Global Data Production for Earth Sciences and Technology Research

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Abstract

The objective of earth science data set generation is to identify and describe phenomena related to global environmental changes and to estimate quantitatively the rate of environmental changes or effect on human activities.

The satellite-based remote sensing data are a key component of data sets. However, they must be validated by *in situ* data and for long-term prediction, the accuracy of data sets is essential. Therefore, it is increasingly important to develop high accuracy algorithm to derive geophysical parameters through validation, to obtain more systematic ground truth to match up data set, and to accumulate remote sensing data for models.

As a satellite program, Global Change Observation Mission (GCOM) concept is in the research phase. This program will start from the launching of Advanced Earth Observing Satellite-II (ADEOS-II) in 2000, followed by four satellites for a 15-year monitoring period.

As for regional applications, Advanced Land Observing Satellite (ALOS) will be launched in 2002.

For the data set generation, a well-organized system is important, involving data providers and scientific community or application users. Global Research Network System (GRNS) is an example of unique system of data set generation research in the Asia-Pacific region.

These satellite programs and data set generation projects should be integrated interdisciplinary, systematically and internationally.

Introduction

Global observation data sets provided by earth observation satellites is expected to contribute significantly to the elucidation of global environmental issues such as global warming, depletion of the atmospheric ozone layer, deforestation of tropical rain forests, and anomalous weather or climatic phenomena like *El Nino*.

Earth observation satellite data are also expected to contribute significantly to the social and economic activities and sustainable development of the Earth with provision of spatial or geographical information on a variety of thematic maps for weather forecast, disaster monitoring, natural resources exploration, land use survey, agricultural environmental studies, forest resources management, prediction of fishing grounds and so on.

Earth observation satellite programs of the National Space Development Agency of Japan (NASDA) are summarized in Table 1.

NASDA has developed, launched and operated Marine Observation Satellite-1/1b (MOS-1/1b), Japanese Earth Resources Satellite-1 (JERS-1), Advanced Earth Observing Satellite (ADEOS).

MOS-1/1b are long-life satellites operated for eight years nine months from February 1987 to November 1995 and six years two months from February 1990 to April 1996, respectively. Total numbers of visible and near infrared radiometer MESSER image scenes received by ground stations in Hatoyama (Japan), Bangkok

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Table 1 Program of NASDA earth observation satellites

Project	Mission	Sensor	Operration
1. MOS-1/1b (Marine Observation Satellite)	-Establishing a basic technology for Earth observation satellites -Developing Multi-Spectral Electronic Self-Scanning Radiometer (MESSR) and Microwave Scanning Radiometer (MSR) -Confirming the performance and functionality of these sensors -Observing the ocean with these sensors	·MESSR (Multispectral Electronic Self-Scanning Radiometer) ·VTIR (Visible and Thermal Infrared Radiometer) ·MSR (Microwave Scanning Radiometer)	Feb. 1987-Mar. 1995 (MOS-1) Feb. 1990-Apr. 1996 (MOS-1b)
2. JERS-1 (Japanese Earth Resources Satellite, NASDA/MITI)	-Establishing a basic technology for the acquisition of the global Earth data focusing on natural resources observation by Synthetic Aperture Radar (SAR) and Optical Sensor (OPS) -Natural resources exploration, land survey, agriculture, forestry and fisheries, environment conservation, coastal monitoring, disaster prevention	·SAR (Synthetic Aperture Radar) ·OPS (Optical Sensor)	Feb. 1992-Oct. 1998
3. ADEOS (Advanced Earth Observing Satellite)	-Contributing to international monitoring of global changes -Maintaining and developing Earth observation technology -Developing technology requied for future Earth observation satellites	·OCTS (Ocean Color and Temperature Scanner) ·AVNIR (Advanced Visible and Near-infrared Radiometer) ·IMG (Interferometric Monitor for Gerrnhouse Gases, MITI) ·ILAS (Improved Limb Atmospheric Spectrometer, EA) ·RIS (Retroteflector in Space, EA) ·NSCAT (NASA ·TOMS (Total Mapping Spectrometer, NASA) ·POLDER (Polarization and Directionality the Earth's Reflectances, CNES)	Sep. 1996-Jun. 1997
4. TRMM (Tropical Rainfall Measuring Mission, NASA/NASDA)	-Acquiring satellite data related to precipitation intensity and concentration in the tropical and subtropical regions	·PR (Precipitation Radar) ·TMI (TRMM Microwave Imager, NASA) ·VIRS (Visible and Infrared Scanner, NASA) ·CERES (Clouds and the Earth's Radiant Energy System, NASA) ·LIS (Lightning Imaging Sensor, NASA)	Nov. 1997-
5. ADEOS-II (Advanced Earth Observing Satellite II)	-Continuing and improving ADEOS missions -Providing data for international climate change research (ex. understanding of global change mechanisms) and fields of practical use (ex. meteorological services, fisheries industry)	·GLI (Global Imager) ·AMSR(Advanced Microwave Scanning Radiometer) ·ILAS-II (Improved Limb Atmospheric Spectrometer-II, EA) ·SeaWinds, NASA ·POLDER (Polarization and Directionality of the Earth's Reflectance, CNES)	2000(scheduled)
6. AMSR-E (on board EOS-PM1, NASA)	-Observing water vapor and sea surface temperature which are essential to elucidate a global water-energy cycle mechanism under Japan-U.S. cooperation	·AMSR-E(Advanced Microwave Scanning Radiometer-E)	2000 (scheduled)
7. ALOS (Advanced Land Observing Satellite)	-Mapping and updating geological information -Conducting Earth observations necessary for sustainable development -Rapidly assessing large-scale disasters -Natural resources exploration -Developing technology necessary for future Earth observation	·AVNIR-2 (Advanced Visible and Near Infrared Radiometer type 2) ·PRISM (Panchromatic Remote Sensing Instrument for Stereo Mapping) ·PALSAR (Phased Array type L-band Synthetic Aperture Radar, NASDA/MITI)	2002 (scheduled)
8. MDS-2/LIDAR	MDS-2 is planned to have three major technical objectives. 1) Demonstration of the technical feasibility of a satellite-borne lidar. 2) Establishment of basic technology for future active optical sensor. 3) Acquisition of experimental observation data on upper clouds and aerosols.	·LIDAR(Light Detection And Ranging)	2002 (scheduled)
9. JEM/SMILES	The objectives of JEM/SMILES are to demonstrate a sensitive submillimeter-wave sounder and to monitor the global distribution of the stratospheric trace gases.	·SMILES (Superconducting Submillimeter-Wave Limb Emission Sounder)	2003 (scheduled)

