

LBA-ECO CD-08 Tropical Forest Ecosystem Respiration, Manaus, Brazil

Summary:

Leaf, live wood (tree stem), and soil respiration were measured along with additional environmental factors over a 1-yr period in a Central Amazon terra firme forest and are provided in this data set as three comma delimited data files. Investigations were carried out at an INPA reserve located along the ZF2 road at km 34 [LBA 34] on two 20 x 2500 m permanent forest inventory plots referred to as the Jacaranda plots (-2.6091 degrees S, -60.2093 degrees W). These long and narrow plots capture ecosystem variation associated with the undulating local topography. Leaf respiration measurements were also made at the tower located at ZF-2 road (km 14 [LBA 14]). Leaf respiration was measured during July and August 2001, woody respiration in August 2000 and June 2001, and soil respiration between July 2000 and June 2001 at 4 to 6-wk intervals.

Understanding how tropical forest carbon balance will respond to global change requires knowledge of individual heterotrophic and autotrophic respiratory sources, together with factors that control respiratory variability. These data were used to estimate ecosystem leaf, live wood and soil respiration with detailed information provided in Chambers et al. (2004).

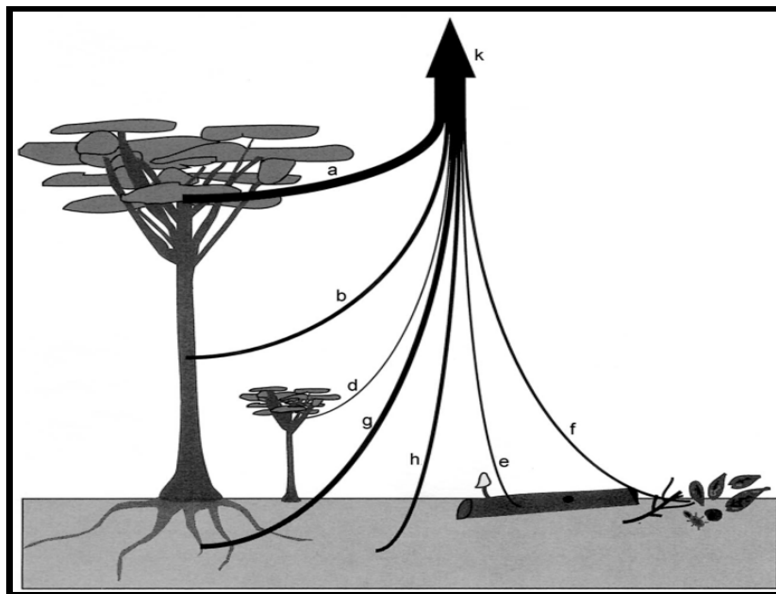


Figure 1. Ecosystem respiration pathways as measured and as described in Chambers et al. (2004).

Data Citation:

Cite this data set as follows:

Chambers, J.Q., E.S. Tribuzy, L.C. Toledo, B.F. Crispim, N. Higuchi, J. dos Santos, A.C. Araujo, B. Kruijt, A.D. Nobre, and S.E. Trumbore. 2009. LBA-ECO CD-08 Tropical Forest Ecosystem Respiration, Manaus, 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/912.

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This data set was archived in January of 2009. Users who download the data between January of 2009 and December 2013 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 (Trumbore / Camargo)

The investigators were Chambers, Jeffrey Q.; Trumbore, Susan E.; dos Santos, Joaquim; Higuchi, Niro and Tribuzy, Edgard Siza . You may contact Chambers, Jeffrey Q. (chambers@tulane.edu)

LBA Data Set Inventory ID: CD08_Ecosystem_Resp_Manaus

Leaf Respiration

This data set describes leaf respiration data collected with a LiCor 6400 on two towers located off the ZF-2 road (km 14 [LBA 14] and km 34 [LBA 34]) in the Central Amazon near Manaus. data were collected over an approximate 24 hour period on the same leaf from trees located near the tower to quantify diurnal variability in respiratory flux. Additionally, leaves from a variety of heights were measured to obtain a profile of respiration change with the height of the leaf from the

ground surface. In some cases common names for species were available, and in other cases common names were not available.

