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

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Revision Date: December 19, 2008

Summary:

This data sets contains data on coarse wood density, moisture content, respiration rates and decomposition rate constants in csv format from Manaus Brazil measured from 1/1/1996 through 12/31/1997. The data for respiration reports CO_2 flux from coarse litter (trunks and large branches > 10 cm diameter) that was studied in central Amazon forests (Chambers et al. 2001). The respiration study took place during the transition from wet to dry season of 1997 (June–August), and sampling from the decomposition study (Chambers et al. 2000) was carried out during both the dry and wet seasons of 1996–97 (see below).

Respiration rates varied over almost two orders of magnitude (1.003-0.014 micro g C g-1 C min-1, n=61), and were significantly correlated with wood density (r2adj = 0.42), and moisture content (r2adj = 0.39). Additional samples taken from a nearby pasture indicated that wood moisture content was the most important factor controlling respiration rates across sites (r2adj = 0.65). Based on average coarse litter wood density and moisture content, the mean long-term carbon loss rate due to respiration was estimated to be 0.13 yr-1 (range of 95% prediction interval (PI) = 0.11-0.15 yr-1).

Decomposition rate constants are reported as mass loss fraction per year, for boles of 155 large dead trees (> 10 cm diameter) in central Amazon forests (Chambers et al. 2000). The measurements were carried out over a 2-year period (1996–1997) on permanent plots monitored by the Biological Dynamics of Forest Fragments Project (BDFFP) of the Smithsonian Institution (Lovejoy and Bierregaard 1990; Rankin-De Merona et al. 1992) and the Biomass and Nutrient Experiment (BIONTE) of the National Institute for Amazon Research (Instituto Nacional de Pesquisas da Amazônia-INPA). Mortality data from 21 hectares of permanent inventory plots, monitored for 10-15 years, were used to select dead trees for sampling. A single csv formatted data file includes dates when trees died, their diameter and breast height (DBH, i.e., at 1.3 m) and taxonomic information.

Measured rate constants varied by over 1.5 orders of magnitude (0.015-0.67 /yr), averaged 0.19 /yr with predicted error averaging 0.026 /yr. Wood density and bole diameter were significantly and inversely correlated with rate constants. A tree of average biomass was predicted to decompose at 0.17 /yr.

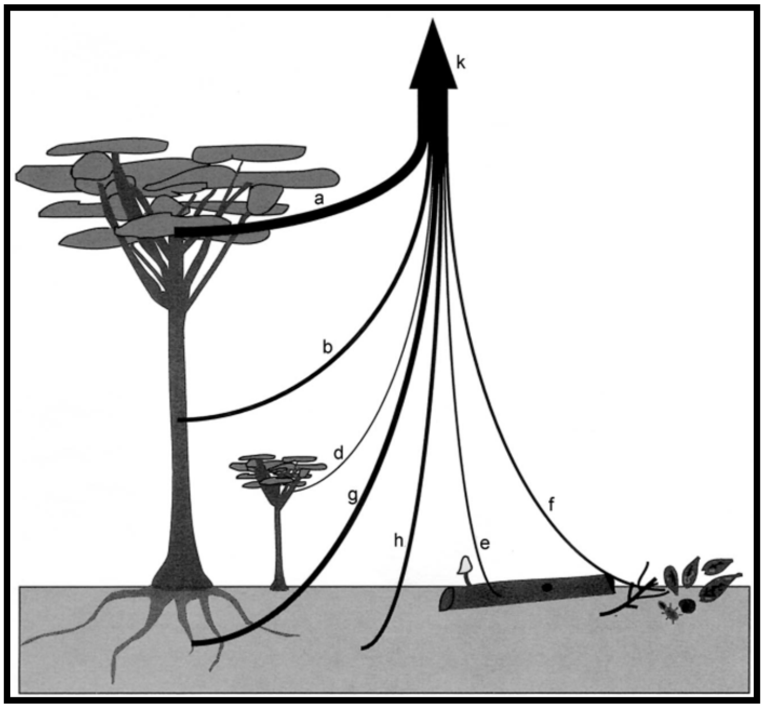

Figure 1. Ecosystem respiration pathways as measured and as described in Chambers et al (2004).

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, along with estimates of ecosystem leaf, live wood and soil respiration, were used to estimate total carbon balance as described in Chambers et al (2004).

