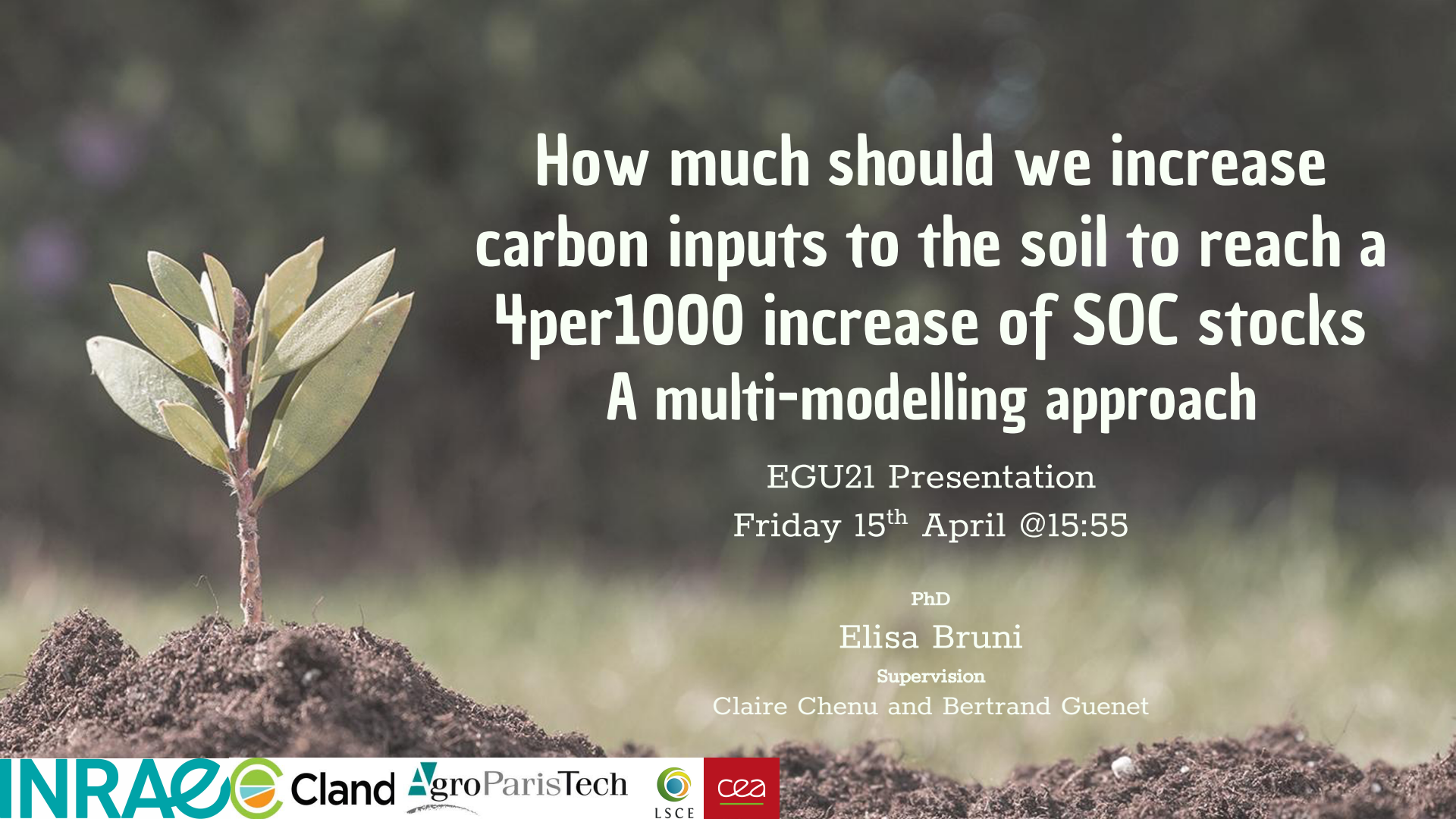




How much should we increase carbon inputs to the soil to reach a 4per1000 increase of SOC stocks A multi-modelling approach

EGU21 Presentation

Friday 15th April @15:55

PhD

Elisa Bruni

Supervision

Claire Chenu and Bertrand Guenet

Outline of the presentation

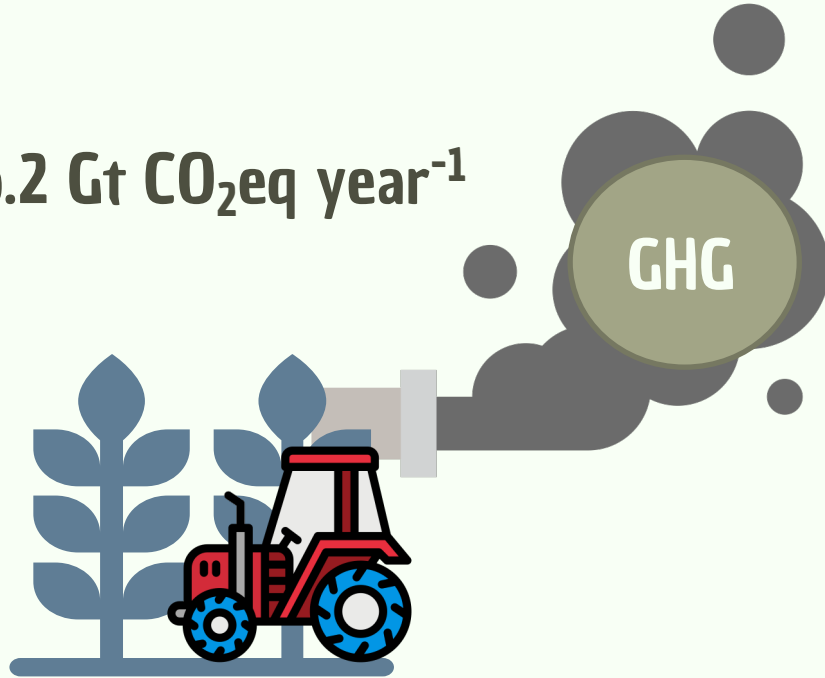
1. Context
2. Experimental sites
3. Multi-modelling
4. Results
5. Conclusion

01

CONTEXT

GREENHOUSE GASES EMISSIONS IN AGRICULTURE

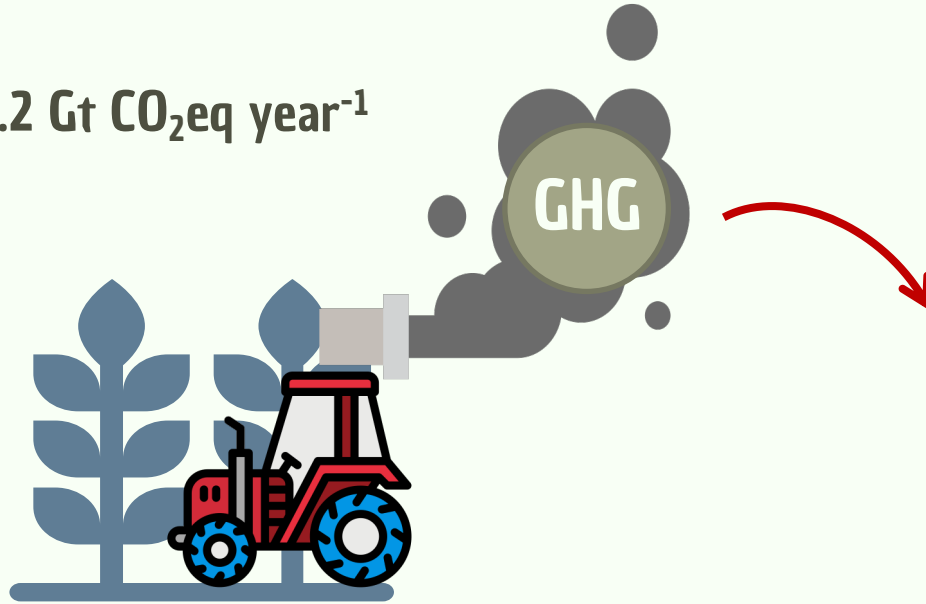
6.2 Gt CO₂eq year⁻¹



According to the last IPCC report, agriculture contributes to CO₂ emissions with 6.2 Gt of CO₂ equivalents each year.

