LBA-ECO CD-02 Leaf Level Gas Exchange, Chemistry, and Isotopes, Amazonia, Brazil

Revision date: May 10, 2011

Summary:

This data set reports leaf gas flux and leaf properties from samples collected from trees, liana, pasture saplings, and pasture grass located at eight different sampling locations in the states of Para (south of Santarem) and Amazonas (near Manaus) from November 1999 through December 2003. Data are reported on photosynthesis measurements, CO2 response curves, light response curves, humidity response curves, and stomatal responses to variations of the leaf-to-air water vapor mole fraction deficit. Leaf weight, carbon and nitrogen concentrations as well as stable isotope signatures for 13C and 15N are reported for a subset of the samples. There is one comma-delimited ASCII data file with this data set.

Data Citation:

Cite this data set as follows:

Ehleringer, J., L.A. Martinelli, C. Cook, T.F. Domingues, L. Flanagan, J. Berry, and J.P. Ometto. 2011. LBA-ECO CD-02 Leaf Level Gas Exchange, Chemistry, and Isotopes, Amazonia, 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/1010

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 May of 2011. Users who download the data between May 2011 and April 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: 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. and Berry, Joseph . You may contact Ehleringer, Jim (ehleringer@biology.utah.edu).

LBA Data Set Inventory ID: CD02_Leaf_Level_Gas_Exchange

These data represent measurements from leaves including photosynthesis measurements, CO2 response curves, light response curves, and humidity response curves from trees, liana, pasture saplings, or pasture grass located at eight different sampling locations in the states of Para and Amazonas in northern Brazil. Data were collected repeatedly from each site between October 1999 and December 2003. In addition to photosynthetic curves and associated environmental variables leaf weight, carbon and nitrogen concentrations as well as stable isotope signatures for 13C and 15N are reported for a subset of samples.

Related data sets:

- LBA-ECO CD-02 Forest Canopy Structure, Tapajos National Forest, Brazil: 1999-2003 (Leaf Area Index (LAI) and Specific Leaf Area (SLA) measurements collected from the same sites)

2. Data Characteristics:

Data are presented in one comma-delimited ASCII file: CD02_Leaf_Level_Gas_Exchange.csv

File: CD02_Leaf_Level_Gas_Exchange.csv

Column	Heading	Units/format	Description
1	Sort_order		Sort order of data file where a unique row is defined by the Site_name, Date, Time_start, Sequence_number, and Curve_type

2	Site_code		Sampling location id code
3	Site_name		Sampling location identification
4	Longitude	degrees	Sampling location in decimal degrees: negative values indicate west and positive values east
5	Latitude	degrees	Sampling location in decimal degrees: negative values indicate south and positive values north
6	Functional_group		Plant life form type: tree, liana, pasture sapling, or pasture grass
7	Position		Position within the forest canopy; Not applicable for pasture sites
8	Sample_ID		Sample id for chemical analysis
9	Species	Genus species	Scientific name of the plant sampled where identified
10	Height	m	Sampling height in meters (m)
11	Date	YYYY/MM/DD	sampling date
12	Time_start	HH:MM	Starting time (local 24 hr clock) for the set of measurements defined by Date, Time_start, and Curve_type. These measurements were made sequentially over a 60-90 minute period
13	Sequence_number		Designates the order in which the measurements were made for a given (Date,Time_start, Curve_type) set of measurements
14	Curve_type		light = photosynthetic dependence on PFD, other parameters constant; CO2 = photosynthetic dependence on CO2 concentration, other parameters constant, including high PFD; RH = photosynthetic dependence on relative humidity, other parameters constant, including high PFD
15	A	micromol CO2 m-2 s-1	Net photosynthetic rate in micromoles of CO2 fixed per meter squared of leaf surface per second (micromol CO2 m-2 s-1)
16	Cond	mol m-2 s-1	Leaf conductance measured in moles of water per meter leaf surface squared per second (mol m-2 s-1)
17	Ci	micromol CO2 mol-1	Intercellular carbon dioxide concentration measured as micromoles of CO2 per mole of air (micromol CO2 mol-1)
18	VPD	kPa	Vapor pressure deficit at the leaf surface measured in kilo Pascals (kPa)
19	E	mmol H2O m-2 s-1	Transpiration rate measured in millimoles of water per meter squared leaf surface per second (mmol H2O m-2 s-1)
20	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
21	T_air	degrees C	Air temperature inside the cuvette
22	Flow	micromol air s-1	Air flow velocity inside the sampling cuvette in micromoles of air per second (micromol air s-1)
23	CO2_S	micromol CO2 mol air-1	Carbon dioxide concentration inside leaf cuvette measured as micromoles of CO2 per mole of air (micromol CO2 mol-1)
24	H2O_S	millimol H2O mol-1	Water vapor concentration inside leaf cuvette measured as millimoles of H2O per mole of air