(Thailand) and Syowa Base in the Antarctic are 265,502, 124,639 and 81,830, respectively. These data sets including images detecting the land cover change due to Mt. Pinatubo eruption in 1991, flood in Bangladesh in 1988 and so on, seem to be useful to detect the land cover changes in the Southeast Asia region.

JERS-1 is also a long-lived satellite operated from February 1992 to October 1998. During this period, 746,199 L band Synthetic Aperture Radar (SAR) scenes and 344,525 Optical Sensor (OPS) scenes had been obtained and the total global land area covered amounts to 97% by SAR and 63% by OPS. NASDA has two data set generation projects making the best use of the large amount of global high resolution data, especially L band SAR data which are characterized by a high sensitivity to the trunk of trees in forests and lower temporal degradation effective for interferometry. They consist of the Global Rain/Boreal Forest Mapping Project (GRFM/GBFM) and SAR interferometry to detect land surface displacement by earthquakes, volcanic activities and so on.

ADEOS is a comprehensive earth observation satellite mainly used for the monitoring of global changes developed and launched in 1996 by NASDA in cooperation with MITI, EA, NASA and CNES, on which eight sensors are installed, OCTS, IMG, ILAS, TOMS, NSCAT, POLDER, RIS to measure the earth environment globally, and AVNIR to observe the land surface and coastal zone locally or regionally.

The main characteristics of ADEOS satellite and sensors are shown in Fig.1 and Table 2.

However ADEOS discontinued its operation before the end of its mission life. It functioned only during the period from 17 August, 1996 to 31 June, 1997 and continuous data have been obtained for about 9 months. ADEOS data sets have demonstrated the effective use of newly developed on-board sensors and they have

