Launch / Tracking and Control Plan
of
Advanced Land Observing Satellite (ALOS) /
H-IIA Launch Vehicle No. 8 (H-IIA F8)

November 2005

Japan Aerospace Exploration Agency (JAXA)

(Independent Administrative Agency)

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1. Overview of the Launch / Tracking and Control Plan

The Japan Aerospace Exploration Agency (hereinafter referred to as "JAXA"), an independent administrative agency, is scheduled to carry out the launch of the Advanced Land Observing Satellite (hereinafter referred to the "ALOS") using the H-IIA Launch Vehicle No. 8 (hereinafter referred to the "H-IIA F8") in Japanese Fiscal Year 2005.
This document describes the launch plan for the ALOS from the time of the liftoff of the H-IIA F8 through the confirmation of the payload separation from the second stage of the launch vehicle, as well as the tracking and control plan of the initial phase of the ALOS in which its three-axis attitude control stabilization, the initial orbit maneuver to a Sun-synchronous subrecurrent orbit* and functional verification of its onboard equipment will be carried out.

* Sun-synchronous subrecurrent orbit: An orbit in which a satellite orbital plane and the direction to the sun are always constant, and the satellite comes back to one specific spot at about the same time in a constant interval.

1.1 Organization in Charge of Launch / Tracking and Control

Japan Aerospace Exploration Agency (Independent Administrative Agency)
President: Keiji Tachikawa
Address: 7-44-1 Jindaiji Higashi-machi, Chofu-shi, Tokyo, 182-8522 Japan

1.2 Person in Charge of Launch / Tracking and Control

(1) Director General for Launch
Tsukasa Mito, Executive Director
(2) Director General for Tracking and Control
Yasushi Horikawa, Executive Director

1.3 Objectives of Launch / Tracking and Control

To launch the ALOS into its scheduled orbit using the H-IIA F8, and carry out tracking and control operations in the initial phase.

1.4 Payload and Launch Vehicle

Launch Vehicle: the H-IIA Launch Vehicle No. 8 (H-IIA F8) (A standard type with a 5-m diameter fairing and two solid strap-on boosters) =One unit
Payload: the Advanced Land Observing Satellite (ALOS) =One unit

1.5 Launch Window (Day and Time)

Launch Vehicle Type	Scheduled Launch Day	Launch Window	Launch Time	Time of the Launch Vehicle Jettison (After liftoff)
H-IIA Launch Vehicle No. 8 (H-IIA F8)	January 19, 2006	January 20 — February 28, 2006	10:33 to 10:43 a.m. (JST)	- Solid rocket boosters, solid strap-on boosters, and nozzle closure: about 0 to 1 minute after liftoff. - Payload fairing: about 9 to 27 minutes after liftoff. - First stage: about 15 to 33 minutes after liftoff.

Dates and times are Japan Standard Time.

1.6 Facilities for Launch / Tracking and Control

Figure-1 shows the facilities of JAXA and organizations that will support JAXA for launch tracking and control operations.

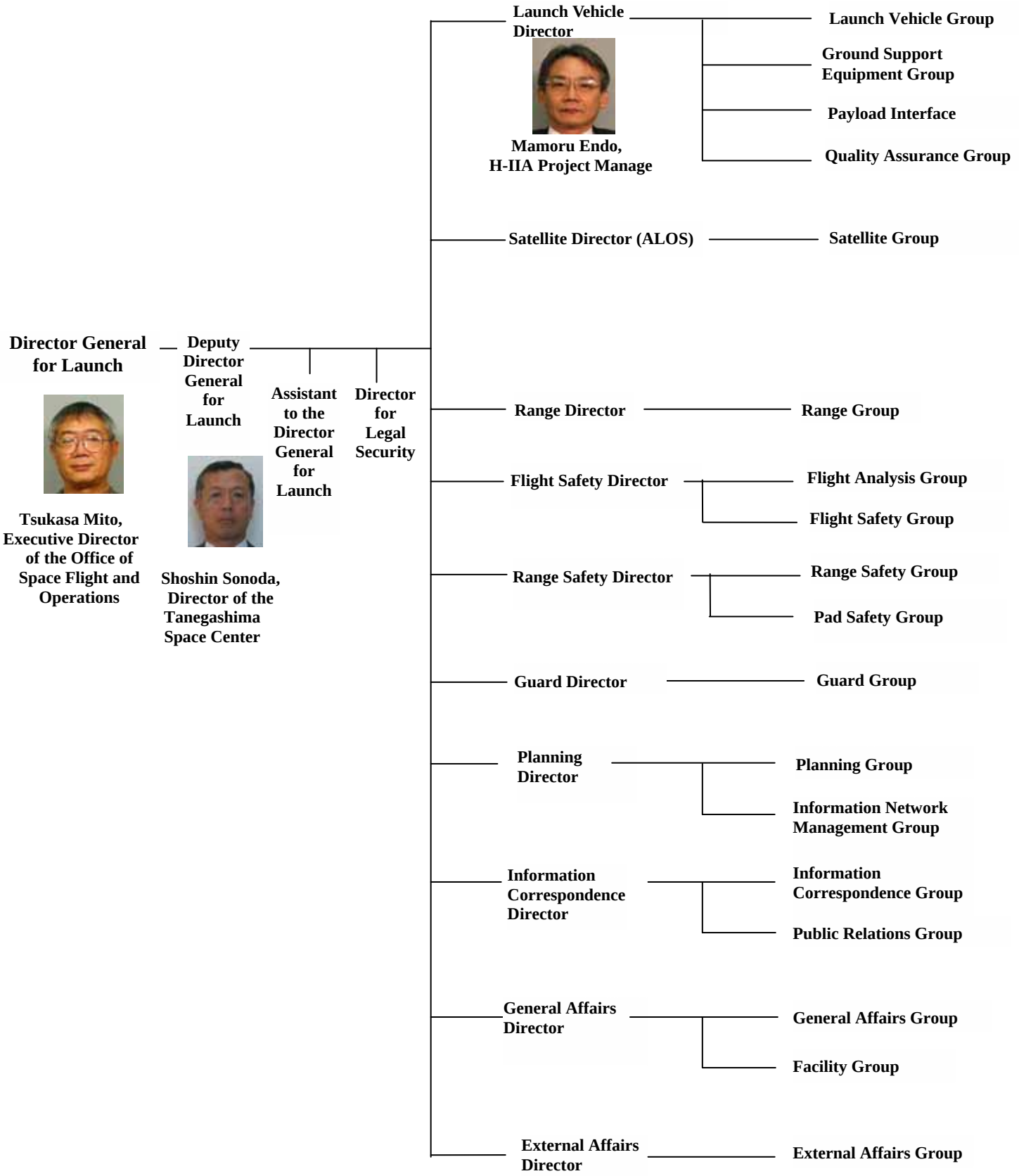
2. Launch Plan

2.1 Launch Site

(1) JAXA Facility
(a) Tanegashima Space Center
Oaza-Kukinaga, Minamitane-machi, Kumage-gun, Kagoshima, Japan

2.2 Launch Organization

The following Launch Team led by the Director General for Launch is organized for smooth and accurate operations of launch site activities, the launch itself and payload orbit injection.



2.3 Launch Vehicle Flight Plan

H-IIA Launch Vehicle No.8 (H-IIA F8) carrying the Advanced Land Observing Satellite (ALOS) will be launched vertically from Launch Pad 1 of the Yoshinobu Launch Complex at the Tanegashima Space Center.
After liftoff, the launch vehicle will shift its pitch plane angle to 115 degrees in azimuth and fly over the Pacific Ocean according to the scheduled flight path shown in Table-1.
Solid Rocket Boosters (SRB-As) will be jettisoned at about two minutes and five seconds after liftoff (hereinafter, time indicates approximate minutes and seconds passed after liftoff) followed by the jettison of the solid strap-on boosters at two minutes and six seconds, the payload fairing jettison at four minutes and 20 seconds, the first stage engine cutoff at six minutes and 36 seconds, and the first stage jettison at six minutes and 44 seconds.
The second stage engine will be ignited at six minutes and 50 seconds and cut off at 15 minutes and 25 seconds. The ALOS will be separated and injected into a sun-synchronous subrecurrent orbit at 16 minutes and 16 seconds at an altitude of about 700 km with an inclination of 98.2 degrees.
Table-1 shows the flight plan and Figure-2 shows the scheduled flight trajectory.

