

Introduction

- In order to fulfill growth and reproduction functions trees put in place a tridimensional structure which, however, is subject to internal and external constraints. This is reflected by the unique architecture of each individual.
- Architecture of large tropical trees is difficult to study due to their size, complexity and longevity.

We used TLS data to quantify architecture of 15 Cameroonian canopy species and to test three hypothesis:

- H1: Architecture is driven by the light requirements of the species*
- H2: Architecture changes across canopy position*
- H3: Trees follow a universal symmetric and fractal architecture (West, Brown and Enquist "WBE" model: West et al. 1999)*

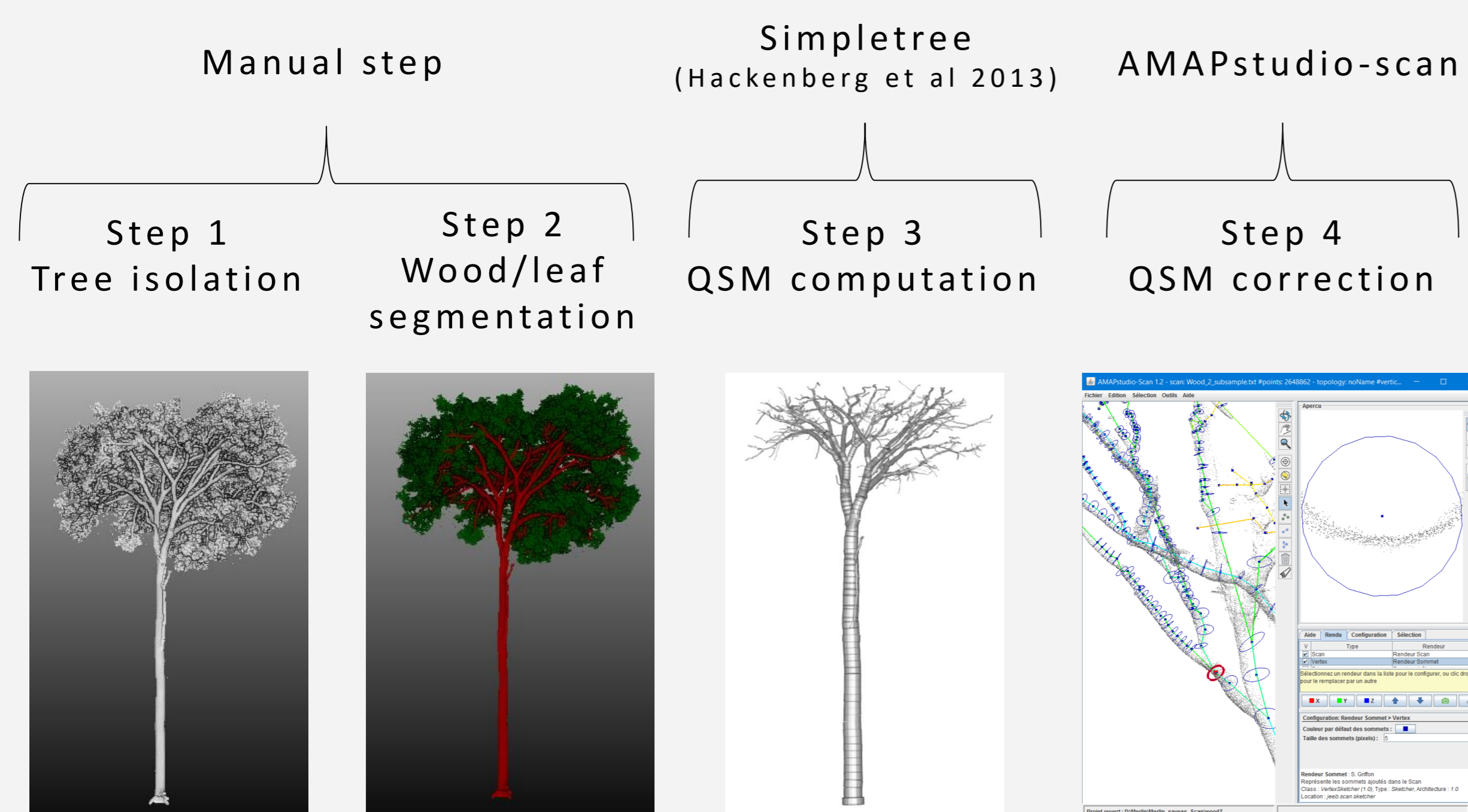
Material & Methods

1. Sampling

59 trees were scanned in East Cameroon using a terrestrial LIDAR scanner C10 Leica (2 to 7 scans per tree)

