

SOIL BIOGEOCHEMICAL CYCLES UNDER CLIMATE CHANGE: A NEW MODEL IMPLEMENTATION

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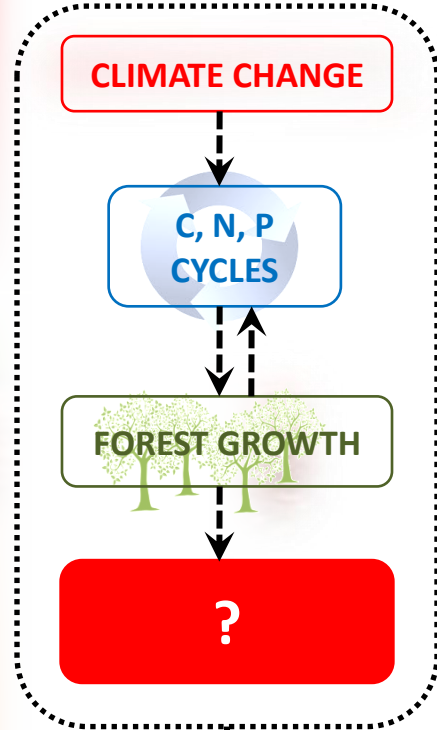
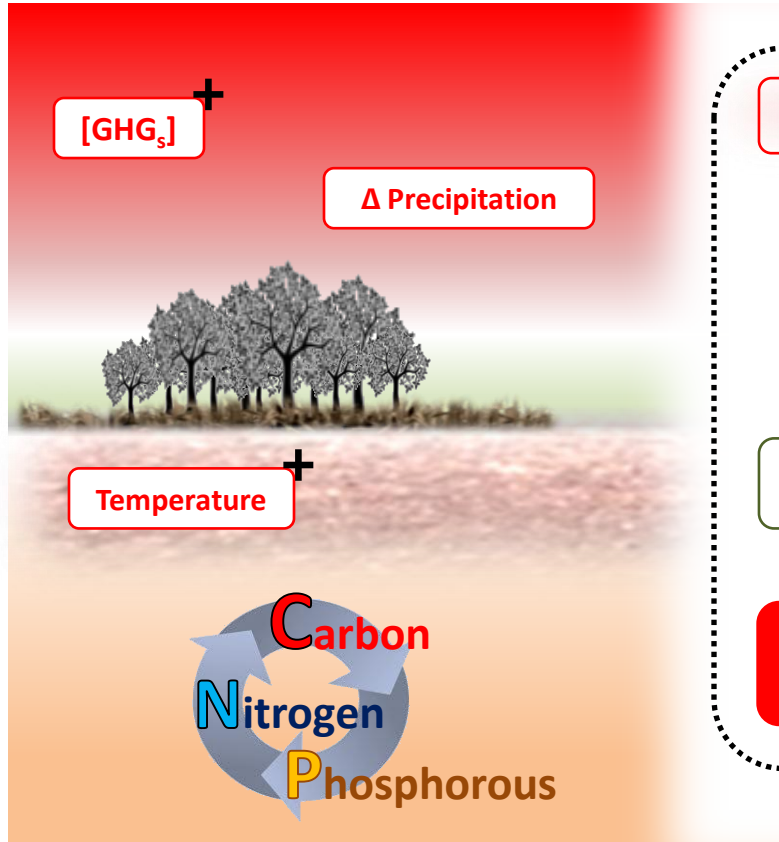
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Introduction - Overview



