ATMOSPHERIC PROFILES: TOVS - NOAA (FIFE)
Get Data

Atmospheric Profiles: TOVS - NOAA (FIFE)

Summary:

The TOVS data were acquired from NOAA/NESDIS to monitor atmospheric conditions that occurred over the FIFE study area during 1987. The TOVS data were obtained from NESDIS in the standard TOVS sounding product format containing atmospheric sounding data for NOAA-9 and NOAA-10 satellites over the FIFE study area.

The TOVS sounding products information is derived from three sensors which measure the intensity of upwelling radiation in the various spectral intervals that occur at maxima over broad layers and depths of the atmosphere. These radiance measurements are processed into Earth-located, calibrated radiance values, "clear" radiances (radiances corrected for cloud effects and angle-of-view), estimates of water vapor in three atmospheric layers (converted to precipitable water in these layers), mean temperatures for selected atmospheric layers, tropopause height and temperature estimates, and geopotential thickness of selected atmospheric layers.

Table of Contents:

1. Data Set Overview:

Data Set Identification:

Atmospheric Profiles: TOVS - NOAA (FIFE).
(TIROS Operational Vertical Sounder (TOVS)).

Data Set Introduction:

The TIROS Operational Vertical Sounder (TOVS) data set contains temperature, water, and brightness temperatures collected over the FIFE study area during 1987.

Objective/Purpose:

The TOVS data were acquired from NOAA/NESDIS to monitor atmospheric conditions that occurred over the FIFE study area during 1987.

Summary of Parameters:

- Layer mean temperature,
- pressure at lower and upper boundary,
- layer precipitable water,
- tropopause parameters,
- ozone,
- cloud cover,
- brightness temperatures and radiances,
- sounding quality, and
- methods used to derive some of the quantities.

Discussion:

The TOVS data were obtained from NESDIS in the standard TOVS sounding product format on magnetic tapes that contained atmospheric sounding data for NOAA-9 and NOAA-10 satellites over the FIFE study area. This data set contains the temperature, water, and brightness temperatures collected over the given latitude and longitude location.

Related Data Sets:

- NOAA Radiosonde Observations.
- NOAA Radiosonde Observations - 1989 (NCDC).
- Upper Air Derivative Data from NMC.
- NOAA Regional Surface Data.
- NOAA Regional Surface Data - 1989 (NCDC).
- FIFE Radiosonde Data.
- Automatic Micrometeorological Observations.

FIS Data Base Table Name:

NOAA_TOVS_DATA.

2. Investigator(s):

Investigator(s) Name and Title:

Staff Science.

Title of Investigation:

Staff Science Satellite Data Acquisition Program.

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Requested Form of Acknowledgment.

The TIROS Operational Vertical Sounder (TOVS) data were obtained by the FIFE Information System (FIS) from the National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite Data and Information Service (NESDIS).

3. Theory of Measurements:

The TOVS sounding products information is derived from the three instruments, namely HIRS/2, MSU, and SSU sensors, which measure the intensity of upwelling radiation in the various spectral intervals that occur at maxima over broad layers and depths of the atmosphere. These radiance measurements are processed into Earth-located, calibrated radiance values, "clear" radiances (radiances corrected for cloud effects and angle-of-view), estimates of water vapor in three atmospheric layers (converted to precipitable water in these layers), mean temperatures for selected atmospheric layers, tropopause height and temperature estimates, and geopotential thickness of selected atmospheric layers. The basic retrieval technique is statistical: eigenvector regression (Smith and Woolf 1976) is employed for water vapor and temperature below 100 mb, while multiple linear regression is used for temperature above 100 mb and total ozone. A combination of eigenvector and linear regression is utilized in the retrieval of cloud altitude and amount. The regression coefficients are derived from a dependent sample of measured radiances and quasi-coincident radiosonde observations.

