NASA Facts

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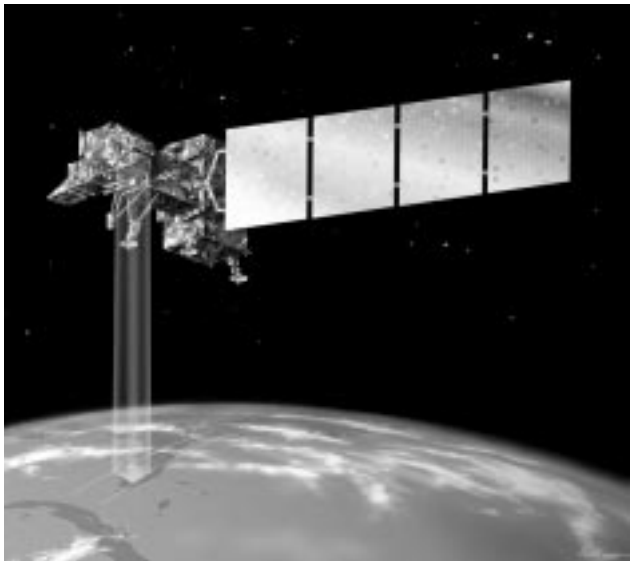
The Landsat Satellites: Unique National Assets

During the summer of 1993, NASA scientists teaming with academic researchers conducted a far-ranging and historic study that concluded 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 10-year period from 1978-1988.

The latest mission in the Landsat series, Landsat 7, is part of NASA's Earth Science Enterprise (ESE) 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 and other civil and commercial purposes.



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

No other current or planned remote sensing system, public or private, fills the role of Landsat in global change research or in civil and commercial applications. Landsat 7 will fulfill its mission by providing 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 of 30 meters (98-feet); 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-area coverage is needed for observation of seasonal changes on regional, continental and global scales. Other systems afford frequent global coverage, but none provide this global

coverage at the 30-meter (98-feet) spatial resolution of the Landsat Thematic Mappers. Unlike the ocean and atmosphere, characterizing the land surface is distinguished by high spatial frequency processes that require a high spatial resolution. 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 26-plus year record of these processes.

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 26-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 civil and commercial users.

Landsat Science History

Images acquired by Landsat satellites were used to produce the first composite multispectral mosaic of the 48 contiguous United States. Landsat imagery has provided critically important information for monitoring agricultural productivity, water resources, urban growth, deforestation, and natural change due to fires and insect infestations. The data have also been used successfully for mineral exploration, to measure forest cover at the state level, and to monitor strip mining and strip mine reclamation.

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 transmitting images. Landsat 7 was authorized by a Presidential Directive signed by President Bush in 1992.

Mission Facts

Landsat 7 is scheduled to be launched in April 1999 from the Western Test Range on a Delta-II expendable launch vehicle. At launch, the satellite will weigh approximately 4,800 pounds (2,200 kilograms). The spacecraft is about 14 feet long (4.3 meters) and 9 feet (2.8 meters) in diameter. It consists of a spacecraft bus, being provided under a NASA contract with Lockheed Martin Missiles and Space in Valley Forge, Pa., and the Enhanced Thematic Mapper Plus (ETM+) instrument, procured under a NASA contract with Raytheon (formerly 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 radiation at visible, near-infrared, short-wave, and thermal infrared frequency bands from the sun-lit Earth in a 115 mile (183 kilometer)-wide swath when orbiting at an altitude of 438 miles (705 kilometers). Nominal ground sample distances or "pixel" sizes are 49 feet (15 meters) in the panchromatic band; 98 feet (30 meters) in the 6 visible, near and short-wave infrared bands; and 197 feet (60 meters) in the thermal infrared band. A Landsat World-Wide-Reference system has catalogued the world's landmass into 57,784 scenes, each 115 miles (183 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 15 sets of encyclopedias at 29 volumes per set.

The satellite will orbit the Earth 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 includes a spacecraft control center, ground stations for uplinking commands and receiving data, a data handling facility and a data archive developed by NASA's Goddard Space Flight Center, Greenbelt, Md., in conjunction with the U.S. Geological Survey (USGS) EROS Data Center (EDC), Sioux Falls, S.D. These facilities, augmented by existing NASA institutional facilities, will communicate with Landsat 7, control all spacecraft and instrument operations, and will receive, process, archive, and distribute ETM+ data. The primary ground station, the data handling facility and archive are located at the EROS Data Center and will fall under USGS management following launch and on-orbit activation of the satellite. NASA will manage flight operations from the control center at the Goddard Space Flight Center until October 1, 2000, when responsibility for flight operations transfers to the USGS as well. The ground system will be able to distribute raw ETM+ data within 24 hours of its reception at the EROS Data Center.

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. All 100 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 the EROS Data Center. 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 satellites 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 as part of a planned 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 Earth Science Enterprise.

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

Landsat 7 was developed as a tri-agency program between the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration (NOAA), and the Department of Interior's U.S. Geological Survey. NASA is responsible for the development and launch of the satellite, and the development of the ground system. As the operator of the national meteorological satellite system, NOAA provided its operational expertise to the developers of the ground system. USGS is responsible for receiving, processing, archiving and distributing the data.

As the operational era begins, Landsat 7 is transitioning to a dual-agency program between NASA and USGS. The transition and management have been governed by a joint management plan agreed to by the three agencies; future management will be governed by a bilateral Memorandum of Understanding between NASA and USGS. The Landsat Project, located at Goddard, manages Landsat development for NASA's Office of Earth Science in Washington, D.C. USGS operations will be performed at a Mission Operations Center at Goddard and at the EDC in Sioux Falls, S.D.

Landsat 7 is part of a global research program known as NASA's Earth Science Enterprise, a long-term program that is studying changes in Earth's global environment. The goal of the Earth Science Enterprise is to provide people a better understanding of natural environmental changes. Earth Science Enterprise data, which will be distributed to researchers worldwide at the cost of reproduction, is essential to people making informed decisions about their environment.

For further information on Landsat 7, visit the websites at: http://geo.arc.nasa.gov/sge/landsat/landsat.html or http://mtpe.gsfc.nasa.gov/landsat/default.htm