- 15 species
- 3 shade tolerance groups (Pioneer, Non-Pioneer-Light-Demanding, Shade Tolerant)
- 4 canopy positions (suppressed -> dominant)

2. Pre-treatments

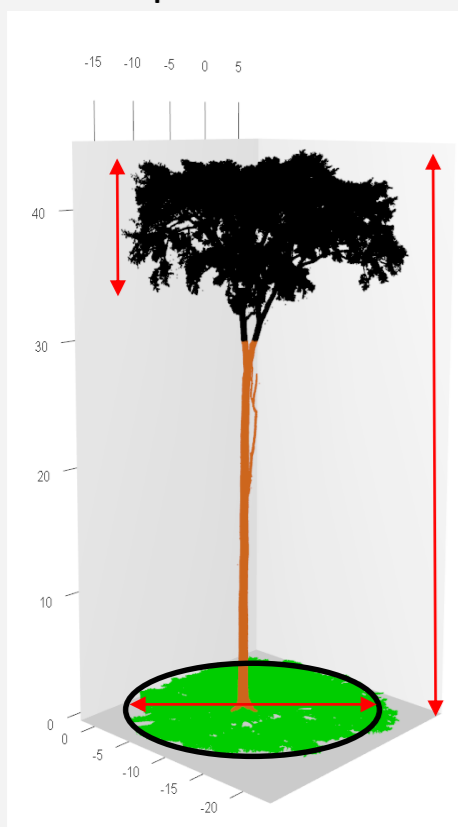


Takoudjou Momo et al 2017

3. Crown metrics quantification

Crown and tree shape metrics

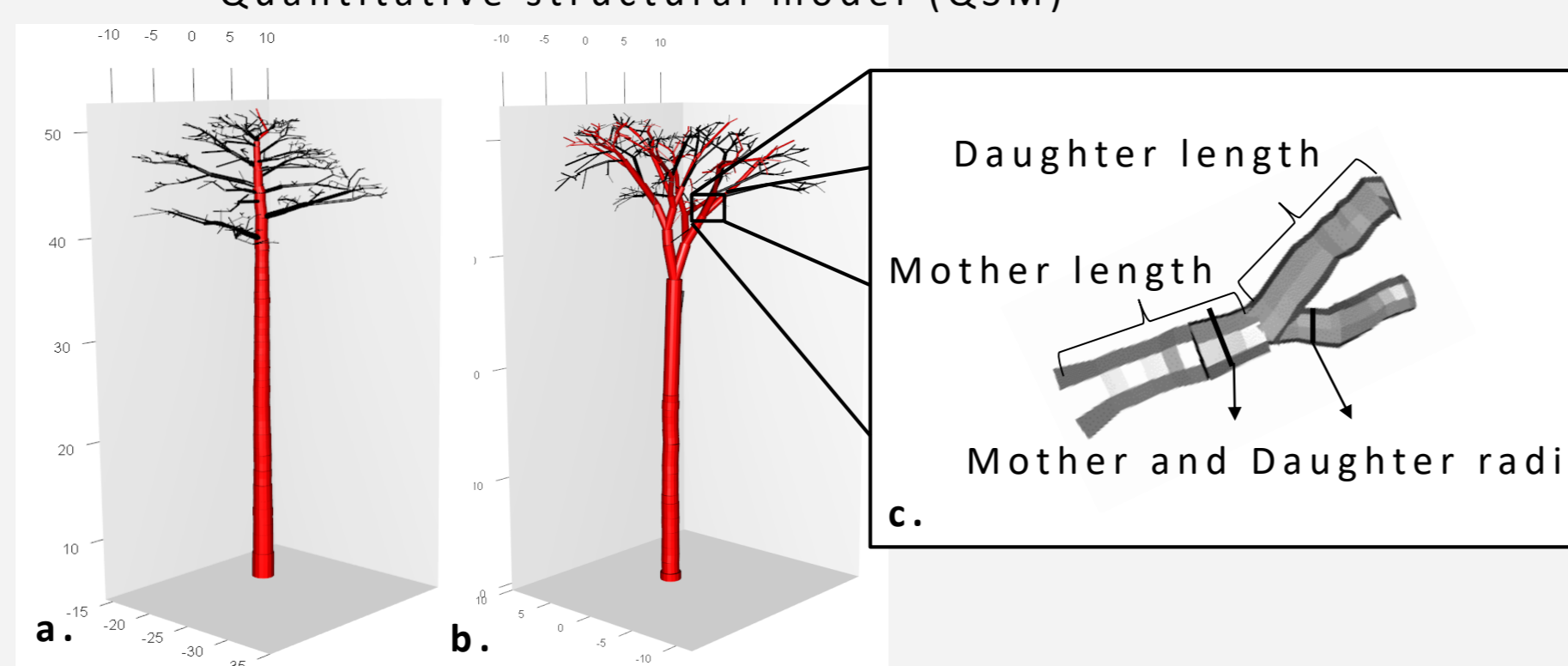