The HIRS/2, using 19 infrared and 1 visible channel, provides temperature and water vapor soundings, surface temperature, and cloud detection. The MSU, with four microwave channels, provides temperature soundings under all sky conditions except rain, and also determines surface emissivity and cloud attenuation. The SSU provides temperature soundings using carbon dioxide gas cells and pressure modulation to observe thermal emissions for the stratosphere.

4. Equipment:

Sensor/Instrument Description:

The TOVS system consists of three separate sensors: High Resolution Infrared Radiometer Sounder/2 (HIRS/2), Stratospheric Sounding Unit (SSU), and Microwave Sounding Unit (MSU). Each of these sensors is a multi-channel radiometer. The HIRS/2 measures incident radiation, primarily in the infrared region of the spectrum (19 channels) including both longwave (15 micrometers) and shortwave (4.3 micrometers) regions, as well as one channel in the visible spectrum. The SSU, a pressure-modulated radiometer provided by the British Meteorological Office, observes thermal emissions from the stratosphere. This instrument measures the radiation with 3 channels in the 15-micrometer carbon dioxide absorption band. The MSU is a passive scanning microwave spectrometer with 4 channels in the 5.5-micrometer oxygen region.

Collection Environment:

Atmosphere.

Source/Platform:

NOAA-9 and NOAA-10 polar orbiting satellites.

Source/Platform Mission Objectives:

The TOVS instruments were designed to provide combined atmospheric soundings from the Earth's surface to the stratosphere, with a nominal ground resolution of about 250 by 250 km.

Key Variables:

Layered temperature, layered water vapor, cloud cover, tropopause pressure and temperature, total ozone, and equivalent blackbody temperatures for 20 HIRS/2, 4 MSU, and 3 SSU channels.

Principles of Operation:

The HIRS/2 measuring scheme is based on the rotating mirror providing 56 measurements per scan in 6.4 seconds. This cross-track scan, combined with the satellite motion in orbit, provides coverage of a major portion of the Earth's surface. There are two modes of operation known as normal earth scan and calibration mode. The instrument automatically operates in the calibration mode every 256 seconds and measures the calibration parameters. The total calibration sequence is equivalent to three scan lines during which no Earth data are obtained. The analog data is digitized onboard spacecraft at a rate of 2880 bits per second. At this rate, there are 288 bits per step (step time = 100 milliseconds) for all 20 channels. This data is digitized to 13 bits precision.

SSU principle of operation is based on the selective chopper radiometers flown on Nimbus 4 & 5, and the pressure modulator radiometer flown on Nimbus 6. The three SSU channels have the same frequency, but different cell pressures. This instrument consists of a single telescope with a 10 degree IFOV which is step-scanned perpendicular to the satellite subpoint track. Data is sampled at the rate of 40 samples per second, and is digitized to 12-bit precision. Therefore, the SSU data rate is 480 bits per second.

MSU is a passive scanning microwave spectrometer with four channels in the 5.5 micrometer oxygen region. This instrument measures an apparent brightness temperature after a 1.84 second integration period per step. The data is quantized to 12-bit precision and combined with telemetry and step position information to produce an effective output data rate of 320 bits per second.

Sensor/Instrument Measurement Geometry:

The HIRS/2 cross-track scan, combined with the satellite's motion in orbit, provides coverage of a major portion of the Earth's surface. The width of cross-track scan is 90 degrees or 2240 km and consists of 56 steps. The mirror is stepped from home position in 55 steps of 1.8 degrees. At the end of the scan (at position 56) the mirror rapidly returns to the home position and repeats the scanning pattern. Each scan takes 6.4 seconds to complete (100 milliseconds per step) and there are 42 km between IFOV'S along the sub-orbital track. The optical FOV is 1.25 degrees which gives a ground IFOV of 17.4 km diameter at the nadir. At the end of the scan, the ground IFOV is 58.5 km cross-track by 29.9 along-track.

