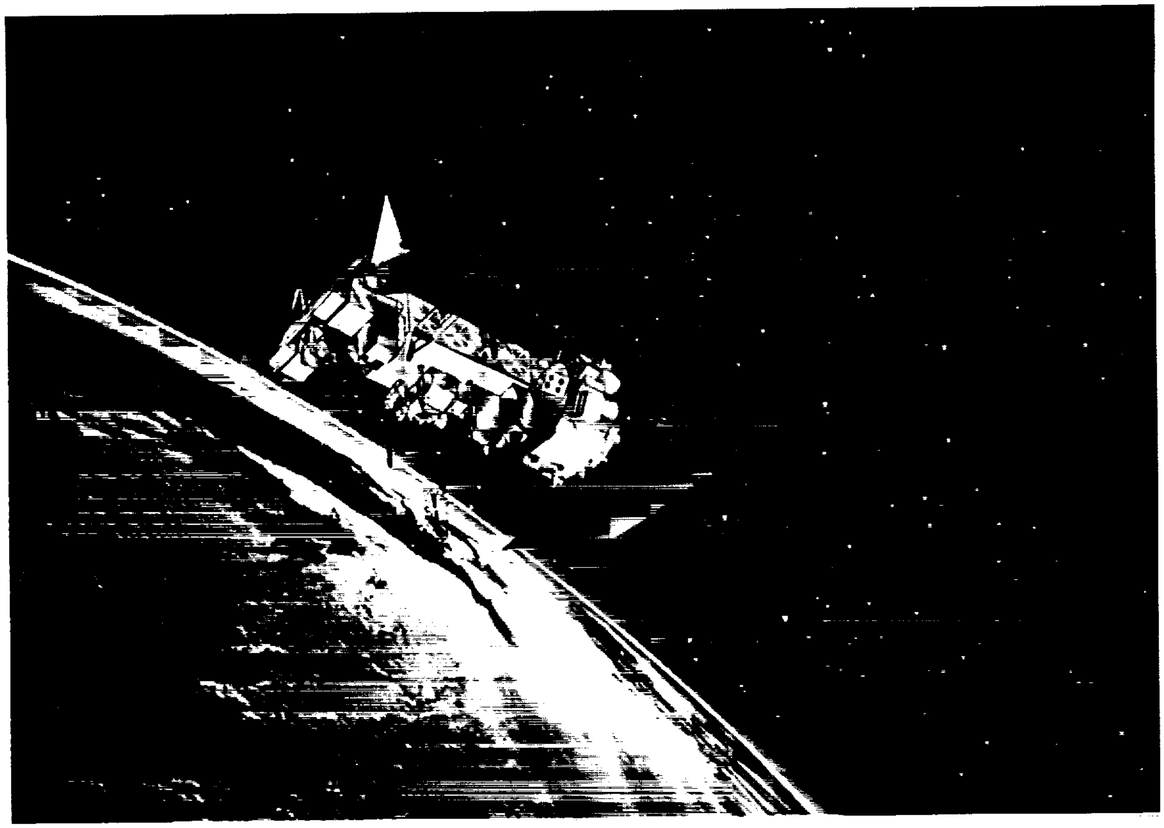
NOAA-L



National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

National Environmental Satellite,
Data, and Information Service
Suitland, Maryland

Systems Acquisition Office
Silver Spring, Maryland

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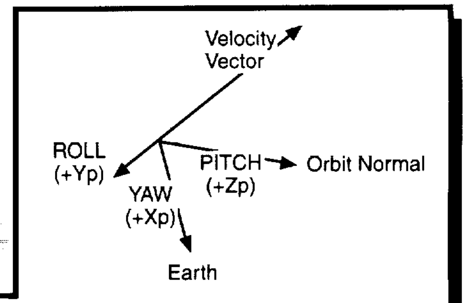
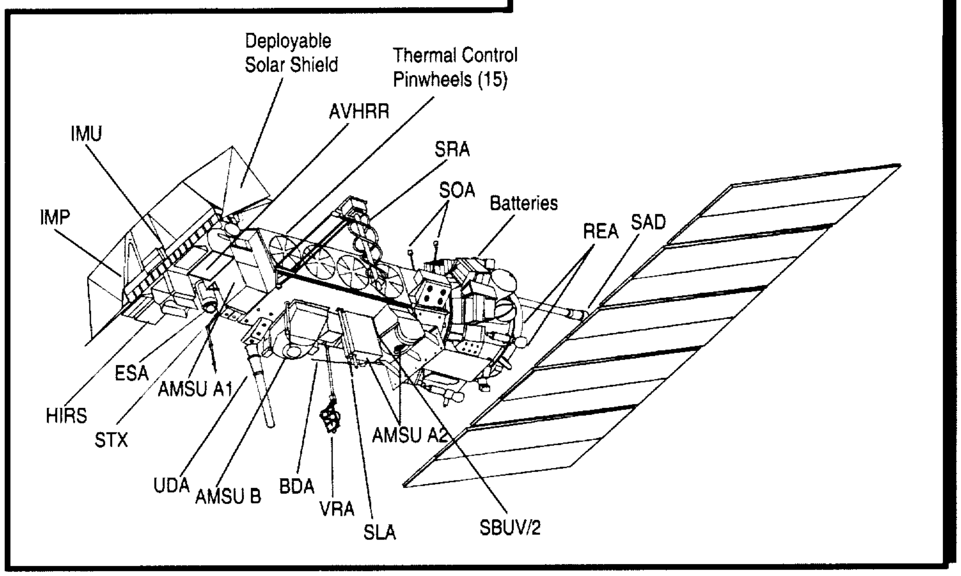
Instrumentation onboard the NOAA-L spacecraft





