Boundary Layer Heights: LIDAR (FIFE)

Summary:

The Quick Look Boundary Layer Height Data Set contains wind and turbulence profiles, convective boundary layer depth, and optical depth of mixed layer haze. The Volume Imaging LIDAR (VIL) system of the University of Wisconsin was used to collect data during FIFE.

By choosing appropriate reflectivity levels, the data from the University of Wisconsin LIDAR have been used to derive unique 2-D and 3-D views of the Atmospheric Boundary Layer (ABL) structure, and the variations in that structure with time. These views and videos provide important insights into many problems facing investigators in all aspects of FIFE, including scaling and the representativeness of point and line samples. The backscattered return, as function of height, and vertical aerosol profiles may be determined when the LIDAR beam is directed straight upward. Various pointing and scanning schemes permit measurement of a variety of mean and turbulent quantities based on often-met assumptions about the flow. Aerosol backscattering from the convective boundary layer shows spatial variations due to non-uniform mixing of the naturally occurring aerosol. The motion of this spatial structure can be observed with the VIL and used to derive wind speed and direction. Winds are derived by computing 2-dimensional cross correlations between successive VIL Constant Altitude Plan Position Indicator (CAPPI) images. Because these measurements are averaged over the VIL scan area, it is possible to avoid the variations due to local wind gusts. Very stable estimates of the area averaged wind can be obtained within approximately 3 minute period required to obtain a pair of CAPPI images.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Boundary Layer Heights: LIDAR (FIFE)
(Quick Look Boundary Layer Height).

Data Set Introduction:

The Quick Look Boundary Layer Height Data Set contains wind and turbulence profiles, convective boundary layer depth, and optical depth of mixed layer haze collected via the Volume Imaging LIDAR (VIL) system of the University of Wisconsin.

Objective/Purpose:

The goals were to measure wind and turbulence profiles, convective boundary layer depth, and optical depth of mixed layer haze.

Summary of Parameters:

Mixed layer height above ground-level.

Discussion:

The Volume Imaging LIDAR (VIL) system of the University of Wisconsin, operated during FIFE and all LIDAR return signals measured at a 90 degree elevation angle were averaged and stored in a file. From plots of those profiles, clouds up to 15 km AGL can be identified.

By choosing appropriate reflectivity levels, the data from the University of Wisconsin LIDAR have been used to derive unique 2-D and 3-D views of the Atmospheric Boundary Layer (ABL) structure, and the variations in that structure with time. some of these views are available in the GRABBAG directory on FIFE CD-ROM Volume 1. Color videos were also produced and are available from the Archive listed in the *Contact Information Section*. These views and videos provide important insights into many problems facing investigators in all aspects of FIFE, including scaling and the representativeness of point and line samples.

Related Data Sets:

- NOAA Wind Profiles Using LIDAR.
- FIFE Radiosonde Wind Profiles.
- NOAA Radiosonde Observations.
- FIFE Radiosonde Data.

FIS Data Base Table Name:

LIDAR_HEIGHT_DATA.

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Edwin W. Eloranta
University of Wisconsin-Madison

Title of Investigation:

LIDAR Measurements of Boundary Layer, Aerosol Scattering and Clouds.

Contact Information:

Contact 1:
George Vassiliou
University of Wisconsin
USA
(608) 262-0792

Contact 2:
Dr. Edwin W. Eloranta
University of Wisconsin
USA
(608) 262-7327

Requested Form of Acknowledgment.

The Quick Look Boundary Layer Height data were produced by E.W. Eloranta. The contribution of these data is appreciated.

3. Theory of Measurements:

Volume Imaging LIDAR measures the radial (along-beam) velocity as a function of range using light-scattering particles in the air as tracers. When the LIDAR beam is directed straight upward and the backscattered return as function of height is recorded, vertical aerosol profiles may be determined. Various pointing and scanning schemes permit measurement of a variety of mean and turbulent quantities based on often-met assumptions about the flow.

The remote-sensing character of LIDAR offers the ability to measure flow parameters simultaneously at all the heights in a profile. Alternatively, the LIDAR scanning at lower elevation angles can probe flow characteristics over a large area or volume. The vertical profiles of momentum flux and turbulent intensity have been the object of experimental measurements to understand and model the dynamics of the atmosphere.

