JAXA TODAY

Japan Aerospace Exploration Agency

April 2016 ⁄ No. 10

Special Features

Japan’s Technical Prowess

Technical excellence and team spirit are manifested in such activities as the space station capture of the HTV5 spacecraft, development of the H3 Launch Vehicle, and reduction of sonic boom in supersonic transport

International Cooperation

JAXA plays a central role in international society and contributes through diverse joint programs, including planetary exploration, and the utilization of Earth observation satellites in the environmental and disaster management fields

JAXA Explore to Realize

Contents

Welcome to JAXA TODAY

The Japan Aerospace Exploration Agency (JAXA) is positioned as the pivotal organization supporting the Japanese government's overall space development and utilization program with world-leading technology. JAXA undertakes a full spectrum of activities, from basic research through development and utilization.

In 2013, to coincide with the 10th anniversary of its establishment, JAXA defined its management philosophy as "utilizing space and the sky to achieve a safe and affluent society" and adopted the new corporate slogan "Explore to Realize." Underpinned by this philosophy, JAXA pursues a broad range of programs in the aerospace and research and development fields.

With the aim of disseminating information about JAXA's activities and recent news relating to Japan's space development programs to as wide an audience as possible, we launched JAXA TODAY in January 2010.

To All Our Readers

Yoshikazu Shoji
Director of the JAXA
Public Affairs Department

My name is Yoshikazu Shoji, and on January 1, 2016, I was appointed as Director of the JAXA Public Affairs Department. I wish to express my appreciation to all of you who have taken the time to look at the latest issue of JAXA TODAY.

JAXA carries out a substantial amount of its work in collaboration with many international partners. From that perspective, I recognize the importance of achieving an even deeper understanding of the programs pursued by JAXA among a broad range of people outside Japan.

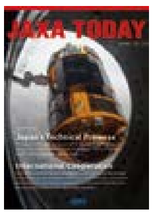
The goal of JAXA TODAY is to provide an easy-to-understand, current snapshot of some of the key activities of JAXA. I am happy when a new reader of JAXA TODAY gains a greater level of understanding of the space development, space science research and aeronautical technology research undertaken by JAXA.

With this as a starting point, nothing would give me greater pleasure than this publication being helpful for generating a deeper knowledge of Japan as a country among our readers.

Cover Story

H-II Transfer Vehicle 5 (HTV5) Awaits Separation from the International Space Station (ISS)

On September 28, 2015, in preparation for separation the following day, HTV5 is grappled by Canadarm2 and detached from the ISS.
(© JAXA / NASA)



Special Feature 1:

Japan's Technical Prowess

Activities of "Team Japan" Connecting the Earth and Space

Since the European Space Agency (ESA) retired the Automated Transfer Vehicle (ATV) in February 2015, the mission of resupplying the International Space Station (ISS) has fallen on the three remaining programs. These are operated by JAXA, NASA and Roscosmos, respectively. The H-II Transfer Vehicle (HTV)—nicknamed "KOUNOTORI" (white stork) in Japanese—is Japan's resupply spacecraft for the ISS. It has established a sound track record of safely transporting a variety of large-scale equipment and high-volume supplies. Hence, the HTV program continues to grow in importance. In particular, Japan's original technology for spacecraft rendezvous and capture has become one of the world standards in this field. The technology involves using the ISS robotic arm (Space Station Remote Manipulator System (SSRMS); also known by its primary component, Canadarm2) to safely grapple and birth the HTV.

In this special feature, we report on the activities of "Team Japan," focusing on the capture of HTV5 in August 2015. This rendezvous and capture involved close collaboration among personnel working at the JAXA Tsukuba Space Center (TKSC) in Japan, the NASA Johnson Space Center (JSC) in Texas and on the ISS.

"Team Japan" Leverages Its Strength in Unity

The excellent level of coordination among "Team Japan" members has been a crucial factor driving the success of numerous important missions. Recent examples include the capture of HTV5—a particularly tension-filled operation—and the deployment of small satellites from Japanese Experiment Module (JEM) Kibo.

"KOUNOTORI" (White Stork) Flies to Its ISS Perch

HTV5 was launched from the Tanegashima Space Center (TNSC) on August 19, 2015. After a successful flight with no major hitches, the resupply spacecraft arrived at its Approach Initiation (AI) point, orbiting 5 km behind the ISS, on August 24 at 15:58 (Japanese Standard Time; JST).

The HTV Control Center at TKSC—spearheaded by HTV5 lead flight director Mayumi Matsuura—was already in joint operations with NASA's International Space Station Flight Control Room in Houston, Texas. In Houston, JAXA Astronaut Koichi Wakata had the role of Capsule Communicator (CAPCOM)—the lead communicator tasked with conveying instructions to the ISS. Onboard the ISS, JAXA Astronaut Kimiya Yui was standing by in his role of operating the SSRMS to capture HTV5.

The commands were sent from TKSC, and HTV5 commenced its final approach. At 17:01 JST, HTV5 arrived at a point 500 meters directly below the ISS. From here, the HTV slowly ascended. At 250 meters from the ISS, and then at 30 meters, HTV5 temporarily ceased its ascent to confirm safety. At 19:22 JST, HTV5 was in a stationary position relative to the ISS, orbiting 10 meters directly below.

The HTV Control Center reported to Houston: "HTV is go for capture. HTV5 has arrived at its preassigned position, and everything is proceeding smoothly." On hearing this, Astronaut Wakata immediately sent the command to the ISS to "Go for capture." The reply from the ISS came from NASA Astronaut Kjell Lindgren, who was assisting Astronaut Yui. "We will now begin the capture of HTV."

The SSRMS grasps the FRGF prior to berthing

Tsukuba Space Center (TKSC)
Lead flight director Mayumi Matsuura watches intently as HTV5 is captured (© JAXA)

Johnson Space Center (JSC)
JAXA Astronaut Koichi Wakata fulfills his role as CAPCOM at the International Space Station Flight Control Room, within the Johnson Space Center, Houston

International Space Station (ISS)
JAXA Astronaut Kimiya Yui (left) and NASA Astronaut Kjell Lindgren carry out training for operating the SSRMS in preparation for the capture of HTV5 (© JAXA / NASA)

Message from Astronaut Wakata

"Thanks to Japan's manufacturing technology—underpinned by a spirit of craftsmanship—along with the passion and wonderful teamwork of the entire international operational team, in space and on the ground, the HTV safely berthed at the ISS. It's a fantastic result."

Message from Astronaut Yui

"Thanks to the support I received from everyone, I was able to do my job soundly, and the capture of HTV5 was a success. I am proud to be Japanese, and I am proud of our team."

Notes:
- HTV5 separated from the ISS on September 29, 2015, and reentered the atmosphere the following day.
- After completing his long-duration mission as a member of ISS Expedition 44/45, Astronaut Kimiya Yui returned to earth on December 11, 2015.

Astronaut Yui operated the SSRMS to bring the tip of the robotic arm near to the Flight Releasable Grapple Fixture (FRGF)—a special-purpose component on the exterior of the HTV. When the tip of the robotic arm got within a few meters, the HTV attitude control thrusters were shut off, putting the spacecraft into free drift. In this state, since the HTV gradually drifts in accordance with the law of inertia, it must be captured during a 90-second window.

In this brief time, Astronaut Yui skillfully maneuvered the robotic arm to successfully capture the HTV. At 19:29 JST, as people around the world looked on in anticipation, the HTV was captured thanks to the unified strength of "Team Japan."

CubeSat Deployment

On September 17, 2015, using the JEM-Small Satellite Orbital Deployer (J-SSOD) on JEM Kibo of the ISS, two CubeSats were deployed—SERPENS (developed by the University of Brasilia and the Brazilian Space Agency) and S-CUBE (developed by the Chiba Institute of Technology). Among all of the ISS' modules, only JEM Kibo—which has both an airlock and a robotic arm—is able to deploy CubeSats in this way.

S-CUBE was deployed at 21:02 JST by Astronaut Yui operating the deployment command aboard JEM Kibo. Then, at 21:12 JST, the JAXA Flight Control Team (JFCT) at TKSC issued the command that deployed SERPENS.

Collaboration with the United Nations Office for Outer Space Affairs (UNOOSA) to Promote the Use of Satellites

As of March 2016, a total of 90 CubeSats have been deployed from JEM Kibo. Apart from Japanese satellites, teams from a wide range of countries have utilized this service, including the United States, Vietnam, Peru and Lithuania. JAXA and UNOOSA initiated collaboration on September 8, 2015, to provide opportunities for the deployment of CubeSats. The two parties will cooperate in efforts to offer opportunities to developing countries for CubeSat deployment from JEM Kibo. This aims to contribute to progress in space-related technology in participating countries.

H-II Transfer Vehicle ("KOUNOTORI") 5 (HTV5)
HTV5 berthed to the Harmony Module (Node 2) of the ISS (© JAXA / NASA)

Deployment of the Chiba Institute of Technology's S-CUBE (© JAXA / NASA)

Deployment of the University of Brasilia's SERPENS (© JAXA / NASA)

Satellite development teams and others gathered at the TKSC to celebrate after witnessing the successful deployment of the right two satellites. Teams from the University of Brasilia (left) and the Chiba Institute of Technology (right) show their joy at the result. (© JAXA)

JAXA is currently pursuing the development of Japan's next-generation mainstay launch vehicle—the H3 Launch Vehicle. The H3 is expected to become the backbone of Japan's space development program from 2020 onward. This project aims to develop a launch vehicle that is highly competitive internationally and establishes a strong commercial presence.

