Wind Profile Data: Radiosonde (FIFE)

Summary:

The wind profile data described in this document were derived from the raw radiosonde data collected during FIFE by Dr. Wilfred H. Brutsaert during the summer and fall of 1987 and the late summer of 1989 The objective of this study was to calculate wind velocity and wind direction from successive horizontal positions of a radiosonde. These data have allowed the measurement of the atmospheric profiles of wind velocity and direction. The raw data have also been corrected for sensor delays and have been interpolated to a set of standard pressure levels.

Successive horizontal positions of the radiosonde balloon in relation to its release point was used to calculate average wind speed and direction. The variables used to make these calculations were obtained from the FIFE Radiosonde Data. The balloon height was calculated by adding 10 m (i.e., the length of the string) to the height of the sonde. The horizontal distance of the sonde, together with the measured azimuth angle (also obtained from the FIFE Radiosonde Data), produced the horizontal position of the sonde. Finally, successive horizontal positions allowed the calculation of average wind velocity and direction over the interval. Note, as a result of the addition of 10 m for most flights, the height of the wind measurements in this data set is 10 meters higher than the companion values in the original FIFE Radiosonde Data.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Wind Profile Data: Radiosonde. (FIFE)
(FIFE Radiosonde Wind Profiles).

Data Set Introduction:

This data set contains wind profile data derived from raw radiosonde data collected during FIFE by Dr. Wilfred H. Brutsaert in the boundary layer above a hilly prairie.

Objective/Purpose:

The objective of this study was to calculate wind velocity and wind direction from successive horizontal positions of a radiosonde.

Summary of Parameters:

Wind velocity and direction.

Discussion:

Intensive radiosonde flights, carried out by Dr. Wilfred H. Brutsaert during the summer and fall of 1987 and the late summer of 1989 have allowed the measurement of the atmospheric profiles of wind velocity and direction. The wind profile data described in this document was derived (corrected for algorithm inconsistencies) from the raw radiosonde data (FIFE Radiosonde Data) collected during FIFE by Dr. Wilfred H. Brutsaert. The raw data have also been corrected for sensor delays (FIFE Temperature and Humidity Profiles) and have been interpolated to a set standard pressure level (FIFE Standard Pressure Level Radiosonde Data). These other data sets are described separately.

Related Data Sets:

- FIFE Radiosonde Data.
    - This data set contains Dr. Brutsaert's actual (raw) radiosonde observations.
- FIFE Standard Pressure Level Radiosonde Data.
    - This data set contains temperature and humidity values at standard levels (5 mb intervals) derived from Dr. Brutsaert's raw radiosonde data.
- FIFE Temperature and Humidity Profiles.
    - This data set contains corrected temperature and humidity profile data derived from Dr. Brutsaert's radiosonde measurements.

FIS Data Base Table Name:

WIND_PROFILE_SONDE_DATA

2. Investigator(s):

Investigator(s) Name and Title:

Dr. Wilfred H. Brutsaert
School of Civil and Environmental Engineering

Title of Investigation:

Radiosonde analysis of wind velocity measurements in the boundary layer above a hilly prairie.

Contact Information:

Contact 1:
Dr. Wilfred H. Brutsaert
Cornell University
Tel.: (607) 255-3676
Email: whb@cornella.cit.cornell.edu (Internet)

Requested Form of Acknowledgment.

The FIFE Radiosonde Wind Profiles were collected by a team from Cornell University directed by Prof. W. Brutsaert.

3. Theory of Measurements:

The wind velocity data in the FIFE Radiosonde Data were calculated by means of an algorithm (developed by the manufacturer) involving the radius of the Earth, the curvature of the surface, etc. This algorithm is correct but produces wind speeds and directions with a large degree of noise and scatter. Therefore, Dr. Brutsaert decided to re-calculate average wind velocity and direction in a simpler way for a flat Earth. This new method used successive horizontal positions of the radiosonde balloon in relation to its release point to calculate average wind speed and direction. The variables used to make these calculations were obtained from the FIFE Radiosonde Data.

4. Equipment:

Sensor/Instrument Description:

See the document entitled FIFE Radiosonde Data for details on the instrumentation used to collect the original data used here.

