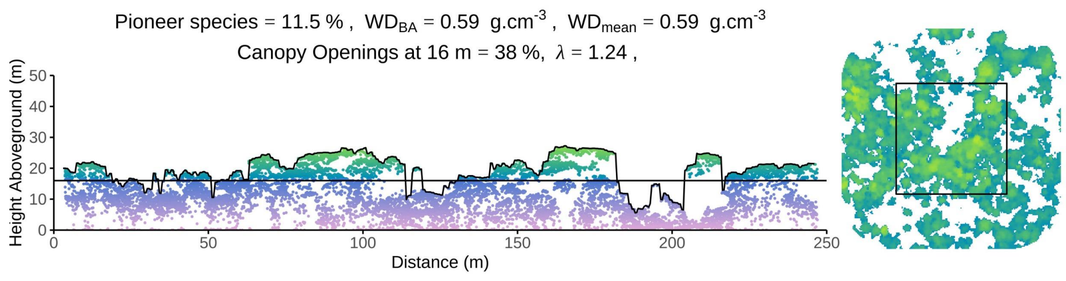
Airborne LiDAR Reveals the Wood Density and the Pioneer Species of Tropical Moist Forests

VANDER LINDEN Arthur (ULiège), SAATCHI Sassan (NASA-JPL) & BASTIN Jean-François (ULiège)

LIÈGE université Gembloux Agro-Bio Tech

Canopy gaps are reliable predictors of wood density and pioneer species, providing us with new additional metrics to consider when mapping biomass at a large-scale using LiDAR.

When LiDAR-based wood density estimates are used in a biomass prediction model, they reduce the RMSE by 10% compared to usual models that use only mean top-of-canopy height (TCH) as a predictor.

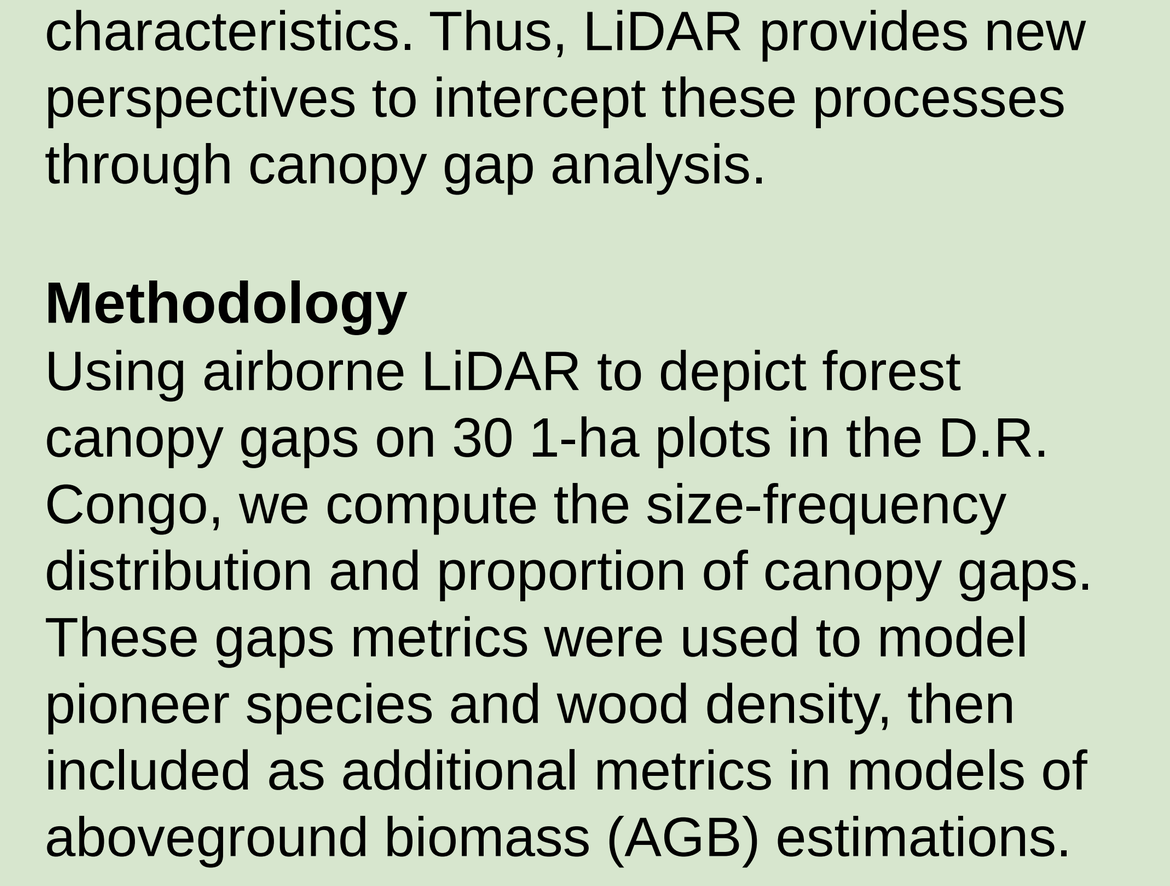


Context

Accounting for wood density variation is the key to reduce significant uncertainties in assessing tropical forest carbon stocks with remote sensing. Yet, canopy gaps foster the growth of pioneer species characterized by lower wood density and specific structural characteristics. Thus, LiDAR provides new perspectives to intercept these processes through canopy gap analysis.

