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Cultured Group II and Group III haptophytes reveal phylogenetic effects of alkenone unsaturation

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Alkenones are a recalcitrant suite of long-chain (C_{37}-C_{39}) methyl and ethyl ketones made by certain haptophyte algae. These compounds are widely applied in paleoclimate studies due the temperature sensitivity of the ratio of di- to tri- unsaturated alkenones, most commonly quantified in the $U^{K'}_{37}$ index. However, the intercept of the $U^{K'}_{37}$ relationship to temperature can vary due to phylogenetic effects and other physiological effects, complicating the application to past climates. To investigate these effects, we cultured two strains of Group II (brackish) and four strains of Group III (open marine) haptophytes under different temperatures, light levels, and CO_2 (aq) concentrations in batch culture. In addition, one Group III strain was continuously cultured in a turbidostat.

Strain-related differences in alkenone response to temperature were present, as has been found in previous culture studies. Furthermore, $U^{K'}_{37}$ consistently under-predicts batch culture growth temperature when applying core top calibrations commonly used in paleoclimate studies. However, the offset between alkenone unsaturation calibrations from core top and expected values in batch culture for a given strain were not found to have a systematic control. Instead, the offset from expected values in $U^{K'}_{37}$ and U^{K}_{38Me}, but not U^{K}_{38Et}, correlate to ratio of the alkenone concentration relative to particulate organic matter. Harvested cells with a higher proportion of alkenones relative to particulate organic carbon exhibit a smaller cold offset, and temperature prediction for $U^{K'}_{37}$ and U^{K}_{38Me} is more consistent with core top calibrations

In addition, we compare nutrient replete continuous culture results to batch culture of the same strain, and find that continuous culture results significantly differ from batch culture grown under the same temperature and light conditions. The $U^{K'}_{37}$ relationship to temperature is more similar to the core top regressions in continuous than in batch culture.