JAXA TODAY

Japan Aerospace Exploration Agency

August 2010 / No. 02

Special Features

JAXA Astronaut Naoko Yamazaki:

15-day mission to the International Space Station realizes a long-held dream

Asteroid Explorer Hayabusa:

Completing a seven-year return space voyage powered by ion engines

JAXA
Japan Aerospace Exploration Agency

Contents

Welcome to JAXA TODAY

The Japan Aerospace Exploration Agency (JAXA) works to realize its vision of contributing to a safe and prosperous society through the pursuit of research and development in the aerospace field to deepen humankind's understanding of the universe. JAXA's activities cover a broad spectrum of the space and aeronautical fields, including satellite development and operation, astronomical observation, planetary exploration, participation in the International Space Station (ISS) project, and the development of new rockets and next-generation aeronautical technology.

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. In this, the second issue, we introduce a wide range of topical articles, including an interview with JAXA Astronaut Naoko Yamazaki, who recently returned from a mission to the ISS, and a report on the Hayabusa (MUSES-C) mission, which overcame a succession of problems to achieve a successful return to Earth. We hope you will find all of the content of interest.

A *Miuta* (*Waka*) Poem by Her Majesty the Empress

At a press conference after his return on July 31, 2009, from a four-month mission on the ISS, JAXA Astronaut Koichi Wakata said that it was when the hatch opened and he could smell the grass that he felt he had been welcomed back to earth. Moved by those words, Her Majesty composed this poem.

宇宙飛行士帰還

夏草の　茂れる星に　還り来て
まづその草の　香を云ひし人

The astronaut's return

On your return to
Our planet, lush with summer grass
First, you astronaut,
You spoke of "the scent of grass"
Pouring into the shuttle.

Source: The Imperial Household Agency

Cover Story

JAXA Astronaut Naoko Yamazaki was a member of the crew of mission STS-131, which flew to the International Space Station (ISS) aboard the Space Shuttle Discovery, carrying a payload of supplies and equipment as part of the ISS assembly program. The cover photograph was taken on April 10, 2010, the sixth day of the mission, and captures Yamazaki at work inside the Leonardo Multi-Purpose Logistics Module (MPLM), which was transported to the ISS by mission STS-131 and connected to the station's Harmony node.

Interview with Astronaut

Naoko Yamazaki

Interviewed by
Midori Nishiura,
Advisor, JAXA Public Affairs

The STS-131 Mission Patch

JAXA Astronaut Naoko Yamazaki realizes a long-held dream by completing a successful 15-day mission in Space. Here she speaks with Midori Nishiura, advisor to JAXA's Public Affairs Department.

JAXA Astronaut Naoko Yamazaki served as load master aboard Space Shuttle Discovery mission STS-131. The primary purpose of STS-131 was to continue the assembly of the International Space Station (ISS) and bring a payload of supplies and equipment to the ISS. As load master, Mission Specialist Yamazaki was responsible for managing operations to transfer materials between the Discovery and the ISS. After completing her two-week mission, Yamazaki and Midori Nishiura—advisor to JAXA on public affairs—spoke at length about Yamazaki's activities in space, her training and her thoughts on future space development.

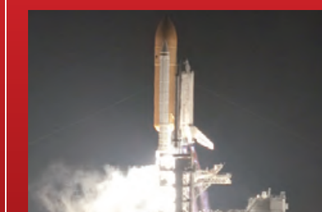
On Board the Space Shuttle

15 Days

The personal logo of JAXA Astronaut Naoko Yamazaki for mission STS-131

All Flight Day photographs ©NASA

Flight Day 1



Space Shuttle Discovery lifted off at 6:21 a.m. EDT (7:21 p.m. JST), April 5, 2010.

Flight Day 2

Astronaut Naoko Yamazaki used the Orbiter Boom Sensor System (OBSS) as an extension to the Discovery's robotic arm—the Shuttle Remote Manipulator System (SRMS)—to check for any damage to the spacecraft's body. This inspection was an important operation to ensure that there were no problems with the shuttle's Thermal Protection System (TPS) during re-entry into the Earth's atmosphere.

Naoko Yamazaki, JAXA Astronaut

Photo by Hiro Arakawa

> “The relaxing sensation of the wind on my face made me feel so grateful for nature”
>
> —*Naoko Yamazaki*

Differences between life in Space and on Earth leave a strong impression even after spending only two weeks in Space

Nishiura: Yamazaki-san, welcome back to Japan, and Earth for that matter!

Yamazaki: Thank you very much.

Nishiura: My work sometimes takes me to various cities in the world, but I must say that going to Space and back is something most of us could hardly imagine.

Yamazaki: Actually, space isn’t really that far away. On board the Space Shuttle, the time from liftoff to arrival in space is just eight and a half minutes. That’s just a fraction of the time it takes for a commercial airliner to fly from Tokyo to New York.

Nishiura: Wow, eight and a half minutes, that’s incredibly quick. But, however quick you get there, the environment must be quite different from the Earth. When you returned to Earth, and landed on the ground, the tremendous difference must have hit you.

Yamazaki: Yes, after our reentry and landing, when I stood on the ground, I was filled with emotion about how great it was to be back on Earth again. I felt Earth’s nature all around me. The relaxing sensation of the wind on my face made me feel so grateful for nature.

Nishiura: Well, there’s no wind or breeze in Space, is there?

Yamazaki: No, there isn’t. That’s why I was so happy to smell the trees’ leafy fragrance carried by the breeze.

Nishiura: Traveling and working in Space must give you a renewed awareness and appreciation of the things we take for granted on Earth normally. One of the biggest differences, of course, is the lack of gravity in Space. Did your body and movements feel heavy once you were back on the ground?

Yamazaki: Yes, my head in particular. My body became accustomed to the microgravity environment aboard the ISS. The Earth’s normal gravity made my head feel like it weighed 100 kilograms. I realized that I had to cope with gravity again, whether I liked it or not.

Two Japanese astronauts work side-by-side to carry out their mission on the ISS

Nishiura: I understand that your main role during the mission was as load master managing the transfer of supplies and equipment between the Space Shuttle and the ISS operating the Leonardo. Having undergone the extensive pre-mission training for this role, were you able to take on the task without any qualms?

