Soil Moisture Release Data (FIFE)

Summary:

This data product was created based on the hypothesis that a variety of ground truth observations of soil moisture could be combined to estimate equal soil moisture contours across a large area (e.g., the FIFE area). A second stage required interpolating from these contours, using the methods of spatial statistics, to average soil moisture values at the nodes of a uniform grid. The grid node values in this product represent the average soil moisture of a 0.5 km x 0.5 km area centered at the node location.

The correlation area method (CAM) was used to combine in situ measurements and airborne gamma remote sensing estimates to obtain aerial averages of soil moisture. Information on biomass and the spatial distribution of vegetation in a model was also used to estimate soil moisture from PBMR measurements. Another simple method, using only ground soil moisture data, was also used to compute soil moisture from the PBMR measurements.

All soil moisture data collected from the aircraft platforms and ground measurements were entered into the ARC/INFO GIS along with the UTM coordinates of each observation. All available and usable measurements of soil moisture were considered in an analysis that produced isolines of soil moisture.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Soil Moisture Release Data (FIFE).
(FIFE Level-3 Example Gridded Soil Moisture Data).

Data Set Introduction:

This data product was created based on the hypothesis that a variety of ground truth observations of soil moisture could be combined to estimate equal soil moisture contours across a large area (e.g., the FIFE area). The grid node values in this product represent the average soil moisture of a 0.5 km x 0.5 km area centered at the node location.

Objective/Purpose:

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

Summary of Parameters:

Average values of soil moisture for 0.5 km x 0.5 km areas of the FIFE research area.

Discussion:

Soil moisture values were estimated for a grid of points located in the FIFE research area for 7 days in 1987 and 8 days in 1989. These grid point estimates are based on composite soil moisture maps prepared by combining data from several sources, including soil maps, point data, remote sensing, and model output products. The grid node values in this product represent the average soil moisture of a 0.5 km x 0.5 km area centered at the node location.

Related Data Sets:

- Peck Gravimetric Soil Moisture.
- Peck Airborne Gamma Ray Soil Moisture.
- Gravimetric Soil Moisture.
- Soil Moisture Transect.
- Neutron Probe Soil Moisture.
- Soil Properties Reference Information.
- Soil Impedance Measurements of Soil Moisture.
- Soil Moisture Contours. (Imagery Data)
- FIFE Level-3 Pushbroom Microwave Radiometer (PBMR) Soil Moisture Imagery. (Imagery Data)

FIS Data Base Table Name:

Not applicable.

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Allen Hope
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San Diego State University

Dr. Eugene L. Peck
Hydex Corporation

Title of Investigation:

Spatial Patterns of Soil Moisture for the FIFE Study Area Derived from Remotely Sensed and Ground Data.

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Requested Form of Acknowledgment.

The FIFE Level-3 Example Gridded Soil Moisture data were provided by Drs. A. Hope and E. Peck. The assistance of Dr. James Wang, NASA, in furnishing PBMR soil moisture data was sincerely appreciated. Thanks to the FIS staff, especially Fred Huemmrich, Diana van Elburg-Obler and Jeff Newcomer, for providing information in such usable form. Thanks also to Eric Wood, Princeton University, for providing soil moisture data in digital form for the Kings Creek Basin.

3. Theory of Measurements:

The study of interactions between land surfaces and the atmosphere requires the extrapolation of field measurements of surface biophysical variables, such as soil moisture and evapotranspiration, over large regions appropriate for characterizing the atmospheric boundary layer. Small sample size and high spatial variation usually combine to produce great uncertainty in estimated regional means for these variables.

This data product was created based on the hypothesis that a variety of ground truth observations of soil moisture could be combined to estimate equal soil moisture contours across a large area (e.g., the FIFE area). A second stage required interpolating from these contours, using the methods of spatial statistics, to average soil moisture values at the nodes of a uniform grid.

4. Equipment:

Sensor/Instrument Description:

The ARC/INFO geographic information system (GIS) was used in two phases of the map preparation.

