Spatial variation in soil CO2 efflux in french and belgian temperate forests

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SPATIAL VARIATION IN SOIL CO_2 EFFLUX IN FRENCH AND BELGIAN TEMPERATE FORESTS

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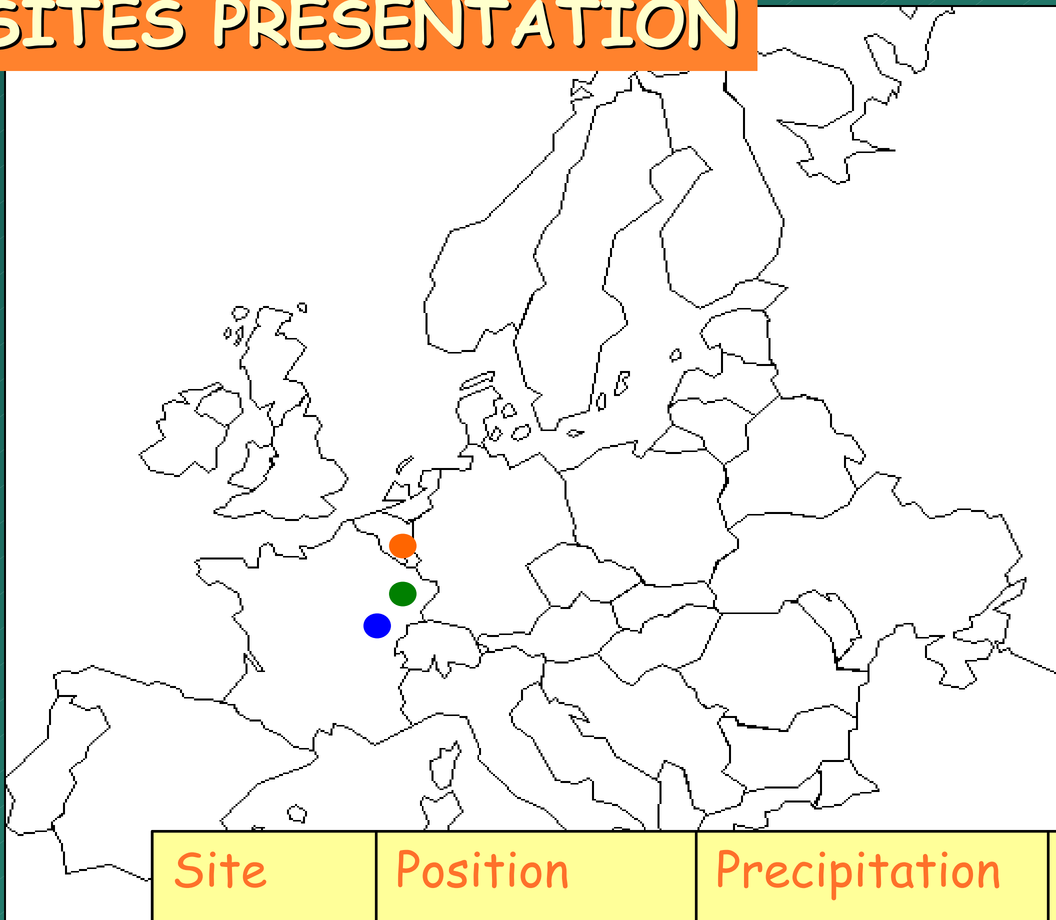
MAIN OBJECTIVE

Quantification of the relative importance of **climatic factors** and **ecosystem properties** on the **spatial variability** of soil CO_2 efflux (SR) from different ecosystems (plots).

1. System comparison and set up of a common protocol.
2. Quantification of climatic influences on SR for each plots.
3. Identification of the main ecosystem properties influencing SR_{plot} variability

