Japan Aerospace Exploration Agency

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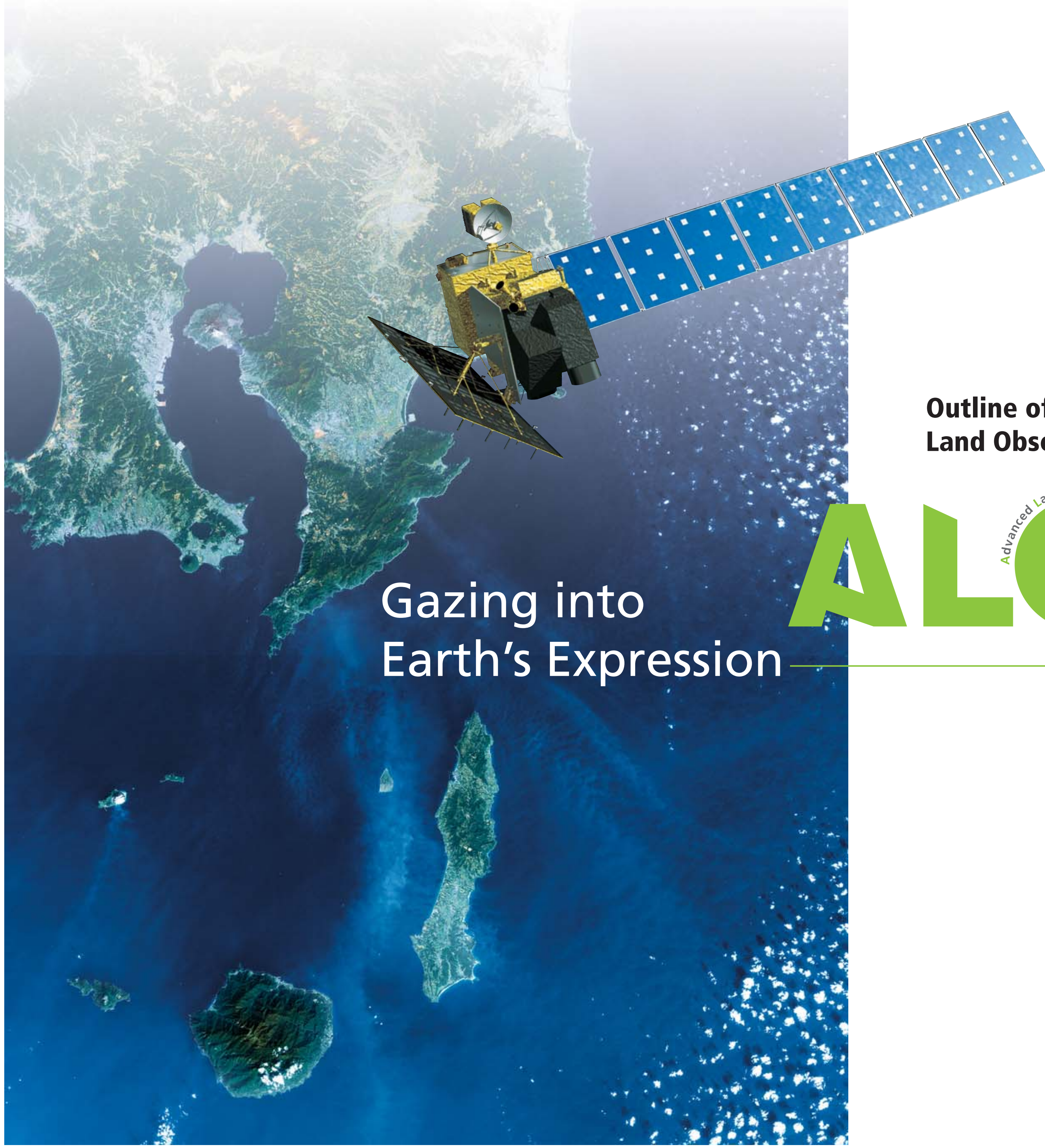