GREENHOUSE GASES EMISSIONS IN AGRICULTURE

6.2 Gt CO₂eq year⁻¹

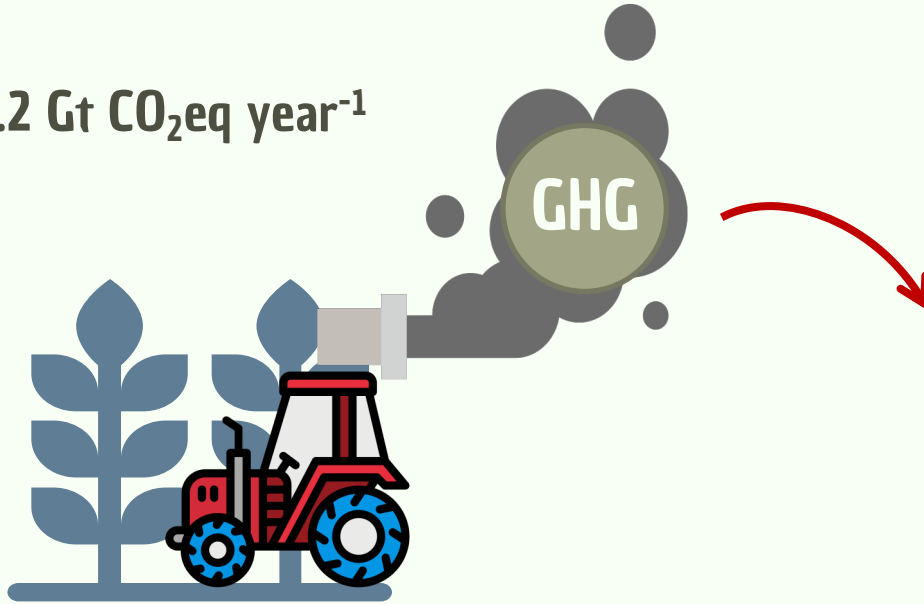


IMPROVED MANAGEMENT PRACTICES

can help to reduce GHG emissions and sequester additional carbon (C) from the atmosphere.

GREENHOUSE GASES EMISSIONS IN AGRICULTURE

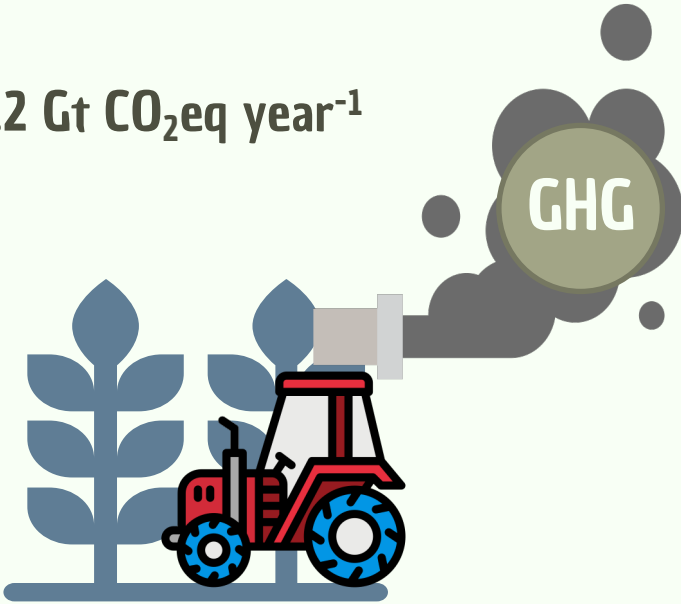
6.2 Gt CO₂eq year⁻¹



**IMPROVED
MANAGEMENT
PRACTICES**

GREENHOUSE GASES EMISSIONS IN AGRICULTURE

6.2 Gt CO₂eq year⁻¹



GHG



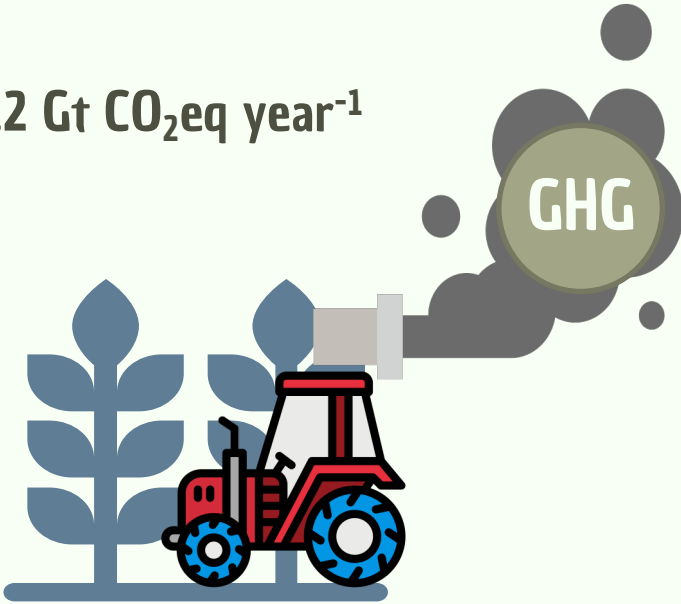
Reduced tillage

restry

**MANAGEMENT
PRACTICES**

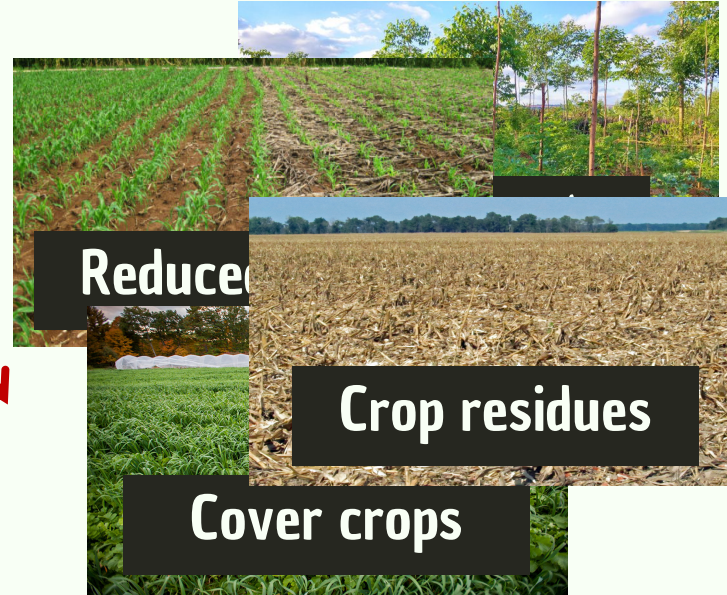
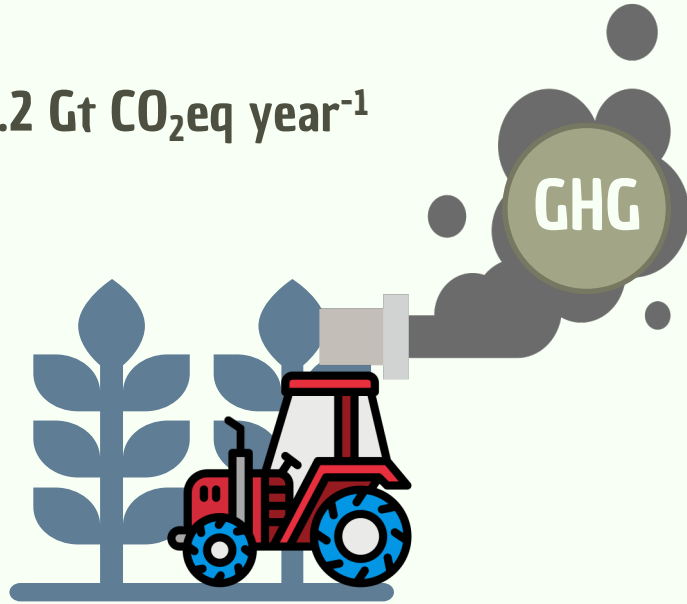
GREENHOUSE GASES EMISSIONS IN AGRICULTURE