LEGEND

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

*Not shown in this view

POES PROGRAM
The NOAA Polar-Orbiting Satellites

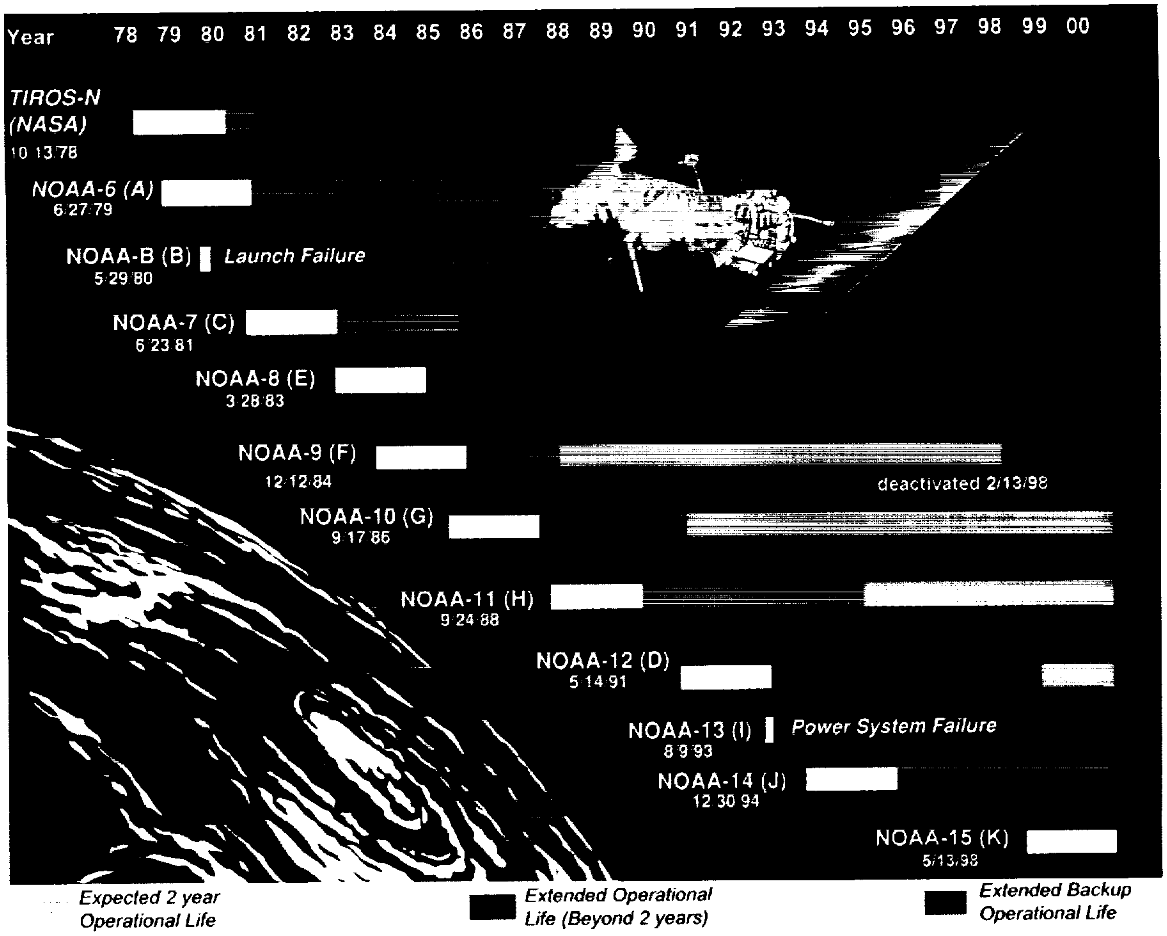
The National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) have jointly developed a valuable series of polar-orbiting Earth environmental observation satellites since 1978. These satellites provide global data to NOAA's short- and long-range weather forecasting systems. The system consists of two polar-orbiting satellites known as the Advanced Television Infrared Observation Satellites (TIROS-N) (ATN). Operating as a pair, these satellites ensure that environmental data, for any region of the Earth, is no more than six hours old. These polar-orbiting satellites have not only provided cost-effective data for very immediate and real needs but also for extensive climate and research programs. The weather data (including images seen on television news programs) has afforded both convenience and safety to viewers throughout the world. The satellites also support the SARSAT (Search and Rescue Satellite Aided Tracking) part of the COSPAS-SARSAT constellation. Russia provides the COSPAS (Russian for Space Systems for the Search of Vessels in Distress) satellites. The international COSPAS-SARSAT system provides for the detection and location of emergency beacons for ships, aircraft, and people in distress and has contributed to the saving of more than 10,000 lives since its inception in 1982.

NOAA-L
Lockheed Martin Space Systems Company

NOAA-L 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 m² (180.63 ft.²)
Weight:	At liftoff ~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-L 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 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-L is the second in the series to support dedicated microwave instruments for the genera-



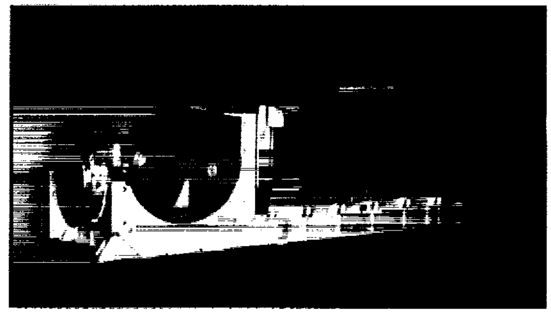
This figure summarizes the operational and extended lifetimes of the TIROS satellites.

tion of temperature, moisture, surface and hydrological products in cloudy regions where visible and infrared instruments have decreased capability.

NOAA-L INSTRUMENTS

The NOAA-L primary instruments have all been designed for a three-year mission. Detailed information for each instrument is found in Appendix A. Further information is available on the web at http://poes.gsfc.nasa.gov, http://www2.ncdc.noaa.gov/docs/klm/index.htm, http://psbsgil.nesdis.noaa.gov:8080/OSDPD/OSDPD2.html, and http://osdacces.nesdis.noaa.gov:8081/SATPROD. The NOAA-L 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

HIRS/3

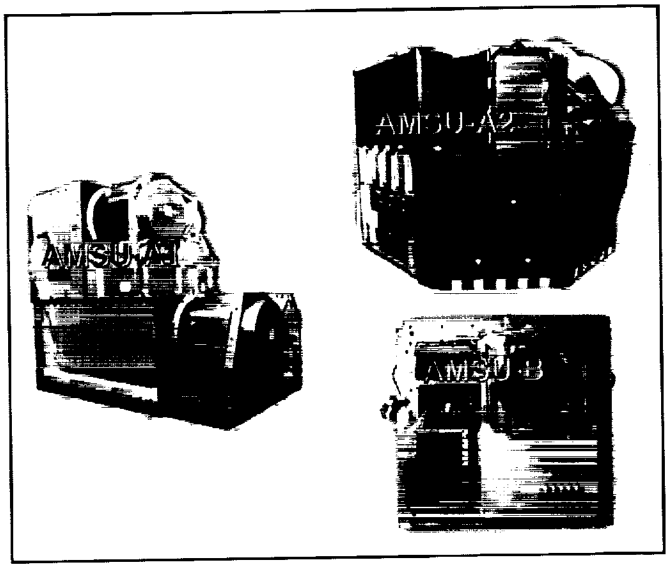
The HIRS/3 is an atmospheric sounding instrument with one visible channel, seven shortwave IR channels, and 12 longwave IR channels. The IFOV for each channel is approximately 1.4° in the visible and shortwave IR channels, and 1.3° in the longwave IR band which, from an altitude of 833 km (517.6 mi), 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.

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)

Matra Marconi via United Kingdom Meteorological Office

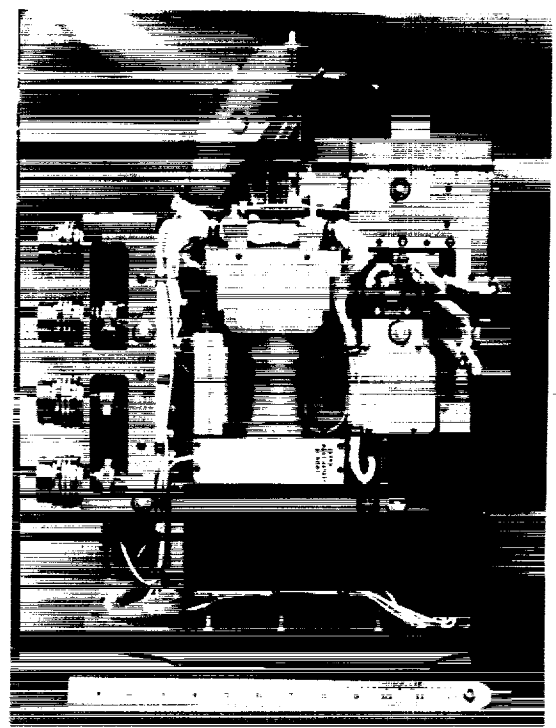
The AMSU-B is designed to allow the calculation of the vertical water vapor profiles from the Earth's surface to about a 200-millibar pressure altitude (12 km or 7.5 mi).

The AMSU-B is a cross-track, continuous line scanning, total power radiometer and uses measurements of scene radiance in five channels. The instrument has an IFOV of 1.1° (at the half-power points). A frequency of 1702.5 MHz can be used for HRPT, but utilizes the opposite antenna polarization (left circular). 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

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 co-aligned 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.



SBUV/2

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 nanometers
- Photochemical processes and the influence of "trace" constituents on the ozone layer.

SPACE ENVIRONMENT MONITOR (SEM/2)

Panametrics Via NOAA Space Environment Center

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 the knowledge of solar terrestrial phenomena and also provides warnings of solar wind occurrences that may impair long-range communication, high-altitude operations, damage to satellite circuits and solar panels, or cause changes in drag and magnetic torque on satellites.