The SSU consists of a single primary telescope with a 10 degree IFOV which is step-scanned perpendicular to the satellite subpoint track. Each scan line is composed of eight individual 4.0 second steps, and requires a total of 32 seconds, including time for the mirror retrace. The 10 degree IFOV gives a resolution of 147 km at the satellite subpoint and the stepping produces a gap between adjacent scan lines of approximately 62 km at nadir.

The MSU sensors consist of two four-inch diameter antennas, each having an IFOV of 7.5 degrees. The antennas are step-scanned through eleven individual 1.84-second Earth viewing steps, taking a total of 25.6 seconds to complete. The 109-km IFOV resolution at the subpoint creates a gap of approximately 115 km between adjacent scan lines.

Manufacturer of Sensor/Instrument:

HIRS/2 Aerospace/Optical Division
International Telephone and Telegraph Corp.
Fort Wayne, Indiana.

MSU NASA Goddard Space Flight Center
Greenbelt, Maryland.

SSU British Meteorological Office
United Kingdom.

Calibration:

HIRS/2 can be commanded to automatically enter a calibration mode every 256 seconds. When the instrument is in the calibration mode, the mirror (starting from the beginning of a scan line) rapidly slews to a space view and samples all channels for the equivalent time of one complete scan line of 56 scan steps. Next, the mirror is moved to a position where it views a cold calibration target and data is taken for the equivalent of 56 scan steps. The mirror is then stepped to view an internal warm target for another 56 scan steps. Upon completion of the calibration mode, the mirror continues its motion to the home position where it begins normal Earth scan.

For the SSU, a calibration sequence is initiated every 256 seconds (8 scans) during which the radiometer is, in turn, stepped to a position to view unobstructed space and an internal blackbody at a known temperature. This calibration mode is synchronized with the HIRS/2 instrument.

Unlike the HIRS/2 and SSU instruments, the MSU has no special calibration sequence that interrupts normal scanning. The calibration data is included in a scan line of data. From the last Earth view position, the reflector rapidly moves 4 steps to view space, 10 additional steps to view the housing, and then returns to the

home position to begin another scan line. Since each scan line requires 25.6 seconds, synchronization of MSU within the other two TOVS instruments occurs every 128 seconds (5 scan lines).

Specifications:

		HIRS/2	SSU	MSU	Units
IFOV (nadir)	17.4	147.3	109.3	km (diameter)	
ANGULAR FOV	1.25	10.0	7.5	deg.	
ALTITUDE	833.0	833.0	833.0	km	
SCAN RATE	9.4	1.9	2.3	scans/min.	
STEP ANGLE	1.8	10.0	9.47	deg.	
STEP TIME	0.1	4.0	1.84	sec.	
DATA RATE	2880.0	480.0	320.0	bits/sec.	
DATA PRECISION	13.0	12.0	12.0	bits	

Tolerance:

Typical values of the noise equivalent differential radiance for the HIRS/2, SSU, and MSU range from 0.001 to 3.00 [mW][m^-2][steradian^-1][cm^-1], 0.30 to 1.00 [mW] [m^-2][steradian^-1][cm^-1], and about 0.3 degrees K, respectively.

Expected tolerance for retrieved layered temperature is on the order of 3.0 degrees K. Tropopause pressure and temperature are defined within 50 mb and 2.5 degrees K. Total ozone can be determined within 15% in the tropics and within 50% in the polar region. Cloud cover is estimated within 20% mb and tropopause.

Frequency of Calibration:

A special calibration sequence is initiated every 256 seconds in the HIRS/2 and SSU sensors, whereas, a calibration target is observed every 25.6 seconds in the MSU sensor (i.e., once per scan line).

Other Calibration Information:

See NOAA Polar Orbiter Data Users Guide, revised December 1991, pages 4-1 through 4-35.