Yamazaki: I was assigned my role as load master more than a year before the mission’s liftoff, so I was able to do a lot of training for it. An important part of our training is dealing with contingencies—it’s vital to avoid having to abandon some part of our mission because of a minor component malfunction or similar problem. So for every task we perform, there’s a backup plan—and often a second backup plan—that we train for, just in case. Thanks to these preparations, when I was actually on my mission performing my role, I’d often think, “Oh, we did this in training!” For example, it was my job to use the space station’s robotic arm to lift the Leonardo Multi-Purpose Logistics Module (MPLM)—developed by the Italian Space Agency (ASI)—out of the shuttle’s cargo bay and connect it to the Harmony node of the ISS. The thing is, the Leonardo MPLM is big and weighs about 12 tons! Of course, there’s no way we could have something that heavy banging into the Space Shuttle or the ISS, so we had to lift it very slowly and carefully. The actual operation went smoothly and finished ahead of schedule. I’m proud to say that all our training on the ground beforehand paid off [laughs].

Nishiura: When you left for your mission in the ISS, JAXA Astronaut Soichi Noguchi was already aboard the ISS on a long-duration mission. I’m sure his presence must have been a huge comfort and great help to you.

Yamazaki: Yes, it was the first occasion for two Japanese astronauts to be aboard the ISS at the same time, so I felt very happy to be a part of this historic event for Japan. Of course, exchanging the Japanese morning greeting of “*ohayo*” wouldn’t have been possible if Astronaut Noguchi hadn’t been aboard! Actually, there were a lot of tasks that Astronaut Noguchi and I performed as a team. We carried the Minus Eighty-Degree Laboratory Freezer for ISS (MELFI) from Leonardo to the Japanese Experiment Module (JEM) Kibo. The MELFI weighs 500 kilograms, so even in the microgravity environment where everything’s weightless, it’s important to have a well-honed technique.

Nishiura: Absolutely! Bravo to both of you for working in perfect harmony.

Yamazaki: Thank you. Astronaut Noguchi and I took up separate positions at the front and rear of the MELFI to carry it, but since the unit’s so large we couldn’t see each other. This meant that when we went through a narrow hatch passageway, we needed to use very precise verbal cues back and forth, such as “I’ll lower my end one more centimeter on your right.” This kind of task can be quite difficult if the two people doing it aren’t on the same wavelength, so to speak. I think that since we’re both Japanese, Astronaut Noguchi and I were able to communicate well. You need to establish the right rhythm in that kind of situation.

International Space Station (ISS)
©NASA

Midori Nishiura, Advisor, JAXA Public Affairs

Photo by Hiro Arakawa

> “Even from this perspective alone, one can see that Space development is critical for the survival of humankind”
>
> —*Midori Nishiura*

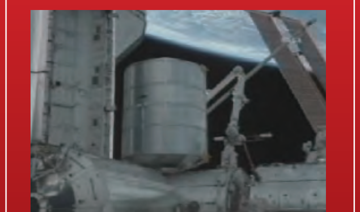
The Earth’s environmental problems played out in microcosm on the ISS

Nishiura: There’s an increasing awareness, which is generating serious debate nowadays, on how mankind can survive into the future with imminent unavoidable problems like global warming, shortages of food and water, and so on. Even from this perspective alone, one can see

Flight Day 3 ›

After the Discovery docked with the ISS, the connecting hatches were opened and the crews of STS-131 and ISS Expedition 23 long-duration mission exchanged greetings. This marked an important occasion for Japanese space flight, as it was the first time that two Japanese astronauts had been aboard the ISS simultaneously.

Flight Day 4 ›



Astronaut Yamazaki used the ISS’ robotic arm—the Space Station Remote Manipulator System (SSRMS)—to remove the Multi-Purpose Logistics Module (MPLM) Leonardo from the Discovery’s cargo bay and attach it to the ISS. This marked the start of the transfer of materials, supplies and equipment brought by STS-131 from Earth.

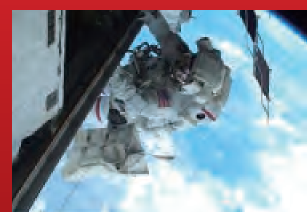
Flight Day 5 ›

Inside the Japanese Experiment Module (JEM) Kibo, Astronaut Yamazaki (on the right) and other STS-131 crew members added commentary to video taken on-orbit, which was transferred to Earth via a downlink.

Flight Day 6 ›

Astronaut Yamazaki carried out preparations for the transfer of the Window Observational Research Facility (WORF), an observational rack that was subsequently installed in the U.S. Destiny Laboratory Module of the ISS. Astronauts entered and exited the platform through a central hatch.

Flight Day 7 ›



On this day, astronauts Clay Anderson and Rick Mastracchio performed their second spacewalk—or extra-vehicular activity (EVA)—of the STS-131 mission. Their main task was the removal of an old Ammonia Tank Assembly (ATA) and the installation of a new ATA. The ATA was part of a radiator system used to remove heat from the space station.

Flight Day 8 ›

JAXA held a public information event in which Astronaut Yamazaki spoke with children at her former school. At the closing of the event, the two JAXA astronauts teamed up for a musical duet, playing the traditional Japanese folk song “Sakura, Sakura” (Cherry Blossoms). Yamazaki played a miniature *koto* (Japanese stringed instrument) and Noguchi a *ryuteki* (bamboo flute) and a small electric piano.

Flight Day 9 ›

The crew continued to transfer equipment and materials. Astronaut Yamazaki and Alan Poindexter, Commander of STS-131, worked with lithium hydroxide (LiOH) canisters, which were used to absorb carbon dioxide (CO_2) as part of the shuttle’s environmental control and life support system (ECLSS).

Flight Day 10 ›

The crews of STS-131 and ISS Expedition 23 participated in a joint in-orbit press conference. Astronaut Yamazaki commented that the mission was proceeding smoothly thanks to good teamwork.

©NASA

that Space development is critical for the survival of humankind. Since you've actually been to and worked in Space, please tell us your views on these important global issues.

Yamazaki: I think that the ISS can be seen as a microcosm of the Earth. On the ISS, people are living within a very limited space, and water and air must be recycled. Urine is purified back into drinking water, and carbon dioxide is extracted from the air we exhale and oxygen is added so that it becomes breathable air again. Since we can't yet produce our own food on the ISS, we must depend on being resupplied from Earth. We also have to reduce our waste as much as possible and make waste very compact.

Nishiura: So even in Space, we can't get away from having to face the waste problem.

Yamazaki: No, we can't. The problems occurring on Earth are being played out in miniature within the very restricted quarters of the ISS. As a result, many of the technologies used on the ISS may be applied back on Earth. For example, since the food prepared for astronauts has to have a long shelf life, only foods that meet very stringent hygiene standards can be used. These hygiene standards are currently utilized for processed food-hygiene management in the United States.