SITES PRESENTATION



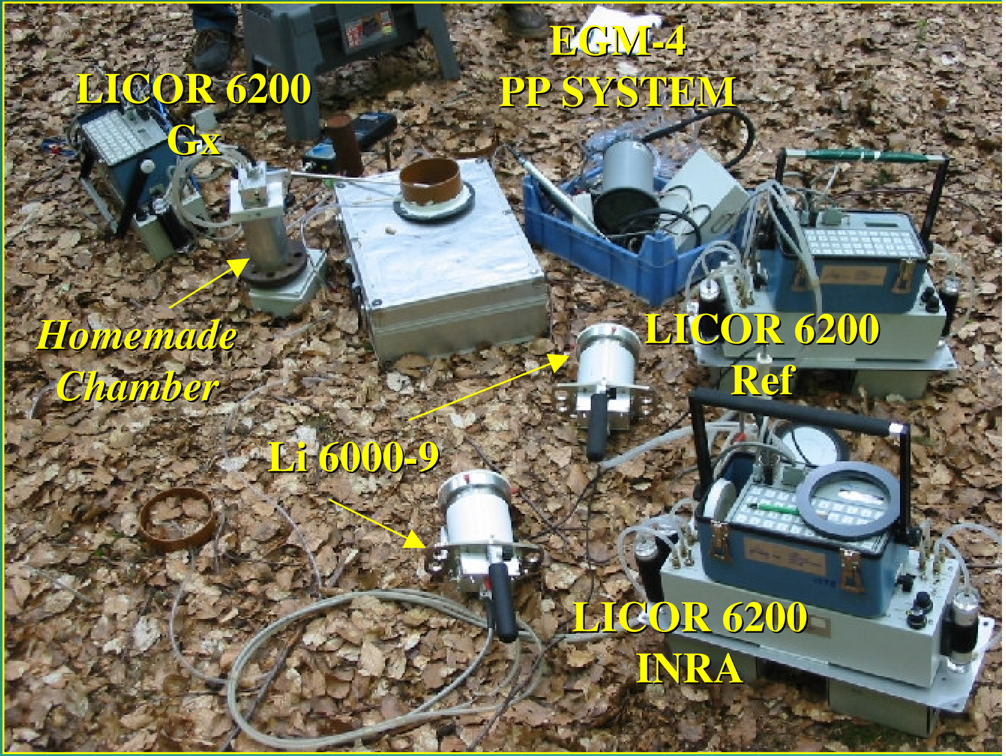
- Vielsalm, University of agricultural science, Gembloux, Belgium
- Hesse, National Institute of the Agronomic Research, Nancy, France
- Chaux, University of Franche-Comté, Besançon, France

Site	Position	Precipitation	Air temperature	Elevation
Chaux	47°07'N 05°42'E	950 mm	10,3°C	250 m
Hesse	48°40'N 7°05'E	1150 mm	10.5°C	300 m
Vielsalm	50°18'N 6°00'E	800 mm	8,5°C	450 m

Sites	Hesse			Chaux			Vielsalm	
plots	H1	H2	H3	C1	C2	C3	V1	V2
Tree species	Beech	Beech/Spruce		Mixed broadleaves			Beech	Douglas fir
LAI	6.3	5.5 - 8	4 - 8	7.2	7.9	7.4	3.3	5.0
Age (years)	35	35	35	Stratified forest			95	68
Ground area (m^2.ha)	20.7	19.7	22.7				129	112
Soil class	Luvisol/Stagnic luvisol			Gleyic Luvisol			Dystric Cambisol	
Texture	7%(S_a); 64%(S_i); 29%(C)			20%(S_a); 50%(S_i); 30%(C)			27%(S_a); 55%(S_i); 18%(C)	
Soil density	1.078	1.103	1.108	1.024	0.978	0.997	1.038	1.044
Litter height (cm)				0.78	1.09	1.12	1.07	1.75
[C] $g.kg^{-1}$ (0-8 cm)	29.61	27.44	29.67				43.7	57.3
[N] $g.kg^{-1}$ (0-8 cm)	1.84	1.41	1.90				2.9	4.8
pH H_2O	4.43	4.49	4.53	4.5	4.5	5	4.46	4.26
pH KCl	3.68	3.61	3.59				3.79	3.46

MATERIAL AND METHODOLOGY

1. Four SR measurement systems



2. Soil Temperature (Ts)
- Thermocouple
- 10 cm depth
- Fixed (climatic station) or mobile (inserted near the measurement point)

