Which drivers control the above-ground biomass of rainforests in New Caledonia?

Elodie Blanchard, T. Ibanez, P. Couteron & P. Birnbaum

Island Biology 2014
University of Hawai'i at Mānoa
7-11 July 2014

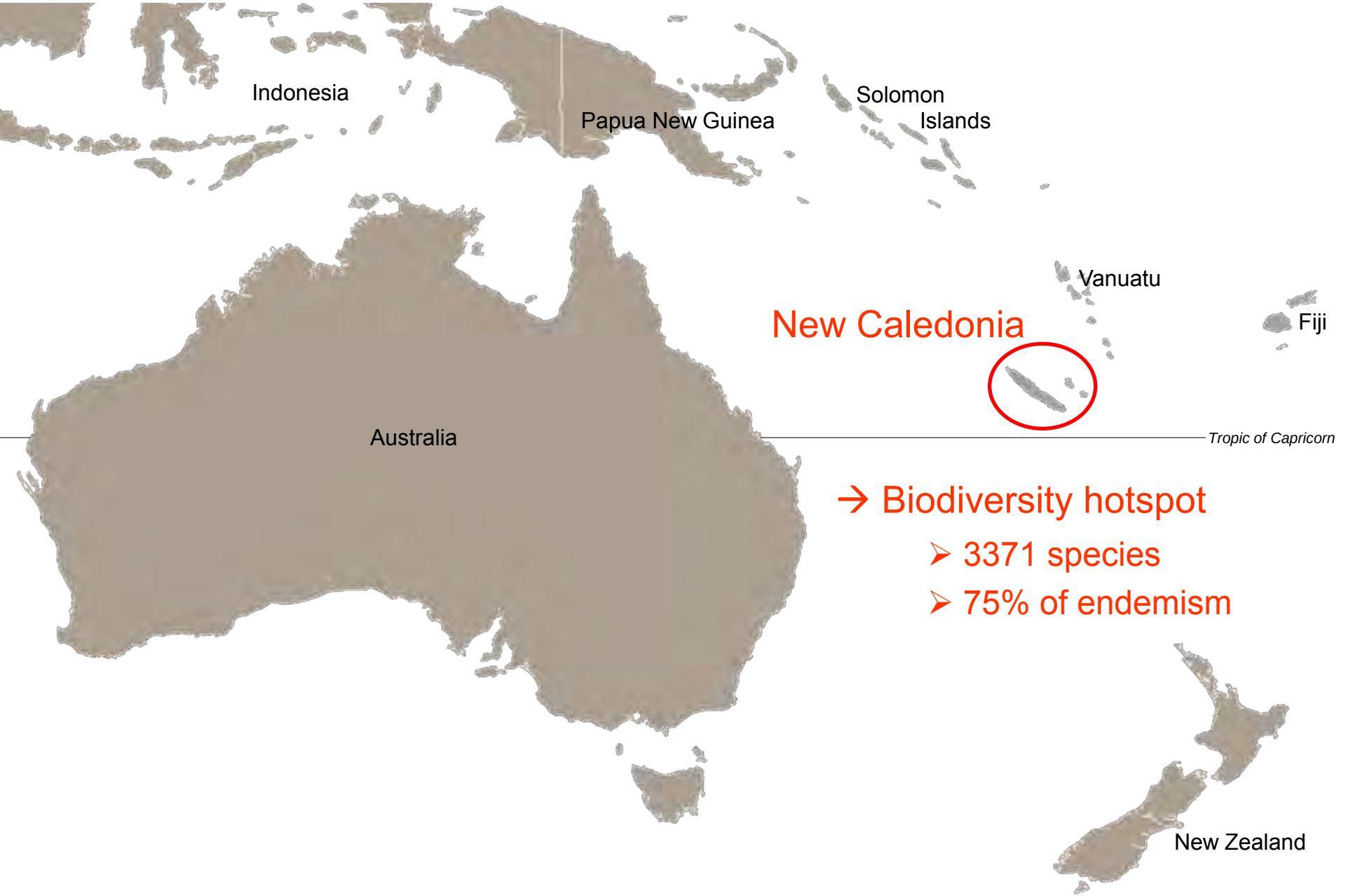
IAC Institut Agronomique néo-Calédonien

IRD Institut de recherche pour le développement

cirad

An archipelago in the South Pacific

An archipelago in the South Pacific

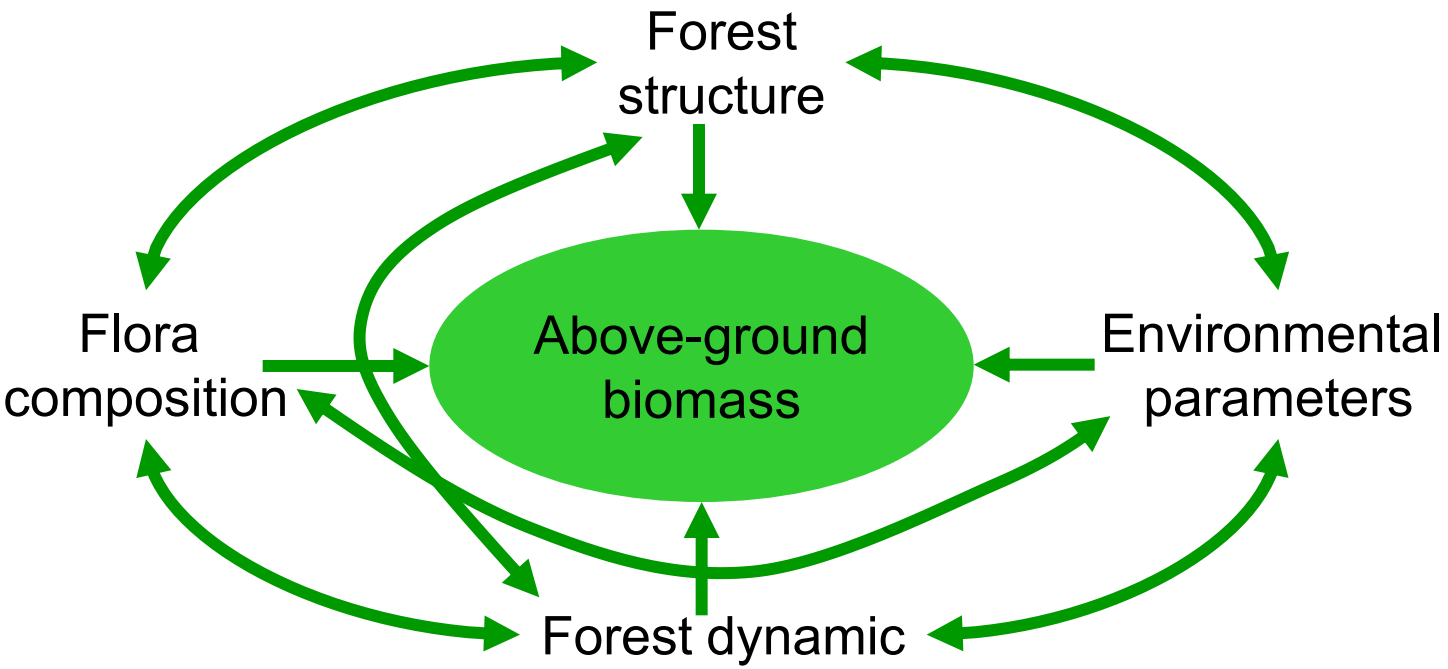


→ Biodiversity hotspot

- 3371 species
- 75% of endemism

Potential drivers of above-ground biomass

→ **Rainforest typology is unknown**



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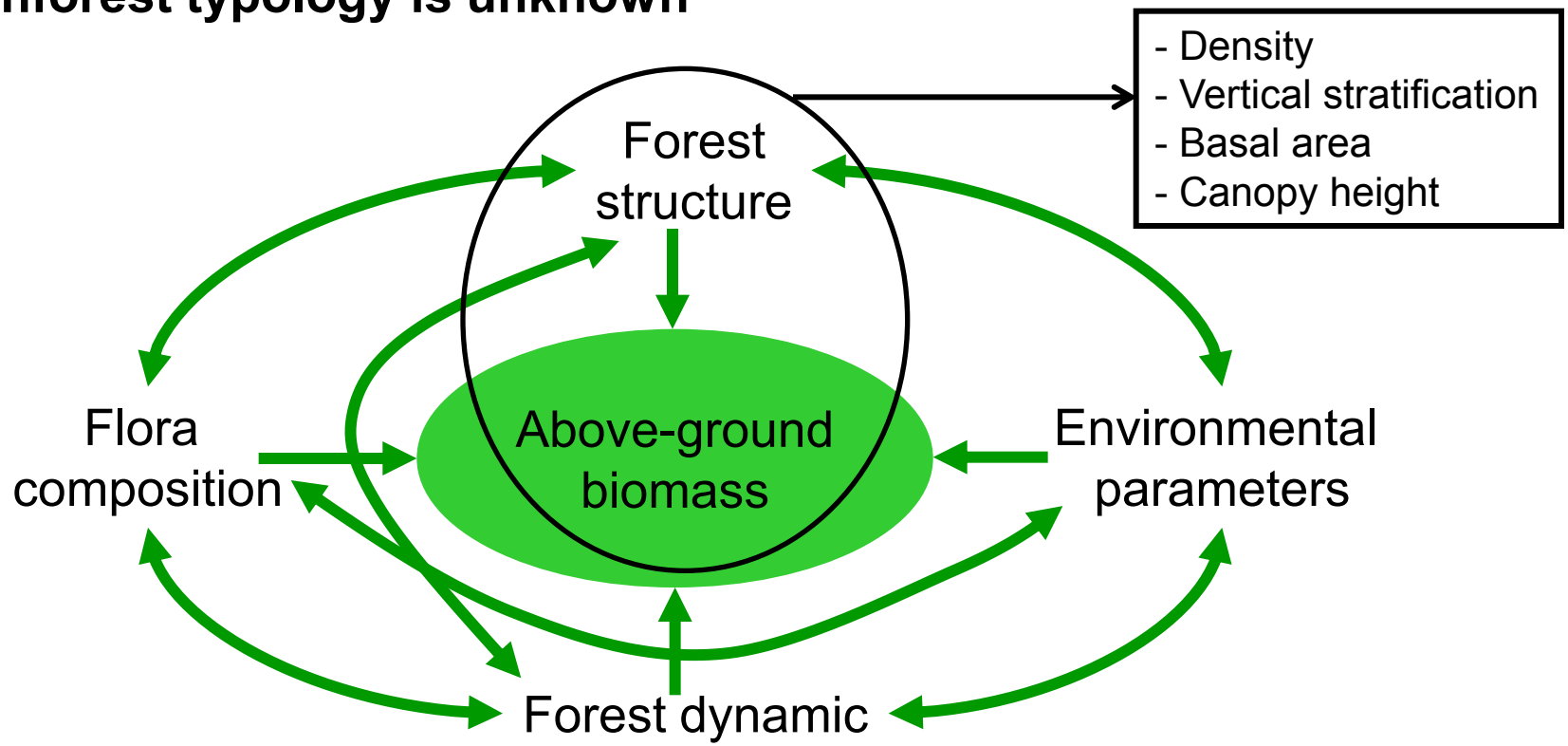

→ **Which structural drivers control rainforest above-ground biomass?**

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Structural and floristic diversity of mixed tropical rain forest in New Caledonia: new data from the New Caledonian Plant Inventory and Permanent Plot Network (NC-PIPPN)

Thomas Ibanez, Jérôme Munzinger, Gilles Dagostini, Vanessa Hequet, Frédéric Rigault, Tanguy Jaffré & Philippe Birnbaum

Keywords
Alpha and beta diversity; Basal area; Environmental gradients; Floristic dissimilarity; Serpentine; Species richness; Stem density; Ultramafic substrates

