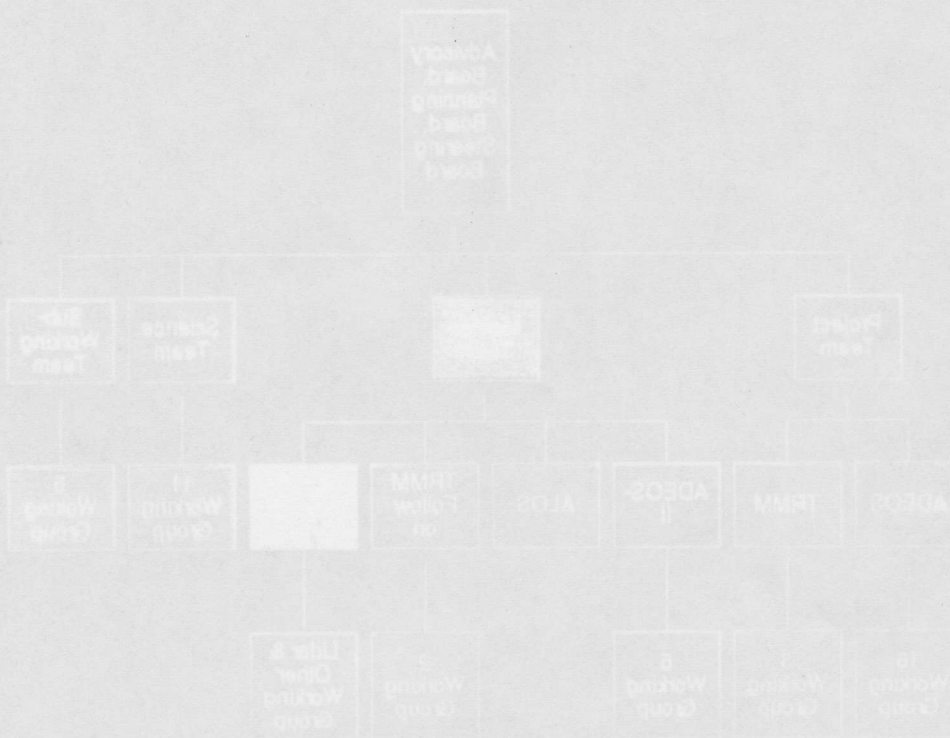


Earth Observation Long Term Senario in Japan

International Work shop on Spaceborne Lidar 1995
 - Technology and Applications -
 October 24 - 26, 1995
 Nara, Japan

Tamotsu Igarashi
 Earth Observation Planning Department
 Office of Earth Observation Systems
 NASDA



