Revision date: October 21, 2009

LBA-ECO CD-04 Meteorological and Flux Data, km 83 Tower Site, Tapajos National Forest

Summary:

Tower flux measurements of carbon dioxide,water vapor, heat, and meteorological variables were obtained at the Tapajos National Forest, km 83 site, Santarem, Para, Brazil. For the period June 29, 2000 through March 11, 2004, 30-minute averaged and calculated quantities of fluxes of momentum, heat, water vapor, and carbon dioxide, storage of carbon dioxide in the air column, are reported.

Data are reported in three comma separated files: (1) 30 minute-averages, (2) the daily (24 hour) averages, and (3) the monthly (calendar) averages.

The variables measured on the 67 m tower relate to meteorology, soil moisture, respiration, fluxes of momentum, heat, water vapor, and carbon dioxide, and were used to calculate storage of carbon dioxide, Net Ecosystem Exchange, and Gross Primary Productivity. Most of the variables have not been gap filled. However, CO2 flux and storage have been filled to avoid biases in Net Ecosystem Exchange; a fill index flag is included to indicate which data points were filled. Variables derived from the filled variables (respiration, NEE, GPP) are essentially filled also. Net ecosystem exchange has been filtered for calm nighttime periods.

Instruments positioned at the top of the flux tower located at km 83, Tapajos National Forest

Data Citation:

Cite this data set as follows:

Miller, S., M. Goulden, and H.R. da Rocha, 2009. LBA-ECO CD-04 Meteorological and Flux Data, km 83 Tower Site, Tapajos National Forest. 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/946

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 October of 2009. Users who download the data between October 2009 and September 2014 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-04 (Goulden / Rocha)

The investigators were Goulden, Prof. Michael L.; Miller, Dr. Scott Dennis and Rocha, Prof. Humberto Ribeiro da . You may contact Miller, Dr. Scott D. (smiller@albany.edu)

LBA Data Set Inventory ID: CD04_Meteorology_Fluxes

Over 3.5 years of 30-minute averaged measured and calculated quantities were compiled at the km 83 tower site (June 29, 2000-March 11, 2004). The variables relate to meteorology, soil moisture, fluxes of momentum, heat, water vapor, and carbon dioxide, including the storage of carbon dioxide in the air column beneath the flux sensors. Data are presented as values measured or calculated at 30 minute intervals as well as calculated daily (24 hour) and monthly (calendar) means.

Related Data Sets:

- LBA-ECO CD-04 CO2 Profiles, km 83 Tower Site, Tapajos National Forest, Brazil: 2000-2004 (canopy atmospheric CO2 concentrations at the same site over the same period)
- LBA-ECO CD-04 Logged Forest Tower Site Soil Respiration Chamber Data, FLONA Tapajos km 83 (soil respiration data from the same site)

2. Data Characteristics:

Data are provided in three comma separated ASCII files:

CD04_km83_tower_fluxes_30_min.csv
CD04_km83_tower_fluxes_dailyavg.csv
CD04_km83_tower_fluxes_monthly_avg.csv

File 1: CD04_km83_tower_fluxes_30_min.csv

There are 64992 records (rows), each corresponding to a 30 minute interval for a total 1354 days beginning June 29, 2000 and ending March 11, 2004. The timestamp corresponds to the beginning of the 30 minute interval. The first timestamp is experiment day 181, or June 29, 2000, where experiment day counts from 0 at 00:00 hours on January 1, 2000. The last timestamp is day 1535, or March 11, 2004, the day that a tree fell on the tower.

Data File Description:

Column #	Heading	Units	Sensor	Description
1	exp_day			experiment day (0 = January 1, 2000, 00:00 hours)
2	year	yyyy		year
3	month	mm		month
4	day	dd		day
5	hr	hh		hour at start of sampling period (GMT:24 hour clock)
6	min	mm		minute at start of sampling period (GMT)
7	solar_in	W/m2	Kipp & Zonen CM6B	downward flux of solar radiation
8	solar out	W/m2	Kipp & Zonen CM6B	upward flux of solar radiation
9	long_in	W/m2	Kipp & Zonen CG2	downward flux of long wave radiation
10	long_out	W/m2	Kipp & Zonen CG2	upward flux of long wave radiation
11	par_in	micromol/m2/s	Li-Cor LI190	downward flux of photosynthetically active radiation
12	par_out	micromol/m2/s	Li-Cor LI190	upward flux of photosynthetically active radiation
13	rnet	W/m2	Rebs Q*7	net radiation at 64 m height
14	T64	degrees C	Campbell Scientific T107	air temperature at 64 m height
15	T40	degrees C	Campbell Scientific T107	air temperature at 40 m height
16	T10	degrees C	Campbell Scientific T107	air temperature at 10 m height
17	T2	degrees C	Campbell Scientific T107	air temperature at 2 m height