Woody Stem Respiration

Data on stem respiration collected from the boles of live trees in the Central Amazon at the INPA reserve located along the ZF2 road at km 34 [LBA 34].

Forest Soil Respiration

This dataset describes seasonal changes in soil CO₂ flux for a Central Amazon site near the ZF-2 road at km 34 [LBA 34] in the INPA reserve north of Manaus. Soil moisture and temperature were quantified in conjunction with soil CO₂ flux data.

Details of these data and analyses are provided in Chambers et al. (2004).

Related_Data_Sets:

LBA-ECO CD-08 Coarse Wood Litter Respiration and Decomposition, Manaus, Brazil

2. Data Characteristics:

Leaf Respiration

Data are provided as a comma-separated value (.csv) ASCII file:

Filename: CD-08_Manauas_ZF2_Jacaranda_plot_leaf_respiration_data.csv

Column	Column Heading	Units/Format	Variable Description
1	Date	yyyy/mm/dd	Date that respiration data were collected
2	Tower	character	Location of the tower where data were collected [LBA 14, LBA 34]
3	common_name	character	Common name of tree (when available).
4	HHMMSS	hh:mm:ss	Hour, minute, and second of day when data were collected (UTC - 5)
5	TOD	decimal fraction of a day	Decimal time for hours and minutes from Column 4, e.g. 2:30 is 2.50
6	Height	meters	Leaf height above ground level where respiration data were collected
7	Respiration	umol CO ₂ /m ² /s	Respiration rate: negative numbers are respiratory flux, positive numbers imply photosynthesis, but also imply measurements with significant unknown errors, but data are provided so as not to bias estimates.
8	Tleaf	deg C	Temperature of the leaf at time respiration data were collected (degree Celsius)
9	Tair	deg C	Air temperature at time respiration data were collected (degree Celsius)

