NOAA-M

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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

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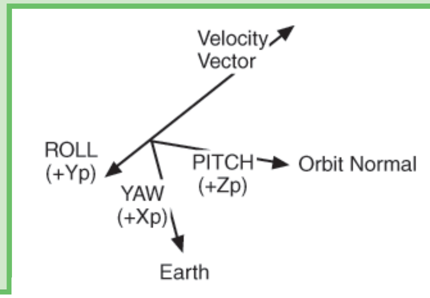
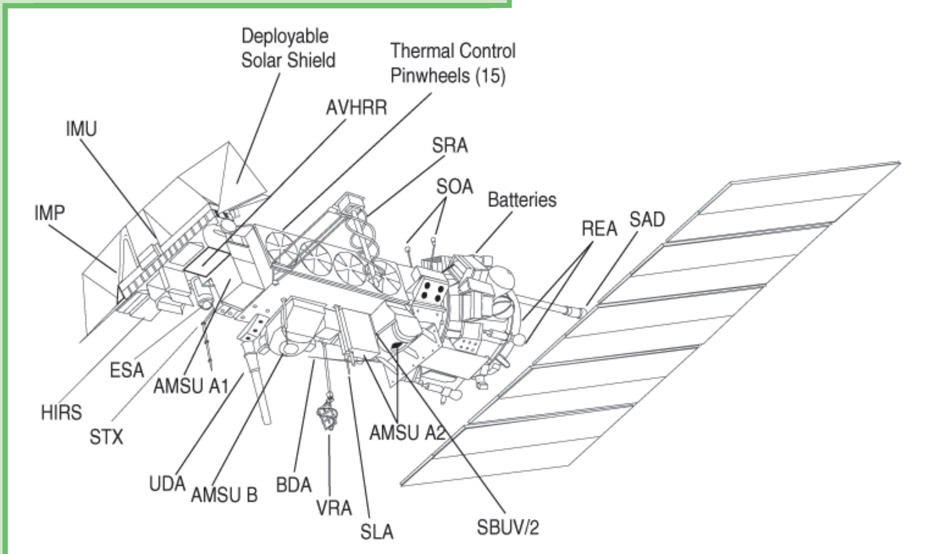
APPROVAL COPY

Instrumentation on board the NOAA-M spacecraft





LEGEND

AMSU	Advanced Microwave Sounding Unit	SBUV/2	Solar Backscatter Ultraviolet Radiometer
AVHRR	Advanced Very High Resolution Radiometer	SEM	Space Environment Monitor
BDA	Beacon Transmitting Antenna	SLA	Search and Rescue Transmitting Antenna (L-Band)
*DCS	Data Collection System	SOA	S-Band Omni Antenna (2 of 6 shown)
ESA	Earth Sensor Assembly	SRA	Search-and-Rescue Receiving Antenna
HIRS	High Resolution Infrared Radiation Sounder	STX	S-Band Transmitting Antenna (1 of 4 shown)
IMP	Instrument Mounting Platform	*TED	Total Energy Detector
IMU	Inertial Measurement Unit	UDA	Ultra High Frequency Data Collection System Antenna
*MEPED	Medium Energy Proton/Electron Detector	VRA	Very High Frequency Real-time Antenna
REA	Reaction Engine Assembly		
SAD	Solar Array Drive		
*SAR	Search and Rescue		

*Not shown in this view

POES PROGRAM

The NOAA Polar-Orbiting Satellites

The National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) have jointly developed a valuable series of Polar-orbiting Operational Earth Observation Satellites. These advanced Television Infrared Observation Satellites, ATN (named after the prototype satellite that was named TIROS-N), have been flying since 1978.

The system consists of a pair of satellites, which ensures that every part of the Earth is regularly observed at least twice every 12 hours. These satellites provide quantitative measurements of global atmospheric and surface forecast models. As users throughout the world have learned how to exploit this quantitative radiometric satellite data, the consistency and accuracy of the prediction of potentially catastrophic environmental events have improved significantly. Better prediction of these events allows emergency managers to activate plans to reduce their impact and protect life and property. In addition, this continuous overlapping source of satellite data has provided the foundation for extensive climate and research programs. In many developing countries and over much of the oceans, satellite data is the only source of quantitative information on the state of the atmosphere and of the Earth's surface, and is an invaluable source of real-time information about severe weather, critical for safety in these remote areas.

The satellites also support an international search and rescue program. Since 1982, this program is credited with saving more than 11,000 lives by detecting and locating emergency beacons from ships, aircraft, and people in distress.

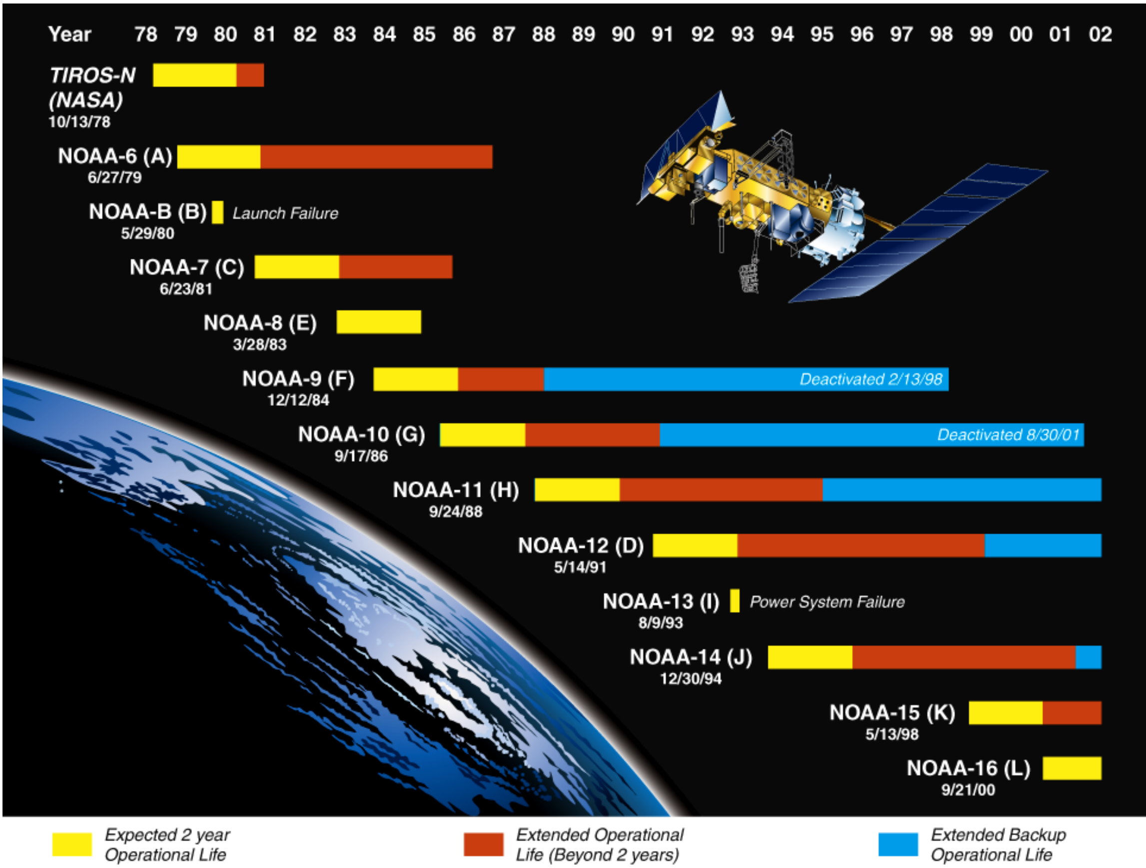
NOAA-M CHARACTERISTICS

Main body:	4.2 m (13.75 ft.) long, 1.88 m (6.2 ft.) diameter
Solar array:	2.73 by 6.14 m (8.96 by 20.16 ft.): 16.76 m^2 (180.63 ft.^{2})
Weight:	At lift-off ~2231.7 kg (4920 lbs.) Weight includes 756.7 kg of expendable fuel.
Lifetime:	Greater than 2 years
Load Power Requirements	833 Watts for 0° sun angle, 750 Watts for 80° sun angle

NOAA-M

Lockheed Martin Space Systems Company

NOAA-M is the latest in the advanced TIROS-N (ATN) series built by Lockheed Martin Space Systems Company (LMSSC). The spacecraft will continue to provide a polar-orbiting platform to support the environmental monitoring instruments for imaging and measurement of



This figure summarizes the operational and extended lifetimes of the TIROS satellites.

the Earth's atmosphere, its surface, and cloud cover, including Earth radiation, atmospheric ozone, aerosol distribution, sea surface temperature, vertical temperature and water profiles in the troposphere and stratosphere; measurement of proton and electron flux at orbit altitude; remote platform data collection; and for SARSAT. Additionally, NOAA-M is the third in the series to support dedicated microwave instruments for the generation of temperature, moisture, surface and hydrological products in cloudy regions where visible and infrared (IR) instruments have decreased capability.

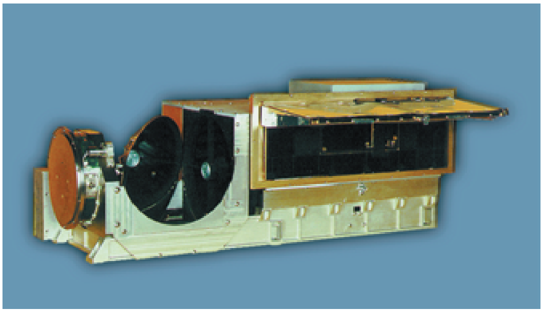
NOAA-M INSTRUMENTS

The NOAA-M primary instruments—HIRS, AVHRR, AMSU-A, and AMSU-B—have all been designed for a three-year mission. Detailed information for each primary instrument is found in Appendix A, as well as for the SBUV/2, which is designed for a two-year mission.

Further information is available on the web at http://poes.gsfc.nasa.gov, http://www2.ncdc.noaa.gov/docs/klm/index.htm, http://psbsgi1.nesdis.noaa.gov:8080/OSDPD/OSDPD2.html, and http://osdacces.nesdis.noaa. gov:8081/SATPROD. The NOAA-M spacecraft carries the following primary instruments (manufacturer is shown in italics).

ADVANCED VERY HIGH RESOLUTION RADIOMETER (AVHRR/3)

ITT A/CD



AVHRR/3

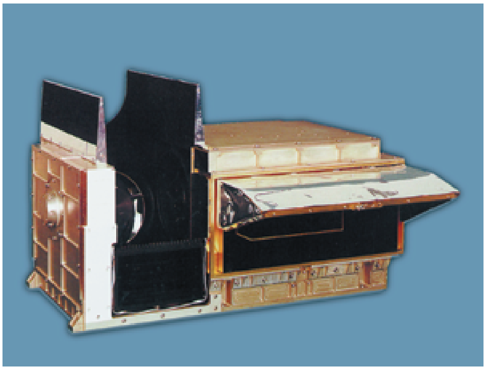
The AVHRR/3 is a six-channel imaging radiometer which detects energy in the visible and infrared (IR) portions of the electromagnetic spectrum. The instrument measures reflected solar (visible and near-IR) energy and radiated thermal energy from land, sea, clouds, and the intervening atmosphere. The instrument has an instantaneous field-of-view (IFOV) of 1.3 milliradians providing a nominal spatial resolution of 1.1 km (0.69 mi) at nadir. A continuously rotating elliptical scan mirror provides the cross-track scan, scanning the Earth from ± 55.4° from nadir. The mirror scans at six revolutions per second to provide continuous coverage.

