

# Abiotic and biotic mediations of scale dependent tree trait effects on soil carbon concentrations

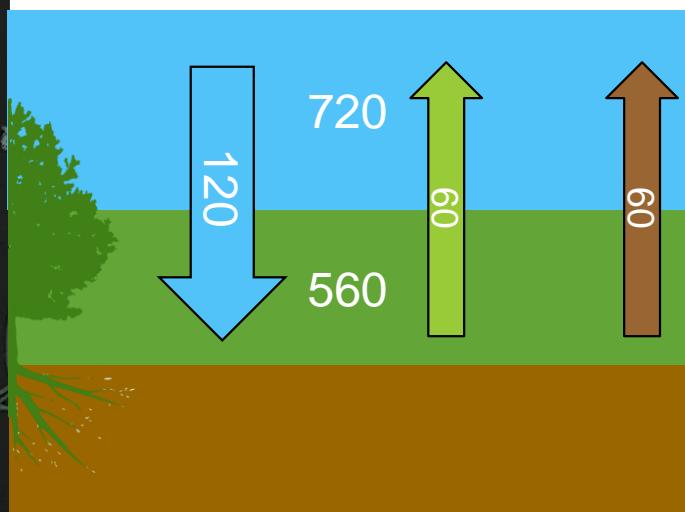
Rémy Beugnon



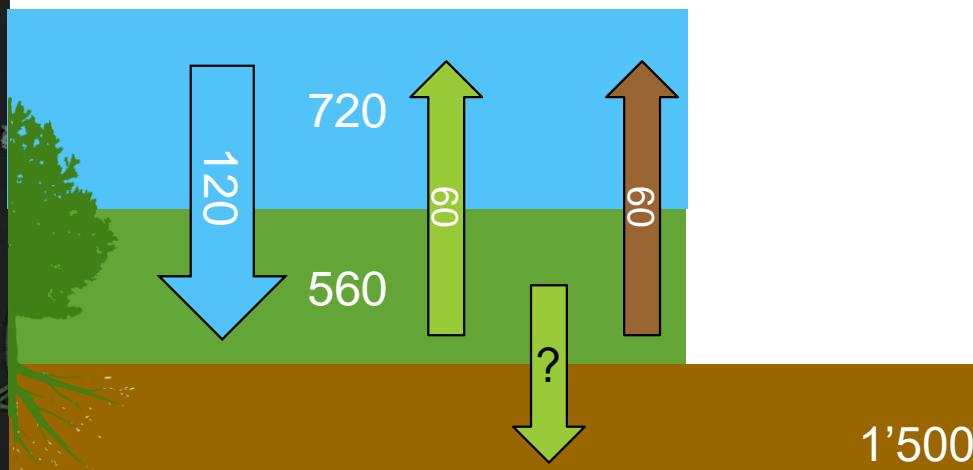
# Carbon on Earth is in earth



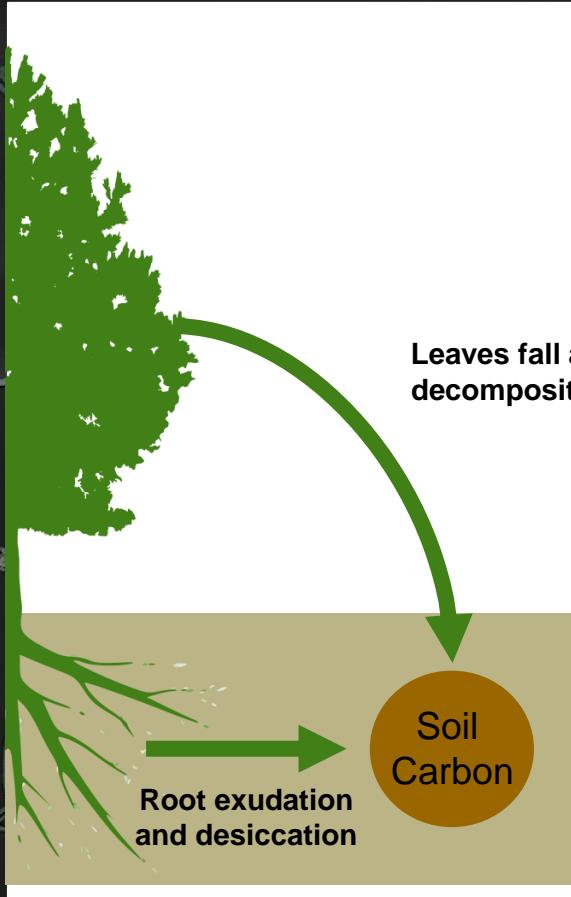
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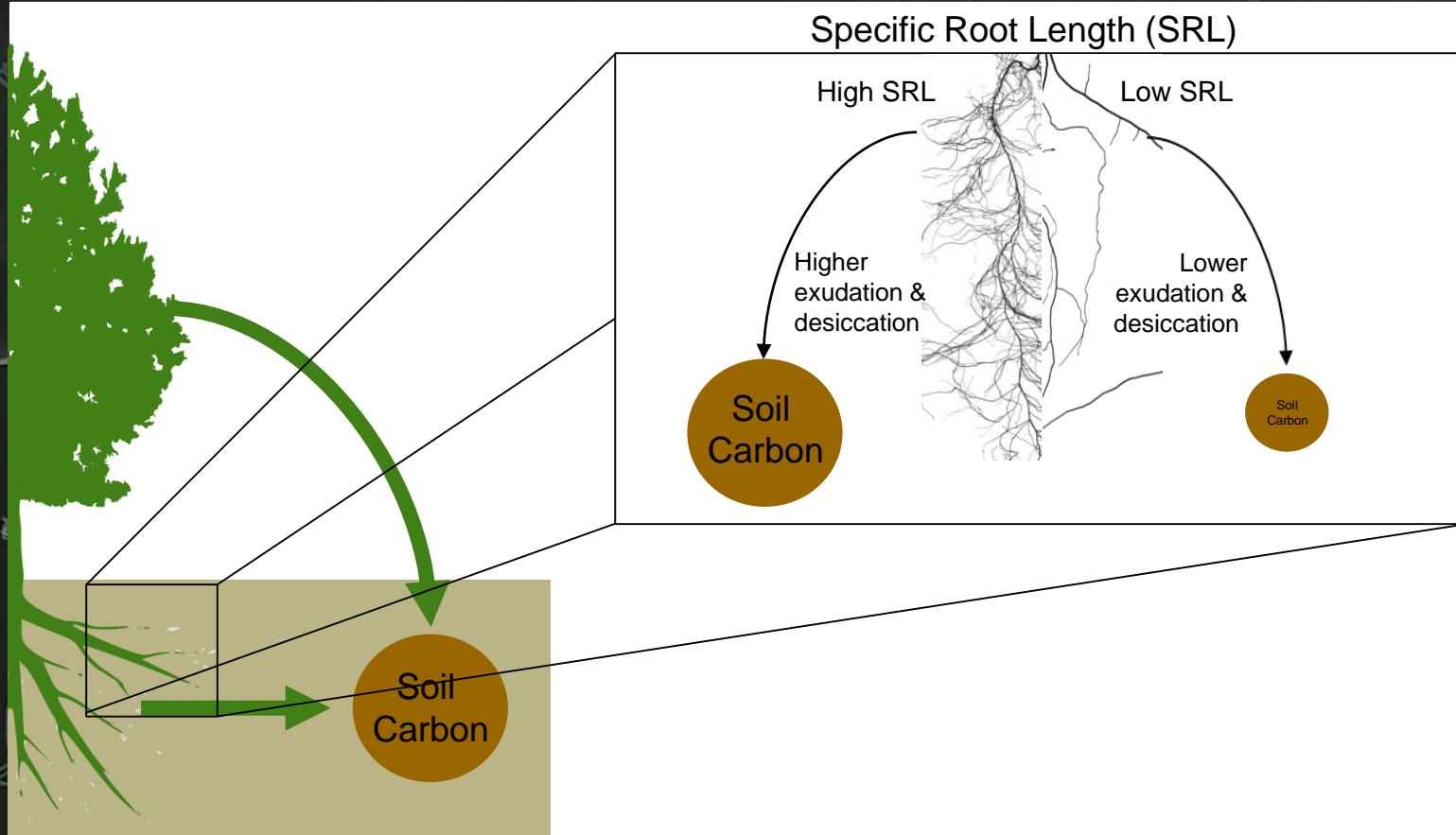
# Carbon on Earth is in earth



# What is the role of trees in soil carbon?



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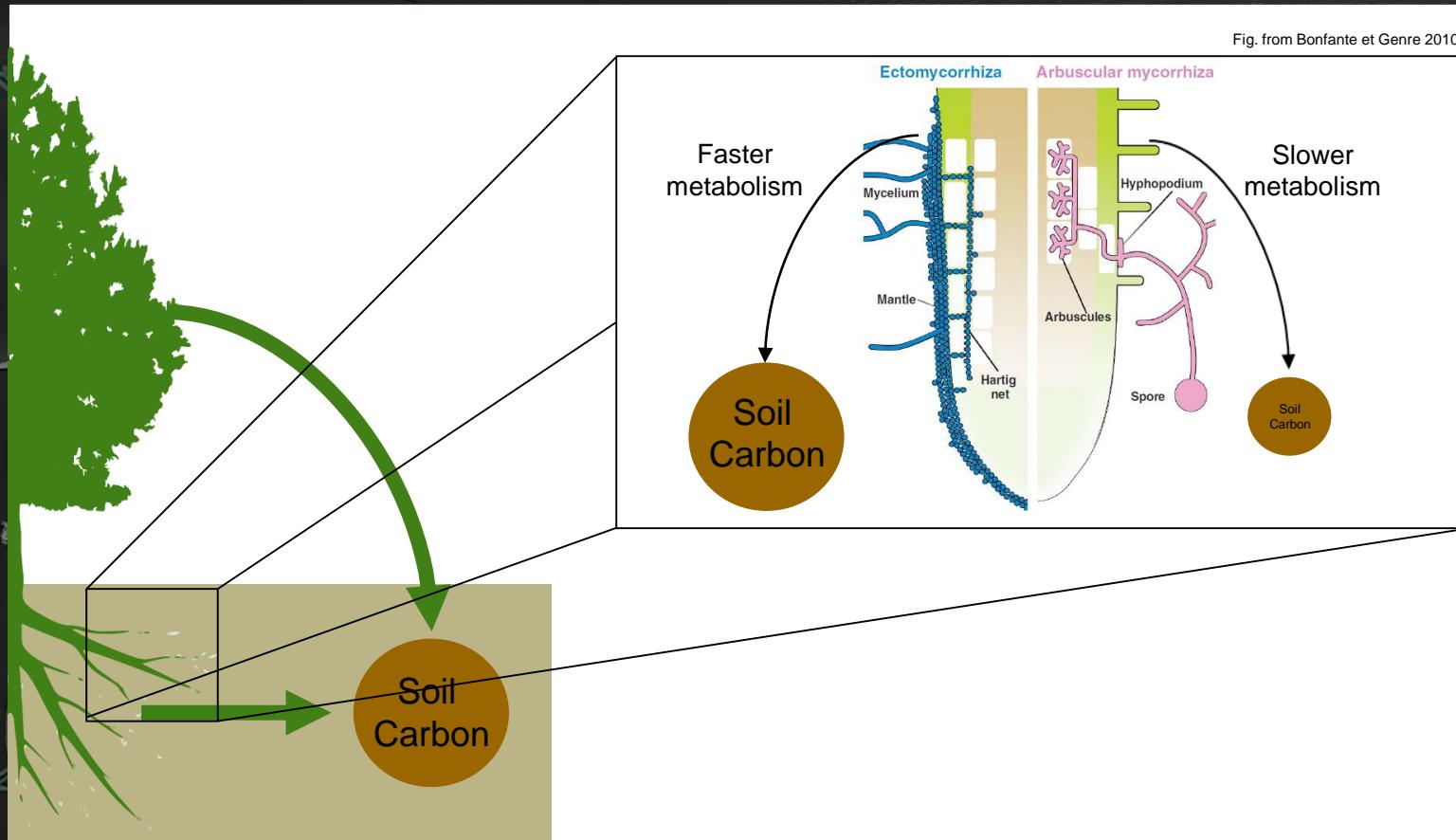
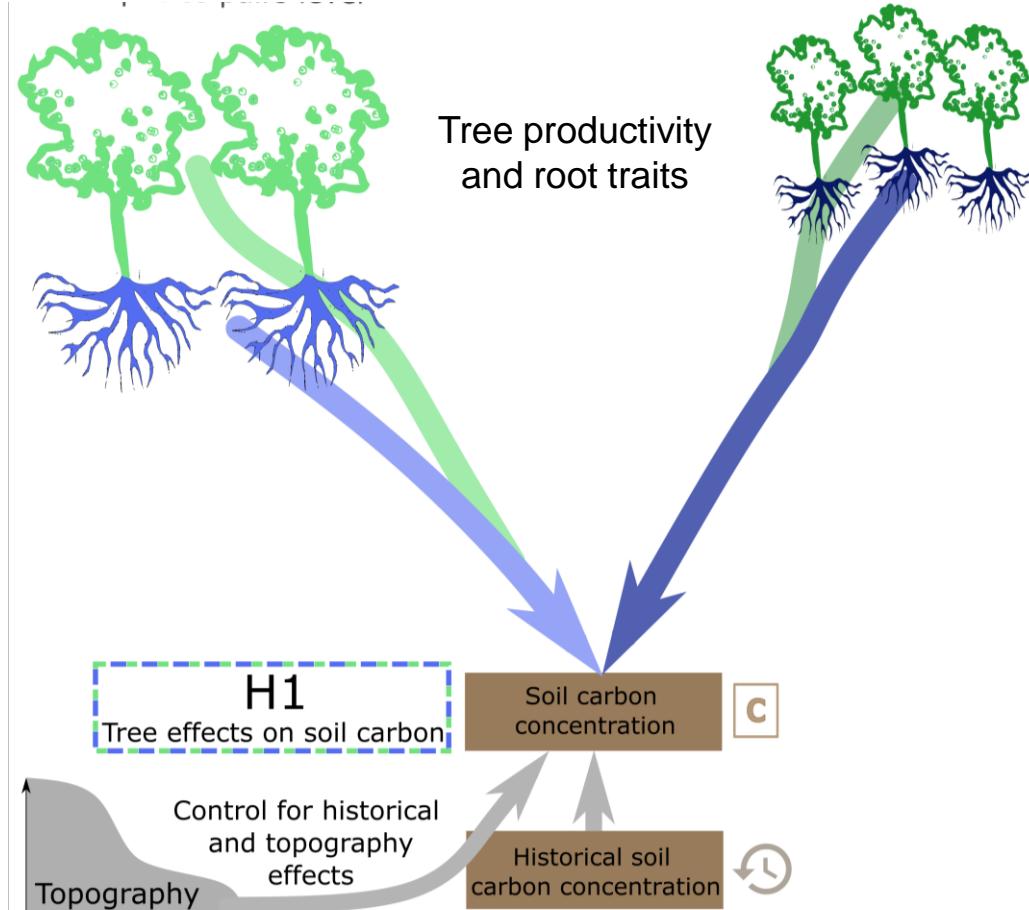