World Earth Observation Satellite Programs

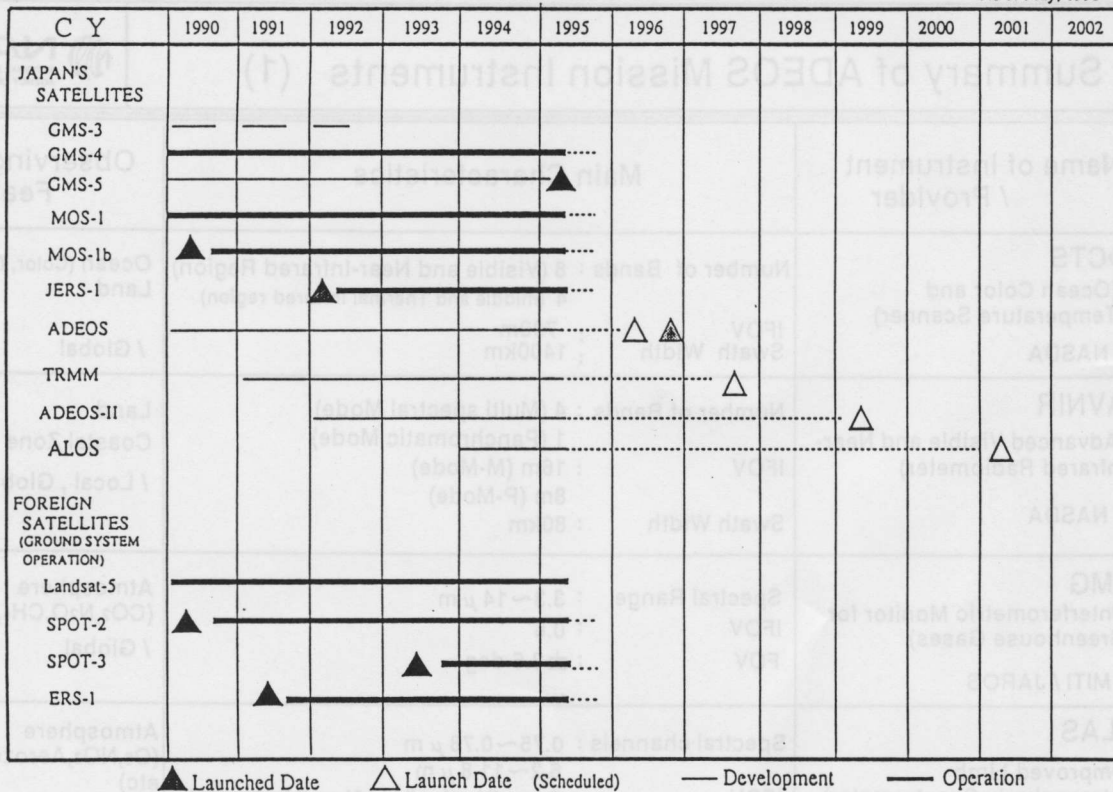
As of May, 1995

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
JAPAN	▲ MOS-1b		▲ JERS-1			▲ GMS-5		▲ ADEOS →	▲ TRMM		▲ ADEOS-II	△ ALOS
USA	▲ NOAA-12 (AM)	▲ UARS	▲ NOAA-I (PM)	× NOAA-J (AM)	▲ NOAA-K (PM)	△ NOAA-L (AM)	△ NOAA-M (PM)	△ NOAA-N				
			▲ TOPEX/POSEIDON			▲ SEASTAR		▲ TRMM		▲ EOS-AM 1		△ EOS-PM
				× LANDSAT-6			△ LANDSAT-7					
ESA		▲ ERS-1				▲ ERS-2			△ ENVISAT	△ METOP		
France	▲ SPOT-2		▲ TOPEX/POSEIDON		▲ SPOT-3		▲ SPOT-4		△ GLOBSAT			△ SPOT-5
Others	▲ FY-1B	▲ IRS-1B	▲ INSAT-IIA		▲ IRS-1C		▲ IRS-1D		▲ RADARSAT			

▲ Operational △ Under development △ Planned × Failure

EARTH OBSERVATION PROGRAMS IN JAPAN

As of May, 1995



- Mission

- Contribution to global change research
- Development of platform research technologies
- Rescheduled for launch in August, 1996
- CDR was held in November 1993.
- PFT(Proto Flight Test) is ongoing at TKSC.
- MOU status for Sensor providers:
 - CNES-NASDA MOU concluded in May 1992.
IEOS DEP articles are incorporated.
 - NASA-NASDA MOU concluded in Oct 1994.
IEOS DEP is attached.
 - MITI-NASDA MOU is under negotiation.
IEOS DEP is attached.
 - JEA-NASDA MOU is essentially completed.
IEOS DEP is attached.

Summary of ADEOS Mission Instruments (1)