Data Citation:

Cite this data set as follows:

Chambers, J.Q., J.P. Schimel, A.D. Nobre, N. Higuchi, L.V. Ferreira, J.M. Melack, and S.E. Trumbore. 2009. LBA-ECO CD-08 Coarse Wood Litter Respiration and Decomposition, Manaus, Brazil. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/911.

Implementation of the LBA Data and Publication Policy by Data Users:

The LBA Data and Publication Policy [https://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 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.

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-08 (Trumbore / Camargo)

The investigators were Chambers, Jeffrey Q.; Nobre, Antonio Donato and Trumbore, Susan E. . You may contact Chambers, Jeffrey Q. (chambers@tulane.edu)

LBA Data Set Inventory ID: CD08_CWD_Resp_and_Decomp_Manaus

Respiration

Data describing CO2 flux from coarse litter (CWD) removed from dead trees measured using an infrared gas analyzer. Details provided in Chambers et al. (2001).

Decomposition

Data on mass loss rates for boles of dead trees located in the field using mortality data from forest inventory plots. Details of this work are described in Chambers et al. (2000).

Related Data Set

- LBA-ECO CD-08 Tropical Forest Ecosystem Respiration, Manaus, Brazil, doi:10.3334/ORNLDAAC/912

2. Data Characteristics:

Respiration

Data for coarse wood respiration are provided in a single comma-delimited ASCII file.

Filename: CD-08_Manaus_forest_coarse_wood_litter_respiration_data.csv

Data File Contents:

Column Number	Column Header	Units	Variable Description
1	Sample_ID	character	Sample ID is concatenation of Tree_ID from the original live tree in the INPA forest inventory plots (e.g., see respiration data file) with b, t, or m at the end of ID that refers to the bottom, top and mid-section of the sampled dead tree bole. The PASTURE samples (PSTRxx) were taken from decomposing logs in an open pasture.
2	Rate1_CO2	ppm/sec	Rate of CO2 increase in the sample chamber (parts per million CO2 per second)
3	V_smpl	mL	The volume of the wood sample placed in the respiration chamber as determined by water displacement
4	Flux	ug C/min	The flux from (2) transformed into proper units for rate calculation
5	Mass_wet	g wet weight	Wet mass of wood sample
6	Mass_dry	g dry weight	Oven dry mass of wood sample
7	Mass_C	g C	Carbon content of wood sample, using average carbon content of 47%
8	Density	g/cm3	The density of the sample (grams per cm cubed)
9	Moisture	g water/g dry weight	The moisture content of the sample (grams of water per gram dry mass)
10	Rate2_resp_flux	ug C/g C/min	The respiratory flux from the sample (micrograms of C flux per gram of C in the sample per minute)
11	Rate3_mass_loss	fraction/yr	Rate from (10) calculated as fractional carbon mass loss rate per year. From Chambers et al., Biogeochemistry 52: 115–131, 2001. To compare respiration rates with long-term decomposition rates (Chambers et al. 2000), 1C was also calculated as an annual carbon loss rate assuming that a constant fraction of material is lost per unit time (Olson 1963) from kc D −ln..mc − 1C/=mc/ (Eqn. 1), where 1C is in units of g C yr−1, mc is the mass of carbon in the wood, and kc is the carbon loss rate (fraction/yr).

Sample Data Records:

Filename: CD-08_Manaus_forest_coarse_wood_litter_respiration_data.csv

Column Number,Column Header,Units,Variable Description
1,Sample ID,character,"Sample ID from the original live tree in the INPA forest inventory plots with b, t, and m at the end of ID refer to as bottom, top and mid-section of the sampled dead tree bole. The PASTURE samples were taken from decomposing logs in an open pasture, as described in detail in the publication noted above. "
2,Rate1,ppm/sec,Rate of CO2 increase in the sample chamber (parts per million CO2 per second)
3,V_smpl,mL,The volume of the wood sample placed in the respiration chamber as determined by water displacement
4,flux,ug C/min,The flux from (2) transformed into proper units for rate calculation
5,Mass_wet,g biomass,Wet mass of wood sample
6,Mass_dry,g biomass,Oven dry mass of wood sample
7,Mass_C,g C,"Carbon content of wood sample, using average carbon content of 47% "
8,density,g/mL,The density of the sample (grams per cm cubed)
9,Moisture,g/g,The moisture content of the sample (grams of water per gram dry mass)
10,Rate2,ug C/g C min,The respiratory flux from the sample (micrograms of C flux per gram of C in the sample per minute)
11,Rate3,fraction/yr,Rate from (10) calculated as fractional carbon mass loss rate per year. From Chambers et al., Biogeochemistry 52: 115–131, 2001. To compare respiration rates with long-term decomposition rates (Chambers et al. 2000), 1C was also calculated as an annual carbon loss rate assuming that a constant fraction of material is lost per unit time (Olson 1963) from kc D −ln..mc − 1C/=mc/ (Eqn. 1), where 1C is in units of g C yr−1, mc is the mass of carbon in the wood, and kc is the carbon loss rate (fraction/yr).

Sample ID,Rate1,V_smpl,flux,Mass_wet,Mass_dry,Mass_C,density,Moisture,Rate2,Rate3
,ppm/sec,mL,ug C/min,g biomass,g biomass,g C,g/mL,g/g,ug C/g C min,fraction/yr
005x-b,0.1327,288,15.4,283,134,63,0.47,1.11,0.2446,0.1376
005x-t,0.1063,372,12.08,398,169,79,0.45,1.36,0.1521,0.0833
053x-m,0.1256,229,14.8,151,85,40,0.37,0.78,0.3705,0.2166
053x-t,0.0579,555,6.27,366,154,72,0.28,1.38,0.0867,0.0466
070x-b,0.0364,185,4.33,197,74,35,0.4,1.66,0.1245,0.0677
...
PSTR06,0.1429,391,16.15,374,245,115,0.63,0.53,0.1403,0.0766
PSTR07,0.02,347,2.28,457,354,166,1.02,0.29,0.0137,0.0072
PSTR08,0.0253,342,2.9,282,224,105,0.65,0.26,0.0275,0.0146
PSTR09,0.0156,412,1.76,311,251,118,0.61,0.24,0.0149,0.0079
PSTR10,0.0057,420,0.64,349,317,149,0.75,0.1,0.0043,0.0023

Decomposition

Data for coarse wood decomposition are provided in a single comma-delimited ASCII file.

Filename: CD-08_Manaus_forest_coarse_wood_litter_decomposition_data.csv

Data Description:

Column Number	Column Heading	Variable Name	Units	Variable Description
1	reserve	Reserve	character	These are reserve names at the BDFFP and Bionte projects at INPA
2	tree_ID	Tree ID Number	character	These are ID tags on the trees that died
3	species_genus	Botanical species, genus, or taxonomic group	character	Botanical classification on dead trees (species, genus, or taxonomic group) -- when genus is followed by sp, spp, or a number, this means the dead tree was only identifiable to genus and/or that species was unknown. When more than one genus given, sample was only identifiable to one of many genera, and when +++ is noted, signifies that additional genera are possible, but was not possible to further distinguish.
4	common_name	Botanical common name	character	Common names used by forest workers in Brazil A ? in this field refers to unknown common name.
5	years_dead	Years Dead	yr	An estimate of the number of years the tree had been dead at the time of sampling (+/- 1.5 years)

6	DBH	Diameter-Breast-Height	cm	The base diameter in cm (at 1.3 m height) of the tree at the time of death
7	wood_density	Wood Density	g/cm3	The oven dry weight wood density (g per cm cubed) of the live tree for either species or genus: corresponding to species/genus data available in data column (3)
8	decomp_rate	Decomposition Rate	fraction/yr	The mass loss fraction per year. This is the mean from three disks removed with a chainsaw from the dead tree. See: Chambers J.Q., Higuchi N., Ferreira L.V., Melack J.M. & Schimel J.P. (2000). Decomposition and carbon cycling of dead trees in tropical forests of the central Amazon. Oecologia, 122, 380-388 for detailed methods for calculation of decomposition rates.

