LBA-ECO ND-07 Trace Gas Fluxes Under Multiple Land Uses, Brazil: 1999-2004

Revision date: August 18, 2011

Summary:

This data set reports on soil-atmosphere fluxes of trace carbon dioxide, carbon monoxide, nitrous oxide, and nitric oxide (CO2, CO, N2O, NO) under various natural and manipulated land use conditions. The studies were conducted near Brasilia, Brazil in pastures and agricultural areas under a variety of management regimes and in more natural areas of cerrado (20-50% canopy cover) and campo sujo (open, grass-dominated), which were either burned every 2 years or protected from fire. Results provide data and relationships needed for regional trace gas models. There are nine comma-separated ASCII data files with this data set.

Data Citation:

Cite this data set as follows:

Pinto, A.S., K. Kisselle, M.M.C. Bustamante, R.A. Burke, M. Molina, R.G. Zepp. 2011. LBA-ECO ND-07 Trace Gas Fluxes Under Multiple Land Uses, Brazil: 1999-2004. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1016

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 August of 2011. Users who download the data between August 2011 and July 2016 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 (Large-Scale Biosphere-Atmosphere Experiment in the Amazon)

Activity: LBA-ECO

LBA Science Component: Trace Gas and Aerosol Fluxes

Team ID: ND-07 (Zepp / Bustamante)

The investigators were Zepp, Richard G.; Bustamante, Mercedes M.C.; Burke, Roger A.; Kisselle, Keith; Molina, Marirosa; and Pinto, Alexandre de Siqueira. You may contact Bustamante, Dr. Mercedes (mercedes@unb.br) and Zepp, Dr. Richard G. (zepp.richard@epa.gov).

LBA Data Set Inventory ID: ND07_Trace_Gas_Land_Use

This data set focuses on the effects of management and land use change on the soil-atmosphere fluxes of carbon dioxide, carbon monoxide, nitrous oxide, and nitric oxide. The studies were conducted near Brasilia in pastures and agricultural areas under a variety of management regimes as well as in more 'natural' areas of cerrado (20-50% canopy cover) and campo sujo (open, grass-dominated), which were either burned every 2 years or protected from fire. To provide data and relationships needed for regional trace gas models, we measured soil-atmosphere fluxes of trace carbon and nitrogen gases (CO2, CO, N2O, NO) under various natural and manipulated conditions.

Related Data sets

- LBA-ECO ND-07 Microbial Biomass in Cerrado Soils, Brasilia, Brazil
- LBA-ECO ND-07 Hydrochemistry of Natural and Developed Land Cover, Brasilia, Brazil

2. Data Characteristics:

Data are provided in nine comma-delimited ASCII files.

Multi-site Data File:

File 1: ND07_Daily_Precip_and_T_air.csv

Column	Heading	Units/format	Description
1	Year	yyyy	Year of measurement
2	Month	mm	Month of measurement
3	Day	dd	Day of measurement

4	T_air_EMBRAPA_CPAC_mean	degrees C	Mean daily temperature in degrees Celsius at the EMBRAPA CPAC site
5	Ppt_EMBRAPA_CPAC	mm	Total rainfall accumulation over 24 hours of sampling period in millimeters (mm) at the EMBRAPA CPAC site
6	T_air_IBGE_mean	degrees C	Mean daily temperature in degrees Celsius at the IBGE site
7	Ppt_IBGE	mm	Total rainfall accumulation over 24 hours of sampling period in millimeters (mm) at the IBGE site
8	Ppt_Dom_Bosco	mm	Total rainfall accumulation over 24 hours of sampling period in millimeters (mm) at the Dom Bosco site
Missing data are represented by -9999			

Example data records:

```
Year,Month,Day,T_air_EMBRAPA_CPAC_mean,Ppt_EMBRAPA_CPAC,T_air_IBGE_mean,Ppt_IBGE,Ppt_Dom_Bosco
1999,9,1,-9999,-9999,22.2,-9999,-9999
1999,9,2,-9999,-9999,22.8,-9999,-9999
...
2000,1,1,-9999,-9999,20.9,16.6,-9999
2000,1,2,-9999,-9999,21.2,8.8,-9999
...
```

Experimental Treatment Data Files:

Fertilization

File 2: ND07_Dois_J1_Farm_Fertilization_CO2_NO_N2O_fluxes.csv

Values are either the means of in situ measurement results from multiple flux chambers or the means of results of gas and soil samples collected from multiple chambers and analyzed in the laboratory.

Column	Heading	Units/format	Description
1	Site_name		Name of farm sampled. All samples in this file were collected at Dois J1 Farm
2	Site_type		Type of farm where the fertilization experiment was conducted: Experimental Plantation
3	Crop_type		Land cover (type of crop) at the sampling site: Non-irrigated Maize
4	Date	yyyy/mm/dd	Sampling date (yyyy/mm/dd)
5	Fertilizer	kg N ha-1	Amount of nitrogen fertilizer applied per Maize growing season

6	Chamber_location		Chamber location within the crop field, either Crop rows or Between crop rows
7	CO2_flux_mean	micromol CO2 m-2 s-1	Flux of carbon dioxide across the soil surface in micromoles of CO2 per meter squared per second. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
8	NO_N_flux_mean	ng NO-N cm-2 h-1	Flux of nitric oxide across the soil surface in nanograms of nitrogen in the form of NO per centimeter squared per hour. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
9	N2O_N_flux_mean	ng N2O-N cm-2 h-1	Flux of nitrous oxide across the soil surface in nanograms of nitrogen in the form of N2O per centimeter squared per hour. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
10	WFPS_mean	%	Water filled pore space in the soil reported as a percent of total soil volume
11	T_chamber_mean	degrees C	Air temperature inside the chamber measured during the measurement of gas flux and reported in degrees Celsius
12	T_soil_2_5cm_mean	degrees C	Soil temperature at 2.5 cm depth measured during the measurement of gas flux and reported in degrees Celsius
13	T_soil_5cm_mean	degrees C	Soil temperature at 5.0 cm depth measured during the measurement of gas flux and reported in degrees Celsius
14	Soil_NO3_mean	mg kg-1 soil	Available soil nitrate extracted with 1N KCl solution and reported in mg N as nitrate per kg soil
15	Soil_NH4_mean	mg kg-1 soil	Available soil ammonium extracted with 1N KCl solution and reported in mg N as ammonium per kg soil
16	Microbial_biomass_C_mean	mg kg-1 soil	Soil microbial biomass measured as the difference in extractable soil C before and after chloroform fumigation
Missing data are represented by -9999			
Note: Coordinates for the Dois J1 Farm were not provided			

