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A novel 14C approach to follow fate of carbon in organic soils

C. Biasi (1), N.M. Tavi (1), M. Oinonen (2), J. Kukkonen (3), C. Platner (4), J. Juutilainen (1), and P. Martikainen (1)

(1) Department of Environmental Science, University of Eastern Finland, PO Box 1627, 70211 Kuopio, Finland (christina.biasi@uef.fi), (2) Finnish Museum of Natural History, University of Helsinki, Dating Laboratory, P.O.Box 64, 00014 Helsinki, Finland, (3) Department of Biology, University of Eastern Finland, P.O. Box 111, 80101 Joensuu, Finland, (4) University of Goettingen, Institute of Zoology & Anthropology, 37073 Gottingen, Germany

Soils contain globally about 1500 Gt of organic carbon (C), and are thus the largest reservoir of C in terrestrial ecosystems. Separating variable sources (e.g. plant-derived and soil-derived sources) releasing carbon dioxide (CO_2) from soil is challenging, but important for better understanding and predicting how different components with variable stability and turnover times will respond to climate and land-use change. To date, the non-destructive isotopic methods (e.g. C3 to C4 transitions) seem to be most reliable in partitioning CO_2 derived from the various sources. However, relatively little data are available for the C-rich peat soils dominating in the northern latitudes which store a great amount (about 30%) of the global soil. A reason is that C4 plants are absent in the cold regions.

We introduce here a novel approach to follow the fate of old, native vs. young plant-derived C in a highly organic soil (Biasi et al., 2011). Our innovation is to use plant cultivations on peat soil where the upper peat layers have been removed (cut-away peatland). There, the plants have a modern 14C signature and the left-over peat is old (about 7500 years old in our study), being thus naturally depleted in 14C. This large difference in age offers an ideal and unique possibility for separating CO_2 released from decomposition of native organic soil and plant-derived recent sources. Large and uniform differences in isotopic signals between plants and soil are rare, but needed for reliably quantifying the contribution of CO_2 derived from each source by isotope partitioning approaches.

By dating CO_2 derived from soil respiration over two growing seasons, we showed from a perennial bioenergy crop (reed canary grass) cultivation in Finland, as an example, that old peat decomposition contributed less to total soil respiration than respiration of recent plant material (30% vs. 70% on average, respectively). The relative proportions of old vs. young C respired from soils were, however, highly variable over the growing season, ranging from 7.8 % in spring to 51 % in autumn. The total amount of peat carbon losses from the cultivated, nutrient-poor site ranged from 392 to 549 g CO_2 m-2 season-1. By comparing this peat soil respiration component of the cultivated soils with soil respiration rates from adjacent uncultivated soils (peat harvesting areas), we were able to reveal information about possibly altered carbon mineralization following cultivation, the priming effect (Kuzyakov et al., 2000). This information is necessary to get knowledge on the impact of cultivation on the decomposition of old SOC reservoirs.

The isotope partitioning approach also allows for quantification of native soil organic matter in microbial biomass, soil fauna, dissolved organic carbon and leaching waters, and examples will be given. This is the basis for developing new understanding on C pools and fluxes in the soil-plant-water-atmosphere system of peatlands.

Taken together, the analysis showed that the approach is reliable for source partitioning with isotopes. The approach offers a new possibility to follow the fate of old, native soil organic matter in highly organic soils.

References:

Biasi C, Tavi N.M., Jokinen S. et al. (2011) Differentiating sources of CO_2 from organic soil under bioenergy crop cultivation: A field-based approach using 14C. Soil Biology & Biochemistry 43, 2406-2409.

Kuzyakov Y, Friedel JK and Stahr K (2000) Review of mechanisms and quantification of priming effects. Soil Biology & Biochemistry, 32, 1485-1498.