paleotemperature reconstructions.