LBA-ECO CD-02 C and N Isotopes in Leaves and Atmospheric CO2, Amazonas, Brazil

Summary:

Data are provided on 13C determination of leaf tissues and atmospheric carbon dioxide (CO2), delta 15N for leaf tissue, and leaf carbon and nitrogen concentrations. Leaves were sampled at various heights within the canopy and atmospheric air was collected along a topographical gradient in the ZF2 Reserve near Manaus, Brazil during the dry season. Data were collected in 2004 from various heights within the canopy and again in 2006 only from the canopy leaves of identified species. There are 3 comma-delimited data files with this data set.

Data Citation:

Cite this data set as follows:

de Araujo, A.C., J. P. H. B. Ometto, A. J. Dolman, B. Kruijt, M. J. Waterloo and J. R. Ehleringer. 2011. LBA-ECO CD-02 C and N Isotopes in Leaves and Atmospheric CO2, Amazonas, 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.

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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: Carbon Dynamics

Team ID: CD-02 (Ehleringer / Martinelli)

The investigators were Ehleringer, James; Artaxo, Paulo Berry, Joseph A; Colares, Andrea; Cook, Craig da Silva, Haroldo Jackson Pereira; de Araujo, Alessandro Carioca; Domingues, Tomas Ferreira; Duarte Ferreira, Shirleane; Figueira, Adelaine Michela; Figueiredo, Rosa Marcia Teixeira; Galvao, Manoella Ishida, Francoise; Lopes, Sebastiao Mazzi, Edmar A; Nardoto, Gabriela Bielefeld; Nobre, Antonio Donato; Ometto, Jean Pierre and West, Adam. You may contact de Araujo, Alessandro Carioca (alessandro.araujo@gmail.com).

LBA Data Set Inventory ID: CD02_C_N_Isotopes

This data set provides 13C of leaf tissues and atmospheric carbon dioxide (CO2), delta 15N for leaf tissue, and leaf carbon and nitrogen concentrations. Leaves were sampled at various heights within the canopy and atmospheric air was collected along a topographical gradient in the ZF2 Reserve near Manaus, Brazil during the dry season. Data were collected in 2004 from various heights within the canopy and again in 2006 only from the canopy leaves of identified species.

2. Data Characteristics:

Data are presented in three comma-delimited ASCII files:

File #1: CD02_Gas_Samples_13C_2004_2006.csv

File #2: CD02_Foliar_13C_15N_2004_2006.csv

File #3: CD02_Met_and_flux_data_2004_2006.csv

File #1: CD02_Gas_Samples_13C_2004_2006.csv

Column	Heading	Units/format	Description
1	Year	YYYY	Year in which samples were collected: 2004 or 2006
2	Month		Month in which samples were collected: August = 8 or October = 10
3	Day		Day of the month in which samples were collected
4	Time	HH:MM	Start of sample collection in local time. Local time is GMT -4
5	Flask		Flask identification number for laboratory purposes
6	Position		Location within the landscape: Valley, Slope, Plateau, and Campinarana
7	Sample_type		Samples are either (atmospheric) gas samples collected in flasks or (soil respiration) samples collected from a 40L chamber placed on the soil surface
8	Height	m	Height in meters above the ground at which the sample was collected for the atmospheric samples
9	conc_CO2	ppm	Measured concentration of carbon dioxide in the sample in parts per million (ppm)
10	inv_conc_CO2	ppm-1	Inverse concentration of carbon dioxide in the sample calculated as 1/ column 8
11	delta_13C_R1	parts per mil	Isotopic ratio of 13C/12C in carbon dioxide referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
12	delta_13C_R2	parts per mil	13C/12C ratio measured in second aliquot from the same sample where available
13	delta_13C_R3	parts per mil	13C/12C ratio measured in third aliquot from the same sample where available
14	delta_13C_Avg	parts per mil	Mean isotopic ratio of 13C/12C in carbon dioxide based on 1, 2, or 3 measurements
Missing data are represented as -9999			

Example data records:

Year,Month,Day,Time,Flask,Position,Sample_type,Height,conc_CO2,inv_conc_CO2,delta_13C_R1,delta_13C_R2,delta_13C_R3,delta_13C_Avg
2004,8,2,19:24,F146,Valley,Atmosphere,30,448.5,0.002,-10.64,-11.11,-9999,-10.87
2004,8,2,19:30,65A,Valley,Atmosphere,20,450.1,0.002,-11.02,-9999,-9999,-11.02
...
2006,10,8,9:17,F11,Valley,Atmosphere,18,396.6,0.003,-9.55,-9999,-9999,-9.55
2006,10,8,9:23,AB81,Valley,Atmosphere,6,438.1,0.002,-11.12,-9999,-9999,-11.12
...
2006,10,21,16:35,H193,Campinarana,Soil respiration,-9999,-9999,-9999,-9999,-9999,-9999,-9999
2006,10,21,16:40,H52,Campinarana,Soil respiration,-9999,973.3,0.001,-20.68,-9999,-9999,-20.68

File #2: CD02_Foliar_13C_15N_2004_2006.csv

Column	Heading	Units/format	Description
1	Year	YYYY	Year in which samples were collected: 2004 or 2006
2	Month		Month in which samples were collected: August = 8 or October = 10
3	Day		Day of the month in which samples were collected
4	Location		Campinarana. In 2006 Campinarana was added to the list as a forest type that only occurs at lower slope and valley locations
5	Height	m	Height of sampling location in meters above ground level
6	Sample_id		Internal sample id
7	Sample_type		Type of material sampled: leaves with mature and young leaves distinguished in 2006 or litter
8	Canopy_position		Location within the canopy based on sample height: Canopy, Understory, Soil, or not identified
9	Species		Species identification where noted: In 2004 species were identified only with local name where possible in 2006 species were identified with scientific names
10	Description		Notations from original field notebooks
11	15N_14N_ratio	per mil	Isotopic ratio of 15N/14N in the leaf sample measured on a continuous flow isotope-ratio mass spectrometer (Finigan Delta Plus) at CENA
12	delta_13C	per mil	Isotopic ratio of 13C/12C in the leaf or litter sample referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA

13	conc_C	percent	Concentration of carbon in the leaf or litter sample measured by dry combustion and reported in percent by weight
14	conc_N	percent	Concentration of nitrogen in the leaf or litter sample measured by dry combustion and reported in percent by dry weight
15	C_to_N		Mass based ratio of carbon to nitrogen in the leaf or litter sample calculated by dividing column 13 by column 14
16	Notes		Comments from the field notebooks; no comment or missing comment = none
Missing data are represented as -9999			

Example data records:

Year,Month,Day,Location,Height,Sample_id,Sample_type,Canopy_position,Species,Description
,delta_15N,delta_13C,conc_C,
conc_N,C_to_N,Notes
2004,8,2,Valley,25,2,leaves,Canopy,not identified,AM 02 BAIXIO - ZF2 KM 34 25m,0.06,-
31.55,49.54,
1.23,40.26,none
2004,8,2,Valley,25,3,leaves,Canopy,not identified,AM 03 BAIXIO - ZF2 KM 34 25m,-0.1,-
31.58,52.32,
2.45,21.36,none
...
2004,8,6,not reported,26,19,leaves,Canopy,Rourca vine,CIPO ROURCA E7 26m,3.44,-
33.04,48.95,
1.56,31.36,none
2004,8,6,Slope,not recorded,20,litter,Soil,not identified,SOLO ENCOSTA ZF2 (KM 34)
SERRAP. DA CAMARA DO SOLO 10:30 AM,2.22,-30.22,48.22,
1.81,26.67,from soil surface layer 10:30 local time
...
2006,10,19,Valley,not recorded,40,mature leaves,Canopy,Eperua glabriflora,,-1.63,-30.19,48.82,
1.42,34.32,none
2006,10,19,Valley,not recorded,41,new leaves,Canopy,Micranda spruceana,,0.4,-29.55,47.97,
1.33,36.11,none
...
2006,10,21,Plateau,not recorded,75,new leaves,Canopy,Ecclinusa guianensis form A,,5.27,-
29.28,49.55,
1.14,43.62,none
2006,10,21,Plateau,not recorded,76,mature leaves,Canopy,Ecclinusa guianensis form A,,5.14,-
30.21,49.72,