Collection Environment:

Ground.

Source/Platform:

Computer GIS.

Source/Platform Mission Objectives:

The objective was to prepare gridded soil moisture data for the FIFE study area, and derive the spatial patterns of daily soil moisture over the study area during the IFC's using data collected from a variety of ground and airborne sources.

Key Variables:

Average percent soil moisture for 0.5 km x 0.5 km areas.

Principles of Operation:

All soil moisture data collected from the aircraft platforms and ground measurements were entered into the GIS along with the UTM coordinates of each observation. The observation values were plotted on a base map at the scale of 1:24,000 with data from different sources represented by different colors. The map was then analyzed to draw isolines of equal soil moisture content.

Sensor/Instrument Measurement Geometry:

Not available.

Manufacturer of Sensor/Instrument:

Not available.

Calibration:

Specifications:

Not available.

Tolerance:

Not available.

Frequency of Calibration:

ARC/INFO GIS accurately represents the input data to the limit imposed by the precision of the machine on which it is run. There are no routine calibration procedures.

Other Calibration Information:

None.

5. Data Acquisition Methods:

The gridded soil moisture values are derived from soil moisture contour maps (see FIFE CD-ROM Volume 1 for the soil moisture contour data). Measurements and estimates of soil moisture for the FIFE study area were obtained by the FIFE staff and investigators, who were members of the FIFE's soil moisture (SM) group using various sensors and estimating techniques. Several measurements and estimates were considered for use in the preparation of the soil moisture maps. Only those actually used are discussed briefly below. For more detail, see the documents on the FIFE CD-ROMs which describe each data set.

- Airborne Gamma Radiation Measurements:
    - The National Weather Service airborne gamma radiation system was used to measure soil moisture during FIFE 1987 and FIFE 1989. Data from 24 gamma radiation flight lines were used (19 from 1987 and 5 from 1989) to create the soil moisture maps. Soil moisture estimates for flight lines and flight line sections are available from the FIFE data collection. Documents describing these data are published on FIFE CD-ROM Volume 1.
    - Peck Airborne Gamma Ray Soil Moisture and Peck Gravimetric Soil Moisture.
- Staff In-Situ Ground Measurements:

    - Ground soil moisture samples were collected daily (during IFC's) by the FIFE staff at the flux and automatic meteorological measuring stations. Soil samples were obtained from five points at these stations, one at the center of the site and four at short distances along cardinal directions from the center. Soil samples for 0 to 5 cm and 5 cm to 10 cm soil depths were obtained at each of the five locations. The soil moisture values for the samples were determined by the gravimetric method (percent water by weight). Average values of soil moisture for the 0 to 10 cm depth were computed and used in the map analyses.
- Neutron Probe Measurements:
    - In situ measurements of soil moisture profiles were obtained by FIFE staff using neutron probes. Details on how and where the neutron probe data were collected is described in the NEUTRON PROBE DATA document (see FIFE CD-ROM Volume 1).
- PushBroom Microwave Radiometer (PBMR) Measurements:
    - PBMR measurements were obtained during the FIFE Intensive Field Campaigns by James Wang and others (Wang et al. 1990). Information on the PBMR flights and soil moisture measurements is on FIFE CD-ROM Volume 4. The PBMR flights were flown in an west-east orientation during 1987 and north-south during 1989. Estimated soil moisture values computed from the PBMR data, for all flights flown during 1987 and 1989, were used in creating these maps. The PBMR data were expressed as percent soil moisture for pixels approximately 15 m by 15 m.

6. Observations:

Data Notes:

Not available.

Field Notes:

All available and usable measurements of soil moisture were considered in the analyses that produced the isolines of soil moisture for each day's gridded moisture data. Peck and Carroll (1992) found that the soil moisture values determined by the hydrologic model application during 1987 did not adequately reflect soil moisture changes as indicated by staff and airborne gamma radiation measurements, hence, these estimates of soil moisture were not used in the soil moisture map analyses. Push Broom Microwave Radiometer (PBMR) soil moisture data from the NASA C-130 air-craft flights were obtained from a model for computing soil moisture estimates (Wang et al. 1990).

