The Dynamic Vegetation Model LPJ-GUESS-HUMBOLDT
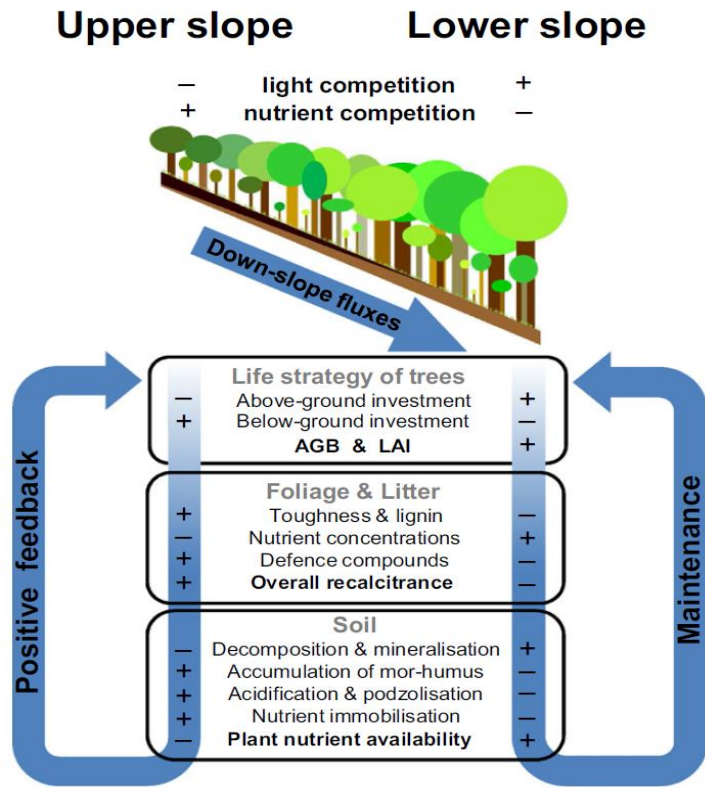
Simulating plant trait shifts within an altitude gradient

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Drivers of Biodiversity in Mountain Forests

- High species diversity along the altitudinal gradient[1]

- As much carbon as lowland tropical forest due to soil storage[2]

- What processes drive this diversity, what is its role in the ecosystem?

- Hypothesis: Temperature and topography cause differences in soil and vegetation nutrient content driving biodiversity

[1] Báez & Homeier (2017)
[2] Leuschner et al. (2013)

Werner & Homeier (2012) Funct. Ecol.

The LPJ-GUESS-HUMBOLDT model

- The **HUMBOLDT** (**H**ydroatmo **U**nified **M**odel of **B**i**O**logical interactions and **L**ocal **D**iversity of **T**raits) combines trait diversity in an individual based model with soil organic matter dynamics (LPJ-GUESS) to reproduce the biodiversity ecosystem changes in mountain biomes.

HUMBOLDT

GUESS

Tropical   Temperate

- Importance: Such a model would be valuable to predict the impacts of environmental change to the biodiversity of tropical mountain forests

