Japan Fiscal Year 2010 Spring Launch Season

Launch Plan of
Venus Climate Orbiter (PLANET-C) /
Small Secondary Satellites
by H-IIA Launch Vehicle No. 17 (H-IIA F17)

March 2010

MITSUBISHI HEAVY INDUSTRIES, LTD.

JAPAN AEROSPACE EXPLORATION AGENCY (JAXA)

(Independent Administrative Agency)

Table of Contents

1. Overview

The Japan Aerospace Exploration Agency (hereinafter referred to as “JAXA”), an independent administrative agency, is scheduled to carry out the launch of the Venus Climate Orbiter PLANET-C (hereinafter referred to the “PLANET-C”) using the H-IIA Launch Vehicle No. 17 (hereinafter referred to the “H-IIA F17”) in the spring launch season in Japanese Fiscal Year 2010. JAXA also offers an orbit injection opportunity to five small secondary payloads (piggyback satellites) by utilizing the excessive launch capability.
This document explains how the launch plan will be carried out: from the time of the liftoff of the H-IIA F17 through the confirmation of the PLANET-C separation from the second stage of the launch vehicle and separation signal transmission to the small secondary payloads.
The launch this time will be performed by MITSUBISHI HEAVY INDUSTRIES, LTD (hereinafter referred to as “MHI”) as a launch and transportation service, and JAXA will be responsible for launch safety control and management.

1.1 Organization and Person in Charge of Launch

(1) Launch Execution
(A) Launch implementation organization
MHI
President: Hideaki Omiya
Address: 2-16-5, Konana Minato-ku, Tokyo, 108-8215 Japan
(B) Person in charge of launch implementation
Takashi Maemura
技監・技師長, MHI Nagoya Aerospace Systems Works

(2) Launch Safety Control and Management
(A) Launch safety control and management organization
JAXA
President: Keiji Tachikawa
Address: 7-44-1 Jindaiji Higashi-machi, Chofu-shi, Tokyo, 182-8522 Japan
(B) Person in charge of launch safety control and management
Norio Sakazume
JAXA Director of the Tanegashima Space Center

1.2 Objectives of Launch

To inject the main payload, the Venus Climate Orbiter “PLANET-C,” into its scheduled orbit by the H-IIA F17, and to provide an orbit injection opportunity to small secondary payloads using excessive launch capabilities.

1.3 Launch Vehicle and Payloads

- H-IIA F17	One unit
H-IIA 202	
Four-meter diameter fairing	
- Payloads: Main Payload: Venus Climate Orbiter “PLANET-C”	One unit
Small Secondary Payloads:	
Small Solar Power sail Demonstrator “IKAROS”	One unit
UNITEC-1	One unit
WASEDA-SAT2 (*1)	One unit
KSAT (*1)	One unit
Negai*” (*1)	One unit

(*1: Those satellites will be packed and loaded to the J-POD, JAXA Picosatellite Orbital Deployer)

1.4 Launch Window (Day and Time)

Launch Vehicle Type	Scheduled Launch Day	Launch Time	Launch Window	Time of the Launch Vehicle Jettison (After liftoff)
H-IIA Launch Vehicle No. 17 (H-IIA F17)	May 18 (Tue), 2010	6:44:14	Between May 19 (Wed) thru June 3 (Thu), 2010	- Solid rocket boosters: about 6 to 10 minutes after liftoff - Payload fairing: about 11 to 26 minutes - First stage: about 15 to 32 minutes

Dates and times are Japan Standard Time.
Launch time will be determined day to day if the launch is delayed.

1.5 Facilities for Launch

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

2. Launch Plan

2.1 Launch Site

(1) JAXA Facilities

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

(b) Ogasawara Downrange Station
Kuwanokiyama, Chichijima, Ogasawara-mura, Tokyo

(c) Christmas Downrange Station
Christmas Island, Republic of Kiribati

(2) Non-JAXA Facility

(a) Goddard Downrange Station
NASA Goddard Space Flight Center

2.2 Launch Responsibility Sharing

The following is the major responsibility sharing between JAXA and MHI with regard to this launch.

(1) MHI Responsibility

MHI is to conduct the launch as a launch provider being commissioned by JAXA under a launch service agreement to inject the main payload, PLANET-C, into its scheduled orbit. Also, MHI will transmit separation signals to the small secondary payloads at a predetermined time.

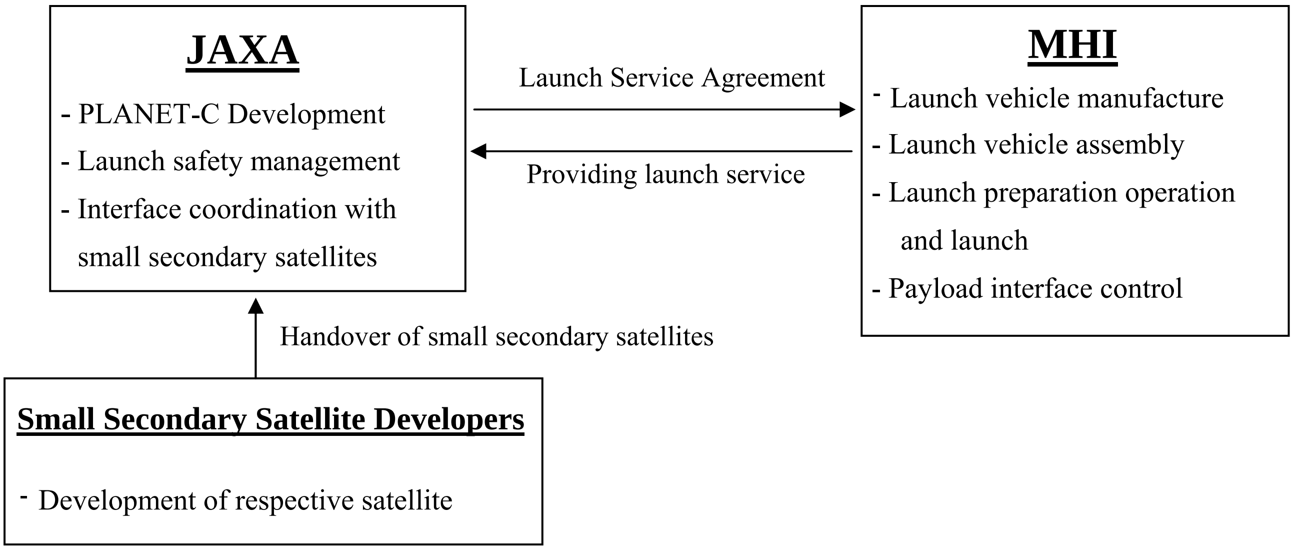
(2) JAXA Responsibility

JAXA develops the PLANET-C and commissions the launch transportation service of the PLANET-C and small secondary payloads to MHI. JAXA also conducts interface control between the small secondary payloads and the launch vehicle with the small secondary payload developers.

For the launch, JAXA will perform launch safety control and management (including ground safety assurance, flight safety assurance, and Y-0 (L-0) countdown operations.) Final go-no go decision for MHI to carry out the launch will also be determined by JAXA in view of securing safety.