6.2 Gt CO₂eq year⁻¹



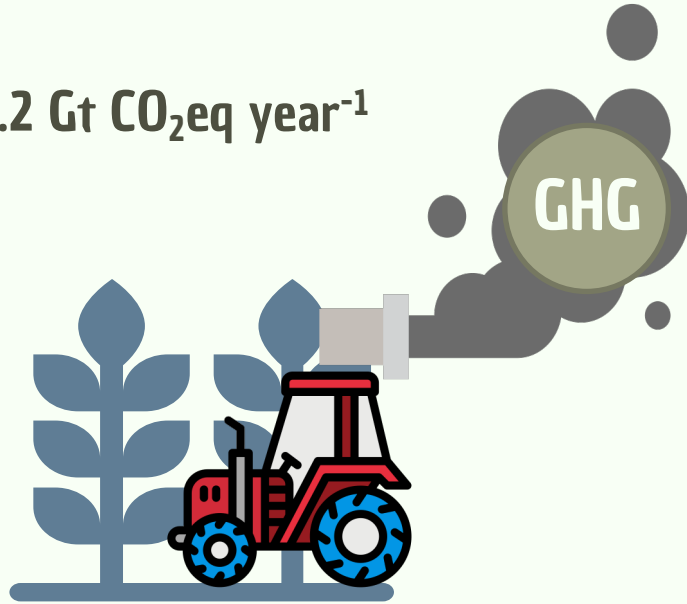
GREENHOUSE GASES EMISSIONS IN AGRICULTURE

6.2 Gt CO₂eq year⁻¹

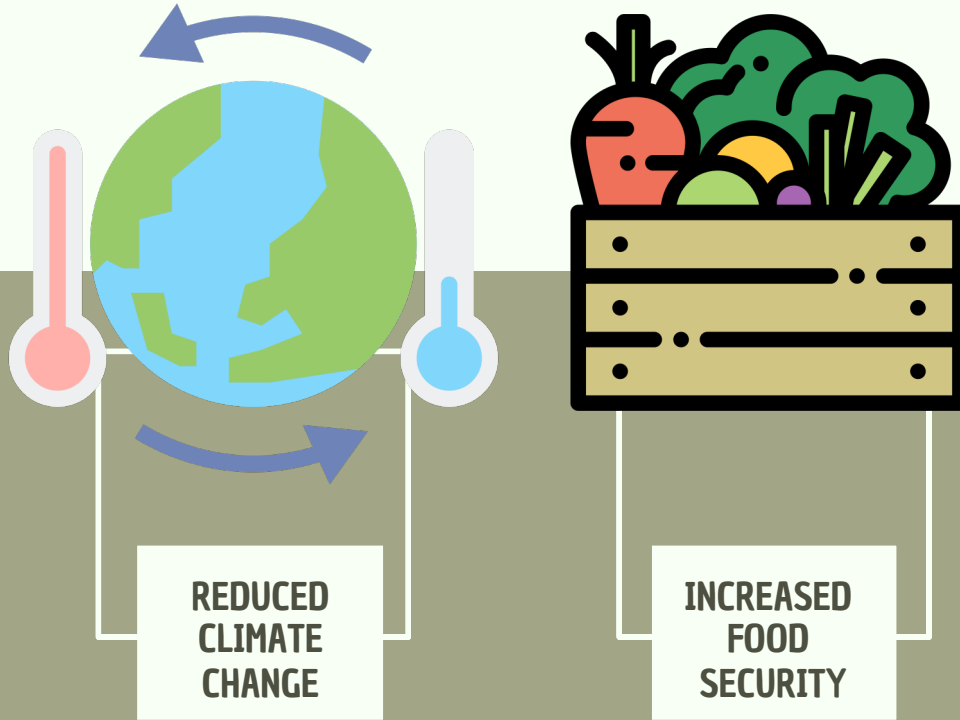


GREENHOUSE GASES EMISSIONS IN AGRICULTURE

6.2 Gt CO₂eq year⁻¹

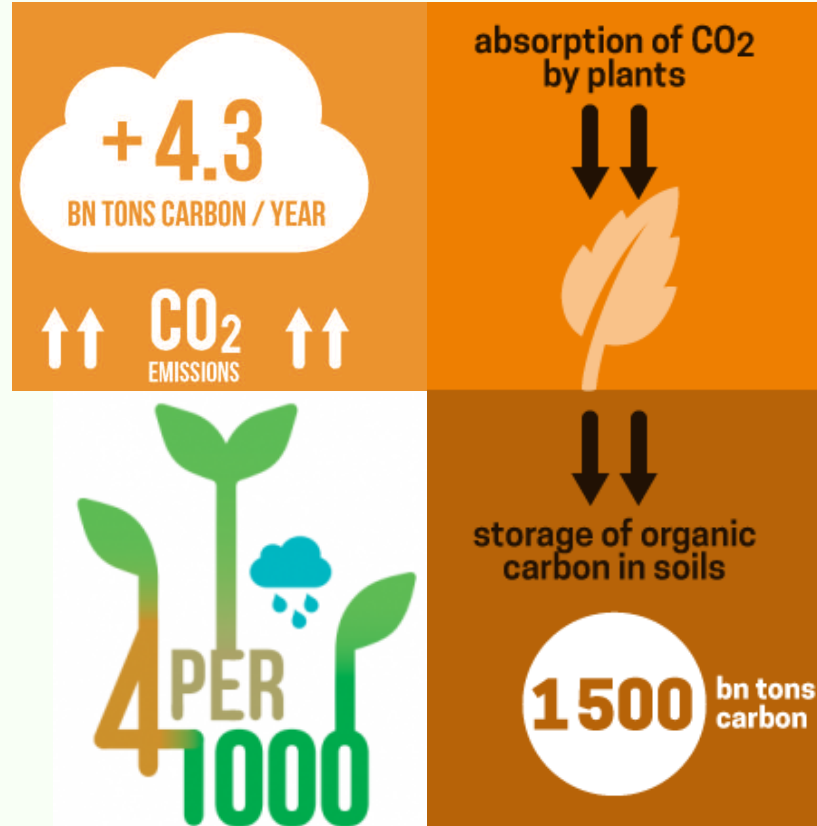


POSITIVE CONSEQUENCES OF SOIL CARBON STORAGE



THE 4 PER 1000 INITIATIVE

4 per 1000 (4p1000) is the theoretical annual increase of soil organic carbon (SOC) stocks that would be needed to compensate for CO₂ emissions from human activities.

