Revision Date: March 13, 2009

LBA-ECO TG-07 Soil Trace Gas Flux and Root Mortality, Tapajos National Forest

Summary:

This data set reports the results of an experiment that tested the short-term effects of root mortality on the soil-atmosphere fluxes of nitrous oxide, nitric oxide, methane, and carbon dioxide in a tropical evergreen forest. Weekly trace gas fluxes are provided for treatment and control plots on sand and clay tropical forest soils in two comma separated ASCII files.

The study site in the Tapajos National Forest (TNF) is near km 83 on the Santarem-Cuiaba Highway south of Santarem, Para, Brazil. Root mortality was induced by isolating blocks of land to 1 m depth using trenching and root exclusion screening. Gas fluxes were measured weekly for ten weeks following the trenching treatment and monthly for the remainder of the year. Monthly data are not included at this time.

Data Citation:

Cite this data set as follows:

Varner, R.K. and M.M. Keller. 2009. LBA-ECO TG-07 Soil Trace Gas Flux and Root Mortality, Tapajos National Forest. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/924

Implementation of the LBA Data and Publication Policy by Data Users:

The LBA Data and Publication Policy [http://daac.ornl.gov/LBA/lba_data_policy.html] is in effect for a period of five (5) years from the date of archiving and should be followed by data users who have obtained LBA data sets from the ORNL DAAC. Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.

> This data set was archived in April 2009. Users who download the data between Apri 2009 and March 2014 must comply with the LBA Data and Publication Policy.

Data users should use the Investigator contact information in this document to communicate with the data provider. Alternatively, the LBA Web Site [http://lba.inpa.gov.br/lba/] in Brazil will have current contact information.

Data users should use the Data Set Citation and other applicable references provided in this document to acknowledge use of the data.

Table of Contents:

1. Data Set Overview:

Project: LBA (Large-Scale Biosphere-Atmosphere Experiment in the Amazon)

Activity: LBA-ECO

LBA Science Component: Trace Gas and Aerosol Fluxes

Team ID: TG-07 (Keller / de Mello)

The investigators were Keller, Michael; Crill, Patrick Michael; Dias, Jadson Dizencourt; McGroddy, Megan; Silva, Hudson C.P.; Silver, Whendee L.; Varner, Ruth and Robertson, Jillana . Contact is Varner, Ruth (ruth.varner@unh.edu).

LBA Data Set Inventory ID: TG07_Root_Mortality_Experiment

An experiment was conducted on sand and clay tropical forest soils to test the short-term effect of root mortality on the soil-atmosphere flux of nitrous oxide, nitric oxide, methane, and carbon dioxide. Root mortality was introduced by isolating blocks of land to 1 m using trenching and root exclusion screening. Gas fluxes were measured weekly for ten weeks following the trenching treatment and monthly for the remainder of the year.

2. Data Characteristics:

Trace gas flux data are provided for treatment and control plots on sand and clay tropical forest soils in two comma separated ASCII files.

Values of -9999 in the ASCII file indicate missing values.

File: Trench_10weeks_NO_CO2_Final.csv

Column	Label	Description
1	Date	YYYY/MM/DD
2	Site_ID	Trench Description: Clay_NoTrench, Clay_Trench, Sand_NoTrench, Sand_Trench
3	Chamber	Chamber Number: 1-5
4	Rep	Replicates for each chamber (A and B)
5	Time	hh:mm (local standard time, UTC-4 hours)
6	Air_T	degrees Celsius
7	Soil_T	degrees Celsius
8	NO_flux	ng-N cm-2 hr-1
9	CO2_Flux	umoles m-2 s-1

Example Data Records

```
Date, Site_ID, Chamber, Rep, Time, Air_ T, Soil_ T, NO_ Flux, CO2_ Flux
2000/06/04,Clay_NoTrench,1,A,12:41,26.7,25,0.7,3.43
2000/06/04,Clay_NoTrench,1,B,12:46,26.9,25.2,1.21,6.18
2000/06/04,Clay_NoTrench,2,A,10:27,26.5,24.7,8.42,3.85
2000/06/04,Clay_NoTrench,2,B,10:33,26.4,25,10.44,3.28
...
2000/08/03,Sand_Trench,4,B,08:48,23.8,23.4,5.94,1.58
2000/08/03,Sand_Trench,5,A,07:57,23.3,23.4,7.56,0.78
2000/08/03,Sand_Trench,5,B,08:04,23.1,23.5,5.19,1.4
```

File: Trench_10weeks_N2O_CH4_Final.csv

Values of -9999 in the ASCII file indicate missing values.