2.4 Major Characteristics of the Launch Vehicle

Table-2 and Figure-3 show the major characteristics and configuration of the launch vehicle.

2.5 Outline of the Advanced Land Observing Satellite (ALOS)

The Advanced Land Observing Satellite (ALOS) aims to collect topographic data to contribute to cartography, regional observation, information gathering from a disaster-stricken area, and recourse surveying by upgrading the land observation technology of the Japan Earth Resources Satellite-1 (JERS-1) and the Advanced Earth Observing Satellite (ADEOS).
The ALOS is equipped with three earth observation sensors namely the Remote-sensing Instrument of Stereo Mapping (PRISM) and the Advanced Visible and Near Infrared Radiometer type-2 (AVNIR-2), which were developed by JAXA, and the Phased Array type L-band Synthetic Aperture Radar (PALSAR), which was developed in cooperation with the Japan Resources Observation System Organization of the Ministry of Economy, Trade, and Industry. With these three sensors, the ALOS is expected to carry out high-resolution land observations.
Table-3 shows the major characteristics of the ALOS, and Figure-4 shows its configuration.

2.6 Securing Launch Safety

(1) Safety and Security of Launch Operations
The safety and security of launch-related operations will be secured by taking necessary actions based on launch-related laws and regulations, guidelines drawn up by the Space Activities Commission, JAXA standards for payload launch, and regulations and standards for range safety control regarding the management of hazardous material at the Tanegashima Space Center. During launch operations, access will be controlled around the facilities where hazardous materials are stored and/or handled.

(2) Liaisons with Residents around the Launch Site
For the safety of local residents, JAXA will hold a briefing session with them to announce the launch plan and ask for their cooperation not to enter access control areas.

(3) Security and Safety Control on the Launch Day

(a) Access to areas shown in Figure-5 will be controlled on the launch day of H-IIA Launch Vehicle No. 8 (H-IIA F8).

(b) Access control on land will be secured by JAXA in cooperation with the Kagoshima Prefectural Police and Tanegashima Police.

(c) Marine access control will be secured by JAXA, which will monitor the area using radars and patrol ships in cooperation with the 10th Regional Coast Guard Headquarters and the Kagoshima Prefectural Government. Liaison personnel will be dispatched to the 10th Regional Coast Guard Headquarters Kagoshima Coast Guard to exchange information with the launch site.

(d) For air security and safety over the launch site, JAXA will ask for cooperation from the Kagoshima Airport Office of the Osaka Aviation Department of the Ministry of Land, Infrastructure and Transport, and the Tanegashima Airport Office. A liaison will be dispatched to the Tanegashima Airport Office for closely exchanging information with the launch site.

(e) For ships and vessels, JAXA will hoist a yellow flag at two points at the Tanegashima Space Center on the launch day. They will be replaced with red ones 30 minutes prior to the liftoff time. A signal flare will be fired two minutes prior to the liftoff. Two flares will be fired after the launch, and then the red flags will be removed.

(4) Flight Safety of the Launch Vehicle

Flight safety of the launch vehicle after liftoff will be monitored and determined by acquired data from the launch vehicle. Any necessary action will be taken based on this data.

2.7 Correspondence Method of Launch Information to Parties Concerned

(1) Correspondence regarding Launch Time/Date Information

(a) The launch day and time will be finalized by 15:00 two days prior to the launch day, and the decision will be conveyed to all related organizations by facsimile.

(b) In the case that the launch is delayed due to adverse weather conditions and/or other factors, the postponement and new launch date will be swiftly informed to all related organizations.

(c) JAXA will announce the status of the launch six hours, two hours and thirty minutes prior to launch, and then again just after liftoff, to the following parties: the New Tokyo Airport (Narita Airport) Office of the Tokyo Aviation Department, the Kagoshima Airport Office and the Tanegashima Airport Office of the Osaka Aviation Department, the Air Traffic Control Center of the Civil Aviation Bureau, and Air Traffic Control Centers in Tokyo, Fukuoka, and Naha.

(2) Prior Notice and Launch Information Announcement for Maritime Traffic Safety

(a) JAXA will request the Hydrographic Department of the Maritime Safety Agency to publish a notice to mariners regarding the marine access control areas shown in Figure-5 and the impact areas shown in Figure-6.

(b) For general navigation ships and vessels, JAXA will announce the launch activity, in addition to the notice for mariners, through radio navigation warnings and shipping broadcasts by Kyodo News Enterprise (a navigation warning offered by the Maritime Safety Agency).

(c) For shipping vessels, JAXA will announce the launch activity through fishery radio stations, and the shipping broadcast of Kyodo News Enterprise (a navigation warning offered by the Maritime Safety Agency).

(3) Prior Notice and Launch Information Announcement for Air Traffic Safety

(a) Air traffic safety will be secured through a supplement of the Aviation Information Publication and the Notice of Airman (NOTAM) issued by the Ministry of Land, Infrastructure, and Transport (MLIT). JAXA will place the request to the Kagoshima Airport Office of the Osaka Aviation Department of the MLIT according to Article 99, Section 2, of the Aviation Act and its related regulations, so that the supplement will be timely issued by the MLIT. The information written in the NOTAM will also be conveyed to the New Tokyo Airport (Narita Airport) Office of the Tokyo Aviation Department.

3. Tracking and Control Plan

3.1 Tracking and Control Plan of the ALOS

3.1.1 Tracking and Control Sites

(1) JAXA Facilities

(a) Tracking and Control Building, Tsukuba Space Center
Sengen, Tsukuba-shi, Ibaraki, Japan

(b) Masuda Tracking and Communication Station
Masuda, Nakatane-cho, Kumage-gun, Kagoshima, Japan

(c) Katsuura Tracking and Communication Station
Haga, Hanatateyama, Katsuura-shi, Chiba, Japan

(d) Okinawa Tracking and Communication Station
Kinnabaru, Afuso, Onna-son, Okinawa, Japan

(e) Earth Observation Center
Aza-Numanoue, Oaza-Ohashi, Hatoyama-machi, Hiki-gun, Saitama,Japan