Example data records:

```
Site_name,Site_type,Crop_type,Date,Fertilizer,Chamber_location,CO2_flux_mean,NO_N_flux_me
an,N2O_N_flux_mean,WFPS_mean,T_chamber_mean,T_soil_2_5cm_mean,T_soil_5cm_mean,
Soil_NO3_mean,Soil_NH4_mean,Microbial_biomass_C_mean
Dois J1 Farm,Experimental plantation,Non-irrigated Maize,2004/11/10,0,Crop rows,0.48,1.17,
-9999,41.89,33.1,28.8,25.8,195.5,
28.14,53.76
Dois J1 Farm,Experimental plantation,Non-irrigated Maize,2004/11/10,0,Crop rows,0.96,0.47,
-9999,49.2,34.3,26.7,25.3,276.2,
16.34,67.96
...
Dois J1 Farm,Experimental plantation,Non-irrigated Maize,2005/04/29,120,Crop rows,0.52,0.3,
-18.61,29.99,31.6,25.3,24.7,215.6,
2.93,63.44
Dois J1 Farm,Experimental plantation,Non-irrigated Maize,2005/04/29,120,Crop rows,0.44,0.33,
-17.69,40.43,30.5,26,24.3,158.3,
2.96,55.95
...
```

Water Addition Experiments

File 3: ND07_IBGE_Water_addition_CO2_N2O_NO_fluxes.csv

Column	Heading	Units/format	Description
1	Date	yyyy/mm/dd	Sampling date (yyyy/mm/dd)
2	Exp_Day		Day in the experimental timeline: Day 0 indicates the initial treatment day; 0-pre indicates day 0 prior to water additions and 0-post is day 0 after water additions all other days are days since initial treatment
3	Treatment		Treatment applied: Control = no water additions; 2 cm = 2 cm of water applied; 18 cm = 18 cm of water applied
4	Chamber_num		Chamber identification number: 1-3
5	CO2_flux	micromoles CO2 m-2 s-1	Flux of carbon dioxide across the soil surface in micromoles of CO2 per meter squared per second. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
6	T_soil	degrees C	Soil temperature measured at 10 cm depth
7	T_air	degrees C	Air temperature reported in degrees Celsius
8	Moist_soil	%	Soil moisture determined after heating the soil at 110 degrees C for 48 hours
9	N2O_N_flux	ng N2O-N cm-2 h-1	Flux of nitrous oxide across the soil surface in nanograms of nitrogen in the form of N2O per centimeter squared per hour Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
10	T_chamb_N2O	degrees C	Mean temperature (degrees C) in the chamber during

			the sampling for N2O (average of initial and final temperatures)
11	NO_N_flux	ng NO-N cm-2 h-1	Flux of nitric oxide across the soil surface in nanograms of nitrogen in the form of NO per centimeter squared per hour Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
12	T_chamb_NO	degrees C	Mean temperature (degrees C) in the chamber during the sampling for NO (average of initial and final temperatures)
Missing data are represented by -9999.			

Example data records:

```
Date,Exp_day,Treatment,Chamber_num,CO2_flux,T_soil,T_air,Moist_soil,N2O_N_flux,
T_chamb_N2O,NO_N_flux,T_chamb_NO
2000/07/10,0-pre,Control,1,1.19,20.6,30.3,26.09,0.17,
24.9,0.29,30.9
2000/07/10,0-pre,Control,2,1.7,20.6,29.5,26.09,0.41,
26.75,0.06,31.4
...
2000/07/10,0-pre,2cm,1,1.87,19.8,27,9,23.79,-9999,
-9999,0.01,32.4
2000/07/10,0-pre,2cm,2,1.41,19.9,29,7,23.57,-9999,
-9999,0.01,35.5
...
2000/07/15,5,18cm,2,2.29,21.6,26.9,19.94,0.15,
30,0.36,27.9
2000/07/15,5,18cm,3,1.88,21.8,32.2,28.42,-0.47,
30,0.19,34.65
...
```

Fire Experiments

File 4: ND07_IBGE_Fire_CO_fluxes_2000.csv

Column	Heading	Units/format	Description
1	Sample_ID		Sample identification number
2	Date	yyyy/mm/dd	Sampling date (yyyy/mm/dd)
3	Treatment		Treatment codes are as follows: CSC = control for campo sujo at IBGE (not burned for 8 yrs); CSQ = campo sujo plot burned biennially since 1992 with last burn during 9/2000; CC = control for cerrado stricto senso at IBGE (not burned since 1974); CSQ = stricto senso cerrado plot burned biennially since 1992 with last burn during 9/2000
4	Chamber_num		Chamber identification number
5	Chamber_type		Chambertop describes the material used. All dark

