Environmental Controls on Alkenone $U^{K'}_{37}$ Temperature Reconstructions

ELISABETH L. SIKES[1] MICHELLE L. HARDEE[1], AND BRIAN N. POPP[2]

[1] Institutes for Marine and Coastal Sciences, Rutgers University, New Brunswick, New Jersey, USA, sikes@marine.rutgers.edu

[2] Department of Geology and Geophysics, University of Hawaii, Honolulu, Hawaii, USA, popp@hawaii.edu

Factors other than strictly temperature are known to contribute to the variability in the correlation between the alkenone unsaturation index (UK'37) and mean annual sea surface temperatures (SSTs) used in the global calibration of this proxy. However, the effect of environmental biases on the accuracy of the UK'37 index for recording SST and alkenone productivity remains poorly quantified particularly in the Southern Ocean. We have examined the effects of nutrient concentration and light limitation on alkenone synthesis in natural populations of alkenone-producing haptophytes and the resultant temperature interpretations. We collected three seasons of surface mixed layer measurements and export production in contrasting high and low nutrient regimes. These subtropical and subpolar sites are closely situated across the Chatham Rise, New Zealand but have contrasting water mass properties which provides an exceptional opportunity to examine these effects on alkenone temperature response. UK'37-based temperatures were compared with in situ temperatures, and in situ 13C incubation experiments in the upper ~175 m were used to determine production rates relative to standing stock to better constrain light, depth, and nutrient impacts on UK'37.

Our results indicate nutrient are a dominate control and light levels are a contributing effect on alkenone production and $U^{K'}_{37}$ temperature. At the subtropical northern site, $U^{K'}_{37}$ temperature reconstructions consistently underestimated measured water column *in situ* temperatures during both austral summer (high light) and late autumn (low light) by ~1°C when a strong thermocline resulted in a highly stratified and nutrient-poor surface mixed layer. In contrast, $U^{K'}_{37}$ temperatures were generally between 1-4°C warmer than *in situ* temperature when isothermal mixing of the water column brought nutrients to the surface in late winter. At the nutrient-replete subpolar southern site, alkenone $U^{K'}_{37}$ temperature accuracy varied in response to light levels. High light levels in summer returned alkenone temperatures < 1°C cooler than observed, but the late autumn and winter decline in available light resulted in $U^{K'}_{37}$ temperature overestimating *in situ* temperatures by 4°C or more. Measurements of alkenone $U^{K'}_{37}$ temperatures in floating sediment traps directly below the euphotic zone indicate that the $U^{K'}_{37}$ temperature in export production records water temperatures that are generally 1-2°C warmer than SST. These results support several hypotheses that non-thermal factors can affect alkenone unsaturation during production and alter the estimation of $U^{K'}_{37}$ temperatures used in paleoceanographic reconstructions.