Space Environment Monitor

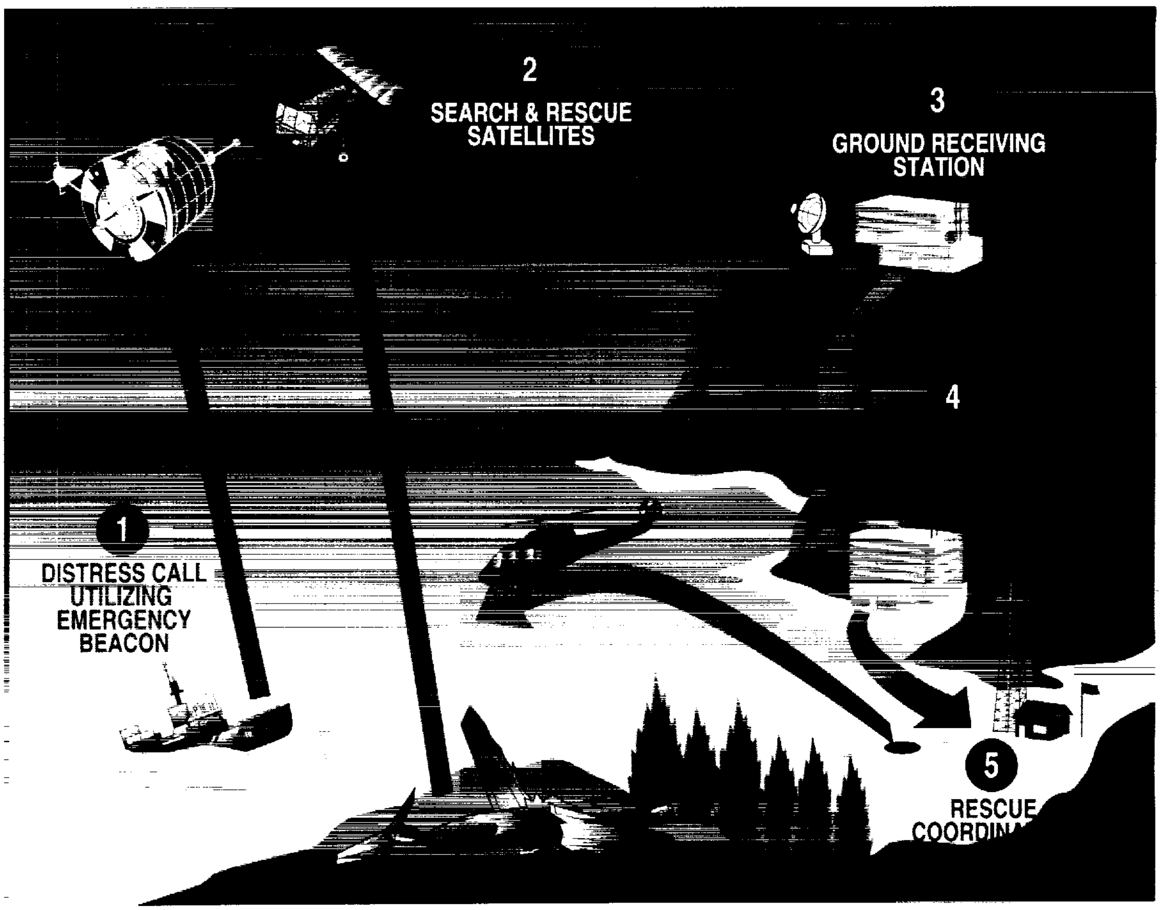
The SEM/2 consists of two separate sensor units and a common Data Processing Unit (DPU). The sensor units are the Total Energy Detector (TED) and the Medium Energy Proton and Electron Detector (MEPED).

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.

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.



Search and Rescue Sequence of Events

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 if the satellite is in view of a ground station known as a Local User Terminal (LUT). The SARP detects the signal only from 406 MHz beacons but stores the information for subsequent downlink to a LUT. Thus, global detection of 406 MHz emergency beacons is provided.

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), whereas the 406-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 MHz emergency beacons. The 406 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.

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).

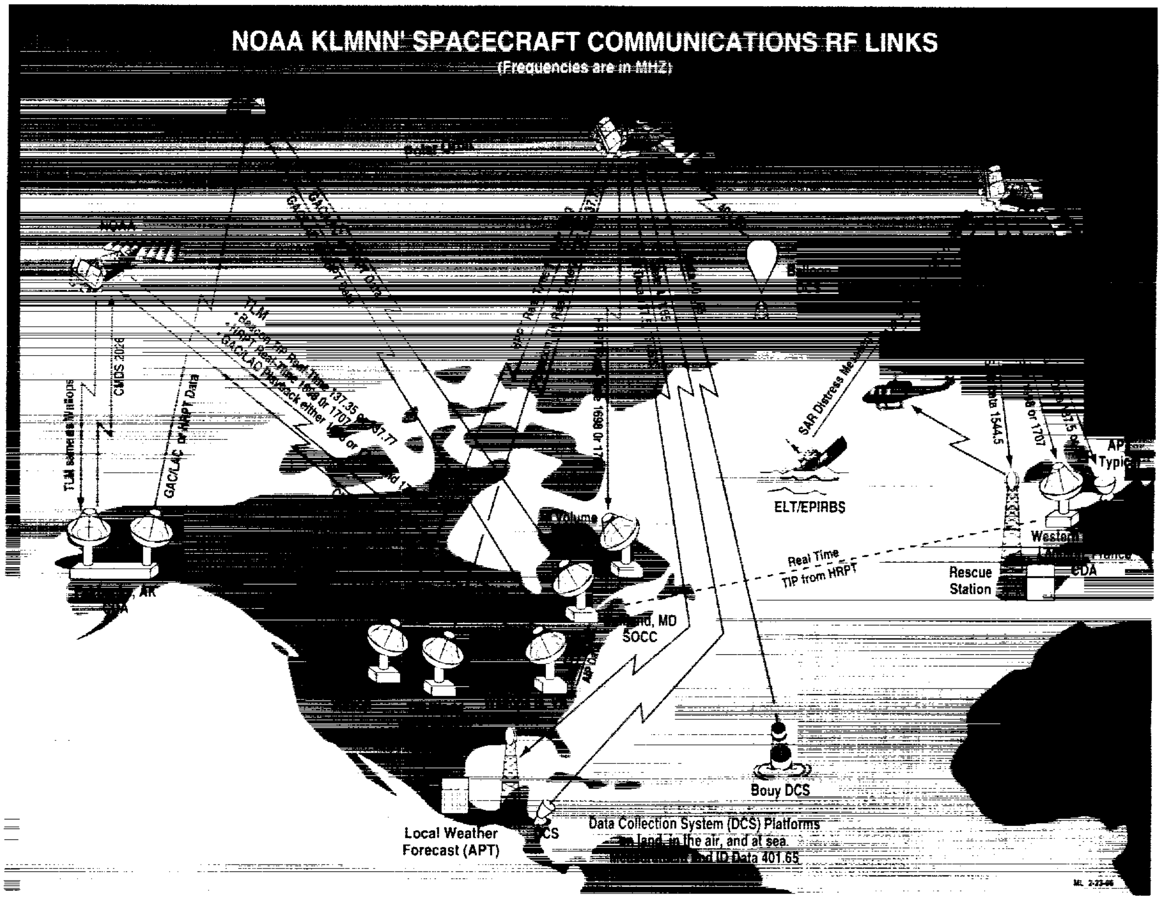
The stored data is transmitted to the ground once per orbit. Subsequently, the data is sent to the French Centre at the Centre National D'Etudes Spatiales (CNES) in Toulouse, France and the Service Argos Facility in Lanham, Maryland, for processing, distribution to users, and storage for archival purposes.

SPACECRAFT COMMUNICATIONS

The spacecraft transmits the 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

High Resolution Picture Transmission (HRPT) - Real-time transmission to "users" of data-video data carrier frequency of 1698, 1702.5, or 1707 MHz with a data rate of 665.4 kilobits per second (kbps). Available for users with the necessary receiver and data handling/processing equipment. A frequency of 1702.5 MHz can be used for HRPT, but utilizes the opposite antenna polarization (left circular).



