

# LBA-ECO CD-02 Carbon and Oxygen Isotopes in Atmospheric CO<sub>2</sub> in the Amazon: 1999-2004

Revision date: May 10, 2011

## Summary:

This data set reports carbon and oxygen stable isotope ratios of atmospheric carbon dioxide (CO<sub>2</sub>) collected at several forest and pasture sites and in the free troposphere over Amazonia. There are three comma-delimited ASCII files with this data set.

Atmospheric CO<sub>2</sub> concentrations and isotope signatures were measured at ten different forest and pasture canopy sites across the states of Amazonas, Para, and Rondonia within the Brazilian Amazon between March 1999 and March 2004. Both daytime and nighttime profile samples were collected.

Samples of CO<sub>2</sub> in the troposphere were collected during aircraft flights over the Amazon/Tapajos Rivers, FLONA Tapajos, and pasture/agriculture areas during five days in May 2003 (wet season). Samples were analyzed for carbon and oxygen isotopes of atmospheric CO<sub>2</sub>. Flights ranged from low altitudes to above the diurnal tropospheric boundary layer.

Measurements of carbon and oxygen stable isotope ratios of atmospheric carbon dioxide (CO<sub>2</sub>) are a powerful indicator of large-scale CO<sub>2</sub> exchange on land across multiple spatial scales. Stable carbon isotope composition of leaf tissue and CO<sub>2</sub> 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, and land-use change (forest-pasture conversion). 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.

## 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 Carbon and Oxygen Isotopes in Atmospheric CO<sub>2</sub> in the Amazon: 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. [doi:10.3334/ORNLDAAC/1011](https://doi.org/10.3334/ORNLDAAC/1011)

## 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](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.

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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-08 (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](mailto:ehleringer@biology.utah.edu))

**LBA Data Set Inventory ID:** CD02\_Atmosphere\_CO2\_Isotopes

This project measured atmospheric CO<sub>2</sub> concentrations and isotope signatures at ten different forest and pasture canopy sites across the states of Amazonas, Para, and Rondonia within the Brazilian Amazon between March 1999 and March 2004. Both daytime and nighttime profile samples were collected.

Samples of CO<sub>2</sub> in the troposphere were collected during aircraft flights over the Amazon/ Tapajós Rivers, FLONA Tapajós, and pasture/agriculture areas during five days in May 2003 (wet season). Samples were analyzed for carbon and oxygen isotopes of atmospheric CO<sub>2</sub>. Flights ranged from low altitudes to above the diurnal tropospheric boundary layer.

### Related data sets:

- [LBA-ECO CD-01 Simulated Atmospheric Circulation, CO<sub>2</sub> Variation, Tapajós: August 2001](#) (simulated CO<sub>2</sub> concentrations performed during similar time period for Para Western (Sanatarem))
- [LBA-ECO CD-04 CO<sub>2</sub> and Heat Flux, km 83 Gap Tower Site, Tapajós National Forest](#) (CO<sub>2</sub> measurements taken at the km 83 tower site during same time period)

## 2. Data Characteristics:

The data on atmospheric CO<sub>2</sub> concentrations and isotope signatures include collections between March 1999 and March 2004 made at ten different sites in the states of Amazonas, Para, and Rondonia within the Brazilian Amazon. Actual time and location for each data point are noted in the data files. Forest and pasture data are in separate comma-delimited ASCII files: **CD02\_Stable\_Isotope\_Air\_Forest.csv** and **CD02\_Stable\_Isotope\_Air\_Pasture.csv**

Carbon and oxygen isotopes of tropospheric CO<sub>2</sub> were collected by aircraft during five days in May 2003 (wet season) on flights over the Amazon/Tapajos Rivers, FLONA Tapajos and pasture/agriculture areas. Flights ranged from low altitudes to above the diurnal tropospheric boundary layer.

Data are in one comma-delimited ASCII file: **CD02\_Stable\_Isotope\_Air\_Troposphere.csv**