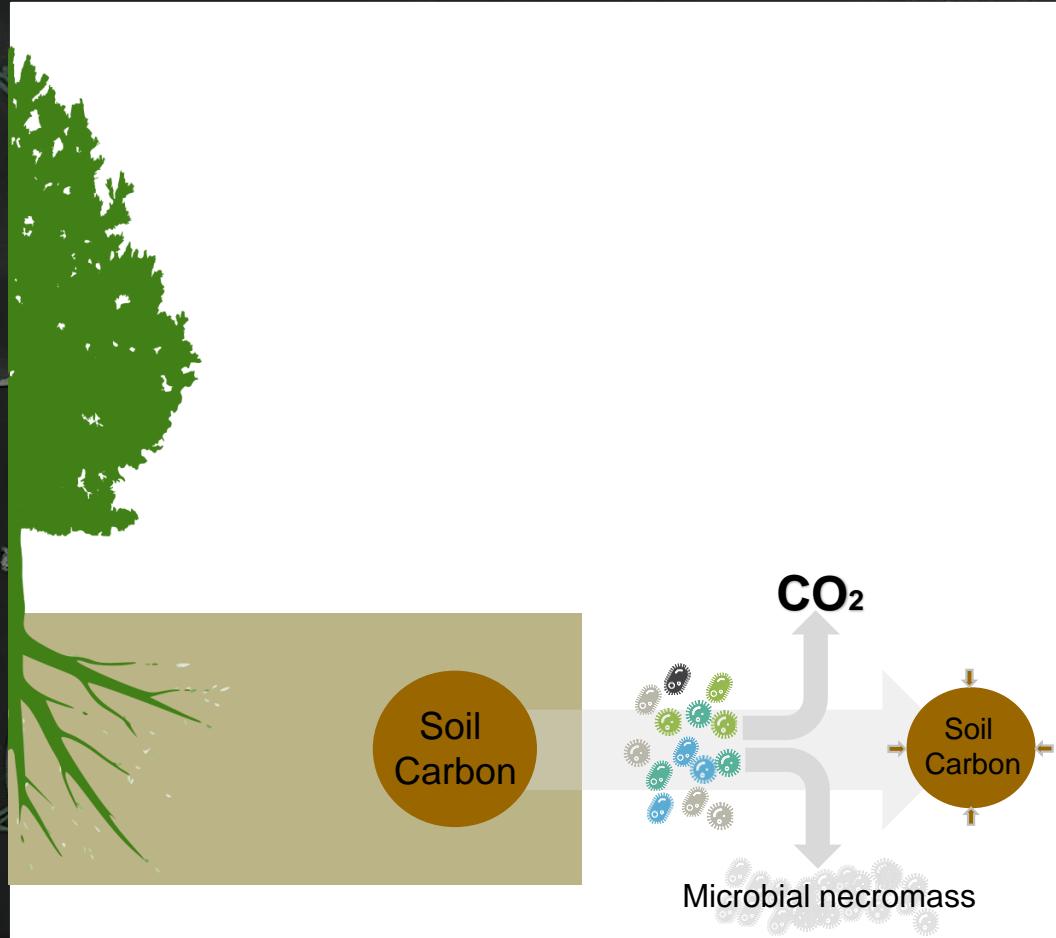
Fig. from Bonfante et Genre 2010

# Hypotheses:

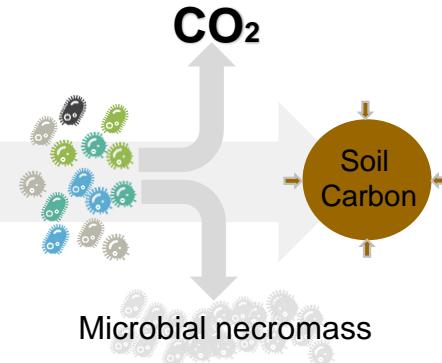
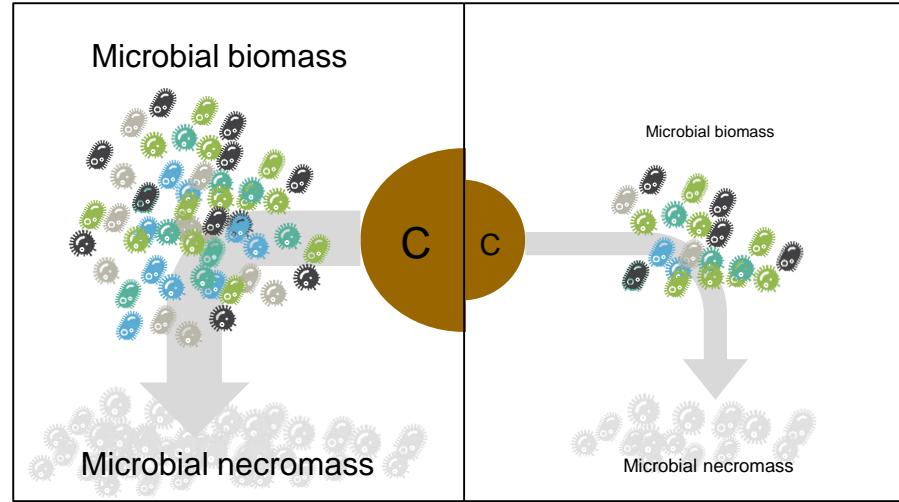
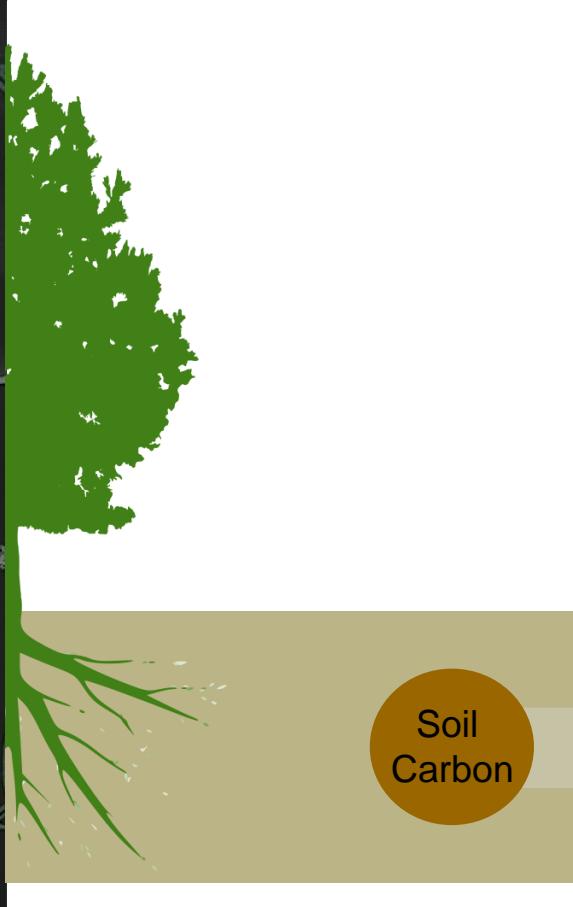
- **Hypothesis 1:** tree productivity and root functional trait identity and dissimilarity drive soil carbon concentrations



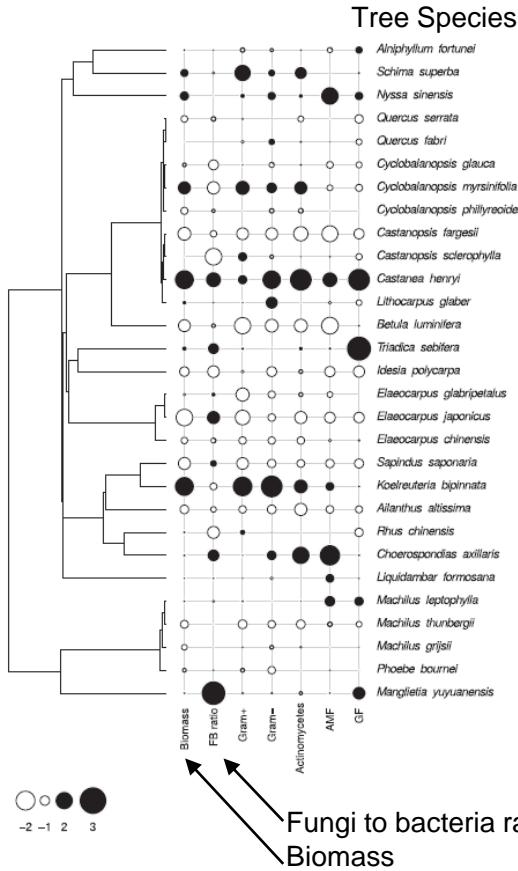
# Soil carbon and soil microbial communities



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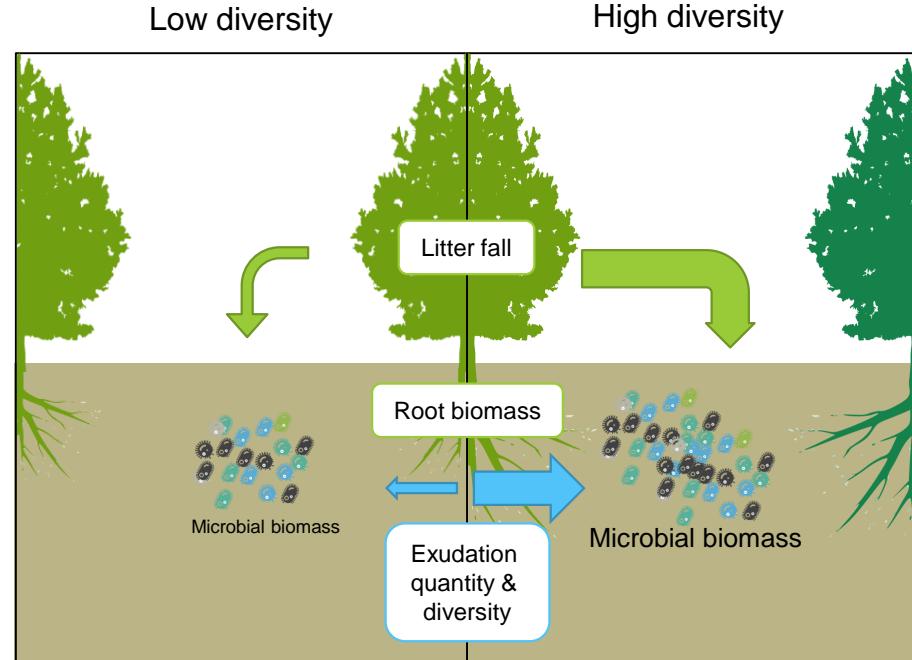
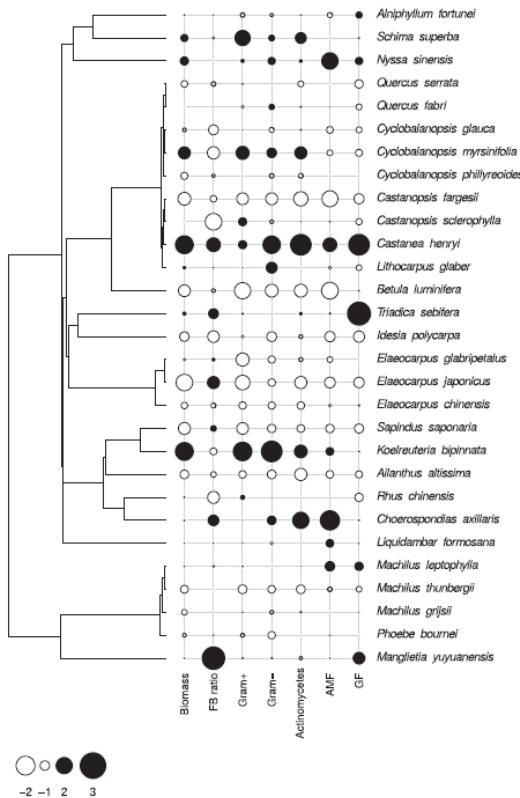


# Standing trees drive microbial communities



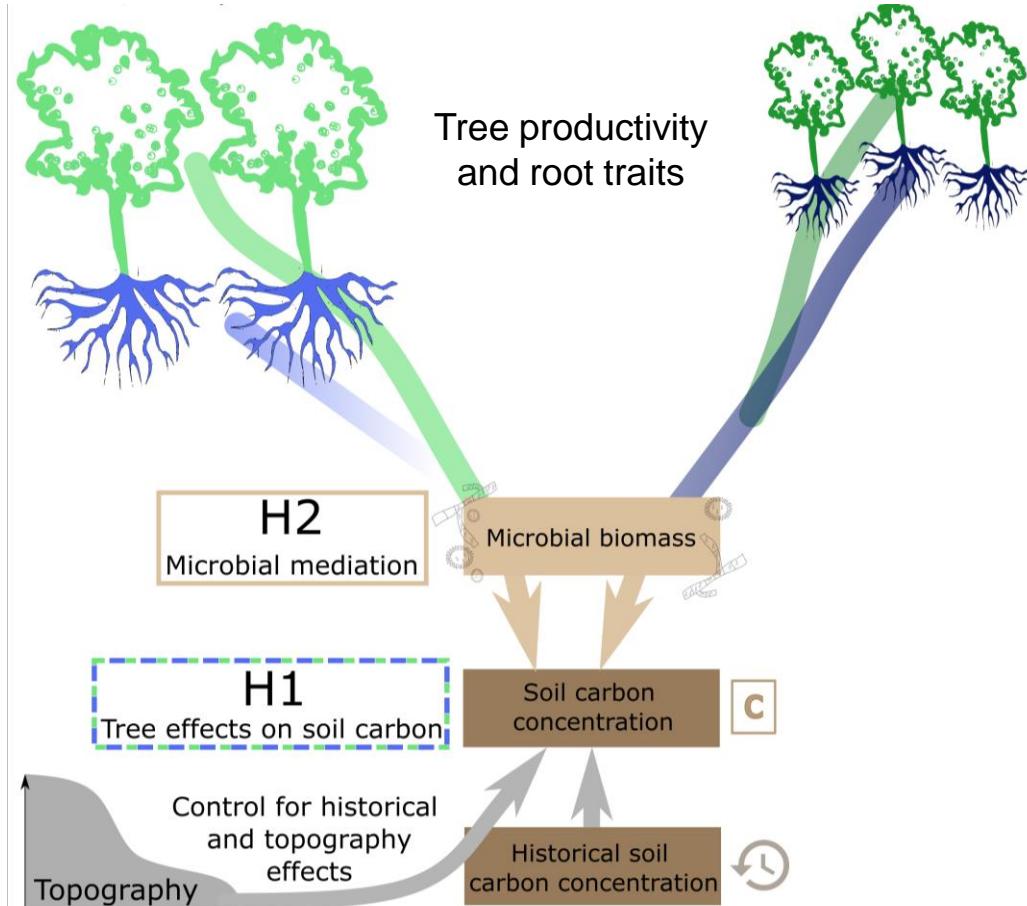
Microbial biomass and community composition are driven by tree species