(f) Kiruna Overseas Mobile Tracking Station
Kiruna, Kingdom of Sweden

(g) Perth Overseas Mobile Tracking Station
Perth, Australia

(h) Santiago Overseas Mobile Tracking Station
Santiago, Chile

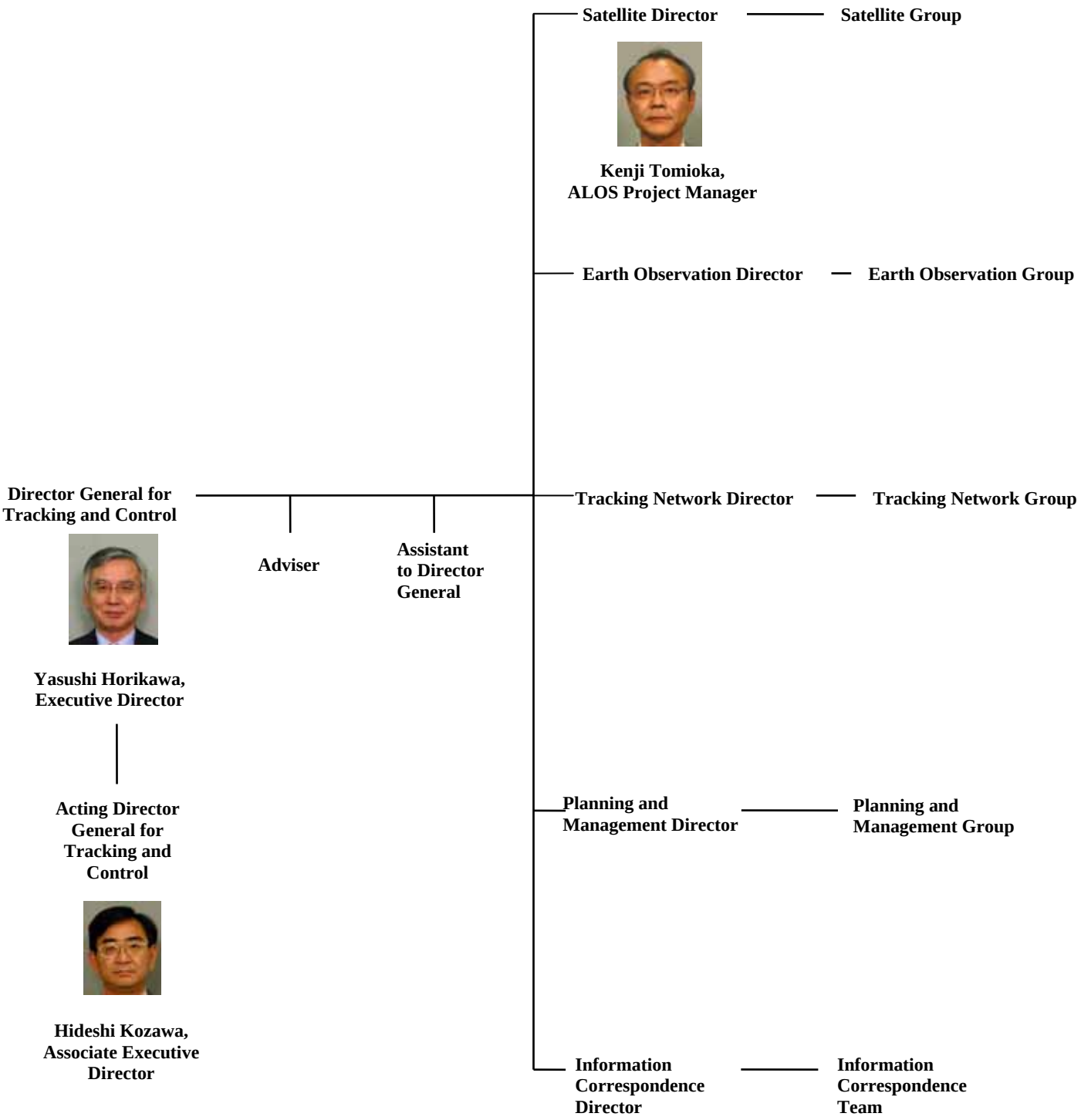
(i) Maspalomas Overseas Mobile Tracking Station
Maspalomas, Grand Canary, Canary Islands

3.1.2 Tracking and Control Organization

Tracking and control operations during the ALOS launch and initial phases will be performed by the Tracking and Control Team shown on the next page.

3.1.3 Tracking and Control Period

The tracking and control period for the ALOS launch and initial phases will be about three months after launch.
After completing the initial phase, ALOS will move to the regular operation phase that includes about five months of the initial calibration and validation phase. The tracking and control will also be performed during the regular operation phase until the completion of the mission period, which is scheduled to be about three years after launch.



Tracking and Control Team

3.1.4 Tracking and Control Operations

The ALOS will be launched by the H-IIA F8 to be injected into a sun-synchronous subrecurrent orbit at an altitude of approximately 700 km and with a period of about 99 minutes.
Before the establishment of the three-axis attitude, the deployment of the solar array paddle, the Data Relay Satellite Comminucation (DRC) antenna, and the Phased Array type L-band Synthetic Aperture Radar (PALSAR) antenna will be carried out. After injection into orbit, onboard equipment will be checked according to a predetermined check list. Subsequently, the establishment of the three-axis attitude and the initial verification for the bus and mission equipment will follow. Then the ALOS will move to the initial calibration phase and start operating its mission equipment.
The tracking and control plan (stations) of the ALOS is shown in Table-4.

3.1.5 ALOS Flight Plan

Figure-7 shows the flight plan of the ALOS from the time of the separation from the second stage of the H-IIA F8 through its arrival at its targeted orbit.
Figure-8 is the trajectory on-orbit of the ALOS during the same period.

3.1.6 Tracking and Control System

The tracking and control operations system of the ALOS is shown in Figure-9.

4. Launch Result Report

(1) The result of the launch will be swiftly reported to the Ministry of Education, Culture, Sports, Science and Technology, and a press conference will also be held by the Director General for the Launch.

(2) After the satellite is injected into its orbit, its information will be promptly provided to international organizations such as the Committee on the Peaceful Uses of Outer Space of the United Nations, and the Committee on Space Research, through related government organizations.

(3) JAXA supports press and media coverage activities while maintaining their safety.

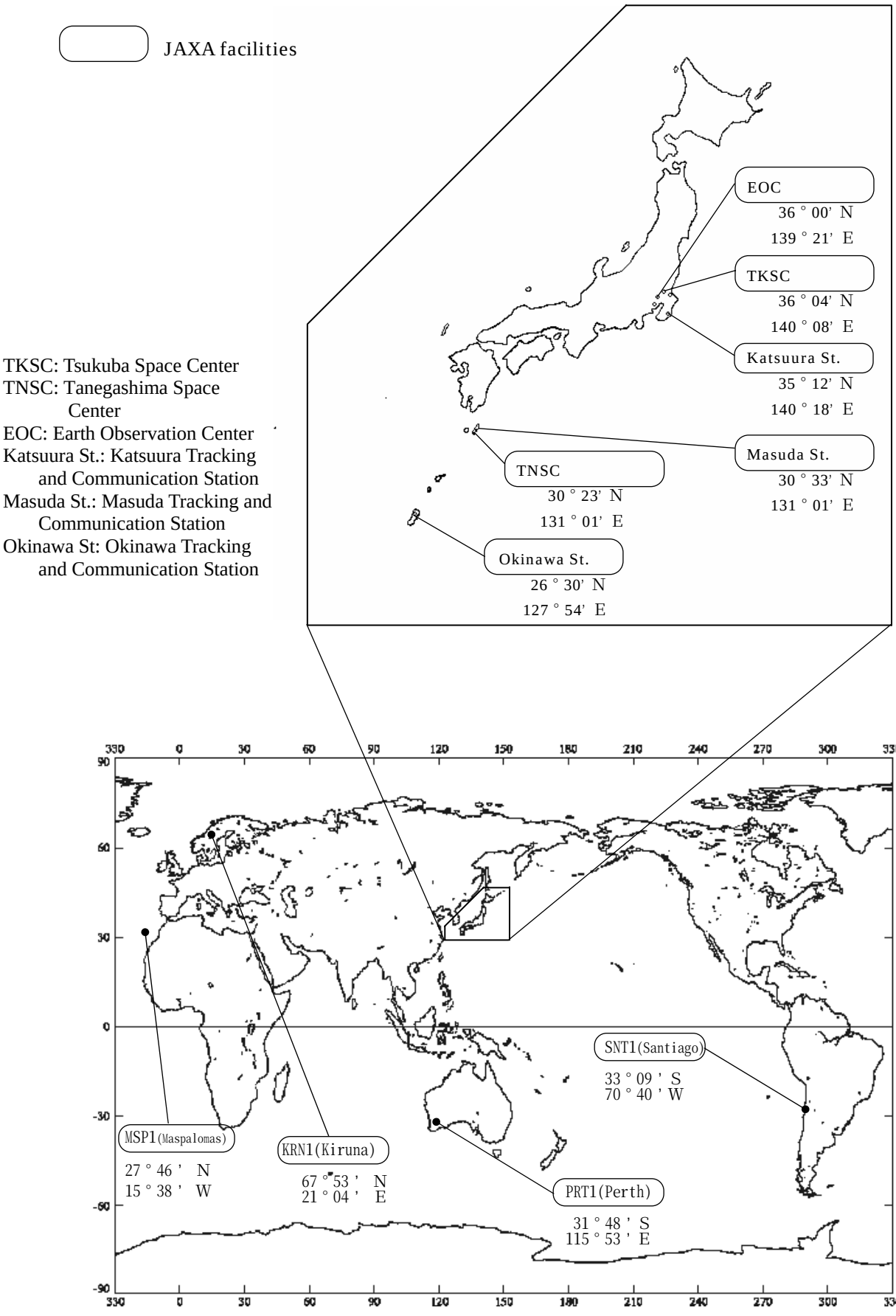


Figure-1: Map of Launch / Tracking and Control Facilities

Table-1 Launch Vehicle Flight Plan

Events	Time after liftoff		Altitude	Inertial velocity
	Min	Sec	km	km/s
1 Liftoff	0	0	0	0.4
2 SSB Ignitions	0	10	0	0.4
3 SSB Burnout	1	8	19	1.0
4 SRB-A Burnout	1	55	55	1.6
5 SRB-A Jettison	2	5	64	1.6
6 SSB Jettison	2	6	65	1.6
7 Payload Fairing Jettison	4	20	165	2.0
8 1st Stage Engine Cutoff	6	36	315	3.6
9 1st and 2nd Stages Separation	6	44	327	3.5
10 2nd Stage Engine 1st Ignition	6	50	336	3.5
11 2nd Stage Engine 1st Cutoff	15	25	697	7.5
12 ALOS Separation	16	16	697	7.5

