SOIL RESPIRATION PARTITIONING AND ITS COMPONENTS IN THE TOTAL AGRO-ECOSYSTEM RESPIRATION

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Objectives

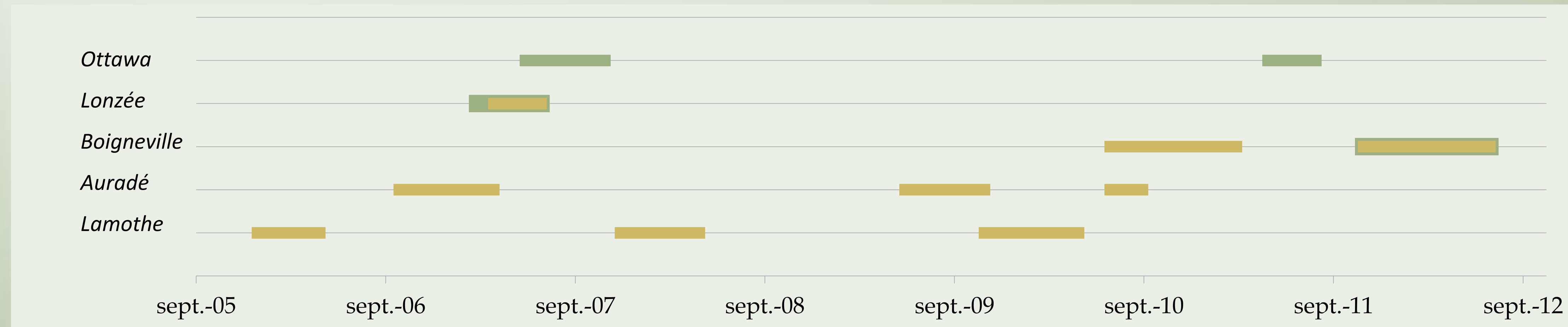
In the context of **climate change the aim of this study is to:**

- obtain a simple operational model with few parameters on **bare soil and wheat crops** (Soil Temperature (Ts), Soil Moisture (SM))
- assess contributions of Heterotrophic Respiration (HR) and Autotrophic Respiration (AR) in SR over croplands
- identify flux partition in Total Ecosystem Respiration (TER)

		Texture [% sand; % silt; % clay]	Mean annual T [°C]	Annual rain [mm]	Soil C content on 15cm [kg/m²]
Lamothe	43°49'N, 01°23'E	12 ; 34 ; 54	13.1	615	2.4
Auradé	43°54'N, 01°10'E	21 ; 47 ; 32	13.3	671	1.8
Boigneville	48°20'N, 02°22'E	11 ; 65 ;24	10.8	598	2.6
Lonzée	50°33'N 4°44'E	5 ; 75 ; 20	9.1	772	2.3
Ottawa	45°22'N ,75°43'W	31 ; 49 ; 20	6.3	914	3.9

Dataset

		Lamothe	Auradé	Boigneville	Lonzée	Ottawa
HR dataset	***Bare soil***					
	Automated measurements	Eddy Correlation	Eddy Correlation	3automated chambers	-	-
	Measurement frequency	Half hourly	Half hourly	4 times a day	-	-
	Root exclusion zones					
	Automated measurements	-	-	3automated chambers	4automated chambers	-
	Measurement frequency	-	-	4 times a day	Half hourly	-
SR dataset	***Wheat planted Area***					
	Automated measurements	-	-	3automated chambers	4automated chambers	1 automated chamber
	Measurement frequency	-	-	4 times a day	Half hourly	Half hourly
	Manual measurements	-	-		-	1 manual chamber
	Measurement frequency	-	-		-	About once a week
	References	Béziat et al., (2009)	Béziat et al., (2009)		Suleau et al. (2011)	



Models

Models chosen are Mod T (using only Ts factor), Mod Tmexp (using Ts and SM) and Mod TMgpp (using Ts, SM and GPP) :

Mod T

$$SR = a * exp^{b*Ts}$$

Mod TMexp

$$SR = a * exp^{b*Ts} * \frac{1}{1 + 30 * exp^{-8.5*\frac{SM-SMmin}{SMcc-SMmin}}}$$

Mod TMgpp

$$SR = \left(a * exp^{b*Ts} * \frac{1}{1 + 30 * exp^{-8.5*\frac{SM-SMmin}{SMcc-SMmin}}} \right) + c * GPP + d$$