			(millimol H2O mol-1)
25	RH_S	%	Relative humidity inside cuvette measured in percent (%)
26	PARi	micromol m-2 s-1	Photosynthetically active radiation flux measured inside the cuvette in micromoles of photons per meter squared per second (micromol m-2 s-1)
27	PARo	micromol m-2 s-1	Photosynthetically active radiation flux measured outside the cuvette in micromoles of photons per meter squared per second (micromol m-2 s-1)
28	Ci_Ca		Ratio of intercellular to ambient carbon dioxide concentrations
29	Leaf_area	m2	Leaf area in meters squared (m2)
30	Dry_weight	g	Leaf dry weight in grams (g) after drying at 70 degrees C
31	delta_13C	per mil	Isotopic ratio of 13C/12C in leaf tissue referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
32	delta_15N	per mil	Isotopic ratio of 15N/14N in leaf tissue referenced to atmospheric air, measured with continuous flow on Finigan Delta Plus at CENA
33	C_conc	%	Leaf tissue carbon content in percent (%)
34	N_conc	%	Leaf tissue nitrogen content in percent (%)
35	C_to_N		Mass based carbon to nitrogen ratio
36	Notes		Comments from the field notebooks
37	Sort_order_original		Sort order of original data file
Missing data are represented by -9999			
Missing character values: "not provided"			

Example Data Records:

Sort_order,Site_code,Site_name,Longitude,Latitude,Functional_group,Position,Sample_ID,Species Height,
Date,Time_start,Sequence_number,Curve_type,A,Cond, Ci,VPD,E, T_leaf, T_air,
Flow,CO2_S,H2O_S,RH_S,
PARi,PARo,Ci_Ca,Leaf_area, Dry_weight, delta_13C,delta_15N,C_conc,N_conc,C_to_N,
Notes,Sort_order_original

1,1,Manaus ZF2 tower site (km 14), -60.115,-2.589,Tree,Mid canopy,12,Not identified,8,
11/3/1999,16:35,1,CO2,0.01,183,-9999,0.1,29.88,-9999,397.5,500.2,26.032,79.93,
1799,17,0.37,-9999, -9999, -31.95,4.53,46.05, 3.7,12.45,
None,18
2,1,Manaus ZF2 tower site (km 14),-60.115,-2.589,Tree Mid canopy,12,Not identified,8,
11/3/1999,16:35,2,CO2,6.1,0.02,351,-9999,0.26,29.88,-9999,317.5,1001.3,26.22,79.75,
1800,11,0.35,-9999,-9999,-9999,-9999,-9999,-9999,-9999,
None,19
...
267,6,Santarem Control Plot site at Seca Floresta - Flona Tapajos,-54.956,-2.898,Tree,Upper

canopy,1122,Cordia bicolor,28,
12/4/2003,14:13,11,CO2,16.2,0.03,970,1.87,0.54,32.05,-9999,300.5,1964.8,29.567,64.96,
800,623,0.49,-9999,-9999,-9999,-9999,-9999,-9999,-9999,
None,3783
268,6,Santarem Control Plot site at Seca Floresta - Flona Tapajos,-54.956,-2.898,Tree,Mid canopy,1127,Tachigalia myrmecophila,20,
12/9/2003,9:02,1,RH,11.3,0.2,259,0.88,1.7,28.49,-9999,199.9,360.6,30.516,81.28,
799,135,0.72,-9999,-9999,-9999,-9999,-9999,-9999,-9999,
None,3829
...

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
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))	-54.5792	-54.5792	-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)

Time period:

- The data set covers the period 1999/10/28 to 2003/12/17
- Temporal Resolution: Quarterly and monthly

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / PHOTOSYNTHESIS CHAMBER/ PHOTOSYNTHESIS
- LABORATORY / CARBON ANALYZER / CARBON
- LABORATORY / ANALYSIS / NITROGEN
- LABORATORY / MASS SPECTROMETER / STABLE ISOTOPES

3. Data Application and Derivation:

Both modeling and observational research have focused on the direct effects of the physical environment on plant physiology. Our data address both effects of the physical environment (including light and temperature) as well as ecosystem type and canopy position at the leaf level. These data are fundamental to the modeling of gas exchange at the level of the leaf or individual and inform larger-scale approaches as well.

4. Quality Assessment:

All the data have been reviewed and there are no known problems and no further changes are anticipated for this data set.

