Improving the accuracy of soil organic carbon models using a Rock-Eval-based initialization method

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OBJECTIVES

1. Extend the application range of the Rock-Eval-based approach by testing it on new, independent sites.

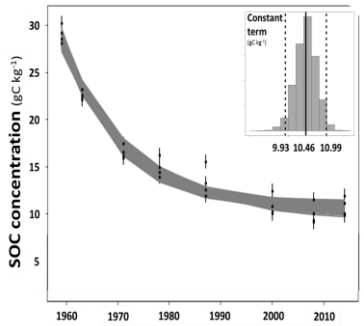
2. Investigate if the accuracy of SOC stock simulations is improved when the stable pool size of the AMG model is initialized by the Rock-Eval-based approach.

ITNRO / METHODS

The Rock-Eval-based approach (Cecillon et al. 2018):

Random forests model calibrated on a unique data set from Long Term Bare Fallow (LTBF) sites in NW Europe and using Rock-Eval thermal analysis (RE) parameters as predictors.

LTBFs



Site-specific stable C

C labile

C stable

estimated proportion

Rock-Eval parameters

predicted C stable proportion

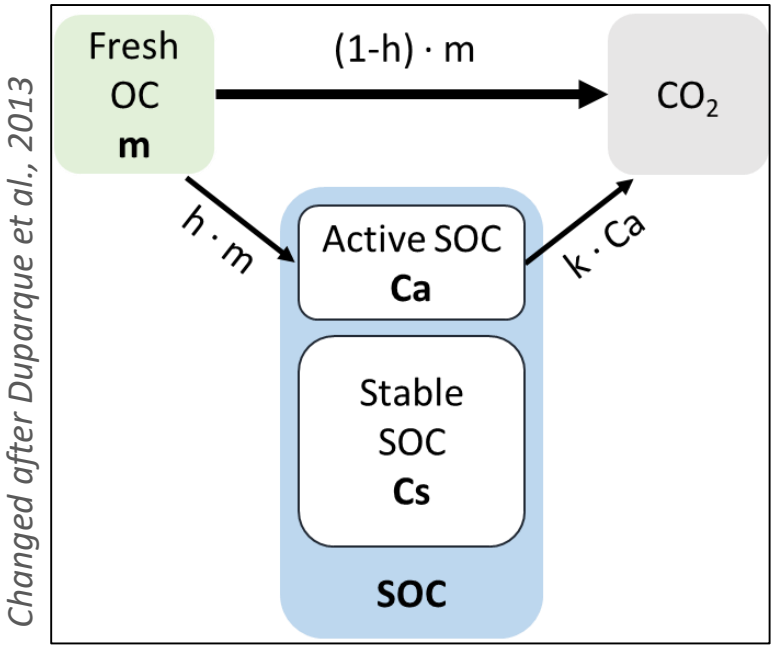
Random forests model

Barré et al., 2010; Cécillon et al., 2018

ITNRO / METHODS

The AMG model (Clivot et al. 2019):