The method used to determine soil moisture estimates for sections of flight lines from the radiation data collected by the airborne gamma flights was presented by Peck et al. (1990) and details of the orientation and flight line numbers are in Peck et al. (1992).

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:

The gravimetric and neutron probe data used to create the soil moisture maps were point measurements. The PBMR was average soil moisture for pixels approximately 15 m by 15 m. The airborne gamma radiation system measures the average soil moisture over an area along a flight line rather than for a specific point on the line. The spatial coverage for the gamma radiation measurements was computed to be about 0.38 square km per flight line section. This coverage was based on a flight line width of approximately 305 m and the average length of a flight line section (1230 m).

The example gridded soil moisture data encompasses an area between 39 degrees 11 minutes 77 seconds and 38 degrees 99 minutes 6 seconds North latitude, and between 96 degrees 61 minutes 42 seconds and 96 degrees 44 minute 30 seconds West longitude.

Spatial Coverage Map:

Not available.

Spatial Resolution:

Average soil moisture values are calculated for a grid of points 1 km apart. The value at each node represents the average soil moisture for an area of 0.5 km x 0.5 km centered on the node point.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

These data were collected during the five IFCs, covering the period from June 2, 1987 through August 10, 1989. Digitized contour maps and example grid values are available for the following days in 1987 and 1989:

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

Temporal Coverage Map:

Not available.

Temporal Resolution:

One moisture map per day.

Data Characteristics:

Refer to the *Data Format Section* below.

Sample Data Record:

Not applicable to gridded data.

8. Data Organization:

Data Granularity:

The gravimetric and neutron probe data used to create the soil moisture maps were point measurements. The PBMR was average soil moisture for pixels approximately 15 m by 15 m. The spatial coverage for the gamma radiation measurements was computed to be about 0.38 square km per flight line section. This coverage was based on a flight line width of approximately 305 m and the average length of a flight line section (1230 m).

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

Data Format:

The uncompressed file structure is the same for both 9-track and CD-ROM products. The data are written to tape in their uncompressed form (described below). For publication on CD-ROM, these data files have been compressed using the FIS algorithm and format described below.

Uncompressed Format:

The basic FIFE level-3 example gridded soil moisture data product is described below. The files appear sequentially on magnetic tape; they will be accessible in any order on CD-ROM or other random access media.

FILE 1 (80 byte ASCII text records)

- Description of the level-3 product files
- Date of collection
- Grid size information
- Summary of geographic coverage
- Summary of soil moisture values
- The CD-ROM filename extension is .SM3.

FILE 2 (170 byte ASCII text records)

- ASCII records containing the gridded soil moisture values in percent.
- The values across the records are separated by blank spaces. Values of 999.99 were inserted where data values were missing. Each value represents the average soil moisture for a 0.5 km x 0.5 km area surrounding a grid node.
- The CD-ROM filename extension is .GSM.

FILE 3 (one 190 byte ASCII text record with 4 values)

- ASCII records containing the UTM northing coordinates for the four corners of the soil moisture image.
- The CD-ROM filename extension is .UTN.

FILE 4 (one 190 byte ASCII text record with 4 values)

- ASCII records containing the UTM easting coordinates for the four corners of the soil moisture image.
- The CD-ROM filename extension is .UTE.

FILE 5 (one 190 byte ASCII text record with 4 values)

- ASCII records containing the latitude coordinates for the four corners of the soil moisture image.
- The CD-ROM filename extension is .LAT.

FILE 6 (one 190 byte ASCII text record with 4 values)

- ASCII records containing the longitude coordinates for the four corners of the soil moisture image.
- The CD-ROM filename extension is .LON.

