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Using C_3 plant remains to quantify atmospheric CO_2 in the fossil record

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Determination of the carbon isotope ($\delta^{13}C$) value of C_3 plant remains is widely used to reconstruct past changes in plant communities, climate, and atmospheric chemistry in recent and deep-time settings. Recent growth chamber experiments isolated the effect of atmospheric CO_2 concentration from these other variables and produced a unifying hyperbolic relationship between CO_2 concentration and net carbon isotope discrimination. We applied this relationship towards reconstructing atmospheric CO_2 concentration within multiple Cenozoic datasets ranging from Quaternary to Paleogene age. However, questions remain as to the best practices for applying this work, and have led to confusion over the utility and application of this proxy towards interpreting $\delta^{13}C$ data in deep-time settings. Here we assess common misapplications when applying the proxy and demonstrate how correct application reconciles inconsistencies within the literature. This reanalysis also adds further support to the effect of CO_2 concentration on carbon isotope value, and is shown to be applicable across diverse environmental settings. Because the remains of C_3 land plants are ubiquitous in sedimentary deposits dating back to at least the Silurian, this proxy therefore has great potential to provide a nearly continuous record of atmospheric CO_2 change across much of the last 400+ million years of Earth history. This includes multiple key periods of the Phanerozoic that are hypothesized to carry large changes in CO_2, but are poorly served by existing proxies, or periods with little proxy consensus or divergence from model estimates.