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

Global Area Coverage (GAC) 4-km resolution AVHRR imagery - Recorded data for transmission to NOAA ground Command and Data Acquisition (CDA) station(s).

Local Area Coverage (LAC) - Recorded 1-km resolution AVHRR imagery - LAC output is supplied only to the spacecraft digital tape recorder (DTR) input selector for recording of pre-scheduled selected areas. The recorded data is transmitted to the NOAA CDA stations.

DIRECT BROADCAST DOWNLINKS

For over 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 High Resolution Picture Transmission (HRPT), (2) the direct sounder broadcast (DSB), also referred to as the real-time 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) 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, DCS/2, and the SBUV. The AMSU-A, AMSU-A1, AMSU-A2, and AMSU-B are also included in HRPT from the AMSU Information Processor (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 1996, there were 541 HRPT receivers worldwide who were registered with the World Meteorological Organization (WMO).

Direct Sounder Broadcasting (DSB)

Very high frequency (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 rates permit 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 1996, there were 2,296 APT receivers worldwide registered with the WMO.

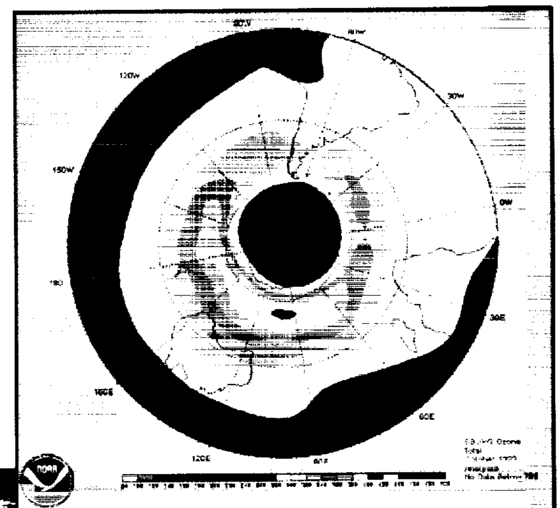
Any two of the five AVHRR channels provided to the MIRP can be selected and processed as "Video A" and "Video B." One APT line, consisting of one line of Video A and one line of Video B, is output every third AVHRR scan. Ancillary AVHRR data appears at one edge of each line and their 64-second repetition 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

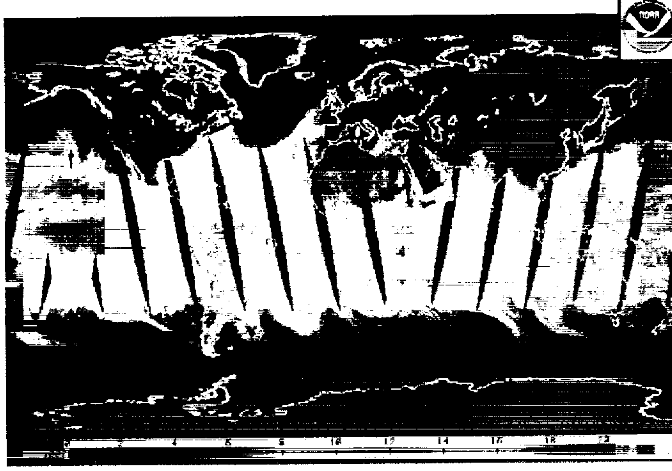
For information about SAR, please refer to the previous section titled *Search and Rescue Instruments* that begins on page NOAA-L/8.

POLAR OPERATIONAL ENVIRONMENTAL SATELLITE PRODUCTS

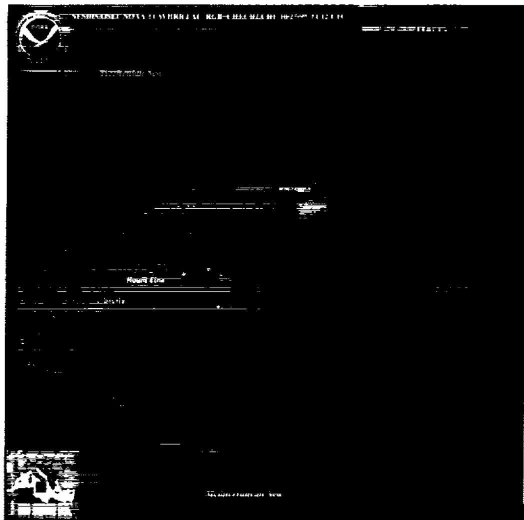
The NOAA polar operational environmental satellites collect global data on cloud cover; surface conditions such as ice, snow, and vegetation; atmospheric temperatures, and moisture, aerosol, and ozone distributions, and collect and relay information from fixed and moving data platforms. The primary imaging system, the AVHRR/3, consists of visible, near IR, and thermal IR channels. The primary sounding suite flying on NOAA-L 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. Examples of products derived from the processed data are shown below.



This image of the total ozone product, generated from NOAA-14's SBUV instrument, clearly depicts the Antarctic Ozone Hole in October 1999. The SBUV instrument, flown on POES afternoon satellites, also provides for the generation of individual ozone profiles and layer ozone values from the surface to 0.01 mb.



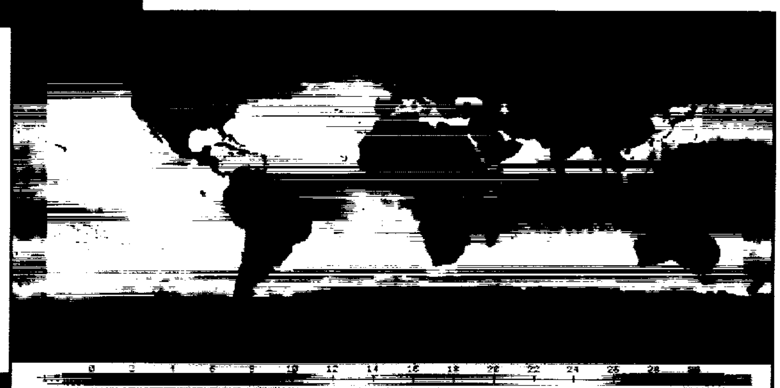
Water vapor mixing ratio products, generated from the first dedicated microwave humidity sounder to fly on POES, are now available at 15 atmospheric levels. This image depicts the 1000 mb water vapor distribution from NOAA-15's AMSU-B on December 21, 1999. Associated atmospheric temperature products are similarly produced for 40 levels, on an orbital basis, from a combination of the HIRS and AMSU-A atmospheric sounding channels (Chs 3-14).

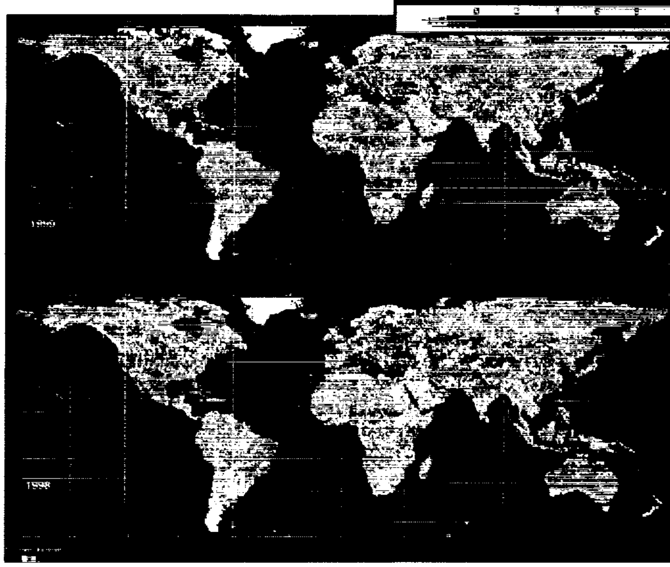


A strong heat signature (red) and an ash plume (blue haze extending from hot spot) associated with eruptions of the Mount Etna volcano in northeastern Sicily. Lava had been fountaining and flowing down the west flank of the mountain in irregular intervals over the past six days. Hot spots in mainland Italy were associated with wildfires.