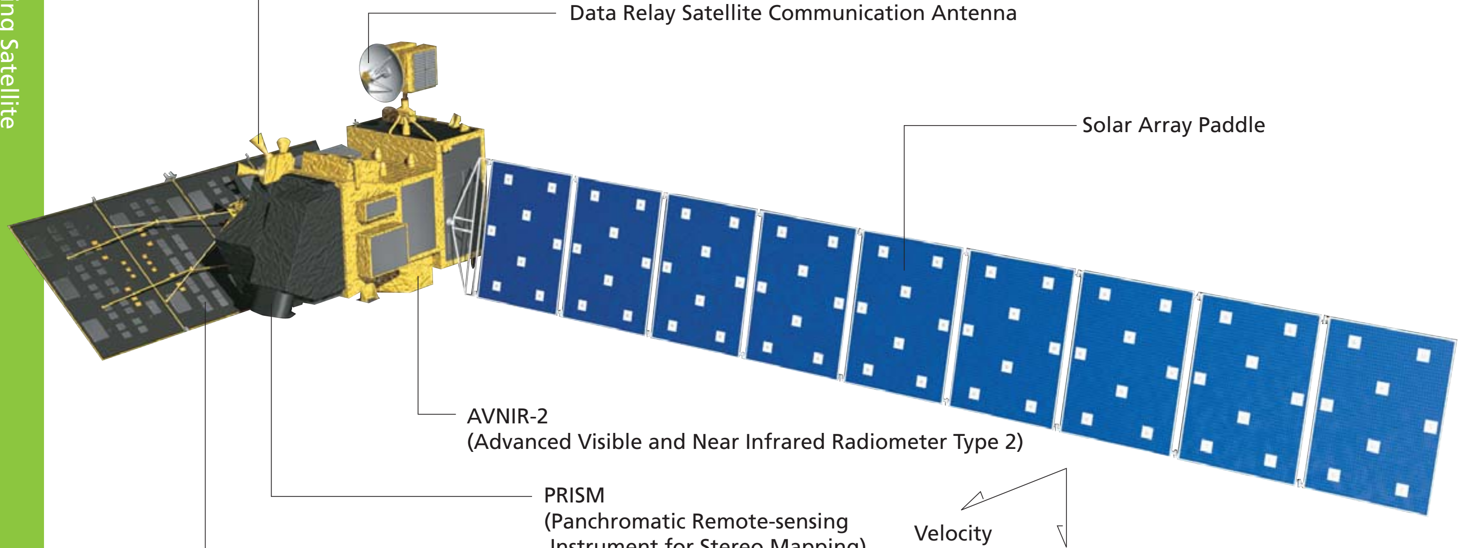
Gazing into Earth's Expression

Outline of the Advanced Land Observing Satellite

ALOS

Advanced Land Observing Satellite

Configuration and Missions



The Advanced Land Observing Satellite

The Advanced Land Observing Satellite (ALOS) aims at collecting global topographic data with a high resolution by upgrading the land observation technology of the Japan Earth Resources Satellite-1 (JERS-1, or Fuyo) and the Advanced Earth Observing Satellite (ADEOS, or Midori).

The ALOS is equipped with three earth observation sensors, namely the Panchromatic Remote-sensing Instrument of Stereo Mapping (PRISM) for obtaining terrain data including elevations; the Advanced Visible and Near Infrared Radiometer type-2 (AVNIR-2) for providing land coverage maps and land-use classification maps; and the Phased Array type L-band Synthetic Aperture Radar (PALSAR) for day-and-night observations of land and ice sheets regardless of the weather. With these three sensors, the ALOS has detailed land observation functions.

Major Characteristics

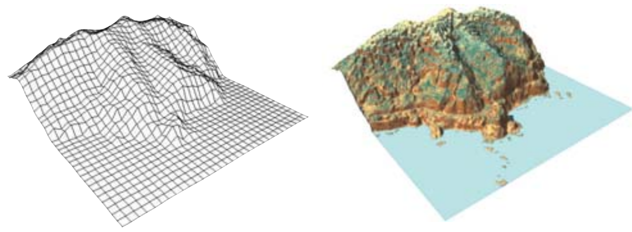
Item	Characteristics
Launch Vehicle	H-IIA Launch Vehicle
Launch Site	Tanegashima Space Center
Satellite Mass	Approx. 4 tons
Power Generation	Approx. 7kW (End of Life)
Designed Life	3 years (minimum), 5 years (target)
Dimension	Main body: about 6.5 m x 3.5 m x 4.5 m Solar array paddle about 3 m x 22 m
Orbit	Sun Synchronous Sub-recurrent Orbit Altitude: approx. 691.65 km Inclination: approx. 98.16 degrees Period: about 100 minutes Recurrent period: 46 days (Sub cycle: 2 days)

Four Missions of the ALOS

The ALOS has the following four missions.

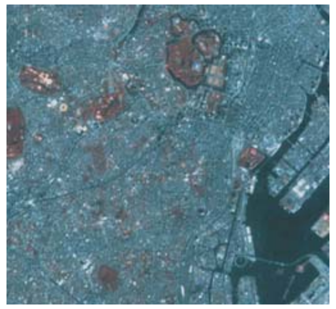
- Cartography: mapping or updating existing maps in Japan as well as other countries in the Asia-Pacific region.
- Regional observations: carrying out regional observations for sustainable development in each region of the world (that harmonizes with the regional environment and development.)
- Disaster monitoring: monitoring and understanding a large-scale disaster in Japan and overseas.
- Resource surveying: surveying resources in Japan and overseas.

Cartography



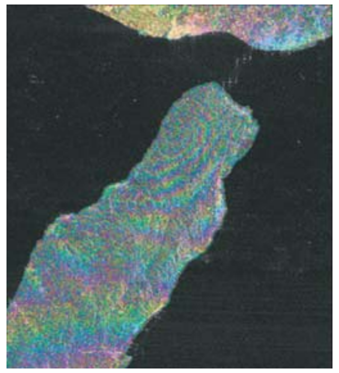
Mapping on a scale of 25,000 .to 1 using ALOS data.

Regional Observations



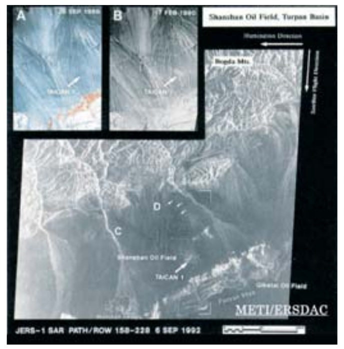
Carrying out regional observations for sustainable development that harmonizes with the environment in each region in the world.

Disaster Monitoring



Quickly monitoring and understanding areas hit by a large-scale disaster, including earthquakes, fires, volcanic eruptions, or heavy oil spills, which cannot be predicted, in Japan and overseas.

Resource Surveying



Unexploited natural resources can be detected by analyzing terrain characteristics.

Observations by the ALOS are available within two days for emergencies all over the world.

Example of disaster monitoring: image of mountain fire in Mongolia taken by the Fuyo-1

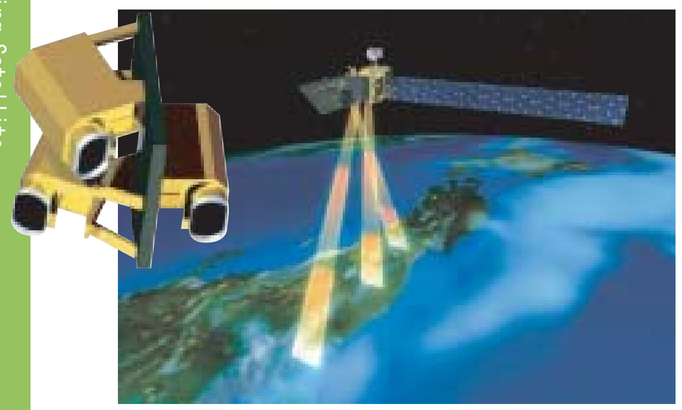
One of the important missions for the ALOS is to perform emergency observations in the case of a disaster. However, in the ALOS orbit, it can return to the same designated point on the earth only once in 46 days.