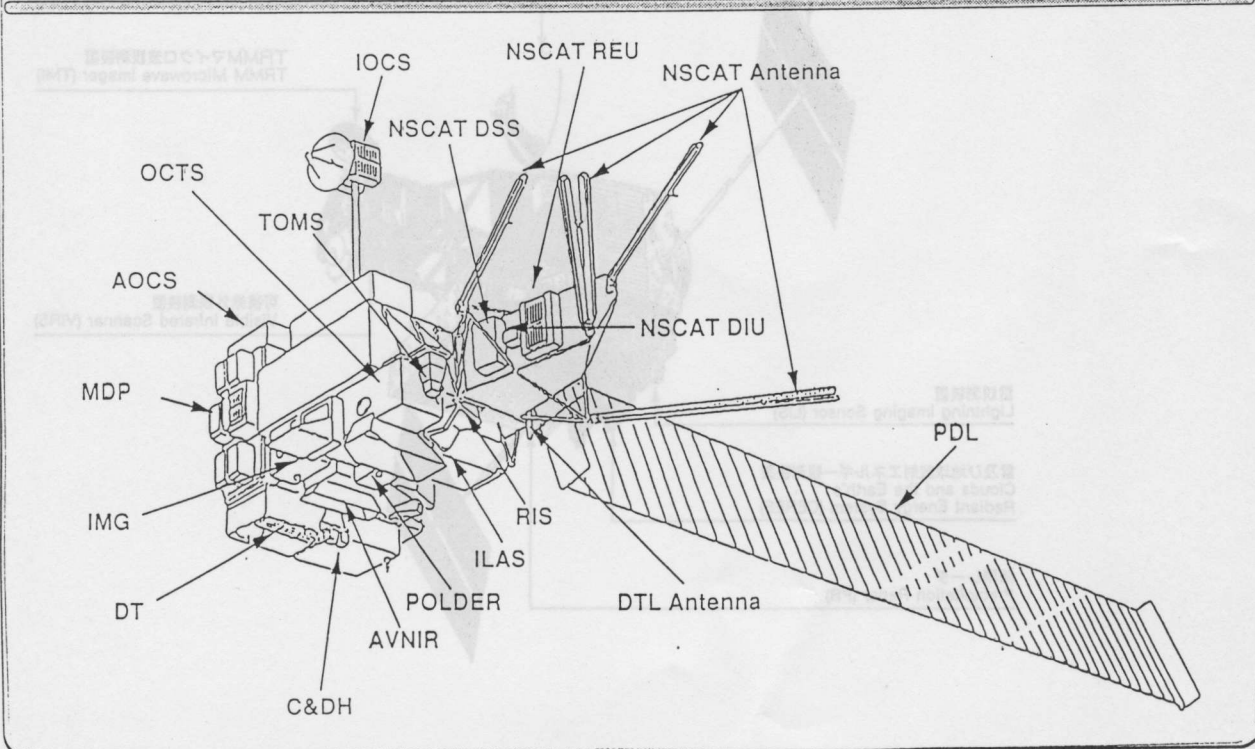
Name of Instrument / Provider	Main Characteristics	Observing Feature
OCTS (Ocean Color and Temperature Scanner) / NASDA	Number of Bands : 8 (Visible and Near-Infrared Region) 4 (middle and Thermal Infrared region) IFOV : 700m Swath Width : 1400km	Ocean (Color, Temperature) Land / Global
AVNIR (Advanced Visible and Near-Infrared Radiometer) / NASDA	Number of Bands : 4 (Multi spectral Mode) 1 (Panchromatic Mode) IFOV : 16m (M-Mode) 8m (P-Mode) Swath Width : 80km	Land Coastal Zone / Local , Global
IMG (Interferometric Monitor for Greenhouse Gases) / MITI / JAROS	Spectral Range : 3.3~14 μm IFOV : 0.6° FOV : ±3.6 deg	Atmosphere (CO ₂ ,N ₂ O,CH ₄ ,CFCs,etc) / Global
ILAS (Improved Limb Atmospheric Spectrometer) / EA	Spectral channels : 0.75~0.78 μm 6.2~11.8 μm IFOV : 2 km (Vertical)×13km (Horizontal)	Atmosphere (O ₃ ,NO ₂ ,Aerozols,CFC11, etc) / Local (North and South Pole Region)

Summary of ADEOS Mission Instruments (2)



Name of Instrument / Provider	Main Characteristics	Observing Feature
RIS (Retroreflector In Space) / EA	Effective Diameter : 50cm Reflectivity : ≥ 0.8 Wavelength Region : 0.4~14 μ m	Atmosphere (O ₃ ,CO ₂ ,CH ₄ ,etc) / Local
NSCAT (NASA Scatterometer) / NASA / JPL	Radio Frequency : 14GHz Wind Observation : Velocity 2 m/s Accuracy : Direction 20° Location 25km Swath Width : 1550km	Ocean (Wind Vector) / Global
TOMS (Total Ozone Mapping Spectrometer) / NASA / GSFC	Spectral Bands : 6 Wavelengths : 308.6~360.0nm Total Ozone Accuracy : < 2% Sulfur Dioxide Accuracy : $\pm 25\%$ IFOV : 3deg FOV : ± 55.5 deg	Atmosphere (O ₃ ,SO ₂ ,etc) / Global
POLDER (Polarization and Directionality of the Earth's Reflectance) / CNES	Spectral Bands : 8 Wavelengths : 443~910nm Absolute Accuracy : 2% \times Wavelength IFOV : 0.37deg FOV : 110deg	Atmosphere (Aerosols) Ocean (Color) Land / Global