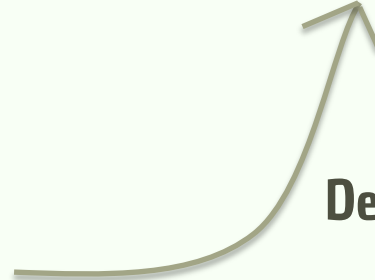


INCREASING SOIL ORGANIC CARBON STOCKS

Increase C inputs



Decrease C outputs



HOW MUCH SHOULD WE
INCREASE **CARBON INPUTS**
TO THE SOIL TO REACH
A 4 PER 1000 OBJECTIVE



02

EXPERIMENTAL SITES



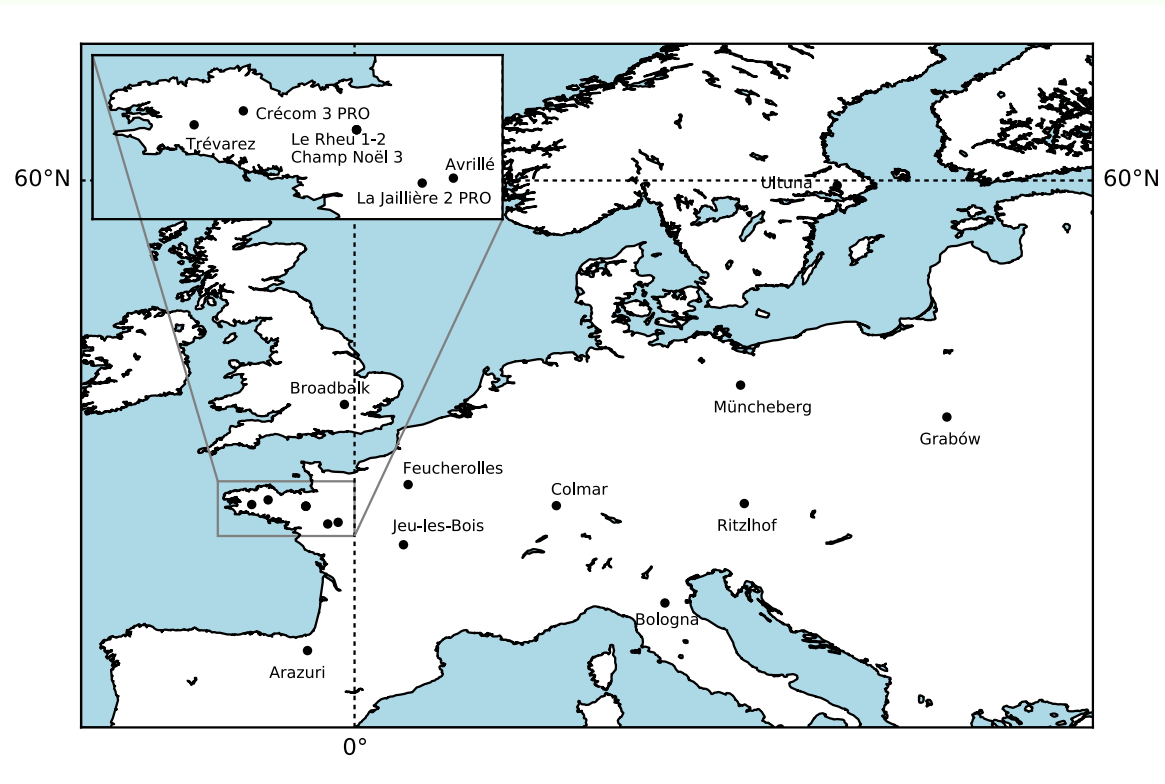
**17 long-term
agricultural
experiments**



**46 exogenous
organic matter
(EOM) treatments**



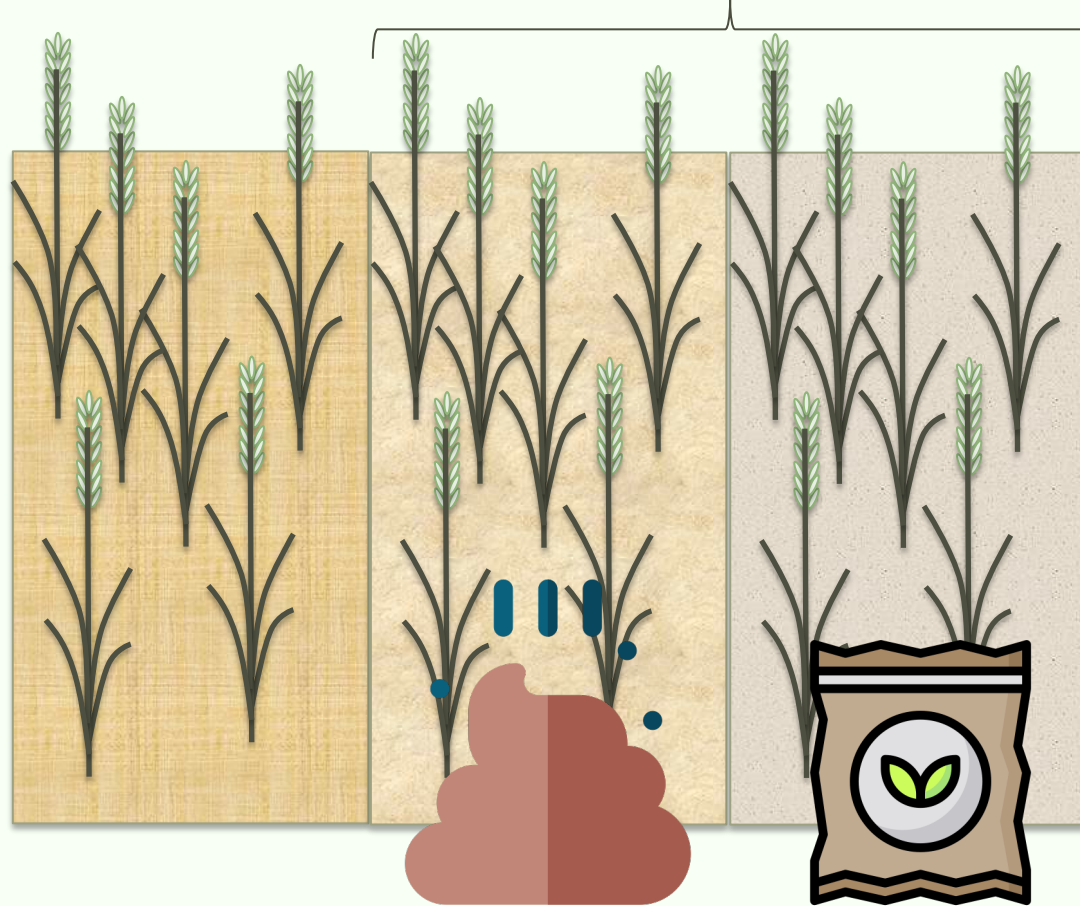
**SOC stocks
measured at
several dates**