3. Soil Water Content (SWC)
- Thetaprobe
- 0-20 cm depth
- Fixed or mobile

COMPARISON

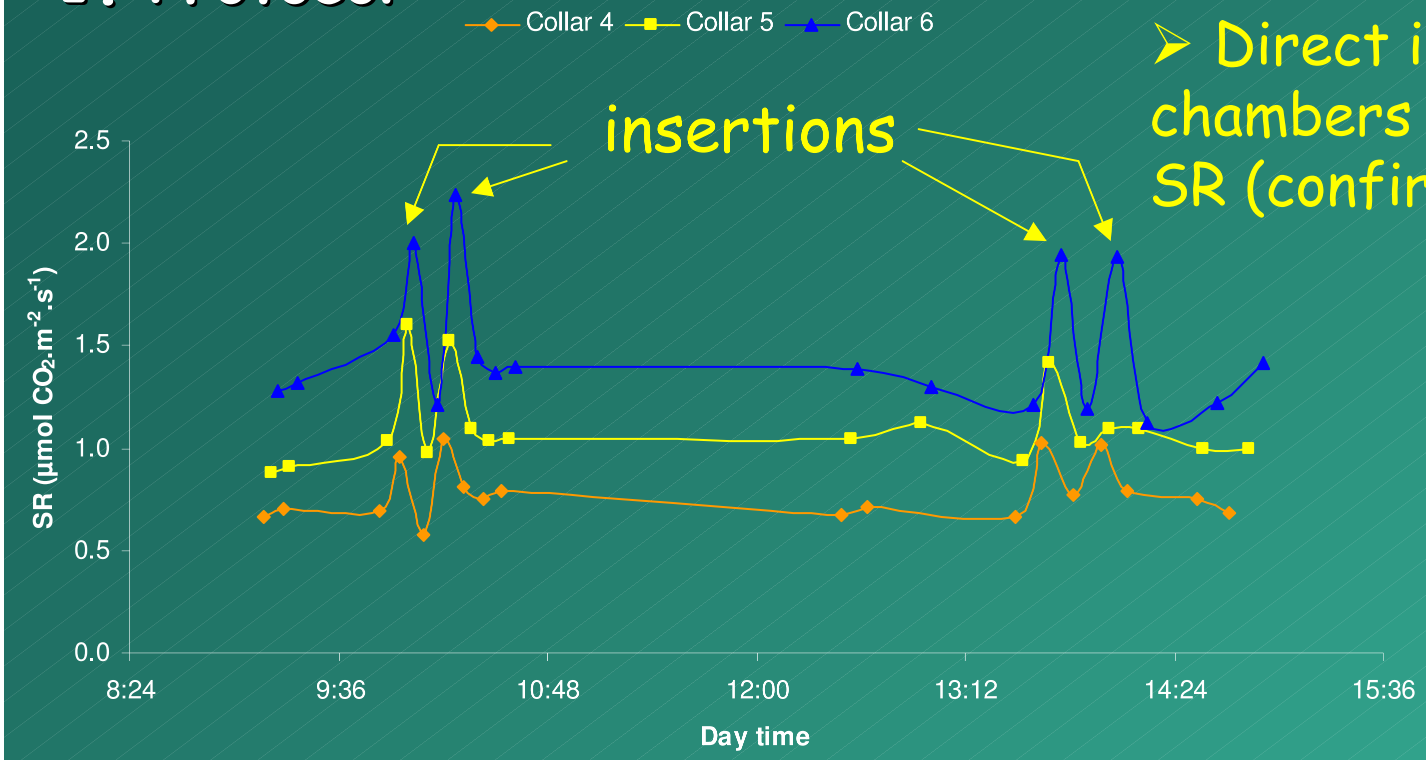
Two campaigns of measurements with the four systems :

- ✓ 05/03 Vielsam (12 collars)
- ✓ 09/03 Hesse (20 collars)

