LBA-ECO TG-03 AERONET Aerosol Optical Thickness Measurements, Brazil: 1993-2005

Revision date: September 27, 2012

Summary:

This data set provides aerosol optical thickness measurements from AERONET CIMEL sunphotometers, sun-sky scanning spectral radiometers, that were located at 22 sites in Brazil for selected times during the period from 1993-2005. There are 22 comma-delimited data files with this data set, one for each site, and one companion text file which contains the latitude, longitude, and elevation of the 22 sites.

The AERONET (AErosol RObotic NETwork) program is an inclusive federation of ground-based remote sensing aerosol networks established by AERONET and the PHOtométrie pour le Traitement Opérationnel de Normalisation Satellitaire (PHOTONS) and greatly expanded by AEROCAN (the Canadian sunphotometer network) and other agency, institute and university partners. The goal is to assess aerosol optical properties and validate satellite retrievals of aerosol optical properties. The network imposes standardization of instruments, calibration, and processing. Data from this collaboration provides globally distributed observations of spectral aerosol optical depths, inversion products, and precipitable water in geographically diverse aerosol regimes. Three levels of data are available from the AERONET website: Level 1.0 (unscreened), Level 1.5 (cloud-screened), and Level 2.0 (cloud-screened and quality-assured). Data provided here are Level 2.0.

Additional Information:

Descriptions of program objectives, affiliations, the instrumentation, operational issues, data products, data-base browser demonstrations, research activities, links to similar data sets, National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) links and personnel involved in AERONET may be found at: http://aeronet.gsfc.nasa.gov/.

Notice to non-AERONET investigators:

To maintain the integrity of the data base and fairness to the individuals who have contributed, use of these data for publication requires an offer of authorship to the AERONET Principal Investigator(s) (PI(s)). For each site there is a PI, the person responsible for deployment, maintenance,and data collection. The PI is entitled to be informed of any use of that site's data.

Data Citation:

Cite this data set as follows:

Schafer J.S., T.F. Eck, B.N. Holben, P. Artaxo, M.A. Yamasoe, and S. Procopio. 2012. LBA-ECO TG-03 AERONET Aerosol Optical Thickness Measurements, Brazil: 1993-2005. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1128

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 September of 2012. Users who download the data between September 2012 and August 2017 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 website [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:

Activity: AErosol RObotic NETwork (AERONET)

LBA Science Component: Trace Gas and Aerosol Fluxes

Team ID: TG-03 (Holben / Artaxo / Setzer)

The investigators were Holben, Brent Norman; Artaxo, Paulo Eduardo; Setzer, Alberto W.; Eck, Thomas F.; Markham, Brian L. and Schafer, Joel S. You may contact Schafer, Joel S. (jschafer@aeronet.gsfc.nasa.gov).

LBA Data Set Inventory ID:TG03_AERONET_AOT

This data set provides aerosol optical thickness measurements from AERONET CIMEL sunphotometers, sun-sky scanning spectral radiometers, that were located at 22 sites in Brazil for selected times during the period from 1993-2005. There are 22 comma-delimited data files with this data set.

2. Data Characteristics:

Aerosol optical thickness (AOT) measurements were obtained at 22 sites across the Amazon Basin and are most accurately representative of aerosol conditions within a 10 km radius of the observation points.

Each site's data record of AOT is recorded in its own data file. There is no data record between the pre-LBA field work (1993-1995) and the resumption of AERONET field activities beginning in 1999. Not all sites have data for all measurement years (1993-1995, 1999-2004). The data provided here are processed to Level 2.0 (cloud-screened and quality-assured).

Data are presented in 22 comma delimited files. Each file name includes the site name and the inclusive years of sampling as well as the processing level (Lev20 represents level 2.0).

Companion File

There is also a companion text file with the latitude, longitude, and elevation of the 22 sites: TG03_AOT_Sites.txt.

