



HAL
open science

Why we are not yet to use $\delta^{13}\text{C}$ for soil CO_2 efflux partitioning in a beech temperate forest and a rain tropical forest

Bernard Longdoz, Daniel Epron, Jérôme Ngao, Stéphane Ponton, Damien Bonal, Valérie Le Dantec

► To cite this version:

Bernard Longdoz, Daniel Epron, Jérôme Ngao, Stéphane Ponton, Damien Bonal, et al.. Why we are not yet to use $\delta^{13}\text{C}$ for soil CO_2 efflux partitioning in a beech temperate forest and a rain tropical forest. Réunion du projet Galiléo "Traçage isotopique du carbone dans les écosystèmes forestiers", Jun 2006, Napoli, Italy. 23 p. hal-01032064

HAL Id: hal-01032064

<https://hal.science/hal-01032064>

Submitted on 6 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Why we are not yet to use $\delta^{13}\text{C}$ for soil CO_2 efflux partitioning in a beech temperate forest and a rain tropical forest

Longdoz¹, Epron¹, Ngao¹, Ponton², Bonal², Le Dantec³

¹UMR Ecologie et Ecophysiologie Forestières, INRA-Université HP Nancy (France)

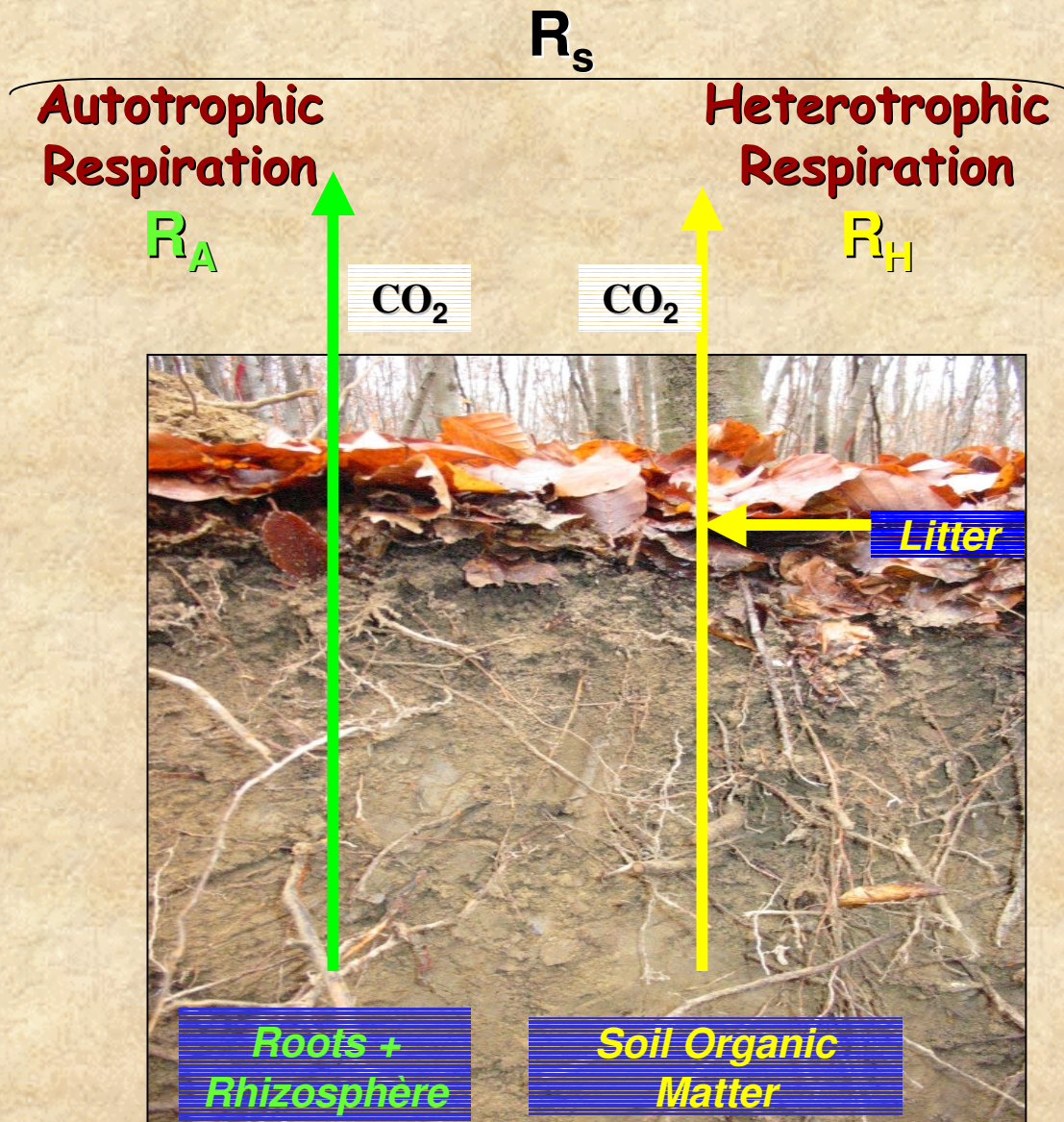
²UMR Ecologie des Forêts de Guyane, INRA Kourou (Guyane Française)

³Centre d'Etude Spatial de la Biosphère, Université PS, Toulouse (France)

Napoli 7/6/2006

Soil respiration partitioning

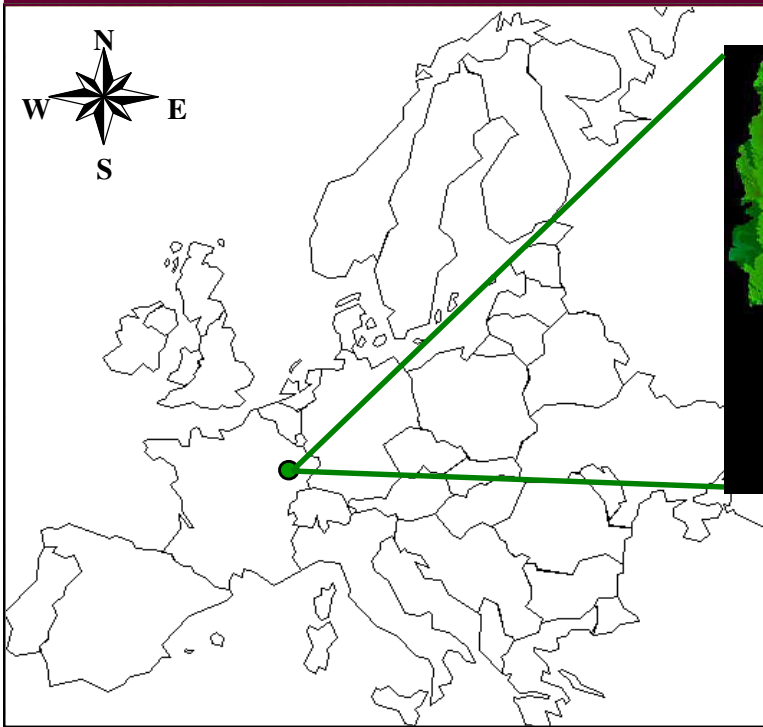
Context



Trees carbon budget
&
Soil carbon budget
by
input/output

HESSE, France (CarboEurope & Fluxnet site)

Site



Location : **48°40'N, 7°05'E**

Climate : **Temperate oceanic**

Mean annual air Temp. : **9.2°C**

Mean annual Precip. : **820 mm**

Soil type:
luvisol/stagnic luvisol (FAO)

Hesse 1 :

Species : **90% Beech** Height : **18m**

Age : **37 years** LAI : **7-4 m² m⁻²**

Hesse 2 :

