Revision date: December 14, 2009

LBA-ECO ND-02 Agricultural and Secondary Forest Soil Trace Gas Flux, Para: 2001-2004

Summary:

This data set reports the results of a study to measure soil emissions of the carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), and nitric oxide (NO) throughout an entire cropping cycle in (1) slash-and-burn and (2) chop-and-mulch prepared agricultural fields from 2001-2004. An adjacent 15-year-old fallow field with secondary forest vegetation served as the control. The study site is within the municipality of Igarape Acu, Para, Brazil, at the Experimental Farm of the Federal Rural University of Amazonia. Flux data are reported in one comma-separated file.

Data Citation:

Cite this data set as follows:

Davidson, E.A., T.D. de Abreu Sa, C.J.R. de Carvalho, R.D. Figueiredo. 2009. LBA-ECO ND-02 Agricultural and Secondary Forest Soil Trace Gas Flux, Para: 2001-2004. 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/950

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 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.

Table of Contents:

1. Data Set Overview:

Project: LBA-ECO

Activity: Biogeochemical Cycles in Degraded Lands

LBA Science Component: Nutrient Dynamics

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

The investigators were Davidson, Eric A.; Carvalho, Claudio Jose Reis de; Moutinho, Paulo Roberto de Souza; Vieira, Ima Celia G.; Figueiredo, Ricardo de Oliveira and Sa, Tatiana . You may contact Davidson, Eric A. (edavidson@whrc.org) and Figueiredo, Ricardo (ricardo@cpatu.embrapa.br)

LBA Data Set Inventory ID: ND02_Mulching_Experiment

This data set reports the results of a study to measure soil emissions of the carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), and nitric oxide (NO) throughout an entire cropping cycle in slash-and-burn and chop-and-mulch agricultural fields and in an adjacent 15-year-old fallow field with secondary forest vegetation. Fires set for slash-and-burn agriculture contribute to the current unsustainable accumulation of atmospheric greenhouse gases, and they also deplete the soil of essential nutrients, which compromises agricultural sustainability at local scales.

2. Data Characteristics:

Flux data for carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), and nitric oxide (NO) are reported in one comma-separated file. Note that positive values indicate emissions from the soil to the atmosphere; negative values indicate net uptake by the soils of atmospheric gases.

Data File Description: Igarape_Acu_Mulching_Experiment.csv

Column Number	Column Heading	Units / Format	Description
1	Site		Study Site (Igarape Acu)
2	Date	Mon-YY	Sample month and year
3	Year	YYYY	Sample year (2001-2004)
4	Month	MM	Sample month (1-12)
5	Treatment		Treatment class: burned, forest, mulched
6	Plot		Plot: a, b
7	Chamber		Chamber Number: 1-8
8	CO2	g C/m2/h	Carbon dioxide flux
9	CH4	mg CH4/m2/d	Methane flux
10	N2O	ng N/cm2/h	Nitrous oxide flux
11	NO	ng N/cm2/h	Nitric oxide flux

Example data record:

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Header records omitted

Site,Date,Year,Month,Treatment,Plot,Chamber,CO2,CH4,N2O,NO
Igarape Acu,Mon-YY,YYYY,MM,,,,g C/m2/h,mg CH4/m2/d,ng N/cm2/h,ng N/cm2/h
Igarape Acu,Dec-01,2001,12,burned,a,1,0.75,-2.4,-1.32,-9999
Igarape Acu,Dec-01,2001,12,burned,a,2,1.01,-2.6,0.36,-9999
Igarape Acu,Dec-01,2001,12,burned,a,3,0.68,-1.03,1.02,-9999
...
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Igarape Acu,Jun-04,2004,6,mulched,b,6,-9999,0.27,-9999,-9999
Igarape Acu,Jun-04,2004,6,mulched,b,7,-9999,-0.08,-9999,-9999
Igarape Acu,Jun-04,2004,6,mulched,b,8,-9999,0.77,-9999,-9999
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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) - Igarape Acu (Para Eastern (Belem))	- 47.60000	-47.60000	-1.10000	- 1.10000	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2001/11/01 to 2004/06/30.
- Temporal Resolution: Seasonal

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 / CHEMILUMINESCENCE / NITRIC OXIDE
- LABORATORY / GC-FID (GAS CHROMATOGRAPH/FLAME IONIZATION DETECTOR) / METHANE

3. Data Application and Derivation:

Effects of slash-and-mulch and slash-and-burn agriculture on emissions of nitrous oxide, nitric oxide, carbon dioxide, and methane from soil were investigated. Fires set for slash-and-burn agriculture contribute to the current unsustainable accumulation of atmospheric greenhouse gases, and they also deplete the soil of essential nutrients, which compromises agricultural sustainability at local scales. Integrated assessments of greenhouse gas emissions have compared intensive cropping systems in industrialized countries, but such assessments have not been applied to common cropping systems of small holder farmers in developing countries. These data support an integrated assessment of greenhouse gas emissions in slash-and-burn agriculture and an alternative chop-and-mulch system in the Amazon Basin.

4. Quality Assessment:

Measurement quality control procedures are described in Davidson et al., 2008.

