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Acclimation of respiration to warming consistent with optimal plant function

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Despite the potentially large impact of leaf dark respiration (Rd) on the feedback between global climate change and atmospheric CO_2, there is neither a consensus on the appropriate method to represent Rd in Land Surface Models (LSMs) nor an accepted theory to account for the widely observed acclimation of Rd to temperature. This situation contributes to large uncertainties in predictions of the future terrestrial carbon balance. Here we analyse an extensive global dataset of Rd in order to test alternative assumptions in LSMs. We provide theoretical predictions of leaf thermal acclimation based on simple optimality principles, and use the dataset to test them.Acclimated Rd is found to be proportional to leaf carboxylation capacity (Vcmax) assessed at growth temperature, Rd at 25°C is only weakly (R2 = 0.14) related to leaf nitrogen. Acclimated Rd is predicted to increase with temperature by about 5% per degree. This sensitivity is well supported by the data but is 45% smaller than the instantaneous, enzyme-kinetic sensitivity of either Rd or Vcmax. We conclude that the data support a novel model formulation that allows for the prediction of Rd acclimation from first principles.