ENVIRONMENTAL SATELLITE DATA AND INFORMATION

The Satellite Data Services Division (SDSD) of the National Climatic Data Center (NCDC) manages a data base of environmental satellite data and information and provides products from this data base to requesters. SDSD is collocated in Suitland and Camp Springs, Maryland with the operational satellite data processing facility of the National Oceanic and Atmospheric Administration's (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS). The environmental satellite data base, an element of the overall NESDIS national environmental data base, is a unique source of data and information; it contains film imagery and digital data collected by a number of environmental satellites from 1960 to the present. It includes data from NOAA's operational environmental satellites and selected data from various National Aeronautics and Space Administration (NASA) research satellites and the Department of Defense Defense Meteorological Satellite Program (DMSP). Summary lists of the satellites from which data are available from SDSD are shown in Tables 1 and 2 below. While much of the data is nominally meteorological, its oceanographic applications have been very extensive, and the data and information has been of interest to agronomists, hydrologists, and geologists as well.

Requests for environmental satellite data services and information should be addressed to: Satellite Data Services Division, National Climatic Data Center, World Weather Building Room 100, Washington, DC 20233 (telephone 301-763-8111 [FTS 763-8111] or Telex 248376). Data collected by the LANDSAT series of satellites are not available from SDSD; requests for these data are serviced by NOAA LANDSAT Services, EROS Data Center, Sioux Falls, South Dakota 57198 (telephone 604-594-6151, Ext. 179 [FTS 784-7151]).

Environmental satellites are operated in two basic types of orbits: Polar Orbiting (inclination generally 90 to 115 degrees) and Geostationary (inclination near zero degrees). Both imagery and digital (quantitative) data are collected by instruments aboard these satellites.

The Polar Orbiting satellites (Table 1) operate in relatively low orbits, ranging from 700 to 1700 km above the earth, and circle the Earth 12 to 14 times per day (with orbital periods from 99 to 115 minutes). The orbits are timed to allow complete global coverage twice per day (normally a daytime and a nighttime view of the Earth) in swaths about 2000 km in width. Data are transmitted from the satellites continuously or on command, or are recorded on board the satellite for playback on command.

Table 1. Polar Orbiting Satellites

Name	Launch Date	Dates of Data Archived by SDSD	Form	Instrument Data Archived
TIROS-1	4/ 1/60	4/ 1/60 - 6/14/60	I	Vidicon (TV Camera System)
TIROS-2	11/23/60	11/23/60 - 9/27/61	I	Vidicon, IR Radiometer
TIROS-3	7/12/61	7/12/61 - 1/23/62	I	Vidicon
TIROS-4	2/ 8/62	2/ 8/62 - 6/18/62	I	Vidicon, IR Radiometer
TIROS-5	6/19/62	6/19/62 - 5/14/63	I	Vidicon
TIROS-6	9/18/62	9/18/62 - 10/21/63	I	Vidicon
TIROS-7	6/19/63	6/19/63 - 2/26/66	I	Vidicon, IR Radiometer
TIROS-8	12/21/63	12/21/63 - 2/12/66	I	Vidicon
TIROS-9	1/22/65	1/23/65 - 9/ 9/66	I	Vidicon
TIROS-10	7/ 2/65	7/ 2/65 - 4/ 2/66	I	Vidicon
ESSA-1	2/ 3/66	2/ 4/66 - 10/ 6/66	I	Advanced Vidicon Camera System (AVCS)
ESSA-3	10/ 2/66	10/ 4/66 - 6/ 1/67	I/D	AVCS and Low Resolution IR Radiometer (LRIR)
ESSA-5	4/20/67	6/ 1/67 - 12/ 3/68	I/D	AVCS, LRIR
ESSA-7	4/16/68	4/16/68 - 3/31/69	I/D	AVCS, LRIR
ESSA-9	2/26/69	4/ 1/69 - 11/15/72	I/D	AVCS, LRIR
ITOS-1	1/23/70	4/28/70 - 6/17/71	I/D	Scanning Radiometer (SR)
NOAA-1	12/11/70	4/26/71 - 6/20/71	I/D	SR
NOAA-2	10/15/72	11/16/72 - 3/19/74	I/D	SR, VHRR, VTPR (See Below)
NOAA-3	11/ 6/73	3/26/74 - 12/17/74	I/D	SR, VHRR, VTPR
NOAA-4	11/15/74	12/17/74 - 9/15/76	I/D	SR, VHRR, VTPR
NOAA-5	7/29/76	9/15/76 - 3/16/78	I/D	SR, VHRR, VTPR
GEOS-3	4/ 9/75	4/14/75 - 12/ 1/78	D	Radar Altimeter
SEASAT	6/27/78	7/ 7/78 - 10/ 9/78	I/D	(See SEASAT Description)
TIROS-N	10/13/78	10/30/78 - 11/ 1/80	I/D	AVHRR, TOVS (See Below)
NIMBUS-7	10/24/78	10/24/78 - Present	I/D	Coastal Zone Color Scanner
NOAA-6	6/27/79	6/27/79 - 6/20/83	I/D	AVHRR, TOVS
NOAA-7	6/23/81	6/23/81 - Present	I/D	AVHRR, TOVS
NOAA-8	3/28/83	6/20/83 - Present	I/D	AVHRR, TOVS

