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Drought responses of Amazon forests under climate change: Separating the roles of soil moisture and canopy responses

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The Amazon forests are one of the largest ecosystem carbon pools on Earth. While more frequent and prolonged droughts have been predicted under future climate change there, the vulnerability of Amazon forests to drought has yet remained largely uncertain, as previous studies have shown that few land surface models succeeded in capturing the vegetation responses to drought. In this study, we present an improved version of the land surface model JSBACH, which incorporates new formulations of leaf phenology and litter production based on intensive field measurement from the artificial drought experiments in the Amazon. Coupling the new JSBACH with the atmospheric model ECHAM, we investigate the drought responses of the Amazon forests and the resulting feedbacks under RCP8.5 scenario. The climatic effects resulted from (1) direct effects including declining soil moisture and stomatal responses, and (2) soil moisture-induced canopy responses are separated to give more insights, as the latter was poorly simulated. Preliminary results show that for net primary production and soil respiration, the direct effects and canopy responses have similar spatial patterns with the magnitude of the latter being 1/5 to 1/3 of the former. In addition, declining soil moisture enhances rainfall in Northern Amazon and suppresses rainfall in the south, while canopy responses have negligible effects on rainfall. Based on our findings, we suggest cautious interpretation of results from previous studies. To address this uncertainty, better strategy in modeling leaf phenology such as implemented in this study should be adopted.