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LBA-ECO ND-02 Trace Gas Flux from Forest Soil, Para, Brazil: 1999-2001

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Summary:

Revision date: December 14, 2009

Summary:

This data set contains soil emissions of nitric oxide (NO), carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄) measured in plots of a secondary-growth forest fertilization experiment located 6.5-km northwest of the town of Paragominas, Para, Brazil during 1999-2001. Control, pre-, and post-treatment plot trace gas emission results are reported in a single comma-separated file.

A highly degraded former pasture with secondary-growth forest (capoeira -- fallow vegetation) at Fazenda Vitoria, 6.5-km northwest of the town of Paragominas, Para, was chosen for this fertilization experiment. Twelve 20 m x 20 m plots were established: three were fertilized with nitrogen (only), three were fertilized with phosphorus (only), and three were fertilized with both nitrogen and phosphorus. The remaining three plots served as the control for these treatments. Application of the fertilizers occurred Jan 19, 2000 and February 2001, at the beginning of the rainy season.



Photographs of one of the control plots (left) and one of the plots fertilized with N and P (right) in the secondary forest in May 2002, two years after the first fertilization treatment. Photo from Davidson et al., 2004.

Data Citation:

Cite this data set as follows:

Davidson, E.A., C.J.R. de Carvalho, I.C.G. Vieira, R.O. Figueiredo. 2009. LBA-ECO ND-02 Trace Gas Flux from Forest Soil, Para, Brazil : 1999-2001. 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/954](https://doi.org/10.3334/ORNLDAAC/954)

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This data set was archived in December of 2009. Users who download the data between December 2009 and November 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.

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1. Data Set Overview:

Project: LBA-ECO

Activity: Forest Fertilization Experiment

LBA Science Component: Nutrient Dynamics

Team ID: ND-02 (Davidson / Carvalho / Dias-Filho / Moller / Moutinho / Sa / Vieira)

The investigators were Belk, Elizabeth Leslie; Carvalho, Claudio Jose Reis de; Davidson, Eric A.; Dias-Filho, Moacyr Bernardino; Figueiredo, Ricardo de Oliveira; Ishida, Françoise Yoko; Markewitz, Daniel; Moutinho, Paulo Roberto de Souza and Vieira, Ima Celia G. . You may contact Davidson, Eric A. (edavidson@whrc.org) and Figueiredo, Ricardo de Oliveira (ricardo@cpatu.embrapa.br)

LBAData Set Inventory ID: ND02_Fertilization_Experiment

These data were collected as part of a larger effort to define and quantify degrees of land degradation in eastern Amazonia. A variety of secondary forest sites, including water and nutrient manipulation experiments, were being used to understand how climate, land-use history, and natural soil fertility affect the recuperation and rates of biogeochemical cycling.

A highly degraded capoeira at Fazenda Vitoria, 6.5-km northwest of the town of Paragominas, Para, was chosen for this fertilization experiment. Twelve 20m x 20m plots were established, three of which were fertilized with nitrogen (only), three of which were fertilized with phosphorus (only), and three of which were fertilized with both nitrogen and phosphorus. The remaining three plots served as the control for these treatments. Application of the fertilizers occurred January 2000 and again in February 2001, at the beginning of each rainy season.

A survey of species biodiversity and biomass was completed in the months prior to treatment. Additional pretreatment measurements began in November 1999, including indices of soil N availability, rhizosphere phosphatase activity, litterbag decomposition, litter and soil chemistry, and soil fauna. By enhancing nutrient availability with fertilizer, this experiment tests whether, and through which processes, nutrient limits affect forest regrowth, biomass accumulation, and recuperation of biogeochemical cycles.

Related Data Sets:

- LBA-ECO ND-02 Secondary Forest Tree Heights and Diameters, Para, Brazil: 1999-2005 (Related data collected during the same period at the same study location.)

2. Data Characteristics:

The file Paragominas_Soil_Trace_Gas.csv is a comma-delimited file containing the means and standard errors of the 9 total trace gas emissions measurements per treatment (N, P, N+P, control) per sampling date. For convenience, the Day of Year is also provided. The actual number of repetitions that were included in each mean/standard error is listed in the respective *_Reps columns. Treatment Status indicates whether the measurements were made before or after the fertilizer was applied.