SSB = Solid Strap-on Boosters

SRB-A = Solid Rocket Boosters

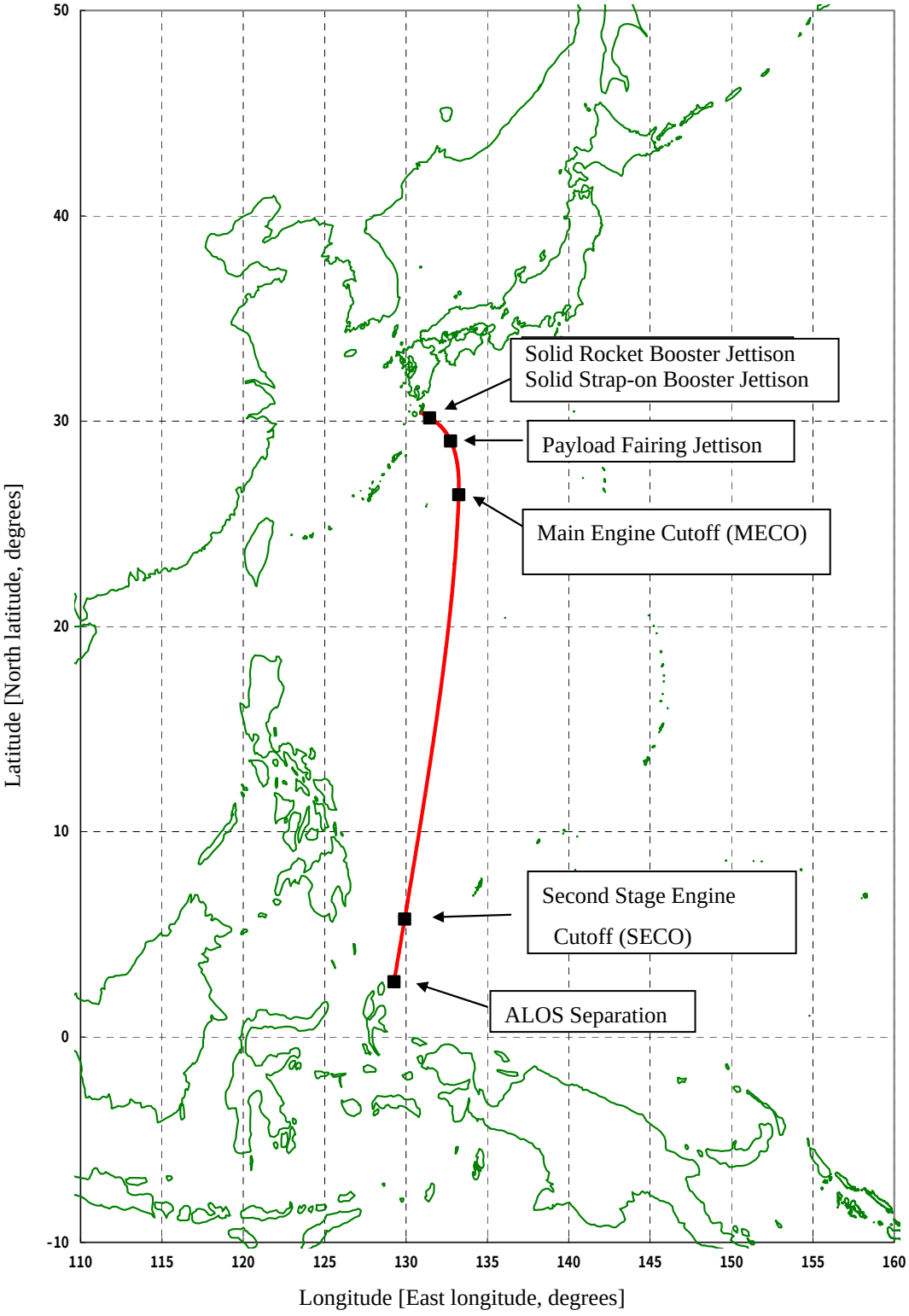


Figure-2: Launch Vehicle Flight Trajectory

Table-2: Major Characteristics of the Launch Vehicle

All Stages					
Name	H-IIA Launch Vehicle Flight No. 8 (H-IIA F8)				
Height (m)	53				
Mass (t)	321 (Without payload)				
Guidance Method	Inertial Guidance Method				
Each Stage					
	First Stage	Solid Rocket Booster (SRB-A)		Second Stage	Payload Fairing
Height (m)	37	15	15	11	12
Outside diameter (m)	4.0	2.5	1.0	4.0	5.1
Mass (t)	114	154 (for two)	31 (for two)	20	1.9
Propellant mass (t)	101	132 (for two)	26 (for two)	17	
Thrust (KN)	1,100 *1	4,570 *1 (for two)	1,490*1 (for two) maximum)	137 *1	
Combustion time (s)	390	120	60	530	
Propellant type	Liquid oxygen /Liquid hydrogen	Polybutadiene composite solid propellant	Polybutadiene composite solid propellant	Liquid oxygen /Liquid hydrogen	
Propellant supply system	Turbo pump	—	—	Turbo pump	
Impulse to weight ratio (s)	440 *1	281 *1	282*1	448 *1	
Attitude control system	Gimbal Sub-engine	Movable nozzle	—	Gimbal Gas jet system	
Major onboard electronics devices	- Inertial guidance system - Telemetry transmitter	—	—	- Guidance control system, - Radar transponder, - Telemetry transmitter, - Command destruct system	

*1: In vacuum. Solid rocket booster's thrust is set to the maximum value.