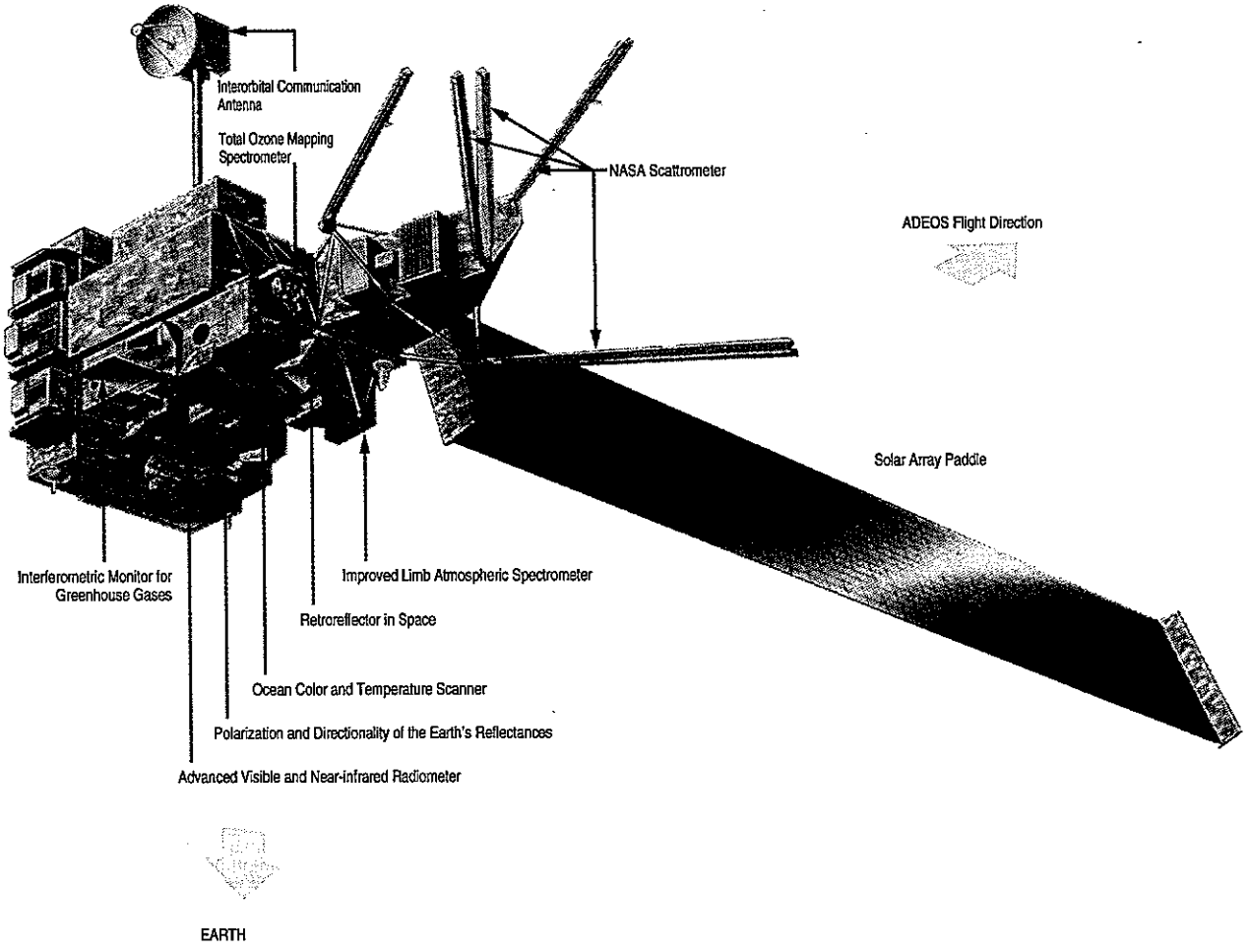


Fig. 1 ADEOS flight segment

Table 2 Main characteristics of ADEOS satellite and sensors

Main Characteristics of ADEOS

Shape	Module type with depoloyable solar padde (one wing) Body: Approx. 4 × 4 × 5 (m) (mission, bus module) Solar padde: Approx. 3 × 26 (m)	
Weight	Approx. 3.5ton (at lift-off)	
Attitude Control	Three-axis stabilized (zero-monentum)	
Design Life	3 years	
Launch Vehicle	H-II (5mg faining)	
Launch Site	Tanegashima Space Center, Kagoshima	
Launch Date	August 17, 1996	
Orbit	Type	Sun Synchronous Subrecurrent
	Altitude	Approx. 800km
	Inclination	Approx. 98.6deg.
	Period	Approx. 101min.
	Recurrent Period	41 days
	Local time descending node	10: 15-10: 45AM
Data Transmission	Direct Transmission and Inter-orbit Communication (Equipped with Mission Data Recorder)	

Major Specifications of NASDA Sensors

Sensor	Ocean Color and Temperature Scanner (OCTS)	Advanced Visible and Near-Infrared Radiometer (AVNIR)
Measurement Objectives	Ocean Color and Sea Surface Temperature	Land and Coastal Zone
Scanning Method	Mechanical	Electronic (CCD)
Wavelength	Visible 6Bands Near-infrared 2Bands Middle-infrared 1Band Thermal-infrared 3Bands	Visible 3Bands Near-infrared 1Band Panchromatic-Band (Visible) 1Band
Spatial Resolution	Approx. 700m	Multi-Band Approx. 16m Panchromatic-Band Approx. 8m
Swath Width	Approx. 1,400km	Approx. 80km

Major Specifications of AO Sensors

Sensor	County	Organization	Objectives and Major Specifications
NSCAT (NASA Scatterometer)	USA	NASA/JPL	Measurement of surface wind speed and direction over the global oceans Swath width: 1,200km, Frequency: 13.995GHz, Wind speed measurement accuracy: 2m/s Direction accuracy: 20° (at spatial resolution of 50km)
TOMS (Total Ozone Mapping Spectrometer)	USA	NASA/GSFC	Observation of total ozone changes, evaluation of changes in UV radiation and the observation of sulfur dioxide Swath width: 2,795km, Wavelength: 308.6, 312.5, 317.5, 322.3, 331.2, 360.0nm
POLDER (Polarization and Directionality of the Earth's reflectances)	FRANCE	CNES	Observation of bi-directionality and polarization of the solar radiation reflected by the Earth-atmosphere system Swath width: 1,825 × 2,470km Wavelength: 443, 670, 865nm (Three different polanization directions) 443, 490, 565, 763, 765, 910nm (No polarization)
IMG (Interferometric Monitor for Greenhouse Gases)	JAPAN	Ministry of International Trade and Industry	Observation of CO_2, CH_4, N_2O and other greenhouse gases Swath width: 8 × 8km Wavelength: 3.3-4.3, 4.0-5.0, 5.0-14.0 μm
ILAS (Improved Limb Atmospheric Spectrometer)	JAPAN	Environment Agency	Observation of the limb atmospheric micro-ingredient over high latitude area Wavelength: 753-784nm, 6.2-11.8 μm Observation altitude: 10-60km
RIS (Retroreflector in Space)	JAPAN	Environment Agency	Measurement of ozone, fluorocarbon, carbon dioxide, etc. by laser beam absorption technique, transmitted from ground station and reflected by the retroreflector on ADEOS Wavelength: 0.3-14 μm, Comer Cube retroreflector: ø50cm

provided scientific findings, including the onset of El Nino in 1996-97 and the demonstration of an ozone hole in the Antarctic.

Tropical Rainfall Measuring Mission (TRMM) is currently involved in the measurement of the three-dimensional distribution of the precipitation rate in tropical and subtropical regions, after the launch in 1997.

For the future program, ADEOS-II, a follow-up satellite of ADEOS will be launched in November 2000, and ALOS, a follow-up satellite of JERS-1 will be launched in the summer of 2002.

Regarding international research collaboration projects, NASDA has acted as a coordination agency for the research project entitled: "Studies for Promotion of Fundamental Data Sets for Earth Science and Technology Researches" under the Global Research Network System (GRNS) supported by the "Special Coordination Fund for Promoting Science and Technology" in cooperation with 30 institutes in the Asia-Pacific region.

ADEOS-II Project

Advanced Earth Observing Satellite-II (ADEOS-II, Fig. 2) is primarily dedicated to the analysis of the water and energy cycle as a part of global climate system, and to the detection of possible signals of long-term climate changes, by continuous monitoring. On ADEOS-II, two core sensors developed by NASDA will be on board; Advanced Microwave Scanning Radiometer (AMSR) and Global Imager (GLI).

