

Toward a better prediction of water stress on vegetation dynamics in Earth System Models

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Forests play a key role in regulation of the global carbon cycle and climate; however, they could be subjected to substantial drought risks in the future due to global warming. Currently, all Earth system models (ESMs) use very few plant functional types (PFTs) with fixed plant characteristics and very limited representation of plant physiology in response to drought. This over-simplification prevents mechanistic and accurate simulation, particularly in the hyper-diverse tropical forests, and may result in over- or under-estimates of forest responses to droughts. In this study, we compared different process-based tree mortality models based on carbon starvation, plant hydraulic failure and phloem failure for the prediction of tree mortality at a drought experiment site in New Mexico under current and future climate conditions. Our results showed that, compared to the simple growth efficiency model, the process-based model better represents the timing of mortality; however, additional data are still needed for accurate predictions of traits that control the key mortality processes under novel climate conditions. There is a strong need for a trait coordination and trade-off model to better predict future vegetation dynamics under droughts across regional and global scales.