EARTH OBSERVATION PROGRAMS IN JAPAN

Tomifumi Godai

Director
Planning & Management Department
National Space Development Agency of Japan
(NASDA)

2-4-1, Hamamatsu-cho, Minatoku, Tokyo 105
JAPAN

SS-1

1. Introduction

In 1972 the first earth observation satellite ERTS(LANDSAT-1) was launched by NASA. A number of investigators from Japan participated in this ERTS program for the satellite data analysis. This was an initial step of space remote sensing activities of Japan. NASDA established the Earth Observation Center(EOC) at Hatoyama near Tokyo in 1978 and started direct reception of LANDSAT data in 1979. Since then, various organizations and universities in Japan have been involved in a wide range of remote sensing activities.

In 1976, NASDA, supported by various groups of Japanese experts, started the investigation study of the Japanese needs and eventual contributions in earth observation program. Following these activities, in 1978, the Space Activities Commission of Japan(SAC), which supervise all space activities in Japan, recommended in the "Outline of Japanese Space Policy" that "marine and land observation satellite series" should be developed in order to establish the earth observation technology and to step forward to operational satellites. This recommendation resulted in developing two remote sensing satellites, namely Marine Observation Satellite-1(MOS-1) and Japanese Earth Resources Satellite-1(ERS-1). NASDA started the development of MOS-1 in 1979 and was launched in Feb. 19, 1987. NASDA also started the R&D of ERS-1 in 1980 and which is now in the critical design phase. Development task of ERS-1 is shared by MITI and NASDA. MITI is developing the mission equipment(sensors) while NASDA the satellite system. ERS-1 is currently planned to be launched in 1992.

Following the fulfillment of these programs, Japan is to pursue its next step earth observation programs. As a next generation earth observation satellite, NASDA plans to launch Advanced Earth Observing Satellite(ADEOS) in early 1994. Moreover, a new earth observation program with Polar Orbiting Platform(POP) is now planned and coordinated among the Space Station Partners, namely, NASA, NOAA, ESA, Canada and Japan. Currently, NASA, ESA and Japan have their own platform launch plans in late 1990's. The overall schedule of Japanese earth observation satellite programs is shown in Table 1.

2 MOS-1 Program

The Marine Observation Satellite-1(MOS-1), the Japanese first experimental earth observation satellite, was launched on Feb. 19, 1987 successfully by NASDA. The aims of MOS-1 is to establish the basic technology for earth observation system, to carry out practical observation of the earth(primary the ocean) using on-board sensors and to verify the performance of the sensors.

(1) Satellite System and Mission Instrument

The profile and description of MOS-1 are shown in Fig.1 and Table 2. MOS-1 has three sensors and a Data Collection System Transponder(DCST). These sensors are the Multispectral Electronic Self Scanning Radiometer(MESSR), the Visible Thermal Infrared Radiometer(VTIR), and the Micro-wave Scanning Radiometer(MSR). The characteristics of the sensors are shown on Table 3.

(2) MOS-1 Operation

After the launch of MOS-1 on Feb. 19, 1987, with spacecraft check out for three months, images data from the three sensors were flawlessly acquired. NASDA is now performing six month experimental operation to check the compatibility between spacecraft and ground station for data reception and processing. After this test operation, MOS-1 shifts to routine operation status.

The ground support system for MOS-1 is shown in Fig.2. Earth Observation Center(EOC) is the main ground station responsible for mission management, scheduling, data acquisition and processing. In Addition to EOC, MOS-1 data are also planned to be received at nine other receiving stations in the world. The world coverage of MOS-1 is shown in Fig.3.

(3) MOS-1 Verification Program(MVP)

MOS-1 Satellite Program includes the MOS-1 Verification Program (MVP) in which the system parameters of mission instrument, function and characteristics of sensors and satellite systems, and its data usefulness will be evaluated. In order to obtain fruitful result, NASDA publicly announced the opportunity to participate in the MVP. In response to this announcement, NASDA received a total of 114 proposals from 11 countries. After evaluation 93 proposals were selected. NASDA is now conducting the MVP by using MOS-1 data, airborne data, and ground/sea truth data in collaboration with the proposal selected organizations.