Form: I - Image; D - Digital
VHRR - Very High Resolution Radiometer; AVHRR - Advanced VHRR
VTPR - Vertical Temperature Profile Radiometer
TOVS - TIROS Operational Vertical Sounder (three sensors; see description)

The series of NOAA polar orbiting satellites that began with TIROS 1 in 1960 reached a third generation with the launch of TIROS-N in October 1978. TIROS-N has been followed by NOAA-6, NOAA-7, and NOAA-8, and further satellites in the series are planned for operation into the 1990's. The primary instruments aboard these satellites are the Advanced Very High Resolution Radiometer (AVHRR) and the TIROS Operational Vertical Sounder (TOVS) complex. The AVHRR is a five channel scanning radiometer with channels in the visible, visible-near IR, and IR water vapor window, selected for production of quantitative sea surface temperature products and visible and IR imagery depicting cloud cover and thermal (e.g., the Gulf Stream) features. The AVHRR produces 1 km resolution data, which is also sampled down to 4 km resolution and recorded on board the satellite for read out on command. The 1 km resolution data is transmitted continuously and up to ten minutes per orbit can be recorded on each of two recorders for playback on command. The TOVS complex includes three instruments. The High Resolution IR Sounder (HIRS-2) is a twenty channel scanning radiometer with channels in the 15 micrometer and 4 micrometer regions and one visible channel. The Microwave Sounding Unit (MSU) is a passive scanning microwave spectrometer with four channels in the 5.5 micrometer oxygen region (corresponding to frequencies from 50 GHz to 58 GHz). The Stratospheric Sounding Unit (SSU) is a step scanned far IR spectrometer with three channels in the 15 micrometer carbon dioxide region. Nadir resolutions are 17.4 km for the HIRS-2, 109.3 km for the MSU, and 147.3 km for the SSU. TOVS data are used for the derivation of atmospheric soundings, vertical profiles of temperature and humidity, on a global basis, and to correct AVHRR data for atmospheric attentuation during the retrieval of sea surface temperature observations. Future satellites in the series will also include a Solar Backscatter Ultra Violet (SBUV/2) radiometer and an Earth Radiation Budget Experiment (ERBE) instrument. The SBUV/2 will be based on the technology developed for the SBUV instrument aboard Nimbus-7. The SBUV/2 will measure backscattered solar radiation and solar irradiance in twelve bands between 252 and 340 nanometers or in an incremental spectral scan from 160 to 400 nanometers. SBUV/2 data will be used to compute global maps of ozone concentration and vertical distribution of ozone in the atmosphere. The ERBE instrument packages will include a wide (Earth limb to limb) and medium (31.8 degrees) field of view channels viewing in a fixed (non-scanning) mode in 0.2 to 5 micrometer and 0.2 to 50 micrometer bands, and three narrow (3 degrees by 4.5 degrees) scanning channels in 0.2 to 5 micrometer, 5 to 50 micrometer, and 0.2 to 50 mirometer bands. The ERBE data will be used to compute, for at least one year, the monthly average radiation budget on regional, zonal and global scales, to determine the equator to pole energy transport gradient, and to determine average diurnal variations in the radiation budget. The ERBE instrument is an experiment of the NASA Langley Research Center, which may be contacted for further information (ERBE Project Manager, Mail Code 158, NASA Langley Research Center, Hampton, VA 23665).