Data Files

Example file names:

930101_931231_Jamari_lev20.csv
990101_020101_Balbina_lev20.csv

All 22 Data files are organized as follows:

Column	Heading	Units/format	Description
1	Date	YYYYMMDD	Sampling date: GMT solar day
2	Time	hh:mm:ss	Sampling time GMT
3	Julian_Day		Sampling date in decimal day of year
4	AOT_1020		Aerosol optical thickness measured at 1020 nanometer wavelength
5	AAOT_870		Aerosol optical thickness measured at 870 nanometer wavelength
6	AOAOT_670		Aerosol optical thickness measured at 670 nanometer wavelength
7	AOAOT_500		Aerosol optical thickness measured at 500 nanometer wavelength
8	AOAOT_440		Aerosol optical thickness measured at 440 nm wavelength
9	AOAOT_380		Aerosol optical thickness measured at 380 nm wavelength
10	AOAOT_340		Aerosol optical thickness measured at 340 nm

			wavelength
11	AOAOT_532		Aerosol optical thickness measured at 532 nanometer wavelength
12	AOAOT_535		Aerosol optical thickness measured at 535 nanometer wavelength
13	AOAOT_1640		Aerosol optical thickness measured at 1640 nanometer wavelength
14	Water_vapor	g per cm2	Water vapor measured at a 940 nm wavelength
15	TripletVar_1020	%	AOT triplet variability expressed in percent for measurements at 1020 nanometer wavelength
16	TripletVar_870	%	AOT triplet variability expressed in percent for measurements at 870 nanometer wavelength
17	TripletVar_670	%	AOT triplet variability expressed in percent for measurements at 670 nanometer wavelength
18	TripletVar_500	%	AOT triplet variability expressed in percent for measurements at 500 nanometer wavelength
19	TripletVar_440	%	AOT triplet variability expressed in percent for measurements at 440 nanometer wavelength
20	TripletVar_380	%	AOT triplet variability expressed in percent for measurements at 380 nanometer wavelength
21	TripletVar_340	%	AOT triplet variability expressed in percent for measurements at 340 nanometer wavelength
22	TripletVar_532	%	AOT triplet variability expressed in percent for measurements at 532 nanometer wavelength
23	TripletVar_535	%	AOT triplet variability expressed in percent for measurements at 535 nanometer wavelength
24	TripletVar_1640	%	AOT triplet variability expressed in percent for measurements at 1640 nanometer wavelength
25	WaterError	%	Error associated with water vapor measurement expressed in percent
26	440-870Angstrom		Angstrom exponent calculated between wavelengths of 440 and 870 nanometers
27	380-500Angstrom		Angstrom exponent calculated between wavelengths of 380 and 500 nanometers
28	440-675Angstrom		Angstrom exponent calculated between wavelengths of 440 and 675 nanometers
29	500-870Angstrom		Angstrom exponent calculated between wavelengths of 500 and 870 nanometers
30	340-440Angstrom		Angstrom exponent calculated between wavelengths of 340 and 440 nanometers
31	440-675Angstrom(Polar)		Angstrom exponent calculated between wavelengths of 440 and 675 nanometers (polar)
32	Last_Processing_Date		Date of last data processing
33	Solar_Zenith_Angle	degrees	Solar zenith angle
missing data are represented by -9999			

Example data records:

```
Date,Time,Julian_Day,AOT_1020,AOT_870,AOT_670,AOT_500,AOT_440,AOT_380,AOT_340,
AOT_532,AOT_535,AOT_1640,Water_vapor,TripletVar_1020,TripletVar_870,TripletVar_670,
TripletVar_500,TripletVar_440,TripletVar_380,TripletVar_340,TripletVar_532,TripletVar_535,Triplet
Var_1640,
WaterError,440-870Angstrom,380-500Angstrom,440-675Angstrom,500-870Angstrom,340-
440Angstrom,
440-675Angstrom(Polar),Last_Processing_Date,Solar_Zenith_Angle

20010323,12:23:20,82.516204,0.027952,0.030284,0.047137,0.099429,0.106299,0.137795,0.1512
75,
-9999,-9999,-9999,5.581906,0.318047,0.285607,0.383834,0.4725,
0.427139,0.555368,0.322343,-9999,-9999,-9999,
-9999,1.964612,1.19464,2.00793,
2.165392,1.388309,-9999,
20010323,18:06:12,82.754306,0.01827,0.010946,0.024154,0.056338,0.05267,0.078061,0.08143,
-9999,-9999,-9999,5.581855,0.180089,0.357506,0.482741,0.284758,0.715288,
0.52998,0.727827,-9999,-9999,-9999,-9999,2.455038,1.213728,2.001613,
2.966815,1.73978,-9999,
20010323,18:21:12,82.764722,0.021373,0.014539,0.029368,0.065036,0.064747,0.092617,0.0976
59,
-9999,-9999,-9999,5.707484,0.245815,0.240916,0.252041,
0.536317,0.441663,0.035977,0.813591,-9999,-9999,
-9999,-9999,2.316579,1.305642,1.992556,2.714735,1.636534,
-9999,20010323,40.88825
```