18	press	kPa	Li-Cor LI7500	air pressure measured at 64 m height
19	h2o_64	mmol/mol	Li-Cor LI7500	atmospheric water content measured at 64 m height
20	Usonic_64	m/s	Campbell CSAT3	wind speed measured on the sonic anemometer at 64 m height
21	WD_64	degrees	Campbell CSAT3	wind direction measured on the sonic anemometer at 64 m height
22	Ucup_64	m/s	Met One 014	wind speed measured on the cup anemometer at 64 m height
23	Ucup_50	m/s	Met One 014	wind speed measured on the cup anemometer at 50 m height
24	Ucup_40	m/s	Met One 014	wind speed measured on the cup anemometer at 40 m height
25	rain	mm	Texas Electronics TE525	rainfall amount measured at 64 m height using a tipping bucket rain gauge during the 30 minute interval
26	Tsoil_10	degrees C	Campbell Scientific T107	soil temperature at 10 cm depth
27	Tsoil_20	degrees C	Campbell Scientific T107	soil temperature at 20 cm depth
28	Tsoil_50	degrees C	Campbell Scientific T107	soil temperature at 50 cm depth
29	h2o_soil_10	m3/m3	Campbell Scientific CS615	soil moisture at 10 cm depth
30	h2o_soil_20	m3/m3	Campbell Scientific CS615	soil moisture at 20 cm depth
31	h2o_soil_40	m3/m3	Campbell Scientific CS615	soil moisture at 40 cm depth
32	hf_soil	W/m2	REBS HFT 3.1	soil heat flux 10 cm depth
33	ustar	m/s	Campbell CSAT3	friction velocity 64 m height
34	hs	W/m2	Campbell Scientific	sensible heat flux measured at 64 m height
35	hl	W/m2	Li-Cor LI7500	latent heat flux measured at 64 m height
36	co2_64	ppm	Li-Cor LI7000	atmospheric CO2 concentration at 64 m height
37	fco2	umol/m2/s	Li-Cor LI7000/LI7500	CO2 flux at 64 m height

38	ifco2			CO2 flux fill index (0= measured, 1= filled)
39	fstor	umol/m2/s	Li-Cor LI7000	CO2 storage below 64 m height
40	ifstor			CO2 storage fill index (0= measured, 1= filled)
41	nee_raw	umol/m2/s		Net ecosystem exchange not u* corrected
42	inee_raw			NEE fill index (0= measured, 1= filled)
43	nee	umol/m2/s		Net ecosystem exchange calculated as the sum of turbuant CO2 flux at 64 m and the change in the amount of CO2 stored in the air column below 64 m
44	ifilt			NEE u* filter index (1= u* filtered)
45	gpp	umol/m2/s		gross primary productivity
46	igpp			GPP fill index (0= measured, 1= filled)
47	resp_meas	umol/m2/s		respiration measured
48	resp_20_pts	umol/m2/s		respiration smoothed using the nearest 20 pts
49	ndays_20_pts	umol/m2/s		ndays respiration smoothed using the 20 nearest points
50	resp_par_40	umol/m2/s		respiration from PAR model PAR >0 and U* > 0.22
missing data are represented by -999				

Example Data Records: CD04_km83_tower_fluxes_30_min.csv

Header records omitted

exp_day,year,month,day,hr,min,solar_in,solar_out,long_in,long_out,par_in,par_out,rnet,T64,T40,T10,T2,press,h2o_64m,
Usonic_64,WD_64,Ucup_64,Ucup_50,Ucup_40,
rain,Tsoil_10,Tsoil_20,Tsoil_50,h2o_soil_10,h2o_soil_20,h2o_soil_40,
hf_soil,ustar,hs,hl,co2_64,fco2,ifco2,fstor,ifstor,nee_raw,inee_raw,nee,ifilt,gpp,igpp,resp_meas,resp_20_pts,ndays_20_pts,resp_par_40