Calibration:

See the document entitled FIFE Radiosonde Data for details on the calibration of the original data used to generate the data set described here.

5. Data Acquisition Methods:

The Wind Profile Sonde data was calculated from the FIFE Radiosonde Data on FIFE CD-ROM Volume 1.

6. Observations:

Not available.

7. Data Description:

Spatial Characteristics:

The FIFE study area, with areal extent of 15 km by 15 km, is located south of the Tuttle Reservoir and Kansas River, and about 10 km from Manhattan, Kansas, USA. The northwest corner of the area has UTM coordinates of 4,334,000 Northing and 705,000 Easting in UTM Zone 14.

Spatial Coverage:

The Wind profile sonde data were calculated from radiosonde data collected from balloon releases at the FIFE site listed below:

SITEGRID_ID	SN_ID	NORTHING	EASTING	LATITUDE	LONGITUDE	ELEV
0928-RSB	102	4332188	710674	39 06 55	-96 33 48	342

The spatial coverage varies with the flight. It depends upon the horizontal distance and direction the sonde has traveled from the launch site.

Spatial Coverage Map:

Not available.

Spatial Resolution:

Resolution for the measurements are about 15 to 20 meter.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

The data were collected during the five IFC's, covering the period from May 25, 1987 through August 12, 1989.

IFC	Dates
IFC-1	05/26/87 - 06/06/87
IFC-2	06/25/87 - 07/11/87
IFC-3	08/06/87 - 08/21/87
IFC-4	10/05/87 - 10/16/87
IFC-5	07/24/89 - 08/12/89

Temporal Coverage Map:

Not available.

Temporal Resolution:

The soundings were made at 2 to 3 hour intervals, depending on weather conditions.

Data Characteristics:

The SQL definition for this table is found in the WIND_SON.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			FIS

cells. The last 3 characters (III) are an instrument identifier.			
STATION_ID The station ID designating the location of the observations.	min = 102, max = 103		FIS
OBS_DATE The date of the observations. max = 12-AUG-89	min = 25-MAY-87,		FIS
START_TIME The time that this radiosonde flight was started. missing = -9999	min = 30, max = 2355,	[GMT]	FIS
FLIGHT_NUM This is the flight number of the radiosonde balloon flight where the data was recorded.			FIS
EAST_WEST_OFFSET The east/west offset from the starting location. East is positive. West is negative.	min = -6142, max = 17730	[meters]	FIS
NORTH_SOUTH_OFFSET The north/south offset from the starting location. North is positive, South is negative.	min = -9969, max = 15087	[meters]	FIS
HEIGHT_ABV_MEAN_SEA_LVL The height above mean sea level for each observation.	min = 340, max = 11397.32	[meters]	FIS
WIND_SPEED The average speed of the wind in this 30 minutes.	min = 0, max = 360	[meters] [sec^-1]	FIS
WIND_DIR The direction from which the wind is blowing, measured in degrees from north.	min = .026, max = 359.924	[degrees]	FIS
FIFE_DATA_CRTFCN_CODE The FIFE Certification Code for the data, in the following format:	* CPI - checked by primary investigator		FIS

```
CPI (Certified by PI),
CPI-???  (CPI - questionable data).
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```
LAST_REVISION_DATE
data, in the format (DD-MMM-YY).       max = 26-JUL-90
```

Footnote:

* Valid levels

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 is "merged" from two separate receiving stations to eliminate transmission errors. CPI-??? Investigator thinks data item may be questionable.

Sample Data Record:

SITEGRID_ID	STATION_ID	OBS_DATE	START_TIME	FLIGHT_NUM	EAST_WEST_OFFSET
0928-RSB	102	25-MAY-87	2354	1	3
0928-RSB	102	25-MAY-87	2354	1	
0928-RSB	102	25-MAY-87	2354	1	6
0928-RSB	102	25-MAY-87	2354	1	10

NORTH_SOUTH_OFFSET	HEIGHT_ABV_MEAN_SEA_LVL	WIND_SPEED	WIND_DIR
134	375.5000	.0000	181.2000
167	415.0000	6.7000	175.3000
215	443.0000	12.1000	187.1000
271	471.0000	11.2000	183.8000

FIFE_DATA_CRTFCN_CODE	LAST_REVISION_DATE
CPI	04-JUN-90
CPI	04-JUN-90
CPI	04-JUN-90
CPI	04-JUN-90

8. Data Organization:

Data Granularity:

The wind profile data contained in this data set was derived from the raw radiosonde data collected during FIFE by Dr. Wilfred H. Brutsaert. The raw data have also been corrected for sensor delays and have been interpolated to a set standard pressure level.

