

LBA-ECO CD-04 Leaf Photosynthesis and Respiration, Tapajos National Forest: 2000-2006

Summary:

This data set reports the results of measurements of (1) leaf-level photosynthesis response curves for the effects of temperature, leaf age, warming, irradiation, and circadian rhythm and (2) leaf-level photorespiration rates at 30 and 37 degrees C. Measurements were made between June 2000 and February 2006 at the km 83 Logged Forest Tower site, the km 67 Primary Forest Tower site, and the control site at Seca Floresta, all in the Tapajos National Forest, Para, Brazil. There are 7 comma delimited ASCII data files with this data set.

Data Citation:

Cite this data set as follows:

Doughty, C., Sousa, A, and Figueira, M. 2012. LBA-ECO CD-04 Leaf Photosynthesis and Respiration, Tapajos National Forest: 2000-2006. Available on-line [<http://daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.
<http://dx.doi.org/10.3334/ORNLDAAC/1060>

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 February of 2012. Users who download the data between February 2012 and January 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.

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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-04 (Goulden / Rocha)

The investigators were Goulden, Prof. Michael L.; Menton, Mary Catherine; Miller, Dr. Scott Dennis; Rocha, Prof. Humberto Ribeiro da; Freitas, Helber Custodio de; Figuera, Michela; Cleilim Albert Sousa; Rob Elliot; Ed Read; and Chris Doughty. You may contact Miller, Dr. Scott Dennis (sdmiller@uci.edu).

LBA Data Set Inventory ID: CD04_Leaf_level_Gas_Exchange

Our understanding of the regulation of gas exchange in tropical forest ecosystems lags behind that of temperate ecosystems despite the important role tropical forests play in the global carbon cycle. This data set provides measurements of leaf-level gas exchange under a variety of experimental conditions. Site measurements were made between June 2000 and February 2006 at the km 83 and km 67 sites and the control site at Seca Floresta, in the Tapajos National Forest, Para, Brazil.

2. Data Characteristics:

Measurements of leaf-level gas exchange under a variety of experimental conditions were collected from three locations in the Tapajos National Forest, south of the city of Santarem in the state of Para. The data are presented in seven comma-delimited ASCII files.

File 1: CD04_Photosynthesis_Circadian_Santarem.csv

Measurements were made between June 2000 and August 2004 at the km 83 and 67 sites in the Tapajo's National Forest, Para, Brazil (Doughty et al., 2006). Neither the specific site nor the specific date for sets of measurements were provided.

Column	Heading	Units/format	Description
1	Set		Unique identifier given to each set of measurements
2	Obs		Observation number identifies consecutive measurements within a set
3	Common_name		Common name, or not provided
4	Scientific_name		Scientific name in the format Genus species or not provided
5	Family		Scientific family or not provided
6	Time	seconds	Seconds since start of set, actual measurements started at 20 minutes to allow for equilibration
7	Photo	umol CO2 m-2 s-1	Photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
8	Cond	mol H2O m-2	Stomatal conductance reported in moles of water per meter

		s-1	squared leaf area per second (mol H2O m-2 s-1)
9	Ci	umol CO2 mol air-1	Intercellular CO2 concentration reported as micromoles of CO2 per mol of air (umol CO2 mol air-1)
10	VpdL	kPa	Vapor pressure deficit of the leaf reported in kilopascals (kPa)
11	T_air	degrees C	Air temperature in the chamber in degrees Celsius (degrees C)
12	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
13	CO2_ref	ppm	Atmospheric CO2 concentration in the reference chamber reported in parts per million (ppm)
14	H2O_ref	mmol H2O mol air-1	Atmospheric water vapor concentration in the reference chamber reported in millimoles of water per mole of air (mmol H2O mol air-1)
15	RH_ref	%	Relative humidity in the reference chamber reported in percentage (%)
16	Flow	umol s-1	Flow rate in chamber reported in micromoles of air per second (umol s-1)
17	PARi	umol m-2 s-1	Photosynthetically active radiation (PAR) flux in the chamber reported as micromoles of photons per meter squared per second (umol m-2 s-1): all wavelengths between 400 and 700 nm included in this measurement
18	Hour	digital hours	Local time using a 24 hour clock and presented in a digital hour format. When a continuous sampling set included samples on two calendar days the time values on day 2 are time +24 for ease of x axis graphing ie 25.0 = 1 am on day 2
19	Calibration		Observation from internal calibration mechanism
Missing data values are represented as -9999			