(4) MOS-1 Data Distribution

All the MOS-1 data acquired and archived by any ground station will be made available on public and non-discriminatory basis. In Aug. 10, 1987, NASDA started to distribute MOS-1 data through Remote Sensing Technology Center of Japan(RESTEC). The concept of MOS-1 data distribution flow is shown in Fig.4.

3. ERS-1 Program

Japanese Earth Resources Satellite-1(ERS-1), with its launching scheduled in early 1992, is under development as a joint program of Ministry of International Trade and Industry(MITI) and NASDA. The main objectives of the ERS-1 are to establish the technology of the active microwave sensor, namely the Synthetic Aperture Radar(SAR), and the high resolution Optical Sensor(OPS), and to examine the terrestrial resources and environment, primarily focusing on the geological and topographical survey.

The profile and description of ERS-1 is shown in Fig. 5 and Table 4. ERS-1 is planned to carry two sensors which are the SAR and OPS. The characteristics of these sensors are shown in Table 5. Their primary design was completed in 1987. The critical design has been started.

4. ADEOS Program

Following the fulfillment of MOS-1 and ERS-1 programs, NASDA plans to launch Advanced Earth Observing Satellite(ADEOS) in early 1994 as a next generation earth observation satellite. The main objectives of ADEOS are as follows.

(1) The development of advanced earth observation sensors.
(2) The development of the modular satellite that is the prototype of the future platform.
(3) The experiments on earth observation data relay using data relay satellites to form a global observation network.
(4) The contribution to domestic and international cooperation by installing sensors developed by domestic and/or foreign organizations.

The profile and description of ADEOS are shown in Fig. 6 and Table 6. ADEOS will carry two core sensors which are Ocean Color and Temperature Scanner(OCTS) and Advanced Visible and Near Infrared Radiometer (AVNIR). In addition to the core sensors, NASDA issued an Announcement of Opportunity(AO) to install the AO sensors as mentioned above. The characteristics of these sensors are shown in Table 7.

5. Polar Orbiting Platform Program

Earth observation program by means of Polar Orbiting Platform (hereinafter referred to as POP Program) is being established among NASA, ESA, STA/NASDA and Canada who are the partners of the Space Station Program. The main objectives of POP Program are to guarantee the continuity of operational meteorological observation which is currently operated by NOAA satellite and to make effective observation of the area of earth science. According to the current schedule, NASA plans to launch one platform in 1995 and ESA plans to launch one in 1997. Japan also have a plan to launch its own platform in late 1990's. The countries who participate in POP Program within the frame work of the Space Station Program will provide on-board sensor instruments. In Japan, NASDA's AMSR(Advanced Micro-wave Scanning Radiometer) and MITI's ITIR(Intermediate Thermal Infrared Radiometer) are planed to be provided to NASA POP as Core sensors. The characteristics of AMSR and ITIR are shown in Table 8.

To make this POP program more effective and fruitful, announcement of opportunity (AO) for the participation in this program was issued from NASA, ESA and STA respectively to the organizations and/or individual researchers concerned.

Table 1 Schedule of Japanese Earth Observation Satellite Programs

Calendar Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000~
Satellite Launch Schedule	▲ MOS-1			△ MOS-1b		△ JERS-1		△ ADEOS	△ NPOP-1		△△ EPOP NPOP-2	△ JPOP		
Satellite Allocation Concept	Japanese Sensors / Japanese Expendable Satellite Bus						Japanese Sensors / Non-Japanese Sensors / Japanese Expendable Satellite Bus				Japanese Sensors / Non-Japanese Sensors / Japanese Platform			
	△ Phase C/D △ Phase B △ Plan							Japanese Sensors / Non-Japanese Sensors / Non-Japanese Platform						

