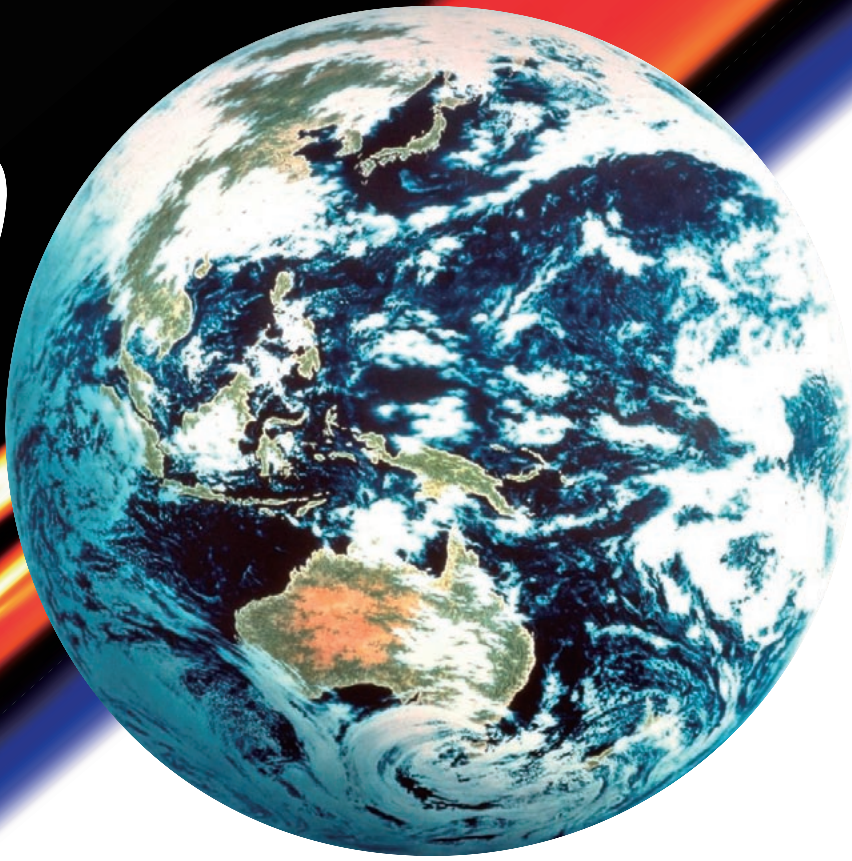
EORC Bulletin

ISSN 1349-113X
JAXA-SP-07-002E

Annual Report 2006
No.10
March 2007



JAXA EORC

This document is provided by JAXA.

Contents

This document is provided by JAXA.

This document is provided by JAXA.

Foreword

The Earth Observation Research Center (EORC) has been developing satellite data analysis technology and exploring Earth observation research activities since April 1995 under the National Space Development Agency of Japan (NASDA). The Japan Aerospace Exploration Agency (JAXA) has taken over these activities since October 2003 involving the Earth Observation Center (EOC) which is the ground station at Hatoyama, a technology division of instrumentation and data receiving/processing, and groups for international liaison, promoting data utilization and publicity. In May 2006 EORC which was the abbreviation of Earth Observation Research and application Center at that time, was divided into the Satellite Application Promotion Center (SAPC) which focuses on satellite data application and its promotion and EORC which takes responsibility for satellite data analysis and research.

EORC has continued to play a major role in the Office of Space Application of JAXA as a unified field center of Earth observation. EORC has been deploying extensive researches in following areas: optical and microwave instrumentation, algorithms to extract physical quantities from satellite data, calibration and validation of satellite data, data processing and distribution system and data application to Earth environmental sciences, weather forecast, fishery, agriculture, forestry, water management, land use, resource exploration and management, natural hazard watch etc., as well as satellite operation and data receiving at EOC, planning of future Japanese Earth observation satellites.

EORC has been involved in several satellite projects of Earth observation since its foundation, including Japanese Earth Resources Satellite - 1 (JERS-1 operated in 1992-98), Advanced Earth Observation Satellite (ADEOS operated in 1996-97), NASA's Tropical Rainfall Measurement Mission with Precipitation Radar (TRMM/PR operating from 1997), NASA's EOS-Aqua with Advanced Microwave Scanning Radiometer-E (Aqua/AMSR-E operating from 2002) and Advanced Earth Observation Satellite-II (ADEOS-II operated in 2002-03). The Advanced Land Observing Satellite (ALOS) was successfully launched in January 2006. ALOS carries Phased Array L-band Synthetic Aperture Radar (PALSAR), Panchromatic Remote sensing Instrument for Stereo Mapping (PRISM) and Advanced Visible and Near Infrared Radiometer - 2 (AVNIR-2), to observe the Earth with high resolution. ALOS has been taking the 0.7 TB/day data for various capabilities of data application. Our present task is to make our experience be applied to Earth science on global changes and practical fields of data utilization for societal benefits such as watch and mitigation of disasters.

In 2006 a new project, namely Global Change Observation Mission (GCOM) was started. GCOM consists of two satellite series, GCOM-W and GCOM-C, as successors of ADEOS-II. GCOM continues to observe the Earth beyond 10 years for better understanding of global change. GCOM will provide us quite useful data in various fields.

This report was prepared to give the overview of the EORC activities in the fiscal year 2006. We hope that it would be useful as a reference book on EORC and help you to understand EORC. In concluding, we would like to thank all EORC colleagues for their utmost endeavors, and many people outside EORC for their continuing support and guidance.

Autaum 2007

Toshio Doura, EORC Director
Katumi Musiake, Technical Counselor

This document is provided by JAXA.

This document is provided by JAXA.

1. OUTLINE OF EARTH OBSERVATION RESEARCH CENTER (EORC)

This document is provided by JAXA.

1. OUTLINE OF EARTH OBSERVATION RESEARCH CENTER

1.1 Objectives

The Earth Observation Research Center (EORC) has been developing continuously as the core organization covering the full spectrum of Earth-observation activities in JAXA, i.e., mission planning, R&D of sensors, algorithms, calibration, validation, data products, ground segments, operations of mission data handling, research coordination, promotion of applications, support of administrative and strategic matters, and so on. In EORC, we analyze observation data acquired by Earth-observation satellites, develop algorithms to derive geophysical parameters and to calibrate and validate satellite data, and try to maintain the quality of the data. We also promote research and application of satellite data in the fields of meteorology, control of forestry and fisheries resources, disaster prevention and national land use, and global environmental changes. To conduct these activities smoothly, we employ new Earth observation instruments, and develop and operate the ground system for Earth-observation satellite data. As part of this task, we operate the Earth Observation Center (EOC) to receive, process, and distribute satellite data.

EORC was founded to conduct Earth-observation satellite data acquisition, processing, and research in April 1995, and has three major goals of data utilization: climate change, disaster monitoring and resource management. After the October 2003 integration of three space institutions in Japan, NASDA, ISAS and NAL, all Earth-observation projects were defined as enterprises of Office of Space Applications (OSA). In 2006, EORC (the former name of Earth Observation Research and application Center) was divided in two centers. One is the Earth Observation Research Center (EORC), which is the core for the analysis and research of Earth-observation satellite data. The other is the Satellite Applications and Promotion Center (SAPC), which is responsible for promoting satellite data and products. The new EORC moved from Tokyo to Tsukuba Space Center in 2006 and has started to communicate with institutions and agencies in Tsukuba.

The global climate and environment changes in recent years are of great concern and even threaten the continuation of the Earth system. Global change may even menace people's daily lives by generating frequent storms and flood damage such as mighty typhoons. The Global Earth Observation System of Systems (GEOSS), a cooperative project for international Earth observation, was started from 2006 to cope with such changes. In concert with these international activities, the Earth Observation and Ocean Exploration System including Earth-observation satellite systems was selected as a national key technology by the Council for Science and Technology Policy (CSTP) in March 2006.

JAXA has been establishing Earth-observation systems to contribute to Earth observation and ocean exploration systems and GEOSS. “Daichi” (ALOS), which was launched on 24 January 2006, participates in the system together with the on-going TRMM and AMSR-E programs. GOSAT and Dual-frequency Precipitation Radar (DPR) on board the GPM core satellite are now in phase C/D and are also expected to participate in the system. To contribute to the future global change mission, EORC has initiated a phase A study of GCOM-W and GCOM-C as the successors of ADEOS-II and AMSR-E aboard EOS-Aqua. Accordingly, the GCOM-W1 project was established in April 2007. In addition, the study of the Cloud Profiling Radar (CPR) aboard EarthCARE is progressing in cooperation with ESA and NICT.

As Japan's core organization for Earth observation, EORC contributes to building a safe and secure society through the development of these satellite systems.

This document is provided by JAXA.

1.2 Organization

In the 3.5 years since the birth of the Japan Aerospace Exploration Agency (JAXA), EORC's role has remained basically the same as before but with modification due to the change of the framework of the Office of Space Applications of JAXA. In May 2006, the Space Application and Promotion Center (SAPC) was established, and the Earth Observation Research and application Center (EORC) became the Earth Observation Research Center (EORC). Accordingly, the functions of general data utilization promotion, coordination of international cooperation, and governmental data utilization promotion were transferred from EORC to SAPC. EORC is a center for research related to Earth-observation satellite data and is a department of the Office of Space Applications of JAXA. Mr. Toshio Doura presides over all organizational activities and reports to the Executive Director of the Office, Dr. Yasushi Horikawa, and Deputy Executive Director of the Office, Mr. Hideshi Kozawa. Prof. Yoshihumi Yasuoka, successor to Prof. Toshihiro Ogawa, is leading research activities as Technical Counselor.

Research activities are conducted in a matrix organization, i.e., researchers of atmosphere, ocean and land disciplines work partly for their own research and partly for satellite projects. Senior Researchers lead their scientist groups, and Project Coordinators manage the projects. The Research Planning Division coordinates and supports all the activities from the management side. The system and information group supports development and operations of computers and network systems. EORC conducts research on future space-borne sensors, and develops and operates ground systems in EOC.

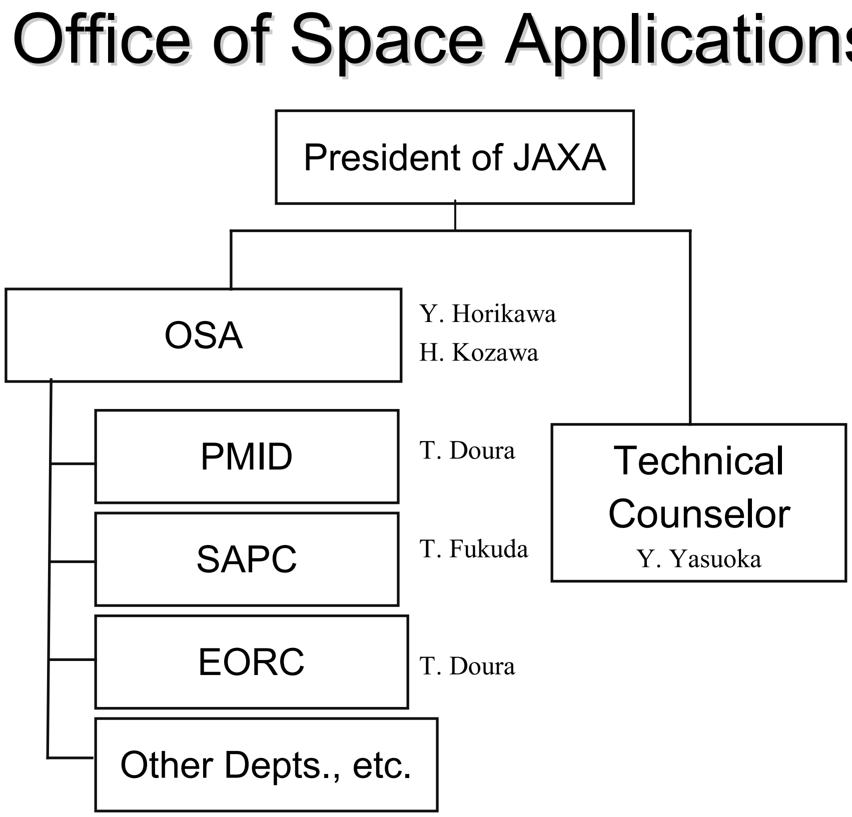


Fig. 1.2-1 Organization of OFFICE of Space Application as of March 2007

This document is provided by JAXA.

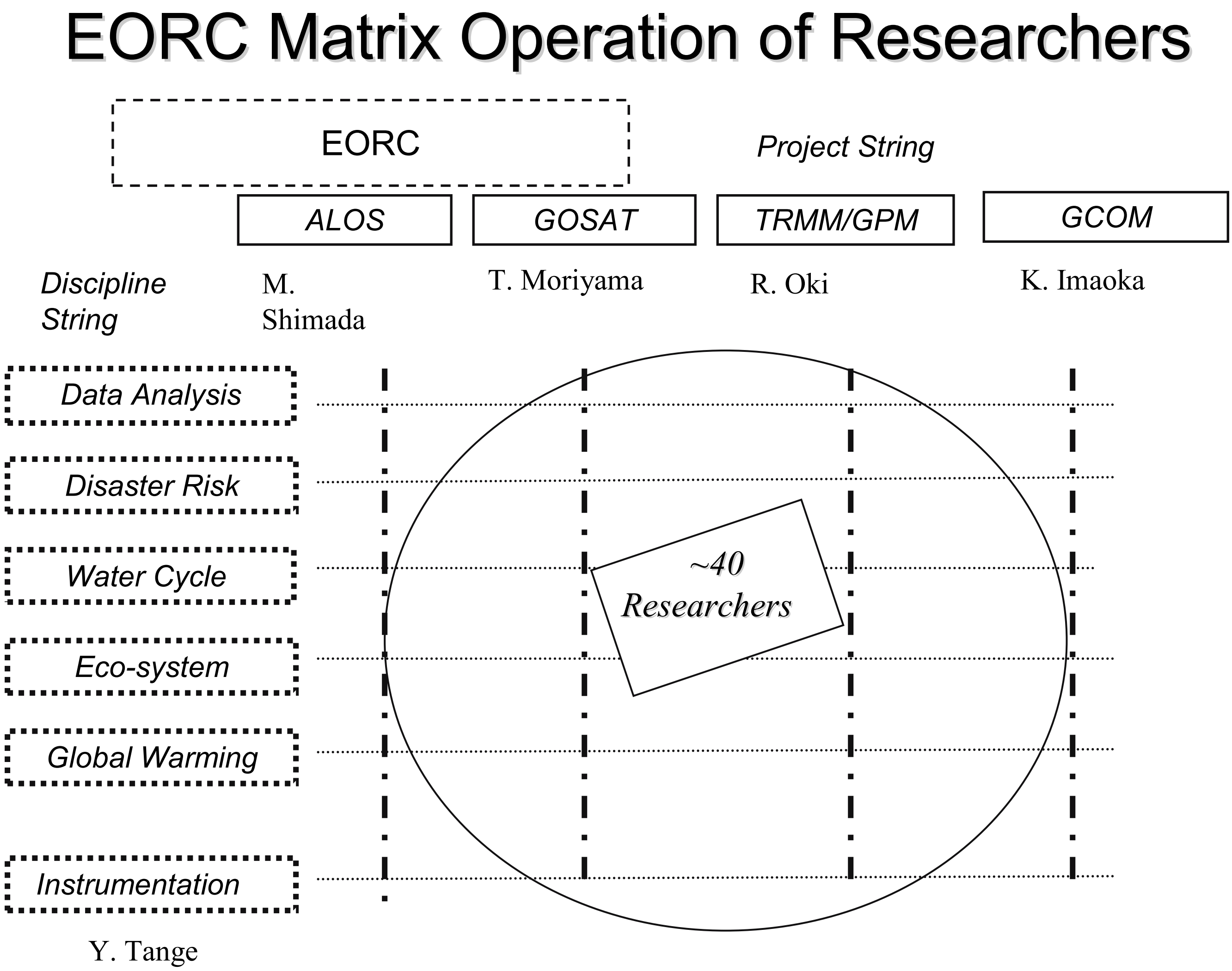


Fig. 1.2-2 EORC organization as of March 2007

This document is provided by JAXA.

1.3 Science Projects

Science projects consist of several satellite projects and Earth science/application projects.

The JERS-1 science project, led by Dr. Masanobu Shimada, Senior Researcher at EORC, continues to process its L-band Synthetic-Aperture Radar (SAR) data to create global forest mapping and to develop analysis technology for applications to detect crustal deformation.

The ADEOS science project, led by Prof. Haruhisa Shimoda, Invited Researcher from Tokai University, continues to process OCTS and AVNIR data mainly for global change study.

The TRMM science project, led by Dr. Tetsuo Nakazawa, Senior Researcher at the Meteorological Research Institute, continues to process PR, TMI, VIRS and LIS data mainly for global change study and improvement of weather forecasting.

The ADEOS-II science project, led by Prof. Akimasa Sumi and Prof. Yoshibumi Yasuoka, Invited Researchers from the University of Tokyo, are improving algorithms to retrieve geophysical parameters from AMSR and GLI and studying a variety of science applications.

The ALOS science project, led by Prof. Ryosuke Shibazaki, Invited Researcher from the University of Tokyo, developed algorithms for orthographic mapping and DEM applications from PRISM, AVNIR and PALSAR. It also carried out the CAL/VAL of PRISM, AVNIR-2, and PALSAR.

The Greenhouse Gas Observing Satellite (GOSAT) was approved to advance into phase C/D. The augmented follow-on mission of a part of AMSR, GLI and SeaWinds aboard ADEOS-II, called “Global Change Observation Mission (GCOM)” as well as Global Precipitation Mission (GPM) are being studied in phase A/B.

The Global Energy and Water Cycle Experiment (GEWEX) project, led by Prof. Akimasa Sumi, is primarily studying TRMM, ADEOS-II and AMSR-E data validation and applications for Asian Monsoon study and for data assimilation.

1.4 Individual Research Activities

About 40 researchers, including invited and post-doctoral researchers, conduct their own research as well as project activities as stated above. There were nine reviewed papers and letters and over 30 oral and poster presentations in calendar year 2006.

1.5 Major Activities

There were two successful H-IIA launches in fiscal year 2005. ALOS was successfully launched on 24 January 2006 by H-IIA F8, and Multi-functional Transport Satellite-2 （MTSAT-2), by H-IIA F9 on 18 February 2005, after the M-V rocket launched ASTRO-EII and ASTRO-F and a Russian Donieple Rocket launched OICETS/INDEX. The series of successful launches of two H-IIA launch vehicles in FY2005 following two successful H-IIA launches in FY2004 seems to suggest JAXA’s complete recovery to reliable operational launch services under the new president Dr. Keiji Tachikawa, who was appointed on 15 November 2004. It should be mentioned that TRMM celebrated its eighth anniversary of continuous observation of rainfall, after the discussion of NASA’s further operation beyond the formerly planned period. In addition, AMSR-E has also surpassed its mission design and will continue observations beyond the three-year design life time. Future programs GOSAT and GPM were approved to advance into phase C/D, with planned

This document is provided by JAXA.

launch dates of 2008 for GOSAT and 2010 for GPM. In the GCOM mission, studies on improved sensors SGLI and AMSR-2, successors of GLI and AMSR/AMSR-E, have started.

・TRMM/GPM

TRMM operation is entering its eighth year. Based on the accumulated data, we have compiled the seven-year rainfall record in the tropics. A new service, the EORC Tropical Cyclone Database integrating TRMM and Aqua/ADEOS-II database pages, is now open at URL (http://sharaku.eorc.jaxa.jp/TYP_DB/index_j.shtml). Access to the TRMM Tropical Cyclone Database increased in FY2004 because many typhoons struck Japan. New PR algorithms for V6 data production were developed, and V6 data processing began on 1 April 2004. Reprocessing of the PR data for 32 of 76 months was completed. The Second TRMM International Science Conference hosted by JAXA, NASA and NICT was held in Nara on 6-10 September. There were about 150 participants in total, and recent scientific results obtained from TRMM observation were presented. The Third Latent Heat Algorithm Workshop was held also on 10 September in Nara. TRMM research activities based on the Fourth RA (FY2004-2006), mainly focusing on data applications, started in 2004, and the first interim report meeting attended by 22 PIs was held on 3-4 March 2005.

The Global Precipitation Mission (GPM) has proceeded to the phase-B study. The Fourth GPM International Workshop was held in June 2004 in the US. The first-term research (FY2003-2004) to develop the GPM/DPR algorithms in cooperation with three invited PIs has concluded, and the second-term research will begin.

・ADEOS-II

Research and applications using ADEOS-II and AMSR-E aboard Aqua continued, standard data products were continuously evaluated and validated, and EORC continued upgrading the product version. Using archived ADEOS-II data sets and living AMSR-E and MODIS data, the capabilities for improving the numerical weather forecasting, fishery information service, and the sea-ice information service were demonstrated in Japan, and some other countries have reached the operational level. Data analyses of the acquired data sets reveal some important signals of climate changes such as the decreasing area of sea-ice cover in Arctic Sea by comparing anomalies or deviations in the years 2003 to 2006 from the average climatology. For the water and energy cycle observation and the global carbon cycle, ADEOS-II and AMSR-E aboard Aqua provided scientific data sets of essential variables required by major international research programs, and useful for scientific projects such as CEOP under WCRP, IGCO under IGOS-P, and UNEP.

In the fields of disaster monitoring and resources management, ADEOS-II and AMSR-E operations demonstrated global medium-resolution imagers to be very significant for the operational global monitoring such as visualization and quantitative estimation of damage and frequent revisiting capability for updating geo-informatics. In the long-term efforts to integrate multiple platforms, multiple sensors, and observations and models, this fiscal year is the first stage after each data product from each sensor has matured. EORC is continuing to produce new water and energy-cycle products using AMSR (water vapor over ocean), GLI (water vapor over land) and SeaWinds (sea-surface winds) and to develop a combined correction algorithm for AMSR and SeaWinds. Multi-sensor data sets for the atmosphere, ocean, snow and vegetation continue to be validated through comparative studies, and data continuity was improved. In efforts to integrate

This document is provided by JAXA.

satellite data and numerical weather forecasting, the Japan Meteorological Agency has explored AMSR-E data use in an operational system for heavy rain and typhoon track prediction. The Agency achieved positive impacts in experiments on events. These results prove the possibility of a future operational observation system from satellites. These results and the future mission concept were presented and explored in the AMSR/GLI Workshop and PI workshop held in Tsukuba in January 2007.

・ALOS/JERS-1

The JERS-1 science project has been conducted over the last several years, but is now beginning to wind down. In order to prepare for PALSAR and PRISM high-level products, we generated the JERS-1 InSAR DEM for several sites and the JERS-1 OPS DEM (DSM) for the Japan area. The Global Rain Forest Mapping Project using JERS-1 SAR data has generated mosaic images of South East Asia, including Peninsular Malaysia, New Guinea, Sumatra, Java, Borneo, Sulawesi, and the Philippines.

After the ALOS launch on January 24, 2007, EORC concentrated on algorithm development and calibration/validation. During PRISM DSM/ORTHO algorithm development, we improved the algorithm to match the target accuracies using real GCP and sensor data. We also set up several calibration sites with Ground Control Points (GCPs) for geometric calibration. The PALSAR DEM/ORTHO algorithm was also improved, and the calibration sites have been set up in cooperation with scientists internationally in the ALOS calibration/validation team activities. We held two review meetings, one on October 23, 2006, and one on March 29, 2007. Through these two review meetings, we achieved the calibration goal set for PALSAR and PRSIM/AVNIR-2 before the ALOS launch. ALOS data acquisition simulations based on the observation requests for the calibration/validation and basic observation scenario were conducted to evaluate and improve the data acquisition plan and the simulation software itself. With regard to disaster mitigation, we responded to the Charter Call by generating and analyzing the ALOS images acquired and disseminating them to users.

The Kyoto and Carbon Initiative (K&C) project intends to quantify the carbon sink-source balance for five years using PALSAR and supporting optical sensor data. We organized one K&C Science Advisory Panel meeting to discuss the definition of high-level prototype products and the establishment of an international science team.

・GOSAT

GOSAT is being developed through cooperation among MOE, NIES and JAXA. JAXA is primarily responsible for instrument and satellite development, launching, operational L0/L1 processing, and post-launch calibration; NIES and MOE are responsible for data utilization of L2 processing and further CO_2 data applications. The project completed the preliminary design stage of satellite and sensors, passed the preliminary design review, and is proceeding to the phase-C/D detailed design.

This document is provided by JAXA.

The EORC research project is responsible for post-launch calibration and data utilization of other parameters such as atmospheric O_3. We conducted the preliminary planning of calibration activity and algorithm development and proceeded into the phase-C study for detailed planning.

1.6 Affiliated Graduate School

EORC is affiliated with graduate schools of two universities in the field of Earth observation. A contract with Chiba University concerning cooperation between EORC and their Graduate Schools was made on March 31, 1998, and that with Tokai University, on February 18, 2004. As a part of this cooperation, EORC provided lectures in Tokai University by dispatching personnel as affiliate professors in Fiscal Year 2006.

This document is provided by JAXA.

2. RESEARCH ACTIVITIES

This document is provided by JAXA.

2. RESEARCH ACTIVITIES

2.1 Research Programs and Projects

2.1.1 TRMM and GPM

1) Overview

TRMM is entering its tenth year of operation. At the end of September 2005, NASA and JAXA decided to operate the TRMM satellite until September 2009. However, after this decision, NASA changed their system to evaluate continuity of satellite missions, and now NASA evaluates all operating missions every two years. TRMM will be evaluated again in 2007, and the decision will be announced in the summer of 2007. There is no significant change of satellite operation from the previous year (2005). Based on the accumulated data, we have compiled a nine-year rainfall record in the tropics.

We have been intensively implementing the phase-B study of Global Precipitation Mission (GPM) .

2) Nine-year record of rainfall by Precipitation Radar（PR）

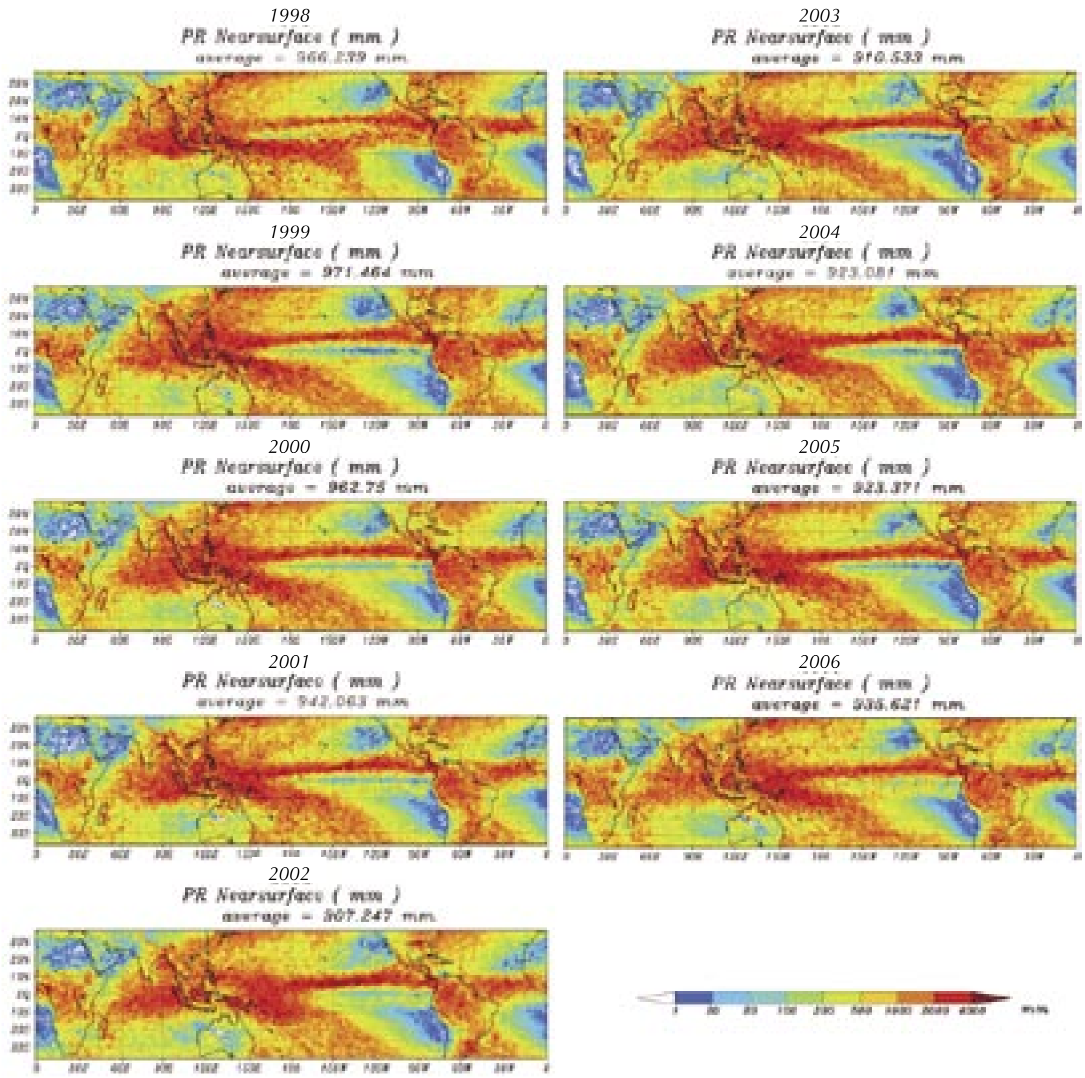


Fig. 2.1.1-1 Annual accumulated rainfall from 1998 to 2006 measured by PR.

This document is provided by JAXA.

We have been evaluating the monthly rainfall in the tropics from 1998 to the present. The primary data of PR is the monthly rainfall map covering 35ºN to 35ºS. The observation area covers half of the Earth. We can clearly identify the regional features of rainfall such as those in the intertropical convergence zone (ITCZ), the arid desert, and the monsoon region and their inter-annual variations.

3) Research highlights

Re-processing of PR data by the latest algorithms (Version 6) for the whole observation period was completed in January 2005. Much research with Version 6 products has now been done.

As a result of applying the V6 algorithm independently developed for PR and TMI, the difference of estimated rain rate between PR and TMI has decreased in comparison with the V5 algorithm, though the TMI rain rate still tends to be greater than that of PR.

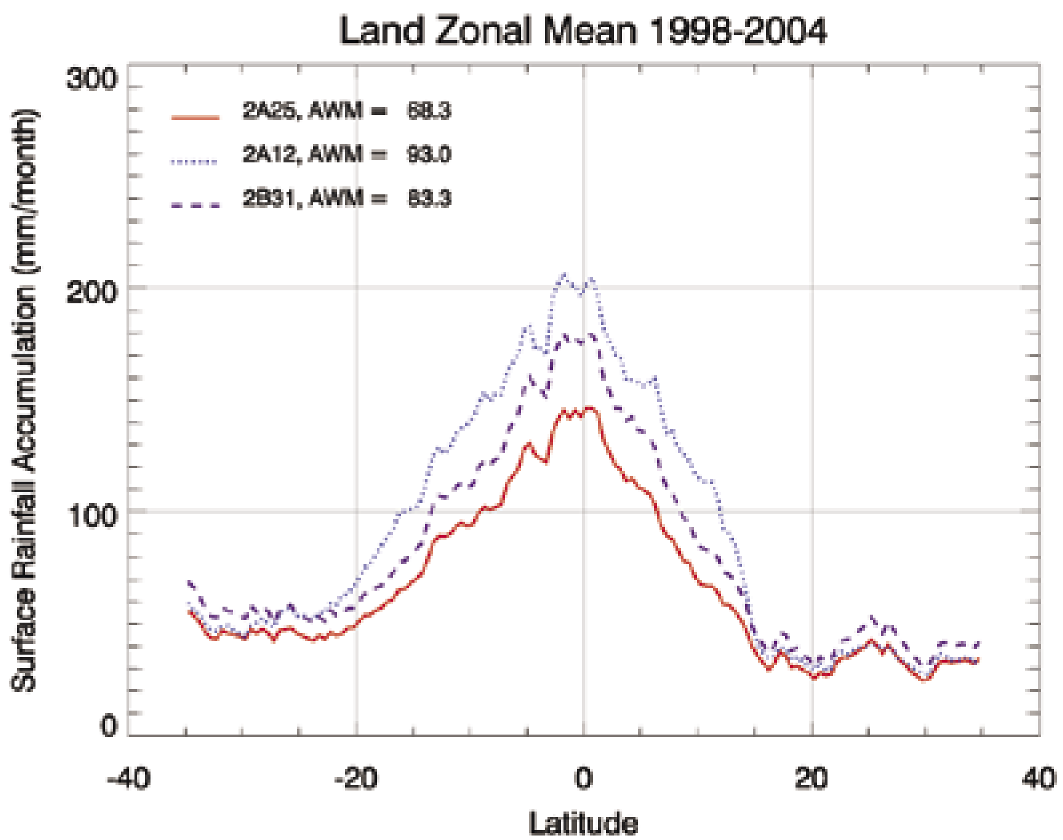


Fig. 2.1.1-2 Surface rainfall accumulation as zonal mean for land (1998-2004) derived from the V6 PR data (red line), the V6 PR-TMI combined data (purple broken line), and the V6 TMI data (blue dotted line).

This document is provided by JAXA.

4) Outreach

The EORC TRMM real-time Tropical Cyclone monitoring service, that was previously limited to only Pacific region, was extended to cover the entire globe in March 2007. Users can now access all tropical cyclone images observed by TRMM in near-real time, that is within 5 or 6 hours after observation. The URL of the TRMM real-time Tropical Cyclone monitoring service is:
http://www.eorc.jaxa.jp/TRMM/NRTtyphoon/index.htm

At the same time, the new service of EORC Tropical Cyclone Database, integrating TRMM and Aqua/ADEOS-II database pages, has been became operated since in June 2005 at the URL http://sharaku.eorc.jaxa.jp/TYP_DB/index_j.shtml. Users are easily able to search tropical cyclone images and data observed by TRMM/PR, TMI, VIRS, Aqua/AMSR-E and Midori-II on the same database page. Furthermore, three-dimensional cyclone images measured by TRMM/PR were avairable from this page so that users can look at brief 3D movies showing depicting detailed cyclone structures.

Fig. 2.1.1-3 An Example of the TRMM real- time Tropical Cyclone monitoring service web page.

This document is provided by JAXA.

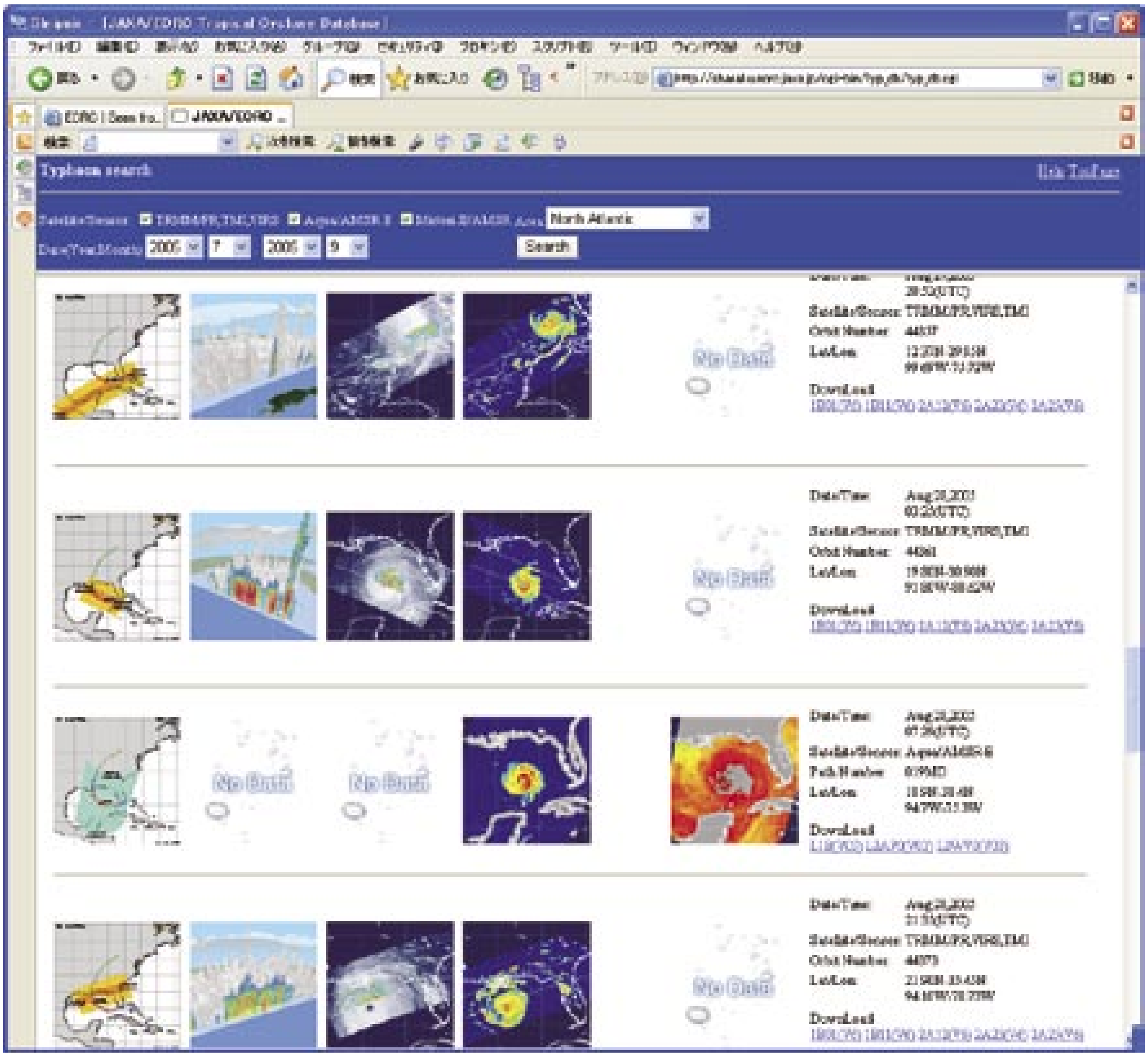


Fig. 2.1.1-4 An Example of JAXA /EORC the JAXA/EORC Tropical Cyclone Tropical Cyclone Database Database web page.

5) International science workshop

The 6th GPM International Planning Workshop hosted by NASA and JAXA was held in November 2006 in the United States, where (GPM is the follow-on mission to TRMM, and its mission profile is shown below.) There were 136 participants from 11 countries and regions in total, and information on recent progress of GPM partners and users was exchangted.

6) Research announcement and research invitation

a. TRMM Research Announcement (RA)

TRMM research activities based on the 4th RA (FY2004-2006), mainly focusing on data applications, started in 2004, and the final report meeting attended by PIs was held on March 5-6, 2007.

This document is provided by JAXA.

The 5th Research opportunity was announced in February to start the new joint TRMM research covering FY2007-2009 in February.

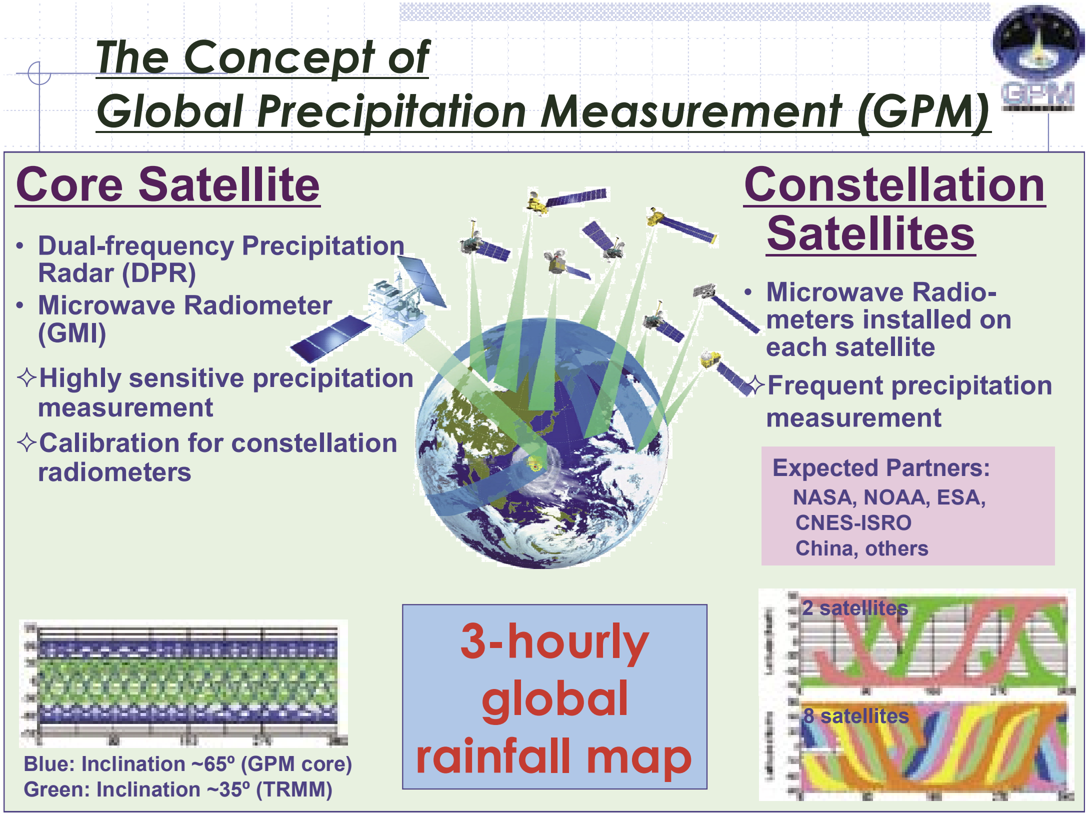


Fig. 2.1.1-5　The Concept of Global Precipitation Measurement (GPM) mission.

b. TRMM Research Invitation (RI)

Development of the next version (Version 7) of TRMM/PR algorithms as a three3-year research period (FY2004-2006) continues in cooperation with three invited PIs.

c. GPM Research Invitation (RI)

The second-term researches (FY2005-2006) started to develop the GPM/DPR algorithms in cooperation with three invited PIs.

This document is provided by JAXA.

2.1.2 GCOM

In addition to the continuous research activities using the ADEOS-II and AMSR-E data, we have been defining the mission objectives, examining appropriate sensor capabilities and performance, and investigating the feasibility of new products and algorithms of the Global Change Observation Mission (GCOM) based on the ADEOS-II experience. Therefore, we are going to use “GCOM” to cover all ADEOS-II and GCOM activities. Japanese fiscal year 2006 was the second year of the research activities solicited via the ADEOS-II 3rd research announcement. The activities covered algorithm development/improvement, validation, Earth science, model applications, and operational use of AMSR, AMSR-E, GLI, MODIS, and SeaWinds products. We held the AMSR/GLI Workshop on January 29 followed by the AMSR and GLI PI workshop on January 30 and 31. About 130 people attended the first-day workshop from various organizations including universities, governmental agencies, and private sectors.