JAXA is taking the lead in the development of key technologies and ground facilities essential for securing a high level of autonomy for Japan's space program. Meanwhile, with the objective of developing a system with superior competitiveness in the commercial launch market, Mitsubishi Heavy Industries Co., Ltd. (MHI), is taking the role of prime contractor and is involved in system development from an early stage. Subsequently, at the operational stage, JAXA is aiming to realize a smooth transition to a structure based on the launch service provided by MHI. In this special feature, H3 Project Team Manager Masashi Okada, along with key members of his project team, discuss their aspirations for the development of the H3.

Special Feature 1:

Japan's Technical Prowess

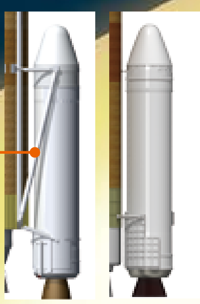
2020: The H3 Launch Vehicle Vision

What are the key criteria driving the H3 development project?

Our objective is to create a launch vehicle that is within easy reach for all potential customers and provides a high level of peace of mind. We also want the H3 to generate excitement and enthusiasm among people globally. It will boast world-class reliability while maintaining a very affordable cost structure. The H3 Launch Vehicle will also be highly competitive in the satellite launch market. To achieve this goal, the starting point for our development study was the launch vehicle's operational concept. All key aspects of the H3 development project have been determined after careful consideration of customer opinions and needs. In addition to such design aspects as launch vehicle configuration and launch capability, we considered factors that would determine the flexibility of services provided by the H3. For example, this included a focus on shortening the lead time between receiving an order and launch, as well as factors that would lead to an increase in available launch opportunities by halving the time required between launches.

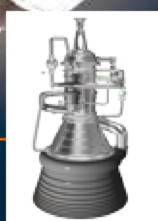
Solid rocket booster (SRB-3)

The project includes development of the SRB-3, which follows the SRB and SRB-A as Japan's third generation solid rocket booster. Development will focus on further simplifying the SRB-A. This will include such innovations as reducing the number of attachment points to the core airframe and replacing the predecessor's movable nozzle with a fixed nozzle. Through such modifications, development will aim for improved reliability and reduced costs.



Simple separation mechanism

The H-IIA and H-IIB launch vehicles use two diagonal thrust struts to release the boosters. In contrast, the H3 will adopt a simple mechanism without struts.


Artist's rendition of the LE-9 1st-stage engine

New 1st-stage engine (LE-9)

The 1st stage will be configured with either two or three 150-ton (in vacuum) thrust LE-9 engines. The combustion chamber pressure will be 10 MPa. This engine will generate the largest thrust capacity in the history of Japan's liquid-propellant rocket-engine development. Development planning includes application of the expander bleed cycle—used in the 2nd-stage engine of the H-IIA Launch Vehicle—thereby reducing the number of components needed. This will enable the H3 to achieve the twin goals of high reliability and low manufacturing cost.

Aiming for a Launch Vehicle within Easy Reach of All Potential Customers while Offering Peace of Mind

Masashi Okada
Project Manager
H3 Project Team
Space Technology Directorate I

Improved 2nd-stage engine (LE-5B-3)

Enlargement of fuel tank capacity makes the 2nd stage's operational flight time longer than that of the H-IIA. As well, we are making improvements to the liquid-hydrogen turbo pump to further increase durability. The mixer for high-temperature hydrogen gas and low-temperature liquid hydrogen will also be upgraded, with the objective of enhancing engine fuel efficiency.

You have said that you are planning for an initial test launch in 2020. At what stage of development is the project currently?

In fiscal year 2015 (FY2015; ended March 31, 2016), we were at the fundamental planning stage of the project. This is a vital phase in which the launch vehicle's overall architecture is being determined. From FY2016 onward, we will enter a more detailed design phase. Since we are working with an extremely tight schedule, we have adopted a methodology for the H3 development project under which we thoroughly identify all potential risks at the design stage. We then implement strategies to eliminate or minimize such risks.

The H3 will be the main launch vehicle supporting Japan's future space development program. This project aims to create a launch vehicle that incorporates all technical fields in which Japan excels, underpinned by launch vehicle technologies accumulated in Japan to date. Although there will be many critical periods during the development process, together with our colleagues in the private sector we will strive to maximize teamwork and the potential of our team to achieve the best results possible.

H3 Launch Vehicle

The H3 Launch Vehicle has a total length of 63 meters, and a two-stage core body with a diameter of 5.2 meters. The engine configuration for the 1st stage will be changeable—either two or three units of the new LE-9 engine. The project is aiming for launch capability of 4.0 tons or greater for a 500-km altitude sun-synchronous orbit, which is used for such applications as Earth observation satellites, and 6.5 tons or greater for satellites being placed into a geostationary transfer orbit.

N-II: A three-stage launch vehicle whose development was based on technology derived from the American Delta rocket.

H-I: A three-stage launch vehicle which drew on the results of the N-I and N-II development projects. The 2nd-stage engine (LE-5), propulsion system, 3rd-stage solid rocket motor, and inertial guidance system were products of Japan's independent technology.

H-II: A two-stage launch vehicle, with both stages developed based on Japan's own technology. The 1st stage adopted the newly developed LE-7—a large-capacity, high-efficiency engine. The 2nd stage used the LE-5A—an upgraded version of the LE-5 developed for the H-I that featured further efficiency improvements and superior reliability.

H-IIA: Currently, this is Japan's mainstay large launch vehicle. Developed based on technologies cultivated during the development of the H-II—the country's first fully domestically developed launch vehicle—the H-IIA has realized high reliability and low cost for the launch of a diverse range of satellites and space probes.

H-IIB: This large launch vehicle increases the launch capability of the H-IIA. At present, it is used to launch the H-II Transfer Vehicle (HTV), Japan's resupply spacecraft servicing the International Space Station (ISS).

Japan's Launch Vehicle Technology Takes On New Challenges

The H3 will maintain a high level of reliability while realizing radical cost reductions and providing customers with a flexible launch service.

Fundamental Change in Thinking Drives H3 Development

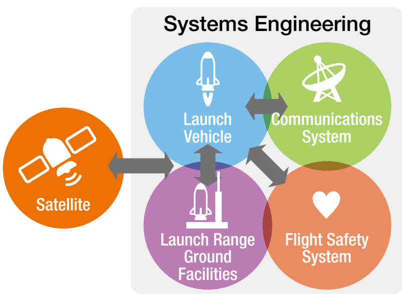
Shigeru Mori
Associate Senior Engineer
Area of Responsibility: Project Management
H3 Project Team
Space Technology Directorate I

The commercial objectives of the H3 Launch Vehicle development project put it on a fundamentally different footing from Japan's launch vehicle development to date. The development partners are focusing on how the launch vehicle will be operated and how it will be marketed to potential customers worldwide. The H3 1st stage will offer the choice of either a two- or three-engine configuration. There will also be flexibility in terms of solid rocket boosters—either none, two, or four SRBs. This architecture will give customers access to a flexible launch service, with a key consideration being the potential maximum number of launches annually. We want to leverage Japan's full technical capabilities to produce a truly state-of-the-art launch vehicle.

Enabling All Team Members to Put Their Heart and Soul into the H3

Shinya Okubo
Associate Senior Engineer
Area of Responsibility: Systems Engineering
H3 Project Team
Space Technology Directorate I

My job is in systems engineering—specifically, integrating systems throughout the launch vehicle and related facilities. I am tasked with ensuring that integrated systems match the mission requirements of the H3 Launch Vehicle. We are carrying out development using an integrated approach that considers the optimal place to deploy each function necessary to meet the mission requirements. This includes all aspects of the project, from the launch vehicle to ground facilities. Key strengths of the H3 are its simplicity and high reliability. Hence, we are striving to create a launch vehicle that will attract satellite orders from customers around the world. I believe that it is my job to ensure that all team members are able to put their heart and soul into the H3.



Development of a Simple and Low-Cost Engine Based on Original Technology

Akihide Kurosu
Associate Senior Engineer
Area of Responsibility: 1st-Stage Engine
H3 Project Team
Space Technology Directorate I

The H3 Launch Vehicle's new LE-9 engine is based on a simple design concept and low cost. This engine adopts the "expander bleed cycle" method—an original technology developed in Japan. Hydrogen gas is used to cool the combustion chamber, and heated up to a temperature of approximately 200°C. This heated gas activates a turbo pump to send propellants to the combustion chamber. Compared with the LE-7A engine used in the H-IIA and H-IIB 1st stage, the LE-9 has a simple structure, so the number of components is reduced by around 20%. That helps to bolster reliability while bringing down cost. I want to complete the development of an engine that will make the people of Japan proud.

