LBA-ECO TG-08 NO, N2O and CO2 Fluxes from Forest and Pasture Soils, Rondonia, Brazil

Summary:

This data set includes the results of measurements of the soil gas fluxes of nitric oxide (NO), nitrous oxide (N2O), and carbon dioxide (CO2), soil moisture, soil temperature, and soil pools of ammonium and nitrate in response to a simulated rain event. Study sites were soils in mature forests and pastures of two ages (11 and 26 yrs old). The study took place during the dry season in August 1998 at Fazenda Nova Vida, Rondonia in the Brazilian Amazon. There is one comma-delimited ASCII file with this data set.

This study investigated how changes in soil moisture (i.e., rains at the end of the dry season) affected the fluxes of NO, N20 and CO2 from forest and pasture soils in the southwestern Brazilian Amazon (Garcia-Montiel, et al., 2003). The main objectives were to measure the short-term dynamics of soil emissions of NO, N20, and CO2 in forest and pasture soils associated with soil wetting after prolonged dryness; and quantify the contribution of the pulses of N oxide fluxesresulting from soil wetting to dry season and annual fluxes.

Data Citation:

Cite this data set as follows:

Garcia-Montiel, D.C., Steudler, P.A., Piccolo, M., Neill, C., Melillo, J., and C.C. Cerri. 2012. LBA-ECO TG-08 NO, N2O and CO2 Fluxes from Forest and Pasture Soils, Rondonia, Brazil. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 June of 2012. Users who download the data between June 2012 and May 2017 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 website [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-08 (Melillo / Cerri)

The investigators were Garcia-Montiel, Diana Cecilia; Steudler, Paul A.; Piccolo, Marisa de Cassia; Neill, Christopher; Melillo, Jerry M.; Cerri, Carlos C. and Cerri, Carlos C. You may contact Steudler, Paul A. (steudler@mbl.edu).

LBA Data Set Inventory ID: TG08_Soil_Gas_Wetting

This study investigated how changes in soil moisture (i.e., rains at the end of the dry season) affected the fluxes of NO, N20 and CO2 from forest and pasture soils in the southwestern Brazilian Amazon (Garcia-Montiel, et al., 2003). The main objectives were to measure the short-term dynamics of soil emissions of NO, N20, and CO2 in forest and pasture soils associated with soil wetting after prolonged dryness; and quantify the contribution of the pulses of N oxide fluxesresulting from soil wetting to dry season and annual fluxes.

2. Data Characteristics:

Data are available in one comma separated ASCII file titled: TG08_Wetup_fluxes.csv

Column	Heading	Units/format	Description
1	State		State in which study was done
2	Location		Location of the study: all data were collected at Fazenda Nova Vida
3	Year	YYYY	Year in which measurements were made (YYYY)
4	Month	8	Month in which measurements were made (8=August)
5	Day	DD	Day of the month on which measurements were made (DD)
6	Time	HH:MM	Start time for flux measurements in local time on a 24 hour clock. Local time is GMT-4
7	Chronosequence		Chronosequence id
8	Landuse		Landuse type: plots were either in forest or pasture
9	Yr_formed	YYYY	Year in which the pasture was created for pasture sites
10	Time_seq		A sequential integer assigned to each flux measurement in a given plot showing the order measurements were taken. Negative numbers were measurements made before irrigations were applied to treated plots
11	Time_treatment	hours	Time before (negative) or after (positive) irrigation treatment
12	Plot		Plot number: each plot was 1 by 2 meters
13	Treatment	CONTROL or IRRIGATE	Irrigate plots were treated with 60 L (30 mm) of water while control plots had no water additions. Measurements taken prior to irrigation treatments in the three plots per land use that did get irrigated were marked control indicating they had not yet been treated.
14	NO_flux	ug NO-N/m2/hr	Flux of nitric oxide measured as micrograms of N in the form of nitric oxide per meter squared of soil per hour. Positive values represent a net flux from the soil to the atmosphere and negative values a net flux from the atmosphere to the soil.
15	CO2_flux	mg CO2-C/m2/hr	Flux of carbon dioxide measured as milligrams of carbon dioxide per meter squared of soil per hour. Positive values represent a net flux from the soil to the atmosphere and negative values a net flux