AVHRR and TOVS data and information available from SDSD include "Level 1b" digital data, derived digital products, and imagery. The Level 1b data is raw data with earth location and calibration information appended. The AVHRR Level 1b data include 10 bit precision data values from four or five spectral channels (either 0.58 to 0.68 micrometers, 0.725 to 1.1 micrometers, 3.55 to 3.93 micrometers, and 10.5 to 11.5 micrometers, or the same first three and 10.3 to 11.3 micrometers and 11.5 to 12.5 micrometers). The visible data values may be converted into albedoes and the IR data into radiances or temperatures using the calibration information supplied. Latitudes and longitudes of benchmark data points along each scan are included. Global coverage is available at 4 km resolution in 2,000 km wide swaths, and coverage of selected areas around the world is available at 1 km resolution.

Users may specify the area and/or time period of interest and the channels desired. Products derived from AVHRR data include sea surface temperature observations (derived temperature values with earth location and time tags) and analyzed sea surface temperature fields (temperatures interpolated to a latitude-longitude grid) at several resolutions ranging from 50 km to 500 km, and polar stereographic mosaics (1024 x 1024 hemispheric arrays) of one visible and one IR channel. AVHRR image products include 1 km imagery of a visible and an IR channel for selected areas and polar stereographic and Mercator mosaics of a visible and an IR channel. The TOVS Level 1b data include all channels from the three TOVS instruments at full sensor resolutions. Global coverage is available. The calibration and earth location are similar to that described for the AVHRR data. The primary product derived from TOVS data and available in digital form are fifteen-level vertical profiles of temperature, three-level profiles of humidity, total ozone content, equivalent black body temperatures for each of the TOVS channels, and other parameters, with earth location and time tags. Information describing AVHRR and TOVS data and products available from SDSD is described in the NOAA Polar Orbiter Data Users' Guide, available from SDSD.

The SDSD data base includes data and products from three NASA satellites: SEASAT (data from all instruments), Nimbus-7 (data from the Coastal Zone Color Scanner (CZCS) only), and GEOS-3 (data from the Radar Altimeter). SEASAT operated from June 1978 into October 1978. The SEASAT-A Scatterometer System (SASS) was an active backscatter scatterometer operating at a frequency of 13.9 GHz which produced earth location and time tagged backscatter coefficients, surface wind stresses, and surface wind vectors (with a 180 degree directional ambiguity). The SEASAT Altimeter was an active radar altimeter which produced earth location and time tagged satellite heights, significant wave heights, and geoid information. The Scanning Multichannel Microwave Radiometer (SMMR), identical to the SMMR instrument flown aboard Nimbus-7, produced earth location and time tagged sea surface temperature, surface wind stress, atmospheric water vapor, liquid water content, and precipitation rate. The microwave Synthetic Aperture Radar (SAR) produced 25 meter resolution surface roughness imagery of a 100 km wide ground swath for selected areas. The Visible and IR Radiometer (VIRR) produced imagery for identification of cloud and geographic features. Time and earth location tagged sensor and geophysical data from the SEASAT instruments are available in digital form, and SAR data are available both in digital and image form. The Nimbus-7 Coastal Zone Color Scanner (CZCS) is a scanning radiometer with six spectral channels centered at 0.443, 0.520, 0.550, 0.670, 0.750 and 11.5 micrometers and selected to allow measurement of ocean color and temperature, suspended sediment and chlorophyll concentrations, and ocean pollutants. CZCS data is available in 1600 km wide by 800 km along-track scenes. The resolution is 800 meters. CZCS digital data includes Level I Calibrated Radiance files (which contain time and earth location tagged, eight bit precision data values and calibration information for all six channels) and Level II Derived Product files (which contain time and earth location tagged values for each of eight derived parameters: subsurface radiances for three channels, aerosol radiance, surface temperature, chlorophyll concentration, diffuse attenuation, and a land or sea flag. Each Level I and Level II image product contains, for one CZCS scene, separate panels for each of the parameters noted above. Radar Altimeter data collected by the NASA GEOS-3 satellite comparable to the SEASAT altimeter data are available from SDSD. Two products are available, "G-Tapes" which contain only geophysical products (smoothed sea surface height and oceanographic parameters) and "I-Tapes" which contain the products and the calibrated data from which they were produced.