Fig. 2.1.2-1 Group photos at PI workshops (Left, AMSR; Right, GLI)

GCOM consists of two satellite series: GCOM-W (Water) and GCOM-C (Climate). Each series will have multiple generations (e.g., three generations) with a one-year overlap to obtain long-term and consistent data records. GCOM-W1 and GCOM-C1 are the first-generation satellites of the GCOM series. The Advanced Microwave Scanning Radiometer 2 (AMSR2) and the Second-generation Global Imager (SGLI) will be the mission instruments of GCOM-W1 and GCOM-C1, respectively. The GCOM-W1 mission was evaluated by JAXA internal reviews and the Space Activities Commission (SAC) of Japan in this fiscal year. In consequence, the GCOM-W1 project team will be set up at the beginning of JFY 2007. We have also prepared for the system requirement review for GCOM-C1 in this fiscal year. We will try to take the GCOM-C1 mission forward into the next stage in JFY 2007.

1) Research and data analysis for AMSR and AMSR-E

The AMSR-E instrument had successfully completed its three-year mission life in 2005 and is continuing to perform global observation. Data products are being used by a wide variety of scientific programs and communities including the Coordinated Enhanced Observing Period (CEOP) and the Global Data Assimilation Experiment (GODAE). All the operational users including the Japan Meteorological Agency (JMA), Japan Fisheries Information Service Center (JAFIC), the National Oceanic and Atmospheric Administration (NOAA), and Canadian Ice Service use the AMSR-E products continuously. The antenna motor torque has been gradually increasing from the summer of 2006. The operation team at JAXA’s Earth Observation Center is carefully monitoring this phenomenon. All other Aqua mission instruments, except the Humidity Sounder for Brazil (HSB), are still performing global observations.

This document is provided by JAXA.

We revised some of the retrieval algorithms for the AMSR and AMSR-E products and released the latest version (version-5) of geophysical products on March 12, 2007. The updated products include sea surface temperature (SST), sea surface wind speed (SSW), and sea ice concentration (SIC).

a. Calibration and data evaluation

Although post-launch calibration activities to improve the quality of brightness temperature (T_b) products were continued, we have not updated the T_b product version this year as we have identified issues in the current calibration procedure. Regarding the assessment of radio-frequency interference (RFI), we have investigated and discussed the C-band channel configuration of AMSR2 on the GCOM-W1 satellite based on the aircraft survey data acquired in the previous year jointly with the Flight Systems Technology Center of JAXA. At least over Japan, there is some RFI-silent frequency ranges around 7.3GHz. In consequence, we proposed the additional channels in 7.3GHz (350MHz) to help eliminate the RFI signals.

b. Algorithm development and validation

Retrieval algorithms for the EORC processing system have been updated by Principal Investigators (PI) and EORC researchers. This fiscal year, three of the EORC research algorithms, the SST, SSW, and SIC algorithms, were selected and implemented on the EOC operational processing system. Correction for SSW was incorporated into the SST algorithm in light of the air-sea temperature difference. Reduced SST errors were observed in some areas including around Japan and the east coast of North America. For the SSW algorithm, some improvements were made for the coefficients of the retrieval scheme and internal Tb correction portion. The SIC algorithm switches between two procedures depending on ice concentrations. The threshold of switching the procedures was changed. No changes were made for other algorithms.

c. Field campaigns

Two monitoring activities are now underway: the ADEOS-II Mongolian Plateau Experiment for Ground Truth (AMPEX) and snow-depth measurement at the Yakutsuk and Tibetan Plateaus. The former is being led by Professor I. Kaihotsu of Hiroshima University, and the latter by Professor T. Koike of the University of Tokyo, both as AMSR PIs. Since the monitoring sites of these parameters are quite sparse worldwide, the measurements are valuable and are expected to be maintained not only for the AMSR project but also for ALOS and related activities.

d. Other activities

In addition to the application for the meso-scale numerical prediction model (used for small-scale weather forecasting around Japan), JMA started to use Tb values of microwave radiometers including AMSR-E for the global numerical prediction model on May 15, 2006. Water vapor information in the lower atmospheric layer can be provided by microwave Tb values. The accuracy of forecasting typhoon movement was confirmed to be improved by using the Tb information in the objective analysis of the global numerical prediction model. Figure 2.1.2-2 plots the forecast errors of typhoon movement for each forecast. The red line represents the forecast with microwave radiometer data; the blue line, that without the data. It can be seen that the red line is generally lower than the blue one. This indicates that the forecast accuracy was improved by using the microwave Tb values. The blue dots are the number of samples used for accuracy verification. Figure 2.1.2-3 depicts observation areas of the five microwave radiometers used in the current analysis. The AMSR-E data (in green) covers oceans that are not covered by the other radiometers could not observe. Therefore, the AMSR-E measurements are imperative for covering the world's oceans.

This document is provided by JAXA.

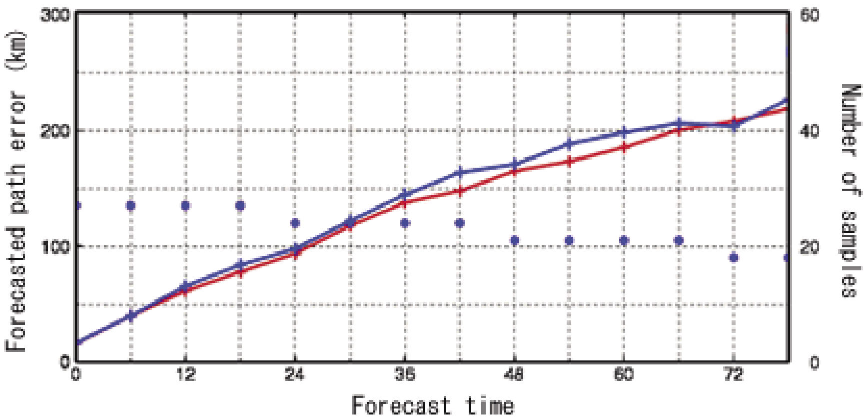


Fig. 2.1.2-2 Forecast errors of the center paths of Typhoons Nos. 11 to 18 in 2004 (courtesy of JMA).

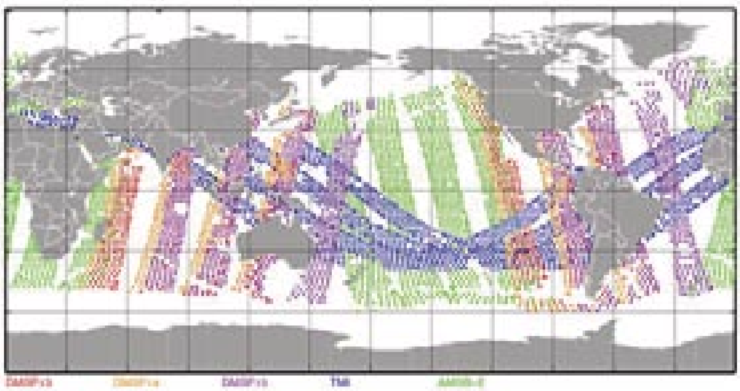


Fig. 2.1.2-3 Spatial distributions for microwave radiometer data. Green dots are for Aqua/AMSR-E, blue dots for TRMM/TMI, red dots for SSM/I-F13, orange dots for SSM/I-F14, and purple dots for SSM/I-F15 (courtesy of JMA).

The various AMSR-E images and data have been continuously updated. In JFY 2006, we opened a new page titled “SST anomaly in the northern high latitude ocean.” Figure 2.1.2-4 depicts the monthly SST anomaly in July of 2002 and 2006. Although the anomaly distribution differs year-to-year, the SST anomaly in the northern high latitude oceans has tended to exhibit positive values in recent years. This phenomenon is consistent with the decrease of sea-ice areas observed by satellite microwave radiometers including AMSR-E. Also, El-Nino and La-Nina events are continuously monitored and displayed on the “AMSR-E El-Nino Watch” page. The El-Nino event in late 2006 was clearly indicated by the AMSR-E observation as seen in the Fig. 2.1.2-5.

This document is provided by JAXA.

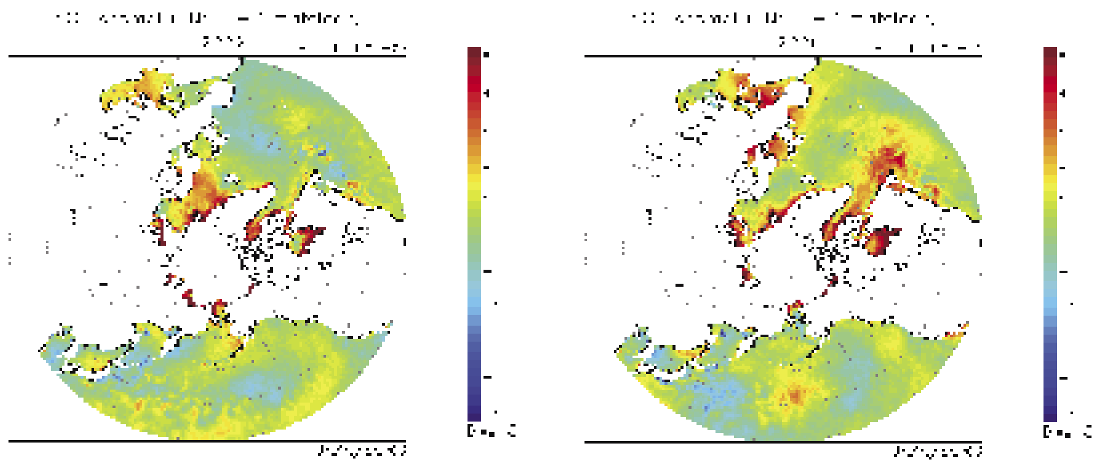


Fig. 2.1.2-4 Examples of monthly SST anomaly in northern polar region for July 2002 (left) and July 2006 (right) (from “SST anomaly in the high-latitude ocean” website).

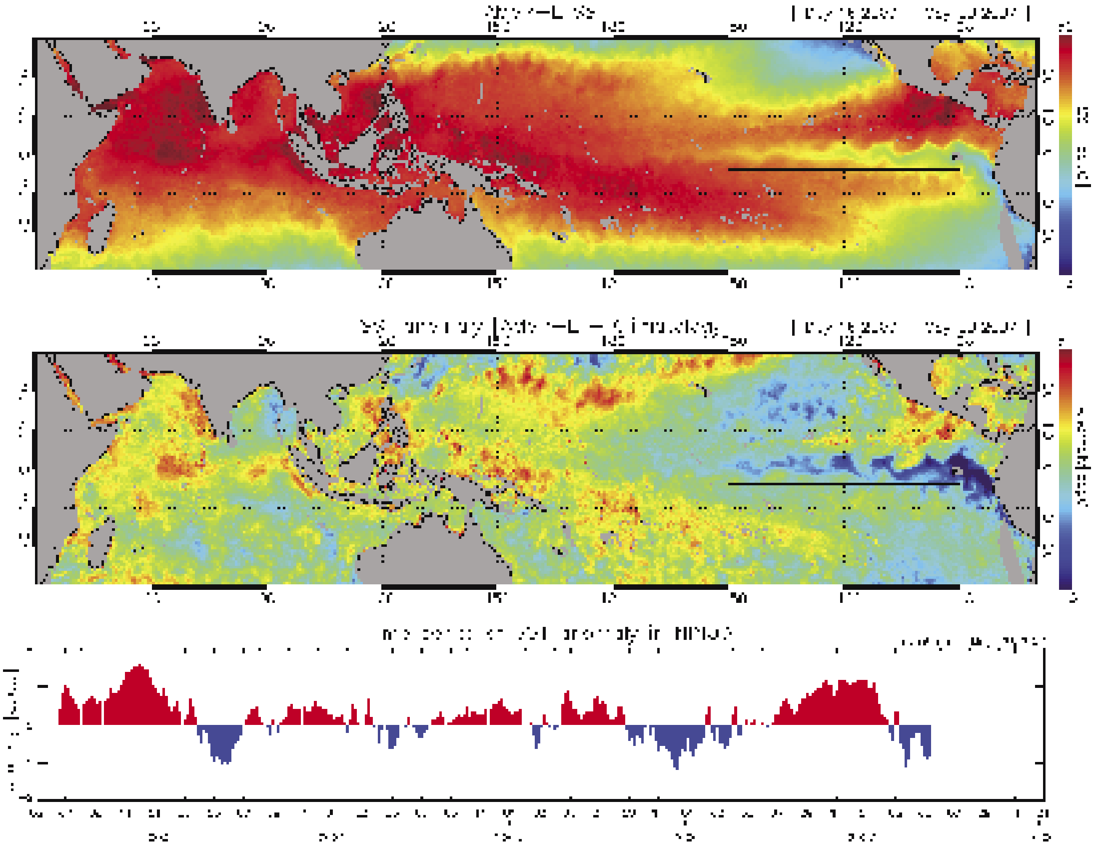


Fig. 2.1.2-5 Examples from “AMSR-E El-Nino Watch” website. From top to bottom, AMSR-E SST distribution (pentad average), SST anomaly distribution, and time series of SST anomaly in the monitoring area indicated by black rectangular box in top and middle images.

This document is provided by JAXA.

Please visit our website “http://www.eorc.jaxa.jp/AMSR/” for more information and images.

2) Research and development on Global Imager (GLI) and Second generation GLI (SGLI)

The GLI researchers at EORC continued to analyze and validate GLI data products using standard and/or research algorithms. This year we conducted the following research.

a. Validation and re-analysis of GLI products
b. Analysis of long-term datasets for detecting climate change
c. Development of new products for SGLI

a. Validation and re-analysis of GLI products

Improvement of the algorithm for retrieving precipitable water and its validation

Absorption coefficients of water vapor employed in the development of the standard GLI algorithm for retrieving precipitable water were replaced with high-resolution coefficients to reduce errors in this product. The uncertainty of the GLI precipitable water product was then estimated using data from sonde and microwave radiometers installed on the ground.

Figure 2.1.2-6 compares results between GLI precipitable water and sonde data. The current GLI standard algorithm based on low-resolution absorption coefficients of water vapor saturates in high precipitable water ranges (right image). After the water vapor absorption coefficients were improved, however, GLI data and sonde became much more consistent. Figure 2.1.2-7 compares GLI-derived precipitable water and that from ground-based microwave radiometer data. GLI data and microwave radiometer data are also very consistent, with an error of around 10%.

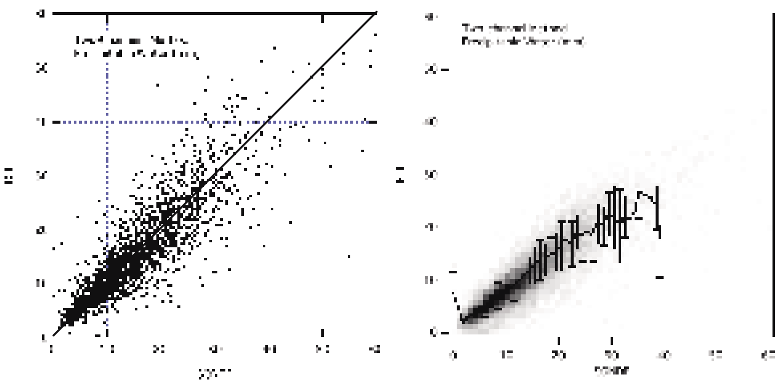


Fig. 2.1.2-6 Comparison of GLI precipitable water with sonde data. Left image is the results with high-resolution absorption coefficients; the right, with low-resolution coefficients.

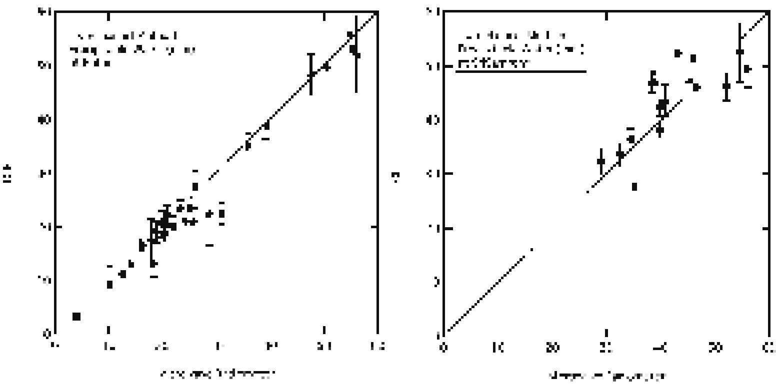
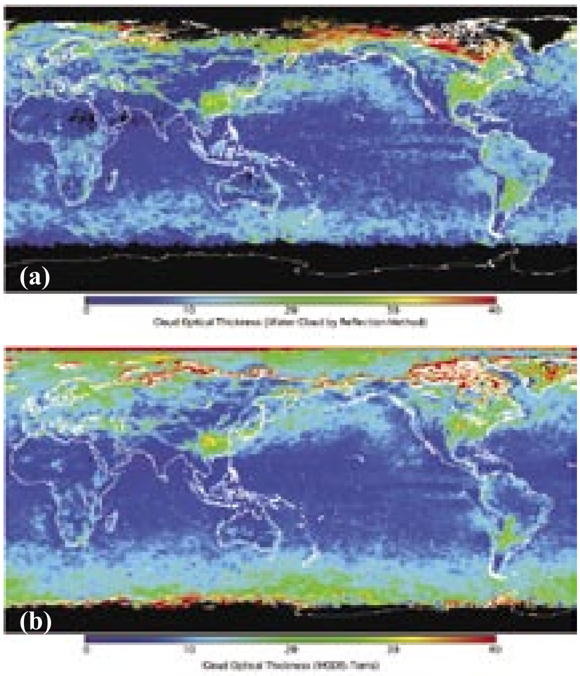


Fig. 2.1.2-7 Comparison of GLI precipitable water with microwave radiometer data. Left: Results for Hefei (China). Right: Results for SriSamrong (Thailand).

This document is provided by JAXA.

Comparison between GLI cloud and aerosol products and those of MODIS

Monthly mean MODIS products are compared with GLI products to evaluate the performance of the GLI algorithms in retrieving cloud and aerosol properties. Figure 2.1.2-8 illustrates GLI- and MODIS-derived cloud optical thicknesses. The parameters are very consistent except for the high-latitude area in the southern hemisphere.



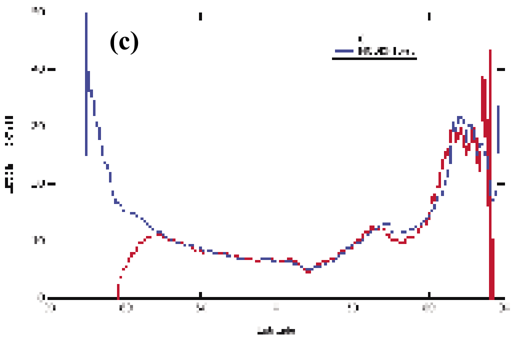
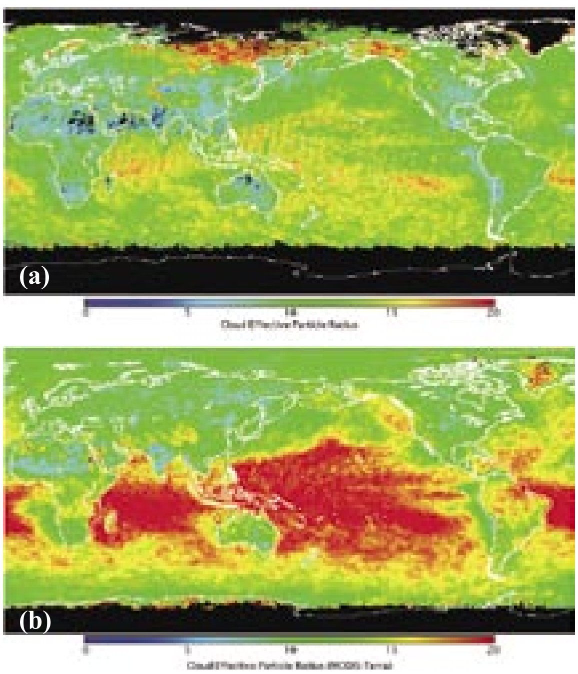


Fig. 2.1.2-8 (a) GLI- and (b) MODIS-derived cloud optical thickness, and (c) latitudinal distribution of both sensor products.

Figure 2.1.2-9 illustrates GLI- and MODIS-derived cloud effective particle radii. The GLI radius tends to be smaller than that of MODIS.



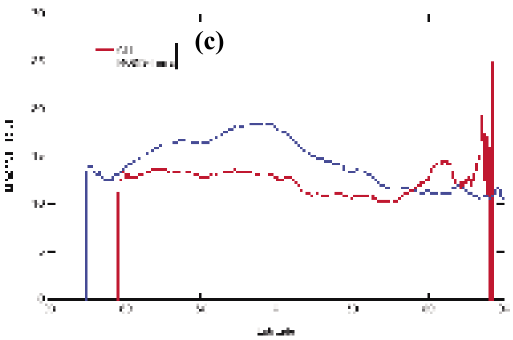


Fig. 2.1.2-9 (a) GLI- and (b) MODIS-derived cloud effective particle radius, and (c) latitudinal distribution of both sensor products.

This document is provided by JAXA.

Figure 2.1.2-10 illustrates GLI- and MODIS-derived aerosol optical thicknesses (AOT). GLI AOT tends to be discontinuous around the equator, mainly from the lack of data due to the current sun-glint correction scheme and also seems to have erroneous peaks at 60 degrees south latitude probably due to cloud contamination. Thus, the schemes for sun-glint correction and cloud detection at low sun-elevation angles should be improved in future development.

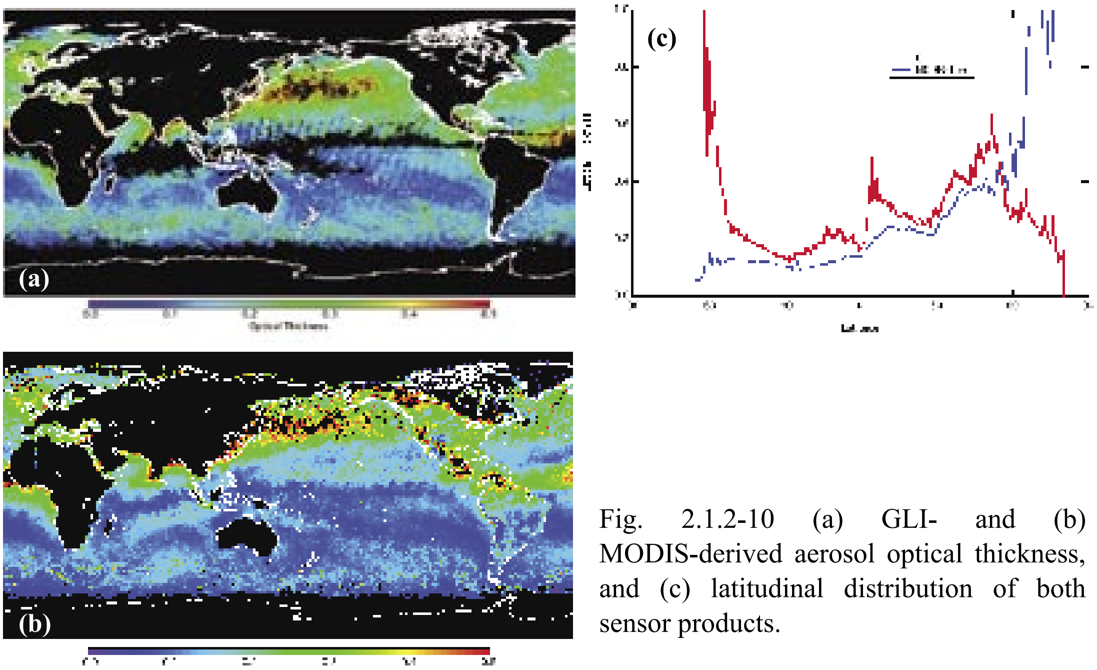


Fig. 2.1.2-10 (a) GLI- and (b) MODIS-derived aerosol optical thickness, and (c) latitudinal distribution of both sensor products.

Re-analysis of GLI snow products

GLI snow products (snow/sea-ice cover extents, snow temperature, snow impurity, snow grain sizes) were re-analyzed, and their quality was evaluated for future data release to the public (planned in FY2007). In this analysis, the composite scheme to generate 16-day average hemispherical datasets was also re-designed. Resultant products were found to have good quality and to exhibit spatially smoother distributions of snow parameters than the previous version (Fig. 2.1.2-11).

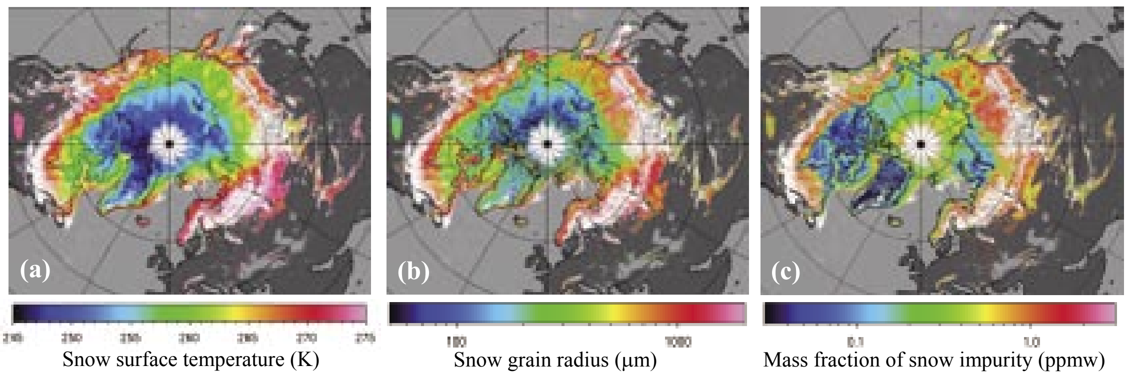


Fig. 2.1.2-11 GLI-derived spatial distribution of (a) snow-surface temperature, (b) snow-grain size, and (c) mass fraction of snow impurities averaged over April 7-22, 2003.

This document is provided by JAXA.

The retrieved snow-surface temperature and grain size can be used to generate a metamorphosis potential map of snow cover. This map indicates how the snow cover will behave physically in the near future. For example, fresh fine snow located under warm temperature tends to rapidly metamorphose to large particles (i.e., unstable) whereas re-frozen old snow under cold temperature tends to remain at it is (stable). Figure 2.1.2-12 presents examples of metamorphosis potential maps.

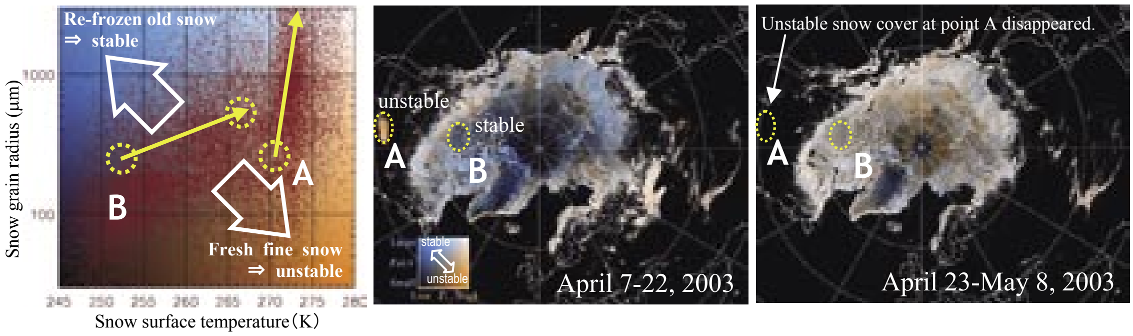


Fig. 2.1.2-12 Concept of the metamorphosis potential of snow cover (left) and the spatial and temporal variation of the potential (middle and right).

Finally, using the relationship between the snow-surface temperature and grain size, the melt on-set date and melt duration can be determined as depicted in Fig. 2.1.2-13.

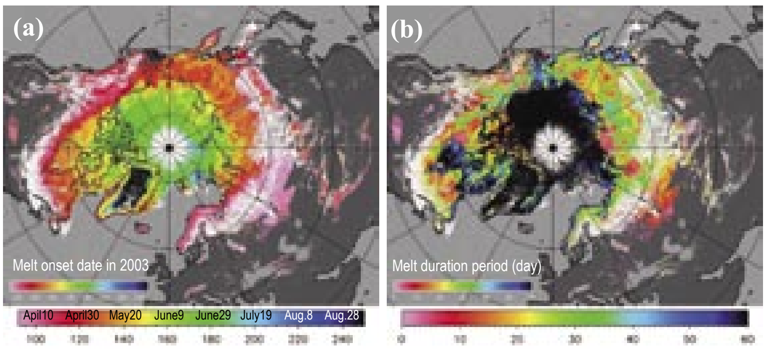
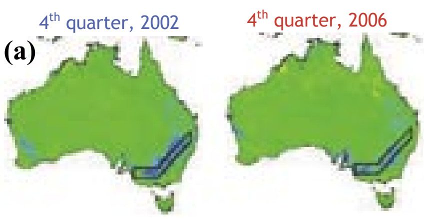


Fig. 2.1.2-13 (a) Melt on-set date and (b) melt duration derived from GLI snow-surface temperature and snow grain size parameters.

b. Analysis of long-term datasets for detecting climate change

<u>Vegetation index in the eastern Australia grain zone and chlorophyll-a concentration at the equator</u>



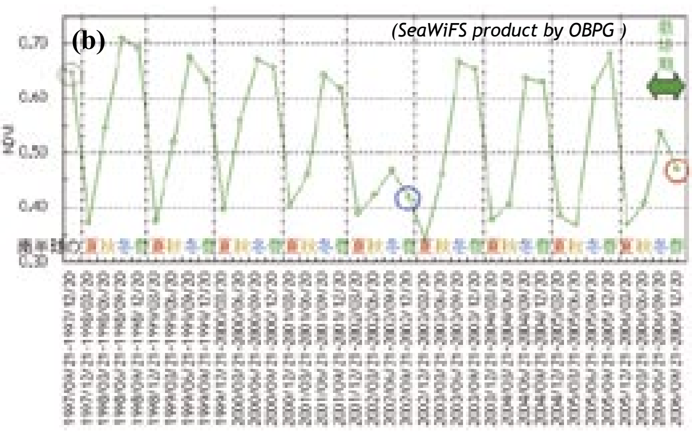


Fig. 2.1.2-14 (a) NDVI anomaly map in Australia of the 4th quarters in 2002 and 2006. (b) Temporal variation of NDVI values December 1997 to December 2006 extracted for the polygon area in (a).

This document is provided by JAXA.

In 2006, eastern Australia suffered the worst drought in 1000 years. Wheat production was reported to decrease significantly and affected the crop trade market all around the world in that year. Figure 2.1.2-14 plots the 10-year NDVI trend in eastern Australia. NDVI in the 4th quarter in 2006 was lower than usual. Thus, the variation of NDVI indicates the effect of environmental stress (water, insolation, and temperature) on vegetation.

The figure indicates that a similar drought occurred in 2002 when there was a severe El Niño. Figure 2.1.2-15 plots the 10-year anomaly trend of the equatorial chlorophyll-a concentration and the relation to El Niño events. In 2002 and 2006, two El Niño events occurred, which resulted in the unusual negative anomaly of the equatorial CLA. These El Niño events are clearly synchronized with the unusual lower NDVI values observed in eastern Australia.

In Fig. 2.1.2-15, another El Niño event, which is the strongest in the last 10 years, can also be identified in 1997-1998. However, the NDVI trend strangely exhibits no reduction in that period (see Fig. 2.1.2-14). These examples tell us how complicated the relationships between climate variables such as NDVI and CHA are. In some cases, the variables are teleconnected but not in others. Therefore, careful and continuous long-term monitoring of the Earth's environment in various approaches is desired to further our understanding of the climate system.

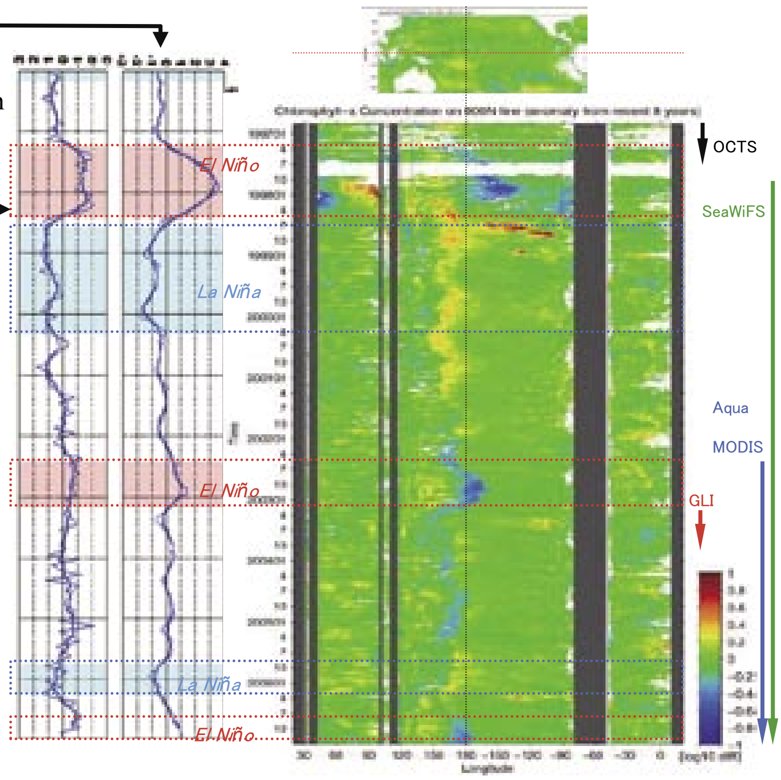


Fig. 2.1.2-15 Relation of the temporal variation of equatorial chlorophyll-a (CLA) concentration anomaly and El Niño events. The CLA trend is depicted as a longitude-time cross-section along the equator derived by four different optical sensors.

c. Development of new products for SGLI

<u>Atmospheric correction over land using GLI 380nm channel</u>

A new scheme for atmospheric correction using GLI channel 1 (WL: 380nm) reflectance was developed for ocean and land applications. Figure 2.1.2-16 depicts the resultant performance of the atmospheric correction. Using the 380nm reflectance, both Rayleigh scattering and Mie scattering by aerosol particles are clearly eliminated from the resultant reflectance images, even over land areas. After the reflectances are validated with ground truth observations, this scheme would significantly contribute to enhancing the accuracy of land products in the future SGLI mission.

This document is provided by JAXA.

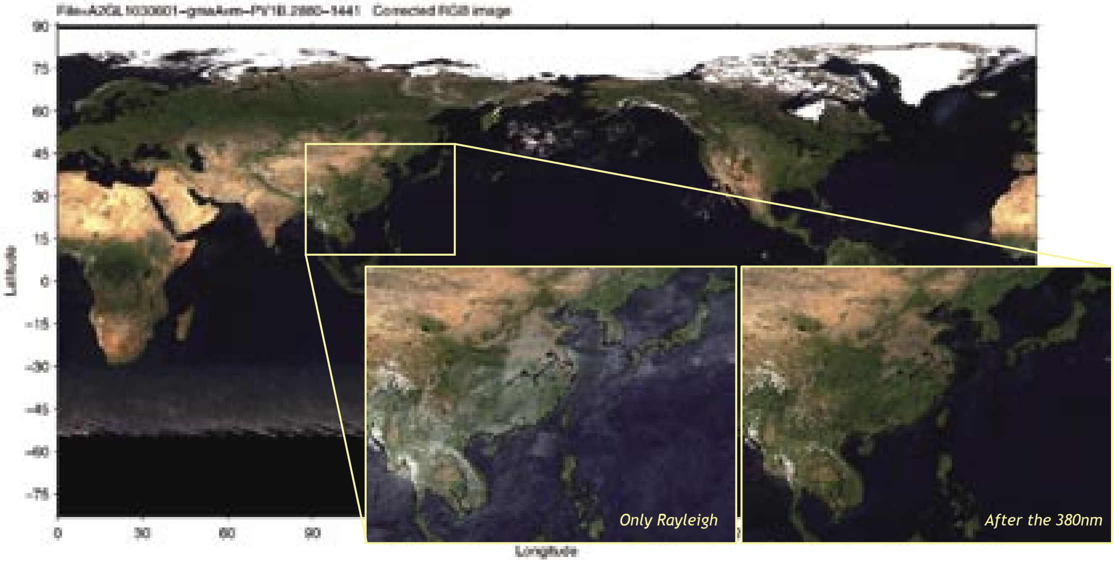


Fig. 2.1.2-16 Performance of the atmospheric correction scheme with and without using 380nm channel (GLI channel 1) reflectance.

Shadow index (SI) and water stress trend (WST)

New generation vegetation indices, shadow index (SI), and water stress trend (WST) are now being developed for monitoring biomass and for assessing vegetation health. SI is a measure of the shadow fraction within the IFOV and will be used for discriminating various vegetation types and also for assessing the health of plants, whereas WST is a trend of vegetation conditions under various water stresses derived from the variation in temperature.

Figure 2.1.2-17 illustrates the shadow index image of the Kanto area retrieved from GLI 250m-resolution data. The SI image clearly indicates the difference of vegetation types observed on the ground. The SI will contribute to monitoring the boundary of grass and forest areas and also to enhancing the accuracy of biomass estimation and land-surface classification.

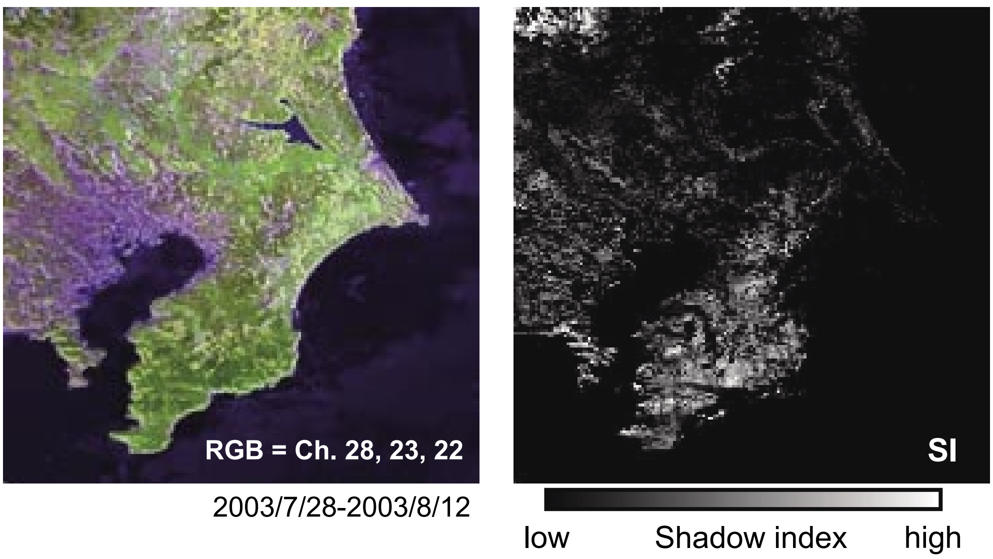


Fig. 2.1.2-17 GLI false color RGB composite image (left) and retrieved shadow index image of Kanto area in Japan.

This document is provided by JAXA.

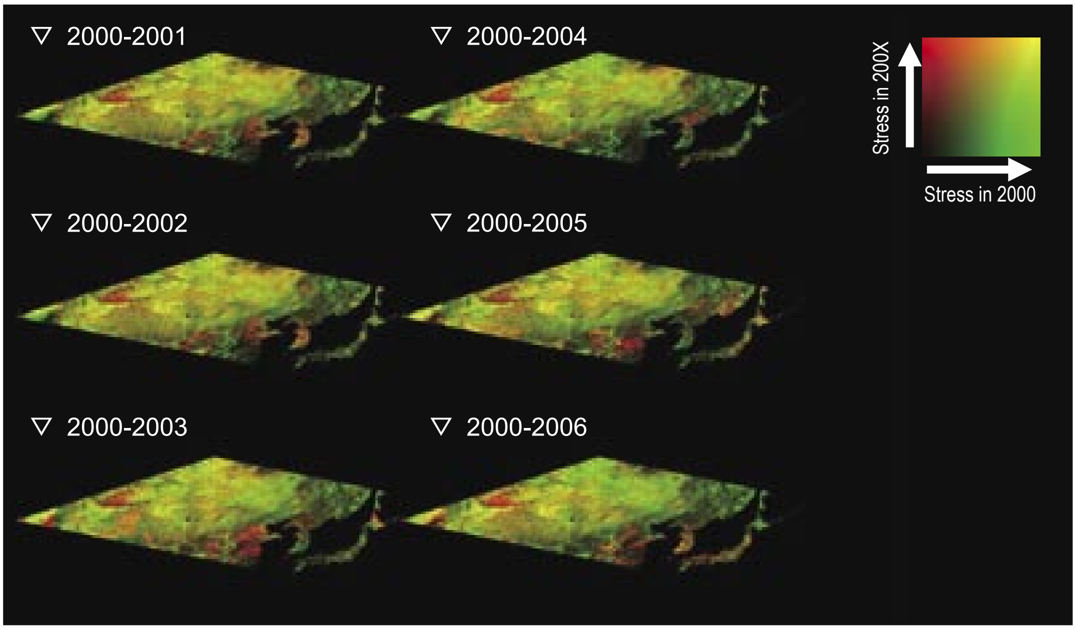


Fig. 2.1.2-18 MODIS-derived 6-year water stress trend (WST) in the eastern Asian region.

Fig. 2.1.2-18 depicts a water stress trend (WST) map of the eastern Asian region retrieved from six-year MODIS data. In the figure, the WST for each year is color-coded by comparing with that in 2000 when little water stress was observed. Seriously water-stressed areas include the Gobi desert and Tibetan Plateau areas, which implies that those areas are getting drier as compared with 2000.

d. Other research

Several other research activities are going on in the GCOM project.