The AVENIR-2 and PALSAR are equipped with a function to freely change their observation areas (through a pointing function or by cocking their neck), by which either of these sensors can observe a specific point on the earth within two days.

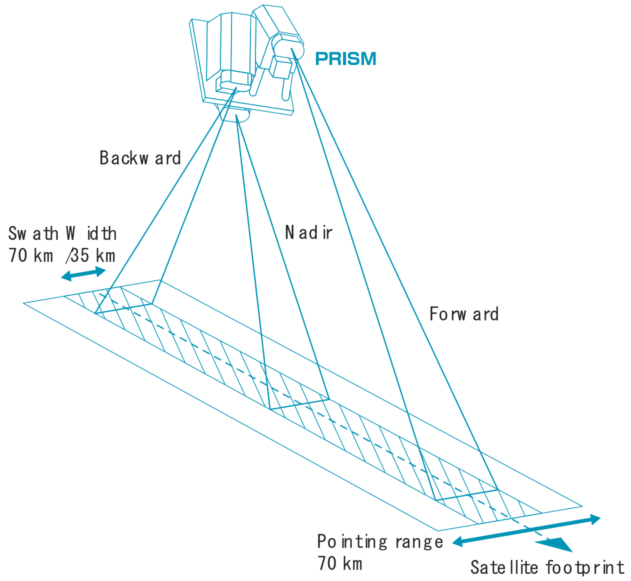
JAXA joined the Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters in February 2005. When a large scale disaster occurs, data acquired by the ALOS will be available for disaster preparation organizations around the world.

Sensors

Panchromatic Remote-sensing Instrument of Stereo Mapping (PRISM)



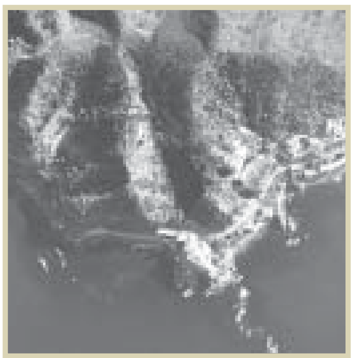
The PRISM is an optical sensor for observing visible terrain areas with a 2.5-meter spatial resolution. It has three independent optical systems to acquire terrain data including altitude data so that images for nadir, forward and backward views can be acquired at the same time. This enables us to get three-dimensional terrain data with a high accuracy and frequency.



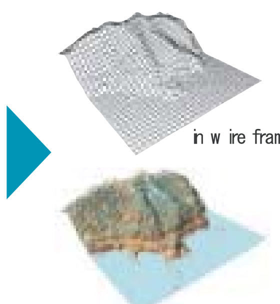
PRISM Major Characteristics

Observation Band (μm)	0.52 to 0.77
Number of Optical Systems	Three sets (Nadir, Forward, Backward)
Base and High Ratio	1.0 (Forward to Backward)
Signal to Noise Ratio	> 70
Modulation Transfer Function	>0.2
Spatial Resolution	2.5 m
Swath Width	35 km (Triplet mode) 70 km (Nadia only)
Pointing angle	+/-1.5 degrees (Triplet mode)

PRISM simulated image (on nadir)

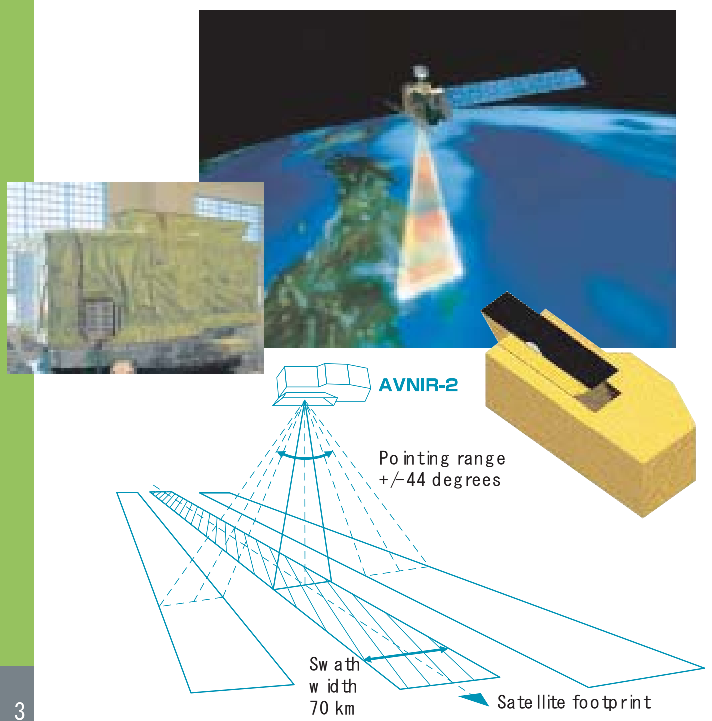


Example of digital elevation model (DEM)*



*By using the DEM, accurate geometric corrections and compilations of a bird's-eye view picture can be possible. With the PRISM, more accurate DEM can be created as it acquires images from three directions with visible terrain areas with 2.5-meter spatial resolution.

Advanced Visible and Near Infrared Radiometer type-2 (AVNIR-2)



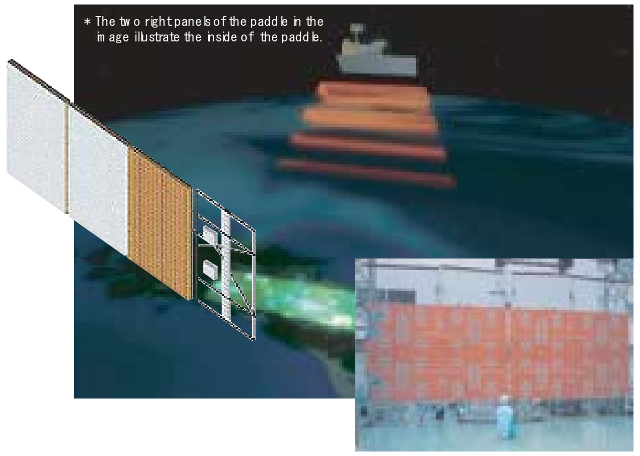
The AVNIR-2 is an upgraded AVNIR on the Advanced Earth Observing Satellite (ADEOS) with higher resolution. It will contribute to create maps for categorizing land usage or vegetations by observing mainly land and coastal areas using visible and near infrared radiometers. The AVNIR-2 is equipped with a pointing function by which it can shift its observation area to the ALOS's moving direction. This function is expected to also be useful for monitoring and understanding the situation of a disaster stricken area.