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:

Dr. Brutsaert calculated wind velocity and direction by obtaining horizontal distance between the sonde and the release point. This distance was obtained from the elevation angle measured by the optical theodolite and from the balloon height. Dr. Brutsaert, re-calculated the height, and humidity (see the *Special Corrections/Adjustments Section* for details) for details. The balloon height was calculated by adding 10 m (the length of the string) to the height of the sonde. The horizontal distance of the sonde, together with the measured azimuth angle (also obtained from the FIFE Radiosonde Data), produced the horizontal position of the sonde. Finally, successive horizontal positions allowed the calculation of average wind velocity and direction over the interval. Note as a result of this addition of 10 m for most flights, the height of the wind measurements in this data set is 10 meters higher than the companion values in the original FIFE Radiosonde Data.

Data Processing Sequence:

Processing Steps:

1. Pressure, temperature, dry-bulb temperature and wet-bulb temperature data were obtained from FIFE Radiosonde Data set.
2. Corrections were made for sensor delays (see the FIFE Radiosonde Data document for details).

3. The height of radiosonde instrument was re-calculated (see the *Special Corrections/Adjustments Section* for details).
4. The balloon height was calculated.
5. The elevation angle and azimuth angle (of balloon) were obtained from the original FIFE Radiosonde Data set.
6. The horizontal distance of the balloon from release point was calculated using elevation angle and balloon height.
7. The horizontal position of balloon was calculated using horizontal distance and azimuth angle.
8. The wind velocity and direction was calculated from successive horizontal positions.

Processing Changes:

None.

Calculations:

Special Corrections/Adjustments:

The height of the sonde was re-calculated from the pressure, temperature (obtained from the FIFE Radiosonde Data) and humidity (derived from the time shifted dry-bulb temperature and wet-bulb temperature data, see the FIFE Radiosonde Wind Profiles document for details). It should be noted that these "improved" heights, as listed in the FIFE Temperature and Humidity Profiles, are not very different (except for the conversion from height above ground level to height above sea level) from those listed in the FIFE Radiosonde Data so that it should be easy to recover the original pressures (which are not listed here) from the FIFE Radiosonde Data.

Calculated Variables:

The following variables were calculated:

- Height of the sonde,
- Balloon height,
- Horizontal distance of balloon from release point,
- Horizontal position of balloon, and
- Wind velocity and direction.

Graphs and Plots:

None.

10. Errors:

Sources of Error:

Not available at this revision.

Quality Assessment:

Data Validation by Source:

Not available at this revision.

Confidence Level/Accuracy Judgment:

Not available at this revision.

Measurement Error for Parameters:

Not available at this revision.

Additional Quality Assessments:

FIS staff applied a general QA procedure to the data to identify inconsistencies and problems for potential users. As a general procedure, the FIS QA consisted of examining the maximum, minimum, average, and standard deviation for each numerical field in the data table. In some cases, histograms were examined to determine whether outliers were consistent with the shape of the data distribution. Inconsistencies and problems found in the QA check are described in the *Known Problems with the Data Section*.

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:

As of the revision data of this document, the following discrepancies or errors in the data have been reported:

1. On June 27, 1987 some observation times are missing (encoded as -9999). The FIS staff did not receive observation time, so a missing flag was entered.
2. For more information on known problems with the data see the document which describes the FIFE Radiosonde Data.

Usage Guidance:

These data are useful for the study of the atmospheric boundary layer.

Any Other Relevant Information about the Study:

Not available at this revision.

12. Application of the Data Set:

This data set provides information useful in the study of the atmospheric boundary layer.