Note that more than one level-3 product most likely exists on any given level-3 product tape. When reading the data from tape be certain to start at the appropriate file (the summary file (FILE 1) is distinguishable by its 80 byte record length). Products on CD-ROM can be located by filename (see the *Output Products and Availability* and the *Data Format Section*). The decompression software (see below) will locate and unpack sets of files automatically.

Compressed Format and Procedure

The example gridded soil moisture data files were compressed before publication on Volume 5 of the FIFE CD-ROM series. The CD-ROM contains source code and executable files for a program (EXPAND) which unpacks the compressed data. The compressed data files have the following structure (the files are created in "stream" format with implicit record boundaries):

- Record 1 : Header record
- Record 2 : Record of column minima
- Records 3 - Z : Encoded sets of compressed data record information

The header record contains the following fields of information:

- Byte 1 (TOTAL_BITS) : The number of bits for each pixel in the original image data (i.e., 7, 8, 16, 32).
- Bytes 2 - 3 (NLINES) : The number of lines or records in the original file (low order byte first).
- Bytes 4 - 5 (NVALS) : The number of values per line of the original file (low order byte first).

The record of column minima contains NVALS values of the type designated by TOTAL_BITS. That is if :

- TOTAL_BITS = 7 ... there are NVALS 8 bit (ASCII) values in the record.
- TOTAL_BITS = 8 ... there are NVALS 8 bit (binary) values in the record.
- TOTAL_BITS = 16 ... there are NVALS 16 bit (binary) values in the record.
- TOTAL_BITS = 32 ... there are NVALS 32 bit (binary) values in the record.

These are the minimum values derived and subtracted from the respective original data matrix columns as the first step of the data compression. For TOTAL_BITS equal to 16 or 32, the two and four byte values, respectively, are stored with low order byte first.

Each original data record is represented by a set of records in the compressed data file. The first record contains a ROW_MINIMUM value, and an NBITS value. There are then NBITS records of encoded values that follow.

- ROW_MINIMUM : Stored as an 8 (ASCII), 8, 16, or 32 bit value depending on the respective value of TOTAL_BITS in the header record. This value was subtracted from each value in the original data record as the second step of the data compression.
- NBITS : Stored as an 8 bit value. Indicates the number of significant (information containing) bits that were left and encoded from the original data record after the column and row minimum values were subtracted. As noted, it also represents the number of encoded records that must be processed/read to reconstruct the original record.
- ENCODED DATA RECORDS: Series of NBITS records containing the encoded information in either run-length encoded or bit-encoded form (see below). The first encoded record contains the highest significant bit; the last contains the lowest.

- RUN-LENGTH ENCODED RECORD:
    - Byte 1 : Record type (= zero; 0) (designates that a run-length encoded record follows)
    - Byte 2 : First bit value for the segment
    - Bytes 3 - 4 : Number of subsequent run-length counts (NR)
    - Bytes 5 - 6 : Actual run-length-1 for first bit value of segment (low order byte first)
    - Bytes 7 - 8 : Actual run-length-1 for opposite bit value (low order byte first)
    - Bytes 9 - 10 : Actual run-length-1 for first bit value of segment (low order byte first)
    - Bytes 11- 12 : Actual run-length-1 for opposite bit value (low order byte first)
    - .
    - .
    - Bytes I - I+1 : Run-length for last set of segment bit values where,

      I = 2*NR + 3 (low order byte first).

- BIT ENCODED RECORD:
    - Byte 1 : Record type (= one; 1) (designates a bit-encoded record follows)
    - Byte 2 : Represents/contains bit settings for output data record pixels 1 to 8.
    - Byte 3 : Represents/contains bit settings for output data record pixels 9 to 16.
    - Byte 4 : Represents/contains bit settings for output data record pixels 17 to 24.
    - .
    - .
    - Byte J+1 : Represents/contains bit settings for the last set of output data record pixels in the record where

      J = NVALS/8 (if the number of pixels in the line is evenly divisible by 8)

      or J = NVALS/8 +1 (if the number of pixels in the line is not an even multiple of 8).