Control plot



EOM treatments



03

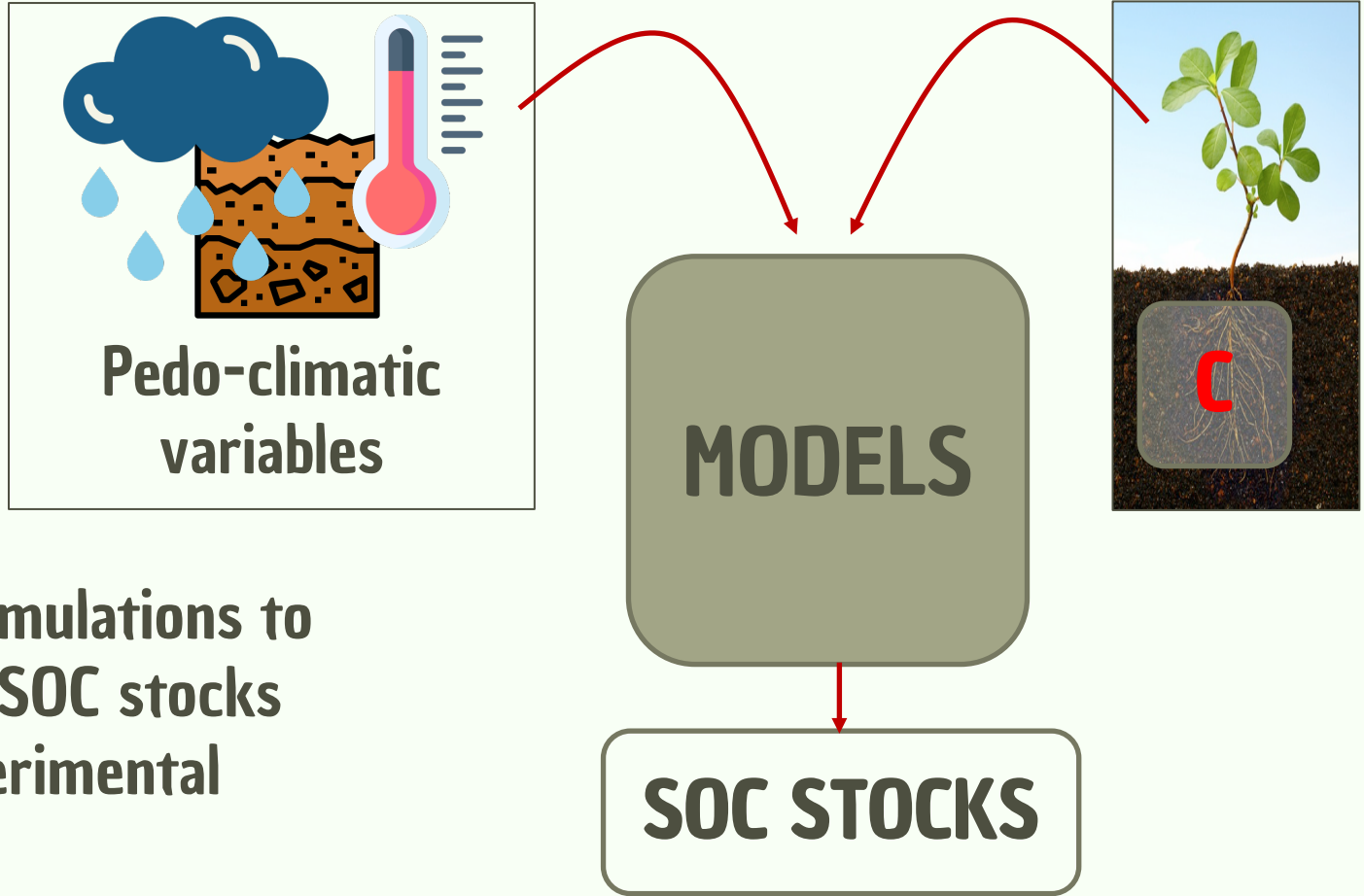
MULTI-MODELLING

Multi-modelling ensemble

- **Century** (Parton et al., 1988)
- **RothC** (Coleman and Jenkinson, 1996)
- **ICBM** (Andren and Katterer, 1997)
- **AMC** (Andriulo et al., 1999)

1

Forward simulations to
reproduce SOC stocks
in the experimental
sites



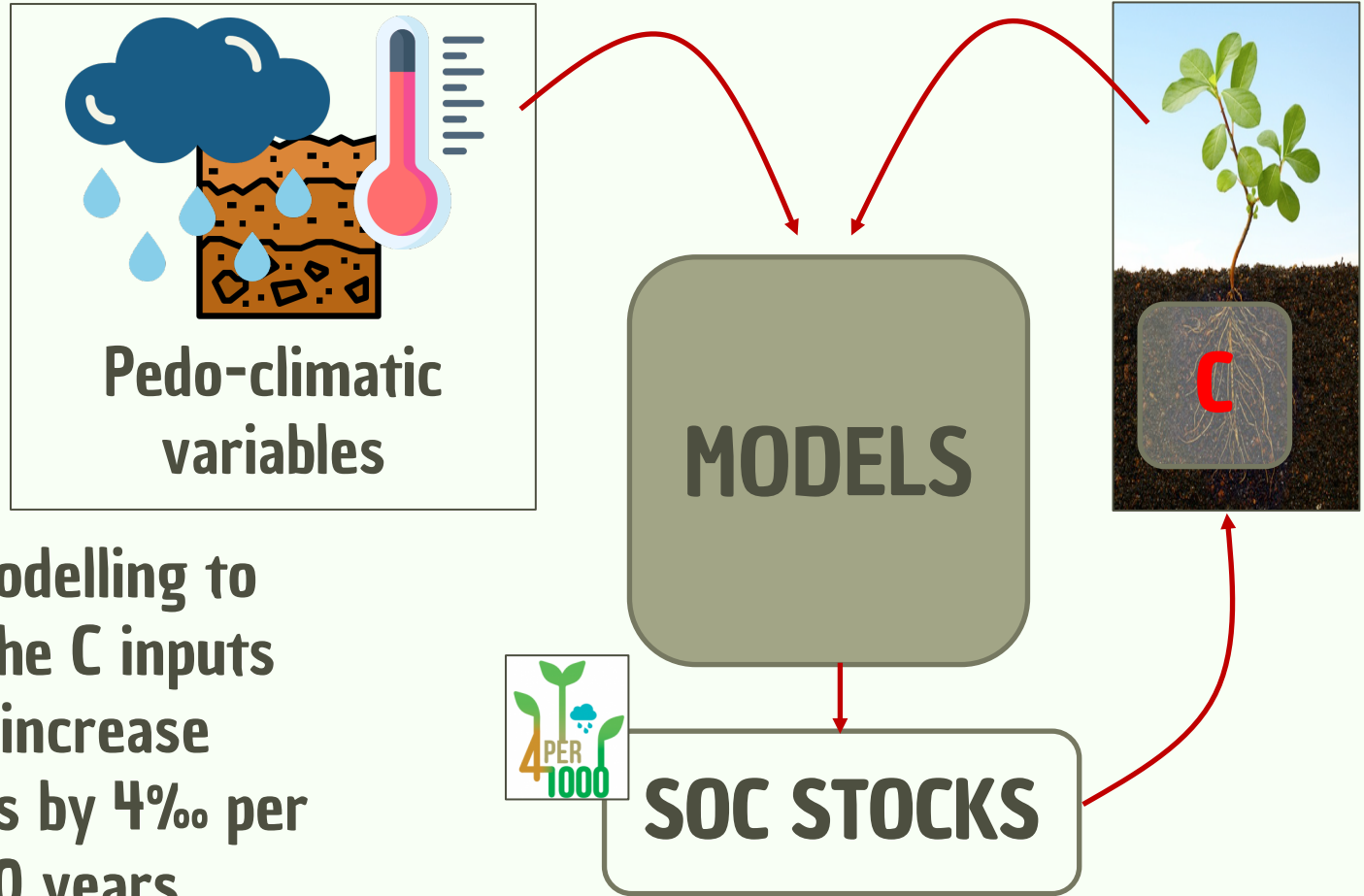
2

Calibration of model parameters to fit observed SOC stocks

MODEL	Calibrated parameters	Function
CENTURY	Q_{10} and T_{ref}	$f(T) = Q_{10}^{\frac{(T-T_{ref})}{10}}$
RothC	T_{param}	$f(T) = \frac{47.91}{1 + e^{\left(\frac{106.06}{T+T_{param}}\right)}}$
ICBM	k_1, k_2, h	$\frac{dY}{dt} = i - k_1 \cdot r \cdot Y(t)$ $\frac{dO}{dt} = h \cdot k_1 \cdot r \cdot Y(t) - k_2 \cdot r \cdot O(t)$
AMG	k_0	$\frac{dACT}{dt} = \sum m_i \cdot h_i - k_0 \cdot ACT(t)$