Efforts to reduce uncertainty of radiation budget

- Cloud process and properties
  - Estimation of vertical structure of cloud particle size (Cloud convection process)
  - Estimation of cloud bottom height by O2 absorption band (763nm)
- Aerosol
  - Evaluation of radiative forcing by aerosols using a ground observation system (SKYNET)
  - Estimation of aerosol properties by GLI NUV (380nm) and combination with POLDER Polarimetry
  - Evaluation of long-term trend of particle size of Asian ocean aerosols
- Snow/ ice
  - Estimation and process of snow-surface albedo considering snow grain size and impurities (dust and black carbon)
- Water vapor
  - Improvement of column water vapor accuracy over land

Estimation of primary production and carbon cycle

- Ocean Primary Production
  - Evaluation and improvement of OPP algorithms by in-situ OPP observations in each ocean area
- Land Net Primary Production
  - Construction of vegetation surface model database for multiangle satellite observation to

This document is provided by JAXA.

improve biomass estimation

- Estimation and evaluation of global land NPP

Contribution to numerical models

- Structure of interactive development between numerical models and satellite observations

Application possibilities

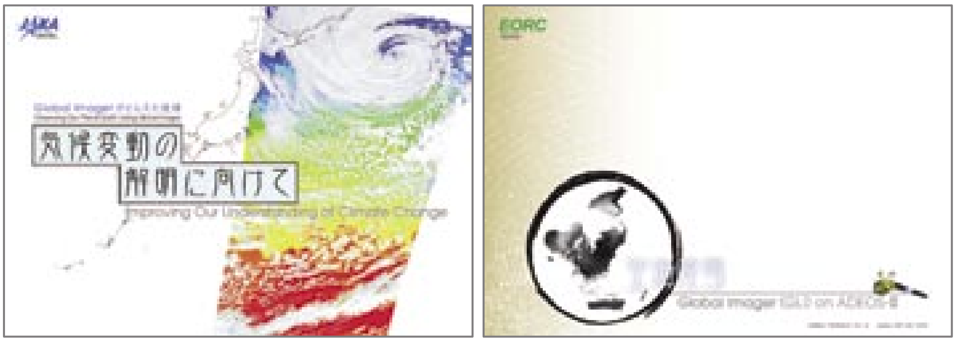
- Improvement (accuracy and temporal and spatial resolution) of microwave-TIR SST merging
- New, quick technique of ocean color atmospheric correction

3) Data simulation service using radiative transfer

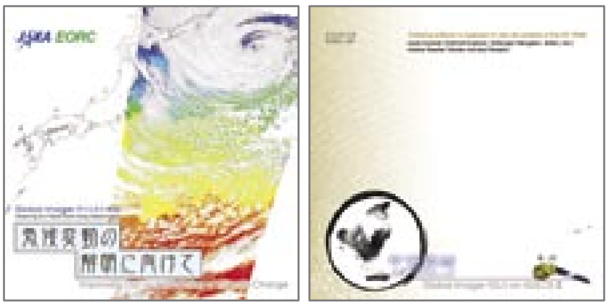
The GLI Signal Simulator (GSS) is a useful tool for the science and engineering community of Earth-observation satellites to simulate top-of-atmosphere radiance. Any scientist, engineer or general user can use it (http://bishamon.eorc.jaxa.jp/ENTGSS/index.html). GSS versions 6.4 and 6.5 were released this year. GSS ver.6.4 can be used by 10 people at the same time (previously two people). Also, comments for the execution time of each calculation are added to the HTML description for sensor channel selection.

4) Publication of a booklet and CD-ROM for GLI scientific results

We published a booklet and CD-ROM entitled "Improving Our Understanding of Climate change - Observing Our Planet Earth Using Global Imager" (ISBN4-906653-03-0), which contains many GLI images from research on Earth science using 10-month GLI datasets.



Booklet



CD-ROM

This CD-ROM contains the PDF version of the booklet, which is also available at the following URL, http://suzaku.eorc.jaxa.jp/GLI/doc/GLI_BOOK_CD/START.HTM

This document is provided by JAXA.

2.1.3 ALOS

1) Overview

ALOS was launched on January 24, 2006, in a sun-synchronous polar orbit of 691km height with a 46-day recurrence cycle. It carried three high-resolution imaging sensors, highly accurate attitude sensors, and dual-frequency GPS receivers. The initial mission check and calibration were performed soon after orbit insertion. The ALOS research activities also started at the same time.

・Data simulation

We compiled observation requests for ALOS calibration/validation and basic observation scenarios. Using the mission simulation software and the satellite orbit data after the launch, we optimized the operation scenario and evaluated success rates for each observation request submitted by the ALOS users. The simulation results help us modify the observation plan to achieve higher data acquisition rates.

・Data utilization system

The ALOS Geoscience and Application Processor (AGAP) generates the ALOS products for the ALOS science activities. It demonstrates that the computing system consisting of 64 Intel Pentium machines is suitable for data conversion from level zero to level 1.0; image processing of PALSAR data; high-level processing of PALSAR, PRISM and AVNIR-2 data; data archiving; and distribution of these data. Computing power is essential for processing the PALSAR data on a continental scale so it can be adapted for the Kyoto and Carbon Initiative project.

・Calibration/validation (CAL/VAL)

The three sensors were calibrated and validated using the CAL/VAL sites deployed world wide. Calibration and validation of the three ALOS sensors were concluded at review meetings on October 23, 2006, and March 29, 2007.

・Algorithm development

We have tuned the routines of the PRISM DEM/ORTHO algorithm, which generates a DEM through a pixel-matching technique and a coarse-to-fine iterative technique. The JERS-1 OPS data was used to verify the method and to demonstrate that the algorithm could generate a DEM within a theoretical error limit. We have developed basic routines of the PALSAR DEM/ORTHO algorithm and confirmed the functions using the JERS-1 SAR data. The current version of the software can generate a DEM corrected for atmospheric delay using meteorological analysis data.

・Kyoto and Carbon Initiative (K&C Initiative)

The ALOS Kyoto & Carbon Initiative is supported by the Global Forest Mapping program of JERS-1 SAR in the era of ALOS and ADEOS-II GLI. Using PALSAR as a principal data source, it organizes four themes (i.e., forestry, wetlands, desert and water, and SAR mosaic products) to support regional- to continental-scale data and information requirements for terrestrial carbon researchers (GTOS TCO Panel, IGOS-P GCO and IGOL Themes), environmental conventions (UNFCCC Kyoto Protocol and Ramsar Convention), and nature conservation. The K&C Science Advisory Panel / Science Team meeting consisting of some 20 scientists from 13 countries met at EORC from February 28 to March 3, 2006, to focus on defining high-level prototype products and the ALOS data acquisition plan. During the first three years after the ALOS launch, the Science Team, along with EORC, is to develop and subsequently generate verified, regional-scale prototype products, including forest and deforestation maps in four continents, flood duration maps in major

This document is provided by JAXA.

river basins, subsurface desert geomorphology maps in Africa, and 50-meter-resolution PALSAR mosaics of all land areas of the Earth.

・PI activities

After the Initial Calibration phase was completed on October 24, 2006, JAXA started releasing calibrated ALOS standard products to the public including PIs. PI research agreements covering 101 of the 124 existing PIs (excluding JAXA PIs, and resigned or disagreeing PIs) were completed in 2006. JAXA issued the second ALOS Research Announcement (RA) on December 8, 2006, for researchers in Asian and Russian countries, based on the ALOS Data Node (ADN) concept that came into effect in 2006. By the March 2007 deadline, 128 effective research proposals were submitted.

2) Calibration and validation of PRISM and AVNIR-2

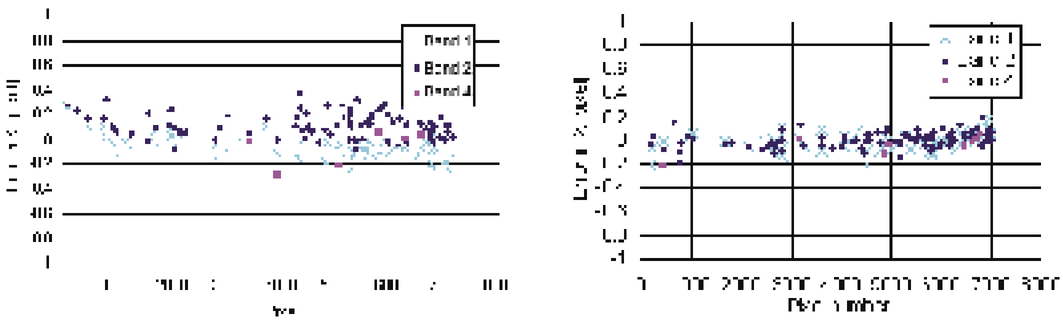
CALVAL during the initial calibration phase (May 16, 2006 to Oct. 23, 2006) resulted in the sensor characterizations and the radiometric accuracies of PRISM and AVNIR-2 almost meeting the goal (except for band-4 of AVNIR-2). However, the geometric accuracies were inadequate because the satellite attitude was not precise or the offset components (i.e., sensor alignments) were not evaluated. In the operational phase after Oct. 23, 2006, we continued to improve the absolute accuracies of PRISM and AVNIR-2. We also continued to evaluate their stabilities.

a. Geometric calibration

PRISM and AVNIR-2 were geometrically calibrated in two steps, i.e. relative calibration and absolute calibration. The relative geometric calibration was done by evaluating and correcting parameters for band-to-band registration of AVNIR-2, and relative CCD alignments for PRISM. The absolute geometric calibration was done by evaluating the sensor alignments for both AVNIR-2 and PRISM.

<u>AVNIR-2</u>

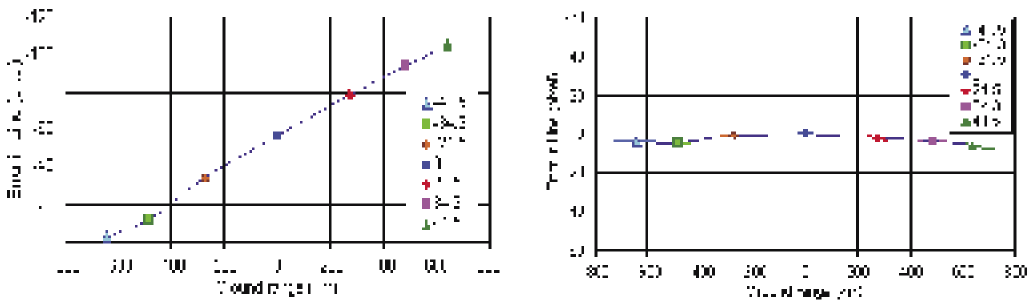
The uncalibrated band-to-band registration, which is referred to as band 3, was measured as -0.3 to +0.4 pixels errors, but was improved to less than 0.2 pixels (Fig. 2.1.3-1) by tuning the band-to-band registration parameters. Pointing angle dependency of the error is also improved using the GCPs as seen in Fig. 2.1.3-2.



(a) Before correction. (b) After correction.

Fig. 2.1.3-1 Improved band-to-band registration for AVNIR-2 (0 degree pointing angle, X direction).

This document is provided by JAXA.

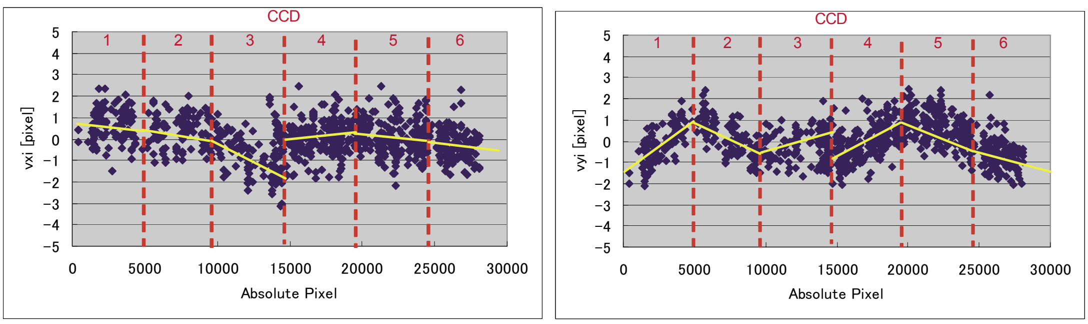


(a) Before correction. (b) After correction.

Fig. 2.1.3-2 Improved sensor alignment for AVNIR-2 (Y direction).

PRISM

While the nadir radiometer has six CCD units to cover a 70km swath, the forward and backward radiometers have eight CCD units to cover the area viewed at nadir with time gaps of about 46 seconds as the Earth rotates. Alignments were measured on the ground before launch, but they might be changed due to vibrations of the launch and changes of thermal conditions in space. Residuals of exterior orientations using 706, 943 and 734 GCPs were used to measure the on-orbit alignment. GCP residuals of exterior orientations, which are back-projected on the image space of the nadir with uncalibrated CCD alignment models, are shown in Fig. 2.1.3-3. Linear regression was applied to govern the deviation at each CCD unit in each sensor. We will keep monitoring its accuracy and variation with season and update them if necessary.



(a) X direction. (b) Y direction.

Fig. 2.1.3-3 Relative CCD alignments at PRISM.

b. Radiometric calibration

Stripe noise needs to be eliminated during standard products processing. The power spectrum of the PRISM image in Fig. 2.1.3-4 shows that a high correlation appears at 1/2 cycle (sample number 2048) and a low correlation at 1/4 cycle (sample number 512). This means that stripe noises appears at every pixel or every other pixel. Zero filling and inverse FFT resolves this problem. Some images were recovered successfully (no stripes), but some were not. Additionally, we implement the averaging DN method to correct the odd-even DN difference.

Cross-calibration using the calibrated satellite data was adopted. We used two types of existing satellite data, a moderate-spatial resolution sensor and a high-resolution sensor.Moderate-spatial-resolution sensors (MODIS on TERRA and AQUA) are used to increase the number of evaluations; high-spatial-resolution sensors (ASTER, SPOT-5, and Landsat) are used to evaluate their pixel scale. Simultaneous observations with ALOS are difficult. We collected many test areas whose images look homogeneous and stable (White Sands, Lunar Lake, Rail Road Valley, and

This document is provided by JAXA.

Ivanpah Playa) and which were observed by ALOS and the other satellites within a one-day time difference and a five-degree difference of incidence angle as the line of sight.

Figure 2.1.3-5 presents evaluation points for AVNIR-2 and MODIS. The left image is Arizaro Salt Lake, Argentina, where the altitude is about 4,000m and the atmosphere is stable. Arizaro was used for calibrating EO-1/Hyperion with the AVIRIS airborne sensor, and the surface reflectance was investigated during the campaigns. The right image is Rab Khali Desert, Saudi Arabia. The yellow dots indicate the evaluation points. The AVNIR-2 data were averaged over a 500m x 500m area. The variance of digital number (DN) is within three percent, indicating a stable target. Figure 2.1.3-6 compares radiance (W/m2/str/micro-m) for each band without atmospheric correction between MODIS (x-axis) and AVNIR-2 (y-axis); the upper figure is a comparison with TERRA/MODIS, and the lower, a comparison with AQUA/MODIS. Figure 2.1.3-6 indicates good agreement between MODIS and AVNIR-2 except for band 4. The reflectance of band 4 of AVNIR-2 is below the estimate for MODIS. Table 2.1.3-1 summarizes the initial results of cross-calibration with MODIS, as derived from Fig. 2.1.3-6. The radiometric accuracies of AVNIR-2 are less than 4.6 percent for bands 1 to 3, and 15.6 percent for band 4.

Absolute calibration of PRISM involves AVNIR-2 using simultaneous images over Arizaro (Fig. 2.1.3-7) and exhibits good agreement.

c. Summary of calibration

Table 2.1.3-2 summarizes the calibration results of standard products (level 1B2) as of March 29, 2007. The satellite position and attitude are precisely determined. The relative geometric accuracies almost met design requirements. The absolute geometric accuracy of AVNIR-2 was improved. The absolute accuracy of PRISM depends on that of the pointing alignment parameter that will be continuously updated. The radiometric accuracies generally met requirements, except for stripe noise in PRISM.

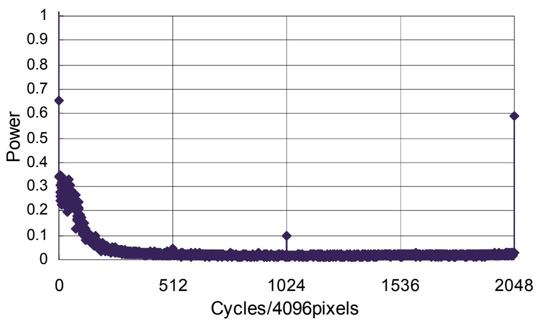


Fig. 2.1.3-4 Power spectrum of PRISM nadir image (CCD #4).

This document is provided by JAXA.

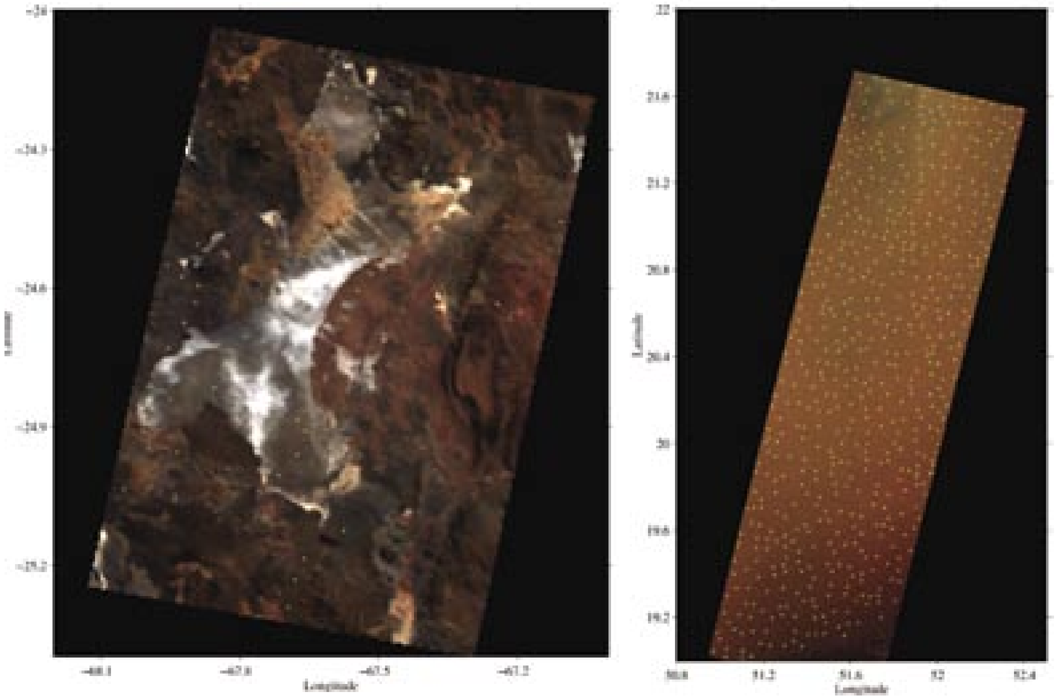


Fig. 2.1.3-5 AVNIR-2 image cross-calibrated with MODIS (Yellow dots denote evaluation points. Left: Arizaro, Argentina. Right: Rab Khali Desert, Saudi Arabia.).

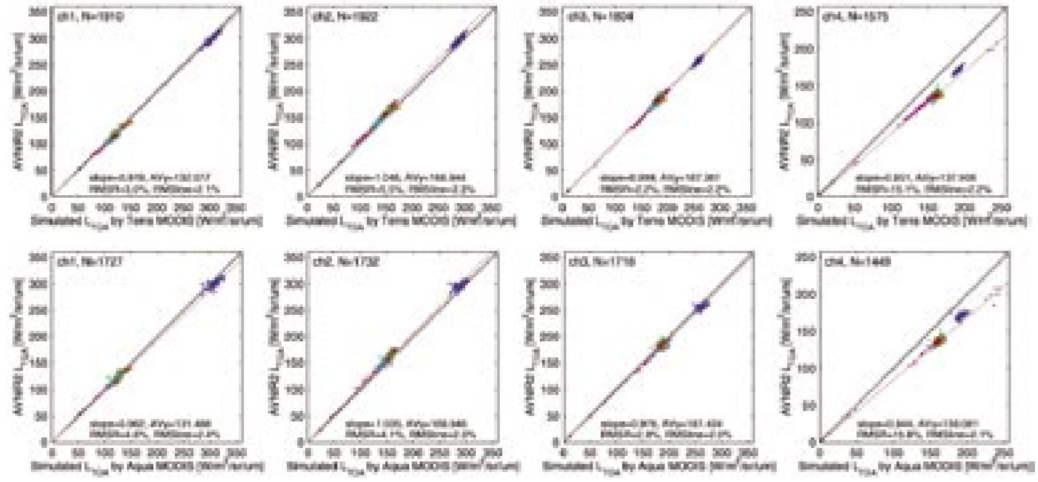


Fig. 2.1.3-6 Comparison of radiances between MODIS (TERRA (upper) and AQUA (lower)) and AVNIR-2 (Left to right: bands 1 to 4. Plots include results for six AVNIR-2 scenes.).

Table 2.1.3-1 Results of radiometric cross-calibration of AVNIR-2 and MODIS (as of March 29, 2007).

AVNIR-2	TERRA/MODIS			AQUA/MODIS		
Band	Number	Slope	RMSR	Number	Slope	RMSR
1	1910	0.978	2.2 %	1727	0.962	3.8 %
2	1922	1.046	4.6 %	1732	1.035	3.5 %
3	1804	0.999	0.1 %	1718	0.978	2.2 %
4	1575	0.851	14.9 %	1449	0.844	15.6 %

* Number: Number of evaluation points. Slope: Radiance ratio of AVNIR-2/MODIS. Ave: average of AVNIR-2's radiance (W/m2/str/micro-m); and RMSR: root mean square of residual.

This document is provided by JAXA.

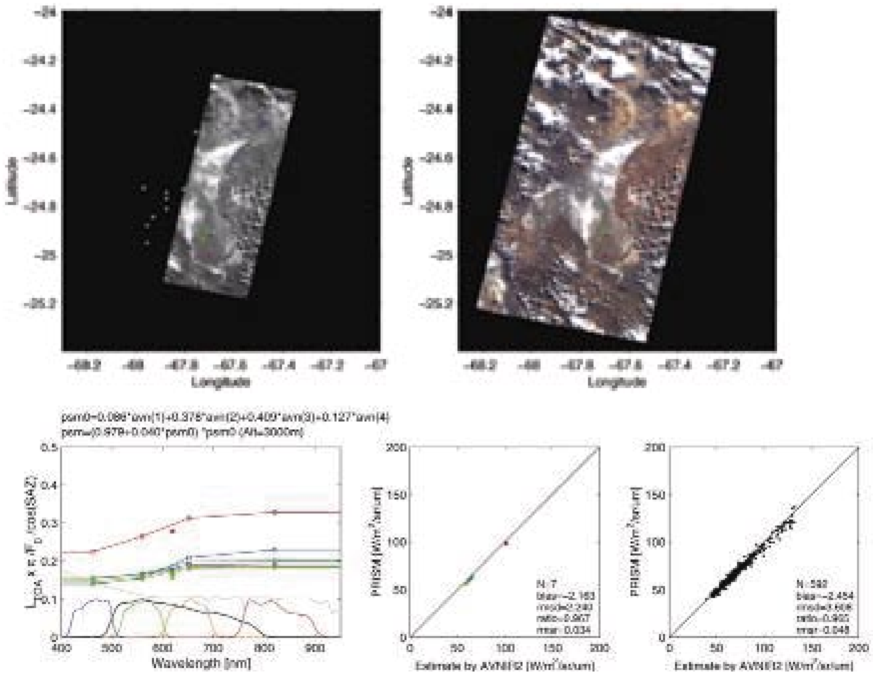


Fig. 2.1.3-7 Cross calibration of PRISM (upper left) with AVNIR-2 (upper right) over Arizaro, Argentina, and comparison of radiances between PRISM and AVNIR-2 (lower center and right).

Table 2.1.3-2 Calibration summary of standard products (March 29, 2007)

Sensor	Accuracy (as of March 29, 2007)
PRISM (L1B2)	Geometry (m): Absolute X (Pixel) Y (Line) (RMS) Nadir 8 9 Forward 11 21 Backward 10 20 Relative 4 3 (3 radiometers, 1σ) Radiometry (%): Relative 0.4 (sometime appear stripe noises) Absolute 4.6 (1σ)
AVNIR-2 (L1B2)	Geometry (m): Absolute X (Pixel) Y (Line) -41.5 to +41.5 deg. pointing 106 19 (RMS) Relative 4 4 (1σ) Radiometry (%): Relative 0.4 (less than 1 DN, 1σ) Absolute 3.8 (B1), 4.6 (B2), 2.2 (B3), 15.6 (B4) (1σ)

d. Validation of generated digital surface model (DSM) by PRISM

The digital surface model (DSM) generating algorithm is a correlation-based triplet of stereo images matching algorithm exclusively developed for PRISM. The major characteristics of the algorithm are as follows;

- Area-based grid matching with cross correlations
- Epipolar geometry constraints for simultaneous triplet images 1-D matching
- Cross correlation patch size dynamic optimization
- Coarse to fine image pyramid.

DSM generation software only estimates the bias errors of roll and pitch angles as the exterior

This document is provided by JAXA.

orientation parameters because the yaw angles of pointing elements given by Star Tracker (STT) and PRISM sensor alignments are accurate enough. The triplet triangulation accuracies of exterior orientations are evaluated with 1, 9, 25 and all GCPs. To evaluate the capability of automatic determination of exterior orientation parameters, the relative orientations are performed without GCP registrations (0-GCP). The absolute accuracies of relative orientations with Tie Points (TPs) are attributed to accuracies of the onboard GPS receiver (GPSR), STT data, and trend compensating sensor alignment parameters. Here, the stereo images are listed in Table 2.1.3-3, and the characteristics of the reference DSM are listed in Table 2.1.3-4 and Fig. 2.1.3-8.

The accuracies of those orientations are presented in Tables 2.1.3-5 to 2.1.3-7 for scene 1 to 3. The GCP residuals are the standard deviations of registered GCPs, and the RMSEs are the errors of independent check points (ICPs), which were not used as the registering GCPs. The results indicate that the triangulation accuracies are 6.4 and 6.2m RMSE for planimetry (xy) and 8.7 and 23.1m RMSE for height (z) without GCPs. The height errors are correlated to the relative pitch errors of forward and backward images against nadir. These height errors are nearly consistent with the absolute pointing pitch errors estimated during sensor alignment trend analysis. Only one GCP registration can improve the absolute accuracies to 1.9 to 2.3m RMSE for planimetry and 2.1 to 3.4m RMSE for height.

The generated DSMs spaced at 10m and 0.3 arc-sec are depicted in Figs 2.1.3-9 to 2.1.3-11. Cloud and land-water (i.e. large rivers or lakes) areas are masked by manual editing. The standard deviations (SD) are almost the same even though the GCP numbers are different. This implies that the planimetric accuracies of 0.3 arc-sec DSM are almost the same among those different numbers of GCP models including 0-GCP. In the flat Saitama site, which includes paddies and urban terrain, the height accuracy is 4.8m RMSE; in Okazaki, Thun, SW, and Bern sites, which include the various terrain, i.e. mountains, farms, and cities), the height accuracies are 5.8 to 7.5m RMSE.

Table 2.1.3-3 Test scenes for validating generated DSM by PRISM.

No.	Ref. DSM Sites	Obs. Date	No. of GCPs	No. of TPs
1	Saitama	2006/4/30	230	9
2	Okazaki	2006/6/21	42	9
3	Thun /SW/ Bern	2006/9/21	54	9

Table 2.1.3-4 Availability of reference DSM and their characteristics.

Site	Source	Size	Height Range	Ground Resolution	Height Accuracy	Source Year
Saitama	LiDAR	14.0x12.0km	100m	1m	<1m	2002
Okazaki	Aerial Photo	6.0x6.0km	400m	10m	~10m	2005
Thun	Aerial Photo	7.5x14.5km	500m	2.5m	0.5~2.5m	2004
SW	Aerial Photo	7.5x14.5km	1000m	2.5m	0.5~2.5m	2004
Bern	Aerial Photo	11.0x11.5km	400m	2.5m	0.5~2.5m	2004

This document is provided by JAXA.

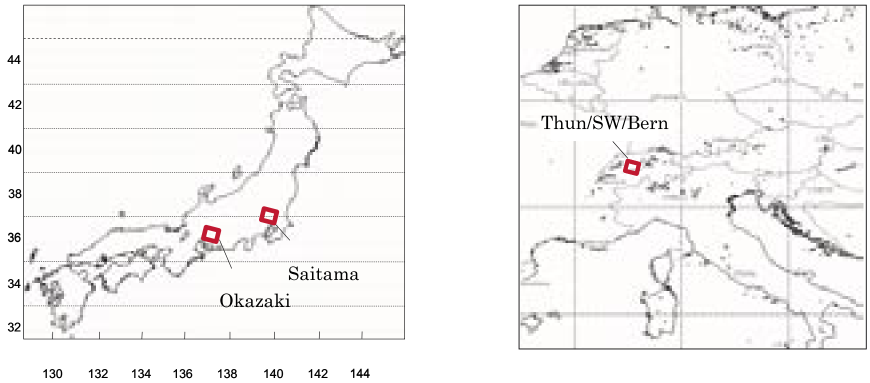


Fig. 2.1.3-8 Location of Reference DSM (left: Japan area. Right: Swiss area).

Table 2.1.3-5 Triplet triangulation residuals and errors of scene 1.

No. of GCPs	0	1	9	25	230
σ xy [m]	-	-	0.83	1.67	1.79
σ _z [m]	-	-	1.67	1.62	1.75
No. of ICPs	230	229	221	205	0
RMSE_xy [m]	6.43	2.18	2.14	1.94	-
RMSE_z [m]	8.72	2.09	2.04	2.07	-

Table 2.1.3-6 Triplet triangulation residuals and errors of scene 2.

No. of GCPs	0	1	9	25	42
σ _xy [m]	-	-	1.96	2.13	2.00
σ _z [m]	-	-	2.21	2.40	1.29
No. of ICPs	42	41	33	17	0
RMSE_xy [m]	6.18	2.32	2.09	1.87	-
RMSE_z [m]	23.07	3.40	2.70	2.78	-

Table 2.1.3-7 Triplet triangulation residuals and errors of scene 3.

No. of GCPs	1	9	25	54
σ _xy [m]	-	2.08	2.03	1.72
σ _z [m]	-	3.50	3.02	1.24
No. of ICPs	53	45	29	0
RMSE_xy [m]	1.87	1.73	1.55	-
RMSE_z [m]	3.02	2.81	2.95	-

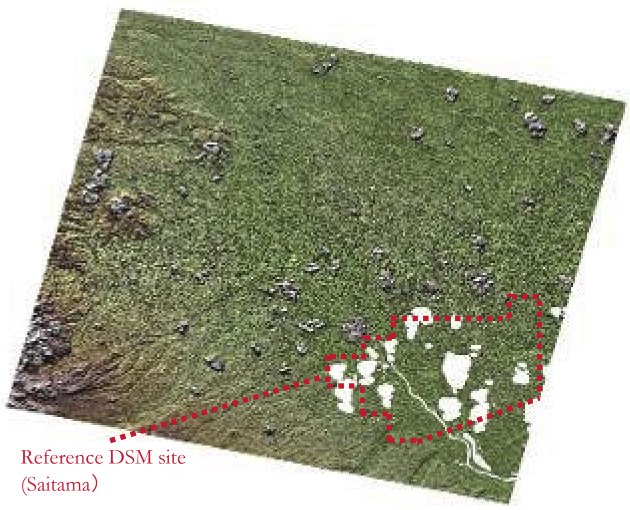


Fig. 2.1.3-9 Color shaded PRISM-DSM of scene 1 (35km x 35km).

This document is provided by JAXA.

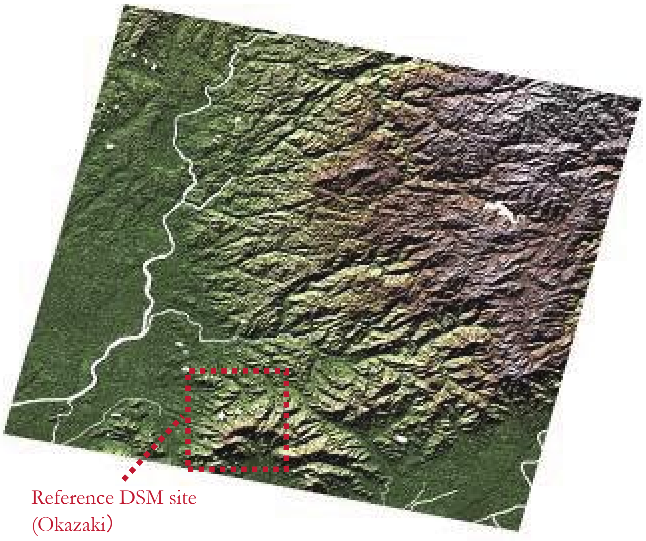


Fig. 2.1.3-10 Color shaded PRISM-DSM of scene 2 (35km x 35km).

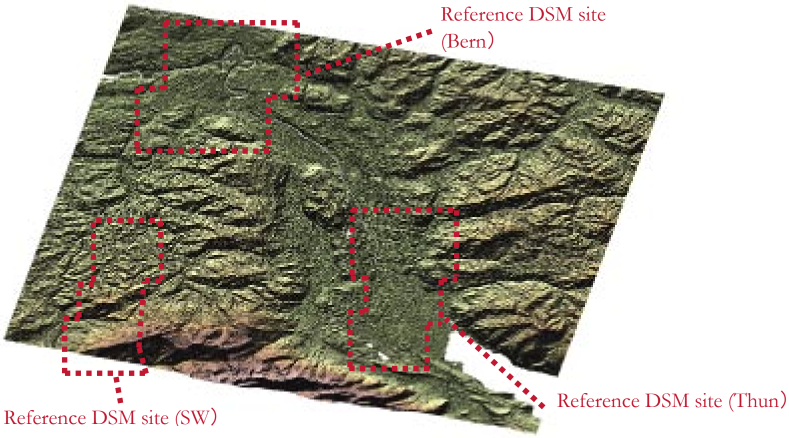


Fig. 2.1.3-11 Color shaded PRISM-DSM of scene 3 (35km x 35km).

Table 2.1.3-8. Height accuracies of Generated DSM.

Site	Model	Points	Bias [m]	SD [m]	RMSE [m]	Max [m]	Min [m]
Saitama	0-GCP	1,260,372	10.37	4.79	11.42	121	-165
	1-GCP	1,260,918	2.36	4.76	5.32	110	-171
	230-GCP	1,258,857	0.84	4.76	4.83	103	-171
Okazaki	0-GCP	538,875	23.48	6.06	24.25	127	-68
	1-GCP	538,879	2.71	5.80	6.41	108	-95
	42-GCP	538,880	0.11	5.78	5.78	105	-99
Thun	1-GCP	1,477,962	-1.12	5.75	5.86	92	-90
	54-GCP	1,478,007	0.98	5.77	5.85	94	-92
SW	1-GCP	1,044,128	4.08	7.42	8.47	99	-132
	54-GCP	1,044,113	1.07	7.38	7.46	90	-135
Bern	1-GCP	1,821,894	1.11	5.88	5.99	87	-57
	54-GCP	1,822,015	-1.33	5.74	5.89	64	-58

This document is provided by JAXA.

3) Calibration and validation of PALSAR

a. General

We will summarize the PALSAR geometric and radiometric calibration results achieved during the ALOS initial calibration phase, which covers five months between May 16, 2006, and October 23, 2006, and the half-year of the operational phase. All the PALSAR modes, FBS (fine beam single), FBD (Fine beam dual), SCANSAR, DSN (band-limited SAR), and POL (Full polarimetry) were calibrated and validated using a total of 500 calibration points collected worldwide and distributed target data from the Amazon. While characterizing PALSAR, determining the antenna pattern, and conducting polarimetric calibration, we adjusted the PALSAR radiometric and geometric model installed on the SAR processor (SIGMA-SAR). Using the reference points, we confirmed that the geometric accuracy of the FBS, FBD, DSN, and POL modes is 9.3m, that of SCANSAR mode is 70m, and the radiometric accuracy is 0.64 dB. Polarimetric calibration was successful; the amplitude balance of VV/HH is 0.025dB and the phase balance is 0.32 degrees.

b. CALVAL

b-1) Stability of the chirp data

PALSAR has only three chirp rates although it has six modes, i.e., FBS, FBD, DSN, SCAN-WB1, SCAN-WB2, and polarimetry. The temporal variation of these chirp rates were measured and plotted in Fig. 2.1.3-12. All the chirp rates are very stable (normalized standard deviation, standard deviation divided by an average) of less than 1.0e-4 during the one-year monitoring period after the ALOS launch. This variation produces only a 1.0 degree maximum disagreement at the pulse end and does not cause compression errors in the range compression step.

$$2\pi \frac{\Delta k}{2}\left(\frac{\tau}{2}\right)^2 \le \frac{\pi}{180} \qquad (1)$$

Here, Δk is the deviation in the chirp rate, and τ is the pulse width. Δk, which causes phase disagreements of 1 degree at the pulse end, is 3.0e7 for FBS, 3.0e7 for FBD, and 8.7e7 for polarimetry. The measurements are always below this. This means that the chirp rate can be made constant.

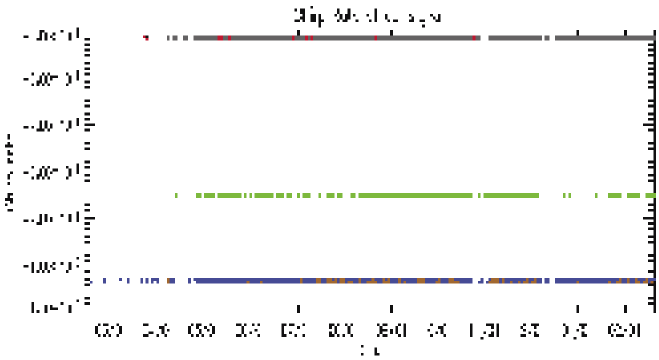


Fig. 2.1.3-12 Temporal stabilities of the three chirp rates observed from the PALSAR calibration data. Here, black indicates the chirp rate of FBS, SCAN-WB2, green is for FBD, DSN, and SCAN-WB1, and the green for polarimetry.

b-2) Raw data summary

Table 2.1.3-9 summarizes the raw data characterization obtained from all the PALSAR data. This result was acquired at the end of the CAL/VAL phase and was slightly improved. The SNR of the natural target is improved for FBD because the FBD of 34.3 is included and in the total worse SNR of only 4.15 was improved. The saturation rate was measured and found to be less than 3%. This is a significant improvement over the previous report [1] and results from the attenuators for all the modes being optimized on Aug. 7, 2006, and the additional update for the SCANSAR made mode for SCAN 2 to 5. Interference did not change so much. In total, PALSAR exhibited better raw data characteristics than did JERS-1 SAR.

b-3) Stabilities of the azimuth antenna pattern (AAP)

This document is provided by JAXA.

In [1], we reported that the PALSAR AAP is almost the same as the pre-launch AAP (exactly the same in the main lobe and only slight differences in the side lobes). The temporal change was evaluated by drawing all the AAPs in the same plane (Fig. 2.1.3-13). The AAP can be obtained by converting the azimuth time to the angle between the satellite and the target, and the orbital deviation (height, shift from the nominal orbit) needs exact conversion of the coordinate system. For simplicity, we evaluate the time variation of the AAP's main lobe only. This figure demonstrates that the main lobe does not change over six flights. The other AAPs at different off-nadir angles and different modes, seven cases in total, also do not exhibit any differences. AAP is thus time invariant.

Table 2.1.3-9 Summary of the PALSAR raw data characteristics

	FBS	FBD	PLR	WB1	WB2
I	16.049	16.188	16.254	16.245	16.041
Q	15.850	15.973	16.078	15.950	15.835
Gain ratio I/Q	1.007	1.010	1.001	1.015	1.008
Phase diff. of I/Q (deg)	1.598	1.579	1.577	1.581	1.597
SNR (dB)	8.6698	6.9575	8.5104	9.4869	8.3310
Chirp rate (Hz/s)	-1.03158 x E12	-0.515923 x E12	-0.850977 x E12	-0.515903 x E12	-1.03159 x E12
Chirp rate Std	2.5e7	2.2e7	4.0e7	1.2e7	5.1e7
Saturation	Saturation rate dropped to 3% after August 7, 2006.				
Interference	In general, the interference is less than JERS-1 SAR (because it has four times greater transmission power) except for occasional greater bandwidth noise.				

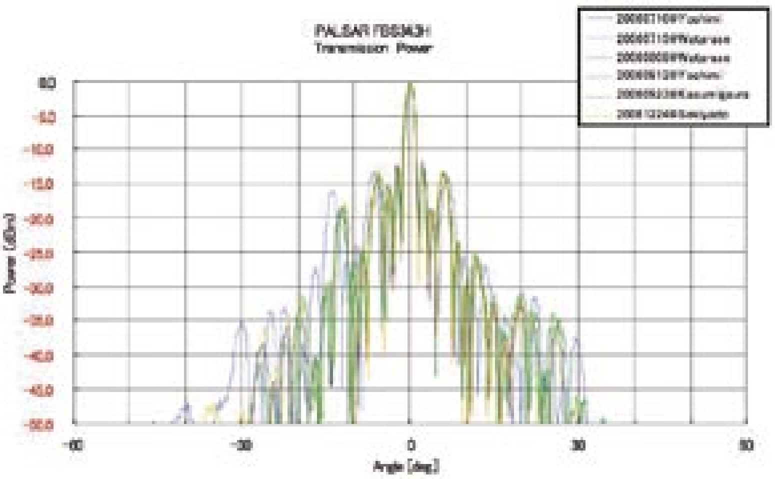


Fig. 2.1.3-13 Measured azimuth antenna pattern (in HH pol). Red curve and Blue curve are real measurement and the ground measurement.

b-4) Elevation Antenna Pattern (EAP)
EAPs were measured using the Amazon data. For off nadir angles of less than 40 degrees, the EAPs were almost the same as the on-ground measurements. At greater off-nadir angles, EAPs were degraded due to the range ambiguities (see Fig. 2.1.3-14; the small circles at 41.5 of FBS and FBD indicate that EAP deviates due to the azimuth ambiguity). Thus, the 34.3-degree and 21.5-degree off-nadir angles are being used for standard operation.

c. Image quality and summary
c-1) Resolution: After calibrating the PALSAR data, we measured the image quality of the PALSAR data using all the corner-reflector responses. The results are summarized in Table 2.1.3-10. The representative Impulse response function (IRF) is presented in Fig. 2.1.3-15 for two cases.
c-2) Geometric accuracy: A geometric accuracy of 9.2 meters RMS was achieved (Fig. 2.1.3-16).

This document is provided by JAXA.

c-3) Radiometric accuracy: See Fig. 2.1.3-17 for the distribution of the calibration factor using all the CRs.
c-4) Disturbances of VV/HH in phase and amplitude: Figure 2.1.3-18 plots these two parameters measured from the CRs.

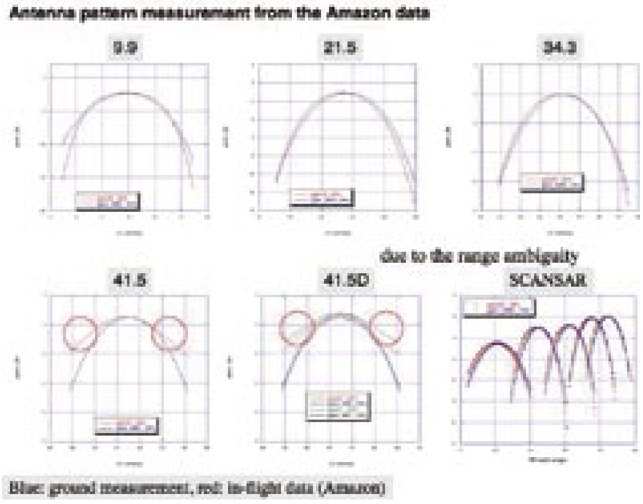


Fig. 2.1.3-14 EAPs before and after launch. Small circles the shoulders of the 41.5 case represent the range ambiguities.

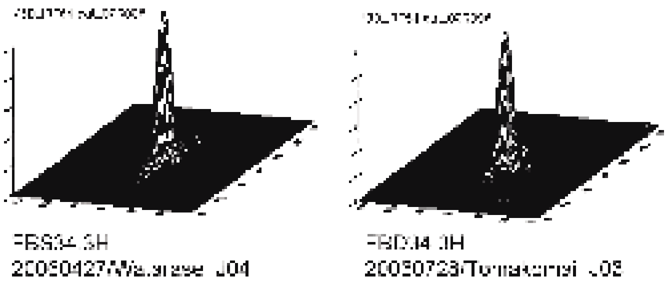


Fig. 2.1.3-15 3D responses (Left: FBS. Right: FBD.)