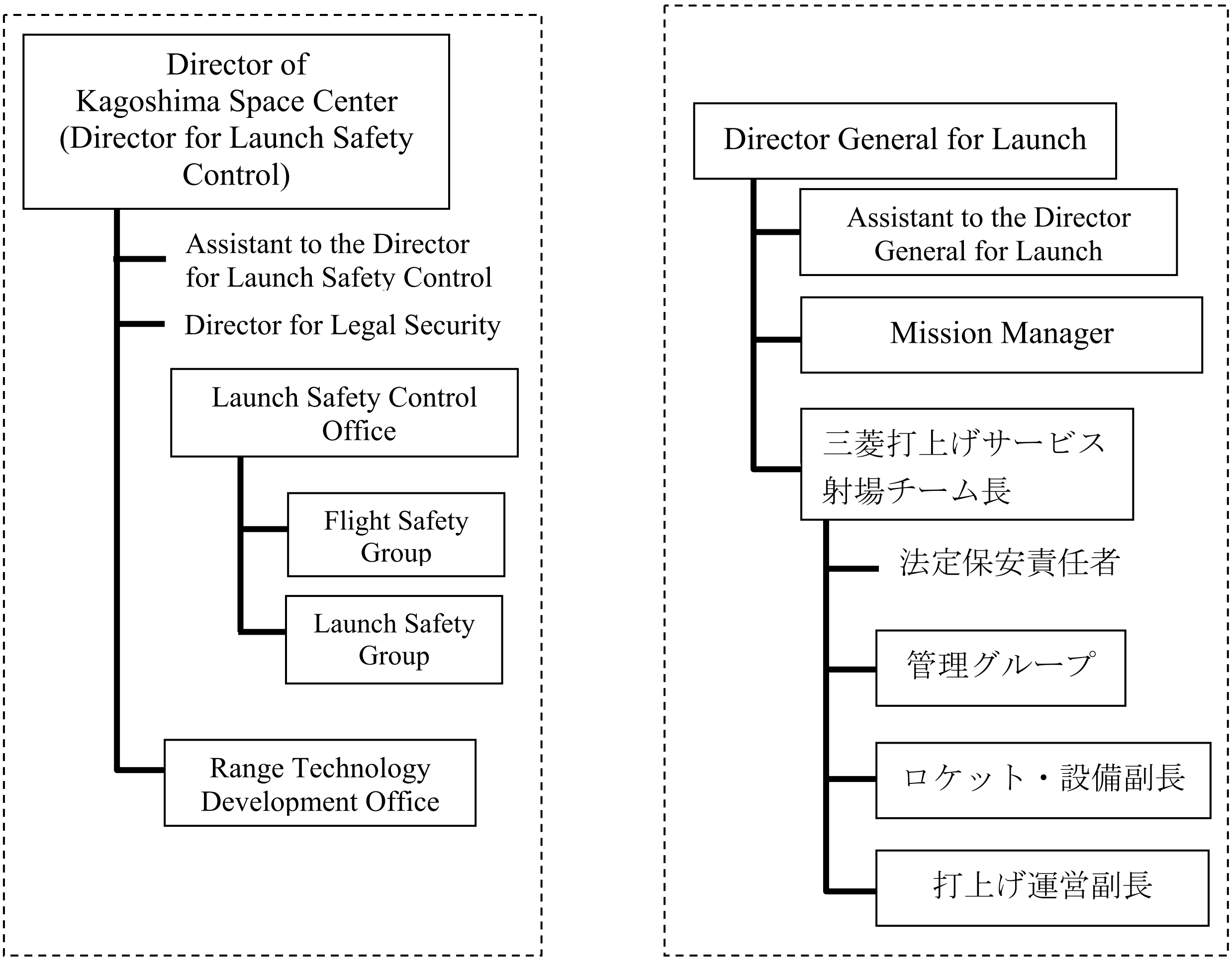
(3) Developers of Small Secondary Payloads

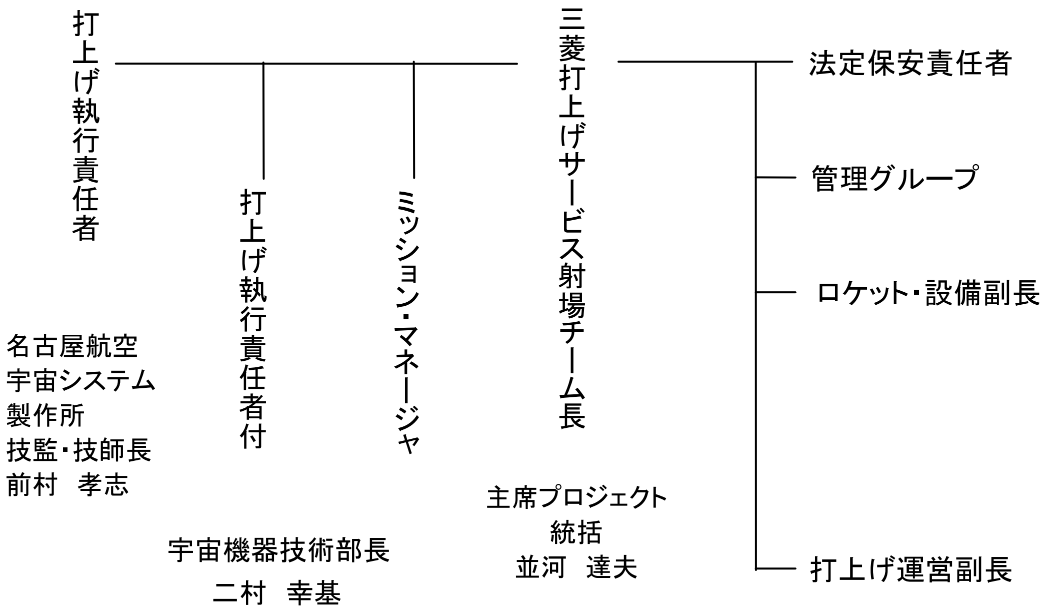
Each organization develops their respective satellites. The developers will implement post-separation operations for the respective satellites after being separated from the launch vehicle, including tracking and control and data receiving.


JAXA
- PLANET-C Development
- Launch safety management
- Interface coordination with small secondary satellites
Launch Service Agreement
Providing launch service
MHI
- Launch vehicle manufacture
- Launch vehicle assembly
- Launch preparation operation and launch
- Payload interface control
Handover of small secondary satellites
Small Secondary Satellite Developers
- Development of respective satellite

2.3 Launch Organization

The following figure shows the overall organization at the time of launch, and the figures on the next two pages show MHI's launch implementation organization and JAXA's launch safety management organization.