Input data: Raw point cloud



- Output data:
- Crown width to crown depth ratio ($C_w:C_d$ ratio)
 - Crown depth to tree height ratio ($C_d:H$ ratio)
 - Tree height to tree diameter ratio ($H:D$ ratio)

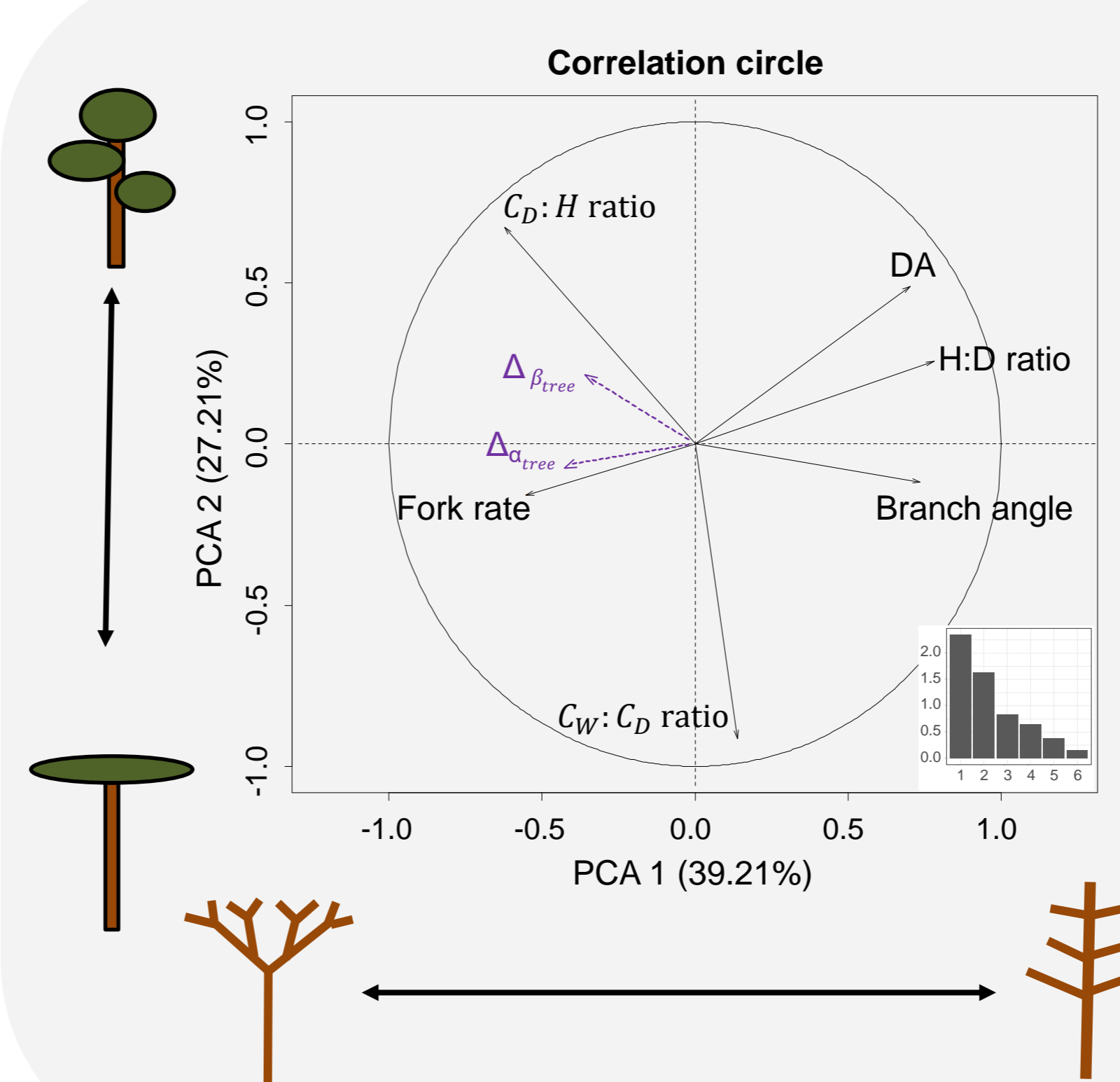
Topological metrics and WBE parameters

Input data: Quantitative structural model (QSM)



