Gamma Ray Data: Peck (FIFE)

Summary:

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.

As part of the FIFE experiment, natural terrestrial gamma radiation data over a network of 24 flight lines were collected. The data acquisition procedure was designed to accumulate and store spectral radiation data along a flight line from which estimates of soil moisture could be computed. Ground-based soil moisture measurements were used to make a one-time calibration of the natural terrestrial radioisotope signal over the flight line network. A time-series of airborne soil moisture measurements (to a depth of 20 cm) was compared to an extensive, independent data set of ground-based soil moisture measurements. Estimates for flight line segments were found to have an average RMS error of approximately 2.5 % soil moisture (Peck et al., 1990).

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Gamma Ray Data: Peck (FIFE).
(Peck Airborne Gamma Ray Soil Moisture).

Data Set Introduction:

The Peck Airborne Gamma Ray Soil Moisture Data Set contains airborne soil moisture measurements. A time-series of airborne soil moisture measurements (to a depth of 20 cm) was compared to an extensive, independent data set of ground-based soil moisture measurements.

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:

Percent soil moisture.

Discussion:

As part of the FIFE experiment, natural terrestrial gamma radiation data over a network of 24 flight lines were collected in June and July 1987, and in August 1989. Ground-based soil moisture measurements were used to make a one-time calibration of the natural terrestrial radioisotope signal over the flight line network. A time-series of airborne soil moisture measurements (to a depth of 20 cm) was compared to an extensive, independent data set of ground-based soil moisture measurements. Airborne soil moisture measurements were made over the flight line network with an average bias of 1.7 percent, an average absolute error of 2.30 percent soil moisture, and a root mean square error of 3.02 percent soil moisture when compared to independent, ground-based soil moisture measurements for 97 airborne soil moisture observations (Carroll and Peck 1988). Estimates for flight line segments were found to have an average RMS error of approximately 2.5 % soil moisture (Peck et al., 1990).

Related Data Sets:

- Peck Gravimetric Soil Moisture.
- FIFE Level-3 Example Gridded Soil Moisture Data.
- Soil Moisture Contours. (Imagery Data)

FIS Data Base Table Name:

PECK_GAMMA_RAY_DATA.

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Eugene L. Peck
Hydex Corporation

Dr. Tom Carroll
National Weather Service, NOAA

Title of Investigation:

Alternative Approach to Ground Truth Soil Moisture.

Contact Information:

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Requested Form of Acknowledgment.

The assistance of the staff of the Kansas State University in the analysis of the ground samples in support of the Peck Airborne Gamma Ray Soil Moisture data 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 and supplying digital information on estimates of soil moisture by microwave (PBMR) has been greatly appreciated and contributed to the usefulness of the airborne gamma soil moisture estimates.

3. Theory of Measurements:

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. Only the mass of the moisture, not the phase, affects the attenuation. The gamma flux originates from the potassium, uranium and thorium radioisotopes in the soil. In a typical soil, 91 percent of the gamma radiation is emitted from the top 10 cm of the soil, 96 percent from the top 20 cm and 99 percent from the top 30 cm. Other sources of radiation, which contribute to the measured gamma flux, include the daughter products of radon gas in the atmosphere, high energy cosmic particles (i.e., greater than 3.0 MeV), and trace sources of radioactivity within the aircraft and the detection system itself (Carroll and Allen 1988).

4. Equipment:

Sensor/Instrument Description:

The airborne detector package consists of five downward-looking 10.2 x 10.2 x 40.6 cm NaI(Tl) scintillation detectors; two 10.2 x 10.2 x 20.3 cm, upward-looking detectors (used to isolate the effects of the random gas contribution); a pulse height analyzer (PHA); a Hewlett-Packard 9825 minicomputer used to reduce and record the output data onto magnetic tape; temperature, pressure, and radar altitude sensors; and a remote control unit used by the system operator or navigator to control and monitor the data collection (Carroll and Allen 1988).

Collection Environment:

Airborne.

Source/Platform:

A twin-engine Aero Commander aircraft.