This document is provided by JAXA.

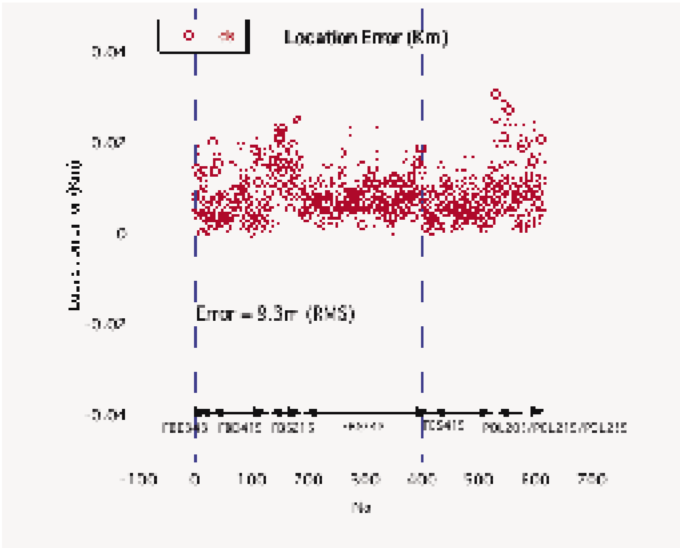


Fig. 2.1.3-16 Geometric error distribution

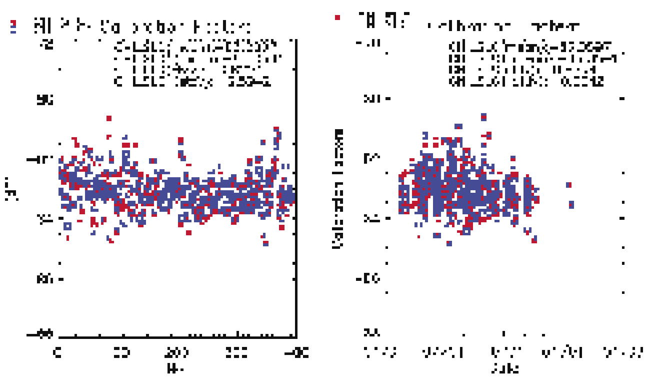


Fig. 2.1.3-17 Distribution of the calibration factors. Left: All modes. Right: Ordered in time.

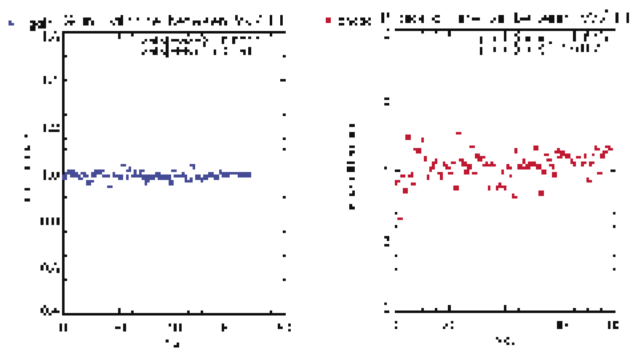


Fig. 2.1.3-18 Amplitude and phase disturbances of the Pol-CALed PALSAR data. (Left: Gain difference. Right: Phase difference.) Here, the distortion matrices were calculated using the Amazon corner reflector.

This document is provided by JAXA.

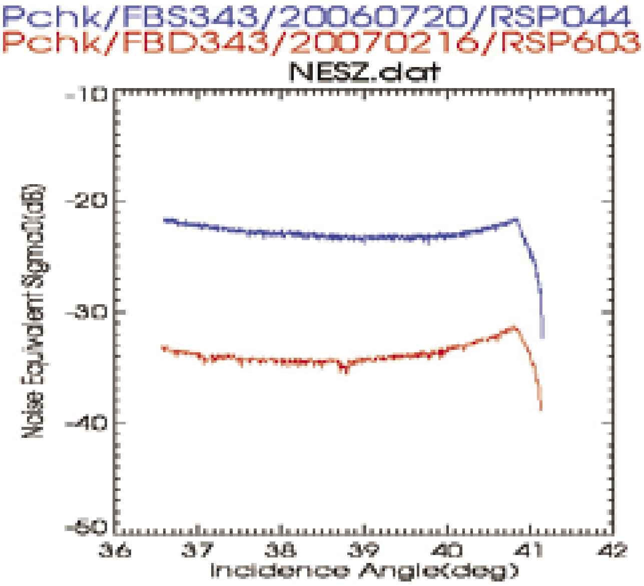


Fig. 2.1.3-19 Noise equivalent sigma-naught vs. incidence angle. Blue: Greenland by FBSHH. Red: Hawaii by FBD-HV.

c-5) Noise equivalent sigma-naught: The noise equivalent sigma-naught parameter expresses how dark targets can be observed. The value is determined by searching for the minimum from the browse strip data generated for cataloging all the PALSAR images at the EORC. Browse processing is possible by combining range compression and the azimuth SPECAN. The minimum value is sought in the azimuth direction in every range bin. Figure 2.1.3-19 presents two cases, a) from the FBS over Greenland ice and b) from HV polarization of the image path over the Hawaiian Islands. Both curves resemble the inverse of the range antenna pattern, and the correct values seem to have been obtained. The noise-equivalent sigma-zero is -34dB, which is 10dB better than the other spaceborne sensors and 13dB better than JERS-1 SAR.

c-6) Stability evaluation of the gamma-zero using the Amazon rain forest: The Amazon rain forest is a uniform reference target for relative (range and azimuth antenna pattern determination) and absolute calibration. The statistical analysis [2] demonstrates that the seasonal variation is only 0.25dB. Thus, the Amazon can be used for calibration. A multiple-beam SAR like PALSAR has many modes for calibration. The limited conditions for deploying corner reflectors require including Amazon-based calibration for both relative and absolute calibration. At the beginning of the PALSAR Cal Val, we used the following for determining the gain offset among the beams, so that the gamma naught could be constant over the incidence angle:

$$\gamma^0 = \sigma^0 / \cos\theta = constant. \qquad (2)$$

where θ is the incidence angle. Here, we confirmed the validity of this assumption using the 10 Amazon data points for the strip mode and two data points for the SCNSAR. Figure 2.1.3-20 indicates the stability of the PALSAR Amazon data. This suggests that the Amazon data is not always seasonally and spatially stable. The difference is between 0.5 dB to 1.0 dB. We need to investigate this variation further. It appears that the Amazon forest can be used for relative calibration but not for absolute calibration. Independently, calibration sites, including corner reflectors, were established worldwide, and more than 600 matched data sets were collected. Calibration, which actually means determining the calibration factor, should rely on the CRs. However, in general, gamma-naught is found to be -6.5dB with a standard deviation of 0.5dB.

This document is provided by JAXA.

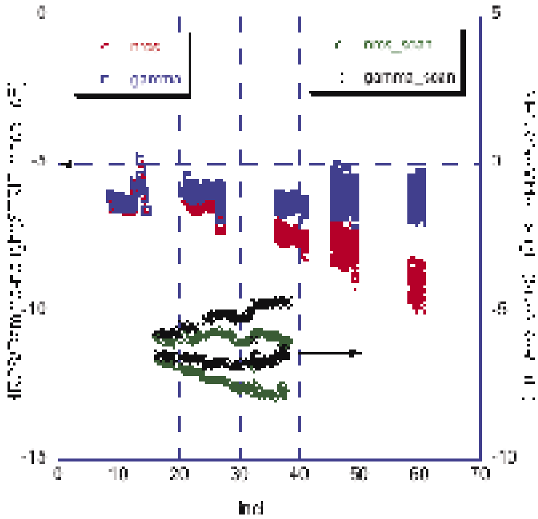


Fig. 2.1.3-20 Measured gamma-naught vs. incidence angle. a. Strip modes. b. ScanSAR.

d. Conversion formula

Conversion of standard products (Level 1.1 or 1.5) that JAXA produces to normalized radar cross-section can be expressed by

$$\sigma^0{}_{sigma-sar,Q16} = 10 \cdot \log_{10}\left\langle DN^2 \right\rangle + CF_1 \qquad (3\text{-}1)$$

$$\sigma^0{}_{sigma-sar,slc} = 10 \cdot \log_{10}\left\langle I^2 + Q^2 \right\rangle + CF_1 - A \qquad (3\text{-}2)$$

where, I (Q) is the real (imaginary) part of SLC (Single Look Complex, process level is 1.1), and DN is the digital number of the amplitude image (1.5). The conversion factor, CF1, is -83.0, and its standard deviation is 0.64dB. An additional factor (A) of 32.0 exists when the SLC is considered. A standard deviation of 0.64 is obtained by using all the CRs deployed worldwide. The CRs are trihedral corner reflectors, and their responses might vary since their characteristics and test site conditions might differ at the times of the over flights. When we used only the Swedish CRs, the largest CRs with a 5m-leaf size, the standard deviation became minimum at 0.17dB. The PALSAR radiometric performance can thus be estimated to be 0.17dB.

Table 2.1.3-10 PALSAR calibration accuracy (summary)

Item	Measured value		Data	Spec.
Geometric accuracy	9.3m (RMS): Strip mode 70m (RMS): SCANSAR		615	100m
Radiometric accuracy	0.64dB (1 sigma) 0.17dB (1sigma: Sweden) -34dB(Noise equivalent NRCS)		478 16	1.5 dB 1.5 dB -23 dB
Polarimetric calibration	VV/HH ratio VV/HH phase diff Crosstalk	0.02 dB (0.04) 0.32deg(1.01) 31~40 dB	79	0.2 dB 5 deg. 30 dB
Resolution	Azimuth Range (14M) Range (28M)	4.49m(0.1) 9.6m(0.1m) 4.7m(0.1m)	478	4.5m 10.7m 5.4m
Side lobe	PSLR (azimuth)	-16dB	478	-10dB

This document is provided by JAXA.

	PSLR (range) ISLR	-12.5 dB -8.6 dB		-10dB -8dB
Ambiguity	Azimuth Range	Not appeared 23 dB		16dB 16dB

e. High-level products and research products

High-level products and research products are being generated. Two examples are introduced below.

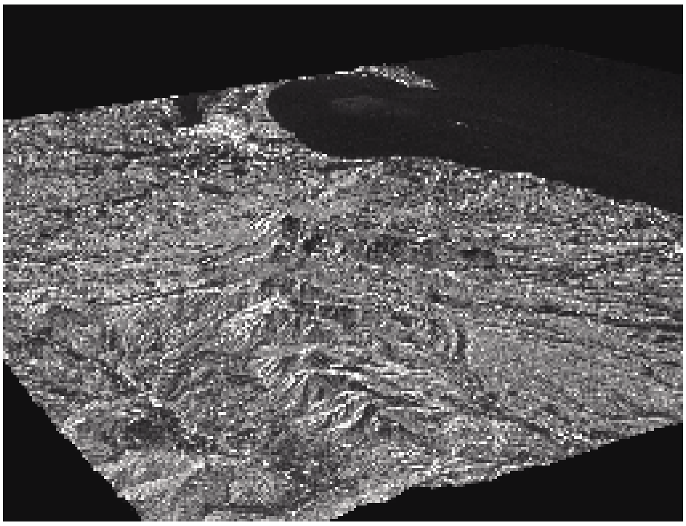


Fig. 2.1.3-21 Bird's-eye view of Mt. Daisen using the InSAR DEM and Ortho-rectified PALSAR image

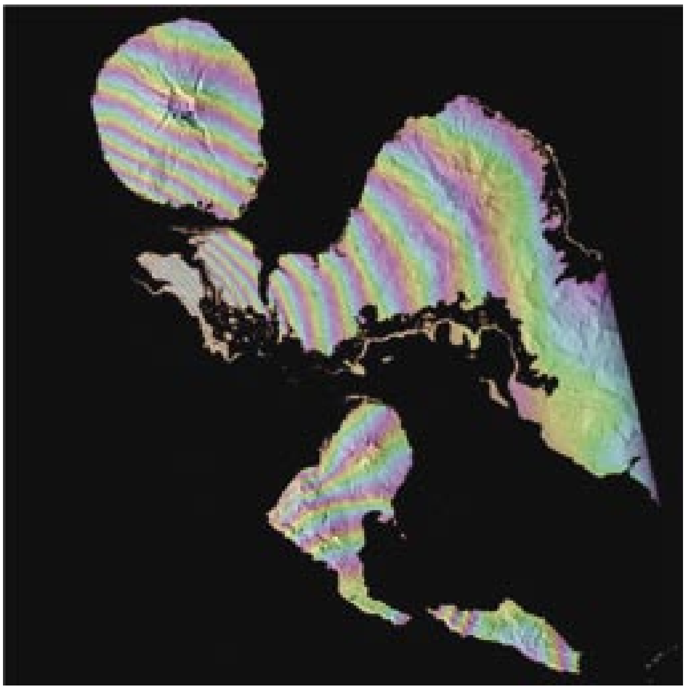


Fig. 2.1.3-22 Surface deformation pattern of Solomon Islands measured by DinSAR.

This document is provided by JAXA.

4) Research on Pi-SAR & PALSAR data

a. Potential applicability of L-band SAR to forests

Tomakomai National Forest in Hokkaido is a well-managed boreal forest with a flat topography and is good place to examine the relationship between SAR-derived parameters and biophysical parameters. Field measurements have been conducted several times and were also conducted this year in August in collaboration with Kochi University of Technology. We examined the deforestation that resulted from a typhoon in 2004.

We selected 32 stands in the SAR image and classified those into four types. In 21 stands, almost all trees and branches had been removed, and only small stumps and branches remained (deforestation). In three stands, tree trunks had been removed, but many stumps and branches were left, or some patchy standing trees remained (transition 1). In two stands, no trees had been removed and fallen trees remained within the stands (transition-2). In the other six stands, trees were not felled by the typhoon (normal forest). The SAR images taken with JERS-1 SAR and PALSAR were processed, and some images were ortho-rectified by using the SIGMA SAR processor to overlay the images. The processed images are presented as RGB color composite image in Fig. 2.1.3-23 (Red - 14 Oct. 1992 JERS-1 SAR; Green - 27 Jul. 1998, JERS-1 SAR; Blue - 27 Jul. 2006 ALOS PALSAR). Most of blue areas in the image are stands damaged by the typhoon, and many of the trees in the stand have been carried out. There is a plantation site in the top-right in the image, and the various colors indicate the active temporal change of σ^0_{HH} between 1992 and 2006.

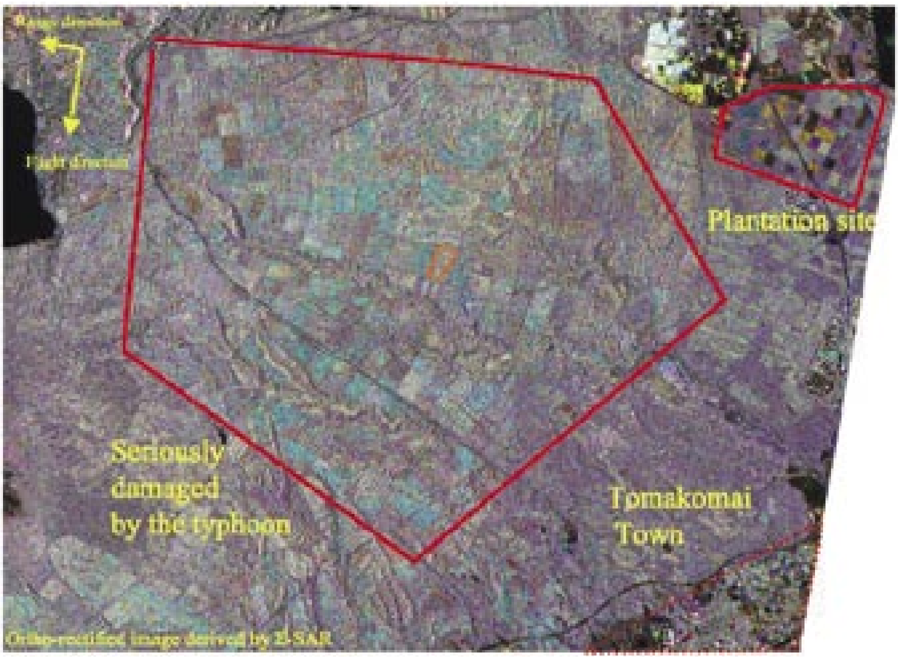


Fig. 2.1.3-23 Color composite image taken with L-band SAR. (Red: 14 Oct. 1992 JERS-1 SAR. Green: 27 Jul. 1998, JERS-1 SAR. Blue: 27 Jul. 2006 ALOS PALSAR).

Figure 2.1.3-24 depicts the temporal change of σ^0_{HH} for the 32 selected stands. The color represents the deforestation types. As demonstrated in Fig. 2.1.3-24, the vacant stands are easily detected by this simple method, even if a small number of tree branches and stumps are left in the stands. The change from the normal forest to vacant stands causes an average 3.1dB decrease in the σ^0_{HH}. We also

This document is provided by JAXA.

examined the dynamic range of σ^0 and found it to be 7.7dB for HH and 10.3dB for HV. This means that the difference of the σ^0 between the stands and the deforested stands is larger for HV polarization, indicating that σ^0_{HV} is preferable for monitoring forests.

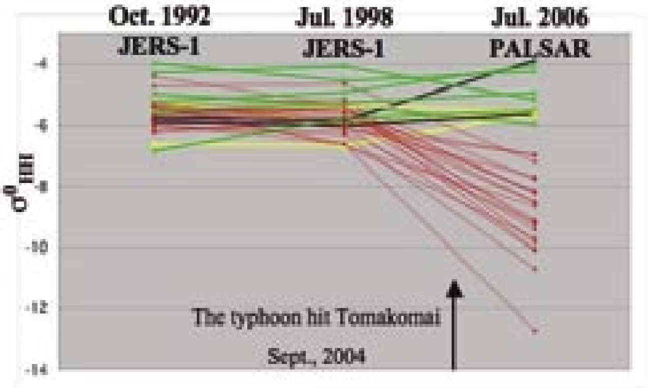


Fig. 2.1.3-24 Temporal change of σ^0_{HH} for the selected 32 stands. Red: Deforested. Yellow: transition 1. Black: Transition 2. Green: Normal.

The temporal changes of the forest are also examined for the plantation area (the results and site photos are in Fig. 2.1.3-25). Site 1 indicates a gradual increase of σ^0, which seem to be saturated at around 17.4 tons/ha (5m in average height) as of 2005. Site 2 exhibits a sudden decrease around 1997 and a gradual increase after that. The average height is 1 to 2m in the site as of 2005. Site 3 suggests a constant value; the data include JERS-1/SAR and PALSAR. These results indicate that the combination of JERS-1/SAR and ALOS/PALSAR has good potential for monitoring plantation stands up to 14 years; the term depends on the tree species, the number density of the trees, the observation mode, and so on.

Fig. 2.1.3-25 Temporal changes of the three plantation stands (Top) and site photos.

b. Potential applicability of L-band SAR in disasters

A debris flow area caused by heavy rain in Kumamoto in July 2003 was observed by air-borne PiSAR. Three-component decomposition calculated from the L-band polarimetry detects the debris flow area well (Fig. 2.1.3-26).

This document is provided by JAXA.

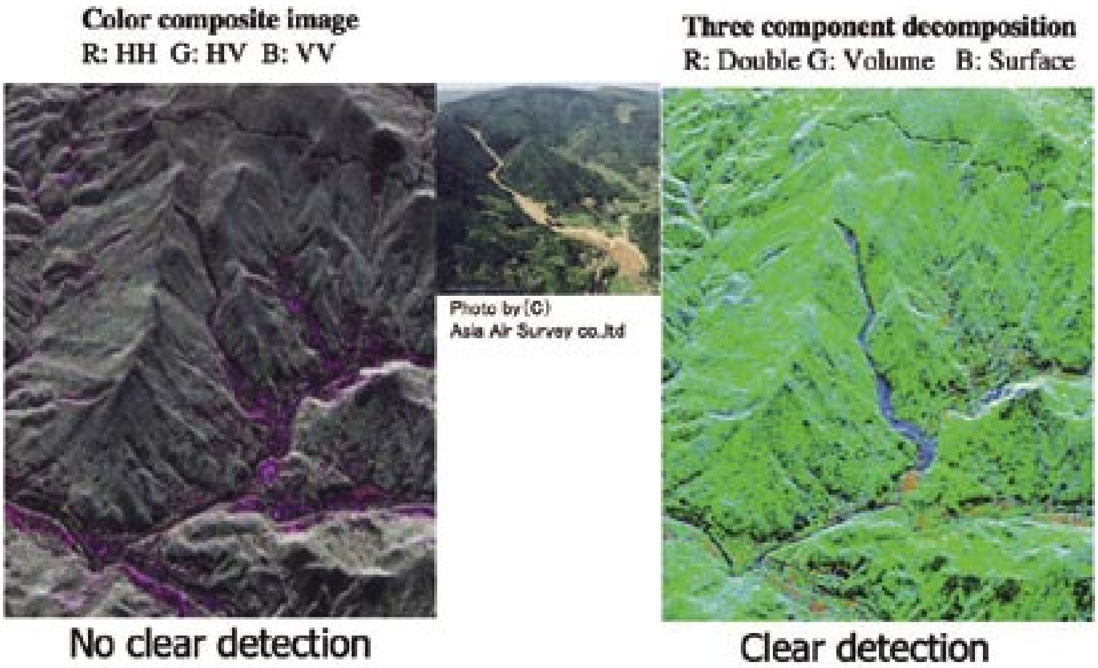


Fig. 2.1.3-26 Debris flow area detected by air-borne L-band SAR.

5) ALOS observation plans

To achieve a good success rate for requests from major users, i.e., Japanese governmental agencies, ALOS data node, and researchers (PI), we made the basic observation scenario and revised it to achieve better success rates. Negotiations started with major users with higher request priority, such as Japanese governmental users and ALOS data node.

After ALOS launch, actual data acquisitions for the basic observation scenario were examined during the first two cycles (after calibration cycles), and the number of scenes was compared with the simulation results in Fig. 2.1.3-27. Data acquisition status mapped for each sensor in Fig. 2.1.3-28 suggests that the number of actual acquisitions is 2 to 34% lower than the simulation. These lower success rates are mainly due to recent operational restrictions, additional operation to check satellite functions, and satellite non-operating periods due to active solar flares.

		Total (2006/10/20~2007/1/19			MMO Sim
		req[scene]	obs[scene]	obs rate[%	result
PALSAR	Asce	68746	33166	48	56
	Desce	5696	1598	28	62
PRISM	Desce	213765	83831	39	58
AVNIR-2	Desce	35895	21062	59	61

Fig. 2.1.3-27 Real data acquisitions under the basic observation scenario for first two cycles compared with the simulation

This document is provided by JAXA.

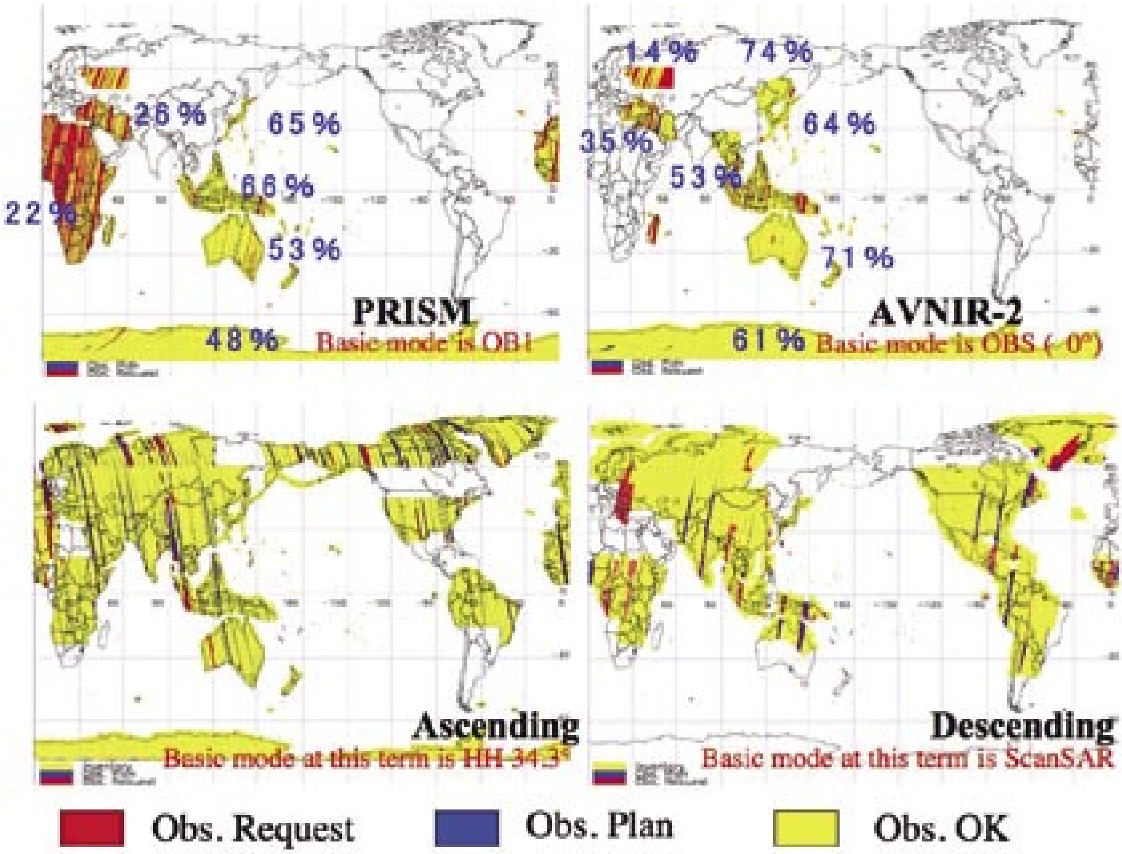


Fig. 2.1.3-28 Data acquisition plotted on map.

6) ALOS Kyoto and Carbon Initiative

The ALOS Kyoto and Carbon (K&C Initiative) initiated by EORC in 2000 is based on the conviction that ALOS has the potential to play a significant role in supporting certain environmental conventions, carbon-cycle science, and natural conservation with information that cannot be obtained in a feasible manner by any other means. In this context, the L-band SAR sensitivity to vegetation structure and inundation, together with the microwave cloud-penetrating capacity to ensure global observations is relevant.

a. Project organization

The K&C Initiative is organized as an international collaborative effort based on the experience and project structure developed for the JERS-1 SAR Global Forest Mapping project. The initiative is led by EORC, which is responsible for the overall management and implementation of the ALOS systematic acquisition strategy, as well as processing and distribution of all ALOS data. Product development is undertaken jointly by EORC and the international K&C Science Team, which involves universities and research organizations from 14 countries.

This document is provided by JAXA.

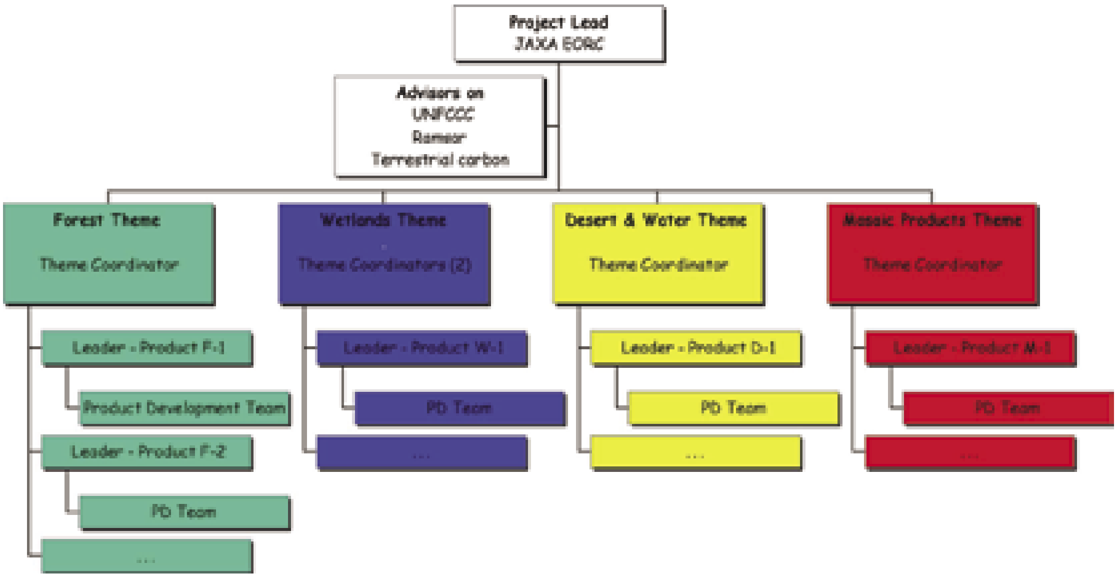


Fig. 2.1.3-29. Structure of the K&C Initiative project.

The Initiative is structured around three main thematic areas: Forest, Wetlands and Desert & Water, in which each relates uniquely to one or more of the project drivers (International Conventions, Carbon Science and Environmental Conservation), as well as a data-oriented theme (Mosaic Products) to support the three other themes with image data products. Each Theme consists of a Theme Coordinator and a number of Product Development (PD) Teams.

The Forest Theme focuses on supporting the UNFCCC Kyoto Protocol and some of the carbon research community concerned with CO_2 fluxes from terrestrial sinks and sources. Key areas considered include land cover (forest) mapping, forest change mapping, and biomass and structure. The Wetlands Theme aims to serve information needs of the Ramsar Wetlands Convention and the Convention on Biological Diversity, as well as the significance of wetlands as sources of tropospheric carbon. Key areas considered include regional wetland inventories, seasonal inundation monitoring and specific inventories of mangroves and peat swamp forests. The Desert and Water Theme addresses issues relevant to water supply and land degradation in arid and semi-arid areas. Key areas considered include freshwater supply and desertification. The Mosaic Products Theme is a semi-independent unit within the Initiative, which in terms of member composition and scope largely constitute a global-scale extension of the JERS-1 SAR Global Forest Mapping project. The principal objective of this theme is to generate continental-scale PALSAR mosaics, to be used both as intermediate input data to the three thematic themes, as well as stand-alone image products to be made available to the public.

b. Implementation

The K&C Initiative is implemented in a number of steps to assure validated development of thematic products from local to global scales.

- Step 0. Implementation of the PALSAR observation strategy

  In accordance with the Systematic Observation Strategy developed by EORC for all three instruments on ALOS, PALSAR acquisitions in support of the K&C Initiative begin immediately following the completion of the commissioning and calibration/validation phases of ALOS, some

This document is provided by JAXA.

nine months (six cycles) after the satellite launch. PALSAR data are processed by EORC and delivered to the K&C Product Leaders within one cycle after acquisition.

- Step 1. Local-scale methodology development
  Local-scale methodology is developed by the Product Leaders and their Product Development (PD) teams, typically using a small number of PALSAR scenes over study sites that are representative of the biomes of interest, with ample in-situ data available for verification.

- Step 2. Regional-scale prototype demonstration
  This step constitutes the essence of the K&C Initiative during the first three years covered within this science plan. Applying the methods and algorithms developed in the previous step, derived products over extensive regions as described in the theme are generated by the PD teams. All products are made available to the public and to specific target users.

- Review
  Three years after the launch of ALOS, EORC is to review all K&C projects and the products developed, with respect to scientific significance, accuracy levels achieved, actual relevance to CCC etc., in relation to the amounts of PALSAR data provided.

- Step 3. Global-scale extrapolation
  Projects deemed successful and with a potential for application over different or larger regions are selected by EORC for extension for another two-year period.

c. Project output

All data products generated within the K&C Initiative, both thematic products as well as PALSAR mosaics, will be made available free of charge for public users. For updated information about the K&C Initiative, please refer to K&C homepage at the EORC www site:
http://www.eorc.jaxa.jp/ALOS/kyoto/kyoto_index.htm

7) PI-activities

After the successful completion of ALOS Initial Calibration phase on October 24, 2006, JAXA started distributing ALOS standard products to the public. The existing PIs with effective PI agreements could start ordering their ALOS data after this date by using web-based JAXA ALOS User Interface Gateway (AUIG) on-line system.
PI agreement renewal efforts have continued throughout 2006. Because of the delay of the ALOS launch, preset effective due date of the ALOS PI research agreements is March 31, 2007, and so, the agreement renewal was necessary for each PI to have an effective PI agreement after April 1, 2007. The status of PI agreements is shown in the table below.
Two additional members were selected for the Cal/Val and Science Team (CVST) in March 2007 as in the scheme of PI research agreement. The CVST will continue to support JAXA Cal/Val activities throughout the ALOS routine operation phase.

Table 2.1.3-11 Status of agreement procedures (as of Mar. 26, 2007)

	Number of researchers			Number of researchers	Number of proposals	Note
	3 proposals per head	2 proposals per head	1 proposal par head			
Selected in RA#1	2	11	138	151	166	

This document is provided by JAXA.

Canceled or not able to conclude	2	2	32	36	42	
Excluded from Agreement	0	1	1	2	3	JAXA staff
CVST members (added as PI)	0	0	5	5	5	2 added in March 2007
Number of Agreements	0	8	110	118	126	
Concluded	0	5	91	96	101	Agreement renewal finished
Unconcluded	0	3	19	22	25	

To augment the current PIs, JAXA issued a second ALOS Research Announcement (RA) on December 8, 2006, for researchers in Asian and Russian countries in order to initiate more extensive scientific or application research by using ALOS data. Since the ALOS Data Node (ADN) concept came into effect in 2006, JAXA issued this RA#2 only for researchers living in the Asian Node area that JAXA is responsible for. One hundred and twenty eight effective research proposals were submitted by the end of March 2007, the deadline.
The other Node organizations, the European Space Agency (ESA), Alaska Satellite Facility (ASF) of University of Alaska Fairbanks, and Geoscience Australia, launched similar PI research program in their respective Node areas.

8) ALOS www

We maintained two web sites:
1) General ALOS information http://www.eorc.jaxa.jp/ALOS/index.htm
2) Principal Investigators (PIs) http://www.eorc.jaxa.jp/ALOS/ForPI/index.htm

The general ALOS site, established on January 6, 2006, with the sample top page in Fig. 2.1.3-30, contained about 60 images in its "Image Gallery." The site also contains the science plan, research announcement (RA), project and symposium information as well as characteristics of satellite and sensors. We maintained the site for the Cal/Val and Science Team (CVST) to share the information on Cal/Val test sites, data acquisition plans, technical information, and meeting information.
The site for RA PIs presents information on PIs, i.e., the PI list including names, organizations, research titles, e-mail address, telephone numbers, PI workshop, ALOS simulation data for research activities, and research agreement related documents.

This document is provided by JAXA.

Fig. 2.1.3.8-30　　Top page of ALOS@EORC web site

9) Satellite data utilization for disaster monitoring

a.　Detection of a surface height increase around Kilauea Caldera, Hawaii, by PALSAR

Using the differential interferometric SAR processing of PALSAR images of southern Hawaii Island, Hawaii, USA, a five-kilometer diameter area around the southwestern part of the Kilauea crater was found to have risen about 10cm between May 2 and Aug. 2, 2006, due to the expansion of a magma reservoir. Figure 2.1.3-31 depicts the amount of crustal deformation in colors. Warm colors indicate a decrease in the distance between the satellite and the land (uplift), and cold colors indicate an increase of the distance (subsidence). Information from GPS receivers installed around Kilauea is consistent with InSAR results.

This document is provided by JAXA.

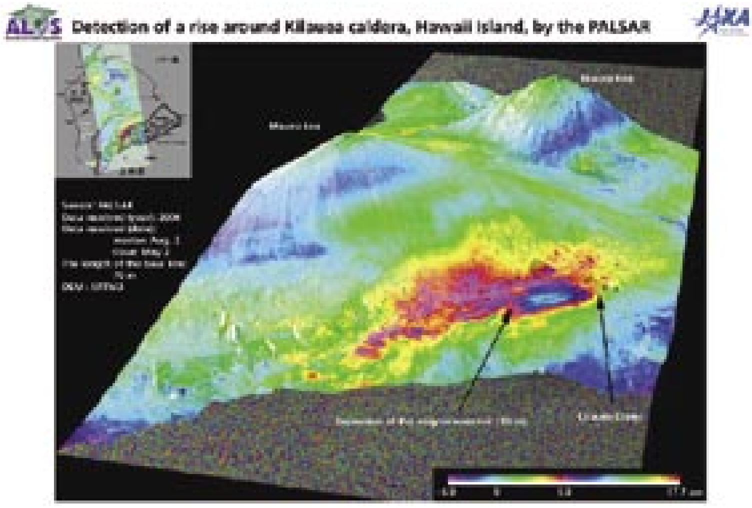


Fig. 2.1.3-31 Crustal deformation at Kilauea caldera, Hawaii, between May 2 and Aug 2, 2006 detected using PALSAR.

b. Detection of oil spill from a sunken tanker by PALSAR

Oil was observed spilling from a sunken tanker by PALSAR on August 11, 2006, near the central Philippine island of Guimaras. The spill was observed again on August 25 by ScanSAR (observation swath 350km, polarization HH, Fig. 2.1.3-32 left) and on August 27 in Polarimetry (observation swath 30km, polarization HH HV VH VV, Fig. 2.1.3-32-right). The oil spill appears as a black streak (within a blue polygon) extending from the accident site (red point). The black stripe in the right image seems to be an internal wave. The black area near the land in the left image represents a smooth area, where the land blocks the wind. However, it is unclear if the other black area is caused by calm water or the oil spill.

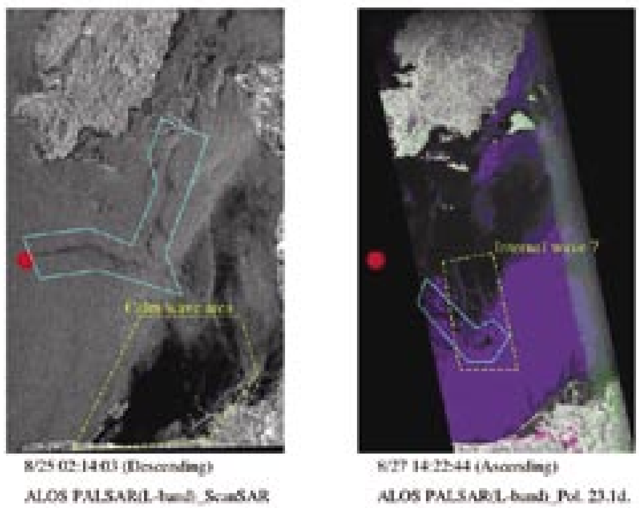


Fig. 2.1.3-32 Oil spill detected by PALSAR. Left - ScanSAR. Right - Polarimetry (HH) Red - HV. Green - VV, blue.

This document is provided by JAXA.

2.1.4 GOSAT

1) Overview

GOSAT seeks to observe greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4) from space in cooperation with the Ministry of the Environment (MOE), the National Institute for Environmental Studies (NIES), and JAXA. The GOSAT satellite carries the Thermal And Near infrared Sensor for Carbon Observation (TANSO). TANSO is composed of two instruments, the Fourier Transform Spectrometer (FTS) with SWIR and TIR bands, and the Cloud and Aerosol Imager (CAI) with UV-SWIR bands. JAXA is primarily responsible for instrument and satellite development, launching, operational L0/L1 processing, and post-launch calibration. NIES and MOE are responsible for data utilization of L2 processing and further CO_2 data applications of source and sink inversion under the Kyoto protocol requirements.

The EORC research project is responsible for post-launch calibration and data utilization of the TIR band. The project was under phase-C study in FY2006 for the preliminary study of calibration activity and algorithm development.

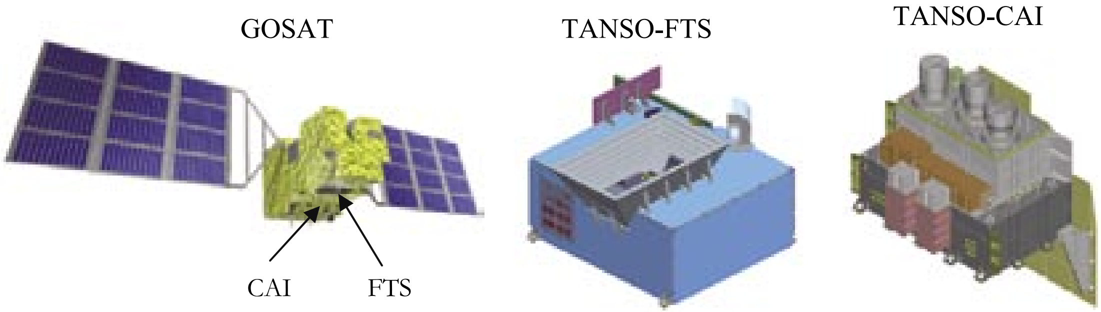


Fig. 2.1.4-1 GOSAT satellite and TANSO instruments: GOSAT satellite (left), Fourier Transform Spectrometer (center), and Cloud and Aerosol Imager (right).

2) Calibration

Post-launch calibration of TANSO will be conducted by onboard calibration and vicarious calibration. The FTS observed radiances are calibrated by using high- and low-radiance targets, such as solar irradiance and deep space for the SWIR band, and a blackbody and deep space for the TIR band. Lunar calibration will be performed once a year to monitor the stability of sensor sensitivity. The onboard calibration data of CAI is obtained by nightside observation of the noise level. Lunar calibration will be performed once a year as for FTS. Basically, the CAI-observed radiances are calibrated by pre-launch test data and post-launch vicarious methods.

The EORC research project mainly studies vicarious calibration methods and related planning. Vicarious calibration is important because it will be the only way to evaluate the sensor characterization other than onboard calibration.

(a) Calibration sites for ground-based measurements

We investigated appropriate calibration sites in preparation for FTS-SWIR. FTS has a large footprint of 10km. The calibration sites should be twice as large as the footprint due to pointing accuracy. The calibration sites are selected to satisfy the following conditions: (1) large homogeneous area, (2) high reflectance with small BRDF, and (3) low aerosol and humidity. Both 1.6μm and 2.0μm SWIR radiation are absorbed under wet conditions. Figure 2.1.4-2 depicts the

This document is provided by JAXA.

investigation of calibration sites using satellite data. Aqua/MODIS data are suitable for the preliminary study of GOSAT because it corresponds to TANSO-FTS observation bands and observation local time. Candidate sites are Tinga Tingana desert in South Australia and Railroad Valley in Nevada. The figures illustrate the 2.1μm band MODIS radiances. The red circle indicates the 10km FTS footprint. We investigated the homogeneity, robustness against registration error, and time series variation at the candidate sites. The annual clear sky rate is also significant information for field experiments.