3

Inverse modelling to estimate the C inputs needed to increase SOC stocks by 4‰ per year for 30 years



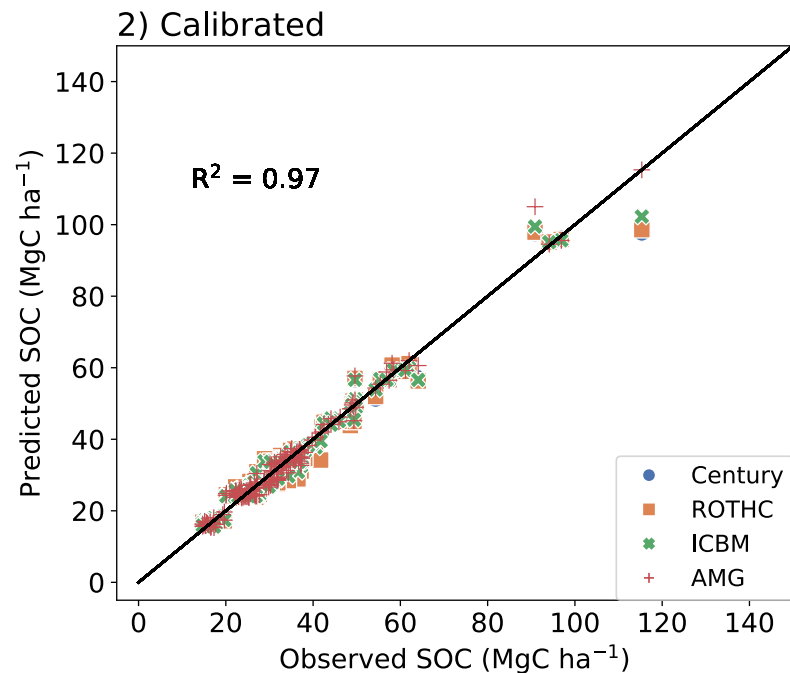
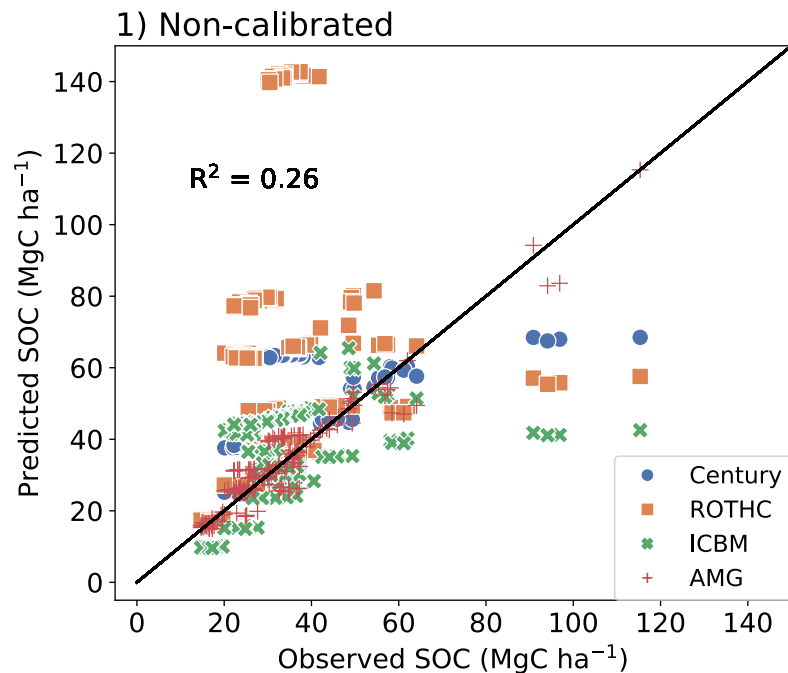
04