# Standing trees drive microbial communities

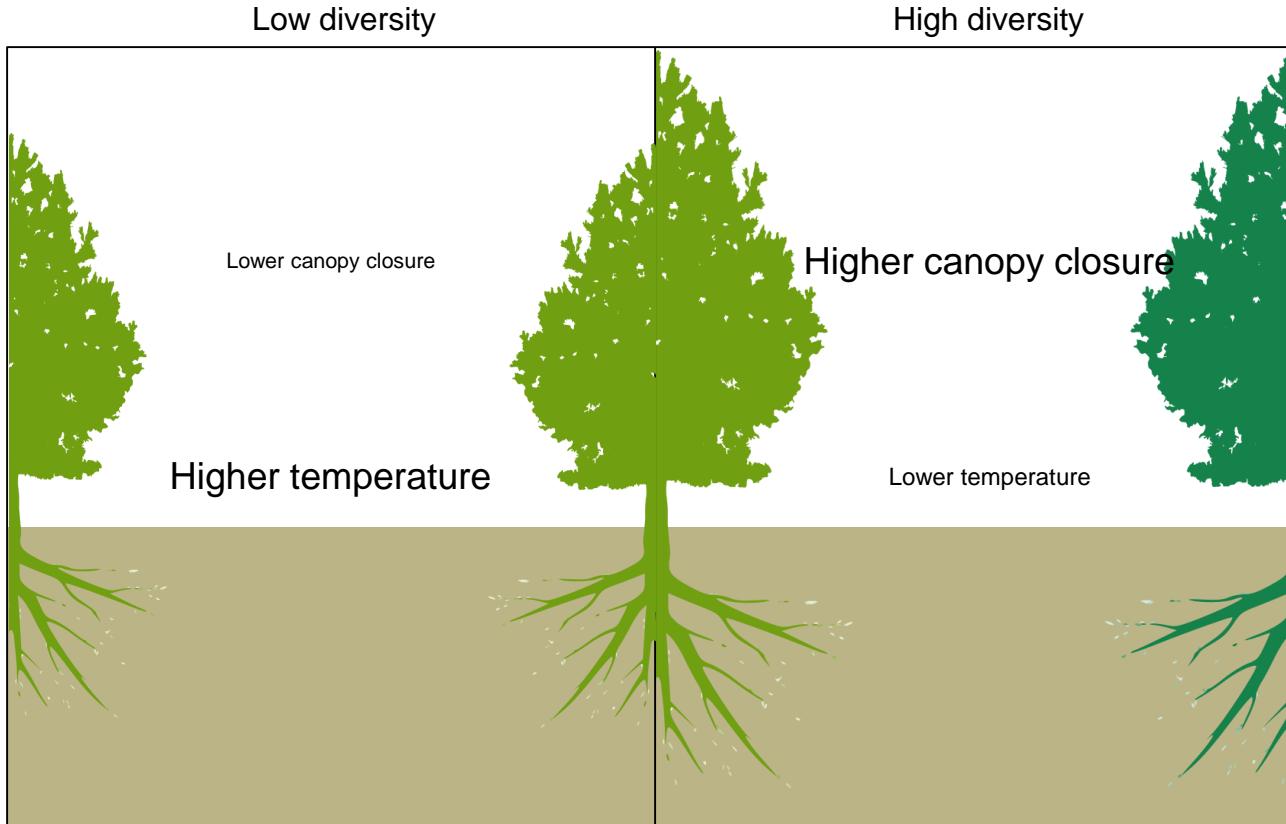


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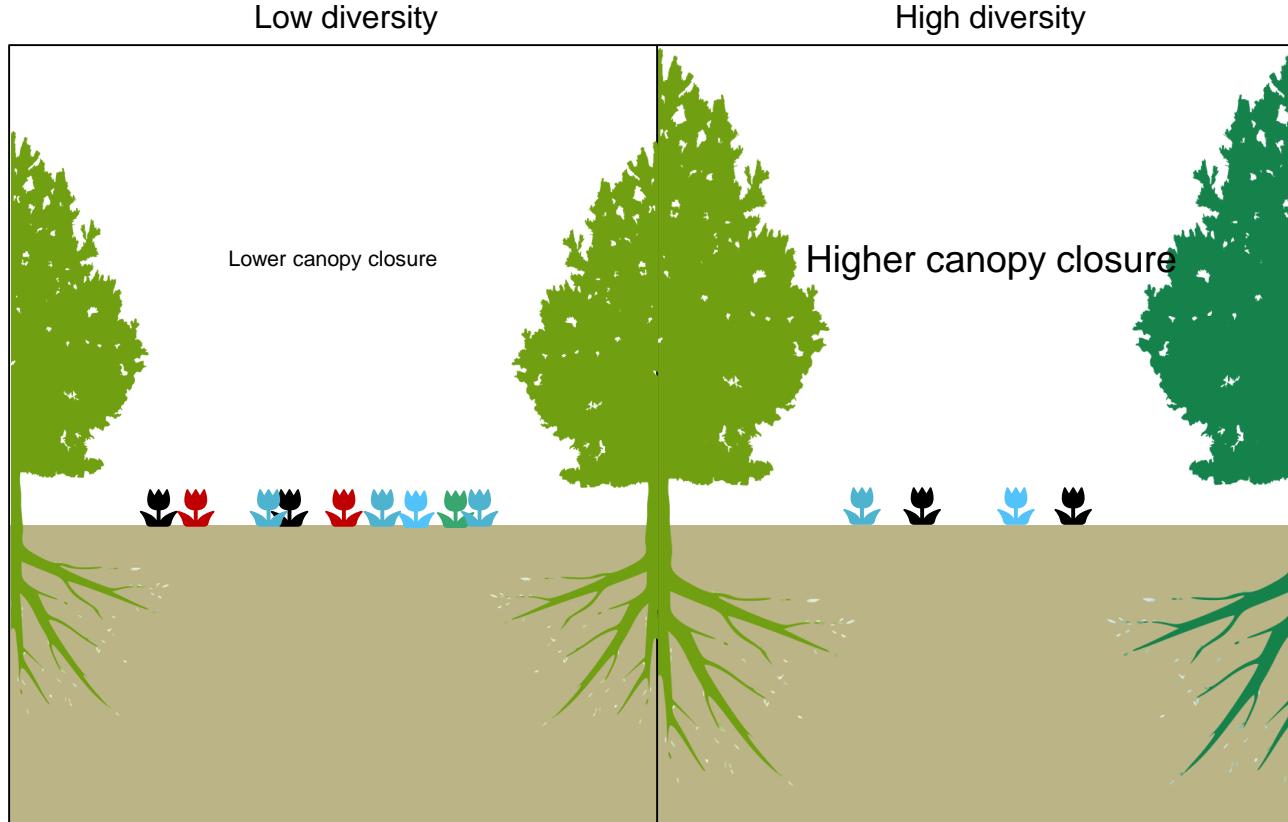
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- **Hypothesis 2:** tree productivity and root functional identity and dissimilarity effects on soil carbon concentrations are expected to be mediated by soil microbial biomass



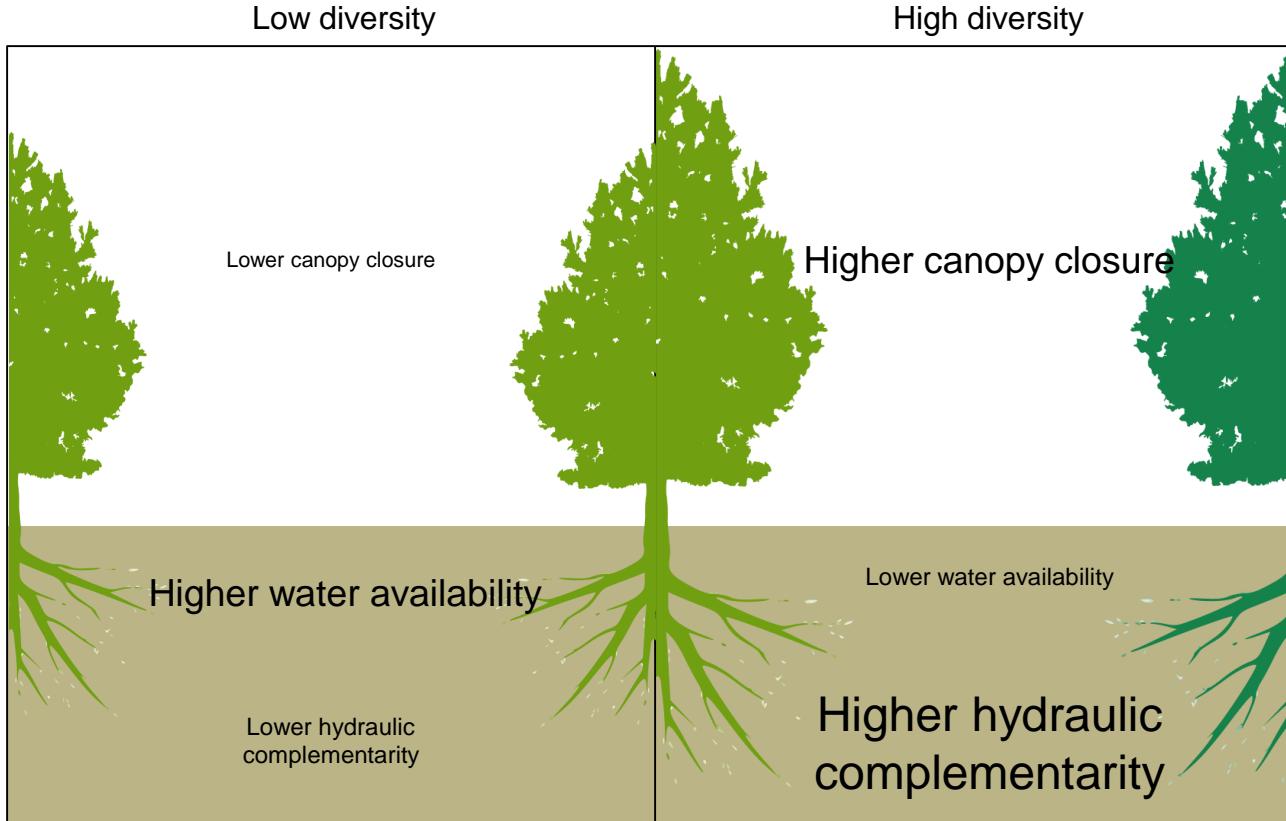
# Forest drive micro-environmental conditions: microclimate



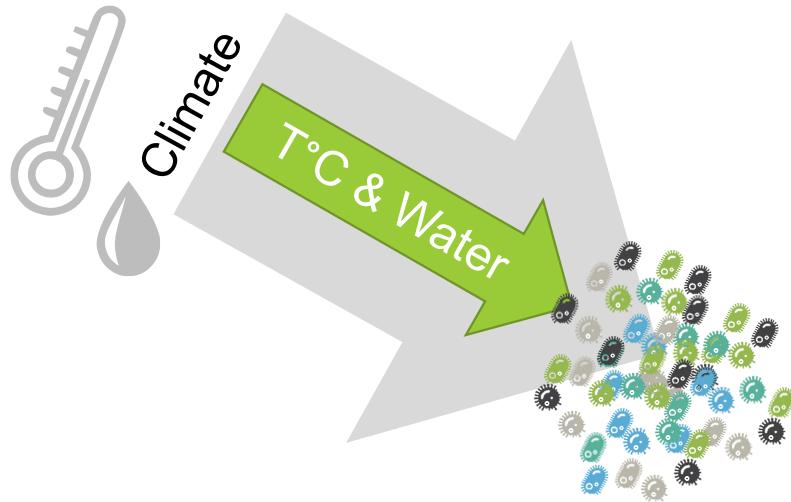
# Forest drive micro-environmental conditions: understory plants



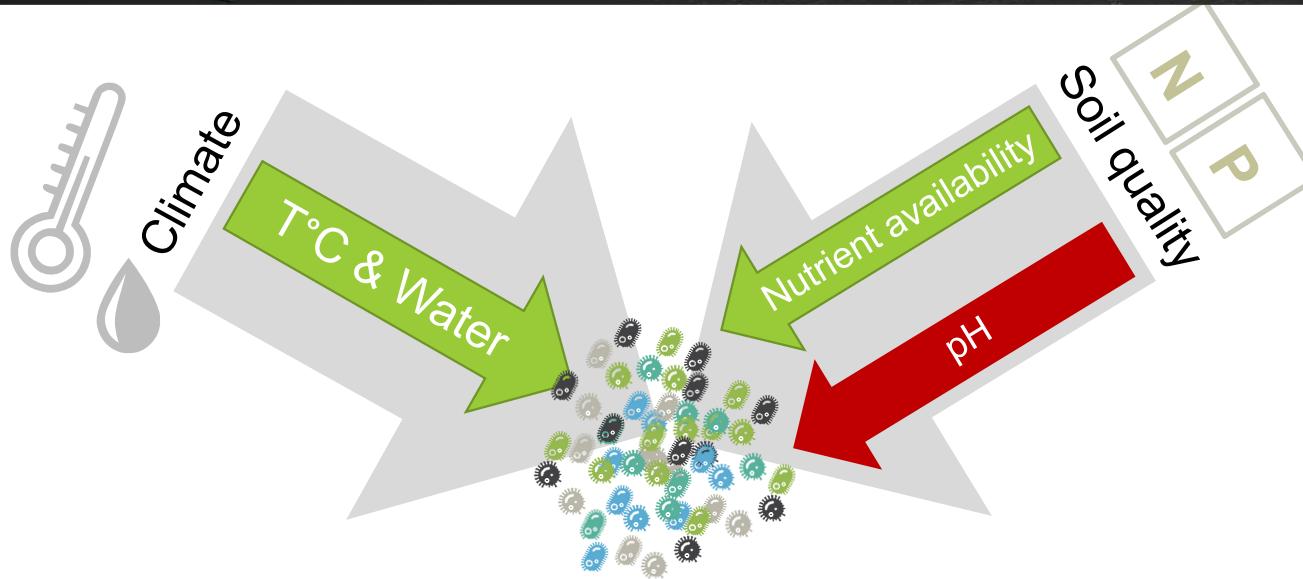
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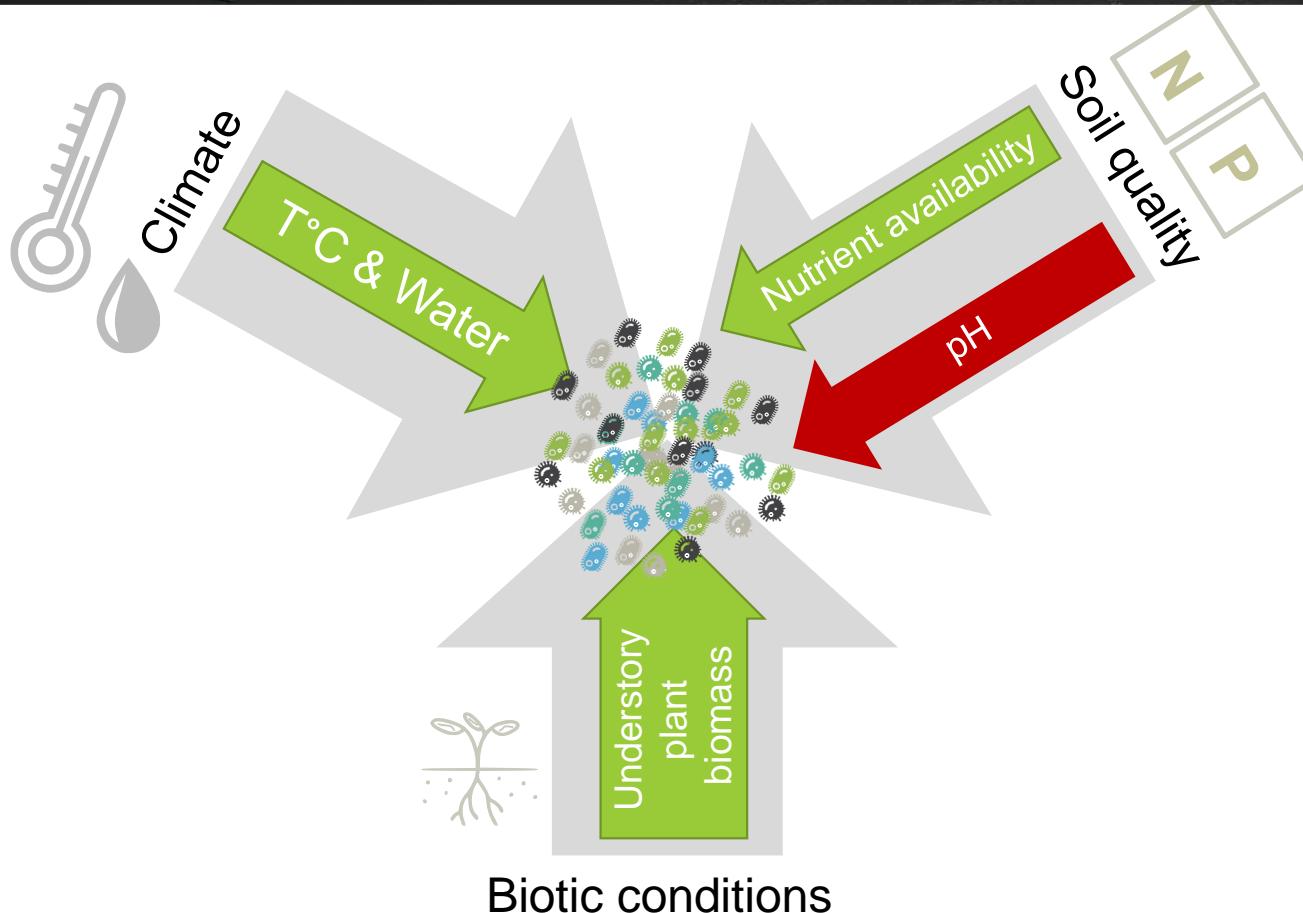
# High sensibility of the microbial community to environmental conditions