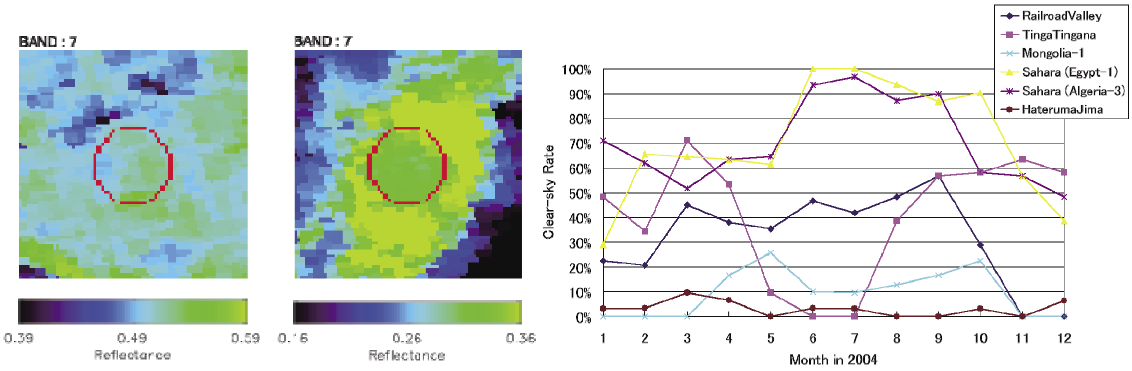


Fig. 2.1.4-2 Investigation of calibration sites using satellite data: MODIS radiance at Tinga Tingana desert (left), Railroad valley (center), and Clear-sky rate at various candidate sites (right).

(b) Calibration sites for cross-calibration with well-calibrated sensors on orbit

The selected calibration sites are utilized for cross-calibration with other well-calibrated sensors. Data accumulation enables estimating SNR and sensitivity on orbit.

The surface-reflectance data, Aqua+Terra MODIS global reflectance of 16 days average data were used. After one-year data was prepared, 22 datasets were found to be available in this study. The calculated indices are (1) Mean reflectance, (2) STDEV/Mean reflectance in a year, and (3) STDEV/Mean reflectance in 5x5 pixels (approximately 25km square area). Index (2) represents the annual time stability, and (3) represents the spatial homogeneity in a large footprint of TANSO-FTS IFOV. The sites where indices (2) and (3) are low have appropriate stability and homogeneity for calibration. Figure 2.1.4-3 illustrates these three indices of calibration for the Sahara desert candidate site. The numbers in these index figures indicate priorities at calibration sites, which are selected for high homogeneity.

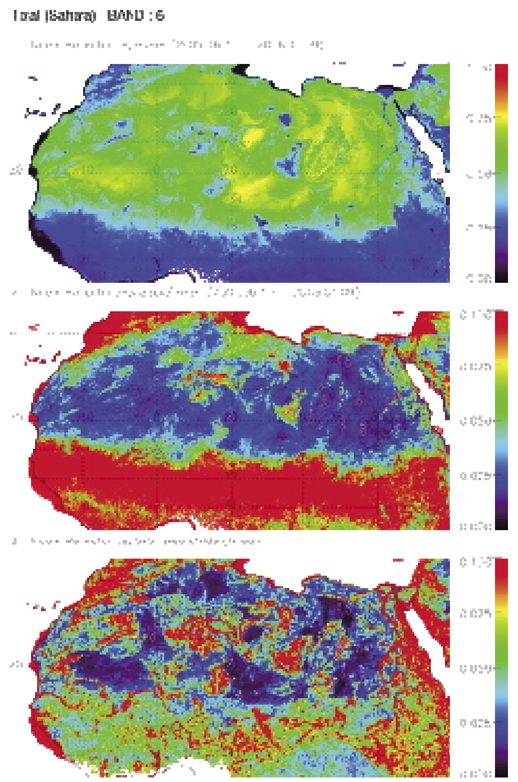


Fig. 2.1.4-3. Calibration site of Sahara desert (Investigation for FTS and CAI SWIR with high reflectivity target)

This document is provided by JAXA.

The desert has high reflectivity in SWIR bands. Several calibration sites were selected in the Sahara (Fig. 2.1.4-3) and Rub Al Khali deserts using MODIS Band 6 (1.64µm) data. Deserts have very stable reflectance throughout the year; hence the desert sites are utilized for accumulating datasets. Inflight calibration of POLDER on ADEOS-I/-II was accomplished using the Sahara desert for performance characterization in orbit. The POLDER site is near the site candidate of this study. At the selected sites, a database of reflectance and BRDF will be prepared for the calibration system, especially for deserts, which are stable in time. Typical parameters are obtained by the current MODIS and multispectral sensor data. The database will provide climatology of surface parameters if we cannot obtain enough match-up data with other operating sensors.

3) Algorithm development and data utilization

The primary objective of GOSAT is to observe the column density of tropospheric CO_2 and CH_4 from SWIR implemented by NIES. The algorithm for retrieving CO_2 and CH_4 density profiles from TIR was developed by CCSR, University of Tokyo. These results from both SWIR and TIR will enable estimating CO_2 sources and sinks using an inversion model prepared by NIES. In addition, further research will be made from TIR for other trace gases.

EORC contributes to data utilization of the TIR band. The spectral coverage is 5.5 to 14.3µm, which includes the 9.6µm absorption band of O_3, where the tropospheric O_3 is one of the important greenhouse gases. Figure 2.1.4-4 presents the results of an O_3 retrieval test with TANSO-FTS specifications. The observed spectra are simulated with addition of 30% O_3 to the US standard atmosphere with TANSO-FTS spectral resolution and sampling frequency. An *a priori* profile is set to the US standard atmosphere as a first guess. The figure depicts the weighting functions of the O_3 emission band. The retrieved O_3 profile is estimated as a Maximum *A Posteriori* (MAP) solution of Rodgers' method. In the estimation of tropospheric O_3 below 12km, the column density and density profile are in good agreement with true value.

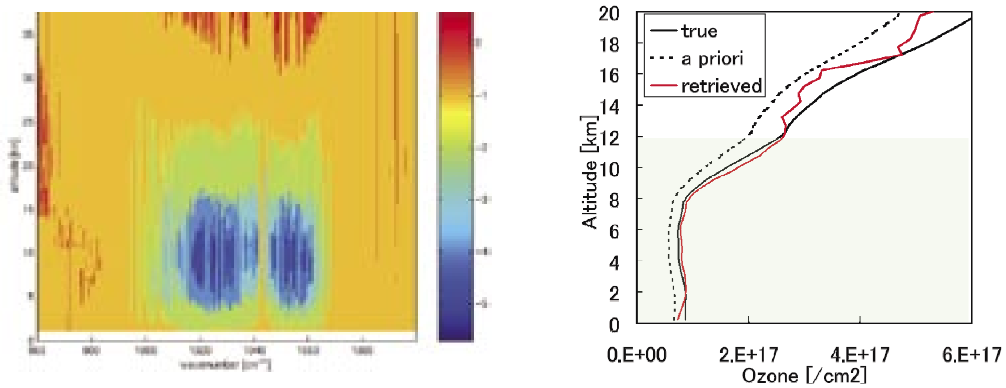


Fig. 2.1.4-4 O_3 retrieval test with TANSO-FTS specification: O_3 weighting function (left), and the result of the O_3 retrieved profile (right).

This document is provided by JAXA.

2.2 Future Programs

The Third Earth Observation Summit was held in February 2005 and adopted the Global Earth Observation System of Systems (GEOSS) 10-year implementation plan. Japan committed itself to contribute to three GEOSS priority areas among nine GEOSS societal benefits: adaptation to global warming and carbon cycle, adaptation to climate variations and water cycle, and preventing and mitigating disasters, especially in the Asia-Pacific region.

Based on such international activities, the Council for Science and Technology Policy in Japan issued the "Earth Observation Promotion Strategy" in December 2004 to clearly state Japan's basic policy on Earth observation and to resolve strategically important issues. The Council has collaterally proceeded with deliberations of important policies for establishing the Third Science and Technology Basic Plan. The Council indicated that it was necessary to carefully select and promote important key technologies that were the basis for sustainable development of the nation, and that would be promoted with a long-term national strategy. In the plan, the Council cited a global-scale integrated observation and monitoring system (the Earth Observation and Ocean Exploration System) including Earth observation satellite systems as an example of national key technologies. Figure 2.2-1 illustrates the concept of the Earth Observation and Ocean Exploration System. One of the components of the system is the Data Integration and Analysis System (DIAS) that has been jointly established by JAXA, JAMSTEC (Japan Agency for Marine-Earth Science and Technology), and Tokyo University. DIAS retrieves useful information for science and society from data acquired by satellites, ships, buoys, and ground stations and provides the information to the public to help them understand the Earth system and deal with global environment issues.

In conjunction with these activities, the Special Committee on Earth Observation of SAC (Space Activity Commission) proceeded with investigations and deliberations for a development plan and optimal data utilization of Earth observation satellites in the future and established a long-term plan for the Japanese Earth observation program contributing to GEOSS in June 2005. The Special Committee stated that the Japanese Earth observation system should be established as an autonomous social infrastructure acquiring and distributing Earth observation data for a long time. The Committee also stated that the system should enhance Japanese unique technologies and be developed in cooperation with foreign Earth observation systems contributing to the GEOSS 10 year implementation plan.

JAXA has been developing Earth observation systems to establish the Earth Observation and Ocean Exploration System within the scope of the long-term plan for the Japanese Earth observation program. JAXA proposes series of satellites for establishing GEOSS to monitor climate change. Table 2.2-1 presents the Japanese Earth observation long-term plan as of 2007.

In order to prevent and mitigate disasters, JAXA will study future missions for disaster management and investigates Earth resources as ALOS follow-on missions. The current study has two missions: a disaster-monitoring satellite constellation mission and a geo-stationary Earth observation mission. The disaster monitoring constellation mission consists of four satellites, two L-band SAR satellites and two optical imaging satellites to observe areas struck by disaster every three hours. The geo-stationary Earth observation mission is a geo-stationary satellite with high resolution to observe afflicted areas on a regular basis. The missions appropriately balanced disaster management and prevention.

In the field of climate change including water-cycle variation, the Global Precipitation Measurement (GPM) program, led by JAXA and NASA, will be conducted in cooperation with

This document is provided by JAXA.

NOAA, ESA, CNES, ISRO, and China. GPM is designed to more accurately and frequently observe tropical rainfall by expanding its observing areas to higher latitudes. GPM is composed of one core satellite and eight constellation satellites. The core satellite carries the dual-frequency precipitation radar (DPR) and a microwave radiometer, and the constellation satellites carry microwave radiometers. JAXA is responsible for launching, and developing a key instrument, the DPR, in cooperation with the National Institute of Information and Communications Technology (NICT). The GPM core satellite will be launched in 2013.

JAXA will develop the Global Change Observation Mission (GCOM) to contribute to studying and predicting global change and preserving the global environment. The GCOM satellite series consists of two satellites: the water-cycle observation satellite, also called GCOM-W (Water), that carries the AMSR follow-on sensor (AMSR2) and the climate-observation satellite, also called GCOM-C (Climate), that carries the GLI follow-on sensor (SGLI). Each satellite series will have three satellites with five-year mission lives, which combined exceed the 11-year solar activity cycle and cover the decadal change of climate. The series totally covers 13 years, providing an overlap of two years. To improve the reliability of satellite bus systems following the ADEOS-II accident, JAXA will develop a series of middle-size bus systems from GOSAT. The bus system will adopt the same concept but allows developing specific modules fitting each mission. The middle-size bus system will basically have one mission (not sensor) for the sake of risk management. GCOM will start observation in around 2012.

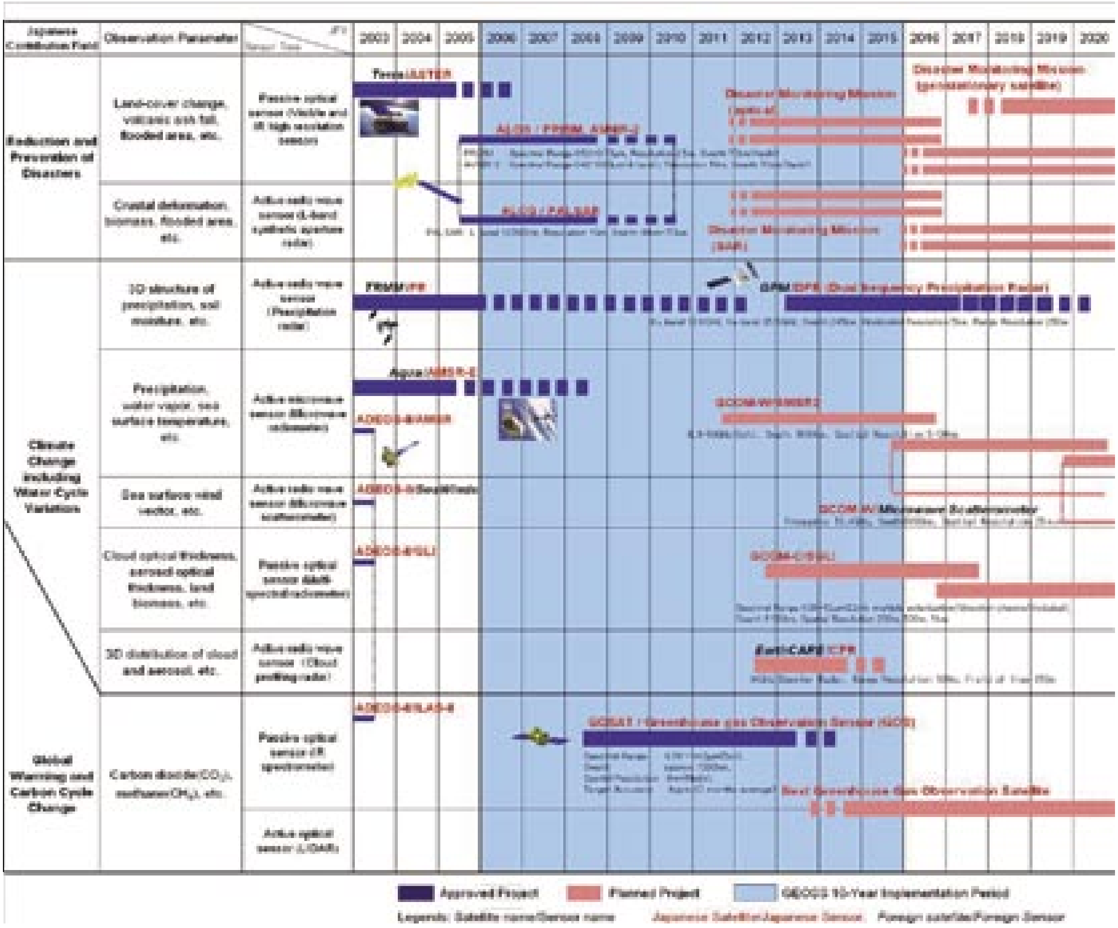
JAXA, jointly with NICT, will install the Cloud Profiling Radar (CPR) on the EarthCARE (Earth Clouds, Aerosols and Radiation Explorer) mission, which is a joint Japanese-European mission with the specific scientific objectives of quantifying aerosol-cloud-radiation interactions so that they may be included precisely in climate and numerical weather forecast models. CPR can observe vertical profiles of liquid, super-cooled and ice water, cloud overlap, particle size, convective updraft, and ice fall speed and extinction. GCOM-C can monitor the global distribution of clouds and aerosols. The combination of EarthCARE and GCOM-C will lead to more reliable climate predictions and better weather forecasts through the improved representation of processes involving clouds, aerosols and radiation. EarthCARE will be launched in 2012.

In the field of global warming and carbon-cycle change, the Greenhouse gas Observing SATellite (GOSAT) is designed to observe the global distribution of greenhouse gas concentration from space and is expected to contribute to international efforts in preventing global warming by acquiring the current absorption and emission levels of greenhouse gases. GOSAT is a joint project among JAXA, the Ministry of the Environment (MOE), and the National Institute of Environmental Studies (NIES) and will be launched in 2008.

JAXA is also studying the next-generation greenhouse gas observation satellite that may carry an IR spectrometer or LIDAR.

This document is provided by JAXA.

Table 2.2-1 Japanese Earth observation long-term plan as of 2007



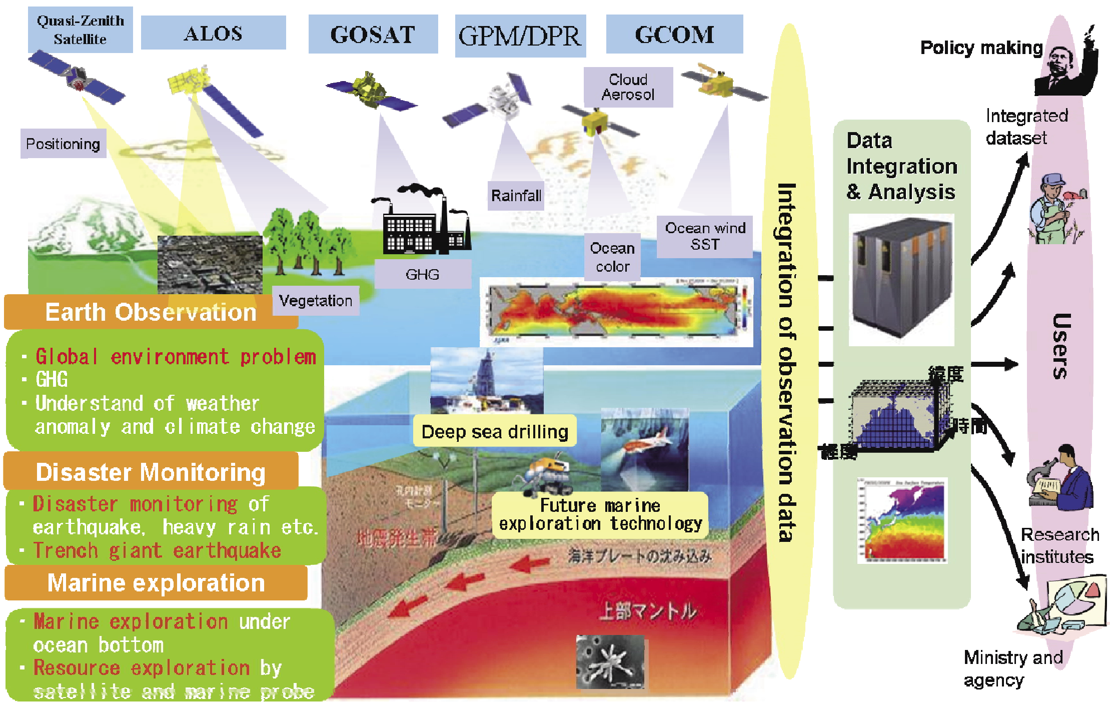


Fig. 2.2-1 Earth observation and ocean exploration system

This document is provided by JAXA.

2.3 Research on Instrumentation

2.3.1 Second-generation Global Imager

1) Background

The first Japanese multi-spectral, wide-angle optical imager, OCTS, was launched in 1996 on board the ADEOS satellite. The objective of OCTS was to observe the ocean color and sea surface temperature. The Global Imager (GLI) was developed as the successor to OCTS and was launched on board the ADEOS-II satellite in 2002. The GLI specifications were increased from OCTS in order to satisfy user requirements for data not only from the ocean but also from the atmosphere, land and cryosphere. The Second-generation Global Imager (SGLI) is the third-generation multi-spectral imaging radiometer for global monitoring.

2) Objective of SGLI

The Global Change Observation Mission (GCOM) is a next-generation Earth-observation program planned for understanding the global climate change. Together with AMSR-2, SGLI plays an essential role in the GCOM program, which consists of GCOM-W and GCOM-C satellites. SGLI is the core sensor of GCOM-C.

SGLI will succeed GLI and provide various high-accuracy products associated with the global climate change, focusing on changes induced by human activities using relatively high-spatial resolution and polarization measurements.

3) Overview of SGLI

The SGLI users group defines the SGLI mission requirements. The baseline requirement is revised from GLI sensor specifications, considering both the data continuity and originality of observation.

- 19 channels from 375nm to 12.5 μ m
- Wide cross-track angle enabling mid-latitude observation every two days
- Polarization observation in three directions (nadir, backward and forward) for aerosol observation over land
- IFOV of 250m

SGLI consists of two independent sensor systems.

- The Visible and Near-Infrared Radiometer (SGLI-VNR) is a push-broom-type sensor for visible and near-infrared (VNIR) wavelengths adapted for both non-polarization and polarization observations
- The Infrared Scanner (SGLI-IRS) is a whisk-broom-type sensor for short-wave infrared (SWI) to thermal infrared (TIR) wavelengths.

This document is provided by JAXA.

Table 2.3.1 GCOM-C/SGLI characteristics

Scanning Type	SGLI-VNR Push-broom electric scan SGLI-IRS Whisk-broom mechanical scan
Observation Channel	SGLI-VNR (Visible & Near infrared) Non-Polarized Observation 11 channels Polarized Observation 2 channels
	SGLI-IRS Short-wave infrared 4 channels Thermal infrared 2 channels
Swath	1150km cross track (SGLI-VNR) 1400km cross track (SGLI-IRS)
Digitalization	12bit
Polarization	3 polarization angles for P
Observing direction	Along Track 0, +45 deg and -45 deg for P Nadir for VN, SW and T
Orbit	Sun-Synchronous, sub-recurrent Altitude: 798km at equator Inclination: 98.6deg Local Mean Sun Time: 10:30

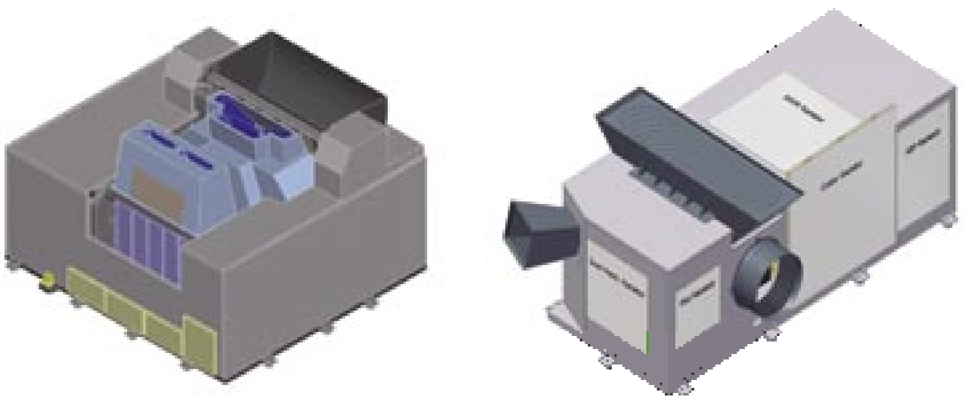


Fig. 2.3.1 SGLI instrument (Left: SGLI-VNR. Right: SGLI-IRS.)

4) Current status

The JAXA's internal review board approved the SGLI hardware research as "Front-Loading Activity" in September 2005 prior to the project start. The SGLI breadboard model (BBM) design was established by the end of 2006, and the BBM is being manufactured. In parallel, we have been studying system performance analysis, calibration procedures with high accuracy, interface design with the spacecraft, development plans, and so on. BBM activities including testing will be completed in September 2008.

Based on this front-loading activity, the GCOM-C project is expected to start in FY2008 depending on budgetary and governmental approval status.

This document is provided by JAXA.

2.3.2 AMSR2

1) Background

The first Japanese space-borne microwave radiometer was the microwave scanning radiometer (MSR), which was launched on MOS-1 in 1987 and MOS-1b in 1990. The Advanced Microwave Scanning Radiometer (AMSR) was developed to attain high performance and high spatial resolution, and to add more frequency bands. AMSR was launched on ADEOS-II in 2002. AMSR-E was developed for NASA's EOS-Aqua and launched in 2002. AMSR2 is the successor to AMSR and AMSR-E, and will be the main sensor of the GCOM-W spacecraft.

2) Objective of AMSR2

The mission of AMSR2 required by operational users and scientists is to continue the AMSR observation, so its major specifications were made almost the same as those of AMSR. The development and on-orbit operation of AMSR and AMSR-E revealed some points that should be improved for AMSR2.

3) Overview of AMSR2

AMSR2 is a conically scanning microwave radiometer. Horizontally and vertically polarized radiation is measured separately in six frequency bands. AMSR2 consists of the control unit (CU) and the sensor unit (SU). An offset parabolic reflector on the SU reflects the radiation from the Earth into an array of feedhorns, which feed the radiation to the detectors. The SU rotates continuously at 40rpm. A cold sky mirror (CSM) and a high-temperature noise source (HTS) are mounted on the rotation axis of the motor, enabling the feedhorn array to see the CSM and HTS once a scan. The deep-space radiation reflected by the CSM and the radiation from HTS are utilized as calibration references for AMSR2.

The current baseline of AMSR2 is as follows.

・ 6 frequency bands and 16 channels ranging from 6.9GHz to 89.0GHz
・ The main reflector (2m diameter) has a deployment mechanism similar to that of AMSR-E.
・ The orbital balancing mechanism is similar to that of AMSR-E.
・ The high-temperature noise source (HTS) will be improved to reduce temperature non-uniformity.

(a) Folded

(b) Deployed

Fig. 2.3.2-1 Sensor unit (SU) of AMSR2.

4) Study in FY2006

We studied the AMSR2 system design and interface between AMSR2 and GCOM-W1 spacecraft on which AMSR2 will be installed. In the study of AMSR2 system design, we focused on improving reliability, which can enable extending the design life for another two years.

This document is provided by JAXA.

As a result, we decided to add a redundant momentum wheel and interface board for two signal processing circuits.

We also studied improving the high-temperature noise source (HTS) and how to mitigate C-band radio frequency interference (RFI) to solve the problems in AMSR and AMSR-E. We performed thermal computer simulations with the new model of HTS system depicted in Fig. 2.3.2-2 to optimize the target temperature of the HTS. The simulations revealed that the temperature gradient of the HTS surface can be significantly reduced, compared to that of AMSR and AMSR-E. We are planning to perform a thermal vacuum test to confirm the performance of the new HTS system. To mitigate C-band RFI, we decided to add a 7.3GHz channel to C-band while retaining the 6.9GHz channel for maintaining continuity with AMSR-E observations. Although a 7.3GHz receiver is added for the new channel, a feedhorn and a low-noise amplifier (LNA) are shared with the 6.9GHz channel because of the limited hardware resources.

As a result of these studies, the system requirements for AMSR2 were almost decided. We are planning to hold the AMSR2 system preliminary design review (PDR) in the middle of FY2007 and start the development test.

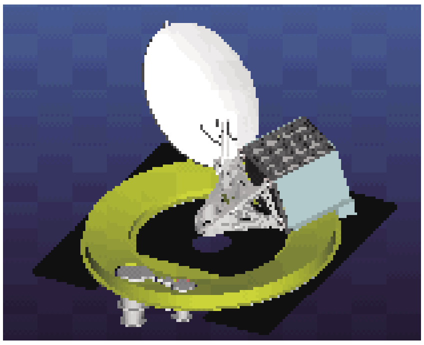


Fig. 2.3.2-2 HTS Configuration

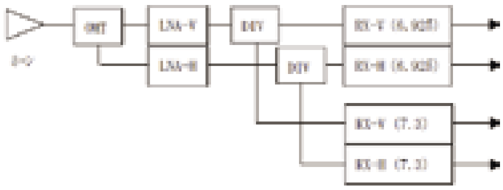


Fig. 2.3.2-3 C-band Configuration for RFI Mitigation

We also made some Bread Board Models (BBMs) and performed tests to evaluate alternative devices or alternative processes. For example, the BBMs of the LNA module and a (MPU board) is are depicted in Fig. 2.3.2-3 and (Fig. 2.3.2-4). We are planning to continue these tests in FY2007.

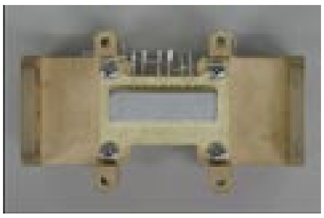


Fig. 2.3.2-3 LNA Module for 36GHz Receiver

Fig. 2.3.2-4 MPU Board

This document is provided by JAXA.

2.3.3 EarthCARE/CPR

1) Background and significance

JAXA and the National Institute of Information and Communications Technology (NICT) are now conducting an Extended Phase A study of the Earth Cloud, Aerosol and Radiation Explorer (EarthCARE) , together with the European Space Agency (ESA). EarthCARE has been selected as the sixth Earth Explorer mission of ESA. EarthCARE is planned to be launched in 2012 for a three-year mission. The Extended-Phase-A study will continue until the end of FY 2007.

2) Overview of the instrument

The objectives of EarthCARE are to observe the three-dimensional distribution and micro-physical characteristics of aerosols and clouds and simultaneously to measure the precise Earth radiation budget. The observation will reveal the interaction of aerosols and clouds, and their radiative forcing of the climate, which is a significant process in the climate system.

JAXA and NICT are to provide the Cloud Profiling Radar (CPR), which is one of two core sensors of EarthCARE. CPR is a 94GHz radar with Doppler measurement mode employing a 2.5m-diameter CFRP core/skin reflector to achieve a high sensitivity of -35dBZ. The horizontal resolution is 500m. The vertical resolution is also 500m with 100m oversampling. The pulse repetition frequency is variable between 6400 and 7200Hz. Peak power of a radar pulse is 1.5 kW.

3) Study in FY 2006

CFRP Core/Skin Panel is employed to achieve a low-thermal-expansion large mirror for high-stability pointing. We manufactured a small-scale mode antenna with a diameter of 0.8m. Surface precision measurement confirmed that the new flexible CFRP core has very good characteristics for the full-size (2.5m) antenna. The interface with the ESA satellite bus system became more detailed in discussions on Interface Requirement Document. Regarding science products, which are the outcome of this mission, many discussions and meetings were held with ESA and user institutes, also in the International workshop including CloudSAT/CALIPSO team / NASA.

Fig. 2.3.3-1 EarthCARE satellite configuration.

Fig. 2.3.3-2 CPR configuration.

This document is provided by JAXA.

2.3.4 Large-diameter mirror

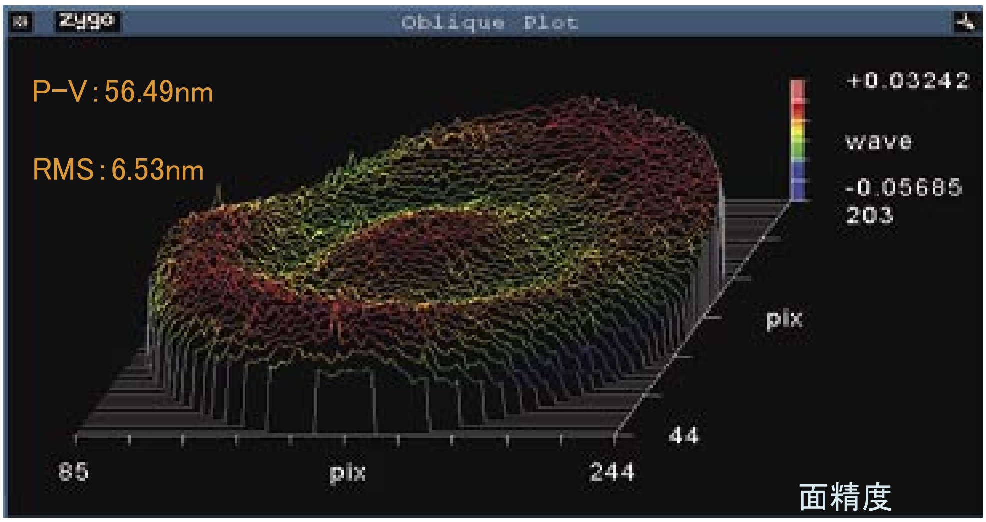
The requirement for Earth-observation instruments with high spatial resolution has been increasing. A lightweight, large-diameter mirror is necessary to realize such instruments.

We have been studying the properties of a reaction-sintered silicon-carbide mirror, a promising candidate for meeting such requirements. Our focus has mainly been on the manufacturability of lightweight substrates with rib-patterned back structures and on the optical performance of the polished mirror surface.

In FY2006, we studied the polishing parameters of two carbon-fiber-reinforced silicon-carbide (C/SiC) mirrors, one of which is coated with Si and the other with SiSiC slurry. The surface roughness of less than 2nm (rms) and surface wave-front errors of less than 20nm (rms) were achieved for both coated mirrors. However, the coated mirrors required three times more polishing time than conventional glass mirrors. Hence, the problem of polishing time should be resolved in the near future by changing the polishing method, polishing machine, or polishing parameters.

We also confirmed the usefulness and effectiveness of the surface wave-front error measurement at 77K using the 160mm diameter NTSiC mirror to evaluate and confirm the uniformity or dispersion of internal physical properties of SiC such as CTE. We believe that this measurement and evaluation method is very promising and useful for estimating the on-orbit optical performance of a large telescope system.

Fig. ?? C/SiC mirror surface wave front



規格：ｒｍｓ　20nm以下　達成

This document is provided by JAXA.

This document is provided by JAXA.

3.GROUND SYSTEM AND DATA PRODUCTS

This document is provided by JAXA.

3. GROUND SYSTEM AND PRODUCTS

3.1 EOC Overview

Earth Observation Center (EOC), located about 50km northwest of Tokyo, was founded in October 1978 to establish and develop satellite remote sensing technologies. EOC has facilities for mission management/operations, and a public information service for earth observation satellite data. This activity covers JAXA owned earth observation satellites and other satellites operated by foreign agencies.

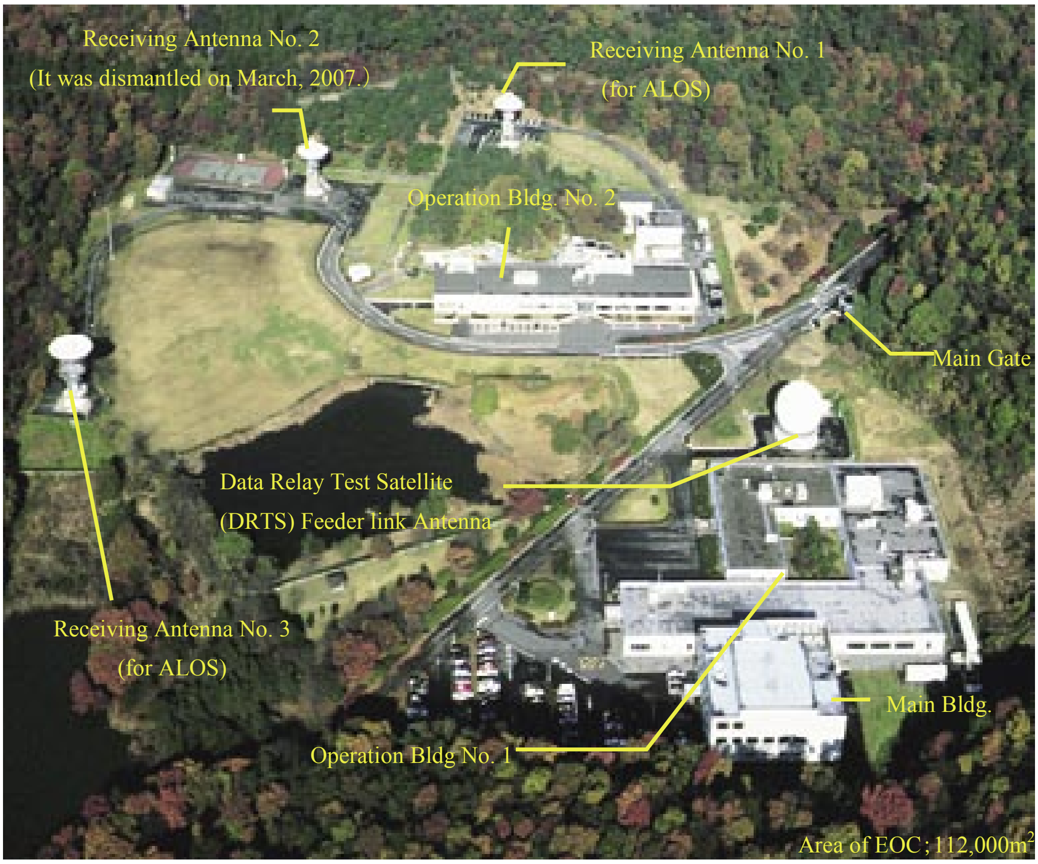


Figure 3.1-1 Bird's-eye view of EOC.

3.1.1 Operation History and Current Status

The first program at EOC started in 1978 using NASA's earth observation satellite, Landsat-2 and -3, and afterward using Japanese satellites including Marine Observation Satellite (MOS-1a and -1b), Japan Earth Resource Satellite-1 (JERS-1), Advanced Earth Observation Satellite (ADEOS), and Precipitation Radar for NASA's Tropical Rainfall Measurement Mission satellite (TRMM/PR).
Foreign satellite programs with French Satellite Pour l'Observation de la Terre (SPOT), European Remote sensing Satellite (ERS), Canadian Radar Satellite (RADARSAT), and Indian Remote sensing Satellite (IRS) have been added to the EOC activities.

This document is provided by JAXA.

EORC ANNUAL REPORT

The new operation with Advanced Land Observing Satellite (ALOS) started in 2006 in addition to the on-going Aqua/AMSR-E operation and TRMM/PR operation, together with worldwide user service for all archived data for 28 years.

1)Aqua/AMSR-E

AMSR-E on NASA's EOS-Aqua is currently in routine operation phase. The data received at the NASA ground stations are transferred to EOC through a dedicated line. EOC generates the standard products, maintains the product version with the latest algorithm, and delivers data to users routinely. These activities have been successfully performed in cooperation with NASA Goddard Space Flight Center (NASA GSFC).

2)TRMM/PR

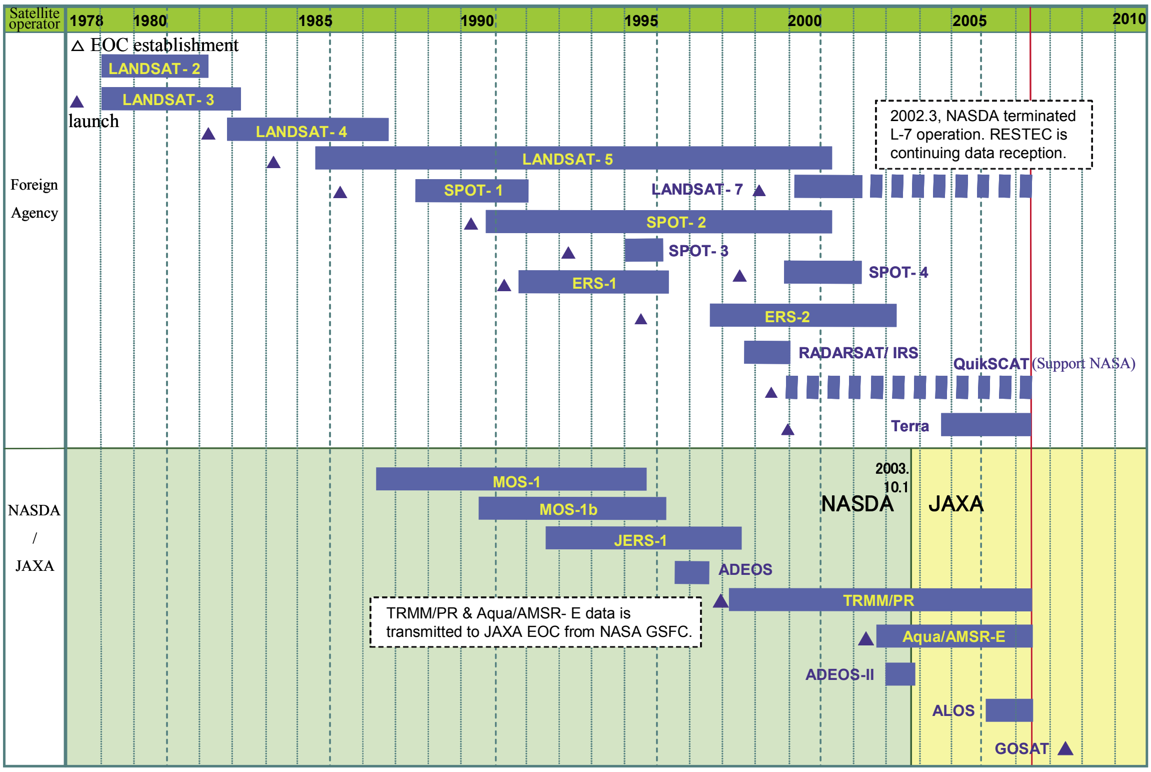
The TRMM/PR data received at NASA Data Relay Satellite station are transferred to EOC through a dedicated line in a timely manner. EOC generates the TRMM/PR standard product, maintains the product version with the latest algorithms, and delivers data to users routinely. These activities have been successfully performed for six years in cooperation with NASA GSFC.

3)ALOS

Advanced Land Observing Satellite (ALOS) was successfully launched on January 24th, 2006 by the H-IIA launch vehicle from Tanegashima Space Center. The routine operation phase is now on-going.

This document is provided by JAXA.

Table 3.1.1-1 The operation history of EOC.



This document is provided by JAXA.

3.1.2 System Overview

Schematic of the EOC system except for ALOS is shown in Figure 3.1.2-1
The data from Earth observation satellites or transmitted via networks are archived and processed for a variety of applications and researches. The data are delivered primarily in the form of CD-ROM, 8mm tape and the other media and partially using the network. Earth Observation Information System (EOIS) and Data Distribution and Management System (DDMS) archive a master data set, generate media for delivery, control the network, and service users.

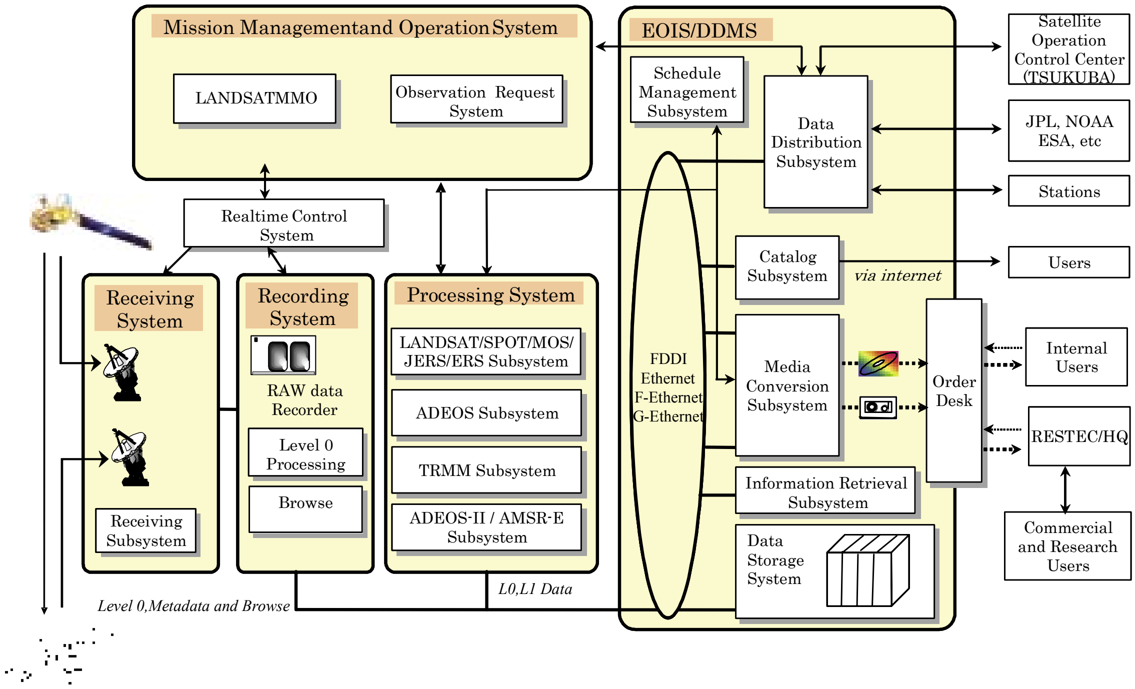


Figure 3.1.2-1 Schematic of the EOC system.

