Mowing Experiment Exotech Data (FIFE)

Summary:

Light radiation striking a vegetative canopy interacts with individual phyto-elements (i.e., leaves, stems, branches) and the underlying substrate. The interaction depends on light quality, radiative form (direct or diffuse), illumination incidence angle, vegetative component optical properties and canopy architecture. Radiation is reflected, transmitted or absorbed. Mowing, grazing, and fertilization can affect the canopy architecture or optical properties of vegetation, thus changing the canopy reflectance.

This study examined the response of spectral reflectance characteristics (using an Exotech radiometer) to canopies that were manipulated using simulated grazing and fertilization of plots. The spectral reflectance data set supports the original hypothesis of a curvilinear relationship between productivity and grazing intensity. Reflectances for the four MSS bands and the standard error for each are reported. These data were collected at two locations within the northwest quadrant of the FIFE study area during the growing season of 1987.

Reflected radiation measurements were converted to radiances and reflectance factor. The reflectance factor is the ratio of the target reflected radiant flux to an ideal radiant flux reflected by an ideal Lambertian standard surface irradiated in exactly the same way as the target.

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1. Data Set Overview:

Data Set Identification:

Mowing Experiment Exotech Data (FIFE)
(Exotech Surface Reflectances for the Mowing Experiment).

Data Set Introduction:

The spectral reflectance data set supports the original hypothesis of a curvilinear relationship between productivity and grazing intensity. Reflectances for the four MSS bands and the standard error for each are reported. These data were collected at two locations within the northwest quadrant of the FIFE study area during the growing season of 1987.

Objective/Purpose:

The objective of this study was to determine effects of simulated grazing on canopy optical properties (reflectance).

Summary of Parameters:

Surface reflectance for the 4 MSS bands.

Discussion:

This study examined the response of spectral reflectance characteristics (using an Exotech radiometer) to canopies that were manipulated using simulated grazing and fertilization of plots. The spectral reflectance data set supports the original hypothesis of a curvilinear relationship between productivity and grazing intensity. Reflectances for the four MSS bands and the standard error for each are reported. These data were collected at two locations within the northwest quadrant of the FIFE study area during the growing season of 1987.

Related Data Sets:

- Vegetation Biomass, Production and Consumption at Selected Sites.
- Mowing Experiment Biophysical Measurements.
- Vegetation Species and Cover Abundance.
- Biophysical Properties of Vegetation.
- Root Biomass.

FIS Data Base Table Name:

MOW_EXOTECH_DATA.

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Tim R. Seastedt
University of Colorado

Title of Investigation:

The Influence of Grazing on Land Surface Climatological Variables.

Contact Information:

Contact 1:
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Contact 2:
Dr. Tim R. Seastedt
INSTAAR
University of Colorado
Boulder, CO
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Requested Form of Acknowledgment.

The Exotech Surface Reflectances for the Mowing Experiment data were collected by T.R. Seastedt and C.L. Turner of Kansas State University.

3. Theory of Measurements:

Light radiation striking a vegetative canopy interacts with individual phyto-elements (leaves, stems, branches) and the underlying substrate. The interaction depends on light quality, radiative form (direct or diffuse), illumination incidence angle, vegetative component optical properties and canopy architecture. Radiation is reflected, transmitted or absorbed.

Mowing, grazing, and fertilization can affect the canopy architecture or optical properties of vegetation, thus changing the canopy reflectance.

Reflected radiation measurements were converted to radiances and reflectance factor. The reflectance factor is the ratio of the target reflected radiant flux to an ideal radiant flux reflected by an ideal Lambertian standard surface irradiated in exactly the same way as the target.

4. Equipment:

Sensor/Instrument Description:

The Exotech four channel radiometer model 100BX produces analog voltage responses to scene radiance in 4 spectral bands. The 4 wavebands are approximately 0.5-0.6, 0.6-0.7, 0.7-0.8 and 0.8-1.1 um (Landsat MSS bands). The wavebands have silicon detectors. The Exotech's dimensions are 12.7 cm by 12.7 cm by 21.6 cm and weighs approximately 2.3 Kg. The Exotech was equipped with a 15 degree field-of-view.

Collection Environment:

Ground-based.

Source/Platform:

The Exotech was hand-held at shoulder height about 1 m above the ground, and directed toward the ground at an approximate nadir view.

Source/Platform Mission Objectives:

The aim of the procedure was to measure reflectance.

