Biogeosciences Discuss., 6, C2926–C2929, 2009
www.biogeosciences-discuss.net/6/C2926/2009/

Biogeosciences Discussions

Interactive comment on "Measuring and modelling continuous quality distributions of soil organic matter" *by* S. Bruun et al.

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Received and published: 10 November 2009

Bruun et al present what appears to a slightly modified version of an excellent hypothesis best expressed previously in the mathematically eloquent book by Agren and Bosatta (1996) and related articles. I would request that literature be considered more fully evaluating the reasons why the continuous quality concept has not been taken up. For discussion, I provide some suggestions I believe would provide a clearer focus for this work.

Overall, this work gives what I feel is an incorrect impression that many workers have ignored or neglected the continuous quality concept. Instead, it seems to me that the concept has been directly or indirectly investigated in a number of situations but is either not consistent with or not the simplest explanation for the data on carbon

dynamics observed in mineral soils.

I first point out that some concepts, such as the contribution of particle size to a proposed continuous quality distribution have probably not been investigated further because early radiocarbon data from a distribution of particle sizes did not support the concept well (Anderson and Paul, 1984).

Perhaps the most important challenge we face in understanding soil C dynamics is determining whether the pool structure now embedded in most simulation models is simply a matter of expedience, or has a strong conceptual basis. In evaluating this, it is commonly asked whether models shouldn't be adjusted to utilize measurable fractions. We may ask in contrast whether an effort to tear ecosystems into their component parts without understanding the functioning of the whole system represents a sort of reductionist folly. Indeed, models such as RothC and CENTURY were created with a clear conceptual basis. I believe I captured the concepts justifying these pools succinctly in work not addressed by Bruun et al. (Baisden and Amundson, 2003).

Quoting Baisden and Amundson (2003): "Most ecosystem models assume ∼3 pools of SOM, but soil scientists have generally not successfully identified a universal set of physical or chemical fractions from the soil which correspond to these pools across a range of ecosystem and soil types (Parton et al., 1996; Trumbore and Zheng, 1996). Yet, within the high resolution radiocarbon techniques used empirically to calibrate the model presented here (Baisden et al. 2002a, Baisden et al. 2002b), strong evidence emerges for three pools of SOM with distinct residence times. These studies separate residence times into roughly annual, decadal and millenial timescalesâĂŤ and we hypothesize that pools with these distinct turnover rates are found for the following reasons. A first (active) pool of SOM turns over rapidly because it contains energy which fuels the growth of the decomposer organisms which consume it. A second (slow) pool requires energy to overcome physical or chemical barriers to decomposition but releases nutrients to the organisms which have invested energy. The third (passive) pool of SOM essentially does not turn over except as a result of exceptional micro- or macro scale events. The individual ideas are not, in general, new (e.g. VanVeen and Kuikman, 1990), but have not to our knowledge been previously integrated to explain the disparity between identifiable soil fractions and model pools."

As noted in this excerpt, I completed an extensive study of soil C dynamics in California annual grasslands, and succeeded in empirically defining residence times for the pools of soil C typically defined in models (Baisden et al., 2002a,b). The work emphasizes that continuous quality distributions may be of strong value in evaluating the turnover of active or litter pools, particularly in cool moist environments. It may also be relevant to consider the relevance of the concept for passive or inert pools. Nevertheless, it is important to evaluate the apparent lack of evidence for continuous quality distributions as a driving concept in the turnover of the large decadal pool soil organic matter associated with stabilization in soil aggregates structure. At least for the ecosystem studied, it is important to note that the Baisden et al. (2002a) data clearly do not support the use of sequential density fractions to identify a continuous quality distribution. No similar data with radiocarbon from multiple timepoints is available for interpretation.

In my view, this work should also address concepts that may lead to a distribution of C residences times like those predicted by the continuous quality hypothesis without actually supporting this proposed hypothesis. Among these are the strong recent evidence for priming as driver of soil carbon turnover (Fontaine et al., 2007; Sulzman et al., 2005). It may also be of relevance to evaluate the fact that the position of soil C within soil macro-structure appears to play an important role (Ewing et al., 2006)

I also note that the authors have not referenced an interesting and extensive contribution to the continuous quality concept by Poage and Feng (2004).

References cited:

Agren G, Bosatta E. 1996. Theoretical Ecosystem Ecology: Understanding Elemental Cycles. Cambridge: Cambridge University Press.

Baisden WT, Amundson R. 2003. An analytical approach to ecosystem biogeochemistry modeling. Ecological Applications 13(3):649-663.

Baisden WT, Amundson R, Cook AC, Brenner DL. 2002a. The turnover and storage of C and N in five density fractions from California annual grassland surface soil. Global Biogeochemical Cycles 16:doi: 1029/2001GB001822.

Baisden WT, Amundson R, Brenner DL, Cook AC, Kendall C, Harden JW. 2002b. A multiisotope C and N modeling analysis of soil organic matter turnover and transport as a function of soil depth in a California annual grassland soil chronosequence. Global Biogeochemical Cycles 16(4):82.

Ewing SA, Sanderman J, Baisden WT, Wang Y, Amundson R. 2006. Role of large-scale soil structure in organic carbon turnover: Evidence from California grassland soils. Journal Of Geophysical Research-Biogeosciences 111(G3):G03012, doi:10.1029/2006JG000174

Fontaine S, Barot S, Barre P, Bdioui N, Mary B, Rumpel C. 2007. Stability of organic carbon in deep soil layers controlled by fresh carbon supply. Nature 450(7167):277.

Poage MA, Feng XH. 2004. A theoretical analysis of steady state delta C-13 profiles of soil organic matter. Global Biogeochemical Cycles 18(2).

Sulzman EW, Brant JB, Bowden RD, Lajtha K. 2005. Contribution of aboveground litter, belowground litter, and rhizosphere respiration to total soil CO2 efflux in an old growth coniferous forest. Biogeochemistry 73(1):231-256.

Interactive comment on Biogeosciences Discuss., 6, 9045, 2009.