# MMR Calibration Data (FIFE)

# Summary:

The MMR Calibration Data Set contains radiance data collected in the summer of 1987 and in July and August of 1989 via a Modular Multiband Radiometer (MMR) instrument. The MMR instrument monitored a nearly lambertian calibration panel stationed near the center of the FIFE study area. The radiances recorded from this instrument can be used to monitor solar insolation and clouds. In some cases, these data were also used to calculate the reflectance factor for reflective radiances measured over vegetation using other MMR instruments located at other FIFE sites or mounted on a helicopter.

# Table of Contents:



# 1. Data Set Overview:

### Data Set Identification:

MMR Calibration Data (FIFE)
(MMR Calibration).

### Data Set Introduction:

The MMR Calibration Data Set contains reflected radiance values from calibration panels (for MMR bands 1 through 8), adjusted for sun angle. The data were collected in the summer of 1987 and in July and August of 1989 via a MMR instrument.

### Objective/Purpose:

Not available at this revision.

### Summary of Parameters:

Reflected radiance values from calibration panels (for MMR bands 1 through 8), adjusted for sun angle.

### Discussion:

An MMR instrument monitored a nearly lambertian calibration panel stationed near the center of the FIFE study area. The radiances recorded from this instrument can be used to monitor solar insolation and clouds. In some cases, these data were also used to calculate the reflectance factor for reflective radiances measured over vegetation using other MMR instruments located at other FIFE sites or mounted on a helicopter. These data were collected in the summer of 1987 on six days, and in July and August of 1989 on 10 days.

### Related Data Sets:

- Surface Reflectance Measured with a Mast-borne MMR.
- Surface Reflectance Measured with a Helicopter-borne MMR.
- Leaf Optical Properties from UNL.
- Surface Radiant Temperature Measured with a Helicopter-borne Infrared Thermometer.
- Surface Temperatures from UNL.
- Surface Temperatures Measured at Multiple Angles.
- Incoming Longwave Radiation Data from UNL.
- Surface Temperatures, Reflected and Emitted Radiation, and PAR from UNL.
- SE-590 Spectroradiometer Reflectance Factors from GSFC.
- SE-590 Reflectance Factors and Radiances from UNL.
- SE-590 Reflectance Factors and Radiances Measured from a Helicopter.
- SE-590 Leaf Level Spectral Observations from GSFC.
- Site Reflectances Extracted from NS001 Imagery.
- Site Reflectances Extracted from Landsat TM Imagery.
- Site Reflectances Extracted from SPOT HRV Imagery.

### FIS Data Base Table Name:

MMR_CALIB_DATA.

## 2. Investigator(s):

### Investigator(s) Name and Title:

Staff Science.

### Title of Investigation:

Staff Science Calibration Program.

### Contact Information:

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**Contact 2:**
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College Park, MD
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cw@umail.umd.edu

### Requested Form of Acknowledgment.

The MMR Calibration data were collected by the staff of Kansas State University under the direction of the FIFE calibration scientist, B.L. Markham.

# 3. Theory of Measurements:

See the documents Surface Reflectance Measured with a Mast-borne MMR and Surface Reflectance Measured with a Helicopter-borne MMR for a description of the theory behind the operation of the MMR instrument.

# 4. Equipment:

### Sensor/Instrument Description:

See the documents Surface Reflectance Measured with a Mast-borne MMR and Surface Reflectance Measured with a Helicopter-borne MMR for a description of the MMR instrument.

#### Collection Environment:

See the *Sensor/Instrument Description Section*.

**Source/Platform:**

See the *Sensor/Instrument Description Section*.

**Source/Platform Mission Objectives:**

See the *Sensor/Instrument Description Section*.

**Key Variables:**

See the *Sensor/Instrument Description Section*.

**Principles of Operation:**

See the *Sensor/Instrument Description Section*.

**Sensor/Instrument Measurement Geometry:**

See the *Sensor/Instrument Description Section*.

