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LBA-ECO CD-02 Carbon, Nitrogen, Oxygen Stable Isotopes in Organic Material, Brazil

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Revision date: June 1, 2010

Summary:

This data set reports the measurement of stable carbon, nitrogen, and oxygen isotope ratios in organic material (plant, litter and soil samples) in forest canopy profiles and pasture (grasses and shrubs) as well as corresponding carbon and nitrogen tissue concentrations in a number of different sites across Brazil. The sampling design captured the temporal variation in rainfall from 1999-2004. Carbon and nitrogen isotope ratios can act as a proxy for interpreting aspects of the carbon and nitrogen cycles in Amazonian rainforests. Data are in three comma-delimited ASCII files.



Figure 1. Map of Brazil and other countries in South America, with the locations of the cities (Santarém, Manaus, and Ji-Paraná) near the field sampling sites.

Data Citation:

Cite this data set as follows:

Ehleringer, J., L.A. Martinelli, J.P. Ometto, T.F. Domingues, L. Flanagan, J. Berry, C. Cook, and G.B. Nardoto. 2010. LBA-ECO CD-02 Carbon, Nitrogen, Oxygen Stable Isotopes in Organic Material, 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. doi: [10.3334/ORNLDAAC/983](https://doi.org/10.3334/ORNLDAAC/983)

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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.

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1. Data Set Overview:

Project: LBA (Large-Scale Biosphere-Atmosphere Experiment in the Amazon)

Activity: LBA-ECO

LBA Science Component: Carbon Dynamics

Team ID: CD-02 (Ehleringer / Martinelli)

The investigators were Cook, Craig; Domingues, Tomas Ferreira; Ehleringer, James; Flanagan, Lawrence; Martinelli, Luiz Antonio; Ometto, Jean Pierre H.B.; Berry, Joseph and Nardoto, Gabriela Bielefeld . You may contact Ehleringer, Jim (ehleringer@biology.utah.edu) .

LBA Data Set Inventory ID: CD02_C_N_O_Organic

This data set reports the measurement of stable carbon, nitrogen, and oxygen isotope ratios in organic material (plant, litter and soil samples) in forest canopy profiles and pasture (grasses and shrubs) as well as corresponding carbon and nitrogen tissue concentrations in a number of different sites across Brazil. Carbon and nitrogen isotope ratios can act as a proxy for interpreting aspects of the carbon and nitrogen cycles in Amazonian rainforests. The objective was to measure carbon and nitrogen isotope ratios of organic material (plant, litter and soil organic matter) in forest canopy profiles and pasture (grasses and shrubs) as well as corresponding carbon and nitrogen tissue concentrations in a number of different sites. The sampling design captured the temporal variation in rainfall over the course of several years. No future modifications of these data are planned.

For additional information, please see the following web site:

- [Ehleringer LBA Web Site](#)

2. Data Characteristics:

Data are in three comma-delimited ASCII files. In all files 9999 is used to signify missing data points.

File 1: LBA-ECO_CD02_Stable_Isotope_CNO_Organic_Matter.csv

Contains stable isotope data on C, N and O from organic matter collected at LBA ECO focus regions in Amazonia, Para, and Rondonia between March 1999 and August 2004:

- Amazonas (Manaus), Sites: ZF2 - Transect E-W, ZF2 km 14, ZF3
- Para Western (Santarem), Sites: SECA Control, km 77, km 67, km 83, km 117, SECA Dry, Mojui
- Rondonia, Sites: Jaru Biological Reserve Tower A (Rebio), Fazenda Nossa Senhora (Fz N Senhora)

Column number	Column heading	Units/format	Description
1	Region		Sampling region
2	Site		Sampling site
3	Latitude	degrees	Location in decimal degrees (+= N and - = S)
4	Longitude	degrees	Location in decimal degrees (+= E and - = W)
5	Ecosystem		Vegetation forest or pasture
6	Description		Information about the sample recorded in the field, may include; canopy position, life form,