Species : **Beech, Hornbeam, Oak**

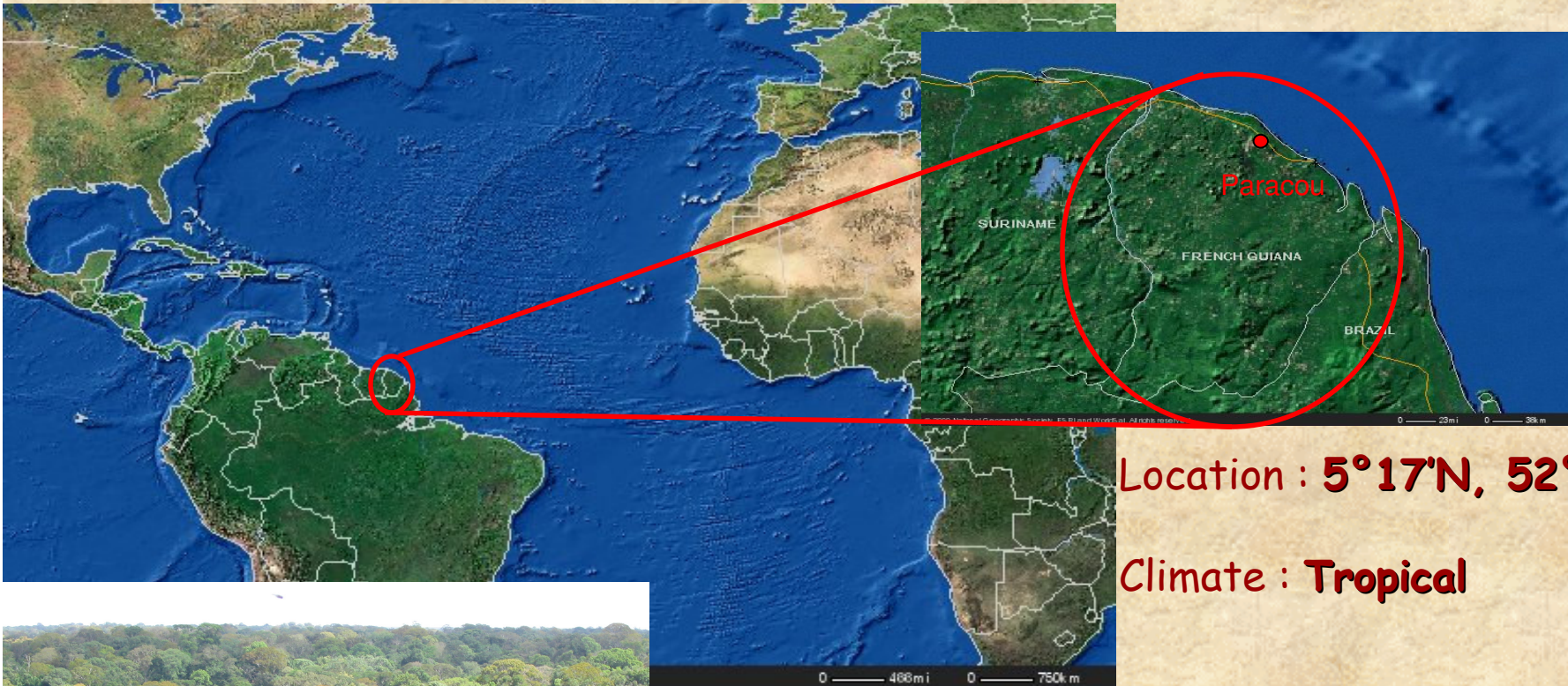
Age : **14 years** Height : **8m** LAI : **8-5 m² m⁻²**



Napoli 7/6/2006

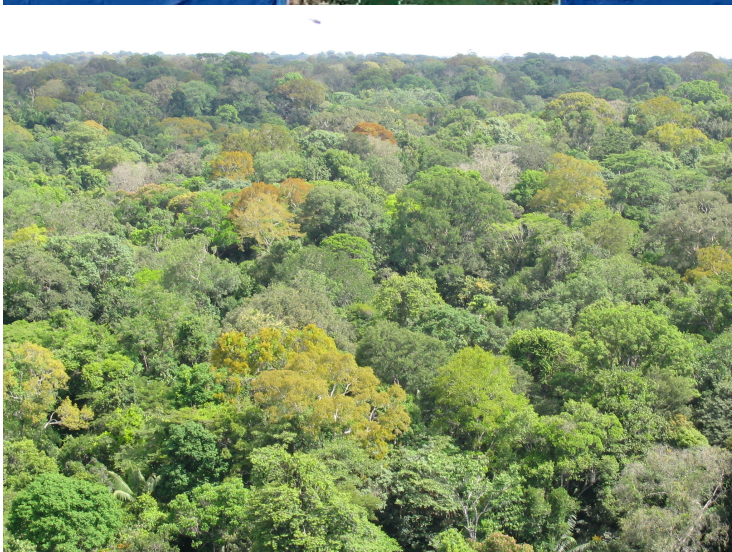
PARACOU, French Guyana

Site



Location : **5°17'N, 52°55'W**

Climate : **Tropical**



Mixed forest :
180 species ha⁻¹

Mean annual Precip. : **2875 mm**

Height : **35 m**

Mean annual air Temp. : **25.8°C**

LAI : **7 m² m⁻²**

Soil type : **ferralitic**

Napoli 7/6/2006

Use of $\delta^{13}\text{C}$ for soil respiration partitioning

Methodology

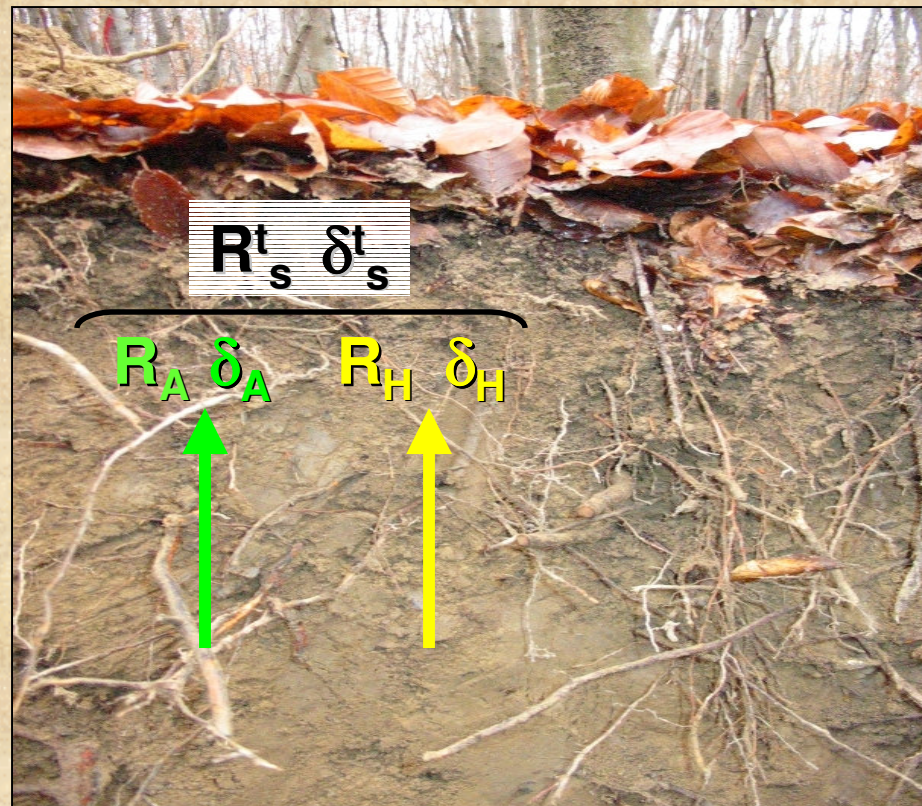
Mass balance equations :

