SAFARI 2000 TOVS Surface and Atmospheric Parameters, 1-Deg, 1999-2001

Abstract

NOAA's TIROS (Television Infrared Observation Satellite) Operational Vertical Sounder(TOVS) is a suite of three sensors: the Microwave Sounding Unit (MSU), the High resolution Infrared Radiation Sounder (HIRS), and the Stratospheric Sounding Unit (SSU) aboard the NOAA series of polar-orbiting operational meteorological satellites.

The retrieved fields include: land and ocean surface skin temperature; atmospheric temperature and water vapor profiles; total atmospheric O3 burden; cloud top pressure and radiatively effective fractional cloud cover; and Outgoing Longwave Radiation (OLR), Longwave Cloud Radiative Forcing and precipitation estimate which are computed from the sounding products.

A subset of the retrieved meteorological fields have been selected by SAFARI 2000 and are provided here for southern Africa on a 5-day mean basis. The data were extracted from 1 degree x 1 degree global fields, with data from each satellite's local AM and PM orbits provided separately.

Preliminary validation studies of the interannual differences of geophysical parameters derived from the TOVS Pathfinder data set imply sufficient accuracy for their use both to study atmospheric behavior as well as validate the ability of General Circulation Models to reproduce this behavior.

TOVS-derived data provide a means to investigate long-term climate change and interannual variability and study local and periodic phenomena such as El Nino and stratospheric warmings.

Background Information

Investigators:
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Project: SAFARI 2000
Data Set Title: TOVS Pentad Surface and Atmospheric Parameters

Sites: Southern Africa

Data Set Citation:
Susskind, J. and L. Iredell. 2004. SAFARI 2000 TOVS Surface and Atmospheric Parameters, 1-Deg, 1999-2001. 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.

Web Site:
http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/FTP_SITE/INT_DIS/readmes/tovs.html .

Data File Information

The data files are stored as annual files of pentad (5-day) images. The pentads are stored in band sequential [BSQ] format (one image after the other) within the yearly files, 73 pentads per file. There is one file for each of the AM and the PM satellite overpasses for each parameter provided.

The files provided by the SRT were global 1 degree x 1 degree binary files that were 360 samples by 180 lines in size. The images progressed northward and eastward from an upper left corner at 90 degrees South and 180 degrees West (thus 90 degrees North was at the bottom).

The yearly files were processed using Research Systems Inc.'s Interactive Data Language (IDL), which was used to flip the images so that North was at the top, to extract the extra bytes of Fortran end-of-file marker characters between each pentad, and to subset the data for southern Africa. After flipping the orientation of the poles, the subsets were extracted from starting pixel 161 and starting line 81, with a size of 71 samples by 61 lines. Each one-degree image pixel is stored as a 4-byte real value. The data set prepared for SAFARI covers the years 1999, 2000, and 2001.

Data Parameters

Number of samples	71
Number of lines	61
Bytes per pixel	4
Images per file	73 (5-day averages)
Fill Value	-999.9
Data Units	see below, varies by variable
Pixel size	1 degree x 1 degree
Projection	Cylindrical Equal Distance

The TOVS Pathfinder Data Set

The Sounder Reasearch Team (SRT) at NASA's Goddard Space Flight Center (GSFC) have developed a methodology to analyze TOVS data to produce a large set of global surface and atmospheric parameters. The data set was designed to produce consistent global fields of three-dimensional atmospheric temperature and moisture structure that could be used to drive global circulation models (GCMs) for improved forecasting. The basic methodology is physically based and model dependent, producing full retrievals of temperature and moisture profiles as well as other geophysical parameters that are derived from the data.

The system uses the Goddard Earth Observing System (GEOS) GCM 6 hour forecast as a first guess for atmospheric temperature and moisture profiles. The retrieval algorithm then modifies these profiles to compute the radiation parameters, using also the HIRS2-MSU soundings, and surface temperatures are derived from the IR channels, correcting for attenuation. An iterative process is used to derive the temperature and humidity profiles, varying the profiles smoothly with height to match the observations. Initial guesses of specific humidity and surface temperature are determined from interpolation of the initial GCM first-guess profiles of air temperature and humidity to the surface pressure level.

Pixels without observations, which are common in the daily data, yet still occur in the pentad and monthly data sets, are identified with fill values. There are no attempts to average or interpolate data in space or time or between a.m. and p.m. overpass times. Note also that care must be given in the analysis of these data over time as there are significant differences in satellite sampling time of day between a.m. and p.m. overpasses, as well as within-overpasses, as orbits drift over time.

These data are particularly well suited for climatic studies because the surface, atmospheric, cloud, and radiative parameters are all produced in an internally consistent manner and simultaneous in space and time. The TOVs data are available from 1979 to 2000, yielding a very useful data set for studying global or regional interannual variability.