This imagery was derived by means of a composite of visible and infrared data from NOAA-14's AVHRR.

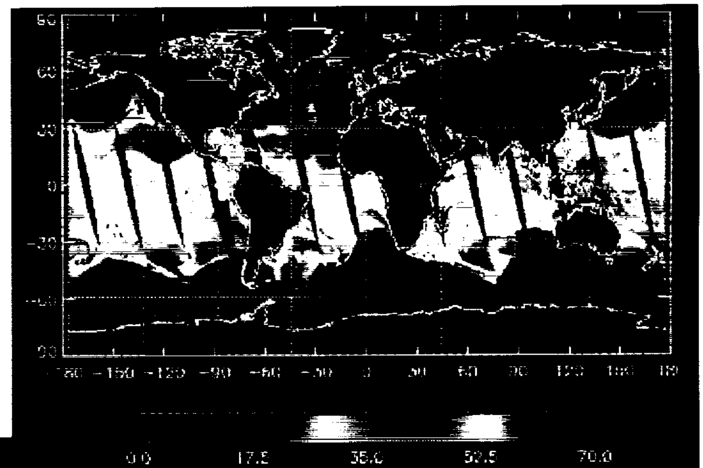
Sea surface temperature products are produced routinely from the AVHRR instrument at global, regional, local, and coastal coverages. This image is an example of a global product produced at 50-km (31 mi) resolution, available twice weekly, from NOAA-14 on December 21, 1999.

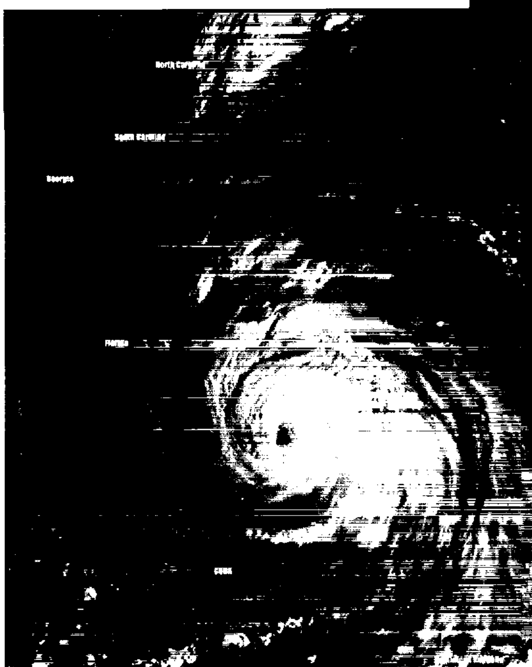




Vegetation condition products are generated from the AVHRR instrument. The red color delineates the areas with severe vegetation stress; the colors from yellow to blue indicate fair to favorable conditions. These images compare the vegetation health conditions from 1999 (top) to 1998 (bottom).

A new suite of microwave-based surface and hydrological products are available using the surface channels from both the AMSU-A and AMSU-B instruments. These new instruments allow for the generation of global total precipitable water, cloud liquid water, rain rate, snow cover, and sea ice concentration products in cloudy regions where traditional visible and infrared instruments have decreased capability. Shown is an image of the total precipitable water field derived from NOAA-15's AMSU-A on March 3, 2000, with values ranging up to 70 mm (2.8 in).



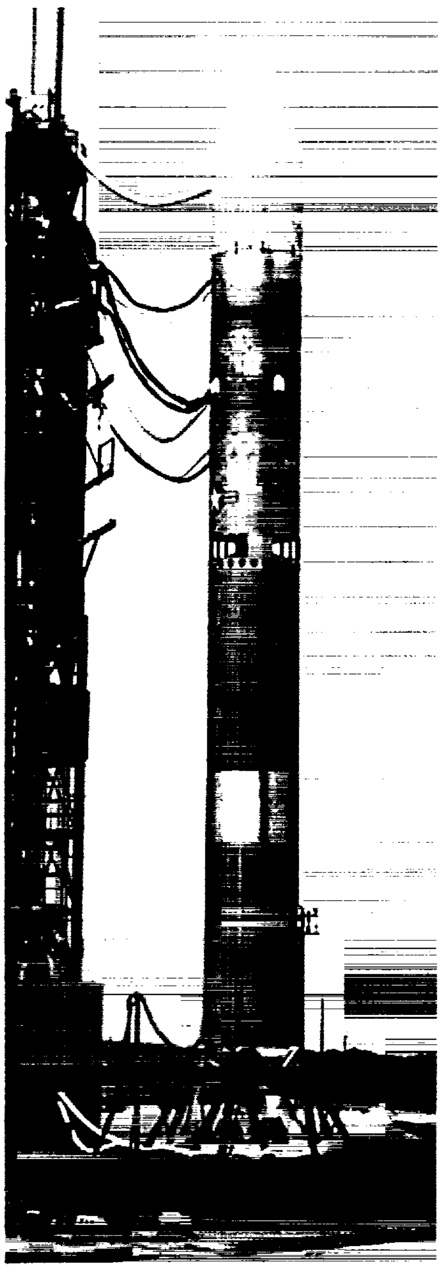


This NOAA-15 image of Hurricane Floyd on September 14, 1999, as it hits Eleuthera Island in the Bahamas was generated using a composite of Channels 1, 2, and 4 from the AVHRR instrument in its high-resolution imaging mode of 1.1 km (0.68 mi).

Snow cover in the Midwest, Northeast, and Mid-Atlantic regions of the United States. This image was produced on March 11, 1999, using a new absorption band on NOAA-15's AVHRR (1.6 micron), designated Channel 3a, which differentiates between snow cover and clouds.

TITAN II LAUNCH VEHICLE

Lockheed Martin Space Systems Company



The NOAA-L 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-L 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 system 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-L 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

TITAN II SLV Engine Data (Vacuum)

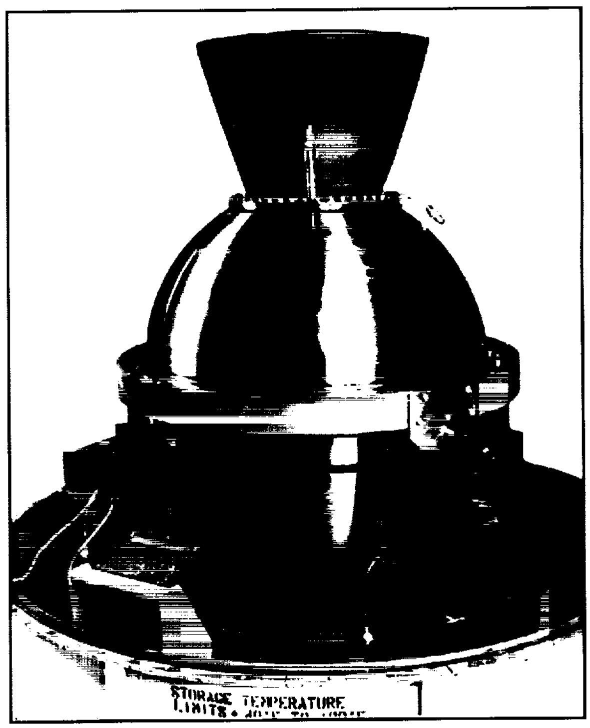
	Stage 1	Stage 2
No. of Engines	2	1
Thrust per engine (lb)	474,000	100,000
Thrust per engine (N)	2,108,352	448,000
Thrust duration from liftoff (sec)	150	326

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 liftoff, 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)

Thiokol Corporation

Thiokol Corporation's 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-L spacecraft, remains with the spacecraft after burnout.