### File #1: CD02\_Stable\_Isotope\_Air\_Forest.csv

Column	Heading	Units/format	Description
1	Region		Sampling region
2	Site		Sampling site
3	Longitude	degrees	Location in decimal degrees
4	Latitude	degrees	Location in decimal degrees
5	Ecosystem		Ecosystem vegetation type: Forest
6	Year	YYYY	Sampling year
7	Month	MM	Sampling month
8	Time	HHMM	Sampling time 24 hour clock (local time)
9	Height	meters	Sampling height in meters (m)
10	CO <sub>2</sub> _conc	ppm	Atmospheric CO <sub>2</sub> concentration, measured with Licor 6200 in the field or a Licor 6252 in the field
11	Inverse_CO <sub>2</sub> _conc	1/ppm	Calculated inverse of atmospheric CO <sub>2</sub> concentration
12	delta_13C	parts per mil	Isotopic ratio of <sup>13</sup> C/ <sup>12</sup> C in carbon dioxide referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
13	delta_18O	parts per mil	Isotopic ratio of <sup>18</sup> O/ <sup>16</sup> O in carbon dioxide referenced to SMOW, measured with continuous flow on Finigan Delta Plus at CENA
Note: 9999 indicates missing data (note this value is used rather than the more common -9999 due to the large number of negative values for delta variables)			
Sampling year, month, and time only are reported; no sampling day is provided.			

### Example data records:

Region,Site,Longitude,Latitude,Ecosystem,Year,Month,Time,Height,  
CO<sub>2</sub>\_conc,Inverse\_CO<sub>2</sub>\_conc,delta\_13C,delta\_18O

Manaus,ZF2 km 14,-2.589,-60.1152,Forest,1999,3,721,0.3,467.5,0.00214,-13.1,39.8  
 Manaus,ZF2 km 14,-2.589,-60.1152,Forest,1999,3,721,5,445,0.00225,-12.1,40.7  
 ...  
 Santarem,SECA Control,-2.857,-54.959,Forest,1999,3,1650,26,363.7,0.00275,-8.9,41.6  
 Santarem,SECA Control,-2.857,-54.959,Forest,1999,3,1703,16,360,0.00278, 8.8,41.6  
 ...  
 Manaus,ZF2 km 14,-2.589,-60.1152,Forest,1999,5,614,0.5,585.3,0.00171,-15.3,34.9  
 Manaus,ZF2 km 14, 2.589,-60.1152,Forest,1999,5,603,5,538.4,0.00186,-14.8,35.4  
 ...  
 Rondonia,Rebio,-10.0832,-61.9309,Forest,2000,9,1130,52, 71.6,0.00269,-8.5,40.1  
 Rondonia,Rebio,-10.0832,-61.9309,Forest,2000,9,1200,52,378.6,0.00264,-8.7,39.5  
 ...  
 Santarem,SECA Dry,-2.857,-54.959,Forest,2004,3,2145,5,430.6,0.00232,-11.3,38.5  
 Santarem,SECA Dry,-2.857,-54.959,Forest,2004,3,2150, .2,498.2,0.00201,-13.8,36.4

**File #2: CD02\_Stable\_Isotope\_Air\_Pasture.csv**

Column	Heading	Units/format	Description
1	Region		Sampling region
2	Site		Sampling site
3	Longitude	degrees	Location in decimal degrees
4	Latitude	degrees	Location in decimal degrees
5	Ecosystem		Ecosystem vegetation type: Pasture
6	Year	YYYY	Sampling year
7	Month	MM	Sampling month
8	Time	HHMM	Sampling time 24 hour clock (local time)
9	Height	meters	Sampling height in meters (m)
110	CO2_conc	ppm	Atmospheric CO2 concentration, measured with Licor 6200 in the field or a Licor 6252 in the field
11	Inverse_CO2_conc	1/ppm	Calculated inverse of atmospheric CO2 concentration
12	delta_13C	parts per mil	Isotopic ratio of 13C/12C in carbon dioxide referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
13	delta_18O	parts per mil	Isotopic ratio of 18O/16O in carbon dioxide referenced to SMOW, measured with continuous flow on Finigan Delta Plus at CENA
Note: 9999 indicates missing data ( note this value is used rather than the more common -9999 due to the large number of negative values for delta variables)			
Sampling year, month, and time only are reported; no sampling day is provided.			

**Example data records:**

```

Region,Site,Longitude,Latitude,Ecosystem,Year,Month,Time,Height,CO2_conc,Inverse_CO2_conc,delta_13C,delta_18O
Manaus,ZF3,-2,-59,Pasture,1999,5,1200,0.27,469.6,0.00213,-12.1,36.6
Manaus,ZF3,-2,-59,Pasture,1999,5,1740,0.27,467.2,0.00214,-12,37.5
...
Rondonia, Rebio,-10.7618,-62.3572,Pasture,2000,2,1545,0.6, 52.8, 0.00283,-7.9,38.9
Rondonia, Rebio, 10.7618,-62.3572,Pasture,2000,2,1545, 0.2,375.3,0.00266,-8.3,38.2
...
Santarem, km 77,-3.0202,-54.959,Pasture,1999,5,1440,0.84,361.7,0.00276,-8.4,43
Santarem, km 77,-3.0202,-54.959,Pasture,1999,5,1440,0.27,391.5,0.00255,-8.4,43.2
...
Santarem, Mojui, -2.76667,-54.57917,Pasture,2002,6,2107, .02,746.8,0.00134,-16.3,38
Santarem, Mojui, -2.76667,-54.57917,Pasture,2002,6,2104,1,628.4,0.00159,-16.3,39.5
...

