NARSTO EPA_SS_BALTIMORE JHU LIDAR Backscatter and Mixing Height Data

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1. Data Set Description:

LIDAR measurements were taken from May 2001 to September 2002 during the Baltimore Experiment of the U.S. EPA Particulate Matter Supersites Program by the Johns Hopkins University (JHU), Department of Geography and Environmental Engineering. A miniature elastic backscatter LIDAR was operated at several Baltimore locations in the vertical mode with typical resolution range of 3.75 m, typical time steps of 5 seconds, and ranges of 5.625-10 km. All vertical profile measurements of aerosol and molecular backscatter were taken during daytime with continuous sampling and can be used to describe composition, dynamics, and extent of the mixing layer and the air aloft. Mixing heights were determined from profile data under cloud-free conditions. Included in this data set are the large ASCII files of the aerosol and molecular backscatter data, the calculated mixing height data, and a companion HTML viewer application with the color images of the LIDAR profiles of the backscatter signals.

On 85 days during May 22, 2001 - September 5, 2002 the backscatter signal was measured with the JHU miniature elastic backscatter LIDAR. The instrument was operated at three sites together with instrumentation for the Baltimore Supersite Experiment: FMC (south Baltimore), CLI and CLF (in the July 2001 data zip file) (Clifton Park, east Baltimore), and PON (Ponca Street, Dundalk, Baltimore) during intensive measurement periods March 8 - April 11 and July 3 - August 14, 2002. During non-intensive measurement periods the LIDAR was operated at HOM (Homewood Campus, north Baltimore). The JHU LIDAR uses a Nd YAG laser emitting pulses of energy of 320 mJ/pulse at 1064 nm. The frequency is 30Hz. In most of the cases, 150 pulses (shots) were averaged corresponding to a 5 s time resolution (time step). The detector samples at 25 ns, which corresponds to a 3.75 m spatial resolution. In general, the range was recorded up to 5.625 km and under certain conditions up to 10 km. The measurements were routinely collected for 30 minutes. The mixing height altitude was estimated from vertical profiles collected during cloud-free conditions using a JHU hybrid backscatter gradient and contour method. It should be mentioned that at 1064 nm wavelength the backscatter signal is mainly due to aerosols.

Reliable backscatter data can be collected only above the incomplete overlap range of the field of view of the telescope and the laser beam, usually 250 - 375 m. The JHU LIDAR data are considered good above 300 m above ground level. The laser beam and telescope were manually aligned before the start of daily measurements. The laser was always operated within the specifications of the manufacturer. During data processing the background backscatter was subtracted from the signal. For more method information see the companion file Miniature Elastic LIDAR Research Procedure (PDF).

The LIDAR data (*.TDA files) were used to produce color-coded plots of range-corrected backscatter signal (arbitrary units) as a function of time and altitude (range). The range-corrected signal represents the backscatter signal multiplied by the square of the range. The backscatter signal is coded from blue, for a weak signal, through red for strong aerosol backscatter. The MatLab (The MathWorks, Inc.) script for producing these plot images is included as a companion file.

The **Baltimore Supersite** collected high-quality ambient air quality measurements with unprecedented temporal resolution at an industrially influenced urban site from 2000 to 2002 with two intensive measurement campaigns. A data set of project results was constructed to take advantage of advanced multivariate statistical techniques. Data were collected on the sources and nature of organic aerosol for the region, and large quantities of urban particulate matter (PM) were collected for retrospective chemical, physical, and biological analyses and for toxicological testing. These data provided important information on the potential health effects of particles to support exposure and epidemiologic studies for enhanced evaluation of health outcome, pollutant, and source relationships. More information can be found at Baltimore Supersite Experiment.

The U.S. EPA Particulate Matter (PM) Supersites Program was an ambient air monitoring research program from 1999-2004 designed to provide information of value to the atmospheric sciences, and human health and exposure research communities. Eight geographically diverse projects were chosen to specifically address these EPA research priorities: (1) to characterize PM, its constituents, precursors, co-pollutants, atmospheric transport, and its source categories that affect the PM in any region; (2) to address the research questions and scientific uncertainties about PM source-receptor and exposure-health effects relationships; and (3) to compare and evaluate different methods of characterizing PM including testing new and emerging measurement methods. Data collected by these projects are publicly available at the NARSTO Permanent Data Archive, Atmospheric Science Data Center at NASA Langley Research Center. Data users should acknowledge the U.S. EPA Particulate Matter (PM) Supersites Program and the project investigator(s) listed below.

The data set should be cited as follows:

Adam, M., M. Pahlow, and M.B. Parlange. 2003. NARSTO EPA_SS_BALTIMORE JHU LIDAR Backscatter and Mixing Height Data. Available on-line via NARSTO Data and Informaton at the Atmospheric Science Data Center at NASA Langley Research Center, Hampton, Virginia, U.S.A.