5. Data Acquisition Methods:

As part of the FIFE staff science data collection effort, the FIFE Information System (FIS) received and archived Television and Infrared Observational Satellite (TIROS) Operational Vertical Sounder (TOVS) data. The data were acquired by the NOAA-9 and NOAA-10 satellites during 1987. The data were obtained from NESDIS in the standard TOVS sounding product format on magnetic tape (see NOAA Polar Orbiter Data Users Guide, revised December 1991, pages 5-1 through 5-14).

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 near 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 NOAA TOVS sounding product acquired for FIFE centered on 39 deg. 03 min. N, 96 deg. 30 min. W, with a specified target area of +/-250 km in all directions (approximately +/-2.5 deg. latitude, +/-4 deg. longitude).

Spatial Coverage Map:

Not available.

Spatial Resolution:

The three sensors, namely HIRS/2, SSU, and MSU have +/-49.5, +/-40.0, and +/-47.35 degrees cross-track scan angle (degrees from nadir). These scans equate to swaths +/-1120 , +/-737, and +/-1174 km. This produces a ground IFOV at nadir (diameter) of 17.4, 147.3, and 109.3 km for the three sensors respectively. Hence, the ground IFOV at the end of scan results in 58.5 km cross-track by 29.9 km along-track for the HIRS/2, 244 km cross-track by 186.1 km along-track for the SSU, and 323.1 km cross-track by 178.8 km along-track for the MSU.

The layered temperature are obtained for 15 layers:

surface to 850 mb,
850 to 700 mb,
700 to 500 mb,
500 to 400 mb,
400 to 300 mb,
300 to 200 mb,
200 to 100 mb,
100 to 70 mb,
70 to 50 mb,
50 to 30 mb,
30 to 10 mb,
10 to 5 mb,
5 to 2 mb,
2 to 1 mb, and
1 to 0.4 mb.
The layered precipitable water are obtained for the layers:

surface to 700 mb,
700 to 500 mb, and
500 to 100 mb.

Projection:

Not available.

Grid Description:

Not available.

Temporal Characteristics:

Temporal Coverage:

The overall time period of data acquisition was from January 1, 1987 through December 31, 1987 with some missing data due to processing problems. There was no NOAA-9 TOVS data available at NESDIS for the period of March, 1987 to August, 1987.

Temporal Coverage Map:

Not available.

Temporal Resolution:

There are generally 2 overpasses per day per satellite at approximate times of 0130, 0820, 1330, and 2020 GMT at the equator. However, not all of these data are processed and distributed due to cloud cover and other data problems. North or south of the equator, adjacent orbits can cause double coverage at an interval of 90 minutes increasing the number of scenes on some days.

Data Characteristics:

The SQL definition for this table is found in the NOAA_TOV.TDF file located on FIFE CD-ROM Volume 1.

Parameter/Variable Name	Parameter/Variable Description	Range	Units	Source
OBS_DATE	The date the data were collected, in the format (DD-mmm-YY).			
OBS_TIME	The time of day that the data were collected, in the format HHMM.		[GMT]	
PLATFORM	The NOAA platform that collected the data (NOAA-9 or NOAA-10).			
LATITUDE	The latitude (DD MM SS.SS) of the			

data location.

LONGITUDE
The longitude (DDD MM SS.SS) of the
data location.

OBS_TYPE
The type of observation recorded in
this record.

LOWER_PRESS
The lower pressure boundary [millibars]
for the reading.

UPPER_PRESS
The upper pressure for the reading. [millibars]

OBS_VALUE
The observed parameter value.

OBS_UNITS
The units of the observed parameter.

VALUE_QUALITY
The quality of the observed value.

SOLAR_ZEN_ANG
The solar zenith angles at the [degrees]
time of data collection.

SURF_ELEV
The elevation of the surface location [meters]
over which the data were collected.

SURF_TEMP
The temperature of the surface over [degrees K]
which the data were collected.

SURF_PRESS
The surface pressure over which the [millibars]
data were collected.