Key Variables:

Surface reflectance in 4 MSS bands.

Principles of Operation:

The Exotech four channel radiometer model 100BX produces analog voltage responses to scene radiance in 4 spectral bands. The Exotech consists of the following: 1) four silicon photodiodes mounted in the filter wells of the housing behind four composite filters, 2) four high sensitivity DC amplifiers, and 3) detachable optics which determine the field-of-view. The DC amplifiers are low-noise, field effect transistor input, operational amplifiers. The amplifiers are gain-switchable via the gain switches on the rear panel of the instrument. For further information consult the Exotech model 100BX instruction manual.

Sensor/Instrument Measurement Geometry:

The Exotech was hand-held at about 1 m above the soil surface with a 15 degree field-of-view and a spot size of approximately 0.22 m diameter at nadir.

Manufacturer of Sensor/Instrument:

Exotech Incorporated
1200 Quince Orchard Boulevard
Gaithersburg, Maryland 20878
(301) 948-3060

Calibration:

The instrument was calibrated with a barium sulfate panel.

Specifications:

Not available at this revision.

Tolerance:

The Exotech regression equations for radiance gains and offsets yield standard errors of estimates as follows:

Waveband #	Radiance Gains SEE*	Offset SEE*
1	1 E-5	4.2 E-4
2	2 E-5	11.9 E-4
3	3 E-5	19.0 E-4
4	4 E-5	36.2 E-4

* SEE = Standard Error of Estimate

Frequency of Calibration:

Not available at this revision.

Other Calibration Information:

None.

5. Data Acquisition Methods:

The Exotech was directed at the plots of interest with approximate nadir view. Many of the plots used were the same as in the Root Biomass, and the Mowing Experiment Biophysical Measurements on FIFE CD-ROM Volume 1.

In these experiments the intensity and frequency of grazing, burning and fertilization of the prairie were examined. Details of these experiments are outlined in the Mowing Experiment

Biophysical Measurements and the Vegetation Biomass Production and Consumption at Selected Sites data sets on FIFE CD-ROM Volume 1.

6. Observations:

Data Notes:

Not available.

Field Notes:

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:

All view zenith angles were measured with respect to gravity not in relation to the slope of the plot.

Below is a list of the FIFE sites for which Exotech data exists:

SITEGRID_ID	STATION_ID	NORTHING	EASTING	LATITUDE
1916-MOW	150	4330296	708270	39 05 56
2139-MOW	152	4329843	712789	39 05 37

LONGITUDE	ELEVATION	COLOCATED
-96 35 30	340	2,70,902
-96 32 23	385	31

Spatial Coverage Map:

Not available.

Spatial Resolution:

The footprint (surface area viewed by the Exotech) had a diameter of 0.22 m which was held at approximate nadir view during all measurements reported here. The plot size was approximately 0.1 square m.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

The overall time period of data acquisition was from May 30, 1987 through October 13, 1987 during the four FIFE IFCs in 1987.

Temporal Coverage Map:

Not available.

Temporal Resolution:

Four to 16 measurements were made in a day. Collection times were during daylight hours and ranged from 1332 to 2124 GMT.

Data Characteristics:

The SQL definition for this table is found in the MOW_EXO.TDF file located on 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 100 x 100 array of 200

meter square cells. The last 3 characters (III) are an instrument identifier.

STATION_ID
The station ID designating the location of the observations.

OBS_DATE
The date of the observations, in the format (DD-MMM-YY).

OBS_TIME
The time that the observation was taken in GMT. The format is (HHMM). [GMT]

MOW_DATE
The date of most recent mowing treatment.

MOW_HEIGHT
If this record is from the mowing height experiment, this column contains the mowed height of the vegetation in cm, otherwise this column is null. [cm]

MOW_FREQ
If this record is from the mowing frequency experiment, the value is the number of times the site was mowed up to the day of observation, otherwise this column is null.

FERTILIZER
If this record is from the brome sites of the mowing height experiment, this column tells if the site was fertilized, F for fertilized, N for no fertilizer, otherwise this column is null.

NUM_OBS
The number of observations used in the averages.

BAND1_MSS_AVG_REFL
The average reflectance from the
Multi-Spectral Sensor (MSS) in
band 1 (0.5-0.6 microns).

BAND2_MSS_AVG_REFL
The average reflectance from the
Multi-Spectral Sensor (MSS) in
band 2 (0.6-0.7 microns).