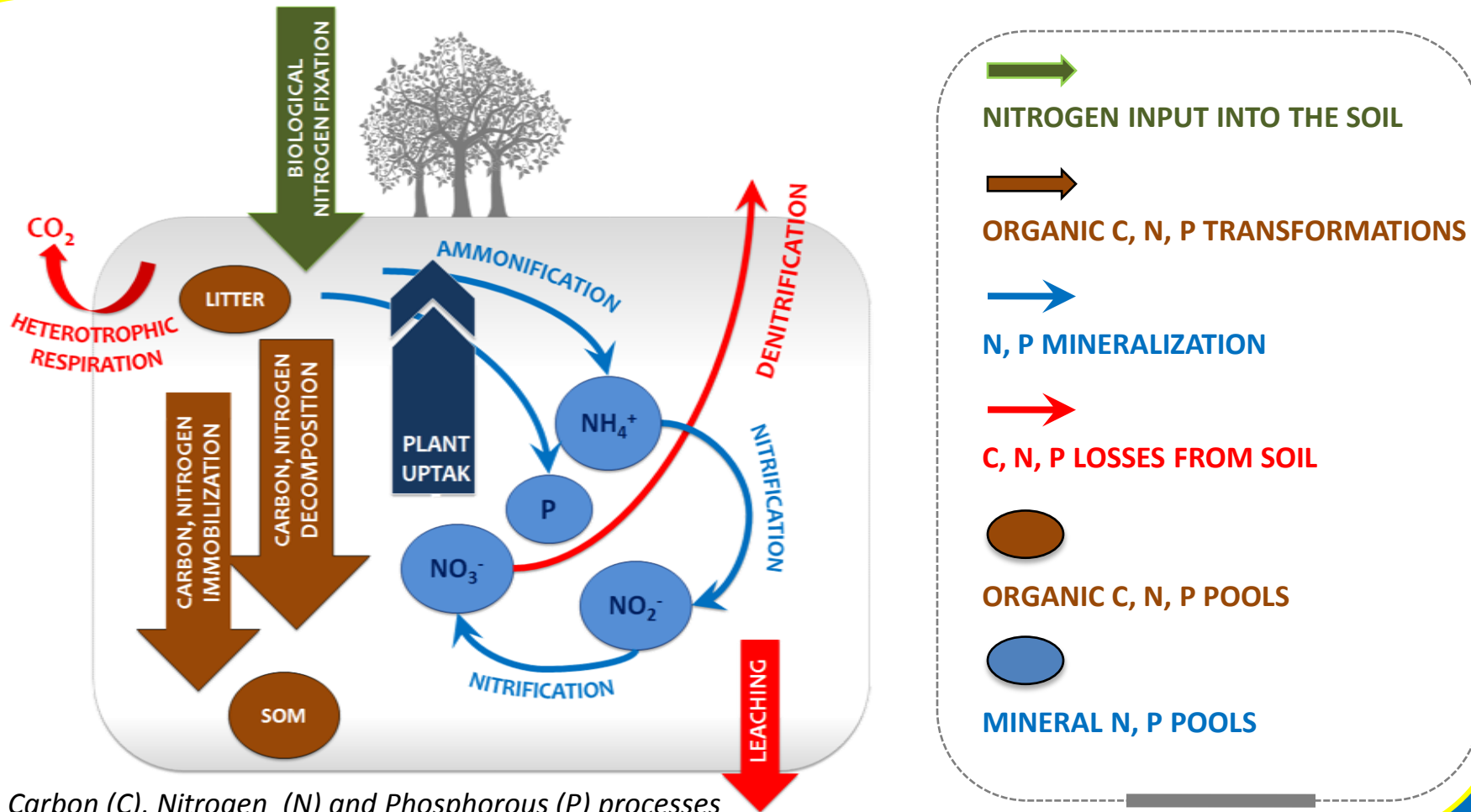
Aims

What are the long-term effects of **climate change** on soil biogeochemical cycles?

How **soil biogeochemical cycles** affect **forest** growth and, consequently, the role of forests to mitigate climate change?

SIMULATION MODELS

Introduction – Soil Biogeochemical Processes



Carbon (C), Nitrogen (N) and Phosphorous (P) processes

Introduction - Simulation Models

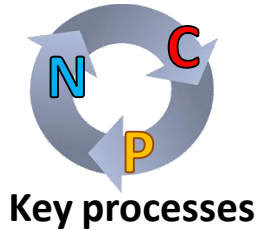
MODEL	EXTENDED NAME	REFERENCE	
LPJ	Lund-Potsdam-Jena	<i>Sitch et al., 2003</i>	Carbon dynamics
ORCHIDEE	ORganizing Carbon and Hydrology In Dynamic Ecosystems Environment	<i>Krinner et al., 2005</i>	
BIOME-BGC	BIOME BioGeochemical Cycles	<i>Golinkoff, 2010</i>	Carbon, Nitrogen dynamics
JSBACH-CN	Jena Scheme for Biosphere– Atmosphere Coupling in Hamburg	<i>Parida, 2011</i>	
PnET-N-DNDC	PnET-Nitrification- DeNitrification-DeComposition	<i>Li & Aber, 2000</i>	
CENTURY PREVIOUS VERS.S	CENTURY model	<i>Parton et al., 1993</i>	Carbon, Nitrogen, Phosphorous dynamics
CENTURY VERS.4	CENTURY model	-	
CLM-CNP	Community Land Model	<i>Yang et al., 2014</i>	
CENW	Carbon, Energy, Nutrient and Water	<i>Kirschbaum & Paul, 2002</i>	
CASA-CNP	Carnegie-Ames-Stanford Approach	<i>Wang et al., 2010</i>	

Introduction – Why a new (restructured) model?

- To **improve** the simulation of the processes already simulated by other models
- To implement a **specific tool** for my study
- To simulate the **processes neglected** by other models, but that could play a **relevant role** under climate change

Materials and methods – Model implementation

Base Structure



C, N, P Decomposition
C, N, P Immobilization
Heterotrophic Respiration
N, P Mineralization
Symbiotic Biological Nitrogen Fixation
Leaching
Denitrification
Plant Uptake