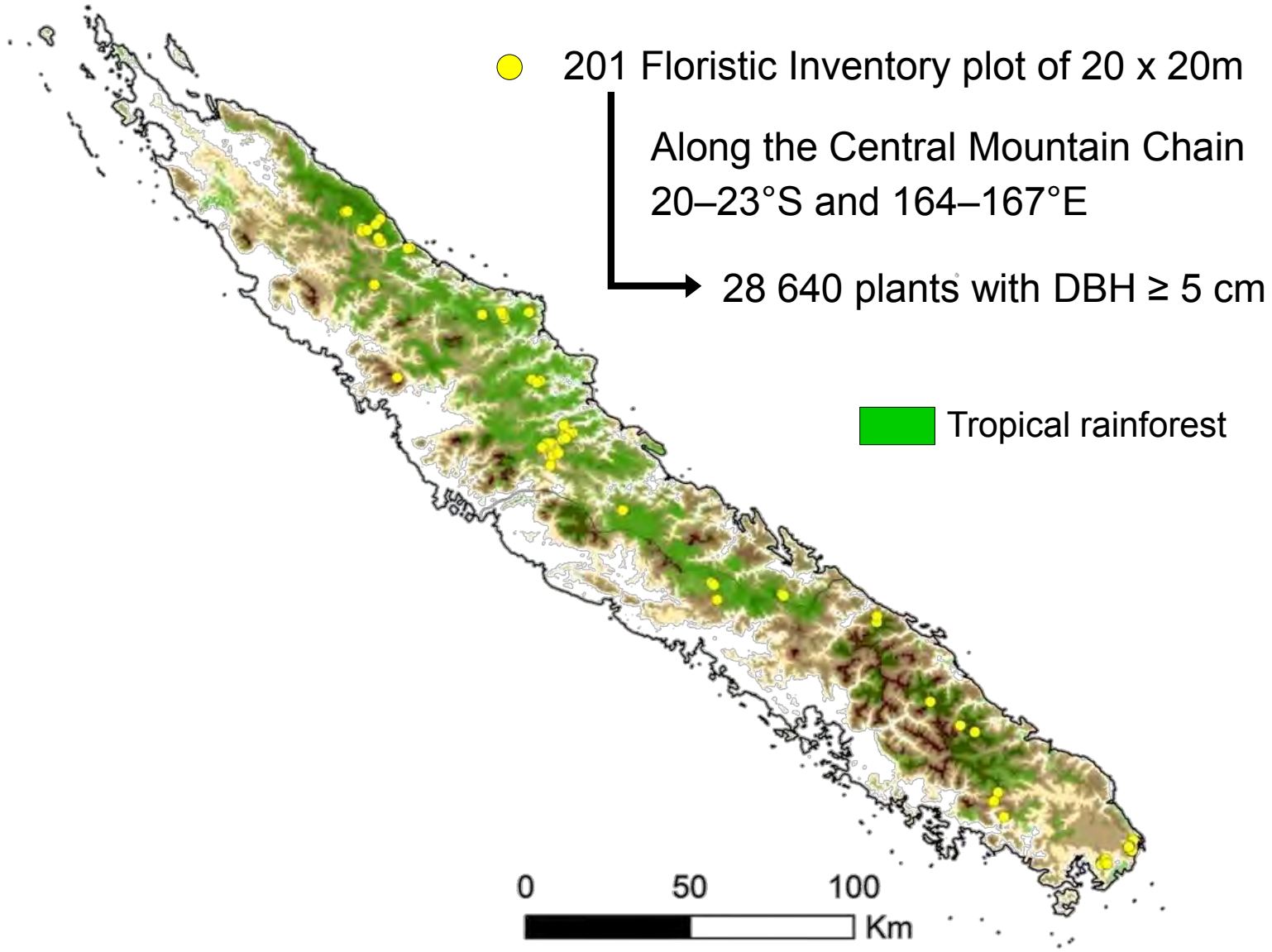
Abstract

Aims: To describe the structural and floristic diversity of New Caledonian mixed tropical rain forest and investigate its environmental determinants.

Location: New Caledonia (SW Pacific), a biodiversity hotspot.

➡ First results on the structure of the tropical rainforest at the landscape scale, in New Caledonia

New Caledonian Plant Inventory and Permanent Plot Network - NC PIPPN, 2005



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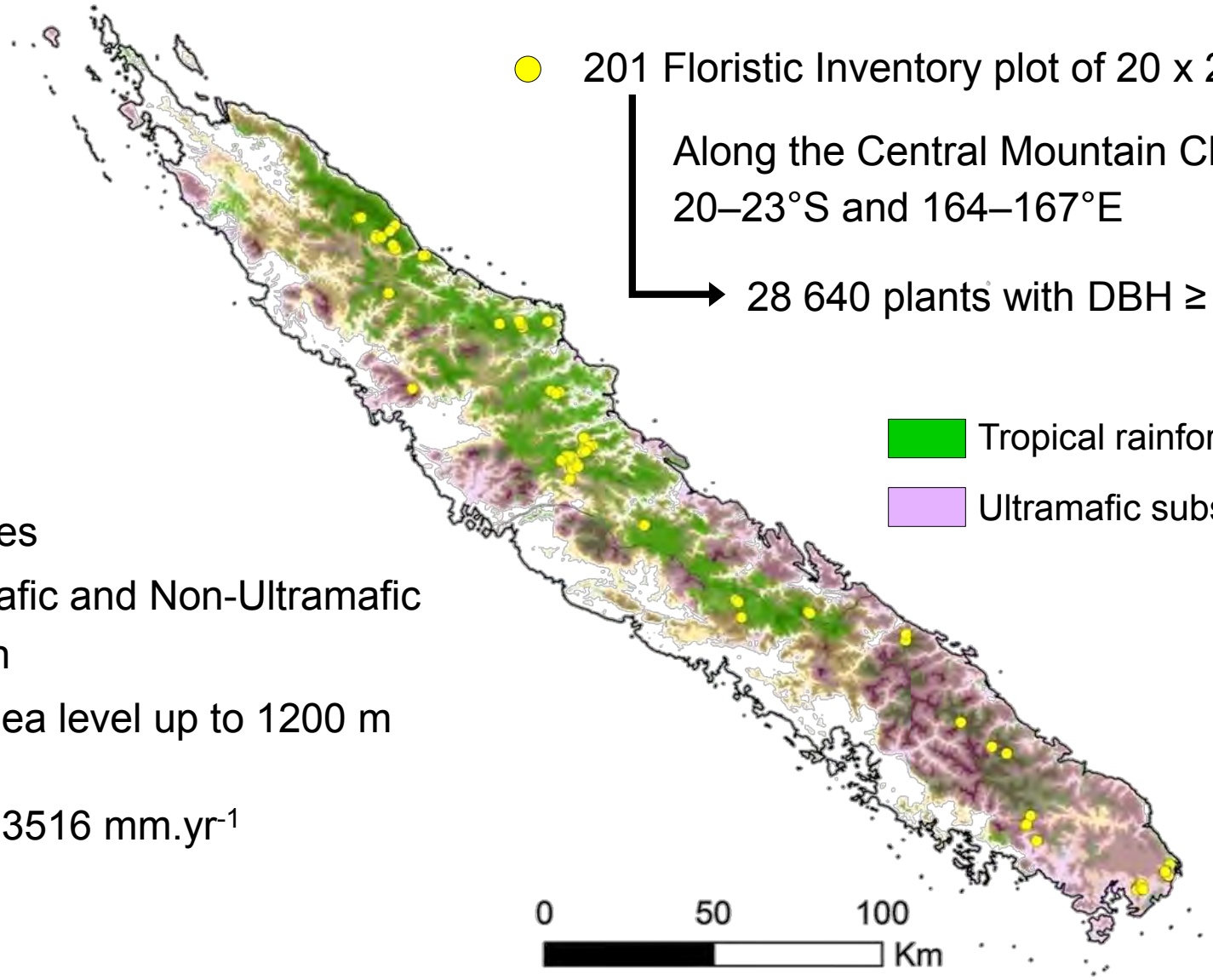


- Substrates

  Ultramafic and Non-Ultramafic
- Elevation

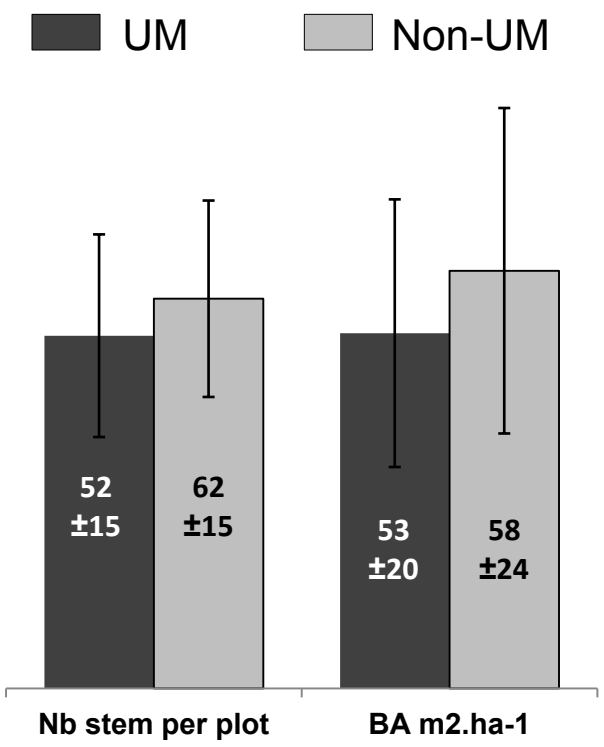
  From sea level up to 1200 m
- Rainfall

  1548 - 3516 $mm.yr^{-1}$

Impact of environmental factors on rainforest structure - *Results from Ibanez et al., 2014*

- **Substrates**

Floristic dissimilarity: Bray-Curtis= 0.97

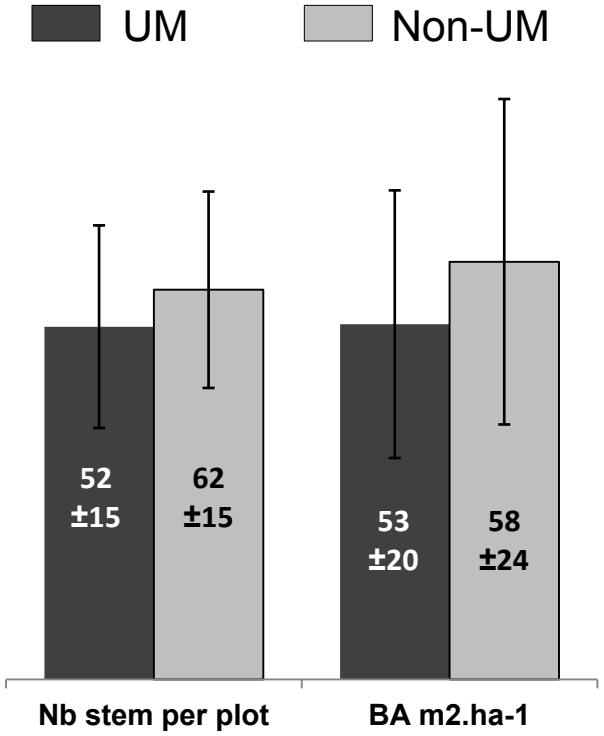


Plants with DBH ≥ 10 cm

Impact of environmental factors on rainforest structure - *Results from Ibanez et al., 2014*

