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Geochemical and biological constraints on the contributions of coccolithophores to the global carbon cycle under ocean warming

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Coccolithophores are key components of the marine carbon cycle. These phytoplankton utilize carbon for both photosynthesis and the production of calcium carbonate coccoliths, facilitating the carbon sink through scavenging and ballasting. Under the stress of climate change, specifically global warming and associated thermal stress, shifts in their organic and inorganic carbon production may have profound implications for oceanic carbon cycling and the efficiency of the biological pump. While previous studies have identified diverse growth responses among species and strains, the underlying geochemical mechanisms and genetic controls remain poorly constrained. A major challenge in the field is that existing datasets are often derived from inconsistent culture settings, and transcriptomic evidence has historically been biased toward *Emiliania huxleyi,* making direct comparisons across different methodological perspectives and species far from straightforward.

In this study, we address these gaps by culturing representative morphotypes of *Gephyrocapsa huxleyi* (formerly known as *Emiliania huxleyi*) and *Calcidiscus leptoporus* under a strictly unified batch culture framework, covering a wide temperature range from 10-30 degree C. We provide an integrated dataset to constrain: (1) coccolithophore carbon utilization and pH regulation strategies using stable carbon and boron isotopes, and (2) corresponding gene expression profiles via transcriptome analysis. By coupling these proxies across multiple species within a consistent culture system, our data aim to elucidate the regulatory mechanisms driving the diverse coccolithophore responses to future climate scenarios and contribute to more robust predictions of ocean carbon budgets driven by the coccolithophore biological pump.