**Manufacturer of Sensor/Instrument:**

See the *Sensor/Instrument Description Section*.

## Calibration:

See Markham 1987a, 1987b and 1987c for a complete description of the calibration for this data set. These documents have been scanned and are on FIFE CD-ROM Volume 1 in the Scanned Documents directory.

**Specifications:**

Changing the field-of-view will change the gains and offsets but will not change the temperature sensitivity coefficients.

**Tolerance:**

The absolute error in calibration is estimated to be approximately 5% in wavebands 1-4 and approximately 10% in wavebands 5-7 (Sellers et al., 1990). The error in the thermal waveband is + or - 0.5 C (Markham, 1987).

**Frequency of Calibration:**

**1987:**

Pre-season and post-season calibrations were supplemented by daily stability checks using a 30 cm integrating sphere (for the first 7 wavebands) and an Everest Model 1000 calibration source (for the thermal waveband). The optical and thermal detectors are known to be temperature sensitive. The calibration procedures and specifics can be found in Jackson et al. 1983; Markham 1987a, b & c; and Markham et al. 1988.

**1988:**

Only a post-season calibration was performed.

**1989:**

Daily stability checks were only performed during the IFC-5 period. The same basic procedures were performed as in 1987 with the following exceptions:

1. The 30 cm integrating sphere, operated at two lamp intensities, and Everest Model 1000 calibration source were located in an environmental chamber at the Kansas State Evapotranspiration Laboratory which was kept at a near constant ambient temperature during the daily stability checks,
2. Temperature sensitivity correction data for the optical detectors were only obtained when the chamber was not being used for stability checks (i.e. no pre- and post-season calibrations were performed). The other calibration procedures were performed pre- and post-season.

**Other Calibration Information:**

See the *Calibration Section*.

# 5. Data Acquisition Methods:

An MMR was mounted over a barium sulfate calibration panel maintained in a fixed location at station 16 (sitegrid = 4439) in 1987 and at stations 906, 916 and 966 (sitegrids 2133, 4439 and 2437, respectively) in 1989.

# 6. Observations:

## Data Notes:

Not available.

## Field Notes:

None.

# 7. Data Description:

## Spatial Characteristics:

The FIFE site 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 MMR and barium sulfate panel were placed at the following locations.

| SITEGRID | STN | NORTHING | EASTING | LATITUDE | LONGITUDE | ELEV | SLOPE | ASPECT |
|---|---|---|---|---|---|---|---|---|
| 2133-MMR | 906 | 4329726 | 711604 | 39 05 34 | -96 33 12 | 443 | 1 | TOP |
| 2437-MMR | 966 | 4329150 | 712375 | 39 05 15 | -96 32 41 | | | |
| 4439-MMR | 16 | 4325215 | 712794 | 39 03 07 | -96 32 28 | 445 | | |
| 4439-MMR | 916 | 4325193 | 712773 | 39 03 06 | -96 32 28 | 443 | 2 | N |

### Spatial Coverage Map:

Not available.

### Spatial Resolution:

This is point data.

### Projection:

Not available.

### Grid Description:

Not available.

## Temporal Characteristics:

### Temporal Coverage:

These data were collected on six days in the summer of 1987 and on ten days in July and August of 1989. Data were collected on the dates listed below.

| OBS_DATE | OBS_DATE |
|---|---|
| 06-JUN-87 | 28-JUL-89 |
| 11-JUL-87 | 04-AUG-89 |
| 15-AUG-87 | 06-AUG-89 |
| 16-AUG-87 | 07-AUG-89 |
| 17-AUG-87 | 08-AUG-89 |
| 11-OCT-87 | 09-AUG-89 |
| 26-JUL-89 | 10-AUG-89 |

27-JUL-89 11-AUG-89

**Temporal Coverage Map:**

Not available.

**Temporal Resolution:**

Spectra were collected about a minute apart during the afternoon.