One campaign in each plots with the reference and the « local » system

1. Protocol
2. Fluxes
3. SWC
4. Ts

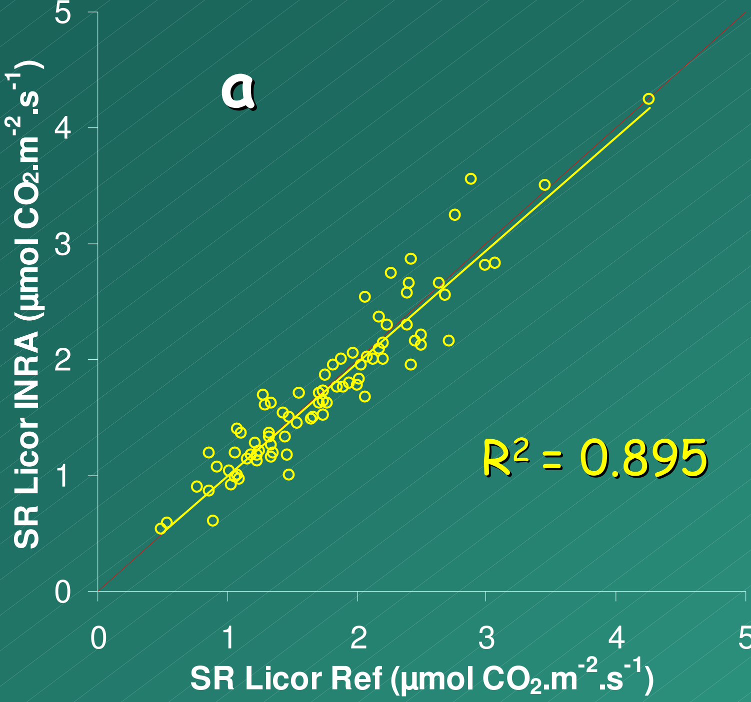
1. Protocol

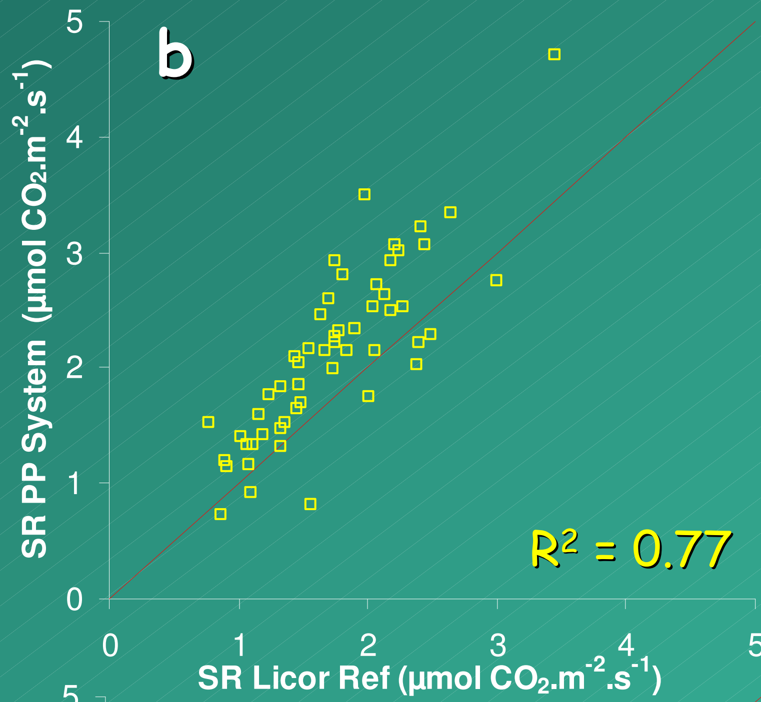


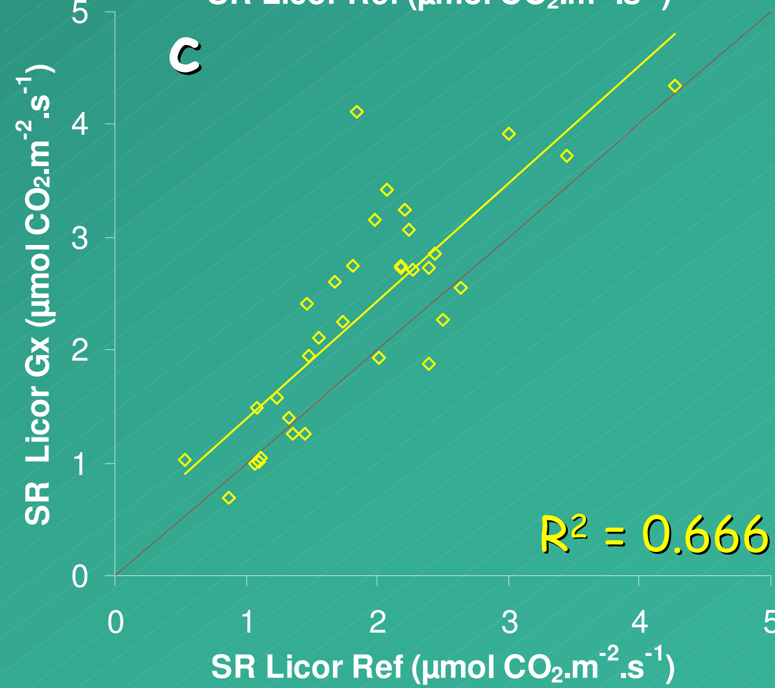
- Direct insertion of chambers generates higher SR (confirmation)