AVNIR-2 Major Characteristics

Observation Band (μm)	Band1: 0.42 to 0.50, Band2: 0.52 to 0.60 Band3: 0.61 to o 0.69, Band4: 0.76 to 0.89
Signal to Noise Ratio	>200
Modulation Transfer Function	Band1 to 3: >0.25 Band4: >0.2
Spatial Resolution	10 m (at Nadir)
Swath Width	70 km (at Nadir)
Pointing Angle	+/-44 degrees

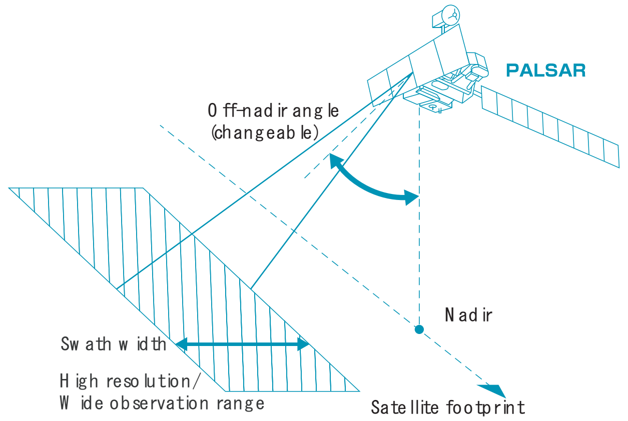
Phased Array type L-band Synthetic Aperture Radar (PALSAR)

The PALSAR is an upgraded Synthetic Aperture Radar (SAR) onboard the Japan Earth Resources Satellite-1 (JERS-1) with improved function and performance. It is an active type microwave sensor which can carry out observations day and night regardless of weather conditions. The PALSAR is equipped with a function to change its observation direction and observation mode to cover wider range (Scan SAR.) The radar is developed in cooperation with the Japan Resources Observation System Organization (JAROS) of the Ministry of Economy, Trade, and Industry (METI).



PALSAR Major Characteristics

Major Observation Mode	High Resolution	ScanSAR
Frequency	L-band (1.27 GHz)	
Polarization	HH, VV, HH&HV, VV&VH	HH, VV
Spatial Resolution	10 m	100 m
Number of Looks	2	8
Swath Width	70 km	250 to 350 km
Off-nadir Angle	10 to 51 degrees	
Noise Equivalent Sigma 0	Approx. -23 dB	



Special technological features of the ALOS

High speed/large volume data handling technology

The sensors onboard the ALOS generate more high-speed data than conventional sensors. For example, three radiometers of the PRISM produce 960 Mbps in total, AVNIR-2's output from the four bands is 160M bps in total and the PALSAR transmits 240 Mbps of observation data in high resolution mode. The total output of the three sensors is 1.36 Gbps, and this cannot be transmitted to a ground station without compressing it. Therefore, the PRISM and AVNIR-2 compress data in real time from 960 to 240 Mbps and 160 to 120 Mbps, respectively. Error correcting codes are added to the compressed data as it tends to be largely affected by errors when being transmitted, and the data is then sent either via a data relay satellite or directly to a ground station. The ALOS is also equipped with a large volume semi-conductor data recorder to store data when real-time transmissions to a ground station are not possible.

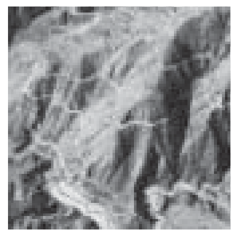
High precision position and attitude determination technology

For one of the ALOS's major missions, cartography, it is essential to know the accurate position of each pixel of an observation image on the ground. Therefore, the ALOS is designed to minimize structural distortion by heat and to determine its position and attitude with high precision. For precision satellite position determination in particular, a dual frequency GPS receiver is mounted. Processing GPS data on the ground, the satellite positioning is determined within an accuracy of 1 meter. In addition, the ALOS has high precision star-trackers for precision attitude determination so that attitude can be determined within an accuracy of 3.0 x 10^{-4} degrees onboard or 1.4 x 10^{-4} when processed on the ground.

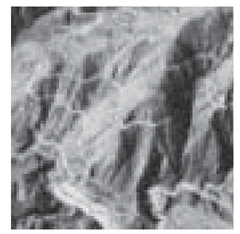
Major Characteristics of the Mission Data Handling System

Data compression		PRISM data Compression method: Discrete Cosine Transfer (DCT) + Huffman encoding Compression ratio: 1/4.5, 1/9 (irreversible compression) AVENIR-2 data Compression method: Differential Pulse Code Modulation (DPCM) + Huffman encoding Compression ratio: 3/4
Data recoder		Method: Semicondactor data recoder Volum: 96GB Record/Playback speed: 360 Mbps (recording) 240 Mbps (playback) Data recoding and playback can be done simultaneously.
Error Correction		Method: Reed-Solomon Code Total bit error ratio: 1×10^{-16}
Data transmission	via a data relay satellite	Transmission speed: 278M sps Bandwidth: 26 GHz range
	direct transmission	Transmission speed: 139M sps Bandwidth: 8 GHz range