Three-compartment soil organic carbon (SOC) stocks model



$$C = Ca + Cs$$

$$\frac{dCa}{dt} = m \cdot h - k \cdot Ca$$

1 **Default initialization of stable C pool size**

1. Cropland — $C_s/C_0^* = 0.65$
2. Grassland — $C_s/C_0^* = 0.40$

OR

2 **Optimization of stable C pool size**

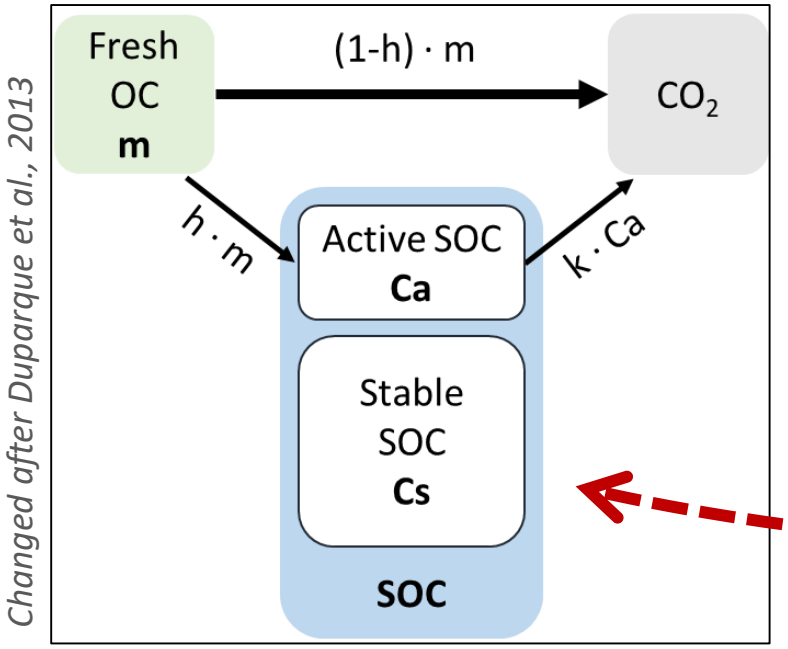
BEST MODEL FIT TO DATA

*C_0: SOC content at the onset of simulation period

ITNRO / METHODS

The AMG model (Clivot et al. 2019):