MHI Launch Implementation Organization

- Director of Kagoshima Space Center (Director for Launch Safety Control) Norio Sakazume
  - Assistant to the Director for Launch Safety Control
  - Director for Legal Security
  - Kagoshima Space Center Launch Safety Control Office Director Takahisa Sato
    - Kagoshima Space Center Launch Safety Control Office Flight Safety Group (Flight Safety) Manager Hirofumi Kawabata
    - Kagoshima Space Center Launch Safety Control Office Launch Safety Group (Security and Safety) Manager Toru Samejima
  - Kagoshima Space Cener Range Technology Development Office (Planning and Management) Director Takashi Nishida

JAXA launch Safety Management Organization.

2.4 Launch Vehicle Flight Plan

The H-IIA Launch Vehicle No.17 (H-IIA F17) carrying the Venus Climate Orbiter "PLANET-C" and five small secondary payloads (piggyback payloads) will be launched vertically from Launch Pad 1 at the Yoshinobu Launch Complex at the Tanegashima Space Center.
After liftoff, the launch vehicle will shift its pitch plane angle to 93 degrees in azimuth and fly over the Pacific Ocean according to the scheduled flight path shown in Table-1.
The 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 payload fairing at four minutes and 25 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 for the first time and cut off at 11 minutes and 37 seconds. Then the launch vehicle will be injected into the circular orbit at an altitude of about 300 kilometers with an inclination of 30.0 degrees, then separate the three small secondary payloads (Negai*", WASEDA-SAT2, and KSAT) that are packed in the J-POD (JAXA pocosatellite Orbital Deployer) one by one.
After that (*), the launch vehicle second stage engine will be ignited for a second time at about 23 minutes and 16 seconds, and cut off at about 27 minutes and nine seconds. At about 28 minutes and 12 seconds, PLANET-C will be separated on the Venus transfer orbit.
The H-IIA F17 will continue its coast flight, and it will jettison the PAF900M (Payload Attach Fitting) at about 36 minutes and 32 seconds and separate the IKAROS at 43 minutes and 27 seconds, and the UNITEC-1 at 48 minutes and 37 seconds.
After completing the above missions, on-orbit technical data will continue to be acquired from the launch vehicle second stage propulsion system in order to cope with future controlled reentry of the second stage.
Table-1 shows the flight plan and Figure-2 shows the scheduled flight trajectory.

* The main mission of the H-IIA F17 is to inject the main payload into Venus transfer orbit; therefore, the flight plan after separating the J-POD loaded small satellites will be different day by day. The plan explained here is a case that has the longest coast flight time.

2.5 Major Characteristics of the Launch Vehicle

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

2.6 Outline of the Main Payload "Venus Climate Orbiter (PLANET-C)"

PLANET-C is a project aiming at observing the Venus atmosphere from the Venus orbit to elucidate mysteries about the Venus atmosphere and to establish planet meteorology as a world pioneer.
Venus circulates just inside the earth's revolution orbit, and its average distance from the sun is similar to that of the Earth. In addition, Venus's diameter and density are also very close to those of the Earth, thus it is believed that the two planets were formulated in the similar manner. However, results of Venus exploration so far indicated that the environments of Venus and Earth are quite different. Venus is covered by the clouds made of concentrated sulfuric acid, and its atmosphere mainly consists of carbon dioxide. Underneath the clouds, the atmosphere circulates to the west at a much faster speed than the Venus's rotation speed.
In order to clarify the many mysteries about the Venus atmosphere, the PLANET-C project will observe the planet from the Venus orbit by an explorer with onboard scientific instruments,

including an infrared observation device to acquire three dimensional meteorological data with a high resolution.
Table -3 and Figure 4 respectively show the major characteristics and On-orbit Configuration of the PLANET-C explorer.

2.7 Outline of the Small Secondary Payloads (Piggyback Payloads)

JAXA has a system to provide an easy and quick launch opportunity for small secondary satellites manufactured by the private sector or universities by using the excessive launch capability to expand the field of space development utilization in Japan. The system also aims at contributing to educational opportunities and human resource development using small satellites.
The small secondary payloads launched by the H-IIA F17 are explained in Table -4 (Outline) and Figure-5 (Overview and Loading Positions.)
The launch of the small satellites is carried out provided that no adversary impact occurs on the main mission (PLANET-C); therefore, if any sign of such an impact is detected, JAXA may not load the small satellites at its own discretion.

2.8 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-6 will be controlled on the launch day of H-IIA Launch Vehicle No. 17 (H-IIA F17).
(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.
(d) For air security and safety over the launch site, JAXA will exchange necessary information with the Tanegashima Airport Office of the Osaka Aviation Department of the Ministry of Land, Infrastructure and Transport.
(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.

2.9 Correspondence Method of Launch Information to Parties Concerned

(1) Correspondence regarding Launch Implementation

(a) A decision on whether the launch will be held as scheduled or delayed will be finalized by 3:00 p.m. two days prior to the scheduled launch day, and that decision will be conveyed to all related organizations listed in a separate document 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 four days and two days prior to the launch day, then six hours, two hours and thirty minutes prior to launch, and again just after liftoff, to the following parties: the Aeronautical Information Service Center, the Kagoshima Airport Office and the Tanegashima Airport Office of the Osaka Aviation Department, the Air Traffic Control Center, 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 and Oceanographic Department of the Japan Coast Guard to publish a notice to mariners regarding the marine access control areas shown in Figure-6 and the impact areas shown in Figure-7.

(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 Japan Coast Guard.)

(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 Japan Coast Guard.)

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

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 well in advance 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 necessary for issuing the NOTAM will also be conveyed to the Aeronautical Information Service Center.

3. Launch Result Report

(1) The result of the launch will be swiftly reported to the Ministry of Education, Culture, Sports, Science and Technology, and the press will also be informed by the Director General for the Launch, Director for Launch Safety Control, or someone equivalent.

(2) JAXA supports press and media coverage activities while paying full attention to maintain their safety.