> "We're moving toward an era where the contribution of Japanese people to world space development will continue to grow and eclipse even what we've seen to date"
>
> —Naoko Yamazaki

Nishiura: I've heard that Space development-related technology was applied to the design of a new shape of beer can to achieve both lightness and strength. There are also high expectations for the application of Space technology in the medical and building construction fields.

Yamazaki: Yes, particularly in the medical field, some evidence suggests that spending time in space may lead to premature aging of the body. Loss of bone density and muscular atrophy are some of the effects that have been observed. Because of this, astronauts must exercise to avoid a decline in physical strength and maintain their muscles and bone density. It's hoped that the results of research relating to the health management of astronauts can be used on Earth in such areas as medical care for the aged.

Nishiura: How do you see Japan, and Japanese astronauts in the world of Space development?

Yamazaki: The Japanese Experiment Module Kibo is very sophisticated, and I believe that it'll prove its worth as a world-class laboratory. The contribution of the H-II Transfer Vehicle (HTV) resupply spacecraft is also significant, and these achievements are recognized by astronauts from all of the countries participating in the ISS. As someone from Japan, I find this very gratifying. I think that we're moving toward an era where the contribution of Japanese people to world space development will continue to grow and eclipse even what we've seen to date. I'm totally committed to helping Japan's space development efforts in whatever way I can.

Flight Day 11

Mission Specialists Naoko Yamazaki and Stephanie Wilson operated the ISS' robotic arm to detach the Leonardo module from the ISS. On this day, the crew maneuvered the module into a low-hover position above Discovery's payload bay.

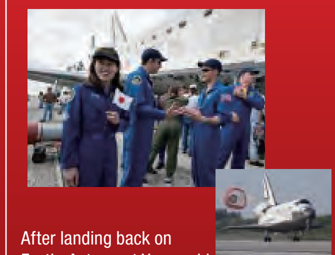
Flight Day 12

After securing the Leonardo module in the shuttle's payload bay (left-hand photo), the crew began the late inspection of Discovery's heat shield. Astronaut Yamazaki used the shuttle's robotic arm and orbiter boom sensor system (OBSS) to carry out the inspection.

Flight Day 13

The crews of STS-131 and Expedition 23 said their farewells prior to the undocking of the Space Shuttle from the ISS. The right-hand photo was taken from the ISS after undocking. The Discovery was docked to the ISS for 10 days, 5 hours and 8 minutes.

Flight Day 16



After landing back on Earth, Astronaut Yamazaki gave an energetic smile as she stood next to the Space Shuttle Discovery. Yamazaki said that she was glad to have successfully completed her mission and was happy to feel Earth's beautiful nature.

Profiles

Naoko Yamazaki and the Space Shuttle STS-131 mission

Space Shuttle Discovery lifted off from the Kennedy Space Center on April 5, 2010 (Japan standard time), with JAXA Astronaut Naoko Yamazaki aboard. Yamazaki is the first Japanese woman to qualify as a Mission Specialist (MS), a position held by certain NASA astronauts during Space Shuttle missions.

The principal objectives of mission STS-131 were to deliver equipment and materials to be used in scientific experiments aboard the ISS and to replenish the supplies needed by the astronauts living on the space station. Astronaut Yamazaki was assigned as the mission's load master and as one of the operators of the robotic arms of both the ISS and the Space Shuttle. The Multi-Purpose Logistics Module (MPLM) Leonardo, which was packed with the materials and equipment to be delivered, was transported to the ISS in the Discovery's payload bay. Using the ISS' robotic arm, Yamazaki moved the Leonardo MPLM from the shuttle's cargo bay and attached it to the ISS. Inside the Leonardo module was a wide range of experiment apparatus, including such large items as the Minus Eighty-Degree Laboratory Freezer for ISS (MELFI). Together with JAXA Astronaut Soichi Noguchi, Yamazaki transferred such equipment as the Muscle Atrophy Research and Exercise System (MARES), to be used in muscle and bone research, and the Window Observational Research Facility (WORF), a new science imaging platform.

Before the Discovery's docking with the ISS and once again prior to its return to Earth, the crew carried out external inspections of the Space Shuttle's body. Yamazaki was assigned as one of the crew members maneuvering the Discovery's robotic arm and boom extension, which is equipped with cameras and sensors, to inspect the portside wing and nose cap of the Space Shuttle. After approximately two weeks in space, the Discovery safely made its reentry and landing.

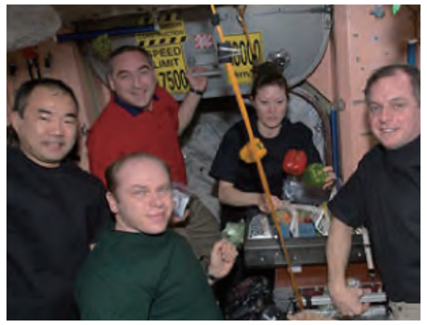
When Yamazaki was a junior high school student, she saw the news of the Space Shuttle Challenger accident. The desire to carry on the work of the astronauts who lost their lives in this accident was one of the things that motivated Yamazaki to become an astronaut herself. Since her selection as an astronaut candidate in 1999, Yamazaki has undertaken 11 years of rigorous training as she worked to realize the long-held dream of going into space.

Photo by Hiro Arakawa

Midori Nishiura

Midori Nishiura, an opinion leader, president of consulting firm Amadeus Inc., advisor to JAXA on public affairs, and Visiting Professor at Yamaguchi University, among many other important roles, has served on the Advisory Board of various major companies and also sits on committees organized by government ministries and agencies. Author of many books as well as articles in leading publications, Ms. Nishiura, having conducted her own interview programs on television, is often called upon to commentate on the news.