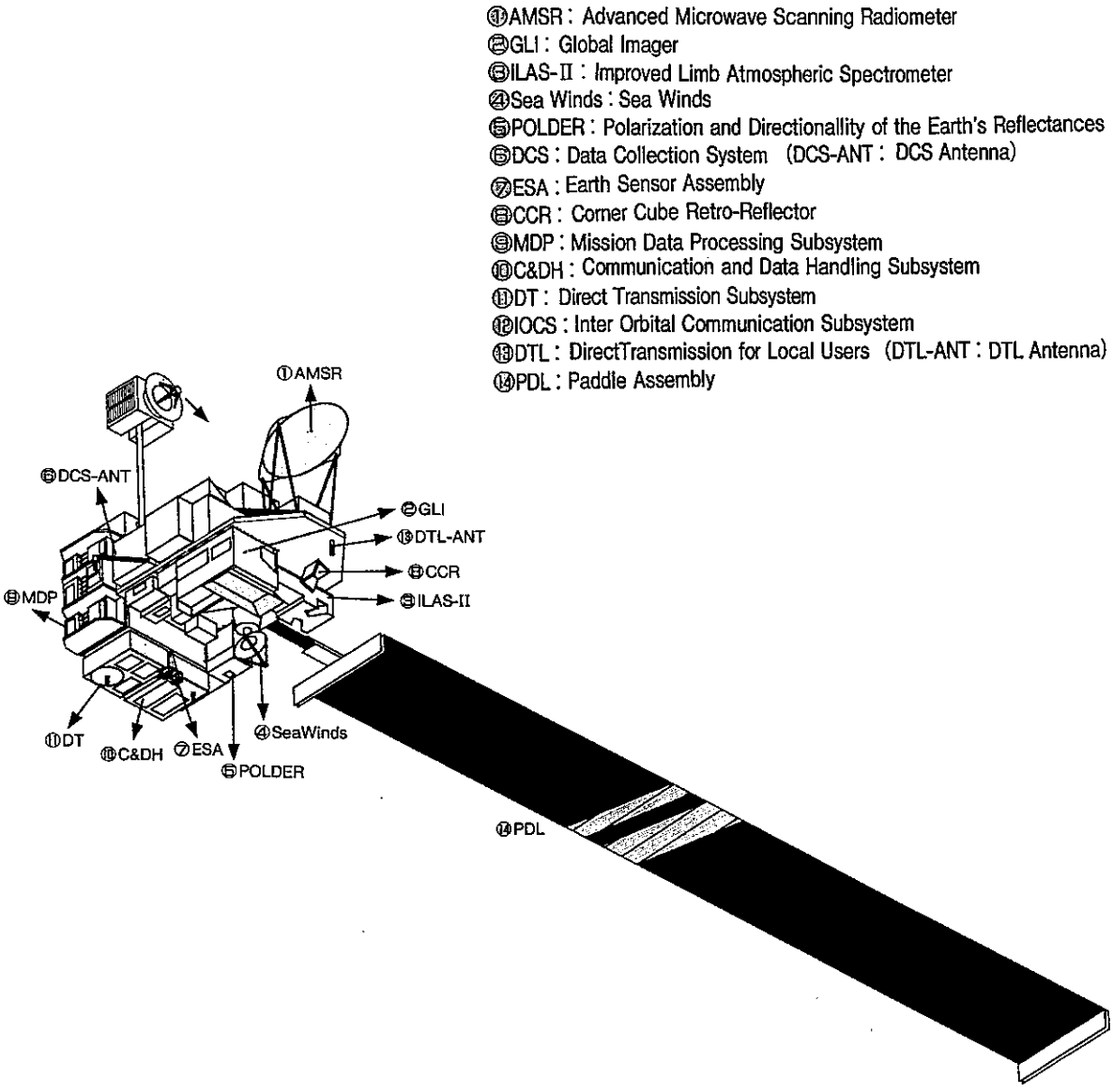
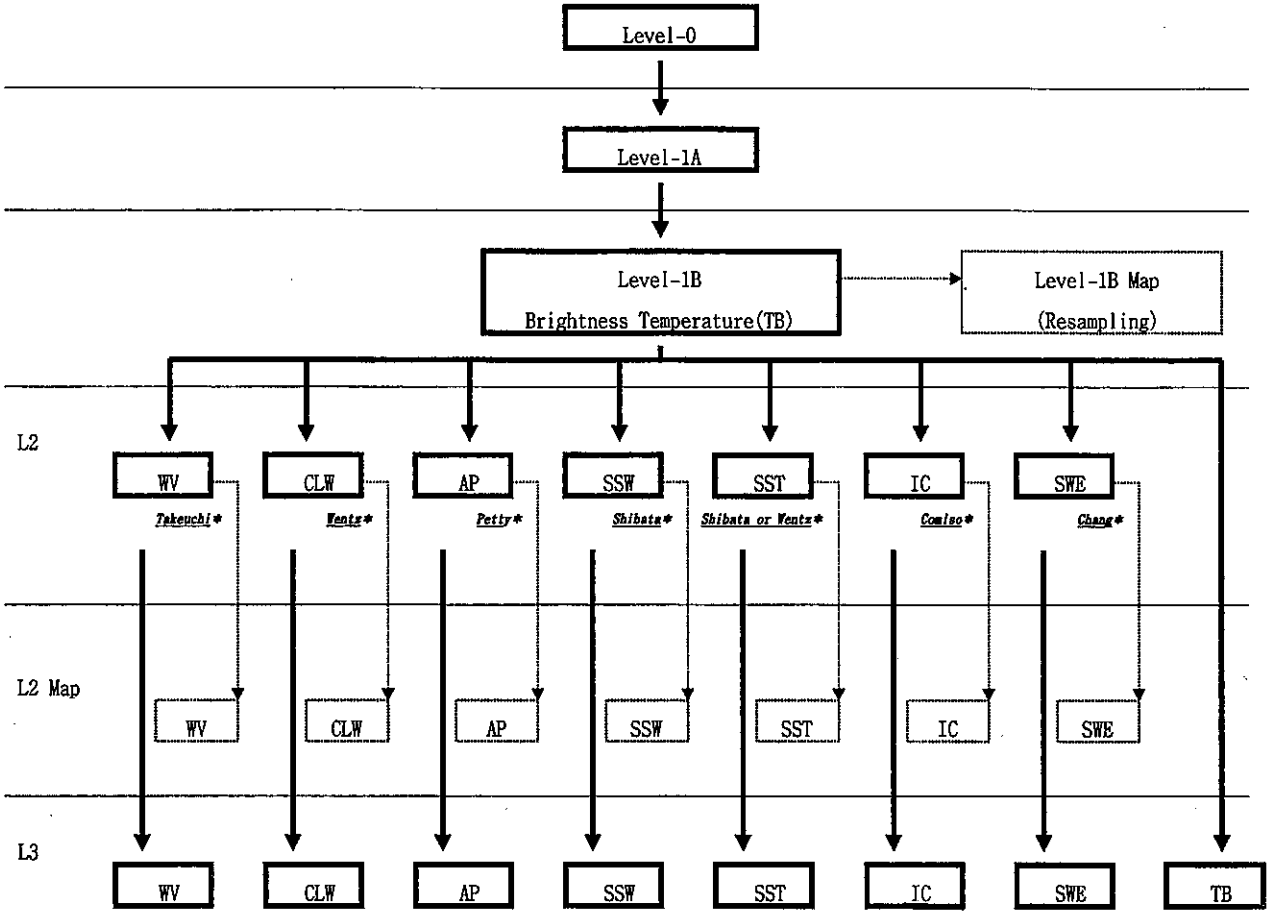