In Orbit Configuration of ADEOS



TROPICAL RAINFALL MEASURING MISSION (TRMM)

TRMM IS A JOINT PROGRAM BETWEEN NASDA AND NASA.

o NASDA RESPONSIBILITIES

PROVIDING A PRECIPITATION RADAR (PR), LAUNCHING THE SATELLITE BY H-II ROCKET, GROUND PROCESSING OF PR DATA

o NASA RESPONSIBILITIES

PROVIDING PLATFORM AND SEVERAL INSTRUMENTS, OPERATION OF THE SATELLITE

LAUNCHING TARGET DATE

- o SUMMER 1997

熱帯降雨観測衛星 (TRMM)

Tropical Rainfall Measuring Mission

太陽電池パドル
Solar Array

追跡・データ中継用アンテナ
High Gain Antenna (HGA)

TRMMマイクロ波観測装置
TRMM Microwave Imager (TMI)

可視赤外線観測装置
Visible Infrared Scanner (VIRS)

雷観測装置
Lightning Imaging Sensor (LIS)

雲及び地球放射エネルギー観測装置
Clouds and the Earth's
Radiant Energy System (CERES)

降雨レーダ
Precipitation Radar (PR)

The major feature of the TRMM instruments

Sensor	Observation Objectives	Frequency	Horizontal resolution	Swath width
Precipitation Radar (PR; NASDA)	3-D rainfall distribution	13.8 GHz	4.3 km (nadir)	~ 220 km
TRMM Microwave Imager (TMI; NASA)	Vertically integrated rainfall distribution	10.7, 19.4, 22, 37, and 85~91 GHz	5 ~ 45 km	~ 680 km
Visible Infrared Scanner (VIRS; NASA)	Cloud distribution and height, rain estimation from brightness temp.	0.63, 1.6, 3.75, 10.8, and 12 μ m	2 km (nadir)	~ 720 km
Cloud and Earth Radiant Energy System (CERES; NASA)	Radiation from cloud and the Earth, energy budget	0.3 ~ 3.5 μ m 8 ~ 12 μ m 0.3 ~ 50 μ m	25 km (nadir)	Scan angle: \pm 80 degrees
Lightning Imaging Sensor (LIS; NASA)	Lightning distribution	0.7774 μ m	4 km (nadir)	~ 660 km

Description of TRMM

Orbit	Non Sun-Synchronous
Altitude	350 km
Inclination	35 deg.
Weight	3.5 ton (approx.)
Launch Vehicle	H-II Rocket
Design Life	3 Years
Launch Date	Summer 1997

ADEOS-II (Advanced Earth Observing Satellite-II)

1. Mission Concept:

- Global Change Observation
- Dedicated of WCRP/GEWEX & CLIVER, IGBP and GCOS

2. Characteristics

(1) Instruments:

NASDA core sensors

- AMSR (Advanced Microwave Scanning Radiometer)
- GLI (Global Imager)
- DCS (Data Collection System)