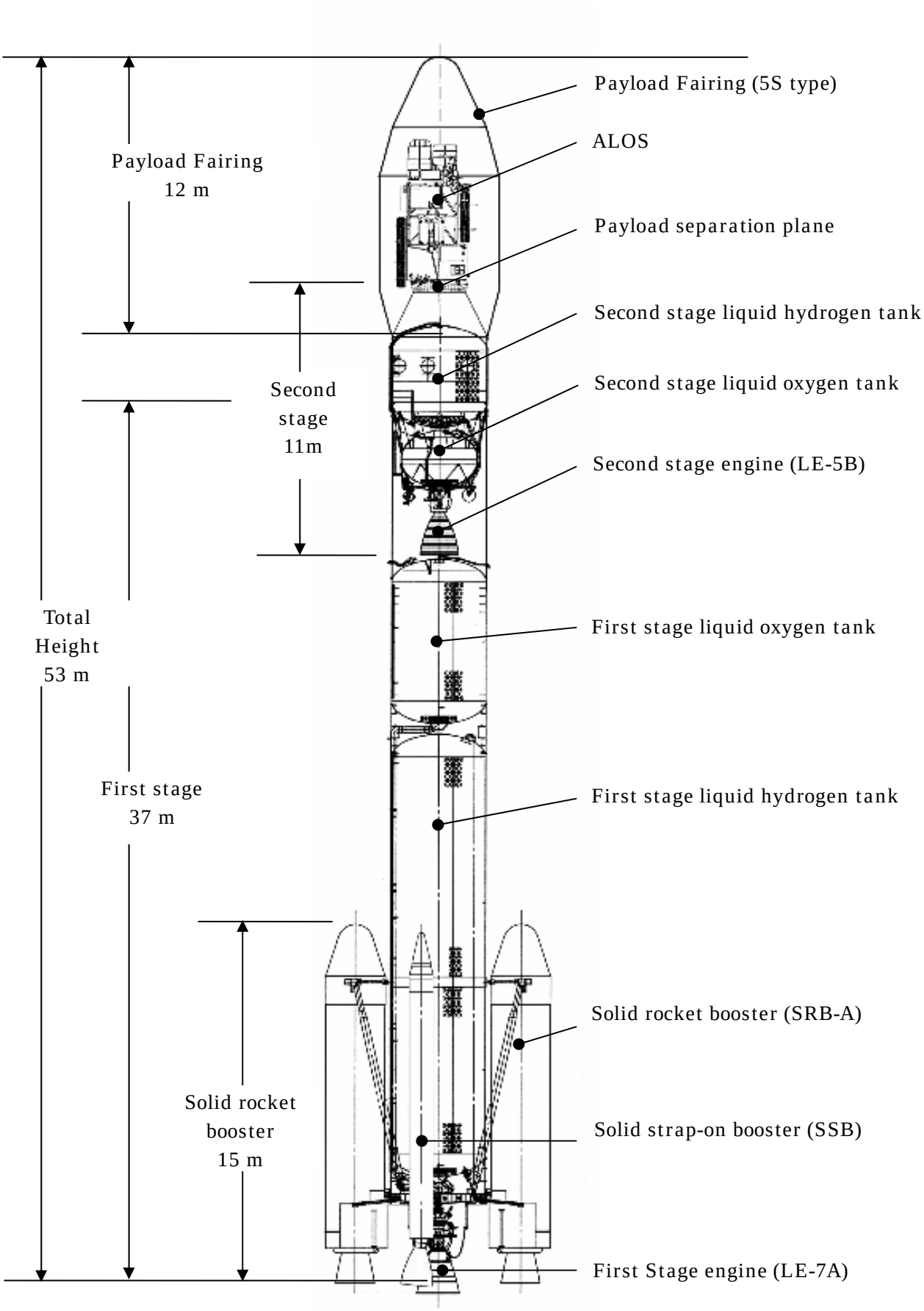


Figure-3: Configuration of the Launch Vehicle

Table-3 Major Characteristics of the ALOS (1/3)

Name	Advanced Land Observing Satellite (ALOS)
Objectives	(1) To carry out technological development necessary for land observation by a satellite. (2) To contribute to the following areas in cooperation with user organizations. - Cartography and correction of existing maps in Japan and countries in the Asian Pacific region. - Regional observation necessary for sustainable development all over the world. - Prompt information gathering at an area hit by a large-scale disaster in Japan and overseas. - Recourse surveying in Japan and overseas.
Orbit	Type: Sun-synchronous subrecurrent orbit Altitude: 691.65 Km Inclination: 98.16 degrees Period: 98.7 minutes Recurrent period: 46 days Number of recurrence: 14 + 27/46 revolutions / day Orbit per recurrent: 671 revolutions Local time at descending node: 10:30 a.m. +/- 15 minutes Recurrent accuracy: +/- 2.5 km
Configuration / Dimension	A box shaped satellite with one solar array paddle, a Phased Array Type L-band Synthetic Aperture Radar (PALSAR), and a data relay satellite communication antenna Main body: about 6.2 m x 3.5 m x 4.0 m Solar array paddle: about 3.1 m x 22.2 m PALSAR antenna: about 8.9 m x 3.1 m
Mass	4.00 ton
Power generation	more than 7,000 W (EOL)
Mission life	3 years
Attitude control method	Zero-momentum three axis control strapdown system with inertial sensor

Table-3 Major Characteristics of the ALOS (2/3)

Mission Equipment	Panchromatic Remote-sensing Instrument for Stereo Mapping (PRISM) - Sensors developed by: JAXA - Observation band: 1 (Panchromatic) - B/H ratio: 1.0 - Resolution (Nadir) : 2.5 m (about 3.61 μ rad) - Field of View (scanning width): about 2.9 degrees (equivalent to 35 km) 70 km in width for nadir-look - Pointing angle: +/- 1.5 degrees (equivalent to 70 km in width) - Data rate: Less than or equal to 960 Mbps
	Advanced Visible and Near Infrared Radiometer Type 2 (AVNIR-2) - Sensors developed by: JAXA - Observation band: 4 - Resolution: 10 m (about 14.28 μ rad) - Field of View (scanning width) : about 5.8 degrees (more than or equal to 70 km) - Pointing angle: +/- less than or equal to 44 degrees - Data rate: 160 Mbps
	Phased Array Type L-band Synthetic Aperture Radar (PALSAR) - Sensors developed by: JAXA and Ministry of Economy, Trade and Industry/JAROS - Frequency: L-band - Method: active phased array - Incidence angle (degrees) High resolution: 8 to 60 Wide area observation : 18 to 43 - Resolution (m) High resolution: 10 Wide area observation: 100 - Scanning width (km) High resolution: 70 Wide area observation: 350 - Data rate: 240 Mbps / 120 Mbps
	Technical Engineering Data Acquisition Equipment (TEDA) - Items for measurement: light particles, heavy ions - Data rate 3.712 kbps

Table-3 Major Characteristics of the ALOS (3/3)

Mission equipment	Deployment Monitor (DM) - Items monitored by DM: PALSAR antenna deployment Solar array paddle deployment Data relay satellite communication antenna deployment ALOS overall movement - Item monitored by LEM: Launch environment - Number of cameras: 6 cameras (CCD cameras) Three cameras (maximum) can be operated at the same time Shooting rate: about 7 frames per second (high speed) about 0.1 frame per second (low speed)
	Laser Reflector (LR) - Method: Prism Array Type - Field of View : Satellite Nadir +/- 60 degrees