➢ **Substrates**

NO IMPACT ON FOREST STRUCTURE



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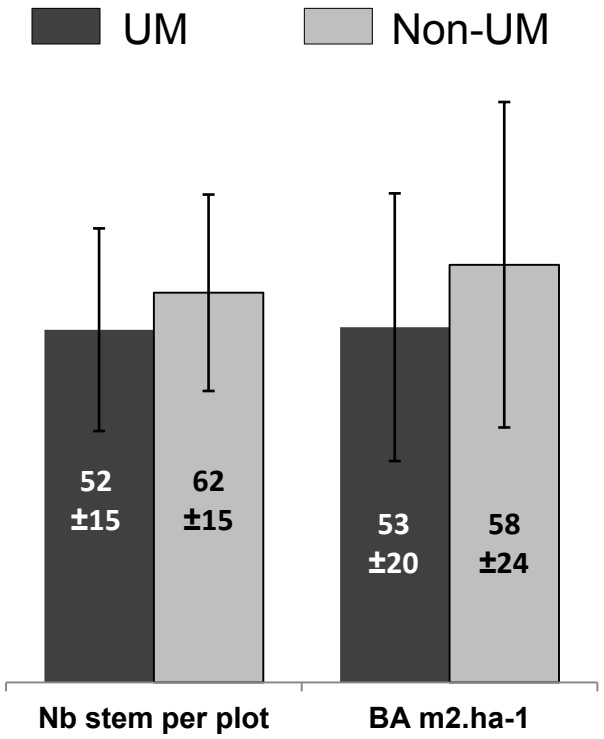
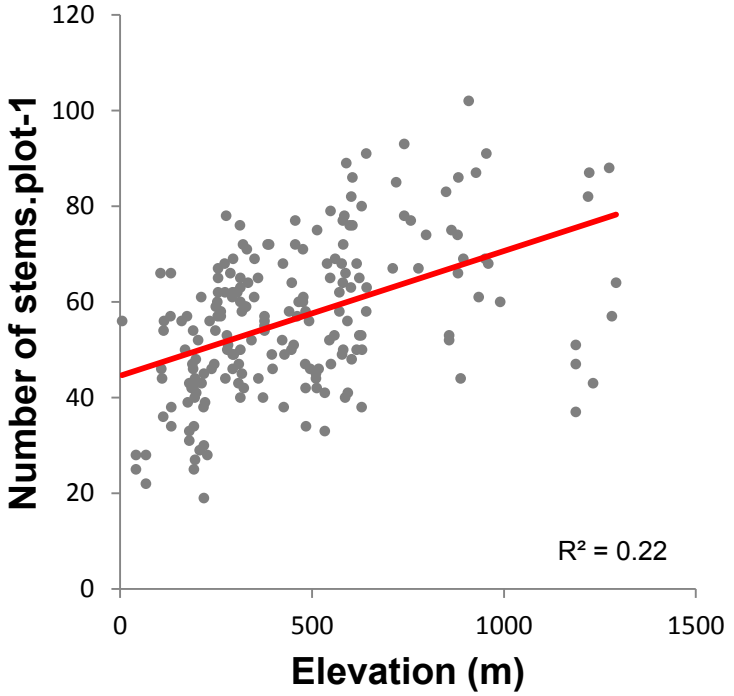


Plants with DBH ≥ 10 cm

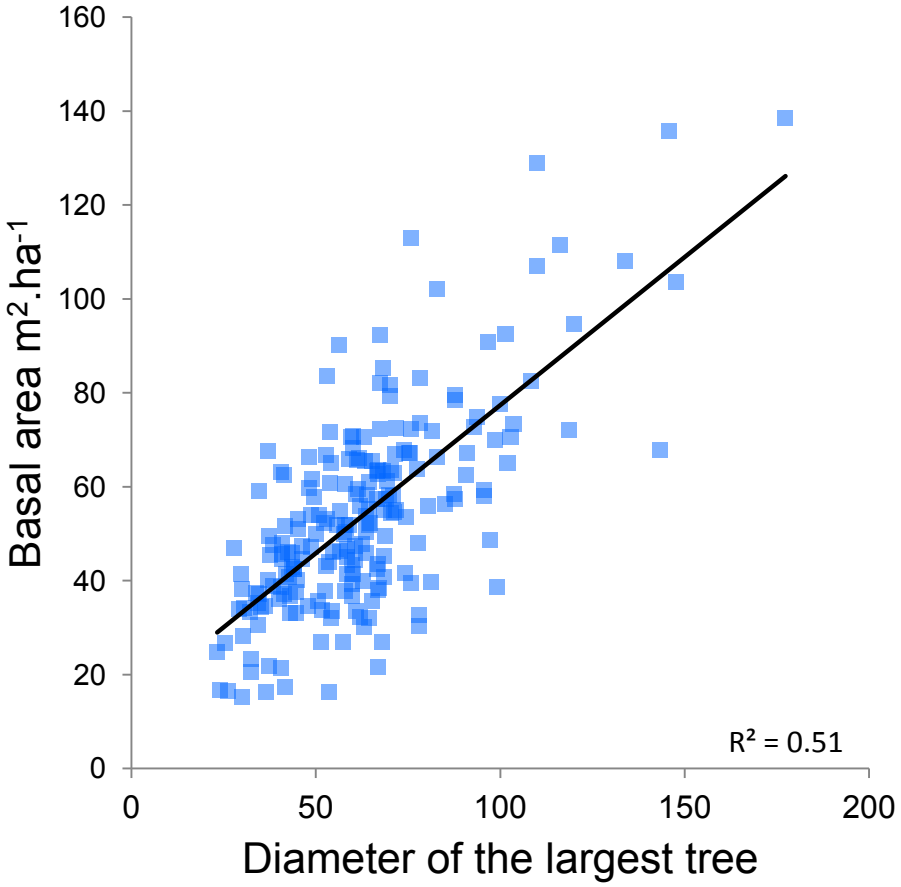
➢ Elevation

% variance of the number of stem explained by elevation: 15,7%



IMPACT ON FOREST STRUCTURE

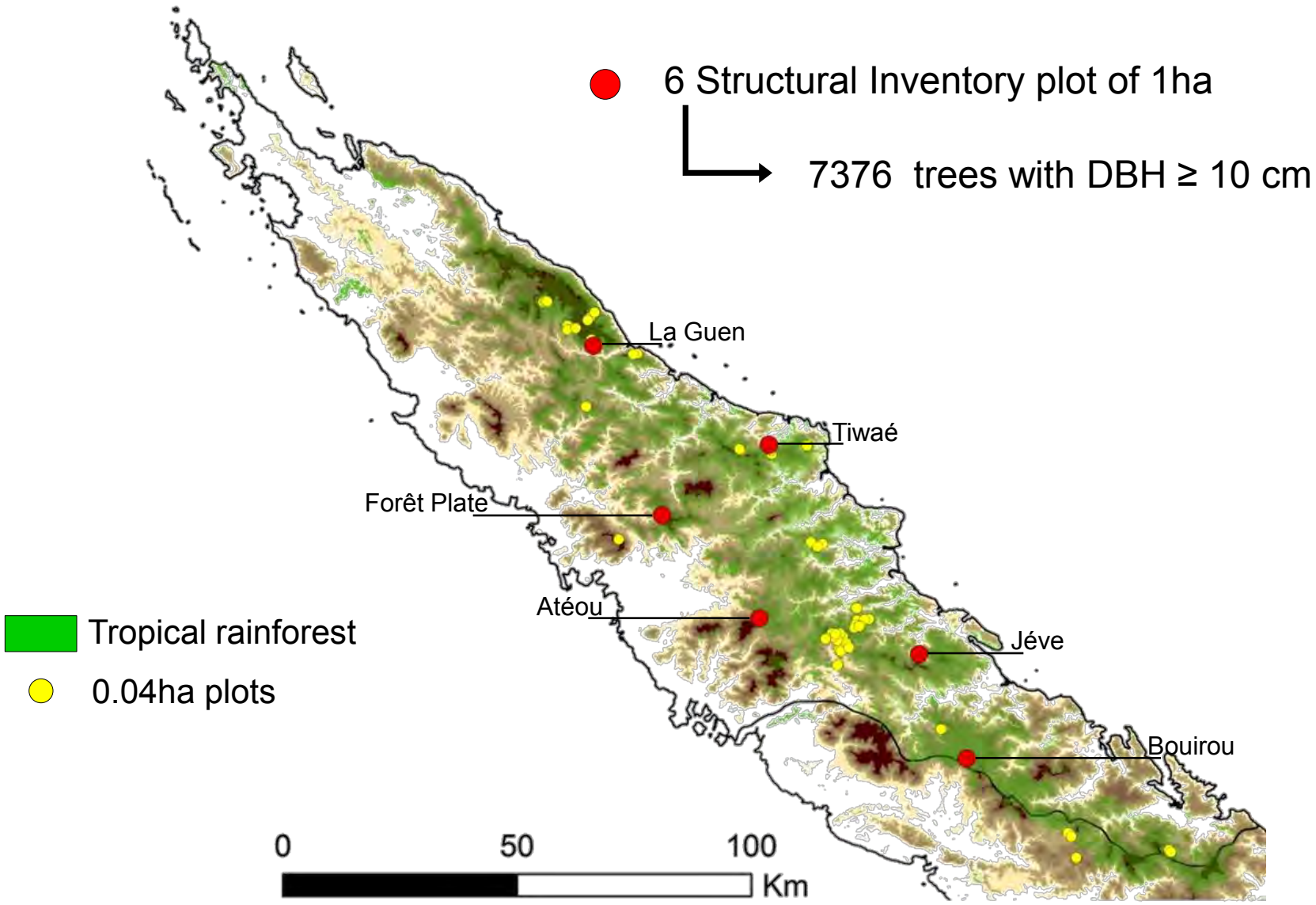
20x20m plots are unsuitable for structural parameter estimation- *Results from Ibanez et al., 2014*



