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Comparative Study of Carbon Cycling in Tropical Forests: An Analysis of Productivity and Efficiency from West Africa to the Amazon

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The paper "Contrasting carbon cycle along tropical forest aridity gradients in West Africa and Amazonia" was published in the journal *Nature Communications* on April 11, 2024, by authors Huanyuan Zhang-Zheng, Stephen Adu-Bredu, Akwasi Duah-Gyamfi, et al., from the Environmental Change Institute, School of Geography and the Environment, University of Oxford, Oxford, United Kingdom, and the Forestry Research Institute of Ghana, Council for Scientific and Industrial Research, Kumasi, Ghana, among other institutions. The research presented contrasts carbon cycle dynamics along tropical forest aridity gradients in West Africa and Amazonia. This study offers a comprehensive field assessment of carbon budgets in multiple forest sites in Africa by monitoring one-hectare plots along an aridity gradient in Ghana, compared to an equivalent gradient in Amazonia. The findings suggest notable differences in productivity and carbon use efficiency between these regions, challenging existing models that have underrepresented African tropical forests' productivity.

1 Experimental Data Analysis

Key findings include: Higher Net Primary Productivity (NPP) and Gross Primary Productivity (GPP) in West African forests compared to Amazonian ones. Carbon Use Efficiency (CUE) was generally higher at medium-aridity sites, with significant differences observed between the two regions in how GPP and CUE correlate with aridity. Notable discrepancies between satellite-based and field-measured productivity data, emphasizing the need for improved modeling approaches.

Graphical representations in the paper illustrate these findings, showing the stark contrasts in productivity and efficiency across the gradients studied (Figure 2).

Figure 1 illustrates the geographical distribution of study sites across two distinct tropical regions, denoted by red dots. Section A represents the aridity gradient within the Amazon basin, whereas section B outlines a similar gradient in West Africa. The color scale maps the mean annual precipitation (MAP), providing a visual correlation between site location and rainfall patterns. This spatial arrangement offers a framework for comparing ecological variables across continents, factoring in the gradient of aridity and its potential influence on regional forest dynamics and productivity.

Figure 2 presents biometric estimates of various carbon flux components in tropical forests, juxtaposing Amazonian and West African sites. The graph uses blue dots to represent Amazonian plots and yellow triangles for West African ones. Polynomial regression lines suggest trends in carbon flux components along an aridity gradient, ranked from wet to dry as indicated by the maximum climatological water deficit (MCWD). The error bars denote the uncertainties in these estimates. The illustrated metrics include net primary productivity (NPP), gross primary productivity (GPP), and carbon use efficiency (CUE), among others. The data underscores the differences and similarities in the carbon dynamics between the two regions, providing insight into the adaptation of forests to varying levels of water availability.