+



Processes neglected by other models

Materials and methods – Base structure implementation

All possible **combinations** among the available **models**

BASE STRUCTURE PROCESSES

Decomposition

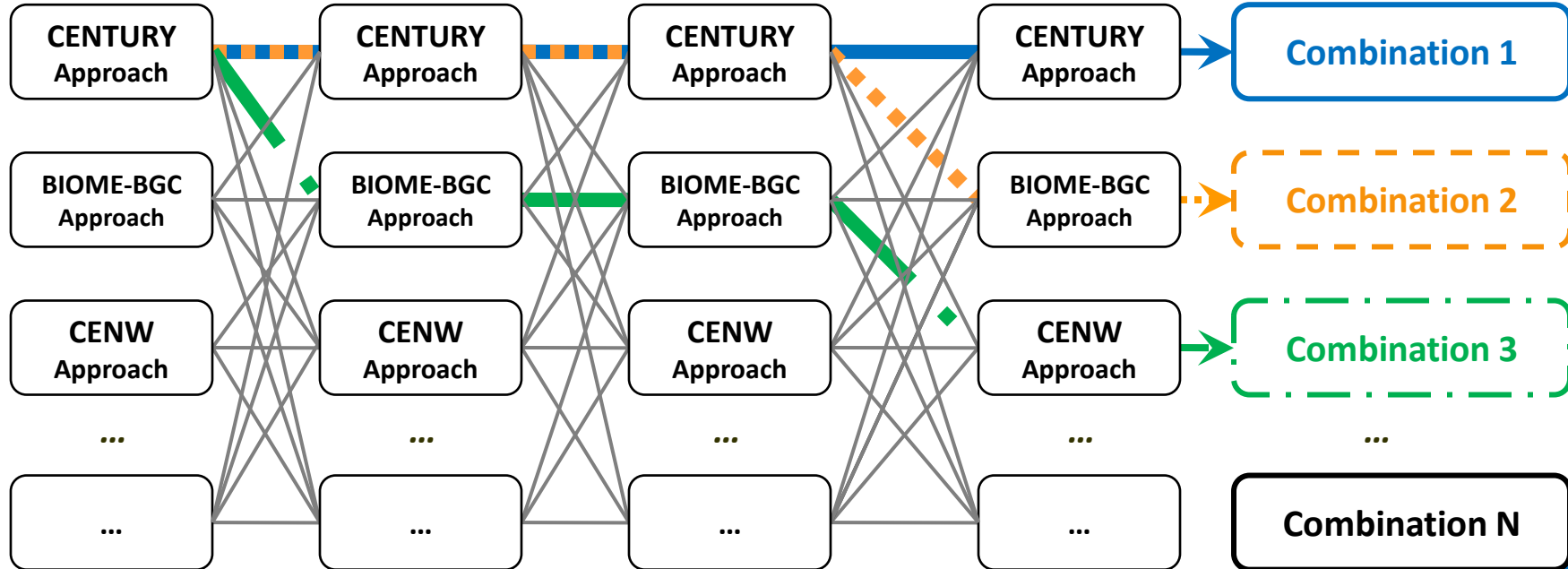
Immobilization

Heterotrophic
Respiration

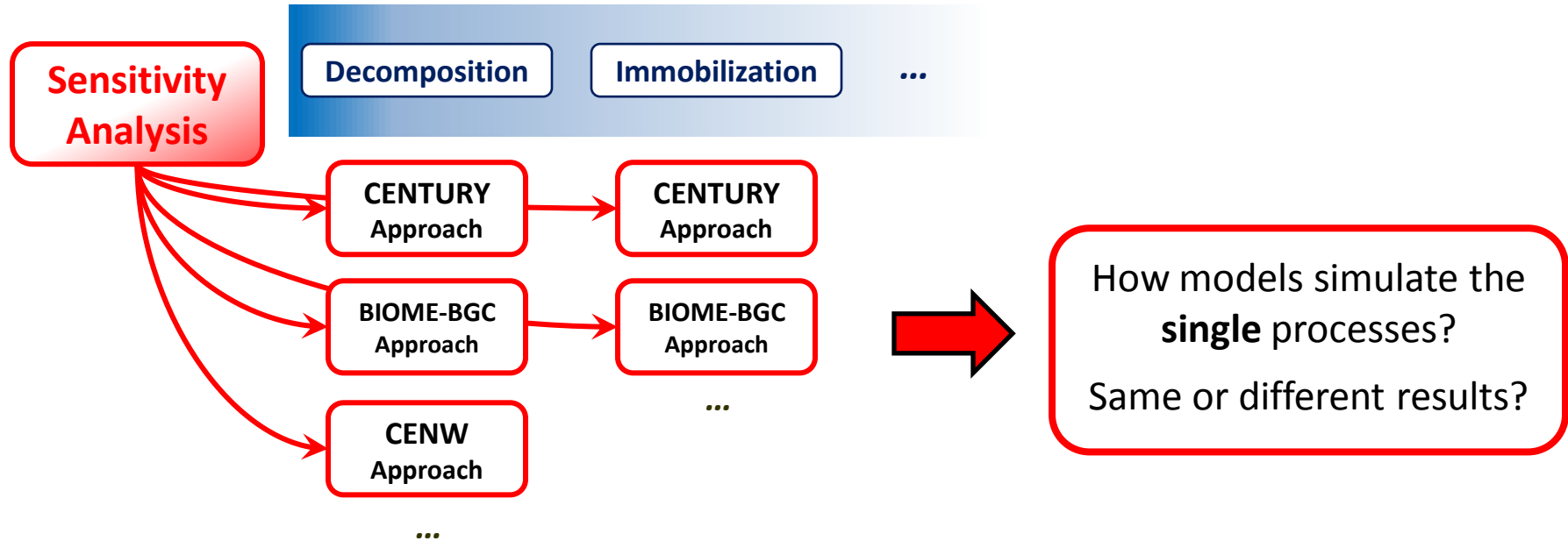
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Plant
Uptake