- Pch – Pair ≤ 0.1 Pa (Fang & Moncrieff, 98; Longdoz & al. 2000)
- 60 s are sufficient between two measurements on the same point
- No impact of the duration of measurement (up to 75 s)

2. Fluxes







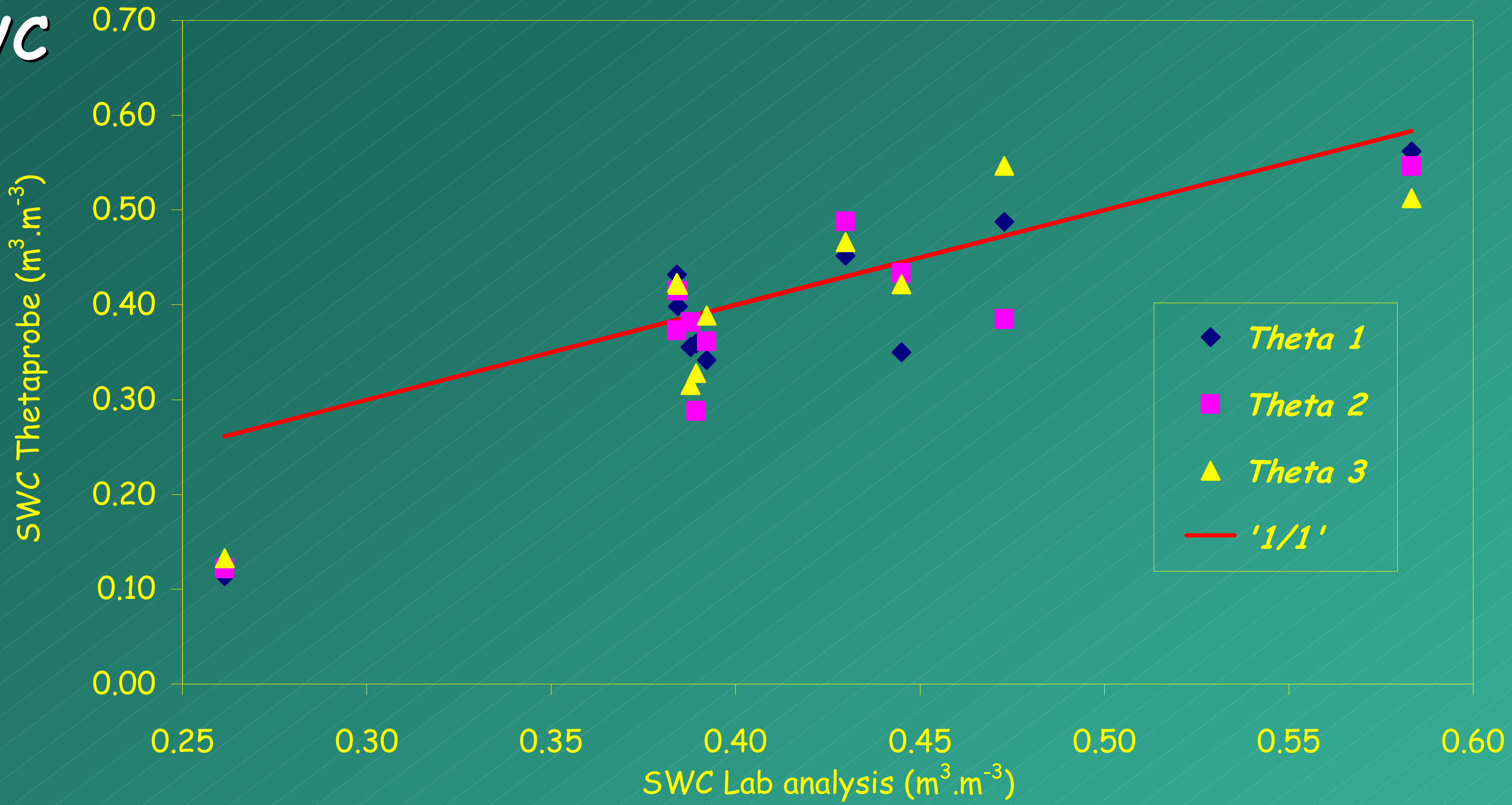
« Systems » equations :