Aiming for Simplicity and the Realization of a Low-Cost Solid Rocket Booster

Eiichi Wada
Engineer
Area of Responsibility: Solid Rocket Booster
H3 Project Team
Space Technology Directorate I

If I were asked to describe our approach to the development of improved solid rocket boosters (SRBs) to be used with the H3 Launch Vehicle, I would say we are "aiming for simplicity." One of the key features of the new SRB-3 is the mechanism used for separation from the main rocket airframe. The SRB-A, which is used with the H-IIA and H-IIB launch vehicles, has six separation points—braces and struts—between the main airframe and two separation motors. The separation motors generate the power to detach the booster outward from the main body. This structure incurs considerable cost in terms of both manufacturing and launch vehicle assembly operations. Hence, for the SRB-3 we will reduce the number of separation struts to three, each of which is furnished with a simple mechanism called a "separation thruster." This mechanism is equipped with a pyrotechnic actuator to separate the booster outward from the launch vehicle body.
I am working to fulfill my mission, which I believe is to develop a high-quality, low-cost SRB that will help to make the H3 an extremely competitive launch vehicle.

Artist's rendition of the LE-9 1st-stage engine

Striving for the World's Most Comfortable Ride for Satellite Payloads

Keita Terashima

Associate Senior Engineer
Area of Responsibility: Structural System Development
H3 Project Team
Space Technology Directorate I

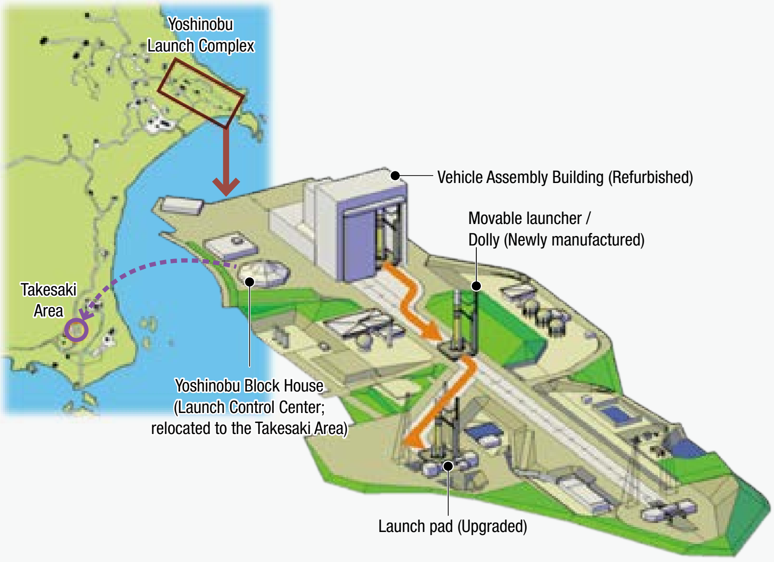
My area of responsibility is the development of the launch vehicle structure. This includes such components as the liquid hydrogen and liquid oxygen tanks, the central structure connecting the tanks, the interstage structure connecting the 1st and 2nd stages, and the fairing to protect satellite payloads. When receiving orders from overseas for satellite launches, key criteria considered by the customer are the measures taken to protect the payload from noise and vibration during liftoff and shock during separation. These measures must be even more robust than those undertaken to date. It is my responsibility to ensure that the satellite payload enjoys the most comfortable ride possible. Hence, I want to make the H3 a world leader in this area.

Halving the Number of Operational Days Needed at the Tanegashima Space Center

Akito Hattori

Manager
Area of Responsibility: Launch Complex Development
Range Technology Development Unit
Kagoshima Space Center
Space Technology Directorate I

With regard to the launch of the H3 Launch Vehicle, as shown in the accompanying chart, it will be necessary to build new facilities and upgrade existing facilities within the Tanegashima Space Center (TNSC). Our goal is to halve the length of time needed between launches compared with the H-IIA, which is the shortest achieved to date. By doing so, we will be able to provide a speedier service and reduce launch costs. As a means of shortening the launch operation time, we are focusing efforts on simplifying the launch vehicle assembly process and introducing automated inspection systems. While utilizing existing facilities efficiently, we will work to ensure that the facilities have a long working life.



Special Feature 1:

Japan's Technical Prowess

A Genuine Step toward the Realization of the Next Generation of Supersonic Transport

—Japan's capabilities for developing original technologies gain high visibility thanks to the success of the flight test demonstration of the low sonic-boom design concept—

Kenji Yoshida
Project Manager
D-SEND Project Team
Aeronautical Technology Directorate

To realize a new generation of supersonic transport, the reduction of sonic boom is one of the most critical issues that must be addressed. JAXA is pursuing this objective through the D-SEND* project, which involves flight test demonstrations and evaluation of configuration design concepts and methods. In July 2015, JAXA carried out the second-phase D-SEND test ("D-SEND#2") at the Esrange Space Center in Sweden. We discussed the significance of the success of this test with D-SEND project manager Kenji Yoshida.

*D-SEND: Acronym derived from the full project title, "Drop test for Simplified Evaluation of Non-symmetrically Distributed sonic boom"

Flight Demonstration of Low Sonic Boom Concept for Supersonic Transport Design

Please describe the research flow for reducing sonic boom.

Yoshida: Initially, in May 2011 we conducted the first-phase test of D-SEND ("D-SEND#1") as a preliminary test. Based on the results of D-SEND#1, for the second-phase demonstration test we released an experimental supersonic aircraft from a large stratospheric balloon at an altitude of 30.5 km. The experimental aircraft—which utilizes JAXA's original low sonic-boom design technology—had a total length of 7.9 meters and weighed 1,000 kg. We measured the sonic boom generated by the aircraft to validate the design technology.

When an aircraft flies at a speed greater than the speed of sound—supersonic speed—shock waves are generated by many parts of the airframe. By the time these shock waves reach the ground, they become compressed with waves generated by the nose and tail of the aircraft. This causes two large pressure fluctuations to occur. On the ground we hear this as an explosive sound, or "sonic boom."

The D-SEND#2 experimental aircraft being lifted up by a mobile crane in preparation for the balloon launch. The aircraft was affixed to the balloon's gondola for the drop test. (© JAXA)

The experimental aircraft used for the flight test demonstration applied JAXA's original configuration design concept. For example, the nose had non-axisymmetric upper and lower surfaces, the wings used an optimal combination of twist-angle and camber distributions, and the aft fuselage had a wide shape. The test was a world-first flight demonstration in which nose and tail sonic booms were reduced while maintaining aircraft stability.

Contributing to the Formulation of International Standards

How do you plan to apply the success of this flight test?

Yoshida: The Committee on Aviation Environmental Protection (CAEP) within the International Civil Aviation Organization (ICAO) is currently deliberating on the formulation of international standards for sonic booms. The results of our second-phase demonstration test, which were reported to the Supersonic Task Group under CAEP in October 2015, received high technical evaluation. However, establishing environmental standards is a difficult process, and we believe that debate is likely to continue regarding what would be an acceptable level for the community and what constitutes an objective parameter.

A World of Supersonic Transport Just Moved a Step Closer to Reality

Have the issues standing in the way of a new generation of supersonic transport been resolved?

Yoshida: Supersonic transport faces issues within two broad categories—economic viability and environmental

The moment at which the D-SEND#2 experimental aircraft—named the Silent SuperSonic Concept Model (S3CM)—was released from a balloon at an altitude of 30.5 km (© JAXA)

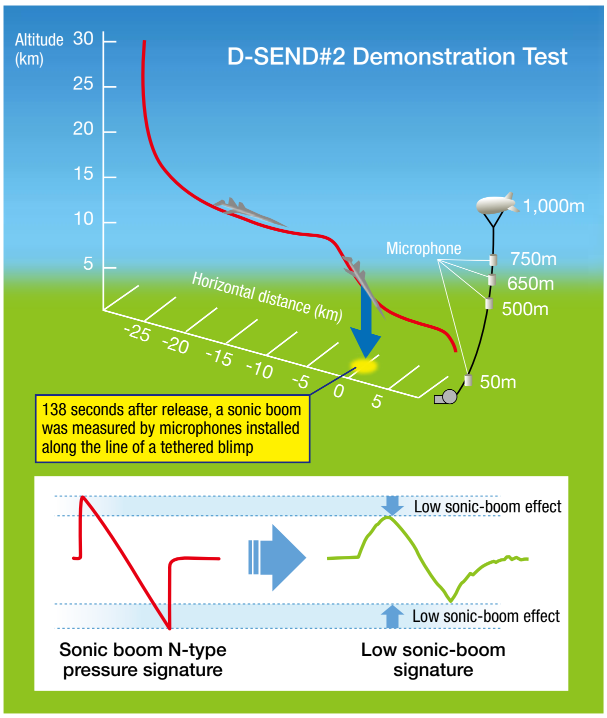
compliance. It would be premature to say that these issues have been completely resolved. The next generation of supersonic transport envisaged by JAXA would be a relatively small airplane. It would have a passenger capacity of 50, cruising at a speed of Mach 1.6, and the airplane would weigh some 70 tons. Based on such a model, in terms of economic performance, its aerodynamic drag would be 13% lower than the Concorde. Furthermore, we believe that the lightweight airframe and improved engines would potentially lower fuel consumption by around 20% compared with the Concorde. In the area of environmental compliance, since the weight of the airframe has a bearing on sonic boom, we estimate that by applying JAXA's low boom design technology to such model, the sonic-boom would be reduced to approximately 25% of that of the Concorde.

Staying at the Leading Edge of Technology Development

What is JAXA's role from here on?

Yoshida: There are two aspects to our role—contributing through international cooperation and developing technology that is globally competitive.