JAXA Astronaut Soichi Noguchi returns to Earth after completing the longest mission in space by a Japanese astronaut

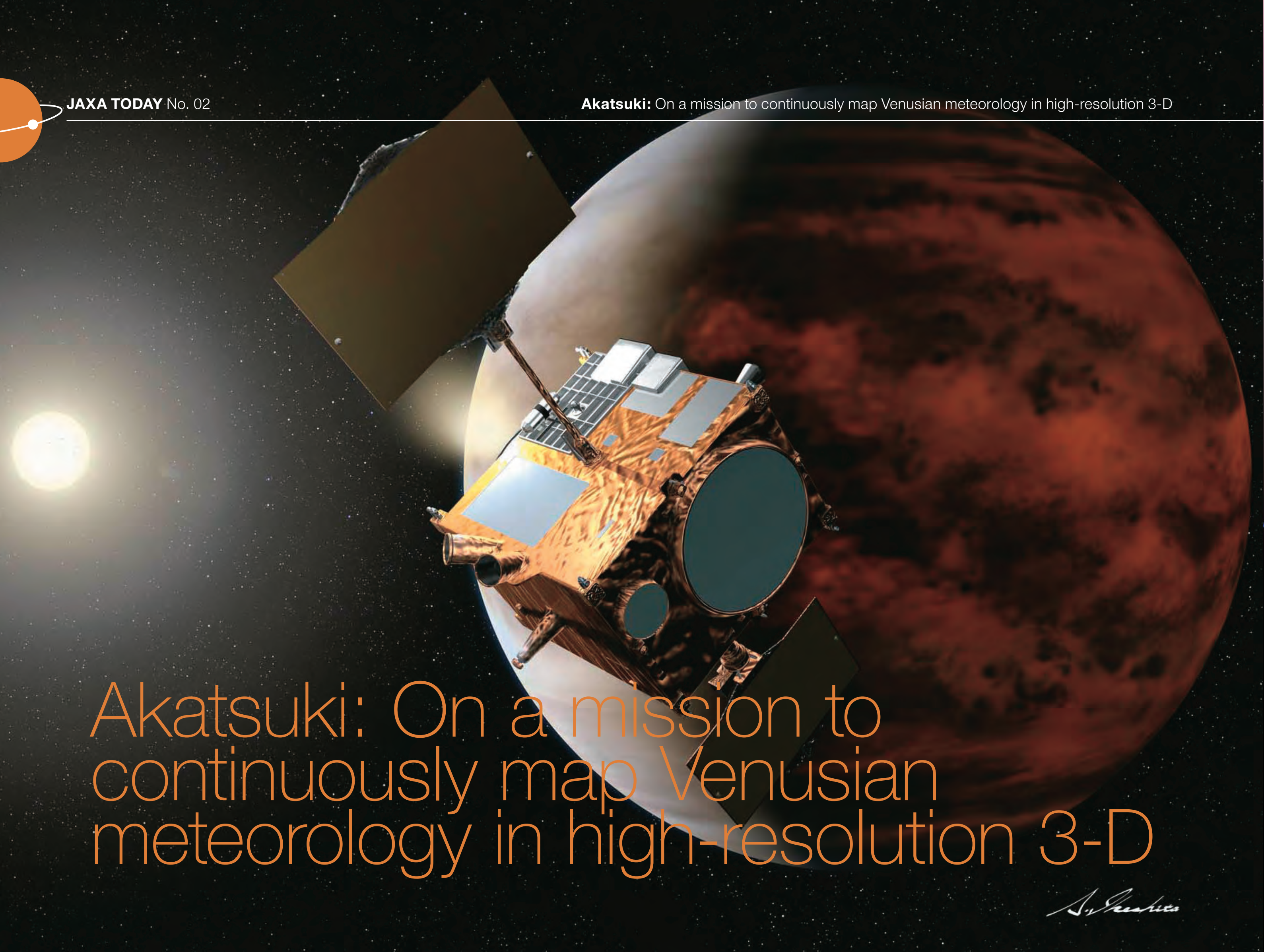


The start of the day on the ISS: the crew enjoy breakfast.
©NASA

On June 2, 2010, after a 161-day long-duration mission on the ISS, JAXA Astronaut Soichi Noguchi returned to Earth aboard a Soyuz spacecraft together with fellow crew members from the United States and Russia. During his mission, Noguchi helped operate and maintain the ISS' systems and conducted a variety of scientific experiments that utilized the space environment.

At a post-return press conference held at JAXA's Houston Office, Noguchi commented, "Through press conferences and other opportunities I want to communicate to the people of Japan the things I experienced, saw and heard during my six-month long-duration mission in space. I want to let people know that, step-by-step, we are moving closer to an era in which people from Japan and many other countries will live in space." Noguchi emphasized that mankind's scope of activities in space will continue to expand in the future.

After breakfast, it's time to start work!
©NASA



Akatsuki: On a mission to continuously map Venusian meteorology in high-resolution 3-D

©Akihiro Ikeshita

How did Venus—so similar to Earth in many respects—end up with such a hostile climate? What forces are driving its sulfuric acid clouds at such fierce speed around the planet? Answers to these and other questions may provide vital clues to understanding climate change here on Earth.