Aerosol backscattering from the convective boundary layer shows spatial variations due to non-uniform mixing of the naturally occurring aerosol. The motion of this spatial structure can be observed with the VIL and used to derive wind speed and direction. Winds are derived by computing 2-dimensional cross correlations between successive VIL Constant Altitude Plan Position Indicator (CAPPI) images. Because these measurements are averaged over the VIL scan area, it is possible to avoid the variations due to local wind gusts. Very stable estimates of the area averaged wind can be obtained within approximately 3 minute period required to obtain a pair of CAPPI images.

4. Equipment:

Sensor/Instrument Description:

The Volume Imaging LIDAR (VIL) is an elastic backscatter LIDAR designed to image the 4-dimensional structure of the atmosphere. This system couples an energetic, relatively high pulse repetition rate laser with a sensitive receiver, and a fast computer controlled angular scanning system.

This energy is directed through a germanium wedged plate that acts as a transmit/receive (T/R) switch and into a ZnSe Fresnel rhomb, which changes the polarization to circular. The beam then enters a 27.94 cm parabolic-parabolic off-axis telescope which provides excellent decoupling between transmitter and detector. The telescope output is directed either vertically through the roof (of the semi-trailer) to an azimuth/elevation scanner or horizontally through a window by a 39.2 cm flat mirror.

Collection Environment:

Ground-based.

Source/Platform:

The LIDAR is mounted on the roof of a semi-trailer.

Source/Platform Mission Objectives:

The University of Wisconsin developed a semi-trailer-mounted Volume Imaging LIDAR system for making atmospheric measurements of winds, turbulence, and backscatter, using aerosols as tracers.

Key Variables:

Mixed layer height above ground-level.

Principles of Operation:

Return signals pass through the system on a precise reverse path, and are changed to p-polarization on emerging from the Fresnel rhomb. These signals are then reflected from the T/R switch onto the detector where heterodyne mixing with the local oscillator occurs. The 20 MHz offset in the local oscillator frequency permits discrimination between receding and approaching velocity components of scatterers.

The volume imaging LIDAR measures the radial component of the air velocity (positive toward the LIDAR) as a function of range along the beam. The LIDAR performed a conical scan through a full circle in azimuth at constant elevation angle, to obtain the radial component of the air velocity. Azimuth is measured clockwise from north at a specified time. The scan was repeated many times within a period long enough (i.e., typically 1 hour) to sample a number of advecting eddies up to the largest scale of interest in the turbulent spectrum.

Sensor/Instrument Measurement Geometry:

The system scanning capability through the roof:

> Elevation -5 deg. to 90 deg.,
> Azimuth 0 deg. to 360 deg.,
> 1 deg. accuracy.

The system scanning capability through the window:

> Elevation +/-10 deg.,
> Azimuth +/-10 deg.,
> 0.001 deg. accuracy.

Manufacturer of Sensor/Instrument:

University of Wisconsin
Madison, Wisconsin

Calibration:

Among the first data taken were returns from a 2.1 m diameter disc located at 2400 m range. The disc was covered with sandpaper of known reflectance. Scattered energy from 1000 pulses was averaged and the result was compared with expected signal levels, adjusted for such things as measured 2-way efficiency of system optics (35%, determined by auto-collimation), carbon dioxide and water atmospheric absorption, truncation losses, shot noise level, etc.

Specifications:

Transmitter:

Average power: 20 W
Repetition rate: 30 Hz
Wavelength: 106.4 nm
Receiver:
Diameter: 0.5 m
Angular scan rate: 25 deg. s^-1
APD quantum efficiency: 35%
Range resolution: 7.5 m
Optical bandwidth: 1.0 nm
Average data rate: 0.5 GB h^-1 (approx.)
Data Processing/storage:
Control computer: DEC VAX/750 with CSPI array processor
Realtime display computer: Stardent GS 1000
Realtime acquisition computer: DEC LSI 11/72
Data storage device 2.6 GB Hitachi optical disk

Tolerance:

Due primarily to pressure changes within the TEA gas over the pulse generation time, the frequency of the pulse changes over its lifetime, leading the frequency modulation or chirp on the order of several hundred KHz to several MHz. High chirps are clearly unacceptable for Doppler systems trying to achieve measurement accuracies of 1 to 2 ms^1 (190-380 kHz).

Frequency of Calibration:

Calibration is performed before each data collection.