Providing the results of this demonstration test to the ICAO is part of our international cooperation. We hope that this will help to bring about the opportunity for supersonic transport development. However, we estimate that the cost of such development—even for an aircraft of the scale envisaged by JAXA—will exceed one trillion yen ($8.3 billion). Of course, such a development project would take the form of a joint international effort. In other words, international competitiveness would greatly depend on how far we could expand our share of the development program. Japan holds patents related to the development of next-generation supersonic transport in such areas as the reduction of aerodynamic drag and low sonic-boom design technology. Consequently, if we can take the initiative from the design stage, I think that we should be able to expand our share of the development program. With this in mind, we are taking a leading-edge approach to technology development. I believe that one of JAXA's major roles is to lay the foundations for internationally competitive technologies, and then pass the baton to Japanese enterprises at the appropriate time.

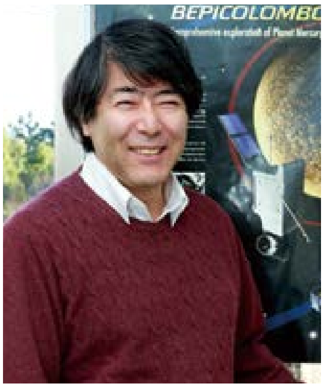


Special Feature 2:

International Cooperation

Japan and Europe Cooperate to Investigate the Mysteries of Mercury—An Unknown World

BepiColombo is a joint mission of the European Space Agency (ESA) and JAXA to explore the planet Mercury. JAXA TODAY spoke to JAXA's BepiColombo project manager Professor Hajime Hayakawa about the unique technical aspects and scientific significance of the mission. Professor Hayakawa also discusses the importance of international cooperation in interplanetary exploration.



Dr. Hayakawa received a Master of Science degree from the Department of Geophysics, Graduate School of Science, The University of Tokyo, in 1981. He participated in the development of the magnetosphere observation satellite Akebono, GEOTAIL and the Mars Explorer Nozomi. In 2006, he was appointed project manager for JAXA in the Mercury exploration mission BepiColombo.

Hajime Hayakawa

Project Manager, BepiColombo Project Team
Professor, Department of Solar System Sciences
Institute of Space and Astronautical Science, JAXA
Doctor of Science

Why have there been relatively few exploration missions to Mercury to date?

Hayakawa: Mercury's close proximity to the sun gives it a very scorching environment. This means that not only is it difficult to send a probe to Mercury, but achieving a high assurance that the spacecraft and its instruments will survive while orbiting the planet is also a major challenge. Reaching Mercury and putting a satellite into orbit around the planet requires a huge amount of energy. Furthermore, the amount of thermal energy received from the sun by Mercury is approximately 10.7 times that of Earth. In addition, the very strong sunlight reflection and heat radiation from Mercury meant that in-orbit observations were considered to pose extreme difficulties.

What has been the most painstaking aspect of MMO's development?

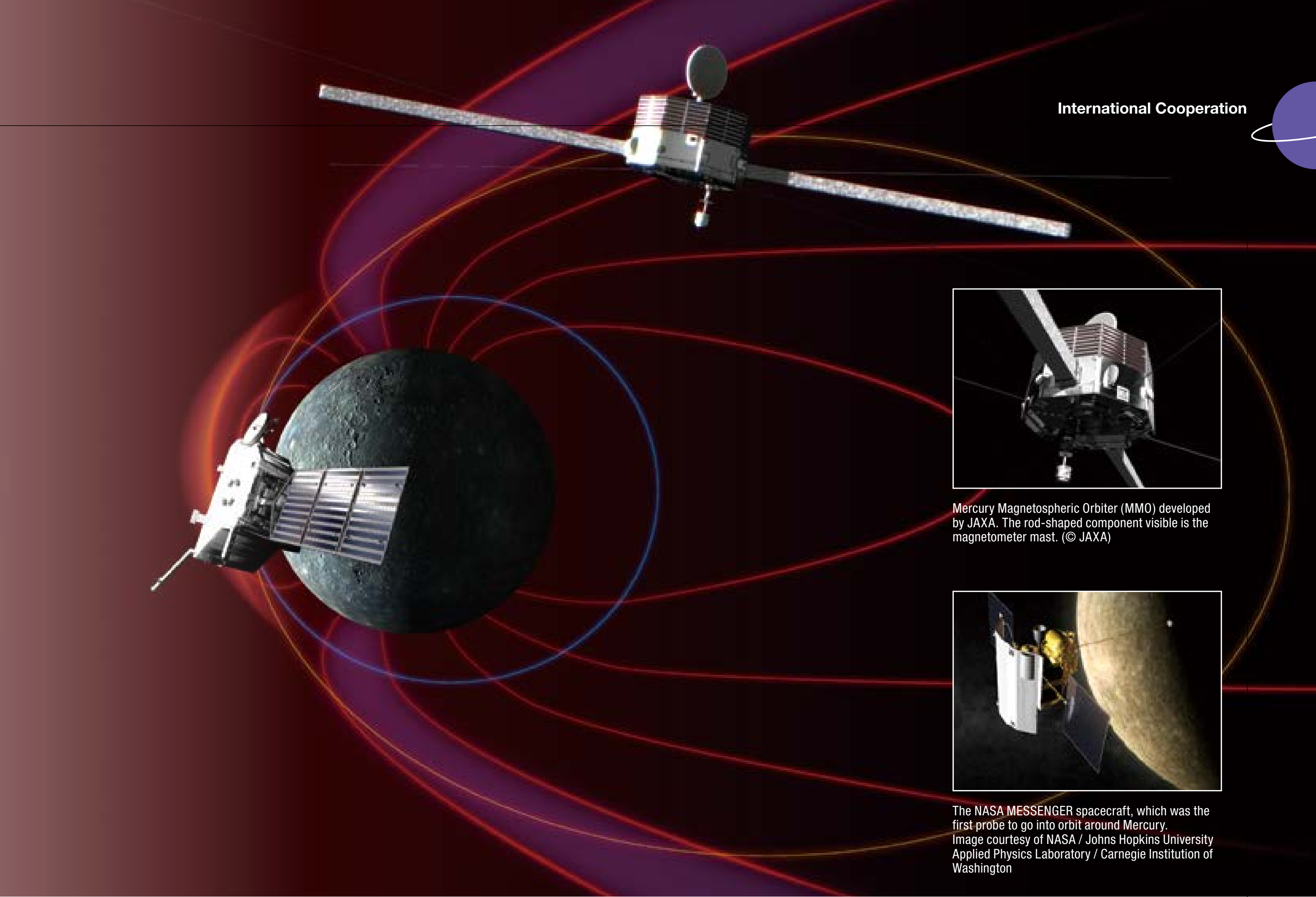
Hayakawa: The greatest challenge we faced was how to develop a space probe that could endure the severe heat conditions. After deliberating on the issue of heat dissipation, we decided to use mirrors on the spacecraft exterior to reflect away sunlight. Hence, we thoroughly considered the thermal radiative properties when designing the structure of the spacecraft. For example, the solar cell panels covering the upper half of the probe are fully covered with mirror material on the reverse surface.

What is the scientific significance of the exploration of Mercury?

Hayakawa: The entire Earth is a magnet, and its magnetic field is stable. Furthermore, if one compares the Earth's magnetosphere and the size of the Earth itself, the ratio is approximately 10:1. Based on the flyby observations of Mercury carried out by NASA's Mariner 10 spacecraft about 40 years ago, scientists have understood that Mercury's magnetic field is quite weak. Those observations also revealed that when comparing the size of Mercury's magnetosphere and the planet itself, the relative size of Mercury in relation to its magnetosphere is much larger than the corresponding ratio for Earth. Through the BepiColombo mission, we will of course seek to elucidate the environment around Mercury. However, we also hope that through comparisons with other planets we will gain a deeper understanding of the Earth's environment.

What is your view of the importance of international cooperation in the field of interplanetary exploration?

Hayakawa: I think that international cooperation is going to become absolutely indispensable from here on. Within the BepiColombo project, JAXA and ESA each have their own space probe. However, regardless of which organization is developing the spacecraft, the optimal scientific instruments were selected as the payload for each probe from among the proposals submitted by researchers in both Europe and Japan. The BepiColombo project has become a model case for Japan–Europe international cooperation, and new missions are also getting under way, including



Mercury Magnetospheric Orbiter (MMO) developed by JAXA. The rod-shaped component visible is the magnetometer mast. (© JAXA)

The NASA MESSENGER spacecraft, which was the first probe to go into orbit around Mercury. Image courtesy of NASA / Johns Hopkins University Applied Physics Laboratory / Carnegie Institution of Washington

The BepiColombo mission will send two interplanetary probes to explore Mercury and its magnetosphere. This artist's impression shows the two spacecraft, MMO (top) and MPO (bottom).
[Note: This illustration is for image purposes only, and the actual distance between Mercury and the sun differs from that shown.]
(© JAXA / ESA)

the Jupiter Icy moons Explorer (JUICE) project to explore Jupiter.

Please explain the relationship between BepiColombo and the NASA MESSENGER mission, which completed surface observations of Mercury in 2015.

