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Combined and isolated effects of *p*CO_2 and soil water content on carbon isotope discrimination during C_3 photosynthesis

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Biomass produced *via* C_3 photosynthesis dominates the terrestrial organic matter (TOM) found within the geologic record. Our previous work revealed an increase in net discrimination ($\Delta^{13}C$) ≈ +4‰ across an increase in *p*CO_2 level from ambient to RCO_2 = 6x within the model C_3 plant *Arabidopsis thaliana,* grown to maturity under constant conditions of light, moisture, and nutrient availability (Schubert and Jahren, 2012, *GCA*), leading us to suggest that changes in ancient *p*CO_2 level can be reconstructed from $\Delta^{13}C$ within terrestrial sediments. Others have observed an average change in $\Delta^{13}C$ ≈ +4‰ when comparing the $\delta^{13}C$ value of herbarium samples collected from cool-cold forests to tropical environments against the MAP recorded (Diefendorf et al., 2010, *PNAS*), leading those authors to suggest that changes in the $\Delta^{13}C$ value of TOM recovered from the geological record can be interpreted as changes in precipitation level and/or water availability.

Because decreasing moisture availability and increasing *p*CO_2 level exert control over $\Delta^{13}C$ through distinctly different mechanisms (i.e., decreased stomatal conductance vs. inhibition of photorespiration, respectively), a simultaneous change in both *p*CO_2 level and moisture availability could combine to influence carbon isotope fractionation. Here we present experiments in which we grew 230 *A. thaliana* plants at each of 5 levels of *p*CO_2: 390, 685, 1075, 1585, and 2175 ppmv. Within each growth chamber, soil moisture content (θ_m) was maintained at 1.50 g g^{-1} for 11 days following germination. Afterwards, we allowed 170 of the plants to dry to θ_m = 0.83, 0.44, and 0.38 g g^{-1}. After 3 weeks of total growth, tissues were analyzed for $\delta^{13}C$ value. We compare the isolated and combined effects of *p*CO_2 and soil moisture upon carbon isotope fractionation across the total range of *p*CO_2 levels reconstructed for the last 350 million years and across moisture levels associated with a ~4.5x change in plant biomass.