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Alkenone carbon isotopic fractionation-based CO2 proxy records and Cenozoic climate sensitivity

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Alkenone carbon isotopic fractionation (ep) provides an important component of the pCO_2 dataset and is one of few proxies available to investigate past orbital cycles in CO_2. An inverse relationship between ep and benthic $d^{18}O$, implying high CO_2 during cold glacial periods, has been reported from the Mid and Late Pleistocene. But, this relationship between ep and benthic $d^{18}O$ breaks down across the long term records for much of the Oligocene to Miocene, underscoring either changes in the relationship of CO_2 to deep ocean temperature and ice volume, and/or different influences on the ep or benthic $d^{18}O$ proxy . Records of mid and high latitude surface ocean temperatures (SST) from the mid-Oligocene through early Miocene, from the same sites as the ep records, provide an alternative approach to assess the relationship between CO_2 and climate. We find that the long term Oligocene-Early Miocene decline in ep coincides with declining Southern Ocean SST. But, North Atlantic alkenone SST temperature shows a complex relationship with ep. Our new high resolution ep records spanning key Oligocene to Miocene time intervals, document 100 ky cycles in ep of 1 to >2 permil, suggesting significant orbital scale CO_2 variation and highlighting the potential for aliasing in low resolution ep records. At the orbital scale, the relationship between ep and benthic $d^{18}O$ in some intervals exhibits a Pleistocene-like relationship, whereas in other intervals ice growth at higher CO_2 is suggested. In evaluating the magnitude of CO_2 changes implied by the ep record, we assess the potential influence of several factors on ep: growth rate driven by temperature change, cell size, and changing influence of carbon concentrating mechanisms and ocean DIC concentration.