Biogeosciences Discuss., 3, S526–S530, 2006
www.biogeosciences-discuss.net/3/S526/2006/


Biogeosciences Discussions



# *Interactive comment on* "Warming mobilises young and old soil carbon equally" *by* F. Conen et al.

**F. Hagedorn (Referee)**

hagedorn@wsl.ch

Received and published: 14 September 2006

General comments: Despite extended experimental work and modeling exercises, there is still no scientific consensus on the temperature dependence of organic matter decomposition (Davidson & Janssens, 2006). How different SOM pools (young or old, labile or stabile) respond to the ongoing warming is crucial for the understanding of feedbacks between SOM and climate change, but published data are contradictory. Conen et al. apply a new approach by making use of a change in C3 to C4 vegetation which introduces a 13C signal into SOM that allows to distinguish between the microbial respiration of 'new' and 'old' SOM. The experiment is well designed and the discussion of results is concise and in general nicely written. The paper is clearly a new contribution to the debate on the temperature sensitivity of C mineralization.

Based on their finding in a lab incubation that the fraction of respired new C was independent from temperature, Conen et al. concluded that young and old SOM pools will respond similarly to ongoing warming. Although the interpretation seems straight forward, I have the following critics (1) Treating of samples might have changed 'old' protected SOM into 'labile' forms, which might have biased the results. (2) For potential feedbacks between SOM cycling and climate change, it is more appropriate to speak from the 'stability' of SOM than from its 'age', because the stability determines its availability to microorganisms. These expression are used (as in many papers) synonymously, but they are - as in the case in incubation studies - not always the same. (3) Soil respiration is largely driven by C inputs, and temperature affects C inputs similarly as mineralization. Consequently, the temperature dependency of C mineralization will strongly depend on the response of C inputs to soils, which clearly limits the conclusion from incubation studies.

Specific Comments

(1) Treating of samples for the incubation experiment might have biased the conclusion. During the first days of a mineralization experiment, mineralized C originates largely from labile SOM (- mineralization studies are used to quantify labile SOM). Labile SOM consists mainly of young, but also of old components. In the experiment of Conen et al., the greater fraction of new SOM in the evolved CO2 than in bulk SOM indicates that young SOM is indeed preferentially mineralized. However, mineralized C still originated to 56 and 45% from old SOM, implying that old SOM can also be labile. Treating the soils for the incubation study very likely increased the readily-mineralizable 'old' SOM pool, since mixing and sieving of soils makes old SOM that was previously protected, available for microorganisms. Consequently, this experiment allows only the conclusion that temperature does not affect the mineralizability of old and young 'labile' SOM. In addition the term 'old' SOM is restricted to SOM older than 45 and 26 years for the two sites.

(2) Stability and age of SOM. I think that for the identification of feedbacks between



BGD
3, S526–S530, 2006





EGU

SOM and ongoing warming, it is more useful to speak from 'labile or stable' SOM than from 'young or old' SOM. Often like in this paper these terms are used synonymously. For SOM pool fractionations and in situ respiration measurements, this might be valid, but as indicated above, soil sampling and treating can decrease the stability of old SOM. Defining SOM according to its stability reflects its susceptibility to decomposition from a thermodynamically point of view. In their recent review, Davidson & Janssens (2006) demonstrated that based on the Arrhenius equation recalcitrant compounds should respond more sensitive to warming than labile ones, because their decomposition requires more activation energy. The results of Conen et al., however, suggest the opposite: the fraction of new C in respired CO2 increased from 45 to 54% through a temperature increase from 10 to 20°C (Rotthalmünster soil). The authors related this increase not to different temperature sensitivities of young and old SOM but to a doubling of C inputs under the C4 vegetation as compared to the C3 vegetation. Supporting the assumption that mineralization of labile SOM is more temperature sensitive would be the increasing Q10 values with increasing respiration rates, which agrees with results from others (e.g. Christensen et al., 1999).

(3) Is temperature sensitivity of decomposition really that important for feedback of SOM cycling with climatic change or doesn't affect warming C in- and outputs to soils equally? Another open but important unknown for potential C-cycle feedbacks with climate change is the response of litter inputs to the ongoing climate change. By compiling C flux data from different forest across Europe, Janssens et al. (2001) showed that soil respiration (also heterotrophic) is rather driven by ecosystems productivity than by temperature. Also, on a global scale, litter and respiration are closely correlated (Raich & Nadelhoffer, 1989) suggesting that litter production and soil respiration depend on each other and/or are driven by the same factors. The close relationship of the in- and outputs from soils suggest that if warming will accelerate decomposition, it will stimulate litter inputs equally. In order to identify potential feedbacks between SOM cycling and climatic change, we need experiments which include all components of the C cycle. A 13C-based study similar to the one of Conen et al. but using soils from



BGD
3, S526–S530, 2006





EGU

different climates or from systems of different productivities would be one approach.

Technical Comments

(1) Title: mobilise, why don't you write mineralize? Mobilize could also include the production of DOC (in fact DOC mobilization is a common term); (2) P. 1356 Abstract: L.2/3 reads a little complicated; maybe change 'critically important in..' into 'critically for predicting future climate change'; (3)L.6/7 . 'Contrasting...hypothesis'. These 2 sentences are not needed. An abstract should focus on your own results. (4) Introduction: L.24 'much of the SOM' maybe change into 'the greatest fraction of SOM. (5) L.25 'a different course of development' reads bad. (6) P. 1357, L.10 'During observation period..' maybe change into: 'Usually CO2 effluxes are decreasing with time..' (7) L. 12. 'Signals towards ' reformulate this sentence. (8) L.19 Delete 'the' in '..to study the...' (9) L. 23 The authors mean different stabilities not ages. (10) Results P. 1359, L. 9 Maybe present the formula of Balesdent to clarify how you calculated the fractions of new C. (11) L.22/23 Why don't you present the data of the re-incubation of samples at other temperatures? This would support your results additionally. (12) P. 1361 L. 1. A change by 1.2 permill in RM-soil is a strong and significant change. Using your equations, I have received that an increase by 5°C, would increase the fraction of young SOM by 10% not by 7.7%. (13) P. 1361 L.6-17 Here you are arguing with different litter inputs affecting the substrate availability - hence, 'labile' SOM is apparently more temperature sensitive, see General Comments. (14) L. 18 Improve the sentence.

Please use the term young and labile more carefully, see General comments (e.g. P. 1357 L. 11; P.1356 L.5, L.22)

References

Christensen, T.R., Jonasson, S., Callaghan, T.V., Havström, M.: On the potential CO2 release from tundra soils in a changing climate, Applied Soil Ecology, 11, 127-134, 1999. Davidson, E. A. and Janssens, I. A.: Temperature sensitivity of soil carbon decomposition and feedbacks to climate change, Nature, 440, 165-173, 2006. Janssens,



BGD

3, S526–S530, 2006

I.A., Lankreijer, H., Matteucci, G., et al.: Productivity overshadows temperature in determining soil and ecosystem respiration across European forests, Global Change Biol. 7, 269-278, 2001. Raich, J.W., Nadelhoffer, K.J.: Belowground carbon allocation in forest ecosystems: global trends, Ecology 70, 1346-1354, 1989.

---

Interactive comment on Biogeosciences Discuss., 3, 1355, 2006.