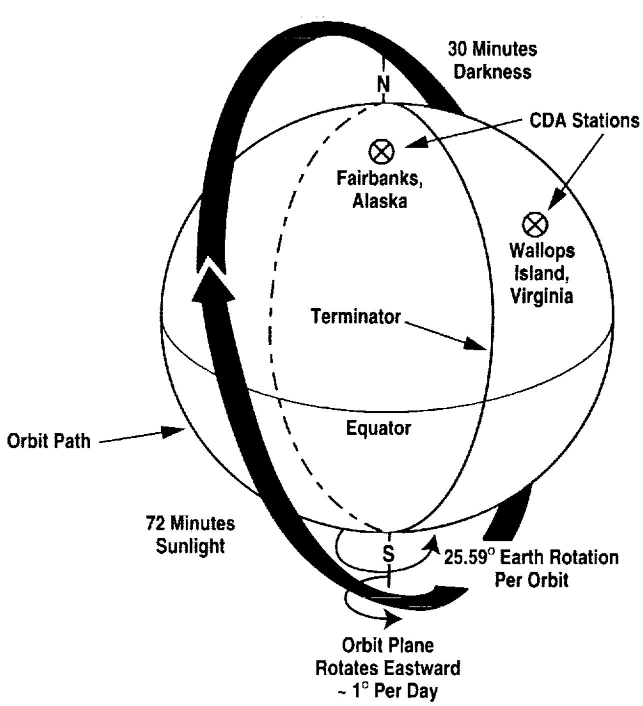
NOAA-L ORBIT

NOAA-L is a three-axis stabilized spacecraft that will be launched into an 870-km (470-nmi) circular, near-polar orbit with an inclination angle of 98.7° (retrograde) to the Equator.

The total orbital period will be approximately 102.14 minutes. The sunlight period will average about 72 minutes, and the Earth shadow period will average about 30 minutes. Because the Earth rotates 25.59° during each NOAA-L 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.

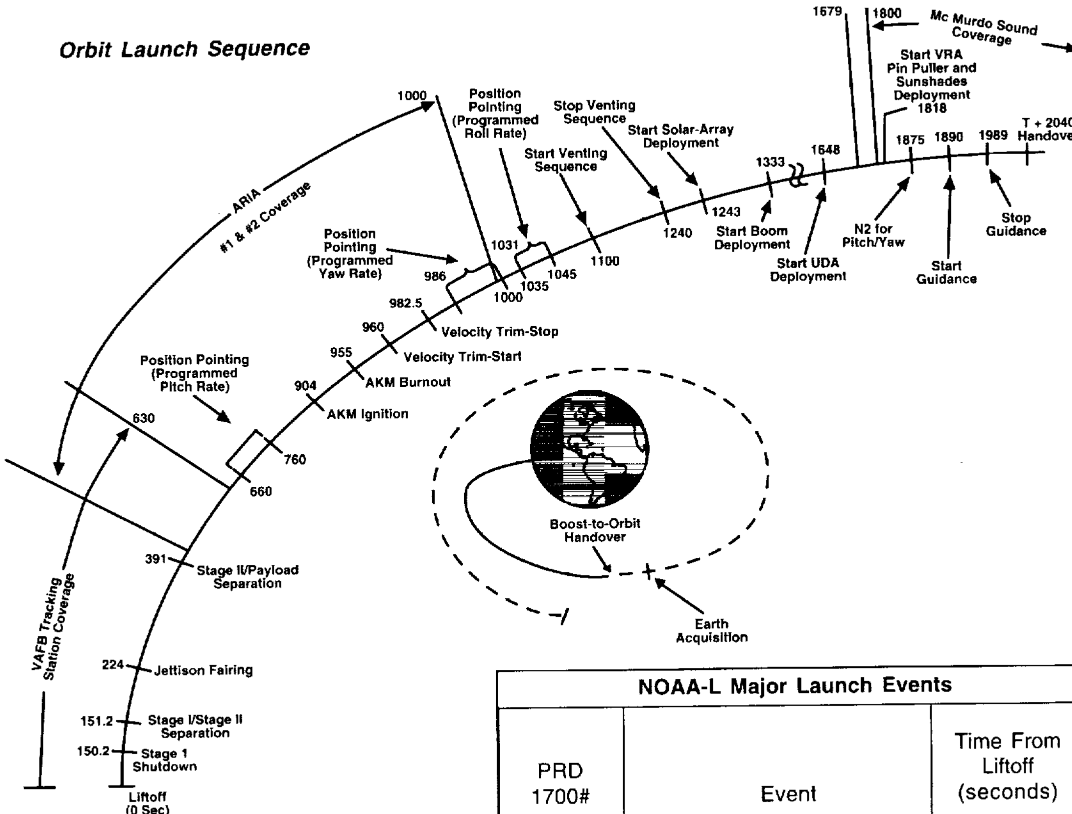
NOAA-L will be launched at 3:22 a.m. Pacific Daylight Time (PDT). The spacecraft will be launched so that it will cross the Equator at about 2:00 p.m. northbound and 2:00 a.m. southbound local solar time.



ORBITAL CHARACTERISTICS

Apogee	870 km (470 nmi)
Perigee	870 km (470 nmi)
Minutes per orbit	102.14
Degrees inclination	98.7442

Orbit Launch Sequence

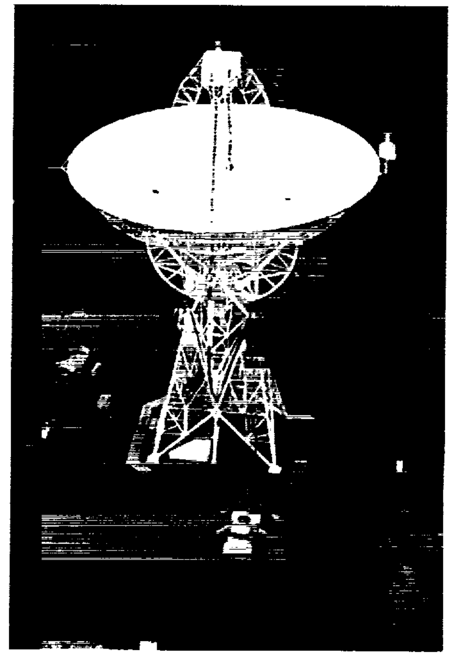


NOAA-L Major Launch Events		
PRD 1700#	Event	Time From Liftoff (seconds)
1	Liftoff (L/O)	T-0
2	Stage 1 Shutdown	150.2
3	Stage I/Stage II Separation	151.2
4	Jettison Fairing	224.0
5	Stage II/Payload Separation	391.0
-	Pitch Rate - Start	660.0
-	Pitch Rate - Stop	760.0
6	AKM Ignition	904.0
7	AKM Burnout	955.0
-	Start Velocity Trim	960.0
8	End Velocity Trim	982.5
9	Start Venting Sequence	1100.0
10	Stop Venting Sequence	1240.0
11	Solar Array Deployment	1240.0
12	Boom Deployment	1333.0
13	Solar Array Mast Deploy	1485.0
14	SRA Antenna Deploy	1568.0
15	UDA Deployment	1648.0
16	VRA Phase I Deploy	1698.0
17	VRA Phase II Deploy	1818.0
18	Sunshades Deployment	1818.5
19	N2 for Pitch/Yaw	1875.0
20	Start Guidance	1890.0
21	Stop Guidance	1989.0
22	Handover	2040.0

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 Communications Network (NASCOM). NASCOM provides any launch-unique communications links for satellite launch. SATCOM provides all voice and data links between SOCC and the CDA stations after launch. SATCOM is provided and operated by NESDIS.