Other Calibration Information:

While performing the calibration, it became clear that at least 50 pulses were needed in order to get meaningful data. Single pulse return particularly for spinning targets, appear extremely noisy due to the Rayleigh phasor fluctuations of many sandpaper scattering centers, while averaging provides good absolute levels for calibrating and clarifies the output pulse shape.

To corroborate this pulsed calibration, a CW calibration was performed using only the 0.6 W output hybrid laser, a small disc covered with the same sandpaper at 160 m, and the telescope focused at 160 m instead of 2.4 km. Observed signal/noise ratio was 43 dB while the expected was 50 dB, confirming the 7 dB discrepancy.

5. Data Acquisition Methods:

The volume imaging LIDAR operated with a carbon dioxide laser transmitting at 106.4 nanometer wavelength. The transmitted energy is collimated by an off-axis paraboloid telescope and directed into the atmosphere through a scanner mounted on the roof of the semi-trailer that houses the system. The same telescope collects radiation backscattered from aerosol particles that are carried with the air motions. The telescope focuses the light on a HgCdTe detector, where the atmospheric signal mixes coherently with a beam from the local oscillator, which is another continuous wave laser held at constant offset frequency from the injection laser.

High bandwidth data acquisition is sustained during extended experiments by using a 7 gigabyte write once optical disk for data storage. A Stellar GS-1000 graphics computer provides 1280 x 1024 pixel resolution color LIDAR images.

Because cirrus level winds are typically 20-40 ms^-1, clouds move before the cloud volume could be completely scanned. In order to generate 3-dimensional images of fast moving cirrus, the LIDAR repeatedly scans a plane perpendicular to the mean cloud layer wind. Three-dimensional scenes are displayed with the third spatial dimension computed from the time between images multiplied by the wind speed.

6. Observations:

None.

7. Data Description:

Spatial Characteristics:

The FIFE study area, with areal extent of 15 km by 15 km, is located south of the Tuttle Reservoir and Kansas River, and about 10 km from Manhattan, Kansas, USA. The northwest corner of the area has UTM coordinates of 4,334,000 Northing and 705,000 Easting in UTM Zone 14.

Spatial Coverage:

The LIDAR operated from a relatively high vantage point in an area of gently rolling terrain approximately 12 km south of Manhattan, Kansas within the FIFE study area.

SITEGRID_ID	STATION_ID	NORTHING	EASTING	LATITUDE	LONGITUDE	ELEVATION
3539-LIW	113	4326922	712836	39 04 02	-96 32 24	447
3639-LIW	123	4326848	712850	39 04 00	-96 32 23	

Spatial Coverage Map:

Not available.

Spatial Resolution:

These are point data. However, the full width at half maximum of the laser power was 0.37 microseconds, which is equivalent to 55 meters spatial resolution. The processor's minimum gate size was considerably larger, so the along-beam resolution of the LIDAR was slightly more than 150 m.

For boundary layer observations the LIDAR is typically programmed to repeatedly scan an atmospheric volume consisting of the elevation angles between the horizon and 20 degrees inside an azimuthal sector of 30 to 60 degrees. Clear air aerosol structure is typically recorded with 7.5 or 15 meter resolution at ranges between the LIDAR and 15 km.

The VIL also provides high spatial resolution depictions of cirrus cloud structure. Cirrus clouds are easily detected at ranges of 100 km. Detailed cirrus images showing a 120 km horizontal extent with 60 m resolution are routinely obtained.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

The overall time period of data acquisition was from June 30, 1987 through July 9, 1987 and July 28, 1989 through August 11, 1989.

During that period, data were collected on the following 23 days:

OBS_DATE	OBS_DATE	OBS_DATE
30-JUN-87	28-JUL-89	05-AUG-89
01-JUL-87	29-JUL-89	06-AUG-89
02-JUL-87	30-JUL-89	07-AUG-89
05-JUL-87	31-JUL-89	08-AUG-89
06-JUL-87	01-AUG-89	09-AUG-89
07-JUL-87	02-AUG-89	10-AUG-89
08-JUL-87	03-AUG-89	11-AUG-89
09-JUL-87	04-AUG-89	

Temporal Coverage Map:

Not available.

Temporal Resolution:

The pulse repetition rate for the measurements was 30 Hz. Scans are repeated at intervals between 2.5 and 5 minutes. Each volume scan consists of between ~4500 and ~9000 LIDAR profiles; producing 5 - 10 million independent measurements of LIDAR backscattering in the scanned volume.