UPPER_TEMP_METHOD
The instrument and channel combinations
used to derive the temperatures of the
atmospheric layers with pressures less
than or equal to 100 millibars.

LOWER_TEMP_METHOD
The instrument and channel combinations
used to derive the temperatures of the
atmospheric layers with pressures from
the surface to 100 millibars.

PRECIP_METHOD
The method used to derive the precipitable
water estimates.

RETRIEVAL_METHOD The method used in the retrieval. $	
SD_LOW The standard deviation of the low-level HIRS/2 channel (7) giving a measure of the atmospheric clarity for the sounding.	
SD_MID The standard deviation of the mid-level HIRS/2 channel (5) giving a measure of the atmospheric clarity for the sounding.	
N_STAR The average value of N* indicating clarity of the atmosphere in calculating the radiance values.	
SOUNDING_QUALITY The quality of the sounding values (good, redundant, questionable, bad).	
TROPO_PRESS The pressure at the troposphere level.	[millibars]
TROPO_TEMP The temperature at the troposphere.	[degrees K]
TROPO_QUALITY The quality of the troposphere values.	[millibars]
TROPO_PARM_METHOD The method used to derive the troposphere temperature and pressure values.	
TOTAL_OZONE The total ozone.	[Dobson units]
OZONE_QUALITY The quality of the ozone amount.	[percent]
OZONE_METHOD The method used to derive the total ozone amount.	
CLOUD_LEVEL The pressure level where any cloud cover was located.	[millibars]
CLOUD_PERCENT The percent of the area covered by clouds.	[percent]

Footnotes:

$ This is an encoded field. See the *Derivation Techniques and Algorithms Section* for a translation of these codes.

Decode the FIFE_DATA_CRTFCN_CODE field as follows:

The primary certification codes are:

EXM Example or Test data (not for release). PRE Preliminary (unchecked, use at your own risk). CPI Checked by Principal Investigator (reviewed for quality). CGR Checked by a group and reconciled (data comparisons and cross-checks).

The certification code modifiers are:

PRE-NFP Preliminary - Not for publication, at the request of investigator. CPI-MRG PAMS data that are "merged" from two separate receiving stations to eliminate transmission errors. CPI-??? Investigator thinks data item may be questionable.

Sample Data Record:

OBS_DATE	OBS_TIME	PLATFORM	LATITUDE	LONGITUDE	OBS_TYPE
01-JAN-87	403	NOAA-9	38 01 12.00	-096 52 47.99	LAYER_TEMP
01-JAN-87	403	NOAA-9	38 01 12.00	-096 52 47.99	LAYER_TEMP
01-JAN-87	403	NOAA-9	38 01 12.00	-096 52 47.99	LAYER_TEMP
01-JAN-87	403	NOAA-9	38 01 12.00	-096 52 47.99	LAYER_TEMP

LOWER_PRESS	UPPER_PRESS	OBS_VALUE	OBS_UNITS	VALUE_QUALITY	SOLAR_ZEN_ANG
950	850	276.4	DEG K	9999	90
850	700	272.2	DEG K	9999	90
500	400	247.1	DEG K	9999	90
700	500	261.1	DEG K	9999	90

SURF_ELEV	SURF_TEMP	SURF_PRESS	UPPER_TEMP_METHOD
401	263.9	950	HIRS + SSU + MSU (3,4)
401	263.9	950	HIRS + SSU + MSU (3,4)
401	263.9	950	HIRS + SSU + MSU (3,4)
401	263.9	950	HIRS + SSU + MSU (3,4)

LOWER_TEMP_METHOD	PRECIP_METHOD	RETRIEVAL_METHOD	SD_LOW
HIRS + MSU	NO RETRIEVAL	544	9999
HIRS + MSU	NO RETRIEVAL	544	9999
HIRS + MSU	NO RETRIEVAL	544	9999
HIRS + MSU	NO RETRIEVAL	544	9999