HUMBOLDT'250

Model Features

- Trait-tradeoffs from local measurements

- Stress-induced changes in stroichiometry, resorption and allometry

- Dynamic C, N and P cycles of organic matter

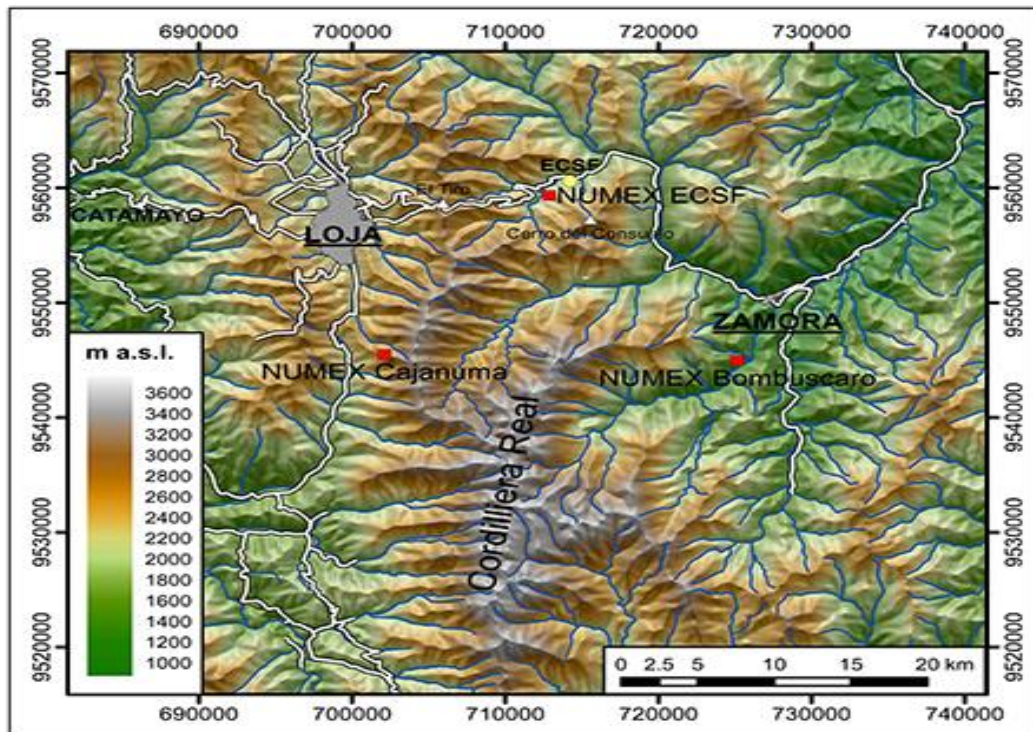- Mycorrhiza uptake of nutrients
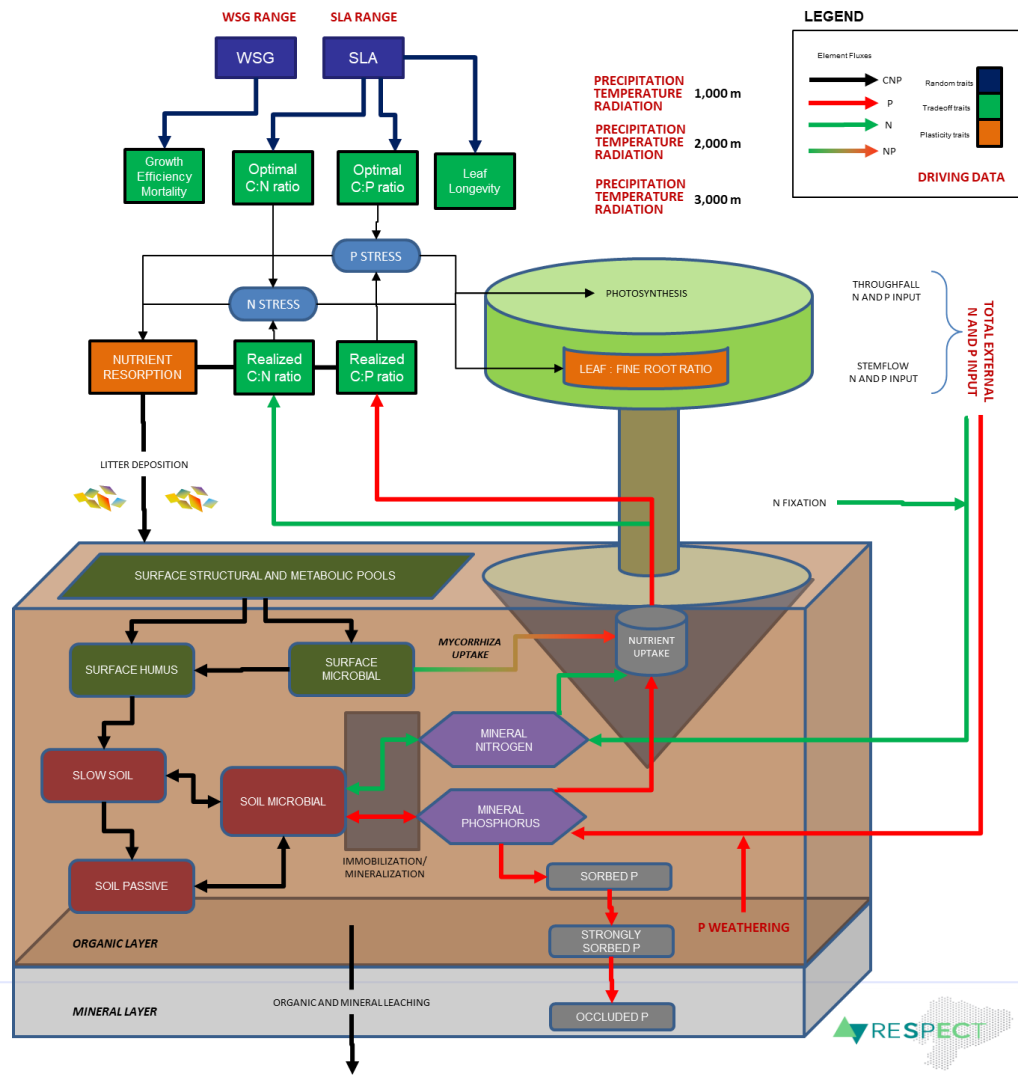
Model Setup and Experiments

