BIAM-LSCE meeting, Jan 29&30, 2024

Microbial carbon use efficiency controls on soil organic carbon <u>Goll, D</u>, He, X, Abs, E, Zhang, H, Ciais, P et al







Carbon dioxide removal for reaching climate targets



Reisinger& Geden 2023 / IEA

Carbon dioxide removal for reaching climate targets



Reisinger& Geden 2023 / IEA

Carbon dioxide removal for reaching climate targets



Reisinger& Geden 2023 / IEA

4per1000

- C sequestration by e.g. increasing C inputs, avoid/reduce tillage, etc
- A cheap CDR, but quite controversial
- Hard to measure the signal in the field
- A doubling of C inputs would be needed according to models, but estimates are highly uncertain.

Received: 4 May 2023 Revised: 26 July 2023 Accepted: 4 August 2023

DOI: 10.1111/gcb.16917

OPINION



Cover crops do not increase soil organic carbon stocks as much as has been claimed: What is the way forward?

Nr. (Cl. 1.12)	Received: 20 November 2023	Accepted: 14 December 2023		
Vincent Chaplot ^{-,-}	DOI: 10.1111/gcb.17128			
	LETTER TO THE EDITOR		Global Change Biology V	VILEY

Cover crops do increase soil organic carbon stocks—A critical comment on Chaplot and Smith (2023)



Bruni et al. Eur J SoilSc 2022

Soil microbes

Microbial communities process most of the carbon entering the soil - shaping their fate.

Microbial communities are highly dynamics, evolving as climate changes.

Microbes are largely omitted in carbon models, or assumed static.



A paradigm shift ?

Massive model-data fusion to constrain SOC model parameter (23) using 50,000 of SOC profiles.

Microbial carbon use efficiency as dominant factor controlling SOC.



Tao et al Nature 2023

A paradigm shift ?

Massive model-data fusion to constrain SOC model parameter (23) using 50,000 of SOC profiles.

Microbial carbon use efficiency as dominant factor controlling SOC.



Feng et al Nature 2023

Modeling litter quality effects

microbes optimally adjust their CUE as a function of litter substrate carbon to nitrogen stoichiometry to maximize their growth rates.





Zhang et al. GMD 2017



Modeling litter quality effects

Model predictions for the same litter quantity but with varying quality (C:N ratio).

C sequestration potential is largely controlled by quality.

Model predictions are uncertain.



Zhang et al. GMD 2017

IMBALANCE

Carbon use efficiency in global models

C models use intrinsic CUE parameters to control respiratory losses.

Apparent soil-level CUE is emerging from SOC models & shows a large spread in among models.



He et al. in prep

CUE - SOC relationship

CUE observation vary widely, asynchronity of changes in CUE (fast) and SOC (slow).

Complex interplay of multiple uncertain environmental controls.

Uncertainty regarding microbial turnover and fate of microbial necromass.



He et al in prep, He et al Nature accepted

Ongoing projects



Carbon Loss In Plants, Soils and Oceans



Impact of long-term phosphorus additions on carbon sequestration in agricultural soils

Period: 2023-2028 Large international project Aim: improve C loss pathways in Earth System Model

Period: 2021-2024 EJP soil project Aim: nutrient effects on CUE and SOC stabilisation

Summary

Microbial carbon use efficiency

a potentially key controller of SOC responses.

poorly constrained in global C cycles models

It is a potential major source of uncertainty regarding

- Remaining carbon budget avoiding dangerous climate change
- Estimation of CO2 removal by nature-based solution e.g. 4per1000)



daniel.goll@lsce.ipsl.fr