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Simulating the impacts of drought on the carbon dynamics in African rainforests

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The trend of hotter and drier climate and the increasing intensity and duration of extreme drought events is affecting African tropical rainforests and could induce higher mortality of tropical evergreen trees. The result may be the forest structure shifting towards a more open type. Such a structural shift would lead to smaller carbon stocks in the rainforests and potentially reduced photosynthetic carbon uptake. To understand the relationships between drought and carbon dynamics in the African rainforests, the newly developed version of the dynamic vegetation model LPJ–GUESS including plant hydraulic features was employed to simulate vegetation growth over the past decades. The results showed that the net carbon flux going into the vegetation decreased during the drought events. Especially in the late 1990s, the net carbon flux decreased to the level before 1960 and remained low until ten years after the consecutive extreme drought. This decrease in the net carbon flux was dominated by the decrease in net primary production rather than the instantaneous loss from tree mortality. Simultaneously, the carbon stock in the rainforests continued to grow but the growth decelerated during and after the drought. To conclude, the drought affected the African rainforests primarily by reducing vegetation productivity rather than causing instantaneous mortality. Such long-term effects are of vital importance since they could easily increase the vulnerability of the forests to other disturbances such as wind throw or pathogens, thus provoking the forest mortality further in the future. This implies that future field experiments should draw special attention to the potential long-term or delayed effects of climate change on trees.