```

**File #3: CD02\_Stable\_Isotope\_Air\_Troposphere.csv**

Column	Heading	Units/format	Description
1	Row		Row number
2	Flask_ID		Identification number for each air sample flask
3	Local_time	HH:MM:SS	Time (HH:MM:SS) of sampling in local time (GMT -4)
4	Flight_time		Duration of flight in minutes
5	Date	YYYYMMDD	Sample date (YYYYMMDD)
6	GPS_date	YMMDD	Date (YMMDD) recorded by GPS
7	GPS_time	HHMMSS	Time (HHMMSS) recorded by GPS unit in GMT time
9	Latitude	degrees	Sampling latitude in decimal degrees
9	Longitude	degrees	Sampling longitude in decimal degrees
11	Altitude	masl	Sampling altitude in meters above sea level
11	Theta	K	Potential temperature calculated in degrees Kelvin
12	Atm_press	pa	Atmospheric pressure measured in Pascals
13	CO2_ref	ppm	Measured CO2 concentration in parts per million for the reference cell of the Licor IRGA
14	CO2_sample	ppm	Measured CO2 concentration in parts per million for the sample cell of the Licor IRGA
15	RH_outside	%	Relative humidity (%) measured outside the window of plane
16	T_outside	degrees C	Temperature in degrees C measured outside the window of the plane
17	CO2_calc	ppm	Atmospheric CO2 concentration in parts per million calculated from Licor measurements =CO2_ref-CO2_sample+350.3

18	Comment		Observation on the flight
19	Flask_CO2	ppm	CO2 concentration in sample flasks, expressed as parts per million, measured independently in the lab
20	Delta_13C	per mil	Isotopic ratio of 13C/12C in carbon dioxide per mil from flasks referenced to PDB, measured with continuous flow on Finigan Delta Plus at CENA
21	Delta_18O	per mil	Isotopic ratio of 18O/16O in carbon dioxide per mil from flasks referenced to SMOW, measured with continuous flow on Finigan Delta Plus at CENA
Missing data values are represented by 9999			

**Example data records:**

Row,Flask_ID,Local_time,Flight_time,Date,GPS_date,GPS_time,Latitude,Longitude,Altitude,Theta , Atm_press,CO2_ref,CO2_sample,RH_outside,T_outside,CO2_calc,Comment,Flask_CO2,Delta_1 3C,Delta_18O 1,N55,16:28:02,847,20030526,30526,202652,-2.32594,-54.9184,326,305.22, 97.17,387.69,357.77,73,28.6,380.22,Flight #1,380.14,-8.26,41.69 2,N62,16:33:40,1185,20030526,30526,203230,-2.18228,-54.919,299,305.41, 97.41,386.65,357.91,74.2,29,379.04,Flight #2,379.6,-8.26,41.5 3,N70,16:38:47,1492,20030526,30526,203737,-2.21994,-54.8018,327,305.63, 97.12,386.97,358.22,69.2,28.9,379.05,Flight #3,549.59,-13.11,38.85 4,N18,16:51:55,2280,20030526,30526,205045,-2.59789,-54.8356,318,304.59, 97.25,385.09,358.42,83.4,28,376.97,Flight #4,376.08,-8.13,41.89 ...
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**Site boundaries:**

(All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Rondonia - Fazenda Nossa Senhora Pasture	-62.3572	-62.3572	-10.7618	-10.7618	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)
Para Western (Santarem) - km 117 Tower Site (Para Western (Santarem))	-56.00000	-56.00000	-1.00000	-1.00000	World Geodetic System, 1984 (WGS-84)

**Time period:**

- The data set covers the period 1999/03/01 to 2004/03/31.
- Temporal Resolution: The forest and pasture data were collected quarterly and monthly, the troposphere data were collected in a one time campaign

**Platform/Sensor/Parameters measured include:**

- LABORATORY / MASS SPECTROMETER / STABLE ISOTOPES
- FIELD INVESTIGATION/CO<sub>2</sub> SENSOR/CARBON DIOXIDE

### **3. Data Application and Derivation:**

Measurements of carbon and oxygen stable isotope ratios of atmospheric CO<sub>2</sub> are a powerful indicator of large-scale CO<sub>2</sub> exchange on land across multiple spatial scales. Stable carbon isotope composition of leaf tissue and CO<sub>2</sub> released by respiration ( $\delta^{13}C$ ) can be used as an estimate of changes in ecosystem isotopic discrimination that occur in response to seasonal and interannual changes in environmental conditions, and land-use change (forest-pasture conversion). 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:**

Standard samples were run along with the field samples for all analyses to check the calibration of the instruments. There are no known problems with the data.