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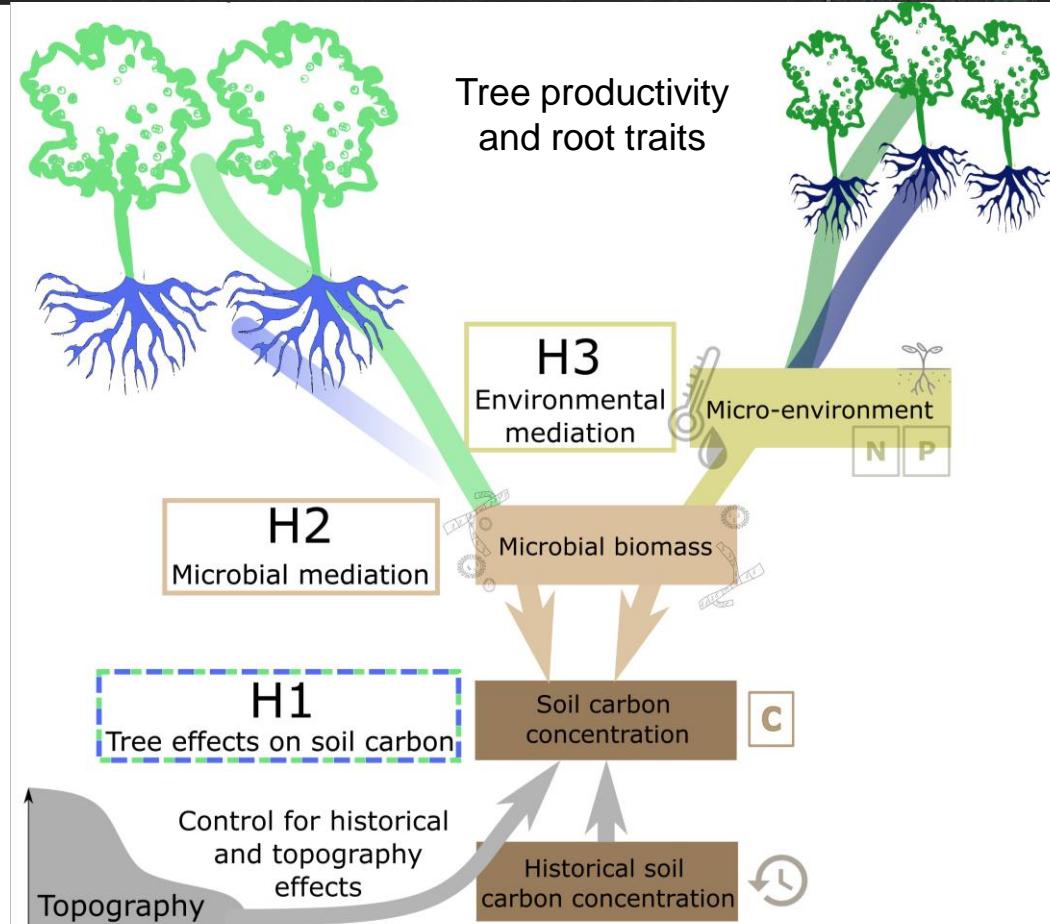


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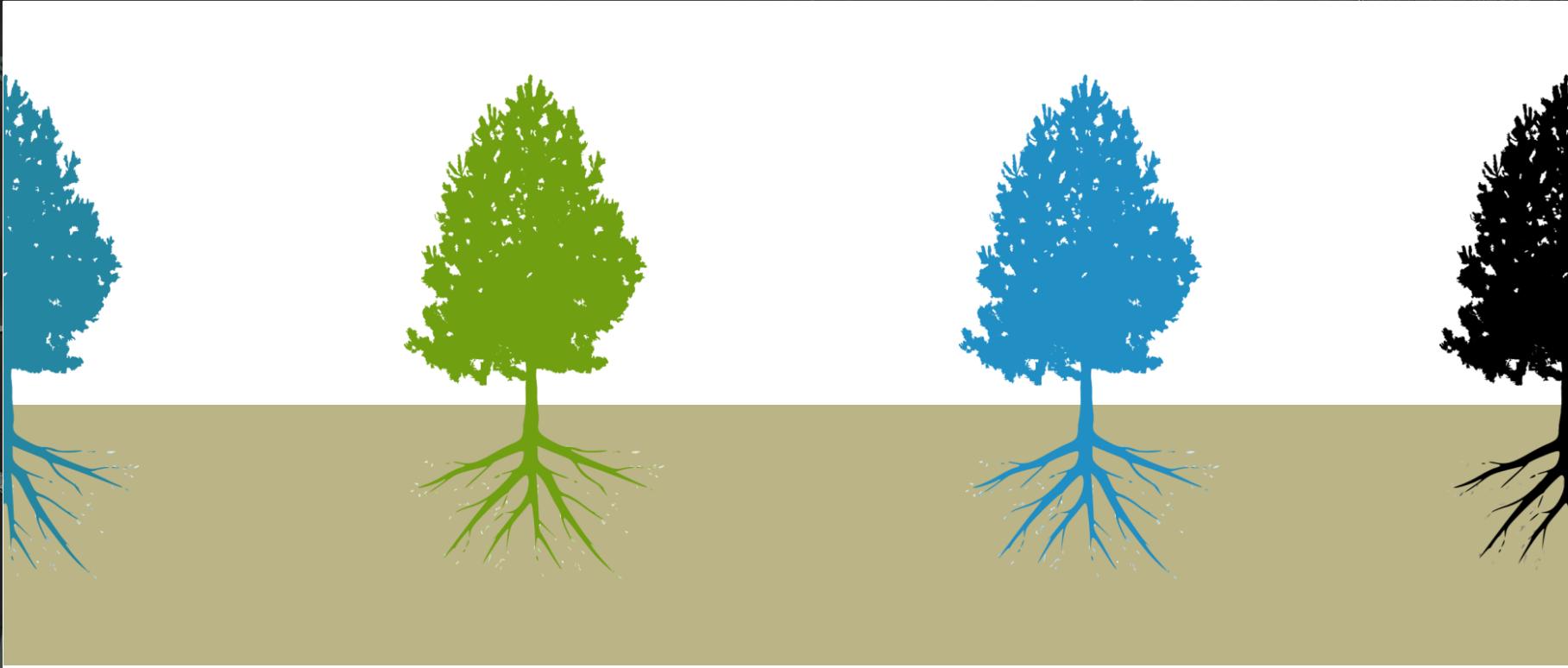


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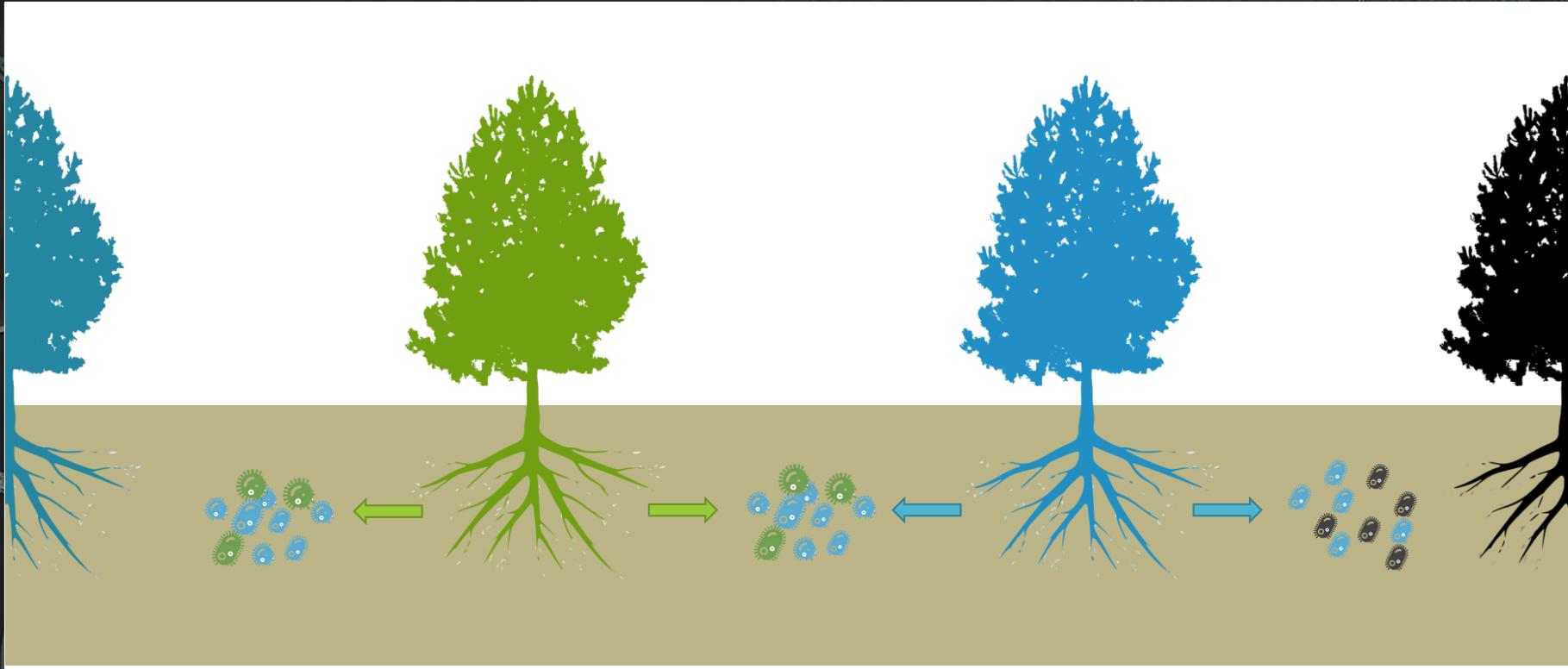
- **Hypothesis 1:** tree productivity and root functional trait identity and dissimilarity drive soil carbon concentrations
- **Hypothesis 2:** tree productivity and root functional identity and dissimilarity effects on soil carbon concentrations are expected to be mediated by soil microbial biomass
- **Hypothesis 3:** tree community effects on microbial biomass are mediated by micro-environmental conditions (climate, soil quality, and biotic environment)



## Tree spatial distribution

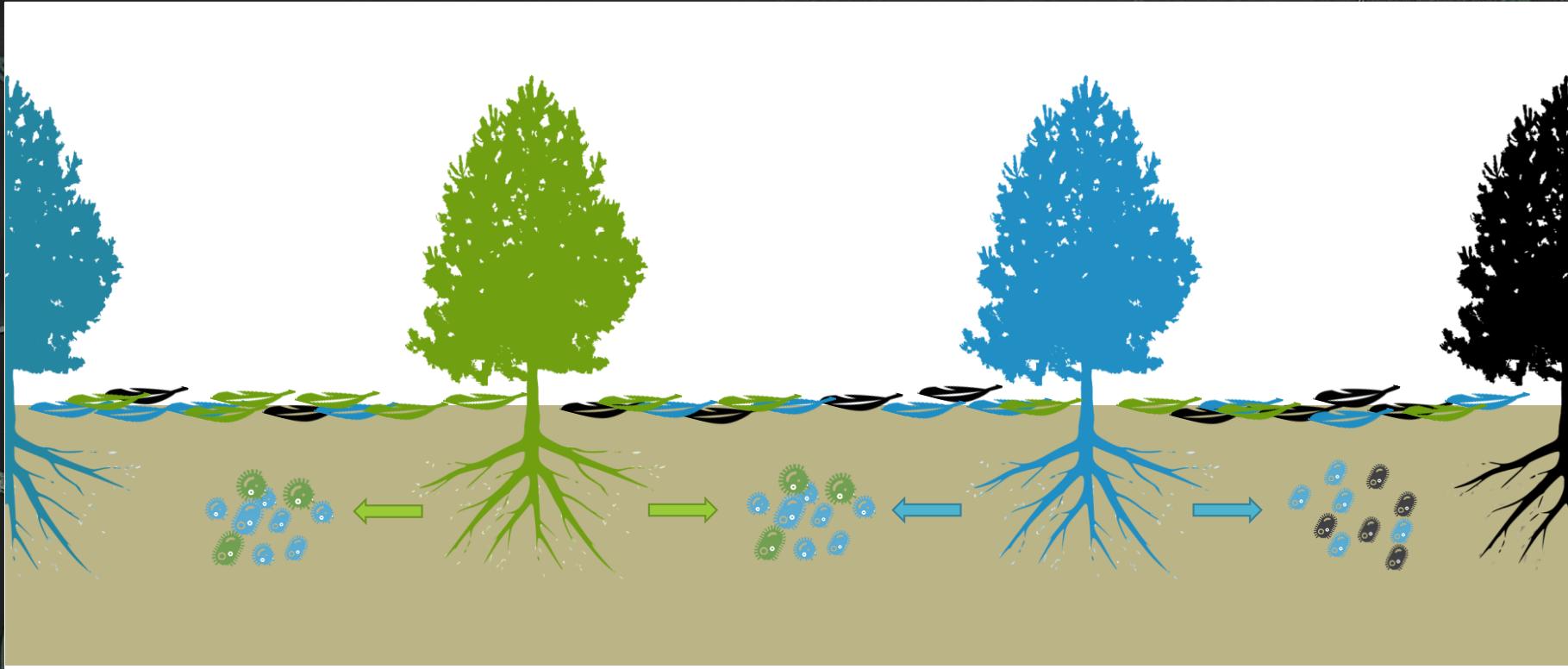


## Tree spatial distribution



e.g. Species-specific microbial association at tree level.

