Completing Below-Ground Carbon Budgets for Pastures, Recovering Forests, and Mature Forests of Amazonia

First Annual Status Report
August 1, 1993 to May 31, 1994

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NAGW-3748
Research Progress:

Davidson visited the research site at Paragominas, Brazil, in August 1993. The first purpose of this trip was to begin training a Brazilian technician to conduct monthly soil respiration measurements. Nepstad visited the research site in November, 1993, and Trumbore visited in February, 1994, to continue the training process.

Another purpose of Davidson’s trip in August was to obtain some data on soil radon profiles that our previous research at the site indicated were necessary to complete a manuscript on the depth distribution of CO$_2$ production in soil. Since the August trip, Davidson and Trumbore have completed a manuscript that is currently under review by colleagues and that should be submitted for publication in the near future. The manuscript describes how profiles of radon and CO$_2$ can be used to estimate at what depth the CO$_2$ is being produced. This information is important for determining the importance of deep roots as sources of carbon inputs in these soils.

During Nepstad’s trip to the research site in November 1993 more data were collected of root biomass and on root decomposition studies. We are now beginning to use these new root data in our model of soil C turnover, which is the subject of another paper currently being drafted by Trumbore.

During Trumbore’s trip, new soil access tubes were installed in a secondary forest and a managed pasture. A WHRC research technician, Paul Lefebvre, is now (late May, 1994) at the site installing more tubes at more secondary forest and managed pasture sites. Soil gases will be analyzed for CO$_2$ and $^{14}$CO$_2$, and soil organic matter will be analyzed for $^{14}$C. This effort will allow us to expand our study to these land use types, as outlined in our proposal.

Nepstad has also visited two new research sites: Santana de Araguaia is to the southeast of Paragominas near the forest-savanna transition where precipitation is lower than Paragominas; Trombetas is to the northwest of Paragominas and has somewhat higher precipitation that Paragominas. Deep soil pits have been dug, soil moisture sensors have been installed, and samples have been removed for measuring root biomass.

A Brazilian student, Gustavo Hees Negreiros, has been working on a geographic information system (GIS) of the Amazon basin which includes data layers on soils and precipitation. Recently, estimates of soil texture from the RADAMBRASIL database have been used to calculate potential soil water storage. These estimates have been merged with climate data to calculate soil water extraction by forest canopies during the dry season. A preliminary map of the areas where deep roots are needed for extracting deep soil water has been produced.
Future research:

The research tasks to be included in the coming year include:
1. measuring dissolved organic carbon (DOC) throughout the soil profile and estimating rates of C input into deep soils via this pathway.
2. year-round monthly soil CO$_2$ flux measurements in four ecosystems: primary forest, secondary forest, managed pasture, and degraded pasture.
3. modeling of soil C dynamics in all four ecosystems.
4. year-round monitoring of soil moisture dynamics at the new research sites at Santana de Araguaria and Trombetos.
5. expansion of the study to a site near Manuas, where precipitation is less seasonal than at Paragominas.
Manuscripts in press:


Manuscripts submitted:

Nepstad, Carvalho, Davidson, Jipp, Lefebvre, Negreiros, Silva, Stone, Trumbore, and Vieira. The deep soil link between water and carbon cycles of Amazonian forests and pastures. Nature.

Manuscripts in preparation:

Davidson and Trumbore. Production of CO₂ in deep soils of the eastern Amazon. Tellus.

Trumbore, Davidson, and Nepstad. A below-ground budget of carbon cycling in forests and pastures of the eastern Amazon. Global Biogeochemical Cycles.

Camargo, Martinelli, Trumbore, and Nepstad. Carbon turnover in forest and pasture soils of the eastern Amazon estimated from δ¹³C and δ¹⁴C. Plant and Soil.


Nepstad, D. Fine root biomass and decomposition to 6 m depth in Amazonian forest, pasture and secondary forest. Plant and Soil.


Papers presented (or submitted for presentation) at professional meetings:

Ecological Society of America, 1994 Annual Meeting, Knoxville TN:
- Davidson et al. Soil carbon dynamics in forests and pastures of the eastern Amazon.
- Nepstad et al. Canopy water relations and leaf phenology in deep-rooted forest and pasture, eastern Amazonia.

First GCTE Science Conference, May 1994, Woods Hole, MA:
- Davidson et al. Soil carbon dynamics in forests and pastures of the eastern Amazon.
- Nepstad et al. Soil water extraction, canopy seasonality, and drought-stress in deep rooted primary forest, pasture and secondary forest, east Amazonia.

American Geophysical Union, Fall Meeting, 1993, San Francisco:
- Trumbore et al. Prediction of CO₂ in pasture and mature forest soils of eastern Amazonia.
- Camargo et al. Δ¹³C, δ¹³C and C inventory differences between forest and pasture in soils of eastern Amazonia.

International Symposium on Resource and Environmental Monitoring, Sept., 1994, Rio de Janeiro:
- Negreiros et al. The distribution of evergreen forests in seasonally-dry Amazonia.
- Lefebvre and Stone. Monitoring selected logging in eastern Brazilian Amazonia using multi-temporal Landsat Thematic Mapper imagery.