$$R_H/R_s^t = \frac{(\delta_s^t - \delta_A)}{(\delta_H - \delta_A)}$$

$$R_A/R_s^t = \frac{(\delta_s^t - \delta_H)}{(\delta_A - \delta_H)}$$

$$\max(\delta_A, \delta_H) > \delta_s^t > \min(\delta_A, \delta_H)$$

Feasibility : $\delta_A \neq \delta_H$



1st Approach

Methodology

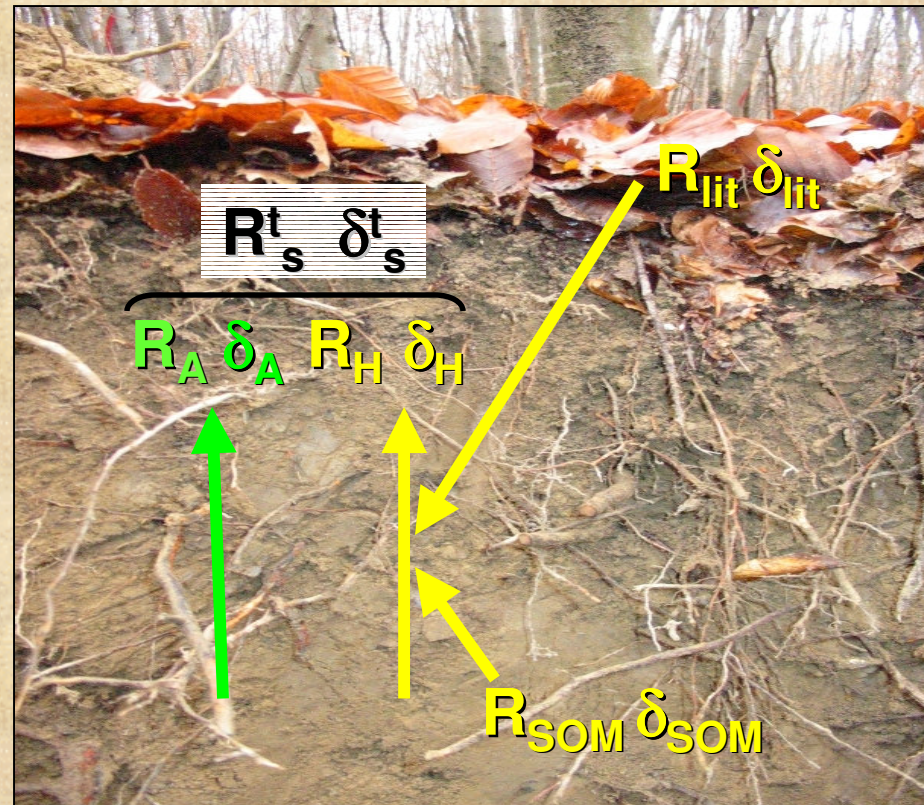
1. $R_s^t = R_s$
2. $\delta_s^t = \delta_s$ Keeling plot
3. $\delta_A = \delta_{LR}$ Incubation
4. $\delta_H = ???$ SOM+lit

$$\delta_H = \frac{R_{SOM} \delta_{SOM} + R_{lit} \delta_{lit}}{R_{SOM} + R_{lit}}$$

δ_{SOM} Incubation

δ_{lit} Incubation

R_{SOM} & R_{lit} !!!



2nd Approach : Trench plot

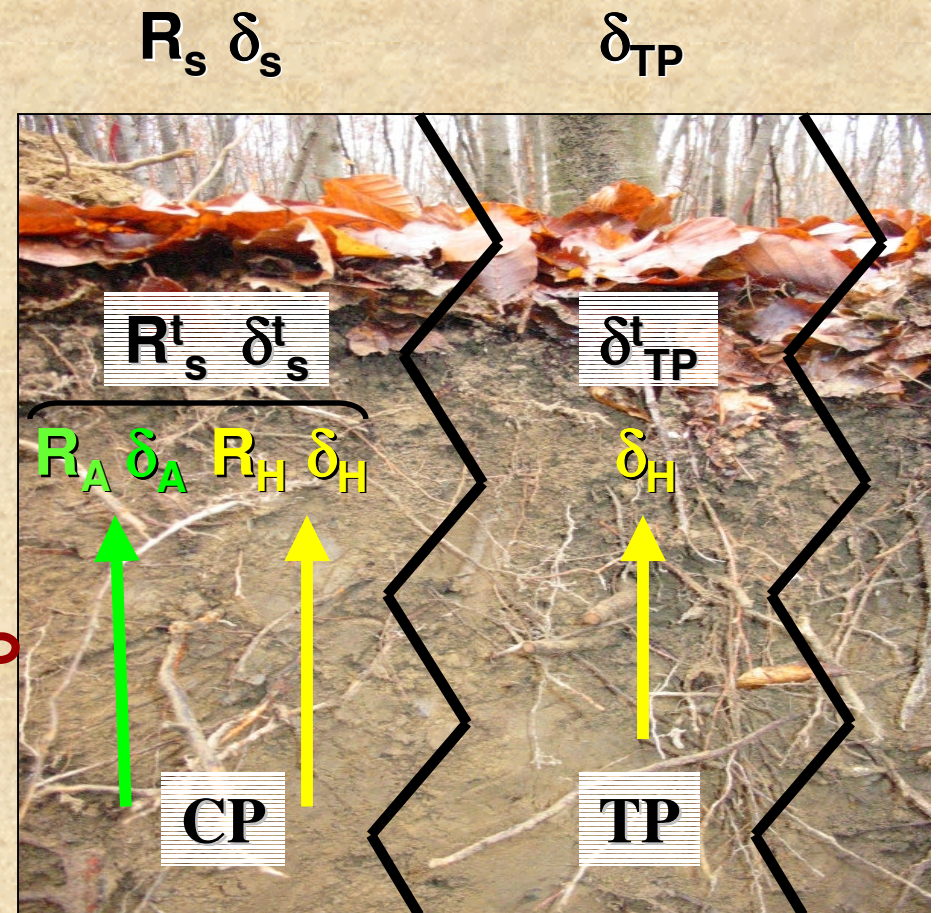
Methodology



1. $R_s^t = R_s$
2. $\delta_s^t = \delta_s$ Keeling plot on CP
3. $\delta_A = \delta_{LR}$ Incubation
4. $\delta_H = \delta_{TP}^t = \delta_{TP}$ Keeling plot on TP