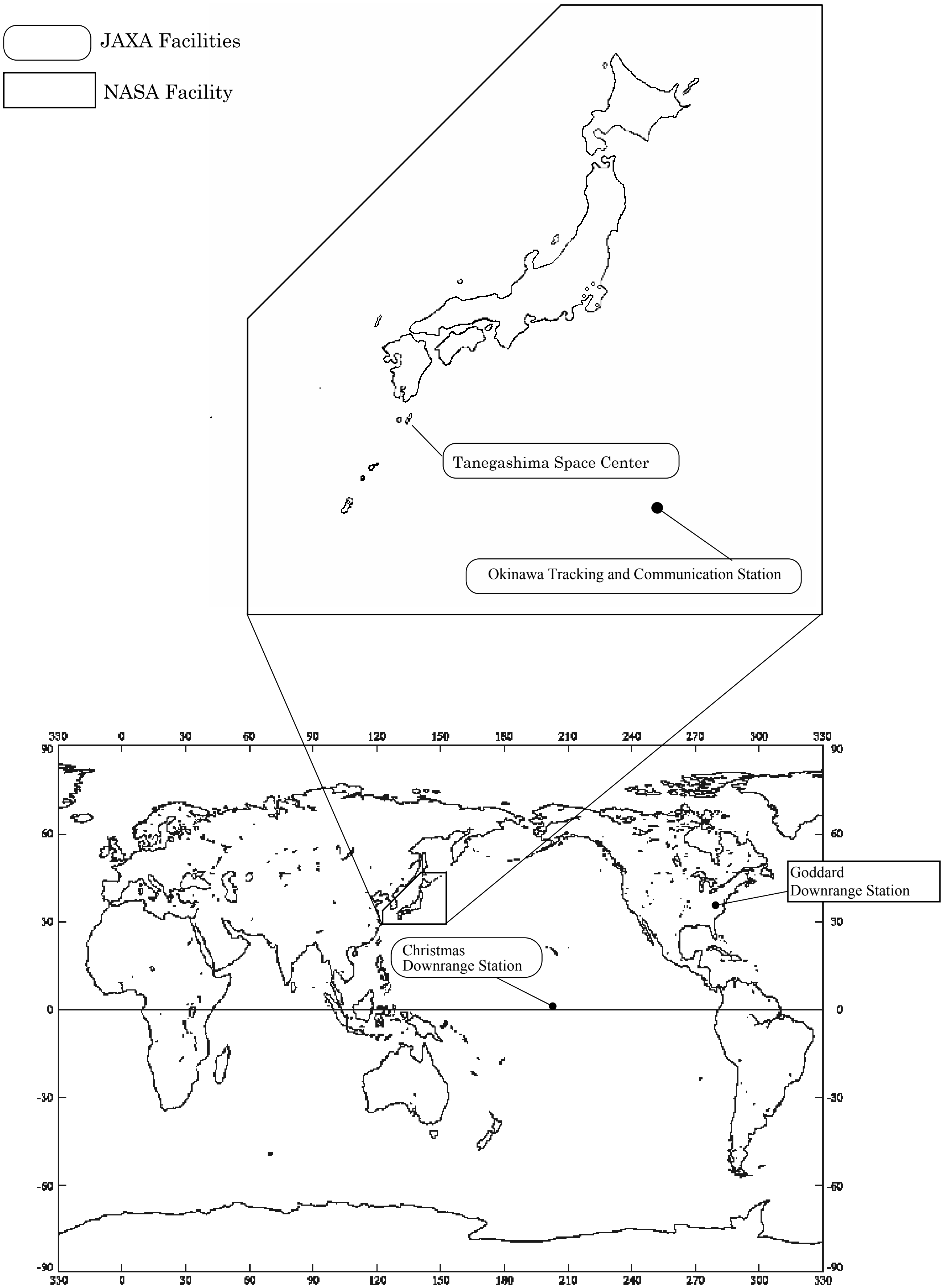
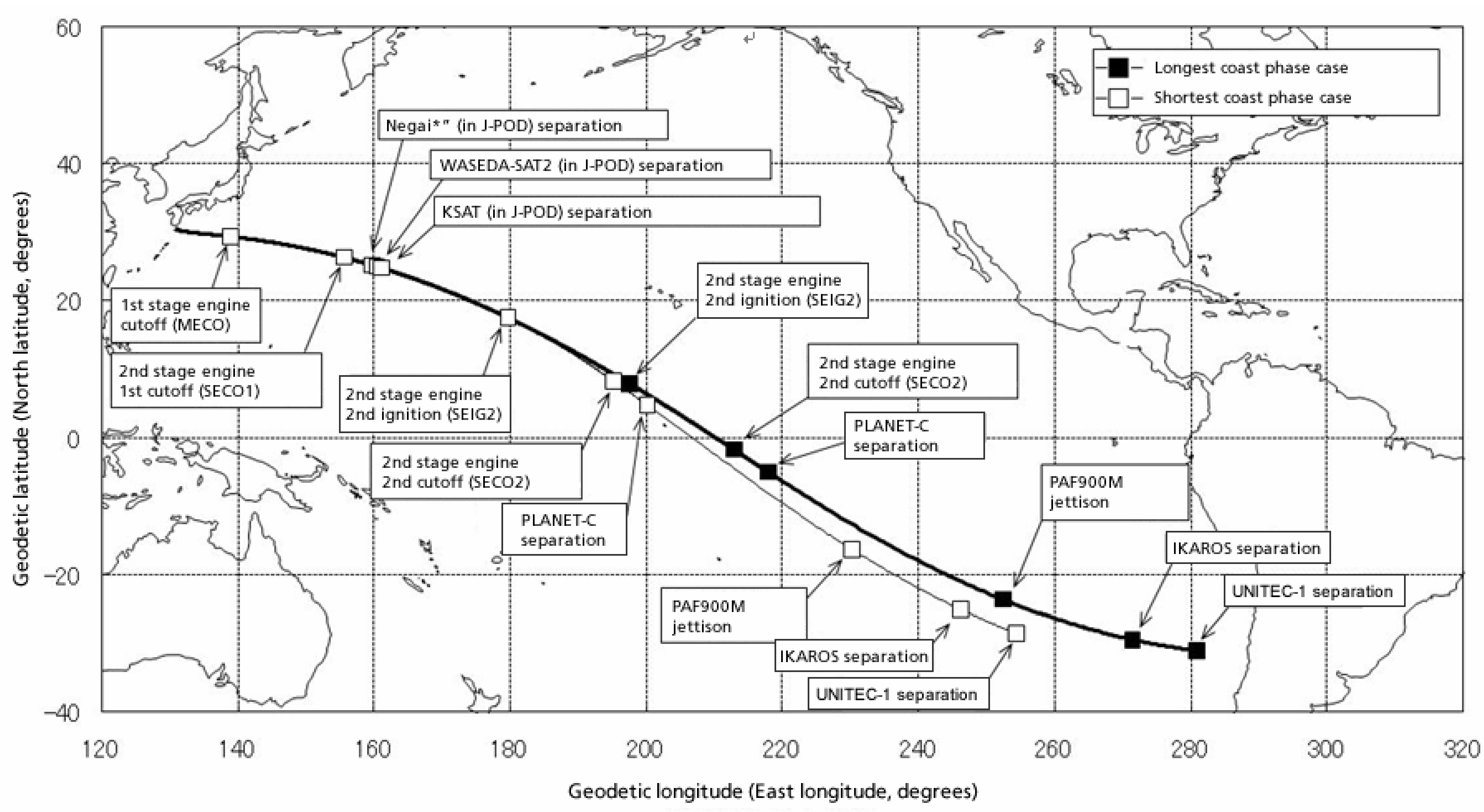