Example data records:

```

Set,Obs,Common_name,Scientific_name,Family,Time,Photo,Cond,Ci,VpdL,T_air,
T_leaf,CO2_ref,H2O_ref,RH_ref,Flow,PARi,Hour,Calibration
1,1,abiu,Micropholis sp., Sapotaceae, 1428.2, 2.16, 0.0245, 211, 0.771, 26.25, 26.04,
369.6,25.152,73.02,103.8,100,10.917,none
1,2,abiu,Micropholis sp., Sapotaceae, 2631.2, 2.32, 0.0237, 188, 0.777, 26.1, 26.08,
370.6,25.735,75.35,323.5,100,11.25033333,none
...
9, 1,liana, Derris amazonica, Leguminosae-Papilionoideae,714 2.33, 0.0356, 258 1.21, 30.33,
29.92, 373.65, 30.093, 68.58, 500, 199, 12.683333, none
9, 2, liana, Derris amazonica, Leguminosae-Papilionoideae, 1314.5, 2.64, 0.0377, 251 1.16,
29.49, 29.94, 373.34, 30.717 73.42, 500.3, 198, 12.8499997,none
...
27, 72, cecropia, Distachya huber, Cecropiaceae,87917.3, 4.1, 0.0521, 245 1.36, 27.51
28.09, 386.2, 23.675, 63.97, 475, 100, 35,none
27, 73, cecropia, Distachya huber, Cecropiaceae,88245.3, 4.37, 0.0577, 246 1.38, 27.17,
28.08, 383.2, 23.771, 65.49, 688.3, 100, 35.1,none

```

File 2: CD04_Photosynthesis_Temp_Curves_Santarem.csv

We made leaf-level measurements at two field sites, working off a 45 m tall scaffold tower at km 67 and a 30 m tall tower at km 83 (Doughty and Goulden, 2008). The specific site for each set of measurements was not provided.

Column	Heading	Units/format	Description
1	Set		Unique identifier given to each set of measurements
2	Obs		Observation number within a set
3	Year	YYYY	Sampling date: year
4	Month	MM	Sampling date: month (1-12)
5	Day	DD	Day of month (1-31)
6	Time	HH:MM:SS	Sampling time in local time (GMT -4) and 24 hour clock
7	Common_name		common name
8	Scientific_name		Scientific name in the format Genus species
9	Family		Scientific family
10	Photo	umol CO2 m-2 s-1	Photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
11	Cond	mol H2O m-2 s-1	Stomatal conductance reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
12	Ci	umol CO2 mol air-1	Intercellular CO2 concentration reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
13	VpdL	kPa	Vapor pressure deficit of the leaf reported in kilopascals (kPa)
14	T_air	degrees C	Air temperature in the chamber in degrees Celsius (degrees C)
15	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
16	CO2_ref	ppm	Atmospheric CO2 concentration in the reference chamber reported in parts per million (ppm)
17	H2O_ref	mmol H2O mol air-1	Atmospheric water vapor concentration in the reference chamber reported in millimoles of water per mole of air (mmol H2O mol air-1)
18	RH_ref	%	Relative humidity in the reference chamber reported in percentage (%)
19	Flow	umol s-1	Flow rate in chamber reported in micromoles of air per second (umol s-1)
20	PARi	umol s-1	Photosynthetically active radiation (PAR) flux in the chamber reported as micromoles of photons per meter squared per second (umol m-2 s-1): all wavelengths between 400 and 700 nm included in this measurement
Missing data values are represented as -9999			

Example data records:

```

Set,Obs,Year,Month,Day,Time,Common_name,Scientific_name,Family,Photo,Cond,Ci,
VpdL,T_air,T_leaf,CO2_ref,H2O_ref,RH_ref,Flow,PARi
1,1,2005,10,04,13:51:41,jarana,Lecythis lurida, Lecythidaceae, 10.1, 0.0791, 142,
1.24,26.55,29.45,368.79,28.07,79.51,500.3,999
1,2,2005,10,04,13:52:01,jarana,Lecythis lurida, Lecythidaceae, 10.4, 0.087, 154,
1.23,26.54,29.43,368.41,28.001,79.35,500.3,999
...
21, 1, 2005, 10, 29, 11:03:47, abiu, Micropholis sp., Sapotaceae, 4.8, 0.0394, 152,
1.74, 27.58, 30.61, 363.08, 26.149, 69.9, 500.3, 1000,
21, 2, 2005, 10, 29, 11:04:08, abiu, Micropholis sp., Sapotaceae, 4.78, 0.0396, 154,
1.72, 27.49, 30.54, 362.89, 26.167, 70.31, 500.3, 999,
...