M
O
D
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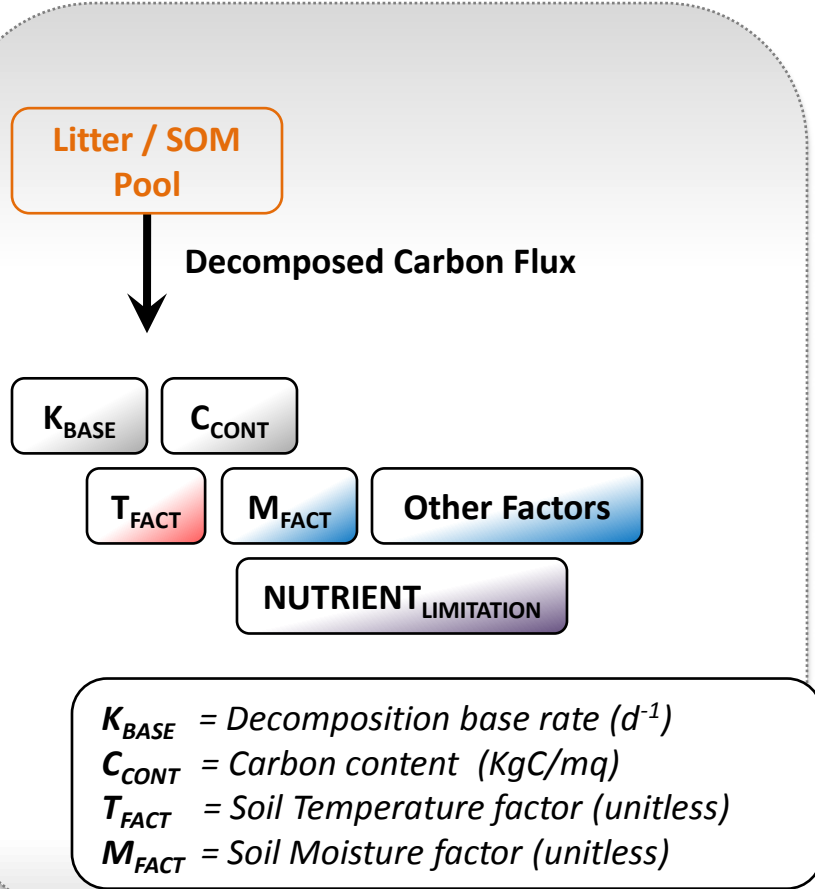
Materials and methods – Base structure implementation (current step)



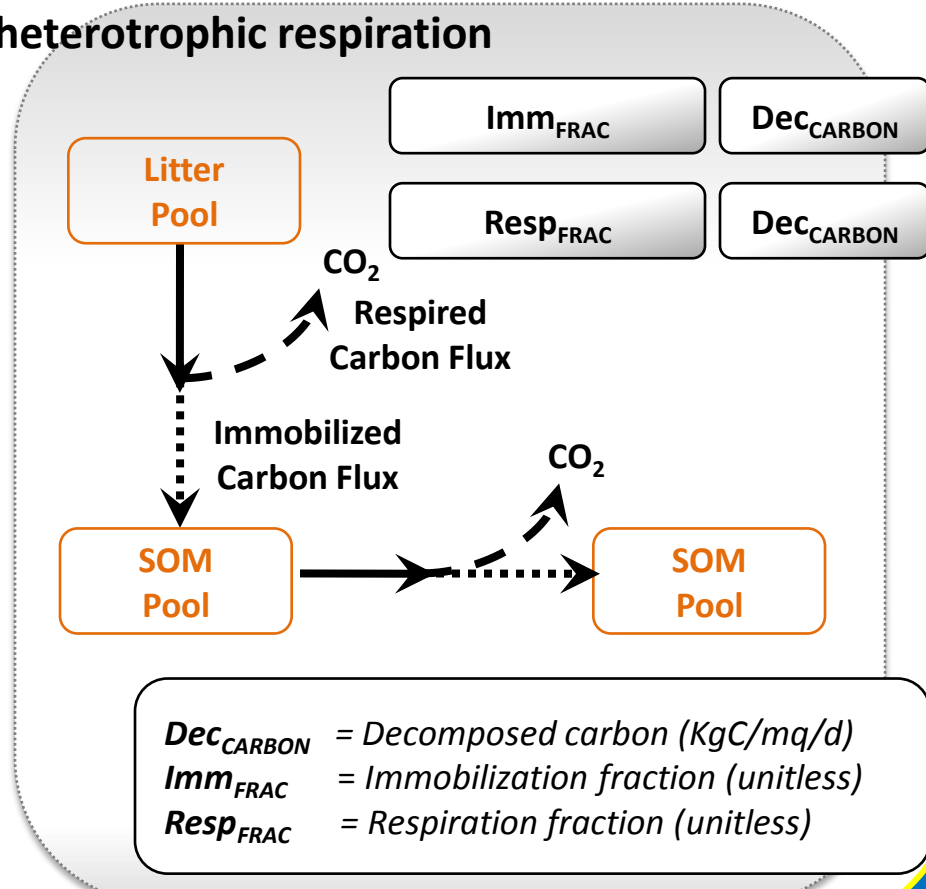
Sensitivity analysis on **decomposition, immobilization** and **heterotrophic respiration**