Figure-1: Map of Launch Facilities

Table-1: Launch Vehicle Flight Plan

	Event	Time after liftoff hr.	min.	sec.	Altitude km	Inertial speed km/s
1	Liftoff		0	0	0	0.4
2	Solid rocket booster burn out*		1	55	52	1.6
3	Solid rocket booster jettison **		2	5	60	1.6
4	Payload fairing jettison		4	25	147	2.9
5	Main engine cutoff (MECO)		6	36	217	5.5
6	First and second stage separation		6	44	223	5.5
7	Second stage engine first-time ignition (SEIG1)		6	50	226	5.5
8	Second stage engine first-time cutoff (SECO1)		11	37	304	7.7
9	Negai*" (loaded in J-POD) separation		12	39	304	7.7
10	WASEDA-SAT2 (loaded in J-POD) separation		12	49	304	7.7
11	KSAT (loaded in J-POD) separation		12	59	304	7.7
	<Longest coast flight case> (See note below)					
12	Second stage engine second-time ignition (SEIG2)		23	16	299	7.7
13	Second stage engine second-time cutoff (SECO2)		27	9	330	11.7
14	PLANET-C separation		28	12	407	11.7
15	PAF (Payload Attach Fitting) jettison		36	32	2302	10.5
16	IKAROS separation		43	27	4787	9.5
17	UNITEC-1 separation		48	37	6812	8.9
	<Shortest coast flight case> (See note below)					
12	Second stage engine second-time ignition (SEIG2)		17	59	302	7.7
13	Second stage engine second-time cutoff (SECO2)		21	51	374	11.6
14	PLANET-C separation		22	55	478	11.5
15	PAF (Payload Attach Fitting) jettison		31	15	2456	10.3
16	IKAROS separation		38	10	4909	9.3
17	UNITEC-1 separation		43	20	6889	8.7

*) At 2% of the maximum combustion chamber pressure
**) Thrust strut cutting
Note) * The main mission of the H-IIA F17 is to inject the main payload into the Venus transfer orbit; therefore, the flight plan after separating the J-POD loaded small satellites will be different day by day. The cases shown above are example flight cases that have the longest and shortest coast flight time, respectively.



Note) * The main mission of the H-IIA F17 is to inject the main payload into the Venus transfer orbit; therefore, the flight plan after separating the J-POD loaded small satellites will be different day by day. The cases shown in the above figure are example flight cases that have the longest and shortest coast flight time, respectively.

Figure-2: Launch Vehicle Flight Trajectory

Table-2 Major: Characteristics of the Launch Vehicle

All Stages				
Name	H-IIA Launch Vehicle No. 17			
Height (meters)	53			
Mass (tons)	289 (Without payloads)			
Guidance Method	Inertial Guidance Method			
Each Stage				
	First Stage	Solid Rocket Booster (SRB-A)	Second Stage	Payload Fairing
Height (m)	37	15	11	12
Outside diameter (m)	4.0	2.5	4.0	4.0
Mass (t)	114	153 (For two SRB-As)	20	1.4
Propellant mass (t)	101	132 (For two SRB-As)	17	—
Thrust (kN)	1,100※	4,525*	137*	—
Combustion duration time (s)	390	120	530	—
Propellant type	Liquid oxygen/hydrogen	Polybutadiene composite solid propellant	Liquid oxygen/hydrogen	—
Propellant supply system	Turbo pump	-	Turbo pump	—
Impulse to weight ratio (s)	440*	283.6*	448*	—
Attitude control method	Gimbal sub-engine	Movable nozzle	Gimbal gas jet system	—
Major onboard avionics	- Guidance control equipment - Telemetry transmitter		- Guidance control equipment - Radar transponder - Telemetry transmitter - Command destruct system	—

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

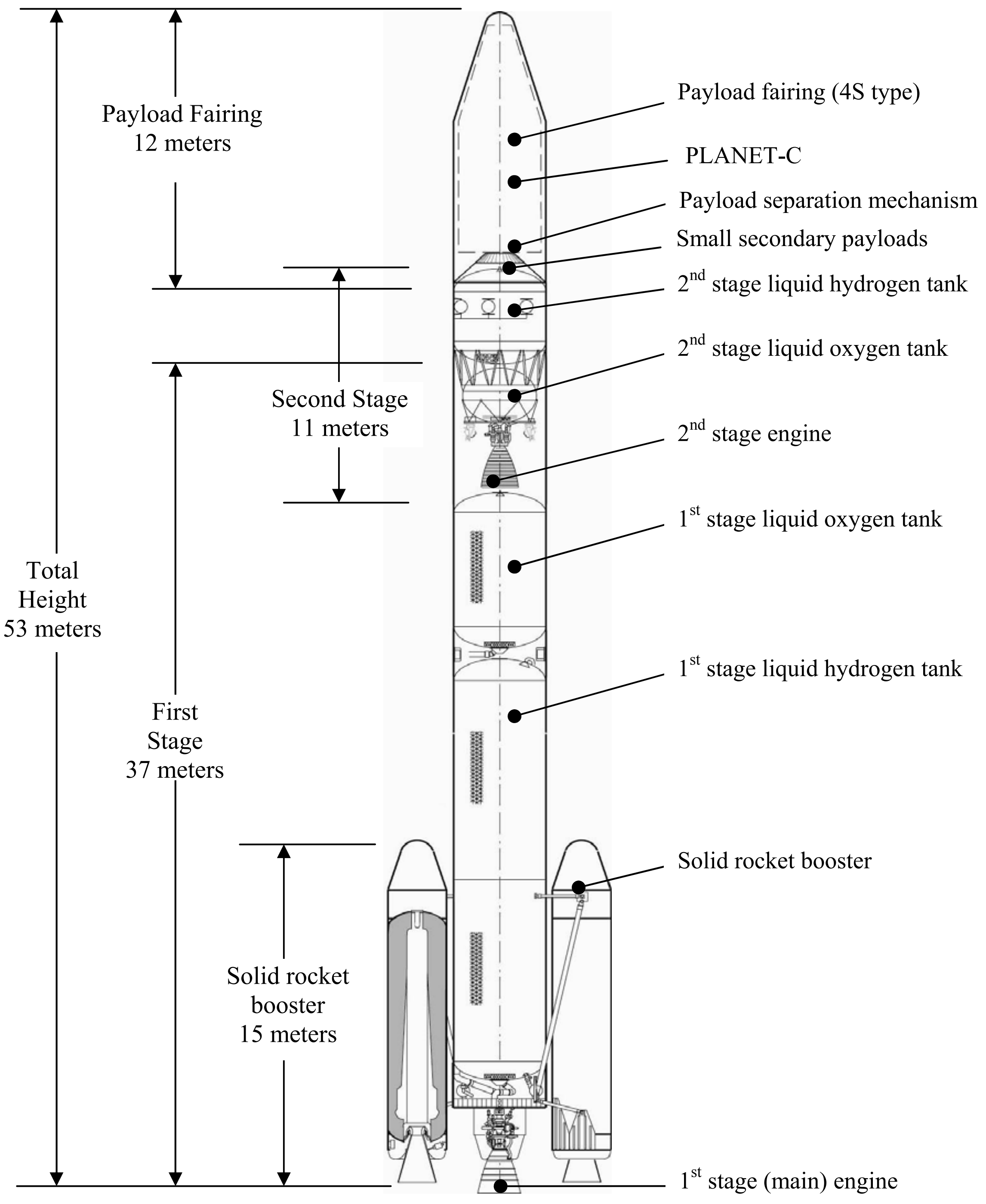


Figure-3: Configuration of the Launch Vehicle (H2A202 type)

