LBA-ECO TG-07 Trace Gas Fluxes, Undisturbed and Logged Sites, Para, Brazil: 2000-2002

Summary:

Trace gas fluxes of carbon dioxide, methane, nitrous oxide, and nitric oxide were measured manually at undisturbed and logged forest sites in the Tapajos National Forest, near Santarem, Para, Brazil. Manual measurements were made approximately weekly at both the undisturbed and logged sites. Fluxes from clay and sand soils were completed at the undisturbed sites. Fluxes were measured at the deck (patio), skid trail, clearing and forest at the logged sites. Soil moisture is reported as daily average water-filled pore space (WFPS) for the undisturbed forest clay and sand soils. Data are reported in three ASCII comma separated files.

Data Citation:

Cite this data set as follows:

Keller, M.M., R.K. Varner, J.D. Dias, H.S. Silva, P.M. Crill, R.C. de Oliveira, Jr., and G.P. Asner. 2009. LBA-ECO TG-07 Trace Gas Fluxes, Undisturbed and Logged Sites, Para, Brazil: 2000-2002. 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/926

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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 M.; Oliveira, Raimundo Cosme de; Silva, Hudson S.; Dias, Jadson Dizencourt and Varner, Ruth K. . You may contact Varner, Ruth K. (ruth.varner@unh.edu)

LBA Data Set Inventory ID: TG07_Soil-Atmosphere_Flux_Km83

The soil-atmosphere fluxes of nitrous oxide (N2O), nitric oxide (NO), methane (CH4), and carbon dioxide (CO2) were studied on two soil types (clay Oxisol and sandy loam Ultisol) over two years (2000-01) in both undisturbed forest and forest recently logged using reduced impact forest management in the Tapajos National Forest, near Santarem, Para, Brazil (Keller et al., 2005). Fluxes were measured over one year each from two recently logged forests on the Oxisol in 2000 and on the Ultisol in 2001. Sampling in logged areas was stratified from greatest to least ground disturbance covering log decks, skid trails, tree-fall gaps, and forest matrix.

2. Data Characteristics:

Manual trace gas exchange measurements of soil-atmosphere fluxes of nitrous oxide (N2O), nitric oxide (NO), methane (CH4), and carbon dioxide (CO2) are reported for both undisturbed forest sites and logged sites. Soil moisture, as daily average water-filled pore space (WFPS), are reported for the undisturbed forest sites only. The files are in ASCII text comma separated format and missing values are represented as -9999.

File Name: N2O_and_CH4_flux_Km83.csv

Columns	Description
Date	YYYY/MM/DD
Air_T	degrees Celsius
Soil_T	degrees Celsius
Deck	deck number at logging site
Type	for logging sites: deck, clearing, trail and forest; for undisturbed: clay and sand soils
Chamber	generally 8 chamber measurements per site and treatment
N2O_Flux	ng-N cm-2 hr-1
CH4_Flux	mg CH4 m-2 d-1

Example Data Records:

Header records omitted
…
Date,Air_T,Soil_T,Deck,Type,Chamber,N2O_Flux,CH4_Flux
2000/01/19,21.8,23.4,-9999,Deck,1,2.46,-4.469
2000/01/19,21.7,23.5,-9999,Deck,2,1.28,-1.907
2000/01/19,21.7,23.2,-9999,Deck,3,2.222,-2.246
...
2002/02/26,26,26.4,-9999,Sand,6,3.843,-1.891
2002/02/26,26,26.3,-9999,Sand,7,1.522,-9999
2002/02/26,26,26.3,-9999,Sand,8,2.095,-2.051

File Name:NO_flux and_CO2_flux_Km83.csv

Columns	Description
Date	YYYY/MM/DD
Type	for logging sites: deck, clearing, trail and forest; for undisturbed: clay and sand soils
Deck	deck number at logging site
Chamber	usually 8 chamber measurements per site and treatment
Air_T	degrees Celsius
Soil_T	degrees Celsius
NO_Flux	ng-N cm-2 hr-1
CO2_Flux	umoles CO2 m-2 s-1