			chambers were kimax
6	Light_conditions		Light fluxes were measured in transparent pyrex chambers; dark fluxes were measured in opaque kimax chambers
7	CO_flux	10^9 molecules cm-2 s-1	Flux of carbon monoxide measured in 10^9 molecules per centimeter squared per second (10^9 molecules cm^-2 s^-1)
8	T_soil	degrees C	Soil temperature in degrees Celsius at 10 cm depth measured at the time of the flux measurement
9	T_air	degrees C	Air temperature in degrees Celsius outside the chamber measured at the timeof the flux measurement
10	Moist_soil	%	Soil moisture at 10 cm depth in percent measured at the time of the flux measurement
11	T_chamber	degrees C	Air temperature in degrees Celsius measured in the chamber measured at the time of the flux measurement
12	UVA_init	W cm-2	Ultraviolet A radiation, including the wavelengths of 315-390 nanometers at the start of the flux measurement measured in Watts per centimeter squared (W cm^-2) with a IL 1700 readiometer with a SED 033 UVA probe
13	UVB_init	W cm-2	Ultraviolet B radiation, including the wavelengths of 280-315 nanometers at the start of the flux measurement measured in Watts per centimeter squared (W cm^-2) with a IL 1700 radiometer using a SED 240 probe
14	Full_init	W cm-2	Total radiation, including the wavelengths of 200- 4200 nanometers at the start of the flux measurement measured in Watts per centimeter squared (W cm^-2) usig an IL 1700 radiometer and an SED 623 probe
15	UVB_integ	W cm-2	Ultraviolet B radiation in the chamber integrated over the duration of the sampling period, reported in Watts per centimeter squared
Missing data are represented by -9999. Data measured but deemed unreliable and thus not reported are indicated as -6666.			

Example data records:

```
Sample_ID,Date,Treatment,Chamber_num,Chamber_type,Light_conditions,CO_flux,
T_soil,T_air,Moist_soil,T_chamber,UVA_init,UVB_init,Full_init,UVB_integ
218,1999/09/08,CSQ,4,Kimax,Dark,8.54E+10,
27.8,33.6,33.5,-9999,-9999,-9999,-9999,-9999,
217,1999/09/08,CSQ,3,Pyrex,Light,5.20E+10,
27.8,33.6,33.5,-9999,-9999,-9999,-9999,-9999
...
18,2000/09/24,CC,6,Kimax,Dark,4.69E+11,
20.8,38,36.6,47.1,2.61E-03,1.77E-05,7.66E-02,1.97E-02
17,2000/09/24,CC,5,Kimax,Dark,2.57E+10,
20.8,38,36.6,40,2.61E-03,1.77E-05,7.66E-02,1.97E-02
...
```

File 5: ND07_IBGE_Fire_CO2_NO_fluxes_2000.csv

Column	Heading	Units/format	Description
1	Site_name		Sample site: IBGE Brasilia
2	Station_ID		Station identification code: Treatment code (column 3) concatenated with Chamber number (column 4)
3	Treatment		Treatment codes are as follows: CSC = control for campo sujo at IBGE (not burned for 8 yrs); CSQ = campo sujo plot burned biennially since 1992 with last burn during 9/2000; CC = control for cerrado stricto senso at IBGE (not burned since 1974); CSQ = stricto senso cerrado plot burned biennially since 1992 with last burn during 9/2000
4	Chamber_num		Chamber number: 1-6
5	Date	yyyy/mm/dd	Sampling date (yyyy/mm/dd)
6	CO2_flux	micromol CO2 m-2 s-1	Flux of carbon dioxide across the soil surface in micromoles of CO2 per meter squared per second. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
7	T_chamb_CO2	degrees C	Air temperature inside the chamber measured during the measurement of CO2 gas flux and reported in degrees Celsius
8	T_air_CO2	degrees C	Air temperature outside the chamber measured during the measurement of CO2 gas flux and reported in degrees Celsius
9	T_soil_CO2	degrees C	Soil temperature at 10 cm depth measured during the measurement of CO2 gas flux and reported in degrees Celsius
10	NO_N_flux	ng NO-N cm-2 h-1	Flux of nitric oxide across the soil surface in nanograms of nitrogen in the form of NO per centimeter squared per hour Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
11	T_chamber_NO	degrees C	Air temperature inside the chamber measured during the measurement of NO gas flux and reported in degrees Celsius
12	T_air_NO	degrees C	Air temperature outside the chamber measured during the measurement of NO gas flux and reported in degrees Celsius
13	T_soil_NO	degrees C	Soil temperature at 10 cm depth measured during the measurement of NO gas flux and reported in degrees Celsius
Missing data are represented by -9999. Data measured but deemed unreliable and thus not reported are indicated as -6666.			

Example data records:

```
Site_name,Station_ID,Treatment,Chamber_num,Date,CO2_flux,T_chamb_CO2,
T_air_CO2,T_soil_CO2,NO_N_flux,T_chamb_NO,T_air_NO,T_soil_NO
IBGE,CC1,CC,1,2000/04/04,4.7,-9999,
22,23,-9999,-9999,-9999,-9999
IBGE,CC2,CC,2,2000/04/04,4.5,-9999,
22,23,-9999,-9999,-9999,-9999
...
IBGE,CC5,CC,5,2000/10/19,2.5,40,
36.2,19.8,1.09,40,36.2,19.8
IBGE,CC6,CC,6,2000/10/19,2.9,40.3,
36.2,19.8,0.31,40.3,36.2,19.8
...
```

Land Cover Types

File 6: ND07_Crops_CO2_NO_N2O_fluxes.csv

Values are either the means of in situ measurement results from multiple flux chambers or the means of results of gas and soil samples collected from multiple chambers and analyzed in the laboratory.