Hayakawa: Initially, MESSENGER was seen as a rival mission, but we are strengthening collaboration with MESSENGER. For example, since NASA began releasing observation data from MESSENGER, we have held joint workshops. MESSENGER's observations have led to numerous new discoveries. There have also been many results that diverged greatly from pre-observation expectations. For example, the position of Mercury's magnetic field is offset by about 20% from the planet's center, and the planet has a large inventory of volatile materials. Such discoveries have led to more questions, thereby posing new mysteries to be investigated. Obviously, one of the major roles of BepiColombo is to seek answers to such questions. At the moment, researchers from Japan and Europe are working together to consider observation methods using the project's two space probes that will lead to the greatest possible output. I believe that the scientific value of the mission is increasing substantially.

In closing, is there anything you would like to say specifically to young researchers?

Hayakawa: I think it is important to maintain a strong sense of curiosity, and be driven by the desire of "wanting to know" the things that one does not yet understand. Mercury is a world full of unknowns, and new mysteries are being thrown up constantly. I believe that it is an exploration field offering a wealth of intellectual curiosity and challenges.

BepiColombo Project

This is a joint project by JAXA and the ESA to explore the planet Mercury. Two interplanetary space probes will simultaneously orbit Mercury to carry out comprehensive observations of the planet. JAXA will send the Mercury Magnetospheric Orbiter (MMO), while ESA will operate the Mercury Planetary Orbiter (MPO). Launch of these spacecraft is planned for 2017. The mission is named after Italian Giuseppe (Bepi) Colombo (1920–1984), a celestial mechanics scientist, mathematician and engineer at the University of Padua. Professor Colombo is well-known for his contribution to NASA's Mariner 10 mission in 1974, the first interplanetary probe of Mercury.

Special Feature 2:

International Cooperation

Utilizing Earth Observation Satellites to Help Build a Better Future for Humankind

JAXA develops and operates a diverse array of satellites, including interplanetary probes, communications and global navigation satellites, and Earth observation satellites. Among these, the main functions and roles of Earth observation satellites are particularly important in both the environmental and disaster management fields, which can have a significant impact on society and people's daily lives. In this article, two JAXA managers outline some of JAXA's capabilities for international cooperation that further utilize such observation data.

Significant Contribution to Disaster Management

Michio Ito

Manager
Earth Observation Research Center (EORC)
Space Technology Directorate I

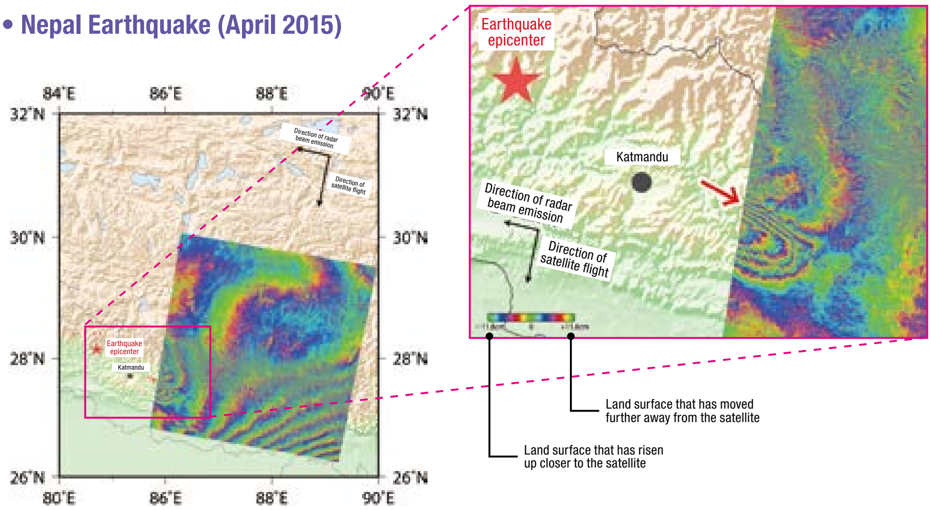
Observing Natural Disasters from Space

Recent years have witnessed the frequent occurrence of major natural disasters in Japan and abroad. To minimize the damage from such disasters, it is imperative to accurately and rapidly ascertain the damage situation. This is one of the missions fulfilled by Advanced Land Observing Satellite-2 (ALOS-2)—launched in May 2014 as the follow-on mission to Advanced Land Observing Satellite (ALOS). ALOS-2 helps to secure people's safety and livelihoods by providing observation data from space to support disaster management efforts.

ALOS-2 is a radar satellite whose primary payload instrument is PALSAR-2. This is a substantially upgraded instrument compared with PALSAR, which was carried by ALOS. PALSAR is an acronym for Phased Array-type L-band Synthetic Aperture Radar. Radar satellites have the ability to conduct observations anytime day or night, and the radio waves they emit can penetrate clouds and rain. ALOS-2 has sophisticated maneuverability and observation capabilities, which are effective for conducting observations following a disaster. For example, in addition to realizing very detailed observations, PALSAR-2 has "spotlight mode," which enables high-resolution observations of specific targets. The satellite's "revisit time"—referring to the number of days necessary for the satellite to orbit the Earth and return to the same observation location—has also been greatly shortened. Furthermore, the spacecraft can rapidly adjust its attitude left and right about its roll axis to point the PALSAR-2 antenna when making observations.

After the Nepal earthquake in April 2015, and during frequent flooding disasters in Asia over the period from July to September 2015, rapid observations by ALOS-2 enabled

• Nepal Earthquake (April 2015)



Based on observation data from ALOS-2, crustal mevement was detected following the April 25, 2015, Nepal earthquake. The pre-earthquake data was taken on March 31, and the post-earthquake data was captured on April 28. On the left-hand side is the overall image, while the right-hand side shows a zoom-in on a portion of the image. In the area east of Katmandu, the interference pattern visible reveals a large diastrophism that occurred as a result of the earthquake.

disaster-management agencies to ascertain the extent and location of damage at an early stage.

Building a System to Monitor Disasters from Space through International Cooperation

The Asia-Pacific region accounts for over 70% of the world's natural disasters. Sentinel Asia is a cooperation framework that utilizes satellite observation data for disaster management activities based on collaboration between space agencies and disaster management agencies in the Asia-Pacific region. Sentinel Asia was launched in 2006 as an initiative through the Asia-Pacific Regional Space Agency Forum (APRSAF), and at present has nearly 100 participating institutions from 25 countries and regions. The number of participating member organizations continues to grow. JAXA acts as the secretariat, and my role is that of secretariat director.

Another initiative is the International Charter on Space and Major Disasters, which is a global cooperation framework established in 2001. Participants include JAXA, several space agencies in Europe, and the United States Geological Survey (USGS), with more than 30 satellites operated by countries worldwide conducting disaster observations. When necessary, Sentinel Asia makes observation requests to the charter.

The aforementioned emergency observations carried out by ALOS-2 after the Nepal earthquake and during other disasters were conducted under the Sentinel Asia framework.

Disaster Monitoring from Space as an Integral Part of the Social Infrastructure

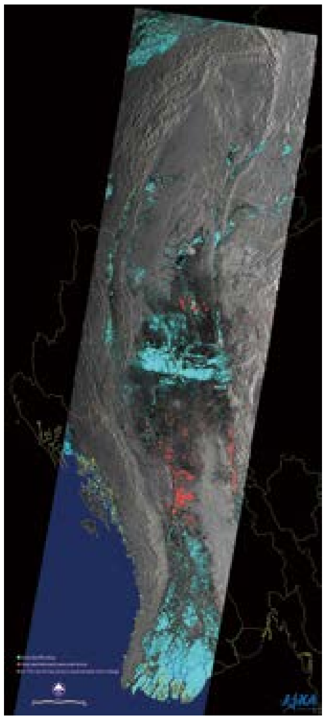
The major earthquake that struck Nepal April 25, 2015, occurred just before a week-long holiday season in Japan. JAXA staff responsible for emergency satellite observations gave up their vacation time to respond to the earthquake, and I believe that JAXA personnel had to cope with considerable mental and emotional pressure. However, JAXA received letters of gratitude from United Nations agencies and organizations in Nepal after the crisis, and I am sincerely glad that we were able to respond to assist with the emergency. Of course, we cannot choose the timing or location of a major natural disaster—it is something that we must deal with to the best of our abilities. Programs for monitoring disasters from space should be built as an integral part of the social infrastructure to ensure that people are able to live secure lives with peace of mind. Hence, I think that it is essential to maintain an operational system capable of immediate response—24-hours-a-day, 365-days-a-year—to disasters that can strike suddenly anywhere, at any time. At present, JAXA positions Sentinel Asia as a project for demonstrating the utilization of space technology. In the future, when Sentinel Asia completes its demonstration phase, we want to aim for the joint operation of a 24-hour system by participating countries and organizations. We see the possibility of establishing such a framework—which may be tentatively called "Sentinel Asia Center"—to take over from the current demonstration project. To realize this goal, JAXA is committed to continuing its leadership role in this sphere.

• Myanmar Floods (July 2015)

April 3, 2015 (before flood)

July 24, 2015 (after flood)

A comparison of the area prior to the floods (April 3, 2015) and following the floods (July 24). The areas that appear darker after the floods are thought to indicate inundation.

