There's no such thing as "The Tropical Rainforest":
incorporating heterogeneity of tropical forests in a global vegetation model

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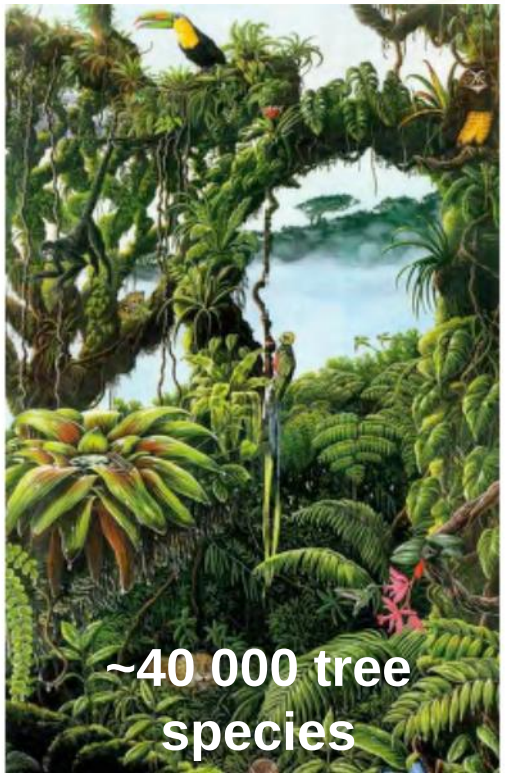
Background & research question

→ Tropical rainforest = high spatial heterogeneity of structure and functioning



- ~55% of global forest C stocks
- ~34% of the global terrestrial photosynthesis

Background & research question

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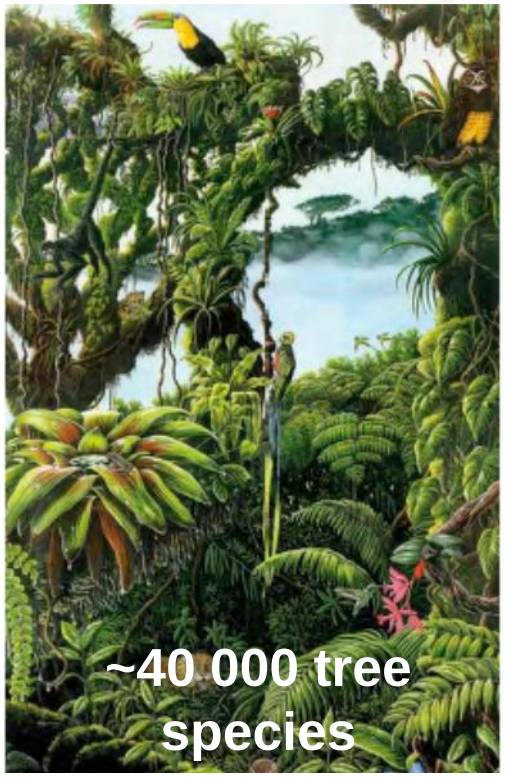
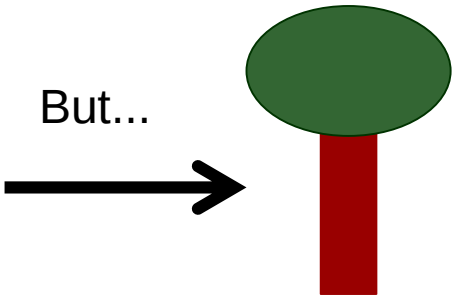


But...

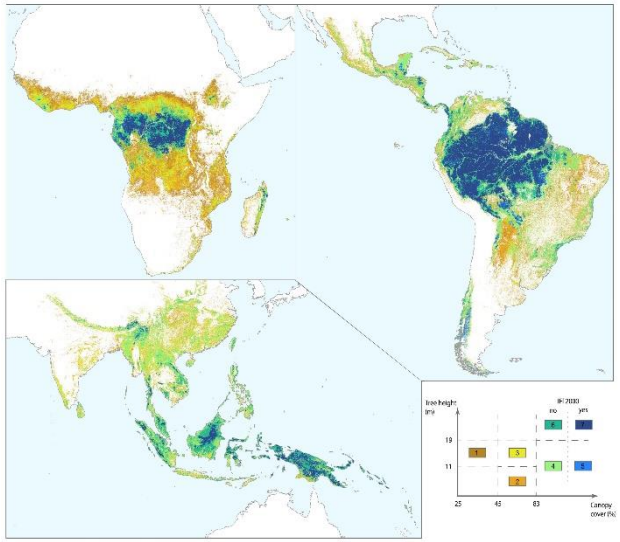


1-3 PFTs

High uncertainties in the estimation of the C cycle due to oversimplifications

Preliminary results – TRENDY v7 comparison

- TRENDY-V7 models (Global Carbon Budget 2018, Le Quéré et al.)
- 15 DGVMs with a unique protocol.
- Mask over the pan-tropical region using forest strata from GLAD (Tyukavina et al. 2015)
- Re-analysis of GPP and Biomass over the 2000-2013 period



Preliminary results – TRENDY v7 comparison

- Most models represent Tropical forests with only 1 or 2 PFTs (Evergreen/Deciduous)
- Only two models have a PFT for savannahs.

Model	CABLE-POP	CLASS-CTEM	DLEM	JSBACH	JULES	LPJ	LPJ-GUESS	LPX-Bern	OCN	ORCHIDEE	ORCHIDEE-CNP	SDGVM	VISIT	SURFEX
PFT	Evergreen Broadleaf Forest Deciduous Broadleaf Forest	Broadleaf evergreen Broadleaf deciduous	Tropical broadleaf deciduous forest Tropical broadleaf evergreen forest Tropical woody wetland South tropical broadleaf deciduous forest South tropical broadleaf evergreen forest	Tropical evergreen trees Tropical deciduous trees	Broadleaf Tree Needle-leaf Tree		Tropical broadleaf evergreen (TrBE) Tropical shade-intolerant broadleaf evergreen (TrIBE), Tropical broadleaf raingreen (TrBR)	Natural vegetation	Evergreen Broadleaf Forest Deciduous Broadleaf Forest	tropical broadleaf evergreen tropical broadleaf raingreen	tropical broadleaf evergreen tropical broadleaf raingreen	Dc_Bl Dc_Nl Ev_Bl Ev_Nl	Tropical evergreen forest/woodland Tropical deciduous forest/woodland	TREE (decideous broadleaf trees) EVER (evergreen broadleaf trees)

