LBA-ECO ND-30 Nutrient Analysis and Gas Fluxes, Forest Chronosequences, Para, Brazil: 2000-2005

Summary:

This data set provides fine litterfall mass and nutrient concentrations from samples collected at chronosequences established at Sao Francisco do Para and Capitao Poco, Para, Brazil. Nitrogen (N) and phosphorus (P) concentrations were determined for litterfall samples from the Sao Francisco do Para, and N, P, potassium (K), calcium (Ca), and magnesium (Mg) concentrations are reported for samples from the Capitao Poco. In addition, carbon (C), N, delta C13, and delta N15 values were determined for leaves from the dominant species of the forests at Sao Francisco do Para; soil physical and chemical characteristics were determined for a subset of the chronosequence plots at the two study sites; and soil trace gas fluxes were determined from the Sao Francisco do Para site.

All samples were collected between March 2001-February 2005. Trace gas fluxes were measured 10 times between October 2000 and June 2002 with 5 sample periods in dry season and 5 in wet season months. There are five comma-delimited data files with this data set.

Data Citation:

Cite this data set as follows:

Davidson, E.A., C.J.R. de Carvalho, A.M. Figueira, F.Y. Ishida, J.P.H.B. Ometto, G.B. Nardoto, R.T. Saba, S.N. Hayashi, E.C. Leal, I.C.G. Vieira and L.A. Martinelli. 2012. LBA-ECO ND-30 Nutrient Analysis and Gas Fluxes, Forest Chronosequences, Para, Brazil: 2000-2005. 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/1129

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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: Nutrient Dynamics

Team ID: ND-30 (Davidson / Carvalho / Figueiredo / Vieira)

The investigators were Carvalho, Claudio Jose Reis de; Davidson, Eric A.; Figueiredo, Ricardo; Vieira, Ima ; Almeida, Arlete Araujo, Thereza Cristina; Asner, Gregory Paul; Costa, Fabiola Fernandes; Ishida, Francoise; Leal, Eliane Constantinov; Leao, Luciene Mota de; Leite, Tania de Sousa; Markewitz, Daniel ; Oliveira, Patricia Chaves de; Pacheco, Nilza Araujo; Rosa, Maria Beatriz Silva da; Sa, Tatiana Deane De Abreu; Saba, Renata Tuma; Schuler, Marysol A. E.; Silva, Marilia ; Silva, Patricio de Souza; Souza, Cleo Marcelo Araujo ; Stone, Thomas A. and Vasconcelos, Livia Gabrig Turbay Rangel. You may contact Davidson, Eric A (edavidson@whrc.org).

LBA Data Set Inventory ID: ND30_Litter_Para

This data set provides fine litterfall mass and nutrient concentrations from samples collected at chronosequences established at Sao Francisco do Para and Capitao Poco, Para, Brazil. Nitrogen (N) and phosphorus (P) concentrations were determined for litterfall samples from the Sao Francisco do Para, and N, P, potassium (K), calcium (Ca), and magnesium (Mg) concentrations are reported for samples from the Capitao Poco. In addition, carbon (C), N, delta C13, and delta N15 values were determined for leaves from the dominant species of the forests at Sao Francisco do Para; soil physical and chemical characteristics were determined for a subset of the chronosequence plots at the two study sites; and soil trace gas fluxes were determined from the Sao Francisco do Para site.

All samples were collected between March 2001-February 2005 . Trace gas fluxes were measured 10 times between October 2000 and June 2002 with 5 sample periods in dry season and 5 in wet season months.

2. Data Characteristics:

Data are presented in five ASCII comma separated files:

File #1: Litterfall_Sao_Francisco_do_Para_2001-2002.csv
File #2: Litterfall_Capitao_Poco_2004_2005.csv
File #3: Foliar_CN_ and _isotopes_Sao_Francisco.csv

File #4: Soil_Physical_Characteristics.csv
File #5: Sao_Francisco_Trace_gas_flux.csv

File #1: Litterfall_Sao_Francisco_do_Para_2001-2002.csv

Collections were made from March 2001-April 2002.