Table-3: Major Characteristics of PLANET-C (1/2)

	Characteristics/Specifications
Name	Venus Climate Orbiter (PLANET-C)
Objective	As the world's first mission to carry out a full-scale study on atmospheric movement around a planet, PLANET-C is to accurately observe the meteorological phenomena of Venus hidden underneath clouds from the Venus orbit by using newly developed infrared observation equipment. Through the observations, it will elucidate the mechanism of Venus's atmospheric dynamism (such as planet-scale high-speed winds) that cannot be explained by conventional meteorology to understand the comprehensive meteorological phenomena of planets.
System structure	1) Mission instruments - 1μm camera (IR1) - 2μm Camera (IR2) - Long wave IR camera (LIR) - Ultraviolet imager (UVI) - Lightening and airglow camera (LAC) - Ultra-stable oscillator (USO) - Digital Electronics (DE) 2) Bus - Power system - Communications system - Data processing system - Attitude & orbit control system (AOCS) - Reaction control system (RCS) - Ignition system (IG-BOX) - Structure system - Thermal control system - System wiring harness system (WHS)

Table-3: Major Characteristics of PLANET-C (2/2)

	Characteristics/Specifications
Shape / Dimension	Box shape with two wing-type solar array paddles 1040 mm x 1450 mm x 1400 mm
Scheduled orbit	Type: Venus elliptical orbit Peri-Venus altitude: 300km Apo-Venus altitude: about 80,000 km Orbit period: 30 hours Orbit inclination angle: 172 degrees
Design life	4.5 years after launch
Mass	About 500 kg at the time of liftoff
Power	Generated power: about 500 w in the Venus orbit (at the end of the mission)
Mission equipment	1μm Camera (IR1) - By capturing infrared emitted from the Venus ground and leaked to space, the IR1 observes the ground, low stratus and vapor. It also aims at detecting active volcanism. Wavelength 0.90, 0.97, 1.01μm; View 12 degrees; Pixel 1024 x 1024; Detector Si-CSD/CCD
	2μm Camera (IR2) - By capturing infrared emitted from the atmosphere that is lower than low stratus and leaked to space, the IR2 observes distribution of clouds and carbon, and their movement. During its trip from the Earth to Venus, it also observes zodiacal light (interplanetary dust clouds.) Wavelength 1.65/1.735/2.02/2.26/2.32μm; View 12 degrees; Pixel 1040 x 1040; Detector PtSi-CSD/CCD
	Long wave IR camera (LIR) - By capturing infrared emitted from clouds, the LIR observes the temperature and distribution of clouds and their changes. Wavelength 10μm; View 12 degrees; Pixel 240 x 320; Detector uncooled bolometer
	Ultraviolet imager (UVI) - By capturing ultraviolet radiation scattered from clouds, the UVI observes sulfur dioxide and trace atmospheric contents at the cloud top. Wavelength 283/365 nm; View 12 degrees; Pixel 1024 x 1024; Detector Si-CCD
	Lightening and airglow camera (LAC) - The LAC observes lightening flashes of lightening discharge and chemical airglow emissions. Wavelength 542.5/557.7/777.4 nm; View 16 degrees; Pixel 8 x 8; Detector multi-anode APD
	Ultra-stable oscillator (USO) - The USO is onboard for radio occultation measures. It studies the layer structure of the Venus atmosphere when radio waves connecting PLANET-C and the ground station pass through the atmosphere.

