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CHARACTERISTICS OF TIROS, GOES, DMSP AND LANDSAT SYSTEMS

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16. Abstract

The characteristics of the TIROS, GOES, DMSP and LANDSAT systems of satellites are described. The data listed for each system are altitude of orbit, inclination/position, orbit type, orbits per day, expected operational lifetime and the sensor systems. The sensor systems are described as to wavelength of each channel, resolution, field of view and other pertinent information.

Data information such as availability rate, collection method, primary use/application and how to obtain additional informatin is also given.

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CHARACTERISTICS OF TIROS, GOES, DMSP AND LANDSAT SYSTEMS

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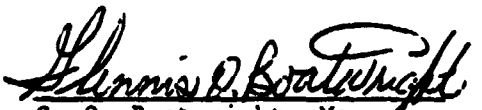

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March 1981

LEMSCO-16504

TIROS

GOES

DMSP

LANDSAT

- TIROS - N/NOAA -

OPERATIONAL SATELLITE SYSTEM

BACKGROUND

The Improved TIROS Operational Satellite (ITOS) was the second generation of the NOAA operational polar-orbiting satellites. This series served the nation's environmental needs from October 1972, until March 1979, when the last ITOS satellite (NOAA-5) was put on "stand-by duty".

The third generation system, called TIROS-N, provides several technological advances over ITOS. Specifically, they are:

- Higher resolution, day and night cloud cover observation on a local and global scale.
- Improved observations of vertical temperature and water vapor profiles on a global scale.
- A high capacity data collection and platform location system.

Launch Dates:

- TIROS-N was launched on October 13, 1978.
- NOAA-A was launched on June 27, 1979.

Future Launch Dates:

- NOAA-B in April 1980, NOAA-C in February 1981, NOAA-D in April 1982, NOAA-E in February 1983, NOAA-F in April 1984, and NOAA-G in February 1985.

This will make a total of eight meterological satellites planned for the TIROS-N Series through 1985.

SATELLITE DATA

- ALTITUDE: TIROS-N: 530 MILES
  NOAA-A: 517 MILES
- INCLINATION/POSITION: 99^0
- ORBIT TYPE: NEAR POLAR - SUN-SYNCHRONOUS
- ORBITS PER DAY: 14.2
- EXPECTED OPERATIONAL LIFETIME: Two (2) to four (4) years per satellite.
- SENSOR SYSTEMS:

- The Advanced Very High Resolution Radiometer (AVHRR).
- The TIROS Operational Vertical Sounder (TOVS).
- The Data Collection System (DCS).
- The Space Environmental Monitor (SEM).

The AVHRR provides data for instantaneous (real-time) transmission and for storage on the satellite digital tape recorders for later (delay-time) playback. The AVHRR has four operational data transmission modes:

- The Automatic Picture Transmission (APT) mode provides instantaneous (real-time), line-of-sight, reception to any worldwide receiving station. Resolution is 4 km of visible and infrared data with a special on-board computer format to remove panoramic distortion and convert resolution from 1 km to 4 km.
- The High Resolution Picture Transmission (HRPT) mode provides instantaneous (real-time), line-of-sight reception to any worldwide, system compatible, receiving station. Resolution is 1 km (at nadir) in all channels.
- The Global Area Coverage (GAC) mode provides on-board recording for later playback (delay-time) of a continuous global orbit. Playback data can be received only at designated receiving stations. Special on-board computers convert the resolution from 1 km to 4 km in all channels.
- The Local Area Coverage (LAC) mode provides on-board recording and later playback (delay-time) of selected portions of each orbit. Playback data can be received only at designated receiving stations. Resolution is 1 km (at nadir) in all channels.

The AVHRR for TIROS-N and for four of the follow-on satellites is sensitive in four channel regions (shown below). A future instrument design change will add a fifth channel in the 12 um region, and will be called AVHRR/2. The AVHRR/2 is to be used on the NOAA-D, F, and G series.