Other agency's sensors candidates

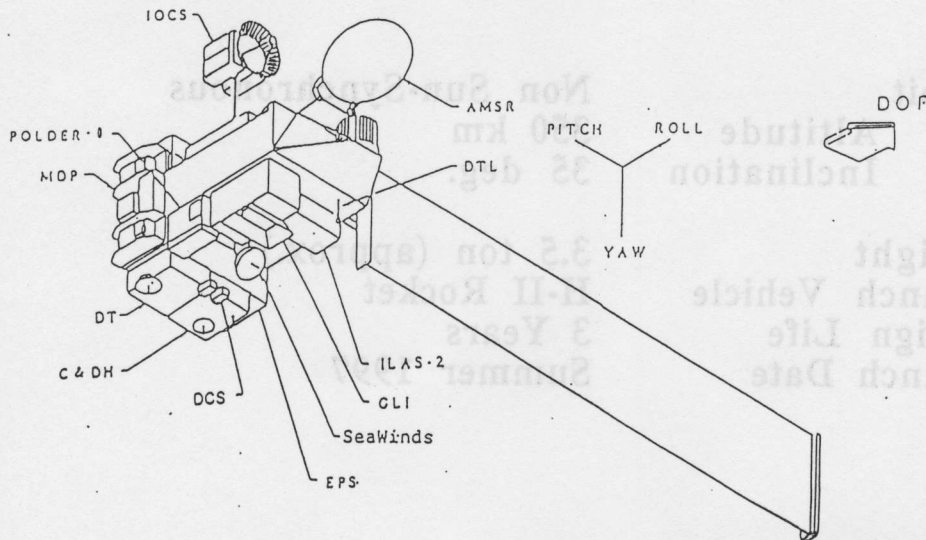
- ILAS-II (Improved Limb Atmospheric Spectrometer) : JEA
- SeaWinds (Modified NSCAT) : NASA/JPL
- TOMS (Total Ozone Mapping Spectrometer) : NASA/GSFC
- POLDER (Polarization and Directionality of the Earth's Reflectances) : CNES

- (2) Launch: - Launch year : February 1999
 - Launch vehicle : H-II

- (3) Mission Life: - 3 year (minimum) --- 5 year (Goal)

- (4) Orbit: - Sun Synchronous Subrecurrent
 - Altitude : 802.92 Km

3. In orbit configuration of ADEOS-II (one candidate)



AMSR	Advanced Microwave Scanning Radiometer
C&DH	Command & Data Handling Subsystem
DCS	Data Collection System
DOF	Direction Of Flight
DT	Direct Transmission Subsystem
DTL	Direct Transmission for Local Users
EPS	Electrical Power Subsystem
GLI	Global Imager
ILAS-2	Improved Limb Atmospheric Spectrometer
IOCS	Inter Orbital Communication Subsystem
MDP	Mission Data Processing Subsystem
POLDER	Polarization and Directionality of the Earth's Reflectance

Main Characteristics of ADEOS-II

Shape	Module type with a deployable solar array paddle Body Approx. 4 x 4 x 5 (m)
Total Weight	Approx. 3.5 ton
Mission Payload	Approx. 1.2 ton
Generator Power	5.0 kw (Approx. 1.2kw for mission instruments) at EOL
Design Life	3 year (minimum) --- 5 year (goal)
Launch Vehicle	H-II rocket (with 5 m Ø fairing), single launch
Launch Site	Tanegashima Space Center, Kagoshima
Launch Date	February 1999
Orbit Type	Sun synchronous subrecurrent
Altitude	Approx. 800 km
Inclination	Approx. 99 deg.
Period	Approx. 101 min.
Recurrent Period	4 days
Local time	Am 10:30 + 15 min.
Data Transmission	Inter-orbit communication and direct transmission (equipped with mission data recorder)

REMARKS	Sensors	MISSION OBJECTIVES
-Evaluation to 1/25,000 scale maps -Contribution to quick revision of current "paper" maps provided by Geographical Survey Institute of JAPAN.	RUMR-2 (Pa)	Digital Terrain Elevation Map -Resolution: 2.5 m (Horizontal) -2.5 m (Vertical) -2 and 3 dimensional
	RUMR-2 (Mu) USAR	Land Usage Data -Resolution: 10 m (Horizontal)
-Contribution to regional "sustainable development" especially in Asia-Pacific region.	RUMR-2 (Pa) USAR	Environmental Data -Resolution: 10 m (Horizontal)
	RUMR-2 (Mu) USAR	Hazard Data -Resolution: 10 m (Horizontal) (Global)
- Flood, volcanic eruption, Earthquake, Oil spill etc. Quick monitoring	USAR (UAV off-Nadir)	
Precision orbit determination and control is required.	USAR	SAR Interferometry Experiment