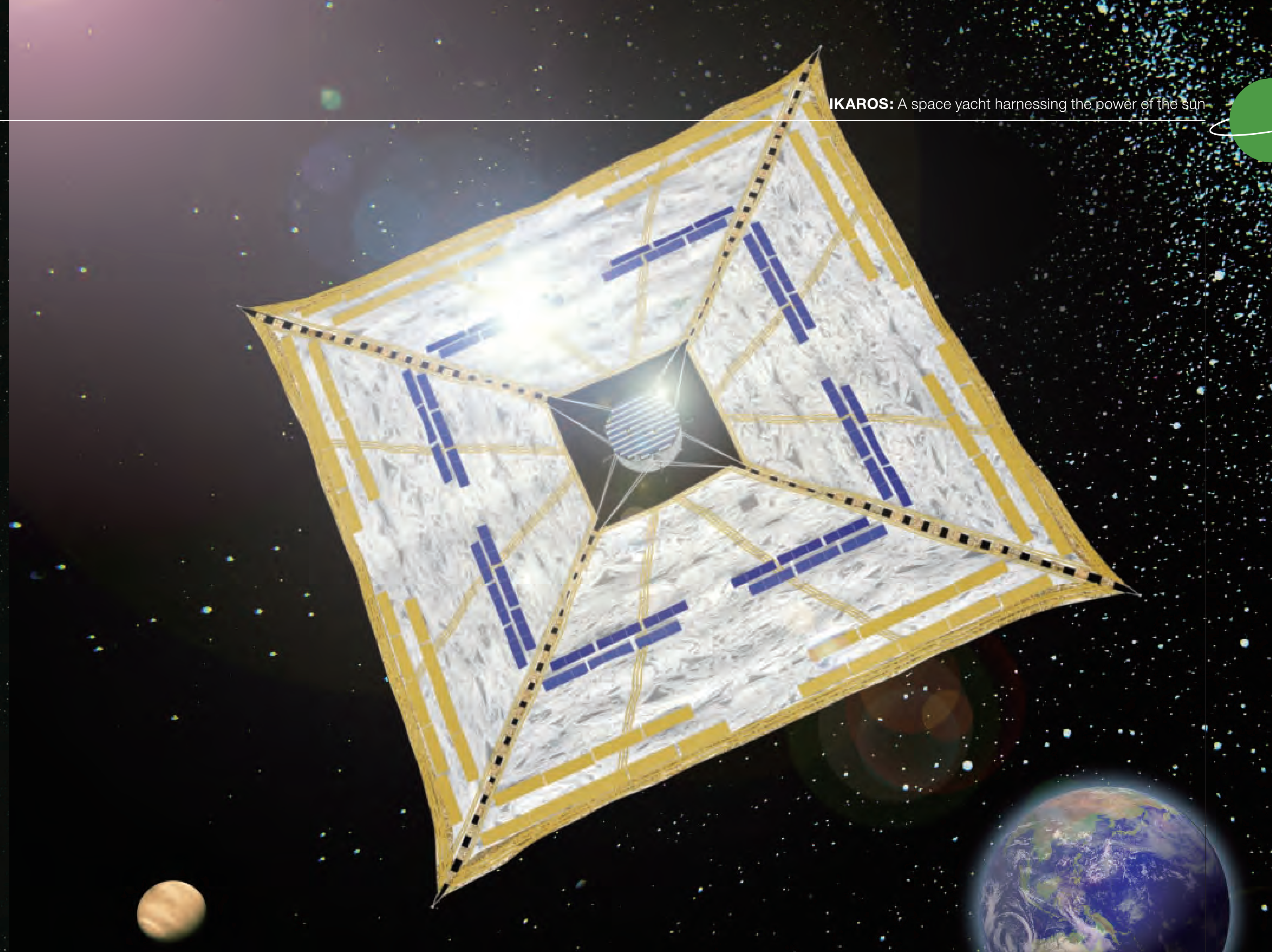
Akatsuki, the Venus climate orbiter also known as PLANET-C, was launched from the Tanegashima Space Center on May 21, 2010, and is currently on its six-month interplanetary cruise to rendezvous with Venus in late 2010. After being inserted into an elliptical orbit that will oscillate between 300 and 80,000 kilometers above the planet's equator, Akatsuki will commence a two-year mission to gather a myriad of data on the Venusian atmosphere and its meteorological phenomena. The highlight of this mission will be a continuous stream of high-resolution 3-D images to be provided by Akatsuki's five main scientific instruments, each operating at different wavelengths ranging from infrared to ultraviolet. This array will enable the spacecraft to peer through the thick Venusian cloud cover, and offers a tantalizing opportunity to unravel one of the solar system's greatest mysteries: the super-rotation of Venus' atmosphere.

During Akatsuki's voyage to Venus, JAXA is conducting tests of the probe's systems and equipment, making sure all is ready for its planned observation program. It is hoped that data gathered by Akatsuki will complement that of the European Space Agency's Venus Express probe, which is now operating in a polar orbit around Venus and making observations with a different array of instruments to those on Akatsuki.

In the next issue of JAXA TODAY, we are planning an in-depth feature on the Akatsuki mission and its background, and look forward to reporting the latest progress.

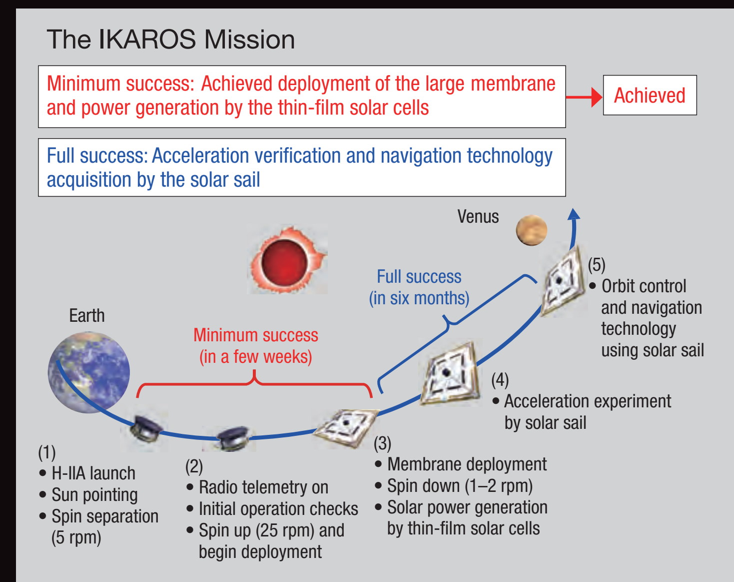
A new dawn

Unlike many Japanese space missions that have received their names after canvassing public opinion, the name "Akatsuki" was chosen by the project team during the development phase of the PLANET-C project. The Japanese word *akatsuki* refers to the period when the first light is visible in the eastern skies just before sunrise. This is the time when Venus is at its most beautiful. Hence, *akatsuki* not only means the dawn of a new day but also implies a strong sense of hope and anticipation. In this sense, the name signifies the project team's determination for the mission to achieve success.

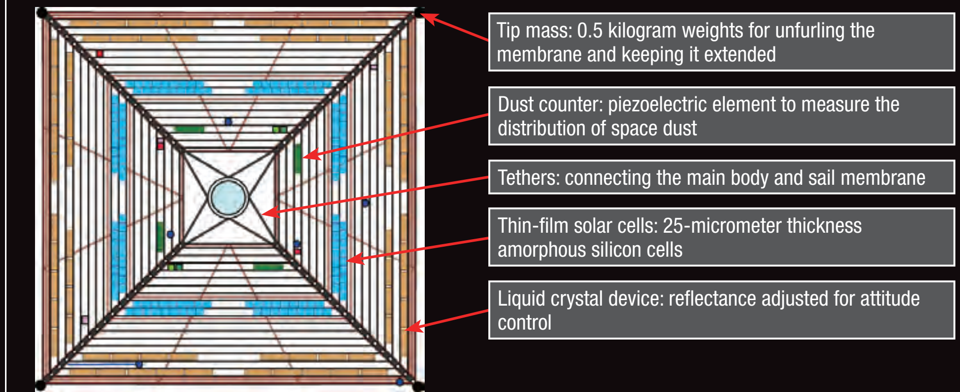


IKAROS: A space yacht harnessing the power of the sun

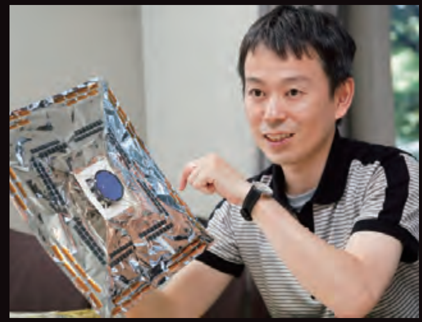
JAXA's Small Solar Power Sail Demonstrator IKAROS was launched with the Venus Climate Orbiter Akatsuki by an H-IIA Launch Vehicle from the Tanegashima Space Center on May 21, 2010. IKAROS—an acronym of Interplanetary Kite-craft Accelerated by Radiation Of the Sun—subsequently achieved its trajectory and is currently on its interplanetary journey toward Venus. Assistant Professor Osamu Mori, the project leader, provides an overview of the IKAROS mission.