The AVHRR/3 provides spectral and gain improvements to the solar visible channels that provide low light energy detection. Channel 3A, at 1.6 microns, provides snow, ice, and cloud discrimination. Channel 3A will be time-shared with the 3.7-micron channel, designated 3B, to provide five channels of continuous data. An external sun shield and an internal baffle have been added to reduce sunlight impingement into the instrument's optical cavity and detectors.

HIGH RESOLUTION INFRARED RADIATION SOUNDER (HIRS/3)

ITT-A/CD

The HIRS/3 is an atmospheric sounding instrument with one visible channel, seven shortwave IR channels, and 12 longwave IR channels. The IFOV for each channel is approximately 1.4° in the visible and shortwave IR channels, and 1.3° in the longwave IR band which, from an altitude of 833 km (517.6 mi), provides a nominal spatial resolution at nadir of 20.3 km (12.6 mi) and 18.9 km (11.7 mi), respectively. The scan mirror provides a cross-track scan of 56 steps of 1.8° each. Each Earth scan takes 6.4 seconds and covers ±49.5° from nadir. IR calibration of the HIRS/3 is provided by views of space and the internal warm target, each viewed once per 38 Earth scans.



HIRS/3

The instrument measures scene radiance in the infrared spectrum. Data from the instrument is used, in conjunction with the Advanced Microwave Sounding Unit (AMSU) instruments, to calculate the atmosphere's vertical temperature profile from the Earth's surface to about 40 km (24.9 mi) altitude. The data is also used to determine ocean surface temperatures, total atmospheric ozone levels, precipitable water, cloud height and coverage, and surface radiance.

ADVANCED MICROWAVE SOUNDING UNIT-A (AMSU-A)

Aerojet

The AMSU-A measures scene radiance in the microwave spectrum. The data from this instrument is used in conjunction with the HIRS to calculate the global atmospheric temperature and humidity profiles from the Earth's surface to the upper stratosphere, approximately a 2-millibar pressure altitude (48 km or 29.8 mi). The data is used to provide precipitation and surface measurements including snow cover, sea ice concentration, and soil moisture.

The AMSU-A is a cross-track scanning total power radiometer. It is divided into two physically separate modules, each of which operates and interfaces with the spacecraft independently. Module A-1 contains 13 channels and Module A-2 contains two channels.

The instrument has an IFOV of 3.3° at the half-power points providing a nominal spatial resolution at nadir of 48 km (29.8 mi). The antenna provides a cross-track scan, scanning ± 48.3° from nadir with a total of 30 Earth fields-of-view per scan line. The instrument completes one scan every 8 seconds.

ADVANCED MICROWAVE SOUNDING UNIT-B (AMSU-B)

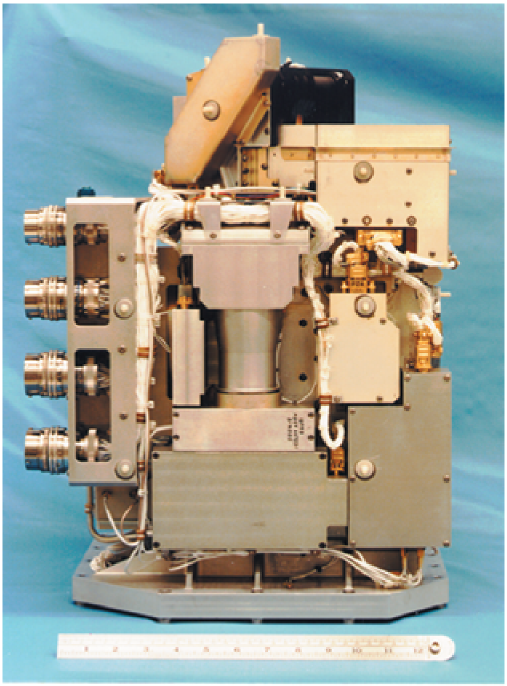
Astrium Limited via United Kingdom Meteorological Office

The AMSU-B is designed to allow the calculation of the vertical water vapor profiles from the Earth's surface to about a 200-millibar pressure altitude (12 km or 7.5 mi).

The AMSU-B is a cross-track, continuous line scanning, total power radiometer and provides measurements of scene radiance in five channels. The instrument has an IFOV of 1.1° (at the half-power points). Spatial resolution at nadir is nominally 16 km (9.94 mi). The antenna provides a cross-track scan, scanning ±48.95° from nadir with a total of 90 Earth fields-of-view per scan line. The instrument completes one scan every 2.66 seconds.

SOLAR BACKSCATTER ULTRAVIOLET RADIOMETER (SBUV/2)

Ball Aerospace



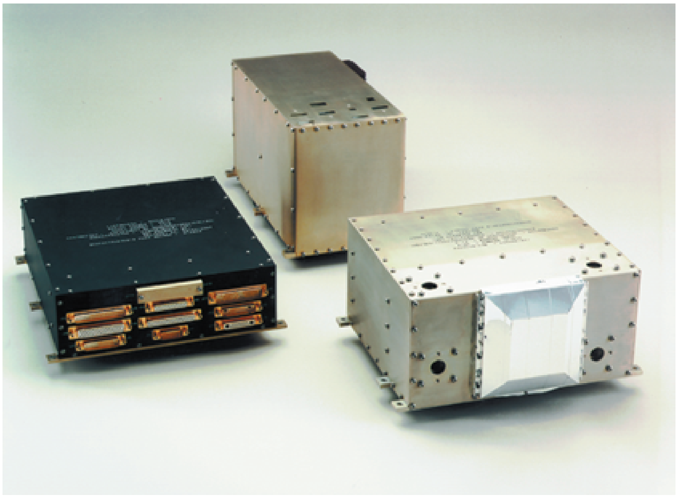
SBUV/2

The SBUV/2 is a nadir-pointing nonspatial spectrally scanning ultraviolet radiometer carried in two modules. The two modules are the Sensor Module with the optical elements/detectors and the Electronics Module. The overall radiometric resolution is approximately 1 nanometer (nm). Two optical radiometers form the heart of the instrument: a monochrometer and a “Cloud Cover Radiometer” (CCR). The monochrometer measures the Earth radiance directly and selectively the Sun when a diffuser is deployed. The CCR measures the 379-nm wavelength and is coaligned to the monochrometer. The output of the CCR represents the amount of cloud cover in a scene and is used to remove cloud effects in the monochrometer data.

The SBUV/2 measures solar irradiance and Earth radiance (backscattered solar energy) in the near ultraviolet spectrum (160 to 400 nm). The following atmospheric properties are measured from this data:

- The global ozone concentration in the stratosphere to an absolute accuracy of 1 percent
- The vertical distribution of atmospheric ozone to an absolute accuracy of 5 percent
- The long-term solar spectral irradiance from 160 to 400 nm
- Photochemical processes and the influence of “trace” constituents on the ozone layer.

SPACE ENVIRONMENT MONITOR (SEM-2)
Panametrics via NOAA Space Environment Center



Space Environment Monitor

The SEM/2 provides measurements to determine the intensity of the Earth's radiation belts and the flux of charged particles at the satellite altitude. It provides knowledge of solar terrestrial phenomena and also provides warnings of solar wind occurrences that may impair long-range communications, high-altitude operations, damage to satellite circuits and solar panels, or cause changes in drag and magnetic torque on satellites.

The SEM/2 consists of two separate sensor units and a common Data Processing Unit (DPU). The sensor units are the Total Energy Detector (TED) and the Medium Energy Proton and Electron Detector (MEPED).

The TED senses and quantifies the intensity in the sequentially selected energy bands. The particles of interest have energies ranging from 0.05 keV to 20 keV. The MEPED senses protons, electrons, and ions with energies from 30 keV to levels exceeding 6.9 MeV.

DATA COLLECTION SYSTEM (DCS/2)
CNES/France

Data collection platforms in the form of buoys, free-floating balloons, and remote weather stations transmit their data on a 401.65-MHz uplink to the spacecraft. The Data Collection System (DCS) measures environmental factors such as atmospheric temperature and pressure and the velocity and direction of the ocean and wind currents. The DCS collects and processes these measurements for on-board storage and subsequent transmission from the satellite.

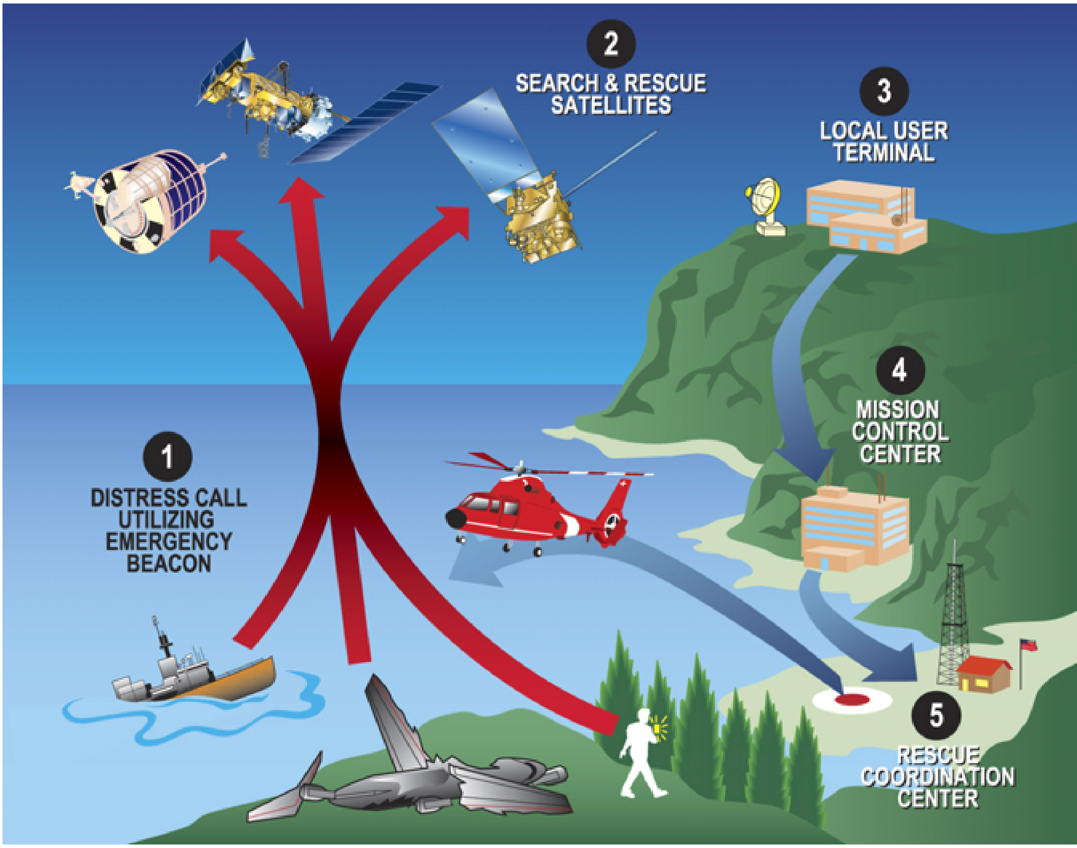
For free-floating telemetry transmitters, the system determines the location within 5 km (3.1 mi) to 8 km (5.0 mi) and “float” velocity to an accuracy of 1 meter per second (mps).

The stored data is transmitted to the ground once per orbit. Subsequently, the data is sent to the French Centre at the Centre National D’ Etudes Spatiales (CNES) in Toulouse, France and the Service Argos Facility in Lanham, Maryland, for processing, distribution to users, and storage for archival purposes.