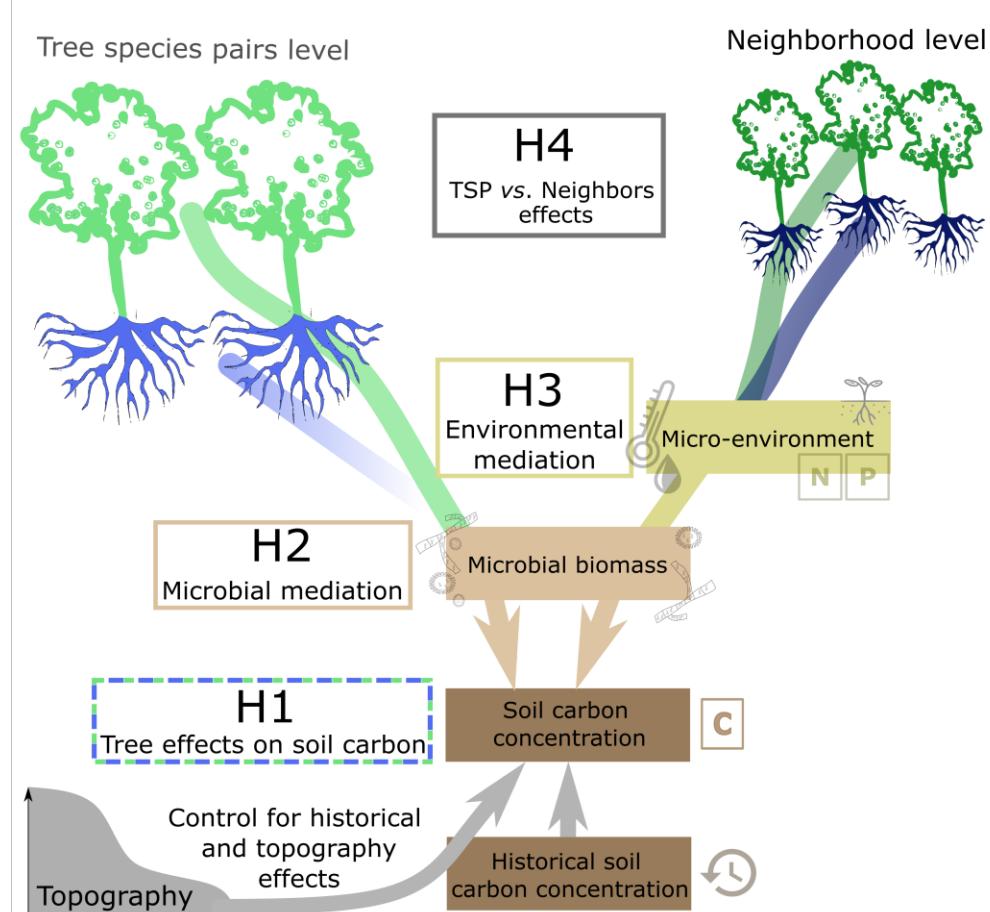
## Tree spatial distribution



e.g. Species-specific microbial association at tree level.  
Litter homogenization at neighborhood level

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- **Hypothesis 4:** we expected tree effects on soil microbial biomass to be scale-dependent



# Sampling design

South-East China

Subtropical climate: warm, rainy summers & cool, dry winters

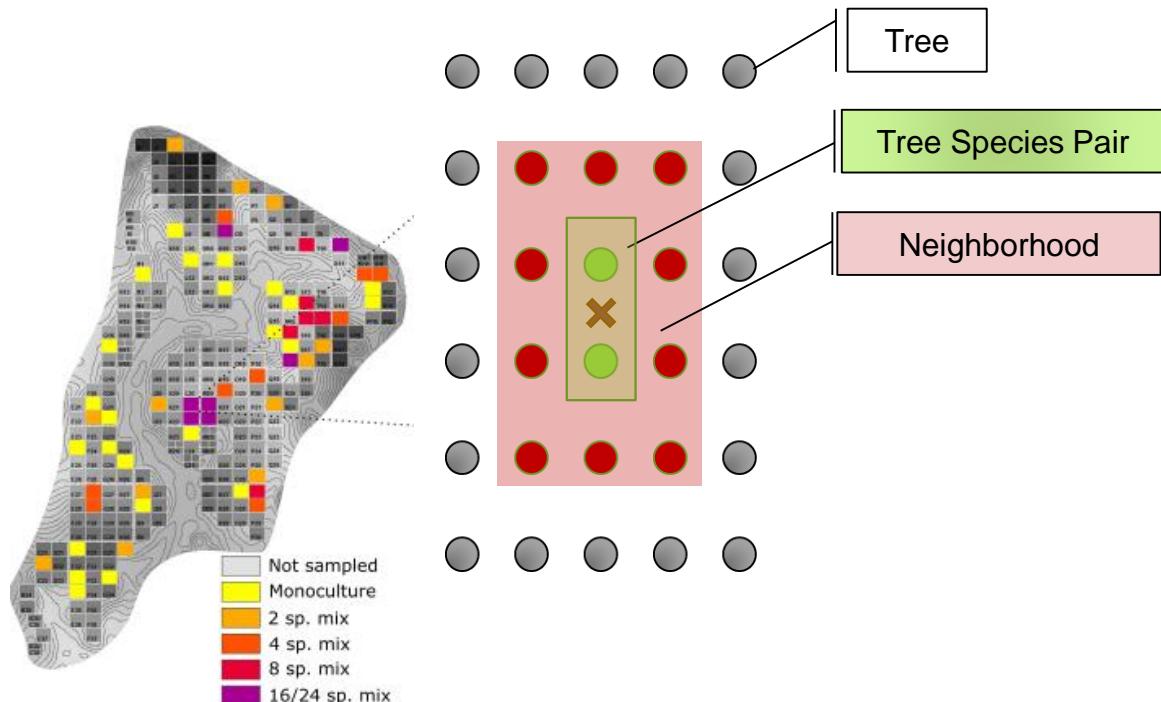
**BEF China platform:**

Tree diversity experiment (since 2009)

Species richness manipulated from 1 to 16, planted in a random scenario



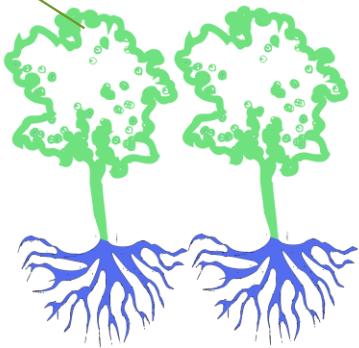
# Tree species pairs design



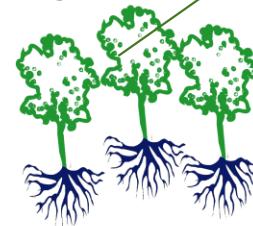
# Sampling design: BEF China

TSP biomass

Tree species pairs level



Neighborhood level



Neighborhood biomass

Canopy structure (ENL)

Litterfall biomass

Litterfall CN ratio



Soil carbon  
concentration

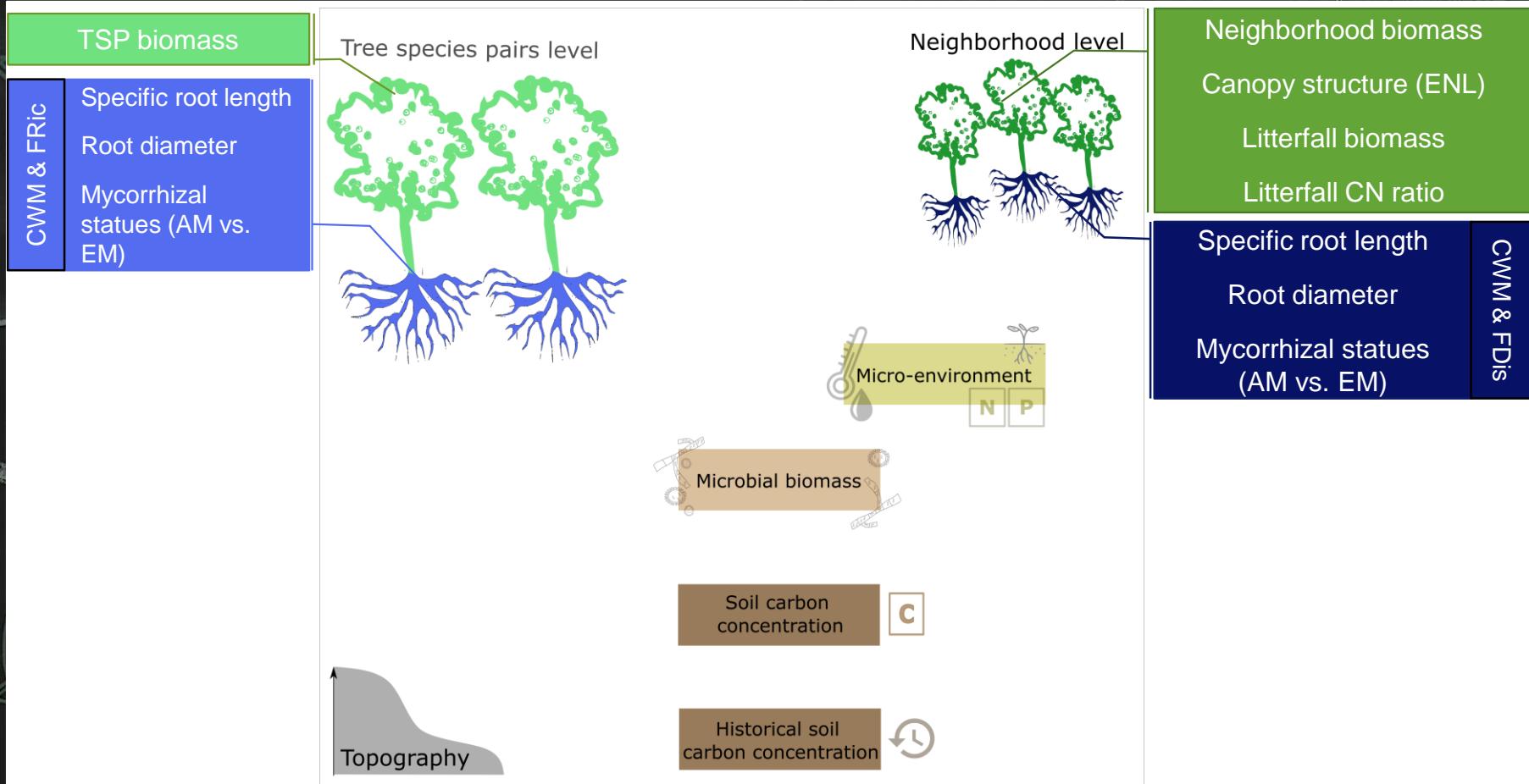
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Historical soil  
carbon concentration

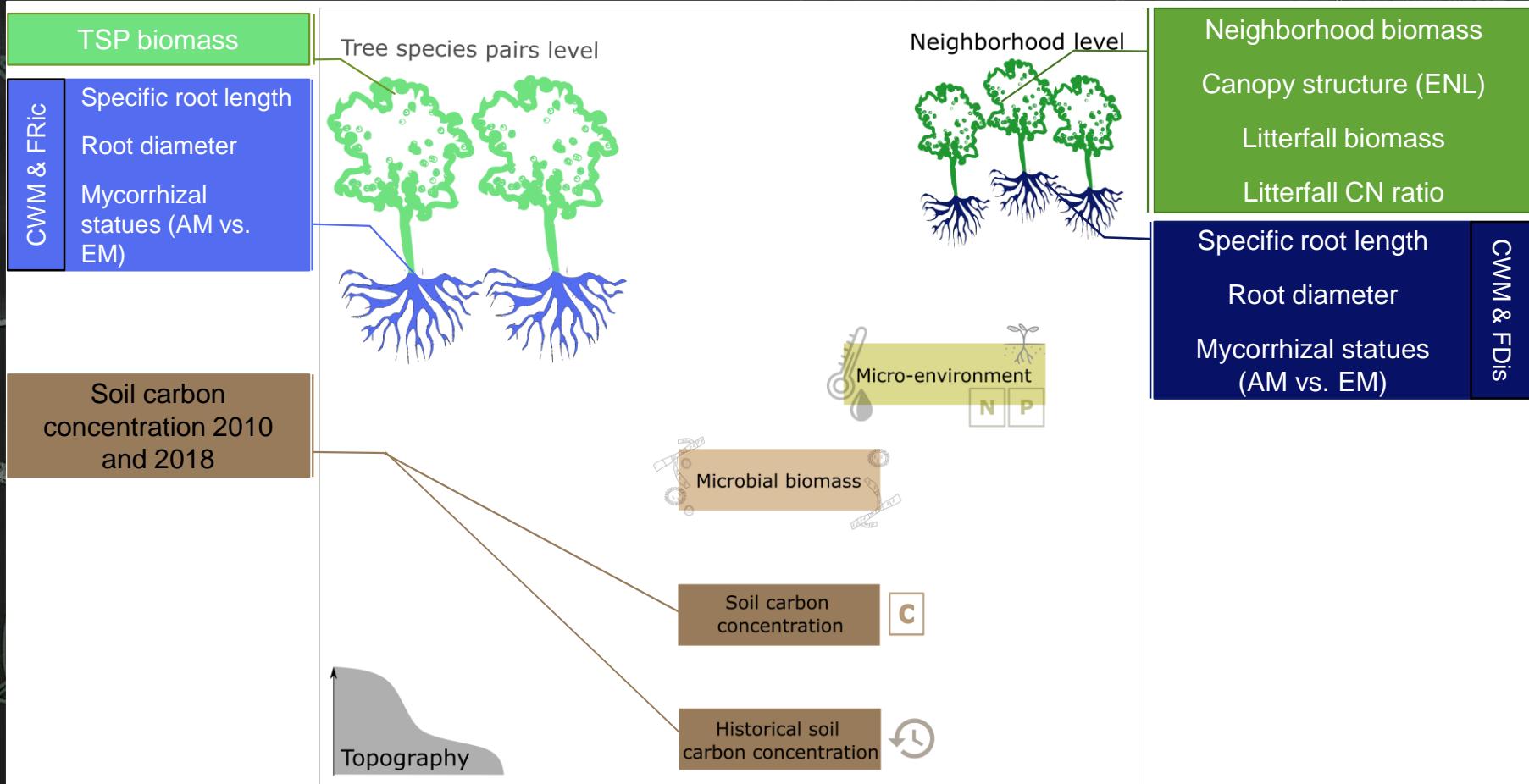
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Topography

