Reliable Methods were Developed for the Estimation of Biochemical Parameters for Photosynthesis within Carbon Cycle Models

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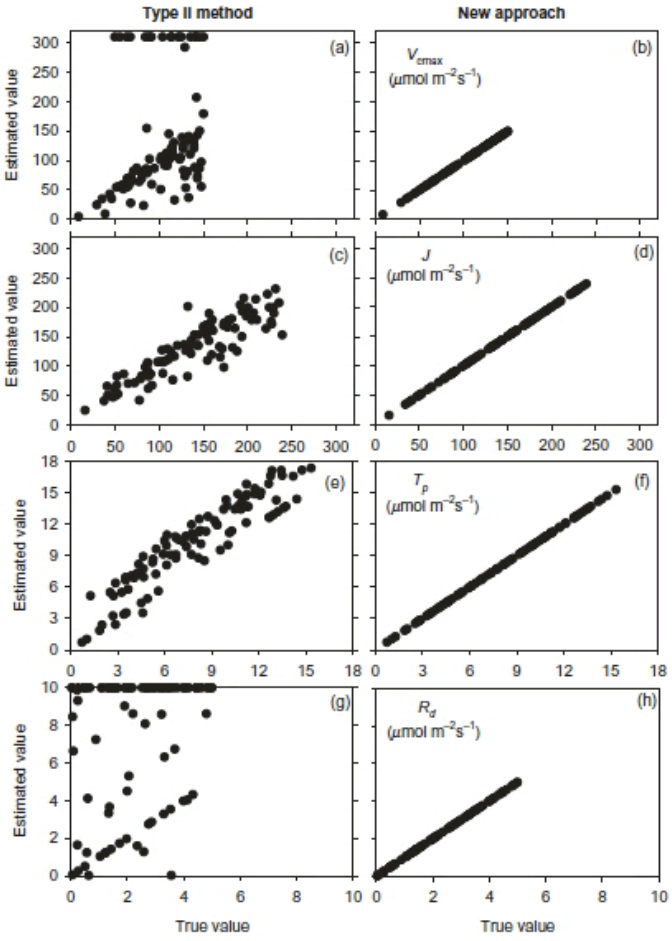
- The Farquhar–von Caemmerer–Berry (FvCB) model of photosynthesis is a key mechanistic expression of leaf biochemistry and physiology for use within models.
- Rreliable estimation of key FvCB parameters has remained a challenging task for two decades.
- This research revealed previously unrecognized complexities of the model and developed a new approach to overcoming these complexities.
- The new approach was tested with simulations, leaf gas exchange data, and chlorophyll fluorescence measurements of multiple species with excellent results (see figure).
- An automated, community service / data collection website to make the new method accessible to the global research community was set up and has been used globally (http://leafweb.ornl.gov).



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OAK RIDGE NATIONAL LABORATORY
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Abstract:

The Farquhar–von Caemmerer–Berry (FvCB) model of photosynthesis is a change-point model and structurally overparameterized for interpreting the response of leaf net assimilation (A) to intercellular CO2 concentration (Ci).The use of conventional fitting methods may lead not only to incorrect parameters but also several previously unrecognized consequences. For example, the relationships between key parameters may be fixed computationally and certain fits may be produced in which the estimated parameters result in contradictory identification of the limitation states of the data. Here we describe a new approach that is better suited to the FvCB model characteristics. It consists of four main steps: (1) enumeration of all possible distributions of limitation states; (2) fitting the FvCB model to each limitation state distribution by minimizing a distributionwise cost function that has desirable properties for parameter estimation; (3) identification and correction of inadmissible fits; and (4) selection of the best fit from all possible limitation state distributions. The new approach implemented theoretical parameter resolvability with numerical procedures that maximally use the information content of the data. It was tested with model simulations, sampled A/Ci curves, and chlorophyll fluorescence measurements of different tree species. The new approach is accessible through the automated website leafweb.ornl.gov.

Citation:

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