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Can leaf net carbon gain acclimate to keep up with global warming?

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Plants are able to adjust their physiological activity to fluctuations and long-term changes in their growing environment. Nevertheless, projected increases in temperature will occur with unprecedented speed. Will global warming exceed the thermal acclimation capacity of leaves, thus reducing net CO_2 assimilation? Such a reduction in net CO_2 assimilation rate (A_{net}) in response to warming may deplete ecosystems' net primary productivity, with global impacts on the carbon cycling. Here we combine data on net photosynthetic thermal acclimation to changes in temperature with a probabilistic description of leaf temperature variability. We analytically obtain the probability distribution of the net CO_2 assimilation rate as a function of species-specific leaf traits and growing conditions. Using this approach, we study the effects of mean leaf temperature and its variability on average A_{net} and the frequency of occurrence of sub-optimal thermal conditions. To maximize the net CO_2 assimilation in warmer conditions, the thermal optimum for A_{net} (T_{opt}) must track the growing temperature. Observations suggest that plants' thermal acclimation capacity is limited, so that growing temperatures cannot be tracked by the T_{opt}. It is thus likely that net CO_2 assimilation rates will decline in the future. Furthermore, for set leaf traits, large fluctuations in leaf temperature reduce average A_{net} and increase the frequency of occurrence of sub-optimal conditions for net CO_2 assimilation.