Source/Platform Mission Objectives:

The mission objectives were as follows:

- To collect spectral gamma radiation information along established flight lines to provide estimates of the mean areal soil moisture.
- To distribute the soil moisture information to sections of flight lines.
- To collect extensive ground samples of soil moisture to adequately calibrate the flight lines.

Key Variables:

Soil moisture.

Principles of Operation:

Flight lines established for the FIFE investigation are, on average, 6.2 km long and 305 m wide. The airborne technique requires a one-time flight line calibration in which background gamma radiation data and ground-based soil moisture data are collected simultaneously and used to calibrate each flight line. Reliable, real-time, mean areal soil moisture measurements can be made for the upper 20 cm of soil over the average 1.9 square km flight line once both the background and current, uncollided terrestrial gamma count rates and background soil moisture data are available. Once a flight line is calibrated, airborne soil moisture measurements can be made with no future ground-based soil moisture data support required.

Sensor/Instrument Measurement Geometry:

The aircraft flies at an altitude of 150 m and measures natural terrestrial gamma radiation over a path 305 m wide. Consequently, radiation data collected over each flight line are mean areal measurements over approximately 1.9 km^2.

Manufacturer of Sensor/Instrument:

National Weather Service NOAA
Minneapolis, Minnesota.

Calibration:

Specifications:

Calibration is accomplished by collecting radiation data at different altitudes and using the changing airmass as an attenuation medium. A reliable calibration can be generated in one area and used in another with a different radioisotope concentration.

Tolerance:

The radioisotope concentration in the soil does not significantly change with time; consequently, there is no need for additional background data collection once a radiation spectrum has been collected for a particular flight line.

Frequency of Calibration:

The airborne technique requires a one-time flight line calibration in which background gamma radiation data and ground-based soil moisture data are collected simultaneously and used to calibrate each flight line. Once a flight line is calibrated, airborne soil moisture measurements can be made with no future ground-based soil moisture support required.

Other Calibration Information:

During the calibration procedure, stripping equations are derived for isolating other extraneous sources of radiation.

5. Data Acquisition Methods:

Twenty-four (24) flight lines were flown a number of times during the FIFE experiment. Ambient radiation data are collected by the detection system and immediately reduced using algorithms developed to describe the presence of atmospheric radon, high-energy cosmic radiation, Compton scattering effects within the radiation spectra, and extraneous background radiation contributed by the aircraft and detection system. Pressure, temperature, and radar altitude data are also recorded and used to calculate the attenuation of terrestrial radiation due to the air mass between the source and sensor (approx. 17 g cm^-2 at an altitude of 150 m).

6. Observations:

Data Notes:

Not available.

Field Notes:

Locations Of Flights Lines

Twenty-four flight lines were flown during the FIFE experiment (nineteen in 1987 and five additional ones in 1989). A general overview of the FIFE gamma-ray surveys showing a map of the 24 flight lines has been published (Peck et al., 1992). Each flight line is divided into a specific number (varying from 3 to 22) of equally spaced sections. The first section begins at the start of the flight line. A flight line may be a straight line or a series of straight line segments.

7. Data Description:

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 Characteristics:

Spatial Coverage:

Twenty-four flight lines were flown during the FIFE experiment (nineteen in 1987 and five additional ones in 1989). Each flight line is divided into a specific number (varying from 3 to 22) of equally spaced sections. Section One begins at the start of the flight line. The SITEGRID_ID gives the location of the start of each flight line. A flight line may be a straight line or a series of straight line segments. The exact location for the start of each flight is as listed below.

See the *Other Relevant Information Section* for more information on the location of the entire flight lines.