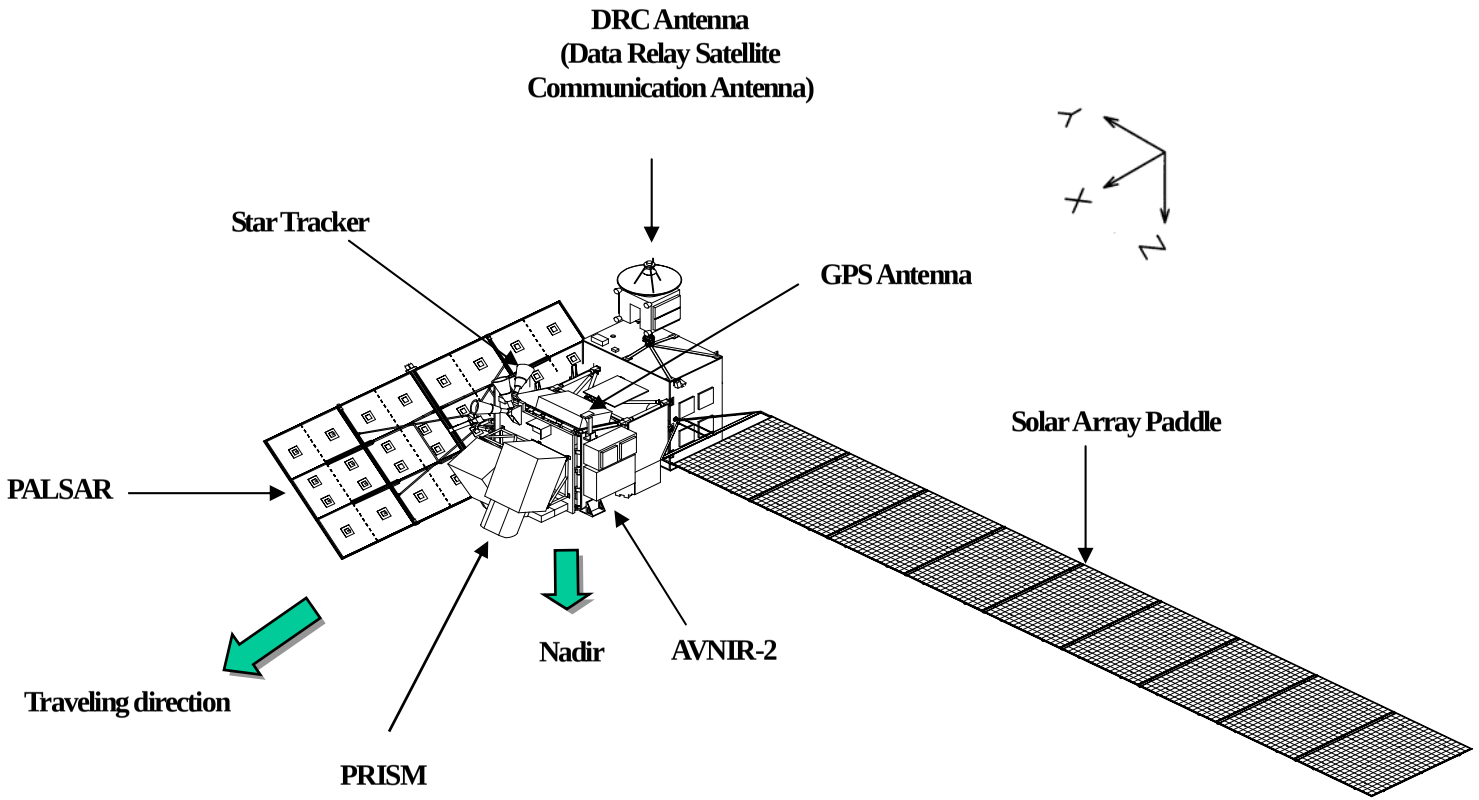
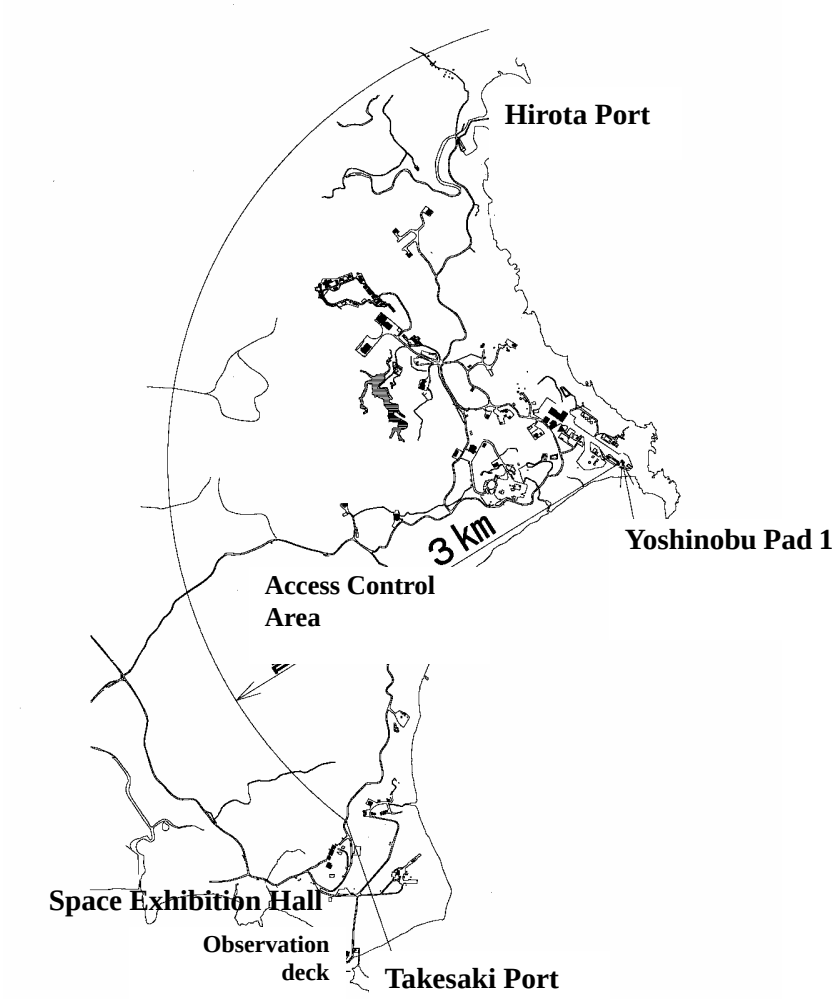
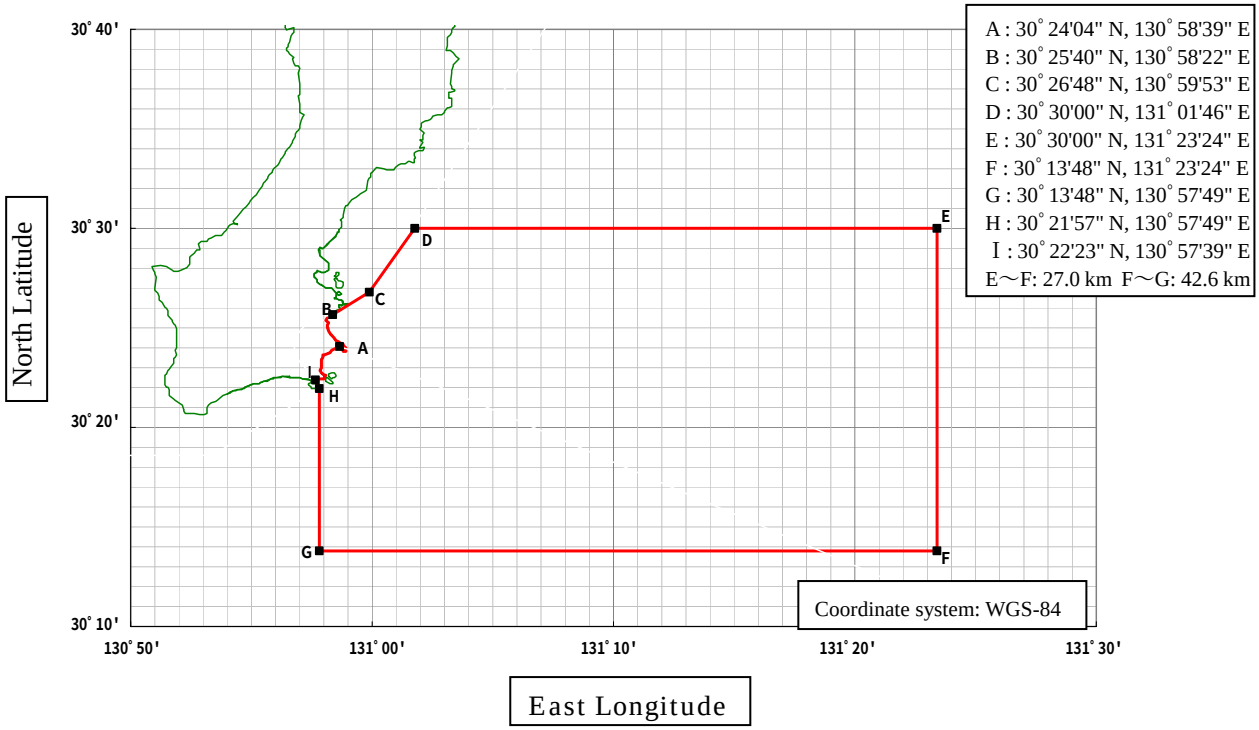