Demography coordination

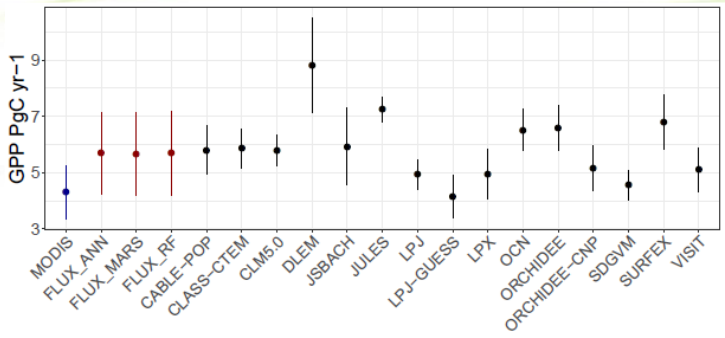
Demography

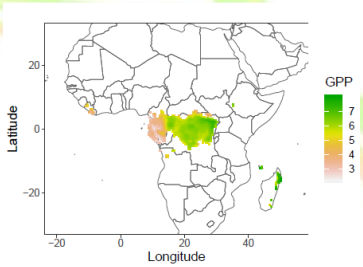
P-model coordination

Preliminary results – TRENDY v7 comparison

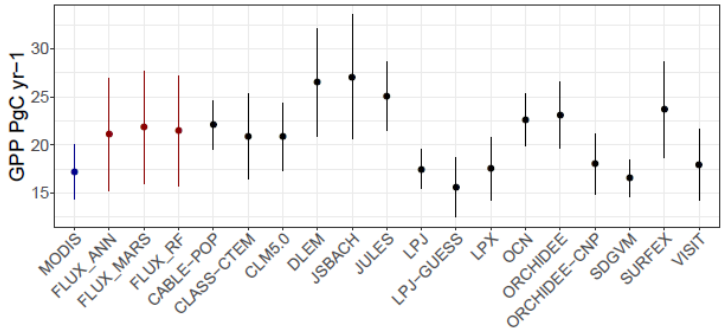
Total GPP
PgC yr^{-1}

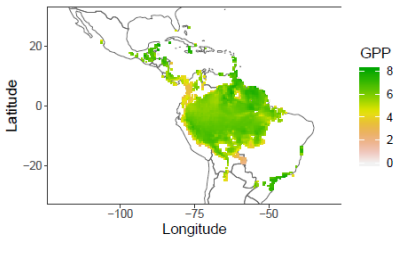
AFR



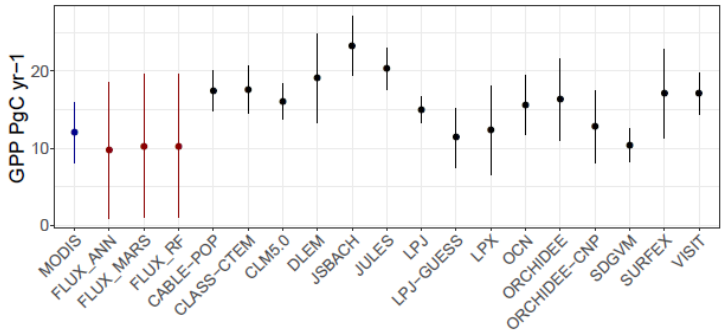


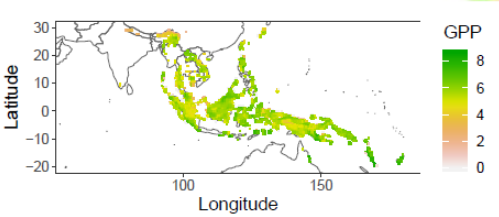
SAM





SEA

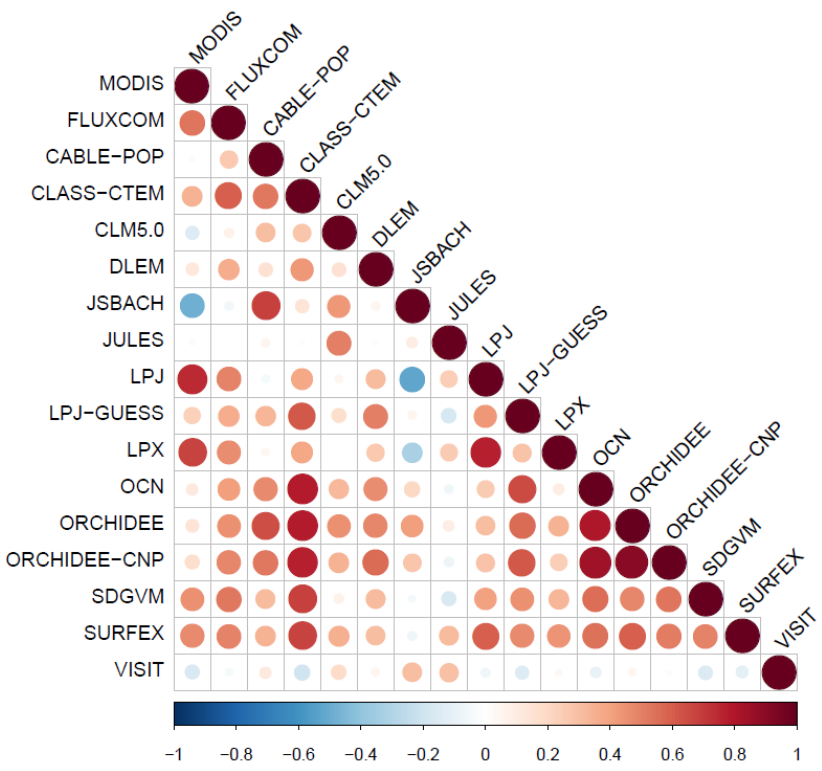




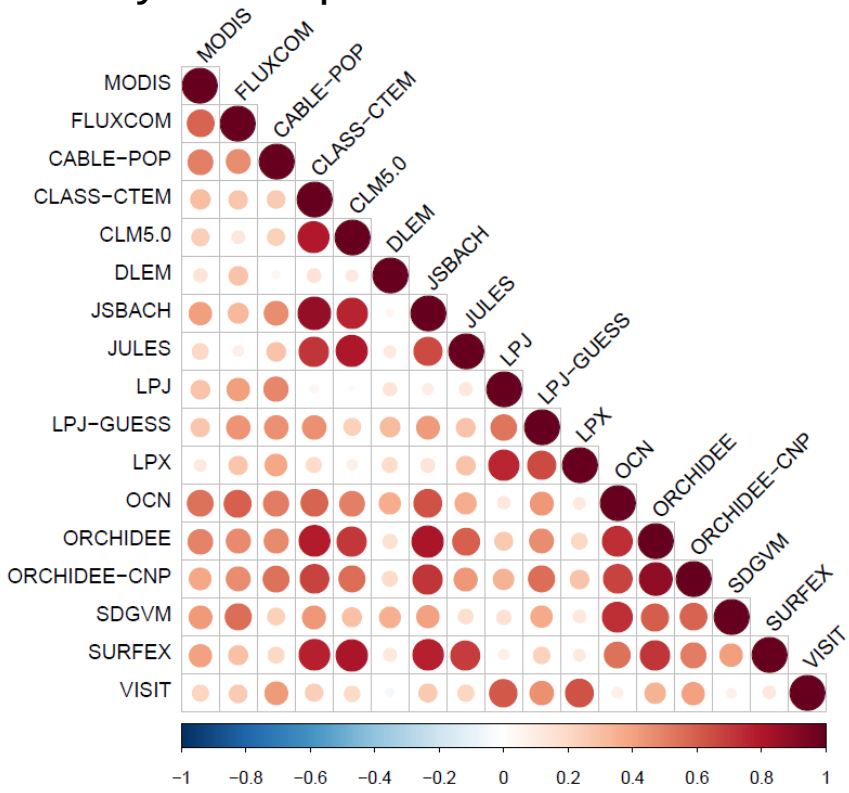
No real distinction between plantations and natural forest

Preliminary results – TRENDY v7 comparison