			common name, scientific name, plot
7	Sample_type		Values are leaves, litter, or soil
8	Year	YYYY	Year of sample collection
9	Month	MM	Month of sample collection
10	Height	meters	Sampling height
11	Time	HH:MM	Sampling time 24 hour clock in local time which is UTC -4 for all sites and sampling dates
12	delta_15N	parts per mil	Isotopic ratio of 15N/14N in organic material referenced to N2, measured with continuous flow on Finigan Delta Plus at CENA
13	delta_13C	parts per mil	Isotopic ratio of 13C/12C in organic material referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
14	C	%	Carbon content referenced to working standard at CENA (Centro de Energia Nuclear na Agricultura at the University of Sao Paulo)
15	N	%	Nitrogen content referenced to working standard at CENA (Centro de Energia Nuclear na Agricultura at the University of Sao Paulo)
16	C_to_N		Mass based ratio of carbon to nitrogen
17	delta_18O	parts per mil	Isotopic ratio of 18O/16O in cellulose referenced to SMOW, measured with continuous flow on Finigan Delta Plus at CENA
missing data are represented by 9999 (note this value is used rather than the more common -9999 due to the large number of negative values for delta variables)			

Example data records:

```

Region,Site,Latitude,Longitude,Ecosystem,Description,Sample_type,Year,Month,Height,Time,delta_15N,delta_13C,C,N,C_to_N,delta_18C
Manaus,ZF2 - Transect E-W,-2,-61,2500 m,Litter,1999,3,0,-999,4.3,-31.1,45.33,1.82,25.01,9999
Manaus,ZF2 - Transect E-W,-2,-61,2500 m,Litter,1999,3,0,-999,4.8,-32.6,43.54,1.21,36.21,9999
Manaus,ZF2 - Transect E-W,-2,-61,2500 m,Litter,1999,3,0,-999,4.3,-30.9,43.92,1.66,26.54,9999
...
Santarem,Mojui,-2.76667,-54.5792,Pasture,Shrub,Leaves,2002,10,0.5,14:30,6.9,-29.6,47.5,1.9,24.62,9999
Santarem,Mojui,-2.76667,-54.5792,Pasture,Shrub,Leaves,2002,10,0.5,14:33,8.1,-31.5,45.68,1.3,36.35,9999
...
Santarem,SECA Dry,-2.857,-54.959,Forest,Ucuubarana,2004,8,16,-999,6.2,-32.5,50.93,1.72,29.62,9999
Santarem,SECA Dry,-2.857,-54.959,Forest,Muirapiranga branca,Leaves,2004,8,20,-999,9.8,-31.5,41.008,1.97,20.9,9999
Santarem,SECA Dry,-2.857,-54.959,Forest,Quaruba branca,Leaves,2004,8,24,-999,5.4,-30.2,42.76,1.27,33.69,9999

```

File 2: **LBA-ECO-CD02_Stable_Isotopes_CN_Leaf_tissue.csv** Contains data on leaf tissue C and N concentrations as well as stable isotope values for both elements for foliage collected in and around the three eddy flux tower sites near Santarem Para between November 1999 and December 2003:

- Para Western (Santarem): km 67 Seca-Floresta (SECA Control) Site
- Para Western (Santarem): km 77 Pasture Tower Site
- Para Western (Santarem): km 67 Primary Forest Tower Site
- Para Western (Santarem): km 83 Logged Forest Tower Site
- Para Western (Santarem): Mojui

Column number	Column heading	Units/format	Description
1	Year	YYYY	Year of sample collection
2	Month	MM	Month of sample collection
3	Season		Season (Dry or Wet)
4	Species		Where identified: vegetation genus and species
5	Site		Sampling site
6	Longitude		Location in decimal degrees (+= E and - = W)
7	Latitude		Location in decimal degrees (+= N and - = S)
8	Treatment		Logged forest, primary forest or pasture
9	Height	m	Sampling height
10	Funct_group		Functional group broadly defined as canopy position (Grass, Liana, Mid Canopy, Sapling, Top Canopy, Understory)
11	Obs		Field observations
12	Leaf_area	m ²	Leaf area in square meters
13	Leaf_dry	g	Weight after drying at 65 degrees C
14	SLA	m ² g ⁻¹	Specific leaf area calculated as area/ mass
15	SLW	g m ⁻²	Specific leaf weight calculated as mass/area

16	delta_15N	per mil	Isotopic ratio of 15N/14N in organic material referenced to N2, measured with continuous flow on Finigan Delta Plus at CENA
17	delta_13C	per mil	Isotopic ratio of 13C/12C in organic material referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
18	C	%	Concentration of C in organic matter measured by combustion on an elemental analyzer at CENA
19	N	%	Concentration of N in organic matter measured by combustion on an elemental analyzer at CENA
20	C_to_N		Mass based ratio of C to nitrogen
21	N_pool_mass	g g ⁻¹	Nitrogen pool per g leaf tissue
22	N_pool_area	g m ⁻²	Nitrogen pool per m squared leaf area
missing data are represented by 9999 (note this value is used rather than the more common -9999 due to the large number of negative values for delta variables)			