Figure-4: On-orbit Configuration of the ALOS



Land Access Control Area



Marine Access Control Area

Figure-5: Access Control Areas for Launch

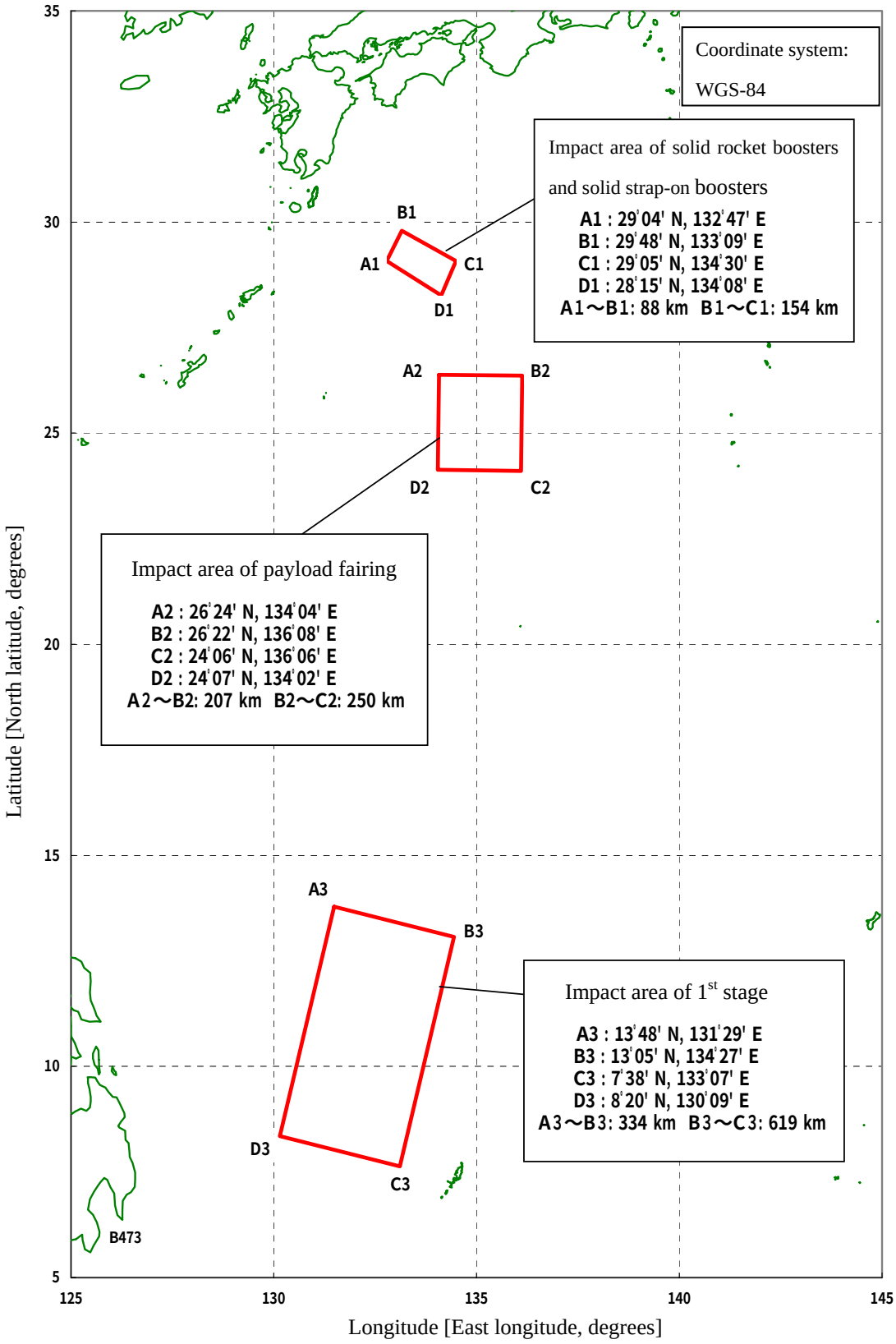


Figure-6: Impact Areas of the Launch Vehicle

Table-4: Tracking and Control Plan (Stations) of the ALOS

Ground stations \ Operational phase			Launch phase	Initial phase		Regular Operation phase (*2)
			Critical phase		Initial functional verification phase	
Tracking and Control System	Tsukuba Tracking and Control Bldg. (TACC)		○	○	○	○
	New GN	Katsuura 1st Mobile Station (KTU1)		○	○(*3)	○(*5)
		Masuda 1st Mobile Station (MSD1)	○(*1)	○	○(*3)	○(*5)
		Okinawa 1st Mobile Station (OKN1)	○	○	○(*3)	○(*5)
		Kiruna 1st Mobile Station (KRN1)		○	○(*3)	○(*5)
		Perth 1st Mobile Station (PRT1)		○	○(*3)	○(*5)
		Santiago 1st Mobile Station (SNT1)		○	○(*3)	○(*5)
		Maspalomas 1st Mobile Station (MSP1)		○	○(*3)	○(*5)
		Tsukuba Primary Ground Terminal (Feeder link station) (PGT)			○(*3)(*6)	○
		Hatoyama Ground Terminal (Feeder link station) (HGT)			○(*3)(*6)	○
Related facilities		RCC *1	○			
		EOC *2		○	○(*4)	○

(*1) A station used as a backup for the satellite operations (CMD/TLM) at the launch site before launch
(*2) The initial phase includes the initial calibration phase.
(*3) Stations used for the initial function verification phase will be determined after operation plans are arranged and coordinated by the Consolidated Space Tracking and Data Acquisition Department based on a request from the Satellite Group. The new GN system will be operated as the main system before DRC checkout, and the SN system will serve this role after DRC checkout.
(*4) A station that will be used for acquiring TEDA data at all time after six days from the launch day.
(*5) Stations that will be used, when necessary, for ensuring precise orbit determination and/or for house keeping operations.
(*6) The SSA omni-line will be used as a backup if an anomaly occurs with the USB line.
*1 RCC: Range Control Center (at Tanegashima Space Center)
*2 EOC: Earth Observation Center (in Hatoyama, Saitama, Japan)

(1) Launch

REV 0
(2) LEM → DM switching
(3) Satellite separation
(4) Paddle deployment
(DM images recorded to MDR)
Mission equipment switched to Sleep Mode

REV 1
(5) Paddle sun acquisition start

Japanese station first AOC: REV 1

(6) REV 7 : DRC pyro ignition 1 to 3

(7) REV 14 : DRC deployment
(DM images recorded to MDR)

(8) REV 27 : PALSAR pyro ignition 1 to 3

(9) REV 29 : PALSAR deployment sequence #1
(DM images recorded to MDR)