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 MCCS)

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 MCC at Suitland, Maryland. The MCC determines the proper Rescue Coordination Center and forwards the distress location data after removing redundant information. There are also MCCs and LUTs in Canada, France, Russia, and 10 other cooperating countries. 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 (OSC) associated support is requested through the Mission Requirements Request (MRR) and the Detailed Mission Requirements (DMR) Document, 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 (AFSCN) in Sunnyvale, California, and the Jet Propulsion Lab (JPL) Deep Space Network (DSN). The DSN provides contingency command uplink capability. The McMurdo Tracking Facility in Antarctica also provides early orbit telemetry and command support.

Synopsis of Prior Spacecraft

TIROS-N was launched October 13, 1978, into a 470-nmi 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 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 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 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.

NOAA-F (9) was launched December 12, 1984, into a 470-nmi 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-Non-scanner (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 morning orbit and is currently in a standby operational mode with all of its data transmitters turned off. The HIRS instrument, the real-time SAR, and other subsystems are performing satisfactorily. The ERBE-Scanner exhibited a scan sticking anomaly that is apparently generic to the instrument. The SAR Processor (SARP) 406 MHz receiver has also failed. The SARP was used to provide global SAR data before its failure. In December 1994, the AVHRR IR channels were damaged and remain 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 indicates 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.

NOAA-H (11) was launched September 24, 1988, into a 470-nmi 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. It also has the capability to mount a deployable Medium Energy Proton and Electron Detector (MEPED), although that instrument is not aboard. The increase of maximum Sun angle from 68° to 80° allows an afternoon nodal crossing closer to noon to enhance data collection. The HIRS/2 and SSU instruments and the power subsystems operate satisfactorily. In September 1994, the AVHRR scan motor failed, leaving the instrument inoperative. 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.

NOAA-D (12) was launched on May 14, 1991, into a 450-nmi 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 afternoon orbit. On August 21, 1993, two weeks after the 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 afternoon orbit and is currently designated as the operational 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. Currently, it is planned for NOAA-L (16) to replace NOAA-J (14) as the operational afternoon satellite.

NOAA-K (15) was launched on May 13, 1998, into a 450-nmi 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 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. Instruments on NOAA-L and later spacecraft have been modified to correct this bias.

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	Centre Frequency GHz	Bandwidth MHz: 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 Channel Characteristics
Data Format for Operating Modes 1, 3, and 4

Minor Frame Number	TIP/SBUV/Word 1	TIP/SBUV/Word 2
0, 10, 20...310	Status Word 1	Range 1 Data
1, 11, 21...311	Status Word 2	Range 2 Data
2, 12, 22...312	Digital A Sub Com (1)	Range 3 Data
3, 13, 23...313	Memory Verify	Not Used
4, 14, 24...314	Status Word 3	Not Used
5, 15, 24...315	Status Word 4	Not Used
6, 16, 26...316	Grating Position	Not Used
7, 17, 27...317	CCR Data	Not Used
8, 18, 28...318	RDCL/GPE (2)	Not Used
9, 19, 29...319	Frame Sync Code	Not Used

General Comment:

The basic SBUV/2 data frame (channel) is a 20-word block, the format of which repeats at one-second intervals. The instrument data sequence is based upon the 32-second TIP Major Frame, making the data format for all operating modes, except Mode 2, identical.

Notes:

(1) Digital A Sub COM is 16 channels deep.
(2) Radiometric DC level/grating position error; eight bits each.

Data Format for Operating Mode 2

Minor Frame Number	TIP/SBUV/Word 1	TIP/SBUV/Word 2
0, 10, 20...310	Status Word 1	Selected Range Data
1, 11, 21...311	Status Word 2	Selected Range Data
2, 12, 22...312	Digital A Sub Com (1)	Selected Range Data
3, 13, 23...313	Memory Verify	Selected Range Data
4, 14, 24...314	Status Word 3	Selected Range Data
5, 15, 24...315	Status Word 4	Selected Range Data
6, 16, 26...316	Grating Position	Selected Range Data
7, 17, 27...317	CCR Data	Selected Range Data
8, 18, 28...318	RDCL/GPE (2)	Selected Range Data
9, 19, 29...319	Frame Sync Code	Selected Range Data

Note:

(1) Same as all other modes.