Column	Heading	Units/format	Description
1	Site_name		Farm or experimental station at which the samples were collected
2	Land_use		Description of the management of the sampling area with dominant crop
3	Vegetation		Information about the land cover including land use (crop type, pasture or cerrado) as well as location within the land cover (between or within crop rows)
4	Date	yyyy/mm/dd	Sampling date (yyyy/mm/dd)
5	Phase		Sample collection timing with respect to major events within the growing season/management regime
6	CO2_flux_mean	micromol CO2 m-2 s-1	Flux of carbon dioxide across the soil surface in micromoles of CO2 per meter squared per second. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
7	NO_N_flux_mean	ng NO-N cm-2 h-1	Flux of nitric oxide across the soil surface in nanograms of nitrogen in the form of NO per centimeter squared per hour. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
8	N2O_N_flux_mean	ng N2O-N cm-2 h-1	Flux of nitrous oxide across the soil surface in nanograms of nitrogen in the form of N2O per centimeter squared per hour. Positive values

			indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
9	WFPS_mean	%	Water filled pore space in the soil reported as a percent of total soil volume
10	T_chamber_mean	degrees C	Air temperature inside the chamber measured during the measurement of gas flux and reported in degrees Celsius
11	T_soil_2_5cm_mean	degrees C	Soil temperature at 2.5 cm depth measured during the measurement of gas flux and reported in degrees Celsius
12	T_soil_5cm_mean	degrees C	Soil temperature at 5.0 cm depth measured during the measurement of gas flux and reported in degrees Celsius
13	Soil_NO3_mean	mg kg-1 soil	Available soil nitrate extracted with 1N KCl solution and reported in mg N as nitrate per kg soil
14	Soil_NH4_mean	mg kg-1 soil	Available soil ammonium extracted with 1N KCl solution and reported in mg N as ammonium per kg soil
15	Microbial_biomass_C_mean	mg kg-1 soil	Soil microbial biomass measured as the difference in extractable soil C before and after chloroform fumigation
Missing data are represented by -9999			

Example data records:

Site_name,Land_use,Vegetation,Date,Phase,CO2_flux_mean,NO_N_flux_mean,
N2O_N_flux_mean,WFPS_mean,T_chamber_mean,T_soil_2_5cm_mean,
T_soil_5cm_mean,Soil_NO3_mean,Soil_NH4_mean,
Microbial_biomass_C_mean
Pamplona Farm,Non-irrigated cotton under Brachiaria straw,Cotton,2004/11/23,Before planting,0.41,0.8,
-9999,33.86,33.7,27.6,25.6,40.13,18.61,
289.58
Pamplona Farm,Non-irrigated cotton under Brachiaria straw,Cotton,2004/11/23,Before planting,0.38,0.86,
-9999,36.34,32.6,27.1,25.7,72.79,21.73,
240.68
...
Pamplona Farm,Non-irrigated cotton under Brachiaria straw,Cotton (crop rows),2004/12/23,After first fertilization,1.95,1.74,
-9999, 41.97,23.6,23.3,23.6,707.14,7.03,
98.89
Pamplona Farm,Non-irrigated cotton under Brachiaria straw,Cotton (crop rows),2004/12/23,After first fertilization,2.56,0.32,
0.69,46.54,23.4,23.7,23.4,320.89,12.17,
240.36
...

File 7: ND07_Pastures_CO2_NO_N2O_fluxes_1999-2002.csv

Column	Heading	Units/format	Description
1	Site_name		Name of study site: EMBRAPA Pasture or Rio de Janeiro
2	Site_type		Site type: Pasture or Mixed species pasture
3	Vegetation		Dominant vegetation species
4	Notes		Information from the field notes on pasture management
5	Irrigation		Irrigation status, where 1 = irrigated site and 2=sites without irrigation
6	Year	yyyy	Year in which the sampling was done (yyyy)
7	Month	mm	Month in which the sampling was done with 1=January and 12=December
8	Base_num		Identification number for chamber base at the EMBRAPA site: 1 - 8
9	CO2_flux	micromol CO2 m-2 s-1	Flux of carbon dioxide across the soil surface in micromoles of CO2 per meter squared per second. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
10	N2O_N_flux	ng N2O-N cm-2 h-1	Flux of nitrous oxide across the soil surface in nanograms of nitrogen in the form of N2O per centimeter squared per hour. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
11	NO_N_flux	ng NO-N cm-2 h-1	Flux of nitric oxide across the soil surface in nanograms of nitrogen in the form of NO per centimeter squared per hour. Positive values indicate a flux from the soil to the atmosphere; negative values indicate a flux from the atmosphere to the soil
12	T_Air	degrees C	Air temperature in degrees Celsius
13	T_Soil_2_5	degrees C	Soil temperature at 2.5 cm depth in degrees Celsius
14	T_Soil_5	degrees C	Soil temperature at 5 cm depth in degrees Celsius
15	T_Soil_10	degrees C	Soil temperature at 10 cm depth in degrees Celsius
16	GWC	percent	Gravimetric water content
Missing data are represented by -9999			

Example data records:

```
Site_name,Site_type,Vegetation,Notes,Irrigation,Year,Month,Base_num,CO2_flux,
N2O_N_flux,NO_N_flux,T_Air,T_Soil_2_5,T_Soil_5,T_Soil_10, GWC
EMBRAPA Pasture,Pasture,Brachiaria brizantha,-9999,0,1999,10,1,4.16,
4.31,-9999,26.8,-9999,20.2,-9999,-9999
EMBRAPA Pasture,Pasture,Brachiaria brizantha,-9999,0,1999,10,2,5.23,
-1.56,-9999,28.3,-9999,19.1,-9999,-9999
...
Rio de Janeiro,Pasture,Brachiaria brizantha,fertilized pasture without water
addition,0,2001,10,1,10.34,
```

-0.08,0.02,26.2,27.3,27.1,26.3,-9999
Rio de Janeiro,Pasture,Brachiaria brizantha,fertilized pasture without water addition,0,2001,10,2,10.29,
2.61,0,25.8,23.9,23.9,23.6,-9999
...
Rio de Janeiro,Mixed species pasture,Brachiaria brizantha+ Stylosanthes guianensis cv. Mineirao,without water addition,0,2002,1,8,5.95,
0.97,0,31,-9999,-9999,-9999,-9999
Rio de Janeiro,Mixed species pasture,Brachiaria brizantha+ Stylosanthes guianensis cv. Mineirao,without water addition,0,2002,2,1,-9999,
-0.86,0.11,-6999,29.6,27.8,26.4,-9999
...