- Are the implemented processes capable of reproducing the observed gradient of functional traits and forest structure?

- Is nutrient limitation relevant for producing this community gradient?

Altitudinal Gradient

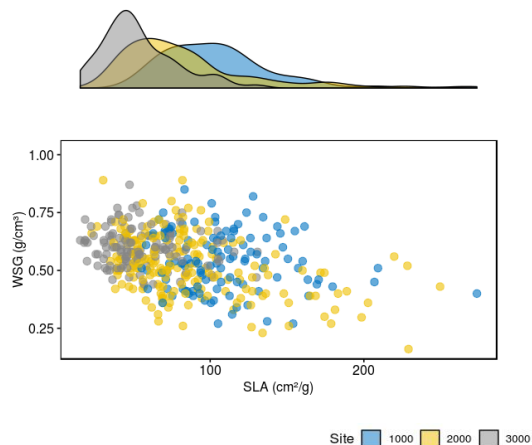**1.000 m, 2.000 m, and 3.000 m elevation plots**

Homeier et al. (2017)

Model driving variables

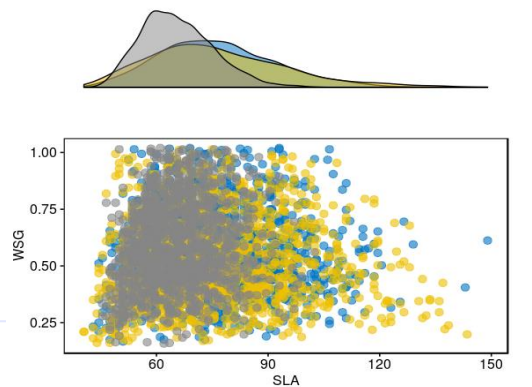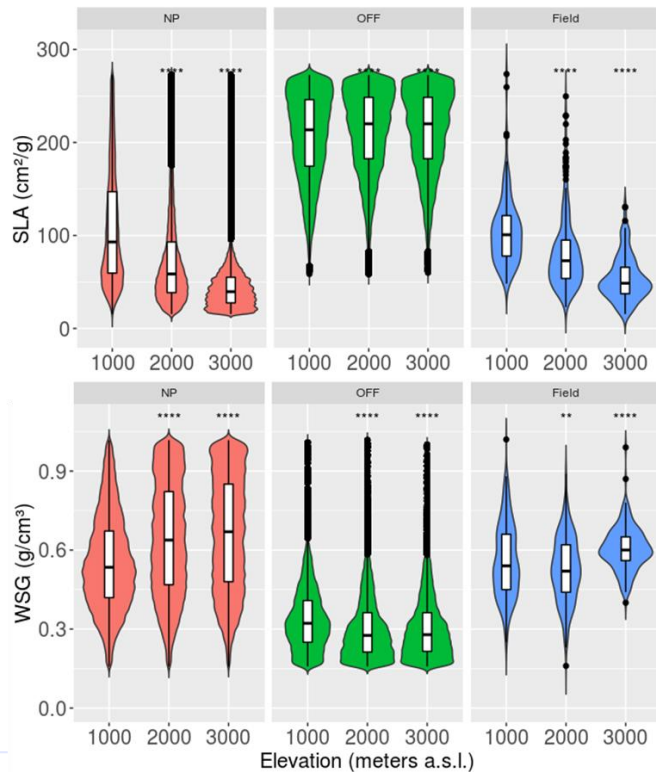| Variable	Unit	Bombuscaro	ECSF	Cajanuma
Elevation	m	1,000	2,000	3,000
Avg. Temp.	C	19.4	15.7	9.4
Avg. M. prec	mm/month	185	162	375
N deposition	Kg/ha		23.3	
P deposition	Kg/ha		4.0	
P weathering	Kg/ha		0.79	
SLA range	cm²/g		15.5 – 273.5	
WSG range	g/cm³		0.158 – 1.02	