Some models perform ok for SAM, not for AFR and vice-versa
Some models are ok over the pan-tropic (SURFEX, SDGVM)
→ Need to find why… but not only PFT representation



AFR



SAM

Spatial correlation GPP

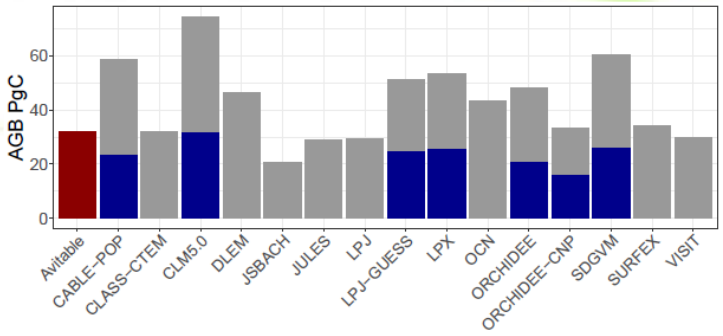
Preliminary results – TRENDY v7 comparison

Total Vegetation Aboveground Biomass in PgC

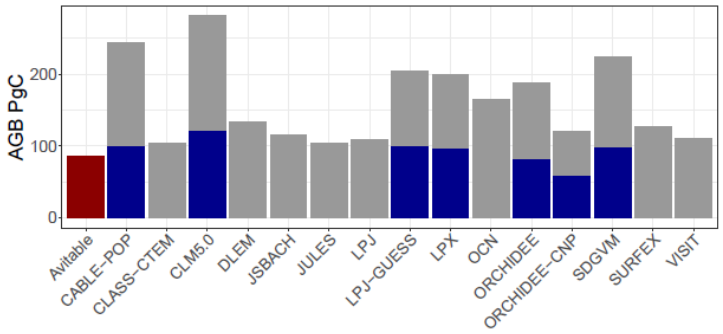
Avitable et al. GCB 2016 (*0,5→ C conversion)

Model cVeg

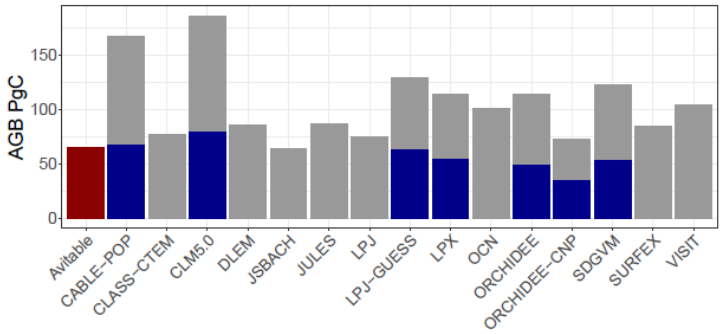
Model cVeg – cRoot (when available)



AFR



SAM



SEA

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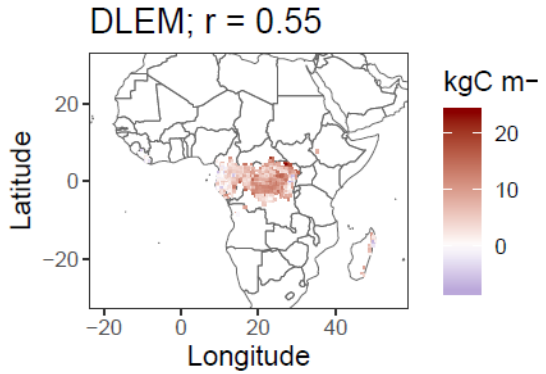

