



ADAR 5500 Camera

The Airborne Data Acquisition and Registration (ADAR) is a multispectral imager that is essentially a very precise digital camera. It is unlike a handheld camera that uses film. The ADAR imager has several types of digital photoreceptors that are able to record very specific wavelengths, or colors, of light.

Positive Systems, Inc., (Whitefish, MT) designs, manufactures and markets the Airborne Data Acquisition and Registration (ADAR™) Systems family of digital aerial photography systems and services.

Aerial Photography

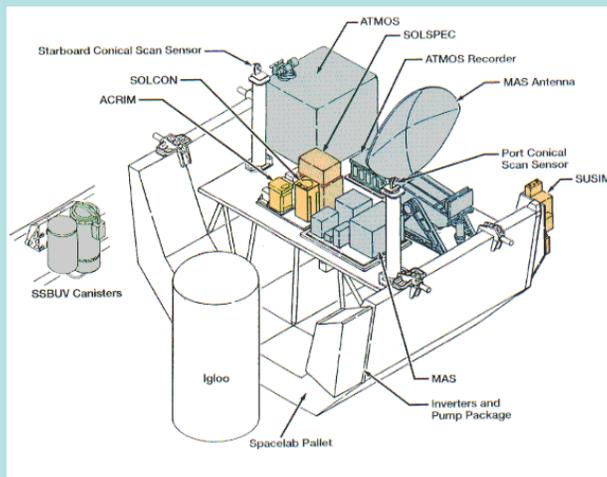
Aerial photography is the process of photographing locations on Earth from a point above the targeted area. This can be accomplished by using any type of craft such as balloon, airplane, rocket, kite, etc. Birds have also been used as an aerial photography platform. The first aerial photograph was taken by Gaspard Felix Tournachon in 1859 from a balloon. In the United States during the Civil War, the Northern Army had a Balloon Corps from 1862-1863 to observe and photograph battlefields and enemy positions. The balloon corps was quickly disbanded when they became easy targets for enemy gunfire. In 1903 in Germany, pigeons with cameras attached to their chest were used for aerial photographs. The first aerial photograph from an airplane was taken in 1908 in France from a Wright Flyer piloted by Wilbur Wright himself. His passenger, L.P. Bonvillain, took the historic photo. Aerial photographs have proven to be valuable in reconnaissance, research, and for entertainment.

ATLAS (Atmospheric Laboratory for Applications and Science)

The focus of ATLAS is to study the chemistry of Earth's upper atmosphere (mainly the stratosphere/mesosphere) and the solar radiation striking the Earth system (both total solar irradiance and spectrally resolved radiance, especially ultraviolet). Science operations onboard ATLAS 1 (March 1992) and ATLAS 2 (March-April, 1993) began a comprehensive and systematic collection of data that will help establish benchmarks for atmospheric conditions and the Sun's stability.



Early method of aerial photography



Schematic of ATLAS instrument
<http://www.ghcc.msfc.nasa.gov/atlas.html>

AVHRR (Advanced Very High Resolution Radiometer)

AVHRR is a five-channel scanning instrument that quantitatively measures electromagnetic radiation, flown on NOAA environmental satellites. AVHRR remotely determines cloud cover and surface temperature. Visible and infrared detectors observe vegetation, clouds, lakes, shorelines, snow, and ice. TIROS Automatic Picture Transmissions (APT) are derived from this instrument.

Defense Meteorological Satellite Program (DMSP)

DMSP is a U.S. Air Force meteorological satellite program with satellites circling in sun-synchronous orbit. Imagery is collected in the visible to near-infrared band (0.4 to 1.1 micrometers) and in the thermal-infrared band (about 8 to 13 micrometers) at a resolution of about 3 kilometers. While some of the data is classified, most is unclassified and is available to civilian users.

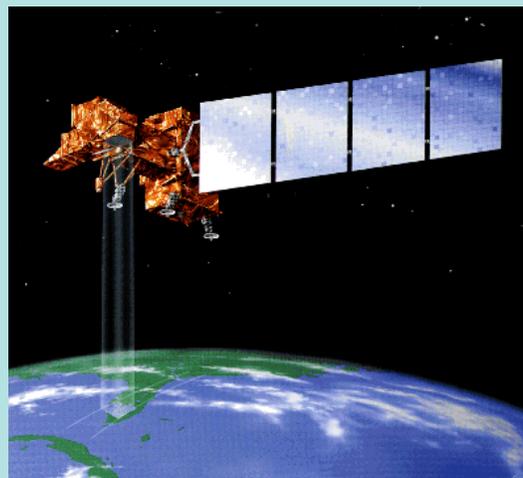
Global Land One-Kilometer Base Elevation (GLOBE)

The Global Land One-Kilometer Base Elevation (GLOBE) Project is an international effort to develop a best-available global Digital Elevation Model (DEM) on a 1-kilometer grid.