The type of encoded record used to represent the compressed information depends on the average run length of all the bits at a given bit position (B) across the original data record after the column and row minimum values were removed/subtracted. That is if the average run length for the bits in position B was greater than or equal to 8, less space was required to write the compressed information as a run-length encoded record. If the average run length for the bits in position B was less than 8, less space was required to pack the bits into bytes and output a bit encoded record.

9. Data Manipulations:

Formulae:

Derivation Techniques and Algorithms:

The correlation area method (CAM), developed by Johnson et al. (1982) and the program documented by Peck et al. (1984), were used to combine in situ measurements and airborne gamma remote sensing estimates to obtain aerial averages of soil moisture.

Wang et al. (1990) used information on biomass and the spatial distribution of vegetation in a model to estimate soil moisture (1987) from PBMR measurements. A simple method, using only ground soil moisture data, was used to compute soil moisture from the PBMR measurements in 1989 (Wang et al. 1992)

All soil moisture data collected from the aircraft platforms and ground measurements were entered into the ARC/INFO GIS along with the UTM coordinates of each observation. The observation values were plotted on a base map at the scale of 1:24,000 with data from each source represented by a different color. All available and usable measurements of soil moisture were considered in an analysis that produced isolines of soil moisture.

Data Processing Sequence:

Processing Steps:

Data points were hand plotted on a base map, then soil moisture contour lines were drawn on the base map. These contours were then digitized using a flat-bed digitizer and the ARC/INFO software. Each soil moisture contour was represented in a data file by the UTM coordinates of the digitized points. When all the contours on a single soil moisture map had been digitized, the GIS was used to regenerate the plot and the contours so they could be superimposed on the original maps to check for errors. The final step in the GIS processing entailed generating a grid of interpolated soil moisture values from the digitized contours.

FIFE staff reformatted and reorganized the product from Peck and Hope for a given day by:

1. Placing the soil moisture values in a spatial array format, tagged with UTM northings and eastings.
2. Using the UTM coordinates to calculate files of latitude and longitude coordinates.
3. Creating the ASCII header files from the processing in steps 1 and 2.
4. Writing the files to tape.

Processing Changes:

None.

Calculations:

Special Corrections/Adjustments:

The grid point values were obtained from the contour map using bivariate quintic interpolation.

Calculated Variables:

Not available.

Graphs and Plots:

None.

10. Errors:

Sources of Error:

The original moisture isolines were drawn by hand before they were digitized using the ARC/INFO software. This will introduce some errors in the data.

The original sources, namely PBMR, gamma radiation, and ground sampling, used for the soil moisture contour map preparation have inherent degrees of error, these errors are subsequently propagated in the final map.

The analyses of the maps were performed subjectively (visually). Although the experience of the person doing the analyses is very extensive in preparing isohyetal maps for different terrains and in the analyses of evaporation maps for the contiguous United States, human errors are inevitable.

Quality Assessment:

Data Validation by Source:

Peck and Hope (1993) regressed surface temperatures calculated from NS001 Thematic Mapper Simulator data on the NDVI, and produced a coefficient of determination of 0.678 which increased to 0.778 when gridded soil moisture values were included in the analysis (n=84). They examined soil moisture dynamics along transects corresponding to environmental or landscape gradients, and determined that changes in soil moisture during a five-day period was manifested and that the drying trend was evident for the days analyzed. The relationship between the mapped soil moisture and observed latent heat fluxes over the same five-day period, confirmed that the decrease in the evaporative fraction over this period appeared to relate directly to the observed soil moisture status.

Confidence Level/Accuracy Judgment:

The estimates of soil moisture from the different input sources have different relationships with the average value of the gridded soil moisture data. Studies previously completed by Wang and Shiue (1989), and Peck and Carroll (1991) reported on the comparisons of these different measurements and estimates of soil moisture. Additional simple comparisons among the various measurements (PBMR, gamma-ray, and ground soil moisture) and gridded estimates showed that accuracy of the intermediate soil moisture contour maps is within 2%.