Column	Heading	Units/format	Description
1	Year	YYYY	Year in which the samples were collected: 2001 or 2002
2	Month		Month in which the samples were collected
3	Forest Age	years	Forest age at the sampling site at the time of collection: mature refers to forest that was never converted to pasture.
4	Mean_dry_mass	kg/ha	Mean dry mass of fine litterfall collected; reported in kilograms per hectare. Monthly mean was derived from 6 samples in each month and the 6 samples are listed below the mean for each month; the mean is the first listed value for each month for each variable
5	SD_dry_mass	kg/ha	Standard deviation of the mean dry mass of fine litterfall collected; reported in kilograms per hectare. Monthly mean was derived from 6 samples in each month and the 6 samples are listed below the mean for each month; the mean is the first listed value for each month for each variable
6	Mean_N	g N/kg dry wt	Mean nitrogen concentration of fine litterfall collected; reported in grams of nitrogen per kilogram dry litter. Monthly mean was derived from 6 samples in each month and the 6 samples are listed below the mean for each month; the mean is the first listed value for each month for each variable
7	SD_N	g N/kg dry wt	Standard deviation of the mean nitrogen concentration of fine litterfall collected; reported in grams of nitrogen per kilogram dry litter. Monthly mean was derived from 6 samples in each month and the 6 samples are listed below the mean for each month; the mean is the first listed value for each month for each variable
8	Mean_P	g P/kg dry wt	Mean phosphorus concentration of fine litterfall collected; reported in grams of phosphorus per kilogram dry litter. Monthly mean was derived from 6 samples in each month and the 6 samples are listed below the mean for each month; the mean is the first listed value for each month for each variable
9	SD_P	g P/kg dry wt	Standard deviation of the mean phosphorus concentration of fine litterfall collected; reported in grams of phosphorus per kilogram dry litter. Monthly mean was derived from 6 samples in each month and the 6 samples are listed below the mean for each month; the mean is the first listed value for each month for each variable
missing data are represented by -9999			

Example data records:

```
Year,Month,Forest Age,Mean_dry_mass,SD_dry_mass,Mean_N,SD_N,Mean_P,SD_P
2001,3,Mature,509,155,12.17,0.38,0.411,0.073
```

2001,3,3,197,134,8.33,0.50,0.665,0.287
2001,3,6,274,122,10.29,0.62,0.517,0.127
...
2001,4,40,492,168,12.30,0.34,0.371,0.057
2001,4,70,685,319,11.93,0.36,0.400,0.379
2001,5,Mature,861,271,7.57,0.33,0.207,0.081
...
2001,7,20,784,450,10.12,0.95,0.268,0.107
2001,7,40,802,289,9.78,0.21,0.228,0.027
2001,7,70,1058,430,11.34,0.63,0.216,0.042

File #2: Litterfall_Capitao_Poco_2004_2005.csv

Collections were made from February 2004-January 2005.

Column	Heading	Units/format	Description
1	Month		Month of the year in which the sample was collected
2	Year		Year in which the sample was collected: 2004 or 2005
3	Forest_age	years	Forest age at the time of collection reported in years: Mature indicates forests that were never converted to pasture
4	Collector		Identification of sample collector
5	Dry_mass	Mg ha-1	Total dry mass of litter collected reported in megagrams per hectare
6	N	g N/kg litter	Nitrogen concentration of the litterfall collected reported in grams of nitrogen per kilogram of litter
7	P	g P/kg litter	Phosphorus concentration of the litterfall collected reported in grams of phosphorus per kilogram of litter
8	K	g K/kg litter	Potassium concentration of the litterfall collected reported in grams of potassium per kilogram of litter
9	Ca	g kg-1	Calcium concentration of the litterfall collected reported in grams of calcium per kilogram of litter
10	Mg	g Mg/kg litter	Magnesium concentration of the litterfall collected reported in grams of magnesium per kilogram of litter

Example data records:

Month,Year,Forest_age,Collector,Dry_mass ,N,P,K,Ca,Mg
2,2004,6,1,0.438,11.383,0.360,0.375,3.457,1.889
2,2004,6,2,0.356,11.959,0.199,0.225,3.036,1.729
2,2004,6,3,0.183,8.218,0.377,0.200,3.152,1.207
...
2,2004,10,4,0.376,10.558,0.343,0.200,2.901,1.119
2,2004,10,5,0.469,11.181,0.276,0.199,2.696,1.313
2,2004,10,6,0.449,9.789,0.232,0.300,3.864,1.078
...
2,2004,20,4,0.271,9.486,0.205,0.325,3.297,0.934
2,2004,20,5,0.166,11.247,0.348,0.578,3.288,1.258
2,2004,20,6,0.271,13.417,0.448,0.631,3.107,0.801