Three-compartment soil organic carbon (SOC) stocks model



Changed after Duparque et al., 2013

$$C = Ca + Cs$$

$$\frac{dCa}{dt} = m \cdot h - k \cdot Ca$$

NOVEL APPROACH TESTED HERE

3 **RE-based initialization of stable C pool size**

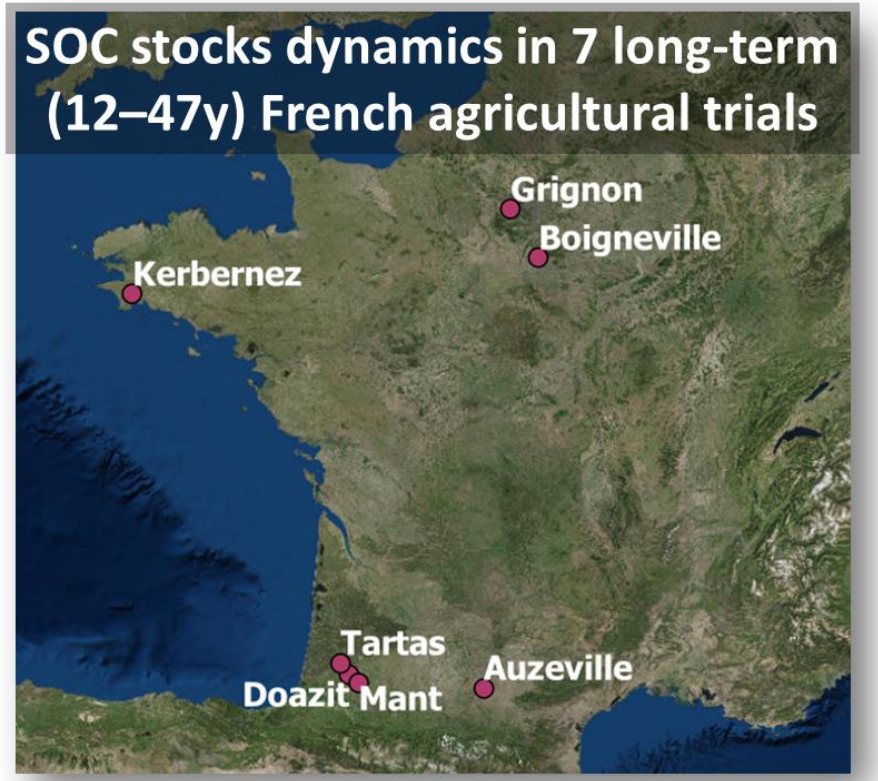
predicted C stable proportion

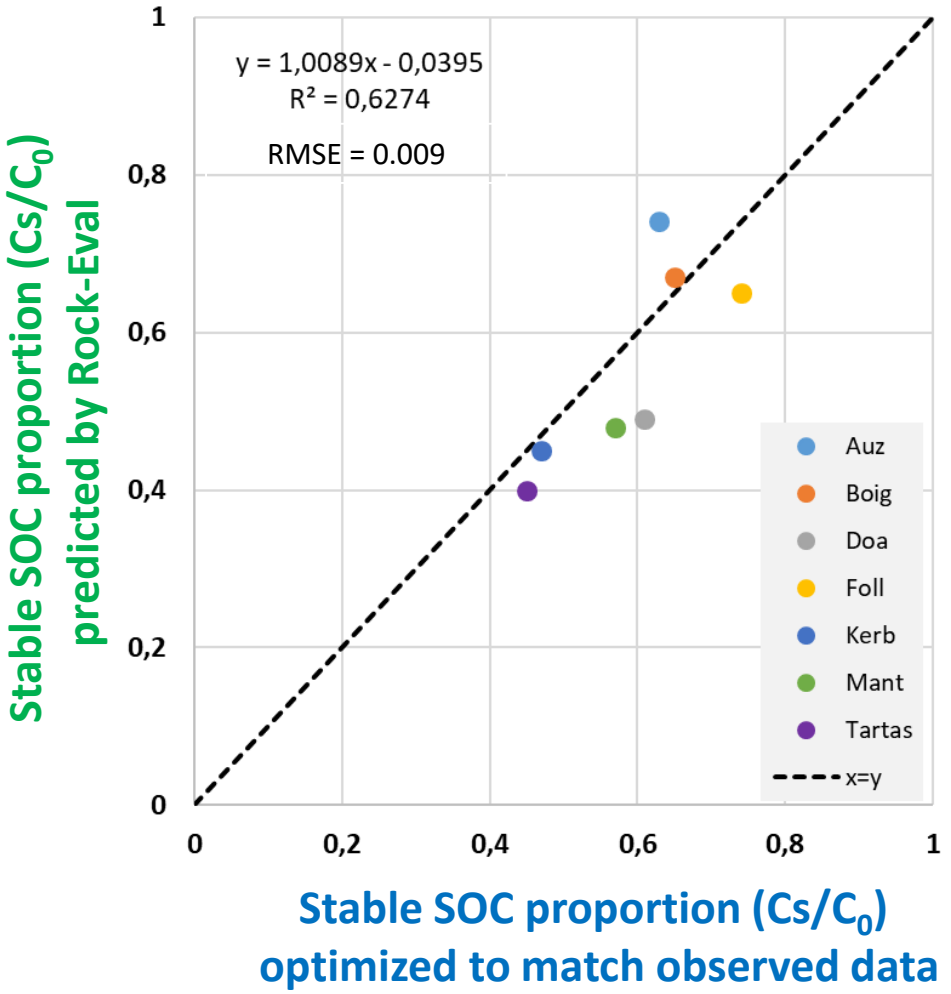
Random forests model

Rock-Eval parameters

RESULTS

Prediction of stable carbon with RE for seven sites:





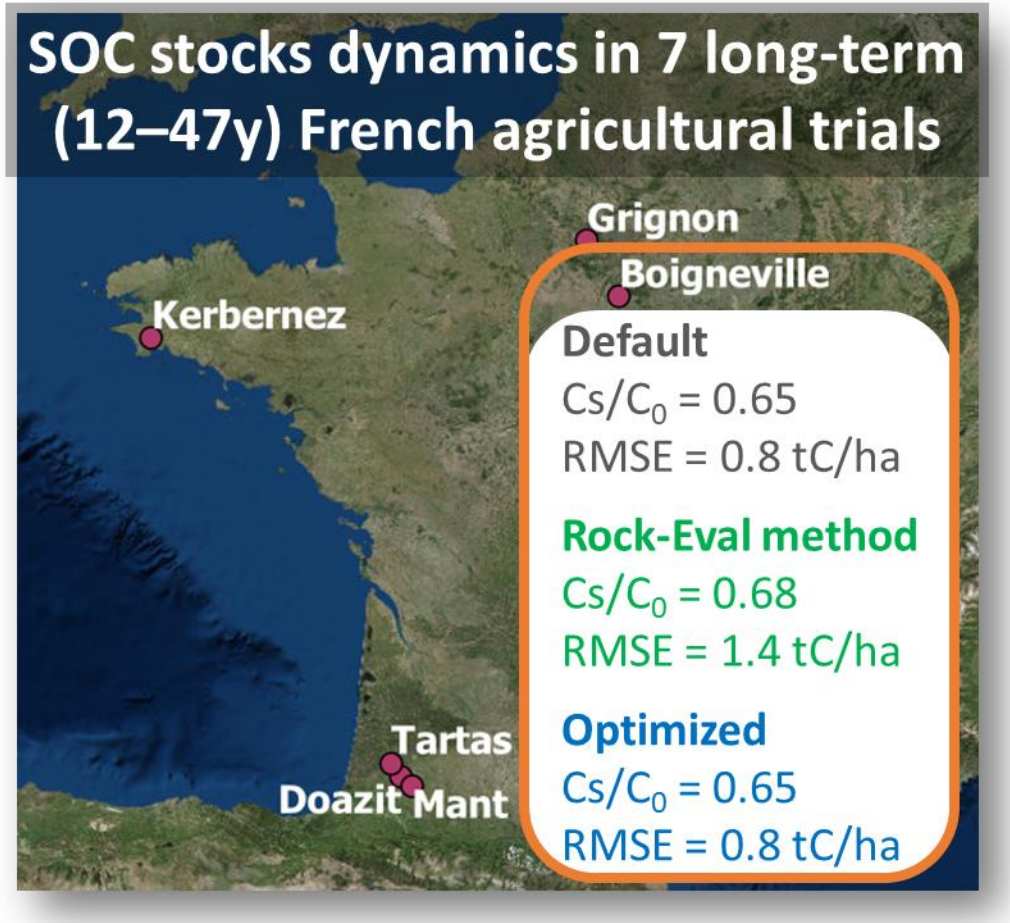
Strong correlation between RE-based predictions of stable carbon and stable carbon optimized by AMG

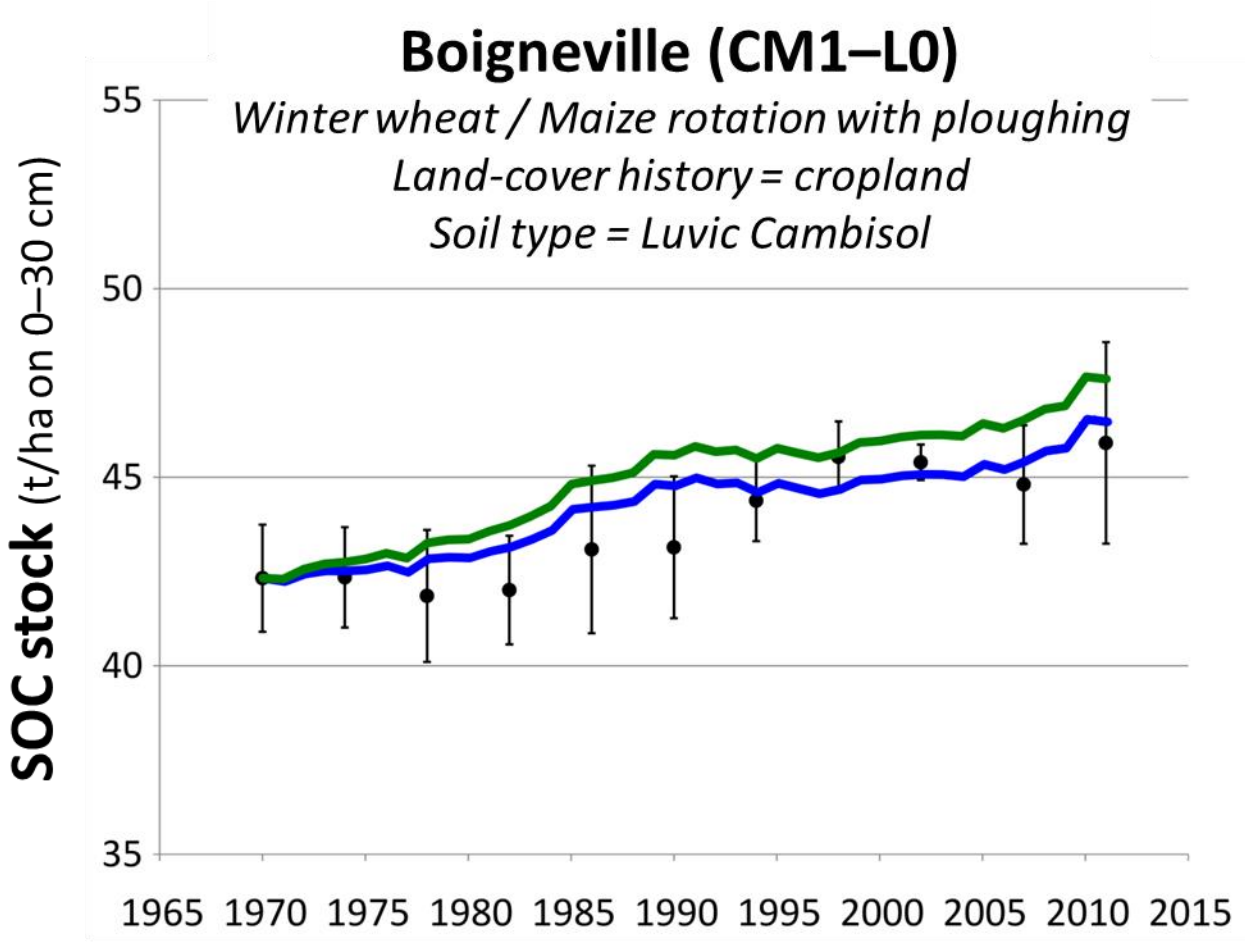
AMG optimisation data from Clivot et al., 2019