1.29,38.66,none

File #3: CD02_Met_and_flux_data_2004_2006.csv

Column	Heading	Units/format	Description
1	Year	YYYY	Year in which data were collected (2004 or 2006)
2	Day	DOY	Day of the year on which data were collected. For 2004, data were collected from day 195 = July 13 thru day 218= August 5. For 2006, data were collected from day 260=September 17 thru day 290=October 17
3	Time		Sampling point in decimal hours. Time given is the end of the 30 minute sampling period
4	Temp_Air	degrees C	Air temperature in degrees Celsius
5	RH	percent	Relative humidity in percent
6	E_act	kPa	Actual water vapor pressure reported in kilopascals
7	E_sat	kPa	Saturated water vapor pressure in kilopascals
8	VPD	kPa	Vapor pressure deficit reported in kilopascals
9	Fco2	umol/m2/s	Carbon dioxide flux measured at 53 m height
10	CO2_conc	ppm	Atmospheric carbon dioxide concentration measured at 53 meters above ground level
11	u_star	m/s	Friction velocity measured at 53 meters above ground level in meters per second
Missing data are represented by -9999			
All data were measured at the top of the KM34 tower at 53 meters above ground level. The tower is located on the plateau.			
All data are averages from a 30 minute sampling period: For the meteorological data each sampling period included 60 measurements (scan time interval 30 seconds); for the flux data each sampling period includes 18,000 samples (scan time interval 0.1 seconds)			

Example data records:

```
Year,Day,Time,Temp_Air,RH,E_act,E_sat,VPD,Fco2,CO2_conc,u_star
2004,195,0.5,23.75,92.8667,2.7294,2.9391,0.2097,-9999,-9999,-9999
2004,195,1,23.14,90.4,2.5604,2.8323,0.2719,-9999,-9999,-9999
...
2004,218,19.5,24.3,79.6667,2.4196,3.0372,0.6176,-0.0987,357.9,0.1854
2004,218,20,24.1867,80.4667,2.4273,3.0166,0.5893,0.7467,358,0.0995
...
2006,260,0.5,25.48,87.9667,2.8665,3.2587,0.3922,-9999,-9999,-9999
2006,260,1,24.7367,93.9333,2.9284,3.1176,0.1892,-9999,-9999,-9999
...
2006,290,23.5,23.93,90.9333,2.7006,2.9699,0.2693,3.609,423.3,0.1774
2006,290,24,23.87,91.4667,2.7072,2.9598,0.2526,0.6092,423.6,0.0905
```

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Amazonas (Manaus) - ZF2 km 34 (Amazonas (Manaus))	-60.20910	-60.0000	-2.50000	-2.60900	South-American Datum, 1969 (SAD-69)

Time period:

- The data set covers the period 2004/08/02 to 2006/10/21
- Temporal Resolution: Two one-week long campaigns were conducted: one in August 2004 and the second in October 2006

Platform/Sensor/Parameters measured include:

- LABORATORY / MASS SPECTROMETER /BON
- LABORATORY / MASS SPECTROMETER / NITROGEN
- LABORATORY / MASS SPECTROMETER / STABLE ISOTOPES

3. Data Application and Derivation:

Measurements of carbon stable isotope ratios of atmospheric CO2 are a powerful indicator of large-scale CO2 exchange on land across multiple spatial scales. Stable carbon isotope composition of leaf tissue and CO2 released by respiration (delta r) can be used as an estimate of changes in ecosystem isotopic discrimination that occur in response to seasonal and interannual changes in environmental conditions. Understanding of carbon dioxide stable isotope composition can play a central role in influencing our understanding of the extent to which terrestrial ecosystems are carbon sinks.

4. Quality Assessment:

All data have been thoroughly checked and are final. Data quality control measures for the laboratory analyses are described in the Methods section below.

