LBA-ECO CD-08 Radiocarbon Dating of Tree Ages in Amazonas, Acre, and Para in Brazil

Revision date: March 1, 2011

Summary:

This data set reports the ages and growth rates of trees determined by radiocarbon dating (14C) in three Amazonia forests. Tree samples were collected from permanent research plots at ZF2 km 34, Manaus, Amazonas, the Catuaba Experimental Farm, Acre, and the km 83 tower site (logged forest site) in the Tapajos National Forest, Para, between 2001-2003.

Samples from 97 individual trees were either tree cores (Manaus and Acre) or a combination of tree cores and slabs cut from stems as part of the logging in the Tapajos National Forest (Para). Radiocarbon dating (14C) was used to determine the age and the mean diameter growth increment of samples from individual trees in various diameter size classes. These measurements can be used to verify and extend short-term diameter increment measurements done with dendrometers and to constrain models of tree demography.

There is one comma-separated ASCII data file with this data set.

Data Citation:

Cite this data set as follows:

Vieira, S., S. Trumbore, P.B. Camargo, D. Selhorst, J.Q. Chambers, N. Higuchi, and L.A. Martinelli. 2011. LBA-ECO CD-08 Radiocarbon Dating of Tree Ages in Amazonas, Acre, and Para in 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/997

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 March of 2011. Users who download the data between March 2011 and February 2016 must comply with the LBA Data and Publication Policy.

Data users should use the Investigator contact information in this document to communicate with the data provider. Alternatively, the LBA Web Site [http://lba.inpa.gov.br/lba/] in Brazil will have current contact information.

Data users should use the Data Set Citation and other applicable references provided in this document to acknowledge use of the data.

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 Camargo, Plinio B. de ; Chambers, Jeffrey Q.; Costa, Enir Salazar da; Martinelli, Luiz Antonio; Perez Acosta, Tibisay Josefina; Southon, John R.; Telles, Everaldo de Carvalho Conceicao; Trumbore, Susan E.; Vieira, Simone Aparecida; Brown, Irving Foster; Selhorst, Diogo; Silva, Juari P. and Santos, Joaquim . You may contact Vieira, Simone (savieira@cena.usp.br)

LBA Data Set Inventory ID: CD08_Radiocarbon_Dates

This data set reports the ages and growth rates of trees determined by radiocarbon dating (14C) in three Amazonia forests. Tree samples were collected from permanent research plots at ZF2 km 34, Manaus, Amazonas, the Catuaba Experimental Farm, Acre, and the km 83 tower site (logged forest site) in the Tapajos National Forest, Para, between 2001-2003.

Samples from 97 individual trees were either tree cores (Manaus and Acre) or a combination of tree cores and slabs cut from stems as part of the logging in the Tapajos National Forest (Para). Radiocarbon dating (14C) was used to determine the age and the mean diameter growth increment of samples from individual trees in various diameter size classes. These

measurements can be used to verify and extend short-term diameter increment measurements done with dendrometers and to constrain models of tree demography.

Related Data Set

- LBA-ECO CD-08 Radiocarbon Dates for Large Trees from Forest near Manaus

2. Data Characteristics:

The CD-08 team collected tree samples at the ZF-2 (Manaus), Flona Tapajos (Santarem) and Catuaba EE (Acre) sites between 2001-2003. Samples collected were either tree cores (Manaus and Acre) or a combination of tree cores and slabs cut from stems as part of the logging in the Tapajos forest (Santarem).

Data are presented in a single comma-separated ASCII file. File name:
CD08_Tree_Ages_by_Radiocarbon_Methods_Amazonas_and_Para.csv

Column	Variable name	Units/format	Variable description
1	Site		Site: Manaus = ZF2 km 25 - INPA Forest Management Site (lat: -2.6091, Long: -60.2093); Santarem = kilometer 83 (Lat: -3.017, Long: -54.9707); Catuaba = Acre - Catuaba Experimental Farm (Lat: -10.0730; Long: -67.6290)
2	Tree_number		Unique identifier for each tree sampled
3	Subsample		For those trees with more than a single isotope analysis, this number is a unique identifier for subsamples along the radius of a tree crossection (see columns14-19)
4	Size_class		Tree size class based on diamter at breast height (DBH) where 1 = 10 to 29.9 centimeters (cm) diameter, 2= 30 to 49.9 cm diameter and 3= greater than or equal to 50 cm diameter
5	DBH	cm	Diameter at breast height in centimeters, measured at 1.3 m height
6	Common_name		Local name
7	Scientific_name		Genus and species. Species identification: Santarem - Sr. Nelson Rosa (Museu Emilio Gueldi); Manaus - Vilany Carneiro e Everaldo Pereira (INPA); Rio Branco - Dr. Marcos Silveira (UFAC)
8	Family		Scientific family
9	Canopy_stratum		Approximate canopy heights associated with these classes are: Emergent (> 45 m), Canopy (25- 35 m), Subcanopy (< 25 m), and Pioneer (used here to identify species that are found to colonize recent gaps and are thought to represent early succession)
10	Age	yr	Estimated tree age in years based on the range of