SEARCH AND RESCUE (SAR) INSTRUMENTS
Search and Rescue Repeater (SARR) DND/Canada
Search and Rescue Processor (SARP) CNES/France

The Search and Rescue instruments are part of the international COSPAS-SARSAT system designed to detect and locate Emergency Locator Transmitters (ELTs), Emergency Position-Indicating Radio Beacons (EPIRBs), and Personal Locator Beacons (PLBs) operating at 121.5, 243, and 406.05 MHz. The NOAA spacecraft carries two instruments to detect these emergency beacons: the Search and Rescue Repeater (SARR) provided by Canada and the Search and Rescue Processor (SARP-2) provided by France. Similar instruments are carried by the Russian COSPAS polar-orbiting satellites.

The SARR transponds the signals of 121.5, 243, and 406.05-MHz emergency beacons. However, these beacon signals are detected on the ground only when the satellite is in view of a ground station known as a Local User Terminal (LUT). The SARP detects the signal only from 406.05-MHz beacons but stores the information for subsequent downlink to a LUT. Thus, global detection of 406.05-MHz emergency beacons is provided.



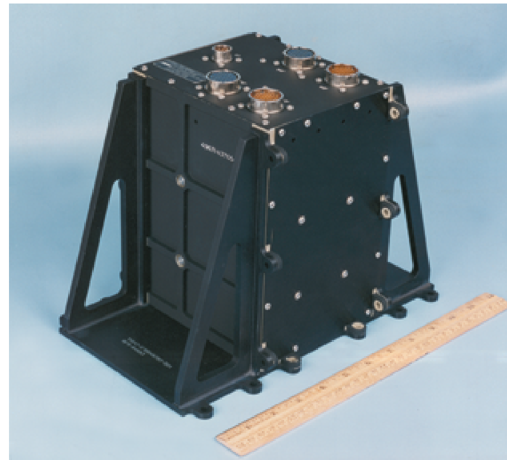
Search and Rescue Sequence of Events

After receipt of information from a satellite's SARP or SARR, a LUT locates the beacons by Doppler processing. The 121.5-MHz and 243-MHz beacons are located with an accuracy of approximately 20 km (12.4 mi), whereas the 406.05-MHz beacons are located with an accuracy of approximately 4 km (2.5 mi). The LUT forwards the located information to a corresponding Mission Control Center (MCC), which, after further processing, forwards the information to an appropriate Rescue Coordination Center that effects search and rescue.

The U.S. fishing fleet is required to carry 406.05-MHz emergency beacons. The 406.05-MHz beacons are also carried on most large international ships, some aircraft, and pleasure vessels, as well as on terrestrial carriers. The 121.5-MHz and 243-MHz beacons are required on many small aircraft with a smaller number carried on maritime vessels.

SOLID STATE RECORDER (SSR) DIGITAL TAPE RECORDER (DTR)

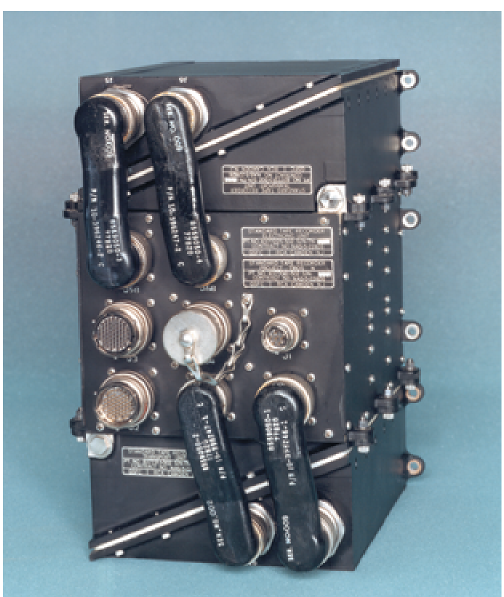
L-3 Communications



Solid State Recorder

The Solid State Recorder and Digital Tape Recorders are complete recording/data storage systems that store selected sensor data during each orbit for subsequent playback. The recorders are part of the Command and Data Handling subsystem of the spacecraft that downloads to the Command and Data Acquisition Stations. A hybrid configuration of four DTRs and one SSR are on the NOAA-M spacecraft to provide multiple data streams, storage capacity, and hardware redundancy.

The DTR consists of an electronics unit containing the data conditioning circuitry, command and telemetry subsystems, power supply, timing references, and spacecraft interfaces. Two pressurized transport units each contain a coaxial reel-to-reel tape transport with associated gearless and motorless negator-spring tape tensioning system, bearing assemblies, motor/capstan, record/playback and erase heads, and record/playback electronics. Each DTR has a nominal storage capacity of 1 Gbit and selectable playback rates up to 2.66 Mbps.

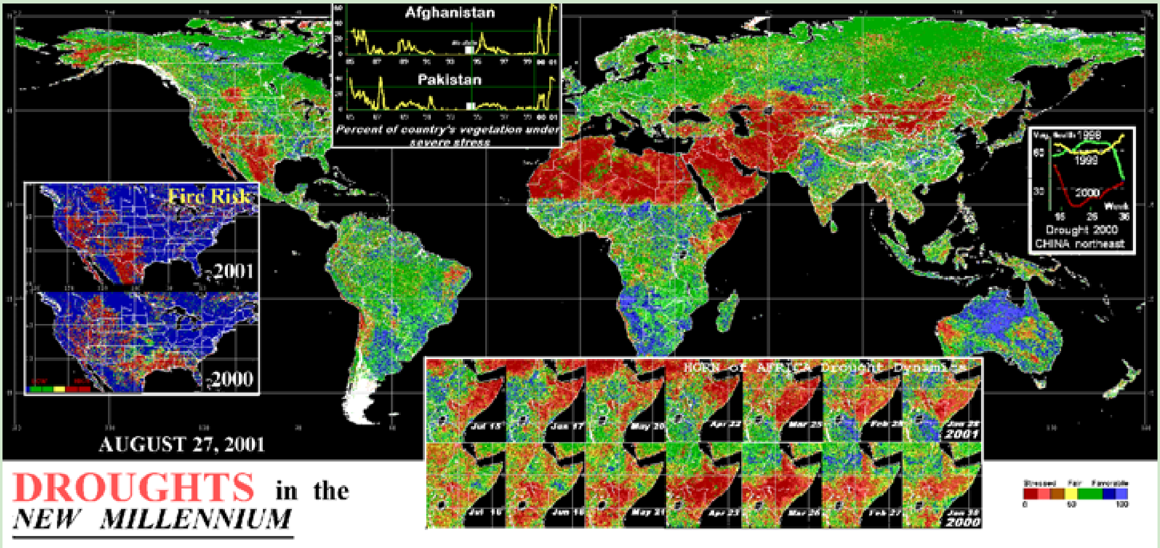


Digital Tape Recorder

The SSR performs identical functions to the DTR using solid state Dynamic Random Access Memory (DRAM) devices instead of magnetic tape and its associated electromechanical elements. It provides an increased storage capacity of 2.8 Gbits and superior bit error rate performance with its custom Error Detection and Correction (EDAC) circuitry.

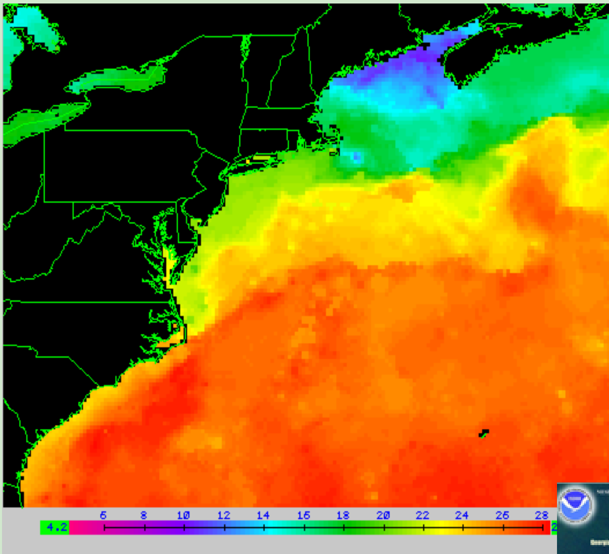
POLAR OPERATIONAL ENVIRONMENTAL SATELLITE PRODUCTS

The NOAA polar operational environmental satellites collect global data on cloud cover; surface conditions such as ice, snow, and vegetation; atmospheric temperatures; and moisture, aerosol, and ozone distributions; and collect and relay information from fixed and moving data platforms. The primary imaging system, the AVHRR/3, consists of visible, near IR, and thermal IR channels. The primary sounding suite flying on NOAA-M is the HIRS/3, AMSU-A, and AMSU-B, which measure atmospheric temperature and humidity. The SBUV-2 instrument is both an imager and a sounder. As an imager, it produces total column ozone maps. As a sounder, it obtains and measures the ozone distribution in the atmosphere as a function of altitude. The SEM-2 contains two sets of instruments that monitor the energetic charged-particle environment near Earth. The TED in SEM-2 provides the data used to determine the level of auroral activity. The SEM-2 MEPED includes four solid-state detector telescopes that are designed to monitor the intensities of energetic particles in the Earth's radiation belts and during solar particle events. Examples of products derived from the processed data follow.



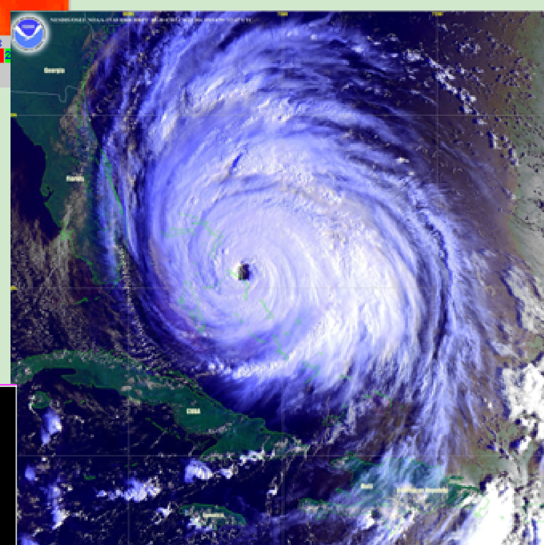
A new satellite-based method for early detection, monitoring, and analysis of drought, using data from the AVHRR, shows that nearly 20 percent of the world's landmass has been stricken by drought during the first two years of the new millennium. During the two-year period, active fires consumed large amounts of forest resources in the northwestern United States. In the Horn of Africa, early drought signs were recorded in January 2000. Over the next four months, the drought expanded and intensified so much that it turned into a national disaster.

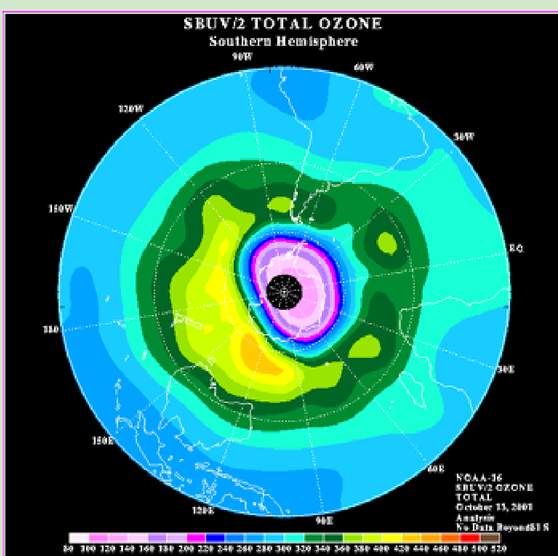
NOAA provides satellite-based early drought warnings and related products to customers around the world. Some of the information can be found at http://orbit-net.nesdis.noaa.gov/crad/sat/surf/vci.