5. Data Acquisition Materials and Methods:

Leaf samples from 29 species of liana, trees, pasture saplings, or pasture grass were collected during field campaigns from eight locations in Para, Brazil (TNF south of Santarem) and Amazonas, Brazil (near Manaus) during the following periods: October and November 1999; March, June, July, and October 2000; February, March, August, and September 2001; September and October 2002: and June, November, and December 2003. Collections were in both dry and wet seasons and included primary forests, logged sites, tower sites, and pasture sites. Field measurements were usually limited to morning hours (8:00 to 13:00 h local time) to avoid afternoon weather. The mean annual precipitation in the Santarem sites is 2,207 mm, with a 5-month dry season when precipitation is less than 100 mm (July through November). Air temperature above the canopy varies little throughout the year, with maximum daily temperatures ranging between 24 degrees and 32 degrees C and minimum daily temperatures ranging between 20 degrees and 25 degrees C. The average annual precipitation for Manaus is 2,186 mm with a mean annual temperature of 27 degrees C. March and April are the wettest months, and July, August, and September are the dry months.

Gas exchange measurements were taken with a photosynthetic gas exchange system with a red–blue light source and an external CO2 source (model LI-6400, Li-Cor). We limited gas exchange measurements to morning hours (0800 to 1300 LT), to avoid afternoon stomatal closure. On all occasions, leaf area used was equal to 6 cm2. For Amax and gS@Amax determinations (430 in total), conditions inside the chamber were controlled to maintain leaf temperature at 30 degrees C, relative humidity around 80%, CO2 concentrations at the sample cell at 360 mmol mol−1, and saturating levels

of photosynthetic active photon flux density (PPFD), 800 mol m−2 s−1 for understory plants and 1800 mol m−2 s−1 for mid- and top-canopy species. The biochemical photosynthesis model used in Simple Biosphere Model (SiB2) (Sellers et al. 1996) and widely used in other land surface models (Bonan 2002) was used to obtain Vcmax values from both light and CO2 response curves. This model is based on the approach of Farquhar et al. (Farquhar et al. 1980), modified by Collatz et al. (Collatz et al. 1991). The dependence of carbon assimilation on photosynthetic photon flux density (light response curves, 98 in total) was obtained by 10 stepwise increments in light level, while holding leaf temperature, relative humidity, and ambient CO2 constant. For the determination of the dependence of carbon assimilation on intercellular CO2 concentration (A–ci curves, 77 in total) under saturating light, 10 ambient CO2 levels were used, while holding constant leaf temperature and relative humidity. The response curves (98 A-PPFD curves and 77 A–ci curves) were measured in six species of each of the following plant functional groups: top-canopy lianas, top-canopy trees, midcanopy trees, and understory trees. Measuring time of each response curve spanned between 60 and 90 min. (Domingues et al., 2005).

Dried subsamples (dried at 65 degrees C in convection ovens until constant weight) of each leaf collected for leaf mass per area (LMA) determinations were used for 13C and N area determinations by continuous-flow isotope ratio mass spectrometry (IRMS Delta Plus Finnigan Mat) coupled with an elemental analyzer (Carlo Erba). Analyses were performed at the Laboratorio de Ecologia Isotopica, Centro de Energia Nuclear na Agricultura, Universidade de Sao Paulo, Piracicaba, Brazil.

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:

Bonan, G., Ed., 2002: Ecological Climatology: Concepts and Applications. Cambridge University Press, 678 pp.

Collatz, G. J., J. T. Ball, C. Grivet, and J. A. Berry, 1991: Physiological and environmental regulation of stomatal conductance, photosynthesis and transpiration: A model that includes a laminar boundary layer. Agric. For. Meteor., 54, 107–136. doi:10.1016/0168-1923(91)90002-8

Domingues, T.F., J.A. Berry, L.A. Martinelli, J.P.H.B. Ometto, and J.R. Ehleringer. 2005. Parameterization of Canopy Structure and Leaf-Level Gas Exchange for an Eastern Amazonian Tropical Rain Forest (Tapajos National Forest, Para, Brazil). Earth Interactions 9(17):1-23. doi:10.1175/EI149.1

Farquhar, G. D., S. von Caemmerer, and J. A. Berry, 1980: A biochemical model of photosynthetic CO2 assimilation in leaves of C3 species. Planta, 149, 78–90. doi:10.1007/BF00386231

Sellers, P. J, and Coauthors, 1996: A revised land surface parameterization (SiB2) for atmospheric GCMs. Part I: Model formulation. J. Climate, 9, 676–705. doi:10.1175/1520-0442(1996)009<0676:ARLSPF>2.0.CO;2

Related Publications

- Domingues, T.F., Martinelli, L. A., Ehleringer, J.R. 2007. Ecophysiological traits of plant functional groups in forest and pasture ecosystems from eastern Amazonia, Brazil. Plant Ecology, v.193, n.1, p.101-112.