# TG-07

# Ecosystem Respiration and Trace Gas Exchange in Undisturbed and Selectively Logged Forests in the Brazilian Amazon Region

## PRINCIPAL INVESTIGATORS


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## ABSTRACT, OBJECTIVES AND APPROACHES


We propose to address two theme areas of LBA-Ecology, carbon storage and exchange and trace gas fluxes. We plan to estimate ecosystem respiration and trace gas fluxes for the undisturbed and logged forest sites at the Tapajos National Forest (TNF). Our proposed work is summarized in two objectives:

•Quantification of the soil-atmosphere exchange of carbon dioxide ($CO_2$), nitrous oxide ($N_2O$), nitric oxide (NO) and methane ($CH_4$) in logged and undisturbed upland forests on contrasting soil types over a range of spatial (~$m^2$ to ~$km^2$) and temporal scales (hours to years) at several LBA forested sites in the Amazon region.

•Quantification of ecosystem respiration components (including soil, bole and coarse necromass) in mature upland forests and in logged forests.

We propose measurements of trace gases using manually deployed and continously operated automated chambers and profiles of trace gas mixing ratios from towers at the TNF. We will extend our measurements to other LBA tower sites using a portable system for measurement of soil-atmosphere $CO_2$ flux and profiles of $CO_2$, $N_2O$ and $CH_4$.


## RESULTS FROM LBA-ECOLOGY PHASE 1

Our LBA-Ecology Phase-1 study included four components: (1) Measurement of soil-atmosphere exchange of carbon dioxide ($CO_2$), nitrous oxide ($N_2O$), nitric oxide (NO) and methane ($CH_4$) in upland forests; (2) development of a forest version of the DNDC simulation model to improve our understanding of the linkage of carbon and nutrient cycles to trace gas production; (3) measurement of the response of biogeochemical cycles in upland ecosystems to land use change with a particular emphasis on selective timber harvest and forest to pasture conversion; and (4) quantification of key portions of the carbon and nutrient cycles through the study of fine-litter and fine-root productivity and turnover. Some key results are displayed in figures 1-5

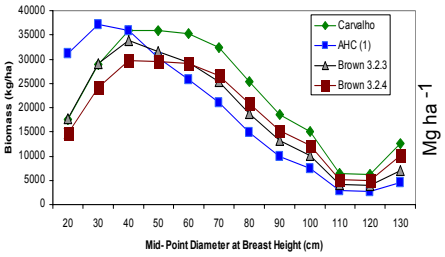


**FIGURE 1**. Above ground biomass density estimated for trees by diameter class using four different allometric relations. Data for 392 ha surveyed at TNF were used to construct this plot. Diameter classes from 35 to 75 cm accounted for over 50% of the biomass regardless of the allometric equation selected.

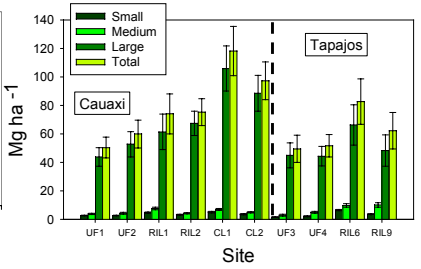


**Figure 2.** Mean (+/- Propagated Error) fallen CWD mass for 10 sampled blocks of undisturbed forest (UF), reduced impact (RIL), and conventional logging (CL) at Cauaxi and Tapajos large debris (> 10 cm dia.), medium (5 -10 cm), and small (2-5 cm) debris.

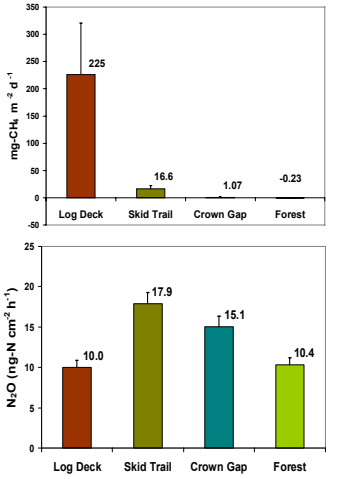


**FIGURE 3.** Mean and standard errors for measured $N_2O$ and $CH_4$ fluxes from 4 sampling strata (log deck, skid trails, crown gaps, and background forest) during the wet season (January through June) 2000. Positive fluxes indicate a net movement of gas from the soil to the atmosphere. Negative fluxes indicate a net movement of gas from the atmosphere to the soil.