Simulation results

Observed

Simulated

Simulation results

NP – Nitrogen and Phosphorus limitation.
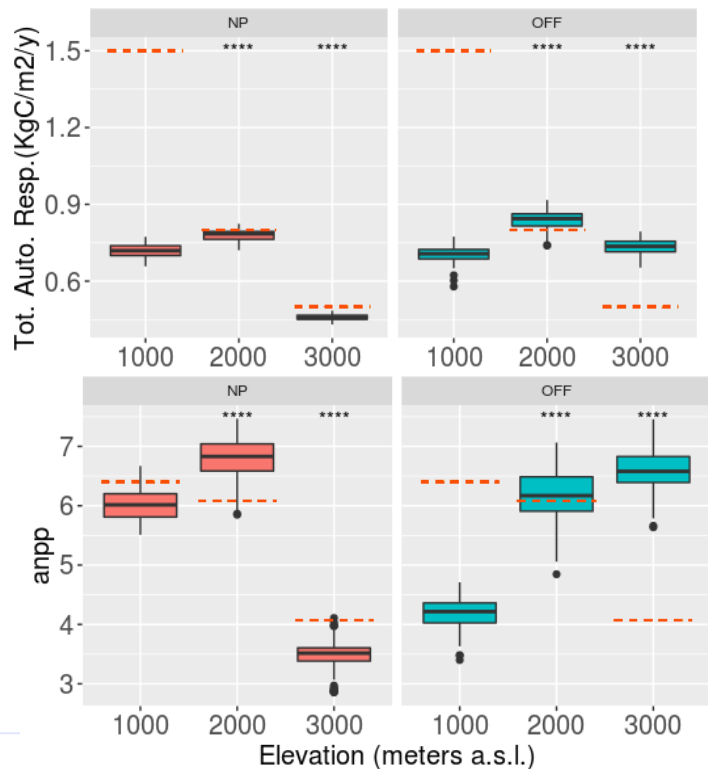OFF – nutrient limitation off
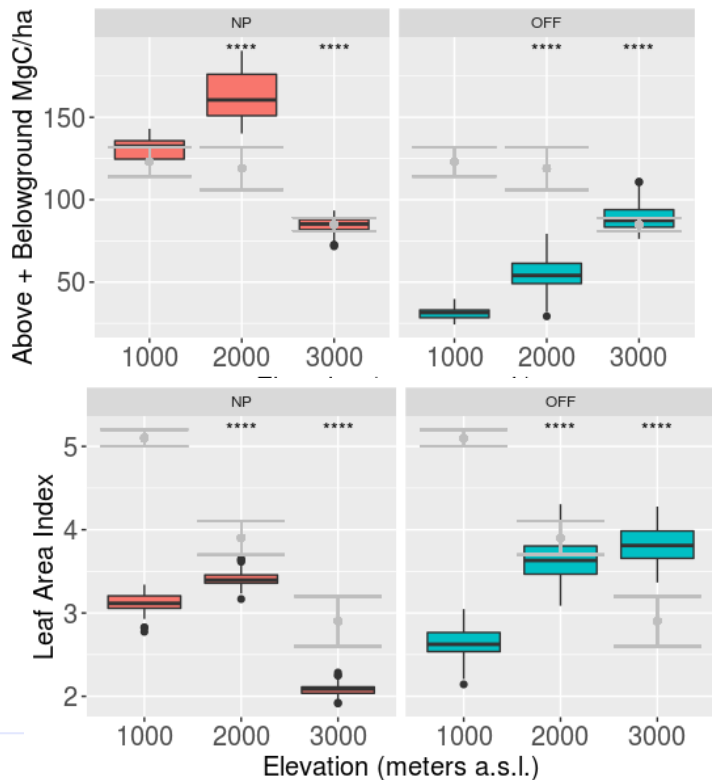
Field averages ±SD