File 8: ND07_Soil_moisture_EMBRAPA.csv

Column	Heading	Units/format	Description
1	Year	yyyy	Year sampled
2	Month	mm	Month sampled with 1=January and 12=December
3	GWC	percent	Gravimetric water content (%) from 0-5 cm deep soil samples

Example data records:

Year,Month,GWC
2000,2,39.7
2000,2,36.9
2000,2,39.4
...
2000,8,12.5
2000,8,14.3
2000,8,12.6
...

File 9: ND07_Soil_moisture_Fazenda_Rio_de_Janeiro.csv

Column	Heading	Units/format	Description
1	Year	yyyy	Year sampled
2	Month	mm	Month sampled where 1=January and 12=December
3	Plot		Plot identification number
4	Vegetation		Description of the dominant vegetation
5	GWC	percent	Gravimetric water content from 0-5 cm deep soil samples, expressed as percent (%)
6	WFPS	percent	Water-filled pore space calculated from the gravimetric water content, expressed as percent (%)

Example data records:

```
Year,Month,Plot,Vegetation,GWC,WFPS
2001,11,1,Fertilized Brachiaria,34.9,76.5
2001,11,1,Fertilized Brachiaria,28.8,64.5
...
2001,11,2,Mixed species,35.3,87.3
2001,11,2,Mixed species,37.3,92.1
...
2002,4,3,Traditional pasture (Brachiaria),32.7,67.6
2002,4,3,Traditional pasture (Brachiaria),31,64
...
2001,11,4,Young pasture (2 yr old Brachiaria),33.7,75.3
2001,11,4,Young pasture (2 yr old Brachiaria),34.9,78.2
...
```

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Brasilia - Reserva Ecologica do Roncador IBGE (Brasilia)	-47.85060	-47.85060	-15.93280	-15.93280	World Geodetic System, 1984 (WGS-84)
Brasilia - Fazenda Dom Bosco (Brasilia)	-47.50000	-47.50000	-16.30000	-16.30000	World Geodetic System, 1984 (WGS-84)
Brasilia - Fazenda Rio de Janeiro (Brasilia)	-47.70000	-47.70000	-15.23333	-15.23333	World Geodetic System, 1984 (WGS-84)
Brasilia - Pamplona (Brasilia)	-47.25056	-47.25056	-16.25056	-16.25056	World Geodetic System, 1984 (WGS-84)
Brasilia - EMBRAPA CPAC (Brasilia)	-47.74356	-47.74356	-15.61042	-15.61042	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1999/09/09 to 2005/12/31.
- Temporal Resolution: Temporal resolution varied between daily and monthly for the different sites and treatments

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / SPECTROPHOTOMETER / SOIL GAS/AIR
- FIELD INVESTIGATION / SPECTROPHOTOMETER / NITROGEN
- LABORATORY / WEIGHING BALANCE/SOIL MOISTURE/ WATER CONTENT
- LABORATORY / CHEMILUMINESCENCE / NITROGEN OXIDES
- LABORATORY / CARBON ANALYZER / CARBON
- FIELD INVESTIGATION / SOIL TEMPERATURE PROBE / SOIL TEMPERATURE
- FIELD INVESTIGATION / IR CO2 ANALYZER (INFRARED CARBON DIOXIDE ANALYZER / SOIL RESPIRATION
- METEOROLOGICAL STATION / TEMPERATURE SENSOR / AIR TEMPERATURE
- METEOROLOGICAL STATION / RADIOMETERS / SOLAR IRRADIANCE
- FIELD INVESTIGATION / PHOTOMETER / ULTRAVIOLET RADIATION
- FIELD INVESTIGATION / IR CO2 ANALYZER (INFRARED CARBON DIOXIDE ANALYZER) / CARBON DIOXIDE

3. Data Application and Derivation:

Calculation of NO Fluxes: Fluxes were calculated from the rate of increase of NO concentration using the linear portion of the accumulation curve.

Calculation of N2O Fluxes: Fluxes were calculated from the rate of increase of N2O concentration determined by linear regression based on four samples.

Calculation of CO Fluxes: For each chamber experiment, the concentration of CO within the chamber was plotted as a function of time after sealing the chamber top over the base. Concentration versus time plots were initially plotted to determine the curve shape. Flux measurements that exhibited increasing concentrations over time were analyzed by performing linear regression on the linear portions of the curve (slope is proportional to CO exchange rate). Many of the positive curves appeared to plateau. This is likely due to the fact that although the production of CO is not dependent on concentration of CO, the consumption of CO increases with increasing CO concentration [Conrad and Seiler, 1985]. So as the CO accumulates in the chamber, the consumption of CO increases. This is an artifact of using the static chamber method since natural CO emissions are typically not contained and not concentrated. To minimize the error in computed fluxes that can result from this effect, we sometimes used only the early time points (0, 10 and 15 minutes) to calculate the CO flux. Sanhueza et al. [1994] also used only the initial points of a particular run to calculate CO fluxes. For measurements in which CO concentrations decreased with time (negative flux), flux values were calculated by multiplying the initial rate (slope x initial CO concentration) by the volume:surface area ratio of the chamber. To better compare CO uptake by the soils in the opaque chamber studies, we computed deposition velocities. The deposition velocity is defined as the ratio of the uptake rate divided by the CO concentration.

4. Quality Assessment:

Detection limits for N2O were 0.6 ng N2O cm-2 h-1 as defined by Verchot et al (1999) using similar methods.

5. Data Acquisition Materials and Methods:

Study Sites

All study sites are located near the city of Brasilia. The climate in the region is tropical (Koppen Aw, http://en.wikipedia.org/wiki/K%C3%B6ppen_climate_classification). The mean annual precipitation is about 1500 mm with two well-defined seasons: dry season (May to September) and wet season (October to April), during which 90 percent of the annual precipitation occurs.