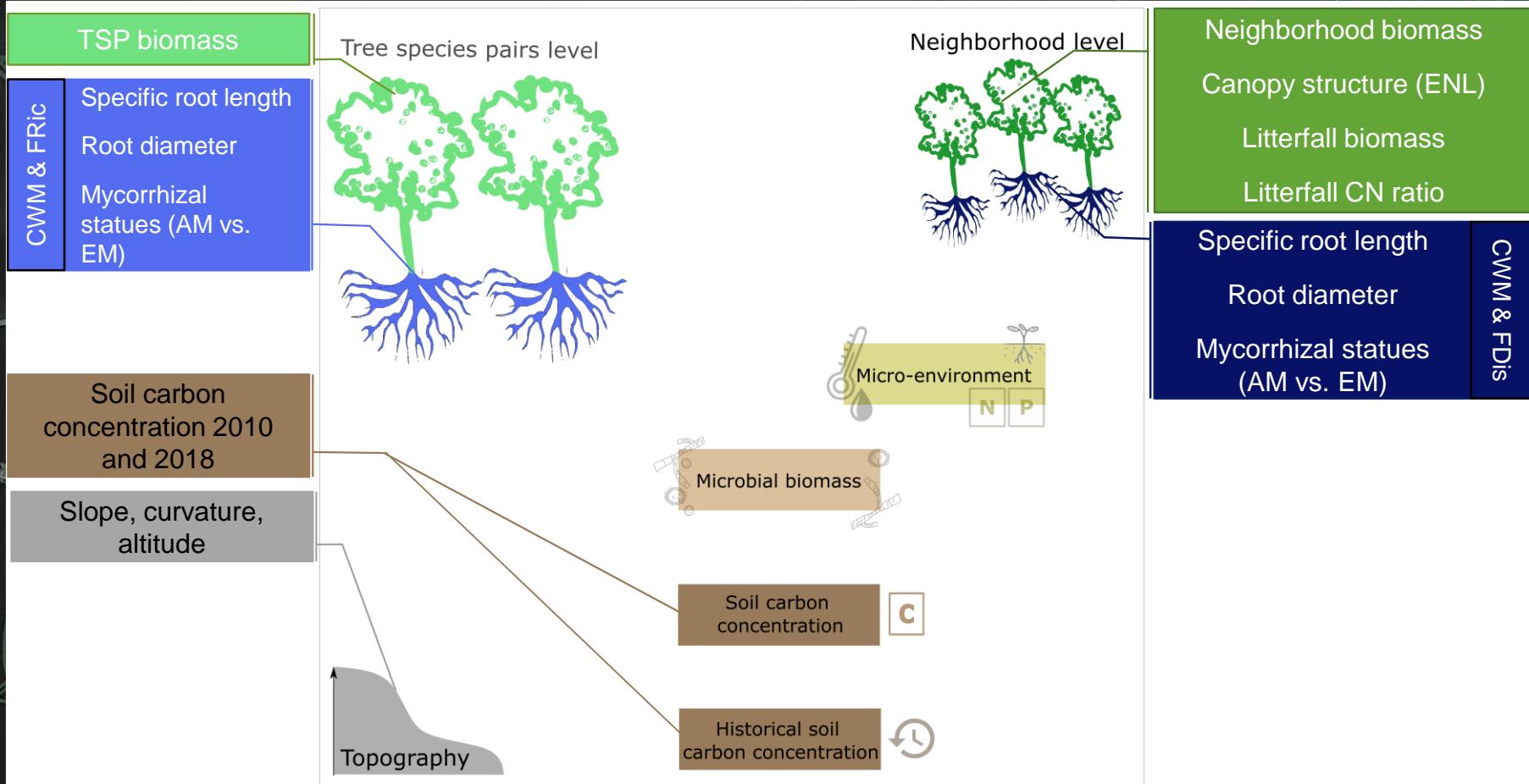
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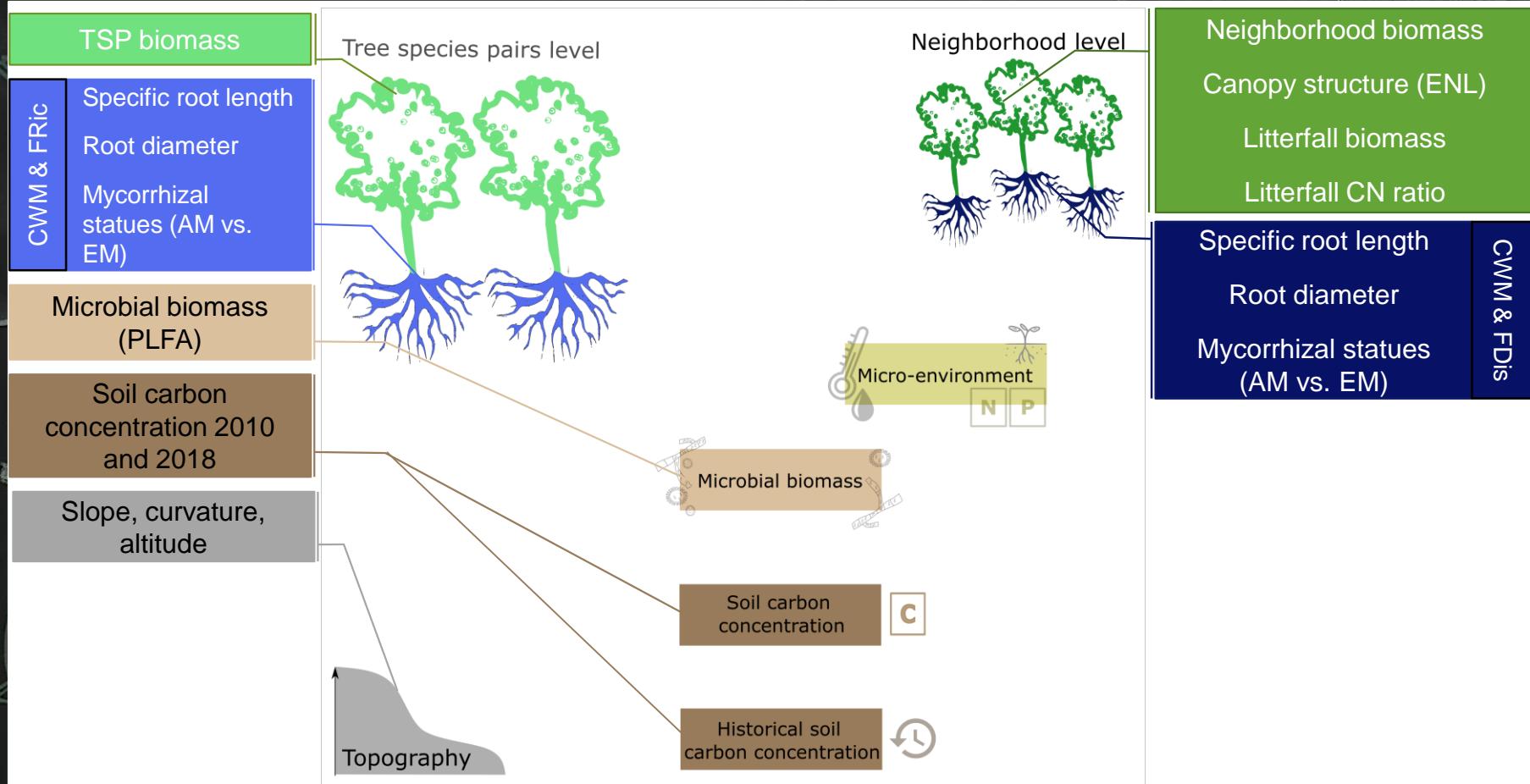
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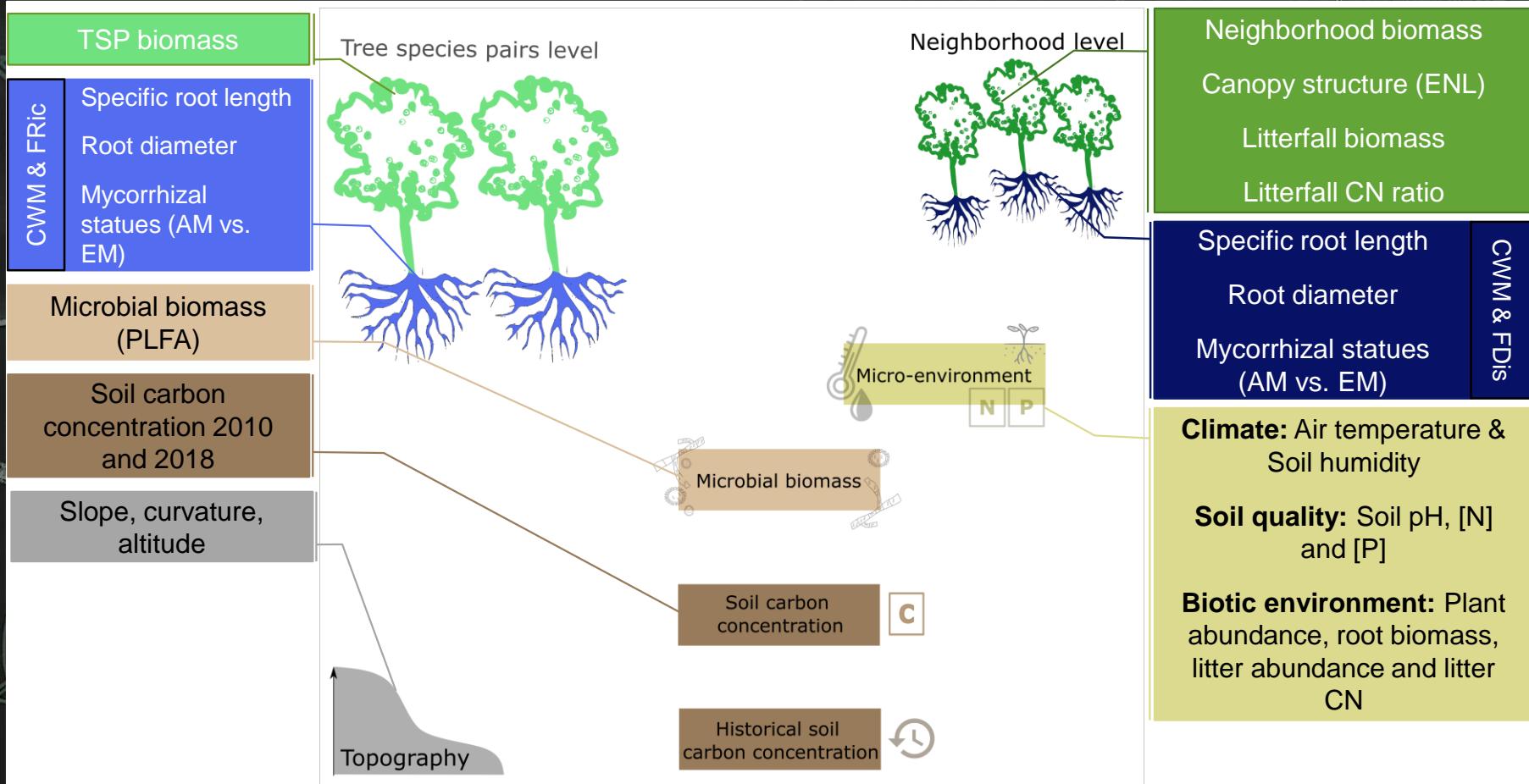
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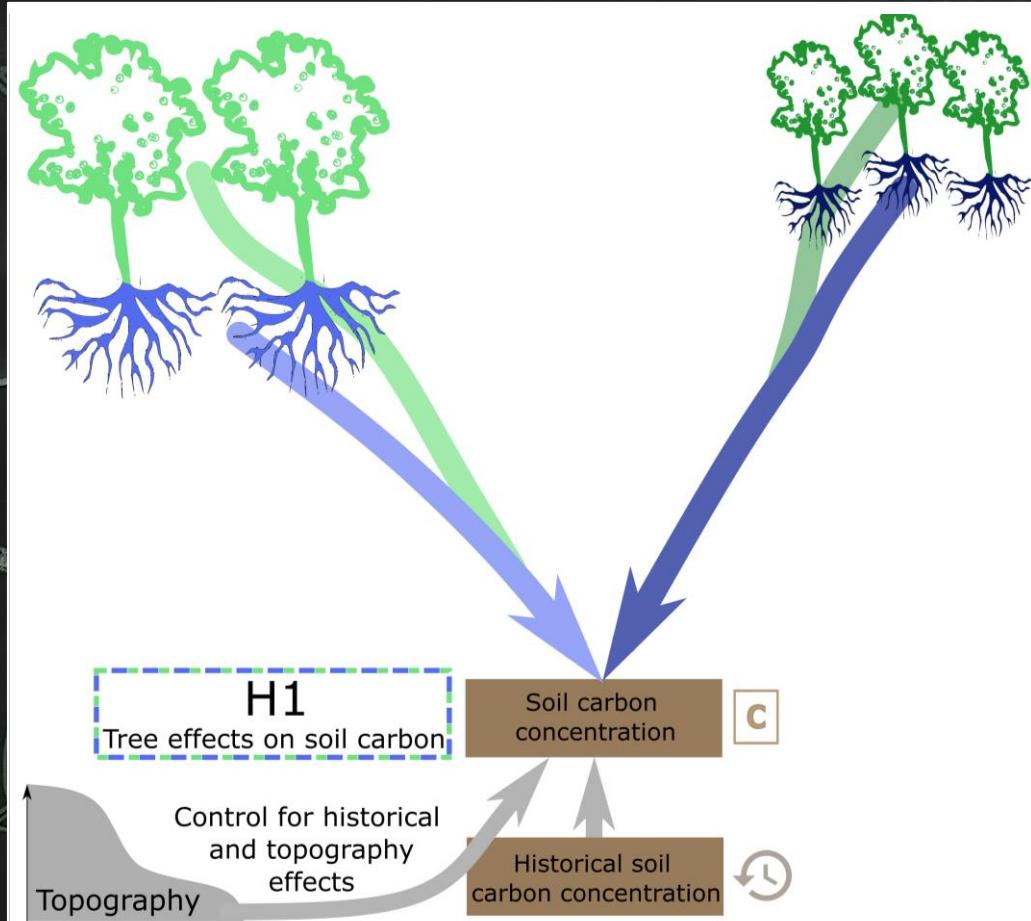
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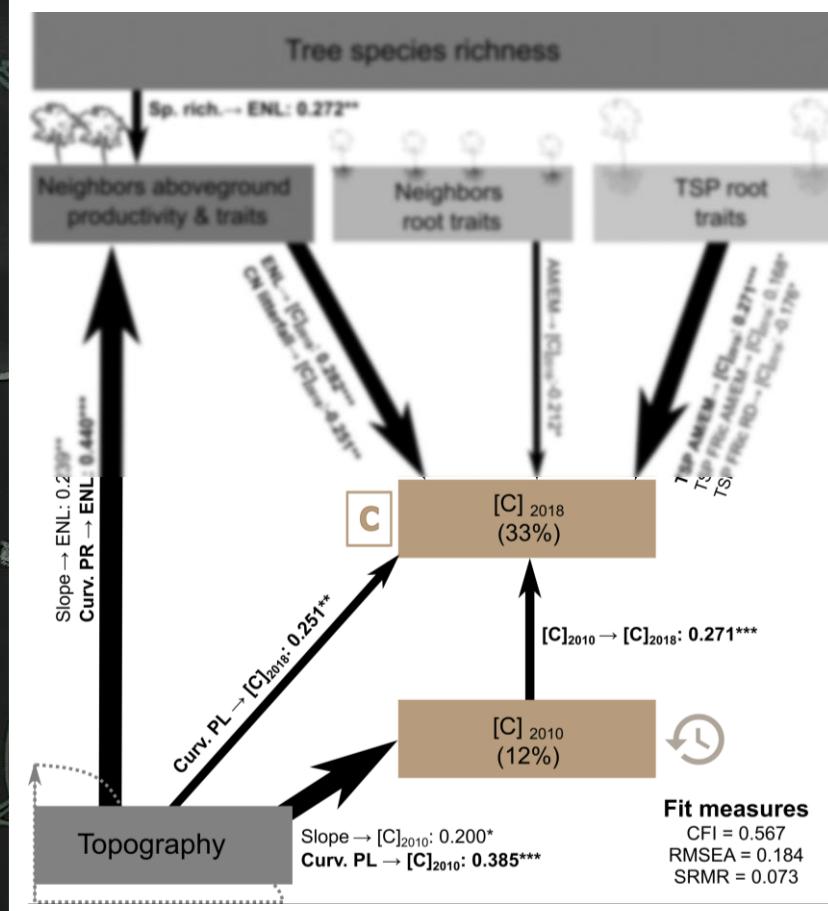
## Sampling design



# Drivers of soil carbon concentration

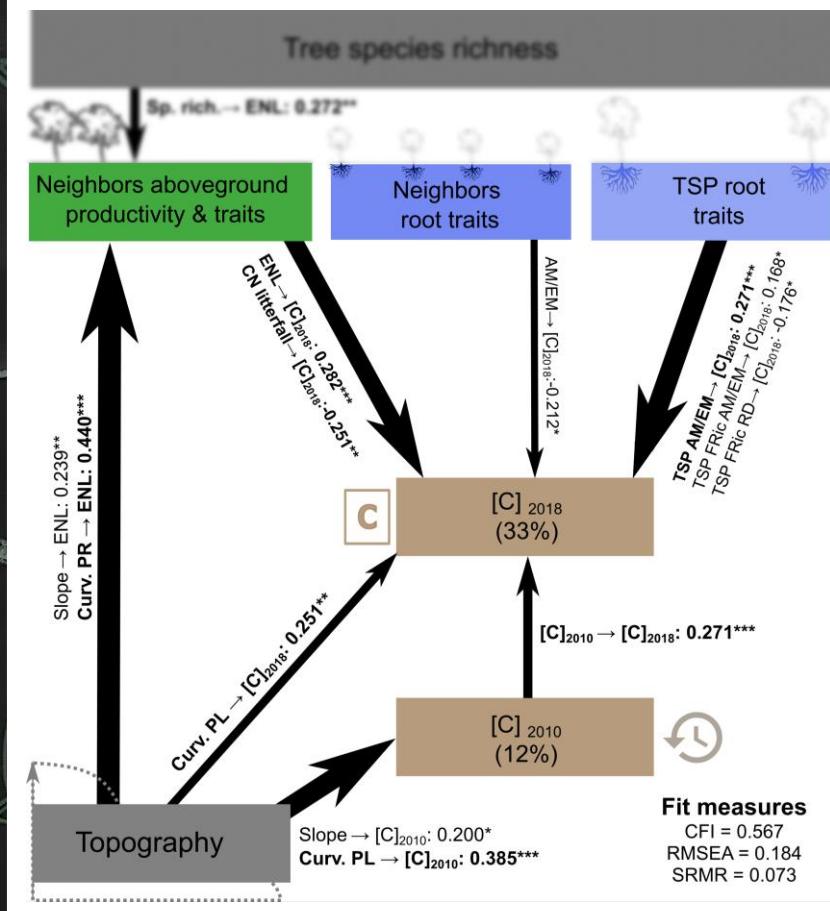


# Drivers of soil carbon concentration



Historical carbon concentration and plot curvature increased soil concentration

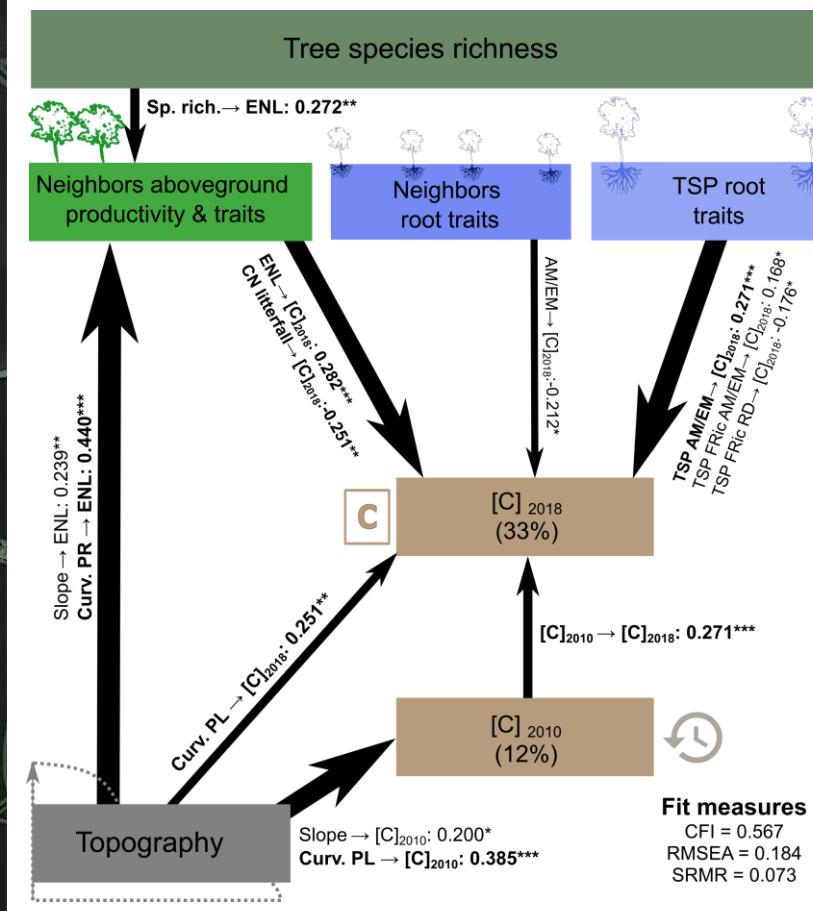
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Neighborhood productivity and TSP root traits strongly affected soil carbon concentration