SITEGRID	STN_ID	NORTHING	EASTING	LATITUDE	LONGITUDE
0563-GRP	619	4333085	717545	39 07 18	-96 29 01
1930-GRP	620	4330223	711036	39 05 51	-96 33 35
2036-GRP	603	4329945	712150	39 05 41	-96 32 49
2714-GRP	605	4328561	707714	39 05 00	-96 35 55
2826-GRP	608	4328472	710145	39 04 55	-96 34 14
3014-GRP	611	4327913	707707	39 04 39	-96 35 56
3025-GRP	606	4328098	710035	39 04 43	-96 34 19
3126-GRP	607	4327854	710138	39 04 35	-96 34 15
3520-GRP	604	4327082	708956	39 04 11	-96 35 05
3527-GRP	609	4326998	710401	39 04 07	-96 34 05
3634-GRP	622	4326727	711828	39 03 57	-96 33 06
3639-GRP	602	4326844	712739	39 04 00	-96 32 28
3757-GRP	616	4326546	716499	39 03 47	-96 29 52
3830-GRP	621	4326457	710969	39 03 49	-96 33 42
3856-GRP	618	4326354	716264	39 03 41	-96 30 02
3907-GRP	601	4326241	706308	39 03 46	-96 36 56
3939-GRP	612	4326104	712735	39 03 36	-96 32 29
4041-GRP	617	4326085	713192	39 03 35	-96 32 10
4427-GRP	610	4325146	710403	39 03 07	-96 34 07
5110-GRP	613	4323729	707000	39 02 24	-96 36 30
5534-GRP	623	4322994	711832	39 01 56	-96 33 10
6562-GRP	615	4320926	717448	39 00 44	-96 29 19
6936-GRP	614	4320230	712292	39 00 26	-96 32 54
8749-GRP	624	4316628	714869	38 58 27	-96 31 11

The aircraft flew at an altitude of 150 m and measures natural terrestrial gamma radiation, on average, over a path 6.2 km long and 305 m wide.

Spatial Coverage Map:

Not available.

Spatial Resolution:

The data acquisition procedure is designed to accumulate and store spectral radiation data along a flight line from which estimates of soil moisture may be computed.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

Airborne gamma radiation data were collected during two periods, June 2 - 10, 1987 and August 1 - 10, 1989. Airborne measurements were made on the following dates:

August 1, 1989	
June 2, 1987	August 2, 1989
June 3, 1987	August 4, 1989
July 6, 1987	August 5, 1989
July 7, 1987	August 6, 1989
July 8, 1987	August 7, 1989
July 9, 1987	August 8, 1989
July 10, 1987	August 9, 1989
August 10, 1989	

Temporal Coverage Map:

Not available.

Temporal Resolution:

The data acquisition procedure is designed to accumulate and store window data in multiple cycles of 5 seconds or longer.

Data Characteristics:

The SQL definition for this table is found in the PECK_GAM.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 m square cells. The last 3 characters (III) are an instrument identifier.			FIS
STATION_ID	The three-digit FIFE site identification number for the site where the data were collected.	min = 601, max = 624		FIS

OBS_DATE The date on which the observation was made.	min = 03-JUN-87, max = 10-AUG-89		HYDEX CORP
DURATION The length of time it took to collect the data.	min = 10.8, max = 460	[sec]	HYDEX CORP
START_SEGMENT The identification number for the first transect segment the data is averaged over. If this column is null, then the average is over the entire transect.	min = 1, max = 21		HYDEX CORP
END_SEGMENT The identification number for the last transect segment the data is averaged over. Several segments may be averaged together if there are not enough data for a single segment average.	min = 1, max = 22		HYDEX CORP
NUM_SEGMENT The number of transect segments averaged together.	min = 1, max = 4		HYDEX CORP
SOIL_MOISTURE The soil moisture as determined from the gamma ray instrument. missing = -99.9 9 or -99.9	min = 8.22, max = 47.58,	[percent]	GAMMA RAY SENSOR
SOIL_MOISTURE_SDEV The standard deviation of the soil moisture. missing = -99	min = .4, max = 6.93,		HYDEX CORP
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 = 15-MAY-92		

Footnote:

* Decode the FIFE_DATA_CRTFCN_CODE field for the following:

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	DURATION	START_SEGMENT	END_SEGMENT
2036-GRP	603	03-JUN-87	33.500	1	1
3520-GRP	604	03-JUN-87	73.300	1	1
3639-GRP	602	03-JUN-87	44.100	1	1
3907-GRP	601	03-JUN-87	21.300	1	2