Method :
a, b, c and d → fitted parameters
Q_{10} = exp (b *10)
Rbase = a

50 iterations on 2/3 of the data in order to reduce the error between simulation and the 1/3 data remaining

Q_{10} = exp (b *10)
Rbase = a

1

Q_{10} values and Rbase set free and adjusted for each site

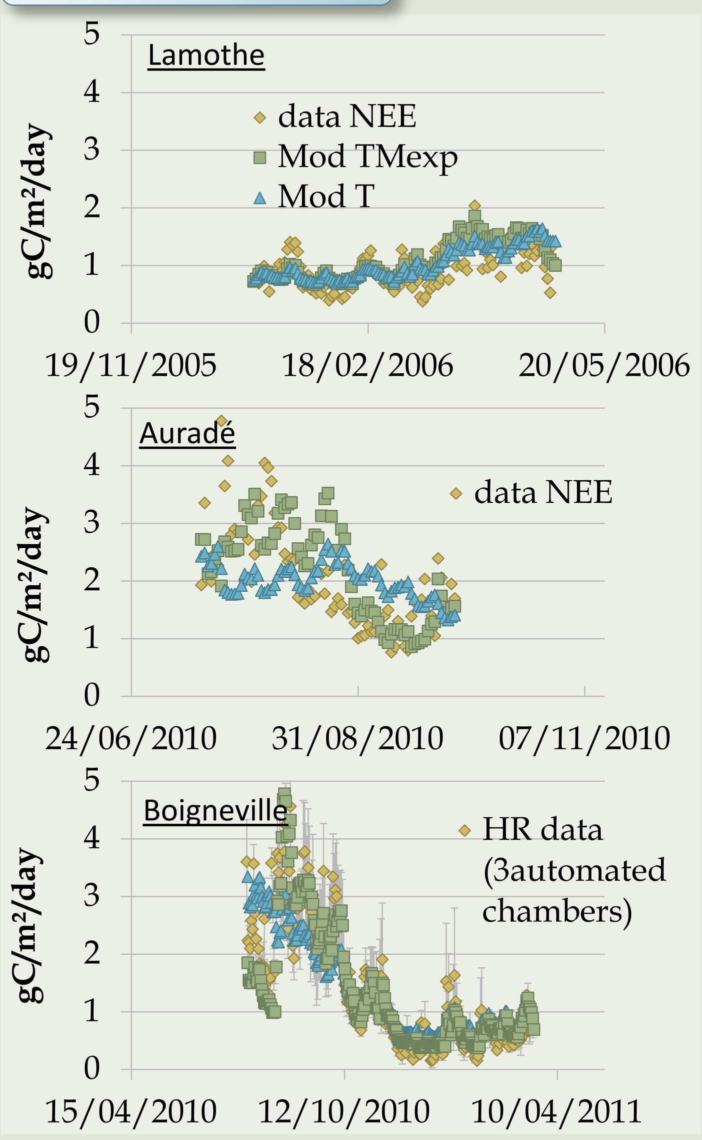
- Temperature response of soil C fluxes change among sites according to different soil types and climate conditions

2

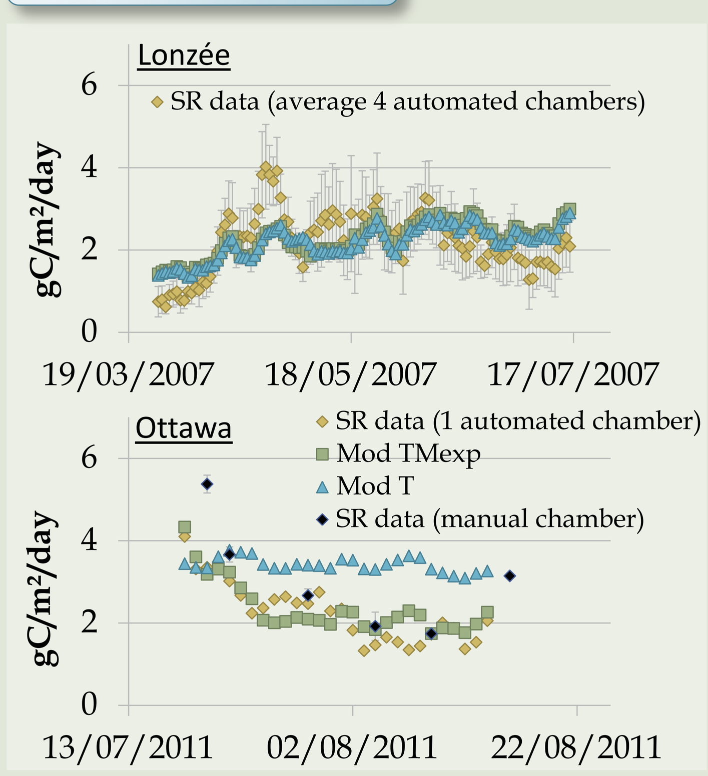
Q_{10} value =2.3 (Hartley et al. (2007), Kutsch and Kappen (1997), Aubinet at al. (2011))

