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LBA-ECO CD-02 Oxygen Isotopes of Plant Tissue Water and Atmospheric Water Vapor

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Revision date: May 10, 2011

Summary:

This data set reports the oxygen isotope signatures of water extracted from plant tissue (xylem from the stems and leaf tissue) and of atmospheric water vapor from twelve different sites (including both pasture and forest) throughout the Amazon region of Brazil. Samples were collected approximately every 4 months between 1999 and 2003 with additional samples collected monthly between January and May of 2003. In 2004 the collection of water samples from plant tissue continued at two sites, though water vapor collections were discontinued, and measurements of deuterium signatures were added to the analyses. In addition, water vapor from the troposphere was collected during a series of aircraft flights over the Tapajos National Forest in May of 2003 and analyzed for oxygen isotopes using the same methodology. There is one comma-delimited ASCII data file with this data set.

Data Citation:

Cite this data set as follows:

Ehleringer, J., L.A. Martinelli, C. Cook, T.F. Domingues, L. Flanagan, J. Berry, and J.P. Ometto. 2011. LBA-ECO CD-02 Oxygen Isotopes of Plant Tissue Water and Atmospheric Water Vapor. 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/1008

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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 May of 2011. Users who download the data between May 2011 and April 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://lbaeco-archive.ornl.gov/>] 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-02 (Ehleringer / Martinelli)

The investigators were Cook, Craig; Domingues, Tomas Ferreira; Ehleringer, James; Flanagan, Lawrence; Martinelli, Luiz Antonio; Ometto, Jean Pierre H.B., Berry, Joseph, and Lai, Chun-ta . You may contact Ehleringer, Jim (ehleringer@biology.utah.edu).

LBA Data Set Inventory ID: CD02_O_H_Isotopes

This data set reports the oxygen isotope signatures of water extracted from plant tissue (xylem from the stems and leaf tissue) and of atmospheric water vapor from twelve different sites (including both pasture and forest) throughout the Amazon region of Brazil. Samples were collected approximately every 4 months between 1999 and 2003 with additional samples collected monthly between January and May of 2003. In 2004 the collection of water samples from plant tissue continued at two sites, though water vapor collections were discontinued, and measurements of deuterium signatures were added to the analyses. In addition, water vapor from the troposphere was collected during a series of aircraft flights over the Tapajos National Forest in May of 2003 and analyzed for oxygen isotopes using the same methodology.

Related data set:

- [LBA-ECO CD-02 Carbon and Oxygen Isotopes in Atmospheric CO₂ in the Amazon: 1999-2004](#) (C and O isotopic signatures of atmospheric CO₂ from the same sites over the same sampling period)

2. Data Characteristics:

Data are presented in one comma-delimited ASCII file:

CD02_Stable_Isotope_Water.csv

Column	Heading	Units/format	Description
1	Region		Sampling region
2	Site		Sampling site within the region.
3	Longitude	decimal degrees	Longitude of sampling site
4	Latitude	decimal degrees	Latitude of sampling site
5	Year	YYYY	Year of collection
6	Month	MM	Month of collection
7	Time	HHMM	Time at which sample was collected in local time 24 hour clock
8	Ecosystem		Ecosystem type: forest, lake, pasture or flight for atmospheric collections
9	Sample_type		Form in which sample was collected (leaf/stem/soil/rain/water vapor)
10	Description		Description of sample and/or sampling conditions where noted
11	Local_name		Common name of tree, shrub or grass where identified
12	Scientific_name		Scientific name of tree, shrub or grass with family in parenthesis where noted
13	delta_18O	parts per mil	Isotopic ratio of 18O/16O referenced to SMOW
14	delta_D	parts per mil	Isotopic ratio of deuterium to hydrogen referenced to SMOW
15	Sampling_height	meters	Height in meters (m) at which sample was collected

Missing values are indicated as 9999. Year, month, and collection time only are reported; no day of collection provided.