Measurement Error for Parameters:

- Airborne Gamma Measurements:
  - Peck and Carroll (1991) compared the soil moisture estimates from the airborne gamma technique using 1987 and a few 1989 data with ground soil moisture. They found that the airborne gamma estimates correlated well with the ground data with average error of 3.1 percent and a bias of 0.1 percent.
- Microwave Measurements:
  - Average values for each 1.0 km^2 area were computed from the digitized information furnished by FIFE staff for the total area covered by the PBMR measurements for the following days in 1987 and 1989:

1987	Number of 1.0 km^2 areas	1989	Number of 1.0 km^2 areas
June 4	282	August 4	190
July 7	356	August 7	640
July 9	360	August 10	192

The number of 1.0 km^2 area values computed for each day are shown above. The actual number of areas were dependent on the height the PBMR sensors were flown and on the area covered by the flights.

The computed average 1.0 km^2 values were compared with the daily measurements at ground stations located in the same 1.0 km^2 areas. The PBMR 1987 estimates were found to have an average error of 6.3 percent and a bias of 6.5 percent. Most of the average error and bias of the PBMR estimates were as a result of high bias (8 to 9 percent) when the volumetric soil moisture was less than 25 percent.

Comparison of the average 1.0 km^2 values computed from the 1989 PBMR files furnished by FIS to the investigators indicated that for 16 areas when the microwave estimates for soil moisture were less than 25 percent, the bias was positive 4.4 percent. For 4 other areas, with microwave estimates greater than 25 percent, a negative bias of 4.8 percent was observed.

- Staff Ground Measurements:
  - The staff ground moisture values have been considered to be the most reliable and the most consistent set of soil moisture measurements for the FIFE area. As such, they have been used for comparison with other measurements. However, these measurements do not necessarily represent the average soil moisture value for an area surrounding the location where the measurements were obtained. The measurement locations, except during the very wet periods, generally had values that were lower than the average of soil moisture for the area surrounding the location. This was shown by Peck (1992) in the final report on the FIFE airborne gamma radiation studies.
  - Generally, the airborne soil moisture estimates for the FIFE flight lines, when correlated with the ground measured soil moisture, have a rms error of approximately 2.5% which is propagated in the final gridded soil moisture

product. Errors arising from other sources mentioned in *Errors Section* were not quantified.

Additional Quality Assessments:

Studies comparing measurements of the various estimates of soil moisture have shown that airborne gamma estimates correlated well with the ground measured soil moisture average error of 3.1 percent and a bias of 0.1 percent. The PBMR estimates for 1987 were found to have an average error of 6.3 percent and bias of 6.5 percent (Peck and Carroll 1991 and 1992). In addition, simple comparisons among the various measurements and estimates 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:

None.

Usage Guidance:

The user of the example gridded soil moisture data values must realize that the values represent mean values for a 0.5 km x 0.5 km area. Since the grid points are 1 km apart, the entire surface is not covered. Use of this data as if it were a continuous map would therefore be improper. Caution should be used in employing these data with models that assume a continuous surface or with raster-based image data.

This gridded soil moisture data is in compressed form on the CD-ROM. The data must be decompressed using the software on the CD-ROM before use.

Any Other Relevant Information about the Study:

Data Decompression Procedure

The EXPAND software has been provided to decompress the data discussed in the Compressed Format and Procedure subsection in the *Data Format Section*. During execution it considers several fields of the compressed data file which were stored as 16 or 32 bit values in low order byte first fashion (this is system-architecture byte-order dependent) and resolves this for the system being used to unpack the data. Note: This implies that data decompressed on one system will not be useable on another system which uses a different byte-order convention.