(10) REV 30 : PALSAR deployment sequence #2

(11) REV 51 : Swith to NM

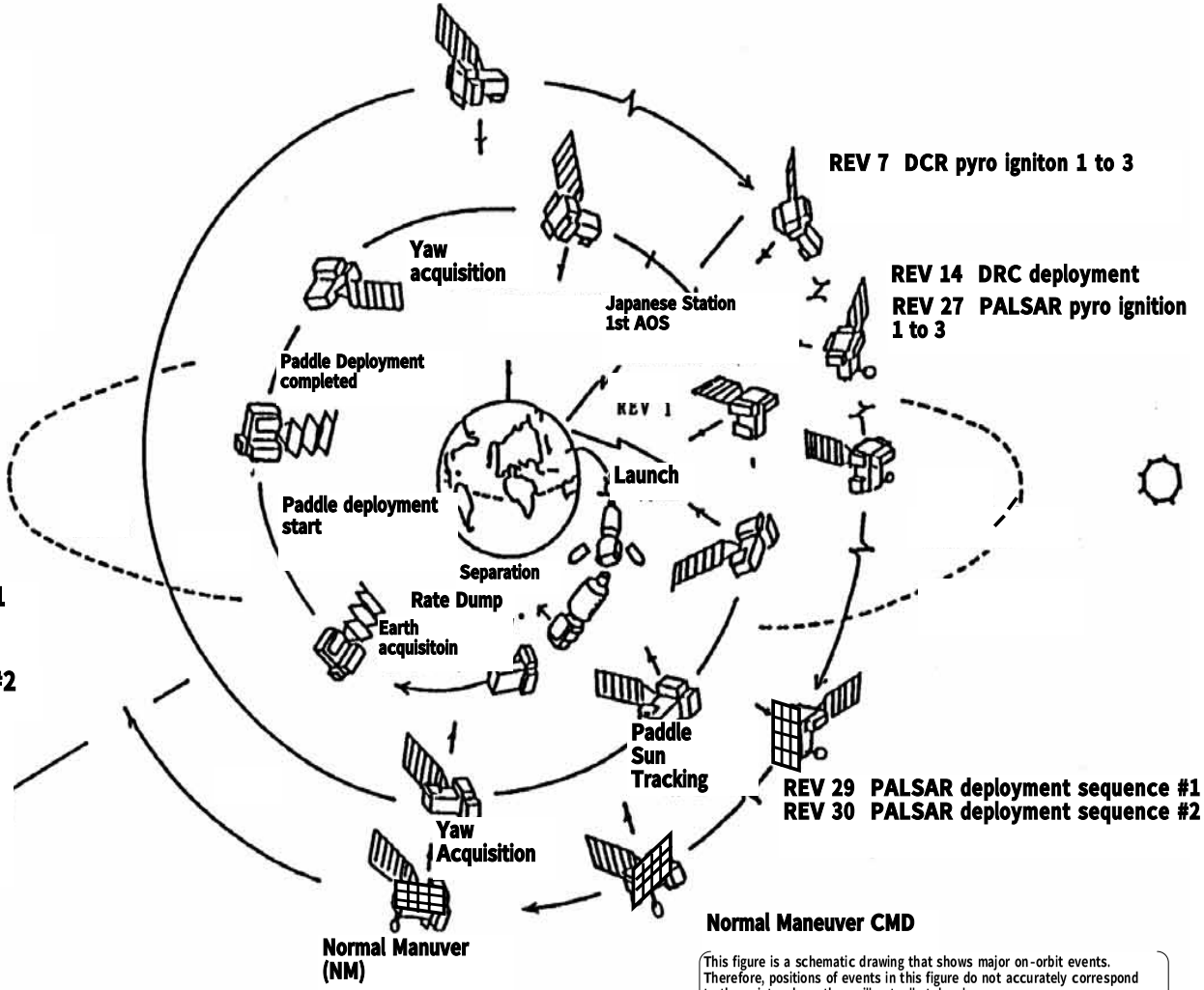


Figure-7 ALOS Flight Plan

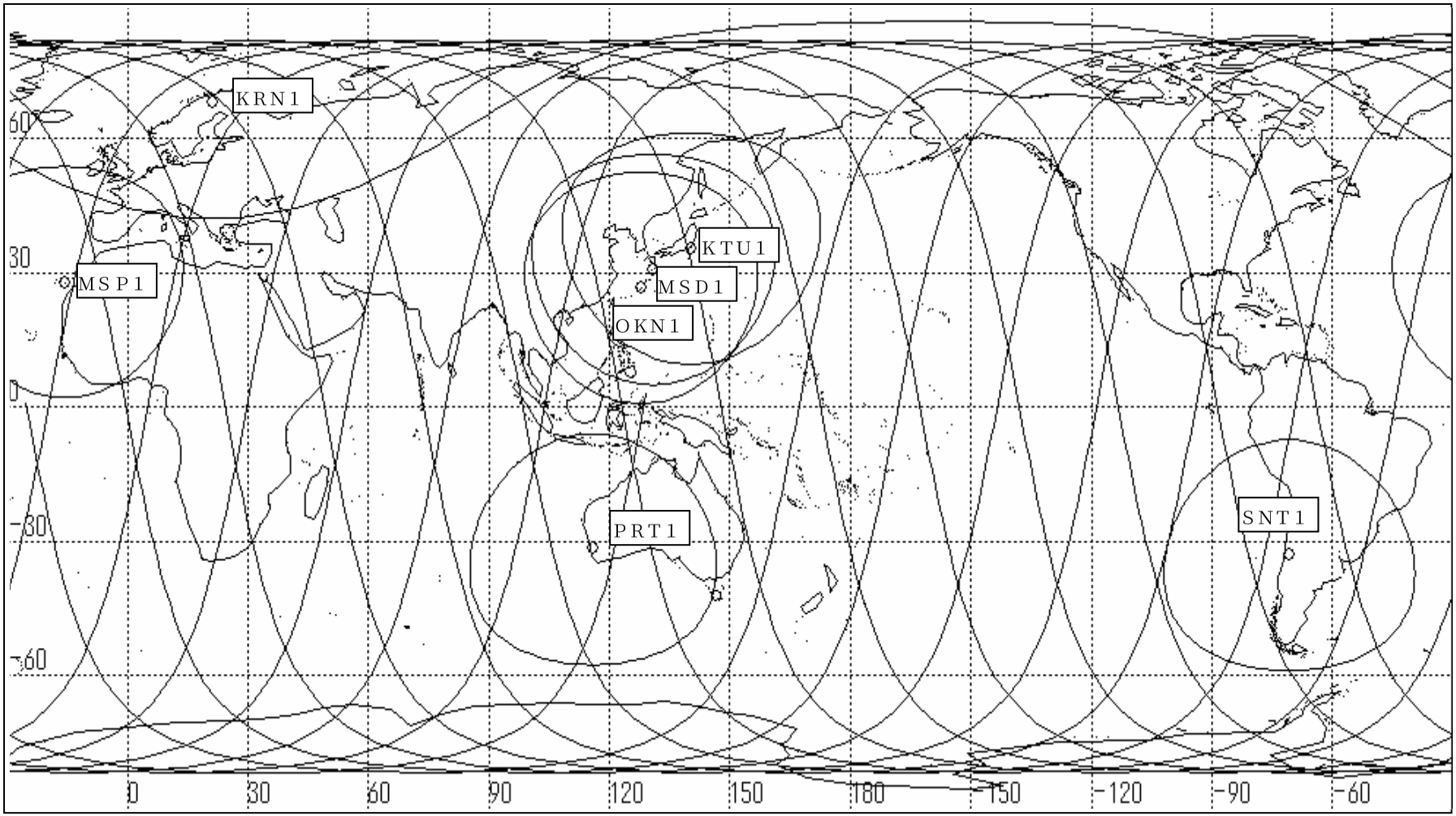
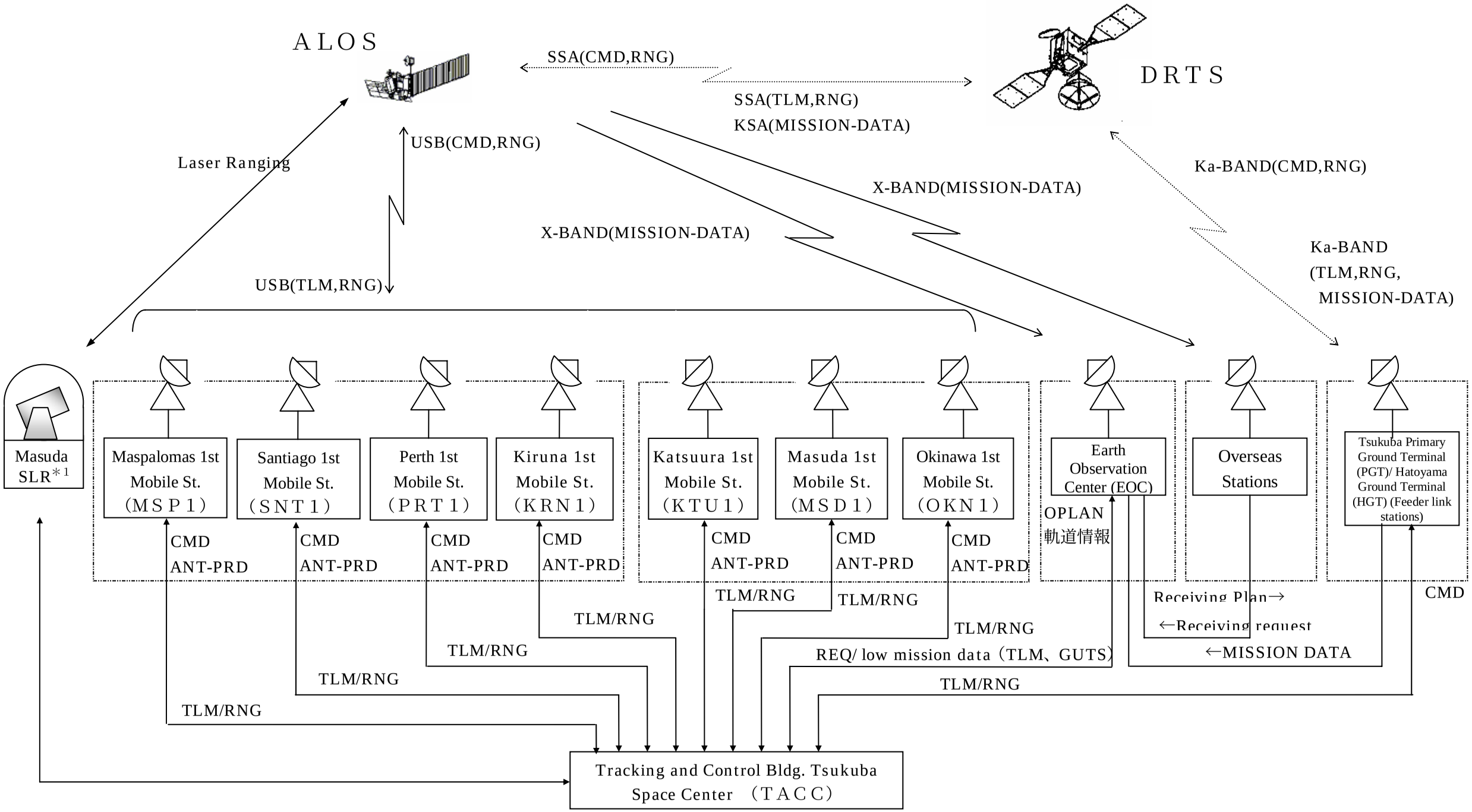


Figure-8: ALOS trajectory on-orbit



＊1)
Supported by the International Laser Ranging Service (ILRS) in Japan and overseas

CMD：Command
TLM：Telemetry
RNG：Ranging Data

ANT－PRD：Antenna Prediction
SLR：Satellite Laser Ranging

REQ: Operation Request
OPLAN：Operation Plan

MISSION DATA：Mission Equipment data

Figure-9: ALOS Tracking and Control System