This document is provided by JAXA.

3.2 Mission Operations for Earth-Observation Satellites

3.2.1 Tropical Rainfall Measurement Mission

1) TRMM/Precipitation Radar ground system configuration
EOC has been processing the PR data and delivering it to the science community and users for seven years. Figure 3.2.1-1 depicts the configuration of the NASA and JAXA TRMM ground systems. Telemetry and science-observation data are transmitted to the ground via NASA's Tracking and Data Relay Satellite (TDRS) operated by NASA GSFC. All acquired data are transmitted to the GSFC Sensor Data Processing Facility (SDPF) on line and processed to Level 0 data within 48 hours after observation. The processed data are distributed to sensor providers to generate standard products. EOC processes the PR data with its own TRMM/PR data-processing system.

2) PR data processing and data management
The TRMM/PR data-processing system consists of four subsystems. Three subsystems are set up in EOC for processing, verification and PR operations planning. One subsystem, the Active Radar Calibrator (ARC), is operated in the Kansai branch of the National Institute of Information and Communications Technology (NICT).
The PR science products presented in Table 3.2.1-1 are distributed to users including worldwide scientists in many fields including meteorology and hydrology. EOC distributes the processed data to EORC and NICT by an on-line network. EOC receives the near real-time data of PR 2A25-R1, PR 2A25-R2, and TMI 1B11 from the TRMM Science Data and Information System (TSDIS) of NASA GSFC on line and forwards them to the Japan Meteorological Agency (JMA).

3) Version 6 PR data
EOC processes and provides the PR data based on a new version (version 6) algorithm. The old data are being reprocessed based on the version 6 algorithm.

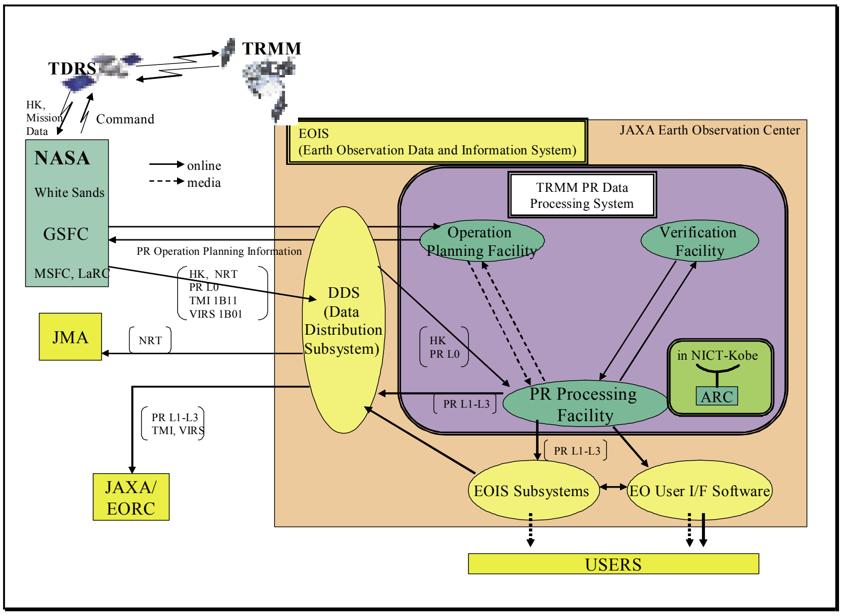


Fig. 3.2.1-1 TRMM Ground System Configuration.

This document is provided by JAXA.

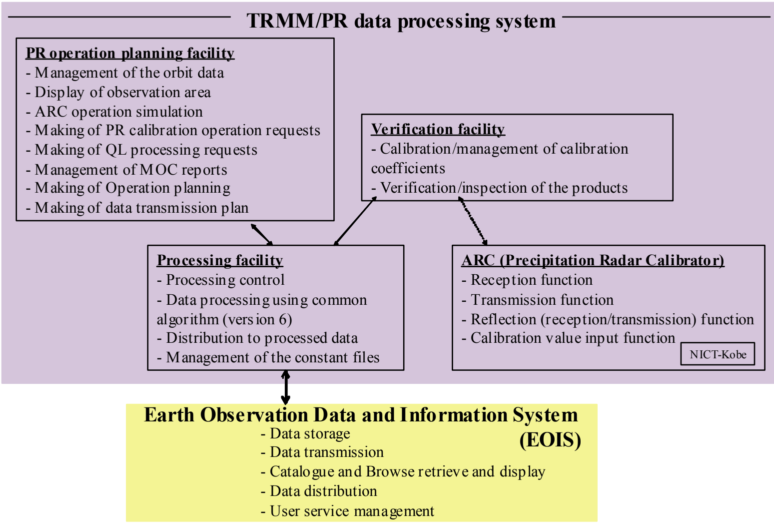


Fig. 3.2.1-2 Overall structure of TRMM/PR data processing system.

Table 3.2.1-1 TRMM data products available from EOC.

sensor	level	full scene	fixed sub scene
PR	1B21	○	
	1C21	○	○
	2A21	○	
	2A23	○	
	2A25	○	○
	3A25	○	
	3A26	○	
TMI	1B11	○	
	2A12	○	
	3A11	○	
VIRS	1B01	○	
COMB	2B31	○	
	3B31	○	
	3B42	○	
	3B43	○	

N.B. Full scene means the product between a southernmost point and the next southernmost point on an orbit; fixed area sub-scene, the product for Southeast Asian region including Japan in (5°-35°N, 80°-160°E).

This document is provided by JAXA.

Table 3.2.1-2 PR version 6 products.

Level	Alterations to Version 6
1B21	Add land/ocean flag values for high-attenuation pixels
1C21	No change
2A21	Implement hybrid surface reference over ocean change in angle bin definition
2A23	Additional bright band parameters, rain type in 3-digit
2A25	Add estimated surface rain. Add epsilon_0 for an adjustment parameter computed from the surface reference and a priori attenuation assumptions Add precipitation water parameters Add copy of rain type from 2A23 Add final PIA and PIA from 2A21
3A25	Add 140 variables, mostly statistics, on the new 2A23 bright band variables and the new 2A25 estimated surface rain
3A26	No change

This document is provided by JAXA.

Table 3.2.1-3 TRMM operation history.

Year 1997 / Month	10	11	12
Events		▼ Launch (11/28)	▼ PR Power ON (12/8)
PR OFF Events			
Obs. Mode			Initial checkout Rx ATT=6dB
Internal Cal.			←
External Cal.			▼ 16
LNA check			▼ 10
Algorithm version up			
Data Release			▼ First image

Year 1998 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events	▼ 7-8 (*2)		▼ 4 (*1)	▼ 25 (*1)					▼ 2 (*2)		▼ 17 (*3)	
Obs. Mode		→	←									
Internal Cal.		Every week			→	←						
External Cal.	▼ 12			▼ 3	▼ 23		▼ 9			▼ 10	▼ 9	▼ 8
LNA check								▼ 10			▼ 7	
Algorithm version up						▼ Ver.3				▼ Ver.4		
Data Release						▼ Data release						

Year 1999 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events	▼ 3-6 (*1)										▼ 17-18 (*3)	
Obs. Mode									Operation mode Rx ATT=9dB			
Internal Cal.										Every day over Austraria		
External Cal.		▼ 9			▼ 11	▼ 15			▼ 28		▼ 6-24	▼ 13
LNA check												
Algorithm version up											▼ Ver.5	
Data Release												

Year 2000 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events									▼ 17-18 (*4)			
Obs. Mode												
Internal Cal.												
External Cal.	▼ 13	▼ 23		▼ 30		▼ 30		▼ 2			▼ 3	
LNA check					▼ 19	▼ 19				▼ 19		
Algorithm version up												
Data Release								▼ Real time data				

Year 2001 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events								▼				
PR OFF Events											▼ 18 (*3)	
Obs. Mode												
Internal Cal.												
External Cal.	▼ 16						▼ 16	▼ 4-30				▼ 8
LNA check		▼ 22			▼ 21		▼ 23		▼ 5		▼ 9	
Algorithm version up								←	Preparation for Ver.6			
Data Release												

Year 2002 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events											▼ 19 (*3)	
Obs. Mode												
Internal Cal.												
External Cal.			▼ 7				▼ 20		▼ 12			▼ 14
LNA check		▼ 4				▼ 2		▼ 17		▼ 20		
Algorithm version up												Preparation for Ver.6
Data Release												

Year 2003 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events												
Obs. Mode								Operation mode Rx ATT=9dB				
Internal Cal.							Every day over Austraria					
External Cal.			▼ 8		▼ 23			▼ 1			▼ 22	
LNA check	▼ 18	▼ 21	▼ 21	▼ 19			▼ 28		▼ 19	▼ 23		▼ 15
Algorithm version up												
Data Release												

Year 2004 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events												
Obs. Mode												
Internal Cal.												
External Cal.		▼ 27		▼ 24					▼ 18			
LNA check	▼ 16		▼ 18		▼ 17	▼ 27				▼ 22	▼ 25	▼ 24
Algorithm version up				▼ 14 Ver.6								
Data Release												

Year 2005 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events												
Obs. Mode												→
Internal Cal.												→
External Cal.					▼ 20							▼ 8
LNA check	▼ 22	▼ 21	▼ 19	▼ 22		▼ 20	▼ 24	▼ 15	▼ 25	▼ 21	▼ 27	
Algorithm version up												
Data Release												

Year 2006 / Month	1	2	3	4	5	6	7	8	9	10	11	12
Events												
PR OFF Events												
Obs. Mode								Operation mode Rx ATT=9dB				
Internal Cal.								Every day over Austraria				
External Cal.								▼ 12				▼ 23
LNA check	▼ 22	▼ 20	▼ 19	▼ 28	▼ 28	▼ 26	▼ 30		▼ 20	▼ 23	▼ 18	
Algorithm version up												
Data Release												

Year 2007 / Month	1	2	3
Events			
PR OFF Events			
Obs. Mode			→
Internal Cal.			→
External Cal.			
LNA check	▼ 28	▼ 18	▼
Algorithm version up			
Data Release			

*1:Sun Acquisition Mode *2:CERES deep space calibration
*3:Leonid meter storm *4:Low power mode

This document is provided by JAXA.

Table 3.2.1-4 Amount of TRMM observed data

Sensor	FY1998	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004
PR	62,840	85,864	76,551	61,498	61,399	101,207	190,282
TMI	14,308	25,564	13,488	11,537	11,358	19,781	52,752
VIRS	15,415	9,339	9,989	5,807	5,058	5,736	11,364
COMB	8,613	6,891	7,210	5,991	6,426	6,106	27,213

Sensor	FY2005	FY2006
PR	166,854	33,616
TMI	69,684	11,405
VIRS	27,012	20,768
COMB	27,962	8,408

This document is provided by JAXA.

3.2.2 AMSR-E Data Processing System

1) AMSR-E overview

The Advanced Microwave Scanning Radiometer for EOS (AMSR-E) aboard NASA's EOS-Aqua satellite has been making observations since its launch in May 2002. AMSR-E flies in an afternoon orbit at around 1330 (ascent).

AMSR-E is a 12-channel passive microwave radiometer operating at six frequencies (6.925, 10.65, 18.7, 23.8, 36.5 and 89.0GHz) with vertical and horizontal polarization.

2) Aqua/AMSR-E ground system overview

a. Aqua/AMSR-E data flow

The AMSR-E data recorded on the Solid-State Recorder (SSR) are received at a NASA ground station in Alaska or Svalbard once an orbit in accordance with the operation flow. The received data are transferred to NASA GSFC and processed into Rate-Buffered Data (RBD). NASA GSFC transfers the AMSR-E Science RBD and Ground-Based Attitude Determination (GBAD) RBD to EOC via a dedicated network. The National Snow and Ice Data Center (NSIDC) also provides EOC with a Production Data Set (PDS) as a back up of RBD via compact disc (CD) for orders of more than 10 files, and via ftp for orders of 10 files or less. The AMSR-E data-processing system at EOC generates near-real-time products and standard products.

b. AMSR-E ground system

The AMSR-E ground system at EOC consists of the AMSR-E data-processing system, Instrument Support Toolkit (IST) system, and the Earth-Observation Information System (EOIS). It is useful for AMSR-E product generation, remote monitoring of the AMSR-E instrument and satellite house-keeping data, and AMSR-E product service.

・AMSR-E data-processing system

The data-processing system that generates level-1 and higher-level products is used not only for the processing plan and for processing itself, but also for product inspection to maintain its quality. The processed products are transferred to EOIS for long-term data archiving (standard products only). The data-processing system and the power supply are designed to be redundant for 24-hour continuous operation and quick recovery from system troubles.

The primary functions of the AMSR-E data-processing system are as follows.

- Front-end processing and level-0 processing with AMSR-E Science and GBAD RBD
- Level-1 processing for geometric correction and conversion to brightness temperature
- Level-2 processing to retrieve geophysical parameters
- Level-3 processing to generate global mapping of Level-1/2 data
- Inspection of product data quality and format
- System management and operations

・Instrument Support Toolkit

The Instrument Support Toolkit (IST) is software provided by NASA for remotely monitoring the AMSR-E instrument and satellite house-keeping data in orbit. The terminal is connected to the Aqua flight operation center at NASA GSFC and provides engineering data. The EOC operator monitors the AMSR-E instrument status under the guidance of the AMSR-E sensor team.

This document is provided by JAXA.

・Earth Observation Information System

The Earth Observation Information System (EOIS) at EOC is used for AMSR-E data service including data archiving, retrieval and distribution to the public. The AMSR-E science products are to be delivered by media or via network. NASA NSIDC also has the function of AMSR-E data service for the U.S. user community.

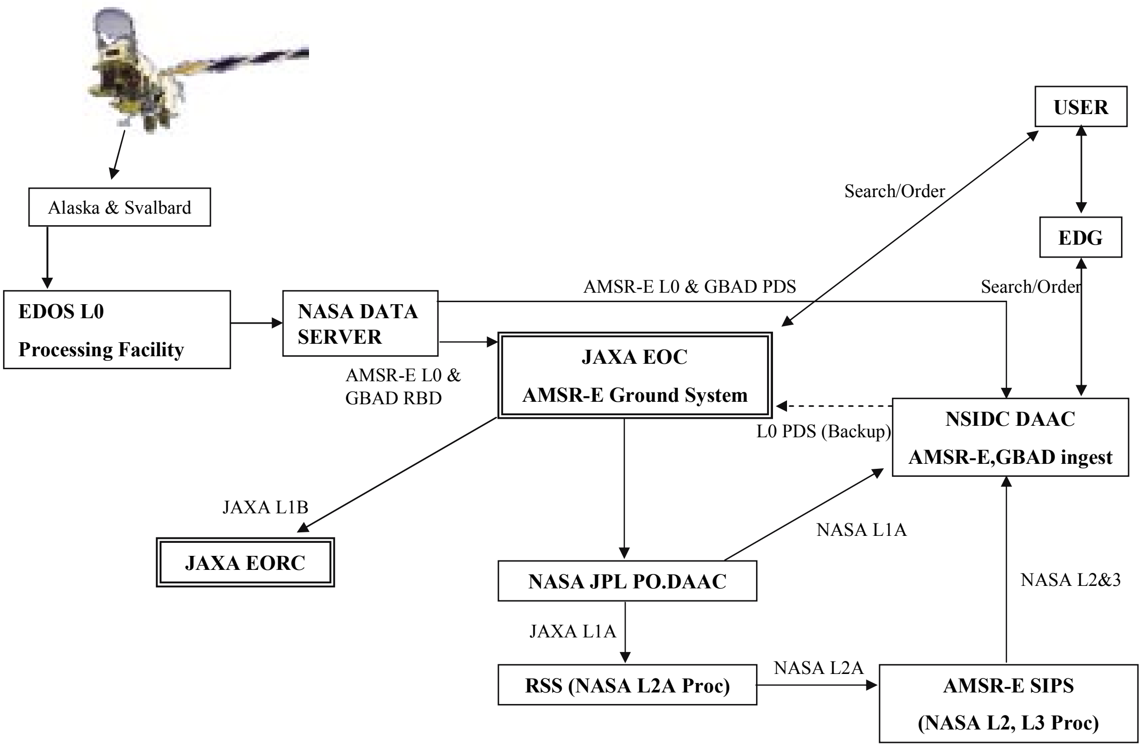


Fig. 3.2.2-1 Schematic view of AMSR-E data flow.

3) AMSR-E science data management

a. Product specifications

The AMSR-E products are in Hierarchical Data Format (HDF). Each AMSR-E level-1A product contains a “scene” of data acquired during a half of a satellite orbit. A scene contains data between the northernmost and southernmost observed points at the center of scans.

This document is provided by JAXA.

Table 3.2.2-1 AMSR-E science products.

Level	Science product
Level 1A	Engineering values corresponding to the digital number (DN) converted from the instrument output voltage. Other necessary information for higher-level processing, including satellite attitudes and instrument conditions included. Data are not map-projected, but stored in the swath format.
Level 1B	Fundamental physical values corresponding to brightness temperature. Data location and quality information included. Data are not map-projected, but stored in the swath format.
Level 2	Geophysical parameters calculated using retrieval algorithms. Sea-surface temperature, sea-surface wind speed, water vapor, precipitation, sea-ice concentration, snow-water equivalence, cloud liquid water, and soil moisture Data location and quality information included. Data are not map-projected, but stored in the swath format.
Level 3	Temporal and spatial averaged values at global grid points for brightness temperature and geophysical parameters. Daily and monthly averaged global mapping available.

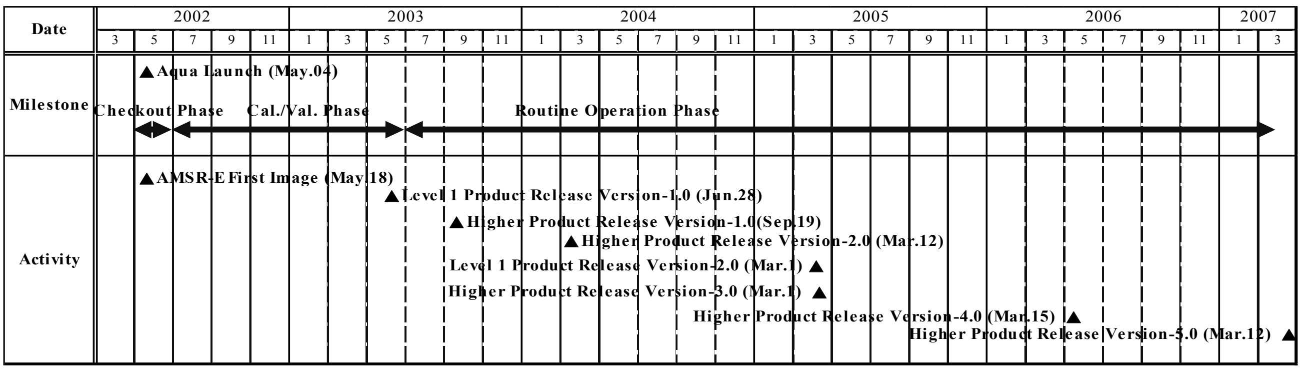
b. Product release

EOC distributes all of the up-dated versions of the AMSR-E level-1 and higher-level products to the public. The current versions are Version 2 for level-1 products and Version 5 for higher-level products.

4) Operation summary

AMSR-E is currently in the routine operation phase. AMSR-E data processing, product distribution and system maintenance are normal. The number of scenes of the level 1 processed data that can be distributed is 50,058 at the end of March 2007.

Table 3.2.2-2 AMSR-E operation history.



This document is provided by JAXA.

3.2.3 ADEOS-II Mission Operation System

1) ADEOS-II overview

The major purposes of the ADEOS-II mission were to advance Earth-observation technologies and to provide global observation data as a follow-on to the ADEOS mission. ADEOS-II carried five Earth-observing instruments (see Table 3.2.3-1) that would accumulate global data 24 hours a day. ADEOS-II also carried the Data Collection System (DCS), which is compatible with the ARGOS system being operated with NOAA meteorological satellites.

Table 3.2.3-1 Instruments aboard ADEOS- II and their providers.

Instrument/System name	Acronym	Provider
Global Imager	GLI	JAXA
Advanced Microwave Scanning Radiometer	AMSR	JAXA
Improved Limb Atmospheric Spectrometer-II	ILAS-II	NIES
SeaWinds	SeaWinds	NASA/JPL
Polarization and Directionality of the Earth's Reflectances	POLDER	CNES
Data Collection System	DCS	JAXA/CNES

NIES: National Institute of Environmental Studies (Japan) [http://www.nies.go.jp/]
JPL: NASA Jet Propulsion Laboratory [http://www.jpl.nasa.gov/]
CNES: Centre National d'Etudes Spatiales (France) [http://www.cnes.fr/]

ADEOS-II operated only about 9 months (January to October 2002) because of a satellite power system failure. The data obtained by two JAXA instruments, GLI and AMSR, were processed and archived at EOC.

This document is provided by JAXA.

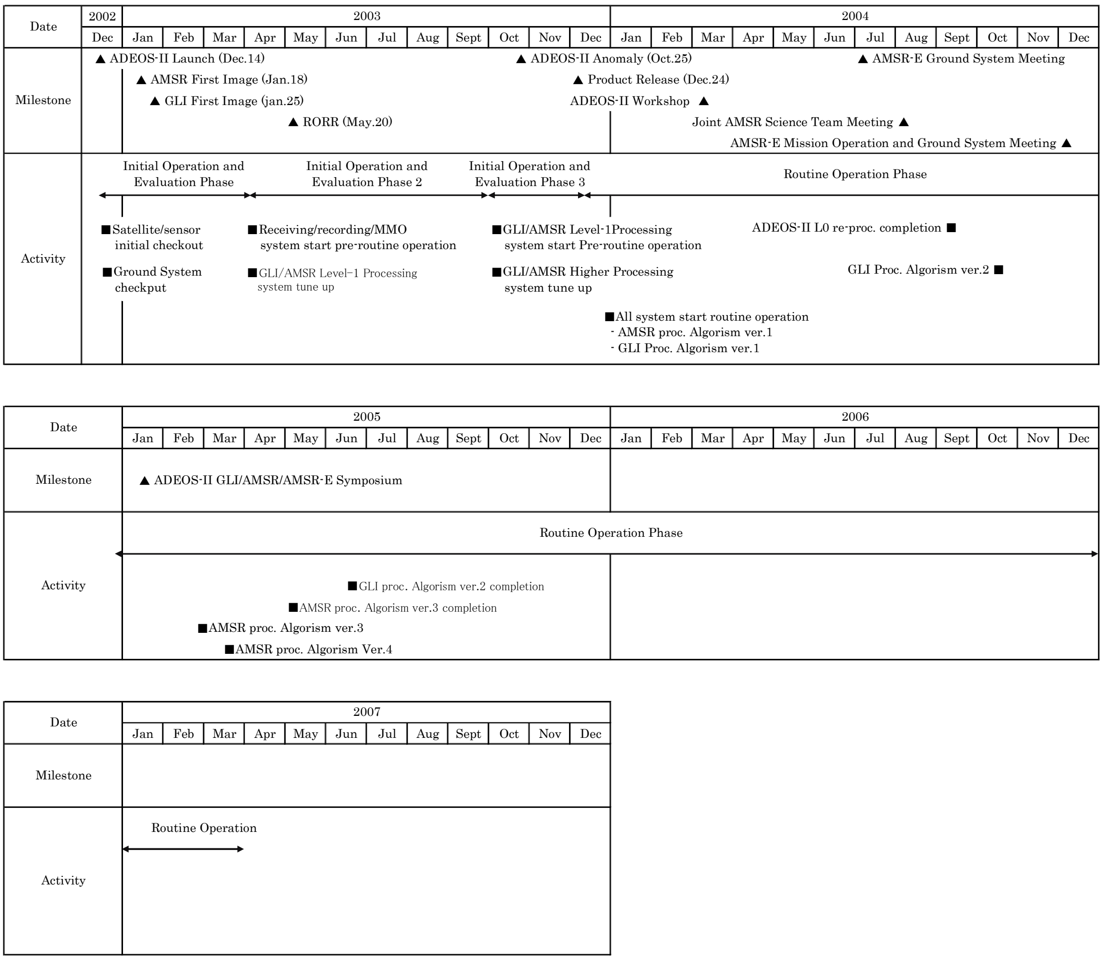


Fig. 3.2.3-1 ADEOS-II operation history.

This document is provided by JAXA.

2) ADEOS-II science data management

The ADEOS-II science data were managed separately by sensor providers. Data management, i.e., data processing, archiving and distribution service for users, was performed independently. The interface with data users was realized based on global internet connections providing the functions of catalog information search, data ordering, and on-line and/or off-line data delivery, together with the associated observation information.

a. GLI science product

GLI is an optical imager that observes the reflected solar radiation from the Earth's surface, including land, oceans and clouds and/or infrared radiation. It is a multi-channel system for measuring biological parameters, such as chlorophyll, organic substance, and vegetation index as well as temperature, snow and ice, and cloud properties. The amount of GLI raw data was about 55GB a day. More than 100,000 scenes with 1km and 250m resolution (scene size: 1,600km(W)× 1,600km(L)) were acquired and archived.
The version 2 algorithm for GLI data processing was released in November 2004, and all the data have been reprocessed to yield version 2 products.

b. AMSR science product

AMSR is a radiometer with eight frequency bands from 6.9GHz to 89GHz. Six frequency bands observe with vertical and horizontal polarization. The 50.3GHZ and 52.8GHz bands observe only with vertical polarization. AMSR acquires radiance data by scanning the Earth's surface conically or mechanically rotating its antenna along the satellite flight path. The aperture diameter of AMSR's antenna is 2m and its instant field of view is about 5km (89GHz band). It scans conically the Earth's surface with a nominal incident angle of 55deg to be constant and minimize the effect of sea-surface wind upon observation data; it has a swath width of about 1600km.

The AMSR data can retrieve various geophysical parameters of the Earth's surface and atmosphere such as water vapor content, precipitation, sea-surface temperature, sea-surface wind, and sea ice, day or night, with or without clouds.
~~U~~pdated versions of the higher-level (version 4) products were released on March 15, 2006.

c. Data service of EOC

There are three types of user service at EOC: catalog information service, off-line data distribution service (on media), and on-line data distribution service (via network). Catalog information is accessible via internet by using the Information Service System (ISS). Public users can use the ISS WWW gateway at

https://isswww.eoc.jaxa.jp/iss/jp/index.html.

Science products of GLI and AMSR are summarized in Table 3.2.3-2. These products are available for delivery on media. Capacity and data format of each medium are shown in Table 3.2.3-3. Some products are also available on-line.

This document is provided by JAXA.

Table 3.2.3-2 GLI/AMSR science products.

Sensor	Level	Science products
AMSR	Level-1B	Brightness temperature
	level-2	Sea-surface temperature, sea-surface wind, water vapor, precipitation, ice concentration, snow-water equivalence, cloud liquid water, and soil moisture
	Level-3	Brightness temperature, sea-surface temperature, sea-surface wind, water vapor, precipitation, ice concentration, snow-water equivalence, cloud liquid water, and soil moisture
GLI-1km	Level-1B	Radiance
	Level-2/2A Level-3 binned Level-3 STA map	Atmosphere Cloud flags, aerosol parameters (angstrom exponent, optical thickness), cloud parameters (optical thickness, effective radius, top height, top temperature, liquid/ice water path, fraction of 10 cloud types), precipitable water Ocean Water-leaving radiance, chlorophyll-a, absorption of colored dissolved organic matter, attenuation coefficient at 490nm, suspended solid weight, bulk sea surface temperature, Land Atmospheric corrected radiance, precise geometric corrected map projection parameter, vegetation index, Cryosphere Snow grain size, snow impurities, snow/cloud flag, Snow-surface temperature, snow grain size 1.64μm
GLI-250m	Level-1B	Radiance

Table 3.2.3-3 Distribution media.

Media	CD-ROM	DVD-R	DLT
Capacity	650 MB	4.7 GB	35 GB
Recording Format	Joliet	UDF	Tar
Data Format	NCSA-HDF	NCSA-HDF	NCSA-HDF

Table 3.2.3-4 ADEOS-II observed data amounts.

Sensor	Data amount	Remarks
AMSR	6,648 scenes	Scene size: 1,600km(W)× 20,000km(L)
GLI 1km	93,338 scenes	Scene size: 1,600km(W)× 1,600km(L)
GLI 250m	10,601 scenes	Scene size: 1,600km(W)× 1,600km(L)
ILAS-II	3,450 downlink segment	1 downlink segment roughly equals 1 path
SeaWinds	3,728 downlink segment	1 downlink segment roughly equals 1 path
POLDER	3,287 downlink segment	1 downlink segment roughly equals 1 path

This document is provided by JAXA.

3.2.4 ALOS mission operation system

1) ALOS Overview

The Advanced Land Observing Satellite (ALOS) was successfully launched on January 24, 2006 from Tanegashima Space Center by the H-IIA launch vehicle. The satellite is now called “Daichi,” which means “Terra” in Japanese.

a. Mission objective

The major objectives of the ALOS mission are as a follow-up to the JERS-1 and ADEOS missions and to further enhance land-observation technology. These data will be used for cartography, regional observations, disaster monitoring, and resource surveying. ALOS carries three instruments developed by JAXA.

Table 3.2.4-1　ALOS instruments and their providers

Instrument Name	Acronym
Panchromatic Remote-sensing Instrument for Stereo Mapping	PRISM
Advanced Visible and Near Infrared Radiometer 2	AVNIR-2
Phased-Array type L-band Synthetic Aperture Radar*	PALSAR

* joint development with Ministry of Economy, Trade and Industry.

Figures 3.2.4-1a ～1c present data acquisition overviews of the ALOS instruments. PRISM (Fig. 3.2.4-1a) has three optical systems for forward, nadir, and backward viewing with 2.5m spatial resolution to obtain terrain images and develop elevation maps. AVNIR-2 (Fig. 3.2.4-1b) has better spatial resolution than ADEOS/AVNIR to provide land-cover/land-use classification maps for monitoring regional environments. PALSAR (Fig. 3.2.4-1c) is an active microwave instrument for cloud-independent all-day land observation and provides performance superior to that of JERS-1 SAR.

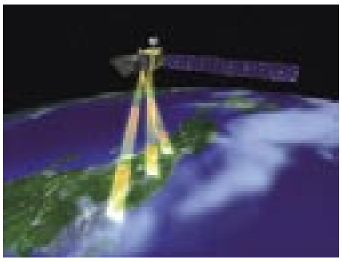


Figure 3.2.4-1a　PRISM.

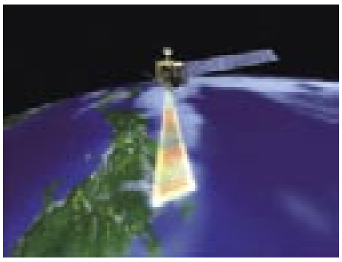


Figure 3.2.4-1b　AVNIR-2.

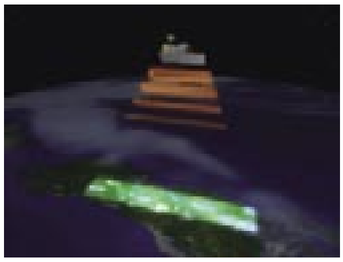


Figure 3.2.4-1c　PALSAR.

b. ALOS mission operation and related system overview

The ALOS Mission Operation System is the ground system installed at EOC for managing ALOS mission operations and receiving, recording, archiving, processing, and distributing ALOS data to various users. The ground segment related to ALOS mission operations is comprised of the following systems, including other related systems (Fig. 3.2.4-2). The ALOS Data Acquisition and Processing System and ALOS Information System are two main parts of the ALOS Mission Operation System.

ALOS Data Acquisition and Processing System

The ALOS Data Acquisition and Processing System performs the primary functions of ALOS mission operations, including mission operation management, data receiving, data recording, and

This document is provided by JAXA.

data processing. The system consists of the Data Receiving Subsystem, Data Recording Subsystem (Ka- and X-bands), Data Processing Subsystem, Mission Operation Management Subsystem, and other subsystems.

ALOS Information System

The ALOS Information System provides the archiving, catalog searching, and online data distribution functions. The system also provides LAN and network connections with external users. The system consists of the ALOS Central Information Subsystem, which handles data archive management; the ALOS User Service Subsystem, which handles data cataloging and data order; and the ALOS Data Distribution Subsystem (ADDS) and ALOS Data Node Interface Subsystem (ADIS), which are access points for online file exchanges with external users.

Tracking and Control System

The ALOS Tracking and Control System (TACS) generates satellite operation plans based on mission operation requests submitted by EOC and performs TT&C operations for the satellite. The Tracking and Control System is installed at the Tracking and Control Center (TACC) of JAXA Tsukuba Space Center (TKSC). This system also performs orbit determination and orbit control.

Ka-band Receiving Station

The Ka-band receiving station at Tsukuba (TKSC) receives mission data as a backup for the Ka-band station at EOC. The Space Network Operation Control System (at TKSC) provides planning and operation of the Space Network for downlink of data via DRTS.

Data Distributor

ERSDAC, a data distributor for ALOS, developed and operates the PALSAR Ground Data System and ERSDAC Data Buffer. These systems provide observation requests, data processing, and product distribution functions.

Data Node

Worldwide distribution of the ALOS data will be performed by four data node organizations appointed from different regions to promote international use of the data. The data node organizations will receive ALOS level 0 data from JAXA and generate and distribute their products to regional users in accordance with their arrangements with JAXA. The data node organizations can also directly receive the ALOS data via X-band (regarded as Foreign Ground Stations in this project) in accordance with an agreement with JAXA.

- Data node in charge of the Asian region	JAXA
- Data node in charge of European and African regions	ESA
- Data node in charge of North and South America regions	NOAA/ASF
- Data node in charge of the Oceania region	Geoscience Australia
- Asian sub-node in charge of the ASEAN region	GISTDA

JAXA Internal Users

A JAXA internal user installs the Data Utilization System and the NASDA EORC Data Buffer at EORC. These systems perform cal/val of the onboard sensors and will be the point of contact for data distribution to validation data users, such as PIs. Higher-level processing algorithms and data sets will be developed using these systems.

TKSC/Space Environment and Effects System (SEES) is the system for TEDA operations developed by the Office of Research and Development, JAXA. This system provides TEDA operation requests and data analysis functions.

This document is provided by JAXA.

Japanese Government Users

The following Japanese government users will receive ALOS data and substantiate the data through operational use in accordance with their agreements with JAXA.

- Earth Remote Sensing Data Analysis Center (ERSDAC)
- Geographical Survey Institute (GSI)
- Ministry of Environment (MOE)
- Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF)
- Japan Coast Guard (JCG)
- Cabinet Office (in the event of disaster)
- Asian Disaster Reduction Center (ADRC) (in the event of disaster)

Overseas Ground Stations

The X-band support stations will support data reception via X-band, under direction of JAXA requests, to complement data reception via DRTS.

The X-band foreign ground stations will receive direct transmission data (138.76 Mbps) via X-band for their own use. JAXA has the right to acquire a copy of the data received at the foreign ground stations, but does not expect to routinely do so.

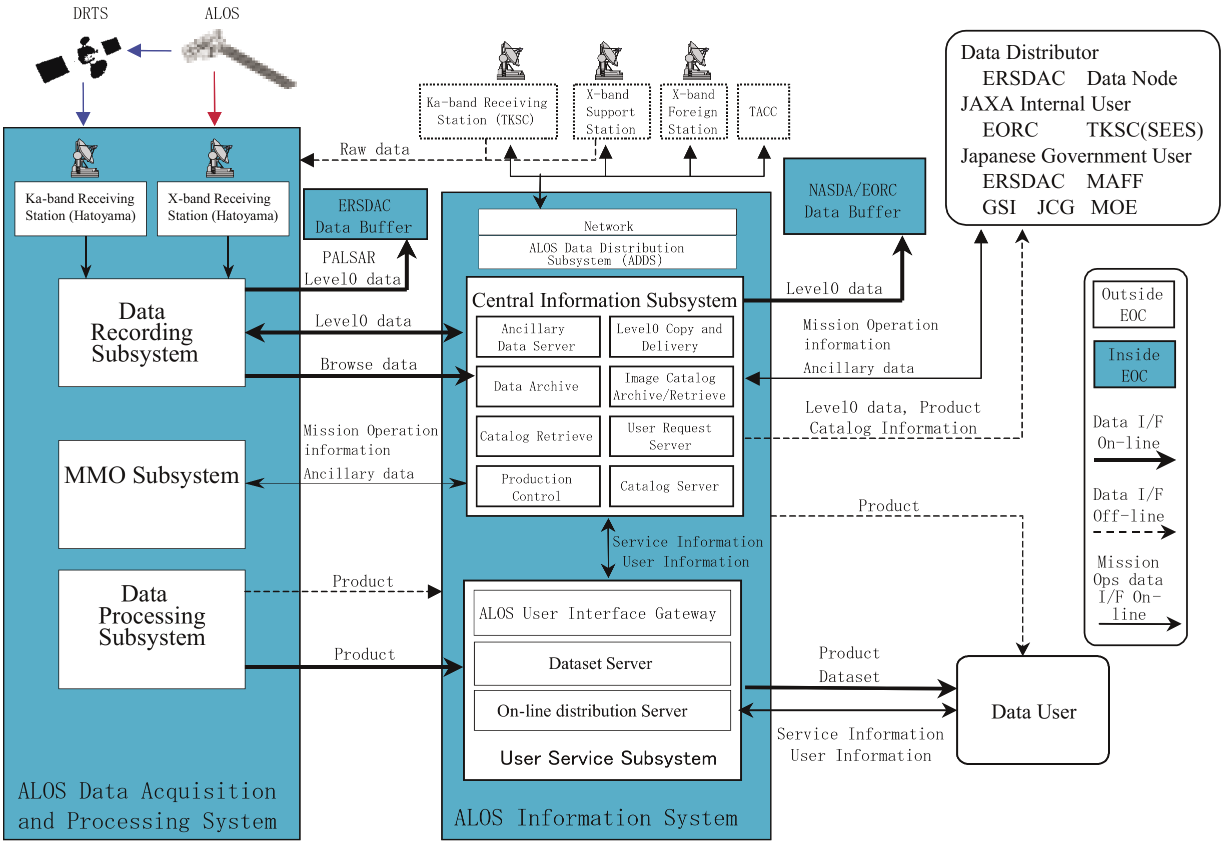


Fig. 3.2.4-2 ALOS mission operation and related system overview

2) Mission Operations

This document is provided by JAXA.

a. ALOS data acquisition baseline

The primary links to transmit ALOS data are the Ka-band receiving station (via DRTS-W) and the EOC X-band station, both at Hatoyama. The Ka-band receiving station at TKSC (via DRTS-W) will serve as a backup. In addition, data transmission to the X-band support stations is planned as an option. Apart from these operations, X-band foreign stations will receive ALOS data for their own near-real-time data utilization.

b. ALOS operational priorities

ALOS satellite operations will be performed in accordance with the following operational priorities.

- Satellite emergency operations
- Housekeeping operations
- Disaster area monitoring
- Calibration/validation
- Basic observations
- Japanese governmental use
- Data node use
- Research purposes
- Observation requests other than those above

c. ALOS instrument operation guidelines

Basic operations for the mission instruments are planned as follows.

- Land and daytime: Observation by one to three sensors of PRISM, AVNIR-2, and PALSAR
- Land and nighttime: Observation by PALSAR, calibration of PRISM and AVNIR-2 (as needed)
- Oceans, etc: Reproduction of the high-rate mission data solid-state recorder (HSSR)

Nominal operations will be performed based on a fundamental observation scenario.

3) ALOS Data Services

The ALOS data services are based on the following concepts.

- Appropriate services for both optical (PRISM, AVNIR-2) and radar (PALSAR) instruments
- Seamless interface from observation to data delivery
- Urgent service for disaster monitoring
- User-friendly service
- Online (internet) service
- Global service that includes foreign users

The service categories and their contents are provided in the table below.

This document is provided by JAXA.

Table 3.2.4-2 ALOS data service categories and contents

Type	Definition	User
Urgent	Primarily for disaster monitoring - First priority (from observation to delivery) - Request file accepted up to 72 hours before the observation - Urgent request less than 4.5 hours before the observation (operator call) - Level 1 data ready for distribution within 3 hours after data reception - Image catalog updated within 1 hour (3 hours for PALSAR) - Data provided by either CD-ROM or online	Japanese Government User (Cabinet office, MEXToffice, ERSDAC, GSI, ADRC) International Charter, JAXA internal user, Data Distributor
Near-real-time	For example, sea-ice monitoring - Request must be submitted as standing request - Near-real-time level 1 via online data delivery within 3 hours after the observation	Japanese Government User (JCG)
Normal	- Request submitted at least one week before the observation - Three request methods Standing request On-demand file request On-demand WWW request	Japanese Government User, JAXA internal user, General user, Data Distributor

a. ALOS data products

The ALOS Mission Operation System produces and distributes the following data

- Mission data (Level 0, 1 data) (Table 3.2.4-3)
- Datasets
- Catalog data
- Ancillary data for data processing

Level 0 data will be delivered on media (Sony DTF-2) to dedicated users. Level 1 data will be delivered on media (CD-ROM) and online to all users. The level 1 data format is CEOS superstructure and CEOS SAR. Catalog data and datasets will be delivered online to all users. However, users will be categorized according to the ALOS data policy. Higher-level products will be generated by the data utilization system at EORC and other data utilization organizations. Figure 3.2.4-3 depicts the ALOS user interface gateway (AUIG), the prototype web user interface. ALOS data can be searched for and ordered through AUIG.

This document is provided by JAXA.

