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Better constraining climate sensitivity to CO_2 since the Miocene through ACTI-CO process modeling of marine CO_2 proxies

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Atmospheric CO_2 is inferred to be an important forcing agent in climate on an array of timescales. Periods of CO_2 higher than preindustrial are not sampled by available direct ice core records, so empirical estimates of climate sensitivity to higher CO_2 levels, and climate model responses such as ice cap growth, are conditioned by the large uncertainty in long term CO_2 proxy records. Here we report results with ACTI-CO, a process model for carbon allocation within the cell, which can be used to improve the accuracy of CO_2 proxy records derived from carbon isotopic fractionation in marine algae. We apply ACTI-CO to new and existing records of carbon isotopic fractionation from diatoms and coccolithophores, focusing on the mid-Miocene to present. We evaluate the degree to which active carbon uptake attenuates the magnitude of change in isotopic fractionation associated with a given CO_2 decrease. We also consider cell size and growth rate changes. The results suggest the potential for significant CO_2 declines since the middle Miocene, consistent with, but potentially larger in magnitude, than those inferred from previous inverse modeling of climate data using glacial-interglacial climate sensitivity to CO_2.