Sample Data Records:

```

Filename: CD-08_Manauas_ZF2_Jacaranda_plot_leaf_respiration_data.csv
Column No.,Column Heading,Units/Format,Variable Description,,,,,,,,,
1,Date,yyyy/mm/dd,Date that respiration data were collected,,,,,,,,,
2,Tower,character,"Location of the tower were data were collected [LBA 14, LBA 34]" ,,,,,,,,,
3,common_name,character,Common name of tree (when available),,,,,,,,,
4,HHMMSS,hh:mm:ss,"hour, minute, and second of day when data were collected (UTC -
5)" ,,,,,,,,,
5,TOD,decimal fraction of a day,"decimal time for hours and minutes from Column 4, e.g. 2:30 is
2.50 " ,,,,,,,,,
6,Height,meters,Leaf height above ground level were respiration data were collected,,,,,,,,,
7,Respiration,umol CO2/m2/s,"Respiration rate: negative numbers are respiratory flux, positive
numbers imply photosynthesis,
but also imply measurements with significant unknown errors, but data are provided so as not
to bias estimates." ,,,,,,,,,
8,Tleaf,deg C,Temperature of the leaf at time respiration data were collected (degree
Celsius),,,,,,,,,
9,Tair,deg C,Air temperature at time respiration data were collected (degree Celsius),,,,,,,,,
,,,,,,,,,
There are no missing data values.,,,,,,,,,,
,,,,,,,,,
Date,Tower,common_name,HHMMSS,TOD,Height,Respiration,Tleaf,Tair,,,,,,,,
yyyy/mm/dd,,,hh:mm:ss,decimal fraction of a day,meters,umol CO2/m2/s,deg C,deg C,,,,,,,,
2001/08/08,LBA 34,Louro Preto,02:46:44,2.767,0.5,2.370,24.10,24.27
2001/08/08,LBA 34,Louro Preto,04:23:10,4.383,0.5,-1.200,24.42,24.72
2001/08/15,LBA 34,Louro Preto,06:30:42,6.500,0.5,-0.699,25.55,26.05
2001/08/15,LBA 34,Louro Preto,07:52:36,7.867,0.5,0.045,29.16,29.83
2001/08/07,LBA 34,Louro Preto,09:37:29,9.617,0.5,-0.582,27.58,28.07
...
2001/07/05,LBA 14,Amap Roxo,17:06:13,17.100,25,-1.010,29.23,29.70
2001/07/05,LBA 14,Amap Roxo,18:23:05,18.380,25,-0.787,28.26,28.63
2001/07/05,LBA 14,Amap Roxo,19:35:51,19.580,25,-1.270,27.07,27.51
2001/07/05,LBA 14,Amap Roxo,20:45:13,20.750,25,-0.864,26.56,27.17
2001/07/05,LBA 14,Amap Roxo,22:03:42,22.050,25,-1.350,26.32,26.96
2001/07/05,LBA 14,Amap Roxo,23:19:40,23.320,25,-1.150,25.91,26.42

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Woody Stem Respiration

Data are provided as a comma-separated value (.csv) ASCII file:

Filename: CD-08_Manauas_ZF2_tree_stem_respiration_data_2000-2001.csv

Column	Column Heading	Units/Format	Variable Description
1	date	yyyy/mm/dd	Date stem respiration data collected
2	plot	character	Identity of plot: L-O = east/west transect plot, N-S = north/south transect plot: these plots are located at KM 34 of the ZF-2 road in the INPA reserve north of Manaus.
3	stem_ID	character	Stem ID number located on metal plate attached to tree with fishing line.
4	Tstem	deg C	Surface temperature of stem where CO2 flux measured (degree Celsius)
5	HHMMSS	hh:mm	Time of day that data were collected (HH:MM) (UTC - 5)

6	slope	umol CO2/mol air/s	The slope of the relationship CO2 flux (micro mol CO2 per mol air) with time (seconds)
7	Carea	m2	The flux area of the chamber attached to the tree (m2)
8	Cvol	L	The volume of the chamber attached to the tree (L)
9	n	mol	The number of moles of air in the sample chamber (mol)
10	rate	umol CO2/m2/s	The flux of CO2 from the stem surface (micro mol CO2 per meter squared per second)
11	dbh	cm	The stem base diameter of the tree (cm) measured at 1.3 meters height.
12	growth_class	character	The growth rate class of the tree with class 1 the highest and class 5 the lowest growth rate.

Sample Data Records:

```

Filename: CD-08_Manauas_ZF2_tree_stem_respiration_data_2000-2001.csv
Column Number,Column Heading,Units/Format,Variable Description,,,,
1,date,yyyy/mm/dd,Date stem respiration data collected,,,,
2,plot,character,"Identity of plot: L-O = east/west transect plot, N-S = north/south transect plot:
these plots are located at KM 34 of the ZF-2 road in the INPA reserve north of Manaus.",,,,,
3,stem_ID,character,Stem ID number located on metal plate attached to tree with fishing line.,,,,,
4,Tstem,deg C,Surface temperature of stem where CO2 flux measured (degree Celsius),,,,,
5,HHMMSS,hh:mm,Time of day that data was collected (HH:MM) (UTC - 5),,,,,
6,slope,umol CO2/mol air/s,The slope of the relationship CO2 flux (micro mol CO2 per mol air)
with time (seconds),,,,,
7,Carea,m2,The flux area of the chamber attached to the tree (m2),,,,,
8,Cvol,L,The volume of the chamber attached to the tree (L),,,,,
9,n,mol,The number of moles of air in the sample chamber (mol),,,,,
10,rate,umol CO2/m2/s,The flux of CO2 from the stem surface (micro mol CO2 per meter
squared per second),,,,,
11,dbh,cm,The stem base diameter of the tree (cm) measured at 1.3 meters height.,,,,,
12,growth_class,character,The growth rate class of the tree with class 1 the highest and class 5
the lowest growth rate.,,,,,