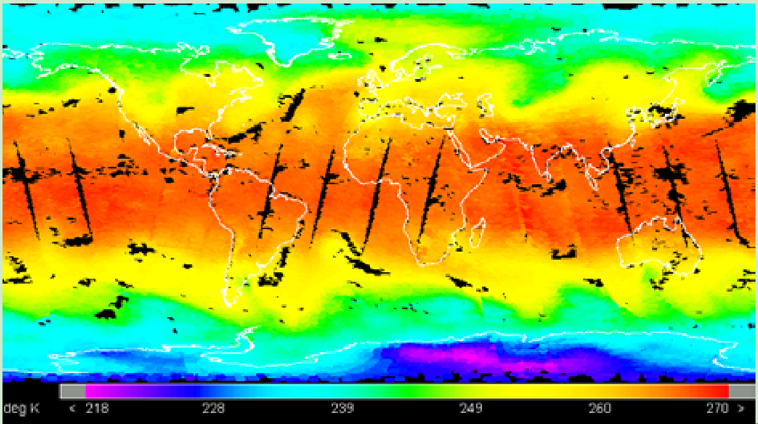
Sea surface temperature products are routinely produced from the AVHRR instruments at global, regional, local, and coastal scales. This image is an example of a local product that shows sea surface temperatures for the North Atlantic off the coast of the United States produced at 14-km resolution from NOAA-16 on October 1, 2001.

This NOAA-15 image of Hurricane Floyd was produced on September 14, 1999. Hurricane Floyd, a Category 4 storm at the time of this image, had sustained winds near the eye of 125 knots (144 miles per hour) and tropical storm-force winds extended outward about 290 miles from the center. This high-resolution 1.1-km image was produced from a composite of channels 1, 2, and 4 from the AVHRR instrument.

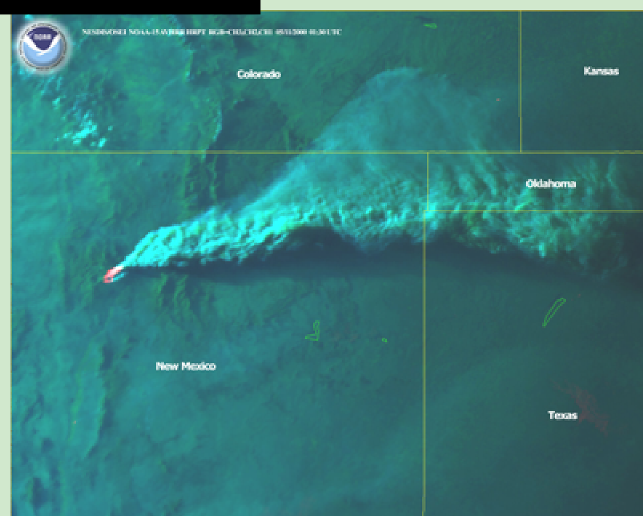




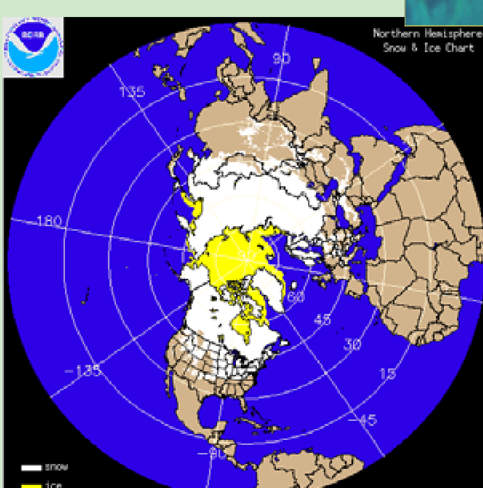
This image of the total ozone product, generated from NOAA-16's SBUV instrument, clearly depicts the Antarctic ozone hole in October 2001. The SBUV instrument is normally flown on POES afternoon satellites. However, because NOAA-M will have a 10:00 a.m. rather than a 7:30 a.m. sun-synchronous orbit, it will have an SBUV instrument. This instrument provides for the generation of individual ozone profiles and layer ozone values from the surface to 0.01 millibar (mb).



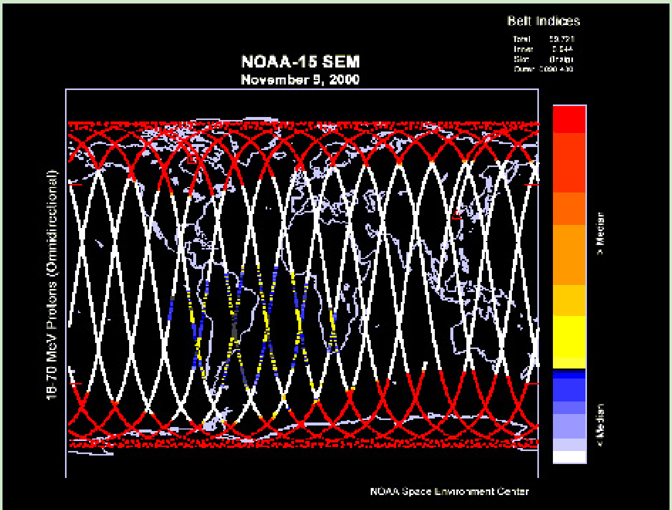
Global atmospheric temperatures are derived from the AMSU-A and HIRS instruments. Temperature products are produced at 40 atmospheric levels from 0.1 mb to 1000 mb. This 500-mb image is from 18 hours of NOAA-16 data, produced on October 10, 2001.



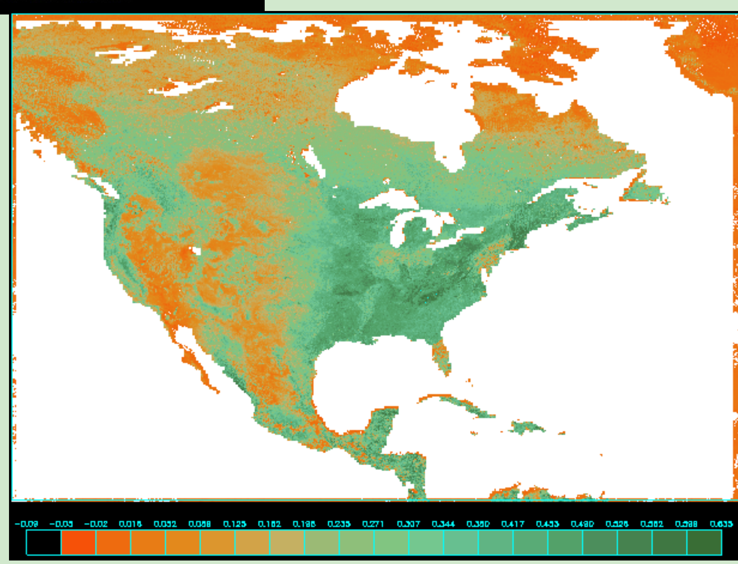
Heat signatures (red) and smoke (light blue haze) are visible from a fire burning near Los Alamos, New Mexico on May 11, 2000. This image was derived by means of a composite of visible and infrared data using the high-resolution NOAA-15 AVHRR instrument data.



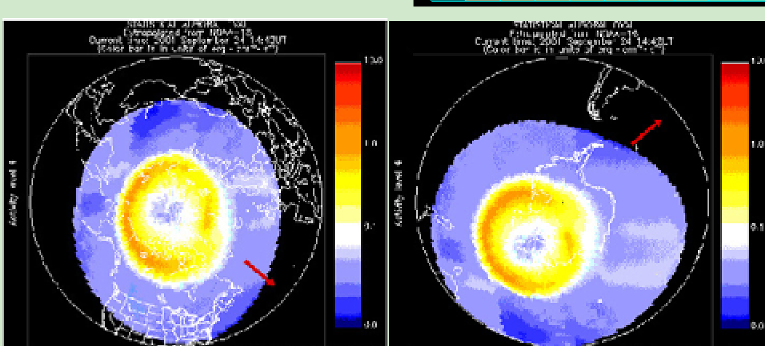
Normalized Difference Vegetation Index (NDVI) products measure the "greenness" of the Earth's surface, which gives an estimation of the density and coverage of green vegetation. NDVI images, derived from AVHRR data, are produced for global and regional scales. Values of the NDVI denote vegetation, rocks and bare soil, or clouds, rain, and snow. This image was produced for North America on October 2, 2001.



This display, generated from NOAA-15's SEM-2 MEPED, shows the responses of the solid-state "dome" detectors that measure the intensities of protons between 16 MeV and 70 MeV throughout the day compared with the median responses of that detector over the past year. The red box shows the satellite location at the beginning of the day. The red triangle shows its location at the time of the last data download.



Snow and sea ice products are generated from the blending of data from the AVHRR and AMSUs, in addition to data from other satellite systems. The new channel 3a (1.6 micron) on the AVHRR can distinguish snow cover from clouds. This image was produced for the northern hemisphere on January 5, 2001. Snow cover is shown in white, while sea ice is yellow.



These plots, generated from the SEM-2 TED, show the current extent and position of the auroral oval at each pole, extrapolated from measurements taken during a polar pass of the NOAA-16 POES satellite. "Center time" is the calculated time halfway through the satellite's pass over the pole.

TITAN II LAUNCH VEHICLE

Lockheed Martin Space Systems Company

The NOAA-M satellite will be launched from the Western Range at Vandenberg Air Force Base, California, by a Titan II space launch vehicle (SLV). The Titan II SLV consists of a Titan II intercontinental ballistic missile that has been converted to an SLV configuration through the extensive use of technology and hardware developed during the Titan III and IV programs. It is capable of placing 5,000 lbs (2,268 kg) into a polar low-Earth orbit.

The Titan II SLV is 34.75 m (114 ft) tall and 3.05 m (10 ft) in diameter. Its trisector payload fairing is 6.1 m (20 ft) long and 3.05 m (10 ft) in diameter. A 1.392-m (54.8-in) diameter conical adapter fitting fastens the NOAA-M spacecraft to the launch vehicle. The fairing attached to the forward face of the launch vehicle protects the spacecraft during flight. The Titan II SLV is a two-stage liquid-fueled vehicle. Each stage employs a hypergolic fuel — “Aerozine 50” (50 percent hydrazine, 50 percent unsymmetrical dimethylhydrazine [UDMH]) and a nitrogen tetroxide oxidizer which are pressurized with dry nitrogen.

In-flight guidance is provided by an on-board inertial guidance system (IGS) that is also used on the Titan IV launch vehicle. The IGS is located on a structural truss between the fuel and oxidizer tanks on Stage II. The IGS consists of an Inertial Measurement Unit (IMU) that contains a gimbaled platform with three integrating gyro accelerometers and a missile guidance computer (MGC), which is a random access, thin film core memory, parallel, binary, digital computer. The IGS is an integral part of the SLV’s flight control system. The flight control sys-

TITAN II SLV Engine Data (Vacuum)

	Stage 1	Stage 2
No. of Engines	2	1
Thrust per engine (lb)	474,000	100,000
Thrust per engine (N)	2,108,352	448,000
Thrust duration from lift-off (sec)	150	326

tem consists of software in the MGC, a Stage I attitude rate gyro, and hydraulic actuators to gimbal the Stage I and II engine nozzles.