Landsat

The Landsat Program is the longest running enterprise for acquisition of imagery of Earth from space. The first Landsat satellite was launched in 1972; the most recent, Landsat 7, was launched on April 15, 1999. The instruments on the Landsat satellites have acquired millions of images. The images, archived in the United States and at Landsat receiving stations around the world, are a unique resource for global change research and for applications in agriculture, geology, forestry, regional planning, education, and national security.

The value of the Landsat Program was recognized by Congress in October of 1992 when it passed the Land Remote Sensing Policy Act (Public Law 102-555) authorizing the procurement of Landsat 7 and assuring the continued availability of Landsat digital data and images, at the lowest possible cost, to traditional and new users of the data.



Landsat 7 instrument

Mariner

The Mariner series of spacecraft were interplanetary probes designed to investigate Mars, Venus, and Mercury. The program included a number of firsts, including the first planetary flyby, the first planetary orbiter, and the first gravity assist.

The first artificial satellite of Mars was Mariner 9, launched in May 1971. In November 1971, the spacecraft entered Martian orbit and began photographing the surface and analyzing the atmosphere with its infrared and ultraviolet instruments. The mission originally consisted of two spacecraft designed to simultaneously map the Martian surface, but the identical Mariner 8 vehicle was lost in a launch vehicle failure.

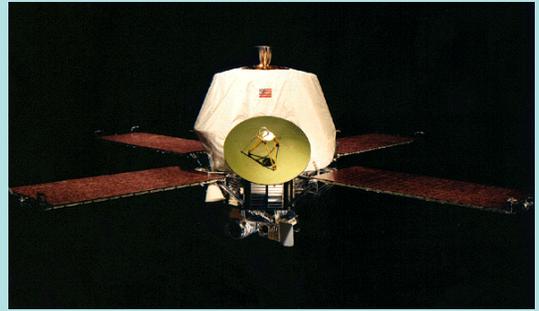
The Mariner 10 spacecraft launched on November 3, 1973. Mariner 10 was the first spacecraft to use a gravity assist trajectory, accelerating as it entered the gravitational influence of Venus, then being flung by the planet's gravity onto a slightly different course to reach Mercury. It was also the first spacecraft to encounter two planets at close range.

Mars Global Surveyor

Mars Global Surveyor is a polar-orbiting spacecraft designed to provide global maps of surface topography and distribution of minerals and to monitor global weather. In November of 1996, NASA and the Jet Propulsion Laboratory began America's return to Mars after a 20-year absence by launching the MGS spacecraft. The spacecraft entered orbit around the red planet on September 11, 1997. This mission ushers in a new and exciting era of scientific missions to study the red planet.

Mars Orbiter Laser Altimeter (MOLA)

MOLA is the Mars Orbiter Laser Altimeter, an instrument currently in orbit around Mars on the Mars Global Surveyor (MGS) spacecraft. The instrument transmits infrared laser pulses towards Mars at a rate of 10 Hz and measures the time of flight to determine the range of the MGS spacecraft to the Martian surface. The range measurements are used to construct a precise topographic map of Mars that has many applications to studies in geophysics, geology, and atmospheric circulation.



Mariner 9



Mariner 10

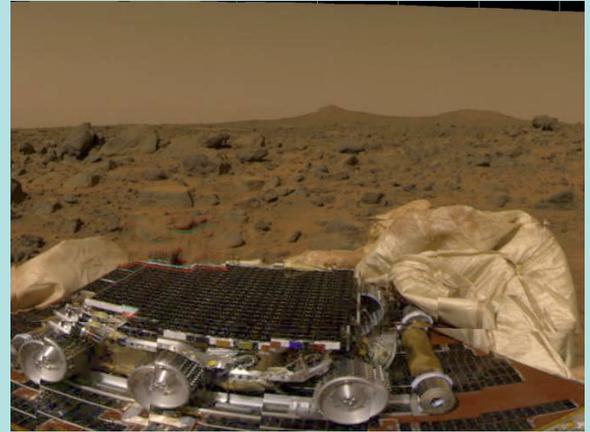


Mars Global Surveyor

Mars Pathfinder Lander

The Mars Pathfinder mission is managed by the Jet Propulsion Laboratory for NASA's Office of Space Science, Washington, D.C. The mission is the second in the Discovery program of fast-track, low-cost spacecraft with highly focused science goals.

