Estimating SOC turnover for assessment of the effects of land management changes in a global change perspective

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Introduction:

Soil organic carbon (SOC) is an integral part of the global C cycle representing two to three times as much carbon as contained in the atmosphere. Estimates of soil organic carbon (SOC) turnover are important in assessments of the effects of land management changes in a global change perspective. We examined the use of "bomb 14C models" to estimate turnover times of SOC fractions.

The objectives of the current study were to compare the results of turnover estimates obtained from "bomb 14C models"

Materials and Methods:

Traditional radiocarbon dating:
Assumptions:
1. All the carbon in the SOC fraction is of the same age.
2. Constant ^{14}C content of the atmosphere.

$$\tau = \frac{1}{\lambda}\ln\left(\frac{A_{abs}}{A}\right)$$

Bomb ^{14}C model
Assumptions:
1. All the carbon in the SOC fraction turns over at the same rate.
2.The ^{14}C content of the inputs corresponds to the atmospheric record.
3. The input of carbon to the fraction has been constant and equilibrium has been reached.

$$A = k\int_0^{\infty}\exp(-(k+\lambda)a)A_I(t-a)da$$

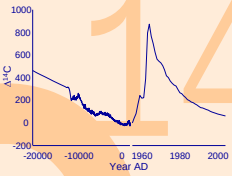
The uncertainty of these estimates were assessed by **Monte Carlo methods** accounting for uncertainties from assumptions of constant input and uncertainties in the ^{14}C content of the CO_2 assimilated by plants

Analytical solution of the ^{14}C bomb model
Assumptions: Same as above except
1. Constant ^{14}C content of the atmosphere.

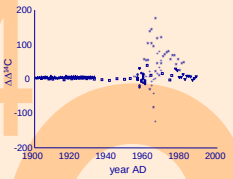
$$\tau = \frac{A_{abs} - A}{A\lambda}$$

Results:

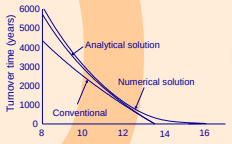
^{14}C record



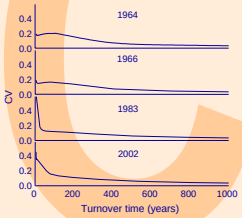
Deviation from ^{14}C record



Comparisson of methods



Uncertainty of estimates



Bruun et al. (2005). Radiocarbon, In press

Conclusions:

1. Due to questionable assumptions, traditional radiocarbon dating must be considered inappropriate for SOC fractions.
2. The numerical solution of the bomb ^{14}C model always produces better results and is just as easy to apply.
3. The uncertainty of the estimates of the numerical solution of the bomb ^{14}C model is large for SOC fractions with fast turnover, due to the uncertainty of the ^{14}C record and of litter input at the sampling site, whereas it appears to be negligible when SOC fractions turning over relatively slowly are analyzed.

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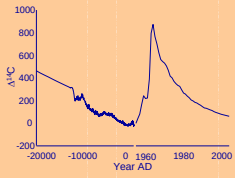
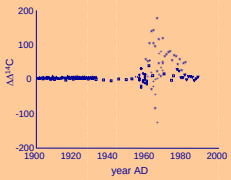
^{14}C reccord



Deviation from ^{14}C reccord



3 Methods used to estimate SOC turnover

- Traditional radiocarbon dating

- Bomb ^{14}C model

- Analytical solution of the bomb ^{14}C model

We compare the methods and analyze the uncertainty of the estimates