181,2000,6,29,0,0,-999,-999,-999,-999,-999,-999,-
999,24.71,23.02,23.49,22.83,98.71,27.66,3.03,61.04,1.97,1.18,0.45,0.00,-

```
999,24.36,24.44,0.43,0.49,0.46,-5.99,0.55,-999,-
999,389.84,3.78,0,7.06,0,10.84,0,10.84,0,-3.93,0,-999,6.910437,8.27,7.86,
181.020833,2000,6,29,0,30,-999,-999,-999,-999,-999,-999,-
999,24.41,22.80,23.33,22.72,98.67,27.98,2.39,84.73,1.84,1.29,0.45,0.00,-
999,24.37,24.44,0.43,0.49,0.46,-6.41,0.46,16.02,-999,389.07,5.92,0,1.45,0,7.37,0,7.37,0,-
0.46,0,-999,6.910437,8.27,7.85,
...
1534.958333,2004,3,13,23,0,-0.21,-999,444.39,440.81,-0.44,-999,-999,-999,-999,-
999,25.22,-999,19.06,-999,139.09,-999,-999,-999,0.00,24.95,24.98,24.94,0.44,-999,-999,-
0.49,-999,-999,-999,402.39,-999,1,0.67,0,-999,1,-999,0,-999,1,-999,11.151,2.04,11.31,
1534.979167,2004,3,13,23,30,-0.24,-999,442.79,438.88,-0.50,-999,-999,-999,-999,-
999,25.01,-999,18.62,2.07,137.23,-999,-999,-999,0.00,24.97,25.00,24.94,0.43,-999,-999,-
1.27,-999,-999,-999,404.85,-999,1,5.92,0,-999,1,-999,0,-999,1,-999,11.151,2.04,11.32,
```

File 2: CD04_km83_tower_fluxes_dailyavg.csv

There are 1354 records (rows), each corresponding to a daily (24 hour) average of the 30 minute values.

Data File Description:

Column #	Heading	Units	Sensor	Description
1	exp_day			experiment day (0 = January 1, 2000, 00:00 hours)
2	year	yyyy		year
3	month	mm		month
4	day	dd		day
5	solar_in	W/m2	Kipp & Zonen CM6B	mean daily downward flux of solar radiation
6	solar_out	W/m2	Kipp & Zonen CM6B	mean daily upward flux of solar radiation
7	long_in	W/m2	Kipp & Zonen CG2	mean daily downward flux of long wave radiation
8	long_out	W/m2	Kipp & Zonen CG2	mean daily upward flux of long wave radiation
9	par_in	micromol/m2/s	Li-Cor LI190	mean daily downward flux of photosynthetically active radiation
10	par_out	micromol/m2/s	Li-Cor LI190	mean daily upward flux of photosynthetically active radiation
11	rnet	W/m2	Rebs Q*7	mean daily net radiation 64 m
12	T64	degrees C	Campbell	mean daily air temperature at 64

			Scientific T107	m height
13	T40	degrees C	Campbell Scientific T107	mean daily air temperature at 40 m height
14	T10	degrees C	Campbell Scientific T107	mean daily air temperature at 10 m height
15	T2	degrees C	Campbell Scientific T107	mean daily air temperature at 2 m height
16	h2o_64	mmol/mol	Li-Cor LI7500	mean daily atmospheric water content measured at 64 m height
17	press	kPa	Li-Cor LI7500	mean daily air pressure measured at 64m height
18	WS_64	m/s	Campbell CSAT3	mean daily wind speed measured on the sonic anemometer at 64 m height
19	WD_64	degrees	Campbell CSAT3	mean daily wind direction measured on the sonic anemometer at 64 m height
20	rain	mm	Texas Electronics TE525	total daily rainfall measured at 64 m height using a tipping bucket rain gauge
21	Tsoil_10	degrees C	Campbell Scientific T107	mean daily soil temperature at 10 cm depth
22	Tsoil_20	degrees C	Campbell Scientific T107	mean daily soil temperature at 20 cm depth
23	Tsoil_50	degrees C	Campbell Scientific T107	mean daily soil temperature at 50 cm depth
24	h2o_soil_10	m3/m3	Campbell Scientific CS615	mean daily soil moisture at 10 cm depth
25	h2o_soil_20	m3/m3	Campbell Scientific CS615	mean daily soil moisture at 20 cm depth
26	h2o_soil_40	m3/m3	Campbell Scientific CS615	mean daily soil moisture at 40 cm depth
27	hf_soil	W/m2	REBS HFT 3.1	mean daily soil heat flux 10 cm depth
28	ustar	m/s	Campbell CSAT3	mean daily friction velocity 64 m height
29	hs	W/m2	Campbell Scientific	mean daily sensible heat flux measured at 64 m height
30	hl	W/m2	Li-Cor LI7500	mean daily latent heat flux measured at 64 m height
31	co2_64	ppm	Li-Cor LI7000	mean daily atmospheric CO2 concentration at 64 m height
32	fco2	umol/m2/s	Li-Cor	mean daily CO2 flux at 64 m