On July 4, 1997, the Mars Pathfinder spacecraft arrived on the red planet. Pathfinder deployed a small rover called Sojourner to explore the Martian landscape. Since its landing, Mars Pathfinder has returned 2.6 billion bits of information, including more than 16,000 images from the lander and 550 images from the rover, as well as more than 15 chemical analyses of rocks and extensive data on winds and other weather factors. The only remaining objective was to complete the high-resolution 360-degree image of the landing site called the "Super Pan" (when this was written, 83 percent had already been received and processed). The last successful data transmission cycle from Pathfinder was completed on Sol 83 (the 83rd Earth day) of the mission.



Mars Pathfinder Lander

NDVI (Normalized Difference Vegetation Index)

To determine the density of green on a patch of land, researchers must observe the distinct colors (wavelengths) of visible and near-infrared sunlight reflected by the plants. As can be seen through a prism, many different wavelengths make up the spectrum of sunlight. When sunlight strikes objects, certain wavelengths of this spectrum are absorbed and other wavelengths are reflected. The pigment in plant leaves, chlorophyll, strongly absorbs visible light (from 0.4 to 0.7 μm) for use in photosynthesis. The cell structure of the leaves, on the other hand, strongly reflects near-infrared light (from 0.7 to 1.1 μm). The amount of leaves on plants affects the absorption and reflectance of the wavelengths.

Nimbus Satellite Program

Nimbus is a NASA program to develop observation systems meeting the research and development requirements of atmospheric and Earth scientists. The Nimbus satellites, first launched in 1964, carried a number of instruments: microwave radiometers, atmospheric sounders, ozone mappers, the Coastal Zone Color Scanner (CZCS), infrared radiometers, etc. Nimbus-7, the last in the series, provided significant global data on sea-ice coverage, atmospheric temperature, atmospheric chemistry (i.e., ozone distribution), Earth's radiation budget, and sea-surface temperature.

Operational Linescan System

Defense Meteorological Satellite Program's (DMSP) Operational Linescan System (OLS) is a network of satellites originally designed to pick up lunar illumination reflecting off of clouds at night in order to aid nighttime aircraft navigation. What the Air Force discovered is that on evenings when there was a new moon, the satellites were sensitive enough to record the illumination from city lights. Over a period of several new moons, the data the satellites retrieved could be pieced together to produce a global image of city lights.

RADARSAT - 1

A joint partnership between the Canadian Space Agency (CSA) and NASA, RADARSAT-1's objective was to create the first, complete, high-resolution radar mosaic of all of Antarctica.

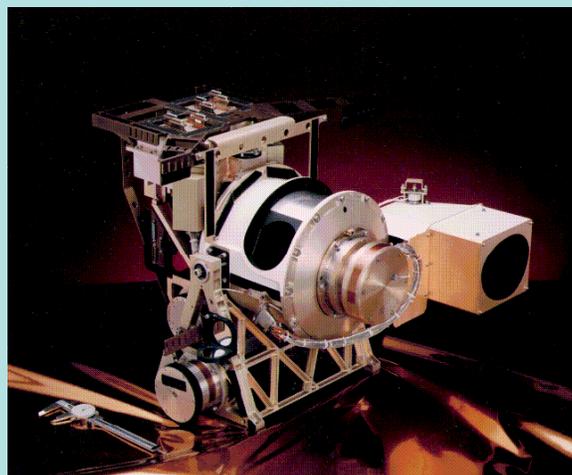
The spacecraft was equipped with a C-Band Synthetic Aperture Radar (SAR) capable of acquiring high-resolution (25 meters) images of Earth's surface, day or night and under all weather conditions. RADARSAT-1 had the first capability to collect data using a variety of swath widths, incidence angles, and resolutions. It could also be maneuvered in orbit to rotate the normally right-looking SAR to a left-looking mode, giving us the first high-resolution mapping of all of Antarctica.

SAR (Synthetic Aperture Radar)

Synthetic Aperture Radar (SAR) is a remote-sensing technology which uses the motion of the aircraft or spacecraft carrying the radar to synthesize an antenna aperture larger than the physical antenna to yield a high-spatial-resolution imaging capability. SAR systems can thus obtain high-spatial-resolution geophysical measurements of the Earth over wide surface areas, under all weather, and day or night conditions.

