Lidar Atmospheric Sensing Experiment (LASE) Validation Langley DAAC Data Set Document

Summary:

An extensive validation experiment was conducted in September 1995 from Wallops Island, Virginia, to evaluate the performance of the LASE (Lidar Atmospheric Sensing Experiment) system for the measurement of water vapor profiles under a wide range of atmospheric and solar background conditions. During this experiment, the LASE system was flown on a high-altitude (ER-2) aircraft on ten missions for a total of 60 hours. LASE measurements of tropospheric water vapor were compared with in situ measurements from balloons and aircraft that were flown under the ER-2 and with remote measurements from the ground and from aircraft. A high-altitude aircraft (Lear Jet) was equipped with two in situ hygrometers, and a medium to low altitude aircraft (C-130) had onboard the NASA Langley airborne water vapor DIAL system and two in situ hygrometers. Several radiosondes were launched during each LASE flight, and some of these sondes were part of a concurrent international radiosonde intercomparison campaign sponsored by the World Meteorological Organization. The NASA Goddard Scanning Raman lidar also provided nighttime water vapor profile measurements from the ground. During this field experiment, LASE was also used in a number of atmospheric case studies including measurements of Hurricane Luis, a coastal sea breeze development, a strong cold front, an upper level front, and cirrus clouds.

More detailed information on the LASE Validation data can be found on the LASE Home Page. Summary and detailed images of the data for each parameter on each flight are available from the LASE Validation web pages.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

LASE_VALIDATION: Lidar Atmospheric Sensing Experiment (LASE) Validation

Data Set Introduction:

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Objective/Purpose:

The ability of a Differential Absorption Lidar (DIAL) system to measure vertical profiles of water vapor in the lower atmosphere has been demonstrated both in ground-based and airborne experiments. In these experiments, tunable lasers are used that require real-time experimenter control to locate and lock onto the atmospheric water vapor absorption line for the DIAL measurements. The Lidar Atmospheric Sensing Experiment (LASE) is the first step in a long-range effort to develop and demonstrate autonomous DIAL systems from airborne and spaceborne platforms. The LASE instrument was developed to measure water vapor, aerosol, and cloud profiles from a high altitude extended range U-2 (ER-2) aircraft.

The measurement of tropospheric water vapor profiles and column content with the LASE system can be used in various atmospheric investigations, including studies of air mass modification, latent heat flux, the water vapor component of the hydrological cycle, and atmospheric transport using water vapor as a tracer of atmospheric motions. The simultaneous measurement of aerosol and cloud distributions can provide important information on atmospheric structure and transport, and many meteorological parameters can also be inferred from these data. In addition, the impact of subvisible and visible aerosol/cloud layers on passive satellite measurements and radiation budgets can be assessed. The atmospheric science investigations that can be conducted with LASE are greatly enhanced because measurements of water vapor profiles and column content are made simultaneously with aerosol and cloud distributions.

Summary of Parameters:

Atmospheric Scattering Ratio
Water Vapor Concentration Profiles

Discussion:

...

Related Data Sets:

...

2. Investigator(s):

Title of Investigation:

Lidar Atmospheric Sensing Experiment (LASE)

Investigator(s) Name, Title, and Contact Information:

Dr. Edward V. Browell	Vincent G. Brackett	Marian B. Clayton
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21 Langley Boulevard	21 Langley Boulevard	21 Langley Boulevard
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3. Theory of Measurements:

...

4. Equipment:

Sensor/Instrument Description:

Collection Environment:

LASE collects DIAL data at 5 Hz while flying at altitudes from 16-21 km. LASE was designed to operate autonomously within the environment and physical constraints of the ER-2 aircraft and to make water vapor profile measurements across the troposphere with accuracy having less than 6 of error. The LASE Instument is being adapted to other aircraft platforms to support planned missions and to increase its utility.

Source/Platform:

- NASA ER-2.
- LASE Configuration on the ER-2.