- **IBGE:** Here, the study focused on two types of Cerrado, cerrado stricto sensu (20-50 percent canopy cover) and campo sujo (open, grass-dominated), located at the research and ecological reserve operated by the Instituto Brasileiro de Geografia e Estatistica (IBGE), 35 km south of Brasilia D.F. The soils are classified as Oxisols, very acidic, with high aluminum saturation and cation exchange capacity.
- **EMBRAPA:** The pasture was established in 1982 (*Brachiaria brizantha*) on an experimental farm of EMBRAPA-Cerrados (Empresa Brasileira de Pesquisa Agropecuaria), when an initial fertilization was done. The area was divided into several 1-ha (100 by 100 m) plots for agricultural studies. The 1-ha plot that was chosen for this work is located on the border of a tableland of about 1200 m altitude, that gently slopes (3-5%). The original vegetation of the area has been classified as cerrado sensu stricto. In 1992, the pasture was replaced by a corn field after plowing and a fertilizer addition. Corn was cultivated for 2 yr and then a new pasture of *Brachiaria brizantha* was established. Soil pits in the pasture area revealed the presence of charcoal particles. However, after the conversion to pasture, the area was not burned anymore.
- **Rio de Janeiro Farm:** This farm is located at Planaltina (Federal state of Goias, Brazil) at 826-m altitude. The soil is classified as Latossolo Vermelho in the Brazilian soil taxonomy. *Brachiaria brizantha* cv. Marandu was introduced on this farm in 1990 after removal of the native vegetation. Information about the native former vegetation was not available, but the remaining vegetation in an area adjacent to the experimental plots until 1999 was defined as cerradao (dense woodland savanna). After 9 yr of use, the pastures exhibited degradation characteristics. The carrying capacity of *B. brizantha* during the rainy season was less than 1 animal unit (AU=450 kg live weight per hectare).
- **Dom Bosco Farm:** This farm is located in the municipality of Cristalina (Federal State of Goias, Brazil), at 826 m altitude. The climate is tropical (Koppen Aw) with two well-defined seasons: dry season (May to September) and wet season (October to April), during which 90% of the annual precipitation occurs. The total precipitation between Aug. 2003 and Aug. 2004 was 2078.5 mm while between Aug. 2004 and Aug. 2005 it was 1555 mm. Precipitation peaks were observed in Nov. 2003 (392.5 mm), Dec. 2003 (295.0 mm), Jan. 2004 (360.0 mm) and Feb. 2004 (449.0 mm). The total area of the Dom Bosco farm is 2,999.4 ha, being 201.0 ha used for irrigated agriculture (central pivot), 504.0 ha for summer crops and 620 ha for legal reserve (preserved native cerrado).

  At the Dom Bosco Farm our study focused on two cultivation systems under no-till and with mechanical harvest: (a) Maize (*Zea maiz* cv. 30k75) and *Brachiaria brizantha* intercropping system followed by irrigated bean (*Phaseolus vulgaris*); (b) Soybean (*Glycine max* cv. P98C81 Pioneer) followed by natural fallow (no winter cover crop). In the maize-bean rotation system, maize was cultivated predominantly during the wet season and bean was cultivated during dry season with irrigation. This cultivation system occupies an area of 75 ha and was introduced in 1998 after ten years of *Brachiaria sp*. cultivation following conversion from native cerrado using slash-and-burn. Maize and *B. brizantha* were planted together in Sep. 2003. Maize was harvested in Feb. 2004 and *B. brizantha* was dried using the herbicide glyphosate (Roundup transorb) one month before the plantation of bean in Jun. 2004. Bean was harvested in Oct. 2004. Irrigation intervals during the bean cycle were thirty hours and six mm of the water were added. Soil remained covered all the year in maize-irrigated bean rotation. Trace gas emissions were measured in this system from Aug. 2003 to Oct. 2005. Soybean cultivation occupies 207 ha in the Dom Bosco Farm and was introduced in 1977 after removal of native cerrado using slash-and-burn. Soybean seeds were inoculated with *Bradyrizobium japonicum* and were planted in Dec. 2003. The harvest occurred in Apr. 2004. In this area, soil was practically uncovered from May to Nov. 2003 because of the rapid decomposition of crop residues. A native cerrado area with same soil type was selected as reference site. The vegetation is classified as a typical

cerrado, termed cerrado stricto sensu (Ribeiro & Walter, 1998). This area has been protected from fire since 1974 but it burned accidentally in Oct. 2004 before the last measurement of soil emissions. Trace gas measurements were taken from Sep. 2003 to Oct. 2004.

- **Pamploma Farm:** This farm is located in the same municipality as Dom Bosco Farm and is subject to the same climate conditions. This commercial farm has a total area of 14,085.2 ha, which 11,407.7 ha are cultivated and 2,677.5 ha are preserved (native cerrado). In the 2004/2005, 3,764 ha were cultivated with cotton for fiber production. An area of 721 ha with high productivity (4.5 ton ha-1), cultivated under no-till and mechanically harvested, was used in this study. Herbaceous cotton (*Gossypium hirsutum* cv. ITA 90-Pioneer) was cultivated from Nov. 2004 to Aug. 2005 over *Brachiaria ruzizienses* straw. *B*. *ruzizienses* was planted by airplane and dried with herbicide (2,4 D - U46DFluid 868/720 CS) 20 days before cotton planting. Previously (May to Oct. 2005), the area was cultivated with soybean followed by natural fallow during winter. This cultivation system was established in 1980 after removal of native cerrado using slash-and-burn. This study includes only the period cultivated with cotton. At the beginning of flowering (Mar. 2005) two applications of growth inhibitor (50 Pix CS) were made to standardize the height of the plants. This practice produces a better harvest and fiber quality. One application of the defoliant (Aurora 400 CE) was made with 70% opening bolls (May 2005). A native cerrado stricto sensu area with the same soil type was chosen as reference site. This area has been protected from fire since 1994 but it burned accidentally in Nov. 2004 before the first gas flux measurement. The measurements were taken during crop cycle from Nov. 2004 to Aug. 2005 (from wet to dry season).