Materials and methods – Sensitivity analysis

Carbon decomposition

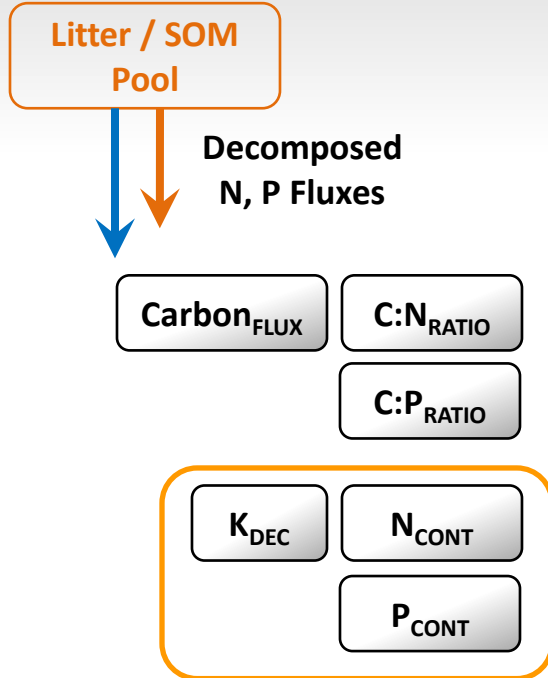


Carbon immobilization and heterotrophic respiration



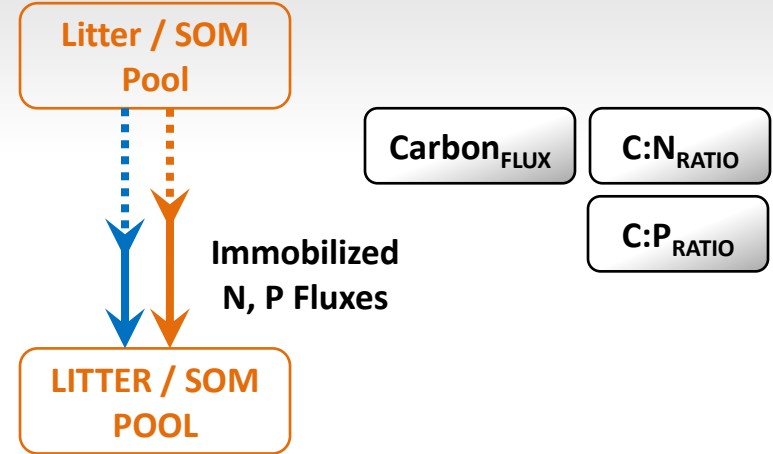
Materials and methods – Sensitivity analysis

Nitrogen, Phosphorous decomposition



CASA Model

Nitrogen, Phosphorous immobilization

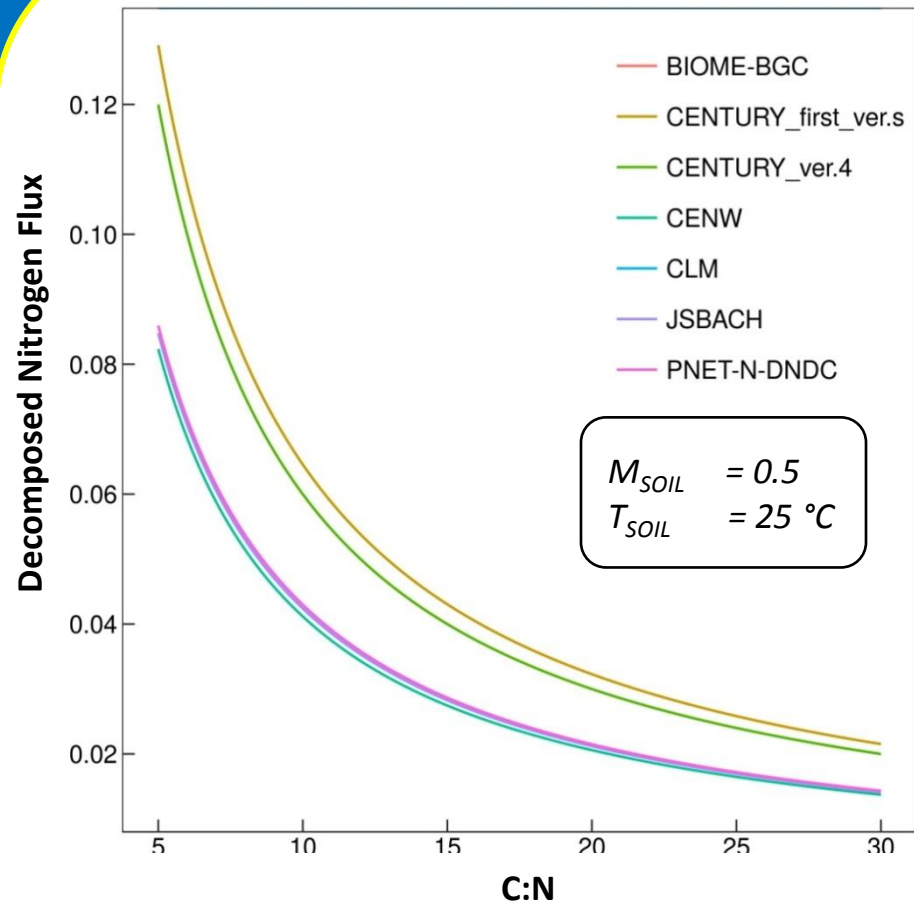


Carbon_{FLUX} = Decomposed or Immobilized Carbon (kgC/mq/d)
C:N_{RATIO} = Carbon: Nitrogen ratio (unitless)
C:P_{RATIO} = Carbon: Phosphorous ratio (unitless)
K_{DEC} = Decomposition rate (d⁻¹)

