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Investigating plant's stomatal and non-stomatal responses to water stress via STEMMUS-SCOPE model

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Water stress factor is utilized to describe drought effects on plant growth in land surface models (LSMs). Accurately representing water stress is critical to understand the impact of climate change on plant and ecosystem. Models use various approaches to describe the responses of vegetation to water stress. Some models assumed water stress causes stomata closure to attenuate gas exchange process, while others assumed water stress reduces the maximum rate of carboxylation (Vcmax) to slow photosynthesis. Only a few models considered both constraints. However, which parameterization can better capture the dry condition is still controversial. A reliable detection and attribution of the impact of water stress on plant is necessary for understanding the consequence of climate change on the ecosystem from a mechanism aspect. In this study, an empirical stomatal conductance scheme (proposed by Ball et al. in1987, called "BB_gs") and a unified stomatal conductance model (proposed by Medlyn et al. 2011, called "ME_gs") were coupled into STEMMUS-SCOPE model to explore the discrepancy between empirical and optimal approaches. Three scenarios were designed to represent the effect of water stress on gas exchange (gs_w), photosynthesis (Vcmax_w) and both processes (gs & Vcmax_w). The coupled model was implemented for three sites with different plant function types, including C3 grassland, C3 shrub, and C4 cropland. Results showed that the optimal stomatal conductance scheme has better performance than the empirical approach because the optimal method considers the realistic stomata regulation. The Vcmax_w scheme captured the drought effects better than other schemes. The results improved our understanding on regional ecosystem functioning under the context of climate change.