The impact of growth rate and pCO2 on coccolithophore carbon isotopes in the past: do model results fit with ocean proxies records?

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The coccolithophore plays important roles in the carbon cycle by both the organic pump and carbonate pump. The growth rate of coccolithophore is a key factor in estimating CO_{2atm} by alkenone carbon isotope and can also reflect the nutrient and productivity level in the ocean thereby the carbon cycle. Some models have suggested growth rate, together with CO2 aq, has a significant influence on the coccolith carbon isotopic fractionation, and we wish to evaluate the potential of this proxy. To better define the processes that might regulate coccolith carbon isotopic fractionation, we extend previous multi-compartment carbon-isotope algal cell models for coccolithophores, incorporating new experimental data on cell permeability and the significance of carbonic anhydrase in the calcification pathway and incorporating a carbon concentrating mechanism.

We then provide the first comparison of the modeled fractionation in coccoliths, with the fractionation observed in natural ocean coccolithophores spanning the late Quaternary when CO_2 aq is independently constrained from the ice cores pCO_2 record. We measured the coccolith carbon isotope fractionation in size fractionated coccoliths spanning the last 800 kyr from the core ODP 807 in the West Pacific Warm Pool, and over the last 100 ka in the Caribbean, in the South Ocean, and in the Western Mediterranean. Besides model estimations, we measured the coccolith and alkenone accumulation rate in the sedment paired with modeled growth rate to test the robustness of paleo-productivity proxies.