

# Temperature sensitivity of different SOM fractions assessed using carbon isotopes: $^{13}\text{C}$

Karhu Kristiina<sup>1</sup>, Tuomi Mikko<sup>1,4</sup>, Vanhala Pekka<sup>1</sup>, Sonninen Eloni<sup>2</sup>, Jugner Högne<sup>2</sup>, Fritze Hannu<sup>3</sup> and Liski Jari<sup>1</sup>

<sup>1</sup>Finnish Environment Institute, P.O.Box 140, FIN-00251, Helsinki, Finland, <sup>2</sup>Dating Laboratory, P.O. Box 64, FI-00014 University of Helsinki, Finland, <sup>3</sup>Finnish Forest Research Institute, P.O. Box 18, FIN-01301, Vantaa, Finland, <sup>4</sup>University of Helsinki, Department of Mathematics and Statistics, P.O.Box 68, Helsinki, Finland

## Old SOM more temperature sensitive than young on an agricultural field

We measured soil respiration and  $\delta^{13}\text{C}$  of the respired  $\text{CO}_2$  from soils of a 5-year-old maize field and a control field in the laboratory (Table 1. and Fig. 1.).

$Q_{10}$  values for soil respiration were calculated by fitting parameters  $R_0$  and  $Q_{10}$  of the equation  $R(T) = R_0 Q_{10}^{T/10}$  to the data. The probability distributions of  $R_0$  and  $Q_{10}$  parameters were sampled using the Markov chain Monte Carlo (MCMC) method (Table 1).

The temperature response of  $\delta^{13}\text{C}$  in the respired  $\text{CO}_2$  was modeled as a first order polynomial ( $\delta^{13}\text{C} = a + bT$ ) and the probability distributions of its two parameters were estimated using a Monte Carlo method, Bootstrap.

The  $\delta^{13}\text{C}$  from the maize field decreased with increasing temperature indicating that the decomposition of old SOM was more temperature sensitive. Slope parameter means for maize and control fields differed significantly ( $p < 0.01$ ) in both measurement sets (Fig.1).

## $Q_{10}$ about 3.6 for old SOM, 2.4 to 3 for young

Based on the measurements on the maize field soils (Fig 1.) we calculated the proportion of maize-derived C ( $p(T)$ ) in the respired  $\text{CO}_2$  as:

$$p(T) = \frac{(\delta(T) - \delta_C)}{\delta_m - \delta_C} = \frac{(a + bT) - \delta_C}{\delta_m - \delta_C}$$

where  $\delta(T)$  is the  $\delta^{13}\text{C}$  of respired  $\text{CO}_2$  from the maize field soil at different temperatures (see Fig.1.),  $\delta_m$  is the  $\delta^{13}\text{C}$  value of maize residues (-12 ‰) and  $\delta_C$  is the average  $\delta^{13}\text{C}$  of the respired  $\text{CO}_2$  from the control field.

The amount of respiration originating from maize-derived C was defined as:  $R_m(T) = p(T)R_{tot}(T)$ . The  $Q_{10}$  values for respiration originating from maize-derived C and from old C3-derived C were calculated as:

$$Q_{10,m}(T) = \frac{R_m(T+10)}{R_m(T)} = \left(1 + \frac{10b}{a + bT - \delta_C}\right) Q_{10,tot}$$

$$Q_{10,C3}(T) = \left(1 + \frac{10b}{a + bT - \delta_m}\right) Q_{10,tot}$$

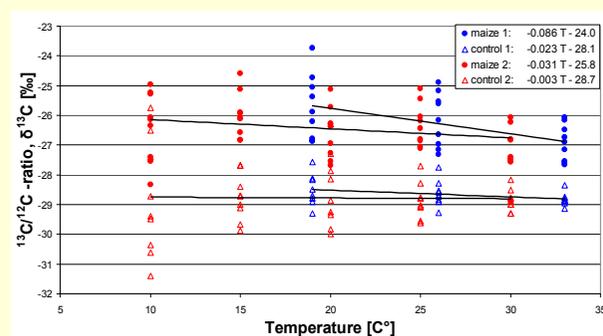
The distributions for  $Q_{10,m}(T)$  and  $Q_{10,C3}(T)$  (Fig.2) were estimated by sampling values for  $a$  and  $b$  parameters from the probability distributions generated with Bootstrap and for  $Q_{10,tot}$  and  $\delta_C$  from the normal distributions, generated with random number generator.

**Table 1.** There were two measurement sets, the second one taken two months after the first one. The  $R_0$  parameters of the two fields differed slightly in set 1, but the  $Q_{10}$  values were similar for both fields and for both measurement sets.

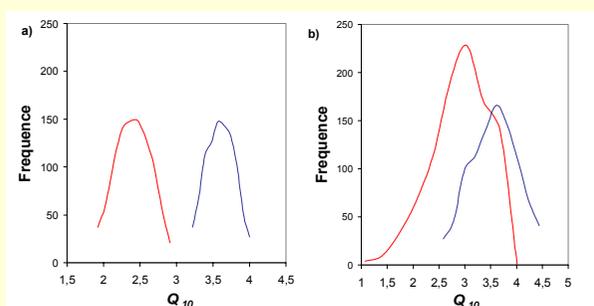
Respiration measurements (n=9)	maize	control
$R_0$ ( $\mu\text{g CO}_2/\text{g OM h}$ )		
Set 1	$0.77 \pm 0.12$ a	$0.63 \pm 0.17$ b
Set 2	$0.70 \pm 0.22$ a	$0.71 \pm 0.21$ a
$Q_{10}$		
Set 1	$3.38 \pm 0.19$ a	$3.59 \pm 0.36$ a
Set 2	$3.46 \pm 0.51$ a	$3.41 \pm 0.48$ a

Mean  $\pm$  SD

Different letters indicate a significant difference ( $P < 0.05$ ) between the two fields after t-test



**Fig.1.** The  $\delta^{13}\text{C}$  level of the  $\text{CO}_2$  was clearly higher for the maize field, indicating that maize cultivation had indeed labeled the young SOM. In addition, the  $\delta^{13}\text{C}$  from the maize field decreased with increasing temperature, indicating that the decomposition of SOM older than 5 years was more temperature sensitive than that of SOM younger than 5 years.



**Fig.2.** 95% of the distributions of  $Q_{10,m}$  (red line) and  $Q_{10,C3}$  (blue line) at  $T=20$  °C based on the first measurement set (a) and the second measurement set (b). The clear difference in  $Q_{10,m}$  and  $Q_{10,C3}$  in first measurements disappeared between the measurement sets, probably because the most labile fractions were depleted from the soil during storage at 4 °C.