Experimental Treatments:

- **IBGE- Fire Experiments:** To assess the effect of fire on soil emissions, burned and unburned plots of the two vegetation types were chosen. The burned areas have been subjected to prescribed fires every two years since 1992. The unburned areas (control) have been protected from fire since 1974. Monthly measurements have been carried out since September 1999 in the control and in the plots burned at the end of the dry season (late September) (Varella et al., 2004).
  IBGE- Water Addition Experiment: To study the effect of early season rains on the trace gas fluxes, water was added to the soil surface in the middle of dry season (July 2000). Six collars were installed in the unburned campo sujo plot and water was added to simulate 2 cm and 18 cm of rain (three per treatment). Three separate rings were used as control. Flux measurements were made before and 30 min, 1, 2, 3 and 5 days after water addition (Pinto et al., 2002).
- **Dois J1 - Fertilizer additions:**The management of fertilizers was representative for the agriculture in Brazilian Mid-West region. In general, for soybeans only one N-application is performed together with P-addition during planting. For the other crops, besides the N-fertilization during planting, one (bean) or two (maize and cotton) broadcast fertilizations are done during crop growth. In this study, two broadcast N-fertilizations were done during bean cultivation. The second broadcast fertilization with a relative low amount of urea was because of the low temperatures just after the first fertilization.
  Note: Coordinates for the Dois J1 Farm site were not provided.

Gas Flux Measurements/Collection in the Field:

- Soil surface fluxes of N2O, NO and CO2 were measured using chamber techniques. Four aluminum collars (21.6 cm diameter) were installed at each plot at least seven days before the first measurement. These collars were inserted at 5 cm depth and the top edges of the collar formed a U-shape groove into which an aluminum or PVC vented chamber (23.5 cm diameter x 20 cm height) could be set. Water in the groove provided a seal for the chamber (Varella et al., 2004). The combined volume of the chamber plus collar was about 8.3 L. NO and CO2 were measured using a dynamic chamber technique. Air was circulated in a closed loop between the chamber and the analyzers.

- CO2 was analyzed over a 3-min period using a LiCor 6200 photosynthesis system with integrated infrared gas analyzer and data system. CO2 concentrations were logged every 2 seconds s, yielding a continuous monitoring of increasing CO2 concentrations that were used to fit the most appropriate regression function. The noisy trace that usually appeared shortly after placing the chamber over the soil as a result of small pressure differentials and other disturbances was ignored when the slope of a linear regression was used to calculate the flux (Pinto et al., 2002).
- NO was analyzed using a Scintrex LMA-3, after first converting NO to NO2 by passing the gas sample through CrO3. NO2 reacts with Luminol solution to produce a luminescent reaction that is functionally related to the mixing ratio of NO2. NO concentration was recorded over a 5-min period. The instrument was calibrated twice daily using mixtures of a NO standard (0.4 ppm) with NO- and NO2-free air.
- N2O fluxes were measured with a static chamber technique (Matson et al., 1990). Four gas samples were collected from the headspace of chamber using 60 mL polypropylene syringes with siliconized polypropylene plungers at intervals of 10 minutes.
- CO fluxes and soil-atmosphere CO exchange was measured using both transparent and opaque static soil chambers. In each vegetation-fire treatment four separate chamber bases were installed (Kisselle et al., 2002). Later in the study (September 2000) two more bases were added to each site. Bases were installed in a transect, spaced 5 m apart.

  The opaque chamber tops were constructed of aluminum (volume 8.7 L) or glass borosilicate (Pyrex, volume 9.4 L) chambers covered with a layer of aluminum foil, white paper, and plastic. Similar fluxes were recorded with both types of opaque chambers. The transparent chamber tops used were jars made of Kimax (borosilicate glass; volume 9.4 L), Pyrex, or quartz (volume 13.6 L). Both the Kimax and Pyrex chamber tops were transparent to visible (400-700 nm) and UV-A (315-400 nm) light, but filtered out a part of UV-B (280-315 nm) radiation with the greatest effect at wavelength <310 nm. The quartz chamber top completely transmitted visible, UV-A, and UV-B radiation into the chamber. Two holes were drilled in the side of each glass jar with a 90 degree radial displacement and approximately 15 cm vertical displacement between each hole. These holes were used as sampling and vent ports. The holes were plugged with small corks, and needles were inserted through the corks. Both needles were left open to the atmosphere during sampling, thereby preventing pressure differentials during sampling.

  After placing the chamber top in the trough of the base, a gas sample of approximately 20 mL was removed from the chamber using a 40 mL glass syringe (Popper & Sons, New Hyde Park, NY) that was connected to the sampling needle. Syringes were fitted with gas-tight Teflon stopcocks (Alltech Associates, Deerfield, IL), and encased in black heat-shrink tubing to keep their contents dark. The syringe was sealed by adding a few drops of distilled water to the top of the barrel. Then the syringe was stored in a cooler (4 degrees Celsius) until the contents were later analyzed for CO. Additional samples were collected (usually at 5 or 10 minute intervals) for a total of at least four samples. All of the seasonal measurements were made during the day.

Gas Flux Measurements/Laboratory Analyses:

- N2O Measurements: At the laboratory, the samples were analyzed with a gas chromatograph (Shimadzu GC-14A) fitted with a 63Ni electron capture detector. Gases were separated on a 1 m precolumn (Hayesep N) and a 2 m analytical column (Hayesep Q) operated at 70 degrees C with a carrier composed of 5 percent CH4 and 95 percent Ar. The samples were analyzed the same day of collection, to avoid loss of N2O from the syringes. N2O fluxes were calculated from the rate of concentration increase, determined by linear regression based on the four samples.
- CO Measurements: Carbon monoxide concentrations were measured using a Trace Analytical RGA-3 Reduction Gas Analyzer (Menlo Park, CA U.S.A.). Separation of CO was accomplished using sequential stainless steel columns, each of which was 0.32 cm in diameter x 76.8 cm long. The first column was packed with Unibeads 1S, 60/80 mesh and the second with molecular sieve 5A, 60/80 mesh. Flow rate was 20 cc min-1. A 10-port injection valve was used for sample introduction and to reverse flow on the Unibeads column at 0.5 min., thus allowing only H2 and

CO to pass to the molecular sieve. Samples were injected using a 1 mL injection loop. For CO calibration, a standard curve was generated each day by injecting calibrated volumes of a 1411 plus/minus 28 micromol mol-1 (ppb) CO standard furnished by Scott-Marrin (Riverside, CA, USA). The data were acquired and analyzed using a personal computer equipped with PeakSimple software.

