SAFARI 2000 AVHRR Daily Site (1.5-km) and 15-Day Regional (1.5 and 6-km) Imagery

Abstract

The Global Inventory Modeling and Mapping Studies (GIMMS) group at NASA/GSFC provided SAFARI 2000 with remotely sensed satellite data products at the site and regional level. These AVHRR (Advanced Very High Resolution Radiometer) data contain two main sets of data: site extracts of SAFARI core sites (Mongu, Etosha, Kasungu, Maun, Skukuza, and Tshane), and regional 15-day composites from sets of single-day images. These AVHRR data contain four main sets of data:

1.5 km daily site extracts of SAFARI core sites (2000)
1.5 km 15-day composites of SAFARI core sites (1998-2000)
1.5 km 15-day composites of the southern African region (Mar, Sept 2000)
6 km 15-day composites of the southern African region (1998-2000)

The data are stored in binary image format files.

The AVHRR Product Web Site is http://edc.usgs.gov/products/satellite/avhrr.html.
The NASA GIMMS Web site is http://ltpwww.gsfc.nasa.gov/ltp/gimms.html.

Background Information

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Project: SAFARI 2000

Data Set Title: SAFARI 2000 AVHRR Daily Site (1.5-km) and 15-Day Regional (1.5 and 6-km) Imagery

Site: SOUTHERN AFRICA

Westernmost Longitude: 8.733000
Easternmost Longitude: 43.199501
Northernmost Latitude: -7.486100
Southernmost Latitude: -35.261700

Data Set Citation:

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AVHRR Background Information

The AVHRR is a five-channel scanning radiometer capable of providing global daytime and night time information about ice, snow, vegetation, clouds, and the sea surface. These data are obtained on a daily basis primarily for use in weather analysis and forecasting; however, a variety of other applications are possible. The radiometers measure emitted and reflected radiation in the visible, near-infrared, middle-infrared, and one or two thermal channels.

The primary use of each channel and spectral regions and band widths on the respective NOAA platforms are given in the following tables:

Channel	Wavelength [µm]	Primary Use
1[1]	0.57 - 0.69	Daytime Cloud and Surface Mapping
2	0.72 - 0.98	Surface Water Delineation, Vegetation Cover

3	3.52 - 3.95	Sea Surface Temperature (SST), Nighttime Cloud Mapping
4[2]	10.3 - 11.40	Surface Temperature, Day/Night Cloud Mapping
5[3]	11.4 - 12.40	Surface Temperature

Notes: [1]Channel 1 wavelength for the Television and Infrared Observation Satellite (TIROS)-N flight model was 0.55-0.90 µm.
[2]For NOAA-7 and -9, channel 4 was 10.3-11.3 µm.
[3]For TIROS-N and NOAA-6, -8, -10, and -12, channel 5 duplicates channel 4.

The wavelength ranges at 50 percent relative spectral response (in micrometers) of the bands for the platform-specific instruments are:

Band	NOAA-9	NOAA-11	NOAA-12	NOAA-14 (this data set)
1	0.570 - 0.699	0.572 - 0.698	0.571 - 0.684	0.570 - 0.699
2	0.714 - 0.983	0.716 - 0.985	0.724 - 0.984	0.714 - 0.983
3	3.525 - 3.931	3.536 - 3.935	3.554 - 3.950	3.525 - 3.931
4	10.334 - 11.252	10.338 - 11.287	10.601 - 11.445	10.330 - 11.250
5	11.395 - 12.342	11.408 - 12.386	10.601 - 11.445	11.390 - 12.340

The AVHRR can operate in both real-time and recorded modes. Direct readout data are transmitted to ground stations of the automatic picture transmission (APT) class at low resolution (4 x 4 km) and to ground stations of the high-resolution picture transmission (HRPT) class at high resolution (1 x 1 km). AVHRR HRPT data were received for Southern Africa for SAFARI 2000 by the Council for Scientific and Industrial Research (CSIR) Satellite

Applications Centre (SAC), near Johannesburg, South Africa.

Sensor/Instrument Description

The AVHRR is a cross-track scanning system featuring one visible, one near-infrared, one middle-infrared, and two thermal channels. The analog data output from the sensors is digitized onboard the satellite at a rate of 39,936 samples per second per channel. Each sample step corresponds to an angle of scanner rotation of 0.95 milliradians. At this sampling rate, there are 1.362 samples per instantaneous field of view (IFOV). A total of 2,048 samples is obtained per channel per Earth scan, which spans an angle of +/- 55.4 degrees from nadir.

Source/Platform

The NOAA satellites orbit the Earth at an altitude of 833 km. The data from these space platforms are transmitted to a ground receiving station. The AVHRR-LAC data used were collected onboard the NOAA-14 polar orbiting platform.

AVHRR Mission Objectives

The AVHRR is designed for multispectral analysis of meteorologic, oceanographic, and hydrologic parameters. The objective of the instrument is to provide radiance data for investigation of clouds, land-water boundaries, snow and ice extent, ice or snow melt inception, day and night cloud distribution, temperatures of radiating surfaces, and SST. It is an integral member of the payload on the advanced TIROS-N spacecraft and its successors in the NOAA series, and as such contributes data required to meet a number of operational and research-oriented meteorological objectives. One of the main uses of AVHRR data has been to study global and regional vegetation. Normalized difference vegetation index data are routinely produced and the AVHRR's thermal channels are useful for studying biomass burning.