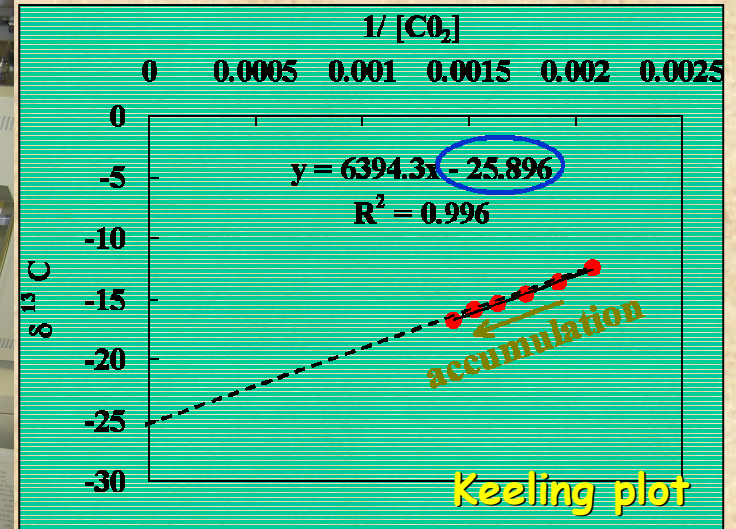
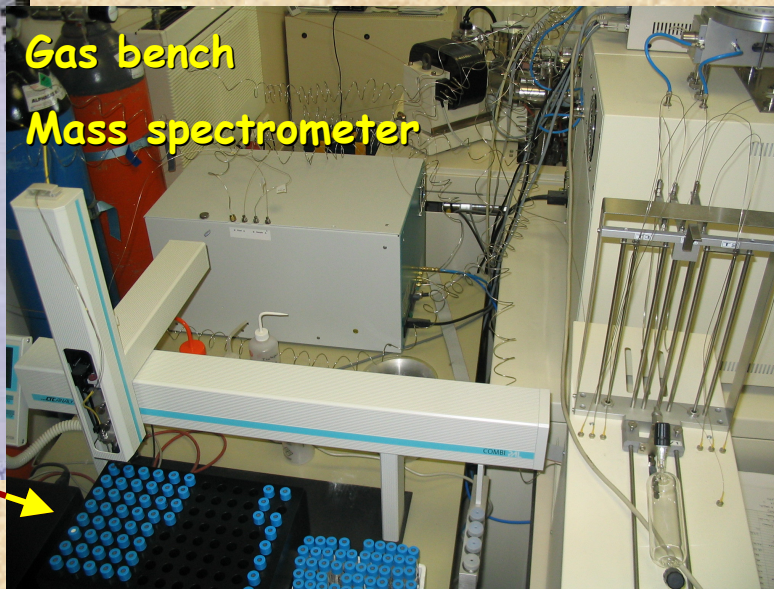
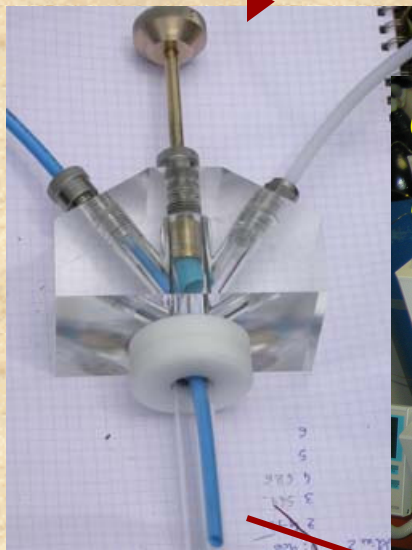
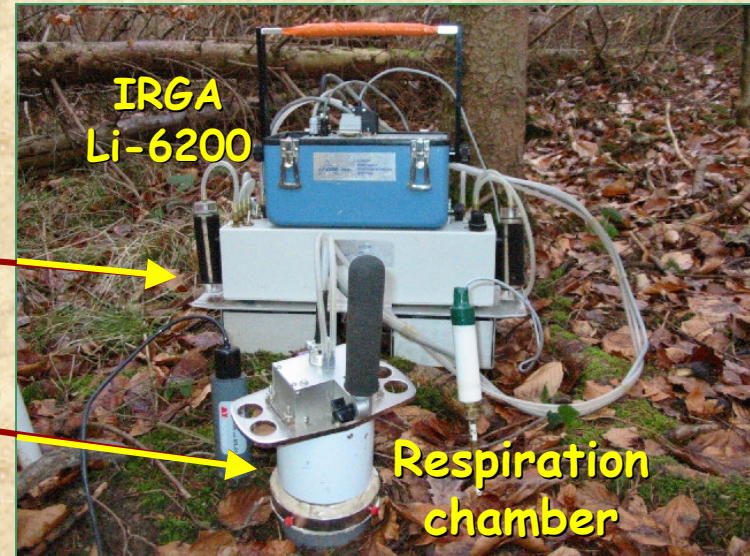
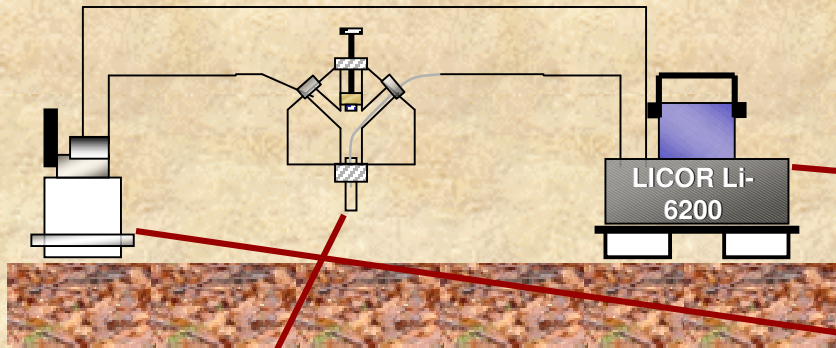
Feasibility : $\delta_A \neq \delta_H$