2. Sample Data Record/Data Format:

JHU Mixing Height Data File Format Description

The mixing height data file is in the NARSTO Data Exchange Standard (DES) format that is described in detail on the NARSTO Quality Systems Science Center (QSSC) web site. The DES files follow a tabular layout and are stored as ASCII comma-separated values files (.csv). The DES does not rely on row position to identify specific information, but uses a tag to describe the information contained in the row. The DES is a self-documenting format with three main sections: the header contains information about the contents of the file and the data originator; the middle section contains metadata tables that describe/define sites, flags, and other codified fields; and the final section is the main data table that contains key sampling and analysis information and the data values. Descriptions of the standardized metadata fields are also available on the QSSC web site.

Data Quality Note: An error in the LIDAR system's telemetry data acquisition software was discovered post analysis that resulted in an error in range values. The range values in this Mixing Height data file have been corrected. Information about Mixing Height plots is provided below.

JHU LIDAR Data File Format Description

The aerosol and molecular backscatter data files in this data set are in a convenient native format as provided by and documented by JHU. The backscatter data are in large ASCII files that start with twelve descriptive header rows and that are followed by a variable number of space-delimited data rows. Each data row represents one vertical profile with an initial time stamp and backscatter values for a fixed altitude measurement interval (usually 3.75 m). The time interval between rows varies: it is generally 5 seconds in the later data. The number of values per row is fixed in a given file but will vary across files. There may be up to 1500 values (columns) per row. There are no zero, negative, or missing backscatter data values. A placeholder value in line 13, first column, is designed as -9999.99.

Data Quality Note: Data collected July 11, 2002 were determined to be unacceptable because of misalignment of the LIDAR system. LIDAR data and images from this date should not be used. The JHU LIDAR data are considered good above 300 m above ground level.

Data Quality Note: **Due to an error in the LIDAR system's telemetry data acquisition software, the *range values* as written in the TDA files (line 13) are incorrect.** The software error was discovered post analysis. To properly use the TDA data, a correction factor of 1.25 (linear multiplication) must be applied to obtain the correct range value. That is, instead of 0, 3, 6, 9 ...4490.89 m, the correct values are 0, 3.75, 7.5, 11.25 ...5613.6 m.

We specify that all of the plots accompanying this data set have incorrect range values (vertical axis). When looking at a plot remember to adjust the vertical axis by a multiplication factor of 1.25. For correct plots, follow these steps.

- To obtain Mixing Height plots with correct range values, please use the data file supplied for the Mixing Height (above), which has been corrected and re-plot the data.
- To obtain color plots of the aerosol backscatter from the TDA files with corrected range values, you can use the MatLab (The MathWorks, Inc.) script for producing these plot images that is included as a companion file. The MatLab script will correct the range (multiply by 1.25) and will produce a corrected profile plot.
- For other analyses or plots of the TDA files, you must first multiply the range by 1.25.

Please contact Marc Parlange (below) if you have any questions about the range correction and use of the LIDAR data.

Data File Contents

Data File Row Number	Row Contents (example)	Row Contents Description	Row Contents Notes (valid values, ranges, comments)
1	* vertical scan	Type of the scanning	For PM Supersite experiment, it is always "vertical scan"
2	* XXX	Site abbreviation	XXX = FMC, CLI, CLF (in July 2001 data zip file), PON, or HOM

3	* Data file name = path\ddMMMnnn.TD	File name of the original JHU binary TD file (with path)	dd-day,MMM-month, nnn - number of the file
4	* Date/time stamp of run: mm/dd/yyyy hh:mm:ss	Date and time	Starting date and time
5	* ExperimentSite: Baltimore PM Supersite	Name of experiment	Always: Baltimore PM Supersite
6	* LaserTarget: No target for the Lidar described.	Description of target For some system adjustments, a certain target can be used (e.g. ground, tree, building)	Here, the target was always the sky, which is entered as "No target for the Lidar described."
7	* Number of shots/LOS = n	Number of shots per line of sight to be averaged	ν=30Hz. n was often 150. (in which case, 150 shots/30Hz=5s, the time step for this file)
8	* NumberofAzimuthCycles = 0	# of azimuth steps	Not applicable. Used when doing 2-D or 3-D scans
9	* AzimuthStart = 0.0020 AzimuthEnd = 0.0020 AzimuthStepSize = 0.0000 AzimuthOffsetAngle = 0.0000	Starting, ending, step and offset of the azimuth angle	Not applicable. Used when doing 2-D or 3-D scans
10	* NumberofElevationCycles = 0	# of elevation steps	Not applicable. Used when doing 2-D or 3-D scans
11	* ElevationStart = 90.0000 ElevationEnd = 90.0000 ElevationStepSize = 0.0000 ElevationOffsetAngle = 0.0000	Starting, ending, step and offset of the elevation angle	Elevation is always 90 degrees (vertical scan). Step and offset not applicable. Used when doing 2-D or 3-D scans
12	*	Empty line	
13	-9999.99 0.00 3.00 6.00 ...	Data column headings: First column=-9999.99 (place holder); remaining columns=height	Height=start of range gate in meters above ground; e.g. 0 represents the range interval [0,3.00]m **See Data Quality Note above.**
14	0.00 492.48 563.41 1441.57 ...	First column=time (0s) Remaining columns = backscatter lidar signal for each height	Time 0s = beginning of the time interval [0,5]s **or if** Time 2.5s = middle of time interval [0,5]s Backscatter lidar signal=arbitrary units **See Time footnote.**
15	5.00 499.85 597.17 1370.72 ...	First column=time (5s) Remaining columns = backscatter lidar signal for each height	Time nominally 5s = beginning of the time interval [5,9.99]s **or if** Time nominally 7.5s = middle of the time interval [5,9.99]s
16 to N	9.99 490.79 581.80 1420.61 ...	First column=time (s) Remaining columns = backscatter lidar signal for each height	Time = beginning or middle of the time interval. N for the nominal 5-second time step can be calculated as: N=(time(end)+5)/5 e.g. N=360 time steps for 30 min N=720 time steps for 60 min

