NASA Facts

National Aeronautics and
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Goddard Space Flight Center
Greenbelt, Maryland 20771

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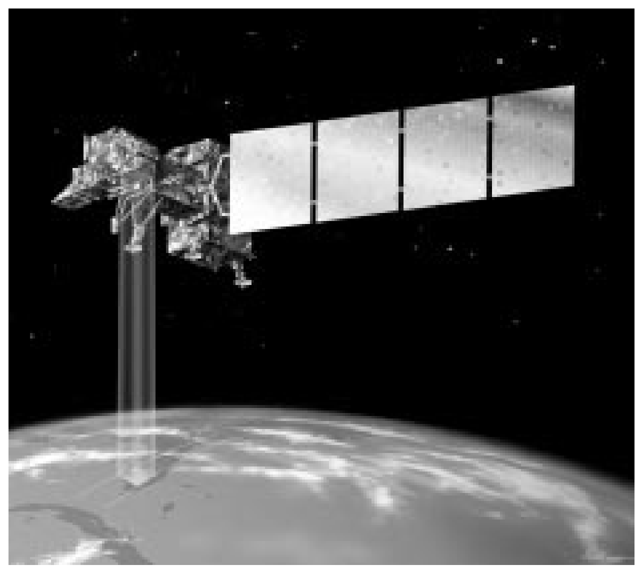
Landsat 7

Background

During the summer of 1993, NASA scientists, teaming with academic researchers, conducted a far-ranging and historic study which concluded that the rate of tropical deforestation had declined from the 1970s, but continued to be a concern along the Brazilian Amazon Basin. The data used by the researchers came from the Landsat satellites and covered the ten-year period from 1978 - 1988.

The latest mission in the Landsat series is part of NASA's Mission to Planet Earth (MTPE) program, and is being built to continue the flow of global change information to users worldwide. Scientists use Landsat satellites to gather remotely sensed images of the land surface and surrounding coastal regions for global change research, regional environmental change studies, national security uses and other civil and commercial purposes.

Landsat 7 was authorized by a Presidential Directive signed by President Bush in 1992, establishing a joint NASA, Air Force program. This was superceded by a second Presidential Directive, signed by President Clinton in 1994, that established a joint program with NASA, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) sharing responsibilities for the Landsat 7 program.



Landsat 7 will gather remotely sensed images of the land surface and surrounding coastal regions.

Landsat Science History

Landsat satellites have produced the first composite multi-spectral mosaic of the 48 contiguous United States. They have been used to monitor timber loses in the U.S. Pacific Northwest, to estimate soil moisture and snow water equivalence and to measure forest cover at the state level. In addition, Landsats have been used to monitor strip mining reclamation, population changes in and around metropolitan areas and to measure water quality in lakes. Landsat images have even been used by law firms to gather legal evidence and by the fast food restaurants, to estimate community growth sufficient to warrant a franchise.

The first Landsats, originally called ERTS for Earth Resources Technology Satellite, were developed and launched by NASA between July 1972 and March 1978. During that time, a second generation of Landsat satellites was developed. Landsat 4 was launched in July 1982 and Landsat 5 in March 1984. Landsat 5 is still receiving images.

Scientific Objectives

The 1992 Land Remote Sensing Policy Act identifies data continuity as the fundamental goal of the Landsat Program. The scientific mission of Landsat 7 is entirely consistent with this legislated goal. The mission is to extend and improve upon the more than 25-year record of images of the Earth’s continental surfaces provided by the earlier Landsat satellites. The continuation of this work is an integral component of the U.S. Global Change Research Program. Landsat 7 also will continue providing essential land surface data to a broad, diverse community of national security, civil and commercial users.

Unique Capabilities

No other current or planned remote sensing system, public or private, fills the role of Landsat in global change research or in national security, civil and commercial applications.

Landsat 7 will fulfill its mission if it provides the same scientific capabilities as the Landsat 4 and 5 Thematic Mappers. These essential capabilities include repetitive, synoptic coverage of continental surfaces; spectral bands in the visible, near-infrared, short-wave, and thermal infrared regions of the electromagnetic spectrum; spatial resolution on the order of 30 meters; and absolute radiometric calibration. No other current or planned remote sensing system matches this combination of capabilities.

Continuation of these capabilities is required for several reasons. The repetitive, broad coverage is needed for observation of seasonal changes on regional, continental and global scales. Other systems will afford frequent global coverage, but none provide this global coverage at the 30-meter spatial resolution of the Landsat Thematic Mappers. Unlike the ocean and atmosphere, the land surface is distinguished by high spatial frequency processes that require a high spatial resolution to characterize. Both man-made (deforestation) and natural changes (glacial recession) are often initiated at scales requiring high resolution for early detection.

The Landsat 7 system will offer the unique capability to seasonally monitor important small-scale processes on a global scale, such as the inter- and intra-annual cycles of vegetation growth; deforestation; agricultural land use; erosion and other forms of land degradation; snow accumulation and melt and the associated fresh-water reservoir replenishment; and urbanization. The other systems affording global coverage do not provide the resolution needed to observe these processes in detail and only the Landsat system provides a 25-plus year record of these processes.

Mission Facts

Landsat 7 is scheduled to be launched in 1998 from the Western Test Range by a Delta-II Expendable Launch Vehicle. At launch, the satellite will weigh approximately 4,800 pounds (2,200 kilograms). It is about 14 feet long (4.3 meters) and 9 feet (2.8 meters) in diameter. The Landsat 7 satellite consists of a spacecraft bus, being provided under a NASA contract with Lockheed Martin Missiles and Space in Valley Forge, Penn., and the Enhanced Thematic Mapper Plus (ETM+) instrument procured under a NASA contract with Hughes Santa Barbara Remote Sensing in Santa Barbara, Calif.