NUM_SEGMENT	SOIL_MOISTURE	SOIL_MOISTURE_SDEV	FIFE_DATA_CRTFCN_CODE	LAST_REVISION_DATE
1	31.420	4.150	CPI	08-JUN-93
1	25.690	2.110	CPI	08-JUN-93
1	35.940	1.510	CPI	08-JUN-93
2	-99.990	-99.000	CPI	08-JUN-93

8. Data Organization:

Data Granularity:

The Peck Airborne Gamma Ray Soil Moisture Data Set contains a time-series of airborne soil moisture measurements (to a depth of 20 cm) collected in June and July 1987, and in August 1989.

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:

Ambient radiation data collected by the detection system are reduced using algorithms to describe the presence of atmospheric radon, high energy cosmic radiation, Compton scattering effects within the radiation spectra, and extraneous background radiation. Pressure, temperature, and radar altitude data are also recorded continuously and used to calculate the attenuation of terrestrial radiation due to the airmass between the source and the sensor. Uncollided terrestrial radiation count rates, normalized to time and airmass, are used as the background and current gamma radiation data sets.

Data Processing Sequence:

Tapes of the airborne data are processed at the National Weather Service, Office of Hydrology, Minneapolis, MN with soil moisture estimates for flight lines determined.

Processing Steps:

The processed data from the National Weather Service were used to compute mean soil moisture values for the flight line sections.

Processing Changes:

Some soil moisture estimates for flight line sections were found during comparison studies to be unreliable and have been indicated in the table. The apparent reason for the unreliable estimates was that ground soil moisture samples were insufficient or not representative of the section during the calibration of the flight line.

Calculations:

Three independent soil moisture values are calculated by measuring the attenuation of the gamma flux as a consequence of increased (or decreased) soil density due to the presence of soil moisture. Soil moisture values are calculated using data from the potassium window (1.36 to 1.56 MeV), the thorium window (2.41 to 2.81 MeV) and the total energy spectrum (0.41 to 3.0 MeV). These independent soil moisture values are weighted (weighing values are dependent upon the airborne collection time for the flight line or section of a flight line) to obtain the values in the tables of airborne soil moisture.

Special Corrections/Adjustments:

Evaluation of the flight line soil moisture estimates have indicated that some of the section values are not reliable and these values have been noted. The FIFE_DATA_CRTFCN_CODE column for those data has been set to CPI-HIGH for soil moisture measurements that are higher than normal and to CPI-LOW for measurements that are lower than normal.

Calculated Variables:

Soil moisture.

Graphs and Plots:

Not available.

10. Errors:

Sources of Error:

Errors associated with the airborne percentage of soil moisture calculation stem from two principal sources: (1) the uncertainty of the background soil moisture data [M(0)], and (2) the uncertainty of the pure uncollided gamma count rates (i.e., background and current radiation data).

Because only a finite number of ground-based soil samples are available over a flight line, a degree of uncertainty is incorporated into the population mean soil moisture estimate [M(0)].

Quality Assessment:

Data Validation by Source:

A time-series of airborne soil moisture measurements (to a depth of 20 cm) is reported and compared to an extensive, independent data set of ground-based soil moisture measurements.

Confidence Level/Accuracy Judgment:

The accumulated ground soil moisture data base allows an estimate of the population soil moisture variance to be calculated with reasonable confidence. Using the estimate of the population variance, it is possible to calculate the number of ground soil samples required per flight line to estimate the population mean soil moisture for the flight line with a confidence interval of 95%.

Measurement Error for Parameters:

Airborne soil moisture measurements were made over the flight line network with an average bias of 0.48 percent soil moisture, a percent bias of 1.7 percent. This translates to an average absolute error of 2.30 percent soil moisture, and a root mean square error of 3.02 percent soil moisture when compared to independent, ground-based soil moisture measurements for 97 airborne soil moisture observations (Carroll et al. 1988). Soil moisture values for sections of flight lines had an RMS error of approximately 2.5 % (Peck et al. 1990).