Source/Platform Mission Objectives:

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Key Variables:

Atmospheric Scattering Ratio
Water Vapor Concentration Profiles

Principles of Operation:

LASE uses a double-pulsed Ti:Sapphire laser for the transmitter with a 30 ns pulse length and 150mJ/pulse. The laser beam is seeded to operate on a selected water vapor absorption line in the 815-nm region using a laser diode and an onboard absorption reference cell. The "on" and "off" wavelengths are separated by less than 70 pm. The laser pulses are sequentially transmitted with about 400 microseconds separation. This permits the use of the same avalanche photodiodes (APD) for detecting the lidar returns. The use of low and high light level APD's provides linear response to atmospheric and cloud/ground returns, respectively. A 40 cm diameter telescope collects the backscattered signals and directs them onto two detectors. Operation with strong and weak absorption regions of a preselected water vapor line can be made during the mission to optimize the measurement of water vapor in different altitude regions.

LASE System Parameters

LASE H2O DIAL PARAMETERS
TRANSMITTER

ENERGY	150 MJ (ON & OFF)
LINEWIDTH	0.25 PM
REP. RATE	5 HZ
WAVELENGTH	813-818 NM
BEAM DIVERGENCE	0.60 MR
PULSE WIDTH	50 NS
AIRCRAFT ALTITUDE	16-21 KM
AIRCRAFT VELOCITY	200 M/S

RECEIVER

AREA (EFFECTIVE)	0.11 M^2
FIELD OF VIEW	1.1 MR
FILTER BANDWIDTH (delta lambda FWHM)	0.4 NM (DAY), 1.0 NM (NIGHT)
OPTICAL TRANSMITTANCE (TOTAL)	29% (DAY), 49% (NIGHT)
DETECTOR EFFICIENCY	80% APD (SI)
NOISE EQ. POWER	2.5 X 10^{-14} W/HZ^{12} (AT 1.6 MHZ)
EXCESS NOISE FACTOR (APD)	2.5

Sensor/Instrument Measurement Geometry:

LASE System Block Diagram.

Manufacturer of Sensor/Instrument:

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Sensor/Instrument:

[Differential Absorption Lidar](#) (DIAL).

Calibration:

Specifications:

...

Tolerance:

...

Frequency of Calibration:

...

Other Calibration Information:

...

5. Data Acquisition Methods:

Lidar returns at 5 Hz are digitized and recorded, and when possible, the data are telemetered to the LASE ground station for real-time processing and experiment control.

6. Observations:

Data Notes:

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Field Notes:

Weather Analysis Summaries are available for each flight via links on the [LASE Validation Experiment web site](#).

7. Data Description:

Spatial Characteristics:

Spatial Coverage:

Data Set Name	Min Lat	Max Lat	Min Lon	Max Lon
LASE_VALIDATION	28.71	42.86	62.66	85.74

Spatial Coverage Map:

Flight Tracks are available for each flight via links on the [LASE Validation Experiment web site](#).

Spatial Resolution:

Point Measurements

Projection:

...

Grid Description:

...

Temporal Characteristics:

Temporal Coverage:

September 8, 1995 to September 27, 1995

Temporal Coverage Map:

...

Temporal Resolution:

3 Seconds

Data Characteristics:

Parameter/Variable:

...

Variable Description/Definition:

...

Unit of Measurement:

...

Data Source:

...

Data Range:

...

Sample Data Record:

File header:

```
26
val01s.arc
Browell, Dr. Edward V., NASA Langley Research Center
LASE / ER-2 Aerosol Total Scattering Ratio Profiles
Science Validation
95 09 08 98 07 22
1
 9
 5
3
0
3
Day of Year,  Julian,  1.00000,  0,  252,  252,  -999.000,  0
Elapsed Time ,  Sec (UT) ,  1.00000,  0,  483,  12191,  -999.000,  0
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Geo. Alt. @ Begn ,  m ,  1.00000,  0,  30,  2429,  -999.000,  0
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Longitude ,  Deg E ,  0.0100000,  0,  -8085,  -7478,  -99900.0,  0
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Data Profile,  ,  0.0100000,  0,  -41707,  32697104,  -99900.0,  0
----------------------------------------------------------------
More information including data resolution and images are available
via WWW at http://asd-www.larc.nasa.gov/lidar/lidar.html or contact
Dr. Edward V. Browell (757)864-1273 (Head, Lidar Applications Group)
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Data record:

```
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    330,       316,       279,       278,       282,       298,       314,       338,
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     94,        93,       106,       116,       106,        97,        92,        94,
     98,        97,       106,       101,       111,       106,       127,       133,
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   4036,      4013,      3952,      3970,      4063,      4105,      4231,      4507,
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   6241,      5531,      4864,      4555,      4486,      4541,      4560,      4694,
   4938,      5127,      5124,      5042,      4923,      4865,      4884,      4916,
   4606,      4286,      3864,      3219,      2665,      2450,      2333,      2219,
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    101,       101,       102,       102,       100,        99,       102,       100,
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    104,       106,       106,       107,       107,       106,       104,       102,
    100,        99,       100,        99,        99,        98,        97,        98,
     99,       101,       102,       102,       102,       100,       102,       101,
    101,       101,       102,       100,       101,       102,       102,       100,
    101,       100,       100,       101,       103,       103,       102,       102,
    104,       103
```

8. Data Organization:

Data Granularity:

The LASE Validation data are organized into granules by flight number and parameter.

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary.

Data Format:

The data are stored in ASCII formatted files following the GTE Data Archive Format.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

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Data Processing Sequence:

Processing Steps:

...

Processing Changes:

...

Calculations:

Special Corrections/Adjustments:

...

Calculated Variables:

...

Graphs and Plots:

Images of aerosol total scattering ratio and water vapor are available for each flight from the LASE Validation Experiment web site.

10. Errors:

Sources of Error:

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Quality Assessment:

Data Validation by Source:

...

Confidence Level/Accuracy Judgement:

...

Measurement Error for Parameters:

...

Additional Quality Assessments:

...

Data Verification by Data Center:

The Langley DAAC performs an inspection process on data received by the data producer via ftp. The DAAC checks to see if the data transfer completed and the data were delivered in their entirety. An inspection software was developed by the DAAC to make sure every granule is readable. The code also checks to see if every data value falls within the range specified by the data producer. This same code extracts the metadata required for ingesting the data into the IMS. If any discrepancies are found, the data producer is contacted. The discrepancies are corrected before the data are archived at the DAAC.

11. Notes:

Limitations of the Data:

...

Known Problems with the Data:

...

Usage Guidance:

...

Any Other Relevant Information about the Study:

...

12. Application of the Data Set:

...

13. Future Modifications and Plans:

...

14. Software:

Software Description:

Currently, there is one sample read program which works with all LASE data sets, read_lase.c. It is written in ANSI C. This program has been tested on the following computers and operating systems:

Computer	Operating System
Sun Sparc	Solaris 2.5
Sun4	SunOS 4.1.3
SGI Origin 2000	IRIX 6.4
HP 9000/735	HP-UX 10.10
DEC Alpha	Digital UNIX 4.0A

This program is written as an example of how to read in the LASE data. As delivered, it reads in and writes to the screen the file header information followed by each profile's header and data.

Software Access:

The software can be obtained through the Langley DAAC. Please refer to the contact information below. The software can also be obtained at the same time the user is ordering this data set.

15. Data Access:

Data Center Identification and Contact Information:

Langley DAAC User and Data Services Office
NASA Langley Research Center
Mail Stop 157D
Hampton, Virginia 23681-2199
USA
Telephone: (757) 864-8656
FAX: (757) 864-8807
E-mail: support-asdc@earthdata.nasa.gov

Procedures for Obtaining Data:

The Langley DAAC provides multiple interfaces to access its data holdings. The graphical and character user interfaces allow users to search and order data; and web interfaces allow direct access to some data holdings for immediate downloading or placing media orders, for searching the data holdings, and downloading electronically available holdings, and for ordering prepackaged CD-ROMs and videocassettes. All of these methods are easily obtained from the Langley DAAC web site.

Images for this data are available from the LASE Validation web pages.

Data Center Status/Plans:

The Langley DAAC will continue to archive this data.

16. Output Products and Availability:

...

17. References:

LASE Validation reference list.

18. Glossary of Terms:

EOSDIS Glossary.

19. List of Acronyms:

EOSDIS Acronyms.

20. Document Information:

- **Document Creation Date:** August 1998
- **Document Revision Date:** December 1998
- **Document Review Date:**
- **Document Project Reference:**
- **Document ID:**
- **Document Curator:** Langley DAAC User and Data Services Office
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