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AmazonFACE – Assessing the response of Amazon rainforest functioning to rising atmospheric CO₂ concentration

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The rapid rise in atmospheric CO₂ concentration over the past century is unprecedented. It has unambiguously influenced Earth's climate system and terrestrial ecosystems. Plant responses to rising atmospheric CO₂ concentrations are thought to have induced an increase in biomass and thus, increased the carbon sink in forests worldwide. Rising CO₂ directly stimulates photosynthesis (the so-called CO₂-fertilization effect) and tends to reduce stomatal conductance, leading to enhanced water-use efficiency, which may provide an important buffering effect for plants during adverse climate conditions. For these reasons, current global climate simulations consistently predict that tropical forests will continue to sequester more carbon in aboveground biomass, while several lines of evidence point towards a decreasing carbon sink strength of the Amazon rainforest in the coming decades, potentially driven by nutrient limitation, droughts or other factors. Mechanistically modelling the effects of rising CO₂ in the Amazon rainforest are hindered by a lack of direct observations from ecosystem scale CO₂ experiments. To address these critical issues, we have been developing a free-air CO₂ enrichment (FACE) experiment in an old-growth, highly diverse, tropical forest in the Brazilian Amazon and we present our main hypotheses that underpin the AmazonFACE experiment. We focus on possible effects of rising CO₂ on carbon uptake and allocation, phosphorus cycling, water-use and plant-herbivore interactions, and discuss relevant ecophysiological processes, which need to be implemented in dynamic vegetation models to estimate future changes of the Amazon carbon sink. We also report recent results from the open-top chamber experiments on understorey saplings under rising CO₂ and phosphorus fertilization, recently conducted at the AmazonFACE site. We give an overview over phosphorus uptake strategies and potential modelling approaches.

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