5. Data Acquisition Materials and Methods:

Site Description:
The research site was the Manaus LBA site located in the Asu catchment in the Reserva Biologica do Cuieiras. The forest belongs to the Instituto Nacional de Pesquisas da Amazonia (INPA). The mean air temperature was 26 degrees C between July 1999 and June 2000 (Araujo et al., 2002). Average annual rainfall is about 2400 mm, with a distinct dry season during July, August and September when there is less than 100 mm rainfall per month (Araujo et al., 2002).

There is little large-scale variation in topography in the region, but at a smaller scale, the dense drainage network has formed a pattern of plateaus and valleys. The mean elevation is about 100 ma.s.l. with about 40 to 60 m difference between plateaus and valleys bottoms. The soils along a typical toposequence consist of well-drained Oxisols and Ultisols on plateaus and slopes, respectively, and poorly drained Spodosols in the valleys (Chauvel et al., 1987). The vegetation is old-growth closed-canopy terra firme (non-flooded) forest. Variation in soil type, topography and drainage status has created distinct patterns in forest vegetation composition. On the plateaus, well drained clay soils favor high biomass forests 35 to 40 m in height with emergent trees over 45m tall: typical terra firme forest.

Along the slopes, where a layer of sandy soil is deepening towards the valley bottom, forest biomass is lower and height is around 20 to 35 m with few emerging trees. In the valleys, the sandy soils are poorly drained and usually they remain waterlogged during the rainy season, supporting low biomass and low tree height (20 to 35 m), with very few emerging trees. A distinct forest type, classified as Campinarana (as it resembles the Campina forest that develops on white sand areas), also occurs between the lower slope and valley bottom areas. This vegetation has lower biomass, tree diversity and tree height (15 to 25 m) (Guillaumet, 1987; Luizao et al., 2004). The forest canopy is stratified in four layers. The first layer is formed by emergent trees, reaching heights of 35 to 45 m above ground level (a.g.l.). Below this layer, there are trees with their canopies between 20 and 35 m. The third layer is formed by understory regeneration, whereas shrubs and seedlings form a fourth layer close to the ground. More elaborate descriptions of the site can be found in Araujo et al. (2002) and Luizao et al. (2004).

Air flask sample collection:
All sampling was carried out in representative plots along a transect that was divided into 3 topographical sections: plateau, slope and valley. In each plot, air samples were collected at different levels above and within the canopy for delta 13C atmospheric analysis. Each profile sampling system consisted of high-density polyethylene (HDPE) tubes (Dekoron 1300, 6.25 mm OD, non-buffering ethylene copolymer coating, USA) with intakes at different heights. Nylon funnels with stainless steel filters were installed on the air intakes to avoid sample contamination by particles. A battery-operated air pump (Capex V2X, UK) was used to draw air through the

tubing, a desiccant tube containing magnesium perchlorate and a glass sample flask. The flow rate was 10 L per minute. The longest air sampling tube had an internal volume of about 0.65 L that corresponds to a maximum residence time of 4 s. All air samples were collected in pre-evacuated 100 mL glass flasks that were closed with two high-vacuum Teflon stopcocks (34-5671, Kontes Glass Co., USA) after air had been pumped through the flask for about 3 minutes. The atmospheric C concentration was measured at the same time with an infrared gas analyzer (IRGA) (LI- 800, LI-COR, Inc., USA). A T piece was connected at the air pump output, which allowed a low sub-sampling flow of about 800 mL per min to be passed through the IRGA.

- Plateau air samples were collected at K34 tower (118 m a.s.l.) with a tube system attached to it.
- The slope profile system was suspended from the highest branch of a tall tree located about midway down the slope (89.2ma.s.l.) at 550 m from the K34 tower
- The valley profile system, which was suspended in the same way as that on the slope, was installed in the valley (77.3 ma.s.l.) at about 850 m from the K34 tower.
- In October 2006, the valley profile system was relocated 500 m to the west and attached to the newly erected B34 tower.

Nighttime sampling began about one hour after sunset (about 19:30 local time) and ended about one hour before sunrise (about 05:30 local time) to avoid any effects of photosynthesis on the estimates of delta 13C Reco. Daytime values of delta 13Ca within and above the canopy were obtained between 07:00 and 18:00 h (local time).