Data Characteristics:

The SQL definition for this table is found in the LIDAR_HT.TDF file located on the FIFE CD-ROM Volume 1.

Parameter/Variable Name

Parameter/Variable Description	**Range**	**Units**	**Source**
SITEGRID_ID This is a FIS grid location code. Site grid codes (SSEE-III) give the south (SS) and east (EE) cell number in a 100x100 array of 200m square cells. The last 3 characters (III) are an instrument identifier.			FIS
STATION_ID The station ID designating the location of the observations.	min = 113, max = 123		UNIVERSITY OF WISCONSIN
OBS_DATE The date of the observations.	min = 30-JUN-87, max = 11-AUG-89		UNIVERSITY OF WISCONSIN
OBS_TIME The time that the observation was taken.	min = 4, max = 2353	[GMT]	UNIVERSITY OF WISCONSIN
MIXED_LAYER_HEIGHT The height of the mixed layer above the ground.	min = 65, max = 2250,	[meters]	VOLUME IMAGING

missing = -9999	LIDAR	
FIFE_DATA_CRTFCN_CODE ** The FIFE Certification Code for the data, in the following format: CPI (Certified by PI), CPI-??? (CPI - questionable data). CPI-???= CPI-questionable data	CPI=checked by principal investigator, CPI-MRG=merged data,	FIS
LAST_REVISION_DATE data, in the format (DD-MMM-YY).	max = 28-AUG-89	

Footnote:

** Decode the FIFE_DATA_CRTFCN_CODE field as follows:

The primary certification codes are: EXM Example or Test data (not for release) PRE Preliminary (unchecked, use at your own risk) CPI Checked by Principal Investigator (reviewed for quality) CGR Checked by a group and reconciled (data comparisons and cross checks)

The certification code modifiers are: PRE-NFP Preliminary - Not for publication, at the request of investigator. CPI-MRG PAMS data which is "merged" from two separate receiving stations to eliminate transmission errors. CPI-??? Investigator thinks data item may be questionable.

Sample Data Record:

SITEGRID_ID	STATION_ID	OBS_DATE	OBS_TIME	MIXED_LAYER_HEIGHT
3539-LIW	113	30-JUN-87	2353	1238
3539-LIW	113	01-JUL-87	4	1151
3539-LIW	113	01-JUL-87	9	1148
3539-LIW	113	01-JUL-87	1450	51

FIFE_DATA_CRTFCN_CODE	LAST_REVISION_DATE
CPI	24-AUG-89
CPI	24-AUG-89
CPI	24-AUG-89
CPI	24-AUG-89

8. Data Organization:

Data Granularity:

This data set contains point data collected via scans that were repeated at intervals between 2.5 and 5 minutes.

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

Data Format:

The CD-ROM file format consists of numerical and character fields of varying length separated by commas. The character fields are enclosed with a single apostrophe. There are no spaces between the fields. Each file begins with five header records. Header records contain the following information: Record 1 Name of this file, its table name, number of records in this file, path and name of the document that describes the data in this file, and name of principal investigator for these data.

Record 2 Path and filename of the previous data set, and path and filename of the next data set. (Path and filenames for files that contain another set of data taken at the same site on the same day.)

Record 3 Path and filename of the previous site, and path and filename of the next site. (Path and filenames for files of the same data set taken on the same day for the previous and next sites (sequentially numbered by SITEGRID_ID)).

Record 4 Path and filename of the previous date, and path and filename of the next date. (Path and filenames for files of the same data set taken at the same site for the previous and next date.)

Record 5 Column names for the data within the file, delimited by commas.

Record 6 Data records begin.

Each field represents one of the attributes listed in the chart in the *Data Characteristics Section* and described in detail in the TDF file. These fields are in the same order as in the chart.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

A data analysis and real time control of the system are facilitated by 2-dimensional and 3-dimensional displays of data.

Data Processing Sequence:

Processing Steps:

Not available at this revision.

Processing Changes:

None.

Calculations:

Special Corrections/Adjustments:

The energy and frequency of the outgoing pulse were monitored by mixing on a second detector a reflection of the transmitted pulse from an optical element with a beam split from the local oscillator. The processor acquired data from this pulse monitor during the first two range gates and then switched to the signal detector. Atmospheric velocities were corrected by any frequency offset detected by the pulse monitor.

