Coccolith stable isotopes in palaeoceanography: Are culture data transferable to the natural environment?

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Coccoliths represent a valuable sedimentary archive to derive palaeoenvironmental information in the pelagic realm, potentially augmenting the palaeoceanographic toolbox by complementing/supplementing widely-used foraminiferal data. A growing number of laboratory culture studies have evaluated the dynamic nature of isotopic fractionation in coccolith calcite when produced under a range of environmental manipulations [1-5]. These approaches aim to develop a mechanistic understanding of the vital effect and correct the palaeorecord for the vital effect. Furthermore, several study cases highlighted the use of the vital effects *per se* as potential palaeo-proxies [1] [6-7].

Here, we address the fundamental question of how such *in vitro* calibrations are transferable to the natural environment and ultimately to the sedimentary archive. By comparing analyses of laboratory cultures (coccolithophore algae biominerals), core top (subfossils) and downcore (calcareous nannofossils) from Pleistocene glacial-interglacial cycles, we show how a suite of critical environmental parameters (e.g. temperature, pH, DIC, nutrient availability, and light irradiance) are recorded in coccolith calcite derived from the bloom-forming and alkenone-producing Noelaerhabdaceae family (*Emiliania huxleyi* and *Gephyrocapsa oceanica*), and discuss discrepancies between these approaches.

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