Column	Label	Description
1	Date	YYYY/MM/DD
2	Site_ID	Trench Description: Clay_NoTrench, Clay_Trench, Sand_NoTrench, Sand_Trench
3	Chamber	Chamber Number: 1-5
4	Rep	Replicates for each chamber (A and B)
5	N2O_Flux	Flux ng-N cm-2 hr-1
6	CH4_Flux	Flux mg CH4 m-2 d-1

Example Data Records

```
Date, Site_ID, Chamber, Rep, N2O_ flux, CH4_ flux
2000/06/04,Clay_NoTrench,1,A,28.03,2.8
2000/06/04,Clay_NoTrench,1,B,13.28,-0.49
2000/06/04,Clay_NoTrench,2,A,9.4,-0.43
2000/06/04,Clay_NoTrench,2,B,4.18,-0.78
2000/06/04,Clay_NoTrench,3,A,1.58,-9999
2000/06/04,Clay_NoTrench,3,B,12.95,-0.97
...
2000/08/14,Sand_Trench,4,B,3.92,-1.07
2000/08/14,Sand_Trench,5,A,-3.39,-1.43
2000/08/14,Sand_Trench,5,B,-1.32,1.15
```

Site boundaries: (All latitude and longitude given in degrees and fractions)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Para Western (Santarem) - km 83 Logged Forest Tower Site (Para Western (Santarem))	-54.97070	-54.97070	-3.01700	-3.01700	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2000/06/04 to 2001/05/15.
- Temporal Resolution: Weekly for ten weeks then monthly for the remainder of the year

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / IRGA (INFRARED GAS ANALYZER) / CARBON DIOXIDE
- LABORATORY / GC-FID (GAS CHROMATOGRAPH/FLAME IONIZATION DETECTOR) / METHANE
- FIELD INVESTIGATION / CHEMILUMINESCENCE / NITROGEN OXIDES
- LABORATORY / GAS CHROMATOGRAPHS / NITROUS OXIDE
- FIELD INVESTIGATION / THERMOMETER / AIR TEMPERATURE

- FIELD INVESTIGATION / TEMPERATURE PROBE / SOIL TEMPERATURE
- FIELD INVESTIGATION / WEIGHING BALANCE / SOIL MOISTURE/WATER CONTENT
- LABORATORY / WEIGHING BALANCE / SOIL MOISTURE/WATER CONTENT

3. Data Application and Derivation:

Root mortality was induced by isolating blocks of land to 1 m using trenching and root exclusion screening. Gas fluxes were measured weekly for ten weeks following the trenching treatment. For nitrous oxide there was a highly significant increase in soil-atmosphere flux over the ten weeks following treatment for trenched plots compared to control plots. N2O flux averaged 37.5 and 18.5 ng N cm-2 h-1 from clay trenched and control plots and 4.7 and 1.5 ng N cm-2 h-1 from sand trenched and control plots. In contrast, there was no effect for soil-atmosphere flux of nitric oxide, carbon dioxide, or methane. These fluxes can be obtained from the data files.

Root biomass in the trenched plots averaged 222 (+/-25) g m-2 in the clays and 260 (+/-25) g m-2 in the sands. Root biomass decreased slightly over the first four weeks following trenching in the clay soils to 173 (+/-21) gm-2. In contrast, root biomass increased slightly in the sand trench plots following root mortality to 277 (+/-30) gm-2, possibly resulting from colonization by decomposers.

4. Quality Assessment:

NO standards were run in the field at the beginning and end of 8 enclosure flux samples or approximately every hour. NO standard response calculated using a linear fit of the two standards encompassing the measurement period was compared to the frequent (generally hourly) standardization. A given hourly standard run varied by as much as 60% from the standard response calculated from the linear fit. On two dates of eight tested, at least 50% of the standards fall outside of the predicted standard response by at least 20% based on the starting and ending standards. On two other dates at least 10% of the standard runs fall outside of this +/-20% window. For additional QA, please see flux measurement section below.

5. Data Acquisition Materials and Methods:

Site Description

The region receives approximately 2000 mm of precipitation per year and has an annual mean temperature of 25 C [Silver et al., 2000]. Vegetation at the site is evergreen, mature tropical forest with a total biomass of about 372 Mg ha-1 [Keller et al., 2001]. Experimental plots were located on contrasting soils, a clay textured Oxisol (80% clay, 18% sand, 2% silt) and a sand textured Ultisol (60% sand, 38% clay, 2% silt) [Silver et al., 2000].

Experimental Design

The experiment was a randomized complete block design (Varner et al., 2003). For each soil type, 5 pairs of 2.5 x 2.5 m plots were located so that there were no trees greater than 10 cm diameter at breast height (DBH; 1.3 m) on the plots. One plot in each pair was randomly selected for trenching. In the trenched plots, trenches were dug to 1-m depth and were lined with a fine stainless steel mesh (<0.5 mm) to prevent the penetration of roots while allowing the movement of water and gases. All vegetation was clipped from the trenched plots at the time of trenching and every two weeks thereafter to prevent colonization of the plot by live roots. The trenching operations were completed in the period from Julian day 147 through 156 in 2000 (May 27 through June 4). For all plots, measurements were made in an interior square region, 2 x 2 m that was surrounded by a 0.5-m wide buffer strip.