Fig. 2 Illustration of the ADEOS-II satellite and its five sensors

In addition, a scatterometer SeaWinds provided by NASA, ILAS-II by EA, POLDER and DCS by CNES will be on board.

AMSR will provide data set mapping for geophysical parameters; water vapor, cloud liquid water, precipitation, soil moisture, snow depth, sea surface temperature, sea surface wind speed, sea ice concentration (Fig. 3). GLI will provide data sets on aerosol-related parameters, cloud-related parameters, sea surface temperature, snow type (Table 3).



* Algorithm developer

Standard Product

Process Level	Product	
L2	WV	Water Vapor
	CLW	Cloud Liquid Water
	AP	Precipitation
	SSW	Sea Surface Wind
	SST	Sea Surface Temperature
	IC	Sea Ice Concentration
	SWE	Snow Water Equivalence

Research Product

Product	
RWV	Research on Water Vapor
RCLW	Research on Cloud Liquid Water
RAP	Research on Precipitation
RSSW	Research on Sea Surface Wind
RSST	Research on Sea Surface Temperature
RIC	Research on Ice Concentration
RSWE	Research on Snow Water Equivalence
RSM	Research on Soil Moisture

Fig. 3 AMSR data processing flow

Table 3 GLI level-2 standard products

Discipline	Standard Product Classification	Product Details(Product Code)		Geophysical Parameter(Code)
1.Atmosphere (15 products)	Aerosol property	Segment analysis	Aerosol Angstrom Exponent(ARAE)	
			Aerosol Optical Thickness(AROP)	
	Cloud property	Pixel by pixel analysis	Cloud flag(CLFLG_p)	
			Cloud Optical Thickness(CLOP_p)	
		Segment analysis	Cloud Effective Particle Radius of water cloud by reflection method (CLER_w_r)	
			Cloud Effective Particle Radius of ice cloud by emission method(CLER_i_e)	
			Cloud Optical Thickness of water cloud by reflection method (CLOP_w_r)	
			Cloud Optical Thickness of ice cloud by reflection method (CLOP_i_r)	
			Cloud Optical Thickness of ice cloud by emission method (CLOP_i_e)	
			Cloud Top Height of water cloud by reflection method (CLHT_w_r)	
			Cloud Top Temperature of water cloud by reflection method (CLTT_w_r)	
			Cloud Top Temperature of ice cloud by emission method (CLTT_i_e)	
			Cloud Liquid / Ice Water Path of water cloud by reflection method (CLWP_w_r)	
			Cloud Type(CLTY)	
			Cloud Fraction(CLFR)	
2. Ocean (6 products)	Atmospheric Correction Products	Full resolution (*1-km resolution, scene unit*) (NL_FR)		- Normalized water-leaving radiance (NWLR) that consists of normalized water-leaving radiance (13bands), Aerosol radiance (4bands), Angstrom exponent, Aerosol thickness - 4-byte quality flag (QF_OC)
		Low resolution(*4-km resolution, path unit*) (NL_LR)		
	In-water Particles Products	Full resolution (*1-km resolution, scene unit*) (CS_FR)		- Chlorophyll-a (CHLA) - Absorption of colored dissolved organic matter (CDOM) - Attenuation coefficient at 490nm (K490) - Suspended solid weight (SS) - 4-byte quality flag (QF_OC)
		Low resolution(*4-km resolution, path unit*) (CS_LR)		
	SST Products	Full resolution (*1-km resolution, scene unit*) (ST_FR)		- Bulk sea surface temperature(SST_b) - 2-byte quality flag (QF_ST)
		Low resolution(*4-km resolution, path unit*) (ST_LR)		
3. Land (3 products)	Atmospheric Correction	Atmospheric correction(ACLC) [1]		
	Precise Geolocation	Precise geolocation(PGCP)		
	Vegetation Index	Vegetation index(VGI) [2]		
4. Cryosphere (2 products)	Snow Grain Size/ Impurities	Scene data(SNGI_p)[3]		- Snow grain size(SNWG) - Snow impurities (SNWI) - Snow/Cloud flag(SCFG)
		Global data (SNGI)[4]		

