Tall trees in Central Amazonia are impacted by periods of high maximum temperatures

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LiDAR scanners have been increasingly used to monitor forest responses to global changes. The authors used repeat measurements using a terrestrial LiDAR to monitor forest phenology in the Central Amazon. Credit: Eduardo Maeda

Amazon forests are increasingly becoming fragmented by deforestation and fire. A new study published in *Nature Communications* and led by researchers in the University of Helsinki, in cooperation with scientists across the globe, uses a novel approach to quantify the impacts of

fragmentation on plant phenology. The study shows the annual life-cycle events in plants from bud burst and leaf expansion to leaf and branch fall. Detailed measurements from terrestrial scanning LiDAR allowed the researchers to track how different layers of the forest are affected by the changing environmental conditions caused by climate and fragmentation.

The warming effects on Amazonian forests

If very high greenhouse gases (GHG) and CO2emissions double from current levels by 2050, maximum temperatures in the Amazon will likely exceed 35 degrees Celsius at least 150 days a year by the end of the century, according to the IPCC's Sixth Assessment Report. The study published in *Nature Communications* elaborates on why this is bad news for the Amazon rainforest. The study shows that tall trees in Central Amazonia are impacted by maximum temperatures of the understory above 35 degrees.

August and September usually register very high maximum temperatures above 35 degrees in many regions in the Amazon. The canopies of old-growth, intact forests usually buffer the high temperatures observed in the understory to some extent. However, when the temperatures in these underlying layers reach 35 degrees, the tall trees then shed their leaves and branches.

"If the number of days registering these very high temperatures inside the forests also increases, we might see that the tall trees will suffer considerably," says postdoctoral researcher Matheus Nunes, the lead author of the study.

The 'breath' of the Earth is in flux

In tropical forests, there are still a lot of uncertainties in the timing and causes of seasonal events, such as leaf shedding and burst. Understanding these patterns is crucial to understanding how tropical ecosystems will respond to climate change.

"We designed an experiment using repeated surveys using a modern laser scanner to investigate the seasonal dynamics of Amazonian forests," says Eduardo Maeda, the project coordinator funded by the Academy of Finland.

In the past decades, there has been a debate whether plants in the Amazon are more limited by light or by water. This study provides evidence that the problem is more complex, as it demonstrated a high variability across the forest vertical layers. In other words, trees occupying the lower layers, or strata, were more light-limited while tall trees occupying the upper strata were mostly affected by climatic variations.

Forest fragmentation

To complicate matters further, the study shows that deforestation in the region exacerbates the negative warming effects.

"The small, fragmented remaining forests tend to have hotter temperatures in the understory, because of more light penetrating the forest," says José Luís Camargo, co-author of the study and director of the "Biological Dynamics of Forest Fragments Project," the world's longest-running study of habitat fragmentation in Central Amazonia.

The hotter temperatures in these remaining forest fragments will add further pressure on the tall trees, which caused trees to shed their leaves and branches for a prolonged time.

Currently, it is estimated that 176,555 km^2 of Amazonian forests are under the influence of edge effects. If deforestation continue and forests become more fragmented, we are likely to see severe consequences and a large-scale shift in the way tropical ecosystems breathe.

More information: Matheus Henrique Nunes et al, Forest fragmentation impacts the seasonality of Amazonian evergreen canopies, *Nature Communications* (2022). DOI: 10.1038/s41467-022-28490-7

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