SOIL BIOGEOCHEMICAL CYCLES UNDER CLIMATE CHANGE:
A NEW MODEL IMPLEMENTATION

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CLIMATE CHANGE

SIMULATION MODELS

C, N, P CYCLES

FOREST GROWTH AND MANAGEMENT

CLIMATE CHANGE MITIGATION

FOREST ECOSYSTEMS

SOIL

NITROGEN

CARBON

PHOSPHOROUS

CLIMATE CHANGE

C, N, P CYCLES

FOREST GROWTH AND MANAGEMENT

CLIMATE CHANGE MITIGATION
1. HOW DO MODELS SIMULATE THE BIOGEOCHEMICAL PROCESSES?

2. HOW DIFFERENT THE MODELS ARE?

3. ARE THE MODELS COMPLETE TOOLS FOR THE STUDY?
LITERATURE REVIEW

**C dynamics (5 models)**
- LPJ
- ROTHC
- ORCHIDEE
- LPJmL
- YASSO15

**C, N dynamics (4 models)**
- BIOME-BGC
- JSBACH-CN
- JULES
- PnET-N-DNDC

**C, N, P dynamics (4 models)**
- CENTURY
- CENW
- CLM-CNP
- CASA-CNP

**TEMPORAL AND SPATIAL SCALE**
Daily to annual; ecosystem to global

**ORGANIC AND INORGANIC POOL STRUCTURE**
Different litter and SOM pools

**SOIL SCHEME**
Bucket layer or different layers

**DIFFERENT SIMULATION APPROACHES**
Equations, parameters, assumptions

**DIFFERENT APPROACHES FOR EACH PROCESS**
- Mineralization: 8
- Denitrification: 7
- Decomposition: 13
- Leaching: 7
- Immobilization: 8
- Plant uptake: 7
- Heterotrophic respiration: 4
- Biological N₂ fixation: 5
SIMULATION MODELS – LIMITATION OF APPROACHES

SIMPLIFIED APPROACHES

TO SIMULATE RELEVANT PROCESSES (IMMOBILIZATION, HETEROTROPHIC RESPIRATION, DENITRIFICATION, BIOLOGICAL N₂ FIXATION).

UNCOUPLÉD C, N, P

EFFECT OF NITROGEN AND PHOSPHOROUS LIMITATIONS ON KEY PROCESSES.
SIMULATION MODELS - LACKS

ROOT EXUDATES AND MYCORRHIZAL FUNGI

PRODUCTION OF ENZYMES, IONS, FREE OXYGEN AND WATER, CARBON-CONTAINING COMPOUNDS.

CARBON FLUX TO ROOT UP TO: 30% NPP

ACHAT et al., 2016  VICCA et al., 2012  PHILLIPS et al., 2011

[CO₂] ↑

FOREST GROWTH ↑

NUTRIENT AVAILABILITY (-)

RHIZOSPHERE

SOM POOL

MINERAL POOL

DECOMPOSITION

MINERALIZATION

ROOT EXUDATES AND MF

MICROBIAL ACTIVITY

ROOT EXUDATES AND MF
3D-CMCC-SOIL MODEL IMPLEMENTATION

A NEW MODEL IMPLEMENTATION

1. CORE

ORGANIC C, N, P TRANSFORMATIONS
DECOMPOSITION, IMMOBILIZATION

PRODUCTION OF MINERAL COMPOUNDS
MINERALIZATION

C, N, P LOSSES FROM SOIL
HETEROTROPHIC RESPIRATION, MINERAL
LEACHING, DENITRIFICATION, PLANT UPTAKE

BIOLOGICAL N₂ FIXATION

2. NOVELTY

ROOT EXUDATES AND MYCORRHIZAL FUNGI
DYNAMICS
3D-CMCC-SOIL CORE IMPLEMENTATION

3D-CMCC-SOIL CORE PROCESSES

DECOMPOSITION  IMMOBILIZATION  HETEROTROPHIC RESPIRATION  ...  PLANT UPTAKE

APPROACHES

3D-CMCC-SOIL CORE

LPJ  LPJ  LPJ  LPJ

ORCHIDEE  ORCHIDEE  ORCHIDEE  ORCHIDEE

BIOME-BGC  BIOME-BGC  BIOME-BGC  BIOME-BGC

...  ...  ...  ...

COMBINATION 1  COMBINATION 2  COMBINATION 3  COMBINATION N

STATISTICAL ANALYSIS + VALIDATION
2. NOVELTY

ROOT EXUDATES AND MYCORRHIZAL FUNGI DYNAMICS

DEFINING THE SIMULATION APPROACH
SEARCHING FOR DATA
THANKS