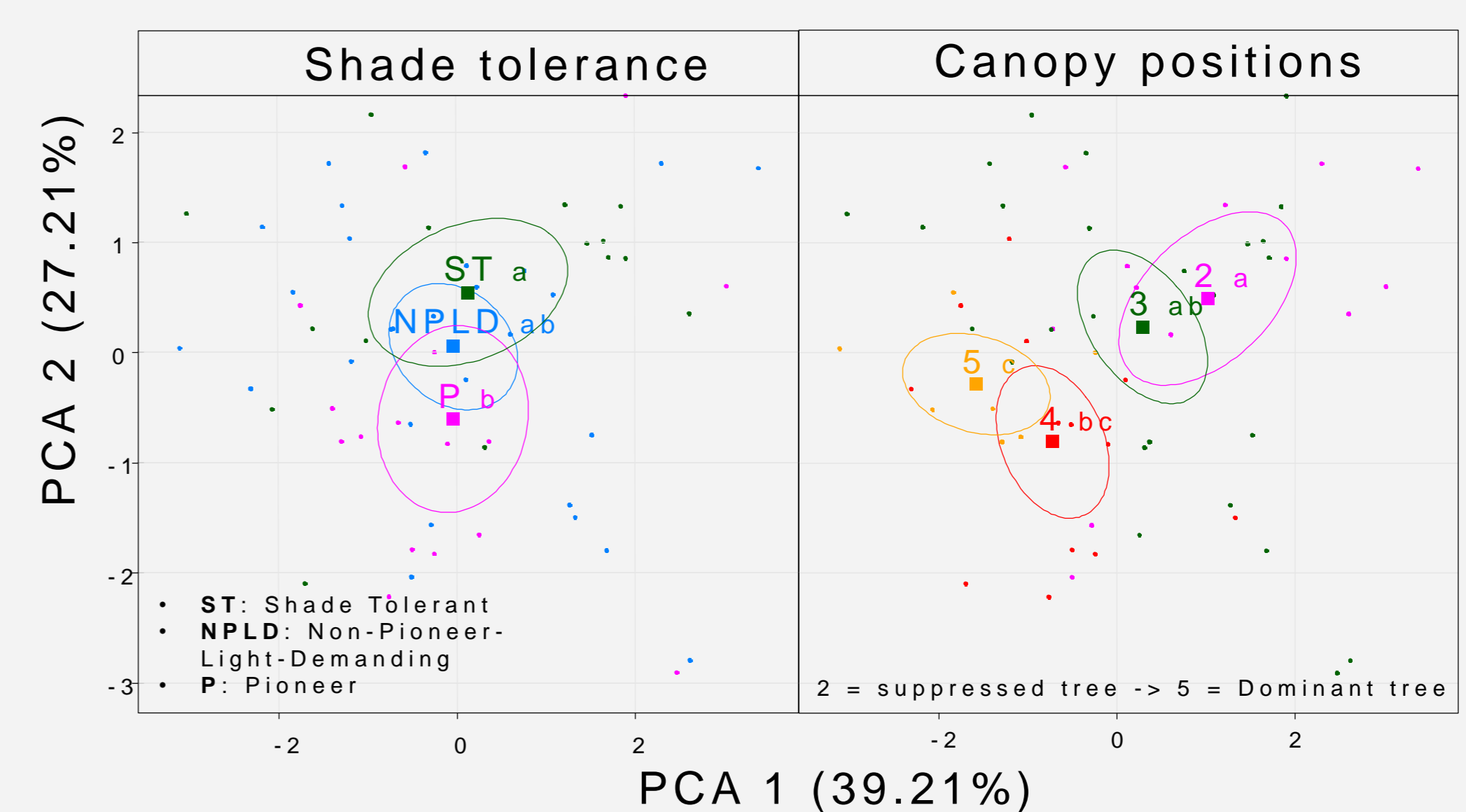
- Output data:
- Dominance of a principal axis index (DA). a.
 - Fork rate. b.
 - Branch angle. c.
 - WBE scaling exponent (α and β from Bentley et al 2013) c.