File Contents / Variable Descriptions: Paragominas_Soil_Trace_Gas.csv

Columns	Units	Description
Site		Paragominas- Vitoria's Farm
Date	YYYY/MM/DD	
Day_of_Year		Julian Day
Treatment_Status		pre-fertilization, post-fertilization-1, post-fertilization-2

Treatment		nitrogen, phosphorus, nitrogen+phosphorus, control
CO2_Mean		Flux carbon dioxide (CO2) measured in the field using chambers attached to an IRGA.
CO2_Std_Err		Standard error of CO2 flux.
CO2_Reps		The number of replicates that were included in each mean and standard error calculations.
CO2_Units	g C m ⁻² h ⁻¹	
NO_Mean		Flux of nitric oxide (NO) measured in the field using chambers attached to a chemiluminescent analyzer.
NO_Std_Err		Standard error of NO flux.
NO_Reps		The number of replicates that were included in each mean and standard error calculations.
NO_Units	ng N cm ⁻² h ⁻¹	
N2O_Mean		Flux of nitrous oxide (N2O) measured by filling syringes in the field from static chambers and analyzed in a laboratory using gas chromatography.
N2O_Std_Err		Standard error of N2O flux.
N2O_Reps		The number of replicates that were included in each mean and standard error calculations.
N2O_Units	ng N cm ⁻² h ⁻¹	
CH4_Mean		Flux of methane (CH4) measured by filling syringes in the field from static chambers and analyzed in a laboratory using gas chromatography.
CH4_Std_Err		Standard error of CH4 flux.
CH4_Reps		The number of replicates that were included in each mean and standard error calculations.
CH4_Units	mg CH4 m ⁻² d ⁻¹	
-9999 has been listed wherever values are missing.		
Three measurement chambers were located in each plot, providing a total of 9 replicates for each treatment type per date.		
Note that positive values indicate emissions from the soil to the atmosphere; negative values indicate net uptake by the soils of atmospheric gases. CO2 = carbon dioxide NO = nitric oxide N2O = nitrous oxide CH4 = methane		

Example Data Record:

```

Site,Date,Day_of_Year,Treatment_Status,Treatment,CO2_Mean,CO2_Std_Err,CO2_Reps,CO2_Units,
NO_Mean,NO_Std_Err,NO_Reps,NO_Units,N2O_Mean,N2O_Std_Err,N2O_Reps,N2O_Units,
CH4_Mean,CH4_Std_Err,CH4_Reps,CH4_Units

Paragominas- Vitoria's Farm,1999/11/18,322,pre-fertilization,nitrogen,-9999,-9999,0,g C m-2 h-1,
-9999,-9999,0,ng N cm-2 h-1,0.16,0.21,9,ng N cm-2 h-1,
-1.59,0.16,9,mg CH4 m-2 d-1
Paragominas- Vitoria's Farm,1999/11/18,322,pre-fertilization,phosphorus,-9999,-9999,0,g C m-2 h-1,
-9999,-9999,0,ng N cm-2 h-1,0.37,0.24,9,ng N cm-2 h-1,
-1.1,0.3,9,mg CH4 m-2 d-1
...
Paragominas- Vitoria's Farm,2001/12/12,346,post-fertilization-2,nitrogen+phosphorus,0.14,0.01,9,g C m-2 h-1,
-99999,-99999,0,ng N cm-2 h-1,0.01,0.06,9,ng N cm-2 h-1,
2.1,0.4,9,mg CH4 m-2 d-1
Paragominas- Vitoria's Farm,2001/12/12,346,post-fertilization-2,control,0.12,0.01,9,g C m-2 h-1,
-99999,-99999,0,ng N cm-2 h-1,0.01,0.12,9,ng N cm-2 h-1,
-0.95,0.22,9,mg CH4 m-2 d-1

```

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Para Eastern (Belem) -Paragominas (Para Eastern (Belem))	-47.516	-47.516	-2.983	-2.983	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1999/11/18 to 2001/12/12.
- Temporal Resolution: Quarterly