Calculated Variables:

Not available.

Graphs and Plots:

None.

10. Errors:

Sources of Error:

The LIDAR measurements are subject to errors that should be considered. Any constant bias is inconsequential in the turbulence analysis because the turbulence quantities are computed relative to the measured average coefficients: A(0), which includes the effects of vertical wind and divergence; A(1), which is the northerly component of horizontal wind multiplied by the constant elevation angle.

The LIDAR measurements also suffer from random errors, partly caused by imperfect frequency control, and partly in common with all coherent systems using many randomly moving scatterers as targets.

Quality Assessment:

Data Validation by Source:

An unsolved issue was the stability of the reference frequency (against which the frequency of the returned pulse must be compared). This can lead to biases which at present, can be partially corrected by manual inspection of the data and the detection of "outliers".

Confidence Level/Accuracy Judgment:

The accuracy of individual radial velocity measurements is +/- 0.25 m^-1. This should result in experimental errors in the momentum flux of the order of 6.25 x 10^-2[m^2][s^-2], well below the typical values which lie in the range of -0.2[m^2][s^-2] to 2.5[m^2][s^-2].

Measurement Error for Parameters:

Although the LIDAR suffered non-trivial instrumental error in the velocity measurements (approximately 0.4[m^2][s^-2] variance), the self-cancellation inherent in the method made the effect on the flux parameters negligible.

Additional Quality Assessments:

Not available at this revision.

Data Verification by Data Center:

The data verification performed by the ORNL DAAC deals with the quality of the data format, media, and readability. The ORNL DAAC does not make an assessment of the quality of the data itself except during the course of performing other QA procedures as described below.

The FIFE data were transferred to the ORNL DAAC via CD-ROM. These CD-ROMs are distributed by the ORNL DAAC unmodified as a set or in individual volumes, as requested. In addition, the DAAC has incorporated each of the 98 FIFE tabular datasets from the CD-ROMs into its online data holdings. Incorporation of these data involved the following steps:

- Copying the entire FIFE Volume 1, maintaining the directory structure on the CD-ROM;
- Using data files, documentation, and SQL code provided on the CD-ROM to create a database in Statistical Analysis System (SAS); and
- Creating transfer files to transfer the SAS metadata database to Sybase tables.

Each distinct type of data (i.e. "data set" on the CD-ROM), is accompanied by a documentation file (i.e., .doc file) and a data format/structure definition file (i.e., .tdf file). The data format files on the CD-ROM are Oracle SQL commands (e.g., "create table") that can be used to set up a relational database table structure. This file provides column/variable names, character/numeric type, length, and format, and labels/comments. These SQL commands were converted to SAS code and were used to create SAS data sets and subsequently to input data files directly from the CD-ROM into a SAS dataset. During this process, file names and directory paths were captured and metadata was extracted to the extent possible electronically. No files were found to be corrupted or unreadable during the conversion process.

Additional Quality Assurance procedures were performed as follows:

- Statistical operations were performed to calculate minimum and maximum values for all numeric fields and to create a listing of all values of the character fields. During this process, it was determined that various conventions were used to represent missing values. (Note: no modifications were made to any data by the DAAC). In most cases, missing value identification conventions were discussed in the accompanying .doc file. Based on a visual check of the minimum and maximum values, no glaring errors or holes were identified that might indicate errors introduced during CD-ROM mastering by the FIFE project or data ingest by the DAAC.

- Some minor inconsistencies and typographical errors were identified in some of the character fields and column labels, however, no modifications were made to the data by the DAAC.
- Some conversions of ASCII data were necessary to move the data from a DOS platform to a UNIX platform. Standard operating system conversion utilities were used (e.g., dos2unix).
- Much of the metadata required for archival is imbedded in the narrative documentation accompanying the data sets and extracted manually by DAAC staff who have read the .doc files provided on the CD-ROM and have hand entered this information into the metadata database maintained by the DAAC. QA procedures have been performed on these metadata to identify and eliminate typographical errors and inconsistencies in naming conventions, to ensure that all required metadata is present, and to ensure the accuracy of file names and paths for retrieval.
- Data requested for distribution to users are checked to verify that files copied from disk to other media remain uncorrupted.