Sample Data Records:

Filename: CD-08_Manaus_forest_coarse_wood_litter_decomposition_data.csv

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Column Number,Column heading,Variable Name,Units,Variable Description,
1,reserve,Reserve,character,These are reserve names at the BDFFP and Bionte projects at INPA,
2,tree_ID,Tree ID Number,character,These are ID tags on the trees that died,
3,species_genus,"Botanical species, genus, or taxonomic group", character ,"Botanical classification on dead trees (species, genus, or taxonomic group) -- when genus is followed by sp, spp, or a number, this means the dead tree was only identifiable to genus and/or that species was unknown.  When more than one genus given, sample was only identifiable to one of many genera, and when +++ is noted, signifies that additional genera are possible, but was not possible to further distinguish.",
4,common_name,Botanical common name, character ,Common names used by forest workers in Brazil.  A ? in this field refers to unknown common name. ,
5,years_dead,Years Dead,yr,An estimate of the number of years the tree had been dead at the time of sampling,
6,DBH,Diameter-Breast-Height,cm,The base diameter in cm (at 1.3 m height) of the tree at the time of death,
7,wood_density,Wood Density,g/cm3,The oven dry weight wood density (g per cm cubed) of the live tree for either species or genus: corresponding to species/genus data available in data column (3),
8,decomp_rate,Decomposition Rate,fraction/yr,The mass loss fraction per year.  This is the mean from three disks removed with a chainsaw from the dead tree.  See: Chambers J.Q., Higuchi N., Ferreira L.V., Melack J.M. & Schimel J.P. (2000). Decomposition and carbon cycling of dead trees in tropical forests of the central Amazon. Oecologia, 122, 380-388, for detailed methods for calculation of decomposition rates.
,,,,,,,
reserve,tree_ID,species_genus,common_name,years_dead,DBH,wood_density,decomp_rate
character , character , character , character ,yr,cm,g/cm3,fraction/yr
B1S2,268x,Virola sp.,Lacre da mata,3.5,14.7,0.44,0.64
B1S2,269X,Osteophloeum platyspermum,Lacre de Mata,3.5,11.7,0.52,0.381
B1S2,111X,Swartzia ulei,Muirajiboia Jerimum,5.5,23.7,0.91,0.288
B1S2,1026,Onychopetalum amazonicum,Envira Preta,5.5,26,0.64,0.276
B1S2,350X,Pourouma longipendula,Embaubarana,3.5,21.5,0.35,0.233
...
PAL,4919,Ocotea rubra,Louro gamela,9.25,60.8,0.55,0.087
PAL,3497,Eschweilera odora,Ripeiro preto,9.25,26,0.82,0.069
PAL,3395,Couepia longipendula,Castanha da galinha,9.25,36.7,0.7,0.061
PAL,4954,Licania canesons *,Macucu,10.5,52.7,0.77,0.052
PAL,5662,Aniba burchelli,Louro,10.5,17.4,0.53,0.029
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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) - ZF3 Biological Dynamics of Forest Fragments Project (BDFFP)	-60.06400	-60.06400	-2.33300	-2.33300	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) -INPA Forest Management Site	-61.00	-61.00	-2.00	-2.00	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1996/01/01 to 1997/12/31.

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / ANALYSIS / DECOMPOSITION
- FIELD INVESTIGATION / LICOR GAS EXCHANGE SYSTEM / RESPIRATION
- FIELD INVESTIGATION / HUMAN OBSERVER / DECOMPOSITION

3. Data Application and Derivation:

Respiration

These data can be used to estimate the carbon flux from decomposing dead trees, and relationships between flux and moisture content and wood density.

Decomposition

These data can be used to estimate total mass loss rates (decomposition) for dead trees as a function of wood density and bole diameter.

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. Theses data, along with estimates of ecosystem leaf, live wood and soil respiration, were used to estimate total carbon balance as described in Chambers et al. (2004).

4. Quality Assessment:

Respiration

One major problem in collecting these data was removing samples from dead tree boles using a chainsaw. Basically, many hours are needed for trapped CO2 to outgas before the actual metabolic production rate can be measured. Details of these issues are available in this publication:

Chambers et al.(2001).

Decomposition

Errors in mass loss rates are associated with information on time of death, wood density for the live trees, and other factors, with details provided in:

Chambers et al. (2000).

5. Data Acquisition Materials and Methods:

Respiration

These data were collected using a LiCor 6252 and closed dynamic chambers which allow CO2 to accumulate in the head space, and this accumulation rate provides a flux estimate in ppm CO2 per second.