The NOAA-M launch and orbit insertion sequence starts at T-3.2 seconds with a thrust buildup period following Stage I engine ignition. After 3.2 seconds, hold-down bolts are fired and the SLV lifts off. After clearing the launch pad, the SLV rolls to its desired flight azimuth, then begins to pitch over in the trajectory plane. At approximately 150 seconds after lift-off, a commanded shutdown occurs based upon control logic that uses the open loop pitch rate for a time-to-go calculation. The control logic then provides a signal that ignites the Stage II engine and fires separation nuts to separate Stage I. The payload fairing is jettisoned at approximately T+224 seconds, followed by an IGS-initiated Stage II shutdown at approximately T+326 seconds. The spacecraft then separates from stage II approximately 65 seconds after Stage II shutdown, once the required attitude and attitude rates have been met.

APOGEE KICK MOTOR (AKM)

ATK Tactical Systems Company

ATK Tactical Systems Company's (formerly Thiokol Corporation) Star 37XFP AKM solid rocket motor is used to circularize the orbit after spacecraft separation. This 94-cm (37-in) spherical rocket motor provides an average 42.38kN (9,455 lbs) of thrust during a motor burn time of 51 seconds. The Star 37XFP motor, which is attached to the NOAA-M spacecraft, remains with the spacecraft after burnout.

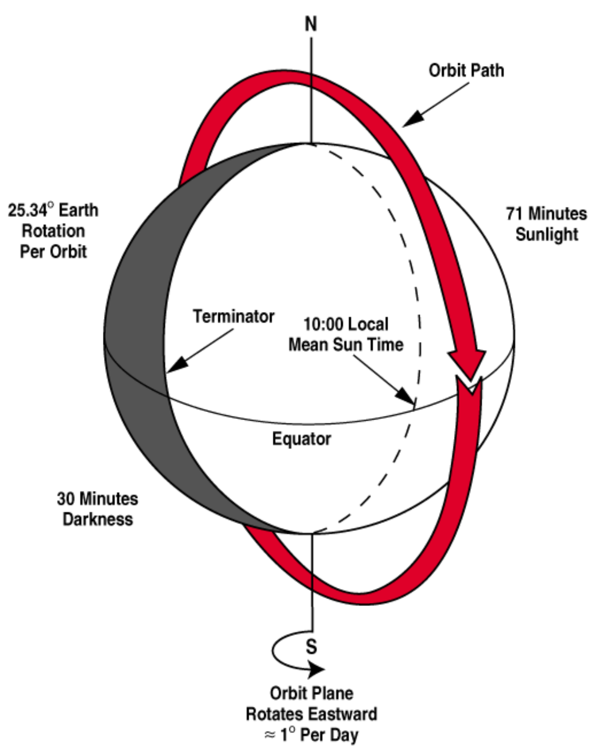
NOAA-M ORBIT

NOAA-M is a three-axis stabilized spacecraft that will be launched into an 833-km (450-nmi) circular, near-polar orbit with an inclination angle of 98.7° (retrograde) to the Equator.

The total orbital period will be approximately 101.35 minutes. The sunlight period will average about 71 minutes, and the Earth shadow period will average about 30 minutes. Because the Earth rotates 25.34° during each NOAA-M orbit, the satellite observes a different portion of the Earth's surface during each orbit.

The nominal orbit is planned to be Sun-synchronous and precesses (rotates) eastward about the Earth's polar axis 0.986° per day (the same rate and direction as the Earth's average daily rotation about the Sun). The precession keeps the satellite in a constant position with reference to the Sun for consistent illumination throughout the year.

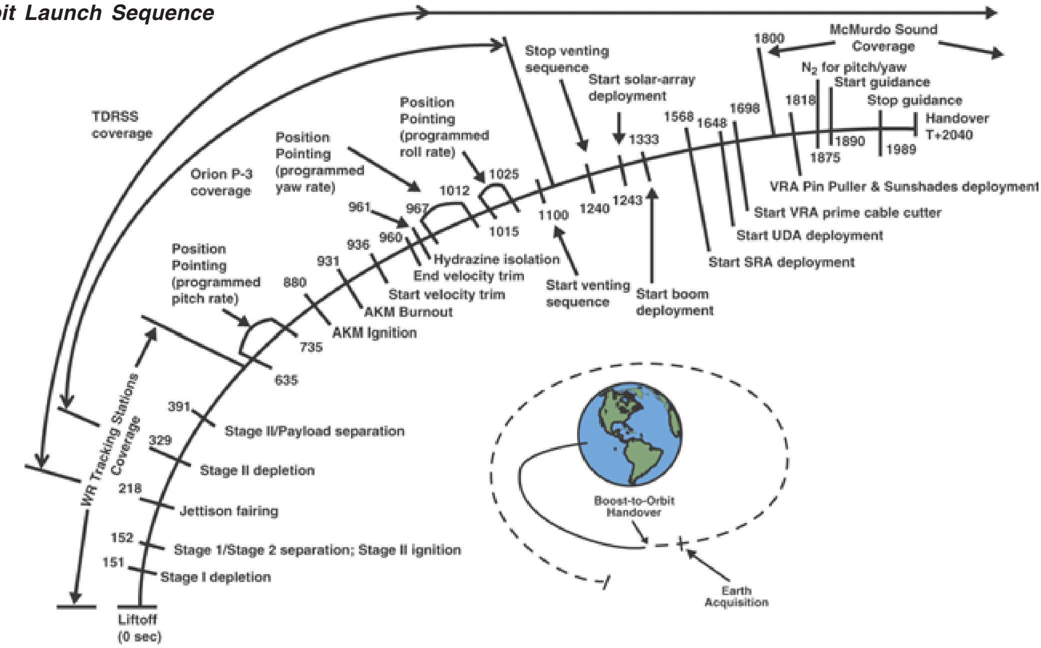
NOAA-M will be launched at 11:22 a.m. Pacific Daylight Time (PDT). The spacecraft will be launched so that it will cross the Equator at about 10 p.m. northbound and 10 a.m. southbound local solar time.



ORBITAL CHARACTERISTICS

Apogee	833 km (450 nmi)
Perigee	833 km (450 nmi)
Minutes per orbit	101.35
Degrees inclination	98.7465

Orbit Launch Sequence



NOAA-M Major Launch Events

Event	Time From Lift-off (seconds)
Lift-off	0.0
Stage 1 Depletion	150.5
Stage I/Stage II Separation	151.5
Jettison Fairing	218.0
Stage II/Payload Separation	391.0
Pitch Rate - Start	635.0
Pitch Rate - Stop	735.0
AKM Ignition	880.0
AKM Burnout	931.0
Start Velocity Trim	936.0
End Velocity Trim	960.0
Start Venting Sequence	1100.0
Stop Venting Sequence	1240.0
Solar Array Deployment	1243.0
Boom Deployment	1333.0
SRA Deployment	1568.0
UDA Deployment	1648.0
VRA Prime Cable Cutter	1698.0
VRA Pin Puller	1818.0
Sunshades Deployment	1818.5
N2 for Pitch/Yaw	1875.0
Start Guidance	1890.0
Stop Guidance	1989.0
Handover	2040.0

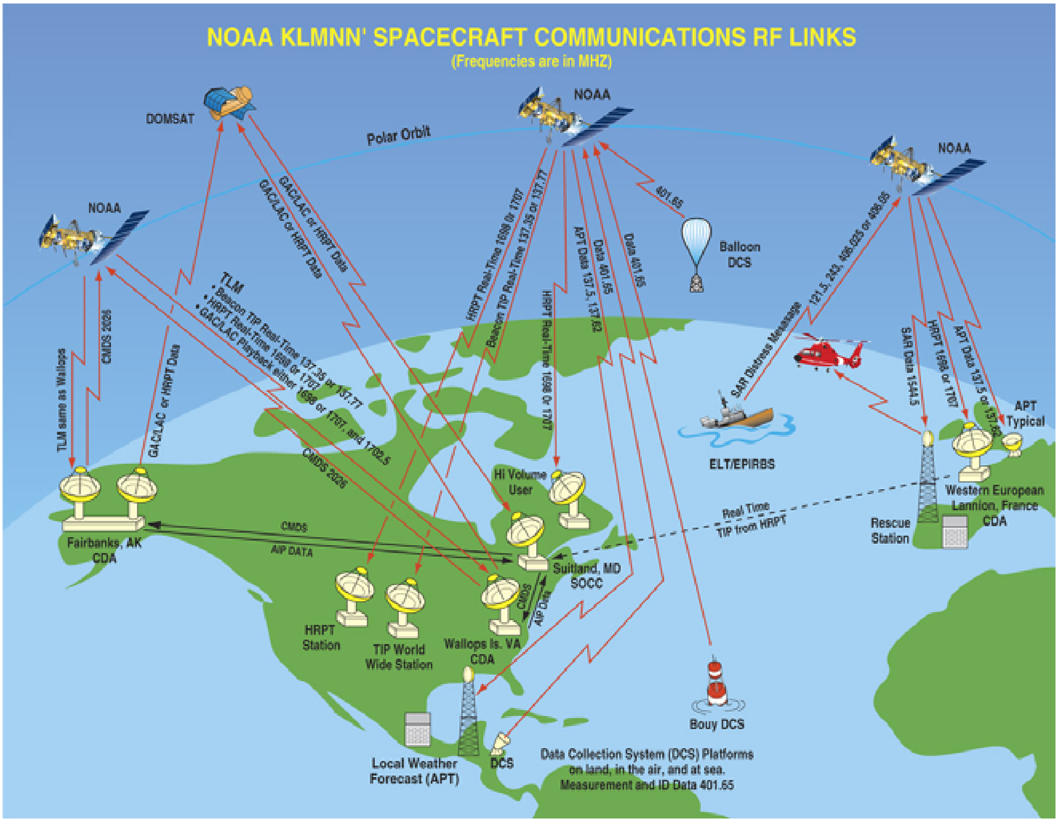
SPACECRAFT DATA COMMUNICATIONS

The spacecraft transmits instrument data to the ground for three primary functions: Command and Data Acquisition (CDA), Direct Broadcast, and Search and Rescue.

COMMAND AND DATA ACQUISITION (CDA) STATION DOWNLINKS

CDA stations located at Fairbanks, Alaska, and Wallops Island, Virginia, receive stored Global Area Coverage (GAC) and Local Area Coverage (LAC) data from each spacecraft. The CDAs can also receive real-time data when the satellites are within the direct readout footprint.

GAC data is recorded and contains satellite housekeeping information, AMSU data, and 4-km (2.5-mi) resolution AVHRR imagery. GAC data contains over 100



NOAA KLMNN' Spacecraft Communications RF Links (Frequencies are in MHz)

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minutes of imagery and is transmitted to a NOAA ground CDA station for relay to centralized viewers.

LAC data is recorded information that contains 1-km (0.6-mi) AVHRR imagery. LAC data is recorded for up to 10 minutes and transmitted to a NOAA ground CDA station for relay to centralized users.

High Resolution Picture Transmission (HRPT) is a real-time transmission of instrument data and satellite housekeeping data. CDA stations intercept HRPT data primarily for satellite housekeeping data, but also relay the higher resolution data to centralized users.

DIRECT BROADCAST DOWNLINKS

For more than 30 years, NOAA has freely and openly provided satellite data through direct broadcast to users in the United States and in 100 other countries throughout the world. In the United States, any commercial firm receiving data through direct readout may provide tailored products to customers and/or viewers.

There are three types of direct broadcasting: (1) the real-time HRPT, (2) the direct sounder broadcast (DSB), also referred to as the real-time very high frequency (VHF) beacon transmissions, and (3) the Automatic Picture Transmission (APT).