a $SR_{Licor\ INRA} = 0.9733 * SR_{Licor\ Ref} + 0.0291$

b $SR_{PP\ System} = 1.1472 * SR_{Licor\ Ref} + 0.1392$

c $SR_{Licor\ Gx} = 1.044 * SR_{Licor\ Ref} + 0.3496$

3. SWC



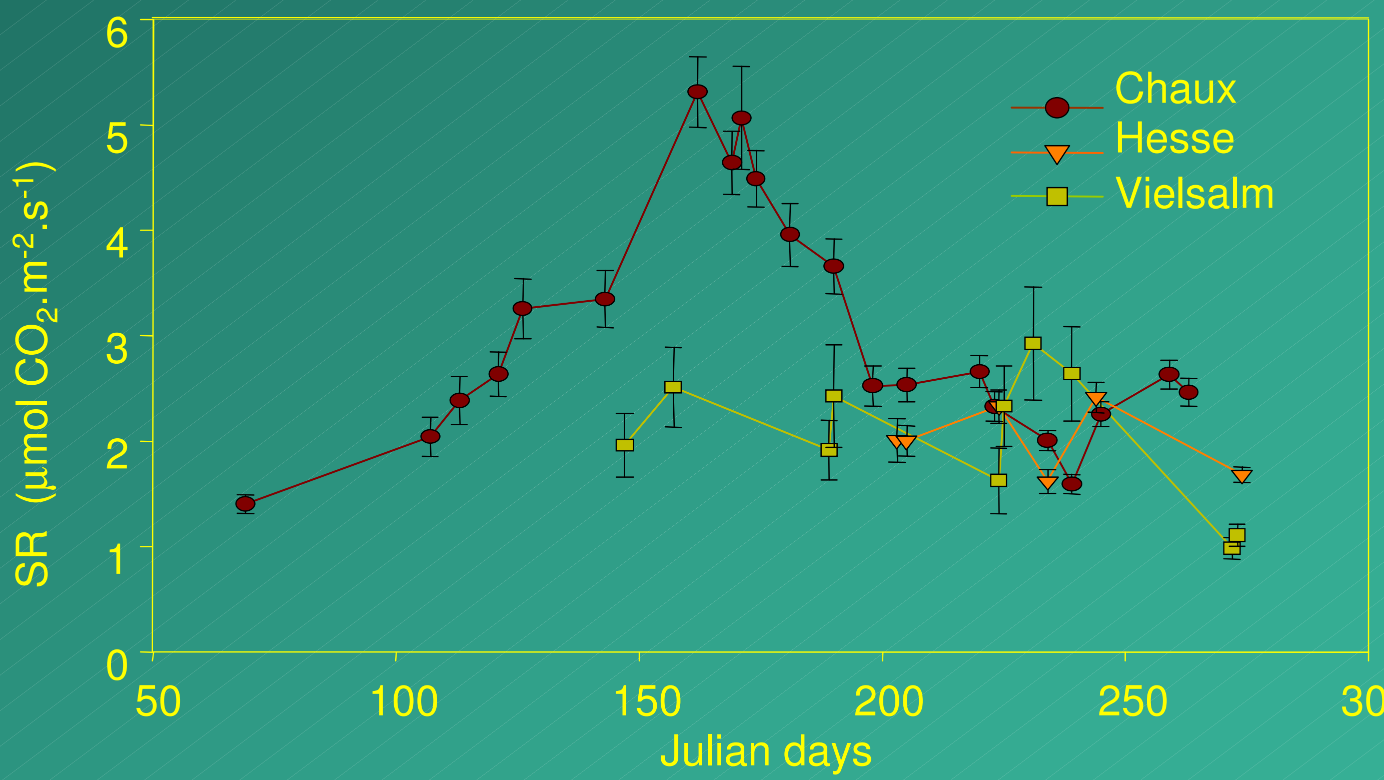
4. Ts

- This year : measurements with fixed probes
- Future : new probes (0 – 5 cm, 10 cm)

CLIMATIC IMPACTS

For each plots :

1. measurements on minimum 12 collars, at several dates
2. conversion to SR_{ref} using the "systems" equations
3. one average value of SR_{ref} , Ts, SWC, by measurement dates