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

Site (Region)	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude	Geodetic Datum
Mato Grosso - Alta Floresta (Mato Grosso)	-56.1049	-56.1049	-9.872	-9.872	World Geodetic System, 1984 (WGS-84)
Mato Grosso - Cuiaba (Mato Grosso)	-56.0208	-56.0208	-15.7295	-15.7295	World Geodetic System, 1984 (WGS-84)
Acre - Rio Branco (Acre)	-67.8689	-67.8689	-9.9567	-9.9567	World Geodetic System, 1984 (WGS-84)
Arica	-70.313	-70.313	-18.472	-18.472	World Geodetic System, 1984 (WGS-84)
Concepcion	-62.028	-62.028	-16.138	-16.138	World Geodetic System, 1984 (WGS-84)
CUIABA-MIRANDA	-56.021	-56.021	-15.729	-15.729	World Geodetic

					System, 1984 (WGS-84)
Para Western (Santarem) - Belterra (Para Western (Santarem))	-54.9517	-54.9517	-2.6484	-2.6484	World Geodetic System, 1984 (WGS-84)
Amazonas (Manaus) - Balbina (Amazonas (Manaus))	-59.4866	-59.4866	-1.9235	-1.9235	World Geodetic System, 1984 (WGS-84)
Rondonia - Abracos Hill (Rondonia)	-62.3579	-62.3579	-10.7621	-10.7621	World Geodetic System, 1984 (WGS-84)
Mato Grosso - Alta Floresta (Mato Grosso)	-56.1049	-56.1049	-9.872	-9.872	World Geodetic System, 1984 (WGS-84)
Balbina	-59.487	-59.487	-1.917	-1.917	World Geodetic System, 1984 (WGS-84)
Rondonia - Jamari (Rondonia)	-62.75	-62.75	-8.6327	-8.6327	World Geodetic System, 1984 (WGS-84)
Rondonia - El Refugio (Rondonia)	-62.03472	-62.03472	-14.7658	-14.7658	World Geodetic System, 1984 (WGS-84)
Rondonia - Ji Parana (Rondonia)	-61.7997	-61.7997	-10.8597	-10.8597	World Geodetic System, 1984 (WGS-84)
Mato Grosso do Sul - Campo Grande (Mato Grosso do Sul)	-54.6169	-54.6169	-20.4497	-20.4497	World Geodetic System, 1984 (WGS-84)
Goias - Porto Nacional (Goias)	-48.6	-48.6	-10.7	-10.7	World Geodetic System, 1984 (WGS-84)
Los_Fieros	-60.617	-60.617	-14.550	-14.550	World Geodetic System, 1984 (WGS-84)
Minas Gerais - Uberlandia (Minas Gerais)	-48.2827	-48.2827	-18.8997	-18.8997	World Geodetic System, 1984 (WGS-84)
Para Western	-49.6827	-49.6827	-3.7169	-3.7169	World

(Santarem) - Tukurui (Para Western (Santarem))					Geodetic System, 1984 (WGS-84)
Para Western (Santarem) - Santarem (Para Western (Santarem))	-54.75	-54.75	-2.4327	-2.4327	World Geodetic System, 1984 (WGS-84)
Potosi_Mine	-62.867	-62.867	-9.283	-9.283	World Geodetic System, 1984 (WGS-84)
Surinam	-55.200	-55.200	-5.800	-5.800	World Geodetic System, 1984 (WGS-84)

Time period:

- The data set covers the period 1993/01/01 to 2005/01/01.
- Temporal Resolution:

Platform/Sensor/Parameters measured include:

- FIELD INVESTIGATION / SUN PHOTOMETER / AEROSOL OPTICAL DEPTH/THICKNESS

3. Data Application and Derivation:

The radiometer makes two basic measurements, either direct sun or sky, both within several programmed sequences. The direct sun measurements are made in eight spectral bands requiring approximately 10 seconds. Eight interference filters at wavelengths of 340, 380, 440, 500, 670, 870, 940 and 1020 nm are located in a filter wheel which is rotated by a direct drive stepping motor. The 940 nm channel is used for column water abundance determination. A preprogrammed sequence of measurements is taken by these instruments starting at an airmass of 7 in the morning and ending at an airmass of 7 in the evening. Optical thickness is calculated from spectral extinction of direct beam radiation at each wavelength based on the Beer-Bouguer Law. Attenuation due to Rayleigh scatter, and absorption by ozone (from interpolated ozone climatology atlas), and gaseous pollutants is estimated and removed to isolate the aerosol optical thickness (AOT).