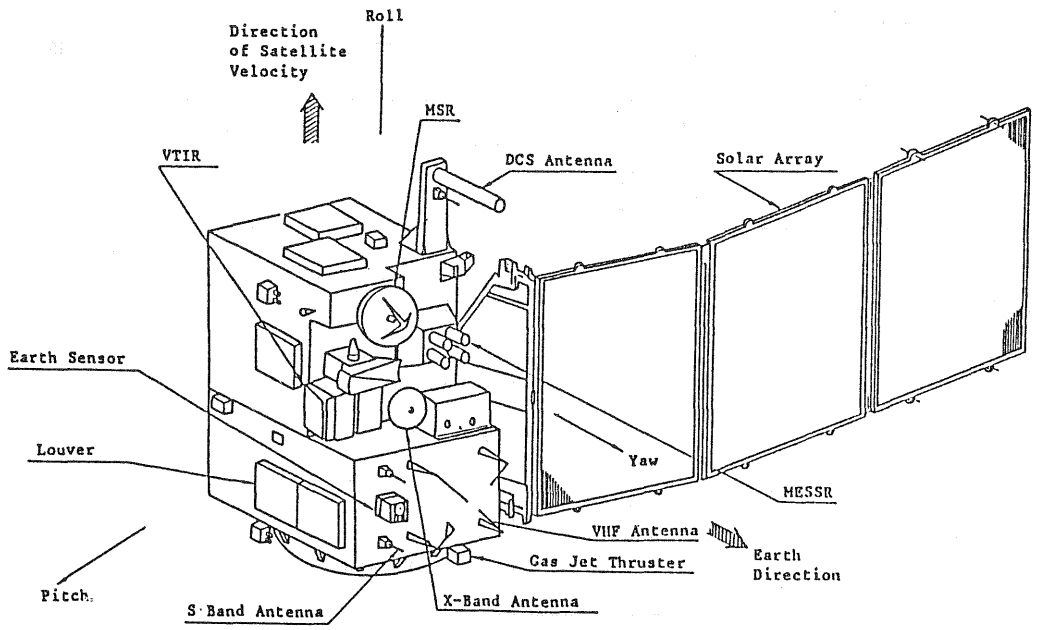

Fig. 1 Profile of MOS-1

Table 2 Description of MOS-1

Item	Parameter
Orbit	Near-Polar (909km) Sun-Synchronous (Local Mean Time 10:05AM) 17 days Coverage Cycle Duration
Weight	740kg
Power	Solar Arrey 640(BOL)
Stabilization	3-Axis, Earth-Pointing
Launch Vehicle	N-II from TNSC
Design Life	2 Years
Instruments	MESSR (Multispectral Electronic Self Scanning Radiometer) VTIR (Visible and Thermal Infrared Radiometer) MSR (Microwave Scanning Radiometer) DCS (Data Collection System)
Launch date	Feb. 19, 1987
Status	Flight segment PM Completed FM Completed and in flight

Table 3 Characteristics of MOS-1 Sensors

Item \ Sensor	MESSR	VTIR		MSR	
Wavelength (μm)	0.51 - 0.59 0.61 - 0.69 0.72 - 0.80 0.80 - 1.1	0.5 - 0.7	6.0 - 7.0 10.5 - 11.5 11.5 - 12.5	———	
Frequency (GHz)	———	———	———	23.8	31.4
Geometric Resolution (IFOV in km)	0.05	0.9	2.7	32	23
Radiometric Resolution	(39dB)	55dB* (Alb.=80%)	0.5K	1K	1K
Swath width (km)	100 (one optical element) x 2	1500		320	
Scanning Method	electric	mechanical		mechanical	

Remarks * Signal to noise ratio excluding quantization noise.