Other Field Measurements:

- Air temperature, soil temperature at a depth of 10 cm, solar irradiance, and soil moisture: Gravimetric soil moisture from soil cores (upper 5 cm of the mineral soil) sampled on the same day as the CO measurement was measured by weight loss after 48 hours at 110 degrees Celsius. Solar irradiance was measured using an International Light (Newburyport, MA) IL1700 radiometer. Full-spectrum irradiance was measured with a SED623 probe (flat response from 200 to 4200 nm), UV-A irradiance was estimated using a SED033 probe (maximum response at 360 nm) and UV-B irradiance was measured with a SED240 probe (maximum response at 290 nm). Each probe was positioned horizontally and fitted with a quartz diffuser to obtain cosine response.
- Water filled pore space was calculated from gravimetric soil moisture content following the procedure given in Linn and Doran (1984). The particle density value used was 2.7 g m-3 as recommended by EMBRAPA cerrado scientists.
- Microbial biomass carbon was determined using the chloroform-fumigation incubation method described in Jenkinson and Powlson (1976) on subsamples from the soils collected for inorganic N determination.
- Field-moist soil was extracted with 1M KCl for 1 hour and the concentration of NH4 in the solution was determined by colorimetry using Nessler reagent while the concentration of NO3 was determined using UV absorption (Meier 1991).

Laboratory Analyses:

- N2O Measurements: At the laboratory, the samples were analyzed with a gas chromatograph (Shimadzu GC-14A) fitted with a 63Ni electron capture detector. Gases were separated on a 1 m precolumn (Hayesep N) and a 2 m analytical column (Hayesep Q) operated at 70 degrees C with a carrier composed of 5 percent CH4 and 95 percent Ar. The samples were analyzed the same day of collection, to avoid loss of N2O from the syringes. N2O fluxes were calculated from the rate of concentration increase, determined by linear regression based on the four samples.
- CO Measurements: Carbon monoxide concentrations were measured using a Trace Analytical RGA-3 Reduction Gas Analyzer (Menlo Park, CA U.S.A.). Separation of CO was accomplished using sequential stainless steel columns, each of which was 0.32 cm in diameter x 76.8 cm long. The first column was packed with Unibeads 1S, 60/80 mesh and the second with molecular sieve 5A, 60/80 mesh. Flow rate was 20 cc min-1. A 10-port injection valve was used for sample introduction and to reverse flow on the Unibeads column at 0.5 min., thus allowing only H2 and CO to pass to the molecular sieve. Samples were injected using a 1 mL injection loop. For CO calibration, a standard curve was generated each day by injecting calibrated volumes of a 1411 plus/minus 28 micromol mol-1 (ppb) CO standard furnished by Scott-Marrin (Riverside, CA, USA). The data were acquired and analyzed using a personal computer equipped with PeakSimple software.

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:

Conrad, R., and W. Seiler. 1985. Influence of temperature, moisture, and organic carbon on the flux of H2, and CO between soil and atmosphere: Field studies in subtropical regions, J. Geophys. Res., 90, 5699-5709.doi:10.1029/JD090iD03p05699

Jenkinson, D. S., and D. S. Powlson. 1976. The effects of biocidal treatments on metabolism in soil. V. A method for measuring soilbiomass. Soil Biology and Biochemistry 8: 209-213. doi:10.1016/0038-0717(76)90005-5

Kisselle, K.W., R.G. Zepp, R.A. Burke, A.D. Pinto, M.M.C. Bustamante, S. Opsahl, R.F. Varella, and L.T. Viana. (2002). Seasonal soil fluxes of carbon monoxide in burned and unburned Brazilian savannas. Journal of Geophysical Research-Atmospheres, Vol. 107, No. D20, pp. art-8051.

Linn, D. M., and J. W. Doran, 1984: Effects of water-filled pore space on carbon dioxide and nitrous oxide production in tilled and nontilled soils. Soil Sci. Soc. Amer. J., 48, 1267-1272. doi:10.2136/sssaj1984.03615995004800060013x

Matson, P.A., P.M. Vitousek, G.P. Livingston and N.A. Swanberg. 1990. Sources of variation in nitrous oxide from Amazonian ecosystems. Journal of Geophysical Research 95: 16789-16798. doi:10.1029/JD095iD10p16789

Meier M. 1991. Nitratbestimmung in Boden-proben (N-min-Method), Laborpraxis 4:244-247.

Pinto, A.D., M.M.C. Bustamante, K. Kisselle, R. Burke, R. Zepp, L.T. Viana, R.F. Varella, and M. Molina. (2002). Soil emissions of N2O, NO, and CO2 in Brazilian Savannas: Effects of vegetation type, seasonality, and prescribed fires. Journal of Geophysical Research-Atmospheres, Vol. 107, No. D20, p. 8089.

Sanhueza, E., L. Donoso, D. Scharffe, and P. J. Crutzen. 1994. Carbon monoxide fluxes from natural, managed or cultivated savannah grasslands, J. Geophys. Res., 99, 16,421-16,427. doi:10.1029/93JD02918

Varella, R.F., M.M.C. Bustamante, A.S. Pinto, K.W. Kisselle, R.V. Santos, R.A. Burke, R.G. Zepp, and L.T. Viana. (2004). Soil fluxes of CO2, CO, NO, And N2O from an old pasture and from native Savanna in Brazil. Ecological Applications 14(4):S221.

Verchot, L.V., E.A. Davidson, J.H. Cattanio, 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