High Resolution Picture Transmission (HRPT)

HRPT provides worldwide direct readout of full resolution spacecraft parameters and instrument data to ground stations within the footprint of the NOAA polar orbiters. The HRPT service was originally designed to provide timely day and night sea surface temperature, ice, snow, and cloud cover information to diverse users, but applications have expanded due to the proliferation of moderately priced equipment and software. HRPT transmissions contain data from all instruments aboard the NOAA polar satellites. The data stream includes information from the TIROS Information Processor (TIP), the AMSU Instrument Processor (AIP) and from the AVHRR/3 providing five of six channels at 1-km (0.62-mi) resolution. The TIP contains spacecraft attitude data, time codes, housekeeping, and low rate instrument science data from the HIRS/3, SEM/2, DCS/2 and the SBUV. The AMSU-A and AMSU-B are also included in HRPT from the (AIP).

To receive the data, users can purchase the necessary equipment (computer, software, antenna) from commercial companies for unlimited access to the HRPT signals. In 2000, there were 628 HRPT receivers worldwide registered with the World Meteorological Organization (WMO).

Direct Sounder Broadcasting (DSB)

VHF beacon transmission is available to users who do not intend to install the more complex equipment necessary to receive high data rate S-band service. The lower data rate from the TIP permits the user to install less complex, less costly equipment to receive the data (HIRS/3, SEM/2, DCS/2, but not AMSU).

Parallel outputs are provided for the DSB real-time VHF beacon transmission and for the Manipulated Information Rate Processor (MIRP) HRPT S-band links. The instrument data is multiplexed with analog and digital housekeeping data. The TIP output directly modulates the beacon transmission. The data is transmitted as an 8.32 kbps split phase signal over one of the beacon transmitters at 137.35 MHz and 137.77 MHz.

Automated Picture Transmission (APT) Data

APT is smoothed 4-km (2.5 mi) resolution IR and visible imagery derived from the AVHRR/3 instrument and transmitted within the footprint of the NOAA polar orbiters. Since APT is captured on low-cost VHF ground stations, it is also very popular in schools. Users purchase the necessary equipment (computer, software, antenna) from commercial companies for unlimited access to APT signals. In 2000, there were 4,907 APT receivers worldwide registered with the WMO.

The Satellite Operations Control Center (SOCC) can program any two of the active five AVHRR channels provided to the MIRP can be selected and processed as "Video A" and "Video B." One APT line, consisting of one line of Video A and one line of Video B, is output every third AVHRR scan. Ancillary AVHRR data appears at one edge of each line and their 64-second repetition period defines the APT frame length. The resulting line rate is two per second. The data is transmitted continuously over a dedicated VHF link as an analog signal consisting of an amplitude-modulated 2400-Hz subcarrier frequency modulating the RF carrier at 137.50 MHz or 137.62 MHz

SEARCH AND RESCUE DOWNLINKS

For information about SAR, please refer to the previous section titled *Search and Rescue Instruments* that begins on page NOAA-M/8.

NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE

SATELLITE OPERATIONS CONTROL CENTER (SOCC)

The control center for satellite operations is located at Suitland, Maryland. SOCC is responsible for operational control of the entire ground system and the following areas:

CDA Stations - The primary command and data acquisition stations are located at Fairbanks, Alaska, and Wallops Island, Virginia. Through a cooperative agreement between NOAA/NESDIS and the Establissement d'Etudes et de Reserches Meteorologiques in France, real-time TIP data can be relayed from the Lannion Centre de Meteorologie Spatiale (CMS) in France via a data link provided by NOAA to the United States.

The CDA stations transmit commands to the satellites and acquire and record environmental and engineering data from the satellites for retransmission to the SOCC. All data and commands are transmitted between the SOCC and the CDAs via commercial communications links.

Ground Communications - The ground communications links for satellite operations are provided by the Satellite Communications Network (SATCOM) and NASA Integrated Services Network (NISN-formerly NASCOM). NISN provides launch-unique communications links for satellite launch. SATCOM provides all voice and data links between SOCC and the CDA stations after launch. NESDIS provides and operates SATCOM.

NESDIS CENTRAL ENVIRONMENTAL SATELLITE COMPUTER SYSTEM (CEMSCS)

CEMSCS acquires the data from the CDA stations via the SOCC and is responsible for data processing and the generation of meteorological products on a timely basis to meet the POES program requirements. NOAA provides all hardware and software for CEMSCS. NOAA will provide ephemeris data.

OTHER SUPPORT SYSTEMS

SAR GROUND SYSTEM (LUTS AND USMCCS)

The U.S. LUTs are located at Fairbanks, Alaska; Vandenberg AFB, California; Wahiawa, Hawaii; Johnson Space Center, Houston, Texas; NOAA, Suitland, Maryland; Anderson AFB, Guam; and Sabana Seca, Puerto Rico. The LUTs receive the SAR data from the satellite, determine the distress location, and forward the data to the U.S. MCC (USMCC) at Suitland, Maryland. The USMCC determines the proper Rescue Coordination Center and forwards the distress location data after removing redundant information. The U.S. LUTs and the USMCC are part of the International Cospas-Sarsat Program that consists of 33 countries of which 24 provide MCCs and LUTs. All MCCs cooperate in forwarding data to provide rapid global delivery of distress locations received through the satellites.

GODDARD SPACE FLIGHT CENTER FACILITY SUPPORT

The Office of Space Communications associated support is requested through the Mission Requirements Request and the Detailed Mission Requirements documents, with other support as described in Memoranda of Understanding. NASA/GSFC provides nominal prelaunch orbital and prediction information, special support for initial orbit estimation, and initial quality control checks of the North American Air Defense (NORAD) orbital data. All ground attitude determination is to be accomplished by the NOAA central data processing facility.

THE NORTH AMERICAN AIR DEFENSE COMMAND (NORAD)

NORAD has prime responsibility for orbit determination, which includes establishing the initial orbit solution and providing updated orbital parameters routinely throughout the life of the mission.

LAUNCH, EARLY ORBIT, AND CONTINGENCY DOWNLINK

An S-band downlink operating at 2247.5 MHz is used during satellite ascent to recover TIP boost telemetry through Western Range tracking sites. During on-orbit operations, orbit mode TIP will be available on this link to provide early-orbit and contingency support through the ground tracking network operated by the Air Force Satellite Control Network in Sunnyvale, California, and the Jet Propulsion Lab (JPL) Deep Space Network (DSN), which provides contingency command uplink capability. The McMurdo Tracking Facility in Antarctica also provides early orbit telemetry and command support. The Tracking and Data Relay Satellite System provides tracking and telemetry support.

Synopsis of Prior Spacecraft

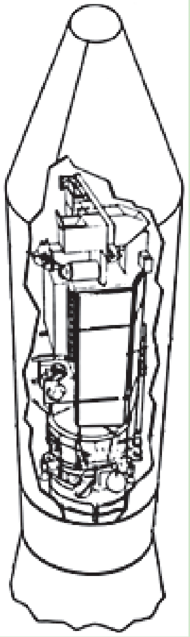
TIROS-N was launched October 13, 1978, into a 470-nmi (870-km) orbit and was the first in the series of a fourth-generation operational environmental satellite system. TIROS-N was a research and development spacecraft serving as a protoflight for the operational follow-on series, NOAA-A through N' spacecraft. The spacecraft was deactivated following an Inertial Measurement Unit (IMU) power supply failure on February 27, 1981.

NOAA-A (6) was launched June 27, 1979, into a 450-nmi (833-km) orbit. The HIRS, a primary mission sensor, failed September 19, 1983. The satellite greatly exceeded its two-year lifetime and was totally deactivated on March 31, 1987, after nearly eight years of operational service.

NOAA-B was launched May 29, 1980, and failed to achieve a usable orbit because of a booster engine anomaly.

NOAA-C (7) was launched June 23, 1981, into a 470-nmi (870-km) orbit. The HIRS, a primary mission sensor, failed February 7, 1985. The spacecraft was deactivated in June 1986 following a failure in the power system.

NOAA-E (8) was launched March 28, 1983, into a 450-nmi (833-km) orbit. It was the first of the ATN satellites and included a stretched structure to provide growth capability; it also included the first SAR package. The redundant crystal oscillator (RXO) failed after 14 months in orbit. The RXO recovered from its failure, finally locking up on the backup RXO in May 1985. The satellite was stabilized and declared operational by NOAA on July 1, 1985. NOAA-E (8) was finally lost on December 29, 1985, following a thermal runaway that destroyed a battery.



POES in launch configuration

NOAA-F (9) was launched December 12, 1984, into a 470-nmi (870-km) afternoon orbit. The MSU, a primary mission sensor, failed May 7, 1987. The Digital Tape Recorder (DTR) 1A/1B failed two months after launch. The Earth Radiation Budget Experiment (ERBE) scanner stopped outputting science data in January 1987. Earlier in the mission, the AVHRR periodically exhibited anomalous behavior in its synchronization with the Manipulated Information Rate Processor (MIRP). The SBUV/2 and the Stratospheric Sounding Unit (SSU) instruments aboard continued to operate satisfactorily. The satellite also had real-time and global Search and Rescue (SAR) on board. The Microwave Sounding Unit (MSU) channels 2 and 3 failed, and the satellite's power system was degraded. In August 1995, a very high power overvoltage condition resulted in the failure of the MIRP, the AVHRR, Battery #1 charge regulator, and IMU temperature control amplifier. The MIRP failure also resulted in the loss of the global SAR data via the Global Area Coverage (GAC) data stream. The satellite's ability to collect, process, and distribute SBUV/2, SSU, and ERBE-Nonscanner (NS) data was now limited to stored TIROS Information Processor (TIP) data. The SARR transmitter failed on December 18, 1997. The satellite was deactivated on February 13,1998.

NOAA-G (10) was launched September 17, 1986, into a 450-nmi (833-km) morning orbit. The ERBE-Scanner exhibited a scan sticking anomaly that is apparently generic to the instrument. The SAR Processor (SARP) 406 MHz receiver also failed. The SARP was used to provide global SAR data before its failure. In December 1994, the AVHRR IR channels were damaged and remained severely degraded from a satellite tumble caused by an overflow of the satellite's ephemeris clock. NOAA-10 was placed in standby on September 17, 1991 (the date NOAA-12 became fully operational). In January 1997, the MSU scanner displayed anomalous readings. The telemetry indicated that the digital encoder failed. The MSU scanner motor was commanded off in February 1997. A MIRP-related missing minor frame anomaly occurred in August 1998. The HRPT data is unusable due to an unstable MIRP and a faulty AVHRR. The satellite was deactivated on August 30, 2001.

This computer-generated image of the continents with the vegetation of the Earth superimposed over it is based on data provided by the AVHRR, aboard the NOAA-7, -8, and -11 satellites

NOAA-H (11) was launched September 24, 1988, into a 470-nmi (870-km) afternoon orbit. The AVHRR, a primary mission sensor, failed September 13, 1994. It is currently in a standby operational mode transmitting global and real-time SAR data directly to local users around the world. The NOAA-H (11) was modified for a 0° to 80° Sun angle and includes fixed and deployable sunshades on the Instrument Mounting Platform. The increase of maximum Sun angle from 68° to 80° allows an afternoon nodal crossing closer to noon to enhance data collection. The SSU instrument and the power subsystems operate satisfactorily. In October 1994, the SBUV/2 diffuser failed; however, the instrument continues to collect global ozone data. In April 1995, DTRs 1B and 5A/B failed to operate. Two gyros have failed and attitude control is being maintained through the use of new reduced gyro flight software. In addition, before the NOAA-D launch, a gyroless flight software package was installed on NOAA-11 to provide attitude control, at expected reduced accuracy, should the X-gyro fail. The satellite was placed in standby mode in March 1995, and was reactivated to provide soundings after a NOAA-12 HIRS filter wheel anomaly in May 1997. The MSU stopped scanning in February 1999. The MSU science data is no longer usable, so the instrument was powered off in March 1999. The HIRS filter wheel stopped moving on April 13, 2000. The HIRS instrument was subsequently turned off on April 26, 2000.