4. Quality Assessment:

See Section 5.0.

5. Data Acquisition Materials and Methods:

The data undergo preliminary processing (real time data), reprocessing (final calibration ~6 mo. after data collection), quality assurance, archiving and distribution from NASA's Goddard Space Flight Center (GSFC) master archive.

Calibration relies upon determination of the calibration coefficients needed to convert the instrument output digital number (DN) to a desired output, in this case aerosol optical thickness (AOT), precipitable water, and radiance (W/m2/sr/um).

The Langley plot is a logarithm of the DN taken during these times plotted against the optical airmass between a range of 5 and 2 (between 3.5 and 2 for 340 nm), where the intercept is the calibration coefficient (zero airmass DN), and the slope is the optical thickness. Langley plots from National Oceanic and Atmospheric Administration's (NOAA's) Mauna Loa Observatory (MLO) have been made to determine the spectral extraterrestrial voltage for these instruments since 1994. The observatory's high altitude and isolation from most local and regional sources of aerosols provides a very stable irradiance regime in the mornings, and is ideally suited to our purposes.

AERONET reference instruments are typically recalibrated at NOAA's MLO every 2-3 months using the Langley plot technique. The zero air mass voltages [Vo, instrument voltage for direct normal solar flux extrapolated to the top of the atmosphere (Shaw, 1983)] are inferred to an accuracy of approximately 0.2 to 0.5% for the MLO-calibrated reference instruments (Holben et al., 1998). Therefore, the uncertainty in AOT due to the uncertainty in zero airmass voltages for the reference instruments is better than 0.002 to 0.005.

The sun-sky radiometers at sites other than GSFC are intercalibrated against a MLO calibrated AERONET reference instrument both before deployment in the field and post- deployment. A linear rate of change in time of the zero airmass voltages is then assumed in the processing of the data from field sites. Our analysis suggests that this results in an uncertainty of approximately 0.01-0.02 in AOT (wavelength dependent) due to calibration uncertainty for the field instruments.

A sequence of three AOT measurements are taken 30 seconds apart creating a triplet observation per wavelength. During the large airmass periods, direct sun measurements are made at 0.25 airmass intervals, while at smaller airmasses the interval between measurements is typically 15 minutes. The time variation of clouds is usually greater than that of aerosols, causing an observable variation in the triplets that can be used to screen clouds in many cases. Additionally the 15-minute interval allows a longer temporal frequency check for cloud contamination.

Data are transmitted hourly or half hourly from the memory of the sun photometer microprocessor via the Data Collection Systems (DCS) to either one of three geosynchronous satellites GOES, METEOSAT or GMS and then retransmitted to the appropriate ground receiving station. The data can be retrieved for processing by internet linkage resulting in near real-time acquisition from almost any site on the globe excluding poleward of 80 degrees latitude. The DCS is a governmental system operated for the purpose of transmitting low volume environmental data from remote sites for various institutions and government agencies.

The frequencies, channels, and transmission windows are assigned by NOAA NESDIS for GOES, EUMETSAT for METEOSAT and GMS, which are broadcast in the 401 to 402 MHz range. The satellite transmitter module used is a Vitel VX1004 which is commercially modified for use with the CE 318 A (The Vitel VX1004/2 is used by the PHOTON group, but it is no longer in production). The antenna is conical approximately 40 cm in diameter and 40 cm long. The transmitter system is battery operated and charged by a 10 watt solar panel.

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:

Holben, B.N., T. F. Eck, I. Slutsker, D. Tanre, J. P. Buis, A. Setzer, E. Vermote, J. A. Reagan, Y. J. Kaufman, T. Nakajima, F. Lavenu, I. Jankowiak, and A. Smirnov, “AERONET-a federated instrument network and data archive for aerosol characterization,” Remote Sens. Environ. 66, 1–16 (1998).

Shaw, G. E., 1983. Sun Photometry, Bull. Amer. Meteor. Soc., 64:4-11.

Related Publications

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