Time footnote: The LIDAR data files collected in 2001 on days June 6-14, July 2-4, and August 14-16 have times indicating the middle of the time interval (e.g., 2.5, 7.5, etc.). All other days have times indicating the beginning of the time interval (e.g., 0, 5, 10).

Example Data File:

* vertical scan
* PON
* Data file name = C:\03JUL02\03JUL002.TD
* Date/time stamp of run: 07/03/2002 10:26:05
* ExperimentSite: Baltimore PM Supersite
* LaserTarget: No target for the Lidar described.

* Number of shots/LOS = 150
* NumberofAzimuthCycles = 0
* AzimuthStart = 0.0020 AzimuthEnd = 0.0020 AzimuthStepSize = 0.0000 AzimuthOffsetAngle = 0.0000
* NumberofElevationCycles = 0
* ElevationStart = 90.0000 ElevationEnd = 90.0000 ElevationStepSize = 0.0000 ElevationOffsetAngle = 0.0000
*

-9999.99	0.00	3.00	6.00	8.99	11.99	14.99	17.99	...	4487.89	4490.89
0.00	492.48	563.41	1441.57	1810.74	1269.53	1326.26	1316.04	...	421.94	435.03
5.00	499.85	597.17	1370.72	1859.35	1300.44	1239.62	1360.21	...	434.70	432.65
9.99	490.79	581.80	1420.61	1867.61	241.91	1293.31	1340.58	...	431.05	442.97
...										
1795.02	492.83	563.67	1439.85	1866.34	1243.47	287.77	1333.77	...	439.07	441.55

File Naming Syntax:

LIDARxxxyymmddnnn.TDA
Where:
xxx = site abbreviation
yymmdd = date
nnn = number of the file on this date
TDA = file name extent used for time-domain / single-dimension data

Example data file name = LIDARPON020703002.TDA

Abbreviations:

Sites = FMC (south Baltimore), CLI and CLF(in the July 2001 data zip file)(Clifton Park, east Baltimore), PON (Ponca Street, Dundalk, Baltimore), HOM (JHU Homewood Campus, north Baltimore). See the mixing height data file for more information about these sites.
TD = "time domain", used as extension for original lidar data in binary format
TDA = "time domain ASCII", used as extension for lidar data in ASCII format

3. References:

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- Melfi, S. H., Spinhirne, J. D., Chou, S.-H., and Palm, S. P.: 1985, Lidar observations of vertically organized convection in the planetary boundary layer over the ocean, J. Clim. Appl. Meteor., 24, 806-821.
- White, A.B., C. J. Senff, and Banta, R. M: 1999, A comparison of mixing depths observed by ground-based wind profilers and an airborne lidar, J. Atmos. Oceanic Technol., 16, 584-590.

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Data Center:

The User and Data Services Office at the Langley Atmospheric Science Data Center is involved throughout the system to monitor the quality of data on ingest, to ensure prompt replies to user questions, to verify media orders prior to filling them, and to ensure that the needs of the users are being met.

If you have a problem finding what you need, trouble accessing the system, or need an answer to a question concerning the data or how to obtain data, please contact the User and Data Services staff.

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5. Acknowledgement:

When data from the Langley Atmospheric Science Data Center are used in a publication, we request the following acknowledgment be included: "These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center".

The Langley Data Center requests a reprint of any published papers or reports or a brief description of other uses (e.g., posters, oral presentations, etc.) of data that we have distributed. This will help us determine the use of data that we distribute, which is helpful in optimizing product development. It also helps us to keep our product-related references current.

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