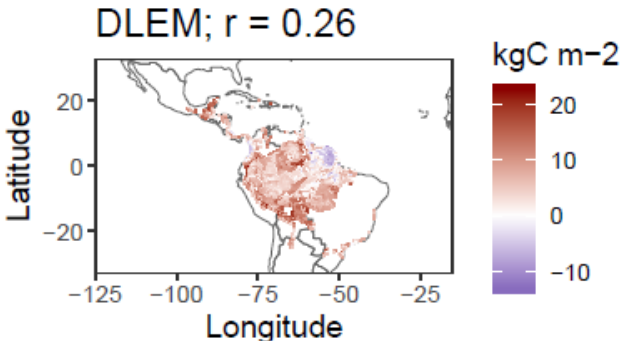

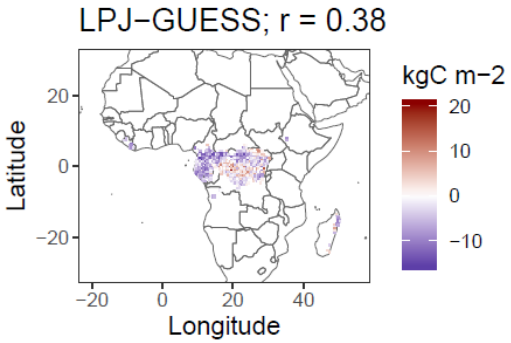

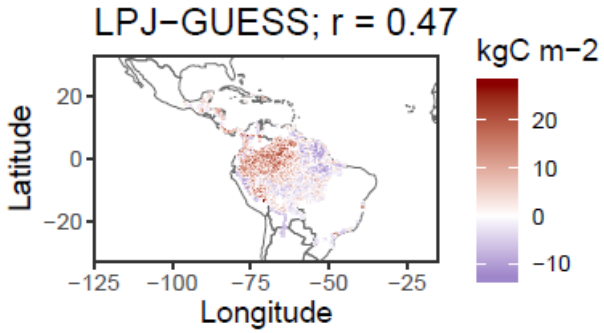

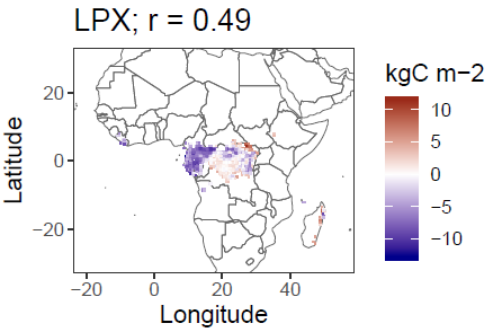

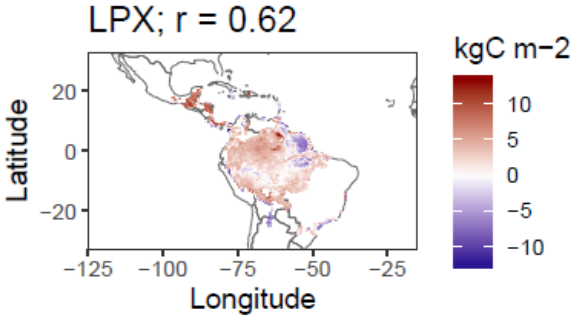

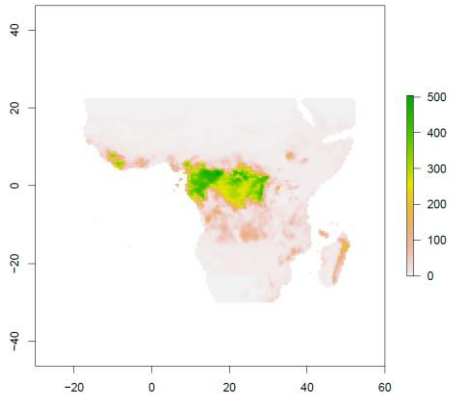

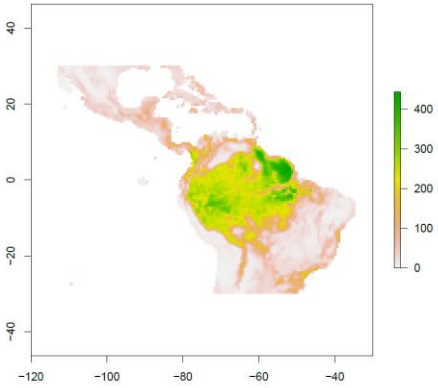

Background & research question

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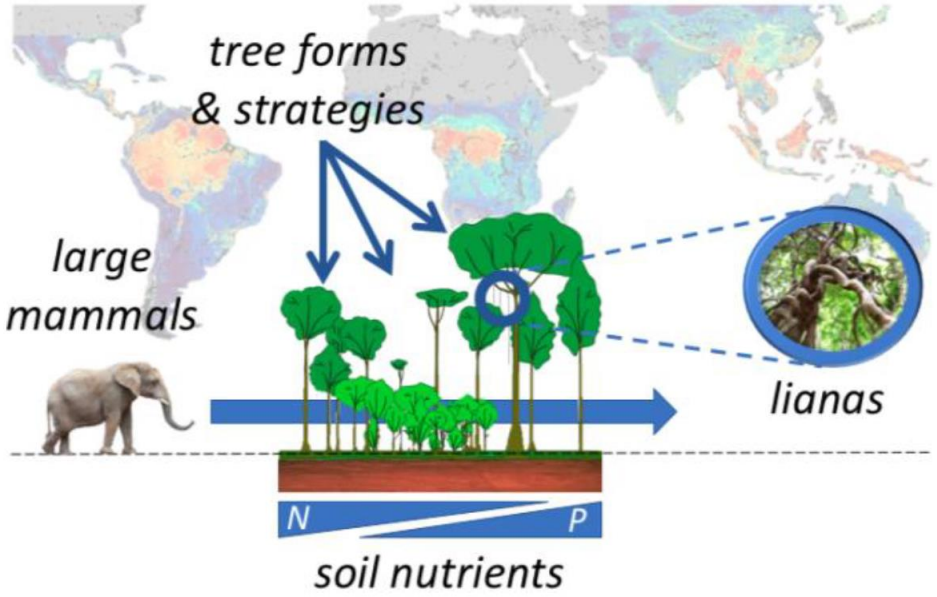


<u>Research question ?</u>:
How the different drivers of forest heterogeneity impact the C cycle at the continental and regional scale.

Specific objectives and expected outputs

Specific project objectives:

(1) Make use of recent and emerging datasets on plant traits and forest structure to create a flexible PFT parameterization for the tropical rainforest;

(2) Contribute to develop a model to account for largely unexplored environmental drivers of rainforest structure and dynamics (i.e. large mammals, lianas, soil nutrients, and allometry);

(3) Observe specific missing components of the rainforest carbon cycle in Africa;

(4) Assess the impact of data abundance and uncertainty on forest dynamics simulations;