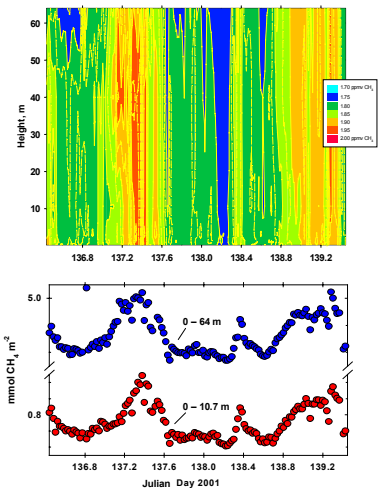


**Figure 4**. Ambient $CH_4$ dynamics at km 67 TNF (old growth forest) for the three days in 2001. The height of the canopy is about 40 m.

**Figure 5**. Total column abundance of ambient $CH_4$ in the forest atmosphere to 10.7 and 64 m.

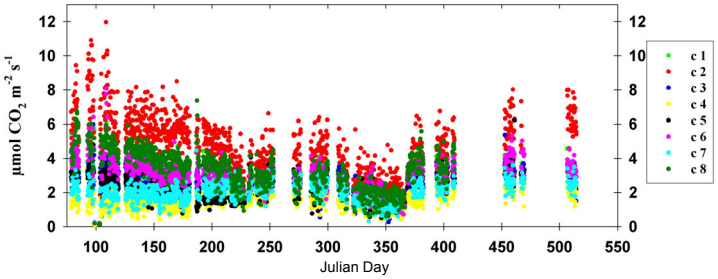


**Figure 6.** Average flux for 8 chambers during the 2001 wet season was 3.2 ± 0.8 µmol $CO_2$ $m^{-2}$ $s^{-1}$ and during the dry season was 2.4±0.2 µmol $CO_2$ $m^{-2}$ $s^{-1}$. During wet season 2002 (day 1-38) fluxes increased to 3.1 ±1.1 µmol $CO_2$ $m^{-2}$ $s^{-1}$

## EXPECTED PRODUCTS, SYNTHESIS AND INTEGRATION

We have identified two novel findings from the first phase of our LBA Ecology investigation. First, it appears that upland forest may be a net source of $CH_4$. Second, we have evidence that there is a large source of $N_2O$ in pastures that is not emitted directly across the soil-air interface. We plan first to confirm these findings and then to search for mechanistic explanations should these sources be confirmed.

We expect to quantify the the fluxes of $N_2O$, NO, $CH_4$ and ecosystem respiration at the stand scale in the TNF at both undisturbed and logged forest sites. Confidence in our estimates will be built on multiple techniques that cover a variety of temporal and spatial scales. For example, our respiration budgets derived mainly from enclosure measurements will be compared to our own profile measurements from towers and to eddy covariance measurements made by other research groups. Our studies at the TNF will be put in a regional context directly through our own studies along the LBA Transects and through comparison with other LBA investigations. We will perform a comparison of soil-atmosphere $CO_2$ flux across multiple LBA sites.

Our carbon cycles studies of logging at the TNF will be complemented by work already accomplished at Paragominas, Para as well as work underway in Tailandia, Para and Juruena, Mato Grosso. Studies of the effects of logging on carbon cycling will be scaled up to sub-regional or regional scale based on the estimates of logging area and logging damage from economic data and remote sensing.

## TG-07 PARTICIPANTS

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## PUBLICATIONS


**Peer Reviewed Papers**

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Asner, G.P. M. Palace, M. Keller, R. Pereira Jr., J.N.M. Silva, and J.C. Zweede. (In Press) Estimating Canopy Structure in an Amazon Forest from Laser Rangefinder and IKONOS Satellite Observations. *Biotropica*

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Keller, M., M. Palace, G.P. Asner, R. Pereira Jr., and J.N.M. da Silva. Coarse Woody Debris in Undisturbed and Logged Forests in the Eastern Brazilian Amazon (Submitted to *Global Change Biology*)

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Keller, M., G. P. Asner, J.M.N. Silva, and M. Palace. Sustainability of Selective Logging of Upland Forests in the Brazilian Amazon: Carbon Budgets and Remote Sensing as Tools for Evaluation of Logging Effects.in Eds: D.J. Zarin, J. Alavalapati, F.E. Putz, M. Schmink *Working Forests in the American Tropics: Conservation Through Sustainable Management?* Publisher, Colombia University Press. New York.

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McGroddy, M.E. W.L. Silver, R.C. de Oliveira Jr., W.Z. de Mello, M. Keller. The fate of phosphorus in a highly weathered Amazonian forest ecosystem: biological cycling versus geochemical sequestration. (Submitted to *Ecology*)

A. H. Rice, E. H. Pyle, S. R. Saleska, L. Hutyra, P. B. de Camargo, K. Portilho, D.F. Marques, M. Palace, M. Keller and S.C. Wofsy. Carbon Balance and Vegetation Dynamics in an Old-growth Amazonian Forest (Submitted to *Ecological Applications*)