Sensor/Instrument Measurement Geometry

The AVHRR is a cross-track scanning system. The IFOV (instantaneous field-of-view) of each sensor is approximately 1.4 milliradians, the spatial resolution of the processed data is 1.5 km in the E-W and N-S dimensions. There is about a 36-percent overlap between IFOVs (1.362 samples per IFOV). The scanning rate of the AVHRR is six scans per second, and each scan spans an angle of +/- 55.4 degrees from the nadir.

Calibration

The thermal-infrared channels are calibrated in-flight using a view of a stable blackbody and space as a reference. No in-flight reflective channel calibration is performed. Channel 3 data are noisy because of a spacecraft problem and may not be usable, especially when the satellite is in daylight (Kidwell, 1991).

Specifications	Units
IFOV	1.4 mRad
RESOLUTION	1.5 km
ALTITUDE	833 km
SCAN RATE	360 scans/min (1.362 samples per IFOV)
SCAN RANGE	-55.4 to 55.4 degrees
SAMPLES/SCAN	2,048 samples per channel per Earth scan

Tolerance

The AVHRR infrared channels 3-5 were designed for a Noise Equivalent Differential Temperature (NEdT) of 0.12 K (at 300 K), and a signal-to-noise ratio of 3:1 at 0.5 percent albedo.

AVHRR Spatial Coverage Information

The spatial coverage of the subsets and regional imagery for SAFARI 2000 are given below. In addition, binary images of latitude and longitude are contained within the top-level directory for each site subset. These files have the same pixel/line dimensions as the site products, the pixels are stored as 32-bit signed integer values. Note that the 6 km fire product size is different than the rest of the image bands (in the following section see the 'SPECIAL' column in the metadata file information provided here), and is not part of the 1.5 km regional product. The 6 km fire images are provided here as part of this data set, but were delivered earlier and separately from the NDVI and other associated AVHRR data. The spatial extent of the regional coverage changed between the delivery of the 6 km fire product and the rest of the AVHRR data. The 6 km fire product image size is given, but spatial coordinates of the imagery were not provided.

The spatial coverage of the Southern African regional images is:

	Latitude	Longitude
Upper Left Corner	-7.486100	8.733000
Upper Right Corner	-7.486100	43.199501
Lower Left Corner	-35.261700	8.733000
Lower Right Corner	-35.261700	43.199501

The spatial coverage of the southern African site extracts are as described below:

Mongu

	Latitude	Longitude
Upper Left Corner	-14.446900	22.249800
Upper Right Corner	-14.446900	24.246300
Lower Left Corner	-16.443399	22.249800
Lower Right Corner	-16.443399	24.246300

Etosha

	Latitude	Longitude
Upper Left Corner	-16.996401	16.004000
Upper Right Corner	-16.996401	18.000500
Lower Left Corner	-18.992901	16.004000
Lower Right Corner	-18.992901	18.000500

Kasungu

	Latitude	Longitude
Upper Left Corner	-11.425100	32.596500
Upper Right Corner	-11.425100	34.592999
Lower Left Corner	-13.421600	32.596500
Lower Right Corner	-13.421600	34.592999

Maun

	Latitude	Longitude
Upper Left Corner	-18.858000	22.506100
Upper Right Corner	-18.858000	24.502600
Lower Left Corner	-20.854500	22.506100
Lower Right Corner	-20.854500	24.502600

Skukuza

	Latitude	Longitude
Upper Left Corner	-24.024599	30.465099
Upper Right Corner	-24.024599	32.461601
Lower Left Corner	-26.021099	30.465099
Lower Right Corner	-26.021099	32.461601

Tshane

	Latitude	Longitude
Upper Left Corner	-23.161301	20.887300
Upper Right Corner	-23.161301	22.883801
Lower Left Corner	-25.157801	20.887300
Lower Right Corner	-25.157801	22.883801

Spatial Resolution

Before any geometric corrections, the spatial resolution varies from 1.1 km at nadir to approximately 2.5 km x 6.8 km at the extreme edges of the scan.

Projection

Geographic longitude, latitude. Binary images of latitude and longitude are provided for the site extract images only. See the spatial coverage section for more details about these files. Corner coordinate information is given in the metadata files, but note that the corner coordinates in the metadata file do not apply to the regional fire products at 1.5 km.

AVHRR Parameters/Variables

Below are lists of the standard channels included for each of the site and regional image products provided. Note that the fire product is different for the daily and for the composited products and that a fire product is not included in the 1.5 km regional data set. The daily site extract fire product is a mask that is flagged for one of 9 classes indicated below under the daily product list. The composited fire product is a fire pixel count image that represents the absolute number of fire pixels detected within the entire compositing period. For the 6 km product, this number represents the number of 1 km fire pixels that are within each 6 km pixel. Also note that brightness temperature for channels 3, 4, and 5 are included only as part of the daily site extracts and that for some date periods the fire products are not available. Latitude and longitude files are available for the site extract images, see the previous section for additional information about these.

