Comment on "Impacts of Fine Root Turnover on Forest NPP and Soil C Sequestration Potential"

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Matamala *et al*. (*1*) recently highlighted the importance of estimating mean residence time (MRT) of fine root C for understanding soil C dynamics. Using isotopic signals of ^{13}C from two CO_2 experiments as a tracer, they estimated MRT of C through fine roots that ranged from 1.20 to 6.25 years. They obtained these MRT values by fitting an exponential equation to the ^{13}C data with a one-pool model that assumed that newly synthesized C is immediately used for fine root growth.

Actually, however, photosyntheically fixed C is first incorporated into the plant C pool to mix with stored nonstructural carbohydrate (NSC), from which root growth draws C. Thus, the interpretation of isotope data needs to consider NSC storage (*2*) and to use a two-pool model—that is, one that includes both NSC and fine roots. We developed such a model (*3*) and estimated MRT of fine roots from the isotope data presented by Matamala *et al*. The resulting MRT values that we derive from this model are 2.37 years for pine roots of <1 mm, 2.01 years for pine roots of 1 to 2 mm, and 6.06 years for pine roots of 2 to 5 mm (*4*), shorter by 44.5%, 64.8%, and 3.0%, respectively, than the estimates in (*1*). For sweetgum roots of <1 mm and 1 to 2 mm, the two-pool model gives estimated MRTs of 1.19 and 1.32 years, respectively—0.8% and 56.0% less than the Matamala *et al*. estimates (*1*).

Whereas the sums of MRT of fine roots and plant NSC estimated from our two-pool model are similar to the estimates from the one-pool model (*1*), separating plant NSC from fine root MRT will lead to estimates of soil C sequestration that are different from those of Matamala *et al*. (*1*). In addition, data points immediately after CO_2 fumigation, which are absent for approximately 10 months of that study, are particularly important for estimation of MRT of plant NSC and need to be collected in future studies.

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References and Notes

1. R. Matamala, M. A. Gonzàlez-Meler, J. D. Jastrow, R. J. Norby, W. H. Schlesinger, *Science* **302**, 1385 (2003).
2. Y. Luo, *Global Change Biol*. **9**, 1118 (2003).
3. The two-pool model is $F(t) = \frac{\beta e^{-\alpha t} - \alpha e^{-\beta t}}{\beta - \alpha}$, where $F(t)$ is old C remaining at time t, and α and β are mean residence times of NSC in plant and fine roots, respectively (5).
4. When we used data from the root ingrowth cores placed 10 months after the initiation of the CO_2 experiments and harvested 24 months after the initiation of the CO_2 experiments to constrain the estimation of MRT of plant NSC, the estimated MRT of fine roots with the two-pool model was still substantially smaller than the value using the one-pool model.
5. Y. Luo, L. White, unpublished data.

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