			calendar ages (see columns 20-24) or on extrapolation of growth rates determined from multiple ages for a single tree
11	Age_error	yr	Estimated error (years) in Age (column 10)
12	Growth_rate	cm diameter increment yr-1	Mean growth rate in centimeters diameter per year, calculated as diameter (column 5) divided by age (column 10)
13	Alternate_growth_rate	cm diameter increment yr-1	Alternate growth rate in centimeters diameter per year, calculated as the slope of the age (column 10) versus distance from center (column 14). Values are only given if they differ from the calculated mean growth rate
14	Distance_from_center	cm	Location of the isotope sample or subsample in centimeters distance from center of tree
15	Delta_14_C	per mil	Delta 14 C measurement in 2004-2005 as per mil. Expressed as in Stuivier and Polach "Discussion: Reporting of 14C Data", Radiocarbon 19, no.3 (1977): 355-363.
16	Delta_14_C_error	per mil	Precision (1 standard error) of the delta 14C measurement
17	Delta_13_C	per mil	Delta 13 C measurement of the sample presented as per mil deviation relative to PDB standard
18	Libby_age	Radiocarbon years Before Present (BP)	Age in radiocarbon years BP, expressed as in Stuivier and Polach "Discussion: Reporting of 14C Data", Radiocarbon 19, no.3 (1977): 355-363
19	Libby_age_error	Radiocarbon years Before Present (BP)	Estimated error (in radiocarbon years BP) in Libby_age (column 18), calculated using Oxcal 3.0 (http://c14.arch.ox.ac.uk/embed.php?File=oxcal.html) and 2 sigma error
20	Calibrated_date_range_1		Calendar age range (years), where multiple calendar year ranges are possible at the 2 sigma level, we give all ranges
21	Calibrated_date_range_2		Calendar age range (years), where multiple calendar year ranges are possible at the 2 sigma level, we give all ranges
22	Calibrated_date_range_3		Calendar age range (years), where multiple calendar year ranges are possible at the 2 sigma level, we give all ranges
23	Calibrated_date_range_4		Calendar age range (years), where multiple calendar year ranges are possible at the 2 sigma level, we give all ranges
24	Calibrated_date_range_5		Calendar age range (years), where multiple calendar year ranges are possible at the 2 sigma level, we give all ranges
missing data are represented by -9999			

Example Data Records:

Site,Tree_number,Subsample,Size_class,DBH,Common_name,Scientific_name,Family,Canopy_stratum,Age,Age_error, Growth_rate,Alternate_growth_rate,Distance_from_center,Delta_14_C,Delta_14_C_error,Delta_13

```
_C,Libby_age,Libby_age_error,
Calibrated_date_range_1,Calibrated_date_range_2,Calibrated_date_range_3,Calibrated_date_ran
ge_4,Calibrated_date_range_5
Manaus,1,1,1,13.3,Branquinha,Rinorea racemosa (Mart.) Kuntze,Violaceae,Subcanopy,195,155,
0.07,-9999,Center,-26.6,4.4,-30,190,40,
1650-1960,-9999,-9999,-9999,-9999
Manaus,2,1,1,14,Tachi preto,Tachigali myrmecophila Ducke.
,Caesalpinoideae,Subcanopy,185,145,
0.08,-9999,Center,-22.9,4.3,-31,160,40,
1670-1790,1790-1960,-9999,-9999,-9999
Manaus,3,1,1,18,Envira bobo,Rollinia insignis R. E. Fr. ,Annonaceae,Subcanopy,37,1,
0.49,-9999,Center,301.8,5.9,-29,Modern,-9999,
1963,-9999,-9999,-9999,-9999
Manaus,4,1,1,22.5,Pau rainha,Brosimum rubescens Taub.,Moraceae,Canopy,192,150,
0.12,-9999,Center,-25.4,3.9,-30,155,35,
1670-1750,1790-1960,-9999,-9999,-9999
```

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 Site (Para Western (Santarem))	54.9707	54.9707	3.017	3.017	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - ZF2 km 34 (Amazonas (Manaus))	-60.2093	-60.2093	-2.6091	-2.6091	World Geodetic System, 1984 (WGS-84)
Acre - Catuaba Experimental Farm (Acre)	-67.629	-67.629	-10.073	-10.073	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 2001/01/01 to 2003/12/31.
- Temporal Resolution: Single measurements: tree cores

Platform/Sensor/Parameters measured include:

- LABORATORY/AMS (ACCELERATOR MASS SPECTROMETER /AGE DETERMINATIONS
- FIELD INVESTIGATION/HUMAN OBSERVER/FOREST COMPOSITION/STRUCTURE
- LABORATORY/AMS (ACCELERATOR MASS SPECTROMETER/RADIOCARBON

3. Data Application and Derivation:

Radiocarbon based measurements of diameter increment rates can be used to verify and extend short-term diameter increment measurements done with dendrometers. They can also be used to constrain models of tree demography.

