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Co-evolution of the oceans and inorganic carbon cycle

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The Cenozoic shift from a hothouse to icehouse provides a natural experiment to explore how a changing climate and macroevolutionary trends control marine pelagic carbonate production and burial. In the modern ocean, the key components of pelagic carbonate burial — planktic foraminifera and coccolithophores — contribute approximately evenly. However, in the past, coccolithophores dominated open ocean inorganic carbon burial. Exactly when and why this shift away from a coccolithophore dominated ooze occurred is unresolved. To this end, we reconstructed a 65Myr record of foraminifer to nannofossil ratios from sites covering the Pacific, Southern, Indian, and Atlantic Ocean. To better understand the climate and macroevolutionary controls on carbonate production, we move away from the commonly reported bulk changes and instead investigate the individual components of carbonate production: foraminiferal and coccolithophore size, weight and abundance. We use a suite of methodologies to extract these data, including the novel application of imaging flow cytometry to rapidly and digitally reconstruct the fossil record of coccolithophore size and abundance. Our ratio data shows a shift towards calcareous zooplankton during the Neogene. Initial qualitative analysis reveals that coccolithophore size is relatively smaller in the modern part of the record, whilst automated microscopy shows that modern subtropical and tropical foraminiferal size is greater than recorded in the previous 65Myr. Foraminiferal size-normalised weight (SNW) is expected to be higher in the modern ocean than in the past due to its suggested carbonate system control (i.e. higher carbonate ion concentrations being conducive to heavier tests). However, SNW data from a high latitude site during the Palaeogene are similar to modern values for extant species – potentially implying something other than a carbonate system control on SNW.