```

29, 12:51:10, louro, Sextonia rubra, Lauraceae, 6.55, 0.0557, 155,
 2.26, 28.57, 31.75, 364.32, 23.285, 58.64, 500.3, 1000,
 29, 12:51:31, louro, Sextonia rubra, Lauraceae, 6.56, 0.0574, 160,
 2.23, 28.46, 31.64, 364.43, 23.219, 58.85, 500.2, 1000

File 3: CD04_Photosynthesis_Warming_30_Santarem.csv

Leaf-level measurements at three field sites, km 67, km 83, and Seca Floresta. The specific site for each set of measurements was not provided.

Column	Heading	Units/format	Description
1	Year	YYYY	Sampling date: year
2	Month	MM	Sampling date: month (1-12)
3	Day	DD	Sampling date: day (1-31)
4	Day_of_year	day	Sampling date as day of year (1-366)
5	Common_name		Common name: gap refers to pioneer species found in a gap located approximately 50 m from the tower
6	Scientific_name		Scientific name in the format Genus species or not provided
7	Family		Scientific family or not provided
8	Leaf_ID		Leaf ID number
9	Photo	umol CO2 m-2 s-1	Photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
10	Cond	mol H2O m-2 s-1	Stomatal conductance reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
11	Ci	umol CO2 mol air-1	Intercellular CO2 concentration reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
12	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
13	Warm		Leaf warmed (1=yes, 0=no)
Missing data values are represented as -9999			

Example data records:

Year,Month,Day,Day_of_year, Common_name, Scientific_name, Family, Leaf_ID, Photo,
 Cond,Ci,T_leaf,Warm
 2005,08,16,228,abiu,Micropholis sp., Sapotaceae ,11,2,0.017,190,30,0
 2005,08,16,228,abiu,Micropholis sp., Sapotaceae ,12,1.7,0.015,190,30,0
 ...
 2007,01,16,381,liana1,Serjania sp.,Sapindaceae,11,7.5,0.07,200,30,1
 2007,01,16,381,liana1,Serjania sp.,Sapindaceae,12,8,0.1,230,30,1
 ...
 2006,01,23,388,gap,not provided,not provided,51,7,0.25,345,30,0
 2006,01,23,388,gap,not provided,not provided,52,6,0.3,350,30,0

File 4: CD04_Photosynthesis_Warming_37_Santarem.csv

Leaf-level measurements at three field sites, km 67, km 83, and Seca Floresta. The specific site for each set of measurements was not provided.

Column	Heading	Units/format	Description
1	Year	YYYY	Sampling date: year
2	Month	MM	Sampling date: month (1-12)
3	Day	DD	Sampling date: day (1-31)
4	Day_of_year	day	Sampling date as day of year (1-366)
5	Common_name		Common name (gap refers to pioneer species found in a gap located approximately 50 m from the tower)
6	Scientific_name		Scientific name in the format Genus species or "not provided"
7	Family		Scientific family or "not provided"
8	Leaf_ID		Leaf ID number
9	Photo_initial	umol CO2 m-2 s-1	Initial photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
10	Photo_post	umol m-2 s-1	Photosynthesis rate after 3-5 minutes of incubation reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
11	Delta_photo	umol m-2 s-1	Difference between initial and post incubation photosynthesis rates
12	Cond_initial	mol m-2 s-1	Initial stomatal conductance reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
13	Cond_post	mol m-2 s-1	Stomatal conductance after 3-5 minutes of incubation reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
14	Delta_cond	mol m-2 s-1	Difference between initial and post incubation conductance rates
15	Ci_initial	umol CO2 mol air-1	Initial intercellular CO2 concentration reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
16	Ci_post	umol CO2 mol air-1	Intercellular CO2 concentration after 3-5 minutes of incubation reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
17	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
18	Warm		Leaf warmed (1=yes, 0=no)
Missing data values are represented as -9999			