The bands contained within each image product are:

6 km and 1.5 km Regional Composites

Primary Data Layers

ID	Description	BITS	UNITS	SCALE	OFFSET	SPECIAL
FIRE	Fire Pixel Count	8	--	1.0	0	X=640 Y=752 *(6 km only)
NDVI	Median 1.5-Km Max NDVI	16	--	0.001	0	

NDVI Composite-Associated Data Layers

ID	Description	BITS	UNITS	SCALE	OFFSET
LST	Land Surface Temperature	16	Kelvin	0.1	0
R1	Reflectance Channel 1	16	percent	0.01	0
R2	Reflectance Channel 2	16	percent	0.01	0
TS	Solar Zenith Angle	16	percent	0.01	0
TV	View Zenith Angle	16	percent	0.01	0
PHI	Relative Azimuth Angle	16	percent	0.01	0

Site Extract Composites Primary Data Layers

ID	Description	BITS	UNITS	SCALE	OFFSET	NOTE
FIRE	Fire Pixel Count	8	--	0.1	0	
NDVI	Maximum NDVI	16	--	0.001	0	
LAT	Latitude	32	--	--	--	signed integer
LON	Longitude	32	--	--	--	signed integer

NDVI Composite-Associated Data Layers

ID	Description	BITS	UNITS	SCALE	OFFSET
LST	Land Surface Temperature	16	Kelvin	0.1	0
R1	Reflectance Channel 1	16	percent	0.01	0
R2	Reflectance Channel 2	16	percent	0.01	0
TS	Solar Zenith Angle	16	percent	0.01	0
TV	View Zenith Angle	16	percent	0.01	0
PHI	Relative Azimuth Angle	16	percent	0.01	0
DAY	Composite Day Index	8	--	--	--

Site Extract Daily

ID	Description	BITS	UNITS	SCALE	OFFSET	NOTE
LST	Land Surface Temperature	16	Kelvin	0.1	0	

R1	Reflectance Channel 1	16	percent	0.01	0	
R2	Reflectance Channel 2	16	percent	0.01	0	
T3	Brightness Temperature Channel 3	16	Kelvin	0.01	0	
T4	Brightness Temperature Channel 4	16	Kelvin	0.01	0	
T5	Brightness Temperature Channel 5	16	Kelvin	0.01	0	
TS	Solar Zenith Angle	16	degrees	0.01	0	
TV	View Zenith Angle	16	degrees	0.01	0	
PHI	Relative Azimuth Angle	16	degrees	0.01	0	
NDVI	Maximum NDVI	16	--	0.001	0	
LST	Land Surface Temperature	16	Kelvin	0.01	0	
FIRE	Fire Mask Composite	8	--	--	--	
LAT	Latitude	32	--	--	--	signed integer
LON	Longitude	32	--	--	--	signed integer

Fire Mask Classes:
0 missing
1 water
2 cloud
3 no fire (and not even a potential fire)
4 no fire (but was a potential fire)
5 unknown
6 fire (low confidence)
7 fire (nominal confidence)

8 fire (high confidence)

Data Format(s)

The images are all flat binary files, the number of bits per pixel are given in the metadata files, as are the image sizes, also given below. There is a metadata file for each site and date/compositing period, in ASCII format.

6 km Regional Composites

515 image rows
639 image columns

1.5 km Regional Composites

2060 image rows
2556 image columns

Site Extracts, Daily and Composites

150 image rows
150 image columns

AVHRR Data Manipulations

Derivation Techniques and Algorithms

The daily data are not corrected for atmospheric or directional reflectance or emittance effects prior to creating composites. Only data for view zenith angles < 57 degrees were used in the composites.

The SAFARI 2000 products are not corrected for atmospheric or bidirectional effects; thus, the composites may have radiometric artifacts caused by these phenomena.

Quality Assessment

We made every possible effort to determine acceptable navigation accuracy (within 1 pixel) and remap all data if anomalies in the data were detected.

Software Description

GIMMS AVHRR Processing System, 1-km version with improved navigation module.

Legend & Additional Sources of Information

References:

Platform/Sensor/Instrument/Data Processing Documentation

Hussey, J. W. 1977. The TIROS-N NOAA Operational Satellite System. U.S. Department of Commerce, NOAA/NESS.

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Robertson, B., A. Erickson, J. Friedel, B. Guindon, T. Fisher, R. Brown, P. Teillet, M. D'Iorio, J. Cihlar, and A. Sancz. 1992. GEOCOMP, a NOAA AVHRR geocoding and compositing system. Proceedings of the ISPRS Conference, Commission 2, Washington, D.C., 223-228.

Teillet, P. M. and B. N. Holben. 1994. Towards operational radiometric calibration of NOAA AVHRR imagery in the visible and near-infrared channels. Canadian Journal of Remote Sensing, 20: 1-10.

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several program-generating composite AVHRR image data sets).

Acknowlegment

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