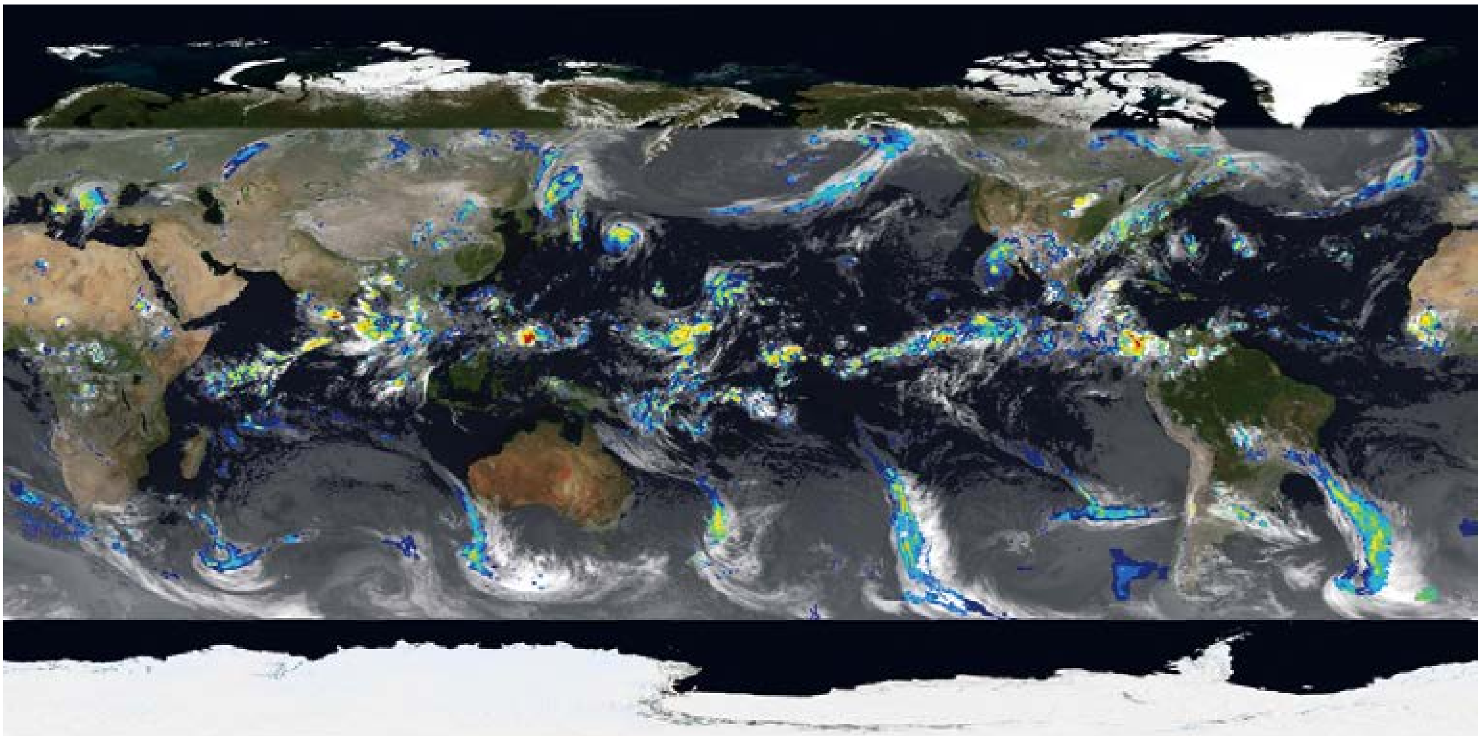


In the left-hand image, the dark blue areas indicate the surface of floodwaters. The green areas are thought to show forests in a normal state. In the processed image on the right-hand side, the light-blue areas indicate the surface of floodwater, while the red areas are thought to show flooding in forest areas and urban areas.

Special Feature 2:

International Cooperation

Playing a Key Role in the Environmental Field



Global Satellite Mapping of Precipitation (GSMaP) for 9:00 a.m., September 10, 2015 (JST), produced based on observation data from the GPM satellite constellation, including GPM/DPR

Yutaka Kaneko

Manager
Earth Observation Research Center (EORC)
Space Technology Directorate I

Tackling Global Environmental Issues through International Cooperation

Humankind faces many environmental issues on a global scale. Hence, when viewing such problems, it is vital to do so from an international perspective rather than from the perspective of a single country. For example, the Global Precipitation Measurement (GPM) mission is a joint international mission to measure global precipitation at frequent intervals with a high level of precision. GPM aims to elucidate mechanisms leading to climate change and changes in the global water cycle. The mission comprises the GPM Core Observatory—which carries the Dual-frequency Precipitation Radar (DPR) developed by Japan—and a constellation of satellites. GPM was initiated by JAXA and NASA, and comprises an international consortium of agencies, including the European Space Agency (ESA), Centre National d'Études Spatiales (CNES), the Indian Space Research Organization (ISRO), the National Oceanic and Atmospheric Administration (NOAA) and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT).

Microwave radiometer observation data from Global Change Observation Mission–Water (GCOM-W) is used by the Japan Meteorological Agency and other meteorological agencies worldwide, including in the United States, Europe and Australia. The data is used in the preparation of daily weather forecasts for such applications as numerical forecasting, analysis of the paths and strengths of typhoons and other storms, and in the preparation of high-resolution sea surface temperature maps.

Observation of the atmospheric concentrations of carbon dioxide and methane—principal greenhouse gases—are carried out by the Greenhouse Gases Observing Satellite (GOSAT). The effectiveness of data from GOSAT was cited in the Fifth Assessment Report (AR5) of the United Nations Intergovernmental Panel on Climate Change (IPCC), and the data is proving useful in assessing the effects of greenhouse gas emission reductions, principally carried out by developed countries.

Collaborating with JICA in Ongoing Efforts to Conserve Tropical Rain Forests

The conservation of forests—which act as a sink absorbing carbon dioxide—is an effective means of limiting global warming. However, frequent illegal logging in Brazil's forested regions has been a major problem leading to deforestation. From 2009 to 2011, JAXA collaborated with the Japan International Cooperation Agency (JICA) in its projects to protect forests in the Amazon basin. Images taken by Advanced Land Observing Satellite-2 (ALOS-2) are shown on page 13. Image data taken by Advanced Land Observing Satellite (ALOS)—the predecessor of ALOS-2—was provided to the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA). Even during the rainy season—which persists for almost half the year near the equator—ALOS was able to carry out observations through cloud and rain. The image data proved to be a powerful tool in the battle against illegal logging, as ALOS data was able to identify the specific areas in which illegal logging was occurring.

In April 2014, JAXA and JICA signed a partnership agreement under which they plan to utilize aerospace technology with the objective of contributing to solutions to issues faced by developing regions as well as a range of global-scale issues. Based on this agreement, JAXA and JICA jointly announced the Initiative for Improvement of Forest Governance at the 2015 United Nations Climate Change Conference (COP21), held in Paris in December 2015. In accordance with this framework, JAXA and JICA will build a forest monitoring system using ALOS-2. Observation data from this monitoring system relating to global deforestation and forest loss will be regularly released through the JAXA web site and other resources. The partners hope that the monitoring system will help to curb illegal logging and contribute to limiting climate change.

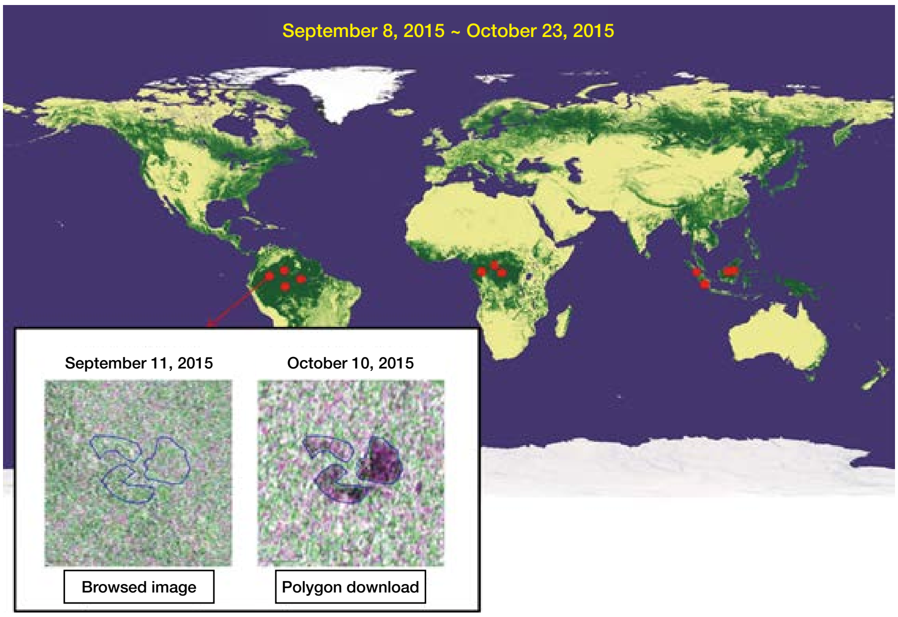
Combining Observation Data from Diverse Sources to Promote New Research

JAXA's Earth Observation Research Center (EORC) is collaborating with national universities and research institutions in Japan to promote multidisciplinary applied research from FY2015 (commencing April 1, 2015) onward. This program aims to utilize observation data in an integrated way, not only from JAXA satellites but also from a broad range of other satellites, including Himawari 8—a geostationary weather satellite operated by the Japan Meteorological Agency. By combining satellite data and a global environmental model, the EORC aims to predict the process of change in the Earth's environment. The objective of the research is to work toward finding solutions to issues across a variety of fields, including the water cycle and water resources, ecosystems and agriculture.