## Data Characteristics:

The SQL definition for the table found in the MMR_CALB.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 the 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 station ID designating the location of the observations. | | | |
| OBS_DATE | The date of the observations, in the format (DD-mmm-YY). | | | |
| OBS_TIME | The time that the observation was taken in GMT. The format is (HHMM). | | | |
| SOLAR_ZEN_ANG | The solar zenith angle. | | [degrees] | |

| | |
|---|---|
| SOLAR_AZIM_ANG<br>The solar azimuth angle in degrees, with 0=north, 90=east, 180=south, and 270=west. | [degrees from North] |

| | |
|---|---|
| BAND1_RADNC_CAL<br>The Barnes MMR channel 1 (.45 - .52 microns) reflected radiance.<br>[ster^-1]<br>[mic^-1] | [Watts]<br>[meter^-1] |

| | |
|---|---|
| BAND2_RADNC_CAL<br>This field contains the Barnes MMR channel 2 (.51 - .60 micrometers) reflected radiance in watts/(m**2 sr micrometer). | [Watts]<br>[meter^-1]<br>[ster^-1]<br>[mic^-1] |

| | |
|---|---|
| BAND3_RADNC_CAL<br>The Barnes MMR channel 3 (.63 - .68 microns) reflected radiance.<br>[ster^-1]<br>[mic^-1] | [Watts]<br>[meter^-1] |

| | |
|---|---|
| BAND4_RADNC_CAL<br>The Barnes MMR channel 4 (.75 - .88 microns) reflected radiance.<br>[ster^-1]<br>[mic^-1] | [Watts]<br>[meter^-1] |

| | |
|---|---|
| BAND5_RADNC_CAL<br>The Barnes MMR channel 5 (1.17 - 1.33 microns) reflected radiance.<br>[ster^-1]<br>[mic^-1] | [Watts]<br>[meter^-1] |

| | |
|---|---|
| BAND6_RADNC_CAL<br>The Barnes MMR channel 6 (1.57 - 1.80 microns) reflected radiance.<br>[ster^-1]<br>[mic^-1] | [Watts]<br>[meter^-1] |

| | |
|---|---|
| BAND7_RADNC_CAL<br>The Barnes MMR channel 7 (2.08 - 2.37 microns) reflected radiance.<br>[ster^-1]<br>[mic^-1] | [Watts]<br>[meter^-1] |

BAND8_RADNC_CAL

| | |
|---|---|
| The Barnes MMR channel 8 (10.4 - 12.3 microns) reflected radiance. [ster^-1] [mic^-1] | [Watts] [meter^-1] |
| RADIANT_TEMP_CAL<br>The radiant temperature of the target. | [degrees Celsius] |
| CHOPPER_TEMP_CAL<br>The temperature of the chopper in the radiometer. | [degrees Celsius] |
| DETECTOR_TEMP_CAL<br>The detector temperature. | [degrees Celsius] |
| DATASET_ID<br>A unique identifier for a given spectra. | # |
| REMARKS<br>Other relavent information on the data. | |
| FIFE_DATA_CRTFCN_CODE<br>The FIFE Certification Code for the data, in the following format: CPI (Certified by PI), CPI-??? (CPI - questionable data). | * |
| LAST_REVISION_DATE<br>data, in the format (DD-mmm-YY). | |

Footnote:

# Use this field to link the spectra described here with those described in the Surface Reflectance Measured with a Mast-borne MMR and the Surface Reflectance Measured with a Helicopter-borne MMR data sets.