SeaWiFS (Sea-Viewing Wide Field-of-View Sensor)

The purpose of the Sea-Viewing Wide Field-of-View Sensor (SeaWiFS) Project is to provide quantitative data on global ocean bio-optical properties to the Earth science community. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications. The SeaWiFS Project will develop and operate a research data system that will process, calibrate, validate, archive, and distribute data received from an Earth-orbiting ocean-color sensor. The SeaWiFS Mission is a part of NASA's Earth Science Enterprise, which is designed to look at our planet from space to better understand the system's behavior and evolution.



SeaWiFS Instrument

SIR-C/X-SAR

SIR-C/X-SAR, part of NASA's Earth Science Enterprise, is studying how our global environment is changing. From the unique vantage point of space, the radar system observes, monitors, and assesses large-scale environmental processes with a focus on climate change. These data, complemented by aircraft and ground studies, give scientists highly detailed information that help them distinguish natural environmental changes from those that are the result of human activity. NASA distributes these data to the international scientific community so that it is available worldwide to people who are trying to make informed decisions about protecting their environment.

SPOT

Systeme Pour l'Observation de la Terre are French, polar-orbiting, Earth-observation satellites with ground resolution of 10 meters. SPOT images are available commercially and are intended for such purposes as environmental research and monitoring, ecology management, and for use by the media, environmentalists, legislators, etc.

Thematic Mapper

The Thematic Mapper is a Landsat multispectral scanner designed to acquire data to categorize Earth's surface. Particular emphasis was placed on agricultural applications and identification of land use. The scanner continuously scans the surface of Earth, simultaneously acquiring data in seven spectral channels. Overlaying two or more bands produces a false color image. The ground resolution of the six visible and short-wave bands of the Thematic Mapper is 30 meters, and the resolution of the thermal infrared band is 120 meters. Thematic mappers have been flown on Landsats 4 and 5.

TIMS (Thermal Infrared Multispectral Scanner)

The TIMS instrument is flown on a DOE Cessna Citation aircraft. The TIMS instrument is a six channel aircraft scanner operating in the thermal infrared region of the electromagnetic spectrum.

TIMS is a simulator for the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), an imaging instrument that flew on EOS AM-1, named TERRA, a satellite launched in December 1999, as part of NASA's Earth Observing System (EOS). ASTER is used to obtain detailed maps of surface temperature, which can then be used in studies of the surface energy balance and evapotranspiration.

TOMS (Total Ozone Mapping Spectrometer)

Flown on NASA's Nimbus-7 satellite, TOMS's primary goal is to continue the high-resolution global mapping of total ozone on a daily basis. The Nimbus-7 launch in 1978 enabled TOMS to begin delivering data in 1979 and to continue providing information until 1993. TOMS has mapped the total amount of ozone between the ground and the top of the atmosphere, provided the first maps of the ozone hole, and continues to monitor this phenomenon. Because of its longevity, TOMS also has obtained information on the more subtle trends in ozone outside the ozone hole region. This results from development of a powerful new calibration technique that removes the instrument measurement drift that developed over the years. With this technique applied to the TOMS 14.5-year data record, a global ozone decrease of 2.69 percent per decade was detected.

To ensure that ozone data will be available through the next decade, NASA will continue the TOMS program using U.S. and foreign launches. In 1991, the former Soviet Union launched a Meteor-3 satellite carrying a TOMS instrument provided by NASA. A third TOMS was launched onboard a NASA Earth probe satellite in 1994, and the Japanese Advanced Earth Observations Satellite (ADEOS) carried a fourth TOMS when it launched in 1996.

Viking Orbiter

NASA's Viking Mission to Mars was composed of two spacecraft, Viking 1 and Viking 2, each consisting of an orbiter and a lander. The primary mission objectives were to obtain high resolution images of the Martian surface, characterize the structure and composition of the atmosphere and surface, and search for evidence of life. Viking 1 was launched on August 20, 1975, and arrived at Mars on June 19, 1976. The first month of orbit was devoted to imaging the surface to find appropriate landing sites for the Viking Landers. On July 20, 1976, the Viking 1 Lander separated from the Orbiter and touched down at Chryse Planitia (22.48° N, 49.97° W planetographic, 1.5 km below the datum (6.1 mbar) elevation). Viking 2 was launched September 9, 1975, and entered Mars orbit on August 7, 1976. The Viking 2 Lander touched down at Utopia Planitia (47.97° N, 225.74° W, 3 km below the datum elevation) on September 3, 1976.



Viking Orbiter



Surface of Mars from Viking