ALKENONE CARBON ISOTOPES DURING A BLOOM OF EMILIANIA HUXLEYI: EFFECTS OF CO2 CONCENTRATION AND PRODUCTION

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The carbon isotopic composition of the C37-alkenones has been used in various paleoceanographic studies to estimate the ancient surface water CO2 concentration [CO2aq]. A number of recent culture, field and sediment studies, however, indicate that the carbon isotopic fractionation in haptophyte algae is predominantly controlled by physiological processes and environmental factors other than the ambient [CO2aq]. The most prominent factors are algal growth rate, nutrient availability, light intensity, the carbon uptake mechanism (passive/active), and the carbon source (CO2aq/bicarbonate). To what extent these different factors might affect the carbon isotopic signal of alkenones ultimately preserved in the sediment is still under debate. A cause of uncertainty are the individual strengths and weaknesses of the different methodological approaches. Culture experiments, for example, cannot perfectly recreate the sum of natural growth conditions and physical processes affecting the carbon isotopic signal in the field and its preservation in the sediment. On the other hand, core-top data represent several hundred to a couple of thousand years and therefore only reflect an average.

Here, we present the first study testing the effects of [CO2aq] on the alkenone isotopic signal under natural bloom conditions in a semi-closed system. In a series of 9
floating mesocosms in a Norwegian fjord a bloom of Emiliania huxleyi was followed over a three week period. The mesocosms were covered by gas tight domes to adjust and maintain 3 different CO2 partial pressures in the tent atmosphere ranging from pre-industrial (190 ppmv) to year 2100 levels (680 ppmv) as predicted by the IPCC’s report. We found that during the exponential growth phase the isotopic fractionation of alkenones decreased by 5 to 7 per mill and reached a plateau during the stationary phase. During the stationary phase the alkenone content per cell increased from 1-2 pg/cell to 6-8 pg/cell. Between the [CO2aq] treatments we observed an alkenone isotopic difference of only 2 per mill. These results indicate that changes in algal physiology and/or environmental conditions occurring during the course of an algal bloom strongly affect alkenone isotope fractionation. This effect overrides a comparatively small variation in the alkenone isotopic signal due to [CO2aq]. Implications for alkenone isotopic fractionation as a paleo-production or paleo-nutrient proxy will be discussed.