Revision date: December 14, 2009

LBA-ECO ND-02 Soil Gas Flux, Rainfall Exclusion, km 67, Tapajos National Forest

Summary:

This data set reports the results of a rainfall exclusion experiment in the Tapajos National Forest (Flona-Tapajos) at km 67 along the Santarem-Cuiaba BR-163 highway. From December 1999 through April 2005, following a one-year pre-treatment phase, rainfall was excluded from one of two 1-hectare plots of seasonally dry humid tropical forest. Soil emissions of carbon dioxide (CO2), nitric oxide (NO), nitrous oxide (N2O), and methane (CH4) were monitored in order to determine the likely effect of increasingly frequent El Nino drought episodes in the Amazon basin. Soil trace gas flux data are provided in one comma-separated data file.

Throughfall exclusion panels, Tapajos National Forest. The throughfall exclusion panels drain into wooden gutters constructed in the forest understory. Photos from Nepstad et al., 2002.

Data Citation:

Cite this data set as follows:

Davidson, E.A., C.J.R. de Carvalho, R.O. Figueiredo. 2009. LBA-ECO ND-02 Soil Gas Flux, Rainfall Exclusion, km 67, 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/955

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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: Rainfall Exclusion 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, Francoise Yoko; Markewitz, Daniel and Moutinho, Paulo Roberto de Souza . You may contact Davidson, Eric A. (edavidson@whrc.org) and Figueiredo, Ricardo de Oliveira (ricardo@cpatu.embrapa.br)

LBA Data Set Inventory ID: ND02_REE_Trace_Gas_Tapajos

Changes in precipitation in the Amazon Basin resulting from regional deforestation, global warming, and El Nino events may affect emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and nitric oxide (NO) from soils. Changes in soil emissions of radiatively important gases could have feedback implications for regional and global climate. Here we report the final results of a five-year large-scale (1 ha) throughfall exclusion experiment, followed by one year of recovery with natural throughfall, conducted in a mature evergreen forest near Santarem, Brazil. The exclusion manipulation lowered annual N2O emissions in 4 out of 5 treatment years (a natural drought year being the exception), and then recovered during the first year after the drought treatment stopped. Similarly, consumption of atmospheric CH4 increased under drought treatment, except during a natural drought year, and it also recovered to pre-treatment values during the first year that natural throughfall was permitted back on the plot. No treatment effect was detected for NO emissions during the first three treatment years, but NO emissions increased in the fourth year under the extremely dry conditions of the exclusion plot during a natural drought. Surprisingly, there was no treatment effect on soil CO2 efflux in any year. The drought treatment provoked significant tree mortality and reduced allocation of C to stems, but allocations of C to foliage and roots were less affected. Taken together, these results suggest that the dominant effect of throughfall exclusion on soil processes during this six-year period was on soil aeration conditions that transiently affected CH4, N2O, and NO production and consumption rather than substrate supply.

The Exclusion treatment involves diverting rainfall (throughfall) from a 1-hectare plot using plastic panels installed in the understory. The Control treatment refers to a similar 1-hectare plot that receives natural rainfall. A total of 18 gas flux chambers for measurements of CO2, NO, N2O, CH4 were installed per treatment.

These data were collected by a collaboration of researchers from The Woods Hole Research Center (WHRC), the Instituto de Pesquisa Ambiental da Amazonia (IPAM), EMBRAPA-CPATU (Belem) and the University of Georgia.

Related Data Sets:

- LC-14 and CD-05 Rainfall Exclusion Experiment data collections will identified.

2. Data Characteristics:

The file Soil_Trace_Gas_Emissions_Tapajos.csv is a comma-delimited file containing the means and standard errors of the 18 total trace gas emissions measurements per treatment (rainfall exclusion or control) per sampling date for the Flona Tapajos Rainfall Exclusion Site. 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 measurement was made before or after the rain exclusion went into effect. A -9999 has been listed wherever values are missing. 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: Soil_Trace_Gas_Emissions_Tapajos.csv

Column Number	Heading	Description
1	Site	Study Site: Flona-rainfall exclusion
2	Date	Sample date (YYYY/MM/DD)
3	Day_of_year	Day of year
4	Treatment_status	Treatment: pre-exclusion, post-exclusion
5	Treatment	Treatment class: exclusion, control
6	CO2_mean	Carbon dioxide, mean
7	CO2_std_err	Carbon dioxide, standard error
8	CO2_reps	Carbon dioxide, number of repetitions
9	CO2_units	Carbon dioxide, measurement units
10	NO_mean	Nitric oxide, mean
11	NO_std_err	Nitric oxide, standard error
12	NO_reps	Nitric oxide, number of repetitions
13	NO_units	Nitric oxide, measurement units
14	N2O_mean	Nitrous oxide, mean
15	N2O_std_err	Nitrous oxide, standard error
16	N2O_reps	Nitrous oxide, number of repetitions
17	N2O_units	Nitrous oxide, measurement units
18	CH4_mean	Methane, mean
19	CH4_std_err	Methane, standard error
20	CH4_reps	Methane, number of repetitions
21	CH4_units	Methane, measurement units

Example data record:

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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