RESULTS

Initialization of AMG Cs pool using RE-based approach

Example 1:





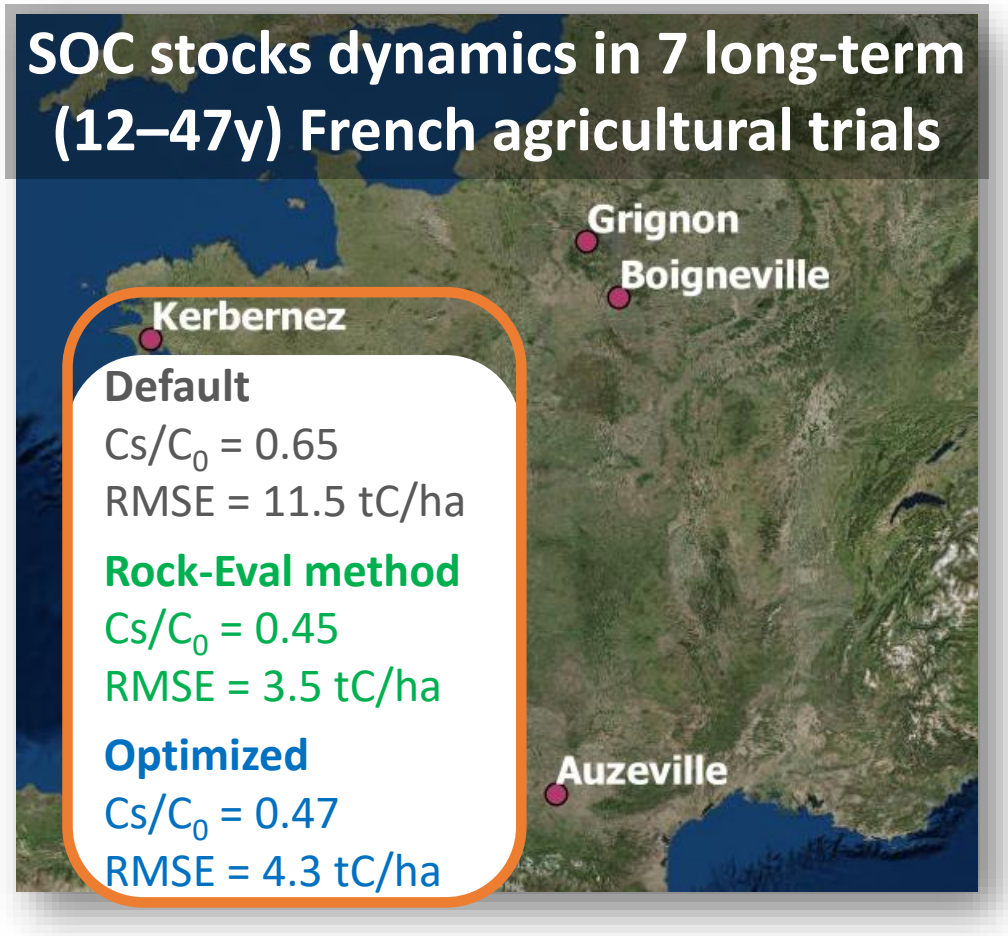
*at Boigneville C_S/C_0 default = C_S/C_0 optimized