Additional Quality Assessments:

The airborne gamma radiation soil moisture values have been compared with the CORE soil moisture measurements (Carroll et al. 1988), with the Pushbroom Microwave Radiometer (PBMR) measurements (Peck and Carroll 1991), and with estimates from water balance model for the Kings Creek basin (Peck and Carroll 1992).

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:

Discussed under other headings.

Usage Guidance:

Soil moisture estimates for the flight lines have been found to be reliable. Some of the estimated soil moisture values for segments of flight lines have been found to be unreliable when compared with other soil moisture estimates and measurements. These have been indicated in the FIFE_DATA_CRTFCN_CODE column.

The digitized Soil Moisture Contours that have been prepared and are in the GRABBAG section of FIFE CD-ROM Volume 1 are based on all available information on soil moisture for the FIFE research area and should be of value when mean area values are required. The contours values represent mean soil moisture for areas of 0.5 km^2.

Any Other Relevant Information about the Study:

Information on the National Weather Service airborne gamma system is available in the reference publications (Carroll 1987, and Carroll and Allen 1988).

The chart below describes the location information which is available for each of the transect segment end points and ground soil moisture sample locations used in the gamma ray soil moisture study. Column names and descriptions are listed below, along with ranges, units, and source for each column. The data associated with the table can be found in the document directory, along with this document.

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. CORPORATION, VIRGINIA	min = 601, max = 624		HYDEX
LOCN_ID_NUM The identification number for	min = 1,		HYDEX

the transect segment or ground sample point. Transect segments have numbers less than 100; ground samples have numbers greater than 100.	max = 210		CORPORATION, VIRGINIA
START_LAT The latitude of the start point of the segment.	min = 38 58 25, max = 39 7 22	[DEGREES MINUTES	NOAA AEROCOMMANDER SECONDS]
START_LON The longitude of the start point of the segment.	min = 96 27 30, max = 96 36 56	[DEGREES MINUTES	NOAA AEROCOMMANDER SECONDS]
END_LAT The latitude of the end point of the segment.	min = 39 0 17, max = 39 7 26	[DEGREES MINUTES	NOAA AEROCOMMANDER SECONDS]
END_LON The longitude of the end point of the segment.	min = 96 26 45, max = 96 37 18	[DEGREES MINUTES	NOAA AEROCOMMANDER SECONDS]
COMMENTS Any comments about the data.			HYDEX CORPORATION, VIRGINIA

12. Application of the Data Set:

The Peck Airborne Gamma Ray Soil Moisture data help provide information for 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 Airborne Gamma Ray Soil Moisture data set is contained on FIFE CD-ROM Volume 1. The CD-ROM file name is as follows:

\DATA\SOILMSTR\PECK_GAM\Yyyyy\ydddgrid.PGR

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.

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 of the year). The filename extension (.*sfx*), identifies the data set content for the file (see *Data Characteristics*) and is equal to .PGR for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

Carroll, T.R. 1987. Operational remote sensing of snow water equivalent and soil moisture in the United States using natural terrestrial gamma radiation. J. Int. Asso. Hydro. Sci. IAHS Pub. 166:213-223.

Journal Articles and Study Reports.

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Carroll, T.R., E.L. Peck, and D.M. Lipinski. 1988. Airborne time-series measurements of soil moisture using terrestrial gamma radiation. Proc. Ann. Conf. Am. Soc. Photogram. Remote Sens. St. Louis, Missouri.

Peck, E. L. 1992. Airborne Gamma Radiation Measurements of Soil Moisture During FIFE. Activities and Results. Hydex Final Report, NASA Contract NAS5-30959. April.

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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 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 IFOV Instantaneous Field of View ISLSCP International Satellite Land Surface Climatology Project NWS National Weather Service ORNL Oak Ridge National Laboratory PBMR Push Broom Microwave Radiometer PHA Pulse Height Analyzer URL Uniform Resource Locator UTM Universal Transverse Mercator A general list of acronyms for the DAAC is available at Acronyms.

20. Document Information:

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