Soil Moisture Data: Peck (FIFE)

Summary:

Water content measurements by gravimetric methods involve weighing a wet sample, removing the water via drying in an oven, and reweighing the sample to determine the amount of water removed. Water content then is obtained by dividing the difference between wet and dry masses by the mass of the dry sample to obtain the ratio of the mass of water to the mass of dry soil. When multiplied by 100, this becomes the percentage of water in the sample on a dry-mass (or, as often expressed, on a dry-weight) basis.

Soil moisture determined using the gravimetric method was measured at 800 sites along 24 transects. These transects were over flown by the airborne Gamma Radiation System used to measure soil moisture. These data are useful for comparison of airborne and ground soil moisture data. This analysis for the airborne Gamma Radiation System, using completely independent soil moisture data showed that the root mean square error of 97 flights was 3.02 percent soil moisture, with a bias of less than 0.5 percent soil moisture (Carroll et al., 1988).

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Soil Moisture Data: Peck (FIFE).
(Peck Gravimetric Soil Moisture Data Set).

Data Set Introduction:

The Peck Gravimetric Soil Moisture Data Set contains soil moisture information. Soil moisture measurements were made along 24 flight lines that were flown during the 1987 and 1989 FIFE IFC's. At each of approximately 800 locations, one or more samples were obtained for a 20 centimeter depth or less. The percentage of soil moisture by weight was then determined.

Objective/Purpose:

The objectives of this research were: 1) to obtain improved estimates of the soil moisture conditions for the FIFE experimental area during the period of Intensive Field Campaigns, and 2) to provide the information for validating and calibrating other remote sensing methods for measuring soil moisture.

Summary of Parameters:

Gravimetric soil moisture.

Discussion:

Soil moisture determined using the gravimetric method was measured at 800 sites along 24 transects. These transects were over flown by the airborne Gamma Radiation System used to measure soil moisture. Soil moisture measurements were collected during June and July 1987, and August 1989. These data are useful for comparison of airborne and ground soil moisture data. For example, using only ground soil moisture data from the CORE stations not used in calibration of the flight lines, average line values were computed for each flight line. These values were compared with the airborne estimates for all flight lines for all days. This analysis for the airborne Gamma Radiation System, using completely independent soil moisture data showed that the root mean square error of 97 flights was 3.02 percent soil moisture, with a bias of less than 0.5 percent soil moisture (Carroll et al., 1988).

Related Data Sets:

- Peck Airborne Gamma Ray Soil Moisture.
- Gravimetric Soil Moisture.
- Soil Moisture Contours. (Imagery Data)

FIS Data Base Table Name:

PECK_SOIL_MOISTURE_DATA.

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Eugene L. Peck
Hydex Corporation

Dr. Thomas Carroll
National Weather Service

Title of Investigation:

Gravimetric Soil Moisture for Gamma Ray Study.

Contact Information:

Contact 1:
Dr. Eugene L. Peck
Hydex Corporation
Vienna, VA
(703) 281-6284
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Contact 2:
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NRSHP, Office of Hydrology
NWS, NOAA
Minneapolis, MN
(612) 725-3039
FAX (612) 725-3338

Requested Form of Acknowledgment.

The assistance of the staff of the Kansas State University in the analysis of the ground samples collected for the Peck Gravimetric Soil Moisture data set is acknowledged. The field assistance rendered by Carrie Miller, in collecting ground soil moisture samples during FIFE 1989 was sincerely appreciated. The cooperation of Dr. Jim Wang, NASA, in providing transect gravimetric soil moisture measurements is greatly appreciated.

3. Theory of Measurements:

One effort in evaluating and using remotely sensed data has been that of determining the correlation between in situ measurements and remotely sensed measurements, and quantifying the added information value of the remotely sensed data. Moisture in the upper layers of the soil profile is an important portion of the total water balance of the earth-atmosphere system. Research has shown that remote sensing observations are sensitive to variations in soil moisture. In interpreting and applying remotely sensed moisture data to provide ancillary data that

complements hydrological observations, one must be conscious of the conceptual framework on which the interpretations are based.

Water content measurements by gravimetric methods involve weighing the wet sample, removing the water by drying in an oven, and reweighing the sample to determine the amount of water removed. Water content then is obtained by dividing the difference between wet and dry masses by the mass of the dry sample to obtain the ratio of the mass of water to the mass of dry soil. When multiplied by 100, this becomes the percentage of water in the sample on a dry-mass (or, as often expressed, on a dry-weight) basis.