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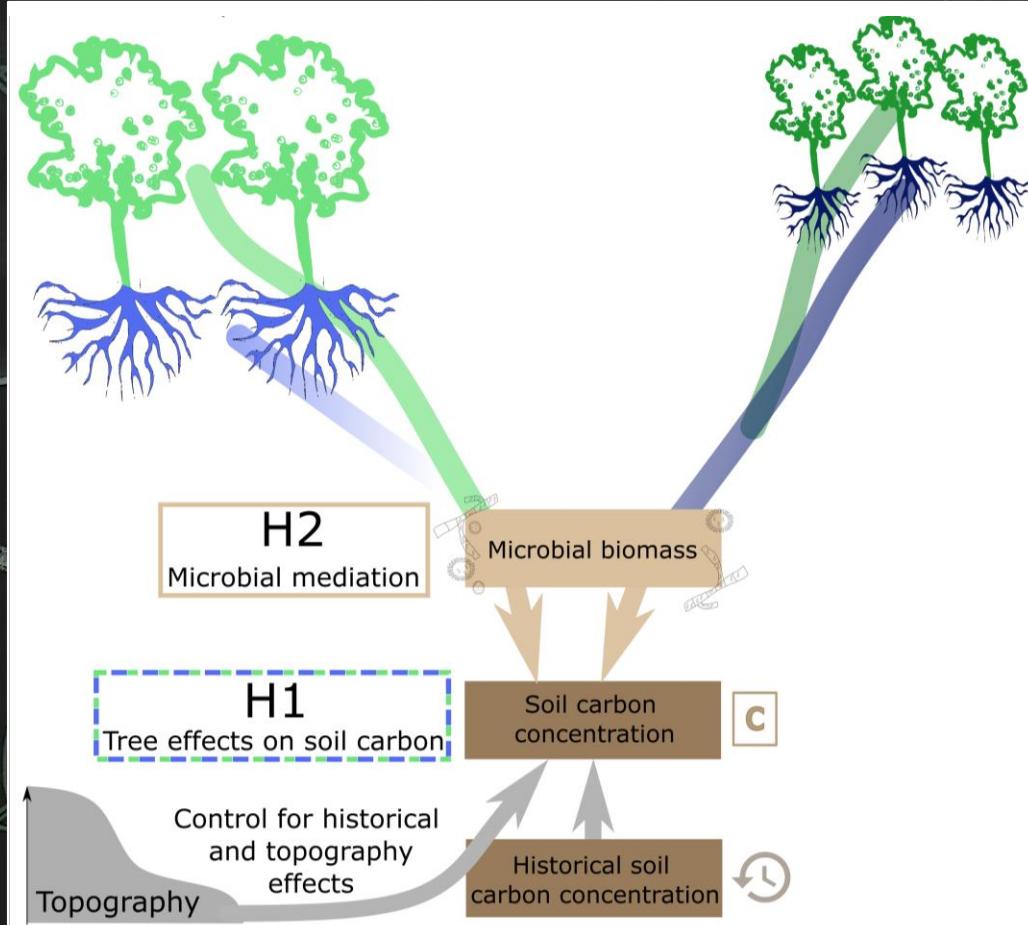


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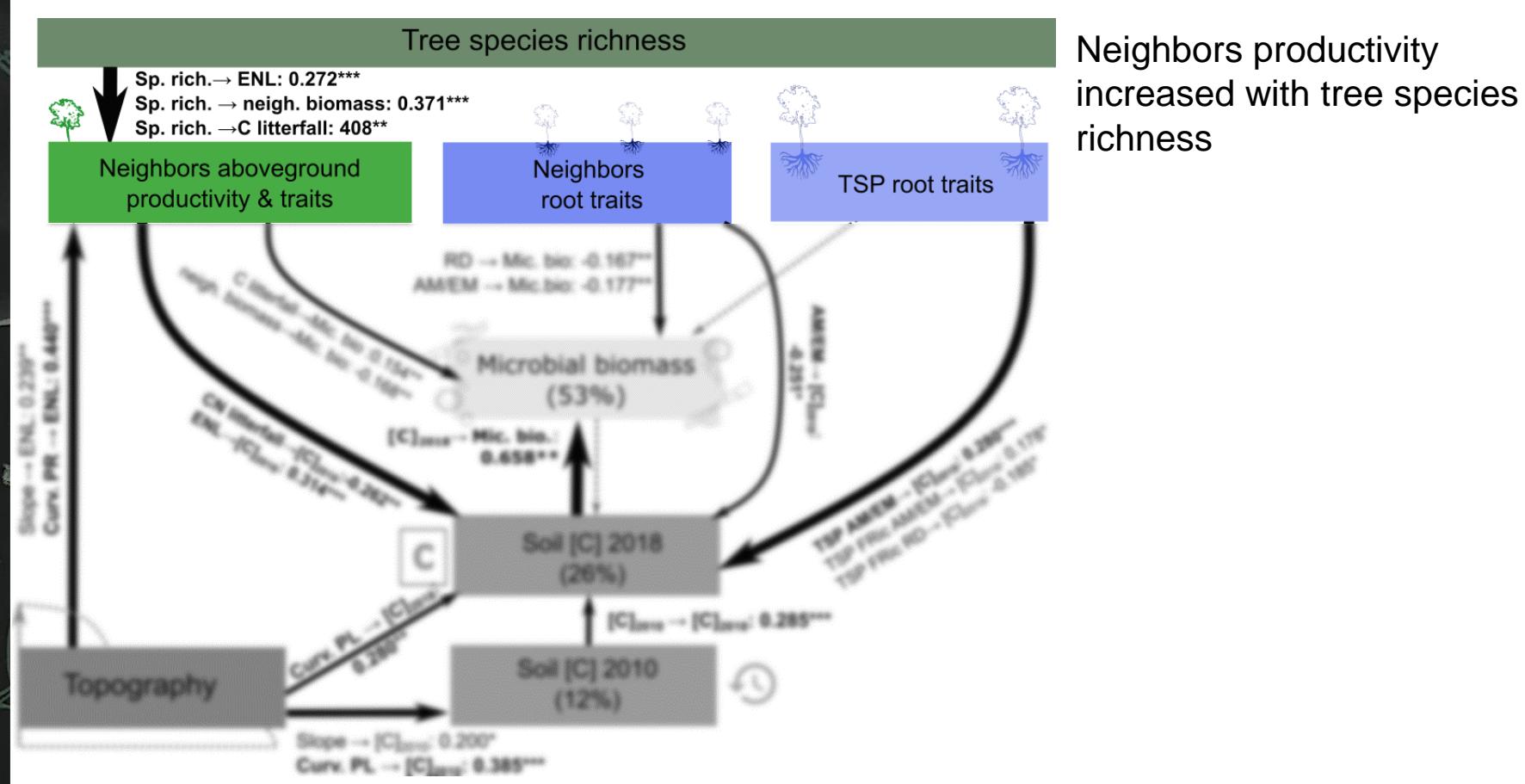
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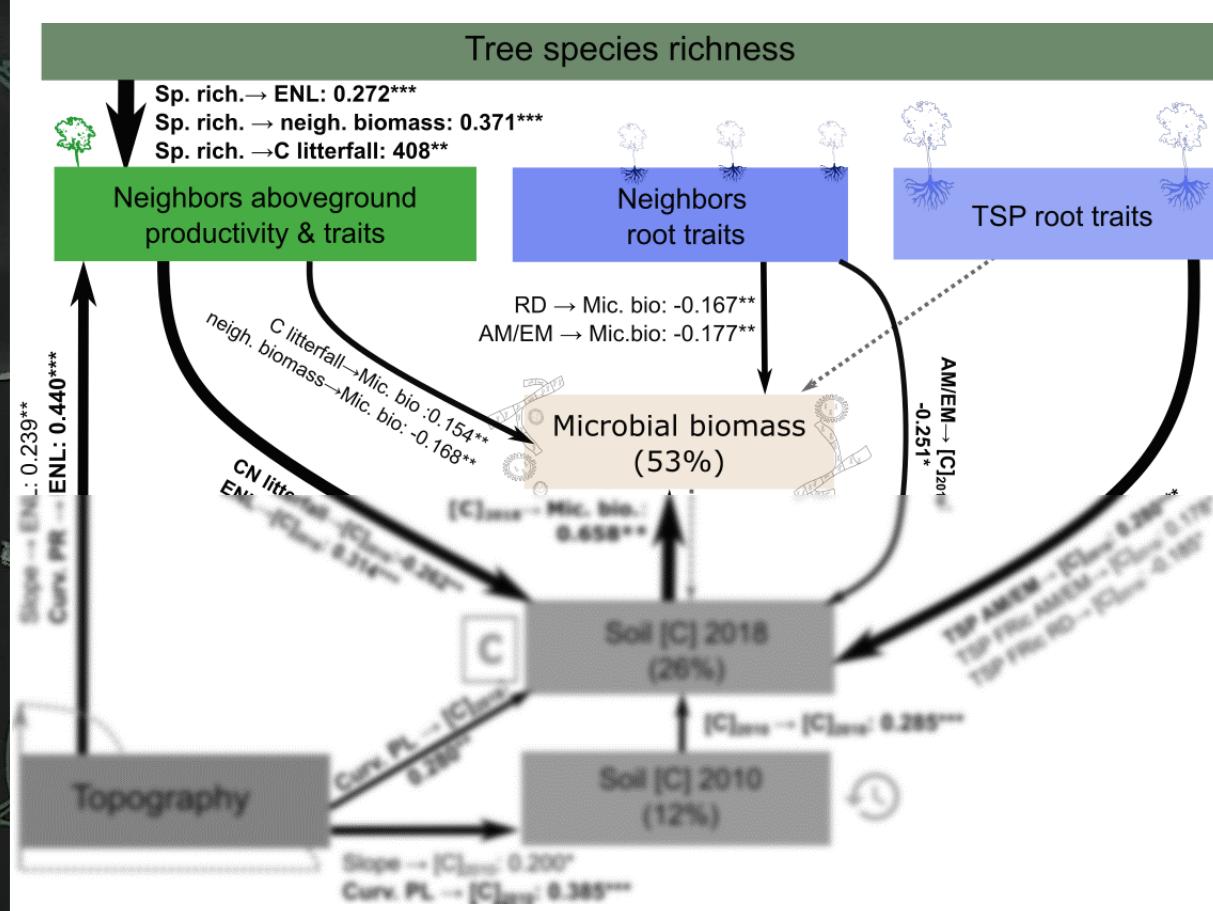
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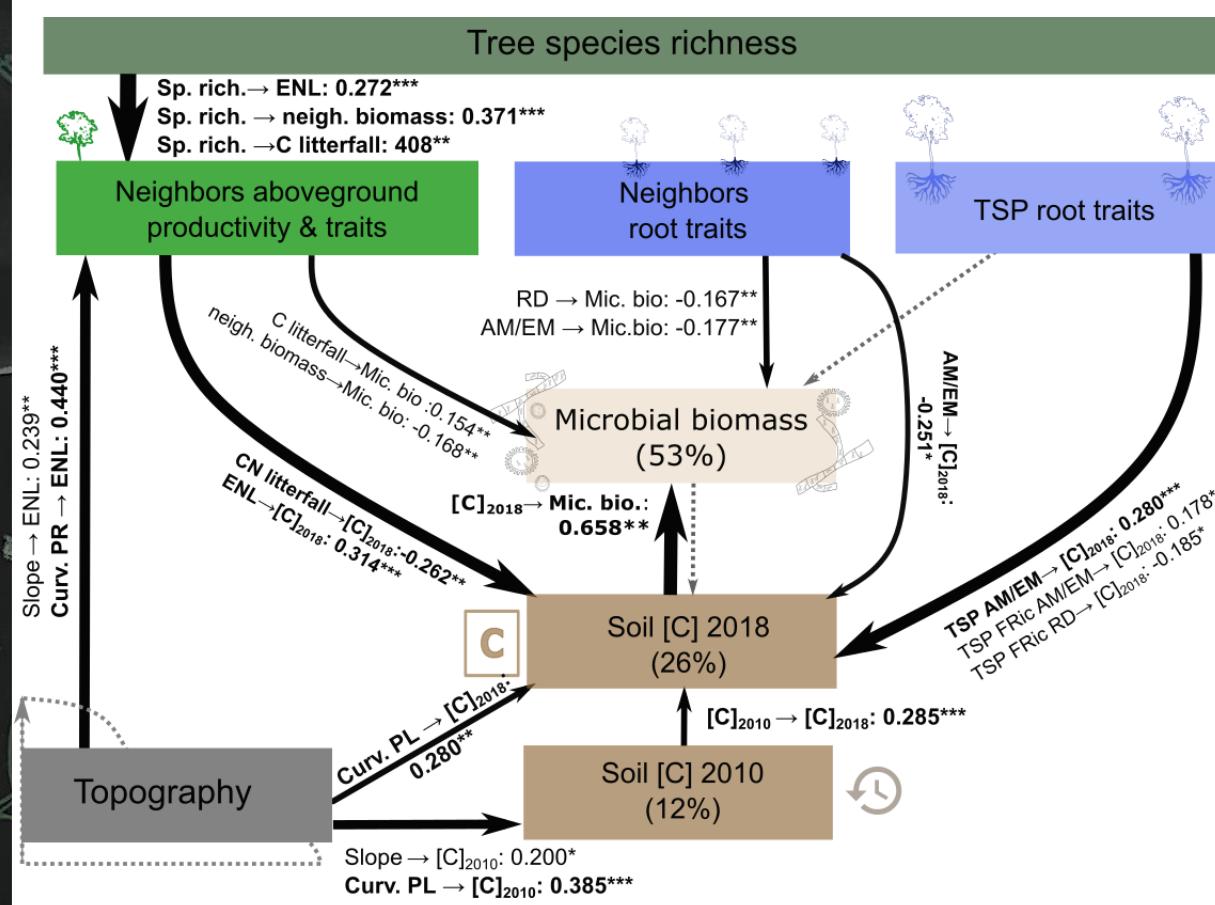
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Neighbors productivity and root functional traits identity affected microbial biomass

