The limits of rainforest growth

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Katrin Fleischer (r.), researcher at the TUM, and Sabrina Garcia (l.) from the Instituto Nacional de Pesquisas da Amazônia working in the Brazilian rainforest. Credit: AmazonFACE

Trees are seen as saviors in an era of climate change. Via their leaves, they absorb carbon dioxide and transform the greenhouse gas into oxygen and biomass. According to estimates by the International Panel

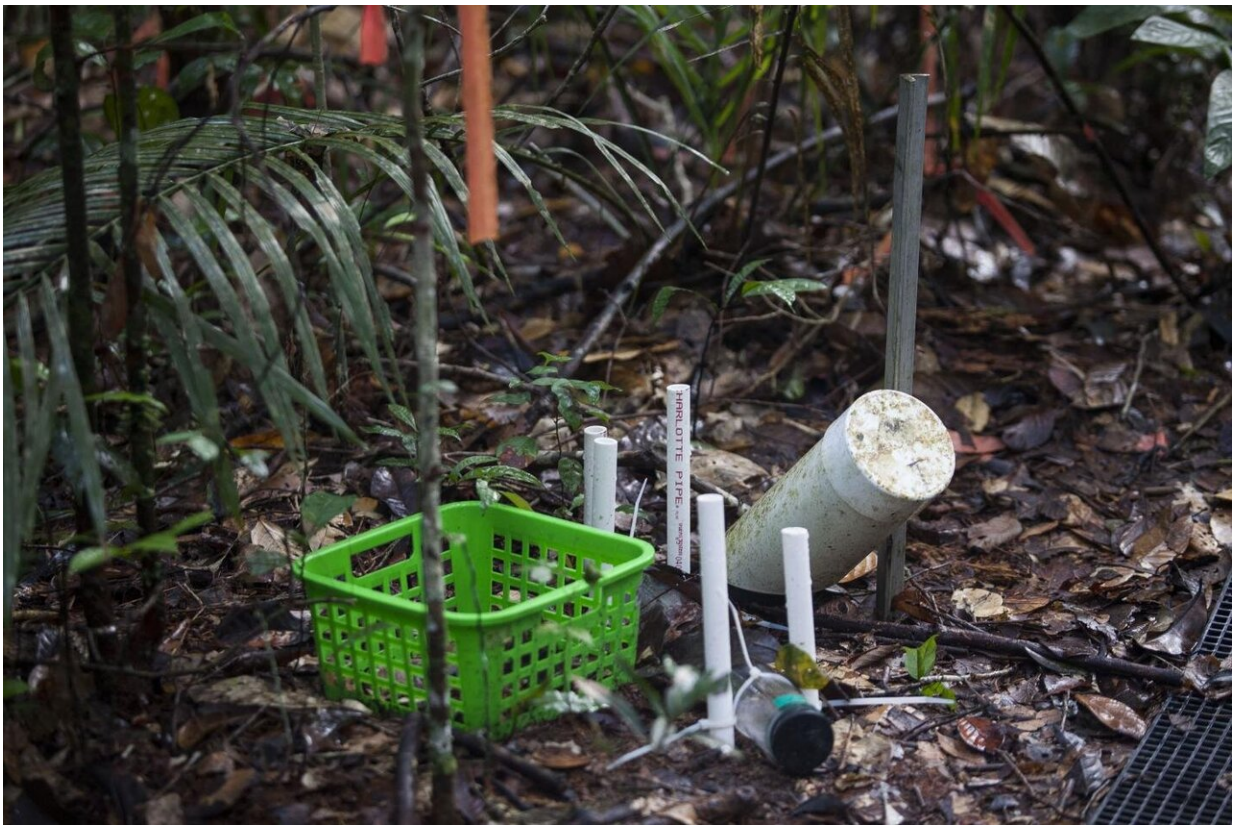
on Climate Change (IPCC), the Amazon rainforests absorb a quarter of the carbon dioxide that is released each year from the combustion of fossil fuels. To date, global climate models have assumed that this absorption capacity will also remain constant in the future.

"But there has been no proof of this to date," emphasizes Dr. Katrin Fleischer. "It is entirely possible that the absorption capacity will even decrease." The ecologist from the Professorship for Land Surface-Atmosphere Interactions at the Technical University of Munich worked together with ecologists and ecosystem modelers from 10 countries to investigate the extent to which the nutrient supply in the Amazon region limits the production of biomass.

14 models compared

In doing so, the team did pioneering scientific work: To date, nobody has investigated this connection in depth, says Fleischer: "Most ecosystem models which allow the future development of ecosystems to be simulated were developed for the temperate latitudes, where there is generally sufficient phosphorus. However, in many areas of the Amazon region, it is in short supply—the ecosystem is many million years old, and the soil is leached of nutrients."