			LI7000/LI7500	height
33	fstor	umol/m2/s	Li-Cor LI7000	mean daily CO2 storage below 64 m height
34	nee	umol/m2/s		mean daily Net ecosystem exchange calculated as the sum of turbulent CO2 flux at 64 m and the change in the amount of CO2 stored in the air column below 64 m
35	resp	umol/m2/s		mean daily ecosystem respiration
36	gpp	umol/m2/s		mean daily gross primary productivity
missing data are represented by -999				

Example Data Records: CD04_km83_tower_fluxes_dailyavg.csv

```
Header records omitted

exp_day,year,month,day,solar_in,solar_out,long_in,long_out,par_in,par_out,rnet,T64,T40,
T10,T2,h2o_64,press,WS_64,WD_64,rain,
Tsoil_10,Tsoil_20,Tsoil_50,h2o_soil_10,h2o_soil_20,h2o_soil_40,hf_soil,ustar,hs,
hl,co2_64,fco2,fstor,nee,resp,gpp

181,2000,6,29,-999,-999,-999,-999,-999,-999,-999,26.12,24.54,24.28,23.62,-999,-999,-
999,-999,0,-999,24.28,24.44,0.42,0.49,0.46,-1.06,-999,-999,-999,396.9,-999,0.04,-
999,6.91,-999
182,2000,6,30,159.74,-999,-999,-
999,333.26,10.7,105.05,26.39,24.64,24.32,23.74,27.73,98.67,2.09,-999,2.54,-
999,24.36,24.43,0.42,0.49,0.45,-1.06,0.27,-999,-999,-999,-2.37,-999,-999,6.91,-999
...
1533,2004,3,12,-999,-999,-999,444.37,-999,-999,-999,-999,-999,-999,24.17,18.34,-
999,1.72,147.13,1.27,24.72,24.75,24.9,0.45,-999,-999,-0.1,-999,-999,-999,392.92,-
999,0.24,-999,11.15,-999
1534,2004,3,13,-999,-999,-999,445.18,-999,-999,-999,-999,-999,-999,24.48,18.49,-999,-
999,141.5,0,24.84,24.88,24.92,0.44,-999,-999,-0.05,-999,-999,-999,411.82,-999,-0.33,-
999,11.15,-999
```

File 3: CD04_km83_tower_fluxes_monthly_avg.csv

There are 44 records (rows), each corresponding to a monthly (calendar) average of the daily values. Months with some missing days were excluded. The experimental day for monthly average was set as a day near the end of the month. Fields are included that report the number of days used to calculate the various quantities.

Data File Description:

Column	Heading	Units	Description
1	exp_day		experiment day (0 = January 1,2000, 00:00 hours)
2	year	yyyy	year
3	month	mm	month
4	solar_in	W/m2	mean monthly downward flux of solar radiation
5	solar_out	W/m2	mean monthly upward flux of solar radiation
6	long_in	W/m2	mean monthly downward flux of long wave radiation
7	long_out	W/m2	mean monthly upward flux of long wave radiation
8	par_in	umol/m2/s	mean monthly downward flux of photosynthetically active radiation
9	par_out	umol/m2/s	mean monthly upward flux of photosynthetically active radiation
10	rnet	W/m2	mean monthly net radiation 64 m
11	T64	degrees C	mean monthly air temperature at 64 m height
12	T40	degrees C	mean monthly air temperature at 40 m height
13	T10	degrees C	mean monthly air temperature at 10 m height
14	T2	degrees C	mean monthly air temperature at 2 m height
15	h2o_64	mmol/mol	mean monthly atmospheric water content measured at 64 m height
16	press	kPa	mean monthly air pressure measured at 64m height
17	WS_64	m/s	mean monthly wind speed measured on the sonic anemometer at 64 m height
18	WD_64	degrees	mean monthly wind direction measured on the sonic anemometer at 64 m height
19	rain	mm	total monthly rainfall measured at 64 m height using a tipping bucket rain gauge
20	Tsoil_10	degrees C	mean monthly soil temperature at 10 cm