Selected data from the Defense Meteorological Satellite Program (DMSP) satellites are available from SDSD. The Special Sensor H is a sixteen channel scanning radiometer (with six channels in the 15 micrometer carbon dioxide region, one in the 10 micrometer ozone region, one in the 12 micrometer window, and eight in the 18 to 30 micrometer rotational water vapor region) similar to the HIRS-2 described above. The SSH data available are raw radiances with earth location and time tags. The Special Sensor Microwave/Thermal (SSM/T) is a passive step scanning microwave radiometer with seven channels in the 50 GHz to 60 GHz oxygen region. Raw radiances with earth location and time tags are available from SDSD. The Operational Line Scanner (OLS) is a high resolution oscillating scan radiometer which produces 0.5 km resolution and 3 km resolution visible and IR imagery. Selected imagery received by Department of Defense ground stations around the world is available from the National Snow and Ice Data Center which maintains a file of these data under an SDSD contract. Questions concerning the OLS imagery may be addressed to: National Snow and Ice Data Center, Campus Box 449, University of Colorado, Boulder, CO 80309 (303-492-5171 or FTS 320-5311).

The Geostationary satellites (Table 2) operate in a higher orbit, 36,000 km (22,300 miles) above the Earth. Their motion is synchronized with the Earth's rotation so that they appear to remain stationary over a point along the Earth's equator (hence the term 'geostationary') and afford repeated looks at a fixed field of view. The field of view covers about 25% of the Earth's surface, generally 50 degrees of latitude North and South of the equator and 50 degrees of longitude East and West of the satellite's position along the equator (subpoint). Two satellites are normally in operation: one referred to as "GOES EAST" located at 75 degrees West longitude, and the other "GOES WEST" located at 135 degrees West Longitude. During normal operations, full disk visible and IR views are transmitted every 30 minutes, and during severe weather periods views of limited areas are transmitted as frequently as every three minutes.

Table 2. Geostationary Satellites

Name	Launch Date	Dates of Data Archived by SDSD	Form	Instrument Data Archived
ATS 1	12/ 6/66	1/ 1/67 - 10/16/72	I	Spin Scan Cloud Camera
ATS 3	11/ 5/67	3/ 2/68 - 9/ 2/74	I	Spin Scan Cloud Camera
SMS 1	5/17/74	6/27/74 - 1/ 7/76	I/D	Visible and IR Spin Scan Radiometer (VISSR)
SMS 2	2/ 6/75	3/10/75 - 8/ 4/81	I/D	VISSR
GOES 1	10/ 6/75	1/ 8/76 - 3/15/80	I/D	VISSR
GOES 2	6/16/77	8/15/77 - 9/15/80	I/D	VISSR
GOES 3	6/15/78	7/13/78 - 3/ 5/81	I/D	VISSR
GOES 4	9/ 9/80	3/ 5/81 - 6/ 1/83	I/D	VISSR Atmospheric Sounder (VAS) and VISSR format
GOES 5	5/15/81	8/ 5/81 - Present	I/D	VAS and VISSR format
GOES 6	4/28/83	6/ 1/83 - Present	I/D	VAS and VISSR format