Decode the FIFE_DATA_CRTFCN_CODE field as follows: 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 | SOLAR_ZEN_ANG | SOLAR_AZIM_ANG |
|---|---|---|---|---|---|
| 4439-MMR | 16 | 06-JUN-87 | 1246 | 71.971 | 75.119 |
| 4439-MMR | 16 | 06-JUN-87 | 1247 | 71.783 | 75.260 |
| 4439-MMR | 16 | 06-JUN-87 | 1248 | 71.595 | 75.401 |
| 4439-MMR | 16 | 06-JUN-87 | 1249 | 71.407 | 75.542 |

| BAND1_RADNC_CAL | BAND2_RADNC_CAL | BAND3_RADNC_CAL | BAND4_RADNC_CAL |
|---|---|---|---|
| 109.18 | 121.90 | 117.57 | 89.06 |
| 110.63 | 123.45 | 119.02 | 90.00 |
| 111.89 | 124.82 | 120.30 | 90.82 |
| 113.15 | 126.19 | 121.42 | 91.63 |

| BAND5_RADNC_CAL | BAND6_RADNC_CAL | BAND7_RADNC_CAL | BAND8_RADNC_CAL |
|---|---|---|---|
| -9.99 | -9.99 | -9.990 | -9.990 |
| -9.99 | -9.99 | -9.990 | -9.990 |
| -9.99 | -9.99 | -9.990 | -9.990 |
| -9.99 | -9.99 | -9.990 | -9.990 |

| RADIANT_TEMP_CAL | CHOPPER_TEMP_CAL | DETECTOR_TEMP_CAL | DATASET_ID |
|---|---|---|---|
| -9.990 | -9.990 | -9.990 | CAL157K3 |
| -9.990 | -9.990 | -9.990 | CAL157K3 |
| -9.990 | -9.990 | -9.990 | CAL157K3 |
| -9.990 | -9.990 | -9.990 | CAL157K3 |

| REMARKS | FIFE_DATA_CRTFCN_CODE |
|---|---|
| NO THERMAL CALIBRATION POSSIBLE | CPI |
| NO THERMAL CALIBRATION POSSIBLE | CPI |
| NO THERMAL CALIBRATION POSSIBLE | CPI |
| NO THERMAL CALIBRATION POSSIBLE | CPI |

| LAST_REVISION_DATE |
|---|
| 10-JAN-94 |
| 10-JAN-94 |
| 10-JAN-94 |
| 10-JAN-94 |

# 8. Data Organization:

### Data Granularity:

These are point data collected during six days in the summer of 1987 and ten days in July and August of 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:

Not available at this revision.

### Derivation Techniques and Algorithms:

Not available at this revision.

## Data Processing Sequence:

### Processing Steps:

**CALIBRATION PANEL PROCESSING FOR THE MMR HELO DATA**

An MMR was mounted to continually view a barium sulfate panel (the Kansas State University #3 panel in 1987 and the University of Nebraska at Lincoln #2 panel in 1989). A measurement was automatically collected every minute during the helicopter flights. In the data processing the MMR voltage values from both the helicopter and calibration panel site were corrected to radiances. If detector voltages were recorded then the detector temperature (**Td**) was determined from the channel 10 voltage (**V10**):

**Td = (LOG(V10) - 1.9316) / (-.04446). [1]**

For each channel (**k**) the voltage (**Vk**) is adjusted for temperature effects as follows:

**V'k = ((Ck + Tc) / (Ck + Td)) * Vk [2]**

where:

**V'k** = adjusted voltage for channel **k**
**Ck** = temperature adjustment coefficient for channel **k**
**Tc**= calibration temperature.

The radiance for channel **k** (**Rk**) in is calculated as follows:

**Rk = ((V'k - Ok) / Gk) * 100. [3]**

where:

**Rk** = Radiance for channel **k** in [Watts] [m^-2][sr^-1][micrometer^-1]
**Gk** = Calibration gains for channel **k**
**Ok** = Offsets for channel **k**

If the detector temperature was not available, the voltage (**Vk**) was used in Equation 3 instead of the temperature adjusted voltage (**V'k**).

**Processing Changes:**

Not applicable.

### Calculations:

**Special Corrections/Adjustments:**

Not available at this revision.