BAND3_MSS_AVG_REFL
The average reflectance from the
Multi-Spectral Sensor (MSS) in
band 3 (0.7-0.8 microns).

BAND4_MSS_AVG_REFL
The average reflectance from the
Multi-Spectral Sensor (MSS) in
band 4 (0.8-1.1 microns).

BAND1_MSS_ST_ERR
The standard error of the mean of
the reflectances from the
Multi-Spectral Sensor (MSS) in
band 1.

BAND2_MSS_ST_ERR
The standard error of the mean of
the reflectances from the
Multi-Spectral Sensor (MSS) in
band 2.

BAND3_MSS_ST_ERR
The standard error of the mean of
the reflectances from the
Multi-Spectral Sensor (MSS) in
band 3.

BAND4_MSS_ST_ERR
The standard error of the mean of
the reflectances from the
Multi-Spectral Sensor (MSS) in
band 4.

FIFE_DATA_CRTFCN_CODE **
The FIFE Certification Code for
the data, in the following format:
CPI (Certified by PI), CPI-???
(CPI - questionable data).

```
LAST_REVISION_DATE
data, in the format (DD-MMM-YY).
```

Footnotes:

A value of -9 means no data were collected.

** 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	MOW_DATE	MOW_HEIGHT	MOW_FREQ
1916-MOW	150	31-MAY-87	1958	29-MAY-87		
1916-MOW	150	31-MAY-87	1959	29-MAY-87		
1916-MOW	150	31-MAY-87	1959	29-MAY-87	5	
1916-MOW	150	31-MAY-87	2000	29-MAY-87	5	

FERTILIZER	NUM_OBS	BAND1_MSS_AVG_REFL	BAND2_MSS_AVG_REFL	BAND3_MSS_AVG_REFL
N	3	.0514	.0454	.2034
F	3	.0440	.0327	.2792
N	3	.0652	.0665	.1752
F	3	.0572	.0551	.1859

BAND4_MSS_AVG_REFL	BAND1_MSS_ST_ERR	BAND2_MSS_ST_ERR	BAND3_MSS_ST_ERR
.2749	.0010	.0034	.0070
.4336	.0011	.0011	.0098
.2417	.0014	.0040	.0114
.2684	.0043	.0045	.0089

BAND4_MSS_ST_ERR	FIFE_DATA_CRTFCN_CODE	LAST_REVISION_DATE
.0114	CPI	09-JUL-90
.0150	CPI	09-JUL-90
.0175	CPI	09-JUL-90
.0079	CPI	09-JUL-90

8. Data Organization:

Data Granularity:

Four to 16 measurements were made in a day. The surface area viewed by the Exotech had a diameter of 0.22 m. The plot size was approximately 0.1 square m.

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:

Conversion of voltage to radiance:

Ls(t,j),Lp(t1,j) or Lp(t2,j) = [V(t,j) - O(j)]/G(j) [1]

where
V(t,j) = waveband response at time *t* (volts)
j = wave band 1-4
G(j) = waveband gain [Volts][W^-1][m^-2][sr^-1][um^-1]
O(j) = waveband offset [Volts]
Ls(t,j), Lp(t1,j) or **Lp(t2,j)** = waveband spectral radiance for surface or reference panel at time *t*, *t1*, or *t2*[W][m^-2][sr^-1][um^-1]

Conversion of radiance to reflectance:

RF(t,j) = Ls(t,j)/ (Lp(t,j)/RFp(t,j)) [2]

where
Ls(t,j) = waveband surface radiance at time *t* [W][m^-2][sr^-1][um^-1]
RF(t,j) = waveband surface reflectance factor at time *t* (%)
RFp(t,j) = waveband reflectance factor for the reference panel at time *t* (%)
Lp(t,j) = band reference panel reflectance at time *t*.

Data Processing Sequence:

Processing Steps:

Not available at this revision.

Processing Changes:

Not applicable.

Calculations:

Special Corrections/Adjustments:

Not applicable.

Calculated Variables:

- Waveband spectral radiance for surface or reference panel at time *t*
- Waveband surface reflectance factor at time *t* (%)

Graphs and Plots:

None.

10. Errors:

Sources of Error:

- Precise height and view angle were not known, because the radiometer was hand-held.
- The data may not have been corrected for the imperfect Lambertian surface used for the calibration panel (i.e., imperfect reflector).
- Variable cloud cover could be a source of error since the incoming radiation measurements were not made simultaneously with the surface measurements.