Table 3.2.4-3 ALOS mission data (Level 0, 1 data)

Processing Level	Definition	
Level 0 (only for ERSDAC, GSI, EORC, Data Node)	AVNIR-2 level 0 data for distribution (including TT&C, AOCS, PCD telemetry)	
	PRISM level 0 data for distribution (including TT&C, AOCS, PRISM mission telemetry)	
	PALSAR level 0 data for distribution (including TT&C, AOCS, PALSAR mission telemetry)	
Level 1 (Processed data)	AVNIR-2, PRISM	
	1A	Uncorrected image, scene unit
	1B1	Radiometrically calibrated image
	1B2	Geometrically corrected image
	PALSAR	
	1.0	Uncorrected image, scene unit
	1.1	Single-look complex data on slant range
	1.5	Multi-look processed image

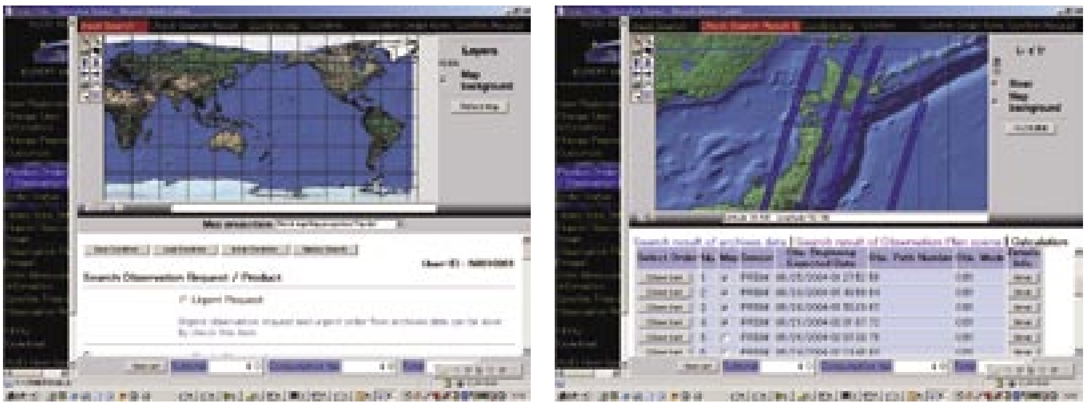


Fig. 3.2.4-3 ALOS User Interface Gateway (AUIG)

This document is provided by JAXA.

b. ALOS data delivery plan

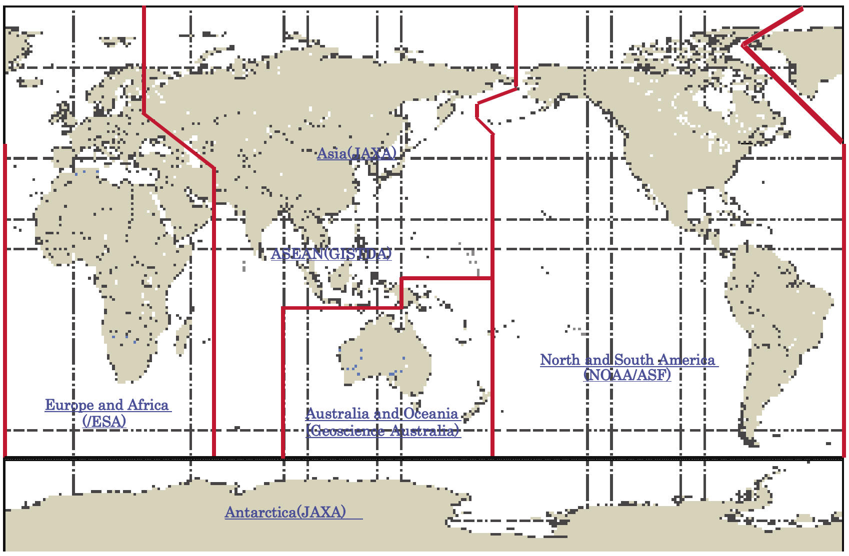
Table 3.2.4-4 presents the ALOS data delivery plan.

Table 3.2.4-4 ALOS data delivery plan

	Initial Checkout (3.5 months)	Initial CAL/VAL (5 months)	Routine operation
Level 0 data	No delivery	Test delivery (limited amount)	Routine delivery
Level 1 data (JAXA internal user)	CAL/VAL only (limited amount)	Uncalibrated data (limited amount)	Calibrated data routine delivery
Level 1 data (general user)	No delivery	No delivery	Calibrated data routine delivery

c. Key technologies and framework of ALOS mission operation system

The ALOS mission operation system uses state-of-the-art technologies to realize mission-critical requirements. The vast ALOS data volume (about 1 TB/day) is a major issue for data recording and archiving, and therefore RAID disks, gigabit networks, a storage area network (SAN), and a Sony PetaSite with DTF-2 media are used. In addition, ALOS data must be processed with superior performance and accuracy. The data processing subsystem utilizes a PC cluster system for advanced distribution processing and highly accurate geometric correction assessment technology. Data delivery is provided both online and via media (CD-ROM); catalog searches and data order functions are seamlessly performed with SOAP/XML. A new data delivery framework is being discussed with data nodes to promote worldwide distributed processing. Figure 3.2.4-4 illustrates how each node is responsible for distributing data to its users within its assigned area. JAXA will provide level 0 data to the nodes.



This document is provided by JAXA.

4) Current Status and Future Plans

The initial checkout phase and initial cal/val phase were completed and the routine operation phase commenced in Oct. 2006.

a. Data reception

The Ka-band transmission via DRTS provides an excellent link for receiving very high bit rate data (277.56Msps) from ALOS.

EOC has been receiving X-band data (138.76Msps) since the first day of the launch to support the spacecraft critical phase activities. An X-band demodulator lock-off problem was caused by interference by onboard reflection via multiple paths. Either a lock-off or a reduced bit error rate occurs at particular points in several receiving passes. This problem is not regarded as critical for the ALOS mission since most bit errors can be corrected by Reed-Solomon error detection and the correction function.

b. Level 0 data processing

The level 0 data processing function works well for a large amount of data, along with moving window displays of the optical instruments.

c. Level 1 data processing

JAXA evaluated the radiometric and geometric accuracy of level 1 products to achieve the requirements summarized in Table 3.2.4-5.The level 1 data processing algorithm was also validated and enhanced by intensive cal/val activities.

Table 3.2.4-5 Summary of Accuracy

Item	PRISM	AVNIR-2	PALSAR
Radiometric accuracy - Absolute - Relative	 10% (1σ) 5% (1σ)	 10% (1σ) 5% (1σ)	 1.5dB 1.0dB
Geometric accuracy (without GCP)	6.0m (3σ)	283.7m@nadir	100m

d. Mission operation planning

JAXA defined a basic observation scenario to maximize the use of ALOS observation data. It will be implemented after the completion of the initial checkout phase as a foreground mission with higher priority, second only to emergency observations when a mission operation schedule is generated by the mission management operation computer.

The observation strategy is available at
http://www.eorc.jaxa.jp/ALOS/obs/overview.htm

e. Archives and catalog

The archiving, catalog searching, online data distribution functions, and the network connection to external organizations are now being evaluated.

The catalog-searching service is provided by the ALOS user interface gateway (see Fig. 3.2.4-3), which is available at
https://auig.eoc.jaxa.jp/auigs/en/top/index.html

This document is provided by JAXA.

f. Emergency observation

Emergency observation for disaster monitoring is an important role of ALOS. Fifty-nine emergency observations have been planned since its launch and the data were provided to the relevant domestic and international agencies, including the international charter “Space and Major Disasters.” Figure 3.2.4-5 depicts the Mt. Merapi volcano eruption in Indonesia on April 29, 2006.

Figure 3.2.4-5 Emergency Observation of Mt. Merapi volcano, Indonesia
(Left: PALSAR. Right: AVNIR-2.)

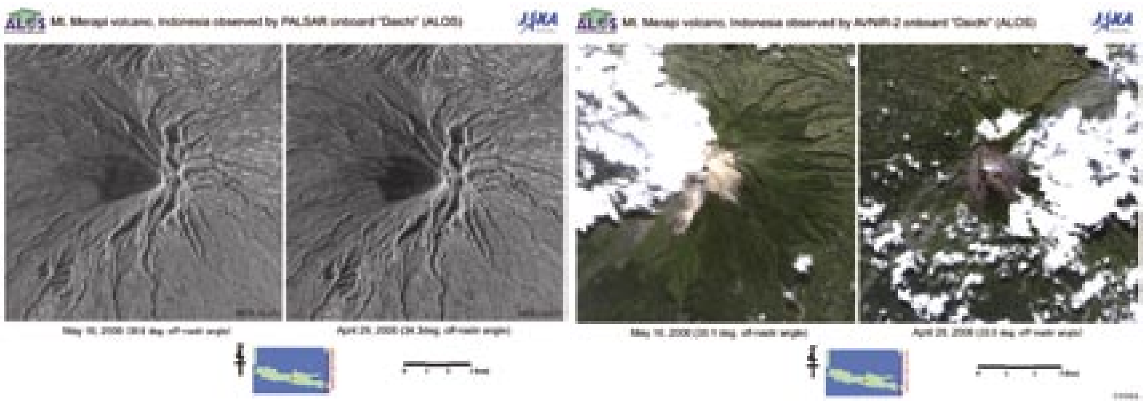
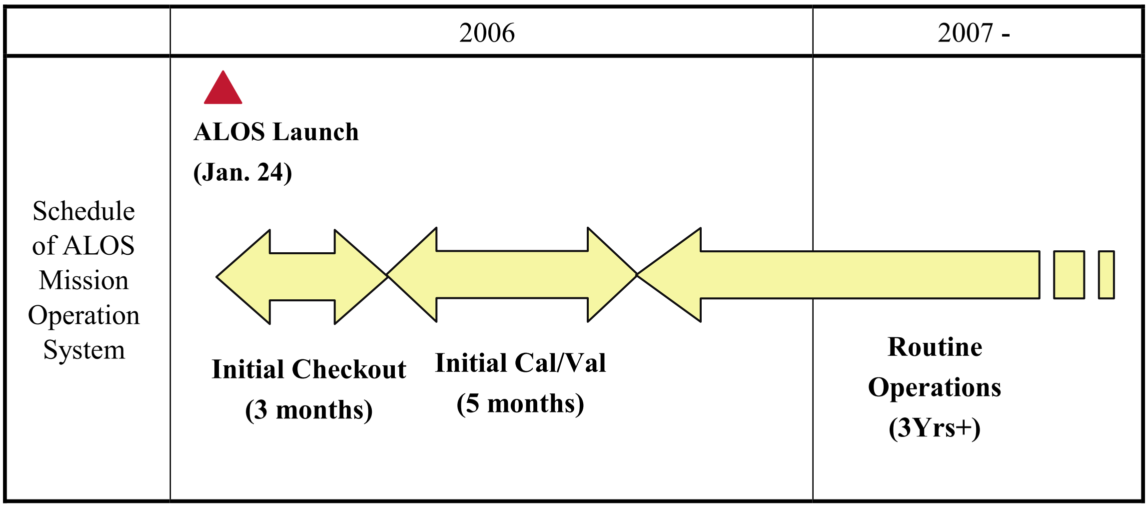


Figure 3.2.4-6 Schedule (after ALOS launch)



This document is provided by JAXA.

3.3 Active Archive of Earth-Observation Satellite Products

EOC is in charge of the archive center of Earth-observation satellite products, which covers JAXA and JAXA-handled missions. EOC provides the most comprehensive satellite information source currently available in Japan via the Earth Observation Data and Information System (EOIS) and the Data Distribution and Management System (DDMS).
EOIS and DDMS are infrastructure systems that archive, manage and distribute Earth-observation data and information. They also include catalog information service, off-line data distribution service, and on-line data distribution service for the Earth-observation community on the World Wide Web. EOIS WWW service, Information Service System (ISS), has been made more operable, secure, and user-friendly.

URL: https://www.eoc.jaxa.jp/iss/en/index.html

1) Catalog information service
Data from MOS-1, JERS-1, ADEOS, ADEOS-II, Aqua/AMSR-E, TRMM, ERS, LANDSAT, SPOT, RADARSAT and IRS are archived and amount to about 220TB, ??which will be available?? for 27 years. The data can be identified, previewed and ordered as products. User accounts will be provided from the EORC order desk.

2) Off-line data distribution service
Earth-observation data are available on digital recording media, by ordering products chosen scene-by-scene using the EUS interface or order sheets. CD-ROM (650MB), DVD-R (4.5GB), 8mm tape (5GB), and DLT (35GB) are available.

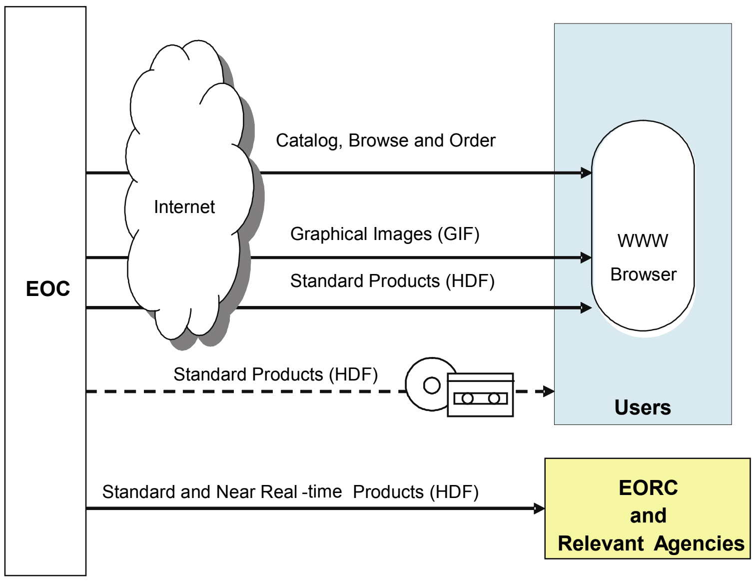


Fig. 3.3-1 EOC data services.

3) On-line data distribution service
EOC provides standard products of higher-level processed data via the internet. All users can download small products of a higher order from the EOC data server via WWW. Since January 2006, EOC has started online data distribution free of charge for Japanese general researchers, who have

This document is provided by JAXA.

service equivalent to PIs after online registration. From April 2007, the same distribution service will become available to foreign general researchers.

EOC provides download service for the AMSR-E, ADEOS-II and TRMM data. User registration is necessary to access the server, but accounts will be issued immediately via on-line sign up.

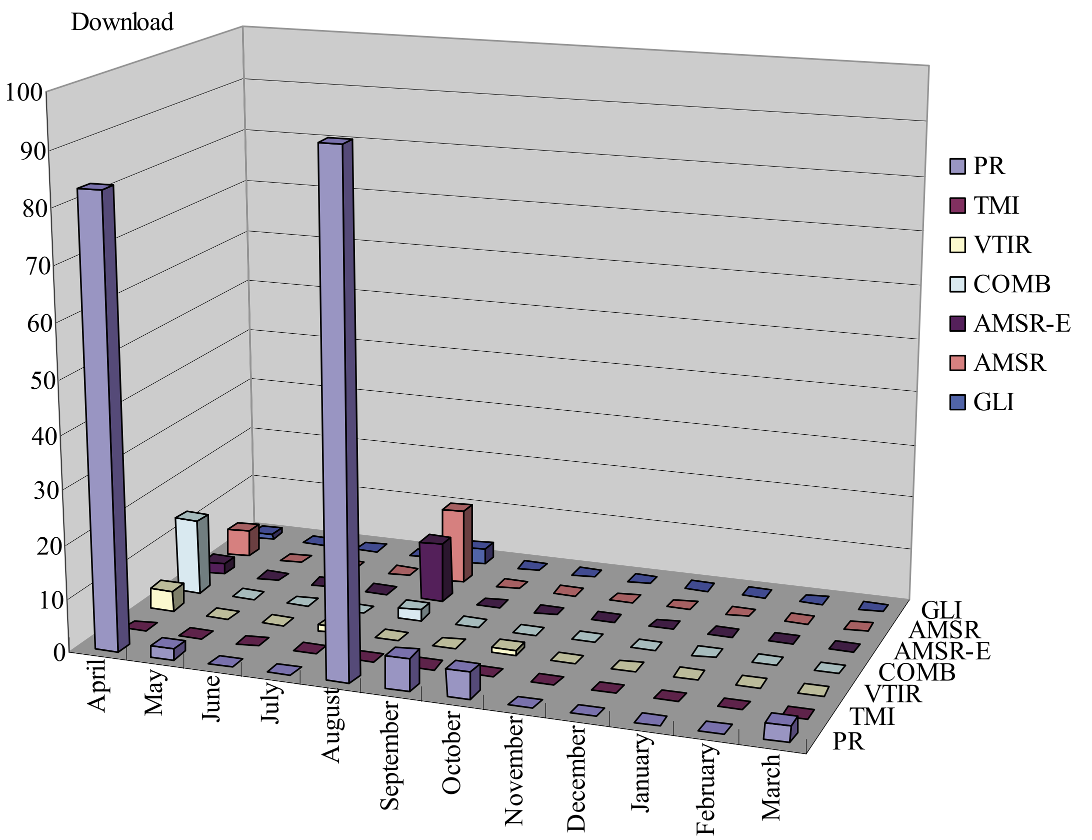


Fig. 3.3.2 Number of downloads to on-line data distribution service in FY2005. (Revision required)

This document is provided by JAXA.

3.4 Studies for Future Projects

The EORC ground system development group has been working for future Earth observation satellite projects GOSAT, GPM and GCOM. The system development for GOSAT and the studies for GPM and GCOM during FY2006 are summarized below.

The Greenhouse Gases Observing Satellite (GOSAT) is a mission for greenhouse gases observation conducted in cooperation with the Ministry of the Environment (MoE) and the National Institute of Environmental Studies (NIES) to observe greenhouse gases including carbon dioxide (CO_2) and methane (CH_4). GOSAT will carry a Michelson Fourier transform spectrometer (TANSO-FTS) to measure the amount of greenhouse gases and a cloud and aerosol imager (TANSO-CAI). GOSAT is scheduled to be launched in the summer of 2008. The recording system and data processing control system completed their critical design phase and entered the manufacturing phase. Part of the critical design and manufacturing has been done for mission management organization system and the GOSAT specific data processing system. Also, the EOC receiving system for GOSAT is being updated. The oversea ground station, i.e., Svalbard station run by KSAT, is updating their interface to handle GOSAT data acquisition requests.

Global Precipitation Measurement (GPM) is a follow-on mission of TRMM conducted in cooperation with NASA. The GPM mission concept is to observe precipitation more frequently and globally than TRMM by employing a TRMM-type core satellite and a fleet of constellation satellites. The GPM core satellite will carry the PR follow-on sensor, DPR, and will be launched in 2013. Due to the launch schedule slip, the schedule and plan for development and operation were reconsidered. The satellite simulation software was developed to evaluate the mission requirements and to mitigate the mission risks.

The Global Climate Observation Mission (GCOM) is a follow-on mission of ADEOS-II and focuses on continuing and improving Earth observation related to global change phenomena. GCOM consists of two series of satellites, GCOM-W and GCOM-C, each of which consists of three sequentially launched satellites covering 10~15 years starting in 2011 (GCOM-W) and 2012 (GCOM-C). GCOM-W will carry the AMSR/AMSR-E follow-on sensor, AMSR2, to contribute to the study of the water cycle. GCOM-C will carry the GLI follow-on sensor, SGLI, to enhance the investigation of climate change. The operational scenario for GCOM-W1 was drafted, and GCOM-W1 completed its mission requirement review (MRR) and system definition review (SDR). The GCOM-W1 project will be initiated on April 1, 2007. The GCOM-C1 preparation team has been working for MRR and SDR, which are being held in April 2007. A conceptual study for merging S/X-band antenna assignment and satellite/sensor command planning functions was carried out.

This document is provided by JAXA.

3.5 New Tsukuba Office and Data Analysis System

3.5.1 Overview of New Tsukuba Office and Data Analysis System

1) New Tsukuba office

EORC was relocated to Tsukuba Space Center (Tsukuba-shi, Ibaraki) from Harumi Office (Harumi, Chuo-ku, Tokyo) in the end of October 2006. Figure 3.5.1-1 presents the guide map to EORC's new office.

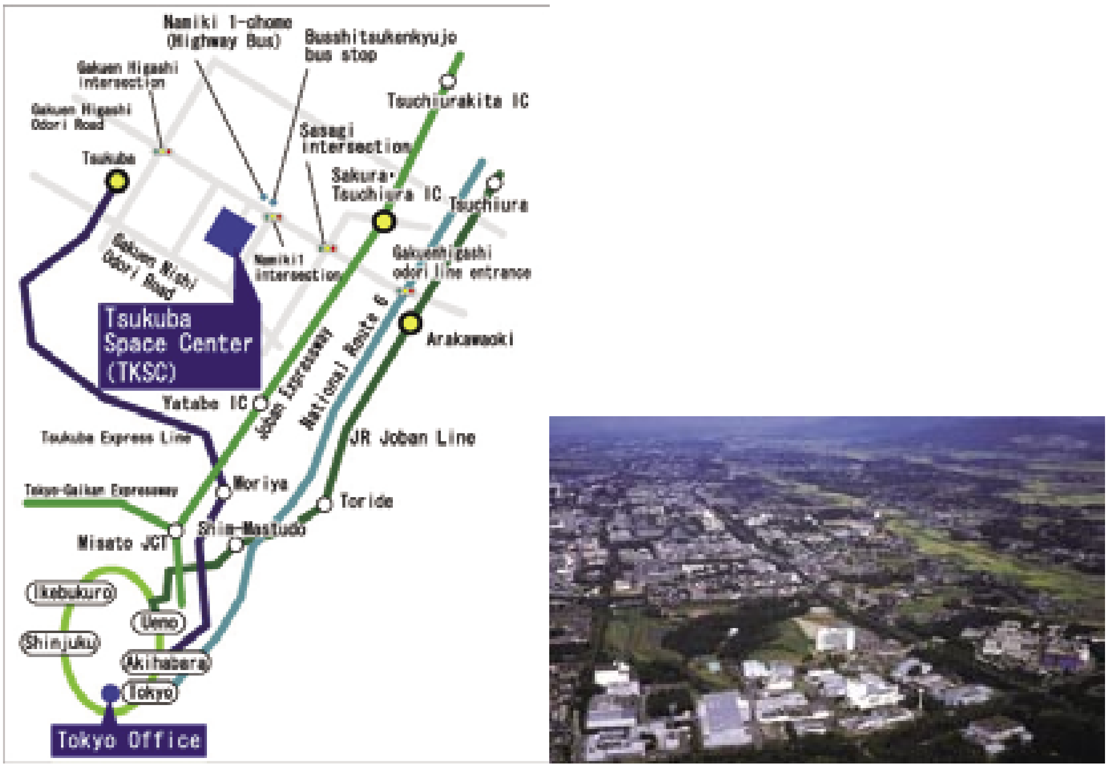


Fig. 3.5.1-1 Guide map and aerial view of the new EORC Tsukuba office (Tsukuba Space Center)

EORC is a field center that unites experts of Earth science and remote-sensing applications in the Space Agency and promotes satellite data utilization. The following table outlines the present office. The new office consists of three buildings.

Table 3.5.1-1 Outline of EORC's New Tsukuba office

Building and Floors	Floor space	Room allocation
Tsukuba Space Center C-4	915 ㎡	Server room, power supply room
Tsukuba Space Center C-1 8F	130 ㎡	Offices
Tsukuba Space Center E-2	910 ㎡	Technical counselor room, offices, operation room, power supply room, meeting room, etc.

Ref. Harumi Office's Floor space was 3,500 ㎡.

This document is provided by JAXA.

2) EORCnet (Data Analysis System)

"EORCnet" is the computer and network infrastructure that supports research and promotion activities at EORC. It is composed of the Data Analysis System (DAS) and three networks, the Internet Connected Segment, the External Interface Segment, and the EORC Internal LAN. The Internet Connected Segment of DAS is connected with the Internet through JAXAnet. The External Interface Segment of DAS has been connected to EOC with the Data Distribution and Management System (DDMS) at 100Mbps through the JAXAnet since the end of September 2006.

We replaced the DAS system and the networks when we relocated the office (see 3.5.2 5).

The following table and figure outline the present EORCnet.

Table 3.5.1-2 EORCnet Outline

Operation	Since the end of October 2006
Security measures	Firewall, virus pattern compulsive distribution system, Secure Socket Layer/Virtual Private Network (SSL-VPN)
Internet Connected Segment	De-Militarized Zone (DMZ)
External Interface Segment	External Interface Segment with EOC
Composition of EORC Internal LAN	・ 8 subnetwork segments ・ 4 subnetworks by project ・ GOSAT ground system subsegment ・ EORC Information System (EIS) subsegment ・ Common subsegment ・ System operation sub-segment
Computers (WS & PC)	323 machines (As of April 1, 2007)
Mass storage tape archive	600TB with 100TB disk cache
Large capacity shared disk equipment	37TB
Network	10Gbit Ether, 1Gigabit Ether, 100Mbps Fast Ether
Power supply capability	450 KVA (C-4:300KVA, E-2:150KVA)

The Internet Connected Segment is the De-Militarized Zone (DMZ: including public WWW and FTP servers).

The External Interface Segment includes the Network Control System (NCS) and the On-demand Data Server (ODS) for data transfer from EOC to EORC.

The EORC Internal LAN consists of eight subsegments corresponding to the four research projects (i.e. TRMM, GCOM, JERS-1/ALOS, and GOSAT), the GOSAT ground system subsegment, EORC Information System subsegment, common subsegment, system operation subsegment.

The common subsegment includes the main routers for DAS, the Mass Storage Tape Archive, large capacity shared disk equipment, common printers, and photograph quality printers. The Mass Storage Tape Archive consists of an LTO tape library (600TB) with a disk cache (100TB).

The system operation subsegment includes computers to manage all DAS machines and the entire network, and to monitor machines for the common segment, media conversion system, etc.

This document is provided by JAXA.

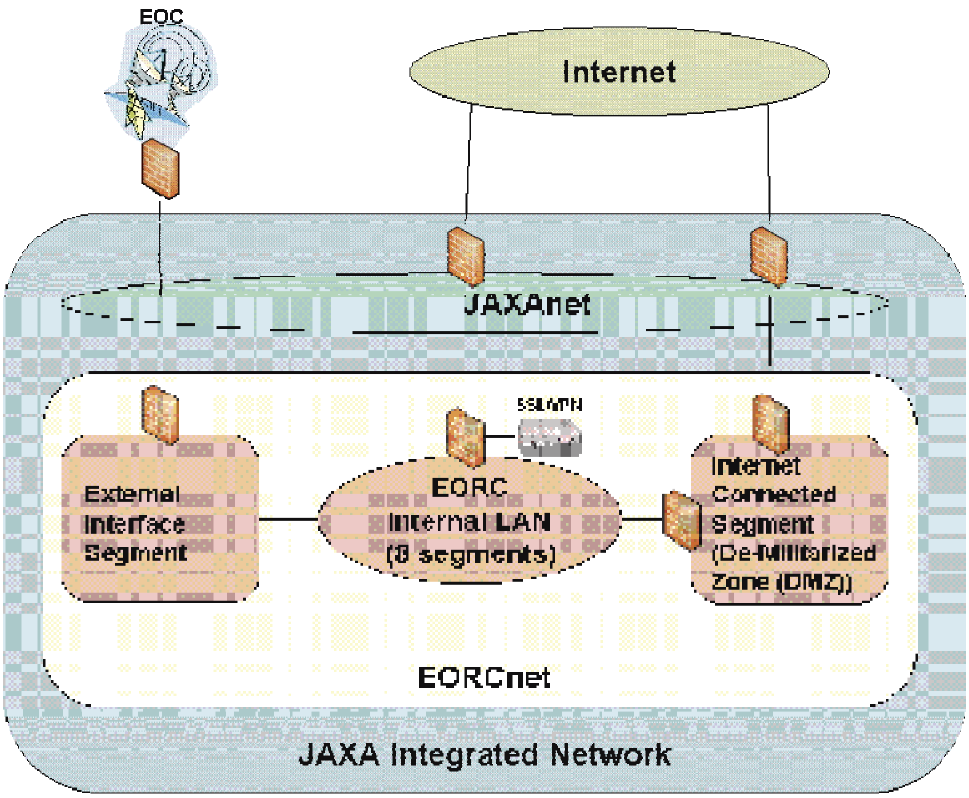


Fig. 3.5.1-2 Schematic of EORCnet.

3.5.2 Operation and Development of Data Analysis System

1) Outline of Activities

We have continued to operate the DAS system to provide data handling and distribution, user support, and homepage operation.

After the relocation, we increased the data rates of the communication line between EOC and EORC from 75Mbps to 100Mbps, the data storage capacity of the mass storage tape archive from 130TB to 600TB, and the data storage capacity of the large shared disk from 5TB to 37TB. We also replaced almost all computer systems after the lease contract expired??.

2) System Operation and Development

a. DAS operation and modification

We have continued regular operations such as daily inspection of machines and networks; management and exchange of consumption items; air temperature control of the power supply room, server room and operation room; Domain Name Server (DNS) management; account management; periodic and occasional system backup; response to malfunctions; management of manuals; installation of media for applications; and operation of DAS internal homepage throughout FY 2006.

Almost all computer systems were replaced and data converted from DTF-2 and DLT tape in mass storage to LTO tape during FY2006.

This document is provided by JAXA.

b. Operation and modification of the Internet Connected Segment

Our regular operations include daily inspection of machines and networks, management and exchange of consumption items, account and mailing list management, periodic and occasional systems backup, response to malfunctions, management of manuals, and installation of media for applications and user support.

The system was modified as follows for greater user and administrator convenience and to reduce cost.

- Elimination of EORC DNS servers, mail servers, antivirus servers, proxy servers, and the Intrusion Detection System (IDS) by merging their functions into the servers of the Information System Department of headquarters office, i.e. JAXAnet.
- Concentration of 14 EORC WWW servers and FTP servers.
- Abandonment of Trusted OS for WWW and FTP servers.
- SSL/VPN system installation on behalf of One Time Key (password) system for access to DAS from other networks.

c. Security measures

EORC computer and network security systems including firewalls and virus pattern compulsive distribution system were implemented except for some PC virus infection/onset.

The JAXA Information Systems Department conducted on-site surveys of EORC HTTP and FTP servers open to the public in May and October 2006, and there were no problems.

d. Network around EORC

The Information Systems Department managed the wide-area Ethernet of the JAXA integrated network throughout FY 2006. After the relocation, the assigned data rates between EORC and EOC were increased from 75Mbps to 100Mbps, but the EORC system was shared by other users in Tsukuba Space Center.

The communication line between EOC and EORC was used for daily data transfer of TRMM, AMSR-E, and ADEOS-II/AMSR standard products; AMSR-E and MODIS near real-time data; ALOS level 0 data and ALOS MOIF (Mission Operation Interface File); and others. These data transfers were implemented by using the Network Control System (NCS). The On-demand Data Server (ODS) is mainly used for researchers within EORC to retrieve and acquire necessary data archived at EOC on line or to order data processing.

Some 440 to 871Gbytes/month of data were transferred from EOC to EORC through NCS during FY2006.

The internet (Asia Pacific Advanced Network (APAN) with TsukubaWAN or the Science Network (SINET)) was used for data transfer of TRMM real-time data from NASA GSFC to JAXA EORC throughout FY 2006. SINET expanded its bandwidth from 100Mbps to 1Gbps in July 2006; the APAN with TsukubaWAN expanded its bandwidth from 10Mbps to 1Gbps in March 2007.

3) Data Management and Data Distribution

a. Data management

EORC continued acquiring the following data online (through NCS and ODS; see 3.5.2 4) or by DVD media and storing them in the LTO mass storage data archive during FY 2006.

This document is provided by JAXA.

- MODIS data received and processed at TSIC-TRIC and JAXA EOC (since July 2004)
- ADEOS-II/GLI standard products processed at JAXA/EOC
- ADEOS-II/AMSR standard products processed at JAXA/EOC
- TRMM standard products processed at JAXA/EOC
- TRMM standard products processed at NASA/GSFC (via JAXA/EOC)
- AMSR-E standard products processed at JAXA/EOC
- AMSR-E near-real-time data processed at JAXA/EOC
- ADEOS-II orbit data
- TRMM orbit data produced at NASA (via JAXA/EOC)
- Meteorological data acquired from JMA (via JAXA/EOC)
- MICOS (Meteorological Information Comprehensive Online Service) data from JWA

EORC bought the SSM/I data aboard DMSP satellites and ECMWF data during CY 2006. All these data are used for EORC research activities such as calibration and validation, and algorithm improvement.

b. Data distribution

JAXA Earth Observation Satellite sample images archived at EORC are open to the public worldwide through the EORC homepage and on media such as CD-ROM and DVD-ROM free of charge for the purpose of research and public benefit. We continued registering and opening ADEOS-II data for PIs and CIs through the Online Data Distribution system (ODD) throughout FY 2006. As of the end of March 2007, 222,761 files of ADEOS-II/GLI data were registered in the ODD. The ODD also provides researchers with ADEOS/OCTS data and SeaWiFS data. During FY 2006, 20 files of GLI data were distributed to researchers online through ODD, and no files were distributed by CD-ROM or DVD-ROM. We started the FTP transfer services of MODIS data to organizations with a cooperative agreement or those holding a contract with RESTEC in July 2004. The estimated amount of MODIS data transferred from July 2004 to March 2005 (during FY2004) was 1,452Gbytes (7,478 scenes), that for FY2005 was 7,003Gbytes (36,054 scenes), and that for FY2006 was 7,632Gbytes (39,294 scenes). The organizations directly connected to JAXA include the Japan Coast Guard and the Japan Meteorological Agency, and those connected through RESTEC were Chiba University, VisionTech Inc., Prefectural Fisheries Experimental Stations, and Tohoku University.

The following images and sample data are distributed through the EORC WWW homepage.

- ALOS images
- MODIS, ADEOS-II, AMSR-E, SeaWiFS , ADEOS, TRMM and JERS-1 data
  (See EORC ANNUAL REPORT FY2004.)
- Ground Truth data
  (See EORC ANNUAL REPORT FY2004.)
- JAXA/EORC CD-ROMs
  (See EORC homepage as for CD-ROMs.)

4) Access statistics to EORC homepage and its operation

The access to EORC homepage was approximately 1,900,000 pages/ month in September 2005 when a major typhoon struck Japan. Figure 4.5.2-1 indicates the trend of access to EORC homepage from April 2003 to March 2007.

This document is provided by JAXA.

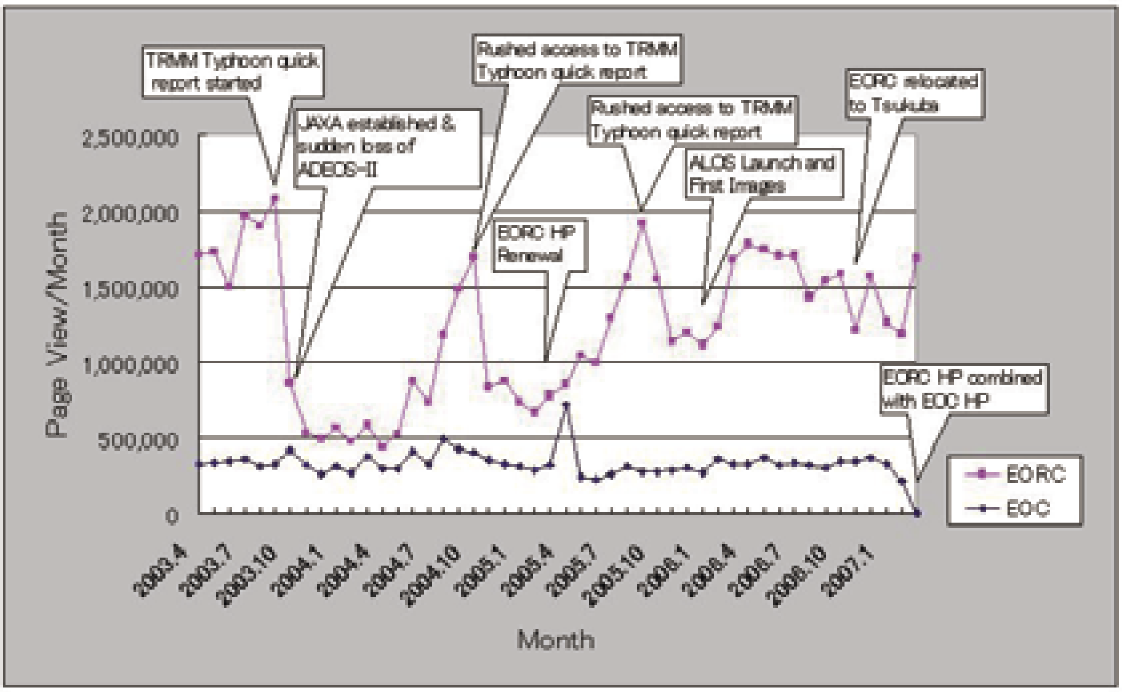


Fig. 3.5.2-1 Trend of access to EORC and EOC homepages

We continued updating the “Seen from Space” mainly composed of ALOS/(AVNIR-2, PRISM and PALSAR) and Aqua/AMSR-E images with the brief explanation on the EORC top homepage over once a week and a total of 69 times during FY 2006. We also continued to update the following major areas included in the EORC homepage.

- ALOS Latest image (since February 2006)
- TRMM typhoon database page by TRMM research project (since October 2002)
- EORC kids page (since February 2003)
- TRMM typhoon quick report page by TRMM research project (since September 2003)
- AMSR-E typhoon quick report page by ADEOS-II research project (since May 2004)
- ”Kuroshio Monitoring” page by ADEOS-II research project (since June 2004)
- ”El Nino Watch” page by ADEOS-II research project (since December 2004)
- AMSR/AMSR-E tropical cyclone database page by ADEOS-II research project (since December 2004)
- “Sea ice concentration in the Sea of Okhotsk” by AMSR-E and MODIS in the ADEOS-II research project (since February 2003; added MODIS data in December 2003 and updated during winter season)
- Today's image from AMSR-E and MODIS by the ADEOS-II research project (since November 2003; originally started by AMSR and GLI in April 2003)

Major events for EORC WWW were combined with EOC WWW in March 2007.

A sample of the EORC top homepage (as of February 28, 2007) is presented in Fig. 3.5.2-2.

This document is provided by JAXA.

Fig. 3.5.2-2 Sample of EORC Top Homepage (Feb. 28, 2007)

5) Improving information system security

EORC has been endeavoring to improve security as a priority action of all JAXA. The following practical measures were implemented in FY 2006.

- Information System Security education was provided by using e-learning (Envivio movie base) for all working staff members including JAXA personnel, temporary workers, and contractor personnel.
- On-site surveys were conducted by the Information Systems Department: in May and October

This document is provided by JAXA.

2006 (see 2) c).

This document is provided by JAXA.

3.6 Direct Data Receiving from EOS

EORC began receiving data from EOS-satellites (Terra and Aqua operated by NASA) directly in July 2004 and can now provide substitute data for the lost ADEOS-II mission data (GLI and AMSR).

By using the receiving antenna installed at EOC, EORC acquires and processes data from MODIS instruments aboard Terra and Aqua and data from AMSR-E aboard Aqua at EOC and EORC. The processed data are provided on a near-real-time basis (within 3 to 5 hours after observation) to institutional users such as the Japan Meteorological Agency (JMA), Japan Fisheries Information Service Center (JAFIC), and Japan Coast Guard (JCG) who use the data for operational applications of weather forecasts, fishery and Tokyo Bay monitoring. General users can also use these data through the internet by contracting with the data distributor. MODIS data service has been available since September 2004, and AMSR-E data service, since April 2005.

Table 3.6-1 Data distribution for MODIS and AMSR-E. MODIS Level-2 is processed using GLI algorithm.

User	Product	Corresponding ADEOS-II product
JMA	**AMSR-E** Level-1B	**AMSR** Level-1B
	MODIS Level-1B	**GLI** Level-1
	MODIS Level-2 (SST)	**GLI** Level-2 (SST)
JAFIC	**MODIS** Level-2 (CHLA)	**GLI** Level-2 (CHLA)
	MODIS Level-2 (SST)	**GLI** Level-2 (SST)
JCG	**MODIS** Level-1B	**GLI** Level-1
	MODIS Level-2 (CHLA)	**GLI** Level-2 (CHLA)
	MODIS Level-2 (SST)	**GLI** Level-2 (SST)
General	**MODIS** Level-1B	
	MODIS Level-2 (CHLA)	
	MODIS Level-2 (SST)	
	AMSR-E Level-2 (SST, 5-day composite)	

This document is provided by JAXA.

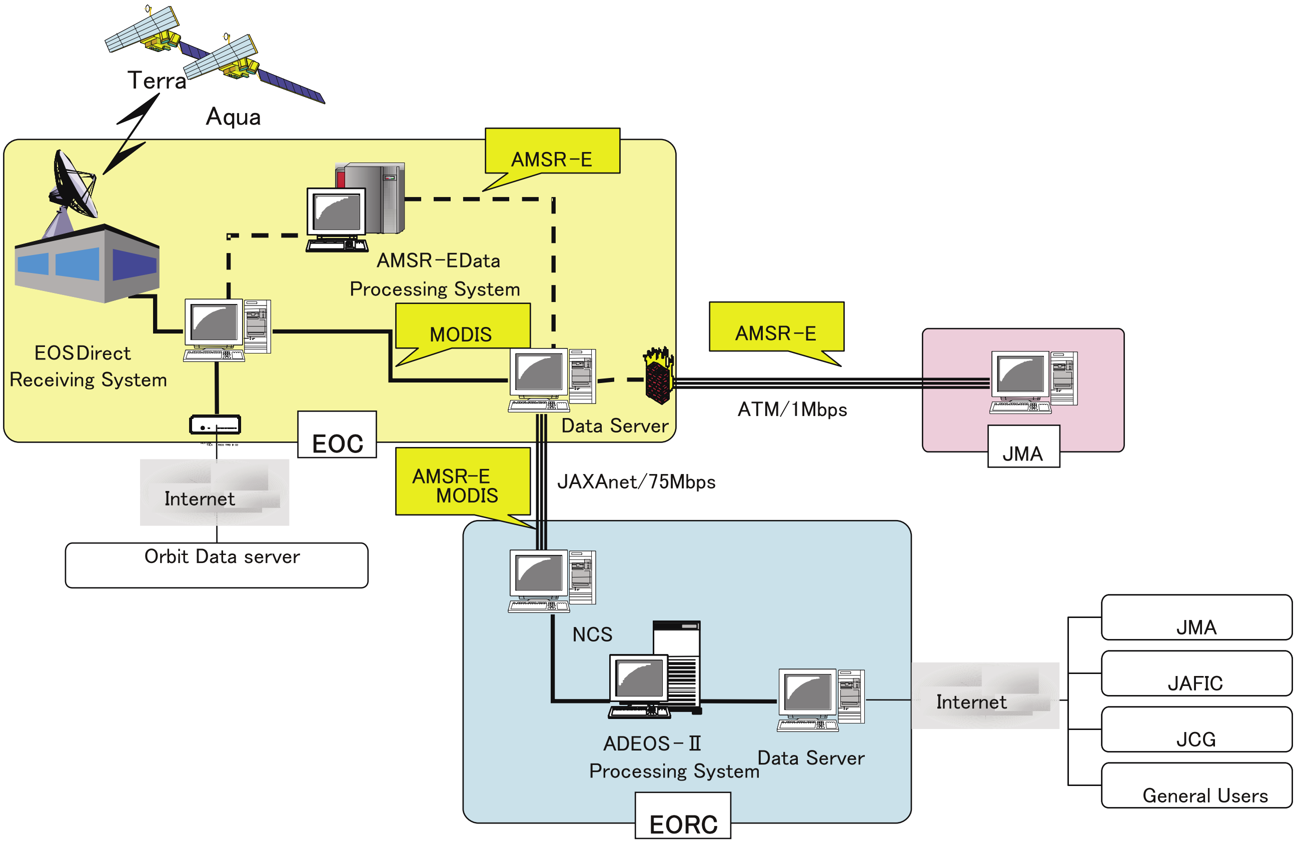


Fig. 3.6-1 Overview of the EOS direct receiving and processing system.

This document is provided by JAXA.