Magnitude of BA is correlated to the diameter of the largest tree


Structural drivers of rainforest biomass
1 ha plot network

Structural plot network - NC PIPPN 2013



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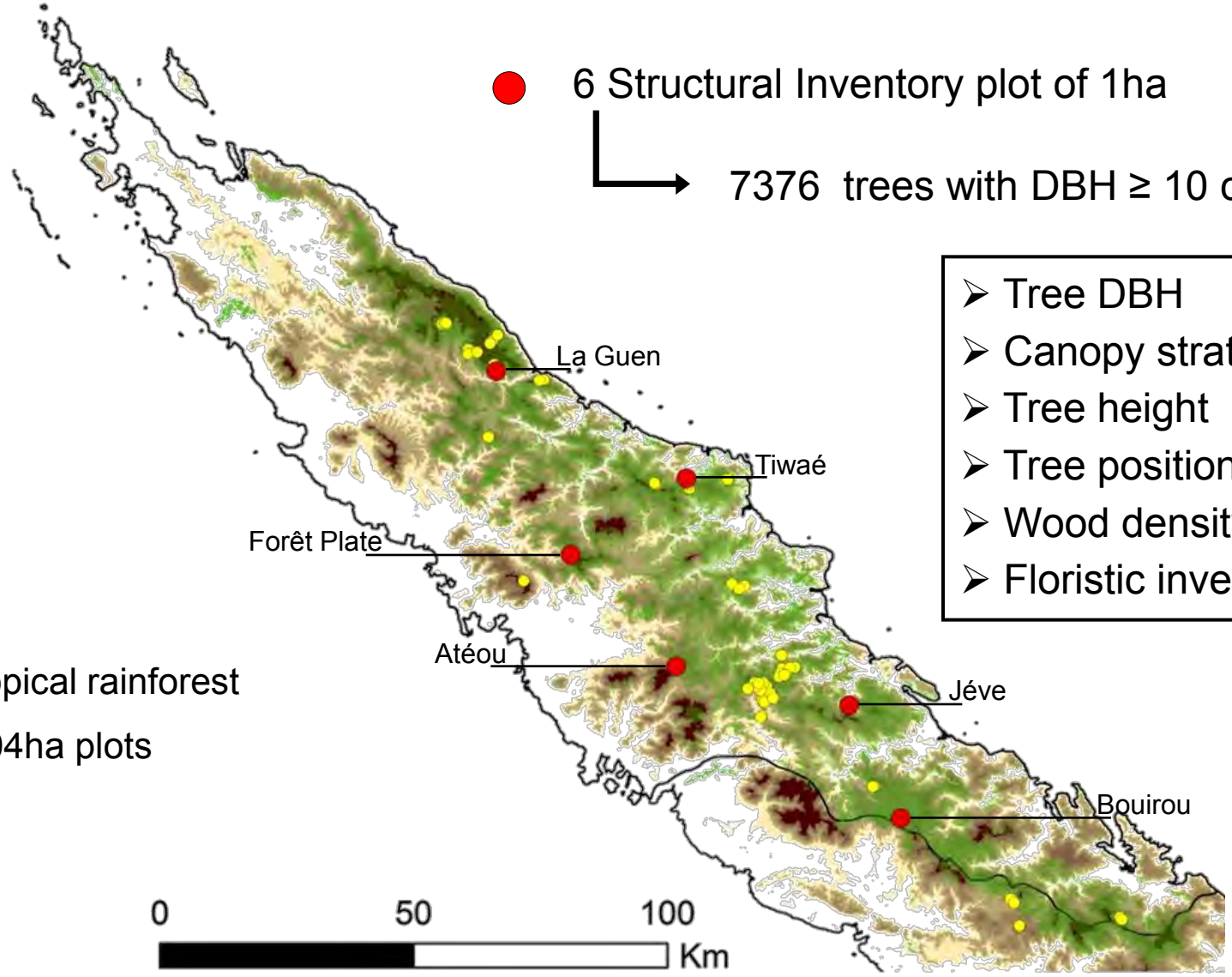
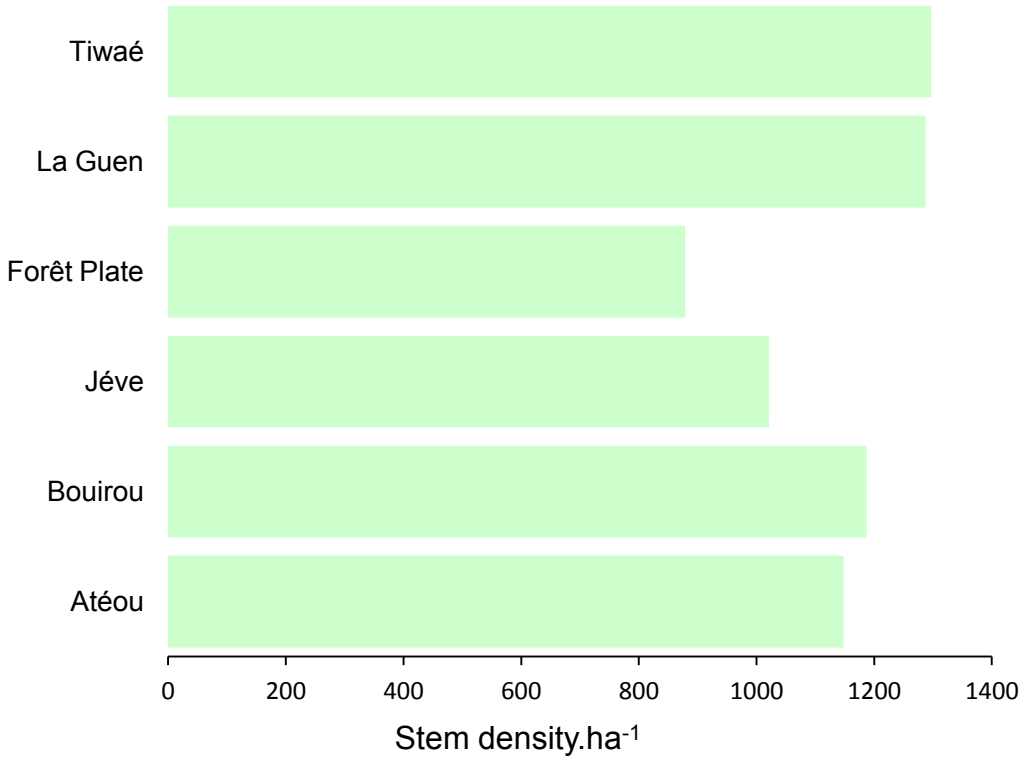


High stem density



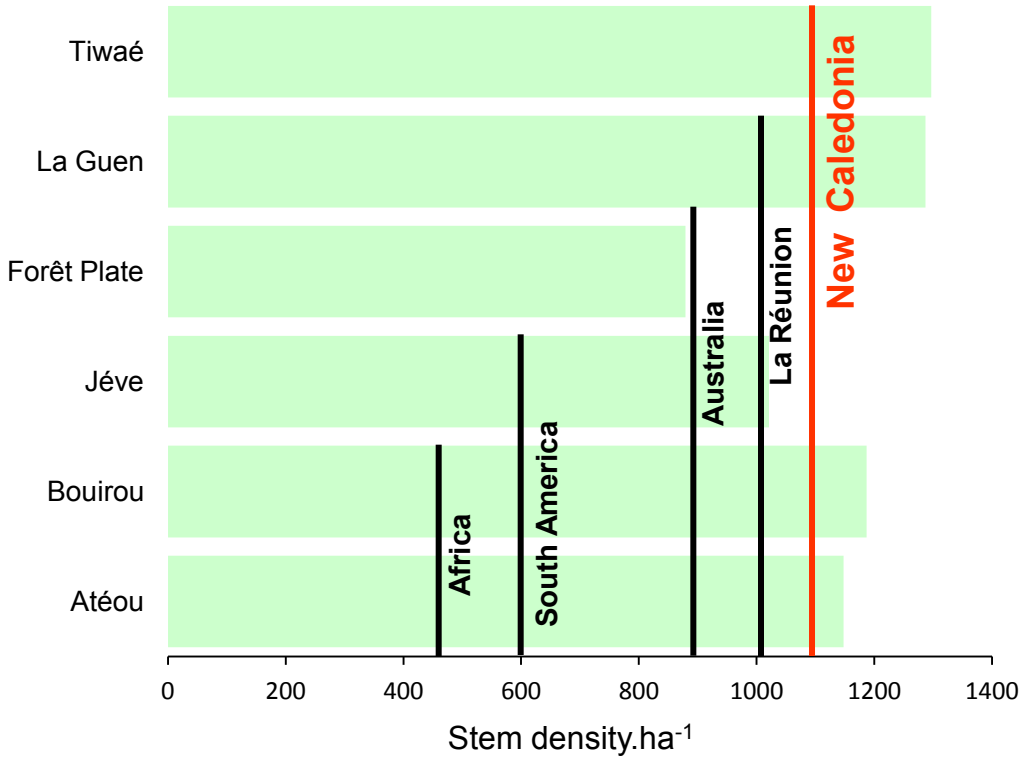
Stem density

- High variation between sites
  MIN= 879 MAX=1297
- High stem density
  MEAN=1137 ± 162

Palms & tree fern density

- Differ among sites
  → Presence/absence
- High stem density & basal area
  Palms - La Guen= 15%
  Tree fern - Bouirou= 12%

High stem density



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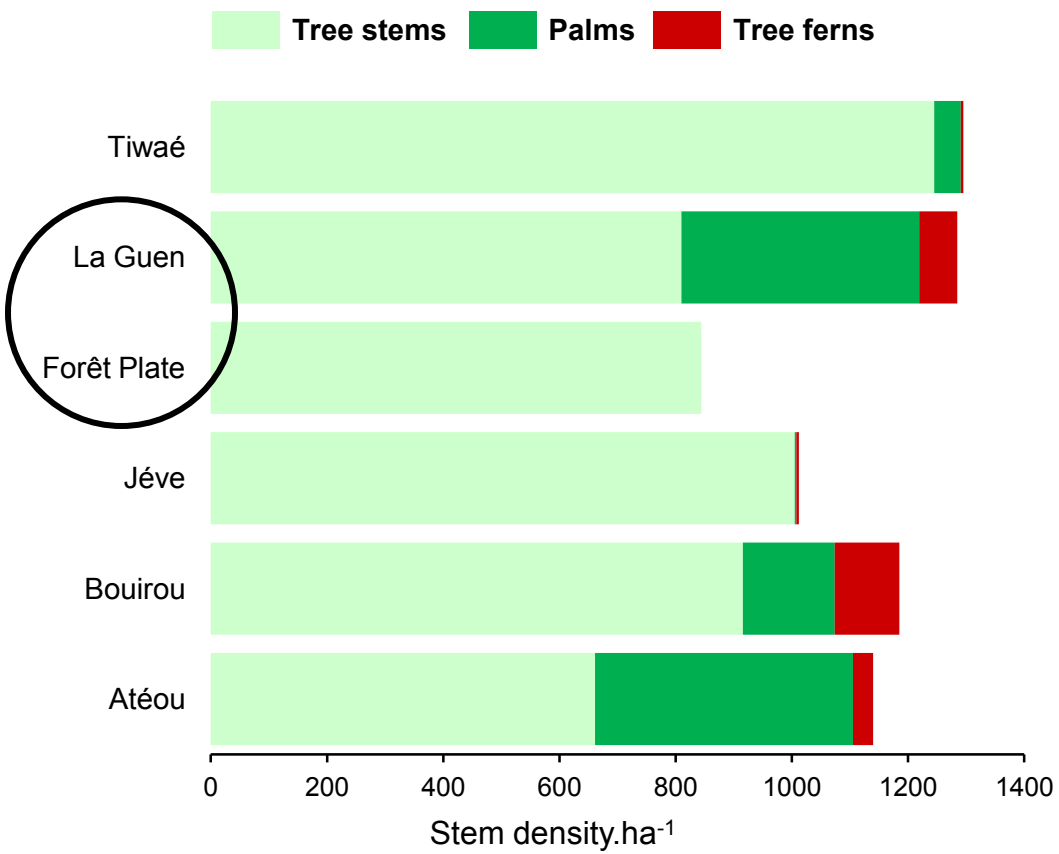

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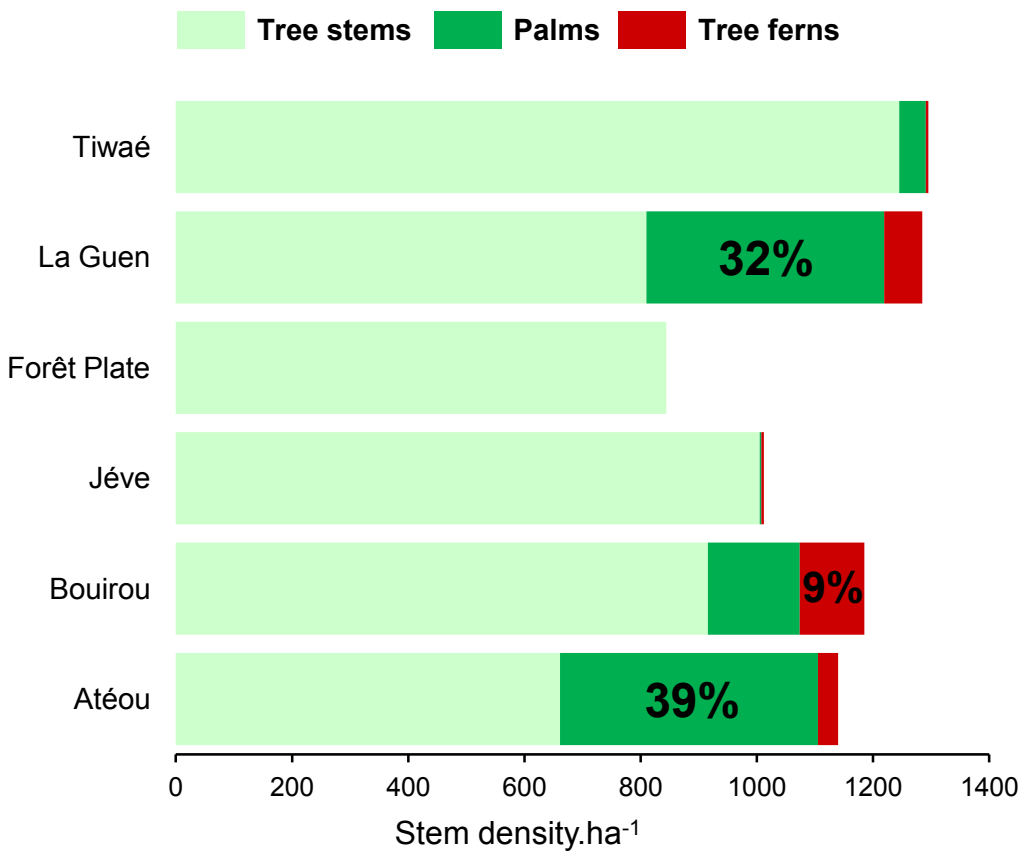