Schematic Illustration of the Unfurled Solar Sail



Membrane: 7.5-micrometer thickness polyimide resin with aluminium vapor deposited on one side; reinforced to prevent splitting



Assistant Professor Osamu Mori

Lunar and Planetary Exploration Program Group

Two main objectives of the IKAROS mission

The primary objective of the IKAROS mission is to demonstrate the solar sail, which may be simply described as a “space yacht.” While a yacht is propelled forward by harnessing the power of the wind in its sails, a solar sail harnesses the power of sunlight, or more precisely, the pressure created by photons from the sun. Hence, IKAROS is an interplanetary spacecraft that requires no propellant fuel to move through space.

Another objective of the IKAROS mission is power generation using thin-film solar cells. This is an original idea—embedding an array of solar cells into the membrane of a solar sail, which generates electricity from the sunlight it receives. For the solar sail to harness the sunlight’s pressure, it must have a large surface area, and this allows us to incorporate a large area of solar cells. For example, even if we sent a spacecraft on a mission to a planet as far from the sun as Jupiter, it would still be possible to generate sufficient electricity for such a mission using a solar array on the sail.

Unfurling the solar sail using centrifugal force

The sail is an extremely thin membrane—its thickness is just 7.5 micrometers—made from a polyimide resin that provides excellent durability in the space environment. Polyimide is used extensively as an insulation material on satellites. The sail is partly covered with thin-film amorphous silicon solar cells, which have been deployed together with the solar sail itself. Compared with the conventional hard solar panels used on satellites, IKAROS’ solar cells are very lightweight.

When fully deployed, the sail membrane is a square kite shape measuring 20 meters along the diagonal. For the launch into space, the sail membrane is packed away. The membrane is accordion-pleated and the four tips, which form a cross like a kite, are wound around the small disc-shaped central body of the spacecraft. When the sail is deployed, it is simply a matter of reversing this process. We use the centrifugal force from the spacecraft’s spinning motion to deploy the sail. Although the spacecraft spins at approximately 25 revolutions per minute (rpm) prior to the sail opening, from the time the sail is unfurled the craft gradually slows down to 1–2 rpm to keep the sail in its opened position. This is called the spin-deployment method.

Steadily achieving its mission since launch

Within the IKAROS mission, we set as our benchmarks for “minimum success” the deployment of the solar sail and generation of electricity from the solar cells. We successfully deployed the sail on June 9 at a distance of 7.4 million kilometers from Earth, and on the following day we succeeded in generating power using the solar cell array. Our minimum success benchmarks were both world firsts.

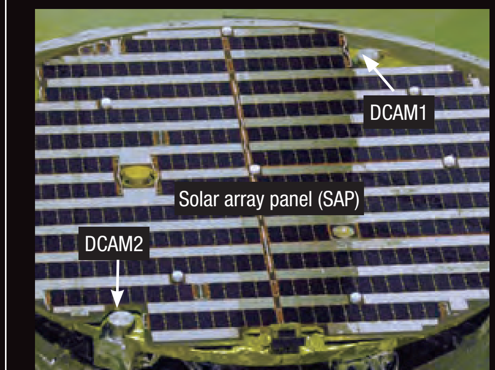
Subsequently, on June 14, using one of two tiny deployable cameras (DCAM2) carried by the spacecraft, we successfully captured images of the fully deployed sail. This remarkable accomplishment is the first time that images have been captured of the main body of an interplanetary spacecraft using a camera that detaches in deep space. The camera is a cylindrical device measuring approximately six centimeters in both diameter and height and was detached from the spacecraft by a spring. The images captured by the camera are relayed to the main craft via radio communications. The detached camera did not return to the main spacecraft but instead became the “world’s smallest satellite.”

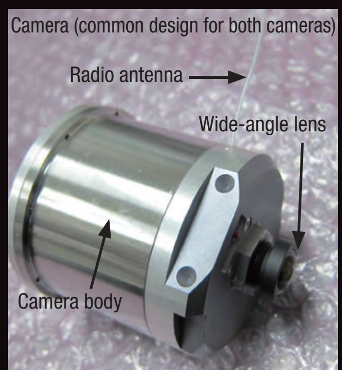
The second detachable camera (DCAM1) was also successfully deployed on June 19, providing images of the entire sail. Since DCAM1 detached slowly and began capturing images from a close distance, we were able to confirm from these images the operational status of the liquid crystal devices that are embedded in the sail, whose reflectance can be adjusted for attitude control.

From here on, over a period of about six months we will measure and observe the power-generating performance of the thin-film solar cells, conduct the first-ever demonstration of acceleration by sunlight photon pressure and verify the orbit control through that acceleration. Hence, we aim to acquire navigation technology by using a solar sail. If we can do all this, the mission will have achieved “full success.”

In the future, under the Jupiter and Trojan Asteroids Exploration Program we plan to send an interplanetary probe using a solar power sail to explore the area around Jupiter. For that mission, we will use a much bigger sail measuring about 50 meters along the diagonal. In addition to the sail, the spacecraft will be a hybrid carrying an ion engine enabling it to accelerate freely as it heads for Jupiter and the Trojan asteroids.

Position of the Detachable Cameras and Labeled Image of the Camera (Common design for DCAM1 and DCAM2)





Assistant Professor Mori (bottom right) and other members of the IKAROS project team participate in an operational meeting.