			depth
21	Tsoil_20	degrees C	mean monthly soil temperature at 20 cm depth
22	Tsoil_50	degrees C	mean monthly soil temperature at 50 cm depth
23	h2o_soil_10	m3/m3	mean monthly soil moisture at 10 cm depth
24	h2o_soil_20	m3/m3	mean monthly soil moisture at 20 cm depth
25	h2o_soil_40	m3/m3	mean monthly soil moisture at 40 cm depth
26	hf_soil	W/m2	mean monthly soil heat flux 10 cm depth
27	ustar	m/s	mean monthly friction velocity 64 m height
28	hs	W/m2	mean monthly sensible heat flux measured at 64 m height
29	hl	W/m2	mean monthly latent heat flux measured at 64 m height
30	co2_64	ppm	mean monthly atmospheric CO2 concentration at 64 m height
31	fco2	umol/m2/s	mean monthly CO2 flux at 64 m height
32	fstor	umol/m2/s	mean monthly CO2 storage below 64 m height
33	nee	umol/m2/s	mean monthly Net ecosystem exchange calculated as the sum of turbulent CO2 flux at 64 m and the change in the amount of CO2 stored in the air column below 64 m
34	resp	umol/m2/s	mean monthly ecosystem respiration
35	resp_2	umol/m2/s	mean monthly ecosystem respiration linear par model
36	resp_3	umol/m2/s	mean monthly ecosystem respiration calculated using the par model
37	gpp	umol/m2/s	mean monthly gross primary productivity
38	CI_par_in	umol/m2/s	95 percent confidence interval for par incoming 64 m
39	CI_par_out	umol/m2/s	95 percent confidence interval for par outgoing 64 m
40	CI_rnet	W/m2	95 percent confidence interval for net radiation 64 m
41	CI_T64	degrees C	95 percent confidence interval for air temperature 64 m
42	CI_h2o	mmol/mol	95 percent confidence interval for h2o concentration 64 m
43	CI_WS	m/s	95 percent confidence interval for wind speed

			sonic anemometer 64 m
44	CI_WD	degrees	95 percent confidence interval for wind direction sonic anemometer 64 m
45	CI_ustar	m/s	95 percent confidence interval for friction velocity
46	CI_hs	W/m2	95 percent confidence interval for sensible heat flux 64 m
47	CI_hl	W/m2	95 percent confidence interval for latent heat flux 64 m
48	CI_fco2	umol/m2/s	95 percent confidence interval for co2 flux 64 m
49	CI_fstor	umol/m2/s	95 percent confidence interval for co2 storage below 64 m
50	CI_nee	umol/m2/s	95 percent confidence interval for NEE
51	CI_resp	umol/m2/s	95 percent confidence interval for respiration
52	CI_gpp	umol/m2/s	95 percent confidence interval for GPP
53	Ndays		number of days included in the calendar month
54	Ndays_par_in		number of days included in the calculation of mean par_in
55	Ndays_par_out		number of days included in the calculation of mean par_out
56	Ndays_rnet		number of days included in the calculation of mean net radiation
57	Ndays_T64		number of days included in the calculation of mean air temperature at 64 m
58	Ndays_h2o		number of days included in the calculation of mean water concentration at 64 m
59	Ndays_co2		number of days included in the calculation of mean CO2 concentration at 64 m
60	Ndays_WS		number of days included in the calculation of mean wind speed
61	Ndays_WD		number of days included in the calculation of mean wind direction
62	Ndays_rain		number of days included in the calculation of total rainfall
63	Ndays_ustar		number of days included in the calculation of mean friction velocity
64	Ndays_hs		number of days included in the calculation of mean sensible heat flux
65	Ndays_hl		number of days included in the calculation of mean latent heat flux

66	Ndays_fco2		number of days included in the calculation of mean CO2 flux
67	Ndays_fstor		number of days included in the calculation of mean CO2 storage
68	Ndays_nee		number of days included in the calculation of mean net ecosystem exchange
69	Ndays_resp		number of days included in the calculation of mean respiration
70	Ndays_gpp		number of days included in the calculation of mean gross primary productivity
missing data are represented by -999			