Nutrient limitation has a sigificant effect on on trait distributions, and trait diversity improves observational agreement along the gradient.
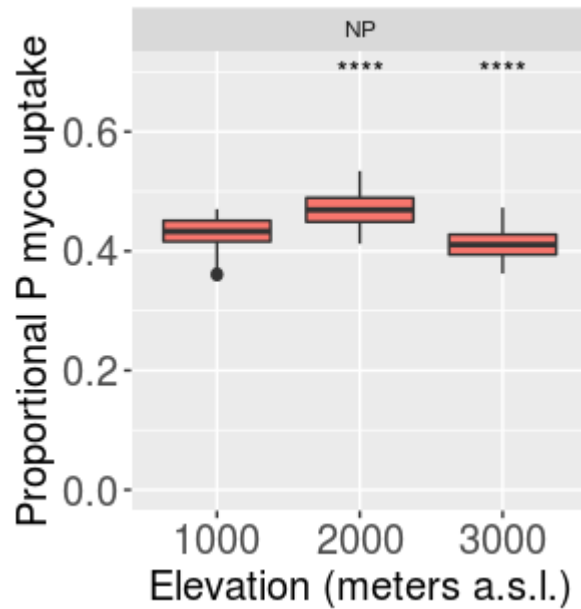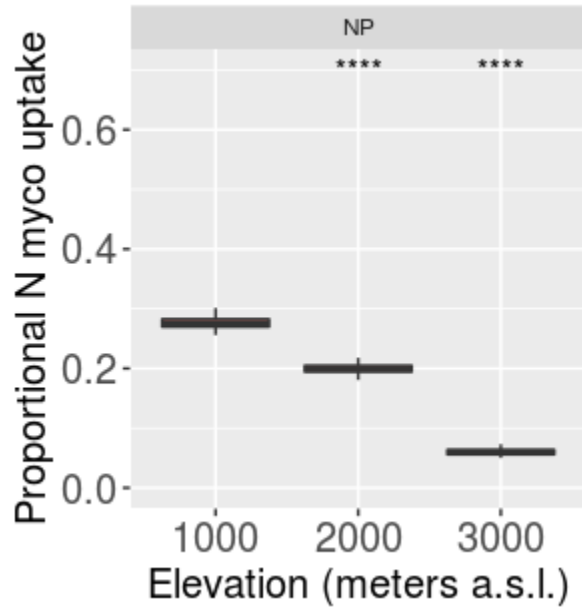
Simulation results

Field averages ±SD

Simulation results

Mycorrhiza uptake is a relevant process for plant nutrient uptake in the model, with P uptake by fungi especially important.

Summary

- The LPJ-GUESS-HUMBOLDT model is able to improve the representation of shifts in trait distributions, forest structure and carbon fluxes when run in an elevational gradient.

- These shifts occur due to the decrease of soil available nutrients, which limit plant growth and promote lower SLA and higher WSG species. No shifts are observed when the Nitrogen limitation is turned off.

- The LPJ-GUESS-HUMBOLDT develops towards improving the representation of biodiversity within the whole Andes TMF and facing climate and environmental change (e.g. Anthr. N dep.) scenarios.

- Improvements to the representation of observed patterns are expected with new measurements which are being currently carried out within the RESPECT project.

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