SD_MID	N_STAR	SOUNDING_QUALITY	TROPO_PRESS	TROPO_TEMP
9999	9.999	GOOD	224	218
9999	9.999	GOOD	224	218
9999	9.999	GOOD	224	218
9999	9.999	GOOD	224	218

TROPO_QUALITY	TROPO_PARM_METHO	TOTAL_OZONE	OZONE_QUALITY
9999	HIRS + MSU	9999	9999
9999	HIRS + MSU	9999	9999
9999	HIRS + MSU	9999	9999
9999	HIRS + MSU	9999	9999

OZONE_METHOD	CLOUD_LEVEL	CLOUD_PERCENT
NO RETRIEVAL	9999	9999
NO RETRIEVAL	9999	9999
NO RETRIEVAL	9999	9999
NO RETRIEVAL	9999	9999

8. Data Organization:

Data Granularity:

The NOAA TOVS sounding product acquired for FIFE centered on 39 deg. 03 min. N, 96 deg. 30 min. W, with a specified target area of +/-250 km in all directions (approximately +/-2.5 deg. latitude, +/-4 deg. Longitude). The ground IFOV for the three sensors at the end of scan results in 58.5 km cross-track by 29.9 km along-track for the HIRS/2, 244 km cross-track by 186.1 km along-track for the SSU, and 323.1 km cross-track by 178.8 km along-track for the MSU.

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:

Retrieval of the meteorological data from the multichannel soundings of the instruments is accomplished by NOAA using algorithms developed by Smith and Woolf (1976) and later modified by McMillin and Dean (1982). The basic retrieval technique was statistical: eigenvector regression was employed for water vapor and temperature below 100 mb, while multiple linear regression was used for temperature above 100 mb and total ozone. A combination of eigenvector and linear regression was utilized in the retrieval of cloud altitude and amount. The regression coefficients were derived from a dependent sample of measured radiances and

quasi-coincident radiosonde observations. These coefficients were updated on a weekly basis.

The retrieval_method (Adolf Werbowetzki 1981) is encoded within a two byte field within the document portion of the NMC/NESDIS data format for these data (Kidwell 1991, p 5-15). This code is also in the RETRIEVAL_METHOD field within this data set (see chart in the *Data Characteristics Section*).

This value is encoded as follows:

RETRIEVAL_METHOD = 256 (A) + 16 (B) + C
where valid values for **A** are:
0 = no HIRS/2 data
1 = clear radiances are derived from completely clear spots
2 = Clear radiances derived from N* approach

where valid values for **B** are:
0 = no HIRS/2 data
1 = all HIRS/2 channels are used in the retrieval
2 = the tropopause HIRS/2 channels were unusable due to clouds and only stratospheric channels were used in the retrieval

where valid values for **C** are:
0 = a statistical retrieval method was used
1 = the minimum information retrieval was used
2 = the minimum information retrieval was attempted but the statistical retrieval was used

Data Processing Sequence:

Processing Steps:

FIS processed the TOVS data as follows:

1. The information about original tape and files were loaded into the on-line inventory.
2. The information contained in the Category 1 (Layer temperatures), 2 (Layer Precipitable Water), 3 (Tropopause Parameters), 4 (Ozone), 5 (Cloud Cover), and 6 (Sounding Radiances) areas of the NMC/NESDIS Sounding Products/Information portion of the TOVS tape entries were read from the tape, unpacked and translated into an ASCII text file using the information from the NOAA Polar Orbiter Data Users Guide (Kidwell 1991).
3. The data in these files were then loaded into the data base.

Processing Changes:

None.

Calculations:

Special Corrections/Adjustments:

None.

Calculated Variables:

Not available.

Graphs and Plots:

None.