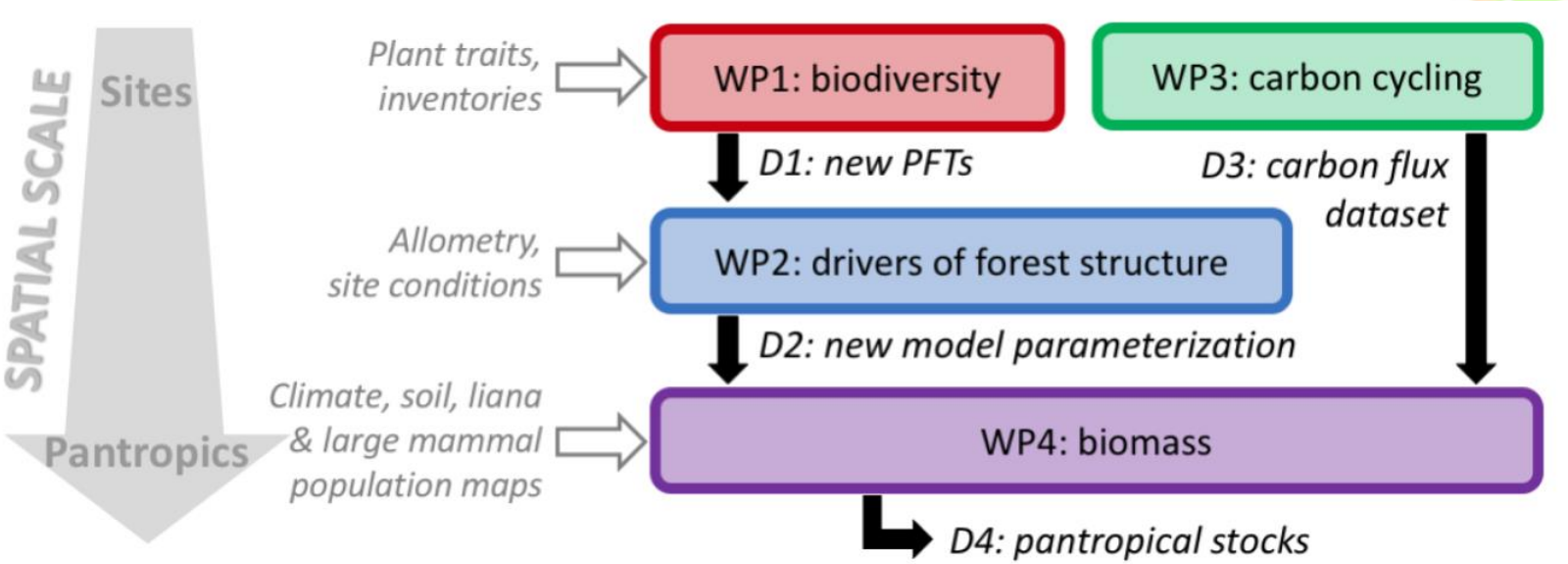
(5) Perform and constrain a final improved simulation of pantropical forest biomass stocks.

Project impacts and novelty:

- First representation of the pantropical rainforest heterogeneity in a DGVM
- New observations of carbon cycling in central Africa (a data-poor region)
- Further understanding of the driving processes of rainforest structure and carbon cycling
- Improved pantropical estimates of aboveground woody biomass, useful to climate-change researchers, decision makers, and land-use planners
- Stepping stone for next research (e.g. impacts of future climate on the rainforest carbon sink)

Work plan and methodology

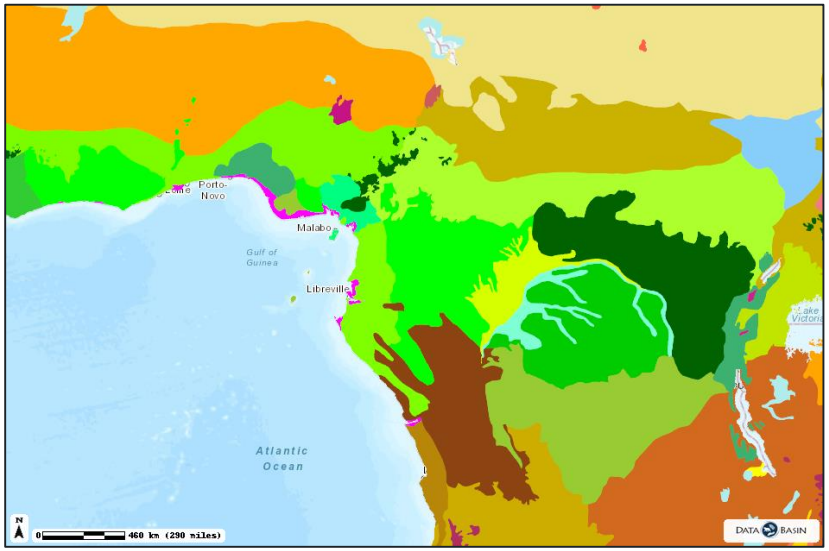
O1: Classification of plant strategies along trait space and environmental gradients→ define new “Flexible” PFTs



- Derive new flexible PFTs along the wood, **root** and leaf economic axes reflecting plant strategies
- Exploration of trade-off between traits
- Exploration of trait dependency to environmental conditions

Work plan and methodology

- Strong environmental filtering on species composition and structure (Fayolle et al. 2012, Fayolle et al. 2014)



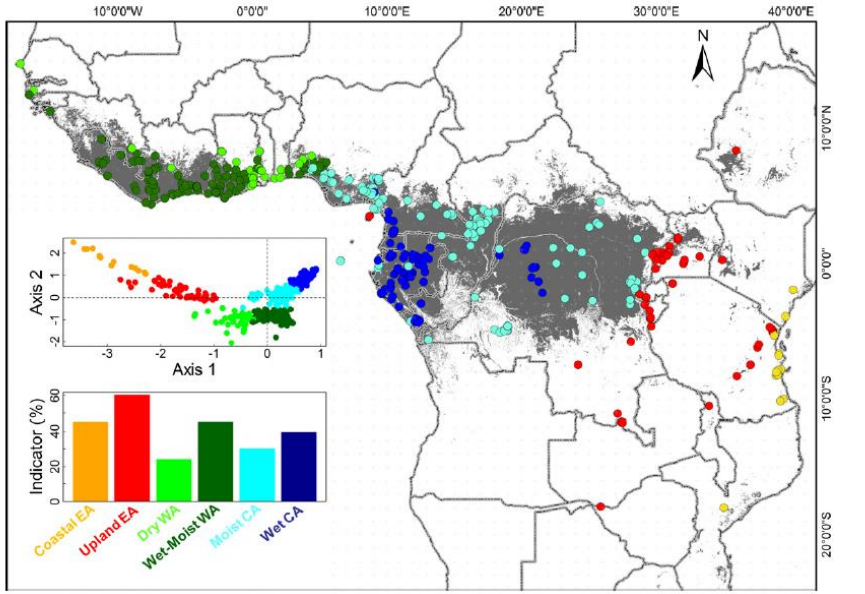


Figure 2 Distribution of the six floristic clusters defined by our analysis of 1175 tree species in 455 sample sites of tropical African forests overlaid on a base map showing country boundaries and forest cover according to Mayaux *et al.* (2004). Each sample is colour coded by cluster: Coastal East Africa (n = 16), Upland East Africa (n = 50), Dry West Africa (n = 37), Wet-Moist West Africa (n = 116), Moist Central Africa (n = 130) and Wet Central Africa (n = 106). Top inset: axes 1 and 2 of the correspondence analysis showing the six clusters. Lower inset: percentage of indicator species for each cluster.