			from the atmosphere to the soil
16	N2O_flux	ug NO2-N/m2/hr	Flux of nitrous oxide measured as micrograms of N in the form of nitrous oxide per meter squared of soil per hour. Positive values represent a net flux from the soil to the atmosphere and negative values a net flux from the atmosphere to the soil
17	NH4_soil_conc_A	ug NH4-N per gm dry soil	Soil ammonium concentration measured in the 0 to 2 cm depth
18	NH4_soil_conc_B	ug NH4-N per gm dry soil	Soil ammonium concentration measured in the 2 to 5 cm depth
19	NH4_soil_conc_C	ug NH4-N per gm dry soil	Soil ammonium concentration measured in the 5 to 10 cm depth
20	N03_soil_conc_A	ug NO3-N per gm dry soil	Soil nitrate concentration measured in the 0 to 2 cm depth
21	NO3_soil_conc_B	ug NO3-N per gm dry soil	Soil nitrate concentration measured in the 2 to 5 cm depth
22	NO3_soil_conc_C	ug NO3-N per gm dry soil	Soil nitrate concentration measured in the 5 to 10 cm depth
23	Soil_moisture_A	gm water/gm dry soil	Percent soil water measured in the 0-2 cm depth,
24	Soil_moisture_B	gm water/gm dry soil	Percent soil water measured in the 2-5 cm depth
25	Soil_moisture_C	gm water/gm dry soil	Percent soil water measured in the 5-10 cm depth
26	Temp_air	degrees C	Ambient air temperature
27	Temp_soil_A	degrees C	Soil temperature at 2 cm depth
28	Temp_soil_B	degrees C	Soil temperature at 5 cm depth
29	Temp_soil_C	degrees C	Soil temperature at 10 cm depth
Missing data are indicated with -9999			

Example data records:

State,Location,Year,Month,Day,Time,Chronosequence,Landuse,Yr_formed,Time_seq,Time_treatment,Plot,Treatment,
NO_flux,CO2_flux,N2O_flux,NH4_soil_conc_A,NH4_soil_conc_B,NH4_soil_conc_C,N03_soil_conc_A,NO3_soil_conc_B,
NO3_soil_conc_C,Soil_moisture_A,Soil_moisture_B,Soil_moisture_C,Temp_air,Temp_soil_A,
Temp_soil_B,Temp_soil_C

```
RONDONIA,NOVA VIDA,1998,8,19,12:17,PVA1,FOREST,0,-2,-20.32,101,CONTROL,
48.36, 56.35,0.37,-9999,-9999,-9999,-9999,-9999,-9999,-9999,
-9999,-9999,32.5,25,23,23.25
RONDONIA,NOVA VIDA,1998,8,20,7:09,PVA1,FOREST,0,-1,-1.38,101,CONTROL,
36.49, 47.71,1.89,21.46,3.03,2.39,43.21,9.33,5.97,12.5,
11.29,14.35,20,22.5,23,23
RONDONIA,NOVAVIDA,1998,8,20,9:32,PVA1,FOREST,0,1,0.42,101,IRRIGATE,
122.23,90,-5.89,14.18,0.21,0.17,29.39,8.3,4.15,4.19,
17.05,15.75,23.5,23.5,23,23
...
RONDONIA,NOVAVIDA,1998,8,17,14:19,PVA1,PASTURE,1987,-2,-17.88,201,CONTROL,
1.31,112.91,7.39,-9999,-9999,-9999,-9999,-9999,-9999,-9999,
-9999,-9999,36,29.5,27.25,26.25
RONDONIA,NOVAVIDA,1998,8,18,6:52,PVA1,PASTURE,1987,-1,-1.37,201,CONTROL,
-0.79,106.37,5.91,19.99,8.08,4.15,0.19,0.85,0.09,10.57,10.86,
11.06,19.25,23.5,24,23.5
RONDONIA,NOVAVIDA,1998,8,18,9:03,PVA1,PASTURE,1987,1,0.4,201,IRRIGATE,
1.69,188.8,-7.29,17.66,4.97,3.77,1.36,0.65,0.17,28.1,15.26,14.15,28.25,26,24.75,24
...
RONDONIA,NOVAVIDA,1998,8,22,-9999,PVA1,PASTURE,1972,-1,-1.47,305,CONTROL,
,-1.27,73.28,23.23,2.84,4.17,0,0,1.18,0.57,6.37,
8.16,8.7,27,25,25,24
RONDONIA,NOVAVIDA,1998,8,22,12:57,PVA1,PASTURE,1972,1,4.12,305,CONTROL,
0.51,85.91,7.75,4.1,1.12,0,1.28,0.49,0.38,7.74,
8.74,9.26,36,32.5,29,27
RONDONIA,NOVAVIDA,1998,8,23,10:40,PVA1,PASTURE,1972,2,25.45,305,CONTROL,
-0.4,91.49,5.37,7.93,3.05,2.3,0.49,1.1,0,6.68,
8.56,9.02,29,26.5,25.25,23
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Site boundaries: (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Rondonia - Fazenda Nova Vida (Rondonia)	-62.81100	-62.81100	-10.15600	-10.15600	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1998/08/17 to 1999/08/23.
- Temporal Resolution: Approximately every 1.5 hours

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / GC (GAS CHROMATOGRAPH) / GAS/AIR
- FIELD INVESTIGATION / IRGA (INFRARED GAS ANALYZER) / SOIL GAS/AIR
- FIELD INVESTIGATION / WEIGHING BALANCE / SOIL MOISTURE/WATER CONTENT
- FIELD INVESTIGATION / CHEMILUMINESCENCE / NITROGEN
- FIELD INVESTIGATION / ION CHROMATOGRAPH / NITRATE

3. Data Application and Derivation:

Trace gas fluxes from tropical forests are important components of the global carbon and nitrogen budgets. These data improve our understanding of the effects of land-use change on the seasonal dynamics of soil-atmosphere gas exchange of NO, N2O and CO2.

4. Quality Assessment:

NO: A 1.032 ppmv NO standard in O2 free N2 (Scott-Marrin, Riverside, CA) was diluted with NO/NO2 free air to produce a 49.2 ppbv NO standard. Ambient air was passed sequentially through scrubbers containing drierite and ascarite to produce NO/NO2 free air (<0.06ppbv NO). The analyzer was calibrated before and after each daily field sampling and varied by less than +10% between calibrations.

CO2: A certified standard of 826 ppmv CO2 in air from Scott Specialty Gases was used to calibrate the IRGA. The analyzer was calibrated before and after each daily field sampling and varied by less than 1% between calibrations.

N20: A Scott-certified standard of 0.985 ppmv N2O in N2 was used for calibration. Prior calibrations with multiple standards showed that the detector response was linear from 0.310 ppmv (ambient) to at least 1.00 ppmv. Nitrous oxide fluxes were calculated using the linear change in N2O concentration against incubation time.

5. Data Acquisition Materials and Methods:

Field site description

This study was conducted at Fazenda Nova Vida, located at km 472 of highway BR-364 in central Rondonia. The climate of the area is characteristic of humid tropical forest, with an annual precipitation of 2,270 mm distributed seasonally with a dry season extending from June through September. Mean annual maximum and minimum temperatures are 25.6 and 18.8 degrees C, respectively, with a seasonal variation of approximately 4 degrees C (Bastos and Diniz 1982). All sites used in this study were in areas at an elevation of approximately 150 m with minimal relief. Soils contained between 20 to 30% clay and were classified as redyellow podzolic latosol in the Brazilian classification and as Kandiudult in the U.S. classification (Moraes et al. 1995).

The sites included a forest and two pastures, one created in 1987 and the other in 1972. At the time of this study the pasture created in 1987 was 11 years old and the pasture created in 1972 was 26 years old.