TIROS-N AVHRR Channel Characteristics

Channel	Resolution at Subpoint	Wavelength (um)	Primary Use
1	1 km	For: TIROS-N 0.55-0.90 NOAA 0.58-0.68	Daytime Cloud and Surface Mapping.
2	1 km	0.725-1.10	Surface Water Delineation
3	1 km	3.55-3.93	SST, Nighttime Cloud Mapping
4	1 km	10.5-11.5	SST, Day/Night Cloud Mapping
5	1 km	11.5-12.5	Sea Surface Temperature (SST)

The TOVS provides data for instantaneous (real-time) transmission and for storage on the satellite digital tape recorders for later (delay-time) playback. The TOVS has three complementary sounding instrument systems:

- The Stratospheric Sounding Unit (SSU) is sensitive to energy in the CO_2 portion of the infrared spectrum and provides temperature information from the stratosphere.
- The High Resolution Infrared Radiation Sounder (HIRS/2) is sensitive to energy from the visible to the CO_2 region of the infrared spectrum. The HIRS/2 provides data that will permit calculation of temperature profiles from the surface to 10mb, water vapor content at three levels of the atmosphere, and total ozone content.
- The Microwave Sounding Unit (MSU) is sensitive to energy in the oxygen region of the microwave spectrum and is used in conjunction with the SSU and HIRS/2.

TIROS-N Operational Vertical Sounder (TOVS) Characteristics

Characteristic	Stratospheric Subsystem (SSU)	Tropospheric Subsystem (HIRS/2)	Microwave Subsystem (MSU)
Resolution at Subpoint	147 km	17 km	109 km
Field of View	10°	1.4°	7.5°
General Spectral Regions Used	15 μm CO_2	15 μm CO_2 11 μm Window 9.7 μm O_3 6.7 μm H_2O 4.3 μm CO_2 3.7 μm Window 0.7 μm Visible	50-57 GHz O_2
Number of Spectral Channels	3	20	4

The DCS is provided by the Centre National d'Etudes Spatiales (CNES) of France, and is called the ARGOS Data Collection and Platform Location System.. The ARGOS DCS provides a means to locate and/or collect data from fixed platforms, moving bouys, and balloon platforms. It includes two services not available in the geostationary (GOES) data collection systems:

- It has the capability to determine platform location using an inverse doppler technique.
- It is able to acquire data from any place in the world, but most particular in the polar regions, beyond transmission of the GOES

The SEM measures solar proton flux, alpha particle, and electron flux density, energy spectrum and total particulate energy distribution and space craft altitude. The SEM has three detectors:

- The Total Energy Detector (TED) measures the intensity of particles in the energy bands of 0.3 to 20.0 kev.
- The Medium Energy Proton and Electron Detector (MEPED) senses protons, electrons, and ions in the range of 30 to around 60 kev.
- The High Energy Proton and Alpha Detector (HEPAD) senses protons and alpha particles from 370 to around 380 kev. The HEPAD augments the measurements currently being made by NOAA's GOES systems.

OTHER INFORMATION

- **SATELLITE DATA; AVAILABILITY RATE:** Instantaneous (real-time), direct readout.
  Playback (delay-time), stored readout.
- **SATELLITE DATA; COLLECTION METHOD:** Electronic (telemetry) transmission from the satellite to a ground receiving station.
- **SATELLITE DATA; PRIMARY GROUND RECEIVING STATION LOCATIONS:** Wallops Island, Virginia; Gilmore Creek, Alaska, and CNES, Toulouse, France
- **SATELLITE DATA; PRIMARY PROCESSING CENTER LOCATIONS:** NOAA/NESS, Suitland, Maryland
- **SATELLITE DATA; PRIMARY USE/APPLICATION:** Meterological, Environmental and R&D
- **TO OBTAIN ADDITIONAL INFORMATION, CONTACT:**

  National Environmental Satellite Service
  National Oceanic and Atmospheric Administration
  U.S. Department of Commerce
  Suitland, Maryland 20233

- GOES -

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE

BACKGROUND

In May 1974, NASA launched the first Synchronous Meterological Satellite (SMS-1) as the first in a series of NOAA's - Geostationary Operational Environmental Satellite (GOES) Program. Since 1974, four more geostationary satellites have been put into space.