1) ACLC has 56 localized areas. North and south polar region (>50N, <50S) is divided into 4 areas each. Middle latitude region (60S-60N) is divided into 48 areas (30° by 30°)
2) VGI has 5 localized areas. North polar region (>50N), North middle latitude region (20N-60N), Equator region (20S-20N), South middle latitude region (20S-60S), South polar region (>50S)
3) SNGI (scene) : 1km/250m resolution
4) SNGI (global) has 4 localized areas. North polar region (>50N), North middle latitude region (20N-60N), South middle latitude region (20S-60S), South polar region (>50S)

As the next generation earth observation mission, NASDA proposed " Mission for Energy and Material Cycles and Ozone Layer Changes" which is the successor of ADEOS-II called GCOM, to continue the 15-year observation by using medium and small satellites systems.

The mission objectives are as follows:

(1) Observation over a long period of time (about 15 years) (Sea surface wind, Chlorophyll-a concentration, Greenhouse gases)

(2) Contribution to documenting and predicting global changes

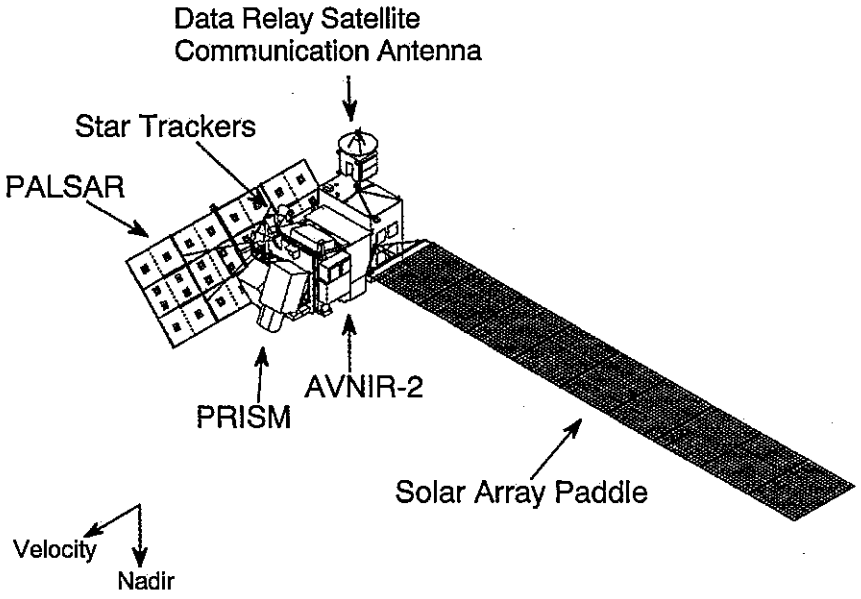
In this mission, the geophysical parameters to be observed are listed in Table 4. For the implementation of the objectives of GCOM, it is necessary to improve the measurement accuracy for prediction. Therefore, four-dimensional data assimilation to models, integration of remote sensing data and ground truth data and link of observation - process study - General Circulation Model (GCM) will be the most important science and technology objectives.

ALOS Project

Advanced Land Observing Satellite (ALOS, Fig. 4) is an earth observation satellite to be launched in 2002 to

Table 4 Observed parameters

	Observation Target	Geophysical Parameters
Atmosphere	1. Atmosphere-Ocean Interaction	
	· Energy Flux	Sea surface temperature, Sea surface wind speed, water vapor above sea surface, Temperature above sea surface
	· Carbon Flux	
	· Physical Process	Sea surface temperature, Sea surface wind speed, Temperature above sea surface, pCO2
	· Biological Process	Sea surface temperature, Chlorophyll concentration, Photosynthetically active radiation (PAR)
	2. Cloud	Cloud type, Cloud top height, Optical thickness
	3. Water Vapor	
	· Horizontal Distribution	Horizontal distribution of total water vapor
	· 3-dimensional Distribution	3-dimensional distribution of water vapor
	4. Temperature	Vertical temperature profile
	5. Cloud Water Content	Cloud water content
	6. Precipitation	Precipitation
	7. Aerosol	
	· Optical Thickness over the Ocean Region	Aerosol type, Optical thickness, Radious distribution
	8. Ozone	Total ozone volume
	9. Trace Gases	
	Horizontal Distribution	Stratosphere ozone, troposphere greenhouse gases
Ocean	1. Ocean Color	Chlorophyll a, Suspended solids (SS), C-DOM (Color Dissolved Organic Matter)
	· Sea Surface Wind	Sea surface wind speed
	· Sea Surface Wind Vector	Sea surface wind direction
	2. Sea Surface Temperature	Sea surface temperature profile
	3. Atmosphere-Ocean Interaction	
	· Water Flux	Precipitation
Land	1. Vegetation	Absorbed photosynthetically active radiation (APAR), Leaf area index (LAI), Biomass, NPP
	2. Land Surface	
	· Land Surface	Land surface
	· Albedo	Albedo
	3. Hydrology	Soil moisture of non-forestry area
Cryosphere	1. Sea ice concentration	Sea ice concentration
	2. Snow area	Snow area
	3. Classification of wet snow and dry snow in non-forested area	Classification of wet snow and dry snow in non-forested area
	4. Water equivalent dry snow in non-forested area	Water equivalent dry snow in non-forested area
	5. Ice area	Ice area
	6. Ice surface temperature	Ice surface temperature