➔ $\delta_s \neq \delta_{TP}$



Soil Keeling Plot

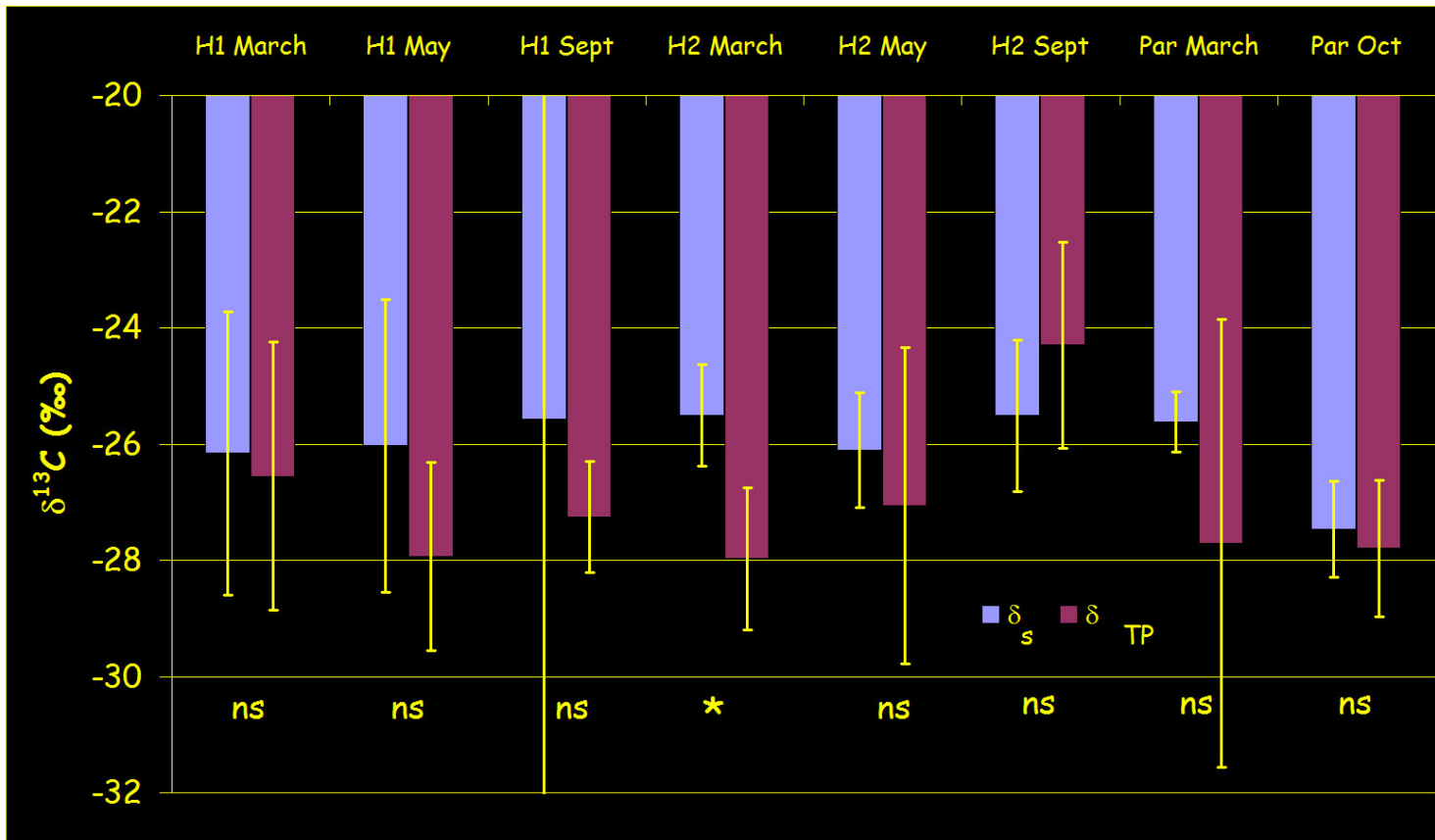
Material & Method



Sampling chamber

Feasibility : $\delta_s \neq \delta_{TP}$

Results



$n \approx 4$

$$\delta_s \approx \delta_{TP}$$

$$\Rightarrow \delta_A = \delta_H$$

or
assumptions

1. $R_s^t = R_s \Rightarrow$

2. $\delta_s^t = \delta_s$ Keeling plot on CP

3. $\delta_A = \delta_{LR}$ Incubation \Rightarrow

4. $\delta_H = \delta_{TP}^t = \delta_{TP}$ Keeling plot on TP

Discrimination during diffusion

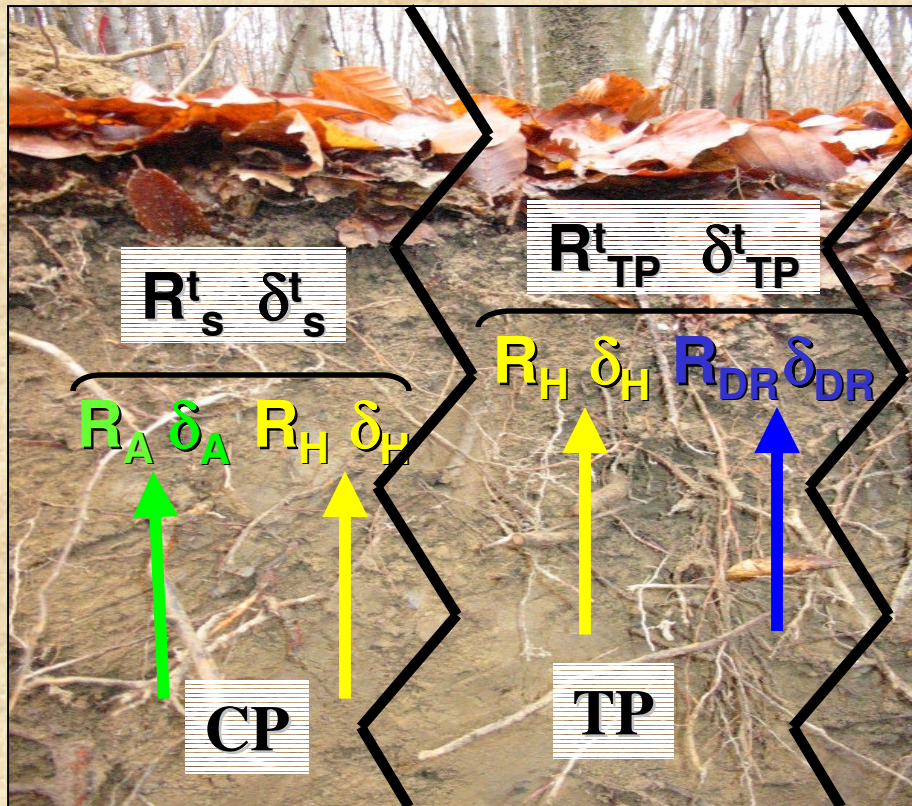
Napoli 7/6/2006

Dead roots

$$\delta_H \neq \delta_{TP}^t$$

Discussion

Dead Roots



Impact of δ_{DR} on δ_{TP} if R_{DR} not significant for R_{TP}

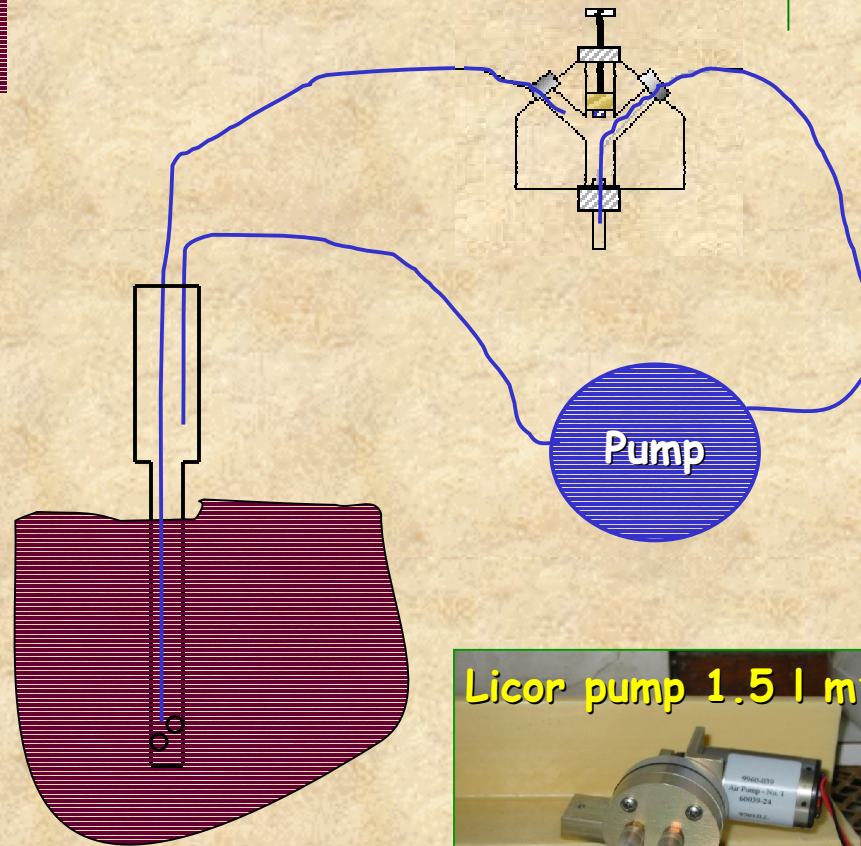
$R_{DR} \approx 50\%$ of R_{TP} (H1 & H2)
(Ngao et al. *in prep.*)