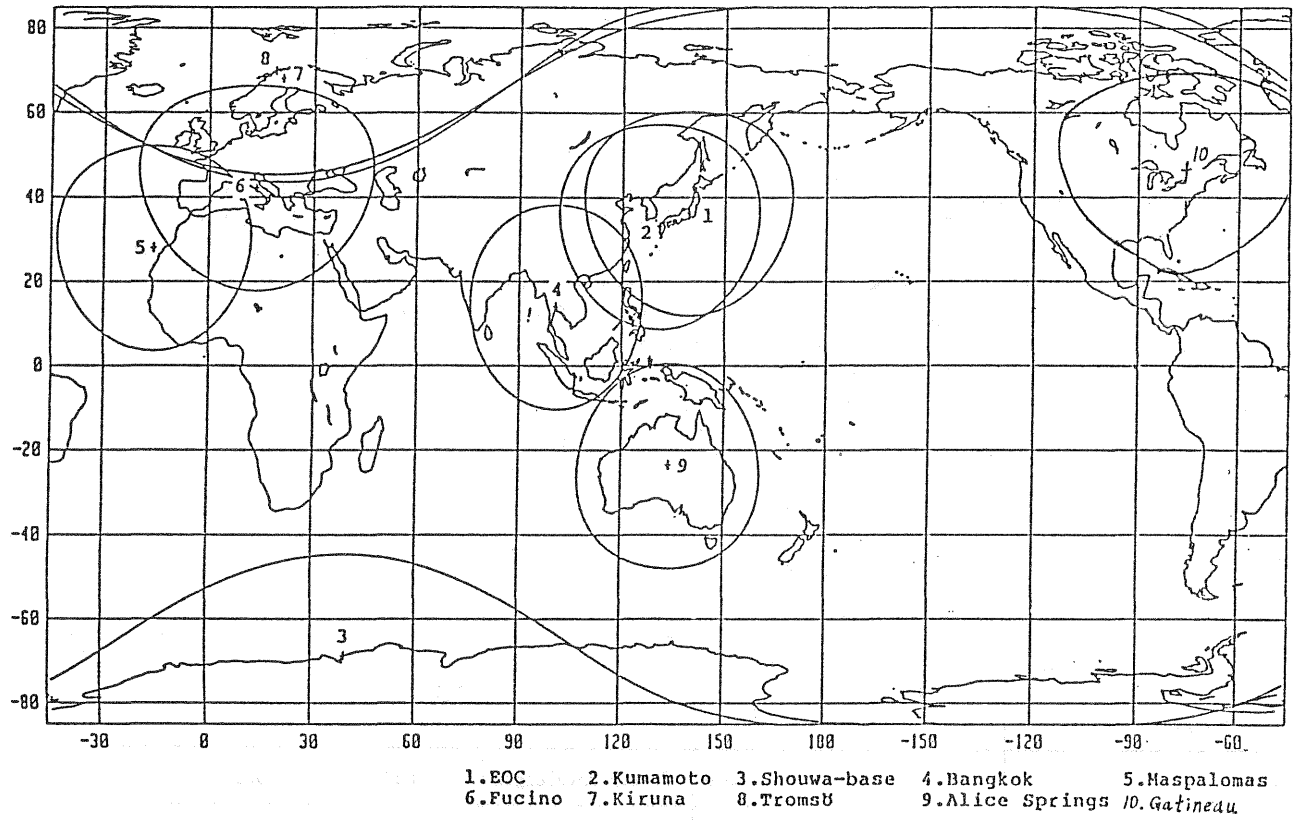

Fig. 4 World Coverage Map of MOS-1

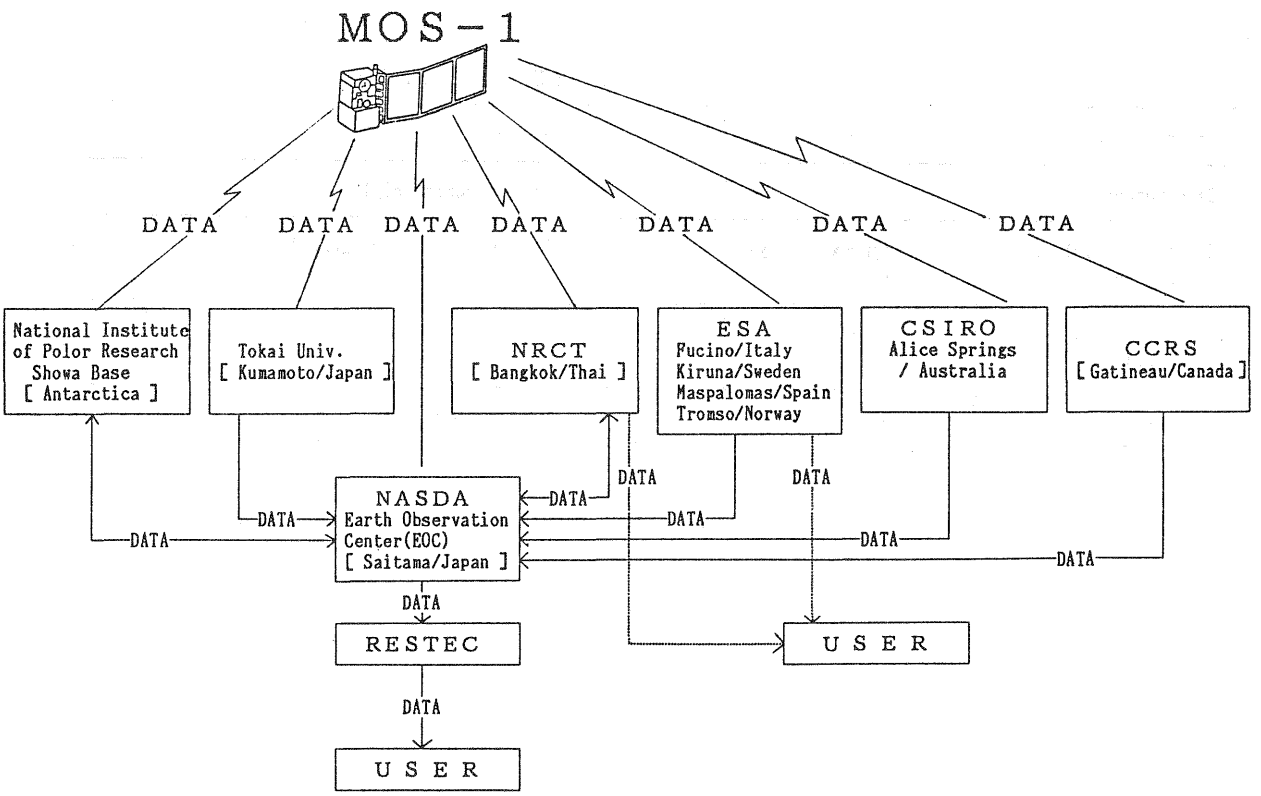

Fig. 5 MOS-1 data distribution flow

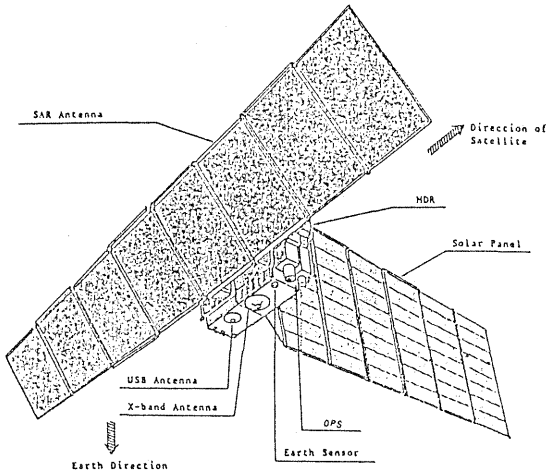

Fig. 6 Profile of ERS-1

Table 4 Description of ERS-1

Item	Parameter
Orbit	Sun-synchronous
Altitude	Approx. 568 km
Inclination	Approx. 97.7°
Recurrent period	44days(Westward)
Local mean time (descending)	10:00-11:00AM
Number of orbit per day	Approx. 15
Weight	Approx. 1400 kg
Launch Vehicle	H-I Rocket
Design Life	2 Years
Launch Schedule	Early 1992

Table 5 Specification of ERS-1 Sensors

Sensor / Item	SAR	OPS			
		Band	Center Wavelength	Band width	Note
Wavelength (μm)	L-band	1 2 3 4 5 6 7 8	0.56 0.66 0.81 0.81 1.655 2.065 2.19 2.335	0.08 0.06 0.10 0.10 0.11 0.11 0.12 0.13	Band4 is for off nadia viewing. Band3 and 4 makes a stereo-pair.
Polarization	H-H	———			
Band number	1	8 (approximately)			
Spatial resolution (meter, squares)	18 (approximately) (3 look)	18 × 24 (approximately)			
Off Nadia Angle (degrees)	35	15.33 (Band4 only)			
Swath Width(Km)	75 (approximately)	75 (approximately)			
Stereoscopic Imaging Capability	———	Yes			