Example data records:

```
Year,Month,Day,Day_of_year,Common_name,Scientific_name,Family,Leaf_ID,Photo_initial,
Photo_post,Delta_photo,
Cond_initial,Cond_post,Delta_cond,Ci_initial,Ci_post,T_leaf,Warm
2005,08,16,228,abiu, Micropholis sp. ,Sapotaceae, 11, 0.5, -0.1
0.6, 0.01, 0.005,0.005,280,360,40,0
2005,08,16,228,abiu, Micropholis sp. ,Sapotaceae, 12, -0.1, -0.3
```

```

0.2, 0.008, 0.008,0,350,335,40,0
...
2005,01,17,382,tachi,Tachigali mymercophyla,Leguminosae-Caesalpinioideae,42,6.5,
0,6.5,0.14,0.02,0.12,250,-9999,38
2005,09,09,252,tree2,Caraipa sp.,not provided,11,1.5,
-0.5,2,0.27,0.011,0.259,260,-9999,39.5
...
2007,01,23,388,gap,not provided,not provided,61,6,
6,0,0.28,0.28,0,360,not provided,not provided
2007,01,23,388,gap,not provided,not provided,71,7,
7,0,0.12,0.12,0,300,not provided,not provided

```

File 5: CD04_Photorespiration_Warming_Santarem.csv

Leaf-level measurements at three field sites, km 67, km 83, and Seca Floresta. The specific site for each set of measurements was not provided.

Column	Heading	Units/format	Description
1	Year	YYYY	Sampling date: year
2	Month	MM	Sampling date: month (1-12)
3	Day	DD	Sampling date: day (1-31)
4	Common_name		Common name: gap refers to pioneer species found in a gap located approximately 50 m from the tower
5	Scientific_name		Scientific name in the format Genus species or "not provided"
6	Family		Scientific family or not provided
7	Leaf_ID		Leaf ID number
8	Oxygen	%	Oxygen level (2% or ambient)
9	Photo	umol CO2 m-2 s-1	Photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
10	Cond	mol H2O m-2 s-1	Stomatal conductance reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
11	Ci	umol CO2 mol air-1	Intercellular CO2 concentration reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
12	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
Missing data values are represented as -9999			

Example data records:

```

Year,Month,Day,Common_name,Scientific_name,Family,Leaf_ID,Oxygen,Photo,Cond,Ci,T_leaf
2005,12,16,abiu, Micropholis sp. ,Sapotaceae,11,2,2,0.035,250,36
2005,12,16,abiu, Micropholis sp. ,Sapotaceae,12,2,6.5,0.16,270,37
...
2006,01,28,copaiba,Copaifera duckei,Leguminosae-Caesalpinioideae,12,ambient,2.5,0.045,260,30
2006,01,28,copaiba,Copaifera duckei,Leguminosae-Caesalpinioideae,13,ambient,6.5,0.12,260,30
...
2006,01,25,gap,not provided,not provided,31,2,7.5,0.19,280,30

```

2006,01,25,gap,not provided,not provided,32,2,8,0.2,260,32

File 6: CD04_Photosynthesis_Subcanopy_Lightcurves_Santarem.csv

Understory species leaf level measurements were made at two field sites, km 67 and km 83. Neither the specific site nor the specific date for sets of measurements were provided.

Column	Heading	Units/format	Description
1	Set		Unique identifier given to each set of measurements
2	Obs		Observation number within a set
3	Time	HH:MM:SS	Start time for measurement set in local time (GMT -4) on a 24 hour clock
4	Height	m	Canopy height from the ground measured in meters
5	Time	seconds	Seconds since start of measurement
6	Photo	umol CO2 m-2 s-1	Photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
7	Cond	mol H2O m-2 s-1	Stomatal conductance reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
8	Ci	umol CO2 mol air-1	Intercellular CO2 concentration reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
9	VpdL	kPa	Vapor pressure deficit of the leaf reported in kilopascals (kPa)
10	T_air	degrees C	Air temperature in the chamber in degrees Celsius (degrees C)
11	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
12	CO2_ref	ppm	Atmospheric CO2 concentration in the reference chamber reported in parts per million (ppm)
13	H2O_ref	mmol H2O mol air-1	Atmospheric water vapor concentration in the reference chamber reported in millimoles of water per mole of air (mmol H2O mol air-1)
14	RH_ref	%	Relative humidity in the reference chamber reported in percentage (%)
15	Flow	umol s-1	Flow rate in chamber reported in micromoles of air per second (umol s-1)
16	PARi	umol m-2 s-1	Photosynthetically active radiation (PAR) flux in the chamber reported as micromoles of photons per meter squared per second (umol m-2 s-1): all wavelengths between 400 and 700 nm included in this measurement
Missing data values are represented as -9999			