➔ Determination of δ_{DR}

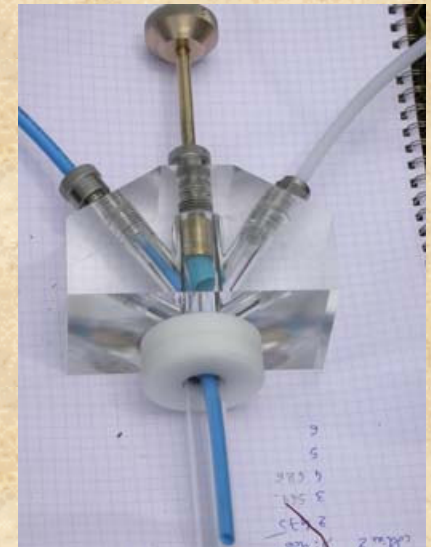
Discrimination during diffusion

$\delta^{13}\text{C}$ of soil air

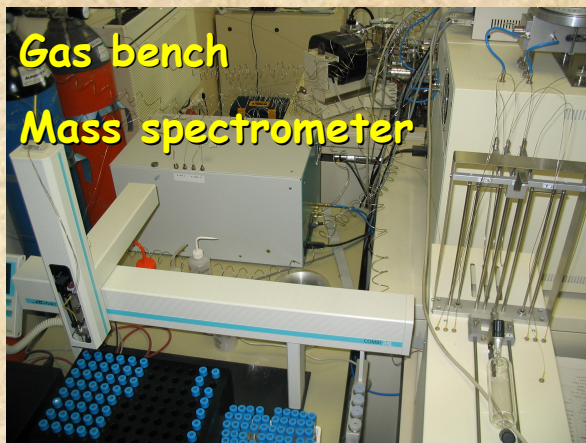
Material & Method



Sampling chamber

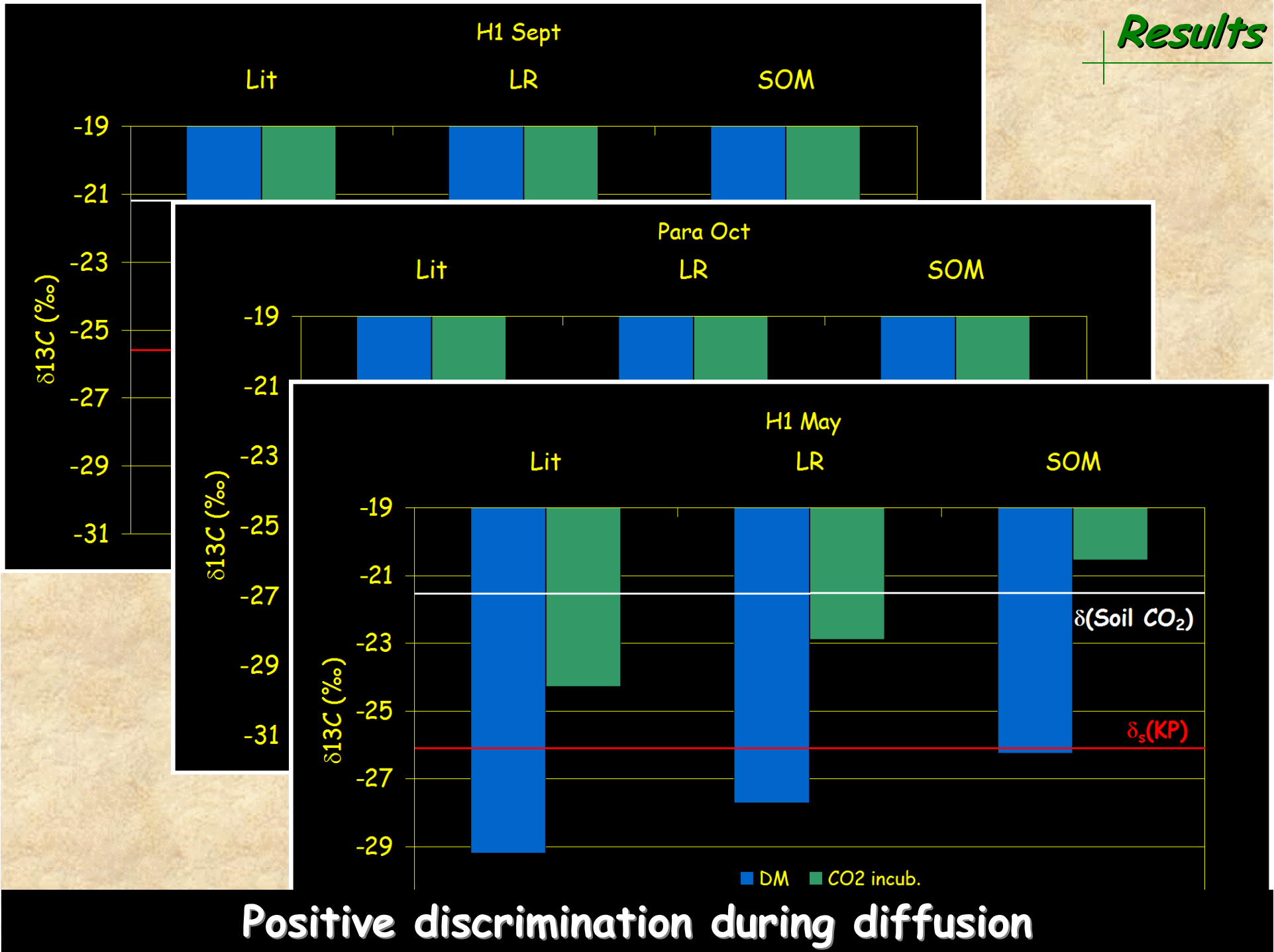


10 sec



Napoli 7/6/2006

Results



Positive discrimination during diffusion

Quantification of the discrimination during diffusion

Discussion

Incubations

+ R_{SOM}, R_{LR} (TP)

+ R_{Lit} (depleted litter)

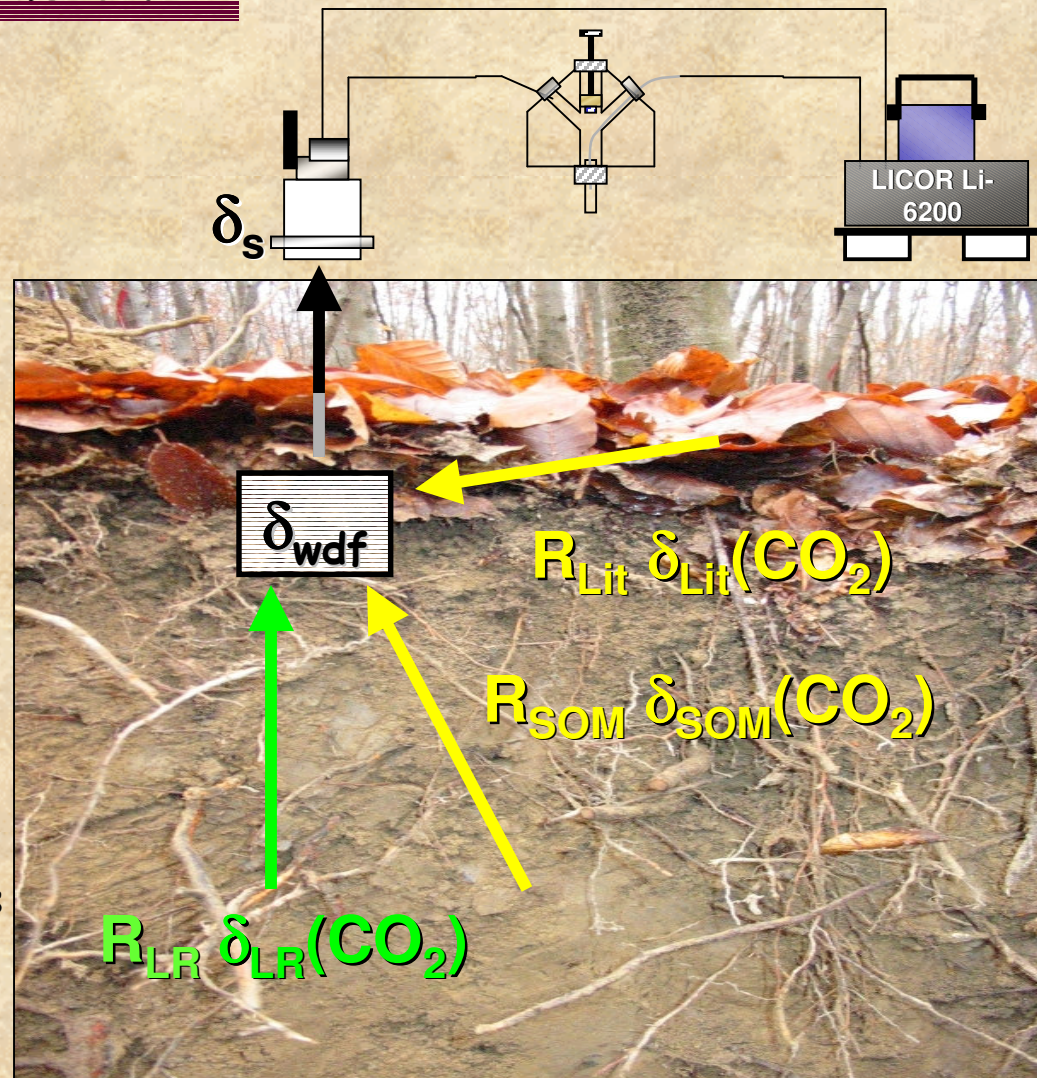
Mass balance equations

→ δ without diffusive fractionation = δ_{wdf}

Confrontation $\delta_{wdf} \Leftrightarrow \delta_s$



Apparent diffusive discrimination



Apparent discrimination during diffusion

	Fract. max	Fract. min	Mean Fract.
Hesse 1	+3.8 ‰	+3.0 ‰	+3.3 ‰
Hesse 2	+2.5 ‰	+2.0 ‰	+2.3 ‰
Total	+3.8 ‰	+2.0 ‰	+2.9 ‰

