The alkenone-pCO_2 method over glacial – interglacial cycles

YI GE ZHANG[1*], ALBERT BENTHIEN[2], LIANG DONG[3], JORIJNTJE HENDERIKS[4], ANN PEARSON[1*]

[1]Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA 02138 (yigezhang@fas.harvard.edu; pearson@eps.harvard.edu)
[2]Alfred Wegener Institute, D-27570, Bremerhaven, Germeny
[3]School of Ocean and Earth Science, Tongji University, Shanghai 200092, China
[4]Department of Earth Sciences, Uppsala University, SE-75 236 Uppsala, Sweden

The alkenone-pCO_2 method is one of the most widely used approaches to reconstruct atmospheric CO_2 in the Cenozoic. Based on the fractionation of stable carbon isotopes between dissolved CO_2 and phytoplankton biomarkers called alkenones, this relationship (known as $\varepsilon_{p37:2}$) scales inversely with growth rate and cell size (collectively represented by the physiological parameter '*b*'), and positively with CO_2. Alkenone-derived CO_2 records for the late Pleistocene, however, often are poorly correlated with ice core CO_2 records. We showed that this is largely due to (1) systematic overestimation of *b* and (2) low sensitivity of $\varepsilon_{p37:2}$ at low-growth sites to atmospheric CO_2 variations [1].

Here we present records from two sites with high $\varepsilon_{p37:2}$ sensitivity, one from the South China Sea (SCS) and one from the tropical Altantic Ocean. We back-calculated *b* to determine the full range of expressed *b* over glacial-interglacial cycles, using $\varepsilon_{p37:2}$, ice core pCO_2 records, and proxy-based ocean temperature estimates. We also assumed overall air-sea equilibrium of CO_2 at both sites. Then, the mean value of *b* was applied to obtain pCO_2 estimates. We also tuned the high-resolution temperature record from the SCS site to ice core pCO_2, to eliminate age model descrapencies. By definition, this approach must yield the correct mean value for pCO_2; but significantly it also produces a composite pCO_2 record that replicates both the amplitude and timing of the 800-kyr ice core data considerably well. We further explored the relationship between coccolithophore cell size and growth rate using coccolith size measurements and the back-calculated values of *b*, providing a potential proxy to constrain phytoplankton growth rate over time and the history of *b*.

[1] Zhang, Y.G., Pearson, A., Huybers, P. and Pagani, M, 2016, Refining the alkenone-pCO_2 method: The role of algal growth conditions, *Earth Planet. Sci. Lett.*, to be submitted.