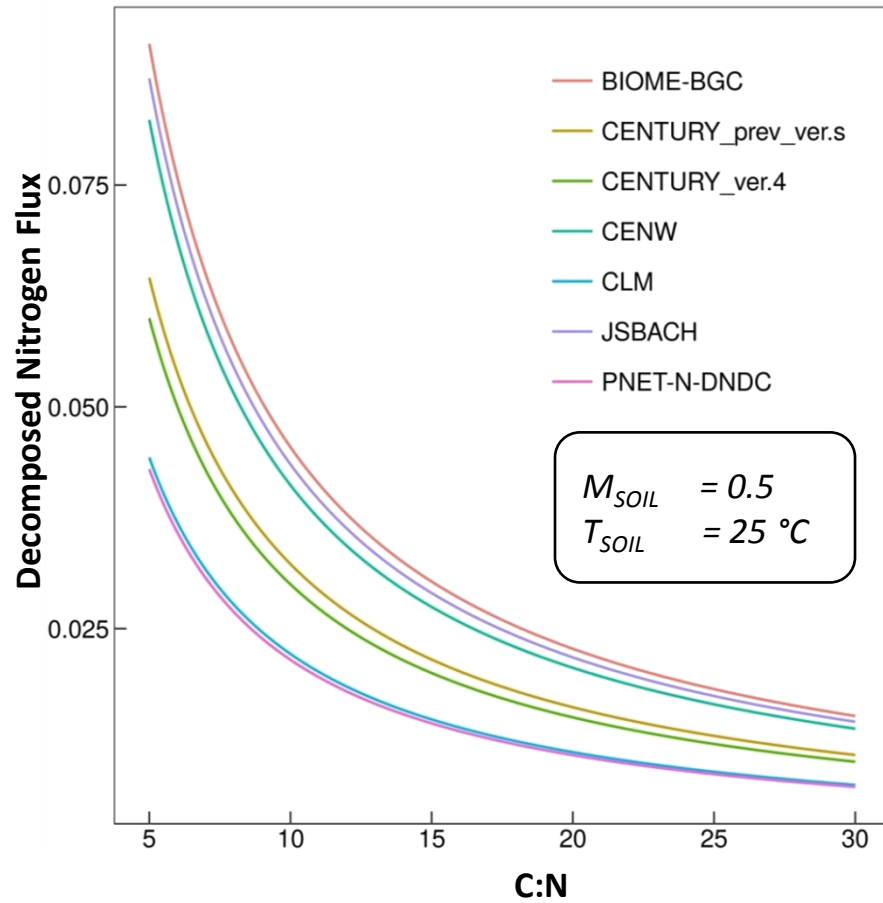
**Sensitivity analysis
(first) Results**

(First) results - Sensitivity Analysis – Nitrogen Decomposition and Immobilization