10. Errors:

Sources of Error:

Users of TOVS data should be aware that the satellite's onboard clock experiences a small drift in time over a period of several months. Specifically, that time drift may be defined by *dt*, where *dt* is the spacecraft clock time minus the actual GMT time. Satellite Operations Control Center (SOCC) monitors this time error and corrects *dt* to +0.5 second when it reaches -0.5 second. The Earth data which is appended to the level-0 data is based on the spacecraft clock time. Therefore, an error in *dt* will be reflected as an error in Earth location. The error in Earth location due to this timing error could be as much as 4 kilo-meters at the satellite subpoint. SOCC applies the correction to *dt* just before an orbital recording begins, so, a user would never see a jump in the Earth location of a particular data set.

Quality Assessment:

Data Validation by Source:

The following tests are performed for quality assessment on the data by NESDIS (as given in NOAA Technical Report NESS 65):

- A superadiabatic temperature lapse rate test is performed on the tropospheric pressure layers bounded by the mandatory and significant pressure levels to insure a stable profile.
- A gross error or "neighbor" check is performed on the difference between the NMC forecast first guess heights and the retrieved heights for all constant pressure levels. Values of this difference are calculated for all points in the neighborhood (within 500 Km). A sounding is required to have at least one neighbor or it is automatically rejected. The value of the height difference for the point is required to agree with the average of the height differences for the other points in the neighborhood to within: +/- 200 m with one neighbor, +/- 100 m with two neighbors, or +/- 75 m with more than two neighbors.

- When retrievals are extended to land areas on an operational basis, further location tests are performed to insure that a proper adjustment has been made for the terrain elevation in the field-of-view.

- Additional checks are generated over selected areas or at selected times to monitor the performance of each channel, the communication links from the data acquisition stations, and the individual programs used to generate a sounding. Some retrieved sounding are compared with standard radiosonde reports, the NMC analyses, and the scanning radiometer data to test for meteorological reasonableness.

Confidence Level/Accuracy Judgment:

Not available.

Measurement Error for Parameters:

The probable errors in TOVS-derived meteorological parameters are estimated (Kidwell 1991) with layer mean temperatures from the surface to 850 mb being +/-2.5 K, and 850 mb to tropopause being +/-2.25 K. Those for layer precipitable water, cloud cover, and cloud base pressure are +/-30%, +/-20%, and +/-100 mb respectively. Total ozone concentrations could have an error of about +/-15% for tropical regions, to +/-50% for polar regions.

Additional Quality Assessments:

Not available.

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:

To date (July 13, 1992) the following discrepancies/problems have been noted in the data:

- For March 1987 through August 1987, only NOAA-10 TOVS data were acquired.

Usage Guidance:

A problem with operationally produced soundings occurs where retrievals based on microwave and infrared radiances are mixed. In many instances, pronounced differences between the two types persist over large geographical areas. These large-scale, systematic differences must be eliminated in order to achieve a proper representation of thermal gradients from a mixture of the two types of soundings.

One solution has been employed in the interactive processing. For every spot where an infrared retrieval is made, a microwave retrieval is also produced. Differences between the retrievals are calculated and mapped across those areas where only microwave retrievals exist. The mapped differences are then added to the microwave retrievals to make them horizontally consistent with surrounding infrared soundings. Unfortunately the current "operational" system is designed to process soundings sequentially, so that major modifications are required to implement such a retrieval-type normalization procedure. However, a similar procedure could be implemented as part of a data analysis system by any user of the TOVS data.

Any Other Relevant Information about the Study:

NESDIS keeps a detailed log of events associated with these data, a selection from that log follows. See Appendix D of NOAA POLAR ORBITER DATA USERS GUIDE for the complete list.