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  Palm - La Guen= 15% of BA
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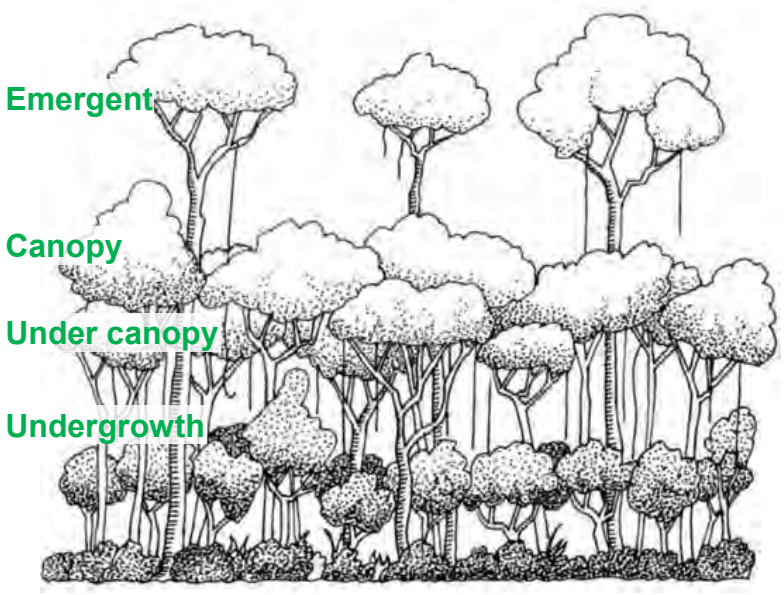
→ Importance to include palms & tree ferns in structural dataset

High diversity in vertical forest stratification



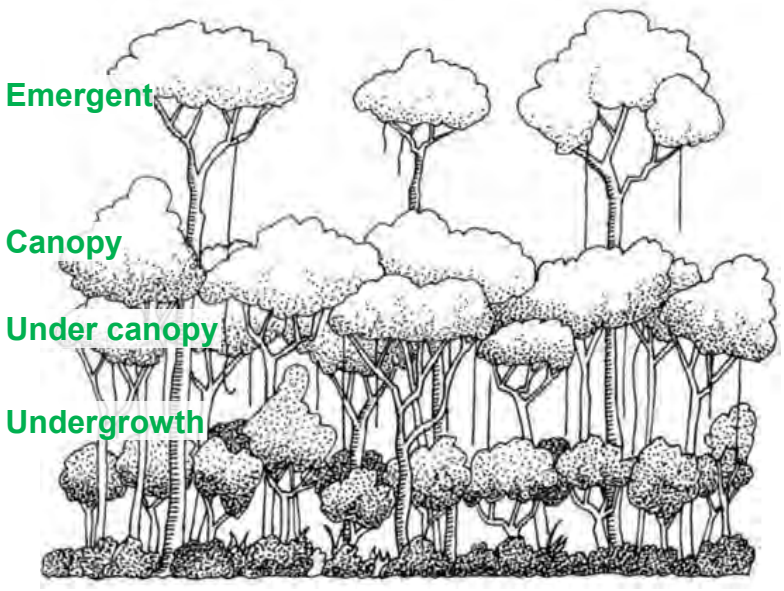
4 Strata

→ Function of the interception of light by tree crown

- **Emergent**: receiving full light from above and from all sides
- **Canopy**: receiving full light from above
- **Under canopy** : receiving a part of light from above
- **Undergrowth**: receiving diffuse no direct light

Heterogeneity of the vertical stratification between site

High diversity in vertical forest stratification



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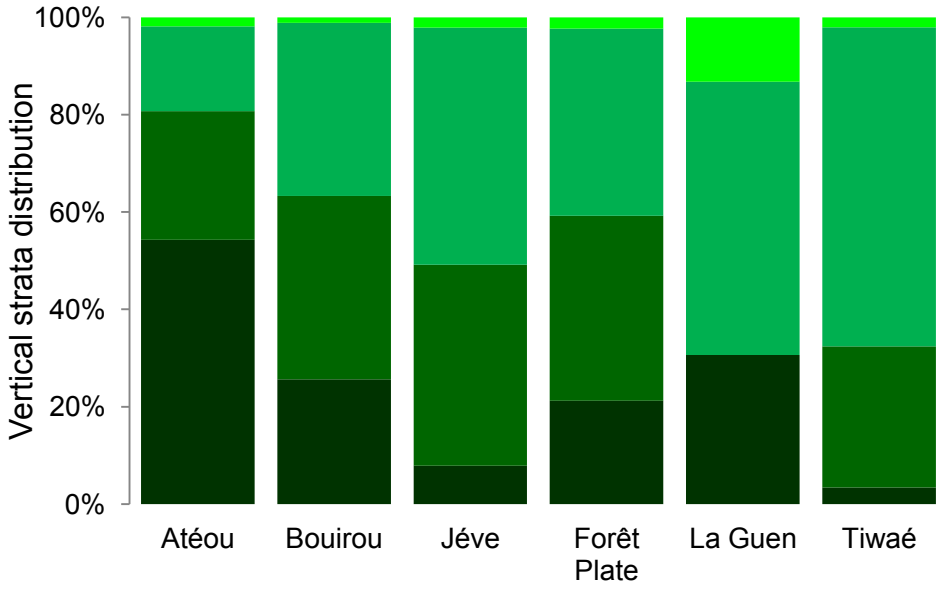
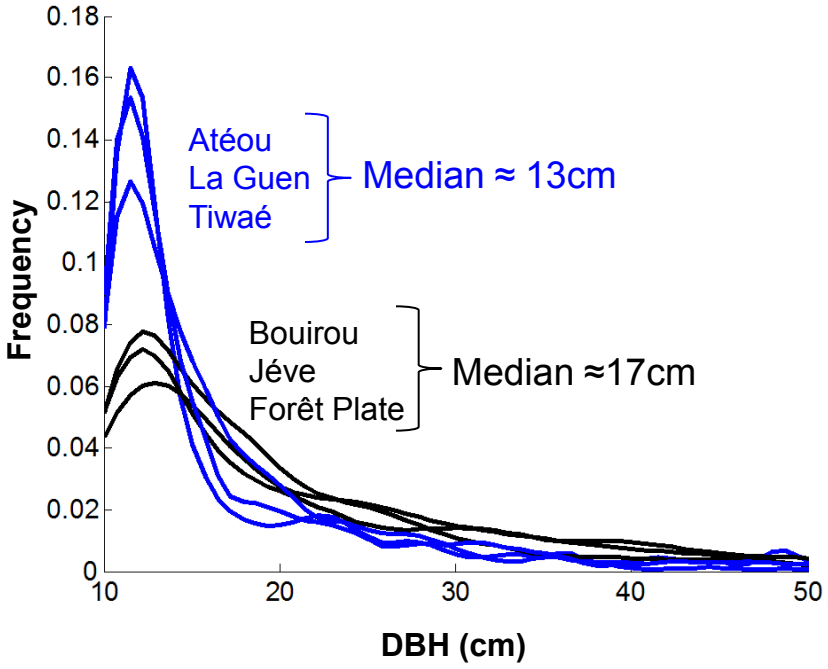
Heterogeneity of the vertical stratification between sites

↓

Different states of the forest dynamic



Small diametric structure…



→ BA of plot ($m^2.ha^{-1}$)

➢ 2 patterns of diametric distribution

➢ % of stems >40: 8-20%
It participate > 50% of BA

➢ BA variability among site

➢ High mean BA: 54 ±15 $m^2.ha^{-1}$

BA world?

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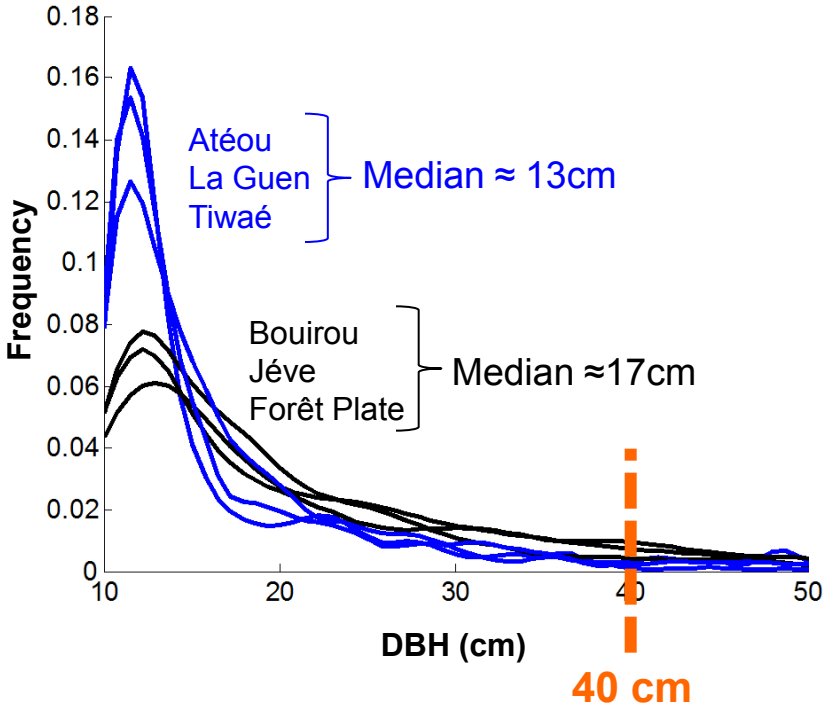

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  50 % of stems are < 13-17 cm
  > 80% stems are < 40cm

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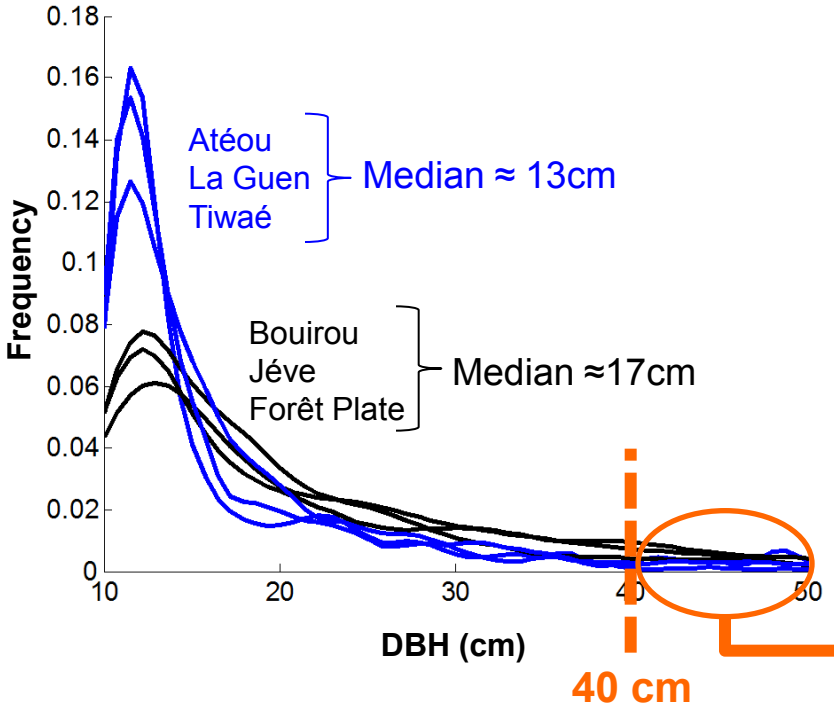