Missing values are represented as -999.9,,,,,,,,
,,,,,,,,
date,plot,stem_ID,Tstem,HHMMSS,slope,Carea,Cvol,n,rate,dbh,growth_class
yyyy/mm/dd,,,deg C,hh:mm,umol CO2/mol air/s,m2,L,mol,umol CO2/m2/s,cm,
2000/08/04,L-O,157,31,14:15,0.068,0.01,0.4,0.01637,0.1113,30,5
2000/08/04,L-O,217,28.6,12:15,0.61642,0.01,0.4,0.01637,1.009,42,2
2000/08/04,L-O,227,27.4,12:00,0.32396,0.01,0.4,0.01637,0.5303,50,4
2000/08/04,L-O,361,26.4,11:34,0.49389,0.01,0.4,0.01637,0.8085,32.5,2
2000/08/04,L-O,631,29.2,11:05,0.38672,0.00925,0.25,0.01023,0.4277,11.6,2
...
2001/06/13,N-S,2585,23.9,10:27,0.328,0.01,0.4,0.01637,0.537,33.8,2
2001/06/13,N-S,2657,26.4,10:34,0.145,0.01,0.4,0.01637,0.237,45.5,5
2001/06/13,N-S,2665,24.3,10:37,0.586,0.00925,0.25,0.01023,0.648,48,3
2001/06/13,N-S,2841,24.9,10:44,0.552,0.01,0.4,0.01637,0.904,11.8,1
2001/06/13,N-S,2962,25,10:48,0.49,0.01,0.4,0.01637,0.802,11,3

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Forest Soil Respiration

Data are provided as a comma-separated value (.csv) ASCII file:

Column	Column Heading	Units/Format	Variable Description
1	date	yyyy/mm/dd	Date soil respiration data were collected
2	topo	character	Topographic position of soil chamber with p: plateau, e: slope, and b: valley bottom
3	id	character	Chamber identification number
4	slope	umol CO2/mol air/s	Slope of the change in chamber CO2 concentration with time: micro mol of CO2 per mol of chamber air per second.
5	Cvol	L	The volume of the chamber (liters)
6	n	mol	number of moles of air in the chamber
7	Carea	m2	The area of the chamber (square meters)
8	rate	umol CO2/m2/s	The CO2 flux rate from the soil surface: micro mole of CO2 per meter squared per second.
9	soil_moisture	percent by volume	The soil moisture content as measured by a Campbell Scientific MoistureSense probe taken at the same time that CO2 was measured: % water by volume.
10	Tsoil	deg C	Soil temperature at the time CO2 flux and moisture content were determined. (degree Celsius)

Sample Data Records:

Filename: CD-08_Manauas_ZF2_Jacaranda_plot_soil_respiration_data.csv
 Column Number,Column Heading,Units/Format,Variable Description,,,,,
 1,date,yyyy/mm/dd,Date soil respiration data were collected,,,,,
 2,topo,character,"Topographic position of soil chamber with p: plateau, e: slope, and b: valley bottom",,,,,
 3,id,character,Chamber identification number,,,,,
 4,slope,umol CO2/mol air/s,Slope of the change in chamber CO2 concentration with time: micro mol of CO2 per mol of chamber air per second,,,,,
 5,Cvol,L,The volume of the chamber (liters),,,,,,
 6,n,mol,number of moles of air in the chamber,,,,,
 7,Carea,m2,The area of the chamber (square meters),,,,,,
 8,rate,umol CO2/m2/s,The CO2 flux rate from the soil surface: micro mole of CO2 per meter squared per second,,,,,
 9,soil_moisture,percent by volume,The soil moisture content as measured by a Campbell Scientific MoistureSense probe taken at the same time that CO2 was measured: % water by volume,,,,,
 10,Tsoil,deg C,Soil temperature at the time CO2 flux and moisture content were determined. (degree Celsius),,,,,,