- Temperature sensibility is the same for each site whatever organic C content, C quality and climate

HR modeling



SR modeling



- Mod TMexp allows a better reproducibility of HR and SR dynamic during drought periods
- Using GPP as a proxy of growth respiration of roots improves predictions of SR (data not shown)

Results

	Soil C content [kg/m² on 15 top cm]	Average T on dataset [°C]	Rbase [gC/m²/d]	Q_{10}	R	RMSE [gC/m²/d]	Rbase [gC/m²/d]	Q_{10}	R	RMSE [gC/m²/d]
HR model										
Lamothe	2.4	9.16	0.54	2.22	0.52	0.20	0.52	2.3	0.52	0.20
Auradé	1.8	15.6	0.55	2.12	0.70	0.46	0.45	2.3	0.68	0.54
Boigneville	2.6	9.4	0.36	3.67	0.85	0.30	0.71	2.3	0.76	0.12
Lonzée	2.3	16.2	0.26	2.82	0.77	0.07	0.41	2.3	0.74	0.07
SR model										
Boigneville	2.6	9.4	0.50	3.40	0.80	0.49	0.84	2.3	0.59	0.61
Lonzée	2.3	14.7	0.93	1.81	0.54	0.38	0.65	2.3	0.53	0.39
Ottawa	3.9	175	0.39	4.04	0.62	1.41	1.65	2.3	0.46	1.96

Adjusted Q_{10} :

- No relationship found between Q_{10} values and temperature range
- Rbase comes into being an offset of Q_{10} values
- Q_{10} among sites show a ranking closely linked to soil C content

Q_{10} = 2.3 :

- For HR, no alteration for R and RMSE . HRbase and Q_{10} are different for Lonzée and Boigneville
  → Rbase more related to soil C content
- For SR, lower R and higher RMSE among sites : different temperature sensibility on growth period
  → Influence of AR

Partitioning HR/SR during crop periods

	Period	Cumulative SR data [gC/m²]	Modeled HR [gC/m²]	%HR/SR
Winter wheat				
Boigneville	27/03/07 – 16/07/07 (112 days)	278	196	70%
Lonzée	27/03/07 – 16/07/07 (112 days)	246	141	57%
Spring wheat				
Ottawa	01/08/2007 – 21/11/2007 (91 days)	195	85	44%
Ottawa	13/05/2011 – 14/08/2001 (92 days)	295	132	45%

Partition of HR modeled in measured SR (**on available SR data periods)**

- HR Boigneville > HR Lonzée whereas similar C content.
  Hyp: organic matter quality (passive pool content) ?→ mechanistic modeling
- Lower proportion of HR for spring wheat
  Hyp: water stress in summer blocking respiration process?
  organic matter quality ? → mechanistic modeling
- Consistent HR contribution in SR on Ottawa during the two years

Partitioning HR and SR / TER during crop period

Period (seedbed to harvest) : 13/10/2006 to 05/08/2007						
	Cumulative TER data [gC/m²]	Modeled HR [gC/m²]	Modeled SR [gC/m²]	%HR/SR	%HR/TER	%SR/TER
Lonzée	1055	536	319	59%	30%	51%

- High HR contribution in SR during crop period
- Important contribution of SR in TER during crop period → key role of agricultural soil in GES balance

Prospects

- Enlarge dataset to study TER partitioning
- Adjust a SR model on Lamothe with automated dataset (2013)
- Comparison with mechanistic modeling to understand partitioning: SR/TER, AR and HR / SR → **see poster session SSS8.2 Blue Poster area, board B768**