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# Acclimation of photosynthetic parameters is not the icing on the cake. It is the cake.

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Photosynthesis and transpiration are tightly coupled through stomatal behaviour and therefore it is impossible to understand and parsimoniously model one without also considering the other. The ratio of leaf-internal to ambient carbon dioxide concentration (ci:ca ratio) is a measure of the "exchange rate" between water and carbon. We have shown that it is possible to predict the observed dependencies of ci:ca on environmental factors (temperature, vapour pressure deficit and atmospheric pressure) based on the "least-cost hypothesis", which states that plants minimize the sum of the unit costs (respiration per unit assimilation) of maintaining the capacities for carbon fixation (Vcmax) and water transport. Moreover, with the help of the "co-ordination hypothesis" (the long-accepted idea that Rubisco capacity and electron transport tend to co-limit photosynthesis) it is possible to predict not only how ci:ca should vary, but also how Vcmax and electron transport capacity (Jmax) should vary, in space and time. We will present empirical support for this idea based on both ecophysiological measurements at the leaf scale, and analysis of carbon dioxide flux measurements at the ecosystem scale. We conclude that acclimation of photosynthetic parameters is pervasive. This is fundamental because it predicts a quite different set of environmental responses than those that are usually applied in models that incorrectly assume constancy of parameter values with time and within plant functional types (PFTs). In addition, acclimation actually simplifies modelling because it describes universal relationships that apply across all PFTs with the C3 photosynthetic pathway, and it removes the need to specify parameters such as Vcmax and Jmax as if they were properties of PFTs.