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# Unravelling the carbon cycle at the tree and forest scale: a TREE4FLUX initiative in Central African Tropical Forests

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Tropical forests play an essential role in the carbon cycle. However, climate change threatens their ability to store carbon. Specifically, understanding the perturbation of climatic regimes on carbon uptake mechanisms is crucial. However, our knowledge concerning the spatial and temporal carbon distribution over trees and forests is limited, especially in the context of tropical forests of Central Africa. The TREE4FLUX project aims to fill these gaps for the first time in the forests of Congo Basin forests, by focusing research at different scales around the CongoFlux tower in the Yangambi Biosphere Reserve (DRC). On the forest ecosystem scale, carbon uptake can be monitored by measurements of CO2 exchanges between the atmosphere and the vegetation using the Eddy Covariance approach. Carbon assessments are also possible through tree-growth measurements within a network of permanent inventory plots. However, refining the carbon cycle at the tree scale requires a detailed study of the numerous inextricable metabolic processes that underlie tree growth, e.g. photosynthesis, wood formation, or respiration. Because they are largely controlled by various climatic drivers, climate-growth relationships over time remain hard to establish. The chronology of carbon uptake and attribution to the different mechanisms remain elusive preventing a grasp of the intra-annual variations of these periodic processes and their articulation over time. This is the case of xylogenesis or wood formation in which each phase is differently involved in the carbon cycle and sensitive to various climatic drivers. To understand the sensitivity of tree growth to climate, we need to untangle the cambium's role in wood formation. For that purpose, monitoring cambial phenology helps characterize the distribution, allocation, and short- and long-term carbon storage in woody material. While tree growth uptakes carbon, respiration releases carbon into the atmosphere at various levels. Heterotrophic and autotrophic respirations have a decisive role in the carbon cycle at the forest scale but face significant misunderstandings in this regard. To upscale our understanding from individual tree to forest scale, we imperatively need respiration monitoring in both living and decayed trees. This requires unravelling the metabolic processes driving both autotrophic and heterotrophic respiration, i.e. the tree growth and decayed process, respectively. Characterization of carbon fluxes according to an integrative approach over climatic variations is required to understand how environmental changes affect ecosystem dynamics and their ability to provide ecosystem services