EXPAND executes the following steps in processing the specified files :

1. Verifies existence of file "EXPND_IN.LIS" in the directory from which EXPAND is being run.
2. Reads the list of files to be read and created as specified in EXPND_IN.LIS.
3. Verifies the existence of the input files specified in EXPND_IN.LIS.
4. Processes each input file based on whether it contains 8, 16, or 32 bit encoded data:

    a) Reads the header record of the file to determine whether the file contains 8, 16, or 32 bit encoded data.
    b) Calls the appropriate data type handling function which will :

        i) Read header record information and allocate needed memory.
        ii) Read record of column minimum values.
        iii) For each original data record,

            (a) Read the row minimum value for this data record.
            (b) Read number of bits (NBITS) encoded for this data record.
            (c) Determine the type of each encoded record and process it according to its type.
            (d) Add back in the respective row and column minimum values before writing the output record.

Several error messages may be encountered during data decompression. Most of these messages relate to errors in file handling (e.g., opening a file, closing a file, reading a file record, writing a file record). Some errors for memory allocation problems are also checked and reported accordingly. These messages have been made as explicit as possible to help in diagnosing the problem (if, in fact, it is user solvable). If you are unable to resolve an error, please report the error to the FIFE User Support Office.

12. Application of the Data Set:

Not available.

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 dataset 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:

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Oak Ridge National Laboratory

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Data Center Identification:

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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 FIFE Level-3 Example Gridded Soil Moisture Data could be made available on 4-mm, 8-mm, 6250 or 1600 BPI computer compatible tapes (CCT).

The FIFE Level-3 Example Gridded Soil Moisture Data are available on FIFE CD-ROM Volume 5. The CD-ROM file name is as follows:

\GRIDDED\SOIL_MST\YyyMmm\yyddd\yddd9999.sfx

Where *yy* is the last two digits of the year (e.g., Y87 = 1987), *mm* is the month of the year (e.g., Y87M06 = June 1987), and *ddd* is the day of the year (e.g., 061 = sixty-first day in the year). Note: capital letters indicate fixed values that appear on the CD-ROM exactly as shown here, lower case indicates characters that change for each path and file.

The format used for the filenames is: *yddd9999.sfx*, where *y* is the last digit of the year (e.g., 7 = 1987, and 9 = 1989), *ddd* is the day of the year, and *9999* replaces the usual *hhmm* (which are the hour and minutes (GMT) when the data were collected). The *hhmm* was replaced with *9999* to indicate that the file contains the whole day's data. The filename extension (*.sfx*) identifies the band or information content for the file. Hence, the filename format and content of these data on CD-ROM Volume 5 are:

- yddd9999.SM3 uncompressed descriptive ASCII header file
- yddd9999.GSM compressed example gridded soil moisture data
- yddd9999.UTN compressed UTM northing coordinates
- yddd9999.UTE compressed UTM easting coordinates
- yddd9999.LAT compressed Latitude file
- yddd9999.LON compressed Longitude file

17. References:

Satellite/Instrument/Data Processing Documentation.

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Wood, Eric F. 1990. Water Balance Model for Kings Creek. Sym. on the First ISLSCP Field Experiment (FIFE). Anaheim, CA. Amer. Meteorol. Soc. Boston, MA. Feb 7-9. p. 163-167.

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* above). 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:

ASCII American Standard Coded Information Interchange BPI Byte per inch CCT Computer Compatible Tape CD-ROM Compact Disk-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 GIS Geographic Information System GMT Greenwich Mean Time GSFC Goddard Space Flight Center ISLSCP International Satellite Land Surface Climatology Project NDVI Normalized Difference Vegetation Index ORNL Oak Ridge National Laboratory PBMR Push Broom Microwave Radiometer URL Uniform Resource Locator UTM Universal Transverse Mercator

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

20. Document Information:

May 12, 1994 (citation revised on October 15, 2002).

This document has been reviewed by the FIFE Information Scientist to eliminate technical and editorial inaccuracies. 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. It is believed that the document accurately describes the data as collected and as archived on the FIFE CD-ROM series.

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