.....
 There are no missing data values.,,,,,,,,,

date,topo,id,slope,Cvol,n,Carea,rate,soil_moisture,Tsoil
 yyyy/mm/dd,,,umol CO2/mol air/s,L,mol,m2,umol CO2/m2/s,percent by volume,deg C
 2000/07/29,p,1,0.292,5.51,0.2256,0.03142,2.1,36,24.4
 2000/07/29,p,2,0.312,5.99,0.2452,0.03142,2.44,39,24.6
 2000/07/29,p,3,0.195,5.97,0.2443,0.03142,1.52,38,24.8
 2000/07/29,p,4,0.244,5.87,0.2404,0.03142,1.87,30,24.8
 2000/07/29,p,5,0.265,5.77,0.2362,0.03142,1.99,30,25.3
 ...
 2001/06/20,b,14,0.139,5.51,0.2256,0.03142,1.90,24.02
 2001/06/20,b,15,0.225,5.42,0.2218,0.03142,1.59,46,23.19

2001/06/20,b,16,0.156,4.69,0.1919,0.03142,0.95,34,23.62
 2001/06/20,b,17,0.125,5.58,0.2282,0.03142,0.91,64,24.13
 2001/06/20,b,18,0.504,5.69,0.233,0.03142,3.74,47,24.03

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Amazonas (Manaus) - ZF2 km 34 (Amazonas (Manaus))	-60.2093	-60.2093	-2.6091	-2.6091	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)

Time period:

- The data set covers the period 2000/07/29 to 2001/08/15.

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / LICOR PLANT CANOPY ANALYZER / LEAF CHARACTERISTICS
- FIELD INVESTIGATION / LICOR PLANT CANOPY ANALYZER / RESPIRATION
- FIELD INVESTIGATION / IRGA (INFRARED GAS ANALYZER) / RESPIRATION
- FIELD INVESTIGATION / IRGA (INFRARED GAS ANALYZER) / SOIL RESPIRATION
- FIELD INVESTIGATION / SOIL MOISTURE PROBE / SOIL MOISTURE/WATER CONTENT

3. Data Application and Derivation:

Leaf Respiration

These data can be used to quantify variability in leaf respiration with height, time of day, and temperature.

Woody Stem Respiration

These data can be used to estimate respiratory flux from live woody tissues. Detailed scaling methods are provided in Chambers et al., 2004.

Forest Soil Respiration

These data can be used to quantify soil respiratory flux and relationships with topography, moisture content, and time of year.

4. Quality Assessment:

Leaf Respiration

A number of positive values are noted which suggest photosynthesis and not respiration. These data, which are clearly in error, were not removed from the data set so as not to bias overall flux estimates. More details on potential errors provided in Chamber et al., 2004.

Woody Stem Respiration

One major source of error is the potential for CO₂ to be transported in the xylem stream. These errors are very difficult to account for, and were not possible to evaluate for this study.

Forest Soil Respiration

The main sources of error inherent in soil respiration measurements is difficulty maintaining an undisturbed boundary layer.

5. Data Acquisition Materials and Methods:

Leaf Respiration

Data were collected using a LiCor 6400 and canopy access towers.

Leaf respiration (R_{leaf}) measurements were made at ambient leaf temperature (T_{leaf}) using a LiCor 6400 equipped with a Blue/Red LED light source turned off creating a dark chamber. Measurements were logged only after the total coefficient of variation (CV) fell below 1%, and the IRGAs were matched prior to each measurement. R_{leaf} was measured at 1-2 hour intervals for the same leaf from different trees (>10 cm Db) located near two canopy access towers along the ZF2 road (ZF2-K14 and ZF2-K34). From 5-13 July 2001 leaf respiration was measured for 12 trees near the ZF2-K14 tower from ground to canopy, and from 7-15 August leaf respiration was measured for 12 trees near the ZF2-K34 tower from ground to canopy, over a 24 hour period.