Example data records:

```
Year,Month,Season,Species,Site,Longitude,Latitude,Treatment,Height,Funct-group,obs,Leaf_area,Leaf_dry,SLA,SLW,delta-15N,delta_13C,C,N,C_to_N,N_pool_mass,N_pool_area
1999,11,Dry,Brachiaria brizantha,km 77,-3.0202,-54.959,Pasture,9999,Grass,Light 1,9999,9999,9999,9999,3.3,-13.3,40.5,0.7,60.49,0.0007,9999
1999,11,Dry,Brachiaria brizantha,km 77,-3.0202,-54.959,Pasture,9999,Grass,Light 2,9999,9999,9999,9999,2.1,-12.9,37.4,1,39.34,0.01,9999
1999,11,Dry,Tachigalia myrmecophila,SECA Control,-2.857,-54.959,Primary Forest,27,Top Canopy,Light 1,0.007,9999,9999,9999,7,-29.5,49.3,3.4,14.34,0.034,9999
...
2001,3,Wet,Brachiaria brizantha,km 77,-3.0202,-54.959,Pasture,1,Grass,Light 1,0.0057,0.4166,0.014,72.51,3.44,-12.33,40.45,1.26,32.23,0.013,0.91
2001,3,Wet,Brachiaria brizantha,km 77,-3.0202,-54.959,Pasture,1,Grass,CO2 1,0.0067,0.4752,0.014,71.25,0.65,12.06,40.85,1.21,33.76,0.012,0.86
2001,3,Wet,Brachiaria brizantha,km 77,-3.0202,-54.959,Pasture,1,Grass,RH% 1,0.0044,0.2809,0.016,63.76,-0.15,-11.61,42.52,1.24,34.29,0.012,0.79
...
2003,12,Dry,Memora tanaecicarpa,SECA Control,-2.857,-54.959,Primary Forest,27,Liana,light,0.0058,0.59,0.01,101.1,7.55,-29.64,43.44,2.46,17.66,0.025,2.49
2003,12,Dry,Memora tanaecicarpa,SECA Control,-2.857,-54.959,Primary Forest,27,Liana,CO2,0.0056,0.519,0.011,93.07,7.26,-29.97,43.555,2.42,18.04,0.024,2.25
2003,12,Dry,Memora tanaecicarpa,SECA Control,-2.857,-54.959,Primary Forest,27,Liana,RH,0.003,0.371,0.008,122.35,8.28,-29.19,43.69,2.23,19.59,0.022,2.73
```

File 3: LBA-ECO_CD02_Geographic_Variability_CN_Organic_Matter.csv

Contains C and N concentration and delta 13C and delta 15N as well as Ca and P concentrations for foliar tissue from five different study sites in the Amazon region:

- Santarem: Flona Site km 67
- Manaus: ZF2 Site km 34 - north-south transect (plateau and swale)
- Manaus: ZF2 Site km 25 - campinarana
- Sao Gabriel da Cachoeira: National Park of Pico da Neblina
- Brasilia: IBGE Reserve

In addition there are C and N concentrations and delta stable isotope values for wood and soil organic matter from the same 5 study sites. All data in this file was collected between January 2002 and October 2003.

Column number	Column heading	Units/format	Description
1	Site		Research Site
2	Longitude	degrees	Location in decimal degrees (+= E and - = W)
3	Latitude	degrees	Location in decimal degrees (+= N and - = S)
4	Year	YYYY	Year of sample collection
5	Month	MM	Month of sample collection
6	Sample_type		Sample type: Leaves, Litter, or Soil
7	Family		Vegetation family
8	Species		Vegetation species from Manaus and Sao Gabriel identified by Carneiro and Pereira, INPA, Manaus, AM, Brazil
9	Legumes_non-legumes		Species are classified as belonging to the Legume family or not
10	Soil_depth	cm	Soil depth in centimeters (cm)
11	Notes		Field observations which may include a description of the vegetation type (burned cerrado,unburned cerrado, or campirinha), topography (plateau or swale) or if the sample was