As errors are discovered in the online tabular data by investigators, users, or DAAC staff, corrections are made in cooperation with the principal investigators. These corrections are then distributed to users. CD-ROM data are corrected when re-mastering occurs for replenishment of CD-ROM stock.

11. Notes:

Limitations of the Data:

Not available.

Known Problems with the Data:

A small fraction of the data was lost due to offset in recording position angles.

Usage Guidance:

The variance due to instrumental error must be subtracted to determine wind vectors, so the LIDAR error must be determined accurately to avoid bias in the intensities. The main source of uncertainty in all turbulence parameters was the limited number of samples of the large eddies. This was the case in spite of averaging for 1 hour, covering an area by scanning in azimuth, and having rapid advection of eddies by 15 [m][s^-1] average winds. Doppler radars using this Velocity Azimuth Display technique can also apply this method to estimate the uncertainty in their flux and turbulence measurements.

Any Other Relevant Information about the Study:

The winds were obtained with the VAD (Velocity Azimuth Display) technique, which is explained in most books treating Doppler radar, (Battan 19xx). The LIDAR directly measures the radial (along-beam component of the wind as a function of range. When scanning 360 degrees in azimuth at constant elevation angle in a horizontally homogeneous wind field, the radial component at a single range varies sinusoidally with azimuth. The phase of the sinusoid gives the wind direction, and the amplitude reveals the speed (modified by the known elevation angle). We performed a least squares fit of a sinusoid to the data to average out the effects of turbulence and random instrument uncertainties over the VAD circle.

The profiles were obtained at irregular intervals. The LIDAR site was at 39 degrees 4 minutes 5 seconds north latitude and 96 degrees 32 minutes 21 seconds west longitude, which is near the intersection of highways I-70 and K-177; elevation was 446 m AGL. Winds are given in meteorological convention: 0 degrees from north and 90 degrees from east. Heights are in meters MSL. The LIDAR cannot operate within a minimum range of 500 m, so the wind profile begins somewhat above the surface. The vertical spacing depends on range gate spacing and elevation angle, which the operators varied from one VAD to another. Maximum height was set by signal/noise limitations or blockage by clouds. Data were edited to remove spurious values. Data in the planetary boundary layer are usually continuous, but gaps appear occasionally in profiles extending to several km. Profiles are unsmoothed, and the LIDAR's short pulse made adjacent data points almost independent.

Wind profiles can also be supplied on request for other times (between mid-morning and late afternoon) when the LIDAR engaged in intensive scanning for turbulence properties. These data sets are temporally intensive, typically with one wind profile per minute.

Some of the lost data were recoverable, and were restored and processed.

12. Application of the Data Set:

This data set can be used to derive unique 2-D and 3-D views of the Atmospheric Boundary Layer (ABL) structure, and the variations in that structure with time.

13. Future Modifications and Plans:

The FIFE field campaigns were held in 1987 and 1989 and there are no plans for new data collection. Field work continues near the FIFE site at the Long-Term Ecological Research (LTER) Network Konza research site (i.e., LTER continues to monitor the site). The FIFE investigators are continuing to analyze and model the data from the field campaigns to produce new data products.

14. Software:

Software to access the data set is available on the all volumes of the FIFE CD-ROM set. For a detailed description of the available software see the *Software Description Document*.

15. Data Access:

Contact Information:

ORNL DAAC User Services
Oak Ridge National Laboratory

Telephone: (865) 241-3952
FAX: (865) 574-4665

Email: ornldaac@ornl.gov

Data Center Identification:

ORNL Distributed Active Archive Center
Oak Ridge National Laboratory
USA

Telephone: (865) 241-3952
FAX: (865) 574-4665

Email: ornldaac@ornl.gov

Procedures for Obtaining Data:

Users may place requests by telephone, electronic mail, or FAX. Data is also available via the World Wide Web at http://daac.ornl.gov.

Data Center Status/Plans:

FIFE data are available from the ORNL DAAC. Please contact the ORNL DAAC User Services Office for the most current information about these data.

16. Output Products and Availability:

The Quick Look Boundary Layer Height data are available on FIFE CD-ROM Volume 1. The CD-ROM filename is as follows:

\DATA\ATMOS\LIDAR_HT\yyyyMULT.LHD

Note: capital letters indicate fixed values that appear on the CD-ROM exactly as shown here, lower case indicates characters (values) that change for each path and file.