NOAA-D (12) was launched on May 14, 1991, into a 450-nmi (833-km) morning orbit and is currently the semi-operational backup morning satellite. It replaced NOAA-G (10) in orbit; however, it does not have a SAR package on board. The Skew Gyro periodically exhibits a high drift rate, which is corrected with real-time operational command procedures. In May 1997 the HIRS filter wheel mechanism degraded to the point that soundings were unusable. The remaining instruments and other subsystems continue to operate satisfactorily. NOAA-12 was placed in standby mode on December 14, 1998, when NOAA-15 became operational.

NOAA-I (13) was launched on August 9, 1993, into a 470-nmi (870-km) afternoon orbit. On August 21, 1993, two weeks after launch, the spacecraft suffered a power system anomaly. All attempts to contact or command the spacecraft since the power failure have been unsuccessful.

NOAA-J (14) was launched on December 30, 1994, into a 470-nmi (870-km) afternoon orbit and is currently designated the backup afternoon satellite. A few hours after launch, a GN_2 regulator valve leak caused the spacecraft to experience an attitude anomaly. The satellite was recovered within hours and remains in a stable orbit. In January 1995, it was determined that one of the four Space Environment Monitor (SEM) telescopes was inoperative, reducing data collected by 12 percent. In February 1995, the SARP failed, the SBUV/2 Cloud Cover Radiometer (CCR) failed, and DTR 4A/4B was deemed inoperable. Also, the ESA exhibited high Quadrant 3 (Q3) data counts due to apparent contamination of the detector. In March 1995, the MSU scanner seized and the instrument was powered off. After three weeks, the MSU was powered on and has been operating satisfactorily since. Flight software was modified in April 1995, to correct the high ESA Q3 counts and to turn off the MSU should the scanner seize up again. Between April 1995 and December 1996 the SBUV grating drive experienced significant degradation. The grating drive control was reprogrammed to compensate for these problems as well as for the CCR failure. All other instruments operate satisfactorily. In November 1995, the Demodulator portion of the Command Receiver and Demodulator (CRD) for On-board Processor #1 (OBP1) failed, resulting in the loss of the backup OBP. OBP1 was commanded off. Flight software and ground software packages were modified to permit the use of and commanding to only OBP2. On October 18, 2001, the AVHRR scanner became unstable, rendering its imagery unusable. NOAA-L (16) replaced NOAA-J (14) as the operational afternoon satellite on March 19, 2001.

NOAA-K (15) was launched on May 13, 1998, into a 450-nmi (833-km) morning orbit and is currently the designated operational morning satellite. It replaced NOAA-D (12) on December 14, 1998, as the primary morning spacecraft. The STX-1, STX-2, and STX-3 high-gain S-band antennas have shown degraded performance in orbit. Beginning September 28, 1999, the satellite was configured to transmit HRPT using the STX-2 omnidirectional antenna and transmit data playbacks using STX-4. The STX-1 and STX-3 downlinks are not used. Since the NOAA-15 launch, the AMSU-B instrument has had a bias in the science data that has been corrected by software processing on the ground. This bias is caused by interference from the L-band and S-band transmit systems on-board the spacecraft. With the use of the omnidirectional antennas and only the STX-2 and STX-4 S-band downlinks, the interference can be modeled to remove the bias to the science data. AMSU-B instruments on NOAA-L and later spacecraft have been modified to correct this bias. Gyro 3 was turned off in June 2000, due to excessive drift in the gyro. The AVHRR scan motor is showing degraded performance that started on May 30, 2000. The AVHRR products are marginally usable. The AMSU-A1 channel-14 detector amplifier stage failed on October 30, 2000. Data from that channel is unusable. Other AMSU-A1 channels are fine. The SARR 243-MHz receive system developed a thermal-related intermittent failure beginning on December 5, 2000. An antenna subsystem is the most likely cause.

NOAA-L (16) was launched on September 21, 2000, into a 470-nmi (870-km) afternoon orbit. It is currently the designated operational afternoon satellite. It replaced NOAA-J (14) on March 19, 2001, as the primary afternoon spacecraft. The Automatic Picture Transmission (APT) VHF downlink showed a severely degraded performance starting on November 13, 2000. A hybrid failure in the VRA antenna subsystem is the most likely cause of the degradation. The APT downlink was commanded off on February 26, 2001. A HIRS instrument cross-track pointing error has been observed since launch. The problem was traced to a prelaunch ground test incident. Data processing procedures were developed to correct for instrument misalignment. The STX-3 output power dropped to 1 watt on September 28, 2001. The link is still usable by the NOAA CDAS.

Appendix A

HIRS/3 Channel Characteristics

Channel	Channel Frequency (cm^{-1})	micron	Half Power Bandwidth (cm^{-1})	Anticipated Max. Scene Temp (°)	Specified Sensitivity [1]	Design Goal
1	669	14.95	3	280	3.00	.75
2	680	14.71	10	265	0.67	.25
3	690	14.49	12	240	0.50	.25
4	703	14.22	16	250	0.31	.20
5	716	13.97	16	265	0.21	.20
6	733	13.64	16	280	0.24	.20
7	749	13.35	16	290	0.20	.20
8	900	11.11	35	330	0.10	.10
9	1,030	9.71	25	270	0.15	.15
10	802	12.47	16	300	0.15	.10
11	1,365	7.33	40	275	0.20	.20
12	1,533	6.52	55	255	0.20	.07
13	2,188	4.57	23	300	0.006	.002
14	2,210	4.52	23	290	0.003	.002
15	2,235	4.47	23	280	0.004	.002
16	2,245	4.45	23	270	0.004	.002
17	2,420	4.13	28	330	0.002	.002
18	2,515	4.00	35	340	0.002	.002
19	2,660	3.76	100	340	0.001	.001
20	14,500	0.69	1,000	100% A	0.10% A	———

[1] NEΔD in mW/m2 Sr cm^{-1}

AMSU-A Channel Characteristics

Ch. No.	Center Frequency	No. of Pass Bands	Bandwidth (MHz) (spec)	Center Frequency Stability (MHz)	Temperature Sensitivity (K) NEΔT (spec)	Calibration Accuracy (K) (spec)	Angle θp
1	23,800 MHz	1	270	10	0.30	2.0	V
2	31,400 MHz	1	180	10	0.30	2.0	V
3	50,300 MHz	1	180	10	0.40	1.5	V
4	52,800 MHz	1	400	5	0.25	1.5	V
5	53,596 MHz ±115 MHz	2	170	5	0.25	1.5	H
6	54,400 MHz	1	400	5	0.25	1.5	H
7	54,940 MHz	1	400	5	0.25	1.5	V
8	55,500 MHz	1	330	10	0.25	1.5	H
9	57,290.344 MHz = f_{LO}	1	330	0.5	0.25	1.5	H
10	f_{LO}±217 MHz	2	78	0.5	0.40	1.5	H
11	f_{LO}±322.2 ±48 MHz	4	36	1.2	0.40	1.5	H
12	f_{LO}±322.2 ±22 MHz	4	16	1.2	0.60	1.5	H
13	f_{LO}±322.2 ±10 MHz	4	8	0.5	0.80	1.5	H
14	f_{LO}±322.2 ±4.5 MHz	4	3	0.5	1.20	1.5	H
15	89.0 GHz	1	<6,000	50	0.50	2.0	V

AMSU-B Channel Characteristics

Channel Number	Bandwidth MHz: Centre Frequency GHz	Double Sided Maximum	Pass Band	IF Band	Stop Band
16	89.0	6,000	3000	≥ 1,000	±400
17	150.0	4,000	2000	≥ 1,000	±400
18	183.31±1.0	1,000	2 x 500	500	-
19	183.31±3.0	2,000	2 x 1,000	1,000	-
20	183.31±7.0	4,000	2 x 2,000	2,000	-

AVHRR/3 Channel Characteristics

Ch. No.	(50% Points) Max Spectral Band Micrometers	S/N	Res. SSP km	Albedo Range %	Counts Range
1	0.58 - 0.68	9:1 @ 0.5% Albedo	1.09	0 - 25 26 - 100	0 - 500 501 - 1000
2	0.725 - 1.00	9:1 @ 0.5% Albedo	1.09	0 - 25 26 - 100	0 - 500 501 - 1000
3A	1.58 - 1.64	20:1 @ 0.5% Albedo	1.09	0 - 12.5 12.6 - 100	0 - 500 501 - 1000
		NEΔT		Max Scene Temp K	
3B	3.55 - 3.93	0.12 @ 300K Scene	1.09	335	
4	10.30-11.30	0.12 @ 300K Scene	1.09	335	
5	11.50-12.50	0.12 @ 300K Scene	1.09	335	

SSP = Sub-Satellite Point
Temp = Temperature
NEΔT= Noise Equivalent Temperature Difference
S/N = Signal to Noise Ratio

SBUV Discrete Ozone Position

Channel	WL (NM)	Description	Channel	WL (NM)	Description
0	252.00	Discrete Pos. 0	6	301.97	Discrete Pos. 6
1	273.61	Discrete Pos. 1	7	305.87	Discrete Pos. 7
2	283.1	Discrete Pos. 2	8	312.57	Discrete Pos. 8
3	287.7	Discrete Pos. 3	9	317.56	Discrete Pos. 9
4	292.29	Discrete Pos. 4	10	331.26	Discrete Pos. 10
5	297.59	Discrete Pos. 5	11	339.89	Discrete Pos. 11