			collected from a liana or a location in the subcanopy
12	delta_13C	per mil	Isotopic ratio of 13C/12C in organic material referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
13	C	%	Carbon content referenced to working standard at CENA (Centro de Energia Nuclear na Agricultura at the University of Sao Paulo)
14	delta_15N	per mil	Isotopic ratio of 15N/14N in organic material referenced to N2, measured with continuous flow on Finigan Delta Plus at CENA
15	N	%	Nitrogen content referenced to working standard at CENA (Centro de Energia Nuclear na Agricultura at the University of Sao Paulo)
16	C_to_N		Mass ratio of carbon to nitrogen
17	Ca	g kg ⁻¹	Calcium concentration determined by nitric acid digest and measured on an atomic absorption spectrophotometer at CENA
18	P	g kg ⁻¹	Phosphorus concentration determined by nitric acid digest method and measured on a spectrophotometer at CENA
missing data are represented by 9999 (note this value is used rather than the more common -9999 due to the large number of negative values for delta variables)			

Example data records:

Site,Longitude,Latitude,year,Month,Sample_type,Family,Species,Legumes_non-legumes,Soil_depth,Notes,delta_13C,C,delta_15N,N,C_to_N,Ca,P
km 67,-54.95,-2.85,2003,6,Leaves,Caesalpinaceae,Chamaecrista xinguensis,Legumes,9999,None,-33.23,53.74,7.48,3.63,14.79,9999,9999
km 67,-54.95,-2.85,2003,6,Leaves,Caesalpinaceae,Chamaecrista xinguensis,Legumes,9999,None,-33.79,47.21,7.74,3.21,14.71,9999,9999
km 67,-54.95,-2.85,2003,6,Leaves,Caesalpinaceae,Chamaecrista xinguensis,Legumes,9999,None,-32.69,49.4,6.91,4.06,12.18,9999,9999
...
ZF2 km 34,-60,-2.5,2003,5,Leaves,Caesalpinaceae,Batesia floribunda Spruce ex Benth.,Legumes,9999,plateau,-30.42,52.51,2.53,1.55,33.81,9999,9999
ZF2 km 34,-60,-2.5,2003,5,Leaves,Caesalpinaceae,Batesia floribunda Spruce ex Benth.,Legumes,9999,plateau,-30.46,50.42,3.91,2.61,19.3,4.81,0.6
ZF2 km 34,-60,-2.5,2003,5,Leaves,Caesalpinaceae,Batesia floribunda Spruce ex Benth.,Legumes,9999,plateau,-31.96,49.92,1.33,1.63,30.6,5.8,0.46
...
IBGE Reserve,-47.51,-15.15,2002,7,Soil,Not provided,Not provided,Not provided,20 to 30,unburned,-23.88,3.15,6.47,0.15,21.18,9999,9999
IBGE Reserve,-47.51,-15.15,2002,7,Soil,Not provided,Not provided,Not provided,30 to 40,unburned,-23.19,3.02,7.87,0.16,19.07,9999,9999
IBGE Reserve,-47.51,-15.15,2002,7,Soil,Not provided,Not provided,Not provided,40 to 50,unburned,-23.03,1.98,8.6,0.1,19.33,9999,9999

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Rondonia - Fazenda Nova Vida (Rondonia)	-62.811	-62.811	-10.156	-10.156	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - ZF2 km 34 (Amazonas (Manaus))	-60.20910	-60.00000	-2.50000	-2.60900	World Geodetic System, 1984 (WGS-84)
Para Western (Santarem) - km 67 Primary Forest Tower Site (Para Western (Santarem))	-54.95900	-54.95900	-2.85700	-2.85700	World Geodetic System, 1984 (WGS-84)
Para Western (Santarem) - km 67 Seca-Floresta Site (Para Western (Santarem))	-55.00000	-55.00000	-2.75000	-2.75000	World Geodetic System, 1984 (WGS-84)
Para Western (Santarem) - km 83 Logged Forest Tower Site (Para Western (Santarem))	-54.97070	-54.97070	-3.01700	-3.01700	World Geodetic System, 1984 (WGS-84)
Para Western (Santarem) - km 77 Pasture Tower Site (Para Western (Santarem))	-54.88850	-54.88850	-3.02020	-3.02020	World Geodetic System, 1984 (WGS-84)
Para Western (Santarem) - Mojui (Para Western (Santarem))	-54.57917	-54.57917	-2.76667	-2.76667	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - ZF2 km 14 (Amazonas (Manaus))	-60.11520	-60.11520	-2.58900	-2.58900	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - ZF3 Fazenda Dimona (Amazonas (Manaus))	-59.00000	-59.00000	-2.00000	-2.00000	World Geodetic System, 1984 (WGS-84)
Rondonia - Jaru Biological Reserve Tower A (Rondonia)	-61.93090	-61.93090	-10.08320	-10.08320	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - ZF2 km 25 - INPA Forest Management Site (Amazonas)	-61.00000	-61.00000	-2.00000	-2.00000	World Geodetic System, 1984 (WGS-84)