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 will be 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:

FIFE Radiosonde Wind Profiles are available on FIFE CD-ROM Volume 1. The CD-ROM filename is as follows:

\DATA\ATMOS\WIND_SON\YyyMmm\ydddNnnn.WPS

Where *yy* is the last two digits of the year (e.g. Y87 = 1987), *mm* is the month of the year (e.g. M12 = December), 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 (values) that change for each path and file.

The format used for the filenames is: *ydddNnnn.sfx*, *y* is the last digit of the year (e.g. 7 = 1987, and 9 = 1989), *ddd* is the day of the year, and *nn*n is the flight number (002 - 450). The file extension, (.*sfx*), identifies the data set content for the file and is equal to .WPS for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

ADAS Operating Manual, AIR, Inc. Boulder CO.

Journal Articles and Study Reports.

Brutsaert, W. and M. Sugita. 1991. A bulk similarity approach in the atmospheric boundary layer using radiometric skin temperature to determine regional surface fluxes. Boundary-Layer Meteor. 55:1-23.

Brutsaert, W. and M. Sugita. 1992. Self-preservation in the diurnal evolution of the surface energy budget to determine daily evaporation. Jour. Geophys. Res. 97:18,377-18,382.

Brutsaert, W. and M. Sugita. 1992. Regional surface fluxes under non-uniform and patchy soil moisture conditions during drying. Water Resour. Res. 28:1669-1674.

Sugita, M. and W. Brutsaert. 1990. Wind velocity measurements in the neutral boundary layer above hilly prairie. Jour. Geophys. Res. (Atmos.). 95(D6):7617-7624.

Sugita, M. and W. Brutsaert. 1990. Regional surface fluxes from remotely sensed skin temperature and lower boundary layer measurements. Water Resour. Res. 26:2937-2944.

Sugita, M. and W. Brutsaert. 1991. Daily evaporation over a region from lower boundary layer profiles measured with radiosonde. Water Resour. Res. 27:747-752.

Sugita, M. and W. Brutsaert. 1992. Landsat surface temperatures and radiosoundings to obtain regional surface fluxes of heat and water vapor. Water Resour. Res. 28:1675-1679.

Sugita, M. and W. Brutsaert. 1992. The stability functions in the bulk similarity formulation for the unstable boundary layer. Boundary- Layer Meteor. 61:65-80.

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:

ABL Atmospheric Boundary Layer ASL Above Sea Level AGL Above Ground Level CD-ROM Compact Disk (optical), Read-Only Memory DAAC Distributed Active Archive Center EOS Earth Observing System EOSDIS EOS Data and Information System. FIFE First ISLSCP Field Experiment FIS FIFE Information System GMT Greenwich Mean Time IFC Intensive Field Campaign IFOV Instantaneous Field of View ISLSCP International Satellite Land Surface Climatology Project Mbps Megabyte per second NESDIS National Environmental Satellite Data and Information Service NOAA National Oceanic and Atmospheric Administration ORNL Oak Ridge National Laboratory TDF Table Definition File URL Uniform Resource Locator UTM Universal Transverse Mercator

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

20. Document Information:

April 22, 1994 (citation revised on October 10, 2002).

Warning: This document has not been checked for technical or editorial accuracy by the FIFE Information Scientist. There may be inconsistencies with other documents, technical or editorial errors that were inadvertently introduced when the document was compiled or references to preliminary data that were not included on the final CD-ROM.

Previous versions of this document have been reviewed by the Principal Investigator, the person who transmitted the data to FIS, a FIS staff member, or a FIFE scientist generally familiar with the data.

Document Review Date:

February 15, 1996.

Document ID:

ORNL-FIFE_WIND_SON.

Citation:

Cite this data set as follows:

Brutsaert, W. H. 1994. Wind Profile Data: Radiosonde (FIFE). Data set. Available on-line [http://www.daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/139. Also published in D. E. Strebel, D. R. Landis, K. F. Huemmrich, and B. W. Meeson (eds.), Collected Data of the First ISLSCP Field Experiment, Vol. 1: Surface Observations and Non-Image Data Sets. CD-ROM. National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland, U.S.A. (available from http://www.daac.ornl. gov).

Document Curator:

DAAC Staff

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