Missing character values: "not provided"

Example data records:

```
Region,Site,Longitude,Latitude,Year,Month,Time,Ecosystem,Sample_type,Description,
Local_name,Scientific_name,delta_18O,delta_D,Sampling_height
Manaus,ZF2 km 14,-2.58900,-60.11520,1999,3,1645,Forest,leaf,random sampling,
not provided,not provided,11.28,9999,25
Manaus,ZF2 km 14,-2.58900,-60.11520,1999,3,1715,Forest,leaf,random sampling,
not provided,not provided,17.02,9999,0.5
...
Rondonia,Fz N Senhora,-10.7618,-62.3572,2000,9,1215,Pasture,leaf,grass W54,
not provided,not provided,10.3,9999,0.4
Rondonia,Fz N Senhora,-10.7618,-62.3572,2000,9,1220,Pasture,leaf,grass W55,
not provided,not provided,12.5,9999,0.3
...
Santarem,km 83,-3.01639,-54.95083,2002,3,1430,Forest,water vapor,5 min.,
not provided,not provided,-13.16,9999,31
Santarem,km 83,-3.01639,-54.95083,2002,3,1430,Forest,water vapor,6 min.,
not provided,not provided,-11.72,9999,21
```

...
 Santarem,SECA Dry,-2.8570,-54.9590,2002,10,1519,Forest,leaf,ST1-6-35_Matamata,
 Matamata,Eschweilera sp.,4.93,9999,11
 Santarem,SECA Dry,-2.8570,-54.9590,2002,10,1519,Forest,stem,ST1-6-35_Matamata,
 Matamata,Eschweilera sp.,-0.26,9999,11
 ...

Site boundaries (All latitude and longitude given in decimal degrees)

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Rondonia - F2 N Senhora (Rondonia-Fazenda Nossa Senhora)	-62.35720	-62.35720	-10.7618	-10.7618	World Geodetic System, 1984
Amazonas (Manaus) - ZF2 km 34 (Amazonas (Manaus))	-60.20917	-60.20917	-2.60907	-2.60907	World Geodetic System, 1984
Para Western (Santarem) - km 67 Primary Forest Tower Site (Para Western (Santarem))	-54.95900	-54.95900	-2.85700	-2.85700	World Geodetic System, 1984
Para Western (Santarem) - km 67 Seca-Floresta Site (Para Western (Santarem))	-55.0000	-55.0000	-2.75000	-2.75000	World Geodetic System, 1984
Para Western (Santarem) - km 83 Logged Forest Tower Site (Para Western (Santarem))	-54.97070	-54.97070	-3.01700	-3.01700	World Geodetic System, 1984
Para Western (Santarem) - km 77 Pasture Tower Site (Para Western (Santarem))	-54.88850	-54.88850	-3.02020	-3.02020	World Geodetic System, 1984
Para Western (Santarem) - km 117 Tower Site (Para Western (Santarem))	-56.00000	-56.0000	-1.0000	-1.0000	World Geodetic System, 1984
Para Western (Santarem) - Mojui (Para Western (Santarem))	-54.57917	-54.57917	-2.76667	-2.76667	World Geodetic System, 1984
Amazonas (Manaus) - ZF2 km 14 (Amazonas (Manaus))	-60.11520	-60.11520	-2.58900	-2.58900	World Geodetic System, 1984
Amazonas (Manaus) - ZF3 Fazenda Dimona (Amazonas (Manaus))	-59.00000	-59.00000	-2.00000	-2.00000	World Geodetic System, 1984
Rondonia - Jaru Biological Reserve Tower A (Rondonia)	-61.93090	-61.93090	-10.08320	-10.08320	World Geodetic System, 1984

Time period:

- The data set covers the period 1999/03/01 to 2004/09/30
- Temporal Resolution: Quarterly and monthly

Platform/Sensor/Parameters measured include:

- LABORATORY /MASS SPECTROMETER / OXYGEN ISOTOPES

3. Data Application and Derivation:

The oxygen isotope ratio ($\delta^{18}\text{O}$) of atmospheric CO_2 is a powerful indicator of large-scale CO_2 exchange on land. Oxygen isotope exchange between CO_2 and water in leaves and soils controls the $\delta^{18}\text{O}$ of atmospheric CO_2 . The data presented here can be used to validate current models including the Craig-Gordon model. These data can also be used to calculate discrimination against isotopically 'heavy' CO_2 during photosynthesis for both pasture and forest ecosystems.

4. Quality Assessment:

Standard samples were run along with the field samples for all analyses to check the calibration of the instruments. There are no known problems with the data.