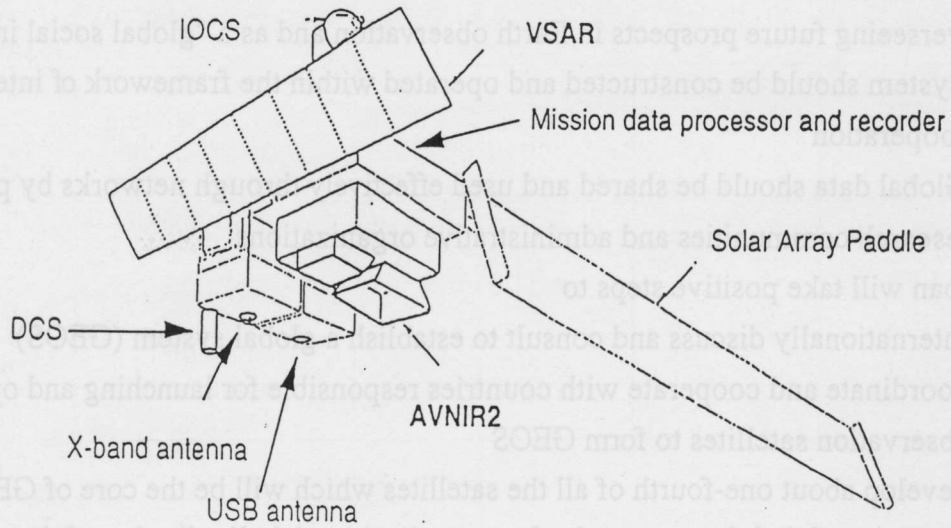
- Mission
 - Global mapping
 - Contribution to regional "sustainable development"
 - Disaster observation
- System Study is underway.
- Budget for Phase B is being requested for JFY 1996.
- Target for launch in 2002

ADVANCED LAND OBSERVING SATELLITE (ALOS)