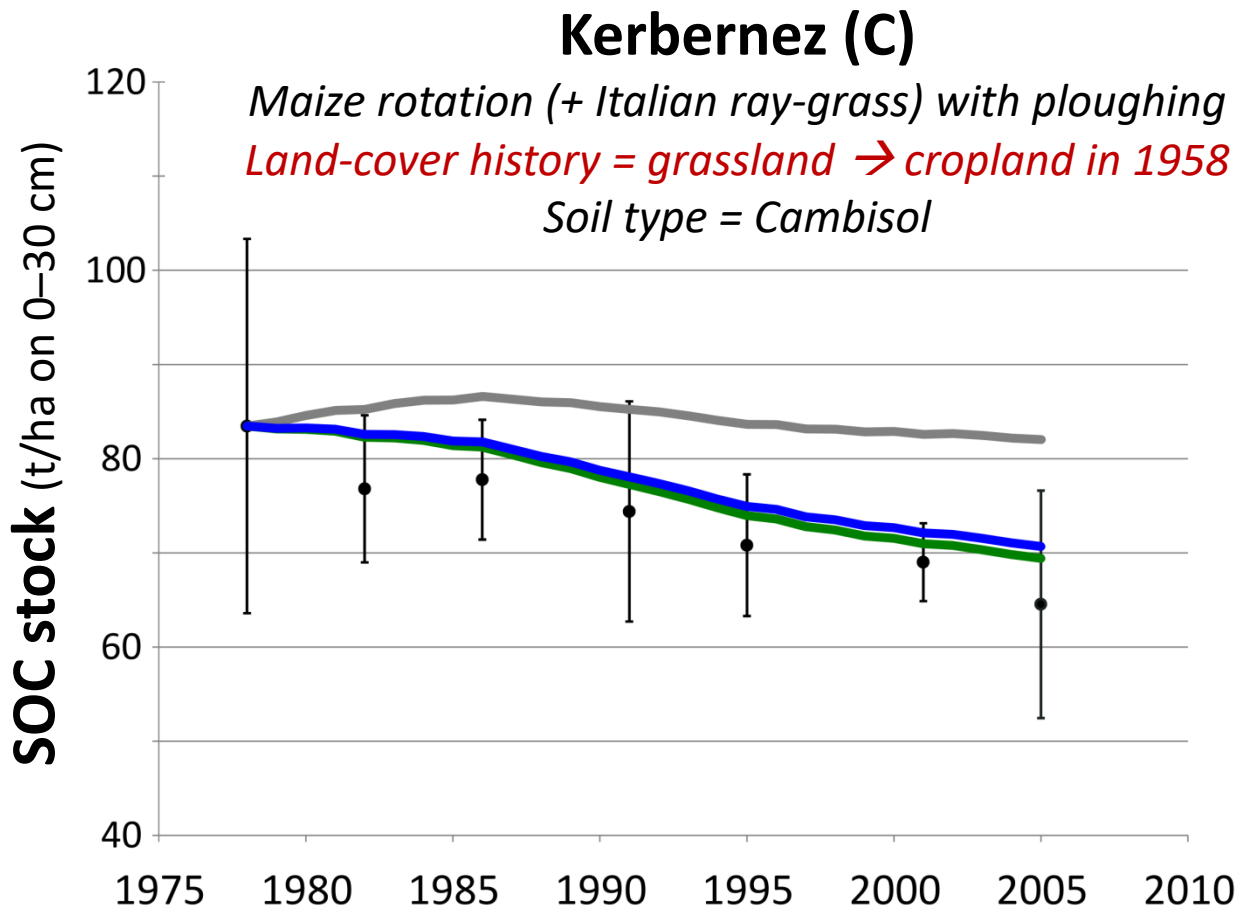
AMG optimisation data from Clivot et al., 2019