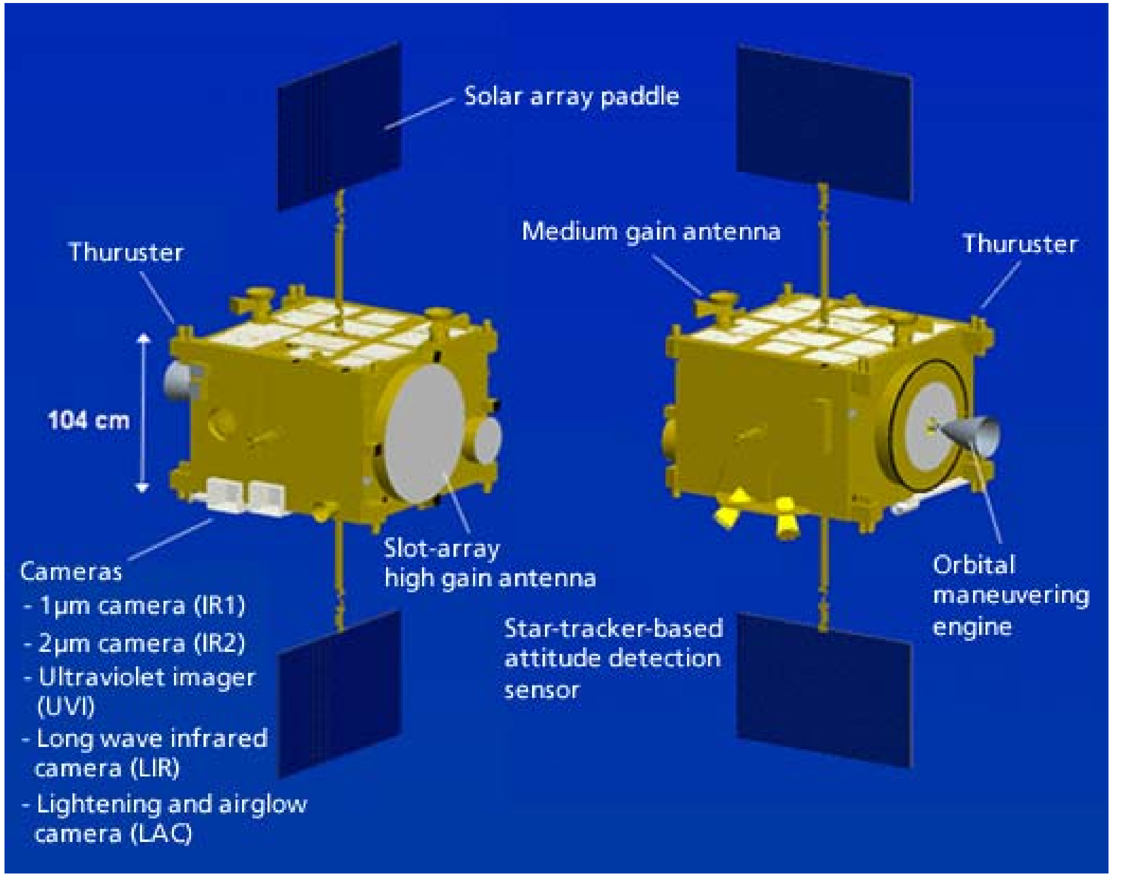


Figure-4: On-orbit Configuration of PLANET-C

Table-4: Outline of the Small Secondary Payloads

Satellite Developer	Satellite name	Mission Outline	Mass/Dimension
JAXA	Small Solar Power Sail Demonstrator (IKAROS)	- Deployment and extension of the large membrane - Power generation by the thin film solar cells - Verifying acceleration by the solar sail - Acquiring navigation technology by the solar sail	Body: Diam. 1.6 m x Height 1.0 m Membrane (after deployment): 14 m x 14 m About 315 kg
University Space Engineering Consortium (UNISEC)	UNITEC-1	- Competition to contend "whose computer for space use will survive the longest in deep space" among computers developed by universities for in-orbit verification - Receiving and decoding technology experiments of faint radio waves from deep space in cooperation with amateur radio communities. - Space outreach through the above experiments - Science and engineering mission in deep space (option)	About 39 cm x 39 cm x 42 cm About 26 kg
Waseda University	WASEDA-SAT-2	- QR code image shooting experiment - Providing images to students - Attitude stability by panel deployment	About 10 cm x 10 cm x 10 cm About 1.2 kg
Kagoshima University	KSAT	- Observation experiments of atmospheric vapor distribution for predicting localized heavy rain - Shooting moving images of the Earth through microwave high-speed communications - Basic communication experiment for super-small positioning satellites	About 10 cm x 10 cm x 10 cm About 1.5 kg
Soka University	Negai*″	- Wish upon a shooting star*″ - a satellite to support the future of children - Space verification of the advanced information processing system using commercial FPGA	About 10 cm x 10 cm About 1.0 kg

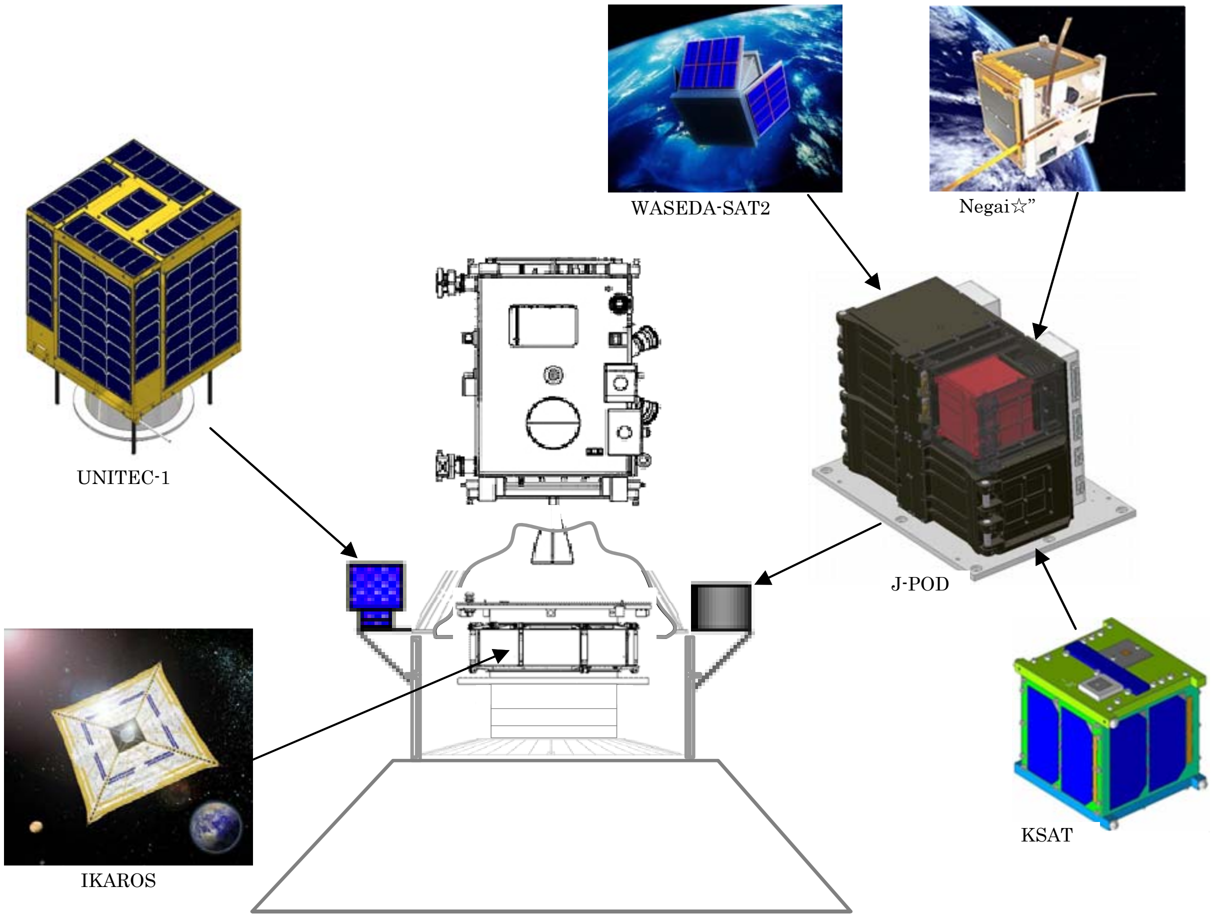
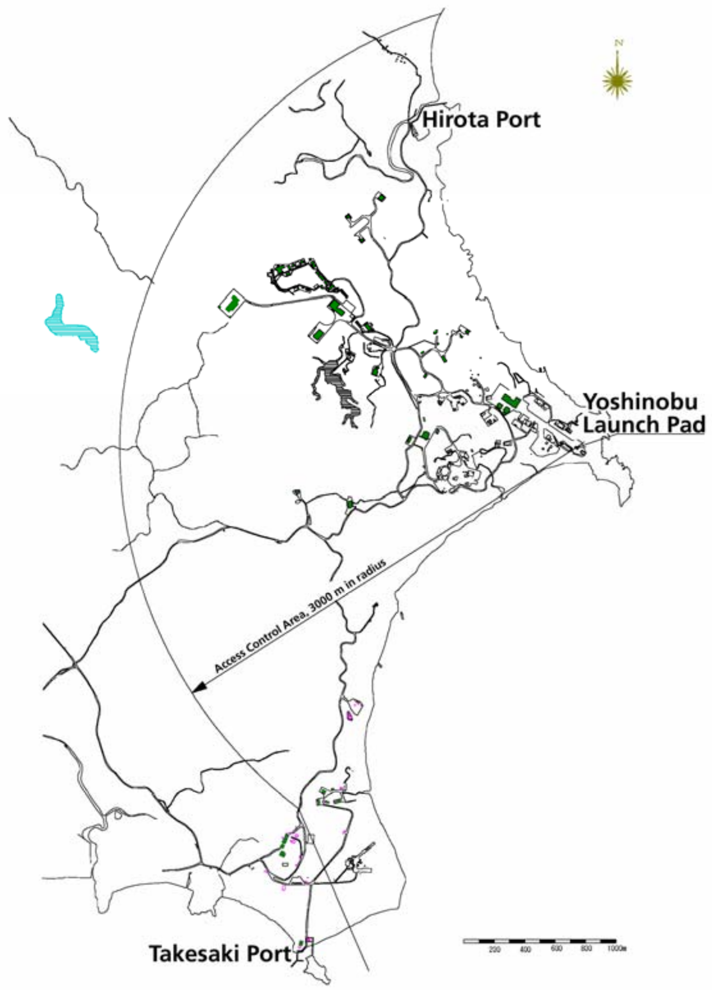
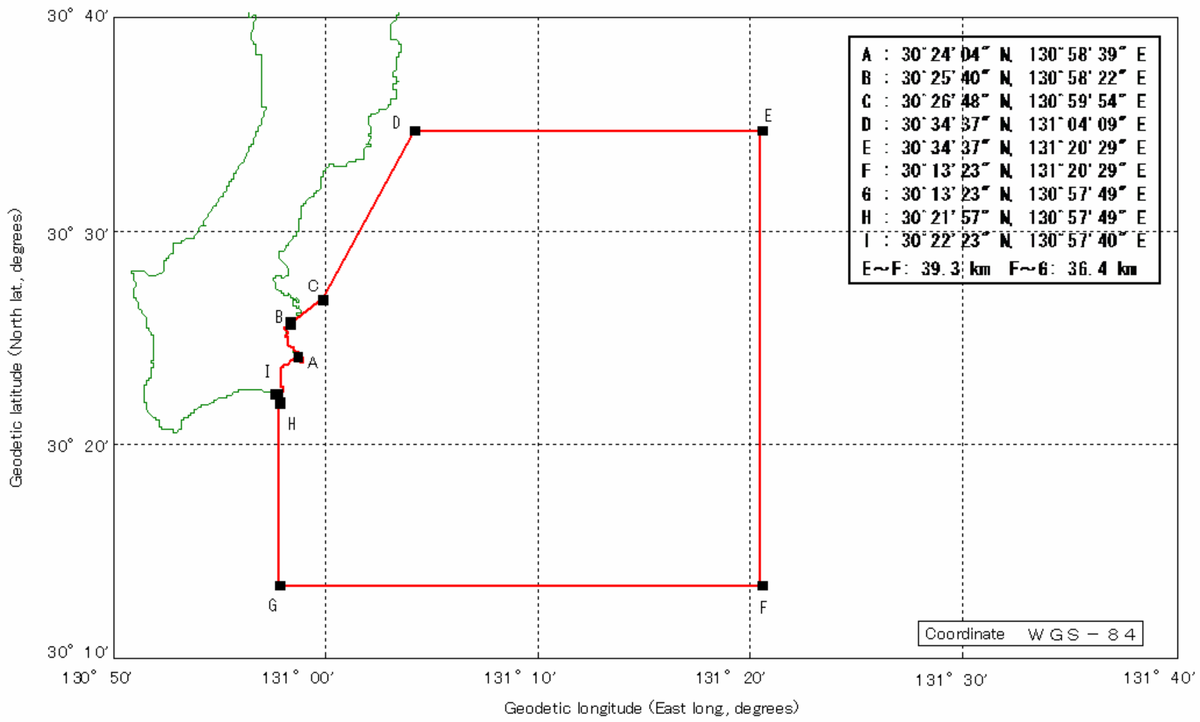