ALOS in-orbit configuration

Characteristics of ALOS

Item	Characteristics	Remarks
Launch Date	August. 2002	
Launch Vehicle	H-IIA	
Launch Site	Tanegashima Space Center, Japan	
Spacecraft Mass	Approx. 4 tons	
Generated Power	Approx. 7 kW	End of Life
Altitude	691.65 km	At Equator
Inclination	98.16 °	
Repeat Cycle	46 days	Sun-Synchronous Semi-Recurrent
Sub-cycle	2 days	
Design Life	3-5 years	
Attitude determination accuracy	2.0×10^{-4} deg (off-line)	
Position determination accuracy	1 m (off-line)	
Data Rate (Down link)	240Mbps via DRTS, 120Mbps (direct transmission)	
Onboard Data recorder	Solid-state data recorder (90Gbytes)	

Fig. 4 ALOS in-orbit configuration and characteristics

provide global observation data using high resolution L band SAR and visible and near infrared radiometer following JERS-1 and ADEOS/AVNIR observation data.

ALOS mission objectives are as follows:

(1) To provide maps for Japan and other countries including those in the Asia-Pacific region (Cartography)

(2) To perform regional observation for "sustainable development" (Regional Observation)

(3) To implement disaster monitoring around the world (Disaster Monitoring)

(4) To survey natural resources (Resources Survey)

(5) To develop technology necessary for future earth observing satellites (Technology Development)

ALOS has three sensors; Panchromatic Remote-Sensing Instrument for Stereo-Mapping (PRISM) for 2.5 m high resolution imaging and digital elevation mapping with three-line scanner, Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2) for multispectral land cover imaging and frequent disaster monitoring

using cross-track pointing viewing mechanism, and Phased Array type L-band Synthetic Aperture Radar (PALSAR) for day-and-night all weather land observation.

The standard data products generated at the Earth Observation Center (EOC)/NASDA for data distribution are listed in Table 5. In addition, Earth Observation Research Center (EORC)/NASDA will develop higher level

Table 5 ALOS data products

Common

Level	Definition	Note
Raw	Demodulated bit stream	Packetized Temporarily archived
0	Frame synchronization and PN decoding of CADUs and R-S Error Detection and Correction of VCDUs Extracted mission telemetry, orbit and attitude data are stored on separate files	Compressed (except for PALSAR) Permanent archive Level for distribution to data node

PRISM

Level	Definition	Note
1A	Uncompressed, reconstructed digital counts appended with rediometric calibration coefficients and geometric correction coefficients (appended but not applied). Individual files for forward, nadir, and backward looking data.	
1B1	Radiometrically calibrated data at sensor input	
1B2	Geometrically corrected data Options G: Systematically Geo-coded (No option: Geo-referenced)	Map projection Resampling Pixel spacing

AVNIR-2

Level	Definition	Note
1A	Uncompressed, reconstructed digital counts appended with radiometric calibration coefficients and geometric correction coefficients (appended but not applied). For PRISM, individual files for forward, nadir, backward looking data.	
1B1	Radiometrically calibrated data at sensor input	
1B2	Geometrically corrected data Options G: Systematically geo-coded (No option: Geo-referenced) D: Correction with coarse DEM	Map projection Resampling Pixel spacing

PALSAR

Level	Definition	Note
1.0	Reconstructed, unprocessed signal data appended with radiometric and geometric correction coefficients (appended but not applied). In polarimetric mode, polarimetric data are separate. In ScanSAR mode, scan data are separate	
1.1	Range and azimuth compressed complex data on slant range, Full resolution	Beam mode: Full resolution mode, Low data rate mode, Polarimetric mode SLC: Single look complex Used for interferometry
1.5	Multi-look processed image projected to map coordinates. Option G: Systematically geo-coded (No option: Geo-referenced)	Map projection Resampling Pixel spacing

products such as digital elevation model (DEM), ortho image of PRISM, AVNIR-2 and PALSAR, global forest map, SAR interferometry processed data for land surface displacement and so on.

The detailed information about ALOS science and the applications research plan and the Research Announcement (RA) will be issued on EORC/NASDA home page (*http://www.eorc.nasda.go.jp*).

GRNS Project

For high accuracy of data set generation, the calibration of sensors, the validation of data sets and production of colocated and contemporary matched up data sets of remote sensing and ground truth data by a well-organized system are important, involving sensor providers, data providers and scientific community or application users.

Regarding international research collaboration projects, NASDA has acted as a coordination agency for the research project entitled: "Studies for Promotion of Fundamental Data Sets for Earth Science and Technology Researches" (Fig. 5, Table 6) under the Global Research Network System (GRNS) supported by the "Special Coordination Fund for Promoting Science and Technology" in collaboration with 30 institutes in the Asia-Pacific region. As a result of the 5-year research project, 5 reports and CD-ROMs have been produced.