**Calculated Variables:**

- Detector temperature (Td),
- Voltage (Vk), and
- Radiance for channel k (Rk).

### Graphs and Plots:

None.

## 10. Errors:

### Sources of Error:

Not available at this revision.

### Quality Assessment:

**Data Validation by Source:**

Comparisons have been made with the surface reflectances measured with the PARABOLA, the helicopter mounted radiometers, and the SE-590 surface and helicopter measurements.

**Confidence Level/Accuracy Judgment:**

On days with variable cloud conditions the data should be used with caution. The AMS incoming solar radiation data at the site or nearby site should be consulted.

On clear days the measurements fall within the precision of the instrument and errors that were discussed in previous sections.

In Markham (1987), Figures 6-12 shows the calibrated responses of the MMR instruments to the 30 cm integrating sphere kept at the Konza headquarters during FIFE. These measurements vary between instruments primarily because of the differences in the faceplates of the instruments (the instrument faceplates were placed flush with the sphere aperture thereby reflecting light back into the source). S/N 102 and 103 have flat black faceplates (identical paints), S/N 103 also had black plastic inserts screwed into the channel apertures (intended for mounting diffuser plates which were not used). S/N 117 had a white faceplate. S/N 128 had a white faceplate with the black plastic inserts. The black plastic inserts appear to be similar to the black paint in reflectance in the silicon portion of the spectrum (0.4-1.0 um) but brighter than the white paint in the SWIR portion of the spectrum. Table 8 presents the range of variability in corrected response to the sphere for 2 instruments, with and without temperature correction.

**Measurement Error for Parameters:**

Not available at this revision.

**Additional Quality Assessments:**

Not available at this revision.

**Data Verification by Data Center:**

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

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

- Copying the entire FIFE Volume 1, maintaining the directory structure on the CD-ROM;

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

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

Additional Quality Assurance procedures were performed as follows:

- Statistical operations were performed to calculate minimum and maximum values for all numeric fields and to create a listing of all values of the character fields. During this process, it was determined that various conventions were used to represent missing values. (Note: no modifications were made to any data by the DAAC). In most cases, missing value identification conventions were discussed in the accompanying .doc file. Based on a visual check of the minimum and maximum values, no glaring errors or holes were identified that might indicate errors introduced during CD-ROM mastering by the FIFE project or data ingest by the DAAC.
- Some minor inconsistencies and typographical errors were identified in some of the character fields and column labels, however, no modifications were made to the data by the DAAC.
- Some conversions of ASCII data were necessary to move the data from a DOS platform to a UNIX platform. Standard operating system conversion utilities were used (e.g., dos2unix).
- Much of the metadata required for archival is imbedded in the narrative documentation accompanying the data sets and extracted manually by DAAC staff who have read the .doc files provided on the CD-ROM and have hand entered this information into the metadata database maintained by the DAAC. QA procedures have been performed on these metadata to identify and eliminate typographical errors and inconsistencies in naming conventions, to ensure that all required metadata is present, and to ensure the accuracy of file names and paths for retrieval.
- Data requested for distribution to users are checked to verify that files copied from disk to other media remain uncorrupted.

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

# 11. Notes:

### Limitations of the Data:

Not available.

### Known Problems with the Data:

Not available at his revision.

### Usage Guidance:

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

### Any Other Relevant Information about the Study:

The filter characteristics of the MMR are described in Markham (1987 a, b, c) available on FIFE CD-ROM Volume 1 in the Scanned Documents directory.

## 12. Application of the Data Set:

The radiances recorded during this study can be used to monitor solar insolation and clouds.

## 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 MMR Calibration data are available on FIFE CD-ROM Volume 1. The CD-ROM filename is as follows:

\DATA\SUR_REFL\MMR_CALB\Yyyyy\ydddMULT.MRC

Where *yyyy* are the four digits of the century and year (e.g., 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: *ydddMULT.sfx*, where *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 .MRC for this data set.