The geostationary satellites are essentially "parked in space" at an altitude and speed that keeps them continually at the same point above the earth's surface. The "parked in space" concept is termed geostationary, earth-synchronous, geo-synchronous, or merely synchronous.

The satellite sensors can acquire data and imagery of the complete earth disc or a fourth of the earth's surface, every 30 minutes, 24 hours a day.

SATELLITE DATA

- **ALTITUDE:** 22,000 MILES
- **INCLINATION/POSITION:** Five (5) geostationary satellites are positioned over the earth's equator at:
  - 75° W, 135° W, and 60° E; and maintained by the United States.
  - 0° Longitude; and maintained by the European Space Agency (ESA).
  - 140° E; and maintained by the National Space Development Agency (NASDA) of Japan.
- **ORBIT TYPE:** Stationary above the earth's equator and traveling at a constant speed of 6,800 mph.
- **ORBITS PER DAY:** 1
- **EXPECTED OPERATIONAL LIFETIME:** Two (2) to four (4) years per satellite.
- **SENSOR SYSTEMS:**

  - The Visible and Infrared Spin-Scan Radiometer (VISSR).

  On the VISSR, an eight kilometer strip scene of the earth's surface is imaged through a 16" telescope aperature, reflected off a spin-scan mirrow, and passed through an optical system into the sensor's detector arrays.

  So that an entire earth frame (disc picture) is imaged, the GOES satellite spins on an axis nearly parallel to the earth's spin axis. And just before the 16" telescope moves (called a sweep) across the earth's surface, the satellite timing system begins data sampling and continues until the sweep has completely passed over the earth. Following each sweep, the spin-scan mirrow is adjusted so that an adjacent or next lower eight kilometer strip is imaged on the next rotation. This adjustment/rotation process is repeated 1,821 times until the entire earth frame (picture disc) is acquired.

  The eight kilometer strip scene is viewed in eight visible (VIS) channel sensors, and in two infrared (IR) channel sensors. The VIS and IR channel and resolution ranges are:

VIS:	Channel Ranges -	0.55 um to 0.75 um
	Resolution -	1, 2, or 8 km depending on a predetermined selection.
IR:	Channel Ranges -	10.5 um to 12.6 um
	Resolution -	8 x 4 km (standard)

OTHER INFORMATION

SATELLITE DATA; AVAILABILITY RATE:	VIS - every 30 minutes during daylight hours. IR - every 30 minutes, 24 hours a day.
COLLECTION METHOD:	Electronic (telemetry) transmission from the satellite to a ground receiving station.
PRIMARY GROUND RECEIVING STATION:	Wallops Island, Virginia is the station maintaining overall control. However, ground receiving stations capable of receiving GOES are located in nearly every country around the world.
PRIMARY PROCESSING CENTER:	Satellite Services Division, World Weather Building, Washington, D.C.
PRIMARY APPLICATION:	Meterological & Environmental
ADDITIONAL INFORMATION CONTACT:	Geostationary Systems Group FB4 Washington, D.C. 20233

Note: VIS and IR data provided to the user is in picture format. Digital format is available, but only on request.

- DMSP -
DEFENSE METEOROLOGICAL SATELLITE PROGRAM

BACKGROUND

In 1968, the U.S. Air Force started collecting meterological data from a satellite system called the Data Acquisition and Processing Program (DAPP). The DAPP system was designed for military applications, and as such; the system and it's imagery products were classified.

In 19[illegible], the USAF (recognizing that DAPP imagery products had potential scientific value) removed the security restrictions and made the imagery easily available to users outside the military applications community.

The DAPP system was later renamed the Defense Meterological Satellite Program (DMSP), with no change in policy for users outside the military community.

The DMSP:
- Block 5-C was the first operational system with two polar-orbiting satellites and a nighttime high-gain visual range, earth-imaging capability for city lights and aurora borealis. This system was phased out in 1977.
- Block 5-D was the first system to achieve constant cross-track spatial resolution of scanner data for automated processing and accurate earth location of data. The first Block 5-D series was launched in September 1976. It malfunctioned in orbit and was restored to operation on April 1, 1977. The second system was launched on June 24, 1977. The Block 5-D is the DMSP's current operational system.

