

# LBA-ECO TG-07 Forest Structure Measurements for GLAS Validation: Santarem 2004

## Summary:

This data set provides the results of a GLAS (the Geoscience Laser Altimeter System) forest structure validation survey conducted in Santarem and Sao Jorge, Para during November 2004 (Lefsky et al., 2005). DBH, total height, commercial height, canopy width and canopy class description were measured for 11 primary forest sites in Santarem along two 75m transects per GLAS measurement. For 10 secondary forest sites in Sao Jorge, the number of stems 0-2cm, 2-5cm, 5-10cm, and greater than 10cm were measured. For all stems greater than 10cm the DBH was measured, and for all sites, the maximum height was recorded. The basal area was calculated for all trees with DBH greater than 10cm within our transects, and biomass was calculated using the Brown, 1997 formula.

Exchange of carbon between forests and the atmosphere is a vital component of the global carbon cycle. Satellite laser altimetry has a unique capability for estimating forest canopy height, which has a direct and increasingly well understood relationship to aboveground carbon storage.

## Data Citation:

### Cite this data set as follows:

Keller, M., R. Oliveira Jr., P. Camargo, F. Espirito-Santo, M. Hunter. 2007. LBA-ECO TG-07 Forest Structure Measurements for GLAS Validation: Santarem 2004. Data Set. Available on-line [<http://www.daac.ornl.gov>] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A.

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The LBA Data and Publication Policy [[http://daac.ornl.gov/LBA/lba\\_data\\_policy.html](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 Users who download LBA data in the five years after data have been archived must contact the investigators who collected the data, per provisions 6 and 7 in the Policy.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 January of 2007. Users who download the data between January 2007 and December 2012 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.

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## 1. Data Set Overview:

**Project:** LBA (Large-Scale Biosphere-Atmosphere Experiment in the Amazon)

**LBA Science Component:** Carbon Dynamics

**Team ID:** TG-07 (Keller / de Mello)

**Team Objective:** Soil Biogeochemistry of Carbon, Nutrients, and Trace Gases in the Amazon Region of Brazil: Field Studies and Models of Natural and Managed Conditions

The investigators on the team were Keller, Michael; Camargo, Plinio Barbosa de; Oliveira Jr., Raimundo Cosme de; Espirito-Santo, Fernando Del Bon, and Hunter, Maria O. You may contact Keller, Michael ([michael@kaos.sr.unh.edu](mailto:michael@kaos.sr.unh.edu))

Forest structure measurements in Sao Jorge, Para and Santarem (Km 67) at locations of GLAS/ICESat (Ice Cloud and Elevation Satellite) waveform measurements made during November 2004. Further field measurements were conducted in primary forests in Manaus, and in Tanguro, Mato Grosso during September 2005.

For additional information, please see the following web sites:

- GLAS (the Geoscience Laser Altimeter System) [<http://glas.gsfc.nasa.gov/>]

### Related Publication:

Lefsky, M.A., D.J. Harding, M. Keller, W.B. Cohen, C.C. Carabajal, F.D. Espirito-Santo, M.O. Hunter, and R. de Oliveira. 2005. Estimates of forest canopy height and aboveground biomass using ICESat. *Geophysical Research Letters* 32(22), L22S02, doi:10.1029/2005GL023971.

## 2. Data Characteristics:

**Study Area:** Santarem Km67 and Sao Jorge

**Spatial Coverage:** 11 primary forest plots (Km67), and 10 secondary forest plots (Sao Jorge) located at GLAS/ICESat waveforms. Each plot is 75 m in diameter, measured using two perpendicular transects. GPS coordinates of all sites are included in the file: STM\_Locations.txt

**Temporal Coverage:** The waveform measurements were taken in Oct03, Feb04, and May-June04 during the 2a, 2b and 2c operational periods. Field measurements were made during Nov04.

### Data Organization:

- Field measurement data are stored in an ASCII tab-delimited format that opens conveniently in a spreadsheet.
- Missing values are represented by blank cells.

File names are STM\_primary\_data.txt, STM\_secondary\_data.txt, and STM\_Locations.txt.

**File Content:** Information concerning parameters and variables is included as header information in each of the respective data files.

### STM\_PRIMARY\_DATA\*

Column 1 ICESat site number (footprint number)  
Column 2 tree number  
Column 3 DBH of tree (cm)  
Column 4 location of tree in plot (x-coordinate;meters)  
Column 5 location of tree in plot (y-coordinate;meters)  
Column 6 crown diameter (m)  
Column 7 Category expressed as Suppressed(S), Dominant(D) or Super-Dominant(SD)  
Column 8 Height of first branch (m)  
Column 9 Height of top of canopy (m)  
Column 10 comment  
Column 11 Basal Area (m<sup>2</sup>)  
Column 12 Biomass (kg dry material) calculated from DBH using the formula of Brown,1997

\* This data set includes a remnant logged forest site in São Jorge that used the same sampling plan as the primary sites in Santarem.

For these plots we established a main plot (20 x 75 m) along the transect and two perpendicular side plots (40 x 27.5 m each). In these plots, DBH and maximum height were tallied for all trees with DBH greater than 35 cm. Within the main plot, DBH for all trees with DBH between 10 and 35 cm were recorded on a subplot (10 x 75 m); for a 30% sample of these smaller trees, we recorded diameter of the canopy, height of the first branch and maximum height (Lefsky et al., 2005). Heights were measured using either a clinometer or a laser range finder.