Airborne soil moisture measurement is based on the difference between natural terrestrial gamma radiation flux measured for comparatively wet and dry soils. The presence of moisture in the soil causes an effective increase in the soil density resulting in an increased attenuation of the gamma flux for relatively wet soil and a correspondingly lower flux at the ground surface. The gamma flux from the ground is a function primarily of the water mass and radioisotopes concentration (which remains constant over time) near the surface.

4. Equipment:

Sensor/Instrument Description:

Apparatus required for gravimetric determination of water content may be used in many different forms, and so exact specifications are not needed. Requirements include an auger or sampling tube or some other suitable device to take a soil sample, soil containers with tight-fitting lids, an oven with means for controlling the temperature to 100 to 110 degrees Centigrade, a desiccator with active desiccant, and a balance for weighing the samples.

Collection Environment:

Ground.

Source/Platform:

Person on the ground.

Source/Platform Mission Objectives:

Determination of soil moisture content.

Key Variables:

Percent soil moisture.

Principles of Operation:

Differences in dry and wet weight of soil.

Sensor/Instrument Measurement Geometry:

Samples were obtained with a 2.54 cm cylindrical coring tube.

Manufacturer of Sensor/Instrument:

Arts Manufacturing
105 Harrison and Oregon Trail
American Falls, ID
83211

Calibration:

Specifications:

Soil core sampler specifications: diameter 2.54 cm.

Tolerance:

Not applicable.

Frequency of Calibration:

Not applicable.

Other Calibration Information:

Not available.

5. Data Acquisition Methods:

Gravimetric samples of the 0-20 cm were taken using a 2.54 core sampler, The total sample was put in a plastic can. Each sample was identified by the sample site ID code. In some cases more than one 0-20 cm measurement was taken. In other cases, samples of 0-10, and 10-20 cm were taken. After sampling, the cans were opened and weighed to obtain the wet weight. Open cans were placed in ovens at 105 degrees Centigrade for a minimum of 48 hours for drying, then they were weighed again to obtain the dry weight.

6. Observations:

Data Notes:

Not available.

Field Notes:

Descriptive information on the site was provided by the person making the soil moisture measurement.

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, 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:

Soil moisture measurements were made along 24 flight lines that were flown during the 1987 and 1989 FIFE IFC's. At each of approximately 800 locations, one or more samples were obtained for a 20 centimeter depth or less. The percentage of soil moisture by weight was then determined.

The locations (latitude and longitude) of the ground sampling points and information on the sampling sites are given in a file in the same directory as this document on FIFE CD-ROM Volume 1. See *Other Relevant Information* for more information on the sites.

Spatial Coverage Map:

Not available.

Spatial Resolution:

These were point data along flight line segments.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

Soil samples were collected during June and July of 1987, during the Intensive Field Campaigns (IFC) of approximately 2 weeks each, and during a final IFC from August 2 - August 10, 1989 as a follow-up effort.

Temporal Coverage Map:

Not available.

Temporal Resolution:

Soil moisture samples were obtained daily during the IFC's.

Data Characteristics:

The SQL definition for this table is found in the PECK_SM.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. FIS
Site grid codes (SSEE-III) give
the south (SS) and east (EE) cell
number in a 100 x 100 array of
200 m square cells. The last 3
characters (III) are an instrument
identifier.

STATION_ID
The three-digit FIFE site min = 601, FIS
identification number for the site max = 624
where the data were collected.

OBS_DATE
The date of the observations. min = 02-JUN-87,
KANSAS STATE
max = 09-AUG-89 UNIVERSITY

OBS_TIME
The time of day that the data min = 1339, [GMT]
KANSAS STATE
were collected, given as the max = 2050,
UNIVERSITY
midpoint of 30-minute average. missing = -999