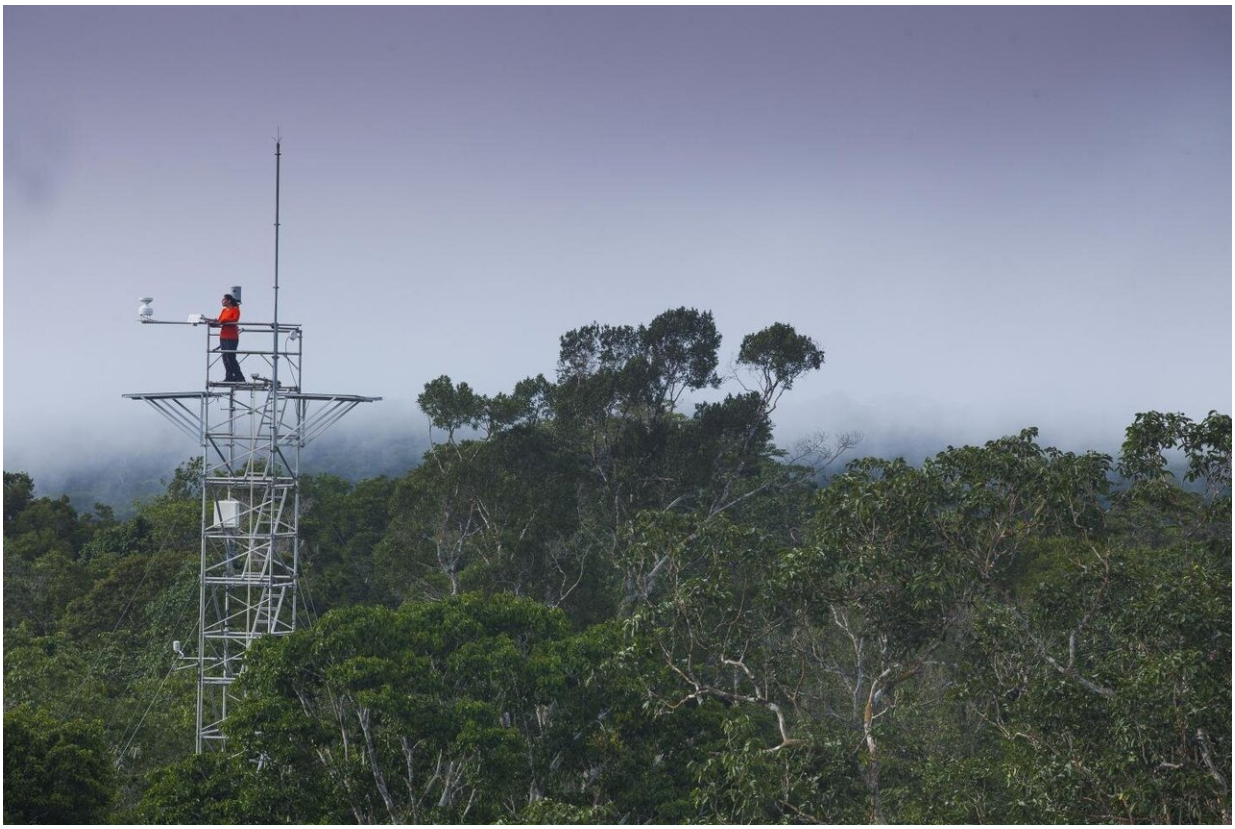
In order to find out how the rainforest will react to an increase in atmospheric carbon dioxide concentration, the researchers selected 14 different ecosystem models. All models were then used to simulate biomass production for the next 15 years: first for the current carbon dioxide concentration of 400 ppm and in a second scenario for an increased concentration of 600 ppm.



The so-called mini rhizotron system makes it possible to directly observe and measure root growth. Credit: AmazonFACE

Trees reaching their limit

The result: Additional carbon dioxide can be absorbed by the trees and transformed into biomass—but only if sufficient phosphorous is available. If it becomes too scarce, the CO_2 fertilization effect once again decreases. The various models, which take into account different factors, predict a decrease in the theoretically possible additional CO_2 absorption in the second scenario of 50 percent on average—whereby some even predict a 100 percent decrease in absorption.



Measuring tower of the AmazonFACE project in the Brazilian rainforest. Credit: AmazonFACE

"This would mean that the rainforest has already reached its limit and would be unable to absorb any more carbon dioxide emissions caused by human kind," explains Fleischer. "If this scenario turns out to be true, the Earth's climate would heat up significantly faster than assumed to date."

How exactly the ecosystem would react, and whether the trees would succeed in absorbing additional phosphorous from the soil via enzymatic processes or by forming more roots which could bind and absorb the scarce nutrients needs to be researched in greater detail, summarizes the ecologist: "What's certain is that the tropical rainforests are not infinitely

resilient CO_2 sinks."

More information: Katrin Fleischer et al, Amazon forest response to CO2 fertilization dependent on plant phosphorus acquisition, *Nature Geoscience* (2019). DOI: 10.1038/s41561-019-0404-9

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