Has (anthropogenic) climate change driven subantarctic Emiliania huxleyi populations beyond their natural state?

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The global ocean acts as a climate regulator through the uptake of Earth's excess heat and the absorption of about 30% of anthropogenic CO₂ emissions since 1750. Southern Ocean waters are warming faster than the global ocean average and their low temperatures and moderate alkalinity make this region especially vulnerable to ocean acidification. Coccolithophores are a major group of calcifying phytoplankton and an important component of the Southern Ocean carbon cycle. Controlled laboratory experiments on Emiliania huxleyi (the most abundant coccolithophore) over a broad range of carbonate chemistry scenarios suggest that this taxon may be susceptible to ongoing environmental change. However, it remains uncertain whether Southern Ocean coccolithophore populations have been modified by environmental change during the industrial era. The main reason for this knowledge gap is the lack of observational data since the onset of the Industrial Revolution. In particular, continuous monitoring of key Southern Ocean ecosystems only started a few decades ago, a period insufficiently long to permit assessments of whether anthropogenic impacts on the environment have affected coccolithophore populations beyond their natural state. In order to overcome this limitation, here we take advantage of the preservation capacity of coccolithophores in the sedimentary record to provide a benchmark of their pre-industrial state. We compare the morphotype assemblage composition and morphometric parameters in coccoliths of E. huxleyi from a suite of Holocene-aged sediments south of Tasmania with annual sediment trap records retrieved at the Southern Ocean Time Series observatory in the Australian sector of the Subantarctic Zone. Our results suggest that carbonate dissolution in the sediments reduced the coccolith mass and length of the coccoliths but, coccolith
thickness appeared to be decoupled from dissolution. The biogeographical distribution of coccolith thickness in subtropical and subantarctic sediments mirrored the distribution of *E. huxleyi* morphotypes, highlighting the important role of *E. huxleyi* assemblage composition on the control of coccolith morphometrics. Moreover, comparison of coccolith assemblages from the sedimentary record with those collected from subantarctic sediment traps indicates that modern *E. huxleyi* coccoliths are about 2% thinner than those from the pre-industrial Holocene. The subtle change in coccolith thickness is in stark contrast with previous work that documented a dramatic reduction in shell calcification in the planktonic foraminifera *Globigerina bulloides* that resulted in a shell-weight decrease of 30-35%, most likely induced by ocean acidification. Overall, our results underscore the variable sensitivity of different marine calcifying plankton groups to ongoing environmental change in the Southern Ocean.