5. Data Acquisition Materials and Methods:

Site Descriptions

The sites were located within the Amazon Basin near Santarem, Manaus, and Ji-Parana, Brazil. In each region, measurements were collected at forest and pasture sites. Each of the forest sites were primary evergreen forests (“terra firme”) with a mean canopy height of 30–35 m, although some emergent trees reached 45– 50 m. The primary forest site near Santarem was located 67 km south of the city, in an area between the Tapajos River and the highway BR 163. The forest covers an area of 600,000 ha and was established as a national forest in 1974 (FLONA Tapajos). The Santarem pasture site was located 77 km south of Santarem. The Manaus forest site was located 70 km from the city, in a forest reserve controlled by the Instituto Nacional de Pesquisas Amazonicas (INPA). The Manaus pasture site was located about 60 km from the forest site, along a secondary road (ZF-3). The grass at this site had less vigorous growth than the Santarem pasture grass. The Ji-Parana primary forest site (Rebio Jarú,) was a reserve controlled by the Brazilian Environment Protection Agency (IBAMA), located north of Ji-Parana (80 km), by the Machado River (120 m above sea level). The pasture site (Fazenda Nossa Senhora da Aparecida) was a cattle ranch 50 km northeast from Ji-Parana (Ometto et al., 2005).

Plant tissue water and water vapor from the canopy:

Water samples were collected to characterize the stable isotope ratios of different water compartments in pasture and forest ecosystems. Xylem water samples were collected from stems to determine plant water sources in the soil. Leaves were sampled for their leaf water, and atmospheric water vapor was trapped so that leaf water values could be modeled. The leaves and stems were collected from several heights within the forest canopy, placed immediately inside individual glass vials sealed with a rubber stopper and wrapped with Parafilm. The samples were kept cold (0-5 degrees C) in the field and later frozen in the lab. Tropospheric water vapor was collected by flights of a small airplane from the surface to above PBL. Air was pumped at different moments through dry ice water traps.

Isotopic analyses:

Water was extracted from the samples using cryogenic vacuum distillation (Ehleringer et al. 2001). Oxygen isotope ratios for all water samples were determined by equilibration of water with CO₂ (Socki et al. 1999). Measurements of the oxygen isotope composition of the equilibrated CO₂ were performed by online injection of CO₂ into a coupled gas chromatograph and isotope ratio mass spectrometer (Delta Plus, Finnigan MAT, Bremen), operating in a continuous flow mode (Fessenden et al. 2002).

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:

- Ehleringer, J.R., J. Roden, and T.E. Dawson. 2001. Assessing ecosystem-level water relations through stable isotope ratio analyses, in *Methods in Ecosystem Science*, O.E. Sala, R.B. Jackson, H.A. Mooney, and R.W. Howarth, pp 181-198, Springer Verlag, New York.
- Fessenden, J.E., C.S. Cook, M.J. Lott, and J.R. Ehleringer. 2002. Rapid 18O analysis of small sized water samples using a continuous-flow isotope ratio mass spectrometer. *Rapid Communications in Mass Spectrometry* 16:1257-1260. doi:10.1002/rcm.711
- Helliker, B.R., J.S. Roden, C.S. Cook, and J.R. Ehleringer. 2002. A rapid and precise method for sampling and determining the oxygen isotope ratio of atmospheric water vapor. *Rapid Communications in Mass Spectrometry* 16:929-932. doi:10.1002/rcm.659
- Hodnett, M. G., M. D. Oyama, J. Tomazella, and A. de O. Marques Filho. 1996. Comparisons of long term soil water storage behavior under pasture and forest in three areas of Amazonia. Pages 79–100 in J. H. C. Gash, C. A. Nobre, J. M. Roberts, and R. L. Victoria, editors. *Amazonian deforestation and climate*. John Wiley and Sons, Chichester, UK.
- Ometto, J.P.H., L.B. Flanagan, L.A. Martinelli, and J.R. Ehleringer. 2005. Oxygen isotope ratios of waters and respired CO₂ in Amazonian forest and pasture ecosystems. *Ecological Applications* 15(1):58-70. doi:10.1890/03-5047
- Socki, R. A., C. S. Romanek, and E. K. Gibson. 1999. On-line technique for measuring stable oxygen and hydrogen isotopes from microliter quantities of water. *Analytical Chemistry* 71:2250-2253. doi:10.1021/ac981140i

Related Publications

- Ehleringer, J.R., D.R. Bowling, L.B. Flanagan, J. Fessenden, B. Helliker, L.A. Martinelli, and J.P. Ometto. 2002. Stable isotopes and carbon cycle processes in forests and grasslands. *Plant Biology* 4(2):181-189.
- Lai, C.T., J.P.H.B. Ometto, J.A. Berry, L.A. Martinelli, T.F. Domingues, and J.R. Ehleringer. 2008. Life form-specific variations in leaf water oxygen-18 enrichment in Amazonian vegetation. *Oecologia* 157(2):197-210. DOI 10.1007/s00442-008-1071-5.

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