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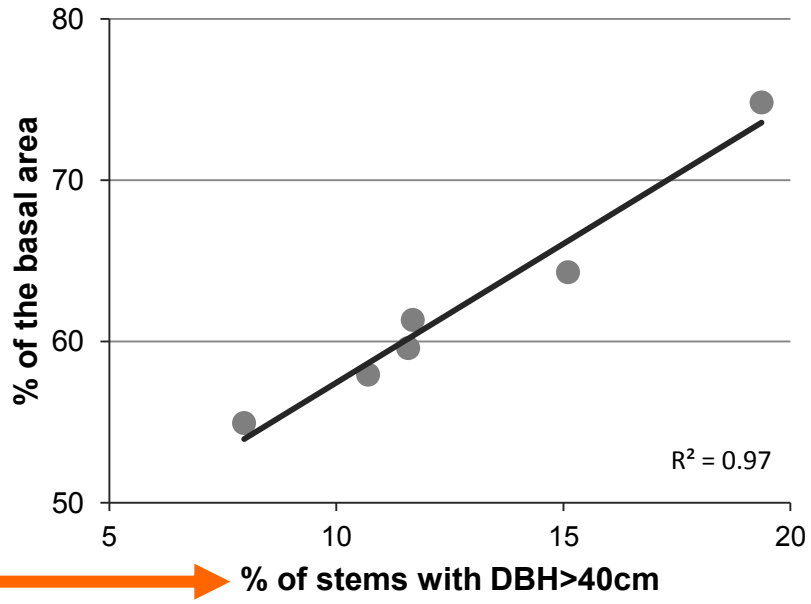

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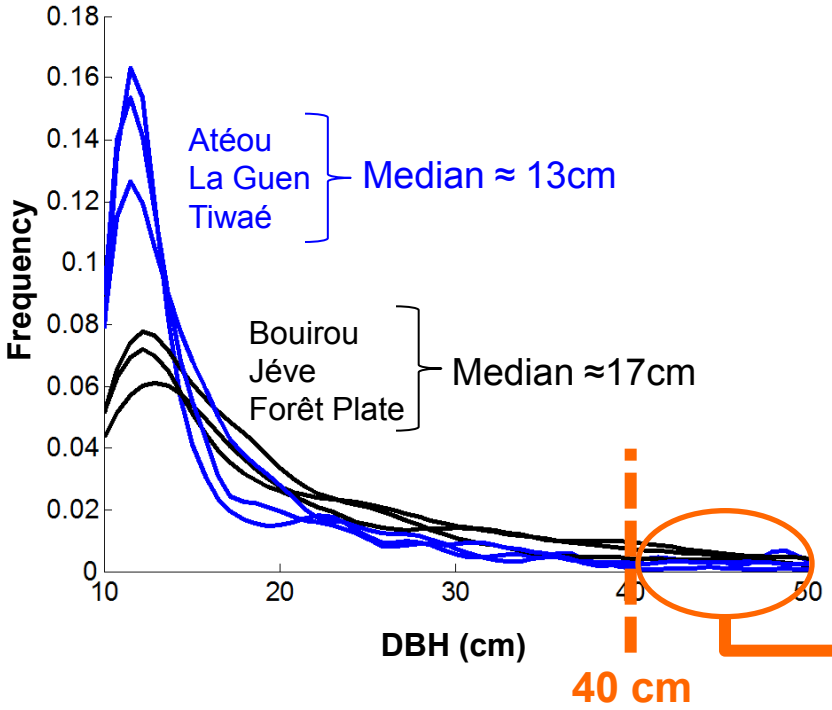

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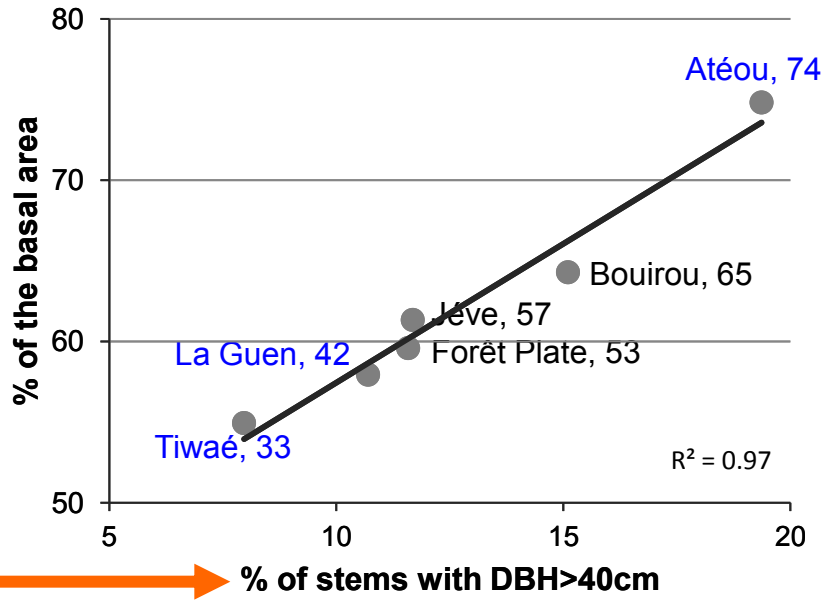

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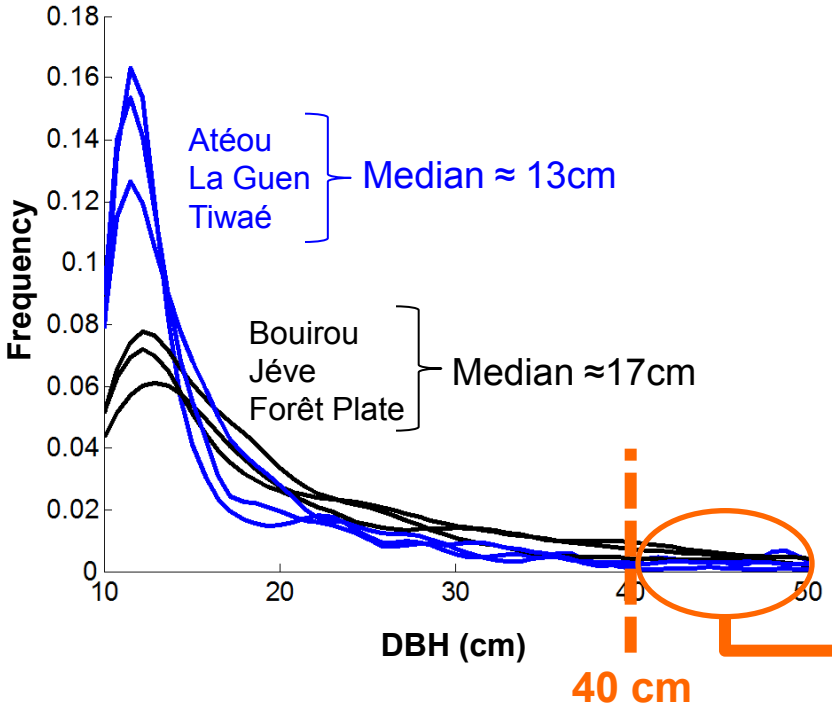

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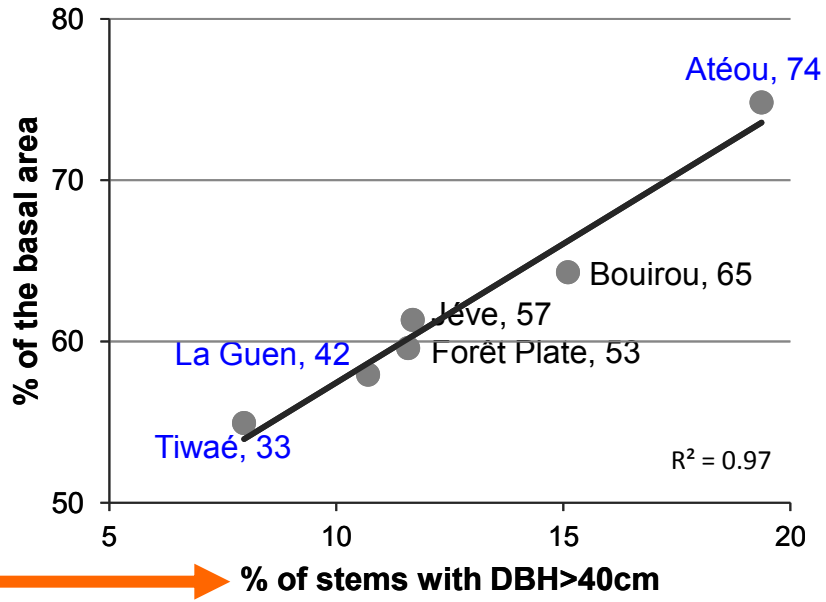

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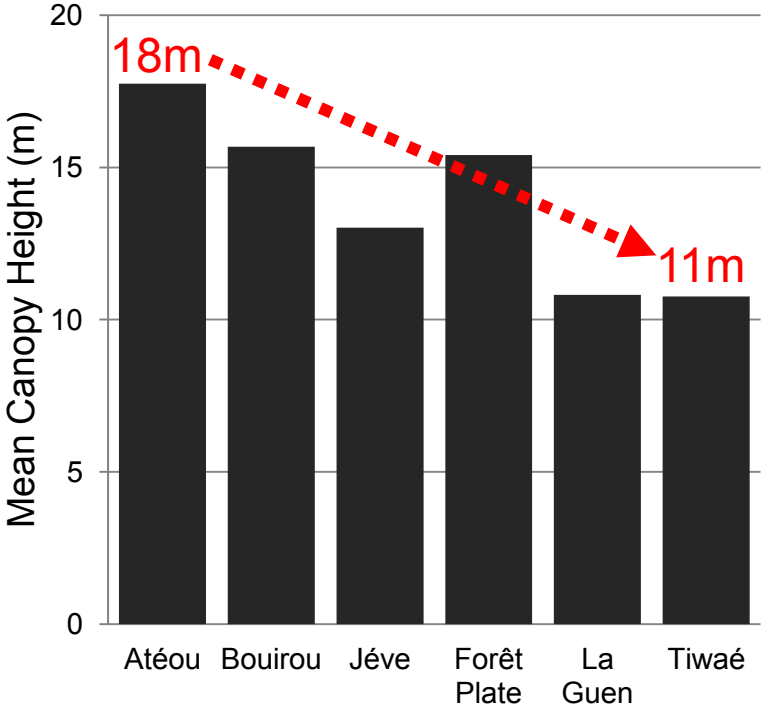
Australia= 50±12.2 / Amazonia= 23±10.2