FORM: I - Image; D - Digital
SMS-2 operation was intermittent.
Starting during the operation of GOES-4, a limited quantity of VAS data is available. Routine VISSR format data continues to be collected.

GOES-4 and the present geostationary satellites, GOES-5 and GOES-6, and future satellites in the series, are equipped with the VAS (VISSR Atmospheric Sounder), the successor to the VISSR (Visible and IR Spin Scan Radiometer) flown aboard earlier satellites in the series. The VISSR provided 1 km resolution visible data (6 bit precision) and 8 km resolution IR data (8 bit precision), and was used primarily to produce time sequences of visible and IR imagery in support of severe weather forecasting and warning activities. The VAS instrument provides 1 km visible data and multichannel IR data at 7 km and 14 km resolution. The VAS instrument includes four IR detectors, two 7 km and two 14 km resolution, and 12 narrow band IR filters mounted on a filter wheel that is rotated to select the channels to be active. At any given time, three or four IR channels will be transmitted. The twelve filters are centered at 14.73, 14.48, 14.25, 14.01, 13.33, 4.53, 12.66, 11.17, 7.26, 6.73, 4.44, and 3.95 micrometers. Data in the VISSR format (1 km visible and one IR channel) continue to be available routinely, as well as limited quantities of multichannel IR data. Eventually, the operational ground data processing system will be upgraded to allow visible and multichannel IR data to become routinely available. In addition to continuing to provide time sequences of visible and IR imagery, the multichannel IR data collected by VAS is being used to compute vertical profiles of atmospheric parameters on a research basis for eventual operational use. Full resolution VISSR data, and VAS data in VISSR format, are available from SDSD. The data consist of preprocessed rather than 'raw' data values. Data from the eight visible data have been normalized, and data from the IR channel have been adjusted to allow their conversion to temperatures by means of a standard lookup table. The data are accompanied by orbit and attitude parameters that can be used to compute earth location information. Tables to allow the user to recover the original 'raw' data values are also available from SDSD. The user may specify the area, type and resolution of data, and time period of interest. Limited quantities of VAS multichannel IR data are also available from SDSD. These data include 10 bit precision data from three or four IR channels, depending upon the programming of the instrument at the time of interest. Two operating modes in use are Multispectral Imaging, in which there is coverage of a large area by three or four channels; or Dwell Sounding, in which there is repeated coverage of a smaller area by more IR channels. The repeated coverage (repeated scans of the same earth locations) is performed to improve the data signal to noise ratio sufficiently to support derivation of vertical profiles of atmospheric temperature and humidity. All data values in both modes are of 10 bit precision. SDSD can provide information as to what mode and coverage of VAS data may be available for areas and times of interest to the user. The VISSR and VAS data are described in the GOES Digital Data Users' Guide, available from SDSD. GOES imagery is also available from SDSD. Users may request reproductions of imagery for areas and times of interest.

Users should consult with SDSD and SDSD publications in preparing orders for satellite data. In general, orders should include as much of the following information as possible:

(1) Name of the Satellite (which in the case of GOES data may be GOES-EAST or GOES-WEST);
(2) Instrument or Data Type (e.g., AVHRR or VISSR);
(3) Data Description (including resolution, spectral channels);
(4) Date and Time Period of Interest;
(5) Geographical Coverage of Interest (preferably in terms of latitude and longitude);
(6) Format (if digital whether 800, 1600, or 6250 bpi density tape is requested; if imagery, whether matte or glossy finish and size);
(7) Optionally, how the requested information will be used.

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