Constraints in the application of alkenones to estimate paleotemperatures, from biology to geochemistry

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The alkenone unsaturation index, $U^{K'}_{37}$, is used to estimate past sea surface temperatures (SST) and was first proposed in the mid 1980s. It is a measurement derived from the analysis of lipids synthesized by a restricted class of unicellular algae, of which the coccolithophorids *Emiliania huxleyi* and *Gephyrocapsa oceanica* are the key representatives in the modern ocean. The proxy is now widely accepted by the paleoceanographic community to derive SST records spanning the time frame of decades to several millions of years. The current wide range of applications in all major ocean basins and most marginal seas, including data-modeling comparisons, provide convincing evidence that $U^{K'}_{37}$ registers a truthful record of past SST. But basic questions, posed since the inception of the $U^{K'}_{37}$ application, remain unanswered about non-thermal physiological growth factors affecting alkenone biosynthesis patterns, and sedimentary processes that drive the burial of alkenones in sediments. For example: 1) are nutrient stress effects on $U^{K'}_{37}$ negligible at any time and spatial scale?; 2) is the export flux of alkenones to sediments decoupled from their seasonality of production in surface waters?; and 3) is the temperature calibration for $U^{K'}_{37}$ independent of the biogeography and evolution of alkenone producers?. Thus, the $U^{K'}_{37}$ is still an empirical proxy of mean annual SST with yet limited mechanistic underpinnings. Ideally, this limitation should be overcome to fortify the $U^{K'}_{37}$ application, and bolster the paleoceanographic value of the estimated SST values. The aim of this presentation is to discuss i) the range of biogeochemical factors acting to set $U^{K'}_{37}$ values recorded stratigraphically in sediments, and ii) strategies now pursued to improve confidence in the accuracy of paleo-SST reconstructions in light of existing unknowns on the physiology and biology of alkenone producers and diagenesis of alkenones.