Compressed image example



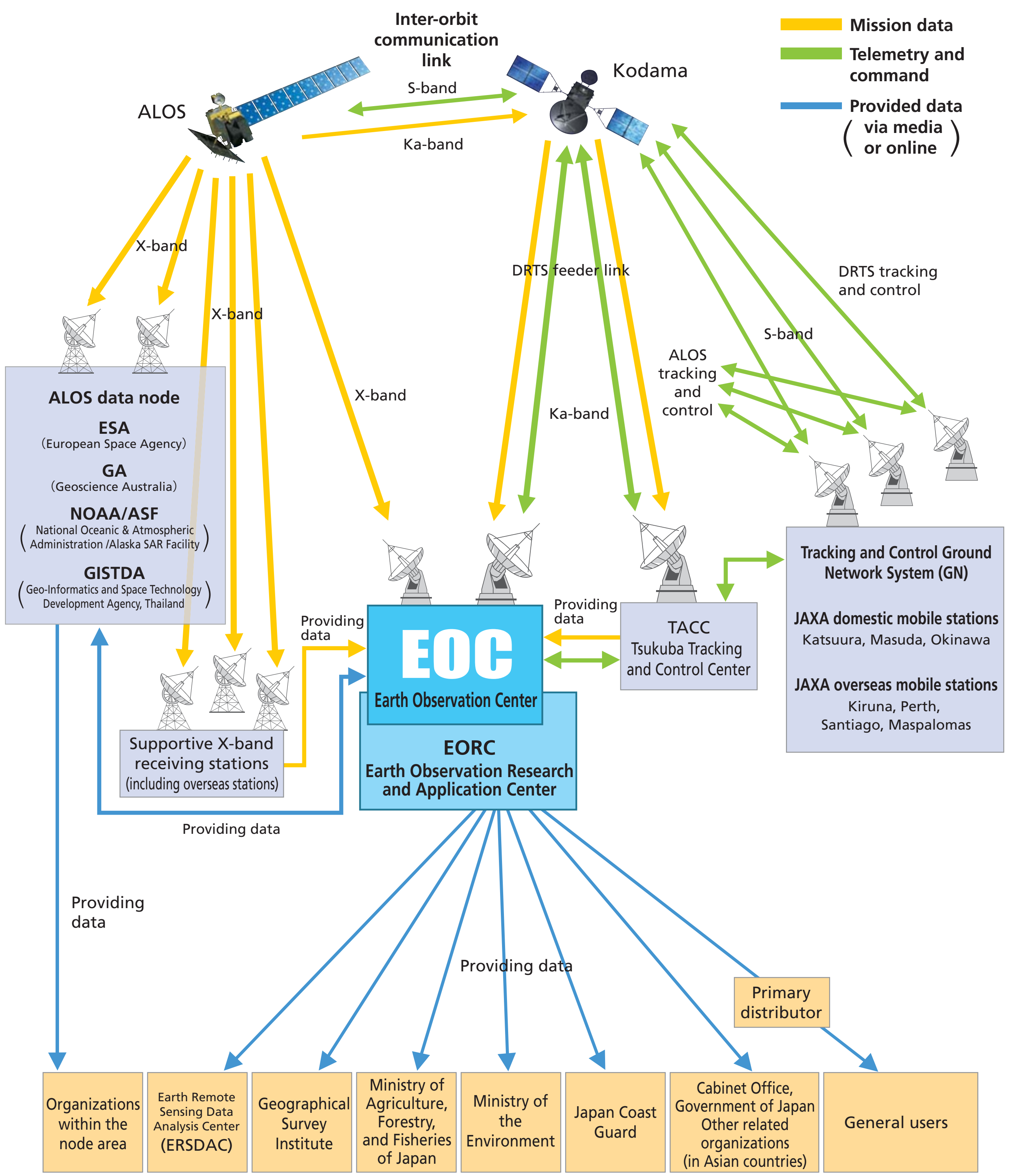
Original image



Compressed image (Compression ratio: 1/4)