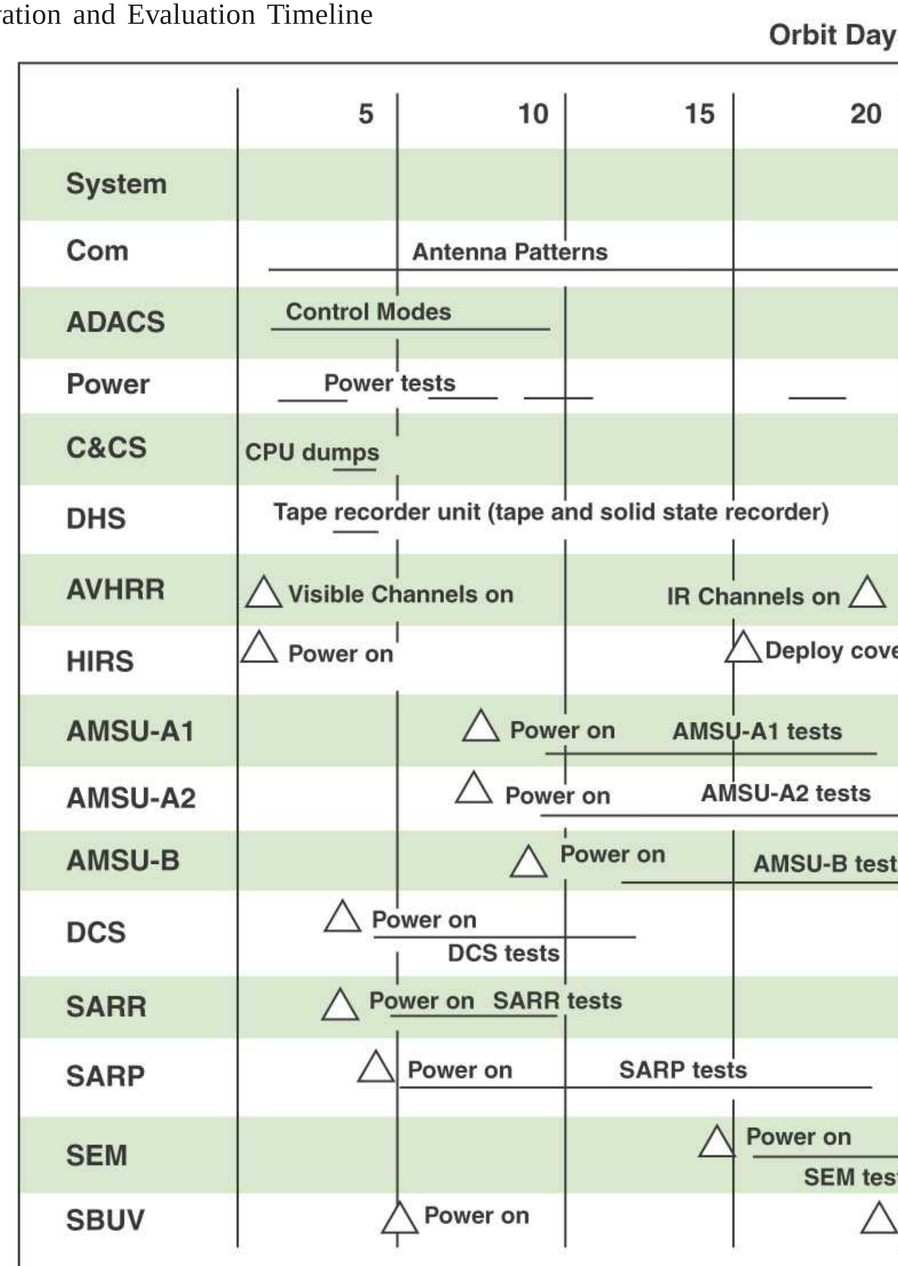
Appendix B

Communications and Data Handling

Link	Carrier Frequency	Information Signal	Data Rate and Baseband Modulation	RF Modulation	Subcarrier Frequency
Command	2026 MHz	Digital commands Clear or encrypted	2 kbps/NRZ-M	PM-carrier BPSK-subcarrier	16 kHz
Beacon	137.77 and 137.35 MHz	TIP data	8.320 kbps split phase	PM +/-67 deg.	
VHF real time (APT)	137.50 and 137.62 MHz	Medium-resolution video data from AVHRR	Analog	FM-carrier AM-subcarrier	2.4 kHz
S-band real time	1698 or 1707 MHz	HRPT	665.4 kbps split phase	PM +/-67 deg.	
S-band playback	1698, 1702.5, or 1707 MHz	High-resolution AVHRR data from MIRP; medium-resolution AVHRR data from MIRP; TIP and AIP outputs	2.66 Mbps NRZ-L	PM +/-67 deg.	
Data collection (uplink)	401.65 MHz	Earth-based platforms and balloons	400 bps split phase	PM +/-63 deg.	
S-band playback to European ground station	1698, 1702.5, or 1707 MHz	TIP or AIP data recovered from tape recorders as scheduled	332 kbps split phase	PM +/-67 deg.	
S-band contingency and launch	2247.5 MHz	Boost during ascent and real-time TIP in orbit	Boost 16.64 kbps/in orbit 8.32 kbps split phase	PM +/-67 deg.	
SAR L-band downlink	1544.5 MHz	Data transmission from SARR and SARP to ground LUTs	Less than or equal to 800 Hz	PM	
SAR uplinks	SARR 121.5/243/406.05 MHz SARP 406.05 MHz	From ground ELT/EPIRBs/PLBs to spacecraft	25 kHz BW for 121.5 MHz 45 kHz BW for 243 MHz 400 bps for 406.05 MHz	AM for 121.5/243 MHz PM for 406.05 MHz	

Appendix C

NOAA-M Activation and Evaluation Timeline



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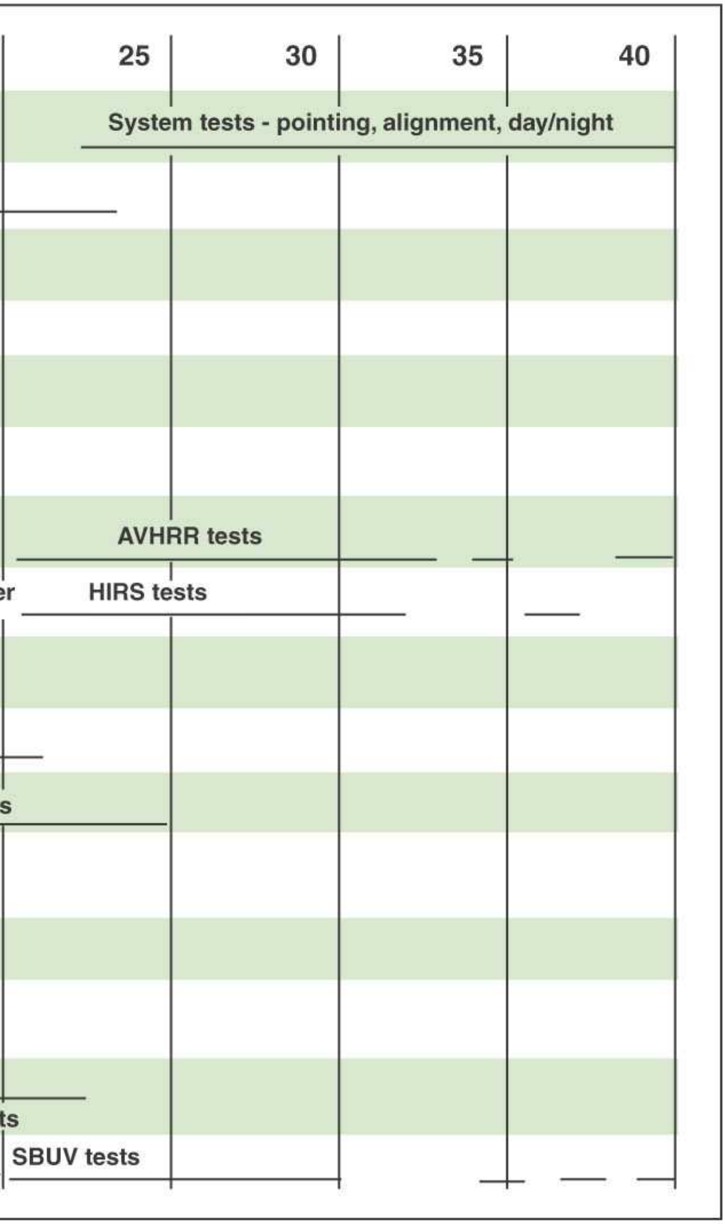

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GLOSSARY

AIP	AMSU Information Processor
AKM	Apogee Kick Motor
AM	Amplitude Modulation
AMSU	Advanced Microwave Sounding Unit
APT	Automatic Picture Transmission
ATN	Advanced TIROS-N
AVHRR	Advanced Very High Resolution Radiometer
BDA	Beacon Transmitting Antenna
bps	Bits Per Second
CCR	Cloud Cover Radiometer
CDA	Command and Data Acquisition
CEMSCS	Central Environmental Satellite Computer System
cm	Centimeter(s)
CMS	Centre de Meteorologie Spatiales
CNES	Centre National d'Etudes Spatiales
COSPAS	Russian Space Systems for the Search of Vessels in Distress
CRD	Command Receiver and Demodulator
DCS	Data Collection System
DND	Department of National Defense
DPU	Data Processing Unit
DRAM	Dynamic Random Access Memory
DSB	Direct Sounder Broadcasting
DSN	Deep Space Network
DTR	Digital Tape Recorder
EDAC	Error Detection and Correction
ELT	Emergency Locator Transmitters
EPIRB	Emergency Position-Indicating Radio Beacons
ERBE	Earth Radiation Budget Experiment
ESA	Earth Sensor Assembly
FM	Frequency Modulation
ft	Feet
GAC	Global Area Coverage
Gbit	Gigabit
GHz	Gigahertz
GN_2	Gaseous Nitrogen
GSFC	Goddard Space Flight Center
HIRS	High Resolution Infrared Radiation Sounder
HRPT	High Resolution Picture Transmission
Hz	Hertz
IFOV	Instantaneous Field-of-View
IGS	Inertial Guidance System
IMP	Instrument Mounting Platform
IMU	Inertial Measurement Unit
in	Inch(es)
IR	Infrared
ITT	ITT Aerospace/Communications Division
JPL	Jet Propulsion Lab
K	Kelvin temperature in degrees
kbps	Thousand (kilo) bits per second
keV	Kiloelectron volts
kg	Kilogram(s)
kHz	Kilohertz
km	Kilometer(s)
kN	Kilonewton
LAC	Local Area Coverage
lb	Pound
LMSSC	Lockheed Martin Space Systems Company
LUT	Local User Terminal
mb	Millibar
Mbps	Million bits per second
MCC	Mission Control Center
MEPED	Medium-Energy Proton/Electron Detector
MeV	Million electron volt(s)
MGC	Missile Guidance Computer
MHz	Megahertz
mi	Mile

MIRP	Manipulated Information Rate Processor
mps	meters per second
ms	Millisecond(s)
MSU	Microwave Sounding Unit
N	Newton
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NDVI	Normalized Difference Vegetation Index
NE∆D	Noise Equivalent Radiance
NE∆T	Noise Equivalent Temperature Difference
NESDIS	National Environmental Satellite, Data, and Information Service
NISN	NASA Integrated Services Network
nm	Nanometer(s)
nmi	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command
NS	Nonscanner
OBP	On-Board Processor
OSC	Office of Space Communications
PDT	Pacific Daylight Time
PLB	Personal Locator Beacon
PM	Phase Modulated
POES	Polar Operational Environmental Satellites
PSK	Phase Shift Keyed
Q3	Quadrant 3
REA	Reaction Engine Assembly
RF	Radio Frequency
RXO	Redundant Crystal Oscillator
SAD	Solar Array Drive
SAR	Search and Rescue
SARP	Search and Rescue Processor
SARR	SAR Repeater
SARSAT	Search and Rescue Satellite Aided Tracking
SATCOM	Satellite Communications Network
SBUV	Solar Backscatter Ultraviolet Radiometer
sec	Second(s)
SEM	Space Environment Monitor
SLA	Search and Rescue Transmitting Antenna (L-Band)
SLV	Space Launch Vehicle
S/N	Signal to Noise Ratio
SOA	S-Band Omni Antenna
SOCC	Satellite Operations Control Center
SSP	Sub-Satellite Point
SSR	Solid State Recorder
SSU	Stratospheric Sounding Unit
STX	S-Band Transmitting Antenna
TED	Total Energy Detector
TEMP	Temperature
TIROS	Television Infrared Observation Satellite
TIP	TIROS Information Processor
UDA	Ultra High Frequency Data Collection System Antenna
UDMH	Unsymmetrical Dimethylhydrazine
VHF	Very High Frequency
VRA	Very High Frequency Real-time Antenna
W	Watt(s)
WMO	World Meteorological Organization

This booklet is dedicated to the memory of Harry G. McCain, POES Program Manager

http://poes.gsfc.nasa.gov

http://www2.ncdc.noaa.gov/docs/klm/index.htm

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