Unique Radiocarbon Data Allow the Development of New Understanding and Models of Root Growth

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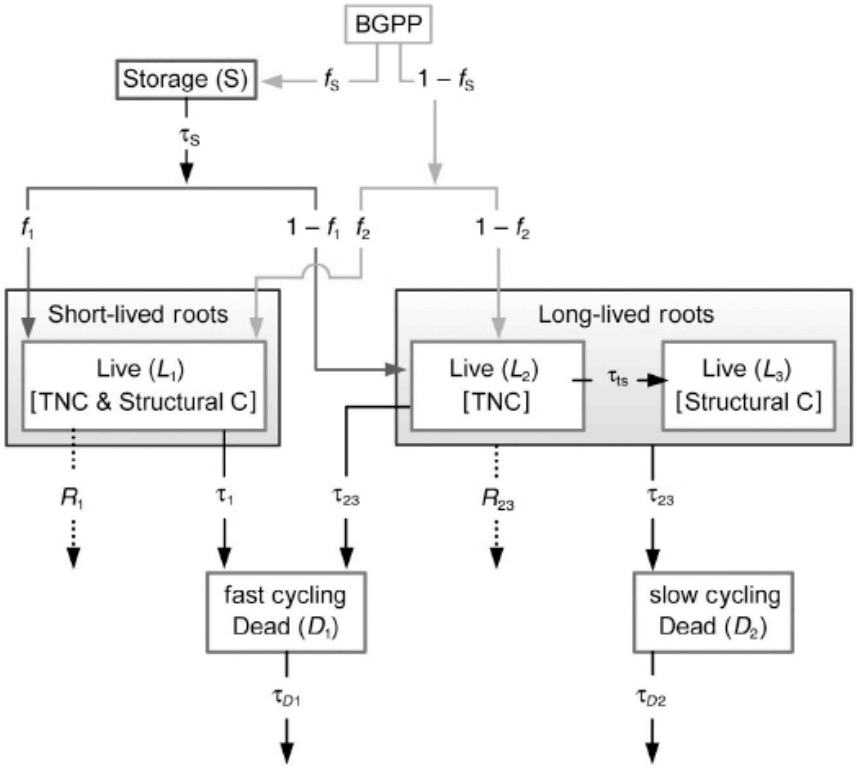
Funding: DOE Office of Science, Biological and Environmental Research

- Unique data obtained from the tracking of a landscape scale isotopic tracer (enriched background ^{14}C), allowed researchers to uncover the true nature of root growth dynamics for an upland oak forest of eastern Tennessee.
- Realistic characterization of C flows into and through fine roots required a model with two live fine-root populations, two dead fine-root pools, and root respiration.
- Predicted live-root turnover times were < 1 yr and ~10 yr for short- and long-lived carbon pools, respectively. These are the first fine-root turnover time estimates that take into account respiration, storage, seasonal growth patterns, and non-normal turnover time distributions.
- These research conclusions are made possible by a coordinated research collaboration between Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Argonne National Laboratory.



U.S. DEPARTMENT OF ENERGY
OAK RIDGE NATIONAL LABORATORY
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Abstract:

• We used an inadvertent whole-ecosystem ^{14}C label at a temperate forest in Oak Ridge, Tennessee, USA to develop a model (Radix1.0) of fine-root dynamics. Radix simulates two live-root pools, two dead-root pools, non-normally distributed root mortality turnover times, a stored carbon (C) pool, and seasonal growth and respiration patterns.

• We applied Radix to analyze measurements from two root size classes (< 0.5 and 0.5–2.0 mm diameter) and three soil-depth increments (O horizon, 0–15 cm and 30–60 cm).

• Predicted live-root turnover times were < 1 yr and ~10 yr for short- and long-lived pools, respectively. Dead-root pools had decomposition turnover times of ~2 yr and ~10 yr. Realistic characterization of C flows through fine roots requires a model with two live fine-root populations, two dead fine-root pools, and root respiration. These are the first fine-root turnover time estimates that take into account respiration, storage, seasonal growth patterns, and non-normal turnover time distributions.

• The presence of a root population with decadal turnover times implies a lower amount of belowground net primary production used to grow fine-root tissue than is currently predicted by models with a single annual turnover pool.

Citation:

Riley WJ, Gaudinski JB, Torn MS, Joslin JD, Hanson PJ (2009) Fine-root mortality rates in a temperate forest: estimates using radiocarbon data and numerical modeling. New Phytologist 184:387-398.

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