### **5. Data Acquisition Materials and Methods:**

The data on atmospheric CO<sub>2</sub> concentrations and isotope signatures include collections between March 1999 and March 2004 made at 10 different sites in the states of Amazonas, Para, and Rondonia within the Brazilian Amazon. Actual time and location for each data point are noted in the data files. Carbon and oxygen isotopes of atmospheric carbon dioxide collected during 5 days in May 2003 (wet season) on flights over the Amazon/ Tapajos Rivers, FLONA Tapajos and pasture/agriculture areas. Flights ranged from low altitudes to over the diurnal tropospheric boundary layer.

**Atmospheric sampling within the forest/pasture canopies:**

At each site we collected samples of air at intervals during a 1-2 day period. Sample lines (Dekoron tubing, 6 mm outer diameter) were located at different heights in the canopy by attachment to a scaffold tower (forest) or wooden pole (pasture). A small filter was placed over the inlet to prevent the entry of insects. Air was pulled down through the tubing, through a desiccant tube containing magnesium perchlorate, and into glass flasks (100 ml, see Ehleringer and Cook, 1998) by a battery-operated pump (Capex V2X, Charles Austin, West Byfleet, Surrey, UK). Air was passed through the flasks for approximately 7-10 minutes before the high vacuum stopcocks on the flask were closed. The flask was then returned to the lab for stable isotope analyses and CO<sub>2</sub> concentration measurement. Sampling times were chosen to obtain diurnal variation of concentrations and isotopes.

**Tropospheric measurements:**

Samples were collected during 5 days in May 2003 (wet season) on flights over the Amazon/ Tapajos Rivers, FLONA Tapajos and pasture/agriculture areas. Flights ranged from low altitudes to over the diurnal tropospheric boundary layer. Samples were collected in a tube attached to the wing of the small plane. Duplicate samples were collected in sample flasks and analyzed for CO<sub>2</sub> concentration,  $\delta^{13}C$  and  $\delta^{18}O$  of CO<sub>2</sub> at CENA.

**Sample analyses:**

CO<sub>2</sub> concentrations were measured with Licor 6200 in the field and Licor 6252 in the lab at CENA/USP



in Piracicaba 13C/12C; 18O/16O - Measured with continuous flow on Finigan MAT Delta Plus (CENA/USP).

## 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](mailto:uso@daac.ornl.gov)

Telephone: +1 (865) 241-3952

## 7. References:

Ehleringer, J.R., and C.S. Cook. 1998. Carbon and oxygen isotope ratios of ecosystem respiration along an Oregon conifer transect: preliminary observations based upon small-flask sampling. *Tree Physiol.* 18:513-519.

Flanagan, L.B., D.S. Kubien, and J.R. Ehleringer, Spatial and temporal variation in the carbon and oxygen stable isotope ratio of respired CO<sub>2</sub> in a boreal forest ecosystem, *Tellus*, 51B, 367-384, 1999.

### Related Publications

- Ometto, J. P. H. B., L. B. Flanagan, L. A. Martinelli, M. Z. Moreira, N. Higuchi, and J. R. Ehleringer. 2002. Carbon isotope discrimination in forest and pasture ecosystems of the Amazon Basin, Brazil, *Global Biogeochem. Cycles*, 16(4), 1109, doi:10.1029/2001GB001462
- Ometto, J.P.H., L.B. Flanagan, L.A. Martinelli, and J.R. Ehleringer. 2005. Oxygen isotope ratios of waters and respired CO<sub>2</sub> in Amazonian forest and pasture ecosystems. *Ecological Applications* 15(1):58-70.
- Ehleringer, J.R., D.R. Bowling, L.B. Flanagan, J. Fessenden, B. Helliker, L.A. Martinelli, and J.P. Ometto. 2002. Stable isotopes and carbon cycle processes in forests and grasslands. *Plant Biology* 4(2):181-189.