EGU26-11112, updated on 14 Oct 2026
https://doi.org/10.5194/egusphere-egu26-11112
EGU General Assembly 2026
© Author(s) 2026. This work is distributed under
the Creative Commons Attribution 4.0 License.

Airborne LiDAR Reveals the Wood Density and the Ecological Succession of Central African Forests through Canopy Gaps

Arthur Vander Linden[1], Jean-François Bastin[1], and Sassan Saatchi[2,3]
[1]TERRA Teaching and Research Centre, Gembloux Agro-Bio Tech, University of Liège, Belgium (arthur.vanderlinden@uliege.be)
[2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA (sasan.s.saatchi@jpl.nasa.gov)
[3]Institute of Environment, University of California, Los Angeles, USA (ssaatchi@ucla.edu)

Wood density stands as one of the most integrative functional traits of trees, reflecting fundamental trade-offs in adaptive strategies and closely connected to ecosystem history and dynamics. Wood density is linked to multiple key processes including carbon accumulation and mechanical support, determining how plants allocate resources between growth and survival. Yet, despite its recognized importance for understanding forest ecology and improving carbon stock estimates, spatially explicit knowledge of local wood density variation remains severely limited, particularly in tropical rainforests.

Community wood density integrates ecological processes operating at the stand scale, primarily through species composition. Regeneration guild strategies drive much of this variation: fast-growing pioneer species exhibit low wood density while shade-tolerant species show substantially higher values. These compositional differences are also expressed through distinct forest structure patterns —early succession stages with pioneer-dominated composition generally develop lower, more uniform canopies, whereas mature forests with non-pioneer light demanding and shade-tolerant species build taller, more complex vertical architectures. We hypothesized that vertical canopy opening profiles, capturing the proportion of gaps at successive height aboveground, contain the ecological signatures of floristic composition and successional stages that ultimately determine community wood density.

These ecological relationships create opportunities to leverage high-resolution airborne LiDAR for detecting wood density variation at large scale through canopy structure. To test these hypotheses, we modeled community wood density at the stand level across 76 one-hectare plots in 18 Central African forests. We derived canopy stratification metrics from cumulative gap proportion curves extracted from Canopy Height Models, characterizing vertical opening patterns.

We show that canopy opening profiles effectively capture structural signatures associated with community wood density variation. Canopy openness at approximately 20 m and overall canopy stratification emerged as the strongest predictors. Variance partitioning and structural equation modelling reveal that this structure-wood density relationship is entirely mediated by floristic composition and successional stage, which jointly determine both forest structure and wood

density. Canopy structure thus acts as a proxy for species composition.

These findings have direct implications for remote sensing applications in tropical forests such as Central African ones. The strong covariation between vertical stratification and species assemblages opens a pathway to account for local wood density variation when mapping AGB through LiDAR-derived indicators. This approach could substantially reduce uncertainties in carbon stock estimates and improve our technique for monitoring forest degradation and successional dynamics across this critical biome.