Geological Society of America, Vancouver, BC, Canada, October 19-22, 2014.

Increased carbon isotope fractionation by terrestrial plants following the Last Glacial Maximum driven by an increase in atmospheric *p*CO_2

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Carbon isotope measurements of terrestrial organic matter ($\delta^{13}C$) have been used to document changes water availability, plant community composition, the $\delta^{13}C$ value of atmospheric CO_2 ($\delta^{13}C_{CO2}$), and atmospheric pCO_2 concentration. Here we document a global 2.0‰ increase in carbon isotope fractionation [$\Delta\delta^{13}C = (\delta^{13}C_{CO2} – \delta^{13}C)/(1 + \delta^{13}C/1000)$] across Termination 1 (18,000 to 11,500 yrs BP) measured in both fossil leaves and bulk terrestrial organic matter (TOM) of C_3 plant species from 21 sites worldwide. We use our recently quantified relationship between $\Delta\delta^{13}C$ value and pCO_2 level to reconstruct an increase in pCO_2 from 192 to 279 ppm from the Late Glacial through the Holocene, which is nearly identical in trend and absolute value to the ice core record (193 to 270 ppm). We contend that local or regional changes in environmental conditions, substrate heterogeneity, and plant community shifts exert secondary control over plant carbon isotope fractionation relative to the primary pCO_2 effect. Because of the robustness of the proxy relationship to diverse C_3 plants growing under multiple levels of water availability, error from the model relationship is small; the greatest source of error is instead caused by variability in the $\Delta\delta^{13}C$ measurements. For this reason, we conclude that pCO_2 level can be accurately reconstructed from the terrestrial plant record by compiling data from a large number of diverse sites. We contend that there is a strong potential for terrestrial $\delta^{13}C$ measurements to be an excellent proxy for reconstructing pCO_2 levels across the history of C_3 plant plants.