SAMPLE_LOCN The identification number for the KANSAS STATE location of the sample. UNIVERSITY	min = 101, max = 210		
SOIL_MOISTURE_GRAVMTRC The gravimetric soil moisture for KANSAS STATE the top 20 centimeters. UNIVERSITY	min = 0, max = 46.03	[percent]	
SAMPLE_SITE_SLOPE The slope of the sample site. CLINOMETER max = 35, missing = -99	min = 0,	[degrees]	
SAMPLE_SITE_ASPCT_DIR The aspect direction of the KANSAS STATE sample site. UNIVERSITY WEST	min = EAST, max = WESTSOUTH		
SAMPLE_SITE_DESCR A description of the sample site, KANSAS STATE for example visual descriptions of UNIVERSITY the soil and vegetation.			
FIFE_DATA_CRTFCN_CODE The FIFE Certification Code for the data, in the following format: CPI (Certified by PI), CPI-??? (CPI - questionable data).	* CPI=checked by principal investigator		FIS
LAST_REVISION_DATE data, in the format (DD-MMM-YY).	max = 17-JAN-90		

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 that are "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    SAMPLE_LOCN
-----------    ----------  ---------    --------    -----------
3639-SMP          602      01-AUG-89      -999          138
3639-SMP          602      01-AUG-89      -999          137
3639-SMP          602      01-AUG-89      -999          136
3639-SMP          602      01-AUG-89      -999          135
     SOIL_MOISTURE_GRAVMTRC    SAMPLE_SITE_SLOPE  SAMPLE_SITE_ASPCT_DIR
----------------------    -----------------  ---------------------
37.710               20              SOUTHEAST
34.550               10              WEST
27.270               15              SOUTH
28.920                5              SOUTH
     SAMPLE_SITE_DESCR                                  FIFE_DATA_CRTFCN_CODE
-------------------------------------------       ---------------------
CLAY;GRS 15";2 4" CORES SHORT OF HY                  CPI
CLAY;GRS 2-4";2 4" CORES GULLY TO W                  CPI
CLAY;GRS 1-2";6" CORE                                CPI
CLAY;GRS 4-5";7" CORE NR LYDAR STA.                  CPI
     LAST_REVISION_DATE
------------------
16-JAN-90
16-JAN-90
16-JAN-90
16-JAN-90
```

8. Data Organization:

Data Granularity:

Soil moisture measurements were made along 24 flight lines that were flown during June and July of 1987 and during August 1989. At each of approximately 800 locations, one or more samples were obtained for a 20 centimeter depth or less.

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:

$$\text{Percent Water content} = \left[\frac{\text{weight of wet soil}}{\text{weight of dry soil}} - 1 \right] \times 100.$$

Data Processing Sequence:

Processing Steps:

Soil samples obtained in the field were placed in sealed plastic containers and taken to the field laboratory of the Kansas State University.

Processing Changes:

The soil sample were weighed to obtain the wet weight, placed in ovens at 105 degrees Centigrade for a minimum of 48 hours for drying, and then were weighed again to obtain the dry weight.

Calculations:

Percent soil moisture on a weight basis. Calculated according to the following formula:

100 X ((Wet wt. - Dry wt.)/(Dry wt.))

Special Corrections/Adjustments:

The method used is the standard for determination of the percent soil moisture on a weight basis and no special correction or adjustment are required.

Calculated Variables:

Percent soil moisture.

Graphs and Plots:

Not available.

10. Errors:

Sources of Error:

Errors could arise in water content measurements depending on the technique used to avoid absorption of water from the air during cooling and prior to weighing. Also, the time necessary to reach 'constant' weight will depend upon the type of oven used (forced- draft of convection type), the size or depth of the sample, the nature of the soil, and if the oven is loaded heavily or not.

Water content values for stony or gravely soils, both on a mass and volume basis, can be grossly misleading. The problem arises from the fact that a large rock can occupy appreciable volume in a soil sample and contribute appreciably to the mass without making a commensurate contribution to the porosity or water capacity of the soil.

Quality Assessment:

Data Validation by Source:

Ground soil moisture measurements were compared with other measurements made along the flight line the same day and with other available soil moisture measurements (primarily from CORE stations).

Confidence Level/Accuracy Judgment:

In 1989, the variation of gravimetric soil moisture values from day to day during the field campaign were plotted on graphs to check for anomalous data points. The results were discussed in the daily group meetings of FIFE investigators.

Measurement Error for Parameters:

Standard methods for sampling and determination of soil moisture by weight using the gravimetric technique were followed (Gardner 1986).

Additional Quality Assessments:

Many comparisons were made with the airborne gamma radiation soil moisture estimates and with the Pushbroom Microwave Radiometer (PBMR) measurements by Wang of NASA. The results indicate that the average of the soil moisture measurements along a flight line were reliable but no specific assessment of individual measurements were made.

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).
- 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:

There are no known problems with the ground soil moisture measurement made in support of the airborne gamma radiation project.

Usage Guidance:

This data set has been used in conjunction with other soil moisture data to validate the soil moisture values predicted by the airborne remote sensing instruments during FIFE. It could be used with caution in similar prairie landscapes to compare remote sensing derived soil moisture and field measured soil moisture.

Any Other Relevant Information about the Study:

The airborne gamma radiation soil moisture estimates have been used in conjunction with all other remote sensed and ground measurements to produce soil moisture contours (representing average soil moisture for an area of 0.5 km^2) for the FIFE research area. These isolines are available in the GRABBAG directory on FIFE CD-ROM Volume 1.

PECK_SITE_REF

Latitude and longitude for the transect segment end points and ground soil moisture sample locations are given. The following chart describes the column names, descriptions, ranges, units, and source for each of the fields that describe the location of information.

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 m square cells. The last 3 characters (III) are an instrument identifier.			FIS
STATION_ID The station ID designating the location of the observations.	min = 601, max = 624		HYDEX CORPORATION, VIRGINIA
LOCN_ID_NUM The identification number for the transect segment or ground sample point. Transect segments have numbers less than 100; ground samples have numbers greater than 100.	min = 1, max = 210		HYDEX CORPORATION, VIRGINIA
START_LAT The latitude of the start point of the segment.	min = 38 58 25, max = 39 7 22	[DEGREES MINUTES AEROCOMMANDER SECONDS]	NOAA
START_LON The longitude of the start point of the segment.	min = 96 27 30, max = 96 36 56	[DEGREES MINUTES AEROCOMMANDER SECONDS]	NOAA

