DOE's Enriched Background Isotope Study Data Improved a Classic Ecosystem Carbon Cycling Model for Application to Forest Ecosystems

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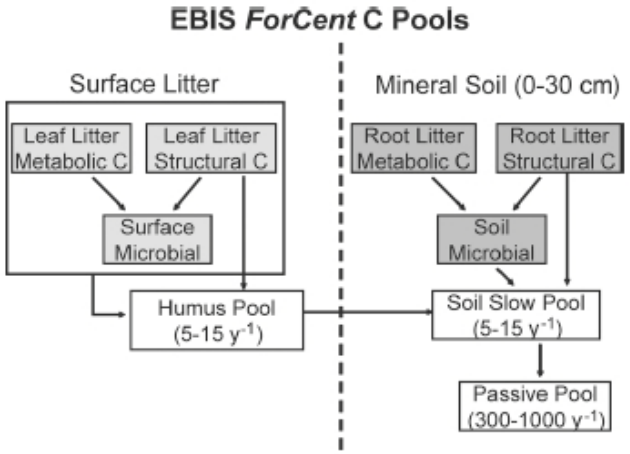
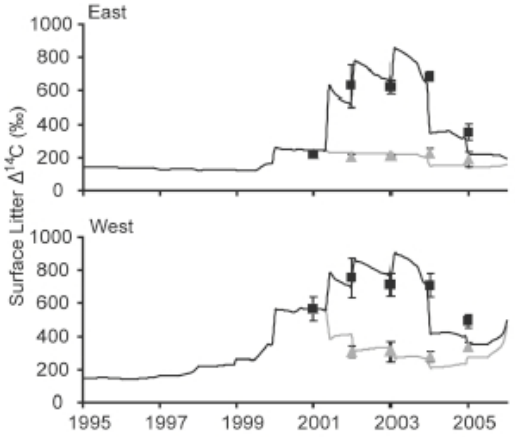
Funding: DOE Office of Science, Biological and Environmental Research

- Data from the Enriched Background Isotope Study (EBIS) were used to improve functional mechanisms within the classic carbon cycling model – DayCent.
- EBIS field studies quantified the fate and transport of uniquely enriched carbon isotopes in experimentally manipulated leaf litterfall for soils of an upland oak forest of eastern Tennessee. The experiment revealed important process not currently included in forest carbon cycle models.
- Major revisions to the DayCent model included (1) adding a surface organic pool, (2) incorporating a detailed root growth model, and (3) the inclusion of plant phenological growth patterns. The next-generation model is named ForCent.
- Comparisons of EBIS data to ForCent model outputs demonstrated the utility of the enhanced model.
- Application improved soil carbon cycle models for forests within land surface models may provide better global carbon cycle projections.





U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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Abstract:

The ForCent forest ecosystem model was developed by making major revisions to the DayCent model including: (1) adding a humus organic pool, (2) incorporating a detailed root growth model, and (3) including plant phenological growth patterns. Observed plant production and soil respiration data from 1993 to 2000 were used to demonstrate that the ForCent model could accurately simulate ecosystem carbon dynamics for the Oak Ridge National Laboratory deciduous forest. A comparison of ForCent versus observed soil pool ^{14}C signature ($\Delta 14C$) data from the Enriched Background Isotope Study ^{14}C experiment (1999–2006) shows that the model correctly simulates the temporal dynamics of the ^{14}C label as it moved from the surface litter and roots into the mineral soil organic matter pools. ForCent model validation was performed by comparing the observed Enriched Background Isotope Study experimental data with simulated live and dead root biomass $\Delta 14C$ data, and with soil respiration $\Delta 14C$ (mineral soil, humus layer, leaf litter layer, and total soil respiration) data. Results show that the model correctly simulates the impact of the Enriched Background Isotope Study ^{14}C experimental treatments on soil respiration $\Delta 14C$ values for the different soil organic matter pools. Model results suggest that a two-pool root growth model correctly represents root carbon dynamics and inputs to the soil. The model fitting process and sensitivity analysis exposed uncertainty in our estimates of the fraction of mineral soil in the slow and passive pools, dissolved organic carbon flux out of the litter layer into the mineral soil, and mixing of the humus layer into the mineral soil layer.

Citation:

Parton WJ, Hanson PJ, Swanston C, Torn M, Trumbore SE, Riley W, Kelly R (2010) ForCent Model Development and Testing using the Enriched Background Isotope Study (EBIS) experiment. *JGR-Biogeosciences* 115:G04001, doi:10.1029/2009JG001193