Example Data Records:

```
Header records omitted
…

Date,type,Deck,Chamber,Air_T,Soil_T,NO_Flux,CO2_flux
2000/09/19,deck,D7,1,30.5,30.8,5.74,1.88
2000/09/19,deck,D7,2,28.9,31.3,7.64,6.99
2000/09/19,deck,D7,3,28.2,30.1,2.38,8.5
...
2002/04/30,sand,-9999,6,27,26.1,3.22,2.89
2002/04/30,sand,-9999,7,27,26.1,6.08,3.78
2002/04/30,sand,-9999,8,27,26.1,3.23,4.84
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File Name: Soil_moisture_Km83.csv

Columns	Description
Date	YYYY/MM/DD
Type	for undisturbed: clay and sand soils
WFPS	percent water filled pore space
WFPS_STD_err	standard error of eight measurements of water-filled pore space

Example Data Records:

```
Header records omitted
…

Date,Type,WFPS,WFPS_STD_err
2000/02/04,Clay,50.5,1.4
2000/02/18,Clay,51.3,1.3
2000/02/25,Clay,51.5,1.3
...
2001/11/20,Sand,22.5,1.7
2001/12/19,Sand,9.7,0.9
2002/02/06,Sand,38.8,1.7
```

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 2000/01/19 to 2002/02/26.
- Temporal Resolution: Weekly

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / IRGA (INFRARED GAS ANALYZER) / CARBON DIOXIDE
- FIELD INVESTIGATION / GC-ECD (GAS CHROMATOGRAPH/ELECTRON CAPTURE DETECTOR) / NITROUS OXIDE
- LABORATORY / GC-FID (GAS CHROMATOGRAPH/FLAME IONIZATION DETECTOR) / METHANE
- FIELD INVESTIGATION / CHEMILUMINESCENCE / NITRIC 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:

In order to quantify the effect of logging on trace gas fluxes, an excess flux was calculated by subtracting a forest background flux value from the flux for a logged site. Data from the forest matrix within the logging sites or the undisturbed forest were used for background fluxes. The

forest matrix values generally were statistically indistinguishable from the nearby undisturbed forest sites.

For additional discussion of the calculation of excess flux and estimates of uncertainty, the users are referred to Keller et al. (2005).

4. Quality Assessment:

The quality of trace gas flux measurements has been discussed by Keller and Reiners (1994). Recently, the question of pressure differentials in chambers has been discussed by Xu et al. (2006). We did not directly measure pressure differentials that could exist in our chamber system although according to the source of our dynamic chamber design, (Rayment and Jarvis 1997) the pressure differential between the chamber and the outside air was less than 0.004 Pa in laboratory tests.

For NO measurements, frequent standardization in the field was necessary (Keller et al, 2005; Varner et al, 2003). The NO2 chemiluminescent analyzer (Scintrex LMA-3) is relatively unstable under the changing temperature, humidity, and background contaminant levels found in the field. We also compared the concentration of the field NO standard periodically with laboratory standards to assure that field standards did not drift (Veldkamp and Keller, 1997).

5. Data Acquisition Materials and Methods:

Field sampling of soil gas flux

Undisturbed forest sites were sampled on 31 dates from 4 February 2000 through 26 February 2002 (Keller et al., 2005). Measurements of soil-atmosphere flux for N2O and CH4 as well as soil water-filled pore space (WFPS) covered this full period, while measurements of fluxes of NO and CO2 commenced on 10 October 2000 and continued through the end of the study period. The Oxisol and Ultisol sites were sampled on the same day, generally between 0800 and 1800 local time. When all systems were operational, fluxes for all four gases were measured from eight chambers at randomly selected points along 30-m transects. After gas flux sampling was completed, soil samples were removed from each gas sampling location for determination of soil moisture content.

For the logging sites, in 2000, we randomly selected a focal site that we sampled approximately monthly. At that site, we measured fluxes in four sampling strata: the focal deck, adjacent skid trails, gaps, and background forest matrix areas. We defined the forest matrix as those areas more than 10 m distant from decks, skid trails, and gaps. Skid trail measurements were alternated between primary and secondary skid trails. On other dates, we made measurements at other randomly selected sites. In the first half (wet season) of 2000, these additional measurements were purposely biased toward decks and skid trails. On each sampling date, flux chamber locations within each stratum were randomly selected along 30-m transects in a manner similar to their selection within the undisturbed forest. For skid trails, transects were aligned diagonally across the trails in order to cross the tire ruts and the raised