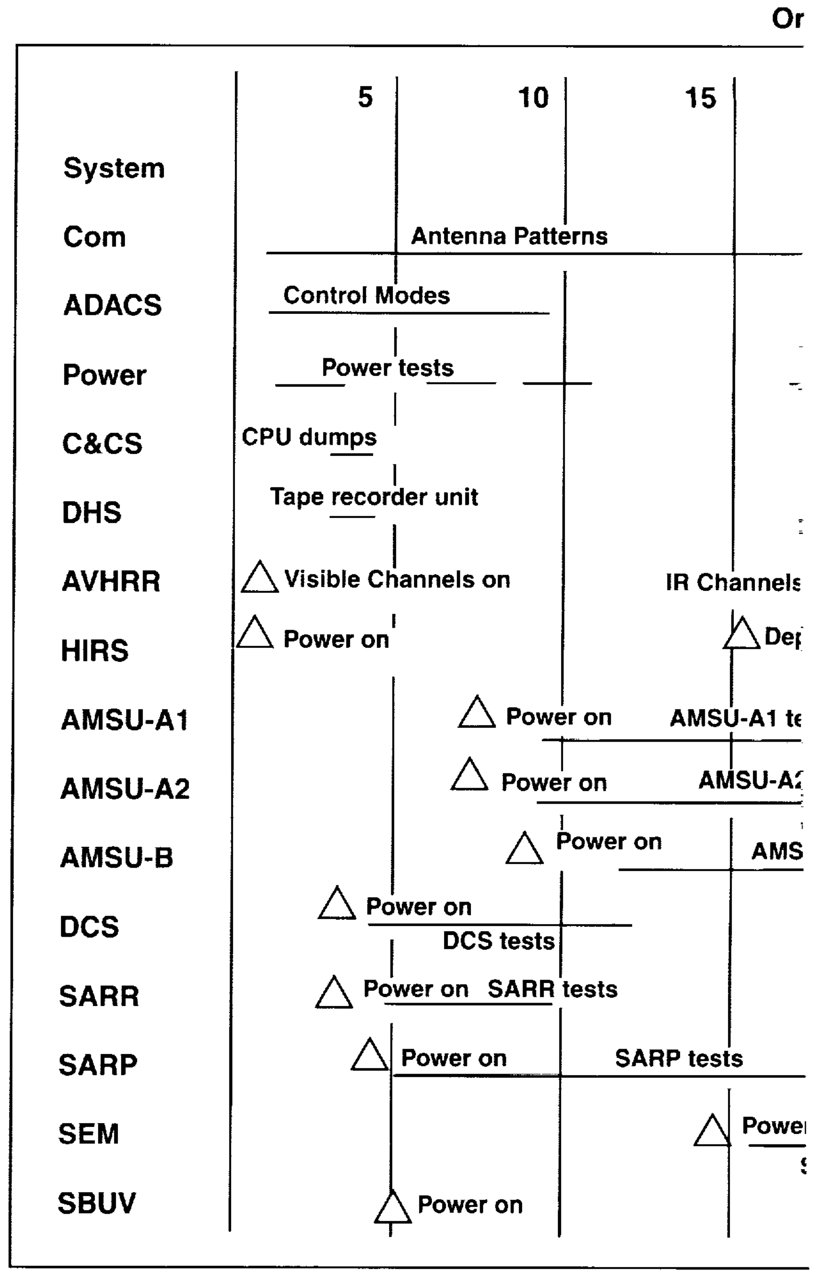
Appendix B

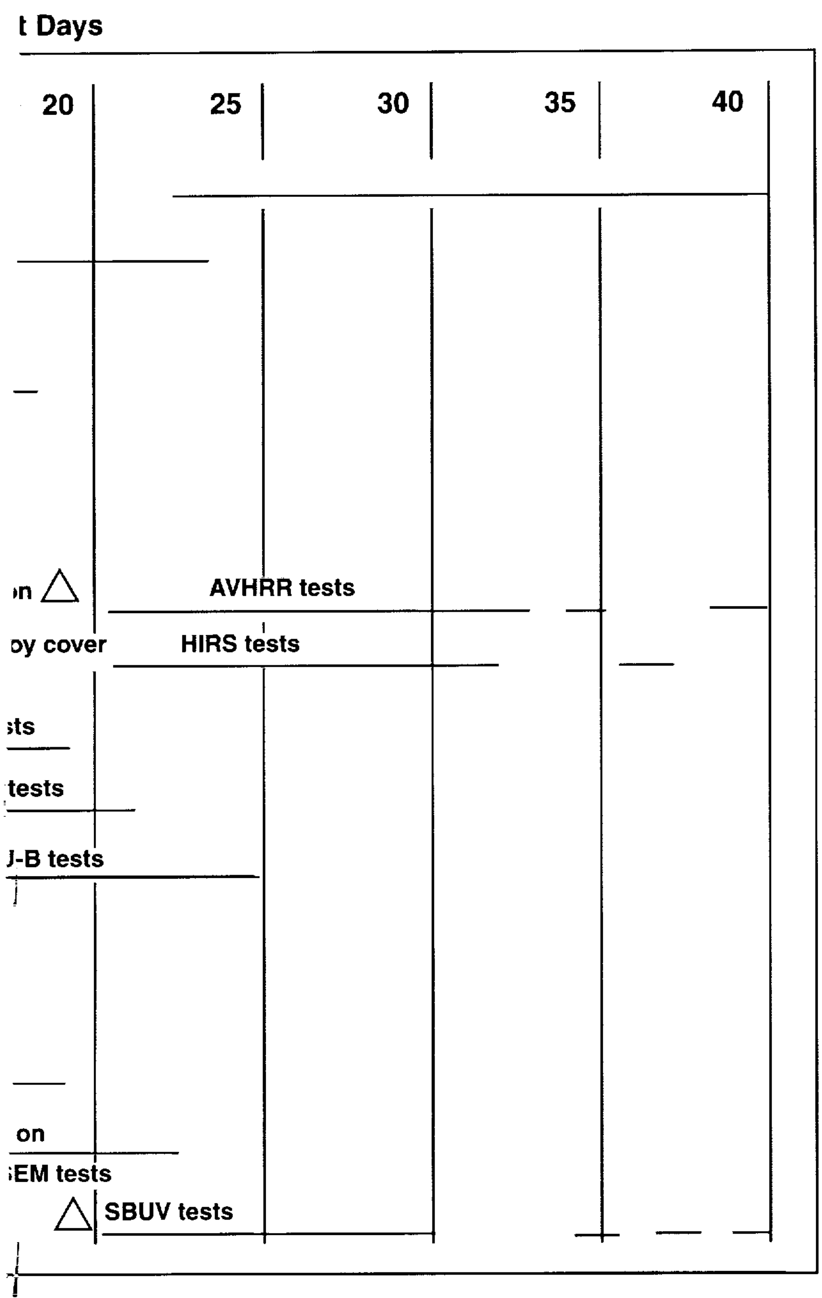
Communications and Data Handling

Link	Carrier Frequency	Information Signal	Baseband	Modulation	Subcarrier Frequency
Command	2026 MHz	Digital commands Clear or Encrypted	2 kbps	NRZ-M	16 kHz
Beacon	137.77 and 137.35 MHz	HIRS, SEM, DCS data, spacecraft attitude data, time code, housekeeping telemetry, memory verification, all from TIP	8.320 kbps	Split-phase phase-shift keyed (PSK)	
VHF real time (APT)	137.50 and 137.62 MHz	Medium-resolution video data from AVHRR	100 Hz - 4.8 kHz	AM/FM	2.4 kHz
S-band real time	1698 or 1707 MHz	High-resolution video TIP and AIP data	665.4 kbps	Split-phase PSK	
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	2.6616 Mbps	Randomized nonreturn-to-zero/PSK	
Data collection (uplink)	401.65	Earth-based platforms and balloons	400 bps PSK	Split-phase	
S-band playback to European ground station	1698, 1702.5, or 1707 MHz	TIP or AIP data recovered from tape recorders as scheduled	332.7 kbps PSK	Split-phase	
S-band contingency and launch	2247.5 MHz	Boost during ascent and real-time TIP in orbit	Boost 16.64 kbps TIP in orbit 8.32 kbps	Split PCM/BPSK	
SAR L-band downlink	1544.5 MHz	Data transmission from SARR and SARP to ground LUTs	250 kHz	PM 2 rad peak	
SAR uplinks	SARR 121.5 MHz 243 MHz 406.05 MHz SARP 406.025 MHz	From ground ELT/EPIRBs/PLBs to spacecraft	(video) 25 kHz for 121.5 MHz 45 kHz for 243 MHz 400 bps for 406 MHz	PM for 121.5/243 MHz FM for 406 MHz	

Appendix C

NOAA-L Activation and Evaluation Timeline




t Days
20
25
30
35
40
AVHRR tests
oy cover
HIRS tests
tests
J-B tests
on
EM tests
SBUV tests

GLOSSARY

AFSCN	Air Force Satellite Control Network
AIP	AMSU Information Processor
AKM	Apogee Kick Motor
AM	Amplitude Modulation
AMSU	Advanced Microwave Sounding Unit
APT	Automatic Picture Transmission
ARGOS	French Data Collection System
AVHRR	Advanced Very High Resolution Radiometer
ATN	Advanced TIROS-N
BDA	Beacon Transmitting Antenna
bps	Bits Per Second
C&CS	Command and Control System
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
CPU	Central Processing Unit
CRD	Command Receiver and Demodulator
DCS	Data Collection System
DHS	Data Handling Subsystem
DMR	Detailed Mission Requirements
DND	Department of National Defense
DPU	Data Processing Unit
DTR	Digital Tape Recorder
DSB	Direct Sounder Broadcasting
DSN	Deep Space Network
ELT	Emergency Locator Transmitters
EPIRB	Emergency Position-Indicating Radio Beacons
ERBE	Earth Radiation Budget Experiment
ESA	Earth Sensor Assembly
FM	Frequency Modulation
FOV	Field-of-View
FSK	Frequently Shift Keyed
ft	Feet
GAC	Global Area Coverage
GHz	Gigahertz
GN_2	Gaseous Nitrogen
GSFC	Goddard Space Flight Center
Hg	Mercury
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	Indium
In	Inch(es)
IR	Infrared
ITT	International Telephone and Telegraph
JPL	Jet Propulsion Lab
K	Kelvin temperature in degrees
kbps	Thousand bits per second
keV	Kiloelectronvolts
kg	Kilogram(s)
kHz	Kilohertz
kl	Kiloliter(s)
km	Kilometers
LAC	Local Area Coverage
lb	Pound(s)
LMSSC	Lockheed Martin Space Systems Company
LUT	Local User Terminal

m	Meter(s)
MCC	Mission Control Center
MEPED	Medium-Energy Proton/Electron Detector
MeV	Megalectron Volt(s)
MGC	Missile Guidance Computer
MHz	Megahertz
mi	mile
MIRP	Manipulated Information Rate Processor
mps	meters per second
MRR	Mission Requirements Request
ms	Millisecond(s)
MSU	Microwave Sounding Unit
N	Newton
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NE∆D	Noise Equivalent Radiance
NE∆T	Noise Equivalent Temperature Difference
NESDIS	National Environmental Satellite, Data, and Information Service
nm	Nanometer(s)
nml	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOM	Nominal
NORAD	North American Air Defense Command
NS	Nonscanner
OBP	On-Board Processor
OBP1	On-Board Processor #1
OSC	Office of Space Communications
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
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 Operational Control Center
SSU	Stratospheric Sounding Unit
STX	S-Band Transmitting Antenna
SW	Shortwave Switch
TED	Total Energy Detector
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
Z	Greenwich Mean Time (GMT)

http://poes.gsfc.nasa.gov

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

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