RESULTS

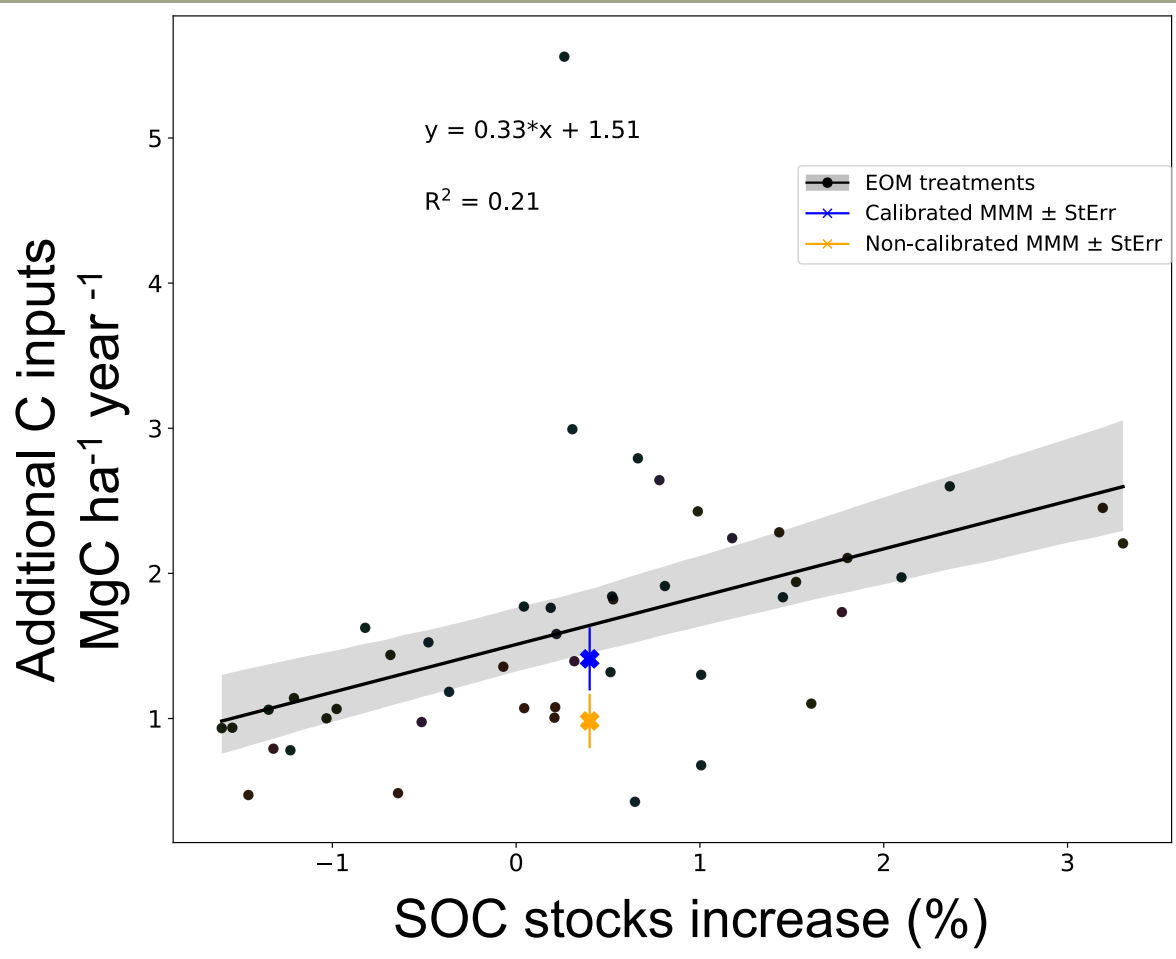


Multi-modelling validation

Calibrated models fit SOC stocks in the control plot



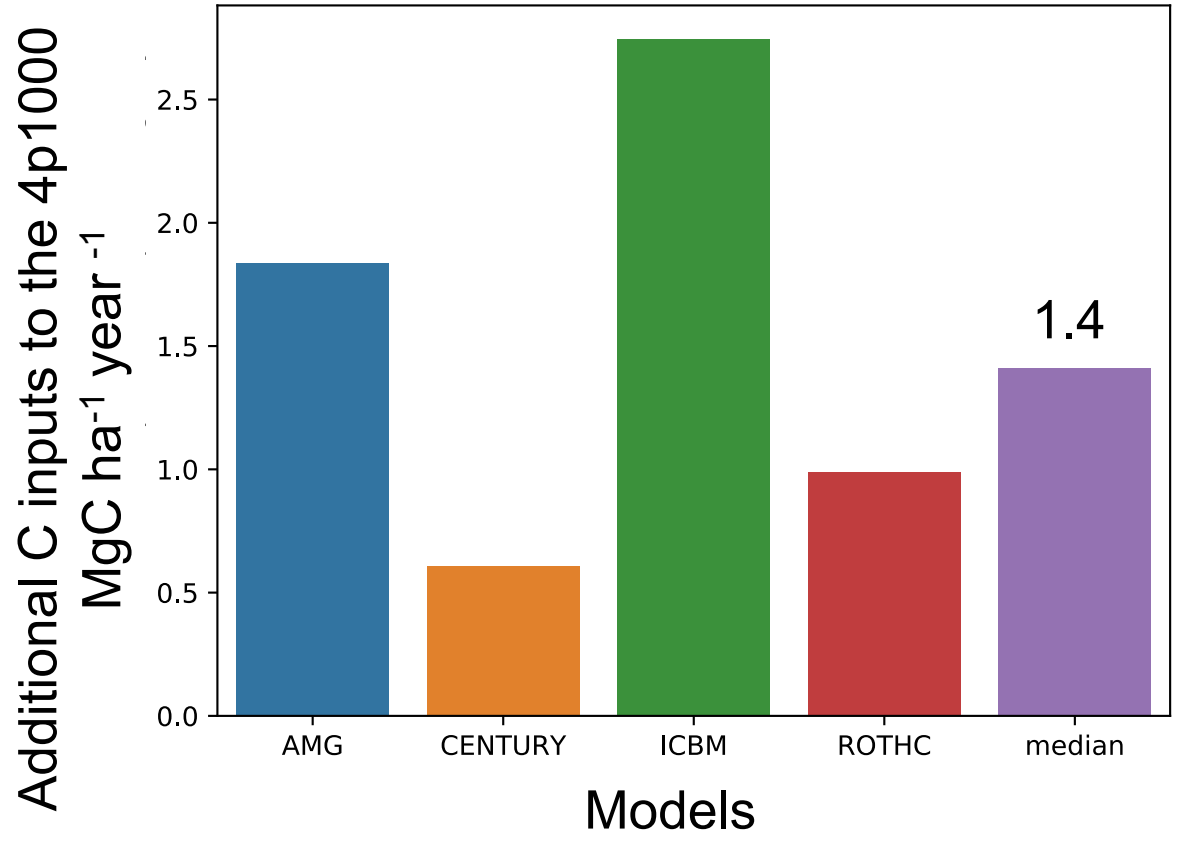
Multi-model
median (MMM) of
the calibrated
ensemble estimates
C inputs to reach
the 4p1000 that are
in line with SOC
stocks increase in
the EOM
treatments