Example data records:

```
Set,Obs,Time,Height,Time,Photo,Cond,Ci,VpdL,T_air,T_leaf,CO2_ref,H2O_ref,RH_ref,Flow,PARi
1,1,10:53:40,3,628.3,-1.04,0.0548,-9999,1.15,27.4,27.07,367.9,23.499,63.83,343.1,0
1,2,10:53:40,3,844.3,1.44,0.0484,308,1.14,27.28,27.06,365.4,23.615,64.6,334.3,25
...
47,1,12:56:20,3,241,2.5,0.00139,-9999,1.09,25.68,28.97,380.5,29.054,87.11,26,1801
47,2,12:56:20,3,423.2,1.8,0.00719,-9999,0.827,25.8,28.12,363.7,28.735,85.53,25.4,1201
...
105,6,15:12:36,32,648.7,-0.063,0.0143,379,1.03,26.72,26.7,378,22.14,62.12,30.1,49
```

105,7,15:12:36,32,723.1,-0.312,0.0154,-9999,1.02,26.86,26.78,377.9,22.284,62,30.3,-1

File 7: CD04_Photosynthesis_Leaf_Age_Santarem.csv

Leaf-level measurements at three field sites, km 67, km 83, and Seca Floresta. The specific site for measurements was not provided.

Column	Column Heading	Units/format	Description
1	Year	YYYY	Sampling date: year
2	Month	MM	Sampling date: month (1-12)
3	Day	DD	Sampling date: day (1-31)
4	Day_of_year	day	Sampling date as day of year (1-366)
5	Common_name		Common name: gap refers to pioneer species found in a gap located approximately 50 m from the tower
6	Scientific_name		Scientific name in the format Genus species
7	Family		Scientific family
8	Leaf_ID		Leaf number
9	Photo	umol m-2 s-1	Photosynthesis rate reported as micromol CO2 fixed per meter squared of leaf area per second (umol CO2 m-2 s-1)
10	Cond	mol H2O m-2 s-1	Stomatal conductance reported in moles of water per meter squared leaf area per second (mol H2O m-2 s-1)
11	Ci	umol CO2 mol air-1	Intercellular CO2 concentration reported as micromols of CO2 per mol of air (umol CO2 mol air-1)
12	T_leaf	degrees C	Leaf temperature in degrees Celsius (degrees C)
13	Age_leaf	years	Approximate age of leaf in years

Missing data values are represented as -9999

Example data records:

```
Year,Month,Day,Day_of_Year,Common_name,Scientific_name,Family,Leaf_ID,Photo,Cond,Ci,T_leaf,Age_leaf
2005,10,26,299,tachi,Tachigali mymercophyla,Caesalpinaceae,21,14,0.45,300,30,0
2005,10,26,299,tachi,Tachigali mymercophyla,Caesalpinaceae,22,14,0.35,280,30,0
...
2004,10,27,300,jarana,Lecythis lurida,Lecythidaceae,11,4.95,0.0596,213,30,1
2004,10,29,302,jarana,Lecythis lurida,Lecythidaceae,11,7.13,0.0554,138,30,1
...
2005,9,28,271,jarana,Lecythis lurida,Lecythidaceae,41,5.5,0.11,300,30,2
2005,9,28,271,jarana,Lecythis lurida,Lecythidaceae,42,3.2,0.06,290,30,2
```

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 83 Logged Forest Tower (Para Western (Santarem))	-54.9707	-54.9707	-3.017	-3.017	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 67 Primary Forest Tower Site (Para Western (Santarem))	-54.95900	-54.95900	-2.85700	-2.85700	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2000/06/01 to 2006/02/28.
- Temporal Resolution: Measurements were done in a series of campaigns of varying length and intensity

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / GAS EXCHANGE SYSTEM / PHOTOSYNTHESIS

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 endogenous patterns (circadian rhythm) on gas exchange 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 (Net Ecosystem Exchange) approaches as well.

4. Quality Assessment:

The data have been checked and there are a few problems at this time.

Known Problem: For all data files, the specific site at which measurements were made was not provided. For files 1 and 6, circadian and subcanopy measurements, no specific measurement dates were provided. The vegetation species for many leaf measurements were not identified or reported.