Example Data Records: CD04_km83_tower_fluxes_monthly_avg.csv

Header records omitted exp_day,year,month,solar_in,solar_out,long_in,long_out,par_in,par_out,rnet,T64,T40,T10, T2,h2o_64,press,WS_64,WD_64,rain, Tsoil_10,Tsoil_20,Tsoil_50,h2o_soil_10,h2o_soil_20,h2o_soil_40,hf_soil,ustar,hs,hl,co2_ 64,fco2,fstor,nee,resp,resp_2,resp_3,gpp, CI_par_in,CI_par_out,CI_rnet,CI_T64,CI_h2o,CI_WS,CI_WD,CI_ustar,CI_hs,CI_hl,CI_f co2,CI_fstor,CI_nee,CI_resp,CI_gpp, Ndays,Ndays_par_in,Ndays_par_out,Ndays_rnet,Ndays_T64,Ndays_h2o,Ndays_co2,Nda ys_WS,Ndays_WD,Ndays_rain, Ndays_ustar,Ndays_hs,Ndays_hl,Ndays_fco2,Ndays_fstor,Ndays_nee,Ndays_resp,Ndays_ gpp 211.5,2000,7,204,-999,-999,- 999,426.1,13.24,140.39,26.75,24.83,24.3,23.56,25.98,98.73,2.01,-999,162.56, -999,24.21,24.32,0.43,0.49,0.45,-1.05,0.27,21.58,112.45,390.21,-1.46,-0.06,- 0.12,7.66,5.55,6.52,8.26, 29.1,0.81,9.81,0.42,0.55,0.21,-999,0.02,3.71,8.23,0.49,0.19,0.57,1.58,0.52, 31,25,25,25,25,15,23,19,0,31, 25,17,14,23,23,21,86,21 242.5,2000,8,229,-999,-999,- 999,478.21,14.01,154.76,26.43,25.86,25.15,24.45,26.55,98.54,2.24,95.79,62.48, -999,25.07,24.91,0.42,0.48,0.45,-0.81,0.3,26.82,121.11,394.41,- 1.63,0.04,0.35,9.38,6.79,9.1,9.34, 26.19,0.63,9.05,0.31,0.18,0.11,9.99,0.02,2.96,6.25,0.44,0.14,0.7,1.43,0.78, 31,29,29,29,27,27,23,28,23,31, 29,18,15,29,23,23,114,23 ... 1490.5,2004,1,154,20.2,426.11,449.19,322.23,-

999,108.27,24.69,24.91,24.48,24.26,16.62,98.53,2.12,126.1,154.18,
24.98,25.01,25.32,0.42,-999,-999,-1.19,0.28,23.93,108.94,406.97,-1.31,-0.01,-
0.48,8.45,4.86,6.04,9.65,
43.48,-999,15.85,0.5,0.39,0.14,12.51,0.03,8.22,19.31,0.62,0.37,0.67,1.1,0.72,
31,21,0,21,24,20,20,20,20,31,
17,10,8,16,18,13,134,13
1520.5,2004,2,157,-999,431.35,444.36,327.67,-
999,108.89,23.79,24.2,24.05,24.02,17.24,98.63,1.9,124.76,246.38,
24.59,24.66,24.87,0.44,-999,-999,-0.69,0.3,-999,-999,404.34,-0.95,-0.08,-
1.11,8.2,7.02,8.97,9.61,
47.77,-999,17.07,0.35,0.25,0.17,15.7,0.03,-999,-999,0.82,0.14,0.98,0.95,0.72,
29,20,0,20,19,22,29,20,22,29,
17,0,0,16,28,16,190,16

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Para Western (Santarem) - km 83 Logged Forest Tower (Para Western (Santarem))	-54.96889	-54.96889	-3.01806	-3.01806	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2000/06/29 to 2004/03/11
- Temporal Resolution: 30-Minute Average

Platform/Sensor/Parameters measured include:

- TOWER / SONIC ANEMOMETER / SURFACE WINDS
- TOWER / TEMPERATURE SENSOR / AIR TEMPERATURE
- TOWER / NET RADIOMETER / NET RADIATION
- TOWER / PYRANOMETER / SOLAR RADIATION
- TOWER / QUANTUM SENSOR / PHOTOSYNTHETICALLY ACTIVE RADIATION
- TOWER / RAIN GAUGE / PRECIPITATION AMOUNT
- TOWER / IRGA (INFRARED GAS ANALYZERS) / CARBON DIOXIDE
- TOWER / IRGA (INFRARED GAS ANALYZER) / WATER VAPOR
- FIELD INVESTIGATION / SOIL MOISTURE PROBE / SOIL MOISTURE
- FIELD INVESTIGATION / THERMOCOUPLE / SOIL TEMPERATURE
- FIELD INVESTIGATION / ANALYSIS / HEAT FLUX
- FLUX TOWER / SONIC ANEMOMETER / CARBON DIOXIDE FLUX
- FLUX TOWER / SONIC ANEMOMETER / WATER FLUX

- FLUX TOWER / IRGA (INFRARED GAS ANALYZER) / WATER FLUX
- FLUX TOWER / IRGA (INFRARED GAS ANALYZER) / CARBON DIOXIDE FLUX

3. Data Application and Derivation:

Data Calculations

For the storage flux, molar densities of CO2 and H2O in the profile were determined using an IRGA. The amount of CO2 stored beneath the eddy flux sensors (64 m) was calculated by integrating the profile between 0 and 64 m. The storage flux was then calculated by differentiating this quantity with respect to time.