(Manaus))					
Brasilia - Reserva Ecologica do Roncador IBGE (Brasilia)	-47.85060	-47.85060	-15.93280	-15.93280	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - Pico Da Neblina National Park (Amazonas (Manaus))	-66.50000	-66.50000	0.48300	0.48300	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1999/03/01 to 2004/08/31.
- Temporal Resolution: Quarterly and monthly

Platform/Sensor/Parameters measured include:

- LABORATORY / MASS SPECTROMETER / STABLE ISOTOPES
- LABORATORY / AA (ATOMIC ABSORPTION SPECTROMETER) / LEAF CHARACTERISTICS

3. Data Application and Derivation:

Tropical forests play a central role in the global carbon cycle and improving our understanding of the factors that influence net carbon gain or loss in these ecosystems will improve our understanding of the global carbon cycle. Carbon isotope ratio analyses of plant materials can provide insight into carbon cycle dynamics by providing a quantitative assessment of stomatal limitations to photosynthesis (Farquhar et al. 1989, Ehleringer and Monson 1993). Variations in the delta 13C of leaves in tropical forests are strongly correlated with position in the canopy profile with lighter foliar delta 13C (more negative) values found in the understory as compared to the canopy (Medina and Minchin 1980, Ehleringer et al. 1986). Variations in delta 13C values between sites may be driven by differences in forest stand structure and resulting effects on light availability and vapor pressure deficit.

Nitrogen isotope ratios provide information about N cycling within ecosystems (Hogberg 1990, Evans and Ehleringer 1993, Martinelli et al. 1999 and many more). Foliar and soil delta 15N patterns in tropical forests have been shown to be elevated relative to values in temperate forests (Martinelli et al. 1999). This pattern may be a result of gaseous N losses associated with microbial metabolism (Austin and Vitousek 1998) or the abundance of leguminous trees and their associated N fixing abilities in tropical forests.

Both N and C isotopes and the variability in delta values within and across sites may be used as a proxy for interpreting aspects of the C and N cycles in Amazonian rainforests.

4. Quality Assessment:

Stable isotope ratios of carbon and nitrogen were measured relative to international recognized standards. Internal working standards (Atropine and soil standard no. 502-308 from LECO Corporation) were included in every run, as regular laboratory procedure. The precision of measurements was plus or minus 0.3 %, 0.1 %, 0.25 per mil and 0.35 per mil for C, N, delta 13C and delta 15N, respectively. Precision for P and Ca analyzes were Ca (3%) and P (<1%).

5. Data Acquisition Materials and Methods:

Leaf samples were collected from plants along a height profile through the canopy at all sites during each study period. Three samples of leaf litter were randomly collected from each study site during each sample trip. All samples were oven-dried at 65 degrees C until constant weight and then ground to a fine powder. Soil samples were air-dried, sieved using a 2-mm mesh and homogenized. A smaller sub-sample was taken, handpicked to remove fine roots and other debris and then pounded. A 1.5-2 mg sub-sample of ground material or 15-20 mg sub-sample of pounded soil were placed and sealed in a tin capsule and loaded into a ThermoQuest-Finnigan Delta Plus isotope ratio mass spectrometer (Finnigan-MAT; CA, USA) in line with an Elemental Analyzer (Carla Erba model 1110; Milan, Italy) at the Laboratory of Isotope Ecology (CENA-USP, Brazil). From these analyzes we obtained both isotope ratio (delta 13C and delta 15N and in a limited number of cases delta 18O from cellulose) as well as tissue elemental content (C and N). Foliar Ca and P concentrations were determined after a tissue digestion with nitric acid + perchloric acid (5:1). P concentrations were determined using color spectrophotometry, Ca concentrations were determined using Atomic Absorption spectrophotometry with the addition of 0.25% Lanthanum oxide solution (to avoid Al interference).

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:

Austin, A and PM Vitousek. 1998. Nutrient dynamics on a precipitation gradient. *Oecologia* 113:519-529.

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Related Publications

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