For example, in the agricultural field, by developing a new yield forecasting system that integrates a grain yield forecasting model with observation data from ALOS-2, GCOM-W1, Global Change Observation Mission–Carbon (GCOM-C), the GPM mission and other sources, JAXA is engaging in research that addresses such issues as future tightness in the supply and demand of food.

Utilizing Satellites to Help Build a Safe and Secure Society

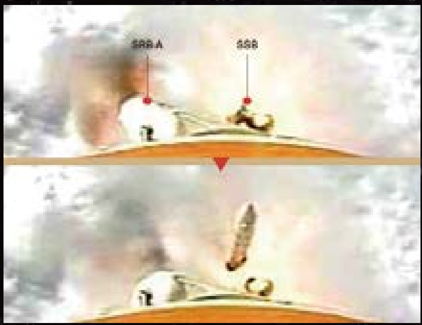
Compared with manned spaceflight and the development of launch vehicles, satellites may seem somewhat mundane. However, using satellites to conduct observations of the Earth's environment offers the potential to find solutions to issues faced by all of humankind in the future. Through satellite monitoring of the global environment, I hope that we can identify the causes of extreme weather events and discover methods for mitigating the damage from natural disasters. Hence, I hope that these efforts will help to build a society of the future in which people can lead safe and secure lives.



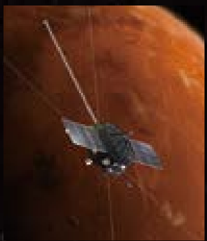
Concept design of the format for deforestation data to be released via the web from the joint JAXA/JICA forest monitoring system. ALOS-2 will conduct observations of areas in which forest depletion is occurring, and data will be updated approximately once every six weeks.

Moving beyond Its First Decade, JAXA Sets Course on a New Stage of Its Journey

Since JAXA's establishment in October 2003 through the merger of three predecessor organizations, and the transition in April 2015 to a new legal status as a National Research and Development Agency, JAXA has steadily built up a record of accomplishments in the aerospace field and in research and development. In just over a decade, internationally JAXA has won a high level of trust as a space agency, reflected in such milestones as Astronaut Koichi Wakata's appointment as the first Japanese



H-IIA F6 rocket immediately following launch. After separation of the solid strap-on booster (SSB; right), the vehicle failed to jettison one of its two solid rocket boosters (SRB-A; left). The launch vehicle was subsequently destroyed via a command from the ground, as it was unable to gain planned altitude owing to the jettison failure.



PLANET-B (NOZOMI) abandons attempt to go into orbit around Mars (computer graphic image) (© Akihiro Ikeshita)

2003

New Organization Suffers Three Early Failures

The newly inaugurated JAXA got off to a bumpy start with three setbacks in its first three months. H-IIA Launch Vehicle No. 6 (H-IIA F6) was destroyed after a launch failure, and two spacecraft—ADEOS-II (Midori II) and PLANET-B (NOZOMI)—ceased operation.

A photograph of the Earth taken from Hayabusa (© JAXA)

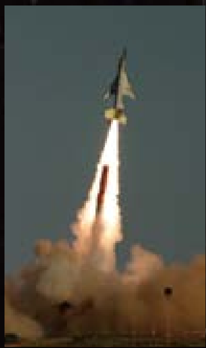
After its Earth swing-by, Hayabusa headed for Asteroid Itokawa (computer graphic image) (© Akihiro Ikeshita)

2004

Hayabusa Heads for Asteroid Itokawa

Asteroid explorer MUSES-C (later renamed Hayabusa) lifted off in May 2003, and in May 2004 successfully executed an Earth swing-by using Earth gravity assist to put it on course for a rendezvous with Asteroid Itokawa. Meanwhile, in the aftermath of the H-IIA F6 rocket failure in 2003, JAXA implemented a thorough review of all projects currently in progress.

Astronaut Soichi Noguchi carries out ISS assembly work during extra-vehicular activity (EVA) (© JAXA/NASA)



NEXST-1 is launched from the Woomera Test Range in Australia (© JAXA)

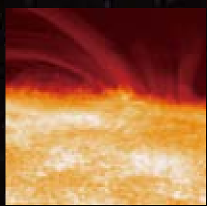
2005

Flights Recommence

In 2005, several successful launches marked JAXA's recommencement of space flight. In February, there was the launch of H-IIA F7, and July saw the safe insertion into orbit of X-ray astronomy satellite Suzaku (ASTRO-EII). Suzaku's predecessor, ASTRO-E, had been lost shortly after launch in 2000, hence this new mission aimed to make up for the earlier setback. Also in July, the Space Shuttle Discovery—with JAXA Astronaut Soichi Noguchi aboard—was launched on the Return to Flight mission for the Space Shuttle program following the Space Shuttle Columbia disaster. In October, JAXA conducted a successful flight test for the National Experimental Supersonic Transport (NEXST-1) scaled aircraft, thus overcoming the first test failure in 2002.

The June 2, 2006, edition of *Science* contained the first feature articles on a Japanese interplanetary exploration mission

A far-infrared image of the Large Magellanic Cloud (LMC) observed by Akari



Eruptive phenomena in the vicinity of solar flares observed by Hinode

2006

Four Satellites Launched into Orbit

This was the year in which JAXA made a full-fledged return to its core role as a space agency with the launch into orbit of four satellites—Advanced Land Observing Satellite (ALOS; "DAICHI"), Engineering Test Satellite VIII (ETS-VIII; "KIKU-8"), Infrared Imaging Satellite (ASTRO-F; "Akari") and Solar Physics Satellite (SOLAR-B; "Hinode"). In June, observation results from Hayabusa of Asteroid Itokawa featured in a set of articles in the journal *Science*.

Images showing the "Earth-rise" taken by SELENE's HDTV cameras (© JAXA / NHK)

The two sub-satellites separate from SELENE (computer graphic image) (© JAXA)

2007

KAGUYA Heads for her Lunar Home

Japan's lunar explorer spacecraft, Selenological and Engineering Explorer (SELENE), was launched in September. SELENE comprised the main orbiter and two sub-satellites. The orbiter's Japanese nickname, KAGUYA, was selected by the general public, and comes from the name of a lunar princess in the ancient Japanese folktale, *The Tale of the Bamboo Cutter*. After their successful release, the sub-satellites Rstar and Vstar were renamed Okina and Ouna, respectively. These names are also derived from characters in the tale. SELENE carried a payload of 15 instruments used in its scientific mission, including high-definition television (HDTV) cameras. Detailed observations of the moon included magnetic fields, topography, the lunar elemental composition and plasma.

The ISS crew, including Astronaut Takao Doi (lower right) gather in Kibo's ELM-PS (© JAXA / NASA)

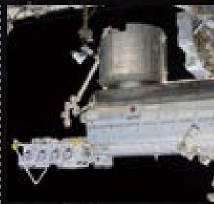
Astronaut Akihiko Hoshide installs experiment racks in Kibo's PM (© JAXA / NASA)

WINDS (computer graphic image) (© JAXA)

2008

Assembly of JEM Kibo Begins

The mission to assemble JEM Kibo got under way after the module was transported to the ISS aboard the Space Shuttle. In March, Astronaut Takao Doi installed the Experiment Logistics Module Pressurized Section (ELM-PS) onto the ISS, and in June Astronaut Akihiko Hoshide installed the Pressurized Module and the JEM Remote Manipulator System (JEMRMS), marking the start of operations for Kibo. Wideband Inter- Networking Engineering Test and Demonstration Satellite (WINDS; Japanese nickname: "KIZUNA") was launched as part of a mission to realize high-speed, wideband telecommunications.



The completed JEM Kibo (© NASA)

HTV approaches the ISS (© NASA)

2009

JEM Kibo and HTV Extend Manned Space Activities

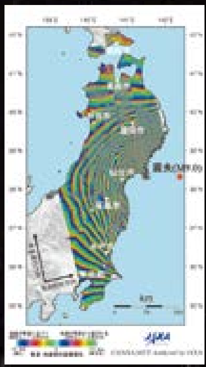
In July, Astronaut Koichi Wakata installed the Exposed Facility (EF) onto the JEM Kibo PM, thus completing the assembly of Kibo. In September, the HTV resupply spacecraft made a successful rendezvous and docking with the ISS. The original method used for rendezvous and docking was developed in Japan and was subsequently used as the model for a system employed by a U.S.-manufactured resupply spacecraft.

commander of the International Space Station (ISS) in 2014, and the successful capture of Japan's HTV5 resupply spacecraft when it made its rendezvous with the ISS in 2015—showcasing the capabilities of "Team Japan." Let's recap some of the highlights of the first dozen years of JAXA's continuing journey.