Mission Operation System

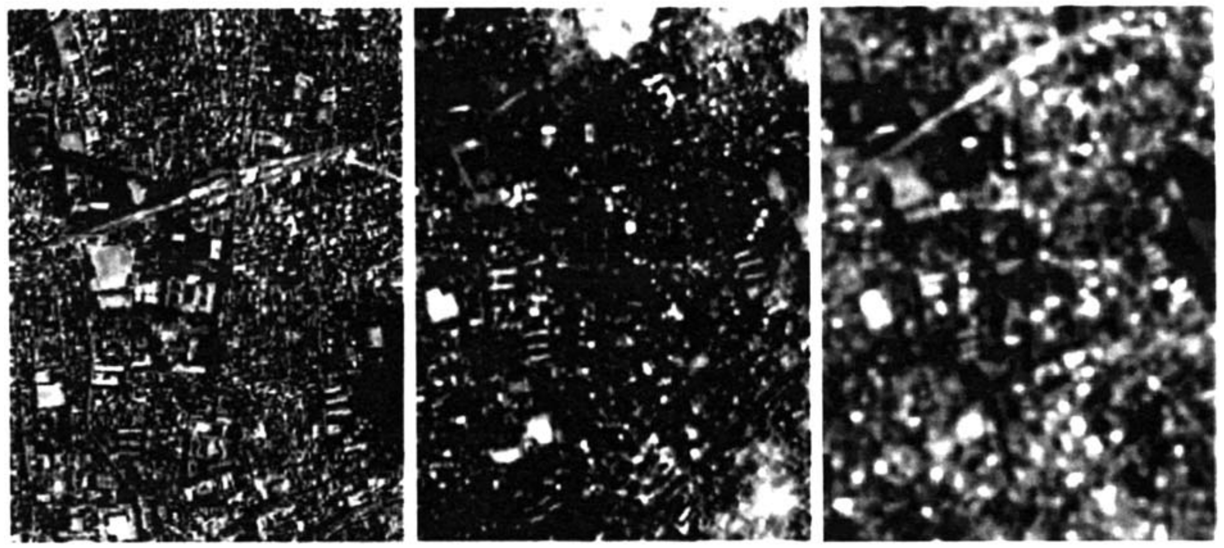
System Overview



Expected Use of ALOS Data

1 Cartography

Detailed map with immediate data transmission



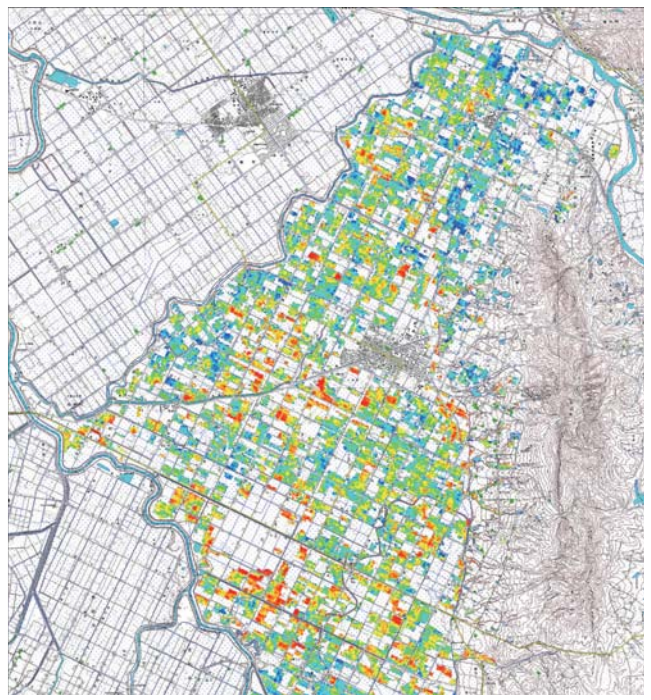
Simulated image (Resolution: 2.5 m) ALOS/PRISM | IRS (Resolution: 5.8 m) | SPOT (Resolution: 10 m)

PRISM images are useful for large scale mapping because even roads and rivers that are shown in a 1/25,000 map are visible in its image data. They are also very helpful for efficiently updating maps due to their immediate transmission and vast area coverage.

2 Regional Observation

For future agriculture

One of the conditions to produce "tasty rice" is said to be less protein in a grain of rice. By using the satellite to cover the vast observation area, we can find out the content rate of the protein in rice for efficient quality control.



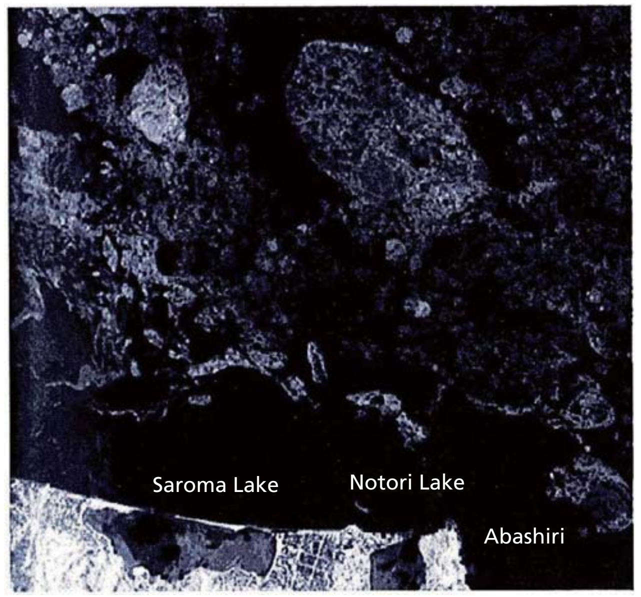
Red and yellow areas indicate more protein in rice.

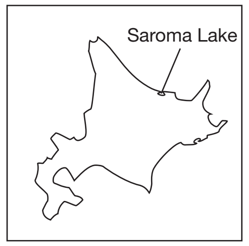
Rice protein content map
(SPOT/HRV data, Sep. 5, 1999)

Expected Use of ALOS Data

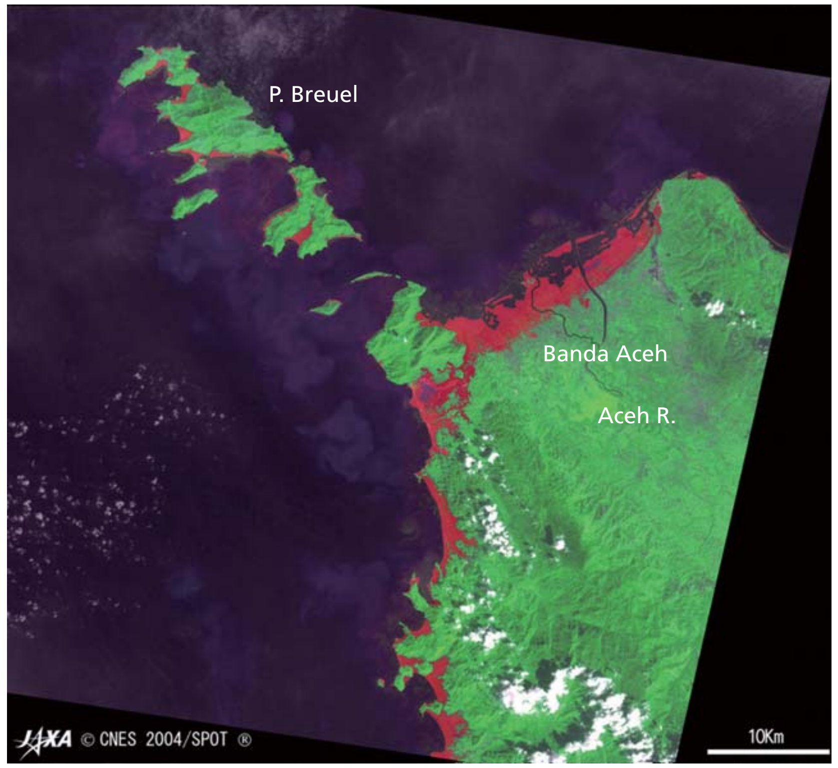
Regardless of weather or day or night (All weather)

Earth observations are possible day and night regardless of weather through the use of a microwave sensor like the PALSAR. In general, bodies of water such as oceans and rivers are indicated in black, and ridges in mountains can be visible. Urban areas look white.





Drift ice can be captured by a microwave sensor. The image shows drift ice rushing in to the shore of Saroma Lake in Hokkaido. Such images are useful for maritime traffic safety.