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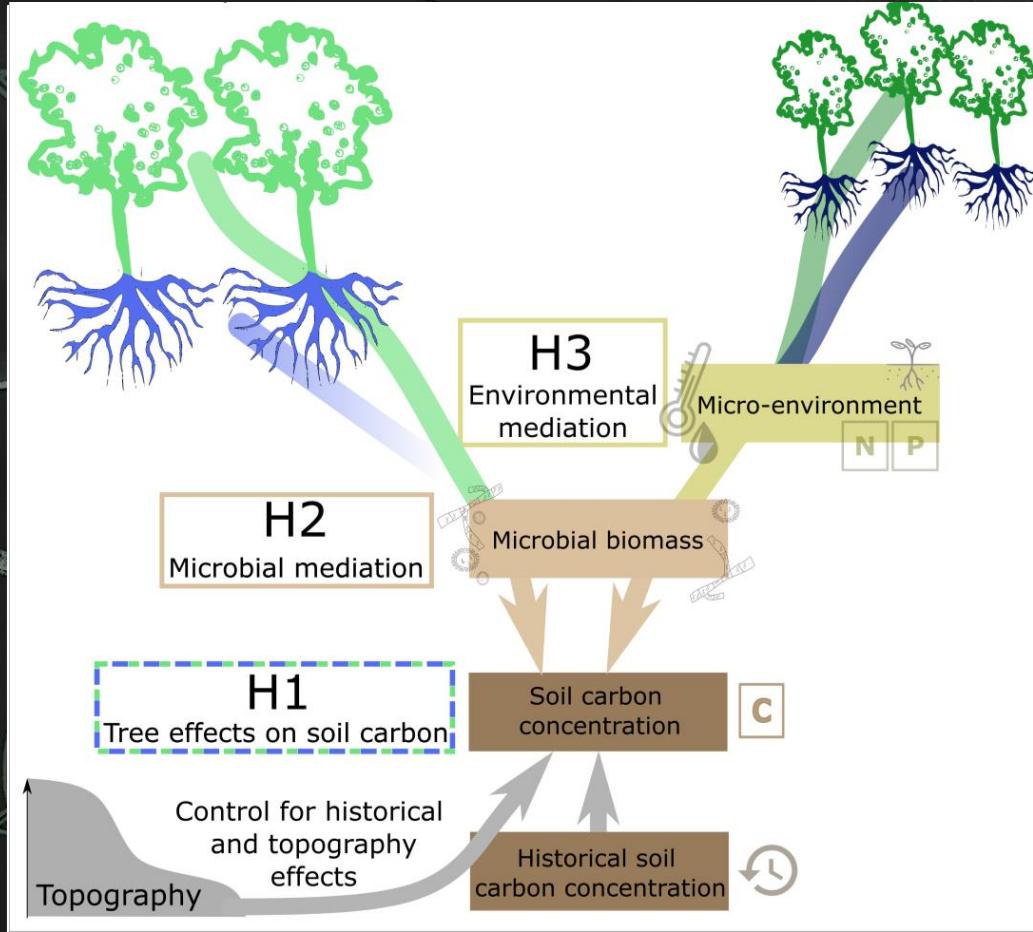


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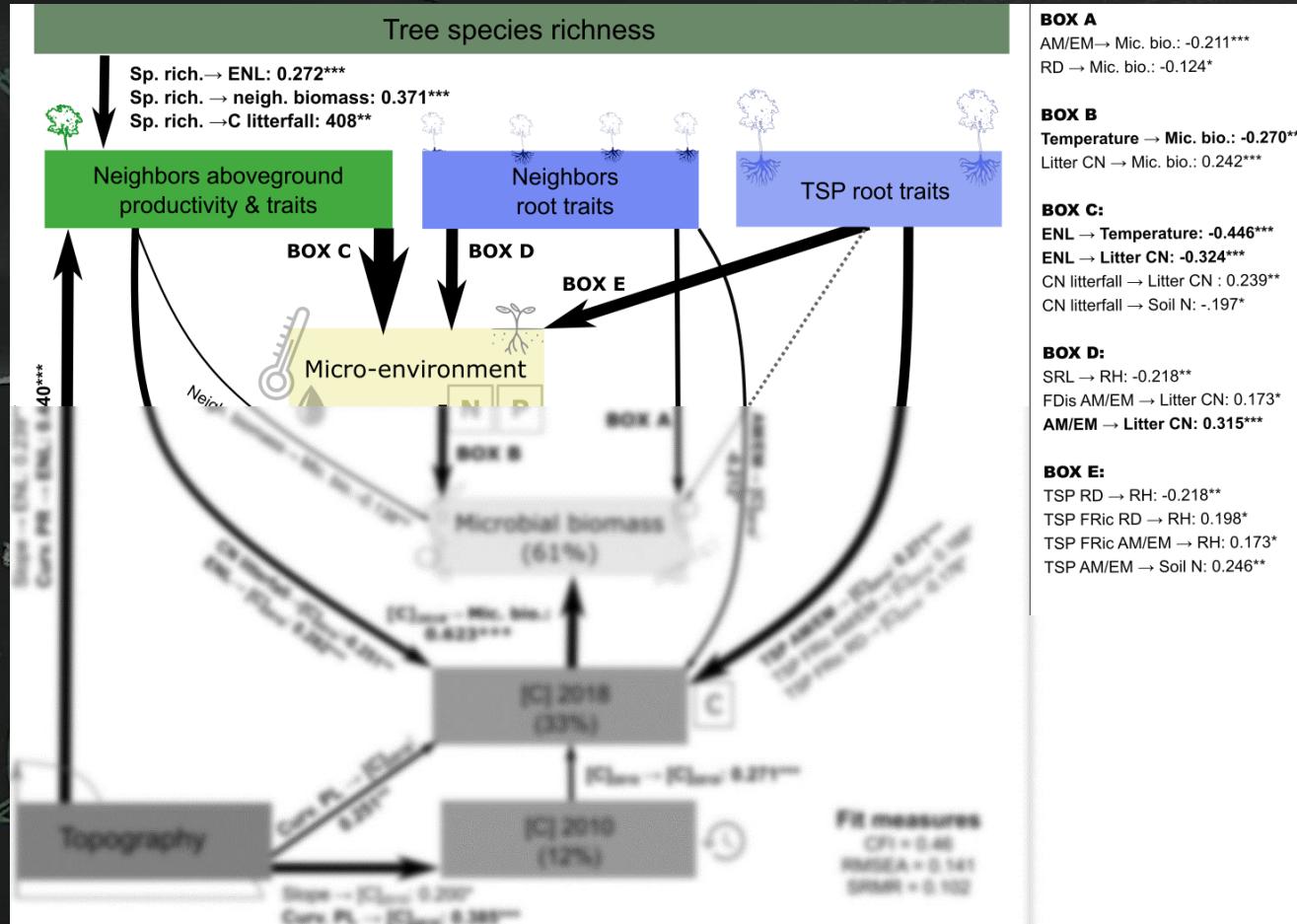
Neighbors productivity and root functional traits identity affected microbial biomass

Soil carbon concentration strongly increased microbial biomass but the feedback effect wasn't detected

# Environmental mediation of tree effects on microbial biomass

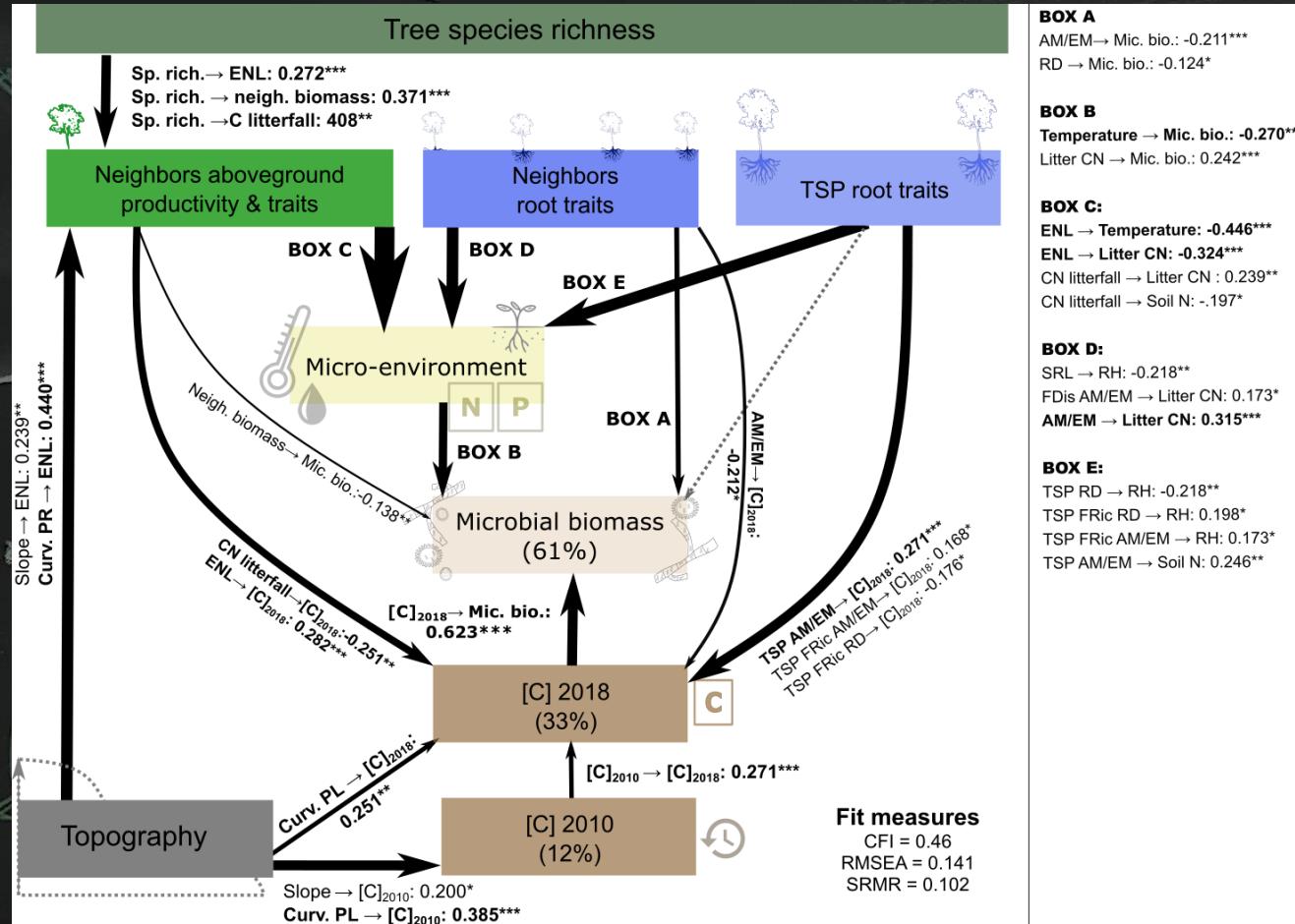


# Environmental mediation of tree effects on microbial biomass



Neighbors productivity, functional traits and TSP root functional traits strongly modified micro-environmental conditions

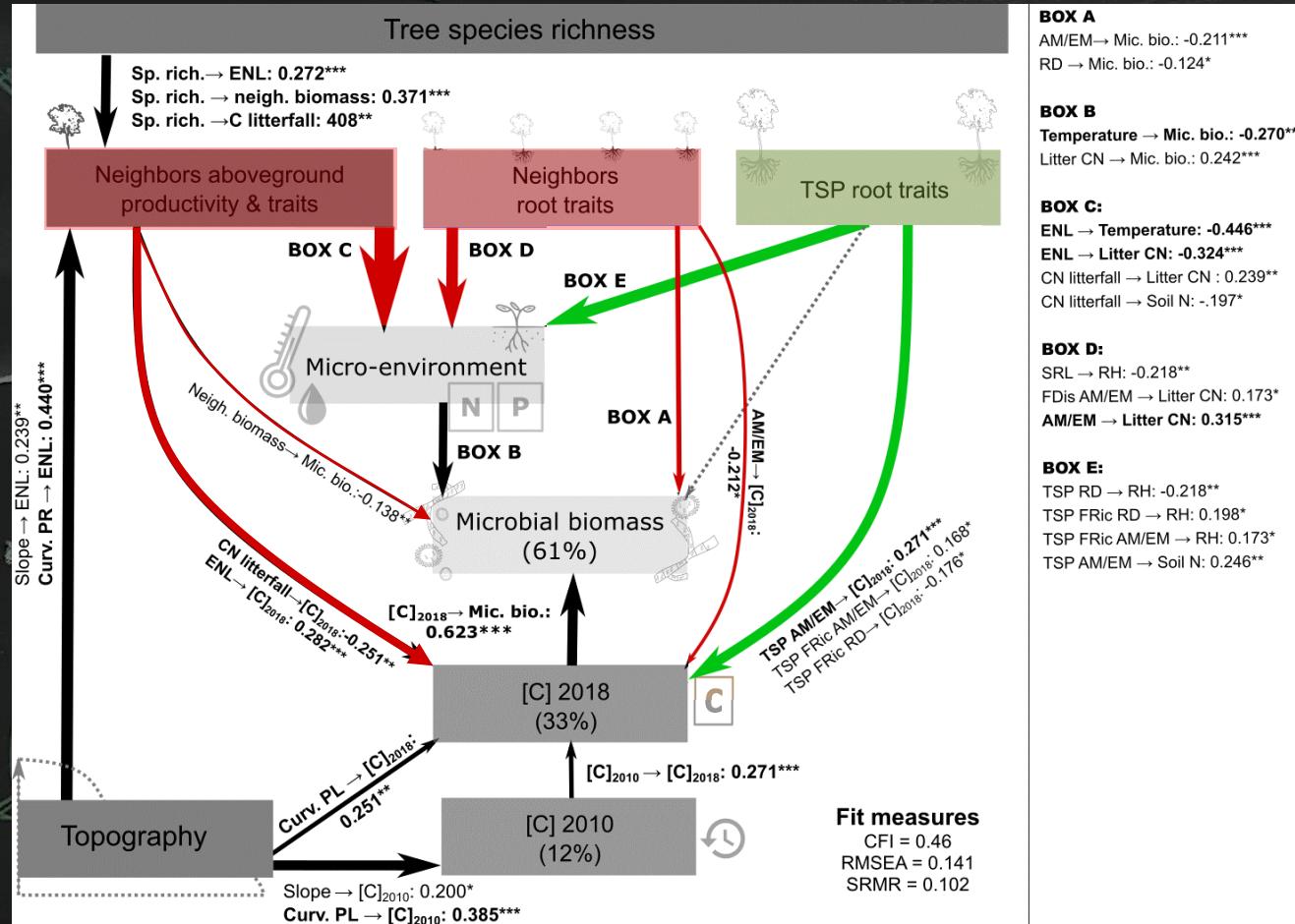
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Micro-environmental conditions were the main drivers of microbial biomass

Tree effects directly affected soil carbon concentration while their effects on microbial biomass were mediated by the environmental conditions

## Conclusion

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- **Tree productivity increased both microbial biomass and soil carbon concentration**
- Tree functional traits effect on soil carbon concentration and microbial biomass **depended of the scale considered**
- **The effects of tree functional traits and productivity** on microbial biomass were mostly **mediated by the micro-environment**
- Our analyses suggested a strong positive effect of soil carbon concentration on microbial biomass but failed to detect feedback effects.

## Discussion

- Confirmation of **the close relationship between microbial biomass and soil carbon concentration:**
  - more temporal studies and measurement of soil carbon structure to understand the mechanisms

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- **High scale dependency** suggests scale dependent processes. This could explain the contradictory results previously found
- Our study highlights the **need to consider the spatial dimension in ecology**



Simone Cesarz & Nico Eisenhauer

### Field and lab helpers



### Collaborators:

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Steffen Seitz, Bala Singavarapu,  
Stefan Trogisch, Yanfen Wang,  
Tesfaye Wubet, Kai Xue



Thank you for your attention