SATELLITE DATA

- ALTITUDE: 517 MILES
- INCLINATION/POSITION: 98^0
- ORBIT TYPE: NEAR POLAR-SUN-SYNCHRONOUS
- ORBITS PER DAY: 14
- EXPECTED OPERATIONAL LIFETIME: Two (2) to four (4) years per satellite.
- SENSOR SYSTEMS:

- A Scanning Optical Telescope System

CHANNEL	WAVELENGTH (um)	RESOLUTION
Visible (VIS)	0.5 - 1.2 um	.6 km or 3.7 km
Infrared (IR)	8.0 - 13.0 um	.6 km or 3.7 km
Swath Width: 2,890 km		Imagery Format: 2890 x 5560 km

- A Sounding Radiometer

An 8-channel system providing vertical temperature and humidity profiled of the atmosphere and total ozone.

OTHER INFORMATION

SATELLITE DATA; AVAILABILITY RATE:	Instantaneous (real-time), direct readout. Playback (delay-time), stored readout.
COLLECTION METHOD:	Electronic (telemetry) transmission from the satellite to a ground receiving station.
PRIMARY GROUND RECEIVING STATION:	Received at U.S. Air Force ground stations, worldwide, and U.S. Navy carriers. DMSP satellites controlled from: Loring AFB, Maine and Fairchild AFB, Washington
PRIMARY PROCESSING CENTERS:	Air Force Global Weather Center (GWC) Offutt AFB, Nebraska
PRIMARY APPLICATION:	Meterological (military application), Scientific/civilian community and R&D.
ADDITIONAL INFORMATION CONTACT:	NOAA/NESS World Weather Building Camp Springs, Maryland 20233 or DMSP Satellite Data Library Space Science and Engineering Center The University of Wisconsin Madison, Wisconsin 53706

- LANDSAT -

BACKGROUND

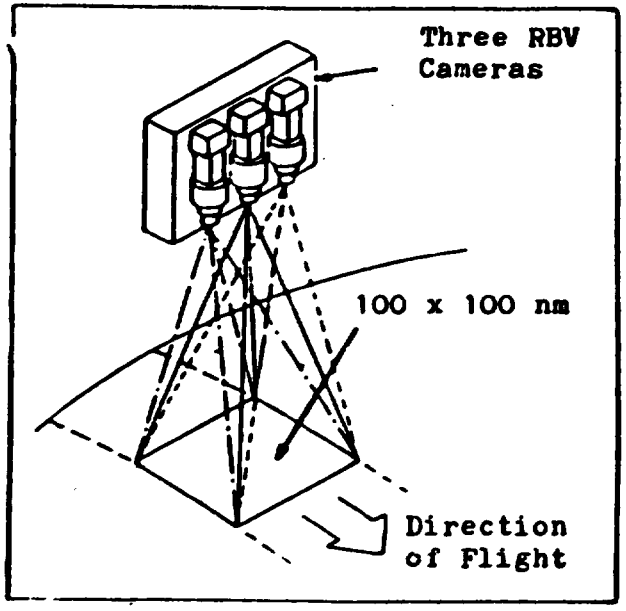
The first satellite in the Earth Resources Technology Satellite (ETRS) Program was launched in July 1972, and named ERTS-1. It was followed into space by a second satellite in January 1975, and at that time the ERTS Program was renamed LANDSAT. In March 1978, a third satellite, named LANDSAT-C, was put into orbit. The three satellites that now make up the LANDSAT system are called LANDSAT 1 and 2, and LANDSAT-3.