File #3: Foliar_CN_ and _isotopes_Sao_Francisco.csv

Column	Heading	Units/format	Description
1	Family		Identification of the tree sampled to scientific family
2	Species		Identification of the tree sampled to scientific name in the format Genus species
3	Forest_age	years	Age of the forest at the time of sampling
4	delta_13C	per mil	Isotopic ratio of 13C/12C in leaf tissue referenced to PDB
5	Foliar_C_conc	percent	Foliar carbon concentration reported in percent by weight
6	delta_15N	per mil	Isotopic ratio of 15N/14N in leaf tissue referenced to atmospheric N
7	Foliar_N_conc	percent	Foliar nitrogen concentration reported in percent by weight

Example data records:

```
Family,Species,Forest_age,delta_13C,Foliar_C_conc,delta_15N,Foliar_N_conc
Annonaceae,Guatteria poeppigiana ,6,-33.63,45.97,-1.62,1.64
Annonaceae,Rollinia exsucca ,6,-30.61,46.41,-2.34,1.66
Annonaceae,Rollinia exsucca ,6,-29.38,45.06,-4.02,1.62
...
Fabaceae,Dipteryx odorata ,6,-29.87,49.24,2.07,2.23
Fabaceae,Dipteryx odorata ,6,-28.93,49.34,0.00,2.25
Fabaceae,Dipteryx odorata ,6,-28.08,49.55,2.58,2.46
...
Mimosaceae,Abarema jupunba var. jupunba ,6,-28.09,49.04,0.70,2.16
Mimosaceae,Abarema jupunba var. jupunba ,6,-31.47,47.99,-0.21,2.13
Mimosaceae,Inga flageliformis ,6,-29.53,48.82,0.21,2.00
```

File #4: Soil_Physical_Characteristics.csv

Column	Heading	Units/format	Description
1	Site	&	Chronosequence location
2	Forest_age	years	Age of forest at the time of sampling
3	Bulk_density	g/cm-3	Mean bulk density for the top 10 cm of soil reported in grams per cubic centimeter
4	SE_BD	g/ cm-3	Standard error of the mean bulk density for the top 10 cm of soil reported in grams per cubic centimeter
5	Clay	g/kg	Mean concentration of soil particles in the clay texture class reported in grams per kilogram
6	SE_Clay	g/kg	Standard error of the mean concentration of soil particles in the clay texture class reported in grams per kilogram
7	Sand	g/kg	Mean concentration of soil particles in the sand texture class reported in grams per kilogram
88	SE_Sand	g/kg	Standard error of the mean concentration of sand particles in the clay texture class reported in grams per kilogram
9	pH_H2O		Mean pH of the soil (0-10 cm depth) measured in a 1: 2.5 slurry with water
110	SE_pH		Standard error of the mean pH of the soil (0-10 cm depth) measured in a 1: 2.5 slurry with water

11	C	g C/kg	Mean soil carbon concentration reported in grams of carbon per kilogram of soil
12	SE_C	g C/kg	Standard error of the mean soil carbon concentration reported in grams of carbon per kilogram of soil
13	N	g N/kg	Mean soil nitrogen concentration reported in grams of nitrogen per kilogram of soil
14	SE_N	g N/kg	Standard error of the mean soil nitrogen concentration reported in grams of nitrogen per kilogram of soil
115	P_Melich	mg P/kg	Mean plant available soil phosphorus concentration based on a a elich I dilute double acid extraction
116	SE_P_Mel	mg P/kg	Standard error of the mean plant available soil phosphorus concentration based on a a elich I dilute double acid extraction
117	P_total	mg P/kg	Mean total soil phosphorus concentration based on a sulfuric acid/ hydrogen peroxide digestion,
118	SE_P_tot	mg P/kg	Standard error of the mean total soil phosphorus concentration based on a sulfuric acid/ hydrogen peroxide digestion
missing data are represented by -9999			