Quality Assessment:

Data Validation by Source:

No information on data validation was provided by the investigator.

Confidence Level/Accuracy Judgment:

On days with variable cloud conditions the data should be used with caution. The AMS incoming solar radiation data at the site or nearby site should be consulted. On clear days the measurements fall within the precision of the instrument and errors that were discussed in previous sections.

Measurement Error for Parameters:

No quantitative assessment was made, see the *Confidence Level/Accuracy Judgment Section*.

Additional Quality Assessments:

FIS staff applied a general Quality Assessment (QA) procedure to the data to identify inconsistencies and problems for potential users. As a general procedure, the FIS QA consisted of examining the maximum, minimum, average, and standard deviation for each numerical field in the data table. An attempt was made to find an explanation for unexpected high or low values, values outside of the normal physical range for a variable, or standard deviations that appeared inconsistent with the mean. In some cases, histograms were examined to determine whether outliers were consistent with the shape of the data distribution.

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 data sets 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).
- 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 data set. 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:

None reported at the time of this revision.

Usage Guidance:

Before using reflectance factors the incoming radiation from the AMS station at a nearby site should be checked for possible cloud-induced error in reflectance factors.

Any Other Relevant Information about the Study:

None.

12. Application of the Data Set:

This data set can be used to study the effects of grazing on canopy optical properties (reflectance).

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 Exotech Surface Reflectances for the Mowing Experiment data are available on FIFE CD-ROM Volume 1. The CD-ROM filename is as follows:

\DATA\BIOLOGY\MOW_EXO\GRIDxxxx\ydddgrid.MEX

Where *xxxx* is the four digit code for the location within the FIFE site grid. 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: *ydddgrid.sfx*, where *grid* is the four-number code for the location within the FIFE site grid, *y* is the last digit of the year (e.g., 7 = 1987, and 9 = 1989), and *ddd* is the day of the year (e.g., 061 = sixty-first day in the year). The filename extension (.*sfx*), identifies the data set content for the file (see the *Data Characteristics Section*) and is equal to .MEX for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

Instruction manual: four channel radiometer Model 100BX. Exotech Incorporated. Gaithersburg, Maryland (1985).

Journal Articles and Study Reports.

Bauer, M.E., B.F. Robinson, C. Daughtry, and L.L. Biehl. 1981. Field Measurement Workshop. Oct. 14-16. Laboratory for application of Remote Sensing. Purdue University. Lafayette, Indiana.

Irons, J.R., R.A. Weismiller, and G.W. Peterson. 1989. Soil reflectance In G. Asrar (ed.). Theory and Applications of Optical Remote Sensing. John Wiley & Sons. New York. p.66-106.

Walter-Shea, E.A., J.M. Norman, and B.L. Blad. 1989. Bi-directional reflectance and transmittance in corn and soybean. Remote Sensing of Environment. 29:161-174.

Walter-Shea, E.A. and L.L. Biehl. 1990. Measuring vegetation spectral properties. Remote Sensing Review. 5:179-205.

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:

CD-ROM Compact Disk (optical), Read-Only Memory DAAC Distributed Active Archive Center EOSDIS Earth Observing System Data and Information System FIFE First ISLSCP Field Experiment FIS FIFE Information System ISLSCP International Satellite Land Surface Climatology Project KSU Kansas State University LTER Long Term Ecological Research Site, Konza Prairie MSS Multispectral Scanner ORNL Oak Ridge National Laboratory SEE Standard Error of Estimate SQL Structured Query Language URL Uniform Resource Locator UTM Universal Transverse Mercator

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

20. Document Information:

May 4, 1994 (citation revised on October 14, 2002).

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:

September 4, 1996.

Document ID:

ORNL-FIFE_MOW_EXO.

Citation:

Cite this data set as follows:

Seastedt, T. R. 1994. Mowing Experiment Exotech Data (FIFE). 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. doi:10.3334/ORNLDAAC/56. Also published in D. E. Strebel, D. R. Landis, K. F. Huemmrich, and B. W. Meeson (eds.), Collected Data of the First ISLSCP Field Experiment, Vol. 1: Surface Observations and Non-Image Data Sets. CD-ROM. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland, U.S.A. (available from http://www.daac.ornl.gov).

Document Curator:

DAAC Staff

Document URL:

http://daac.ornl.gov