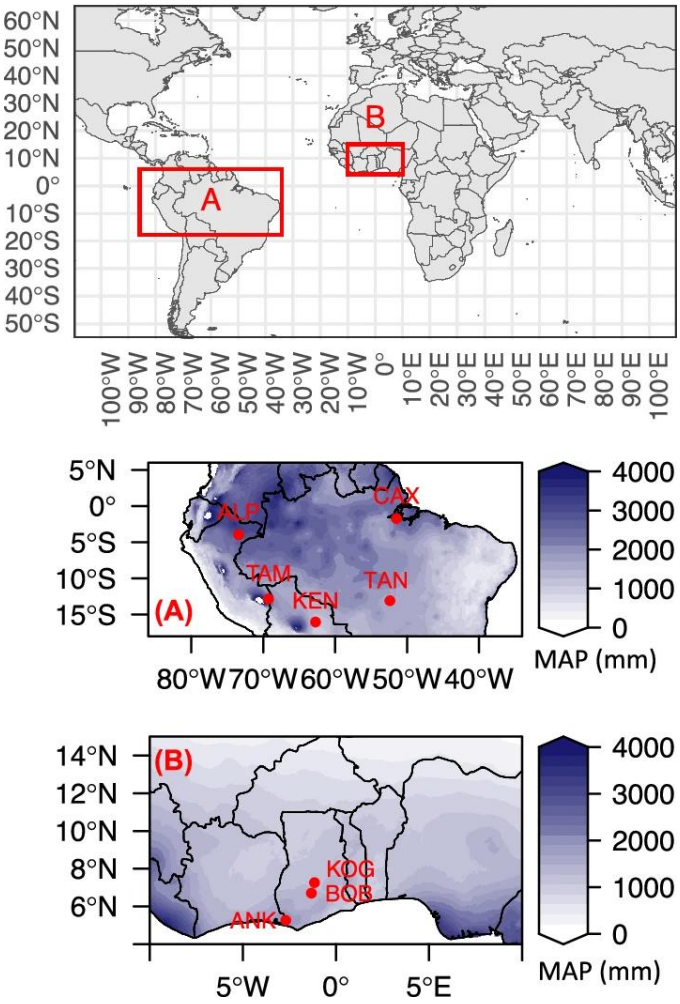

Figure 1 Map of the study sites

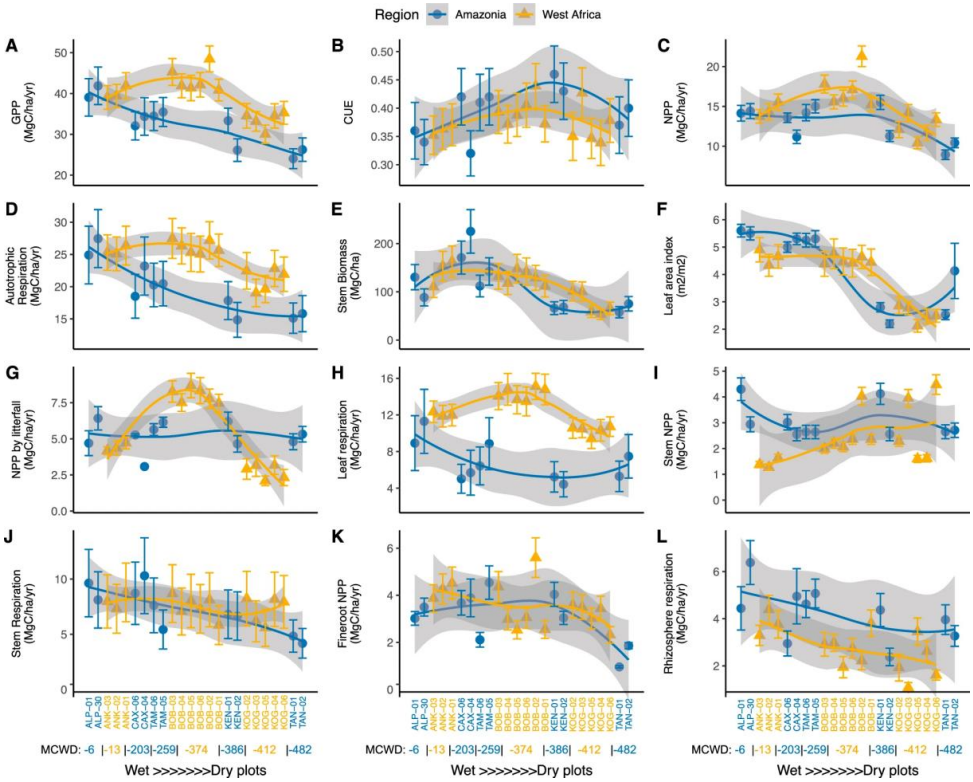

Figure 2 Biometric estimates of various components of carbon fluxes

2 Analysis of Research Findings

The study reveals that the African forests, particularly at mid-aridity sites like Bobiri, exhibit higher productivity than those in Amazonia, possibly due to different environmental exposures and historical biogeographic conditions. The higher productivity in Africa is linked to substantial GPP allocation to the canopy and semi-deciduous characteristics, which differ significantly from Amazonian forests.

3 Evaluation of the Research

This research contributes significantly to our understanding of tropical forest carbon cycles, particularly by providing robust field data that challenge existing remote-sensing and model-based estimates. The methodology, involving detailed biometric measurements across a network of plots, provides a replicable model for future studies in other tropical regions.

4 Conclusions

The findings underscore the critical role of direct field measurements in understanding and modeling tropical forest carbon dynamics. The study highlights the need for reevaluating tropical forest carbon budgets globally, particularly for underrepresented regions like West Africa.

5 Access the Full Text

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