3.7 Data Delivery Statistics

Table 3.7-1 Statistical summary of data delivery from EORC

	Satellite	FY2002	FY2003	FY2004	FY2005	FY2006	
		Total	Total	Total	Total	Distributed by JAXA	Distributed by Private Distributor
Distribution Result per Satellite	MOS	116	75	42	39	157	22
	JERS-1	7,383	15,096	8,575	4,504	1,997	3,287
	ADEOS	13,001	1,807	193	6	23	20
	TRMM (1)	89,774	71,834	182,445	139,235	107,027	773
	Aqua (2)	1,956	76,663	252,678	211,536	289,806	0
	ADEOS-II	0	20,384	98,540	37,108	107,652	8
	AD2 (Substitute)	0	0	17,742	36,054	6,709	32,585
	ALOS	-	-	-	-	6,423	3,864
Total		112,230	185,859	560,215	428,482	519,794	40,559

1. PR only
2. AMSR-E only

N.B.

- Only satellites or sensors developed by JAXA are included in this table, except ADEOS-II substitutes, i.e. data received directly from EOS. Data users outside of JAXA are considered here; JAXA's internal users are not included. Data are counted by scene, and the number comes from the sum of scene-order and standing-order.
- ALOS data delivery started in Oct. 2006.

This document is provided by JAXA.

４. INTERNATIONAL COLLABORATION

This document is provided by JAXA.

4. INTERNATIONAL COLLABORATION

4.1 International Meetings

International meetings organized by EORC in FY2005 are listed in chapter 8.

4.2 International Collaboration Research

EORC accommodates foreign researchers as PIs for TRMM, ADEOS-II and ALOS science projects through Research Announcements (RA). Some of these researchers develop, calibrate and validate algorithms for higher-level products and engage in science research.

4.3 Foreign Guest Researchers

EORC was established as a field center that unites experts of Earth science and remote sensing applications. Since its establishment, it has conducted cooperative research in fields relating to satellite Earth observation data and Earth science, together with application fields with close collaboration among Earth science specialists inside and outside of Japan. EORC receives foreign guest researchers not only to promote cooperative activities but also for individual research by various systems and purposes.

Number of foreign guest researchers in EORC

	No. of persons
JAXA Invited Researchers	0
Post-doctorates	0

Numbers at the beginning of FY 2006

This document is provided by JAXA.

4.4 International Arctic Research Center (IARC)

IARC was established for promoting international cooperation and coordination for arctic climate change research at the University of Alaska Fairbanks. JAXA (ex-NASDA) commissioned Hokkaido University and the University of Alaska to conduct Arctic research on global change using the IARC-JAXA Information System (IJIS) and satellite data on April 1, 2006. Research themes and leading researchers (PIs) are as follows.

- Monitoring of influence of 2004 Alaskan large forest fire on terrestrial environment; Masami Fukuda, Hokkaido University.
- Linkages between freshwater discharges, sea-ice conditions and primary productivity and climate changes in the sub Arctic marginal seas and Arctic Ocean, Sei-ichi Saitoh, Hokkaido University.
- Spatial and temporal estimation of greenhouse gas budget by synthesis of satellite data and field observation; Yoshinobu Harazono, International Arctic Research Center, University of Alaska.
- GINA-IARC remote sensing and fire science collaboration; Virgil Buck Sharpton & Claude Duguay, Geophysical Institute, University of Alaska, and Michel Allard, Laval University.
- Variability in the distribution, age structure and thickness of the arctic perennial sea ice; Gennady Belchansky, International Arctic Research Center, University of Alaska.
- Detection of soil moisture and carbon sequestration based on remote sensing and field observation along Alaska transect: buildup of algorithm; Yong Wong Kim, International Arctic Research Center, University of Alaska.
- Development and validation of polar ocean ecosystem model by using satellite data; Jia Wang, International Arctic Research Center, University of Alaska.

This document is provided by JAXA.

This document is provided by JAXA.

5.LIST OF SCIENTIFIC CONTRIBUTIONS

This document is provided by JAXA.

5. LIST OF SCIENTIFIC CONTRIBUTIONS (January-December 2006)

5.1 Scientific Journal Articles (Asterisks show non-staff members.)

Frouin, R*. P.-Y. Dechanpms*, L. Gross-Colzy*, H. Murakami, and T.Y. Nakajima*, 2006: Retrieval of Chlorophyll-a Concentration via LinearCombination of ADEOS-II Global Imager Data, J. Oceanography, 62, 331-337.

Hori, M., Te. Aoki*, T. Tanikawa*, H. Motoyoshi*, A. Hachikubo*, K. Sugiura*, T. J. Yasunari*,H. Eide*, R. Storvold*, Y. Nakajima*, F. Takahashi*, 2006: In-situ measured spectral directional emissivity of snow and ice in the 8-14 um atmospheric window. Remote Sensing of Environment, Vol 100/4 pp 486-502.

Hosoda, K., H. Murakami, A. Shibata, F. Sakaida, and H. Kawamura, 2006: Difference characteristics of sea surface temperature observed by GLI and AMSR aboard ADEOS-II, J. Oceanogr., 62, 339-350, doi:10.1007/s10872-006-0059-1

Hosoda, K., H. Murakami, F. Sakaida, and H. Kawamura, 2007:Algorithm and validation of sea surface temperature observation using MODIS aboard Terra and Aqua in the western North Pacific, J. Oceanogr., 63, 267-280

Ishizaka, J.*, Y. Kitaura*, Y. Touke*, H. Sasaki*, A. Tanaka*, H. Murakami, T. Suzuki*, K. Matsuoka*, H. Nakata*, 2006: Satellite Detection of Red Tide in Ariake Sound, 1998-2001. J. Oceanogr. 62: 37-45.

Isoguchi, O., and *H. Kawamura, 2006: MJO-related summer cooling and phytoplankton blooms in the South China Sea in recent years, Geophys. Res. Lett., 33, L16615, doi:10.1029/2006GL027046. Isoguchi, O., and *H. Kawamura, 2006: Oyashio seasonal intensification and its effect on subsurface temperature variation off the Sanriku coast, J. Geophys. Res., 111, C10006, doi:10.1029/2006JC003628.

Kawai, Y.*, H. Kawamura*, S. Takahashi*, K. Hosoda, H. Murakami, M. Kachi and L. Guan*, 2006: Satellite-based high-resolution globaloptimum interpolation sea surface temperature data . Journal of Geophysical Research, 111, C06016.1-C06016.17.

Murakami, H., K. Sasaoka, K. Hosoda, *H. Fukushima, *M. Toratani, *R. Frouin, *B. G. Mitchell, *M. Kahru, *P.-Y. Deschamps, *D. Clark, *S. Flora, *M. Kishino, *S. Saitoh, *I. Asanuma, *A. Tanaka, *H. Sasaki, *K. Yokouchi, *Y. Kiyomoto, *H. Saito, *C. Dupouy, *A. Siripong, *S. Matsumura, and*J. Ishizaka, 2006: Validation of ADEOS-GLI ocean color products using in-situ observations, J. Oceanography, 62, 373-393.

Tadono, T., M. Shimada, H. Murakami, A. Mukaida*, J. Takaku* and S. Kawamoto*, 2006: Preliminary results of calibration for ALOS optical sensorsand validation of generated PRISM DSM, Proceedings of SPIE, SPIE International Symposium on Remote Sensing (Remote Sensing Europe 2006), The International Society for Optical Enginnering.

5.2 Books

松浦直人：11 日本の地球観測計画，第４章 衛星画像，第４部 リモートセンシング解析演習、利用ソフトとデータ，農業リモートセンシング・ハンドブック（第１版：ＣＤ版），システム農学会，Ⅳ 81-82，2006年10月

This document is provided by JAXA.

5.3 Reviews and Others

Isoguchi, O., and M. Shimada, 2006: PALSAR geometric evaluation using DEM, Asian Journal of Geoinform, 6, number 4, 47-56.

Tadono, T., M. Shimada, H. Murakami, T. Hashimoto, J. Takaku*, A. Mukaida* and S. Kawamoto*, 2006: Initial results of calibration and validation for PRISM and AVNIR-2, Asian Journal of Geoinformatics, Vol.6, No.4, pp.11-20.

柴田彰*、今岡啓治：ADEOS-II/AMSR、Aqua/AMSR-E観測の成果、日本リモートセンシング学会誌、Vol. 26, No. 1 (2006), pp. 37-40

今岡啓治*、柴田彰：改良型高性能マイクロ波放射計AMSR-E、検査技術、Vol. 11、No. 9（2006）、pp. 33-38

5.4 Conference Proceedings

Hosoda. K., H. Murakami, A. Shibata, F. Sakaida, and H. Kawamura, 2006: Global intercomparison of sea surface temperature measured by infrared and microwave radiometers on a single satellite, Geoscience and Remote Sensing Symposium, 2006, IGARSS '06

Imaoka, K., Fujimoto, Y., Arai, Y., Shibata, A., Morokuma, S., and Y. Sasaki: Radio-frequency interference signals in the AMSR and aircraftC-band measurements. IGARSS2006, Denver, USA, 2006.

Imaoka, K., Shibata, A., Kachi, M., Kasahara, M., Iida, Y., Tanaka, K., Kimura, T., Tange, Y., and H. Shimoda: Status of the GCOM-W and onboard AMSR follow-on instrument. SPIE Int'l Symposium, Remote Sensing Europe, Stockholm, Sweden, 2006.

Isoguchi, O., *T. Toyozumi, *F. Sakaida, and *H. Kawamura, 2006: Yamase-derived gap winds off the western Hokkaido coasts and their effects on sea surface temperature fields, Proceedings of IGARSS 2006, Colorado, USA, DVD.

Kachi, M., R. Oki, S. Shimizu and M. Kojima, 2006: Global Precipitation Measurement (GPM) Mission and its Application Use. Proceedings of SPIE Asia Pacific Remote Sensing 2006, Vol. 6407.

Murakami, H., M. Toratani* and H. Fukushima*, 2006: Satellite ocean color observation with 250 m spatial resolution using ADEOS-II GLI, Remote Sensing of the Marine Environment, Proceedings of SPIE, Volume 6406-05, Nov. 28.

Tadono, T., M. Shimada, M. Watanabe, H. Murakami, O. Isoguchi, J. Takaku* and A. Mukaida*, 2006: Initial results of calibration and validation for PRISM and AVNIR-2 onboard "Daichi" (ALOS) and their data utilization, 第5回水文過程のリモートセンシングとその応用に関するワークショッププロシーディングス, 57-66.

Yamamoto, H*., H. Yoshioka*, H. Murakami, A. Ono, and Y. Honda*, 2006:, The possibility of aerosol correction over land using ADEOS-II GLI 380nmreflectance, Proceedings of SPIE, Volume 6298-0S, Sep. 27.

今岡啓治*、柴田彰、可知美佐子、村上浩、堀雅裕、笠原希仁、岡村吉彦：地球環境変動観測ミッション(GCOM)による長期継続観測、第5回水文過程のリモートセンシングとその応用に関するワークショップ論文集、pp.99-104、2006.

This document is provided by JAXA.

5.5 Oral Presentations

5.5.1 Open Conferences

Hori, M., Te. Aoki*, K. Stamnes*, W. Li*, 2006: Spatial and temporal variations of satellite-derived snow physical parameters in the Arctic regions during the spring-fall seasons in 2003, the International Glaciological Society (IGS) International Symposium on Cryospheric Indicators of Global Climate Change, Cambridge, England.

Hosoda. K., H. Murakami, A. Shibata, F. Sakaida, and H. Kawamura, 2006: Global intercomparison of sea surface temperature measured by infrared and microwave radiometers on a single satellite, Geoscience and Remote Sensing Symposium, 2006, IGARSS '06, Boulder

Isoguchi, O., M. Shimada, 2006: The ALOS Mission:PALSAR - Overview & current status, International workshop: Application of SAR data in Taiwan, Kainan University, Taiwan.Isoguchi, O., *T. Toyozumi, *F. Sakaida, and *H. Kawamura, 2006: Yamase-derived gap winds off the western Hokkaido coasts and their effects on sea surface temperature fields, IGARSS 2006, Denver, USA. Isoguchi, O., and M. Shimada, 2006: Disaster monitoring technique using ALOS/PALSAR, SPIE Asia-Pacific Remote Sensing 2006, Goa, India.

Kachi, M., and R. Oki: Japanese Precipitation Missions. The Second IGWCO Planning Meeting, Paris, France. 2-4 March, 2006.

Kachi, M., and R. Oki: Japanese Activities for Applying Satellite-derived Precipitation to Flood Forecasting. The Second IGWCO Planning Meeting. Paris, France. 2-4 March, 2006.

Kachi, M., R. Oki, S. Shimizu and M. Kojima: Global Precipitation Measurement (GPM) Mission and its Application Use. SPIE Asia Pacific Remote Sensing 2006. Goa, India. 12-15 November, 2006.（※JAXA安岡技術参与による代理発表）

R. Oki, and M. Kachi: JAXA's precipitation missions. 3rd IPWG Workshop. Melbourne, Australia. 23-27 October, 2006.（※気象研青梨氏による代理発表）

Tadono, T., M. Shimada, M. Watanabe, A. Mukaida*, S. Kawamoto*, N. Imoto* and J. Yamashita*, 2006: Initial results of calibration and validation for ALOS optical sensors, Proceedings of International Geoscience and Remote Sensing Symposium (IGARSS), CD-ROM.

5.5.2 EORC International Workshops

Isoguchi, O., and M. Shimada, 2006:PALSAR geometric evaluation using DEM, 4th PALSAR cal/val meeting, Harumi, Tokyo. Isoguchi, O., and M. Shimada, 2006:Preliminary study on developing an L-band geophysical model function using ALOS/PALSAR, 5th PALSAR cal/val meeting, Harumi, Tokyo.

5.5.3 Japanese Society Meetings

磯口治, 島田政信, *川村宏, 2006:SAR・散乱計による"やませ"に伴う北海道周辺域の局地風, 2006年度日本海洋学会秋季大会, 名古屋.

This document is provided by JAXA.

大串文美*, 島田政信, 田殿武雄, 渡辺学, 南澤舞*, 2006: ALOS校正検証のための観測計画と基本観測計画について, 日本リモートセンシング学会第41回学術講演会論文集, 329-330.

岡村吉彦, 田中一広, 木村俊義, 村上浩, 丹下義夫: 地球環境変動観測ミッション(GCOM)搭載用多チャンネル走査放射計(SGLI)の概念設計.信学技報, vol.106, no. 107, SANE2006-81, pp. 85-88, 2006年6月

小野朗子*, 小野厚夫： バンド和で正規化したスペクトルを用いた植生指数の開発, 日本リモートセンシング学会第40回学術講演会論文集, pp. 21-22, 2006.

小野朗子*, 梶原康司, 本多嘉明: 植物の生育状況把握のための植生指数の開発, 日本写真測量学会平成18年度年次学術講演会発表論文集−空間情報の計測と利用−, pp. 193-194.

小野朗子*, 梶原康司, 本多嘉明: 植物の生育状況把握のための植生指数の開発 II, 日本写真測量学会平成18年度秋季学術講演会発表論文集−空間情報の計測と利用−, pp. 93-94.

小野朗子*, 小野厚夫： バンド和で正規化したスペクトルを用いた植生指数の開発 II, 日本リモートセンシング学会第41回学術講演会論文集, pp. 11-12, 2006.

菊地信行, 久慈誠, 高村民雄, 竹中栄晶: GLI可降水量プロダクトの検証その２,気象学会秋季大会,2006年10月

田殿武雄, 島田政信, 高久淳一*, 向井田明*, 山下淳子*, 石橋慶憲*, 2006:陸域観測技術衛星「だいち」搭載PRISMによる標高データの抽出について,水文・水資源学会2006年度研究発表会要旨集, 148-149.

田殿武雄, 島田政信, 渡辺学, 高久淳一*, 向井田 明*, 2006:「だいち」搭載光学センサ(PRISM, AVNIR-2)の校正検証の初期結果,第50回宇宙科学技術連合講演会, 日本航空宇宙学会, アブストラクト 26,講演集 (CD-ROM), 276-281.

田殿武雄, 島田政信, 橋本俊昭, 村上浩, 高久淳一*, 向井田明*, 2006: ALOS搭載光学センサ(PRISM, AVNIR-2)の初期校正結果 -速報-, 日本リモートセンシング学会第41回学術講演会論文集, 129-130.

細田皇太郎, 村上浩：Terra・Aqua搭載MODISによる日本近海域SST推定アルゴリズム(2)、日本海洋学会2006年度春季大会、2006年3月、横浜

堀雅裕, 青木輝夫*、K. Stamnes*, W. Li*, 2006: ADEOS-II/GLIデータを用いた半球規模積雪物理特性の時空間変動解析, 日本気象学会, 名古屋市, 愛知.堀雅裕, 青木輝夫*、K. Stamnes*, W. Li*, 2006: ADEOS-II/GLIデータを用いた半球規模積雪物理特性の時空間変動解析, 日本雪氷学会全国大会, 秋田市, 秋田.堀雅裕, 2006: 光学（GLI)センサによる積雪観測, 日本雪氷学会全国大会, 衛星観測分科会, 秋田市, 秋田.

向井田明*, 田殿武雄, 河本佐知*, 高久淳一*, 井本成俊*, 2006:初期校正運用機関におけるALOS/PRISMの画質評価, 日本リモートセンシング学会第41回学術講演会論文集, 323-324.

This document is provided by JAXA.

This document is provided by JAXA.

6.EORC PUBLICATION LIST

This document is provided by JAXA.

6. EORC PUBLICATION LIST

GLI解析成果集冊子「気候変動の解明に向けて. Global Imagerがとらえた地球」

Earth Observation Research and application Center CD-ROMs

- JAXA/EORC-081　気候変動の解明に向けて. Global Imagerがとらえた地球（CD-R版）

This document is provided by JAXA.

7. BUDGET AND PERSNNEL

This document is provided by JAXA.

7. BUDGETS AND PERSONNEL

7.1 Budgets (for fiscal years of 1995 to 2006, units in million yen)

1995	3,145
1996	4,557
1997	4,438
1998	3,304
1999	3,629
2000	4,974
2001	11,789
2002	12,106
2003	10,363
2004	9,762
2005	10,273
2006	9,328

7.2 Number of Personnel

	FY1995	FY1996	FY1997	FY1998	FY1999	FY2000	FY2001
NASDA workers	16	27	24	26	29	31	77
invited scientists	5	11	22	29	36	39	71
post-doctorates	0	2	1	3	3	9	10
STA fellows	0	1	1	2	2	2	2
contract workers	5	10	12	17	16	18	18
total	26	51	60	77	86	99	178

	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006
NASDA/JAXA workers	57	80	78	81	82
invited scientists	72	14	15	15	11
post-doctorates	11	8	7	4	5
STA fellows	0	0	0	0	0
contract workers	25	19	21	23	19
total	165	121	121	123	117

numbers at the beginning of FY

This document is provided by JAXA.

8. HISTORY OF EORC

This document is provided by JAXA.

8. HISTORY OF EORC

1995

April 1	EORC established.
June 6	Global Observation Information Network (GOIN) conference held jointly with NASA and USA; Ms. Makiko Tanaka, Minster of the Science and Technology Agency was invited.

1996

March 5-9	First EORC Symposium.
August 14	First Earth Observation Research Committee meeting.
August 17	Advanced Earth Observation Satellite (ADEOS) launched from Tanegashima Island.
September 1	First image from ADEOS released.
September 25-27	Remote Sensing Technology Fair held in Makuhari Messe.

1997

January 2	Observation of spilled oil from Russian tanker which sank in the Japan Sea started.
March 10-14	Second ADEOS Workshop held in Yokohama.
June 30	ADEOS ceased functioning.
July 3	Observation of spilled oil from Liberian tanker in Tokyo Bay.
August 21	Third Earth Observation Research Committee meeting.
October 1	Earth Frontier Research System established.
November 28	TRMM launched from Tanegashima Island.
December 17	First image from TRMM released.

1998

January 26-30	Third ADEOS Symposium held in Sendai.
April 1	Dr. Toshihiro Ogawa was appointed Executive Director of EORC.
April 15-June 15 and August 31-September 15	GEWEX/GAME-Tropics Campaign in Thailand.
May 13	Joint TRMM Science Team (JSTS).
May 14-September 30	GEWEX/GAME-Tibet Campaign.
May 20-June 1	TRMM Validation Project IMCET.
June 2	Global Rainfall Forest Mapping Project Workshop.
June 26	Fourth TRMM Science Team Meeting.
July 6	Press release on TRMM/TMI observing El Nino/La Nina sea surface temperature.
July 6-9	Earth Observation Subcommittee to evaluate NASDA's Earth Observation field.
July 10	Press release on TRMM/PR 3-D Rainfall Image of Typhoon No. 1.
September 1	TRMM data release.
September 1-2	Earth Observation Fair 1998 held in Tokyo.
September 9-11	Second GLI Workshop.

This document is provided by JAXA.

September 21-October 10	BIBLE experiment in Darwin and Indonesia.
October 12	ADEOS Research Report Symposium. JERS-1 ceased function.
November 4-6	ADEOS Research Report Workshop.
November 9-12	Second AMSR Workshop.
November16-17	ADEOS PI meeting for ESCAP countries.
November16-20	JERS-1 PI/GRFM/GBFM Workshop.
November 24	SeaWiFS data release.
December 9-10	PALSAR, AIR SAR & INSAR Workshop.
December 14-16	Symposium on the Precipitation Observation from Non-Sun Synchronous Orbit held in Nagoya.

1999

January 13-14	International Workshop on Earth Science Study in Asia-Pacific Region.
March	International PR Team Meeting.
April 2	ADEOS-II Program Meeting.
May 15-June 7	TRMM Ishigaki/Miyako Islands Campaign.
May 17-18	JERS-1 Symposium.
June 21-23	TRMM Kyoto Symposium.
July 6-8	BIBLE Workshop.
September 14-15	Earth Observation Fair 1999 in Yokohama.
October 4-5	Remote Sensing Training Seminar in Marine Application.
October 12-14	Airborne SAR observation experiments held in Tsukuba, Mt. Fuji, and Tomakomai.
November 2-12	Applications of Marine Remote Sensing Training Course held in Bangkok under cooperation with IOCCG, NASA, JRC/EC, and AIT.
November 4-5	PALSAR Workshop.
December 6-10	ADEOS/ADEOS-II Symposium/Workshop were held in Kyoto.

2000

February 14-15	CEOS Disaster Management WG meeting.
February 18	Earth Observation Lecturing Tour #1 held at Ino Junior High School in Kochi Prefecture.
March 11	Earth Observation Lecturing Tour #2 at Misato Observatory in Wakayama Prefecture.
April 3	Press release on Mt. Usu’s volcanic activities by using Earth Observation satellite data.
May 16	Press release on Mt. Usu’s volcanic activities by using Earth Observation satellite data.
May 22-24	Sponsored ASSFTS meeting in Kyoto.
June 26	Ad-hoc committee decided major specifications for next EORC Data Analysis System.

This document is provided by JAXA.

June16-17	Fifth GAME International Science Panel meeting.
June 28	GLI science leaders meeting decided policy for ocean channels saturation Issue.
July 3-8	Sponsored International Ozone Symposium in Sapporo.
July 9-13	Sponsored IGARSS 2000 in Hawaii.
July 10	TRMM 3rd Research Announcement issued.
July 13	ADEOS-II Joint Program Meeting.
July 19	ALOS 1st Research Announcement PIs selected.
August 2-3	Earth Observation Fair.
September 14	Progress Meeting for joint Research with Fisheries Agency on Ocean Biology and Fishery Application.
October 9-12	Sponsored SPIE Meeting in Sendai.
October 30-November 1	AMSR/AMSR-E Workshop.
November 7-10	GLI Workshop.
November13-14	NOAA-NASDA Earth Observation Joint Working Group.
November 27	ATMOS-A1/GPM Meeting.
November 28	Symposium Commemorating the Third Anniversary of the Launch of the TRMM Satellite.
November 29-30	Joint TRMM Science Team Meeting.
November 28-December 14	BIBLE Experiment at Darwin.
December 1	International Symposium on the Earth Observation from Space.
December13-14	Symposium on ADEOS-II data utilization in Asia and Pacific, co-organized by UN/ESCAP and NASDA/EORC.

2001

January 22	Meeting for Joint Research with Fisheries Agency on Ocean Biology and Fishery Application.
January 26	TRMM 3rd Research Announcement selected.
January 29-February 2	WCRP/GEWEX Science Steering Group meeting.
January 30-February 1	Participated in EOS Workshop.
February 19-20	ALOS Data Node Technical Interface Meeting #1.
March 27-30	ALOS Symposium/1st PI Workshop.
April 1	Start of big EORC involving former EOSD and EOC functions.
April 2-4	Hosted CEOS SAR CAL/VAL meeting.
June 1	The first TRMM (3rd RA) PI Meeting.
June 7	ALOS Ground System Design Review.
June 13	TRMM/SDPF Operation Readiness Review.
July 30	Opening of new office in Harumi moved from Roppongi.
August 1	Special Lecture by Nobel Laureate Professor F. Sherwood Rowland on “Stratospheric Ozone Depletion : Theory, Measurements from Space and Ground”.
August 7-24	TRMM satellite altitude boosted.
August 30	Airborne SAR Observation Experiments at EOC.
October 1-2	6th GAME International Science Panel Meeting.

This document is provided by JAXA.

October 3-5	5th GAME International Study Conference on GEWEX in Asia and GAME
November 1-2	Joint TRMM Science Team Meeting.
November 2	ADEOS-II Ground System Development Completion Review.
November 6	Airborne SAR Observation Experiments at EOC.
November 9	Global Precipitation Measurement (GPM) Symposium.

2002

January 7-23	PEACE and Airborne OPUS Experiments at Nagoya and Kagoshima Airports.
February 18-20	2nd ALOS Data Node Technical Interface Meeting.
February 27	EOS-PM1/AMSR-E Ground System Development Completion Review.
March 11	EORC of Head Office (former EOSD) moved and joined EORC of Harumi.
April 10-12	4th ALOS Data Node Inter-Agency Meeting.
April 20-May 15	PEACE-B and AirborneOPUS Experiments at Nagoya Airport.
May 4	AMSR-E Joint Science Team Meeting.
May 5-10	CEOS Working Group on Information System and Service at ESA/ESRIN.
May 13-17	Kyoto and Carbon Initiative, 2nd Science advisory Panel Meeting.
May 20-22	2nd International Planning Workshop on GPM.
June 11	Airborne SAR Observation Experiments.
June 24-28	Sponsored IGARSS 2002 in Sydney.
July 22-26	1st TRMM International Science Conference.
July 25	MODIS Image was released.
August 8-10	AMSR-E Joint Science Team Meeting.
September 3-6	Pan Ocean Remote Sensing Conference 2002.
October 14-15	The Kyoto and Carbon Initiative, 3rd Science Advisory Panel Meeting.
October 17	“What was found by ADEOS” Lecture.
November 6	Airborne SAR Observation Experiments.
November 6-7	7th GAME International Science Panel(GISP) Meeting.
November 8	MODIS data was released.
November 14	International Symposium Commemorating 5th Anniversary of TRMM.
November 29	Satellite Observing System for the Ecology of Marine and Fisheries Meeting.
December 14	ADEOS-II was launched successfully.
December 24-25	2nd Workshop for TRMM PI Interim Reports.

2003

January 16-17	SAR Workshop 2003.
January 18	First light image of AMSR was successfully received and processed.

This document is provided by JAXA.

January 25	First light image of GLI was successfully received and processed.
February 19	Workshop of Atmospheric Environment Monitoring Using Satellite
February 19-20	1st Workshop of GPM Data Working Group.
March 5-6	PEACE-B and ITCT 2002 Joint Science Team Meeting held at NOAA.
March 5-7	5th ALOS Data Node Inter-Agency Meeting.
March 12-14	ADEOS-II AMSR Workshop 2003.
May 20	ADEOS-II Routine Operation Readiness Review at Tsukuba Space Center.
May 20-23	ALOS Kyoto & Carbon Initiative 4th Science Advisory Panel Meeting.
May 22-23	ADEOS-II NGN Mission Operation Meeting at Tsukuba Space Center.
June 18	Release of AMSR-E Level-1 product.
June 24	Operation Transfer Review of AMSR-E L1 processing system.
June 24-26	3rd GPM Workshop in Noordwijk.
July 21-25	ALOS special session at IGARSS 2003 in Toulouse.
June 24-26	3rd GPM Workshop in Noordwijk.
July 26-29	3rd ALOS Data Node Technical Interface Meeting.
August 24-30	16th APAN Meetings -Earth Monitoring Workshop in Busan.
August 25	GPM/DPR Project Readiness Review #1.
August 26-27	Polarimetric Interferometric SAR Workshop 2003 in Niigata.
September 1	NASDA/CRL joint Pi-SAR AO was issued.
September 14-19	Participated in CEOS Working Group on Information System and Service in Chiang Mai.
September 16-19	ALOS international CAL/VAL meeting #1.
September 19	Release of AMSR-E physical parameter products.
October 21-22	AMSR Science Workshop in Monterey.
October 25	ADEOS-II stopped.
October 27-30	6th ALOS Data Node Inter-Agency Meeting in Sydney.
November18-21	ALOS Kyoto & Carbon Initiative 5th Science Advisory Panel Meeting.
November 25	GOSAT Project Readiness Review #1.
December 7	NASDA/CRL joint Pi-SAR PIs were selected.
December 11	Release of AMSR Level-1 product.
December 24	Release of ADEOS-II GLI/AMSR Level-1 and physical parameter product.

2004

January 15	1st PI meeting of Pi-SAR AO Program.
January 19-23	ALOS 2nd PI Meeting and Final Meeting of JERS-1 RI Program at Awaji Yumebutai Conference Center.
February 2-3	GPM Asia Workshop in Tokyo.
February 3-4	Water Cycle Asia Workshop in Tokyo.

This document is provided by JAXA.

February 2-6	IGOS International Workshop in Tokyo.
February 7-10	Pi-SAR 1st AO observation flights.
February 19-20	GPM Data Working Group Workshop.
March 1-3	ADEOS-II Workshop in Tokyo.
March 9-12	3rd CEOP International Implementation Planning Meeting at UCI.
March 9	Seminar on Pilot Project for ALOS Data Utilization in Bangkok.
April 21	GOSAT Symposium.
April 23	GEO-IV Plenary Meeting.
April 25	Earth Observation Summit-II.
May 17-19	7th Inter-Agency Meeting of the ALOS Data Node.
May 17-21	3rd ALOS Kyoto and Carbon Initiative Coordinators Meeting in Santa Barbara.
June 28-30	10 th ICRS in Okinawa.
July 22	EOS Direct Data Reception System Operational Phase Readiness Review
August 3	Pi-SAR 2nd AO observation flights.
August 23-24	Pi-SAR Workshop 2004.
September 3	2nd DAS/GOSAT/GPM Ground System Meeting.
September 5-7	TRMM International Meeting.
September 17	JAXA Symposium for Pilot Project in Indonesia.
September 20-24	IGRASS 2004 in Anchorage.
October 5	Satellite Remote Sensing Committee.
October 7	3rd DAS/GOSAT/GPM Ground System Meeting.
October 19-22	4th ALOS Kyoto and Carbon Initiative Coordinators Meeting.
October 31-November 7	APRSAF-11.
November 3-7	Pi-SAR 3rd AO observation flights experiment.
November 21-22	Training Workshop on Digital Asia at the 25th ACRS in Chiang Mai.
November 22-26	Exhibition at 25th ACRS in Chiang Mai.
December 7-10	FY16 ADEOS-II PI Workshop.

2005

January 11	SAR Workshop 2005.
January 20	Asian Workshop in Kobe.
February 12-15	Pi-SAR 4th AO observation flights.
February 16	Earth Observation Summit III.
February 16	Signing of International Charter on “Space and Major Disasters”.
February 22	2nd Seminar on Pilot Project for ALOS Data Utilization in Thailand.
February 28-March 3	ALOS Kyoto and Carbon Initiative 6th Advisory Panel / Science Team Meeting.
February 28- March 4	CEOP/IGWCO Joint Meeting.
July 25-29	IGARSS2005, Seoul, Korea
September 12-16	Joint AMSR Science Team Meeting.
October 11-13	APRSAF-12, Fukuoka, Japan
October 16-21	56th Intern. Astronautical Congress, Space Fair Exhibition, Fukuoka

This document is provided by JAXA.

October 25	Intern. Arctic Research Center Seminar, Fairbanks, Alaska
November 7-9	5th Global Precipitation Measurement(GPM) Intern. Planning Workshop, Tokyo
November 7-11	ACRS2005 26th Asia Remote Sens. Conference, Hanoi, Vietnam
November 9	GPM Program Meeting, Tokyo

2006

January 9-13	18th GEWEX Science Steering Group Meeting, Dakar
January23	Symposium on AMSR/GLI in Tokyo
January24-26	AMSR Workshop in Tokyo
January 24	ALOS was launched successfully.
February16-17	SCOSA in Hanoi, Vietnam
March 1-3	IGOS Water Theme Workshop, Paris
March 2-3	Workshop for 4th Precipitation Measuring Mission Science PI Interim reports.
March6-10	EarthCare CPR JMAG Meeting
March 23	4th GPM Science Team Meeting, Tokyo
May 17-29	4th TRMM Latent Heating Workshop, Seattle
June 15	GCOM Symposium, Tokyo, JapanJune 26-29 ALOS Ca//Val & Science Team Meeting #
July 18	NASA-JAXA GPM Program Meeting/GPM Science Coordination Group meeting, Tokyo
July 31-August 4	IGARSS2006, Denver, U.S.A
July 31	IGARSS GPM special session
September 6-8	Joint AMSR-E Science Team Meeting, La Jolla, USA
September 12	SPIE GPM special session
September 26-28	Capacity Building in Asia, “Earth Observations in the service of water management”, Bangkok
September 29	16th UN/IAF Workshop on the use of space technology for water management, Spain
October 9-13	ACRS2006 27th Asia Remote Sens. Conference, Ulaanbaatar, Mongolia
October 12-13,16-17	ALOS Ca//Val & Science Team Meeting #5
November 3	NASA-JAXA GPM Program Meeting, NASA HQs
November 6-8	6th GPM International Planning workshop, Annapolis
November 28	GPM/DPR Preliminary Design Review (Baseline Document Review)
December 4-8	APRSAF-13, Jakarta, Indonesia
December 19	GPM/DPR Preliminary Design Review

2007

January 16-19	Kyoto & Carbon Initiative Science Team Meeting #7
January 22-26	19th GEWEX Science Steering Group Meeting, Hawaii
January 29	AMSR/GLI Workshop, Tsukuba, Japan

This document is provided by JAXA.

January 30	GLI PI Workshop, Tsukuba, Japan
January 30-31	AMSR PI Workshop, Tsukuba, Japan
February 1	Special lecture on TRMM data handling/training to Asia Mini-project participants, AIT
February 16	5th Precipitation Measuring Mission Science Research Announcement issued
February 19-20	I 7th International Conference on Global Change: Connection to the Arctic (GCCA-7), Fairbanks, Alaska
March 5-6	Workshop for 4th Precipitation Measuring Mission Science PI final reports.
March 6-7	SAR Workshop 2007
March 17	Symposium on Alaskan Wild Fire and Global Change, Tokyo, Japan
March 20	5th GPM Science Team Meeting, Tokyo

This document is provided by JAXA.

This document is provided by JAXA.

9. ACRONYMS AND ABBREVIATIONS

This document is provided by JAXA.

9. ACRONYMS AND ABBREVIATIONS

(1) Institutes & Organizations

ASIT	National Institute of Advanced Industrial Science and Technology (Japan)
ASF	Alaska Satellite Facility
CEOS	Committee of Earth Observation Satellite (International)
CNES	Centre National d'Etudes Spatiales (France)
ECMWF	European Center for Medium-Range Weather Forecast
EOC	Earth Observation Center (JAXA/EORC, Japan)
EORC	Earth Observation Research Center (JAXA, Japan)
ERSDAC	Earth Remote Sensing Data Analysis Center (Japan)
ESA	European Space Agency
ESRIN	European Space Research Institute
GA	Geoscience Australia
GEO	Group on Earth Observations
GISTDA	Geo-Informatics and Space Technology Development Agency (Thailand)
GPCC	WMO’s Global Precipitation Climatology Center (International, in Germany)
GSFC	Goddard Space Flight Center (NASA, USA)
GSI	Geographical Survey Institute (Japan)
GSJ	Geological Survey of Japan (ASIT, Japan)
HEEIC	Hiroshima Earth Environmental Information Center (Hiroshima, Japan)
INPA	Brazilian National Institute of the Amazon
IGOS	Integrated Global Observing Strategy
INPE	Brazilian National Institute for Space Research
IOCCG	International Ocean Color Coordinating Group (International)
JAFIC	Japan Fisheries Information Service Center
JAMSTEC	Japan Marine Science and Technology Center
JAROS	Japan Resources Observation System Organization
JAXA	Japan Aerospace Exploration Agency
JCG	Japan Coast Guard
JHD	Hydrographic Department of Japan
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JPL	Jet Propulsion Laboratory (NASA, USA)
JRC	Joint Research Center of European Commission
JWA	Japan Weather Association
LAPAN	National Institute of Aeronautics and Space of Indonesia
LIPAP	Lanzhou Institute of Plateau Atmospheric Physics (China)
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
METI	Ministry of Economy, Trade and Industry (Japan)
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
MOE	Ministry of Environment (Japan)
MRI	Meteorological Research Institute (JMA, Japan)
MSFC	Marshall Space Flight Center (NASA, USA)
MWR	Ministry of Water Resources (India)
NASA	National Aeronautics and Space Administration (NASA, USA)
NASDA	National Space Development Agency of Japan
NCEP	National Center for Environmental Prediction (NOAA/NWS, USA)
NIAES	National Institute Agro-Environmental Sciences (Japan)

This document is provided by JAXA.

NICT	National Institute of Information and Communications Technology (Japan)
NIED	National Research Institute for Earth Science and Disaster Prevention (Japan)
NIES	National Institute for Environmental Studies (Japan)
NOAA	National Oceanic and Atmospheric Administration (DOC, USA)
NWS	National Weather Service (NOAA, USA)
PWRI	Public Works Research Institute (Japan)
RAL	Rutherford Appleton Laboratory (UK)
RESTEC	Remote Sensing Technology Center (Japan)
SSC	Swedish Space Corporation
TKSC	Tsukuba Space Center (JAXA, Japan)
TMD	Meteorological Department of Thailand
UCSB	University of California, Santa Barbara (USA)
UKMO	UK Met Office
WMO	UN's World Meteorological Organization (International, in Switzerland)

(2) Projects

CEOP	Coordinated Enhanced Observing Period
GAME	GEWEX Asian Monsoon Experiment
GBFM	Global Boreal Forest Mapping Project
GCMAPS	Global Carbon Cycle and Related Mapping based on Satellite Imagery Program
GEWEX	Global Energy and Water Cycle Experiment
GOIN	Global Observing Information Network
GFM	Global Rain Forest Mapping Project
PEACE	Pacific Exploration of Asian Continental Emission
SPF	Stratospheric Platform
WCRP	World Climate Research Program
WOCE	World Ocean Circulation Experiment

(3) Satellites and spacecrafts

ADEOS	Advanced Earth Observing Satellite
ADEOS-II	Advanced Earth Observing Satellite-II
ALOS	Advanced Land Observing Satellite
Aqua	Earth Observing System PM-1 (USA)
DMSP	Defense Meteorological Satellite Program (USA)
DRTS	Data Relay Test Satellite
ENVISAT	Environment Satellite (Europe)
ERS-1,2	ESA Remote Sensing Satellite-1, 2
GCOM	Global Change Observation Mission
GOSAT	Greenhouse gasses Observing Satellite
GPM	Global Precipitation Measurement
GOES	Geostationary Operational Environmental Satellite (USA)
ISS	International Space Station
JEM	Japanese Experiment Module (ISS)
JERS-1	Japanese Earth Resources Satellite-1
LANDSAT	Land Remote Sensing Satellite (USA)
MOS	Marine Observation Satellite
NOAA	National Oceanic and Atmospheric Administration (USA)
SPOT	Satellite Pour d'Observation de la Terre (France)
Terra	Earth Observing System AM-1 (USA)
TRMM	Tropical Rainfall Measuring Mission (USA)

This document is provided by JAXA.

(4) Instruments

AMSR	Advanced Microwave Scanning Radiometer (ADEOS-II)
AMSR-E	Advanced Microwave Scanning Radiometer for EOS (Aqua)
AVHRR	Advanced Very High-Resolution Radiometer (NOAA)
AVNIR	Advanced Visible and Near Infrared Radiometer (ADEOS)
AVINIR-2	Advanced Visible and Near Infrared Radiometer-2 (ALOS)
CERES	Clouds and the Earth's Radiant Energy System (EO-1, TRMM, Terra, Aqua)
DPR	Dual-frequency Precipitation Radar (GPM)
GLI	Global Imager (ADEOS-II)
GMI	GPM Microwave Imager (GPM)
ILAS	Improved Limb Atmospheric Spectrometer (ADEOS)
ILAS-II	Improved Limb Atmospheric Spectrometer -II (ADEOS-II)
IMG	Interferometric Monitor for Greenhouse gases (ADEOS)
LIS	Lightning Imaging Sensor (TRMM)
MODIS	Moderate Resolution Imaging Spectroradiometer (Terra, Aqua)
MSS	Multi Spectral Scanner (LANDSAT)
OCTS	Ocean Color and Temperature Scanner (ADEOS)
OPS	Optical Sensor (JERS-1)
PALSAR	Phased Array Type L-band Synthetic Aperture Radar (ALOS)
Pi-SAR	Polarimetric Interferometric Synthetic Aperture Radar
POLDER	Polarization and Directionality of the Earth's Reflectances (ADEOS-II)
PR	Precipitation Radar (TRMM)
SAR	Synthetic Aperture Radar (JERS-1 etc.)
SeaWiFS	Sea-viewing Wide Field-of-view Sensor (Orb View-2, SeaStar)
SMMR	Scanning Multispectral Microwave Radiometer (Nimbus-7)
SMILES	Superconducting Submillimeter-wave Limb Emission Sounder (ISS/JEM)
SSM/I	Special Sensor Microwave/Imager (DMSP)
SWIR	Short Wave Infrared Radiometer (JERS-1/OPS)
TMI	TRMM Microwave Imager (TRMM)
VIRS	Visible Infrared Scanner (TRMM)
VNIR	Visible and Near Infrared Radiometer (JERS-1/OPS)

(5) Computers and information

DCW	Digital Chart of the World
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
EOIS	Earth Observation Information System
EOSDIS	Earth Observation Satellite Data Information System
GIS	Geographic Information System
GMT	Generic Mapping Tool
HDF	Hierarchical Data Format
ISS	Information Service System

(6) Others

DAS	Data Analysis System
DCS	Data Collection System
DT	Direct Transmission (system)
GCM	General Circulation Model
GCP	Ground Control Points

This document is provided by JAXA.

MDR	Mission Data Recorder
MOU	Memorandum of Understanding
SST	Sea Surface Temperature

This document is provided by JAXA.

Earth Observation Research Center (EORC)

Japan Aerospace Exploration Agency

Tsukuba Space Center
2-1-1 Sengen,Tsukuba-shi,Ibaraki,305-8505 Japan
Tel. +81-29-868-5608 Fax. +81-29-868-5987

This document is provided by JAXA.