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / IRGA (INFRARED GAS ANALYZERS) / SOIL RESPIRATION
- FIELD INVESTIGATION / CHEMILUMINESCENCE / NITROGEN OXIDES
- FIELD INVESTIGATION / GC-ECD / NITROUS OXIDE
- FIELD INVESTIGATION / GC-FID / METHANE

3. Data Application and Derivation:

Understanding secondary successional processes in Amazonian terrestrial ecosystems is becoming increasingly important as continued deforestation expands the area that has become secondary forest, or at least has been through a recent phase of secondary forest growth. Most Amazonian soils are highly weathered and relatively nutrient poor, but the role of nutrients as a factor determining successional processes is unclear. Soils testing and chronosequence studies have yielded equivocal results regarding the possible role of nutrient limitation. The most striking result of this study so far is the significant response of tree growth to N fertilization. Repeated fire and other losses of N from degraded pastures may render tree growth N limited in some young Amazonian forests. Changes in species composition and monitoring of long-term effects on biomass accumulation will be addressed as this experiment is continued.

4. Quality Assessment:

The quality checks for flux measurement are described in Davidson et al. (2004). Equipment failure caused missing data for NO measurements on three dates.

5. Data Acquisition Materials and Methods:

A highly degraded former pasture with secondary-growth forest (capoeira -- fallow vegetation) at Fazenda Vitoria, 6.5-km northwest of the town of Paragominas, Para, was chosen for this fertilization experiment. Four treatments applied to twelve 20 m x 20 m plots at the Paragominas Fazenda Vitoria site.

Three of the twelve 20 m x 20 m plots were fertilized with nitrogen (100 kg N/ha); three were fertilized with phosphorus (50 kg P/ha); three were fertilized with both nitrogen and phosphorus (100 kg N/ha and 50 kg P/ha). The remaining three plots were not fertilized and served as the experimental control. Fertilization was carried out in the beginning of the rainy season in 2000 and again in 2001.

Three chamber bases made of PVC pipe were placed in each of the 12 plots in November 1999. Fluxes were measured in November 1999 and twice in January 2000, about one week before and one week after the fertilization application. Measurements were repeated in April, September, and December 2000, and a similar schedule was followed in 2001. The three chambers in each plot provided a total of 9 replicates of CO₂, NO, N₂O and CH₄ for each treatment type per date (total measurements = 36).

Fluxes of NO and CO₂ are measured in the field using dynamic chambers connected to a Scintrex LMA-3 chemiluminescent analyzer and a Licor 6252 IRGA. Fluxes of N₂O and CH₄ are measured by filling syringes with gas from static chamber headspace at 10-minute intervals, and analyzing the samples in a laboratory using gas chromatography. See Verchot et al. (1999, 2000) for details on flux measurement methodology.

6. Data Access:

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

Data Archive Center:

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov

Telephone: +1 (865) 241-3952

7. References:

- Davidson, E.A., C.J.R. de Carvalho, I.C.G. Vieira, R.D. Figueiredo, P. Moutinho, F.Y. Ishida, M.T.P. dos Santos, J.B. Guerrero, K. Kalif, and R.T. Saba. 2004. Nitrogen and phosphorus limitation of biomass growth in a tropical secondary forest. *Ecological Applications* 14(4):S150. doi:10.1890/01-6006
- Verchot, L.V., E.A. Davidson, J.H. Cattonio, and I.L. Ackerman. 2000. Land-use change and biogeochemical controls of methane fluxes in soils of eastern Amazonia. *Ecosystems* 3:41-56. doi:10.1007/s100210000009
- Verchot, L.V., E.A. Davidson, J.H. Cattonio, I.L. Ackerman, H.E. Erickson, and M. Keller. 1999. Land use change and biogeochemical controls of nitrogen oxide emissions from soils in eastern Amazonia. *Global Biogeochemical Cycles* 13:31-46. doi:10.1029/1998GB900019

Related Publications

- Davidson, E.A., C.J.R. de Carvalho, I.C.G. Vieira, R.D. Figueiredo, P. Moutinho, F.Y. Ishida, M.T.P. dos Santos, J.B. Guerrero, K. Kalif, and R.T. Saba. 2004. Nitrogen and phosphorus limitation of biomass growth in a tropical secondary forest. *Ecological Applications* 14(4):S150.