5. Data Acquisition Materials and Methods:

Measurements were made between June 2000 and February 2006 at the km 83 and 67 sites and the control site at the Seca Floresta experiment (Nepstad et al. 2002) in the Tapajos National Forest, Para, Brazil [Goulden et al., 2004; Saleska et al., 2003]. The vegetation was semi-deciduous closed tropical forest with canopy emergents on flat upland terrain.

Circadian rhythm: [File 1- CD04_Photosynthesis_Circadian_Santarem.csv]

Measurements were made between June 2000 and August 2004 at the km 83 and 67 sites in the Tapajo's National Forest, Para, Brazil (Doughty et al., 2006). Neither the specific site nor the specific date for sets of measurements were provided. The gas exchange rates of 56 leaves exposed to constant conditions for 20 to 48 hours in light and 6 leaves in darkness were measured with a LiCor 6400 gas exchange system. Most of the illuminated measurements were made at a Photon Flux Density (PPFD) of 100 micromol m⁻² s⁻¹, a leaf temperature of 30 degrees C, a chamber CO₂ concentration of 370 micromol mol⁻¹ air, and either a constant chamber vapor pressure or a constant flow through the chamber. Some runs were made at a PPFD of 1000 micromol m⁻² s⁻¹ or without temperature control or

without CO₂ control. The neighboring leaves on the branch being tested were kept in darkness, and a larger section of the branch was shaded under a tarp, throughout each run. Leaves were accessed on the ground or from scaffolding. Plants were identified following Ribero et al. [1999].

Temperature curves: [File 2- CD04_Photosynthesis_Temp_Curves_Santarem.csv]

Leaf level measurements were made at two field sites, working off a 45 m tall scaffold tower at km 67 and a 30-m tall tower at km 83 (Doughty and Goulden, 2008). The specific site for sets of measurements was not provided. We visited the field at least once a week from August to December 2004 to make photosynthesis measurements on three focal species (*Sextonia rubra*, *Micropholis* sp., *Lecythis lurida*) using a portable gas exchange system (LI 6400, Li-Cor Biosciences, Lincoln, NE). Repeated measurements were made of the response of leaf gas exchange to irradiance, holding leaf temperature constant at 30 degrees C, and the response to leaf temperature, holding flow, irradiance and CO₂ concentration constant. The temperature response curves were made by placing leaves in the chamber at 30 degrees C and 1000 micromol m⁻²s⁻¹, allowing conditions to equilibrate for several minutes, and then raising the temperature in the chamber while recording the observations every 20 seconds. Each temperature response curve took 10 to 20 minutes, and the maximum achievable temperature was approximately 42 degrees C. Observations immediately after the initial temperature increase were often out of calibration and were removed from subsequent analysis.

Warming measurements:

The field campaign lasted from July 2005 to February 2006 and focused on six canopy top tree species and two canopy top liana species accessed with three canopy access towers and 6 gap specialist species in a gap at km 83. We studied two species accessible from a 30 m scaffold tower at the km 83 site, four species from a 45 m scaffold tower at km 67, and two species from a 30 m tower at the control site, Seca Floresta. The specific site for sets of measurements was not provided.

- The following eight canopy top species were tested: *Abuta* sp., *Copaifera ducke*, *Protium punctulatum* Macbri, *Caraipa* sp., *Tachigali mymercophylla*, *Sextonia rubra*, *Micropholis* sp., and *Serjania* sp.
- In a gap approximately 50 meters from the km 83 eddy flux tower, the following gap species were tested: *Protium* sp., *Mabea subsessilis*, *Cecropia sciadophylla*, *Cariniana micrantha*, *Mabea* sp., and *Iryanthera sagotiana*.

Photosynthesis [File 3- CD04_Photosynthesis_Warming_30_Santarem.csv and File 4- CD04_Photosynthesis_Warming_37_Santarem.csv]

Leaf-level gas exchange was measured once a week at all sites from July 2005 to February 2006 using a portable gas exchange system (LI 6400, Li-Cor Biosciences, Lincoln, NE). The rates of gas exchange were measured under a standardized set of conditions (temperature 30 degrees C and approximately 37 degrees C; PPFD 1000 micromol m⁻²s⁻¹; ambient CO₂).

- We repeatedly measured two leaves on each of four branches on each of the eight canopy species (n = 64 each week), and returned to a leaf until it abscised, at which point we chose another nearby leaf.
- Two leaves each week were measured on each of the 6 gap species (n = 12). Each gas exchange measurement lasted approximately 3-5 minutes and the data were averaged once the measurement stabilized.