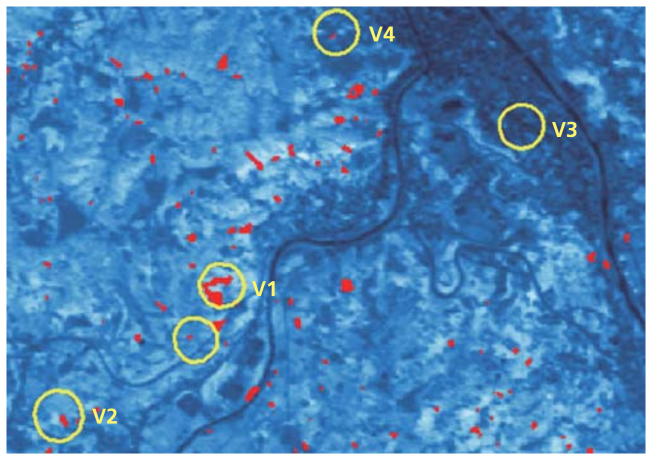
The photo shows damage in Banda Aceh, Indonesia, by the tsunami tidal wave caused by a huge earthquake off Sumatra on December 26, 2004. Flooded areas are in vermilion.

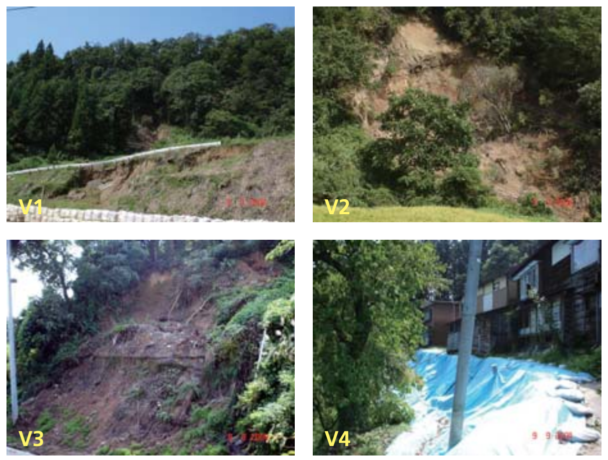
Tsunami damage following earthquake off Sumatra (combination of images taken by SPOT and JERS-1)

3 Monitoring a disaster

To minimize the damage of a natural disaster

When we consider measures to deal with a disaster, it is important to understand the exact range and status of a disaster-stricken area by comparing its images taken before and after the disaster.





The photo is an observed image of the Chuetsu region in Nigata that was badly damaged by flooding on July 13, 2004. (Red spots indicate destroyed areas.)

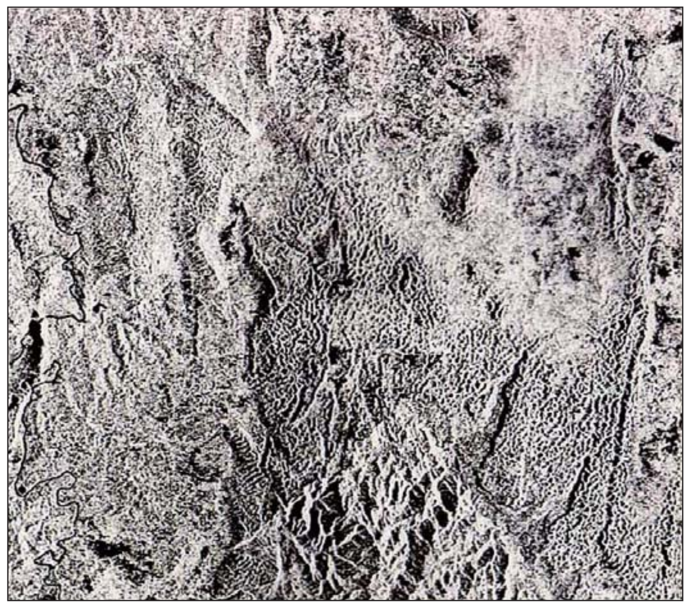
A map of destroyed areas by landslide and photos of those areas
(A map was made by combining the SPOT-5 images taken on August 15, 2001 and July 24, 2004.)

Provided by the Satellite Data Promotion Committee

4 Resource surveying

To find natural resources such as oil and minerals

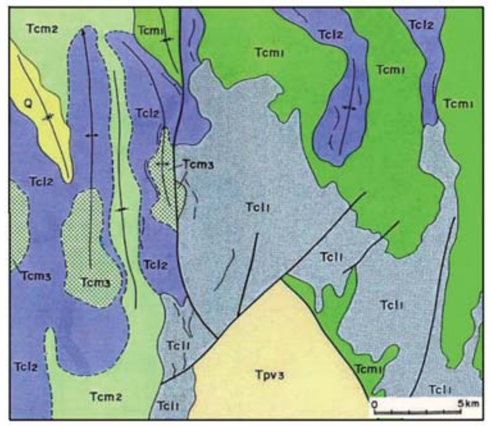
Analysis of image data can be helpful for surveying resources such as extracting rocks and geological features which are indexes of resource distribution.



JERS-1 SAR image

Karst, which is unique in limestone areas, can be seen in this image taken by a microwave sensor (Synthetic Aperture Rader, SAR.) Although this area is vastly covered by a tropical rain forest and unevenness of the land surface can be observed. (Sulawesi Island, Indonesia)

©ERSDAC



Geological map analysis based on SAR images

JAXA Earth Observation Missions

Aqua/Terra

Polar Orbit Platform

(Launched on May 4, 2002 / December 18, 1999)

The Aqua and Terra are NASA earth observation satellites for studying the environmental relationship between the atmosphere, ocean, and the earth.

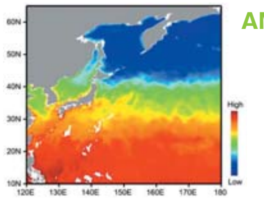
Both of them are equipped with the MODIS sensor, thus daily changes in the earth can be captured as the same spot can be observed once or twice a day, during daytime and night.