Work plan and methodology

O1: Classification of plant strategies along trait space and environmental gradients→ define new “Flexible” PFTs

O2: Define, implement and calibrate modules representing drivers of forest structure (allometry, mammals, lianas, nutrient/drought stress)

→ ED2 & ORCHIDEE

Received: 7 September 2018 | Revised: 2 July 2019 | Accepted: 4 July 2019
DOI: 10.1111/gcb.14769

Check for updates

PRIMARY RESEARCH ARTICLE

Global Change Biology WILEY

Modeling the impact of liana infestation on the demography and carbon cycle of tropical forests

Manfredo di Porcia e Brugnera[1] | Félicien Meunier[1,2] | Marcos Longo[3,4] | Sruthi M. Krishna Moorthy[1] | Hannes De Deurwaerder[1] | Stefan A. Schnitzer[5,6] | Damien Bonal[7] | Boris Faybishenko[8] | Hans Verbeeck[1]

nature geoscience ARTICLES
https://doi.org/10.1038/s41561-019-0395-6

Carbon stocks in central African forests enhanced by elephant disturbance

Fabio Berzaghi[1,2,3*], Marcos Longo[4,5], Philippe Ciais[2], Stephen Blake[6,7], François Bretagnolle[3], Simone Vieira[8], Marcos Scaranello[4], Giuseppe Scarascia-Mugnozza[1] and Christopher E. Doughty[9]

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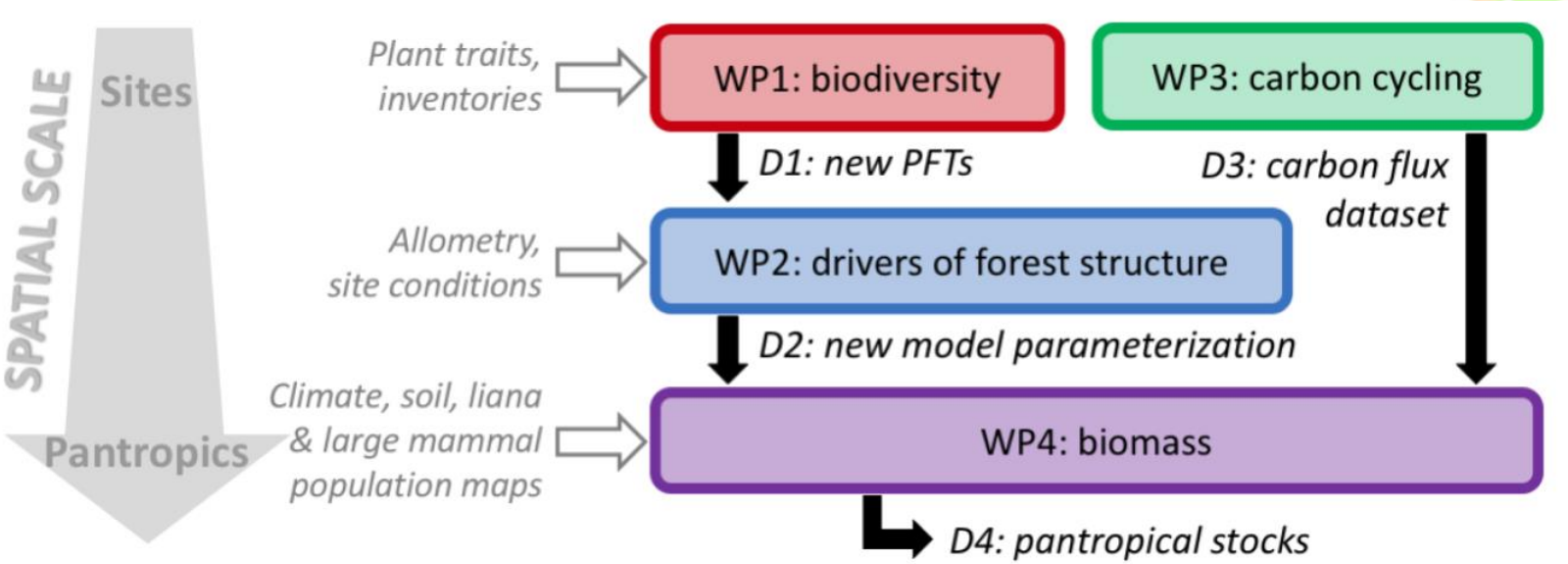


O3: Understanding the seasonal patterns of CO2 exchange at 2 sites

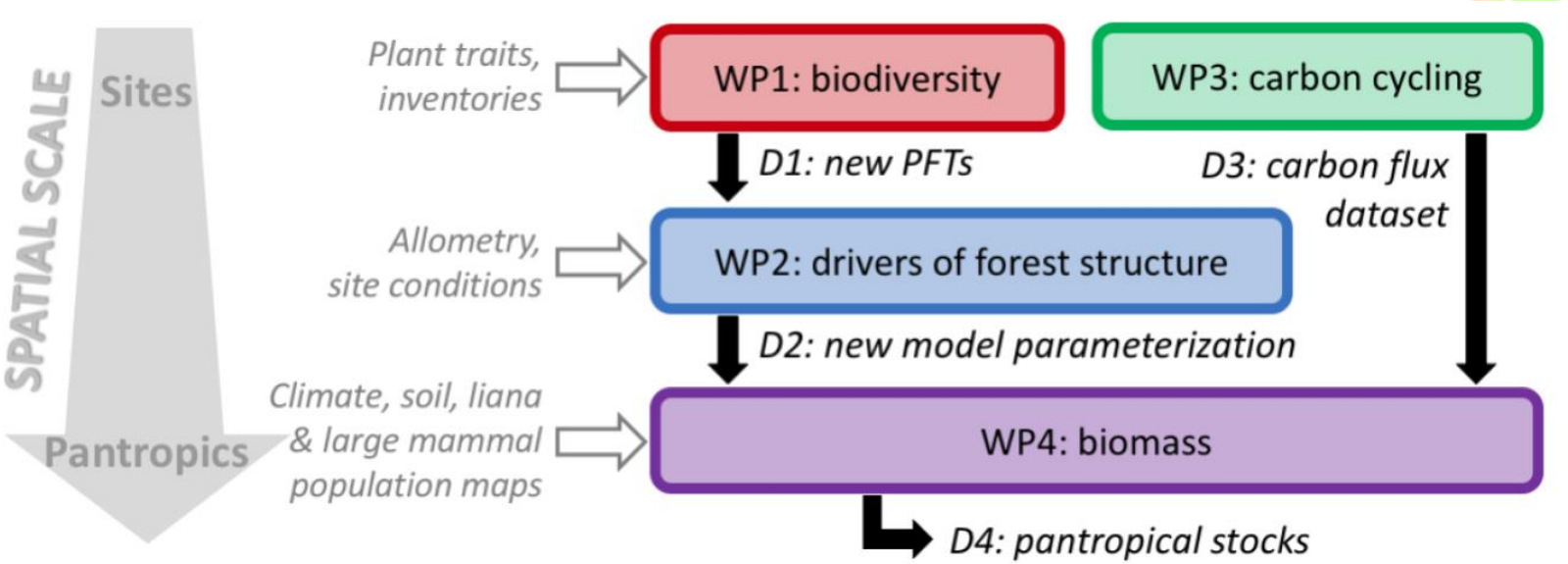
→ First flux tower installed in RDC (Yangambi)