≠ 4.4 ‰ according to Davidson (1995), fct of Cs, Ca, δa

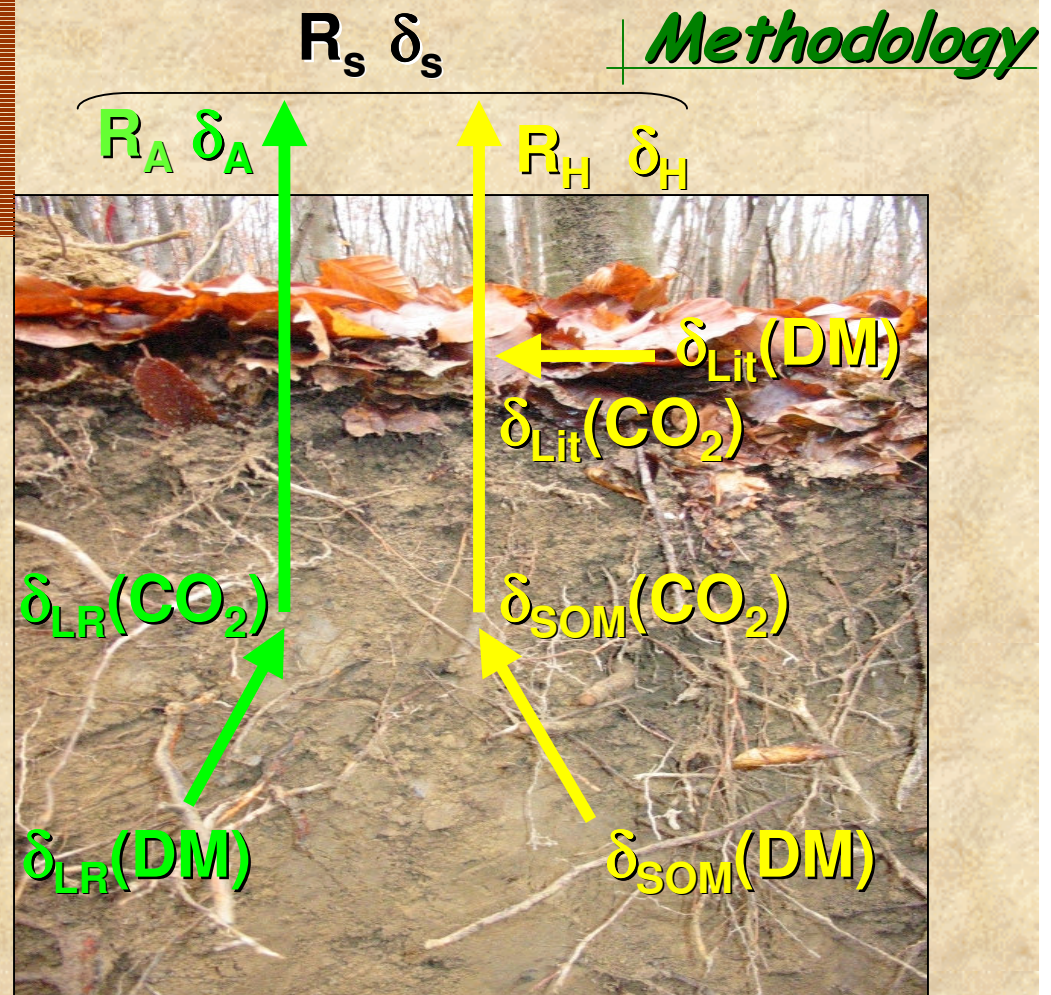
Apparent fractionation during production (DM → CO₂)?