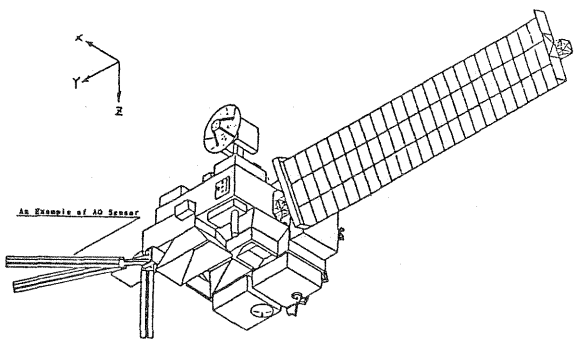

Fig 7 Profile of ADEOS

Table 6 Description of ADEOS

Item	Parameter
Orbit	Sun-synchronous (Approx. 800km)
Weight	Approx. 3000 kg
Power	Approx. 3.5 kw
Launch Vehicle	H-II Rocket (Dual Launch)
Design Life	3 Years
Launch Schedule	FY 1993

Table 7 Characteristics of ADEOS Sensors

OCTS(Ocean Color and Temperature Scanner)	
Spectral Channels	Visible 6 Channels Near-Infrared 2 Channels Middle-Infrared 1 Channel Thermal-Infrared 3 Channels
FOV	±40 Degree(1400 km at the altitude of 800 km)
IFOV	0.85 mRAD(0.7 km at the altitude of 800 km)
Data Rate	2.1 MBPS
Weight	180 kg
Power	240 W
AVNIR(Advanced Visible and Near Infrared Radiometer)	
Spectral Channels	Visible 3 Channels Near-Infrared 1 Channel
FOV	4.6 Degree(65 km at the altitude of 800 km)
IFOV	20 μRAD(16 m at the altitude of 800 km)
Pointing Angle	±40 Degree(1500 km at the altitude of 800 km)
Data Rate	100 MBPS
Weight	200 kg
Power	250 W
AO Sensors (AO:Announcement of Opportunity)	
Total Weight	Approx. 200 kg
Total Power	Approx. 300 W
Volume	TBD
Thermal	Self Dissipation
Data Rate	< 100 MBPS
FOV	TBD
Schedule	AO Release Sep. 1987 Deadline for Receipt End of 1987 Selection Middle of 1988

Table 8 Characteristics of AMSR and ITIR

CANDIDATE SENSOR	AMSR ADVANCED MICROWAVE SCANNING RADIOMETER	ITIR INTERMEDIATE THERMAL INFRARED RADIOMETER
BASIC SPECIFICATION (TENTATIVE)	• FREQUENCY 6.6, 10.65, 18.7, 23.8, 31.55 GHz • SPACIAL RESOLUTION 9.2 - 28 km • SWATH WIDTH 1,200 km	• WAVELENGTH 0.85 - 11.7 μm (NUMBER OF BANDS:11) • SPACIAL RESOLUTION 15m (NIR/SWIR) 60m (TIR) • SWATH WIDTH 30km
OBSERVATION FIELD AND FEATURES OF UTILIZATION	• OCEAN AND ATMOSPHERE OBSERVATION • DATA CONTINUITY OF MOS-1 MSR	• MINERAL RESOURCES OBSERVATION • GEO-THERMAL OBSERVATION
TECHNOLOGICAL FEATURES AND EXPECTED TECHNOLOGICAL RESULTS	• MULTI-FREQUENCY • ESTABLISHMENT OF TECHNOLOGIES REQUIRED FOR LOW NOISE RECIEVER AND LARGE ANTENNA • ELECTRICALLY SCANNING	• PUSHBROOM TYPE SENSOR SYSTEM • ESTABLISHMENT OF TECHNOLOGIES REQUIRED FOR HIGH RESOLUTION OBSERVATION • MULTI-BAND SENSOR COVERING NEAR INFRARED THROUGH THERMAL INFRARED WAVELENGTH