Decomposed Nitrogen Flux

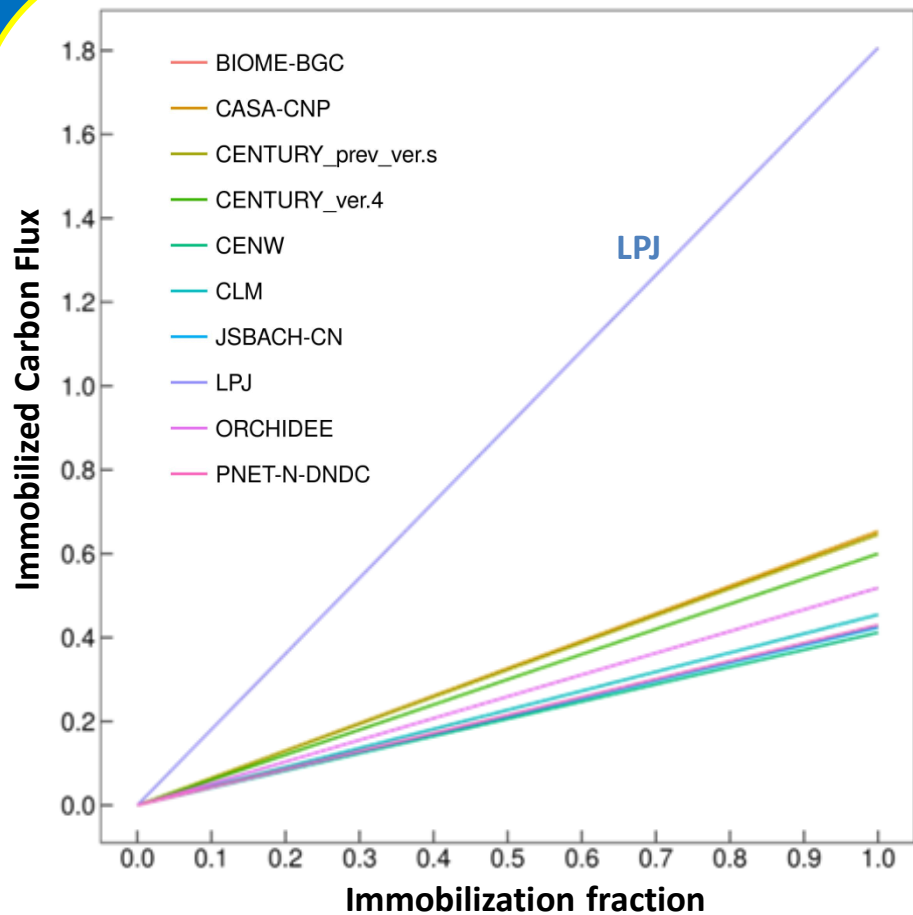


Immobilized Nitrogen Flux

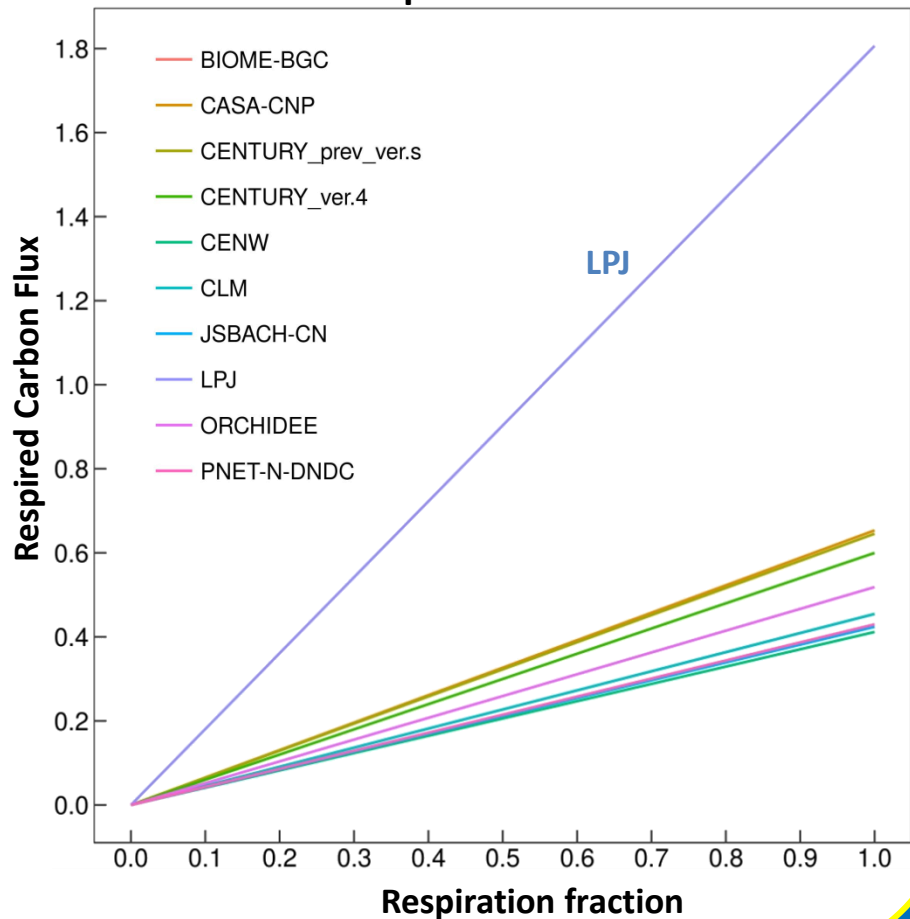


(First) results - Sensitivity Analysis – Carbon Immobilization and Heterotrophic Respiration

Immobilized Carbon Flux



Respired Carbon Flux



(First) Discussions - What can we say?

The first results show that models could simulate differently the single processes.

For Carbon Decomposition

Most models simulate an **exponential increase** of temperature effect on carbon decomposition. Only the formulation of **CENTURY_prev._ver.s** and **PnET-N-DNDC** encapsulates the **inhibition of microbial** activity at high temperatures.

Only **CASA-CNP** model simulates the **inhibition** of microbial decomposers after an optimum soil moisture.

For other processes

No relevant differences among the analyzed models.

(First) Conclusions

The sensitivity analysis of decomposition, immobilization and heterotrophic respiration shows that different models could lead to different results.

For the base structure implementation, the combinations among models will be fundamental to understand how the differences compensate each other

Next Steps

Base Structure



Key processes

Organic C, N, P transformations

N, P mineralization

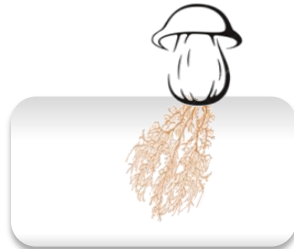
N input into the soil

C, N, P losses from soil

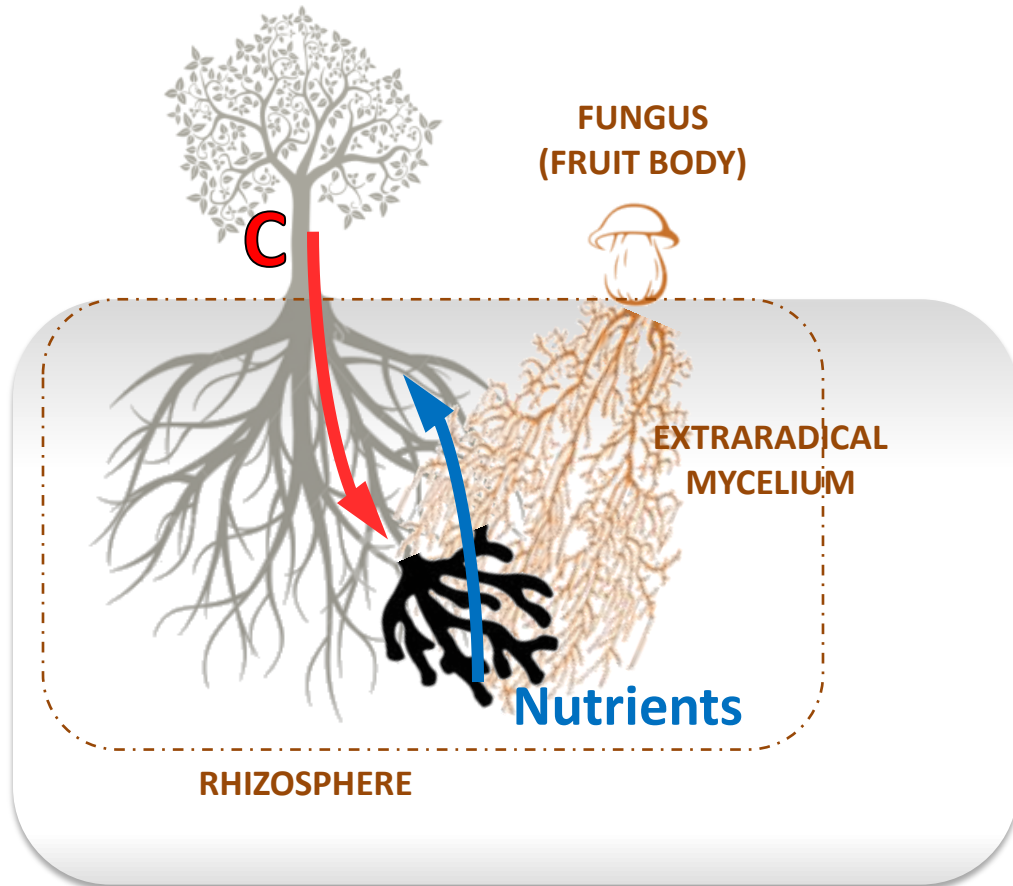
- Sensitivity analysis on the other processes
- Combinations
- Base structure **validation** on real data