area between the ruts. We sampled gas fluxes using enclosures consisting of a section of polyvinylchloride pipe (0.25-m diameter) that served as a base and an acrylonitrile-butadiene-styrene cap that fit snugly on the base. The combination of base plus cap was nearly cylindrical with a height of about 20 cm when inserted into the soil. Bases were inserted at most 30 min prior to flux measurements and they were removed immediately after completion of flux measurements in order to avoid artifacts related to root mortality from chamber insertion (Keller et al. 2000; Varner et al. 2003). Dynamic open chambers were used for measurement of NO and CO2 (Varner et al. 2003), 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, in a haphazard order, after lifting the chamber top to equilibrate the head space with ambient air.

Field analytical system for NO and CO2

We used an integrated flow system to measure NO and CO2. The chamber flow rate 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 (Rayment and Jarvis 1997). Using this design, the pressure differential between the chamber and the outside air was less than 0.004 Pa in laboratory tests. The chamber base was capped for 3 to 10 min. 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-Cor 6262, the sampled air then passed through a flow control manifold where it was mixed with a makeup airflow of about 1200 cm3 min-1 and a flow of NO (1 ppm) in oxygen-free nitrogen standard gas that varied from 3 to 10 cm3 min-1 as measured on an electronic mass flowmeter (Sierra Top-Trak). The flowmeter was checked occasionally against a NIST-traceable electronic bubble flowmeter (Gilibrator). The makeup air and standard additions maintained optimum and linear performance of the NO2 chemiluminescent analyzer (Scintrex LMA-3) according to the manufacturer's recommendations. 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. Frequent standardization in the field was necessary because the LMA-3 was relatively unstable under the changing temperature, humidity, and background contaminant levels found in the field. Varner et al. (Varner et al. 2003) found that intraday variation in standards could be as great as 60% even after accounting for linear drift between the beginning and the end of a measurement day. We also compared the concentration of the field NO standard 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 flowmeter for the NO standard gas were recorded on a datalogger (Campbell CR10). Fluxes were calculated from the linear increase of concentration versus time adjusted for the ratio of chamber volume to area and the air density within the chamber.

Analysis of CH4 and N2O

We made static enclosure measurements 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-min sampling period with 20-mL nylon syringes. Analysis of grab samples for CH4 and N2O were completed within 36 h by utilizing a Flame Ionization Detector (FID) and Electron Capture Detector (ECD) gas chromatography. Gas concentrations were calculated by comparing peak areas for samples to those for commercially prepared standards (Scott-Marin) that had been calibrated against the LBA-ECO (a component of the Large-Scale Biosphere-Atmosphere Experiment in Amazonia) standards prepared by the National Oceanic and Atmospheric Administration/Climate Monitoring and Diagnostic Laboratory (NOAA/CMDL). Fluxes were calculated similarly to those for CO2 and NO.

Determination of soil WFPS

Soil samples were taken to 10-cm depth in each chamber location on each date for determination of soil moisture (oven dried at 105C). Soil moisture was expressed as WFPS using soil bulk densities of 1.25 and 1.02 g/cm3 for Ultisol and Oxisol soils, respectively, at the undisturbed forest sites (Silver et al. 2000). We recorded air and soil (2-cm depth) temperature using thermistor probes to accompany each soil enclosure measurement. Precipitation was measured daily using a manual rain gauge in an open field approximately 3-7 km from the various study areas.

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:

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