Summary of TOVS Data Available -
TOVS Pathfinder Atmospheric Sounding Data

- Layer mean temperature at 4 coarse layers
- Total effective cloud fraction
- Cloud fractions at 7 pressure layers
- Longwave cloud radiative forcing

- Outgoing long-wave radiation
- Cloud top pressure
- Precipitation estimate
- Precipitable water vapor above the surface and four pressure levels
- Surface pressure
- Cloud top temperature
- Cloud fraction at 7 pressure layers
- Surface skin temperature
- Specific humidity at surface and at 5 pressure layers
- Temperature at multiple levels
- Retrieved virtual temperature between levels

Level 3 product available	from 1979 to 2000
Temporal periods available	daily, 5 day avg, monthly
Type of fields available	mean, count, sd
Orbit coverage available	ascending, descending, both

The 26 field names and description for those selected for SAFARI 2000 data set:

Miscellaneous	
cldfrc	Total cloud fraction (0 to 1)
olr	Outgoing Longwave Radiation (W/m**2)
rain	Precipitation estimate (mm/day)
qualind	Indicator of data quality; grouped 0, 1, 2, 3
utime	Satellite nadir time (hours)
skintemp	Surface skin temperature (K)
sfairtemp	Surface air temperature (K)
Atmospheric Temperature	
t1000	Atmospheric Temperature (K) 1000 mb level
t850	Atmospheric Temperature (K) 850 mb level
t700	Atmospheric Temperature (K) 700 mb level
t500	Atmospheric Temperature (K) 500 mb level
t400	Atmospheric Temperature (K) 400 mb level

t300	Atmospheric Temperature (K) 300 mb level
Specific Humidity	
sphumsf	Specific humidity (g/kg) Surface level
sphum1000	Specific humidity (g/kg) 1000 mb level
sphum850	Specific humidity (g/kg) 850 mb level
sphum700	Specific humidity (g/kg) 700 mb level
sphum500	Specific humidity (g/kg) 500 mb level
sphum300	Specific humidity (g/kg) 300 mb level
Total Precipitable Water	
pptasurf	Total precipitable water (cm) Above surface level
ppta850	Total precipitable water (cm) Above 850 mb level
ppta700	Total precipitable water (cm) Above 700 mb level
ppta500	Total precipitable water (cm) Above 500 mb level
ppta300	Total precipitable water (cm) Above 300 mb level
Layer Mean Temperature for Coarse Layers	
lmtsft500	Layer mean temperature (K) Surface- 500 mb
lmt500t300	Layer mean temperature (K) 500 mb - 300 mb

Pentad Table (dates associated with each of the 73 pentads)

Month	days	pentad #
January	1 - 5	1
	6 - 10	2
	11 - 15	3
	16 - 20	4
	21 - 25	5
	26 - 30	6
	31 - 4	7
February	5 - 9	8
	10 - 14	9
	15 - 19	10
	20 - 24	11
	25 - 1	12 *
March	2 - 6	13
	7 - 11	14
	12 - 16	15
	17 - 21	16
	22 - 26	17
	27 - 31	18
April	1 - 5	19
	6 - 10	20
	11 - 15	21
	16 - 20	22
	21 - 25	23
	26 - 30	24

Month	days	pentad #
May	1 - 5	25
	6 - 10	26
	11 - 15	27
	16 - 20	28
	21 - 25	29
	26 - 30	30
	31 - 4	31
June	5 - 9	32
	10 - 14	33
	15 - 19	34
	20 - 24	35
	25 - 29	36
	30 - 4	37
July	5 - 9	38
	10 - 14	39
	15 - 19	40
	20 - 24	41
	25 - 29	42
	30 - 3	43
August	4 - 8	44
	9 - 13	45
	14 - 18	46
	19 - 23	47
	24 - 28	48
	29 - 2	49

Month	days	pentad #
September	3 - 7	50
	8 - 12	51
	13 - 17	52
	18 - 22	53
	23 - 27	54
	28 - 2	55
October	3 - 7	56
	8 - 12	57
	13 - 17	58
	18 - 22	59
	23 - 27	60
	28 - 1	61
November	2 - 6	62
	7 - 11	63
	12 - 16	64
	17 - 21	65
	22 - 26	66
	27 - 1	67
December	2 - 6	68
	7 - 11	69
	12 - 16	70
	17 - 21	71
	22 - 26	72
	27 - 31	73

*** Note:** for all three years, pentad number 12 covers February 25-March 1, but for the year 2000,
this includes leap day and thus contains six days instead of five.

Additional Sources of Information

Monthly Atmospheric Soundings from TOVS - GSFC DAAC documentation -- http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/FTP_SITE/INT_DIS/readmes/tovs.html [Internet Link]

References

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