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Mycorrhizal fungi



Mycorrhizal fungi



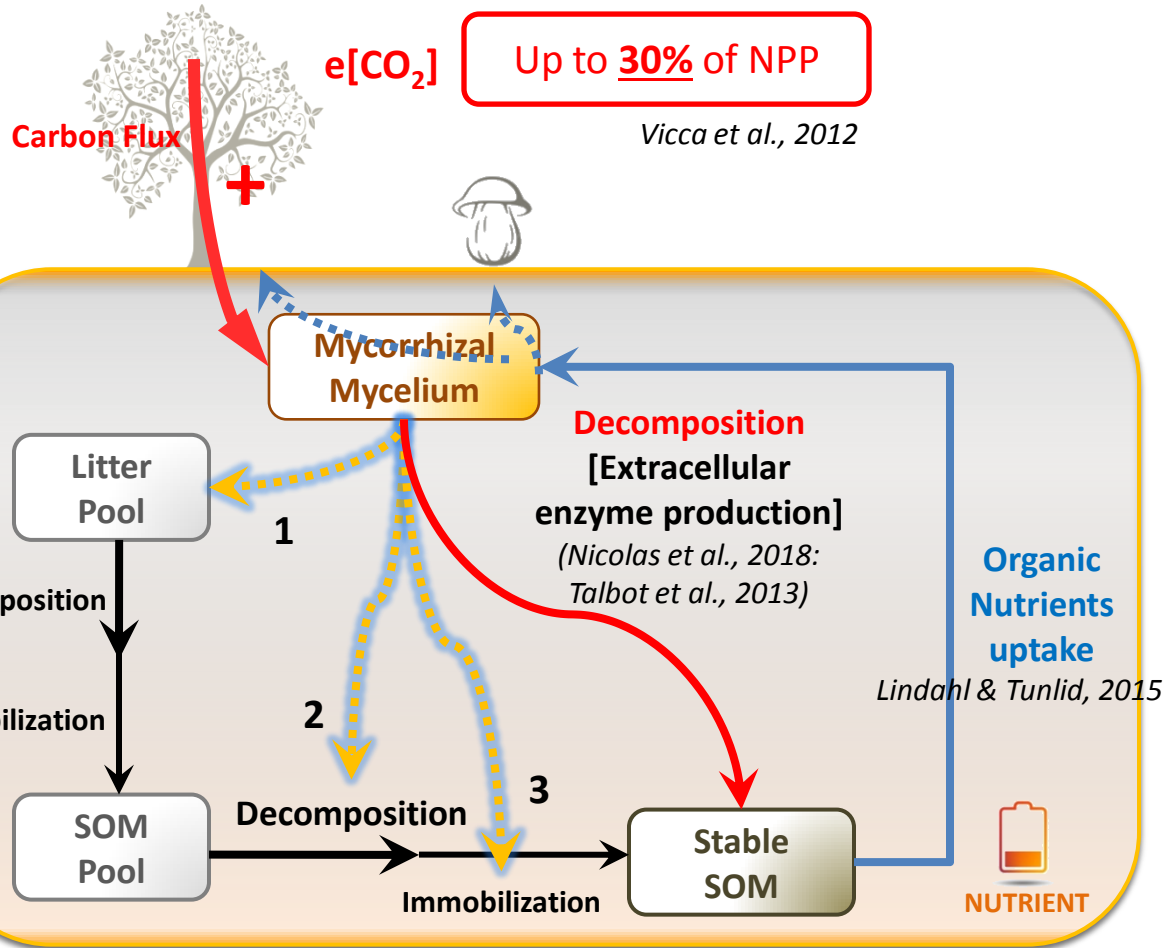
Boreal and Temperate forests

Mutualistic relationship between plant roots and mycorrhizal fungi

Carbon flux from host plant to fungus

Nutrient flux from the fungus to host plant

What (I think) is missing into the models?



Effects on:

1. Litter input of dead mycelium
2. Decomposition (of more recalcitrant SOM)
3. Immobilization of organic compounds



THANKS



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