- 1/8-12/87 Increase in number of cloudy retrievals believed due to noisy HIRS for NOAA-9. On 1/12 new HIRS calibration limits were applied. Percent cloudy retrievals reduced possibly because of drop in HIRS channel 1 noise.
- 2/3/87 NOAA-9 MSU channel 3 performance significantly deteriorated, resulting in large temperature biases above 250 mb.
- 2/20/87 NOAA-9 HIRS noise level is unstable and generally increasing since about 1/5/87. Increased noise induced by SSU and AVHRR instruments resulting in retrieval accuracy.
- 2/26/87 NOAA-9 HIRS noise high again.
- 3/18/87 NOAA-10 quality problem above 30 mb. Sounding for NOAA-10 above 100 mb will be discontinued.
- 6/18/87 Processing modified to accept SSU data up to 24 hours old for TRET processing.

12. Application of the Data Set:

The TOVS data were acquired from NOAA/NESDIS to monitor atmospheric conditions that occurred over the FIFE study area during 1987.

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://

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 TIROS Operational Vertical Sounder (TOVS) data are available on FIFE CD-ROM Volume 1. The CD-ROM file name is as follows:

\DATA\SAT_OBS\NOAA_TOV\YyyMmm\yyddd\ydddhhmm.NTV

Where *yy* is the last two digits of the year (e.g., Y87 = 1987, or 87 = 1987), and *mm* is the month of the year (e.g., M12 = December). 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: *ydddhhmm.sfx*, where *y* is the last digit of the year (e.g., 7 = 1987, and 9 = 1989), *ddd* is the day of the year (e.g., 061 = sixty-first day in the year), *hh* is the GMT hour (e.g., 13 = 1300), and *mm* is the minutes. The filename extension (*.sfx*), identifies the data set content for the file (see the *Data Characteristics Section*) and is equal to .NTV for this data set.

17. References:

Satellite/Instrument/Data Processing Documentation.

Adolf, Werbowetzki 1981. NOAA Technical Report NESS 83: Atmospheric Sounding User's Guide.

Kidwell, K.B. 1991. NOAA polar orbiter Data (TIROS-N, NOAA-6, NOAA-7, NOAA-8, NOAA-9, NOAA-10, NOAA-11 and NOAA-12) User's Guide. National Environmental Satellite Data, and Information Service. NOAA. 141 p (revised).

McMillin, L.M., and C. Dean. 1982. Evaluation of a new operational technique for producing clear radiances. J. Appl. Meteor. 21:1005-1014.

McMillin, L.M., D.Q. Wark, et al. 1973. NOAA Technical Report NESS 65: Satellite Infrared Soundings From NOAA Spacecraft.

Smith, W.L., H.M. Woolf, C.M. Hayden, D.Q. Wark, and L.M. McMillin. 1979. The TIROS-N operational vertical sounder. Bull. Am. Meteor. Soc. 60:1177-1187.

Journal Articles and Study Reports.

Smith, W.L., and H.M. Woolf. 1976. The use of eigenvectors of statistical covariance matrices for interpreting satellite sounding radiometer observations. J. Atmos. Sci. 33:1127-1140. 69:22-27.

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 (refer to the *Data Center Identification Section*). Documentation about using the archive and/or online access to the data at the ORNL DAAC is not available at this revision.

18. Glossary of Terms:

A general glossary for the DAAC is located at Glossary.

19. List of Acronyms:

CD-ROM Compact Disk (optical), Read-Only Memory DAAC Distributed Active Archive Center EOSDIS Earth Observing System Data and Information System FIFE First ISLSCP Field Experiment FIS FIFE Information System FOV Field-of-View HIRS-2 High Resolution Infrared Sounder-Version 2 IFOV Instantaneous Field-of-View ISLSCP International Satellite Land Surface Climatology Project MSU Microwave Sounding Unit NESDIS National Environmental Satellite Data and Information Service NOAA National Oceanic and Atmospheric Administration ORNL Oak Ridge National Laboratory SSU Stratospheric Sounding Unit TOVS Tiros Operational Vertical Sounder URL Uniform Resource Locator UTM Universal Transverse Mercator

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

20. Document Information:

May 11, 1994.

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.

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