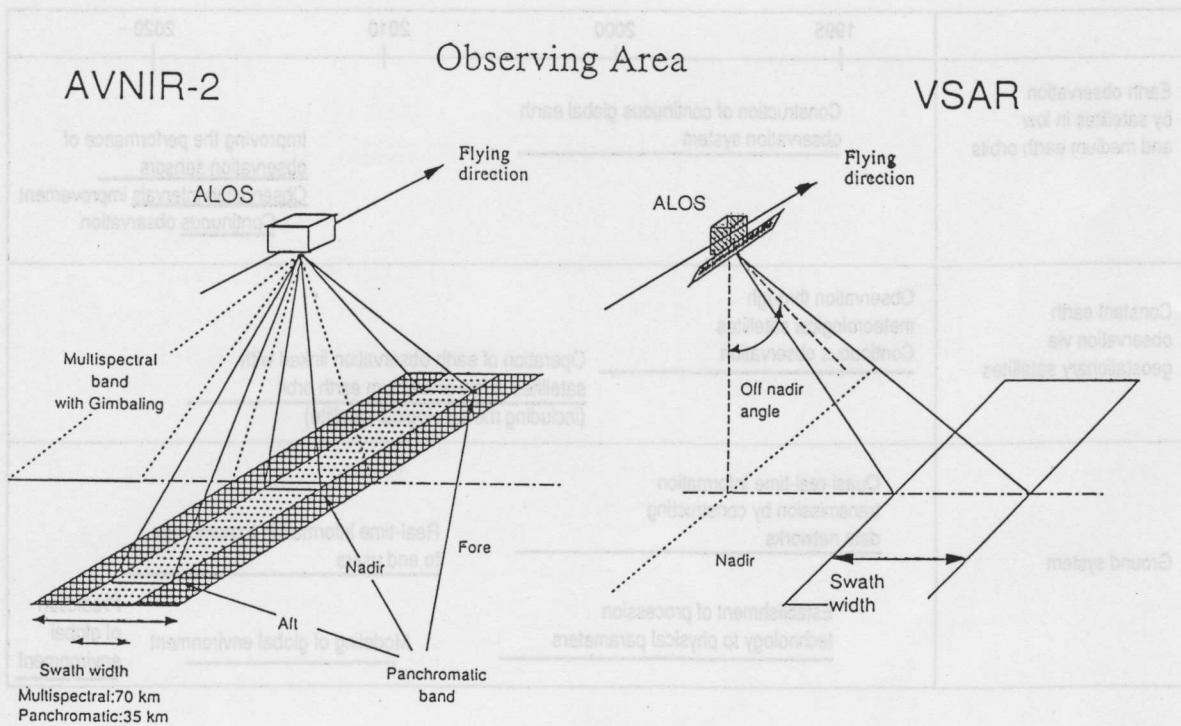
ALOS MISSION OBJECTIVES

MISSION OBJECTIVES		Sensors	REMARKS
Mapping	Digital Terrain Elevation Map (2 and 3 Dimensional) -Resolution: 2.5 m (Horizontal) 3-5 m (Vertical)	AVNIR-2 (Pa)	-Equivalent to 1/25,000 scale maps. -Contribution to quick revision of current "paper" maps provided by Geographical Survey Institute of JAPAN.
	Land Usage Data -Resolution: 10 m (Horizontal)	AVNIR-2 (Mu) USAR	
Regional Environmental Monitoring	Environmental Data -Resolution: 10 m (Horizontal)	AVNIR-2 (Mu) USAR	-Contribution to regional "sustainable development" especially in Asia-Pacific region.
Hazard monitoring	Hazard Data -Resolution: 10 m (Horizontal)	AVNIR-2 (Mu) (Gimbal) USAR (Var off-Ndr)	Quick monitoring - Flood, Volcanic eruption, Earthquake, Oil spill etc.
Technology Experiment	SAR Interferometry Experiment	USAR	Precision orbit determination and control is required.

ADVANCED LAND OBSERVING SATELLITE (ALOS)



ADVANCED LAND OBSERVING SATELLITE (ALOS)



Global Earth Observation System (GEOS)

Overseeing future prospects in Earth observation and as a "global social infrastructure"

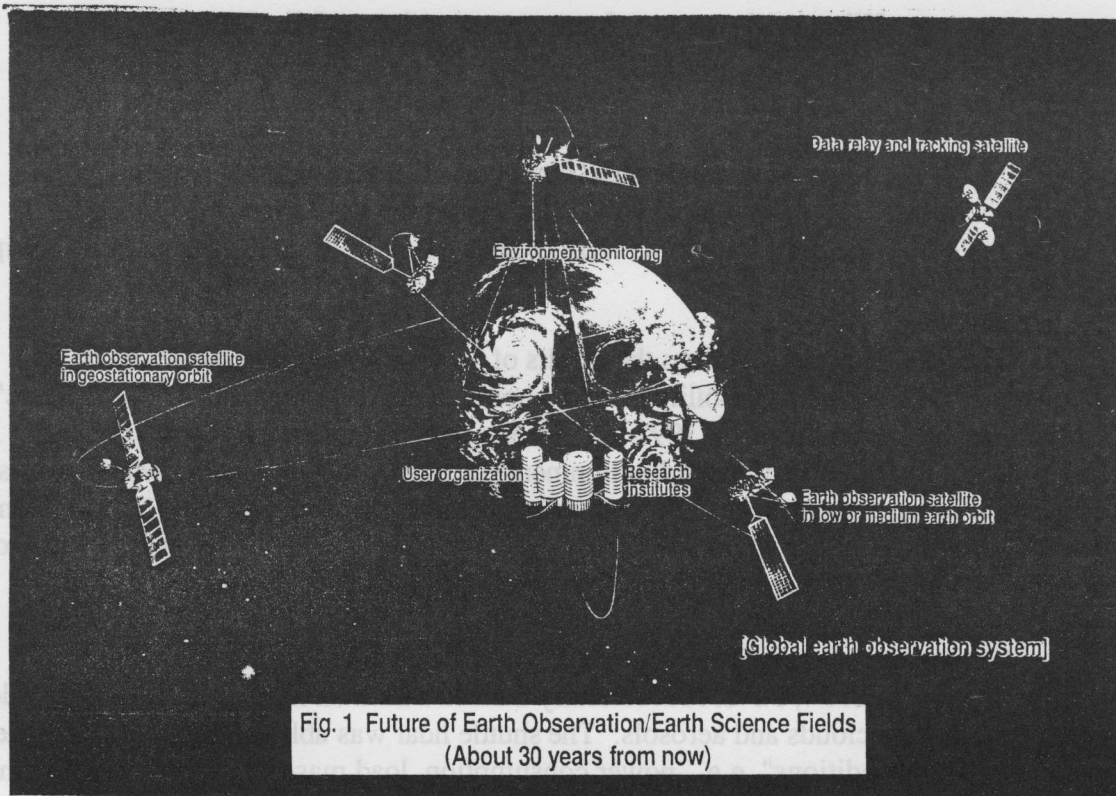
- System should be constructed and operated within the framework of international cooperation
- Global data should be shared and used effectively through networks by proper research communities and administrative organizations