### Example Primary Data Records:

Footprint Mass (kg)	Number	DBH (cm)	x (m)	y (m)	Dia Crown (m)	Cat	Branch Ht (m)	Total Ht (m)	Comment	BA (m <sup>2</sup> )
035	01	32.1	-1	65	3	S	5.8	6.7	0.080928212	911.6
035	02	17.8	2	71	4	S	9.6	17.3	0.024884555	208.4
035	03	21.3	-4	65	4	S			0.035632729	333.5
035	04	14.5	3	61	3	S			0.016512996	118.2
...										

### STM\_SECONDARY\_DATA

Column 1 ICESat site number  
Column 2 plot number within site\*  
Column 3 subplot number (4x4m plots have 4 subdivisions)  
Column 4 number of stems 0-2 cm  
Column 5 number of stems 2-5 cm  
Column 6 number of stems 5-10 cm  
Column 7 number of stems greater than 10 cm  
Column 8 DBH of stems greater than 10 cm  
Column 9 mass (kg) of stems greater than 10 cm

Column 10 maximum height of stems in plot\*\*  
 Column 11 plant type\*\*\*  
 Column 12 comments

\* we sampled using various densities of randomly-located plots along a 75 m transect, plot density varied as a function of stem density (19 2 × 2 m plots in a recently abandoned agricultural fields, eight or nine 4 × 4 m plots in secondary forests) (Lefsky et al., 2005)

\*\* the height of the tallest stem in the footprint is included in the Location file

\*\*\* Cecropia stems were counted separately and biomass was calculated using the Brown (1997) formulae.

**Example Secondary Data Records:**

Footprint	Plot	Subplot	0-2 (cm)	2-5 (cm)	5-10 (cm)	>10 (cm)	DBH (cm)	Mass (kg)	Plot Max. Height (m)	Plant Type	Comments
085	1	0	3	0	1	14.6	109.1	5.0		Other	
085	2	0	0	0	0					Other	
085	3	4	0	0	0	3.0				Other	
085	4	7	4	0	0					Cecropia	
...											

**STM\_LOCATIONS**

Column 1 Footprint #  
 Column 2 GPS data from ICESat for center of footprint  
 Column 3 northern bound of measured plot  
 Column 4 southern bound of measured plot  
 Column 5 eastern bound of measured plot  
 Column 6 western bound of measured plot  
 Column 7 center point of measured plot  
 Column 8 highest point in plot (m)

\*Columns 3-7 were measured in the field using a Garmin handheld unit.

**Example Location Data Records:**

Locations of Santarem Footprints										
Footprint #	ICESat center	field N	field S	field E	field W	Field Ctr	highest point (m)			
085	S3.108 W54.9933		8.6							
084	S3.10644 W54.9931		14.7							
095	S3.12360 W54.9955	S3.12327 W54.99542	S3.12394 W54.99556	S3.12364 W54.55918	S3.12356 W54.99582					14
096	S3.12516 W54.9957	S3.12488 W54.99564	S3.12520 W54.99539	S3.12512 W54.99601						18
...										

All GPS coordinates are in WGS84

**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 67 Primary Forest Tower Site (Para Western (Santarem))	-55	-54.9125	-2.848	-3.19912	WGS-84

**Time period:**

- The data set covers the period 2004/11/08 to 2004/11/18.

**Platform/Sensor/Parameters measured include:**

- FIELD INVESTIGATION / ANALYSIS / FORESTS
- FIELD INVESTIGATION / CLINOMETER / CANOPY CHARACTERISTICS
- FIELD INVESTIGATION / STEEL MEASURING TAPE / FOREST COMPOSITION/VEGETATION STRUCTURE

### 3. Data Application and Derivation:

These data can be used to estimate the terrestrial carbon storage on a global scale, and gain understanding of forest structure. The 75x75 m sampling plots were chosen as a best approximation of the area of highest laser energy. The true average ellipsoid of the Lidar waveforms for the operations periods used was 53x97 m. Further choices concerning field sampling were made to effectively cover the greatest amount of plot area in the least amount of time. For further information on waveform processing and field data collection, please refer to Lefsky, et al. 2005 in Geophysical Research Letters.

### 4. Quality Assessment:

There is uncertainty within the height measurements due to the difficulty of measuring tree height from the ground within a dense canopy. We checked for a bias between heights measured with a clinometer and heights measured with the laser. No bias was found. Since collection, no systematic errors within the data have been found.

### 5. Data Acquisition Materials and Methods:

Field data environment:

Field mission objective: To obtain forest structure data for comparison with Lidar waveforms.

Management and funding: NASA

**Sensors used include:**

- ANALYSIS
- CLINOMETER
- STEEL MEASURING TAPE

### 6. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) [<http://www.daac.ornl.gov>] or the EOS Data Gateway [<http://redhook.gsfc.nasa.gov/%7Eimswww/pub/imswelcome/>].

**Data Archive Center:**

**Contact for Data Center Access Information:**

E-mail: [uso@daac.ornl.gov](mailto:uso@daac.ornl.gov)  
Telephone: +1 (865) 241-3952  
FAX: +1 (865) 574-4665

### 7. References:

Brown, S. (1997), Estimating Biomass and Biomass Change of Tropical Forests: A Primer, (FAO Forestry Paper - 134), U. N. Food and Agric. Org., Rome.

Lefsky, M. A., D. J. Harding, M. Keller, W. B. Cohen, C. C. Carabajal, F. Del Bom Espirito-Santo, M. O. Hunter, and R. de Oliveira Jr. (2005), Estimates of forest canopy height and aboveground biomass using ICESat, Geophys. Res. Lett., 32, L22S02, doi:10.1029/2005GL023971.