The ETM+ instrument is an eight-band multispectral scanning radiometer capable of providing high-resolution imaging information of the Earth's surface. It detects spectrally-filtered radition at visible, near-infrared, short-wave, and thermal infrared frequency bands from the Sun-lit Earth in a 115 mile (185 kilometer)-wide swath when orbiting at an altitude of 438 miles (705 kilometers). Nominal ground sample distances or "pixel" sizes are 50 feet (15 meters) in the panchromatic band; 98 feet (30 meters) in the visible, near and short-wave infrared; and 197 feet (60 meters) in the thermal infrared band. A Landsat World-Wide-Reference system has catalogued the worlds land mass into 57,784 scenes, each 115 miles (185 kilometers) wide by 106 miles (170 kilometers) long. The ETM+ will produce approximately 3.8 gigabits of data for each scene, which is roughly equivalent to nearly 16 sets of encyclopedias at 29 volumes per set.

A reaction control system will maintain the orbit at an altitude of approximately 438 miles (705 kilometers) with a sun-synchronous 98 degree inclination and a descending equatorial crossing time of 10 a.m. The orbit will be adjusted upon reaching orbit so that its 16-day repeat cycle coincides with the Landsat Worldwide Reference System. This orbit will be maintained with periodic adjustments for the life of the mission. A three-axis attitude control subsystem will stabilize the satellite and keep the instrument pointed toward Earth to within 0.05 degrees.

A silicon cell solar array, nickel hydrogen battery power subsystem will provide 1,550 watts of load power to the satellite. A communications subsystem will provide two-way communications with the ground. The command uplink and the housekeeping telemetry downlink will be via S-band while all the science data will be downlinked via X-band. A command and data handling subsystem will provide for commanding, data collection, processing and storage. A state-of-the-art solid state recorder capable of storing 380 gigabits of data (100 scenes) will be used to store selected scenes from around the world for playback over a U. S. ground station. In addition to stored data, real-time data from the Enhanced Thematic Mapper Plus can be transmitted to cooperating international ground stations and to the U.S. ground stations.

Landsat Ground System

The Landsat ground system offer a 24-hour turn around on raw data and includes a spacecraft control center and a data processing facility are being developed by the Goddard Space Flight Center in Greenbelt, Md. These Landsat-unique facilities, augmented by existing NASA institutional facilities, will be used to communicate with Landsat, control all spacecraft and instrument operations and process data. After launch and on-orbit activation of the satellite, Landsat-unique portions of the ground system will be turned over to NOAA for operation. Flight operations will be controlled by the control center at Goddard with commands uplinked via the primary ground station at the EROS Data Center in Sioux Falls, S.D., operated by the USGS. Scientific data will be captured, processed, archived, and distributed for NOAA by the same facility.

The ground system at the data center will be capable of capturing and processing 250 Landsat scenes per day and delivering at least 100 of the scenes to users each day. A maximum of 25 of these scenes can be radiometrically corrected to within five percent and geometrically located on the Earth to within 820 feet (250 meters). Uncorrected data that is ordered will contain sufficient information to allow a user to do the correction. Data captured will routinely be available for user ordering within 24 hours of its receipt at EDC. The user will be able to query metadata and image browse data from the archive electronically to determine if it contains suitable information. If so, the data can be ordered and delivered either electronically or in a digital format by common carrier.

Calibration and Validation

The data from these systems cannot easily be compared and integrated for the detection, monitoring and characterization of global change without calibration to common units of measurement. Calibration is essential to the role of Landsat 7 in the Earth Observing System era. Landsat 7 will be launched into a constellation of satellites dedicated to Earth observations. The Enhanced Thematic Mapper Plus aboard Landsat 7 will be calibrated accurately in order to use its data in concert with the data from the other satellites and thereby realize the full potential of the integrated remote sensing systems under development by the Mission to Planet Earth Office.

The inclusion of a new full-aperture-solar-calibrator and a partial-aperture-solar-calibrator on Landsat 7 will afford improved calibration relative to the earlier Thematic Mapper and Multi-Spectral Scanner sensors on Landsats 4 and 5. These two devices will permit use of the Sun, with its known exo-atmospheric irradiance, as an absolute radiometric calibration source. The data provided by the on-board solar calibrators, in conjunction with an internal calibration lamp and occasional ground-based validation experiments, will permit calibration to an uncertainty of less than five percent. This level of accuracy is consistent with the radiometric requirements for the Earth Observation System sensors.

Management

NASA is responsible for the development and launch of the satellite and the development of the ground system. NOAA is responsible for operation and maintenance of the satellite and the ground system for the life of the satellite. The USGS, on behalf of NOAA,will capture, process, and distribute the data and is responsible for maintaining an archive of Landsat data.

Landsat 7 is part of a global research program known as NASA's Mission to Planet Earth, a long-term program that is studying changes in Earth's global environment. The goal of Mission to Planet Earth is to provide people a better understanding of natural environmental changes. Mission to Planet Earth data, which will be distributed to researchers worldwide at the cost of reproduction, is essential to people making informed decisions about their environment. The Landsat Project, located at the Goddard Space Flight Center manages Landsat development for NASA's Office of Mission to Planet Earth in Washington, D.C.