Trace Gas Flux Measurements

The soil-atmosphere fluxes of CO2, NO, N2O and CH4 were measured weekly for approximately 10 weeks following the trenching treatment. Two chamber bases were inserted approximately 2 cm depth in the soil at randomly selected points in the sampled plots within 30 minutes of the weekly flux measurement. These chamber bases were removed immediately after flux measurements were completed. Dynamic flow-through chambers were used for measurement of NO and CO2 and static vented chambers were used for measurements of N2O and CH4 [Keller and Reiners, 1994]. The measurement of these two pairs of gases was sequential after lifting the chamber top to equilibrate the headspace with ambient air.

An integrated backpack system was used to measure NO and CO2 over 3 to 10 minutes from enclosures. The flow through the chamber was regulated to about 300 cm3 min-1. Air entered the chamber through a chimney-like air-gap that was specifically designed to minimize exchange with the outside air and to avoid pressure fluctuations within the chamber.

Air flowed from the soil enclosure through a Teflon-lined polyethylene sample line 30 m in length and then it entered an infrared gas analyzer (Li-Cor 6262) for CO2 measurement. From the Li-6262, the sampled air then passed through a flow control manifold where it was mixed with a make-up air flow of about 1200 cm3 min-1 and a flow of NO (1 ppm) standard gas that varied from 3 to 10 cm3 min-1 as measured on an electronic mass flowmeter (Sierra Top-Trak). The make-up air and standard addition maintain optimum and linear performance of the NO2 chemiluminescent analyzer (Scintrex LMA-3). The mixed sample stream passed through a Cr2O3 catalyst for conversion of NO to NO2 [Levaggi et al., 1974]. The NO2 chemiluminescent analyzer was standardized by a two-point calibration approximately hourly. The intra-day stability of the calibration on each sampling date was checked by comparison of each standard run to a linear interpolation between the standards runs at the beginning and end of the daily measurement period. The concentration of the field NO standard was compared periodically with laboratory standards to assure that they did not drift [Veldkamp and Keller, 1997]. Signals from the CO2 and NO2 analyzers and the mass flow meter for the NO standard gas were recorded on a datalogger (Campbell CR10). Fluxes were calculated from the linear increase of concentration versus time.

Static enclosure measurements were made for CH4 and N2O fluxes using the same bases and vented caps [Keller and Reiners, 1994]. Four enclosure headspace samples were taken over a 30-minute sampling period with 20-ml nylon syringes. Analysis of grab samples for CH4 and N2O were completed within 36 hours by FID and ECD gas chromatography. Gas concentrations were calculated by comparing peak areas for samples to those for standards.

Roots were sampled using a root corer with a 6-cm internal diameter [Vogt and Persson, 1991]. Cores were removed to 10 cm depth on 2 dates (June 4 (day 156) and 30 (day 182)) following trenching. Roots were sorted and dried at 65 degree C and weighed.

6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive Center:

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Keller, M., et al., (2001) Biomass in the Tapajos National Forest, Brazil: Examination of sampling and allometric uncertainties, Forest Ecol. Manage., 154, 371– 382. doi:10.1016/S0378-1127(01)00509-6

Keller, M., and W. A. Reiners, (1994). Soil-atmosphere exchange of nitrous oxide, nitric oxide, and methane under secondary succession of pasture to forest in the Atlantic lowlands of Costa Rica, Global Biogeochem. Cycles, 8, 399-410. doi:10.1029/94GB01660

Levaggi, D., et al., (1974). Quantitative analysis of nitric oxide in presence of nitrogen dioxide at atmospheric concentrations, Environ. Sci. Tech., 8, 348-350. doi:10.1021/es60089a003

Silver, W. L., et al., (2000). Effects of soil texture on belowground carbon and nutrient storage in a lowland Amazonian forest ecosystem, Ecosystems, 3, 193– 209. doi:10.1007/s100210000019

Varner, R.K., M. Keller, J.R. Robertson, J.D. Dias, H. Silva, P.M. Crill, M. McGroddy and W.L. Silver, (2003). Experimentally induced root mortality increased nitrous oxide emission from tropical forest soils, Geophys. Res. Letts., 30, 10.1029/2002GL016164.

Veldkamp, E., and M. Keller, (1997) Nitrogen oxide emissions from a banana plantation in the humid tropics, J. Geophy. Res., 102, 15,889-15,898. doi:10.1029/97JD00767

Verchot, L. V., et al., (1999). Land use change and biogeochemical controls of nitrogen oxide emissions from soil in eastern Amazonia, Global Biogeochem. Cycles, 13, 31-46. doi:10.1029/1998GB900019

Vogt, K. A., and H. Persson, (1991). Measuring growth and development of roots, in Techniques and approaches in forest tree ecophysiology, edited by J. P. Lassoie and T. M. Hinkley, 447–502, CRC Press, Boca Raton, Fl.