A photograph taken by miniature deployable camera DCAM2 shows IKAROS' fully unfurled solar sail
(© JAXA)

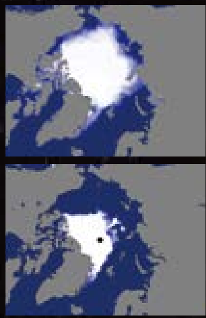
The final image of Earth taken by Hayabusa

The glowing trail made by Hayabusa and its sample-return capsule as they re-enter the atmosphere
(© JAXA)



A map showing crustal movement caused by the Great East Japan Earthquake based on observation data provided by ALOS

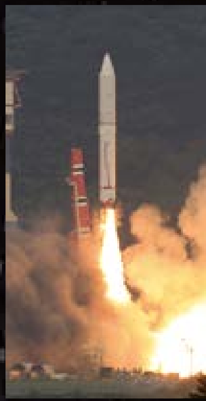
Astronaut Satoshi Furukawa serves a long-duration mission aboard the ISS from June 2011
(© JAXA / NASA)



The observation by SHIZUKU of Arctic sea ice cover on September 16, 2012, is shown on the bottom. The extent of sea ice cover is much smaller than that shown on the top, which is based on the average minimum Arctic sea ice cover in September during the 1980s.

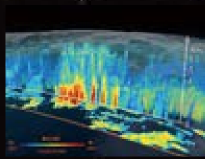
Astronaut Akihiko Hoshide prepares an experiment in JEM Kibo
(© JAXA / NASA)

FTB "Hisho" prepares for takeoff
(© JAXA)



Epsilon Launch Vehicle lifts off from the Uchinoura Space Center in Kagoshima, Japan
(© JAXA)

Astronaut Koichi Wakata operates the Space Station Remote Manipulator System (SSRMS) to assist an EVA
(© JAXA / NASA)



Precipitation data captured by DPR from an extratropical cyclone. The data is shown as a three-dimensional (3D) distribution
(© JAXA / NASA)

An artist's rendition of Hayabusa2 touching down on an asteroid 162173 Ryugu (computer graphic image)
(© Akihiro Ikeshita)

The first launch of the H3 Launch Vehicle scheduled to take place in 2020 (computer graphic image)
(© JAXA)

Astronaut Kimiya Yui carries out training for operation of the ISS' robotic arm
(© JAXA / NASA)

An image of Venus taken by Akatsuki
(© JAXA)

X-ray astronomy satellite ASTRO-H, which was developed through a large-scale, joint international project (computer graphic image)
(© Akihiro Ikeshita)

JAXA Astronaut Takuya Onishi
(© JAXA / GCTC)

2010

Hayabusa Returns to Earth

After successfully touching down on Asteroid Itokawa, Hayabusa overcame a myriad of difficulties to make a triumphant return to Earth after an epic seven-year journey through deep space. Long lines of people waited to see the sample-return capsule when it was put on public display. Other milestones, such as MICHIBIKI—the first satellite of the Quasi-Zenith Satellite System (QZSS)—and the Small Solar Power Sail Demonstrator IKAROS, also helped fuel an unprecedented level of interest in space among the general public.

2011

Assisting Disaster-Affected Areas from Space

After the Great East Japan Earthquake struck on March 11, control of JEM Kibo was temporarily transferred from the Kibo Mission Control Room (MCR) at the Tsukuba Space Center (TKSC) to NASA. ALOS carried out emergency observations to ascertain the extent of damage from the earthquake and tsunami. Astronaut Satoshi Furukawa—serving a long-duration mission aboard the ISS—sent messages of support and encouragement to people in the disaster-affected areas.

2012

SHIZUKU Observes the Earth's Water Cycle

JAXA launches a satellite called Global Change Observation Mission 1st–Water (GCOM-W1; Japanese nickname: "SHIZUKU"), which aims to enhance understanding of the global water cycle. SHIZUKU began observations using the giant revolving antenna of its main instrument, Advanced Microwave Scanning Radiometer 2 (AMSR2). Astronaut Akihiko Hoshide used the JEM Airlock and JEMRMS (robotic arm) to deploy "CubeSat" small satellites during his long-duration ISS mission. JAXA commenced operation of the Flying Test Bed (FTB) "Hisho," which is used for experiments and demonstration of cutting-edge aircraft technology and instruments.

2013

Dawn of a New Era for Launch Vehicles

On September 14, JAXA successfully launched its new Epsilon rocket, which realizes lower operational costs and high performance. The launch vehicle carried into orbit SPRINT-A (Japanese nickname: "HISAKI"), an ultraviolet astronomy satellite tasked with observing Solar System bodies. The first Epsilon launch heralded the start of a new era in Japanese solid-fuel rocket development. In November, Astronaut Koichi Wakata began a long-duration mission aboard the ISS. He subsequently became Japan's first ISS Commander in March 2014.

2014

Continuation and Expansion of Planetary Exploration

Using the Dual-frequency Precipitation Radar (DPR) carried by the Core Observatory satellite of the Global Precipitation Measurement (GPM) mission, JAXA began providing precipitation data with even higher precision than was possible to date. In December, Hayabusa2 was launched on its journey to explore Asteroid 162173 Ryugu. The mission hopes to bolster understanding of the evolution of the Solar System and matter that led to the origins of life.

2015

New Organizational Form Aims for World-Leading Research and Development

In April, JAXA's organizational form was transitioned from its previous status as an Independent Administrative Agency, to become a National Research and Development Agency. This reform is aimed at maximizing the benefits generated by JAXA's research and development programs. JAXA newly developed the ASTRO-H X-ray astronomy satellite, which is expected to be launched during FY2015 (ending March 2016). ASTRO-H will make possible high-sensitivity observations over a very broad wavelength range, from X-rays through gamma rays. JAXA is taking a lead role in this joint international mission. During his mission aboard the ISS, Astronaut Kimiya Yui conducted a successful capture of the HTV5 resupply spacecraft. December saw the Earth swing-by of Asteroid Explorer Hayabusa2, and Venus Climate Orbiter Akatsuki (PLANET-C) successfully placed into orbit around Venus.

2016

Strengthening of International Cooperation Structure, Including Joint Projects with Universities and Research Institutions

In February, JAXA launched X-ray astronomy satellite ASTRO-H, which will conduct high-sensitivity observations over a very broad wavelength range, from X-rays through gamma rays, as part of a joint international mission led by Japan. Astronaut Takuya Onishi is scheduled to begin a long-duration mission aboard the ISS in June.

Liaison Diary: Thailand

The JAXA Bangkok Office plays an important liaison role in JAXA's communications and coordination with space agencies in the Southeast Asia region. In addition, the office functions as a base for Sentinel Asia—a disaster management support system in the Asia–Pacific region. In this interview, director of the JAXA Bangkok Office, Masanobu Tsuji, discusses the main roles of his office as well as his lifestyle in the Thai capital.

Please briefly introduce yourself.

I joined NASDA in 1985. From 1987, I was responsible for the development and operation of image processing equipment for Earth observation satellites. Part of my job involved converting data sent from Thailand into images at the Earth Observation Center (EOC) in Hatoyama, Saitama Prefecture, Japan. After NASDA launched Japanese Earth Resources Satellite (JERS-1) in 1992, it was decided that from 1993 we would carry out image processing in Thailand as well as Japan. I was tasked with installing the image processing equipment in Thailand, and subsequently I was dispatched to the Remote Sensing Technology Center of Japan (RESTEC) to instruct NRCT staff on how to use the equipment. This assignment involved me living in Thailand for approximately 18 months. I returned to work in Bangkok in March 2015 to take up my current role.

What is the role of the Bangkok Office?

In 2006, Sentinel Asia was launched as an initiative through the Asia-Pacific Regional Space Agency Forum (APRSAF) for disaster management support utilizing satellite data. A Sentinel Asia Project Office was established within JAXA's Bangkok Office. JAXA and GISTDA jointly hold operational training sessions, and a mirror server has been installed within GISTDA to improve the system's data access.

Since JAXA was established in 2003, there has been an increase in the office's role in handling liaison and coordination with space agencies in several Southeast Asia countries, including Indonesia, Malaysia and Vietnam. In November 2016, the 23rd Session of APRSAF (APRSAF-23) will be held in the Philippines, and we anticipate an increase in opportunities for communication with the Philippines over the coming months.

Please tell us about your lifestyle away from work.

Thailand is in the midst of a cycling boom. In late-December 2015, a 23.5 km-long cycling path was opened in the area around Suvarnabhumi International Airport. On weekends, I enjoy riding around the course on the bike I brought over from Japan.

Has living in Thailand affected your self-identity as a Japanese person?

The travel sections of local bookstores in Bangkok feature guidebooks in Thai for a range of Japanese cities, such as Tokyo, Osaka, Sapporo, Sendai and Fukuoka. Sapporo, in particular, is a popular destination for Thai tourists, since they can experience snow. Here in Thailand, Japanese restaurant chains are expanding their store networks, and when I go to these restaurants I see far more Thai customers than Japanese. The things I have mentioned are quite typical in my neighborhood, so my self-identity as a Japanese person has not really changed.

Is there anything you would like to say to our readers in closing?

New technologies are helping to make society more affluent. A wide array of new services based on space technology are being launched in countries across the Asia–Pacific region. For example, Earth observation satellite data is used to support disaster management, and a global navigation satellite system (GNSS) underpins vehicle dispatching systems, such as those used for taxis.

The Bangkok Office will continue to serve as an interface for JAXA to enhance its cooperation with space agencies and institutions that use satellite data in the Asia–Pacific region.

From left to right: Bangkok Office deputy director Mr. Taku Ujihara, director Mr. Masanobu Tsuji, and local staff member Ms. Wasineetip Rainvalee

The JAXA Bangkok Office is located in a building that houses many Japanese companies, and is within close walking distance of two Mass Rapid Transit (MRT) stations.

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