Membrane Deployment Sequence and Mechanism

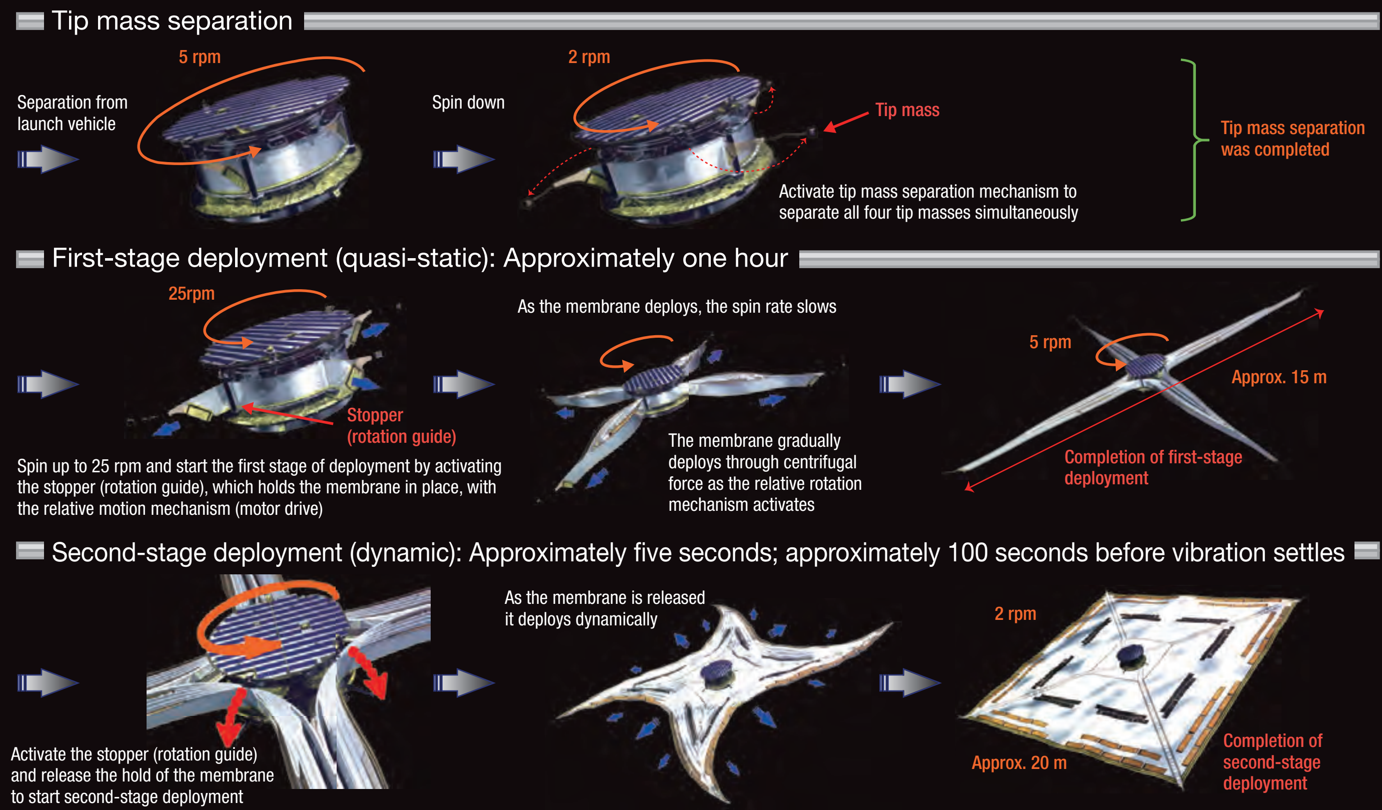


Image taken by DCAM2 shows the fully unfurled sail

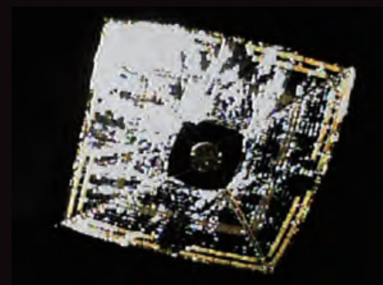
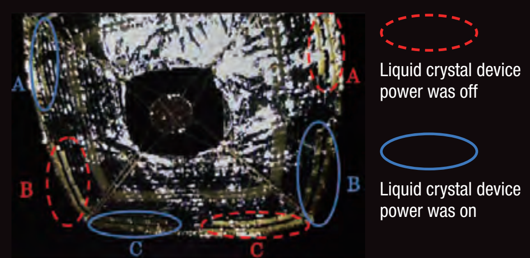
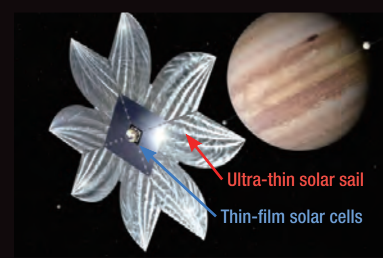


Image taken by DCAM1 confirms that the liquid crystal devices are operating properly



Jupiter and Trojan Asteroids Exploration Program (Future Plan)



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Hayabusa's triumphant return

"As the small light moved from its low position in the northwest sky toward a higher position in the southeast, it slowly grew brighter. As we gazed up, we saw what appeared to be a huge explosion in the night sky directly in front of us. The dazzling light—like a display of fireworks—glowed above the nighttime desert. Gasps and shouts of excitement rang out. The light continued on—descending in a straight line toward the southeast as it gradually scattered and dispersed. It finally disappeared in a wisp just before it crossed in front of the Milky Way. I had thought for a moment that I could hear the loud reverberation of an explosion, but in reality there was no sound at all..." (continued on page 16)

Photograph: Hiroshi Yamaguchi
http://www.yamane-office.co.jp/

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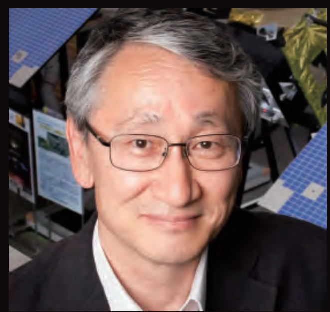
Asteroid explorer Hayabusa completes its return mission using ion engines

Hayabusa's core mission was to collect and return to Earth a surface sample from the asteroid Itokawa. When Hayabusa's sample-return capsule touched down, it completed the world's first-ever return space mission to a celestial body other than the moon. In this special feature article, Hayabusa project manager Professor Jun'ichiro Kawaguchi and ion engine development manager Professor Hitoshi Kuninaka provided insights into the many unique innovations the Hayabusa project team utilized to realize this extraordinary return space voyage spanning more than seven years and six billion kilometers.