- Forest vegetation consisted of open moist tropical forest with a large number of palm trees. This forest was altered by selective logging, which removed 1 to 3 trees/ha between 1987 and 1989.
- The pastures were formed by slash and burning of the original forest with no intermediate cropping phase, soil tilling, chemical fertilization or liming. Both pastures were planted with Brachiaria brizantha (Hochst) Stapf. All sites used in this study were in areas at an elevation of approximately 150 m with minimal relief. Soils contained between 20 to 30% clay and were classified as redyellow podzolic latosol in the Brazilian classification and as Kandiudult in the U.S. classification (Moraes et al. 1995).

Experimental design

Five 1 by 2 m plots were established in each of the forest and in the two pasture sites. One half of each plot was used for gas flux measurements; the other half was used for soil sampling for soil water content and inorganic N pools. Three of the five established plots were randomly selected for irrigation. The other two non-irrigated plots were used as controls.

Rainfall of 30 mm was simulated by sprinkling 60 L of stream water in each plot. Using stream water to irrigate the plots did not cause N fertilization of soils because concentrations of NH4+ and NO3- (0.74 and 2.09 uM/L) were very small relative to the concentrations in the soil solution.

- On August 18,1998, rain was simulated (30 mm) in the 11-year-old pasture site
- On August 20th, 1998, rain was simulated in the forest site.
- On August 22, 1998, rain was simulated in the 26-year old pasture site.

Measurement Frequency:

At each treatment site, soil gas fluxes were measured between 1500 and 1700 hours the day before the start of the irrigation, and again at about 0600 hours the day of the treatment (immediately before irrigation). Addition of water to the plot usually took 7 to 8 minutes. In order to allow water to percolate into the soil, we waited approximately 20 minutes and then made a series of measurements at 1 to 1.5 hour intervals for the next 12 hours to follow the time course of the emissions. Fluxes were measured once more the next day, approximately 30 to 34 hours after irrigation.

Control plots were measured four times over the whole experiment: 1) the day before irrigation, 2) the morning immediately before irrigation, 3) at approximately mid-day on the day of irrigation and 4) the next day at the end of the experiment.

Air and soil temperatures:

Shaded ambient air temperature about 1 m above the ground was measured during each incubation. Soil temperature at 2, 5, and 10 cm depth were measured during each incubation. Because of large temperature variation in pastures, readings were conducted before and after the incubation and then average values were used for flux calculations.

Gas measurements and sampling:

NO, N2O and CO2 were measured using a re-circulating chamber design. A modified two-piece chamber design was used (Bowden et al., 1990) where the lower portion of the PVC chamber (anchor) was inserted 2 cm into the soils at least 2 days before the experiment and left in place for the duration of the experiment. During each flux measurement, the chamber top was placed on the anchor giving 7.0-8.5 L headspace, and the changes in headspace-gas concentrations were measured over a 20 minute incubation time. The chamber top was also equipped with a luer lock sampling port for collecting headspace-gas samples for N2O analysis.

Field Gas measurements:

NO concentrations were measured with a Unisearch Associates LMA-4 NO2 analyzer. Our design used the LICOR pumping system to circulate air at 1 L/min through 1/4 Teflon lines connected to the chamber top. The internal NO analyzer pump subsampled this airflow at about 400ml/min and returned the air to circulating sample stream. A Campbell data logger was used to record the outputs from the NO Analyzers at 5-second intervals. Incubations were initiated by collecting ambient air concentration data for at least 1 minute prior to placing the chamber top on the anchor to ensure initial conditions were stable and representative. The Unisearch NO2 analyzer determines NO concentrations using a Luminol chemiluminescent technique with a CrO3 converter to oxidize NO to NO2. We modified the analyzer to increase the efficiency of water removal from the analyzer sample air stream by increasing the pressure differential across the stock Nafion dryer and by connecting an inline silica gel drying tube to the outer shell of the drier. This modification resulted in stable converter efficiencies for at least 50 hrs of use under 25-30 degrees C temperature and approximately 90% relative humidity conditions. We also added a 1/4 Teflon line to return the exhaust from the analyzer air pump back to the circulating sample air stream.