Net ecosystem exchange (NEE) was calculated for each half-hour interval as the sum of the turbulent CO2 flux at 64 m and the change in the amount of CO2 in the air column beneath 64 m (the storage flux). Ecosystem respiration was calculated from nighttime measurements of NEE during periods with sufficient vertical mixing; i.e., friction velocity ms-1 [Miller et al., 2004]. The necessary -threshold at this site was determined by comparing flux tower estimates of with several independent lines of evidence (scaled-up estimates of respiration components [Chambers et al., 2004b], and radon-based estimates of nocturnal mixing [Martens et al., 2004]. Uncertainties in the calculation of respiration and NEE at the Tapajos sites are discussed in detail in Saleska et al. [2003] and Miller et al. [2004].

Gross primary productivity was calculated by subtracting NEE from ecosystem respiration. Continuous 30-minute GPP were averaged to construct daily and monthly estimates of GPP. Uncertainty in monthly and annual GPP was calculated as the 95% confidence interval based on averaging daily GPP.

An additional estimate of respiration (R) was calculated as the intercept (PAR=0) of a non-linear least squares fit of a light curve model, NEE = R + (A*PAR)./(PAR+B), using measured PAR and NEE (when PAR>0 umol/m2/s and u*>0.22 m/s) , and A and B and R are the regression constants. For each day, the light model was applied to all available data within 20 days, thus a 40 day window.

Gap filling

Missing flux intervals in the yearly record were filled differently depending up on the length of the data gap and whether the gap was biased towards certain meteorological conditions. All gaps in NEE shorter than 2 hours were filled using linear interpolation. Longer gaps that were not considered biased to certain meteorological conditions were filled using mean diurnal variation (Falge et al. 2001). We used 20 days of reliable data nearest the missing interval to fill the gap. Missing intervals due to window obstruction of the open-path IRGA were distributed unevenly over the day. Daytime gaps were biased towards cloudy conditions and to account for that these gaps in NEE were filled using a light-curve model based on this data set.

Applications

Analysis of eddy covariance observations provides information useful for identifying which physiological and physical processes play dominant roles in controlling CO_2 exchange. In turn, this information contributes to the development and improvement of models of ecosystem- atmosphere CO_2 exchange and to understanding which processes are particularly sensitive to future change.

4. Quality Assessment:

Missing values or data that were flagged as unreliable either by an objective algorithm or subjective inspection have been given a value of -999. It is up to the end-user to fill these values if necessary. Separate columns are included for CO_2 flux, storage, NEE, and GPP that indicate that the value was measured/calculated, or filled. These columns can be used by the end-user to substitute their own filling strategy.

5. Data Acquisition Materials and Methods:

Flux measurements were made from a 67 m tall tower, additional measurements were made on two 2 m tripods installed on the forest floor. The data acquisition computer and closed-path gas analyzers were located in an air-conditioned hut 8 m south of the tower base. Data acquisition and control systems were automated and data were downloaded weekly. Five data loggers connected by a coaxial network collected the instrument data in two types of files: slow files with 30 min statistics and fast files with 4- or 0.5 Hz observations which was then stored on the data acquisition computer. The turbulent fluxes of sensible heat, latent heat, CO_2, and momentum at 64 m were determined with the eddy covariance technique. The signals directly required for flux calculation were digitized and stored at 4 Hz. Wind and temperature were measured with a 3-axis sonic anemometer pointed due east (Campbell Scientific, Logan UT). Winds from the east predominate at 64 m, accounting for about 85% of day and night intervals.

The molar densities of CO_2 and H_2O at 64 m were measured with two independent InfraRed Gas Analyzers (IRGAs).