• Dry matter

$\delta_{LR}(DM)$ $\delta_{SOM}(DM)$ $\delta_{Lit}(DM)$

• Incubation

$\delta_{LR}(CO_2)$ $\delta_{SOM}(CO_2)$ $\delta_{Lit}(CO_2)$



$\delta^{13}\text{C}$ of Dry Matter

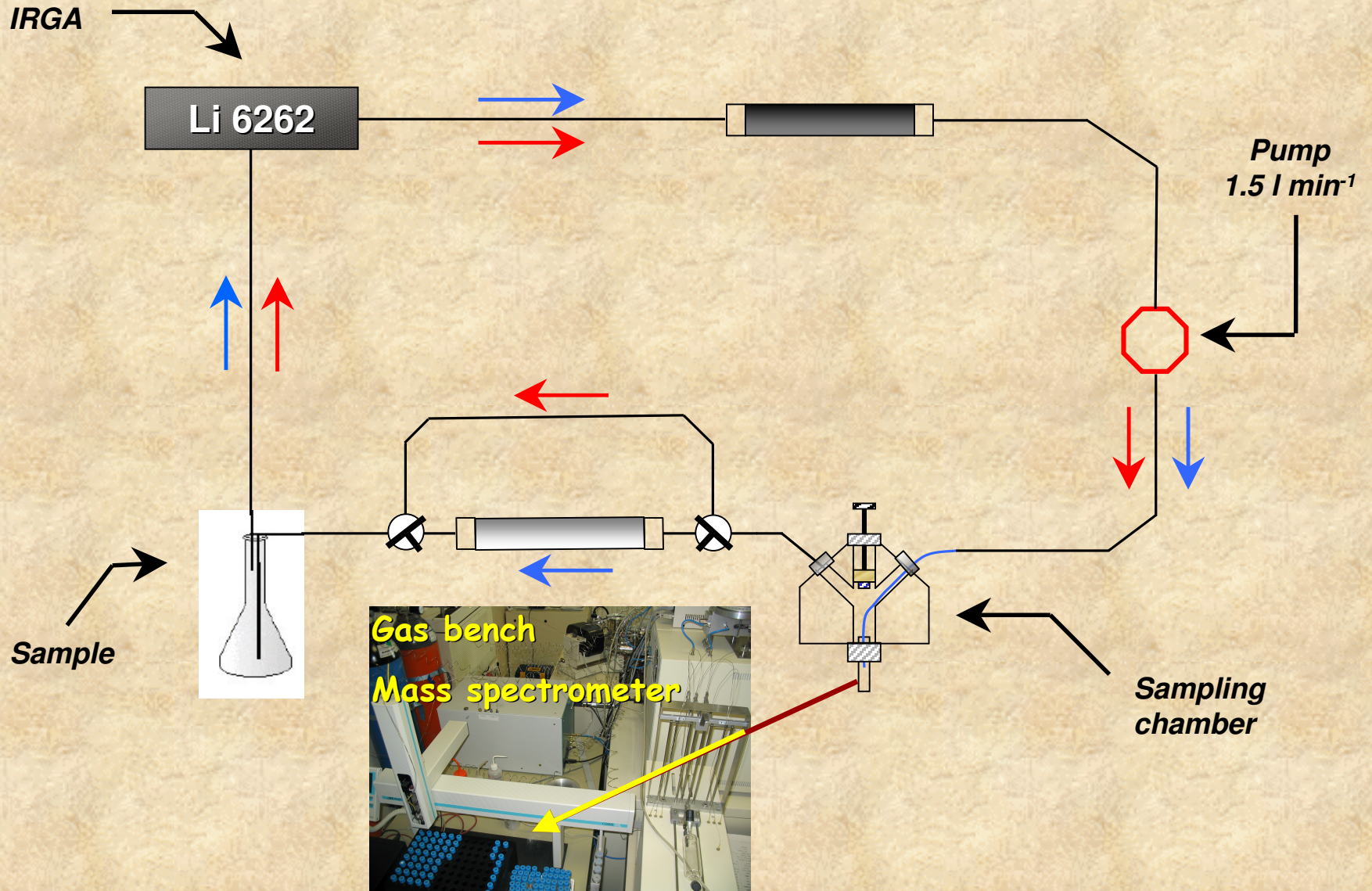
Material & Method



Napoli 7/6/2006

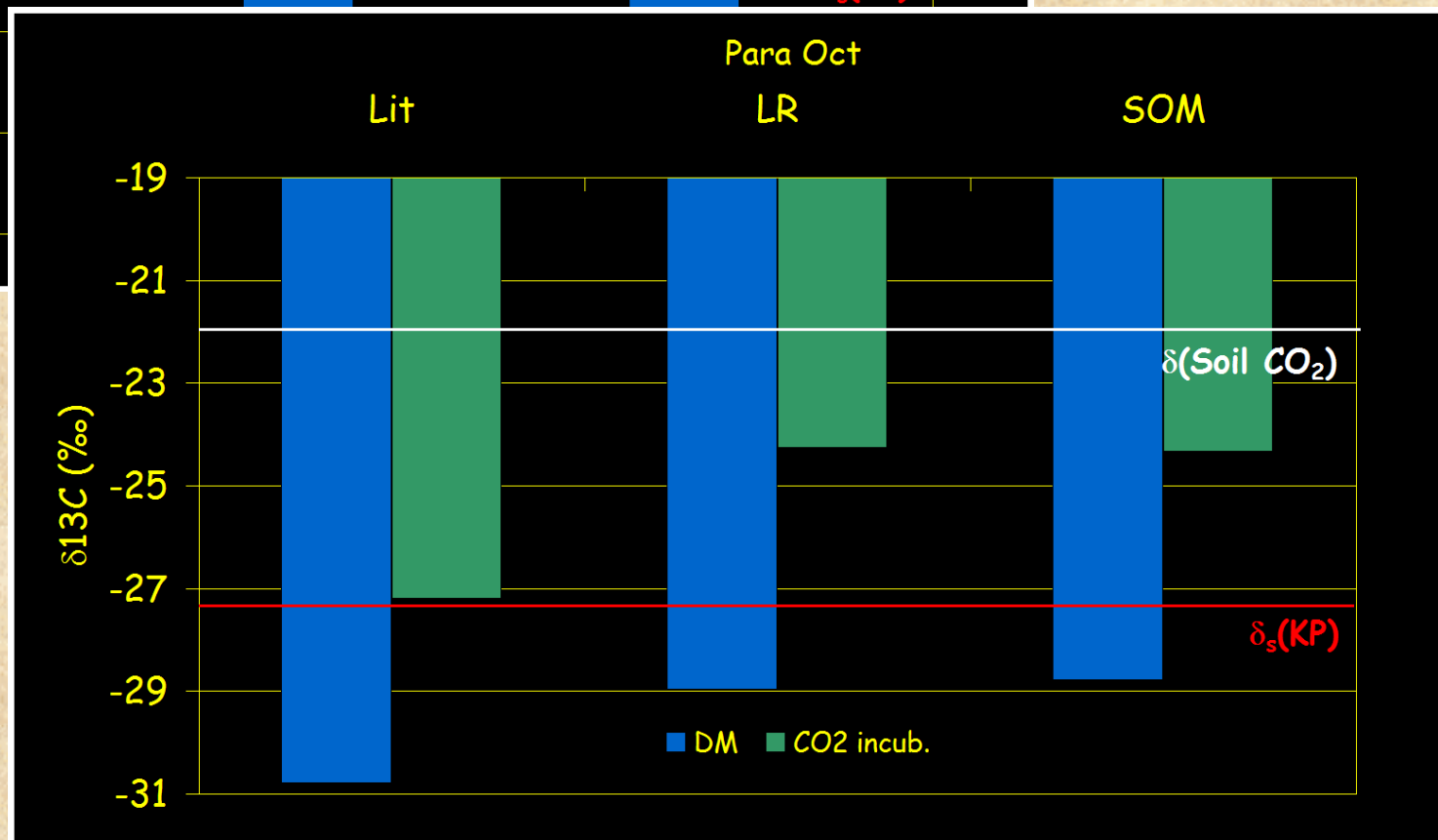
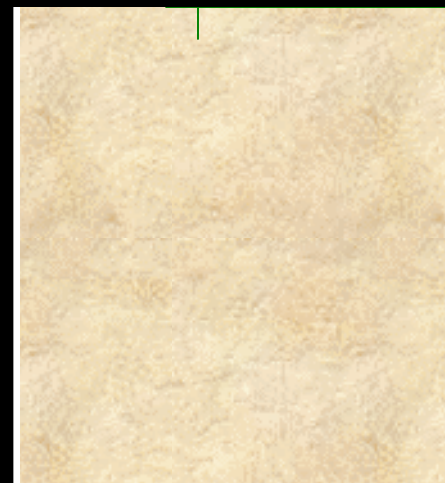
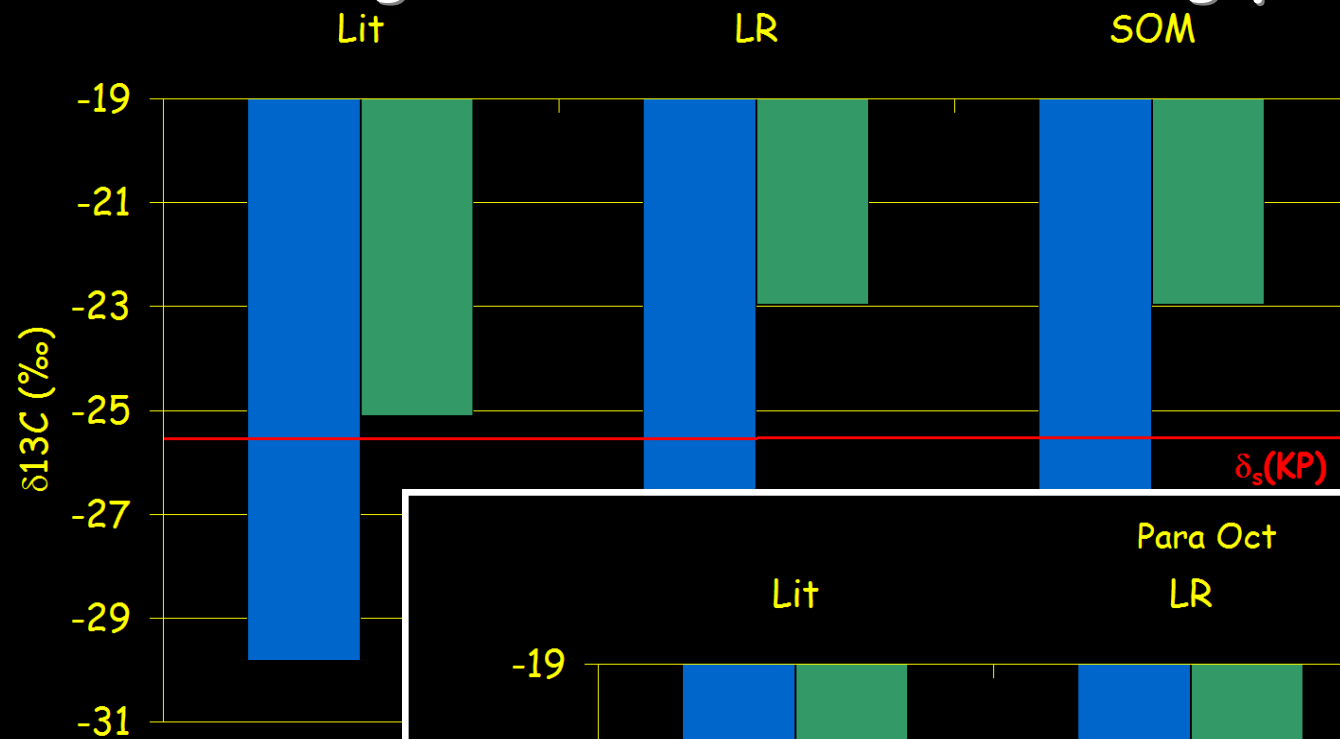
Incubation

Material & Method



Napoli 7/6/2006

Negative discrimination during production



Apparent discrimination (DM→CO₂) during production

	Fract. max	Fract. min	Mean Fract.
Living Roots	-5.3 ‰	-3.7 ‰	-4.6 ‰
SOM	-5.8 ‰	-2.9 ‰	-4.6 ‰
Litter	-8.2 ‰	-3.7 ‰	-5.3 ‰
Total	-8.2 ‰	-2.9 ‰	-4.9 ‰

✓ Comparison between δ_S and δ_{TP} not yet usable for soil respiration partitioning (dead roots, diffusion discrimination)

✓ Quantification of apparent discriminations:
production $\simeq -5$ ‰
diffusion $\simeq +3$ ‰

✓ Discriminations during soil respiration process (production / diffusion) have to be better described

THANKS
TO YOU

Napoli 7/6/2006

Napoli 7/6/2006

$$\delta_H = ?$$

$$R_H/R_s = \frac{(\delta_s - \delta_A)}{(\delta_H - \delta_A)}$$

$$R_A/R_s = \frac{(\delta_s - \delta_H)}{(\delta_A - \delta_H)}$$

Dead roots $(\delta_{TP}^t, R_{TP}^t) \delta_H = ?$ $\delta_A = ?$