The Aqua is equipped with the AMSR-E sensor that is an updated version of the AMSR from the Midori-II.

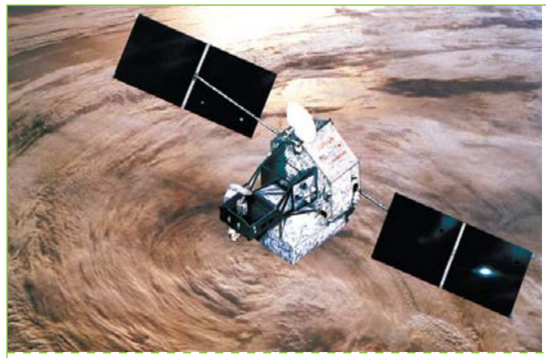
MODIS

Land and oceanic ice distribution in the northern hemisphere (Aug. 13 to Sep. 21, 2003)

AMSR-E



Ocean surface temperature data (June, 2002)



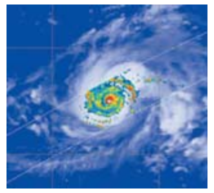
TRMM

Tropical Rainfall Measuring Mission

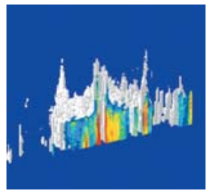
(Launched on November 28, 1997)

The TRMM is a NASA satellite of which JAXA was in charge of the precipitation radar and launch. Tropical zones account for approximately two thirds of the total global rainfall. Therefore, acquiring and analyzing precipitation data in the tropics can contribute to understanding global climate changes and environmental protection.

PR



PR



Precipitation data from Typhoon No. 8 over the West Pacific Ocean in a horizontal cross section (top) and three-dimensional rain structure (bottom) (Aug. 2, 2000)

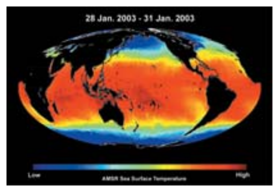
ADEOS-Ⅱ

Environment Observation Engineering Satellite, Midori-Ⅱ

(Launched on December 14, 2002 / Operation completed on October 25, 2003)

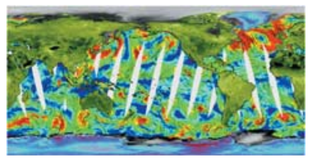
The Midori-Ⅱ was launched as a successor of the observation mission of the Midori, the earth observation platform engineering satellite. The Midori-Ⅱ's achievements contributed to understanding global environment changes such as abnormal climate patterns around the world and the expanding ozone hole. Six pieces of domestic and overseas observation equipment were onboard.

AMSR



Global ocean temperature distribution by AMSR

SeaWinds



First image of ocean wind taken SeaWind (Provided by JPL)

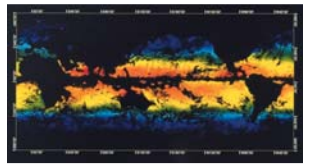
ADEOS

Earth Observation Platform Engineering Satellite, Midori

(Launched on August 17, 1996 / Operation completed on June 30, 1997)

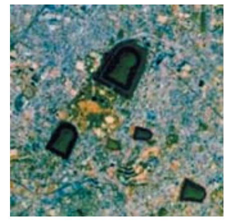
The Midori is an earth observation satellite that is intended to deal with global environmental changes such as global warming, ozone layer depletion, decreasing tropical rain forests, and abnormal climates. It is equipped with eight sets of domestic and foreign observation sensors.

OCTS



Ocean temperature distribution (March 30 to April 5, 1997)

AVNIR



The Imperial mausoleum of Emperor Nintoku in Sakai City, Osaka (Jan. 26, 1997)

JERS-1

Earth Resources Satellite, Fuyo-1

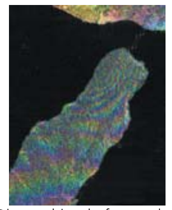
(Launched on February 11, 1992 / Operation completed on October 12, 1998)

The main purpose of the Fuyo-1 was to explore resources all over the land area of the earth contributing to land surveys, agriculture, forestry, fishery, and environmental preservation, as well as monitoring the costal environment. A synthetic aperture radar and optical sensor have been installed.

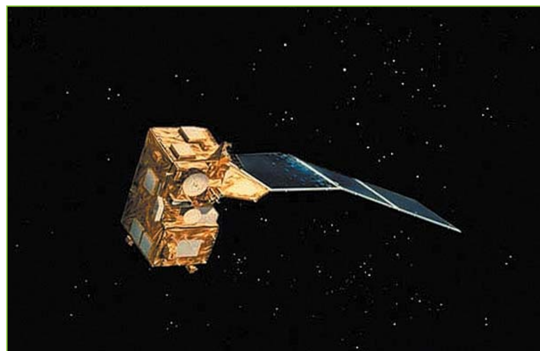
OPS

Kasumigaura area (April 29, 1992)

SAR



Diastrophism before and after the Great Hanshin Earthquake (Sep. 9, 1992 and Feb. 6, 1995)



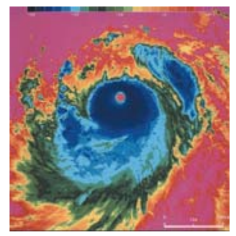
MOS-1/1b

Marine Observation Satellite, Momo-1, Momo-1b

Momo-1
(Launched on February 19, 1987 / Operation completed on November 29, 1995)
Momo-1b
(launched on February 7, 1990 / Operation completed on April 25, 1996)

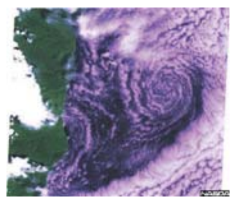
The Momo-1 was the first Japanese earth observation satellite designed and developed by Japanese technology. It was part of the earth observation system development by satellite for efficient use of global resources and environment preservation. Two optical sensors (MESSR and VTIR) were onboard.

VTIR



Temperature distribution of a typhoon (Aug. 26, 1987)

MESSR



A cold whirl offshore at the Maritime Territory, Russia (June 1987)