Example data records:

```
SSite,Forest_age,Bulk_density,SE_BD,Clay,SE_Clay,Sand,SE_Sand,pH_H2O,SE_pH,
C,SE_C,N,SE_N,P_Melich,SE_P_Mel,P_total,SE_P_tot
Sao Francisco do Para,3,1.35,0.03,65,17,898,27,5.3,0.2,
10.5,0.4,0.74,0.03,1.2, 0.2,33,3
Sao Francisco do Para,6,1.37,0.03,85,17,785,28,5.1,0.2,
11.9,0.6,0.7,0.1,2, 0.3,47,8
Sao Francisco do Para,10,1.3,0.04,60,18,873,31,5.3,0.2,
9.5,0.5,0.73,0.05,1.3, 0.1,32,3
...
Sao Francisco do Para,Mature,1.25,0.03,100,0,755,25,4.4,0.4,
14.7,1.4,1.11,0.04, 2,0.1,62,2
Capitao Poco,3,-9999,-9999,149,10,799,20,5.4,0.1,
13.5,1.4,0.85,0.15,4.2,0.7,87,2
Capitao Poco,10,-9999,-9999,100,13,819,12,5.1,0.1,
11.6,0.1,0.8,0,6.5,1.5,67,6
```

File #5: Sao_Francisco_Trace_gas_flux.csv

Column	Heading	Units/format	Description
1	Year	YYYY	Year in which samples were measured
2	Month		Month in which samples were collected
3	Season		Season in which samples were collected either wet or dry
4	Class		Forest Class: sites were classifed as young; intermediate; advanced or mature based on the age of the forest. Samples were also measured in a pepper plantation identified here
5	Age	years	Forest age in years at the time of sampling ; age recorded only for the regrowth forests
6	Site		For each age there were two sites identified here as a and b
7	Plot		Plot identifiication within the site

8	Chamber		Chamber identification
9	Flux_N2O	ng N/cm2/h	Flux of nitrous oxide reported in nanograms of nitrogen per centimeter squared per hour (ng N/cm2/h)
10	Flux_CH4	mg CH4/m2/d	Flux of methane reported in milligrams of methane per meter squared per day (mg CH4/m2/d)
11	Flux_CO2	g C/m2/h	Flux of carbon dioxide reported in grams of carbon per meter squared per hour (g C/m2/h)
12	Flux_NO	ng N/cm2/h	Flux of nitric oxide reported in nanograms of nitrogen per centimeter squared per hour (ng N/cm2/h)
missing data are represented by -9999			

Example data records:

```
Year,Month,Season,Class,Age,Site,Plot,Chamber,Flux_N2O,Flux_CH4,Flux_CO2,Flux_NO
2000,Oct,Dry,Young,3,a,1,1,-0.61,-1.4,0.1,0.24
2000,Oct,Dry,Young,3,a,1,2,-0.59,-1.87,0.08,0.19
2000,Oct,Dry,Young,3,a,1,3,-0.4,-1.98,0.11,0.24
...
2000,Oct,Dry,Young,3,a,2,1,-0.39,-1.11,0.07,0.17
...
2000,Oct,Dry,Intermediate,20,a,1,3,0.09,-0.99,0.09,0.09
2000,Oct,Dry,Intermediate,20,a,2,1,-0.21,-1.26,0.09,0.03
2000,Oct,Dry,Intermediate,20,a,2,2,-0.08,-2.18,0.06,0.06
```

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Para Eastern (Belem) - Sao Francisco do Para (Para Eastern (Belem))	-47.78333	-47.78333	-1.26667	-15.93280	World Geodetic System, 1984 (WGS-84)
Brasilia - Reserva Ecologica do Roncador IBGE (Brasilia)	-47.36667	-47.36667	-2.2	-2.2	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2000/10/01 to 2005/01/31
- Temporal Resolution: Litterfall was collected monthly in Sao Francisco do Para between March 2001 and April 2002. In Capitao Poco litterfall was collected monthly between February 2004 and January 2005. Gas sampling at San Francisco do Para was done 10 times between October 2000 and June 2002 with 5 sample periods in dry season and 5 in wet season months. Investigators failed to record sampling dates for isotopic or soil observations.

