Spatial variation of photosynthesis in tropical pristine forests: saplings vs. adults

Lore Verryckt[(1)], Clement Stahl[(2)], Sabrina Coste[(3)], David Ellsworth[(4)], Erik Verbruggen[(1)], Elodie Courtois[(1)], Ifigenia Urbina[(5)], Sara Vicca[(1)], Josep Peñuelas[(5)], Ivan Janssens[(1)]

(1) University of Antwerp, Belgium (2) INRA, UMR Ecofog, French Guiana (3) Université de Guyane, French Guiana (4) Western Sydney University, Australia (4) CREAF Barcelona, Spain

The role of phosphorus?

Understanding what determines the spatial variation of photosynthesis is crucial for modelling canopy photosynthesis. **Within canopy variation** is often explained by **leaf stoichiometry**. Trees **optimise** their **nitrogen (N) allocation** to maximise photosynthetic capacity under the different light conditions. The **role of phosphorus (P)** in this relationship is still **unknown**, but low P might influence how N is used (Reich et al. 2009).

Research aims

Determine the drivers of variation in leaf photosynthesis through

(1) studying the **vertical variation** in photosynthesis,

(2) the role of nutrients, and specifically **P**, on this variation and

(3) how these patterns vary **spatially**.

Study site

The tropical forests of **French Guiana** are very **poor in soil P availability**. At our study site the soil Olsen P concentration ranges from 2.3 ppm in the bottomland to 1.5 ppm at the terra firme, whereas inorganic N ranges from 9.2 to 18.6 ppm.

The plots of this study are situated in **Paracou**, a forest site 100 km west of the capital Cayenne.

Methodology

We carried out 468 **gas exchange** measurements **at different height levels** in the canopy of 8 plots distributed over two topographic positions. We compared gas exchange of **upper canopy, lower canopy, and saplings**.

Focus is on 5 common families:

- Fabacea (n = 110),
- Lecythidaceae (n = 69),
- Myristicaceae (n = 42),
- Annonaceae (n = 41),
- Chrysobalanceae (n = 33).

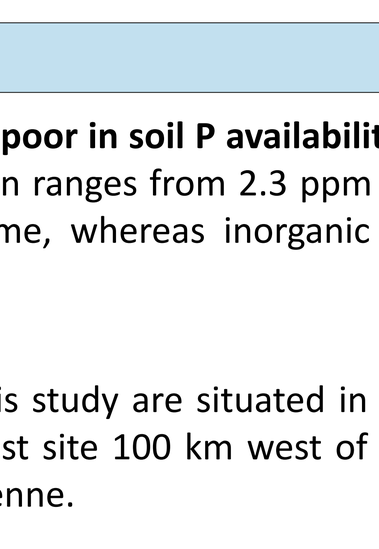

Figure 1. Measuring photosynthesis with a LI-6400XT (left) in the canopy and (right) on saplings in the tropical forest of French Guiana.

Results

Vertical variation

The carboxylation rate, **Vcmax**, and the electron transport rate, **Jmax**, **increase with** increasing **height** level in the canopy**. Leaf P explains** this **vertical variation** in both Vcmax and Jmax – note the separation of upper canopy leaves for P and Vcmax or Jmax. We did not find differences in leaf N between upper and lower canopy for adult trees.

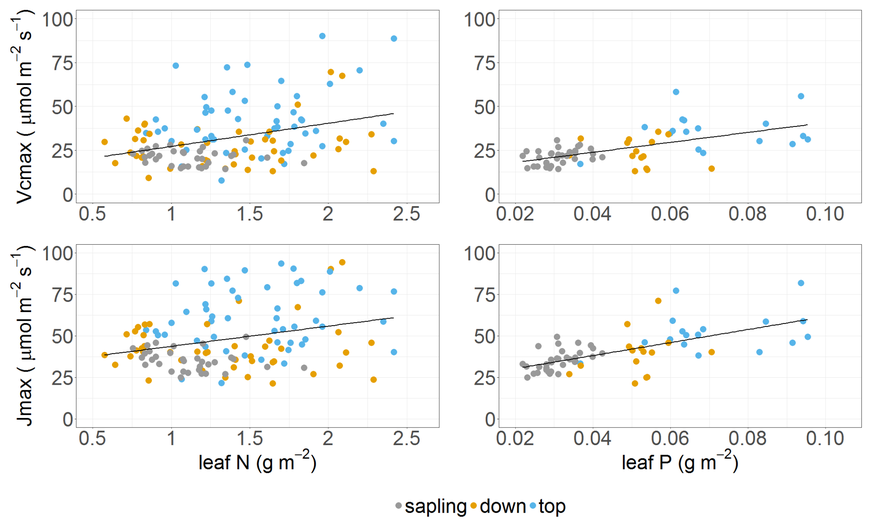

Figure 2. Phosporus contributes more to the vertical variation of Vcmax and Jmax than nitrogen. (n = 295)

Co-limitation N and P?

Domingues et al. (2010) reported **co-limitation of photosynthetic capacity** by N and P in West African woodlands. When we apply this model to our data, the model generally **overestimates** values for Vcmax and Jmax. Is another factor co-limiting the photosynthetic capacity?

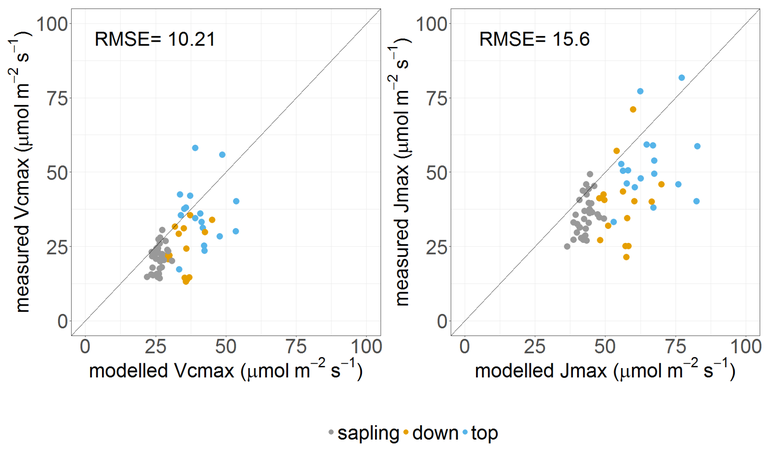

Figure 3. Overestimation of the photosynthetic capacity (Vcmax and Jmax) with the model described by Domingues et al. (2010). RMSE is the root-mean-square error. (n = 295)

The role of phosphorus!

At our field site the **vertical profile** is **determined more by P** than by N. Since most vegetation models use N to model photosynthetic capacity, this information is crucial to improve these models.

Spatial variation of photosynthetic capacity was not found. Both Vcmax and Jmax are **not** well explained by the **co-limitation by N and P**. In the near future we will study this in more detail.

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Further information
https://lllinfrenchguiana.wordpress.com/
lore.verryckt@uantwerpen.be

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Opening new horizons

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