Results & Discussion



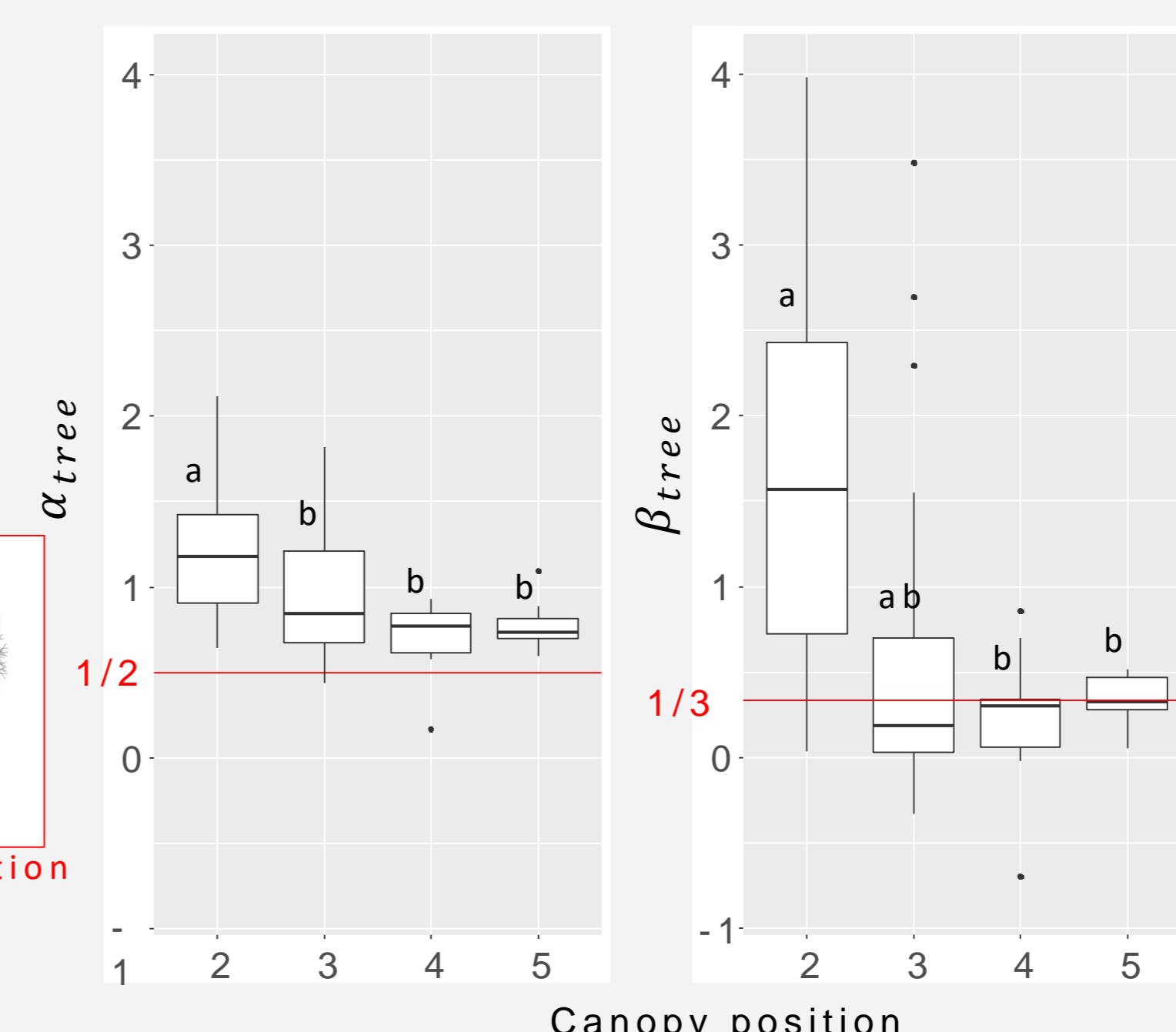
The multivariate analysis shows two orthogonal architectural gradients

- PCA 1 (horizontal) : Topological gradient
- PCA 2 (vertical): Crown shape gradient



- Effect of shade tolerance on PCA2
- Shade tolerant: slender and deep crown
 - Pioneer: shallow and wide crown

- Effect of canopy position on PCA1
- Convergence toward an architecture with many forks & a low apical dominance when reaching high canopy position



α and β converge toward the WBE expectation when reaching high canopy position

Conclusion

- Tree architecture was divided in shape vs topology metrics and both are complementary and interpretable in terms of growth strategy
- Tree converge to a similar topological architecture no matter of their species and functional group, probably due to reiteration processes.
- Large dominant trees present scaling exponent close to an idealized WBE tree. Do trees converge to a fully optimized architecture in non limiting condition (less competition for large dominant trees) ?