Towards a unifying theory for carbon isotopic partitioning in coccolithophores: Implications for paleo-proxies

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Coccolithophores are ubiquitous single-celled marine algae. They produce calcium carbonate and organic matter intracellularly from dissolved inorganic carbon (DIC). Each of these carbon fixing processes occurs in a different cellular compartment, has a different set of associated isotopic fractionation factors, and the substrate is a different species of DIC. The isotopic composition of organic and inorganic coccolithophore biomass is a function of cellular geometry, rates of calcification and photosynthesis and external parameters such as [DIC], pH and temperature. If some of these parameters can be constrained, others may be inferred from isotopic compositions. Coccolithophore biomass has contributed to pelagic sediment for over 200 Myr, making these algae a unique, and currently underutilized, source of paleoceanographic and paleoclimatic information. Here we present results from culture manipulation experiments, and an isotopic flux model, which we show may reconcile apparent interspecific isotopic responses to carbon limitation, and shed light on the enigmatic “vital effect”.