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Modelling a temperature dependent biological pump: warming in the Eocene and implications for δ13C data

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Temperature affects the rate of metabolic processes, both photosynthesis and respiration. During climate periods warmer than today, this may have considerable consequences for global carbon cycling. We consider the early Eocene, when global temperatures were higher and deep ocean temperatures $\sim$10 degrees C warmer than the present day. In the lower Eocene, benthic isotope stacks show co-varying orbitally paced fluctuations in carbon and oxygen isotope ratios, suggesting that carbon cycling and ocean temperatures were somehow related. Using cGenie, an earth system model used extensively for paleoclimate studies, we consider temperature-dependency in nutrient uptake and in subsequent remineralisation rates in the ocean carbon cycle. We compare the impact of these processes on water-column δ13C and nutrient distributions for a baseline Eocene climate background and compare this to the pre-industrial case. We also present model output for warming scenarios, considering a range of warming rates. These transient climate simulations demonstrate that these changes in metabolic rate processes may have an impact on our interpretation of changes in δ13C as seen in the ocean sediment record.