The format used for the filenames is: *yyyyMULT.sfx*, where *yyyy* are the four digits of the century and year (e.g. 1987 and 1989). The filename extension (*.sfx*), identifies the data set content for the file (see the *Data Characteristics Section*) and is equal to .LHD for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

Hall, F.F. Jr., R.E. Cupp, R.M. Hardesty, T.R. Lawrence, M.J. Post, R.A. Richter, and B.F. Weber. 1987. Six Years of Pulsed-Doppler LIDAR Field Experiments at NOAA/WPL in Preprint Vol. 6th Symp. on Meteor. Observations and Instrumentation. Amer. Meteor. Soc. Boston. pp. 11-14.

Post, M.J., R.A. Richter, R.M. Hardesty, T.R. Lawrence, and F.F. Hall, Jr. 1982. National Oceanic and Atmospheric Administration's (NOAA) pulsed, coherent, infrared Doppler LIDAR-characteristics and data. SPIE Vol. 300 Physics and Technology of Coherent Infrared Radar. (1981). Soc. Photo-Opt. Instrumentation Engr. Bellingham, Washington. pp. 60-65.

Journal Articles and Study Reports.

Battan, L.J. 19xx. Radar Observation of the Atmosphere. University of Chicago. Press. 324pp.

Eberhard, W.L., R.E. Cupp, and K.R. Healy. 1989. Doppler LIDAR measurement of profiles of turbulence and momentum flux. J. Atmos. Oceanic Technol. 6:809-819.

Hall, F.F. Jr., R.M. Huffaker, R.M. Hardesty, M.E. Jackson, T.R. Lawrence, M.J. Post, R.A. Richter, and B.F. Weber. Wind Measurement Accuracy of the NOAA Pulsed Infrared Doppler LIDAR Applied Optics. Vol. 23 (1984). 2503-2506.

Gal-Chen, T., and R.A. Kropfli. 1984. Buoyancy and pressure perturbations derived from dual-Doppler radar observations of the planetary boundary layer: Applications for matching models with observations. J. Atmos. Sci. 41:3007-3020.

Kunkel, K.E., E.W. Eloranta, and J.A. Weinman. 1980. Remote determination of winds, turbulence spectra and energy dissipation rates in the boundary layer from LIDAR measurements. J. Atmos. Sci. 37:978-985.

Sellers, P.J., F.G. Hall, G. Asrar, D.E. Strebel, and R.E. Murphy. 1988. The First ISLSCP Field Experiment (FIFE). Bull. Am. Meteor. Soc. 69:22-27.

Sugita, M., and W. Brutsaert. 1990. Wind velocity measurements in the neutral boundary layer above hilly prairie. J. Geophys. Res. 95:7617-7624.

Archive/DBMS Usage Documentation.

Contact the EOS Distributed Active Archive Center (DAAC) at Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee (see the *Data Center Identification Section*). Documentation about using the archive and/or online access to the data at the ORNL DAAC is not available at this revision.

18. Glossary of Terms:

A general glossary for the DAAC is located at Glossary.

19. List of Acronyms:

ABL Atmospheric Boundary Layer AGL Above Ground-level CAPPI Constant Altitude Plan Position Indicator CD-ROM Compact Disk (optical), Read-Only Memory DAAC Distributed Active Archive Center DEC Digital Equipment Corporation EOSDIS Earth Observing System Data and Information System FIFE First ISLSCP Field Experiment FIS FIFE Information System ISLSCP International Satellite Land Surface Climatology Project LIDAR Light Detection and Range ORNL Oak Ridge National Laboratory T/R Transmit/Receive URL Uniform Resource Locator UTM Universal Transverse Mercator VAD Velocity Azimuth Display VIL Volume Image LIDAR

A general list of acronyms for the DAAC is available at Acronyms.

20. Document Information:

May 4, 1994.

Warning: This document has not been checked for technical or editorial accuracy by the FIFE Information Scientist. There may be inconsistencies with other documents, technical or editorial errors that were inadvertently introduced when the document was compiled or references to preliminary data that were not included on the final CD-ROM.

Previous versions of this document have been reviewed by the Principal Investigator, the person who transmitted the data to FIS, a FIS staff member, or a FIFE scientist generally familiar with the data.

Document Review Date:

August 30, 1996 (citation revised on October 3, 2002).

Document ID:

ORNL-FIFE_LIDAR_HT.

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