Flux measurements at K34 tower:
Flux measurements were collected at the K34 tower (118 m a.s.l.) as described in Araujo et al., 2002. Data reported here are for time periods selected to coincide with flask and vegetation results More flux data from the K34 towere is reported in LBA-ECO CD-32 Brazil Flux Network Integrated Data: 1999-2006 (Seleska et al., in process).

Sampling of foliage and litter
In August 2004, leaf samples were collected once from trees at each topographical section by a tree climber, sampling a vertical profile through the forest canopy. The sampling heights were not uniform among the topographical sections, as follows: plateau (3, 10, 17, 21, 24, 26, and 30 ma.g.l.), slope (3, 8, 10, 12, 20, 26, 28, 30 ma.g.l.), and valley (3, 7, 20, 2 5 ma.g.l.). There was no botanical classification for the trees sampled in August 2004. In October 2006, sun leaves at the top of the canopy were collected once by a tree climber at plateau and valley sections. Trees with botanical classification to species level were now systematically selected according to either their importance value index (IVI) or occurrence at both plateau and valley areas (Oliveira and Amaral, 2004; Oliveira and Amaral, 2005). Each sample from a single tree consisted of at least five healthy leaves that were combined according to their status (either mature or young).

In August 2004, litter samples were randomly collected at each topographical section. These were bulked by topographic section to form single samples. The samples were pre-dried at ambient air temperature for 3 days in a home-made greenhouse located an open-sky area and shipped to CENA for stable isotope ratio and elementary analyses.

Soil-respired CO2 sampling
In August 2004, CO2 released from the soil was sampled at each topographical section using the protocol described by Flanagan et al. (1999) and Ometto et al. (2002). The sampling was repeated at plateau and valley sites in October 2006 and now included the Campinarana site. Samples were collected using a stainless steel chamber with an internal volume of about 40 L and a small electric fan to enhance mixing within the chamber. Samples were collected at two sites in each topographical section. At each site, five sample flasks were filled using five minutes time intervals between sampling for determining the carbon isotope ratio of soil respired CO2 (delta13CRsoil).

Laboratory analyses
The delta13 C_a (atmospheric concentrations of CO2) in sample flasks were measured using a continuous-flow isotope-ratio mass spectrometer (IRMS) (Delta Plus, Finnigan MAT, Germany) as described by Ehleringer and Cook (1998) and Ometto et al. (2002). Measurement precision of this method was 0.13 percent for 13C (Ometto et al., 2002). The air remaining in the flask after stable isotope ratio analysis was used to measure ca using a system similar to that described by Bowling et al. (2001a). Measurement precision and accuracy of this method were 0.2 and 0.3 ppm, respectively (Ometto et al., 2002).

Leaf and litter samples were dried at 65 degrees C to constant weight, then ground with mortar and pestle to a fine powder. A 1 to 2 mg subsample of ground organic material was sealed in a tin capsule and placed into an elemental analyzer (Carlo Erba Instruments, Model EA 1110 CHNS-O, Milan, Italy) for combustion and subsequent elemental C and N analysis. The CO2 generated by combustion was purified in a gas chromatograph column and passed directly to the inlet of the IRMS (Delta Plus, Finnigan MAT, USA) operating in continuous-flow mode. These provided stable isotope ratios of carbon, oxygen and nitrogen (13C/12C; 18O/16O; 15N/14N) with a measurement precision of 0.2 percent (Ometto et al., 2006). The carbon isotope ratio was expressed in the delta notation (delta), which relates the measured 13C/12C molar ratio of the sample and the international Pee Dee Belemnite (PDB) limestone standard (Ehleringer and Rundel, 1989).

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:

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Saleska, S.R., H.R. da Rocha, A.R. Huete, A.D. Nobre, P. Artaxo, and Y.E. Shimabukuro. In process. LBA-ECO CD-32 Brazil Flux Network Integrated Data: 1999-2006. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

Related Publications

- de Araujo, A.C., J. P. H. B. Ometto, A. J. Dolman, B. Kruijt, M. J. Waterloo and J. R. Ehleringer. 2008. Implications of CO2 pooling on delta13C of ecosystem respiration and leaves in Amazonian fores. Biogeosciences, 5: 779-795.