4. Quality Assessment:

Radiocarbon methods typically use 2-3 secondary standards with each batch of samples to assess overall accuracy. We tested a variety of methods for extraction and characterization of cellulose before opting to use the Jayme-Wise method (see Gaudinski et al. 2005 for details of the comparisons and the selected method procedures). We processed Firi-J wood (an IAEA standard for radiocarbon) to holocellulose using his method and included it as a secondary standard to demonstrate on an ongoing basis that our method did not introduce any changes in radiocarbon signature. Overall accuracy (based on our ability to reproduce radiocarbon standards over many different measurements and over a period of years) is plus or minus 3 per mil (one standard deviation) for samples close to Modern values (see Xu et al. 2007).

5. Data Acquisition Materials and Methods:

Radiocarbon (14C) was used to determine age and mean diameter increment for a total of 97 individual trees. Samples were collected from permanent plots in three different forests located near Manaus (the BIONTE Project), Rio Branco (Catuaba) and Santarem (FLONA Tapajos). At the Catuaba site 10 trees in each diameter class (10-30 cm DBH, 30-50 cm DBH and > 50 cm DBH) were randomly selected for coring. At the Manaus and Santarem sites tree disks were collected from ongoing harvests at or near the permanent plot sites. At the Santarem site, most of the trees sampled fell into one diameter class due to the harvesting design.

Samples of ~5 mg wood were taken at intervals along the radius defined by the core or along the mean radius observed in a cut slab. Holocellulose was purified from wood, combusted (see Gaudinski et al. 2005; we used the Jaymne- Wise method described in that paper). The purified holocellulose was combusted in quartz tubes with cupric oxide wire and the resulting CO2 purified cryogenically and then reduced to a graphite target for accelerator mass spectrometry measurement of 14C at the Keck Carbon Cycle Accelerator Mass Spectrometry facility at UC Irvine (Xu et al. 2007; Southon and Santos 2004). An aliquot of the purified CO2 was sampled with a syringe, placed in a He-filled septum vial and analyzed for stable isotopes (13C) using a Gase-Bench II coupled to a continuous flow stable isotope ratio mass spectrometer (Xu et al. 2007).

For each tree we measured the radiocarbon age of the center portion of the tree and used the program OXCAL 3.0 to determine the calibrated ages for wood grown before 1950 (Ramsey 2001, Ramsey et al. 2001). For calibrated ages that fell between approx. 1650 and 1950 14C ages can be problematic due to variations in cosmogenic production of 14C. For samples that fell into this age category we either reported the center of the calibrated age range and used the oldest and youngest calendar ages as the stated error or extrapolated tree age from the more recent rates of diameter increment determined by radiocarbon history since 1950 (Cain and Suess 1976, Levin and Hesshamer 2000).

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:

Cain, WF and Suess HE. 1976. J Geophysical Res Oceans Atmospheres 81: 3688-3694. doi:10.1029/JC081i021p03688

Gaudinski, J B, Dawson, T, Quideau, S, Schuur, EAG, Roden, J, Trumbore, S E, Sanquist, D R, Oh, S W and Wasylishen, R E. 2005. Analytical Chemistry, 77: 7212-7224.Gaudinski, J B, Dawson, T, Quideau, S, Schuur, EAG, Roden, J, Trumbore, S E, Sanquist, D R, Oh, S W and Wasylishen, R E. 2005. Analytical Chemistry, 77: 7212-7224.doi:10.1021/ac050548u

Levin, I and Hesshamer V. 2000. Radiocarbon 42: 69-80.

Oxcal 3.0 (http://c14.arch.ox.ac.uk/embed.php?File=oxcal.html)

Ramsey, CBD. 2001. Radiocarbon 43: 355-363

Ramsey, CB et al. 2001. Radiocarbon 43: 381-389.

Southon, JR and Santos GM. 2004. Radiocarbon 46: 33-39.

Stuivier and Polach. 1977. Radiocarbon 19, no.3: 355-363.

Xu, X, Trumbore, S, Zheng, S, Southon, JR, McDuffee, KM, Luttgen, M, Liu, JC. 2007. Nucl. Instr. and Meth. in Phys. Res. B. doi: 10.1016/jnimb.2007.01.175.

Related Publications

- Vieira, S., S. Trumbore, P.B. Camargo, D. Selhorst, J.Q. Chambers, N. Higuchi, and L.A. Martinelli. 2005. Slow growth rates of Amazonian trees: Consequences for carbon cycling. Proceedings of the National Academy of Sciences of the United States of America 102(51):18502-18507.