Title
Constructing a database of terrestrial radiocarbon measurements

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Authors
Trumbore, Susan
Torn, Margaret
Smith, Lydia

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Constructing a Database of Terrestrial Radiocarbon Measurements

Terrestrial Radiocarbon Database Workshop; Berkeley, California, 20–22 July 2011

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Soils play a large role in the global carbon (C) cycle, but soil C stocks and dynamics remain highly uncertain. Radiocarbon (^{14}C) observations provide critical information on the rates of exchange of soil C with the atmosphere and hydrosphere and how those rates vary with edaphic (soil-related) factors and over a range of time scales. For example, the degree to which radio decay has affected ^{14}C demonstrates the importance of short-range-order minerals for stabilizing organic C on millennial time scales in some soils. Time series that track the infiltration of "bomb" ^{14}C help identify the components of soil C that cycle on decadal to centennial time scales. Radiocarbon signatures in microbial biomass or respiration indicate shifts in substrate use that accompany vegetation, nutrient availability, or temperature change on even shorter time scales. Taken together, such measurements can be used to test and parameterize models of soil C dynamics.

A workshop at the Lawrence Berkeley National Laboratory was held to initiate the construction of a global database of ^{14}C measurements in soil and other ecosystem compartments such as litter or respired C. Although a wealth of such observations exist, they are scattered in small data sets held by individual researchers and have not been assembled or used for multisite analysis, global assessments, or model testing. Given the need for global synthesis products to evaluate and develop models of soil C across a range of spatial scales, the goal of the workshop is to assemble data in a common format for analysis and provide a continuing common repository.

Workshop participants defined a set of research questions the database will help answer, including, What is the C sequestration capacity of global soils? Does the age of organic matter vary predictably with depth across soil types? How do human activities modify the dynamics of C in soils, and do responses vary with soil type? How important is soil mineralogy as a control on C cycling over a range of time scales? How well do models represent C cycle processes, and how can they be improved?

Functional goals identified for the database include query capabilities; simple modeling tools to help users interpret ^{14}C data and assess errors; and the ability to combine data with gridded global attributes, such as temporally resolved temperature and precipitation, net primary production (NPP), and gross primary production, and a climate-based decomposition index. Near-term synthesis goals include analyzing depth profiles of ^{14}C across gradients in ecosystem state factors (climate, organisms, relief, parent material, time, and human influence) and soil orders, mapping surface soil ^{14}C values on soil temperature and moisture, and comparing soil C turnover times to NPP and soil C stocks.

Data sets were identified from 18 contributors and six continents, with ^{14}C measurements from soils representing nine soil orders, plant and microbial tissues, and respiration fluxes. This first workshop, however, emphasized only U.S. contributors. Additional observations are sought, especially for other regions and different disturbance, experimental treatment, and land-use regimes, to expand the database and make it available to a wide community of scientists.

To contribute to the Terrestrial Radiocarbon Database, please contact Margaret Torn (mstorn@lbl.gov). The authors thank the National Soil Carbon Network for facilitating this workshop and the upcoming session on this topic at the AGU Fall Meeting.

—SUSAN TRUMBORE, Max Planck Institute for Biogeochemistry, Jena, Germany; E-mail: susan.trumbore@bgc-jena.mpg.de; and MARGARET TORN and LYDIA SMITH, Lawrence Berkeley National Laboratory, Berkeley, Calif.; and University of California, Berkeley

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Integrating and Scaling Carbon, Water, and Energy Fluxes With Optical Measurements

FLUXNET and Remote Sensing Open Workshop: Towards Upscaling Flux Information From Towers to the Globe; Berkeley, California, 7–9 June 2011

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About 140 scientists from 15 countries, representing the remote sensing and land-atmosphere flux measurement and modeling communities, attended a workshop to address the technical, methodological, and scientific challenges to integrating flux and optical measurements across a spectrum of spatial and temporal scales.

Recent advances in upscaling and data fusion have enabled scientists to produce spatially explicit data sets of regional and global flux products. Field sites that make up FLUXNET, a global network of eddy covariance towers that measures carbon dioxide, water vapor, and energy transfer between the Earth's surface and the atmosphere, and SpecNet, a network of sites that performs optical sampling at FLUXNET sites, have become important sources for bottom-up inputs to models that upscale flux quantities from canopies to landscapes and from landscapes to the globe. Data from flux towers also serve as a validation tool for top-down modeling from satellite and aircraft optical measurements. These capabilities have brought climate and ecosystem scientists within reach of quantifying carbon, water, and energy fluxes "everywhere and all of the time" and enabled insights into climate-ecosystem interactions and trends over a range of spatial and temporal scales.

However, these new capabilities have raised many questions as well. For example, How should FLUXNET and SpecNet standardize or harmonize templates, spectral indices, and approaches? Modelers must also identify methodological gaps in spatial and temporal aggregation of data across scales, assess the quality of model outputs, and quantify uncertainty. In addition, the FLUXNET and SpecNet communities must decide on the level of error that is acceptable as a basis for climate policy, given measurement limitations and the reality of data gaps. Part of this goal requires continued development of integrated cyberinfrastructures to provide data for analysis and synthesis across climatic and ecological zones.

The first day of the workshop was devoted to providing an overview of the current status of FLUXNET and SpecNet and presenting new measurements, modeling approaches, and data products. Among the topics discussed were tower-based developments in automated hyperspectral systems and digital cameras for phenological monitoring. Other talks addressed bottom-up modeling approaches, including linking three-dimensional radiative transfer models to energy exchange models, scaling up tower data and images from the Moderate Resolution Imaging Spectroradiometer (MODIS), using cloud computing, and relying on a number of data-driven approaches and assimilation techniques. Also discussed were methods for identifying carbon dioxide (CO_2) sources and sinks by merging ground-level CO_2 measurements with monitoring from space by the Orbiting Carbon Observatory. Last, NASA introduced the NASA Earth Exchange, a new supercomputing environment in which remote sensing data, Earth system models, and computer resources are allotted to individual users in a shared computing environment.

The two subsequent days were composed of discussion sessions and panels. Topics