A low forest canopy



➢ Heterogeneity of the mean canopy height among sites

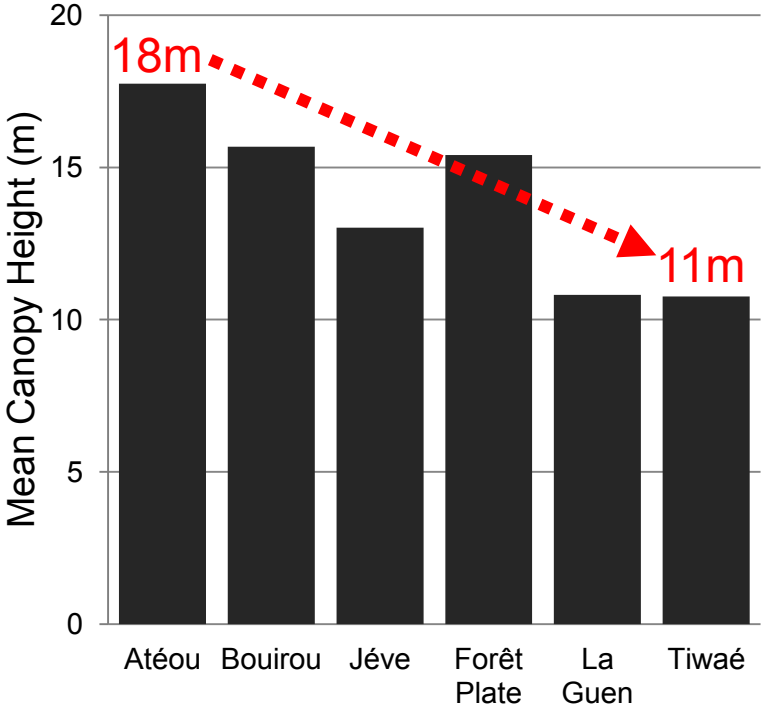
➢ Diameter-Height allometry: model (ref)

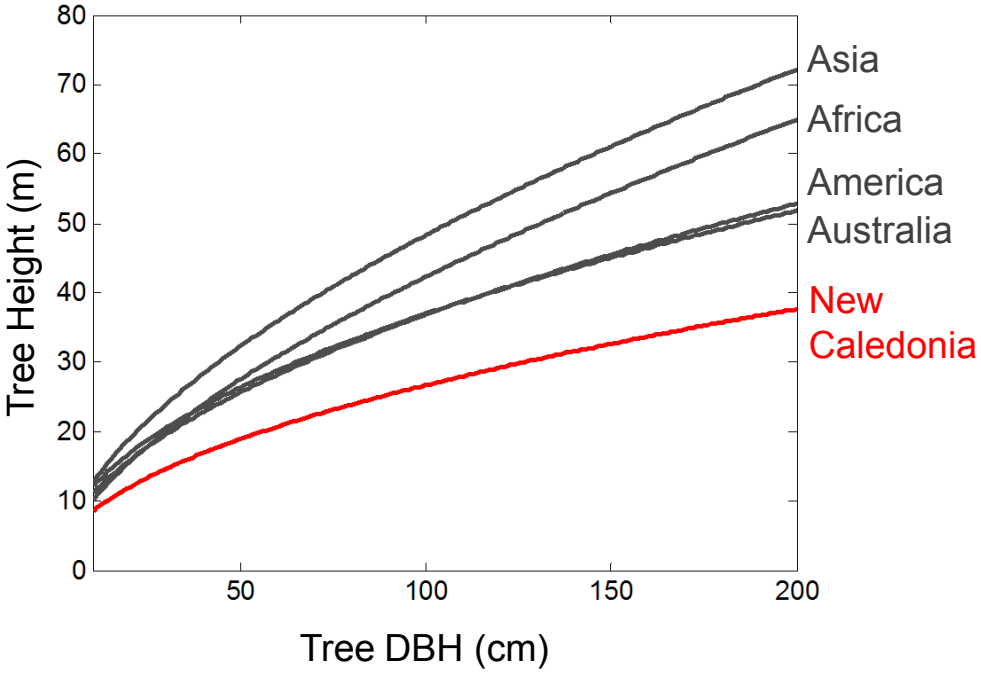
➢ Low canopy height

Ham: ~ 70 m in Asia

~50m in America

A low forest canopy



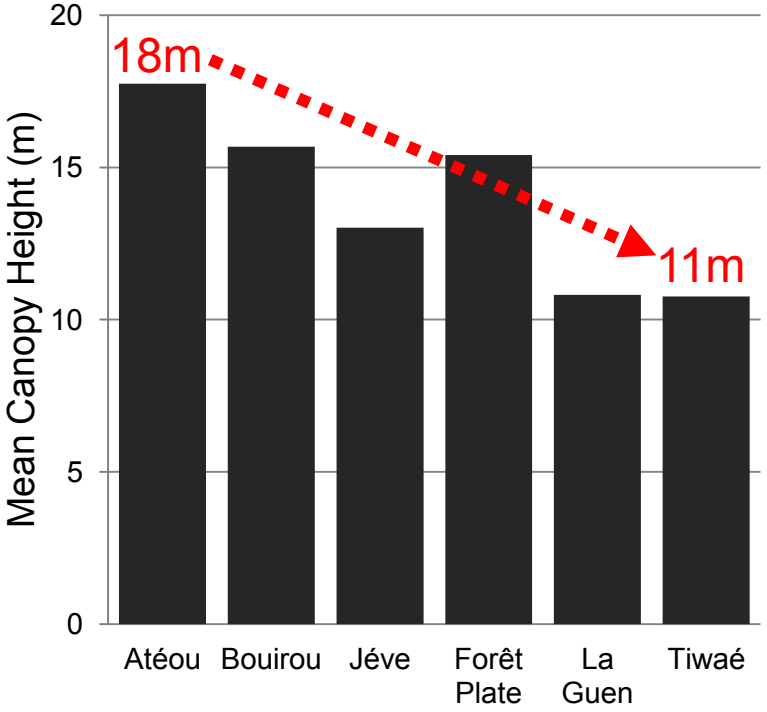


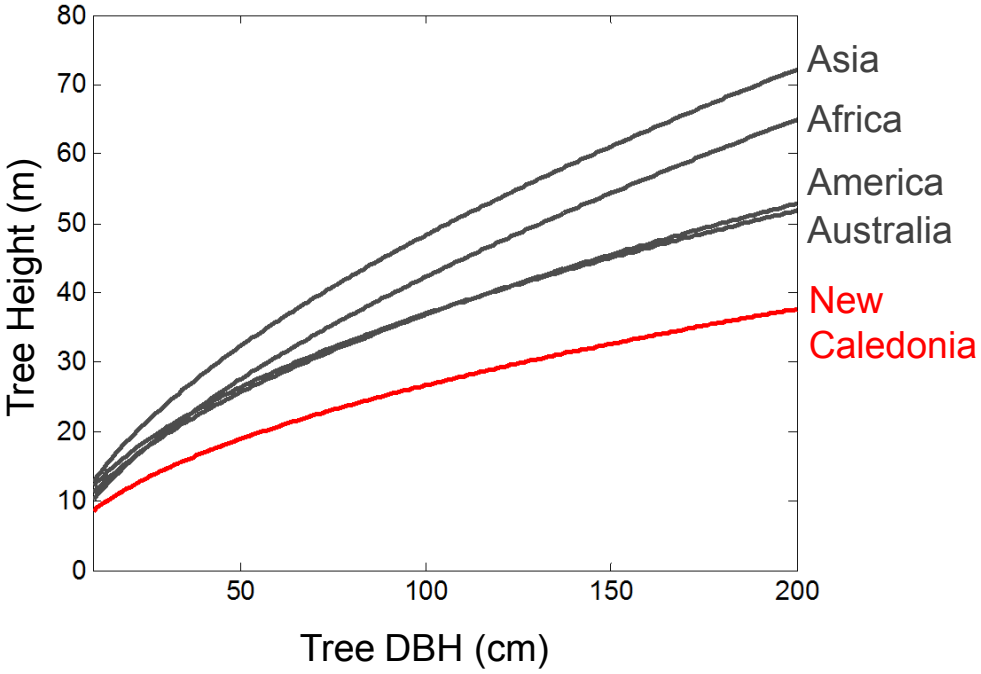
➢ Heterogeneity of the mean canopy height among site

➢ Diameter-Height allometry
(Feldpausch et al., 2011)

➢ Low canopy height: 38m
Hmax: ~ 70 m in Asia
~50m in America

A low forest canopy





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Hmax: ~ 70 m in Asia
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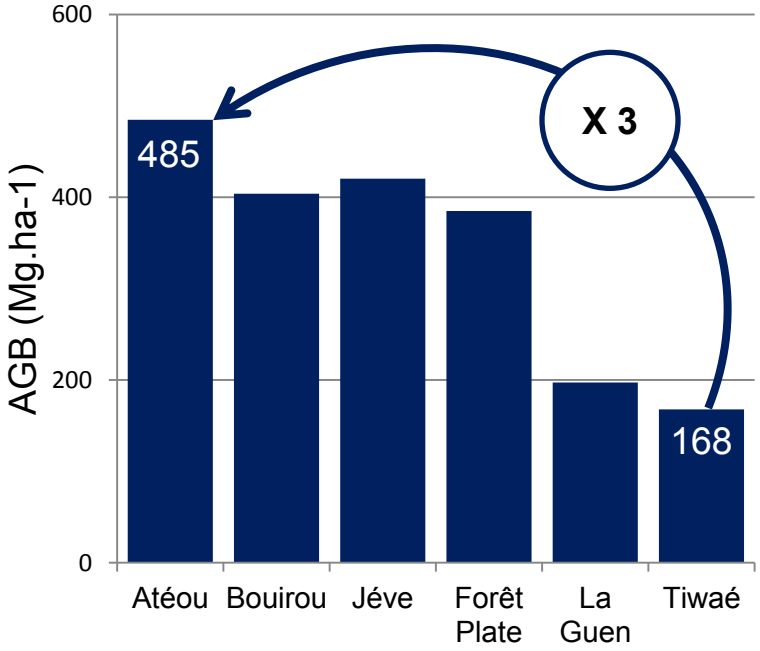
Caledonian rainforests are « Stocky »

