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Carbon Isotope Discrimination in Leaves of C_3 Plants

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Carbon isotope composition is regarded as a powerful tool in understanding carbon cycling, both as a tracer and as a process recorder. However, accurate predictions of, for example, partitioning the net carbon flux into its components or obtaining climate information from tree rings, requires a good understanding of plant metabolism and related isotopic fractionations. Mechanistic models have concentrated largely on photosynthetic pathways and their isotopic composition. This cannot be said for respiratory processes. The mechanistic models of leaf isotope discrimination hence do not describe dawn, dusk and night very realistically or not at all. A new steady-state approach of the carbon isotope distribution in glucose potentially addresses the time of twilight and night (Tcherkez *et al.* 2004).

Here, a new model of ^{13}C discrimination in leaves of C_3 plants is presented. The model is based on the steady-state approach of Tcherkez *et al.* (2004) but with much reduced complexity while retaining its general characteristics. In addition, the model introduces some new concepts such as a day-length dependent starch synthesis, night-length dependent starch degradation, energy-driven biosynthesis rates, and continuous leaf discrimination calculation for the whole diel cycle. It is therefore well adapted for biosphere-atmosphere exchange studies.

The model predicts enriched sucrose and starch pools in the leaf compared to assimilated CO_2. Biosynthesis on the other hand acts as the sink of the remaining, depleted carbon. The model calculates slightly different absolute starch compositions from the Tcherkez *et al.* (2004) model but this depends on chosen fractionation factors. The greatest difference between the two models is during dawn, dusk and night. For example, while Tcherkez *et al.* has changing phloem sucrose isotope composition during night, the model here predicts constant sucrose export composition. Observations seem to support rather constant phloem isotope composition but no adequate assessment is possible based on current data.

References

Tcherkez G., Farquhar G.D., Badeck F.-W. & Ghashghaie J. (2004) Theoretical considerations about carbon isotope distribution in glucose of C_3 plants, *Functional Plant Biology* 31, 857-877