Japan will take positive steps to

- internationally discuss and consult to establish a global system (GEOS):
- coordinate and cooperate with countries responsible for launching and operation of observation satellites to form GEOS
- develop about one-fourth of all the satellites which will be the core of GEOS by 2010
- construct global data networks for smooth and quick distribution of the observation data domestically and internationally including the Asia-Pacific regions

Table 1 Research and Development in the Fields of Earth Observation / Earth Science in Japan

	1995	2000	2010	2020 ~
Earth observation by satellites in low and medium earth orbits	Construction of continuous global earth observation system			Improving the performance of <u>observation sensors</u> <u>Observation intervals</u> improvement <u>Continuous</u> observation
Constant earth observation via geostationary satellites	Observation through meteorological satellites Continuous observation		Operation of earth observation linked with satellites in low or medium earth orbit (including meteorological satellite)	
Ground system	Quasi-real-time information transmission by constructing data networks	Establishment of procession technology to physical parameters	Real-time information transmission to end users Modeling of global environment	Prediction of global environment



Japanese Scenario of Long Term Earth Observation(Draft)

NASDA/EOPD Oct.23,1995 © Igarashi

CY	1995	2000	2005	2010	
Global Observation (sun synchronous/ medium altitude) Large bus	96 Summer OCTS AVNIR	ADEOS IMG ILAS TOMS NSCAT POLDER	99 AMS-2 GLI Sea-Winds POLDER	03 ADEOS-III ILAS-III Sea-Winds-II? (DIAL) (ODUS-2)	08 ADEOS-IV TERSE A-POLDER (JLAWS) (CPR)
Regional Land Observation (sun synchronous/ medium altitude) Large bus			02 Winter AVNIR-2 V-SAR	04 ALOS V-SAR AVNIR-3	06 ALOS-B1 A-SAR L-ALT-G/ADALT
Diurnal cycle Observation (low-high inclination/low- medium altitude) Medium- Large bus		97 TRMM PR TMI VIRS CERES LIS	03 ATMOS-A1 PR-2 AMSR-2 VIRS-2 CERES	04 ALOS-A1 V-SAR AVNIR-3	05 ATMOS-A2 DPR ATMOS-B1 CPR ABSI L-ALT DIAL 06 ATMOS-C1 MILES or AMAS ODUS-2 LAS-III
Geostationary Observation Large bus	Land/Ocean/Atmosphere Observation		05 GOM GEO-1 Microwave Sounder GEO-2 GEO-3 GEO-4 GEO-5 GEO-6 GEO-7 GEO-8 GEO-9 GEO-10 GEO-11 GEO-12 GEO-13	10 GEO-10 GEO-11 GEO-12 GEO-13	
J/Experimental Observation Small bus	Mission resources 150kg 150W	LIDAR	01 MILES ELMOS: Electro magnetic environment monitor		
JEM, Space shuttle (low inclination/low altitude)	JEM(Space Station)	CPR LIDAR DIAL	MILES JLAWS		Water vapor sounder Vertical temperature profile
Airborne Experiment	PR POLDER	AMS-2 GLI LIDAR/LALT L-SAR TERSE (NASA Airplane or sensors if available)			

Japanese sensor to foreign satellites:
 : ODUS → EOG/CHIM(2002)
 TERSE → EXPLORER

Foreign sensors to Japanese satellites:
 : SeaWiFS → ADEOS-III
 : ABI → ADEOS-III
 : IASI → ADEOS-III
 : APO → ATMOS-B1
 : CPR → ATMOS-B1
 : DIAL → ATMOS-A2

One out of three