→ Leaf gas exchange measurement planned in 2020 at the tower site

Work plan and methodology

O1: Classification of plant strategies along trait space and environmental gradients→ define new “Flexible” PFTs

O2: Define, implement and calibrate modules representing drivers of forest structure (allometry, mammals, lianas, nutrient/drought stress)



O3: Understanding the seasonal patterns of CO2 exchange at 2 sites

O4: New estimates of pantropical forest biomass stocks

Thanks!

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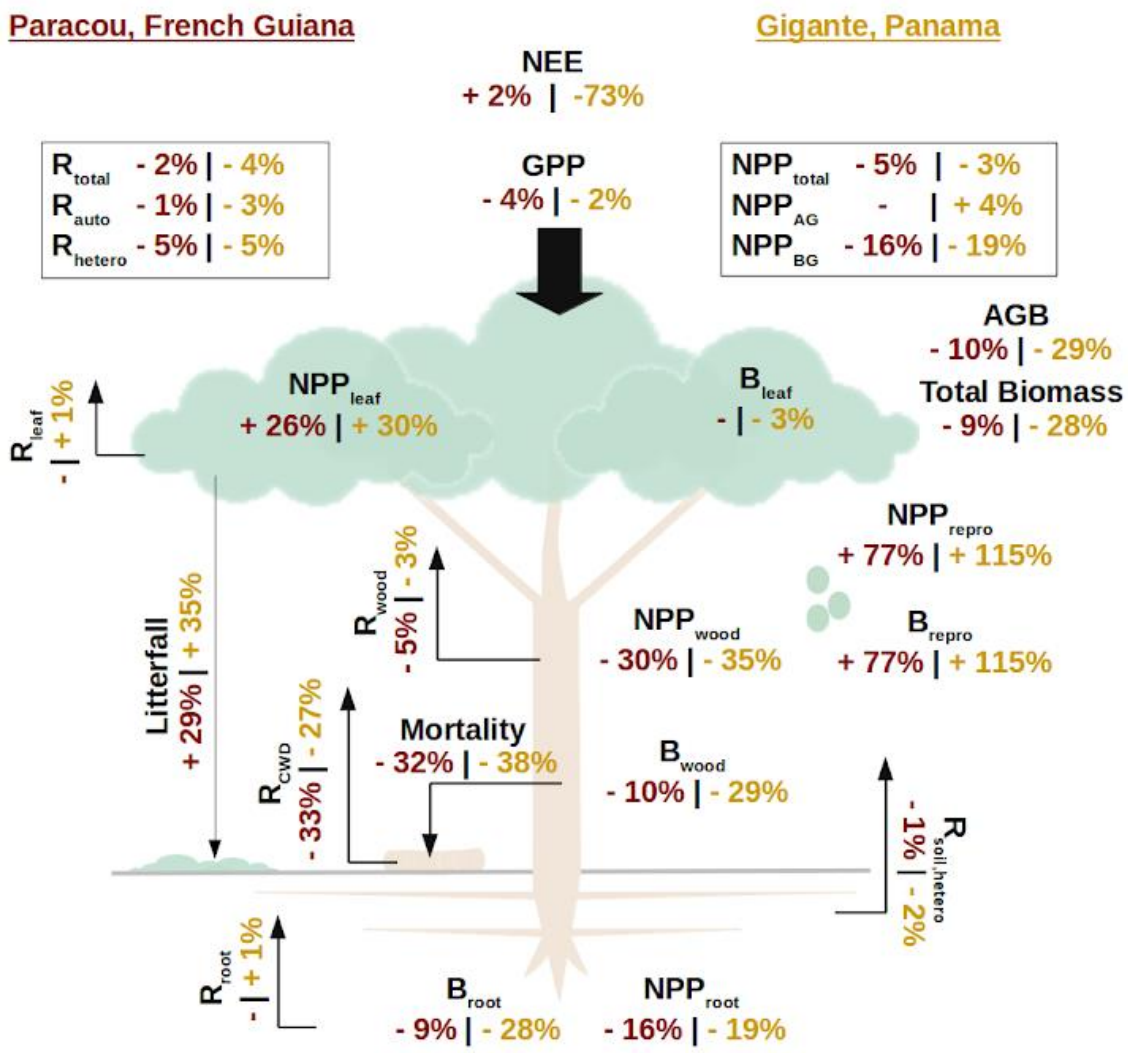


Relative changes in tropical forest carbon pools and fluxes due to lianas

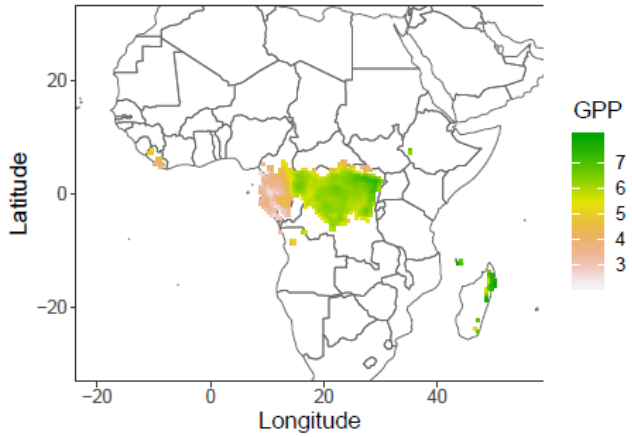
→ felicien.meunier@gmail.com, manfredo.diporciaebrugnera@ugent.be