## 17. References:

### Satellite/Instrument/Data Processing Documentation.

Barnes Engineering. 1982. Calibration and data book: Multispectral 8- channel radiometer, Barnes Engineering Company, Stamford, CT.

Jackson, R.D., D.A. Dusek, and E.E. Ezra. 1983. Calibration of the thermal channel on four Barnes model 12-1000 multi-modular radiometers. U.S. Water Conservation Laboratory Report 12, Phoenix, Arizona, pp. 75.

Jackson, R.D., S.M. Moran, P.N. Slater, and S.F. Biggar. 1987. Field calibration of reference reflectance panels. Remote Sens. Environ. 22:145-158.

Markham, B.L. 1987a. Memo on review of Phoenix calibration of MMR Channel 8. GSFC/NASA, Greenbelt, MD 20771.

Markham, B.L. 1987b. FIFE MMR Calibration Report. GSFC/NASA, Greenbelt, MD 20771.

Markham, B.L. 1989c. MMR Calibration data for FIFE 89 and related studies. GSFC/NASA, Greenbelt, MD 20771.

## Journal Articles and Study Reports.

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

Blad, B.L., E.A. Walter Shea, C.J. Hays, and M.A. Mesarch. 1990. Calibration of field reference panel and radiometers used in FIFE 1989. AgMet Progress Report 90-3. Dept. of Agricultural Meteorology, Univ. of Nebraska-Lincoln, Lincoln, Nebraska 68583-0728.

Markham, B.L., F.M. Wood, and S.P. Ahmad. 1988. Radiometric calibration of the reflective bands of NS001 Thematic Mapper Simulator (TMS) and Modular Multispectral Radiometers (MMR). Society of Photo-Optical Instrumentation Engineers Recent Advances in Sensors, Radiometers, and Data Processing for Remote Sensing 924:96-108.

Robinson, B.F., M.E. Bauer, D.P. DeWitt, L.F. Silva and V.C. Vanderbilt. 1979. Multiband radiometer for field research. Measurements of Optical Radiation, Proc. Soc. Photo-Optical Instrumentation Engr. 196:27-32.

Robinson, B.F., R.E. Buckley and J.A. Burgess. 1981. Performance evaluation and calibration of a modular multiband radiometer for remote sensing research. Proc. Soc. Photo-Optical Engineers 208:146- 157.

Sellers, P.J. and F.G. Hall. 1989. FIFE-89 Experiment Plan. GSFC/NASA, Greenbelt, MD 20771.

Sellers, P.J., F.G. Hall, D.E. Strebel, R.D. Kelly, S.B. Verma, B.L. Markham, B.L. Blad, D.S. Schimel, J.R. Wang, and E. Kanemasu. 1990. FIFE Interim Report. GSFC/NASA, Greenbelt, MD 20771.

Walthall, C.L., 1989. The FIFE Helicopter Mission: Summary. Laboratory for Global Remote Sensing Studies, Univ. of Maryland, College Park, MD.

Walthall, C.L. and E.M. Middleton, 1992. Assessing spatial and spectral variations in grasslands with the use of a helicopter platform. J. Geophys. Res. 97(17):18,905-18,912.

### Archive/DBMS Usage Documentation.

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

## 18. Glossary of Terms:

A general glossary for the DAAC is located at Glossary.

## 19. List of Acronyms:

AMS Automatic Meteorological Station DAAC Distributed Active Archive Center EOSDIS Earth Observing System Data and Information System FIFE First ISLSCP Field Experiment FIS FIFE Information System GMT Greenwich Mean Time IFOV Instantaneous Field of View IFC Intensive Field Campaign ISLSCP International Satellite Land Surface Climatology Project MMR Modular Multiband Radiometer ORNL Oak Ridge National Laboratory PAMS Portable Automatic Mesonet SWIR Shortwave Infrared URL Uniform Resource Locator

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

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