Flona-rainfall exclusion,1998/09/10,253,pre-exclusion,exclusion,0.14,0.01,18,g C/m2/h,
6.19,1.11,18,ng N/cm2/h,0.62,0.08,16,ng N/cm2/h,
-0.90,0.44,16,mg CH4/m2/d
Flona-rainfall exclusion,1998/09/10,253,pre-exclusion,control,0.12,0.01,18,g C/m2/h,
3.93,0.47,18,ng N/cm2/h,0.61,0.10,17,ng N/cm2/h,
-0.36,0.61,17,mg CH4/m2/d
...
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Flona-rainfall exclusion,2005/04/12,105,post-exclusion,exclusion,0.10,0.02,18,g C/m2/h,
0.27,0.02,18,ng N/cm2/h,4.52,0.78,18,ng N/cm2/h,
-0.37,0.23,18,mg CH4/m2/d
Flona-rainfall exclusion,2005/04/12,105,post-exclusion,control,0.09,0.01,18,g C/m2/h,
0.36,0.04,18,ng N/cm2/h,5.54,1.33,18,ng N/cm2/h,
-0.26,0.17,18,mg CH4/m2/d

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) - Rainfall Exclusion Site (Para Western(Santarem))	- 54.959	-54.959	--2.857	- 2.857	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1998/09/10 to 2005/04/10.
- Temporal Resolution: Quarterly

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:

Changes in precipitation in the Amazon Basin resulting from regional deforestation, global warming, and El Nino events may affect emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and nitric oxide (NO) from soils. Changes in soil emissions of radiatively important gases could have feedback implications for regional and global climate. Here we report the final results of five year of a large-scale (1 ha) throughfall exclusion experiment, followed by one year of recovery with natural throughfall, conducted in a mature evergreen forest near Santarem, Brazil. The exclusion manipulation lowered annual N2O emissions in 4 out of 5 treatment years (a natural drought year being the exception), and then

recovered during the first year after the drought treatment stopped. See Davidson et al. (2008) for more information.

4. Quality Assessment:

The quality of each flux measurement was vetted by the PI. Measurements were discarded if measured concentrations were outside of a reasonable range, or where the tracing of chamber concentrations was too erratic to reliably fit a slope. See Davidson et al. (2008) for more information.

5. Data Acquisition Materials and Methods:

Two 1 ha plots were identified from an initial survey of 20 ha of forest. A 1.5 m deep trench was excavated around the perimeter of the treatment plot to reduce the potential for lateral movement of soil water from the surrounding forest into the plot. A similar trench was excavated around the control plot to avoid the confounding of treatment and trenching effects. All measurements reported here were taken at least 20 m from the trench edge to guard against edge effects.

Plastic PAR-transmitting greenhouse panels were installed in the understory of the exclusion plot only for the duration of the rainy season. The panels were
installed such that small gaps were left around tree stems to allow in nutrient-rich stemflow. In all, about half of the annual rainfall was diverted from the exclusion plot. While they were in place, panels were flipped on their sides every two days to return any accumulated litter to the forest floor beneath.

Eighteen soil gas flux chambers were installed in each plot for a total of 18 CO2, NO, N2O, CH4 measurements per treatment.

Fluxes of nitric oxide (NO) and carbon dioxide (CO2) were 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 were measured by filling syringes with gas from static chamber headspace at 10-minute intervals, and analyzing the samples in a laboratory using gas chromatography.

Discussion of methods can be found in Davidson et al., 2008 and Verchot et al., 1999 and 2000.

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:

Davidson, E.A., D.C. Nepstad, F.Y. Ishida, P.M. Brando. 2008. Effects of an experimental drought and recovery on soil emissions of carbon dioxide, methane, nitrous oxide, and nitric oxide in a moist tropical forest. Global Change Biology 14:2582-2590. DOI: 10.1007/s10533-008-9231-6

Verchot LV, Davidson EA, Cattanio JH, Ackerman IL (2000) Land use change and biogeochemical controls of methane fluxes in soils in eastern Amazonia. Ecosystems 3:41-56. doi:10.1007/s100210000009

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 13:31-34. doi:10.1029/1998GB900019

Related Publications

- Nepstad, D.C., P. Moutinho, M.B. Dias, E. Davidson, G. Cardinot, D. Markewitz, R. Figueiredo, N. Vianna, J. Chambers, D. Ray, J.B. Guerreiros, P. Lefebvre, L. Sternberg, M. Moreira, L. Barros, F.Y. Ishida, I. Tohlver, E. Belk, K. Kalif, and K. Schwalbe. (2002) The effects of partial throughfall exclusion on canopy processes, aboveground production, and biogeochemistry of an Amazon forest. Journal of Geophysical Research-Atmospheres, Vol. 107, No. D20.
- Davidson, E.A., F.Y. Ishida, D.C. Nepstad. 2004. Effects of an experimental drought on soil emissions of carbon dioxide, methane, nitrous oxide, and nitric oxide in a moist tropical forest. Global Change Biology 10:718-730. doi:10.1111/j.1365-2486.2004.00762.x
- Davidson, E.A., D.C. Nepstad, F.Y. Ishida, P.M. Brando. 2008. Effects of an experimental drought and recovery on soil emissions of carbon dioxide, methane, nitrous oxide, and nitric oxide in a moist tropical forest. Global Change Biology 14:2582-2590. DOI: 10.1007/s10533-008-9231-6