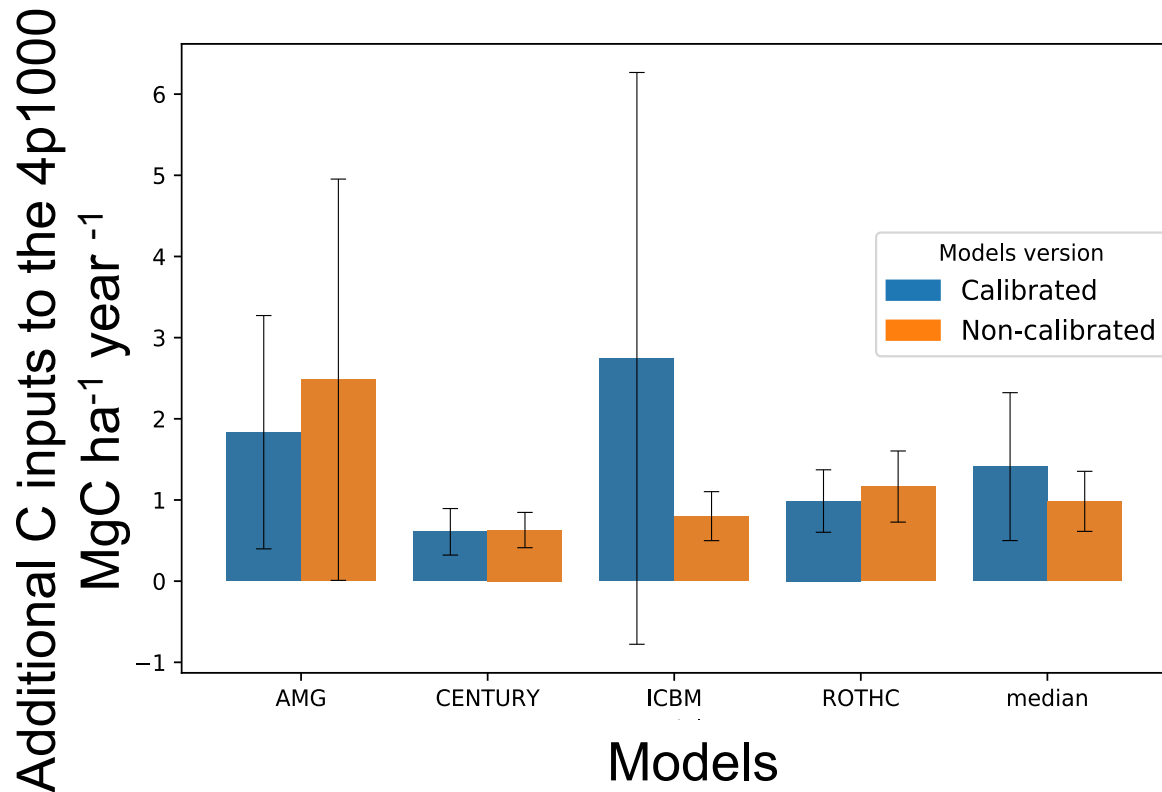


**Additional C inputs to
reach the 4p1000**

Average
additional C
inputs to reach
the 4p1000
across the sites
Models and MMM



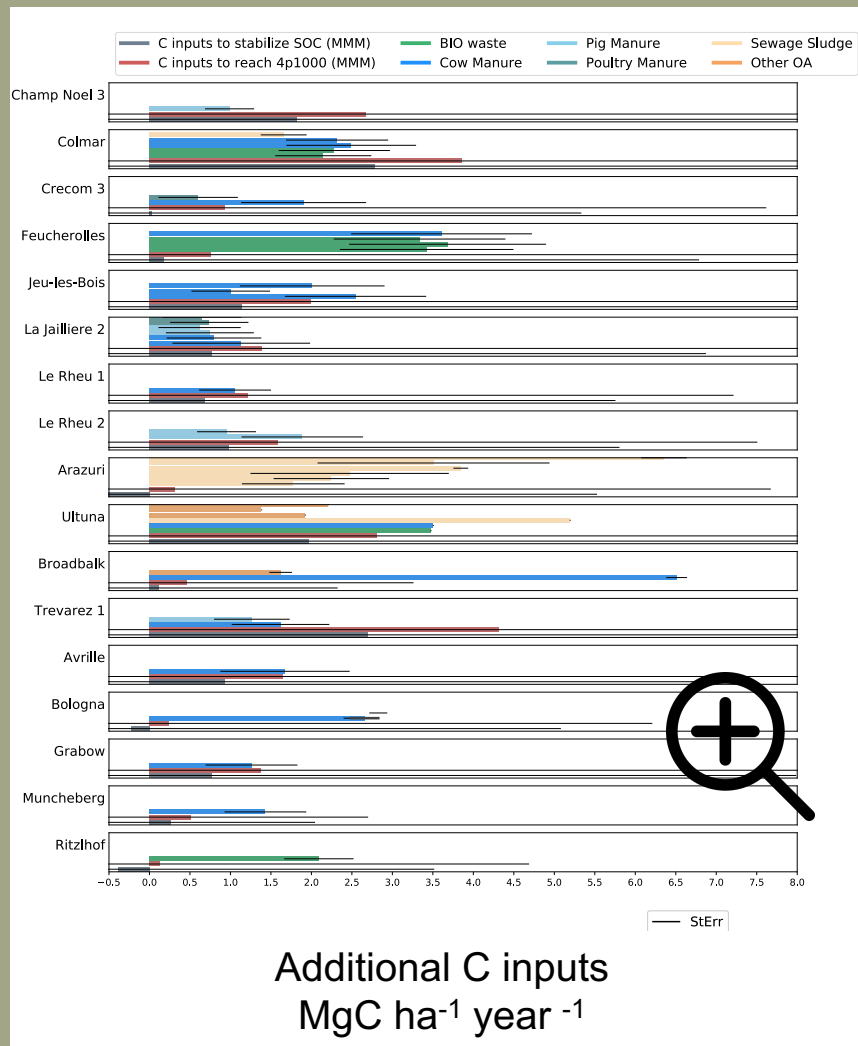
Effect of parameters' calibration on the modelling results

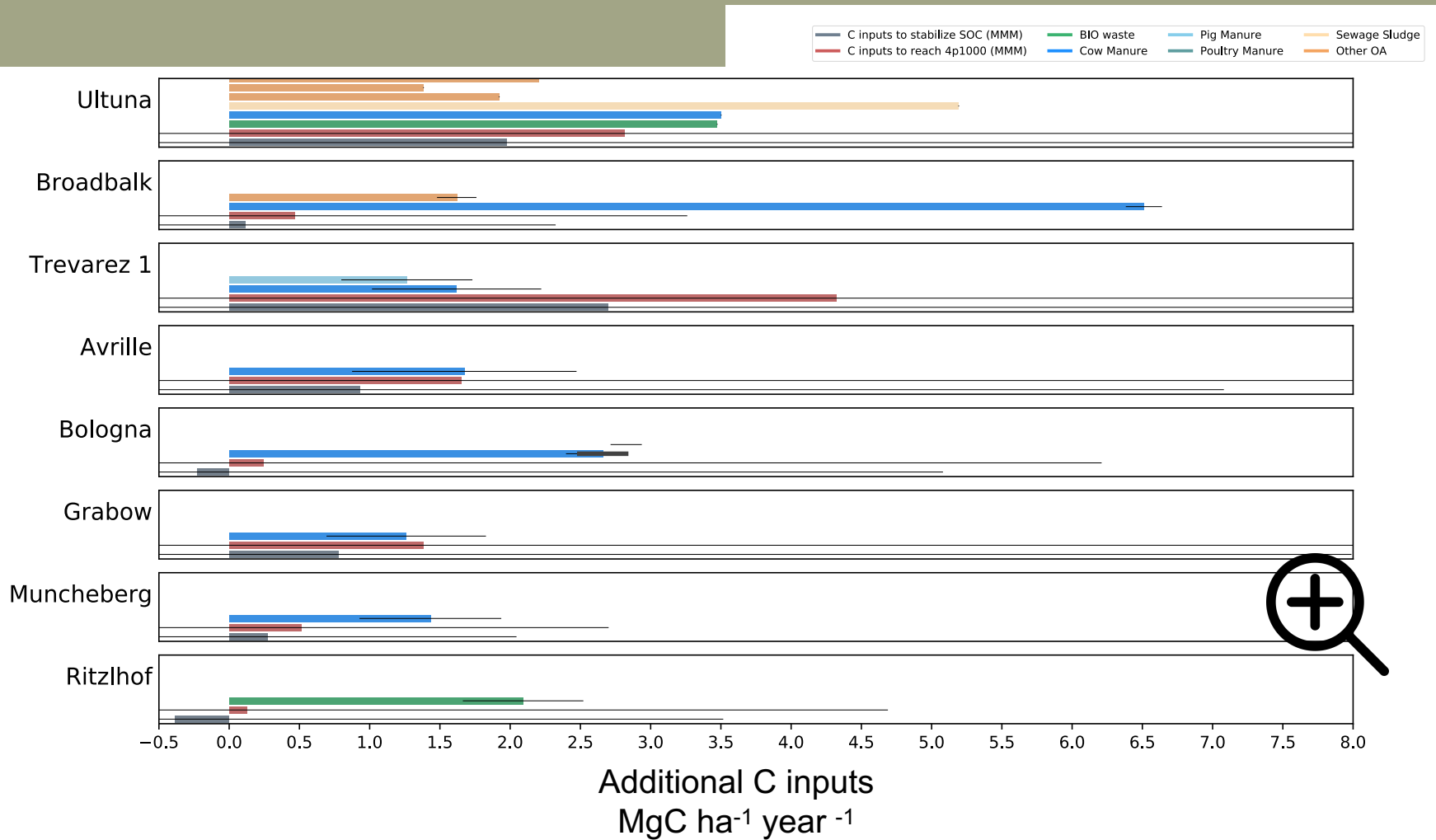




Feasibility of the 4p1000

Modelled additional C inputs VS C inputs in EOM treatments





05

CONCLUSION

- Calibrating the multi-modelling ensemble improved the simulation of SOC stocks in the 17 experimental sites
- However, the non-calibrated version gave similar results when estimating the additional C inputs to reach the 4p1000 target
- There was a high variability among different models
- Increasing SOC stocks by 4p1000 per year seemed feasible under some experimental conditions. However, a high level of C inputs must be employed, raising concern on the feasibility of the 4p1000 target at large scale

THANK YOU

Contact: elisa.bruni@lsce.ipsl.fr

References

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