

The Effect of Mesophyll Conductance on Gross Primary Production: Global Simulations with a Land Surface Model

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Plant physiologists have long recognized that mesophyll conductance (g_m) strongly affects photosynthesis with an effect comparable to that of stomatal conductance. Yet, this term has been ignored in land surface models used for large-scale carbon and climate simulations. Here we present a simple but realistic parameterization of g_m based on the synthesis of new advances in plant physiological studies. In this formulation, g_m is calculated from its association with plant functional types and its dependence on environmental conditions. We implement this parameterization in the Community Land Model version 4 (CLM4), a representative land component of climate models. Such inclusion of g_m necessitates recalibration of photosynthetic parameters, we then update the V_{cmax} , J_{max} and TPU derived from leaf gas exchange measurements. With the modified CLM4, we investigate the impact of g_m on the global terrestrial gross primary production (GPP). Our simulations show that the inclusion of g_m reduces the estimated global annual GPP, particularly under drought stress. In addition, we examine whether the omission of g_m could be compensated by adjustment of the photosynthetic parameter V_{cmax} . Further, we discuss the impact of g_m on projection of future carbon cycling and its feedbacks to climate.

Keywords: Carbon Cycling, Mesophyll Conductance, GPP