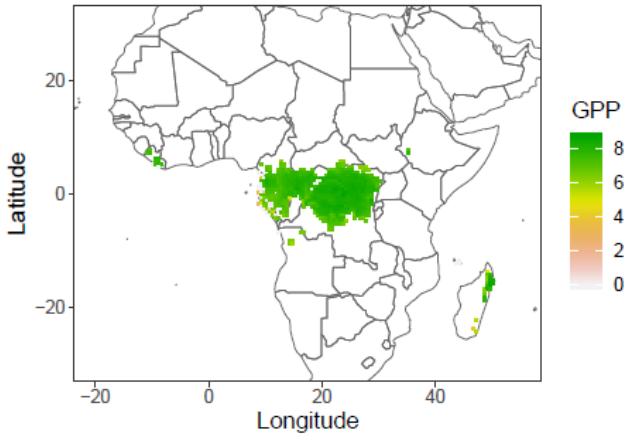
Spatial comparison

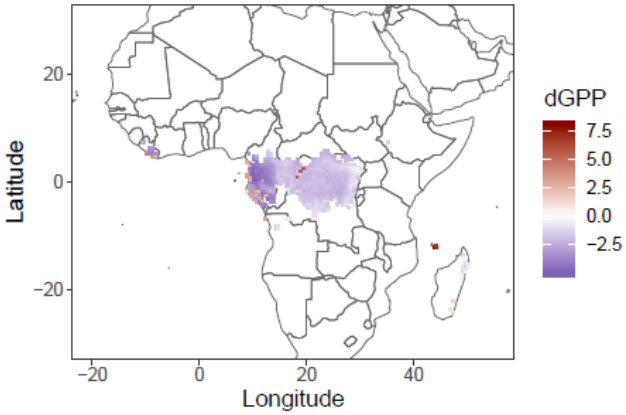
MODIS

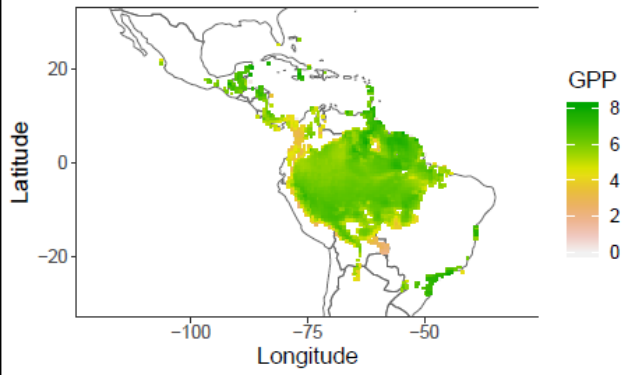
FLUXCOM

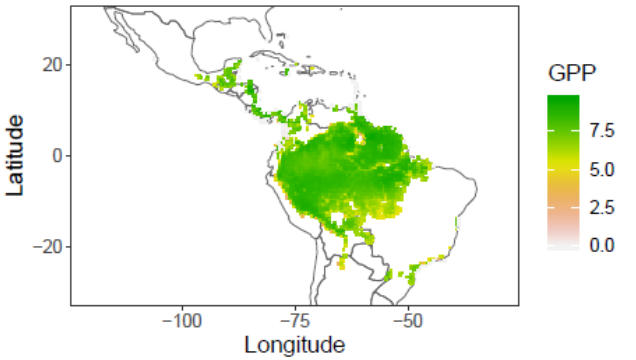
MODIS-FLUXCOM

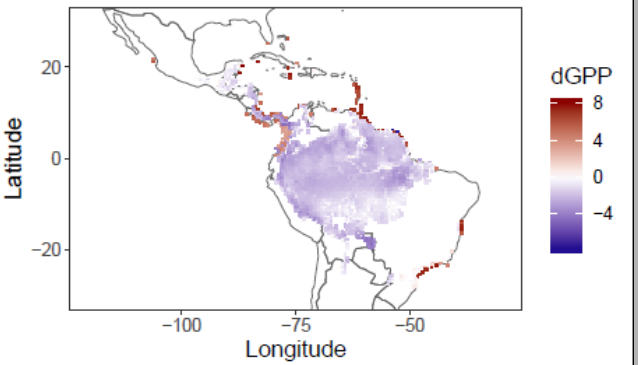




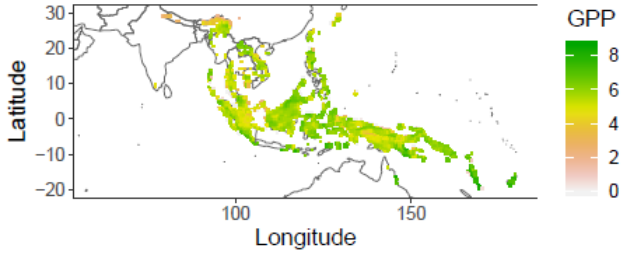




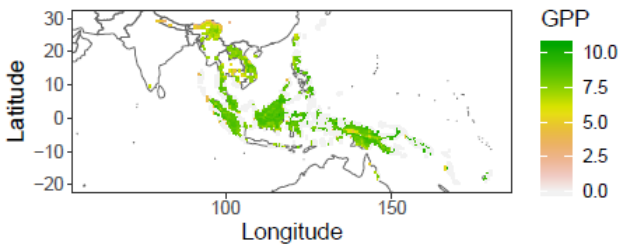




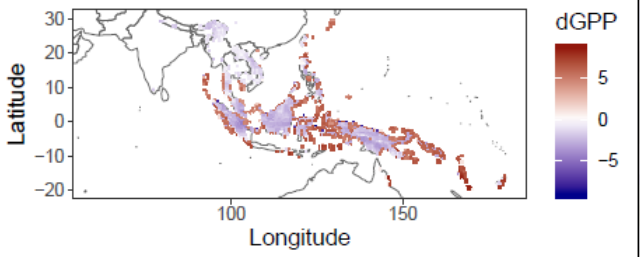
MODIS



FLUXCOM



MODIS-FLUXCOM



MODIS-FLUXCOM, GPP temporal correlation

→Discrepancies between products
→Question of good dataset to assess heterogeneity…