This data set describes leaf respiration data collected with a LiCor 6400 on two towers located off the ZF-2 road (km 14 [LBA 34] and km 34 [LBA 14]) in the Central Amazon near Manaus. data were collected over an approximate 24 hour period on the same leaf from trees located near the tower to quantify diurnal variability in respiratory flux. Additionally, leaves from a variety of heights were measured to obtain a profile of respiration change with the height of the leaf from the ground surface. In some cases common names for species were available, and in other cases common names were not available.

Woody Stem Respiration

Data were collected using close dynamic chambers attached to the boles of live trees and CO₂ flux quantified using a LiCor 6252 infra-red gas analyzer.

Stem respiration (R_{wood}) was measured using an infra-red gas analyzer (IRGA, LI 6252 with an LI-670 Flow Control Unit) operated as a closed dynamic chamber (CDC) system with a flow rate of 1.0 L min⁻¹. Semi-circular polyvinyl chloride (PVC) chambers were cinched to the base of the tree (at ~Db) using nylon straps. Closed cell foam coated with silicon was glued to the rim of the chamber to provide a malleable seal that conformed to irregularities in the trunk. The measurement interval was about one minute. Measurements were made eight times between Aug. 2000 and Jun. 2001 at approximately 4-6 week intervals.

Fifty trees were selected from five relative growth classes using data collected during the first year of a tree community growth study. Briefly about 300 trees were randomly selected from three size classes from the Jacaranda plots. Each tree was outfitted with a dendrometer band used for measuring small changes in

circumference (i.e. < 0.05 mm). Using these increments, average woody tissue production (10 months from Sep. 1999 to Jul. 2000) was estimated for all trees using an allometric model that predicts tree mass as a function of base diameter (Db; at 1.3 m height or above the buttresses) and expressed as mg growth kg⁻¹ (dry weight) biomass day⁻¹. Next, trees were classified into four classes each representing 25% of total wood production, and a fifth class for trees that experienced no measurable growth during the 10 month period. Ten trees were randomly selected from each of these five growth classes.

Soil Respiration

Measurements were collected using a LiCor 6252 and closed dynamic chambers, and Campbell MoistureSense probes for soil water content.

To explore how soil respiratory flux varies with changes in topography and soil texture, 54 PVC collars were equally distributed among plateau, slope and valley soils, with each collar separated by 15 m. The IRGA system and methodology were the same as used for stem respiration with the exception that the chamber top had a small pressure equilibration vent. In conjunction with soil surface flux measurements, soil temperature and soil volumetric water content (VWC) (TDR probes, HydroSense, Campbell Scientific) were also measured.

6. Data Access:

This data set 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:

Chambers, J. Q., E. S. Tribuzy, L. C. Toledo, B. F. Crispim, N. Higuchi, J. dos Santos, A. C. Arajo, B. Kruijt, A. D. Nobre, and S. E. Trumbore. 2004. Respiration from a tropical forest ecosystem: Partitioning of sources and low carbon use efficiency. *Ecological Applications* 14:S72-S88. [doi:10.1890/01-6012](https://doi.org/10.1890/01-6012)

Related Publications

- Chambers, J.Q., E.S. Tribuzy, L.C. Toledo, B.F. Crispim, N. Higuchi, J. dos Santos, A.C. Araujo, B. Kruijt, A.D. Nobre, and S.E. Trumbore. 2004. Respiration from a tropical forest ecosystem: Partitioning of sources and low carbon use efficiency. *Ecological Applications* 14(4):S72-S88. [doi:10.1890/01-6012](https://doi.org/10.1890/01-6012)