Platform/Sensor/Parameters measured include:

- LABORATORY / MASS SPECTROMETER / ISOTOPES
- LABORATORY / CARBON ANALYZER / CARBON
- LABORATORY / CHN ANALYZER / NITROGEN
- LABORATORY / CHN ANALYZER / LITTER CHARACTERISTICS
- FIELD INVESTIGATION / WEIGHING BALANCE / LITTER CHARACTERISTICS
- FIELD SURVEY / GAS CHROMATOGRAPH / TRACE GASES
- LABORATORY / ANALYSIS / SOIL PH
- LABORATORY / ANALYSIS / SOIL BULK DENSITY
- LABORATORY / ANALYSIS / SOIL CHEMISTRY

3. Data Application and Derivation:

These data were used to examine patterns in N cycling over the course of secondary succession and their implications for nutrient limitation of successional forests in the tropics.

4. Quality Assessment:

Lab analyses were all done according to standard protocols with calibration curves and standards included in every run.

5. Data Acquisition Materials and Methods:

Site description:

Two forest-age chronosequences, including stands ranging in age from 3 to 70 yr and remnant mature forests, were established in the Brazilian state of Para, in eastern Amazonia, southeast of the city of Belem. A set of seven indicators of N-cycling rates was obtained for the chronosequence in our main study site in the municipality of Sao Francisco do Para. To provide replication, a second chronosequence was established in the municipality of Capitao Poco.

Mean annual precipitation is 2,200 mm for Sao Francisco do Para and Capitao Poco. The dominant soils are Typic Hapludults. Human settlement in this region expanded during the era of rubber extraction in the late nineteenth century. Government programs for distributing rural lands for agricultural development, mostly by small landholders, increased forest clearing in the mid-twentieth century. Many farms have now undergone nine or more cycles of slash-and-burn agriculture.

Sample Collections:

Collections (0.25 m2 per collection) of fine litterfall were made monthly for a year in each plot at both chronosequences.

Fresh foliar samples were collected in the 6-, 20- and 40-yr-old successional forests and the mature forest plots.

At Sao Francisco do Para, fully expanded leaves were collected for the dominant species at each site, according to the species importance values indices.

Soil emissions of N2O were measured at Sao Francisco do Para using syringe sampling of static chambers and gas chromatography with an electron capture detector (Verchot et al 1999). Three

chamber fluxes were measured per date in each of the twenty-six plots at Sao Francisco do Para, with five dates in each of the dry and wet seasons.

Analytical Methods:

Finely ground litter and foliar samples were analyzed for C and N concentrations using a Carlo-Erba CHN analyser, for C and N stable isotope ratios using a Delta Plus ThermoQuest-Finnigan mass spectrometer, and for P by acid digestion followed by colorimetric spectrophotometry.

Foliar C, N and isotope anlayses were done at CENA in Piracicaba using their standard methods (for more details see Ometto et al. 2006).

Soil nutrient analyses and foliar analyses other than C, N and stable isotopes were all done at EMBRAPA Belem using their standard protocols (Silva 1999).

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:

Ometto, J.P.H.B., Ehleringer, J.R., Domingues, T.F., Berry, J.A., Ishida, F.Y., Mazzi, E., Higuchi, N., Flanagan, L.B., Nardoto, G.B., and Martinelli, L.A. 2006. The stable carbon and nitrogen isotopic composition of vegetation in tropical forests of the Amazon Basin, Brazil, Biogeochemistry, 79, 251-274.

Silva, F.C. d. 1999. Manual de analises quimicas de solos,plantas e fertilizantes.

EMBRAPA Communicacao para Transferencia de Technologia. Brasilia, Brasil. Vieira, I.C.G. et al. 2003. Classifying successional forests using Landsat spectral properties and ecological characteristics in eastern Amazonia. Remote Sens. Environ. 87, 470-481.

Verchot, L.V. et al. 1999. Land use change and biogeochemical controls of nitrogen oxide emissions from soils in eastern Amazonia. Global Biogeochem. Cycles 13,31-46.

Related Publications

- Davidson, E.A., C.J. Reis de Carvalho, A.M. Figueira, F.Y. Ishida, J.P.H.B. Ometto, G.B. Nardoto, R.T. Saba, S.N. Hayashi, E.C. Leal, I.C. G. Vieira and L.A. Martinelli. 2007. Recuperation of nitrogen cycling in Amazonian forests following agricultural abandonment. Nature Vol 447| 21 June 2007| doi:10.1038/nature05900