Methodology

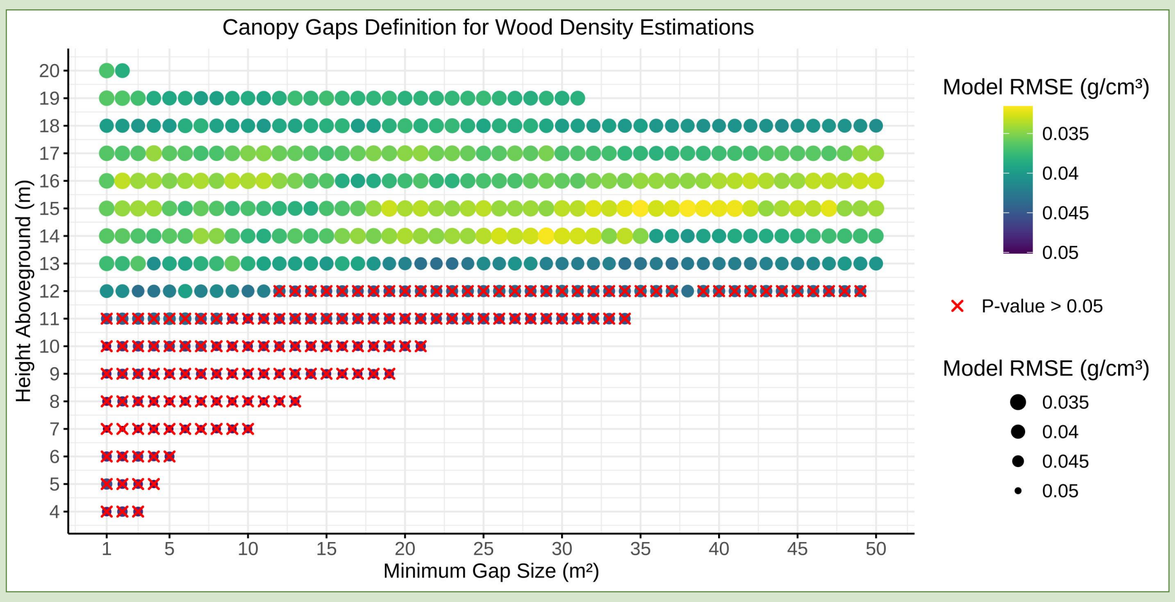
Using airborne LiDAR to depict forest canopy gaps on 30 1-ha plots in the D.R. Congo, we compute the size-frequency distribution and proportion of canopy gaps. These gaps metrics were used to model pioneer species and wood density, then included as additional metrics in models of aboveground biomass (AGB) estimations.

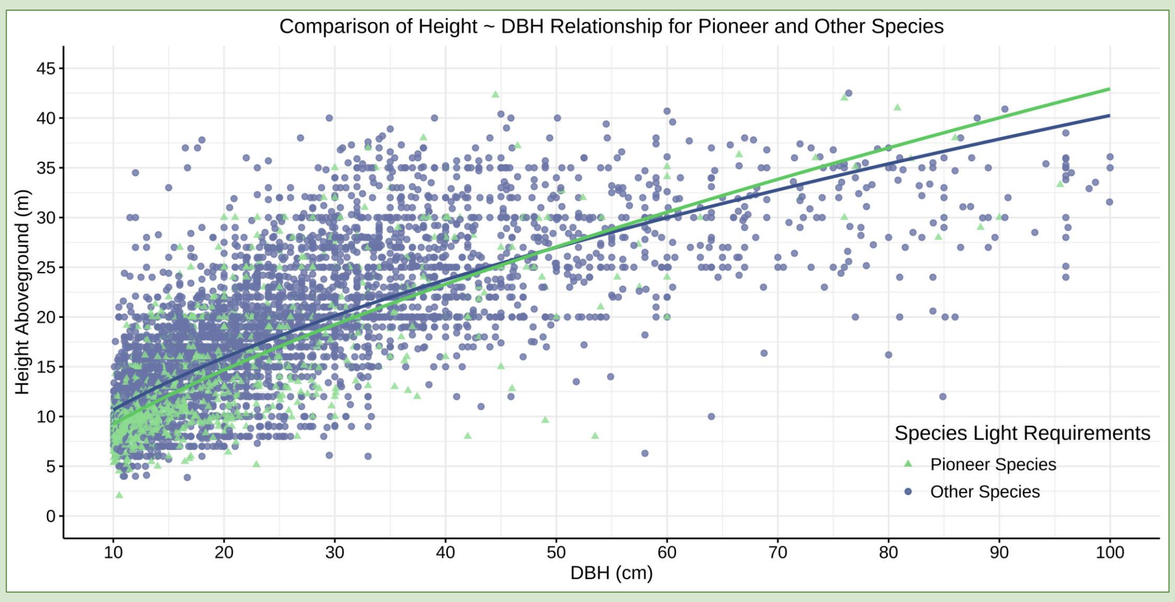


The graphs above illustrate the reduction in RMSE and bias when wood density, measured or estimated, is included in AGB estimation models based on LiDAR mean top-of-canopy height (TCH).

How to define canopy gaps ?

Defining a gap is not straightforward. To represent wood density accurately, the size-area definition of gaps must be adapted to the specific structural characteristics of pioneer species. These species, typically lower in height during early growth stages, are also characterized by lower wood density





The first graph above shows model sensitivity to gap definition and the ideal height range for wood density analysis. The second graph shows height differences of pioneer species in early growth stages

We will expand the analysis to encompass all forest types across the Democratic Republic of Congo to reinforce the study's conclusions.

Gembloux Agro-Bio Tech (ULiège)
Arthur VANDER LINDEN

Biodiversty, Environment and Landscape
Avenue Marechal Juin 27 (Bât. ABT0 G52)
5030 Gembloux (Belgium)

E-mail: arthur.vanderlinden@uliege.be
Web: biodiversity-landscape.be

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