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High-resolution pCO_2 reconstruction across the early Cenozoic greenhouse and late Cenozoic icehouse climates

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Historical data and ice core records provide the best-constrained data on global temperatures and atmospheric carbon dioxide concentrations (pCO_2), which can be used to calculate short-term estimates of climate sensitivity. These data, however, may not be representative of longer timescales and represent a period of Earth history when pCO_2 and global temperatures were relatively low; recent work suggests that climate sensitivity may change under different climate states and timescales. Here we present a new high-resolution pCO_2 reconstruction for the early (65 to 50 Ma) and late (30 to 0 Ma) Cenozoic using a proxy based on changes in carbon isotope fractionation in C3 land plants. This work uses widely available carbon isotope data from various terrestrial organic substrates to produce a nearly continuous record of pCO_2. This record identifies both large-scale trends (e.g., the early Cenozoic is characterized by higher pCO_2 than the late Cenozoic), as well as transient, highly elevated pCO_2 during the early Eocene hyperthermals. We discuss the uncertainties associated with this new pCO2 reconstruction, which include the effects of precipitation, plant community shifts, and source effects on the $\delta^{13}C$ record. Additionally, uncertainty associated with the correlation in time between $\delta^{13}C$ estimates of atmospheric CO_2 and the terrestrial $\delta^{13}C$ of organic matter is included in the error propagation. Comparison of the new pCO_2 record to existing global average temperature records based on the $\delta^{18}O$ value of well-preserved marine foraminifera can yield new insight into Earth system climate sensitivity across a wide range of climate states and timescales.