Figure-5: Overview and Loading Position of the Small Secondary Payloads



Land Access Control Area



Marine Access Control Area

Figure-6: Access Control Areas for Launch

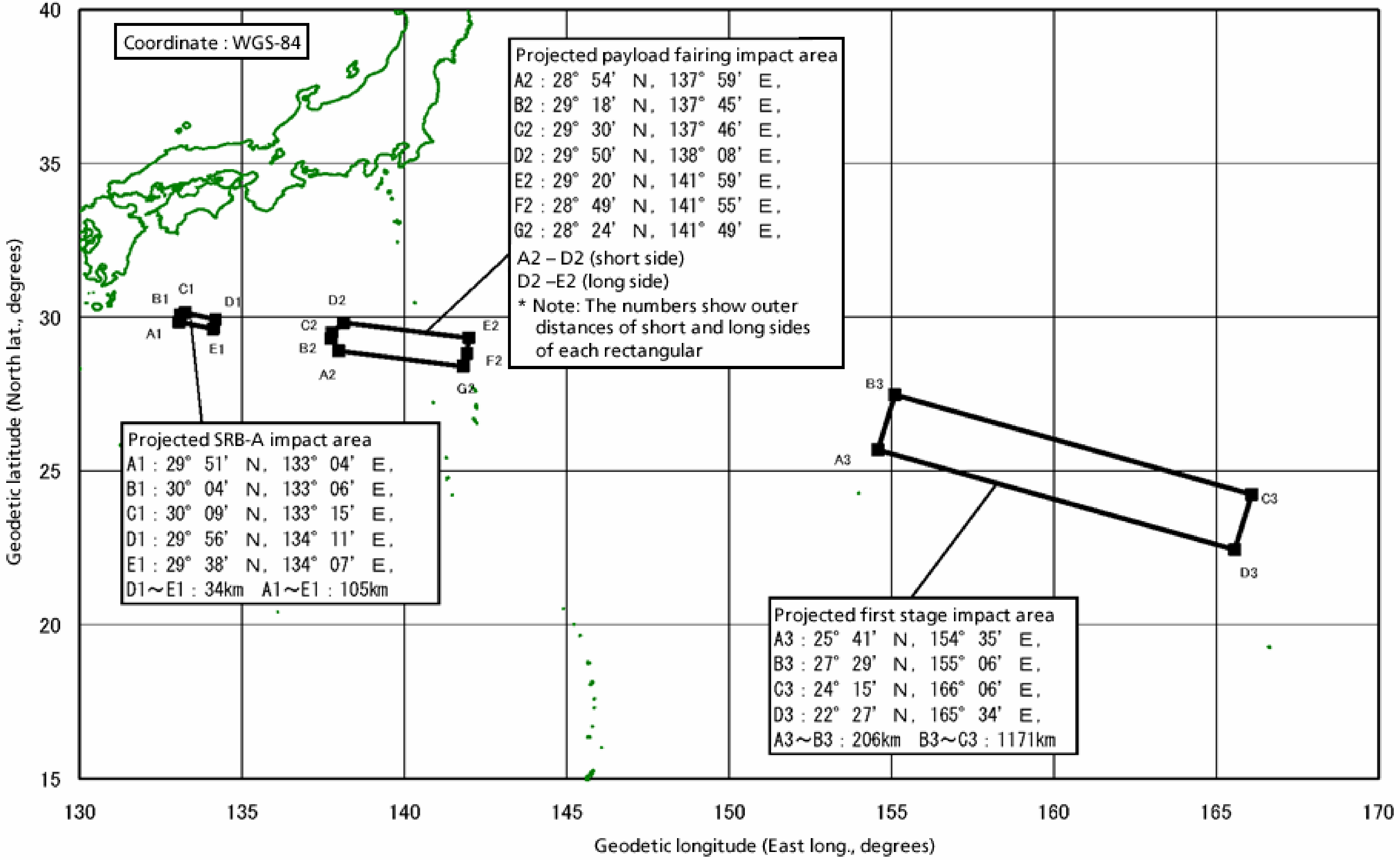


Figure-7: Impact Areas of the Launch Vehicle Jettison