5. Data Acquisition Materials and Methods:

Study Site and Agricultural Practices:

The study site is within the municipality of Igarape Acu, Para, where small-holder agriculture is the dominant land use. At the Experimental Farm of the Federal Rural University of Amazonia, a 15-year-old fallow field was prepared for planting during the dry season of 2001. One field (2 ha) was cut and burned in November 2001 and another field (2 ha) was chopped and mulched in December, 2001. Both fields were planted in maize in January 2002. The mulched plot was fertilized with 60 kg N, 60 kg P, and 30 kg K per hectare (as urea, triple superphosphate and potassium chloride) at time of planting of corn. In addition, 30 kg N ha-1 as urea was added in the mulched fields 45 days after germination of the corn. Cassava was planted under the maize in February 2002, and the maize was harvested in May 2002. The plots were weeded, and leguminous trees Acacia mangium, Willd, and Sclerolobium paniculatum, Vogel, were planted in 2 m x 2 m spacing in June 2002. The cassava was harvested in June 2003, and the site was allowed to return to fallow, enriched with the planted N-fixing trees.

Experimental and Control Plots and Measurement Frequency:

Each field was subdivided into plots, and two 10 x 10 m plots were selected within each of the two fields for trace gas measurements. Eight chamber bases, polyvinyl chloride (PVC) rings (20cm diameter), were inserted about 2 cm into the soil in each of these four plots. An additional eight rings were installed in the adjacent fallow field with 15-year-old second growth (capoeira) vegetation. It was necessary to remove the rings before the burning and mulching treatments and to reinstall them afterwards. Otherwise, the rings were left in place throughout the measurement period. Measurements were begun prior to treatment in November, 2001, and were repeated once every one to three months thereafter, and sometimes more frequently to capture the effects of management operations until June 2004.

Flux Measurements:

Fluxes of N2O and CH4 were measured using a static chamber technique (Verchot et al., 1999) using the chamber bases described above. At each measurement date, a 20 mL sample of headspace gas was collected by syringe at 0, 10, 20, and 30 minutes after placing a vented PVC chamber over each ring. These gas samples were analyzed in a laboratory in Belem by gas chromatography within 48 hours, using an electron capture detector for N2O analysis and a flame ionization detector for CH4 analysis. Fluxes were calculated from the rate of

concentration change, determined by linear regression. A few data gaps resulted from occasional failure of the gas chromatographs.

Fluxes of NO and CO2 were measured in the field from the same PVC rings using portable gas analyzers. A dynamic chamber method was used for measuring fluxes of NO and CO2 (Verchot et al., 1999). A vented PVC cover made from an end cap of a 20-cm diameter PVC pipe was placed over a PVC ring to make a flux measurement. Air drawn from the chamber was circulated through a nafion gas sample dryer, a Scintrex LMA 3 NO2 analyzer (Scintrex Limited, Concord Ontario, Canada), and a LiCor infrared gas analyzer and then back to the chamber, using teflon tubing and a battery operated pump, at a flow rate of 0.5 L min 1. Varying the flow rate from 0.4 to 1.2 L min-1 had no detectable effect on measured flux rates. NO is converted to NO2 by a CrO3 converter, and the NO2 is detected by chemiluminescent reaction with Luminol. Fluxes were calculated from the rate of increase of NO and CO2 concentrations, recorded by a datalogger at 12-s intervals between 1 and 3 minutes after placing the cover over the ring. The instrument was calibrated twice daily in the field. An instrument failure prevented NO measurements after May 2003.

Details for methodology of measuring these four gases are described in Cattanio et al. (2002). Both dynamic and static chamber flux measurements were made on the same day and, in most cases, within 90 minutes of each other.

Sensors used include:

- IRGA (INFRARED GAS ANALYZER)
- GC-ECD (GAS CHROMATOGRAPH/ELECTRON CAPTURE DETECTOR)
- CHEMILUMINESCENCE
- GC-FID (GAS CHROMATOGRAPH/FLAME IONIZATION DETECTOR)

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:

Cattanio, J.H., E.A. Davidson, D.C. Nepstad, L.V. Verchot, and I.L. Ackerman. 2002. Unexpected results of a pilot throughfall exclusion experiment on soil emissions of CO2,

CH4, N2O, and NO in eastern Amazonia. Biology and Fertility of Soils 36:102-108. doi:10.1007/s00374-002-0517-x

Davidson, E.A., T.D. de A. Sa, C. J.R Carvalho, R.O. Figueiredo, M.S.A. Kato, O.R. Kato, F.Y. Ishida. 2008. An integrated greenhouse gas assessment of an alternative to slash-and-burn agriculture in eastern Amazonia. Global Change Biology, 14, 998–1007, doi:10.1111/j.1365-2486.2008.01542.x

Kato SA, Kato OR, Denich M, Vlek PLG. 1999. Fire-free alternatives to slash-and-burn for shifting cultivation in the eastern Amazon region: The role of fertilizers. Field Crops Research, 62, 225-237. doi:10.1016/S0378-4290(99)00021-0

Verchot LV, Davidson EA, Cattanio JH, Ackerman IL, Erickson HE, Keller M 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., T.D. de A. Sa, C. J.R Carvalho, R.O. Figueiredo, M.S.A. Kato, O.R. Kato, F.Y. Ishida. An integrated greenhouse gas assessment of an alternative to slash-and-burn agriculture in eastern Amazonia. Global Change Biology (2008) 14, 998–1007, doi: 10.1111/j.1365-2486.2008.01542.x

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