Electric resistance heaters powered by solar panels were used to continuously warm four individual leaves for each species. Each heater was composed of a constantan wire (30 ohms) wrapped in aluminum foil and folded into approximately 40 cm². Six volts were ran through the wire (1.2 Watts) and placed the heaters approximately 2 cm below the leaves by attaching them to the petiole with wire. A nighttime comparison of leaf temperatures between 5 heated leaves and a non-heated leaf on a night

when the leaf thermocouple positions were verified, showed the electric resistance heaters warmed the leaves by an average of 1.96 degrees C plus/minus 1.4 degrees C (SD) at night.

Photorespiration [File 5- CD04_Photorespiration_Warming_Santarem.csv]

CO₂ concentration over time was measured at 2 percent oxygen to estimate the rate of photorespiration. The composition of the air entering the gas exchange system was regulated by mixing 10 percent ambient air with 90 percent pure nitrogen from a tank, thereby reducing the oxygen concentration entering the system to approximately 2 percent. The gas mixture was then scrubbed of CO₂, and pure CO₂ was injected to bring the CO₂ mixing ratio to 370 ppm. Photorespiration rates for leaves were determined at PPF 1000 micromol m⁻²s⁻¹ and 30 and 37 degrees C. The gas exchange observations at 37 degrees C were recorded before significant stomatal closure.

Sub-canopy measurements: [File 6- CD04_Photosynthesis_Subcanopy_Lightcurves_Santarem.csv]
The leaf-level gas exchange using scaffold towers at the km 83 and km 67 field sites was measured from the following sub-canopy and understory species: *Eschweilera amazonica*, *Lecythis* sp., *Chimarrhis turbinata*, *Faramea platyneura*, and *Sclerolobium paraense*. A portable gas exchange system (LI 6400, Li-Cor Biosciences, Lincoln, NE) was used in April and May 2002 to measure the rates of gas exchange under various irradiance levels (PPFD 0, 50, 100, 200, 500, 1000, 1500, 1800 micromol m⁻² s⁻¹) at constant temperature (30 degrees C) and ambient CO₂. We grouped the data as understory (0-10 meters), and sub-canopy species (10-25 meters).

Effect of leaf age: [File 7- CD04_Photosynthesis_Leaf_Age_Santarem.csv]
The leaf-level gas exchange in the canopy was measured from scaffold platforms (Doughty et al. 2006; Doughty and Goulden 2008) at the LBA-ECO km 83, km 67, and Seca Floresta field sites. The km 83 scaffold was located within 300 meters of the main eddy flux tower. A portable gas exchange system (LI 6400, Li-Cor Biosciences, Lincoln, NE) was used at the km 83 site from August to December 2004 and at all of the sites from August to January 2005. The rates of gas exchange were measured under a standardized set of conditions (temperature 30 degrees C; PPF 1000 micromol m⁻²s⁻¹; ambient CO₂). We repeatedly measured two leaves on each of two branches for canopy species, and returned to a leaf until it abscised, at which point we chose another nearby leaf.

6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) or the EOS Data Gateway.

Data Archive Center:

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov

Telephone: +1 (865) 241-3952

7. References:

Doughty, C.E., M.L. Goulden, S.D. Miller and H.R. da Rocha. 2006. Circadian rhythms constrain leaf and canopy gas exchange in an Amazonian forest. *Geophysical Research Letters* 33: L15404, doi:10.1029/2006GL026750.

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Saleska, S.R. et al., 2003. Carbon in Amazon forests: Unexpected seasonal fluxes and disturbance-induced losses. *Science* 302: 1554-1557.

Related Publications

- Doughty, C.E., M.L. Goulden, S.D. Miller, and H.R. da Rocha. 2006. Circadian rhythms constrain leaf and canopy gas exchange in an Amazonian forest. *Geophysical Research Letters* 33(15): L15404, doi:10.1029/2006GL026750, 2006.
- Doughty C.E. and M.L. Goulden. 2008. Seasonal patterns of tropical forest leaf area index and CO₂ exchange. *Journal of Geophysical Research-Biogeosciences* 113: G00B06, doi:10.1029/2007JG000590.
- Doughty C.E. and M.L. Goulden. 2008. Are tropical forests near a high temperature threshold?. *Journal of Geophysical Research-Biogeosciences* 113:G00B07, doi:10.1029/2007JG000632.