Geophysical Research Abstracts
Vol. 21, EGU2019-3285, 2019
EGU General Assembly 2019

Acclimation and adaptation of photosynthetic temperature responses

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The response of leaf photosynthesis to temperature is a key determinant in modelling plant growth. Previous studies have shown that there are differences in the optimum temperature for net photosynthesis (Topt) among species. However, it is unknown whether differences among species are largely genetic (adaptation) or plastic (acclimation). In this study, we hypothesise that Topt is more strongly related to climate of origin than growth environment. We assembled a global dataset of photosynthetic CO_2 response curves including data from 141 species from the tropics to Arctic tundra. We demonstrate that Topt varies strongly across this dataset. We separated temperature acclimation and adaptation processes by considering seasonal and common-garden datasets. We found acclimation to growth temperature to be a stronger driver of this variation, than adaptation to temperature at climate of origin. We developed a summary model to represent photosynthetic temperature responses and adaptation and showed it predicts the observed global variation in optimal temperatures with high accuracy. We discuss the implications of our findings for ecosystem models attempting to predict the function of global forest ecosystems in a warming climate.