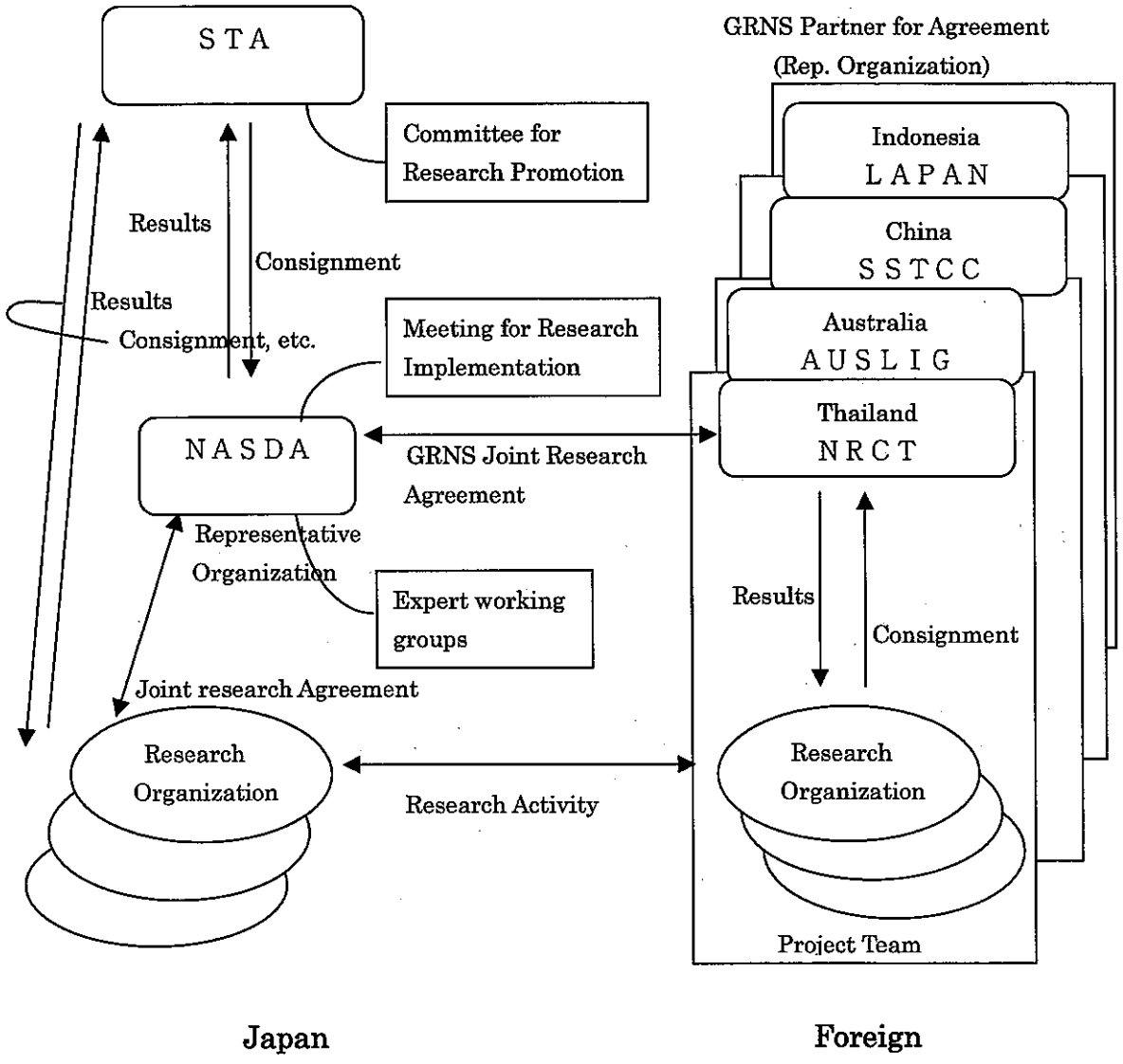


Fig. 5 Structure for implementation of global research network system

Table 6 Institutes and research themes

Field	Theme	Japanese Institute	Foreign Institute
Hydrology	- Studies for production of monthly average precipitation data set - Studies for production of runoff data sets	MRI NIED, RESTEC	CMA BMRC MWR RID
Vegetation	- Studies for production of forest coverage data sets	FFPRI	NRCT, RFD,CAF CSIRO/DWLE,
	- Development of methods to calculate carbon storage and accumulation in forest	FFPRI	NFI RFD, KU
	- Development of methods to calculate greenhouse gas balance	NIRE	DLD
Desertification	- Studies for production of desertification data sets	JIRCAS HEEIC	CSIRO/DWLE
Oceanography	- Development of ocean color evaluation methods - Development of methods to diagnose coral reef health	JAMSTEC JAMSTEC GSJ	BPPT, LIPI, LAPAN CSIRO/COSSA AIMS, LAPAN, LIPI
Standardization /Fundamental Map	- Studies for data sets Standardization and normalization - Production of fundamental base maps	NASDA GSI	

After the evaluation by other scientific groups, release of the data sets to the public was recommended at the International Workshop on Earth Science Study in Asia Pacific Region (IWESSAPR) held in 1999. The standardized data sets produced in the GRNS project have been remade as IWESSAPR data sets by eliminating restricted data and will be open to wide-ranging scientific communities.

Conclusion

In the context of agricultural application of remote sensing data, NASDA is providing MOS-1/1b, JERS-1, ADEOS, TRMM, IRS, RADARSAT, LANDSAT, SPOT and ERS-1/2 satellite data. In the future, ADEOS-II and ALOS data will be provided.

Continuous monitoring of the global environment by the GCOM mission will also be useful to provide anomalous weather and climatic trends for the planning of agricultural activities. For the improvement of prediction accuracy, integration of satellite data and ground-based observation data and multi-sensor data fusion technology will be promoted.

For regional development, in addition to the use of high resolution SAR and optical sensor images on ALOS and others, spectral images will be produced. GLI on ADEOS-II will provide 36 channel 1 km resolution global data and 250 m regional data in Asia.

These satellite programs and data set generation projects should be integrated interdisciplinary, systematically and internationally.