- The first measurement was made by drawing 20 to 24 standard liter min^{-1} (slpm) of air through a closed-path IRGA (LI-COR LI7000 or, before Dec. 2000, a LI 6262, Lincoln NE) in the instrument hut. Air was drawn through a coarse polyethylene screen inlet 50 cm above the sonic anemometer, down a 9.5-mm-inner-diameter 75-m-long Teflon PFA tube, and through a 1 micron pore 142 mm diameter Teflon filter. The sample tube was encased in an insulated heating bundle that maintained its entire length at 65^oC (Unitherm 2256, Cape Coral FL) to prevent condensation and reduce water vapor exchange with the wall. The pressure in the IRGA cell was actively controlled at 85 kPa (MKS Instruments, Andover MA). The IRGA reference cell was flushed with 1 slpm of CO_2 and H_2O free air from a purge air generator (Matheson GEN PGW 28 LC, Montgomeryville, PA). The IRGA was calibrated daily at 2300 local time by sequentially sampling purge air, CO_2 standard in air (+-1% Scott Marin, Riverside CA), CO_2 free air (Scott Marin, Riverside CA), and room air drawn through a thermoelectrically cooled condensing column at 16o C (LI-COR LI610, Lincoln NE). The LI-7000 absorbances were recorded and the gains, zeros, instrument non-linearity, temperature, pressure and effects of water vapor accounted for in subsequent processing.

- An independent measurement of CO_2 and H_2O at 64 m was made with an open path IRGA (LI-COR LI7500, Lincoln NE) positioned 40-cm south of the sonic anemometer. The open path was calibrated by comparison with the simultaneous measurements made with the closed-path eddy covariance IRGA. The open path IRGA CO_2 and H_2O signals were corrected for the simultaneous fluctuations in air density using two approaches: applying the ideal gas law to the individual 4 Hz observations using the humidity-corrected sonic temperature, and applying the corrections to the 30-minute statistics.

The CO_2 fluxes for both the open and closed path IRGAs were calculated as the 30-minute covariance of the vertical wind velocity (w) and the CO_2 mixing ratio after subtracting the 30-minute mean (c'). The time lag for the closed path IRGA (typically 11 s) was determined by maximizing the correlation between w and c'. The fluxes were rotated to the plane with no mean vertical or cross wind.

A third IRGA (LI-COR LI7000 or, before Dec. 2000, a LI800, Lincoln NE) sequentially measured the molar densities of CO_2 and H_2O at 12 altitudes (0.1, 0.35, 0.7, 1.4, 3, 6, 10.7, 20, 35, 40, 50, 64 m above the ground) every 48 minutes. Four slpm of air was drawn through a 2 micron filter at each altitude, down 5.5-mm inner-diameter polyethylene lined tubing (Furon Dekabon 1300), through a solenoid manifold in an enclosure at the base of the tower (Parker General Valve, Fairfield NJ), into the equipment hut, and through the IRGA cell. The pressure in the IRGA cell was actively controlled at 83 kPa (MKS Instruments, Andover MA). The IRGA was calibrated for CO_2 and water vapor daily by sequentially sampling purge air, CO_2 standard in air (+-1% Scott Marin, Riverside CA), CO_2 free air (Scott Marin, Riverside CA), and 16o C dew point air (LI-COR LI610, Lincoln NE).

Observations about the physical environment were archived at 0.5 Hz and all measurements were done at 64 m height unless otherwise noted. Precipitation was measured with a tipping bucket gauge (TE525: Texas Electronics Dallas). Atmospheric pressure was measured by the L17500. Incoming and reflected photosynthetically active photon flux density (PPFD) was measured with silicon quantum sensors (Li-Cor LI190). Net radiation was measured with a thermopile net radiometer (REBS Q*7.1: REBS). Incoming solar radiation was measured with a thermopile pyranometer (model CM6: Kipp and Xonene,
Delft, The Netherlands). Air temperatures at 64, 40, 10 and 2 m heights were measured with ventilated thermistors (model 076B, Met One). Horizontal wind speeds at 64, 50, and 40 m height were measured with cup anemometers (model 014; Met One). Soil temperatures at 19 locations at depths of 0.02 to 0.25 m were measured with copper constantan thermocouples (Omega Engineering) and soil heat flux at 2 cm depths was measured with 5 flux plates (REBS HFT3.1). Soil moisture at depths between 0.1 and 2.5 m across 20 locations was measured with water content reflectometers (Campbell Scientific CS615). Litter moisture was measured using 6 fuel moisture probes position immediately above the forest floor.

Soil respiration was measured beginning in August 2001 with 15 automated chambers (Goulden and Crill 1997) located in intact forest approximately 50 m east of the tower and 50 m from the nearest logging-created gap. These chambers were sampled sequentially at 12 min intervals and soil respiration calculated from the increase in chamber CO2 concentrations over the sampling period.

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

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