Largest trees as descriptors of AGB

Above-ground biomass : $AGB = 0.0509 * \sum(WD * DBH^2 * H)$ *Chave et al.,2005*

Mg.ha-1

H: tree Height and WD: Wood Density



→ inter-site AGB heterogeneity

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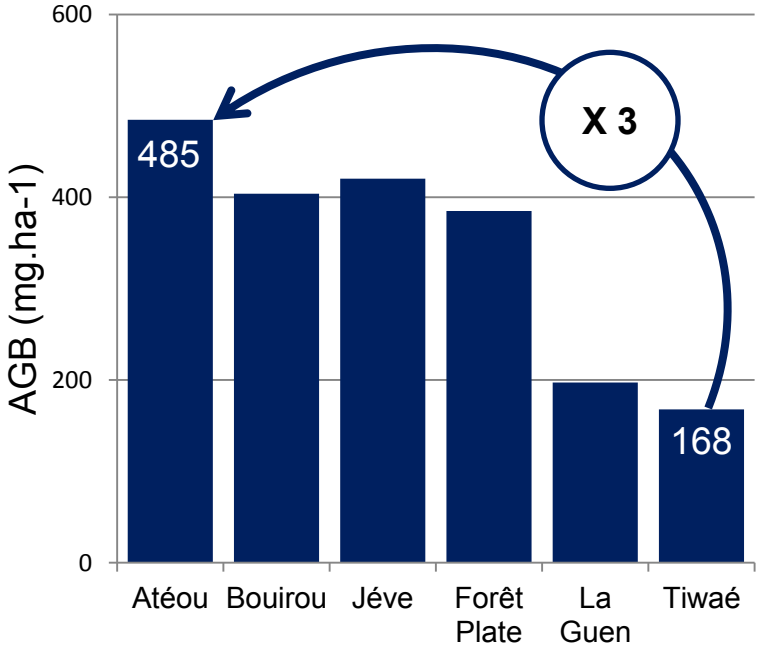
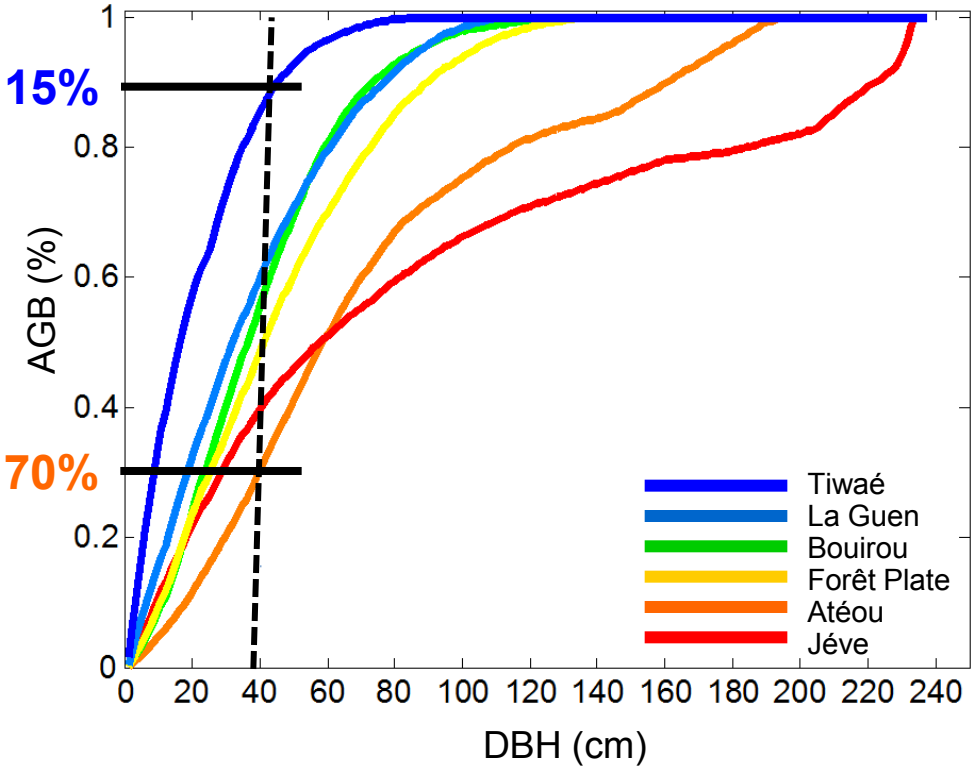
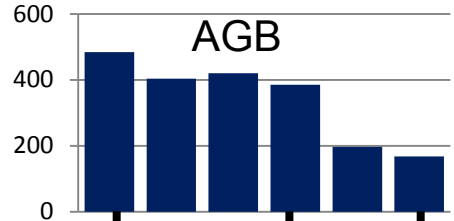




→ inter-site AGB heterogeneity

→ different contributions of large diameters to explain biomass

Large tree density is the main driver of above-ground biomass



Atéou

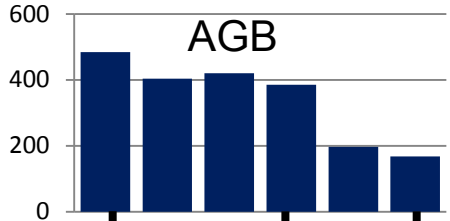
Jéve

Tiwaé

\- Tree density +

\+ DBH size **Crown size** Canopy stratification -

Antin et al., 2013



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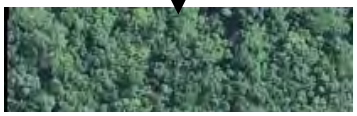

Canopy grain = the image aspect of the uppermost forest layer

Canopy texture provides information on forest structure

Conclusion

(1) Rainforest structure

- **High** Density
- **High** Basal area
- **Low** Canopy height

Conclusion

1. Rainforest structure
   - **High** Density
   - **High** Basal area
   - **Low** Canopy height

   → **High heterogeneity in New Caledonian rainforest**

2. Rainforest biomass
   - → First estimation
   - → High **variability**
   - → **Large DBH density**

Conclusion

1 Rainforest structure

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High heterogeneity in New Caledonian rainforest

2

- First estimation
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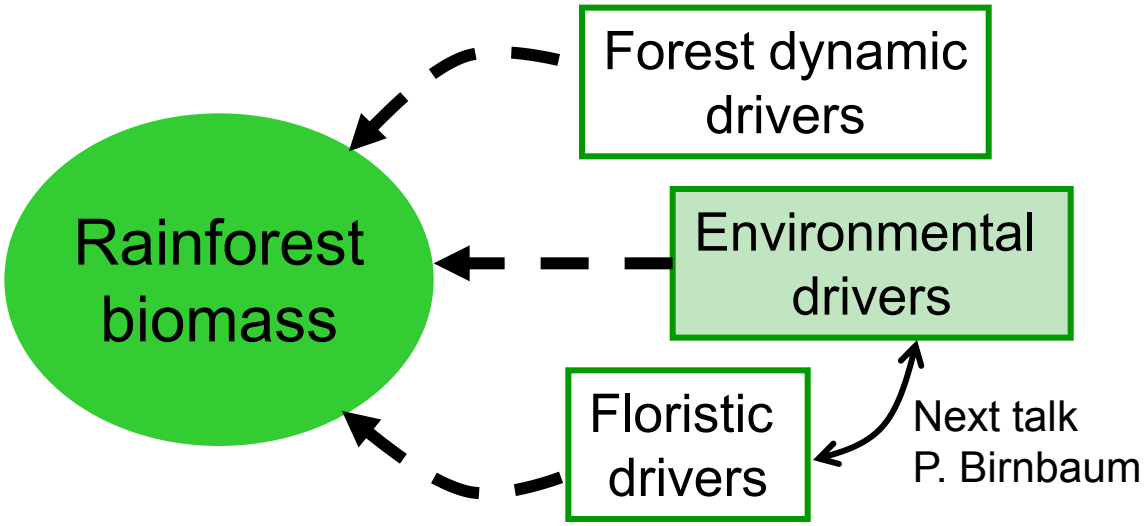

Next step: Defining a **typology of rainforests**

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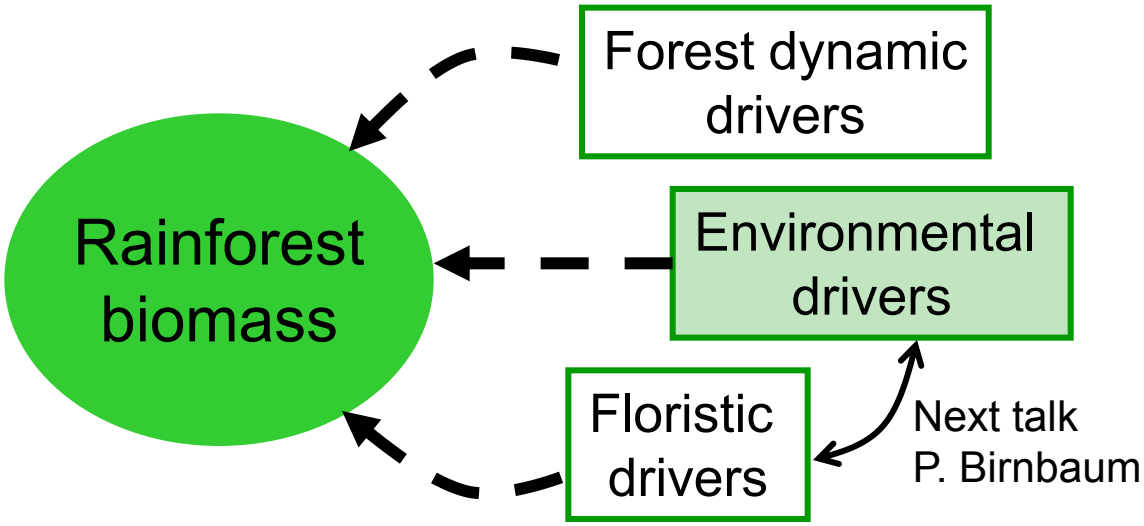

Next step: Defining a **typology of rainforests**

CANOPY GRAIN APPROACH

FOTO method *(Couteron, 2002; Proisy et al.,2007; Barbier et al., 2010)*

→ integrates size, number and tree crown overlap

Contact: blanchard@iac.nc

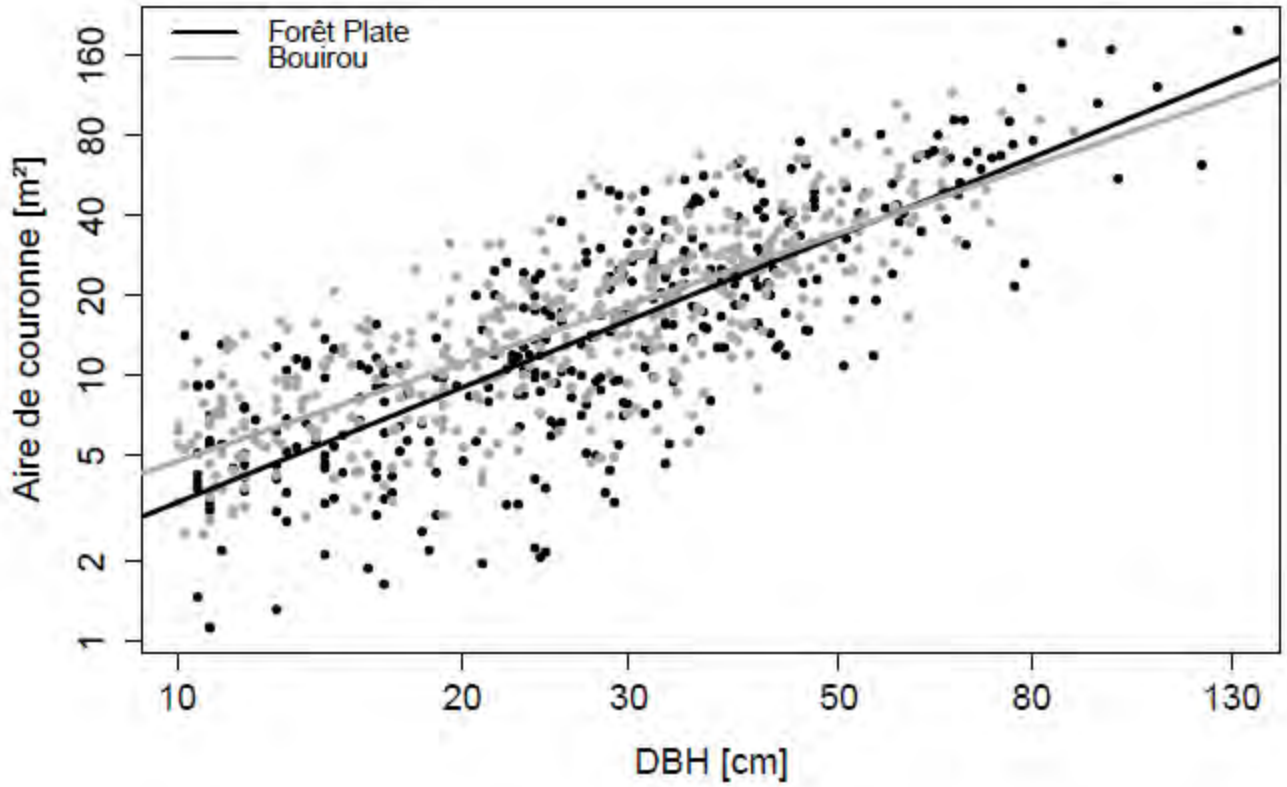

FIGURE 10 – Régression linéaire : allométrie $\log(K_{area}) = \log(a) + b.\log(D)$