Fluxes were calculated from the rate of increase or decrease of NO concentrations using the steepest linear portion of the curve, usually within 1 or 2 minutes after placing the chamber top on the anchor. This procedure allowed deposition of ambient NO2 and O3 to the soil surface (Davidson et al., 1991). A 1.032 ppmv NO standard in O2 free N2 (Scott-Marrin, Riverside, CA) was diluted with NO/NO2 free air to produce a 49.2 ppbv NO standard. Ambient air was passed sequentially through scrubbers containing drierite and ascarite to produce NO/NO2 free air (less than 0.06 ppbv NO). The analyzer was calibrated before and after each daily field sampling and varied by less than +10% between calibrations.

A LICOR model 6252 infrared gas analyzer (IRGA) was used to measure CO2 concentrations. Our design used the LICOR pumping system to circulate air at 1 L/min through 1/4 Teflon lines connected to the chamber top. A Campbell data logger was used to record the outputs from the CO2 analyzer at 5-second intervals. Incubations were initiated by collecting ambient air concentration data for at least 1 minute prior to placing the chamber top on the anchor to ensure initial conditions were stable and representative. A certified standard of 826 ppmv CO2 in air from Scott Specialty Gases was used to calibrate the IRGA. CO2 emissions were calculated using the steepest portion of the concentration data against incubation time from the first 2 to 4 minutes after the chamber was closed. The analyzer was calibrated before and after each daily field sampling and varied by less than +1% between calibrations.

N2O sampling and analysis:

Headspace-gas samples were collected using 10-mL Becton Dickinson syringes equipped with stopcocks for determination of (N2O) at the beginning and at 2 or 3 times during the 15-min chamber incubation.

Nitrous oxide concentrations were determined using electron capture gas chromatography with a detector temperature of 310 degrees C. Gas samples were analyzed on site within 12 hours of collection. A Scott-certified standard of 0.985 ppmv N2O in N2 was used for calibration. Prior calibrations with multiple standards showed that the detector response was linear from 0.310 ppmv (ambient) to at least 1.00 ppmv. Nitrous oxide fluxes were calculated using the linear change in N2O concentration against incubation time.

Soil sampling and analyses:

Soil samples were collected from 0-2, 2-5, and 5-10 cm soil depths in each of the 1x1 m subplots assigned for soil coring using a 2.5 cm diameter soil corer. Soil collection was synchronized with gas flux measurements. No soil was collected the day before irrigation, but it was collected early in the morning before irrigation started. Roots and stones were removed by hand the day of collection and soil was mixed by hand.

Extraction of NH4 and NO3 was done with 2 mol/L KCl. After 24 hr, extracts were centrifuged and 20 mL were preserved with phenyl mercuric acetate for later analyses using an automated flow injection system. Ammonium-nitrogen was measured colorimetrically after Nessler reaction (Piccolo et al. 1994). Nitrate-nitrogen was measured as NO2- following reduction with a Cd catalyst. (Piccolo et al. 1994) Final soil N pools were corrected for moisture content. Gravimetric moisture content was obtained by drying a soil subsample to constant weight at 105 degrees C.

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:

Bastos T.X. and Diniz T.D.de A.S. 1982. Avaliacao de clima do Estado de Rondonia para desenvolvimento agricola. EMBRAPA-CPATU, Belem, Brazil, Boletim de Pesquisa 44.

Bowden, R.D., P.A. Steudler, J.M. Melillo, and J.D. Aber. 1990. Annual nitrous oxide fluxes from temperate forest soils in the northeastern United States. J. Geophys. Res. 95: 13,997-14,005.

Davidson, E. A. 1991. Fluxes of nitrous oxide and nitric oxide from terrestrial ecosystems, in Microbial Production and Consumption of Greenhouse Gases: Methane, Nitrogen Oxides, and Halomethanes, edited by J.E. Rogers and W.B. Whitman, pp. 219-235. Am. Soc. for Microbiol., Washington D.C.

Moraes J.F.L., Volkoff B., Cerri C.C. and Bernoux M. 1995. Soil properties under Amazon forest and changes due to pasture installation in Rondonia, Brazil. Geoderma 70: 63â¿½"81.

Piccolo, M.C., Neill, C., and Cerri C.C. 1994. Net nitrogen mineralization and nitrification along a tropical forest-to-pasture chronosequence. Plant and Soil 162: 61-70.

Related Publications

- Garcia-Montiel, D.C., Steudler, P.A., Piccolo, M.C., Neill, C., Melillo, J.M., and C.C. Cerri. 2003. Nitrogen oxide emissions following wetting of dry soils in forest and pastures in Rondonia, Brazil. Biogeochemistry 64: 319-336.