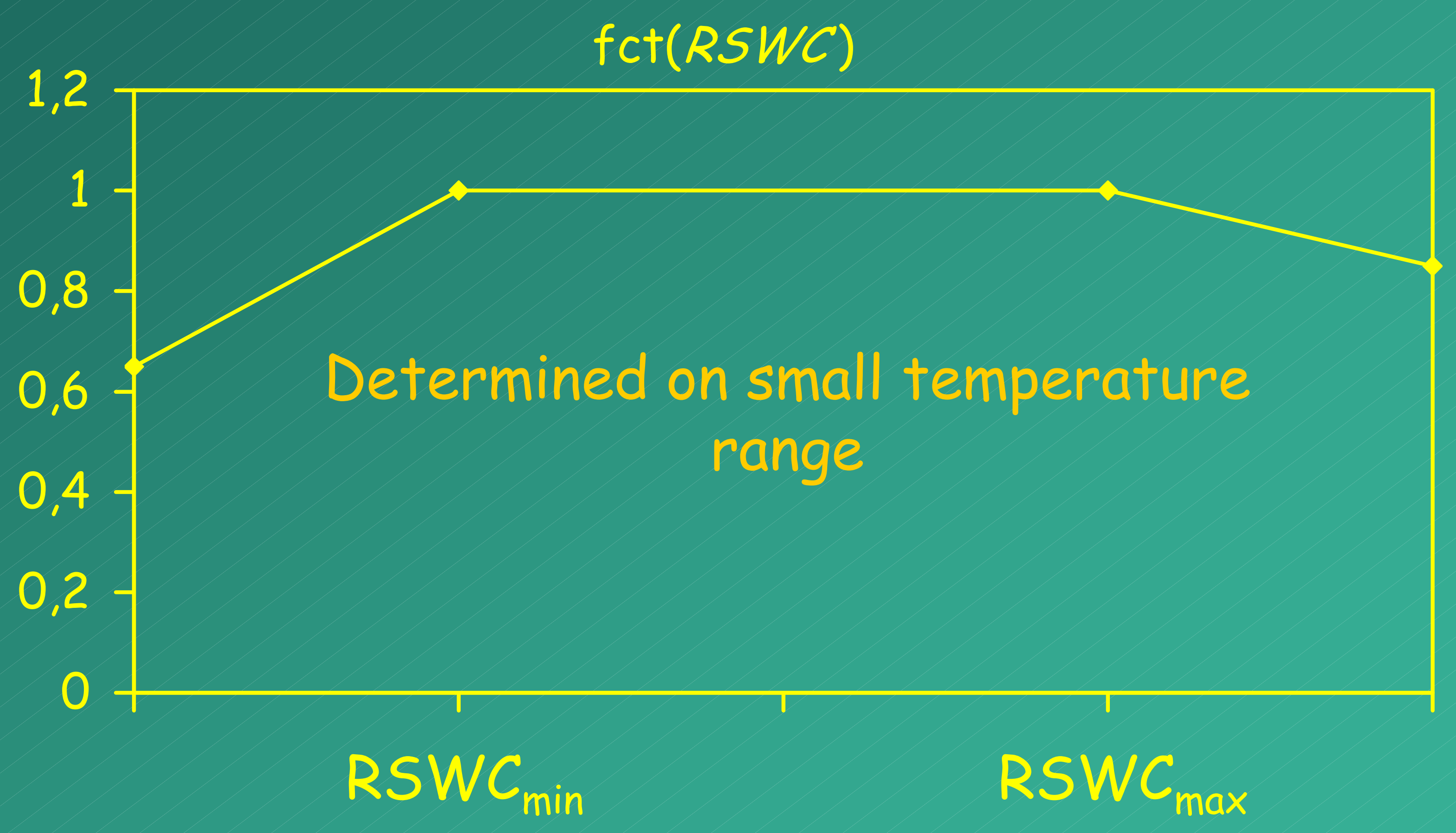


Model

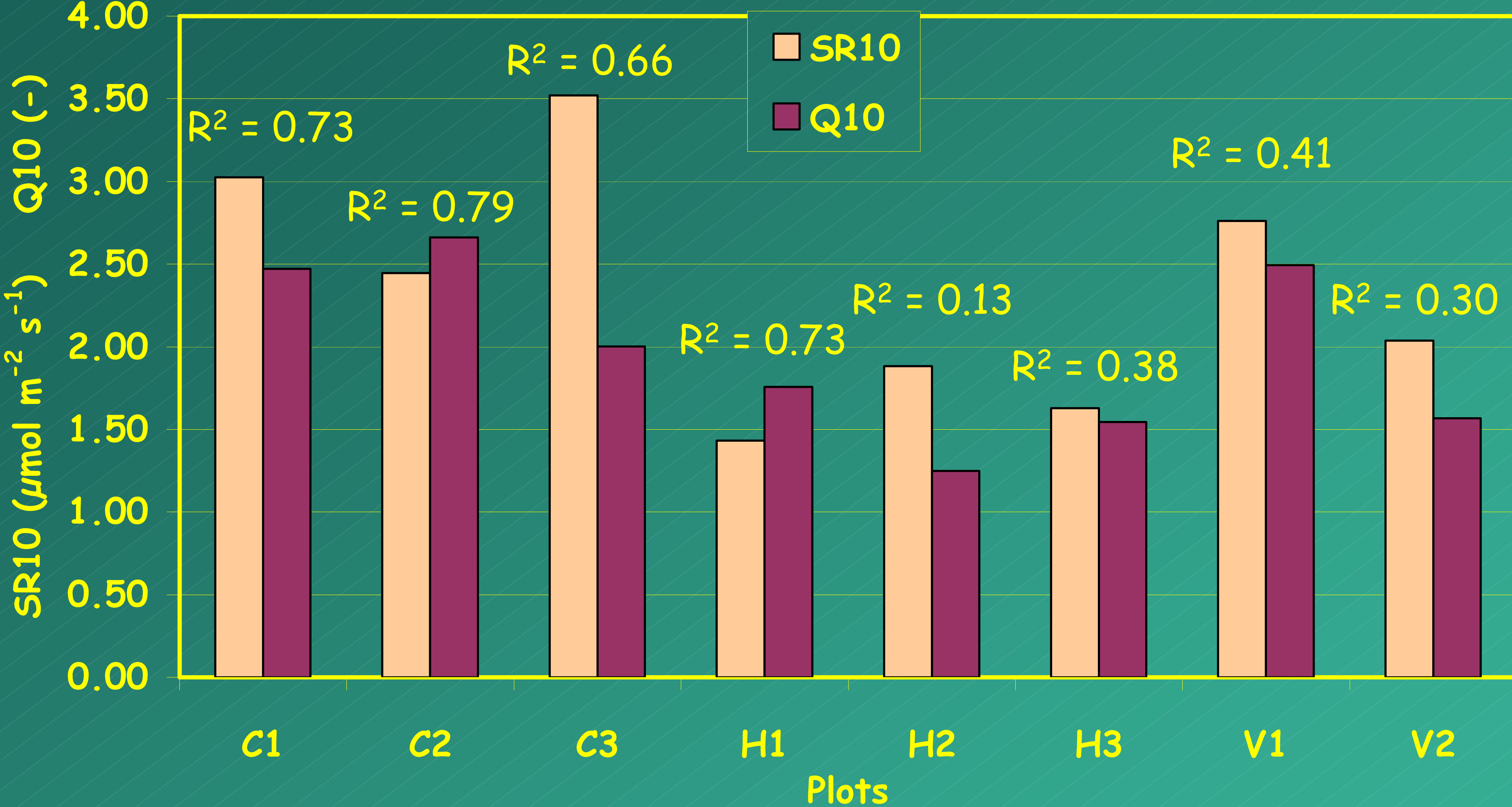
Multiplicative model : separation of SWC and Ts impacts

$$SR = SR_{10} * Q_{10}^{\left(\frac{T-10}{10}\right)} * fct(RSWC)$$

where
RSWC = SWC/SWC_{sat}



INTERPLOTS VARIABILITY



- Ts range to small during measurement periods for Hesse and Vielsalm
- Tendency : small SR_{10} and Q_{10} for young and coniferous plots (to be confirmed)

CONCLUSIONS AND PERSPECTIVES

- Relatively good accurency between systems ➔ inter-plots variability consistent
- Work still in progress (more data to improve climatic impact)
- Small SR_{10} and Q_{10} for young and coniferous plots ?
- More plots with contrasted environmental conditions and properties

OTHERS TEAMS ARE WELCOME