```
END_LAT
The latitude of the end point of    min = 39 0 17,   [DEGREES      NOAA
the segment.                        max = 39 7 26     MINUTES
AEROCOMMANDER
SECONDS]
```

```
END_LON
The longitude of the end point of   min = 96 26 45,  [DEGREES      NOAA
the segment.                        max = 96 37 18    MINUTES
AEROCOMMANDER
SECONDS]
```

```
COMMENTS
Any comments about the data.                                        HYDEX
CORPORATION,
VIRGINIA
```

---

12. Application of the Data Set:

This data set provides information useful in validating and calibrating other remote sensing methods for measuring soil moisture.

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 Peck Gravimetrical Soil Moisture data are available on FIFE CD-ROM Volume 1. The CD-ROM file name is as follows:

\DATA\SOILMSTR\PECK_SM\Yyyyy\ydddgrid.PSM

Where *yyyy* are the four digits of the century and year (e.g., Y1987 = 1987). 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 .PSM for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

Gardner, W.H. 1986. Water content. p. 635-662. In: A. Klute (ed.) Methods of Soil Analysis. Part 1. Physical and mineralogical methods. 2nd ed. Agronomy Monogr. 9. ASA and SSSA. Madison, WI.

Carroll, T.R., and M. Allen. 1988. Airborne gamma radiation snow water measurements and soil moisture measurements and satellite areal extent of snow cover measurements: A user's guide. Version 3.0. Office of Hydrology. National Weather Service. Minneapolis, MN.

Journal Articles and Study Reports.

Carroll, T.R. 1981. Airborne soil moisture measurement using natural terrestrial gamma radiation. Soil Science. 132:358-366.

Carroll, T.R., and E.L. Peck. 1988. Airborne time-series measurements of soil moisture using terrestrial gamma radiation. Proc. Am. Congr. Sur. Map. and Am. Soc. for Photogram. & Rem. Sens. St. Louis, MO.

Peck, E.L., T.R. Carroll, and D.M. Lipinski. 1990. Airborne gamma radiation soil moisture measurements over short flight lines. Sym. on the First ISLSCP Field Experiment. Anaheim, CA. American Meteorological Soc. Boston, Massachusetts. p. 79-84.

Archive/DBMS Usage Documentation.

The Collected Data of the First ISLSCP Field Experiment is archived at the EOS Distributed Active Archive Center (DAAC) at Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee (see *Data Center Identification*). 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 ORNL Oak Ridge National Laboratory URL Uniform Resource Locator UTM Universal Transverse Mercator

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

20. Document Information:

May 9, 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:

February 18, 1996.

Document ID:

ORNL-FIFE_PECK_SM.

Citation:

cIte this data set as follows:

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Document Curator:

DAAC Staff

Document URL:

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