SATELLITE DATA

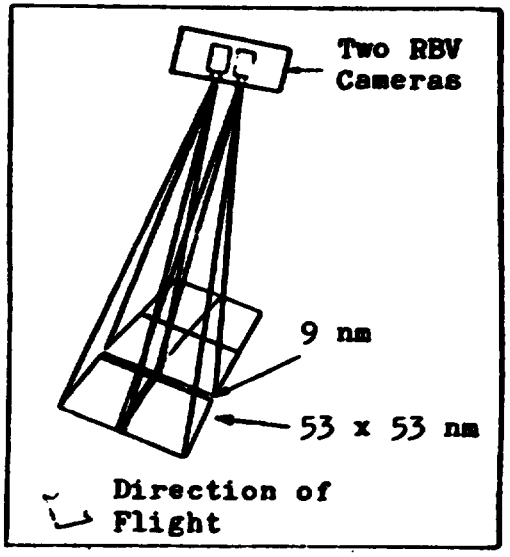
- ALTITUDE: 580 MILES
- INCLINATION/POSITION: RANGES BETWEEN 98° AND 99° FOR ALL THREE SATELLITES
- ORBIT TYPE: NEAR POLAR - SUN-SYNCHRONOUS
- ORBITS PER DAY: 14
- EXPECTED OPERATIONAL LIFETIME: Design lifetime - one year.
- SENSOR SYSTEMS:
  - The Return Beam Vidicon Camera (RBV).
  - The Multispectral Scanner (MSS).
  - The Wideband Video Tape Recorders (WBVTR).
  - The Data Collection System (DCS).

The RBV is used to obtain high resolution television pictures of the earth. On LANDSAT 1 & 2, the RBV operates by shuttering three independent cameras simultaneously, each sensing a different spectral band in the range of 0.48 to 0.83 um. The ground area image is 100 x 100 nautical miles. On LANDSAT-3, the RBV differs in that effective resolution is increased by a factor of two, spectral band response is 0.50 to 0.75 um, and two panchromatic cameras are used to produce side-by-side images rather than three overlapping images of the same scene. Each side-by-side scene images a ground area approximately 53 x 53 nautical miles. See diagrams below.

RBV Cameras - LANDSAT 1 & 2



RBV Cameras - LANDSAT-3



The MSS produces a continuous image strip of the earth's surface in various spectral bands. On LANDSAT 1 & 2, the MSS responds to earth reflected sunlight in four spectral bands. On LANDSAT-3, a fifth band has been added that responds to thermal infrared radiation. The MSS continually scans the earth in a 100 nm swath perpendicular to the LANDSAT orbital track. Scanning is accomplished in the cross-track direction by an oscillating mirror and motion along the orbit provides the along-track scan.

LANDSAT MSS Response Bands

Band	Spectral Response (Micrometers)
4	0.5 - 0.6
5	0.6 - 0.7
6	0.7 - 0.8
7	0.8 - 1.1
8	10.4 - 12.6 (Landsat-C only)

Note: Bands 1, 2, and 3 designated RBV spectral response bands.

The WBVTR. The uses of data from the RBV and MSS sensors are complementary in several respects and both sensors can be operated simultaneously over the same terrain during daylight hours. When operated over a ground receiving station, their data are transmitted in real time to the ground receiving site and recorded there on magnetic tape. When the RBV and MSS sensors are operated at locations remote from a ground receiving station, two wideband video tape recorders (WBVTR) are used to record the video data. Each WBVTR records and reproduces either RBV or MSS data upon command and each has a recording capacity of 30 minutes.

The DCS obtains data from remote, automatic data collection platforms, which are equipped by specific investigators, and relays the data to ground stations whenever the LANDSAT satellite can mutually view any platform and any one of the ground stations. Each DCS platform collects data from as many as eight sensors, supplied by the cognizant investigator, sampling such local environmental conditions as temperature, stream flow, snow depth, or soil moisture. Data from any platform are available to investigators within 24 hours from the time the sensor measurements are relayed by the satellite.

OTHER INFORMATION

SATELLITE DATA; AVAILABILITY RATE: Instantaneous (real-time), direct readout.
Playback (delay-time), stored readout.

COLLECTION METHOD: Electronic (telemetry) transmission from the satellite to a ground receiving station.

PRIMARY GROUND RECEIVING STATION: Fairbanks, Alaska; Goldstone, California, and Greenbelt, Maryland

PRIMARY PROCESSING CENTERS: Goddard Space Flight Center (GSFC), Maryland

PRIMARY APPLICATION: Land Use Resources, Marine and Water Resources, Meterological, Environmental, Agricultural and Forestry Production, and R&D.

ADDITIONAL INFORMATION CONTACT: National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

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NOTICE: Comments and queries concerning this chart are welcomed, and should be addressed to:

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