Annual-scale adaptation of a soil heterotrophic respiration model to three agricultural sites in Belgium and South-Western France.

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1. Introduction

➔ **Context :**

- Within the context of climate change, agricultural soils have been less investigated so far, despite their considerable importance through the world.
- Despite the numerous Soil Organic Matter (SOM) decomposition models that work at different spatial and temporal scales, there is still a lack of understanding of the mechanisms which control SOM decomposition.

➔ **Objectives :**

- To model soil respiration in agricultural soils:
  - at an annual timescale with a daily time resolution
  - at the ecosystem scale (field)
- The present results focus on heterotrophic respiration.

2. Model description

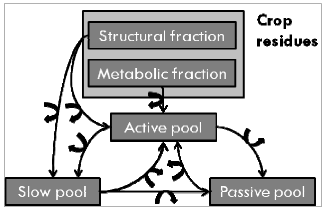
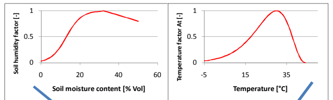


Fig.1 – Carbon flows in a model layer.

Soil heterotrophic respiration model:

- Derived from CENTURY (Parton et al., 1987).
- 3 layers containing 3 to 5 carbon pools each (Fig.1).
- Daily meteorological inputs (soil temperature and soil moisture content).
- Outputs : daily carbon flows between pools (Fig. 1) and respiration fluxes (thick arrows in Fig. 1).



Carbon (C) flows in and out of each pool (x):

$$\frac{dC_x}{dt} = F_{x,in} - F_{x,out}$$

With the fluxes (*) computed as: $F_x = K_x \cdot Q_x \cdot Aw \cdot At \cdot C_x$

(*)The respiration fluxes are a part of Fx and are function of biochemical characteristics of residues and soil clay content.

- Decomposition constant (K_x)
- Soil texture factor (Q_x)
- Soil humidity factor (Aw)
- Soil temperature factor (At)
- Pool carbon content (C_x)

3. Site description

Site	Auradé (AUR)	Lamasquère (LAM)	Lonzée (LON)
			
Country	France	France	Belgium
Coordinates	43°54'97''N, 01°10'61''E	43°49'65''N, 01°23'79''E	50°33'08''N, 4°44'42''E
Mean annual T° [°C]	13	13	10
Mean annual P [mm]	693	640	800
Soil texture (C:Si:Sa)	32:47:21	54:34:12	20:75:5
Crop rotational cycle	Rape-Wheat-Sunflower-Wheat	Triticale-Maize-Wheat-Maize	Sugar beet-Wheat-Seed potato-Wheat
SOC [kg.m^{-2}] (depth)	4.3 (0-45cm)	9.8 (0-45cm)	6.2 (0-60cm)

4. Parameterization

- Site parameters: based on site data.
- Biochemical parameters: based on a literature survey:

Parameter	Value [%DM]	Parameter	Value [%DM]
Wheat leaves and stems		Wheat roots	
Nitrogen	0.5	Nitrogen	0.45
Lignin	9.2	Lignin	17.15
Cellulose	42.1	Cellulose	35.8
Hemicellulose	31.4	Hemicellulose	36.8

5. Calibration

Aim : To fix the two parameters of the temperature response.

Procedure :

- Model run on a 30-cycle loop with a local mean climatic year.
- Minimization of difference between computed and measured SOC

6. Initialization

Aim : Distribute SOC between pools.

Procedure :

- Model run on a 30-cycle loop with a local mean climatic year.
- SOC initial distribution: 3% active, 40% slow and 57% passive (Parton et al., 1987).

Result :

C Pool content (% SOC)	Auradé	Lamasquère	Lonzée
Active	2.2	2.6	2.6
Slow	38.5	35	36
Passive	52.6	57	55
Crop residues	6.7	5.4	5.4

➔ The most clayey site (LAM) has the highest proportion of C in the passive pool.

7. Preliminary results: comparison with experimental data

➔All soil respiration flux measurements were performed in 2007 using the dynamic closed chamber method.

Auradé

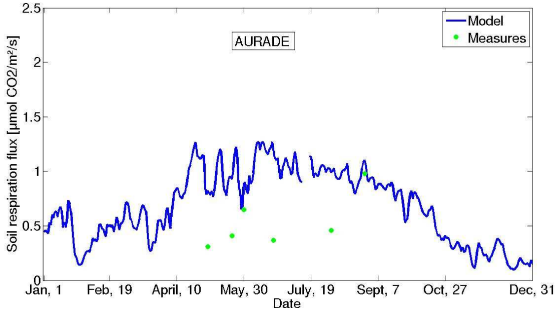


Fig.2.: Temporal evolution of the modelled and measured fluxes (manual system) at the Auradé site in 2007.

Lamasquère

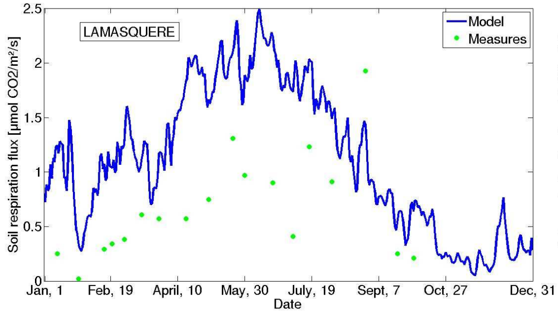


Fig.3.: Temporal evolution of the modelled and measured fluxes (manual system) at the Lamasquère site in 2007.

Lonzée

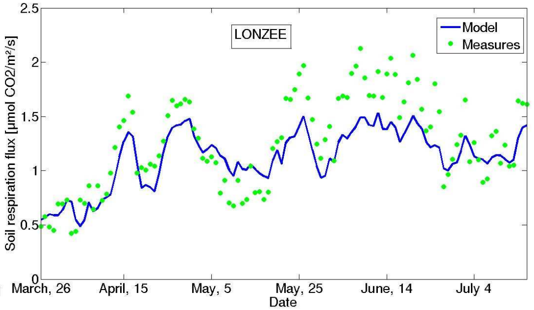


Fig.4.: Temporal evolution of the modelled and measured fluxes (manual system) at the Lonzée site in 2007.

Comments on Fig.2, 3 and 4:

- At each site, soil temperature is the soil respiration main driver.
- Differences between sites may be driven by SOC.
- Overall good agreement between modelled and measured fluxes in Lonzée, except for the extreme values.
- Large model overestimation in Auradé and Lamasquère.
  - →Impact of soil moisture ?
  - →In Lamasquère, overestimation of total SOC ?

8. Conclusions and perspectives

- The results at LON suggest that the model may potentially be a good soil respiration predictive tool.
- The discrepancies at AUR and LAM indicate that some adjustments have to be made, probably regarding the SOC content, its distribution between pools, and the temperature and humidity responses.

➔To go further:

- ❖To validate the model with other site-year soil respiration data.
- ❖To investigate the possible link between SOC content and soil respiration fluxes through a field experiment.

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