RESULTS

Initialization of AMG Cs pool using RE-based approach

Example 2:

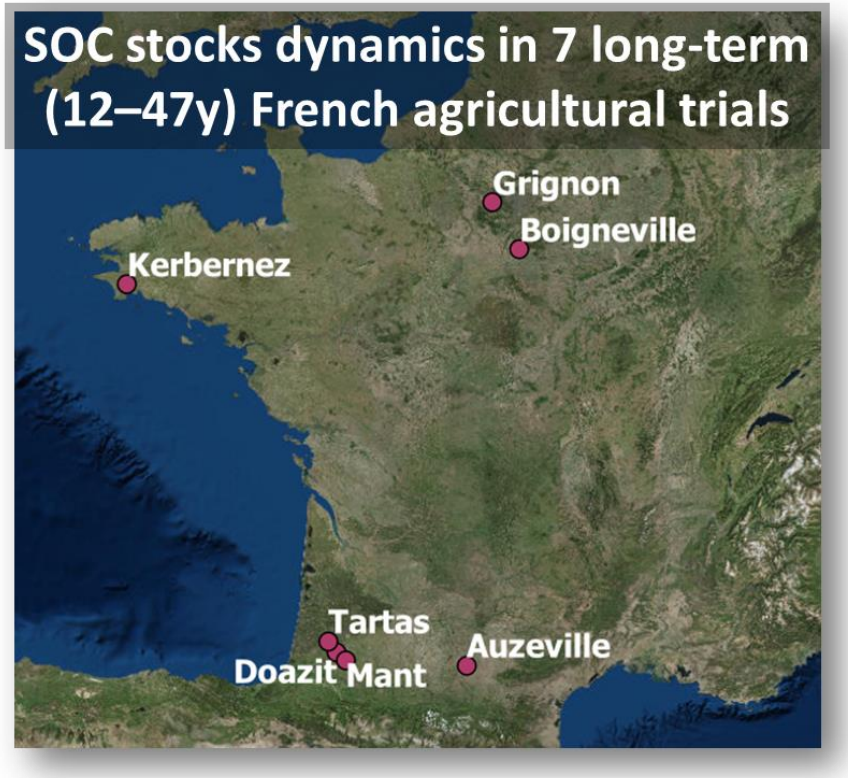




AMG optimisation data from Clivot et al., 2019

RESULTS

Initialization of AMG Cs pool using RE-based approach
Overall impact on accuracy of simulations for the 7 selected sites



Overall RMSE of AMG SOC simulations

Default	Rock-Eval	Optimized
3.7 tC/ha	3.2 tC/ha	2.1 tC/ha
[0.2–11.5]	[1.4–5.1]	[0.6–4.3]

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(P_i - O_i)^2}$$

AMG model initialized using the Rock-Eval-based approach is more accurate !

AMG optimisation data from Clivot et al., 2019

TAKE-HOME

1. The Rock-Eval-based approach can accurately predict stable carbon proportion in a sample. Thus it presents a possibility for a fast, routine method for initialization of the Cs pool.

2. Initialization of the Cs pool of AMG using RE improves the accuracy of simulations compared to default initialization. This improvement is pronounced for sites with complex land-use history.