Field methods: Boles from 155 dead trees were previously sampled for a coarse litter decomposition study (Chambers et al. 2000). Briefly, these 155 samples were randomly chosen from a larger population of 880 dead trees using mortality data from the BDFFP and BIONTE plots. This population was stratified by DBH, wood density, and time since death, to ensure adequate representation of large trees, low and high wood densities, and decomposition time intervals. Cross-sections (usually 3) were removed from the boles with a chainsaw, or a machete for boles in advanced stages of decomposition. Decomposition (mass loss) rate was estimated using the original mass, the mass at the time of sampling, and the time decomposing, assuming first order decay. Rates were inversely correlated with wood density and bole diameter.

For this study, two additional cross-sections were removed from 61 of the previously sampled boles at least 1 m from previous cuts. A wedge was removed from the cross-sections using a machete. The sample was placed in a plastic container (3.8 L, Rubbermaid) and the seal was coated with a small amount of high-vacuum grease (Dow Corning) to minimize leaking. The change in chamber headspace CO2 concentration was measured as ppm CO2 s^{-1} (or mmol CO2 mol^{-1} air s^{-1}, 1CO2) using an infra-red gas analyzer (IRGA, LiCor 6200). The chamber was modified to create an air-tight seal with the IRGA sensor head.

Decomposition

Mass at a known time after the tree died was obtained by removing samples with a chainsaw, and measuring sample mass in the field with a portable balance. Samples were transported to an INPA lab to determine oven dry weight.

The measurements were carried out over a 2-year period (1996–1997) on permanent plots monitored by the Biological Dynamics of Forest Fragments Project (BDFFP) of the Smithsonian Institution (Lovejoy and Bierregaard 1990; Rankin-De Merona et al. 1992) and the Biomass and Nutrient Experiment (BIONTE) of the National Institute for Amazon Research (Instituto Nacional de Pesquisas da Amazonia-INPA). Data from permanent plots included dates when trees died, their diameter and breast height (DBH, i.e., at 1.3 m) and taxonomic information. Plots spanned a 50´ 40 km area (~2°30’ S, 60° W) approximately 70 km north of Manaus in the Brazilian Amazon with an elevation of 100–150 m.

Bole sampling: Three cross-sections were cut from each selected dead tree to determine mass loss rate. First, the length of the bole from the base to the first major branch point was measured. The bole was then divided into three equal-length segments and cross-sections (5–10 cm thick) were cut from the center of each section using a chainsaw or, for friable wood, a machete. Cross-sections were weighed on a portable electronic balance and the average thickness was measured. Wedges from each cross-section were removed with a machete, weighed, and returned to the laboratory. Moisture content was determined by drying wood to constant weight at ~70°C in a drying oven..

Estimating decomposition rates: Decomposition rate constants (kd) were calculated using a single exponential model that assumes that a constant fraction of the mass is lost per unit time (Olson 1963) given by:

kd= –ln(Mt/Mo)/t

where Mt is the mass at time t and Mo is the original mass of a cross-section, and decomposition rates are given as fractional mass lost per year. Mt was measured by weighing cross sections in the field and subtracting moisture content after drying.

6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC)

Data Archive Center:

Contact for Data Center Access Information:

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Chambers J.Q., Tribuzy E.S., Toledo L.C., Crispim B.F., Higuchi N., dos Santos J., Arajo A.C., Kruijt B., Nobre A.D. & Trumbore S.E. 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

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Chambers J.Q., Higuchi N., Ferreira L.V., Melack J.M. & Schimel J.P. 2000. Decomposition and carbon cycling of dead trees in tropical forests of the central Amazon. Oecologia, 122, 380-388.doi:10.1007/s004420050044

Lovejoy T, Bierregaard R 1990. Central Amazonian forests and the Minimum Critical Size of Ecosystem Project. In: Gentry A (eds) Central Amazonian forests and the Minimum Critical Size of Ecosystem Project. Yale University Press, New Haven, pp 60–71

Olson, J. S. 1963. Energy storage and the balance of producers and decomposers in ecological systems. Ecology 44:322–331.doi:10.2307/1932179

Rankin-De Merona JM, Prance GTH, Hutchings RW, Silva MFD, Rodrigues WA, Uehling ME 1992. Preliminary results of a large-scale tree inventory of upland rain forest in the central Amazon. Acta Amazon 22:493–534