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Discussions

Interactive comment on "Biological and physical influences on soil $^{14}CO_2$ seasonal dynamics in a temperate hardwood forest" *by* C. L. Phillips et al.

Anonymous Referee #2

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C.L. Phillips and co-authors present an impressive set of measurements of 14CO2 from the soil profile of a temperate forest over a growing season with the goal of determining the driving factors of changes to respiration 14CO2 signature. The authors use multiple methods, namely, in vitro incubation of soils from various depths, trenched plots, and dynamic CO2 transport models, to test three main hypotheses the could drive the seasonal pattern. The authors conclude instead that the overriding influence of soil C added over the course of the growing season was the most likely cause of the observed 14CO2 shift, detailing how none of the original hypotheses adequately explain the trend independently.

The manuscript lays out a comprehensive soil respiration dataset that takes advantage

of a unique set of tools to examine the problem from multiple perspectives. In particular, the combination of trenched plot respiration data along with 14C partitioning of soil respiration represents a valuable contribution. The methods and reasoning are well documented and presented. The quality of the manuscript is very high, and more than adequate for publication in its present form. I offer a few minor suggestions that authors may consider incorporating into the text. In particular, addition of a few more citations could strengthen the discussion of the findings.

(line 26 on p. 10737): The authors mention that there were no vertical trends in Δ14C of production between 0-20 cm. This strongly suggests that most CO2 in this layer is root derived, since soil C declines strongly in 14C with depth in this interval. This finding adds additional support to the authors' conclusions about the importance of recently added root C to soil respired CO2. There is not likely to be much of an age gradient in 14C of roots with depth (Schrumpf et al. 2013).

Section 3.4 details the results of in vitro incubation study of the same soils. The primary finding is that the CO2 production rates from incubation and trenched plots are similar, but the 14C signature of respired CO2 differs. The authors attribute this difference to the lack of decaying roots (as they were picked out) in the incubated soils as the cause of the difference. However, this explanation is partially incompleteâĂŤby the laws of mass balance, there must be another source of low 14CO2 in incubated soils that is not present in trenched plots (since respiration amounts are nearly the same in both treatments, despite the fact that incubated soils lack roots which provide a high 14CO2 source to trenched soils). It is quite likely that removal of soils and root picking caused a disturbance to incubated soils that released older (low 14CO2) C sources for microbial respiration. This is often seen with removal of deep soils, such as in the study of Ewing and co-authors (2006). It may be useful to readers if the discussion could address this possibility as a reason for extremely low 14CO2 observations from incubations that were not observed in situ.

Another factor that may be contributing to the decline in 14CO2 respired over the growing season is a potential change in the 14C signature of the autotrophic endmember over the growing season. Some studies have shown a decline in the age of root respired CO2 over the growing season (recently reviewed by Hopkins et al. 2013). Indeed, this is likely a partial contributor to the divergence of the Rh/Rtot from isotopic partitioning vs. trenching methods.

Reference Marin-Spiotta et al. 2011 (line 16, p. 10742) was missing from the citation list.

***** 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. J. Geophys Res, G03012.

Schrumpf M, Kaiser K, Guggenberger G, Persson T, Kögel-Knabner I, Schulze ED. 2013. Storage and stability of organic carbon in soils as related to depth, occlusion within aggregates, and attachment to minerals. Biogeosciences 10: 1675-1691.

Hopkins F, Gonzalez Meler MA, Flower CE, Lynch DJ, Czimczik C, Tang J, Subke J-A. 2013. Ecosystem-level controls on root-rhizosphere respiration. New Phytologist. doi: 10.1111/nph.12271

Interactive comment on Biogeosciences Discuss., 10, 10721, 2013.