Dr. Jun'ichiro Kawaguchi

Project Manager,

Program Director, Lunar and Planetary Exploration Program Group (JSPEC)

Professor, Department of Space Systems and Astronautics, Institute of Space and Astronautical Science (ISAS), JAXA

Dr. Hitoshi Kuninaka

Group Leader, Spacecraft System, JSPEC

Professor, Space Transportation, ISAS JAXA

An overview of Hayabusa's seven-year voyage

Hayabusa—whose name means "peregrine falcon" in Japanese—was launched on May 9, 2003, on an M-V rocket on a mission to the asteroid Itokawa, which travels in an elliptical orbit between the orbits of Earth and Mars. Hayabusa's primary objective was to take a sample from the asteroid and return it to Earth. Asteroids are thought to retain a comparatively significant amount of information relating to the period during which the Earth, Venus and other planets were born. Hence, if a sample could be returned from an asteroid it may provide important clues to such questions as "What substances were the bases for planet formation?"

On September 12, 2005, Hayabusa effected a rendezvous with Itokawa, and during October of that year it carried out detailed observations of the asteroid's surface. In November, although Hayabusa made two touchdowns onto the asteroid's surface, shortly afterward a fuel leak caused the spacecraft to malfunction and lose communication with its controllers back on Earth. Although communication was recovered in January 2006, at that point Hayabusa was found to be rotating and drifting off in the wrong direction. The project team needed to correct the spacecraft's attitude, but two of the craft's three reaction wheels—essential to attitude control—had malfunctioned, leaving just a single functioning reaction wheel. Despite this severe handicap, the project team managed to redirect Hayabusa's rotation axis, and in April 2007 the spacecraft was able to take advantage of a launch window to finally enter its return trajectory to Earth. Owing to the large number of problems and equipment failures along the way, its return to Earth had been delayed three years compared with the original schedule. Whether or not Hayabusa had been able to obtain a sample from Itokawa would not be known until after its return home.

Just as Hayabusa's return seemed to be at hand in November 2009, a further problem occurred with the loss of operation of all the craft's ion engines. However, the project team combined the functioning parts of two engines to successfully convert to "cross operation" of the ion engines. After such a drama-filled mission, Hayabusa made its miraculous return to Earth on June 13, 2010. Although the main body of the spacecraft burned up after reentry to the atmosphere, the sample-return capsule, which had been released immediately before reentry, landed safely in the South Australian Outback within the Woomera Prohibited Area (WPA). The capsule was recovered soon after and is presently undergoing preparations for full analysis of its content.

Seeking a mission with novel challenges

Around the end of the 1980s, the Institute of Space and Astronautical Science (ISAS)—at the time affiliated to Japan's Ministry of Education, Science, Sports and Culture—and NASA's Jet Propulsion Laboratory (JPL) established a joint study group on planetary exploration. Although the main themes of the group were comet probes and asteroid rendezvous observations, the scale of NASA's bold plans were overwhelming for us. Even the types of missions that we at ISAS could not even contemplate yet were being realized by NASA through efforts combining existing technologies.

It was around this time that we began to set our sights on novel and ambitious missions of our own. What we came up with—without fully parsing all the implications—was a "sample-return mission to an asteroid using ion engines." At the time, Japan was still a relative newcomer in the space exploration field, so such a mission seemed a very big stretch indeed. However, it was the accumulated know-how fostered at ISAS that allowed us to aim for such an ambitious target. In 1995, we made a successful funding request and the project commenced in the following year.

▶Timeline of the capsule's return and recovery

June 5

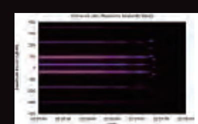
Recovery base camp set-up
The recovery crew begins setting up its antennae and other equipment to be used for the capsule recovery.

June 13

15:06
Subaru Telescope captures images of Hayabusa
Subaru Telescope—operated by the National Astronomical Observatory of Japan at the Mauna Kea Observatory on Hawai'i—successfully captures images of Hayabusa, which is approximately 170,000 kilometers from Earth. Its magnitude of brightness was approximately +21. The photograph shows Subaru Telescope on the left-hand side of the Mauna Kea summit.

19:51
Command sent to Hayabusa for the release of the sample-return capsule
(Sagamihara Campus Control Room)
Immediately after the command is sent, a disturbance is detected in Hayabusa's attitude and the capsule separation is confirmed. Hayabusa's final mission begins, as it attempts to capture images of Earth.

22:27
All radio communications from Hayabusa cease
Uchinoura Space Center (Kagoshima)
All signals from Hayabusa being tracked by the Uchinoura Space Center go dead. Communication is lost. When signals cease, Hayabusa is part way through transmission of data of its final image of Earth.



Sagamihara Campus Control Room
The operation support staff receive bouquets of flowers.

22:51
Reentry fireball observed
(NASA's DC-8 Airborne Laboratory)
The glowing spacecraft and capsule with heat trail.
©NASA

Choosing a target asteroid

From among the limited number of small celestial bodies that we could target for exploration, we focused on an asteroid called "1998 SF36," which offered a good launch window opportunity. However, we concluded that the capabilities of the M-V rocket launch vehicle alone would not be sufficient to reach this target. After considering many different options, we developed the concept of a return voyage combining an Earth swing-by with ion engines. The trajectory plan entailed the probe orbiting the Earth for a year, operating its ion engines and building up energy, and then making an Earth gravity assist swing-by for acceleration toward the asteroid. In August 2003, after the launch of Hayabusa, the International Astronomical Union (IAU) officially named the asteroid for Professor Hideo Itokawa, a Japanese aerospace engineer who pioneered the country's space development efforts. Hayabusa effected a rendezvous with Itokawa in September 2005 and soon commenced observations.

A series of crises: communication lost after Itokawa landings; attitude control becomes inoperable

In late 2005, Hayabusa made two touchdowns on the asteroid, the first on November 20 and then again on November 26. However, shortly thereafter, in December 2005, we lost all communication with the spacecraft. Eventually, about two months later, we were able to regain radio contact with Hayabusa. At that point the craft was drifting off course and we were unable to thrust the ion engines in the direction required. The first thing we needed to accomplish was an attitude correction of the craft's spin axis. Unfortunately, owing to a fuel leak, the chemical engines—needed for the attitude correction maneuver—were not functioning. In the case of a conventional spacecraft, at this point we would have given up. Luckily, however, we were able to successfully perform an ejection of the ion engines' xenon gas propellant to regain attitude control. Our original engineering design had never even contemplated this way of using the xenon gas.

In February 2007, we reignited the ion engines and between April and October of that year we performed the first phase of the trajectory maneuver operation in preparation for the return to Earth.

The situation, though, was still quite tenuous. Only one of the spacecraft's three reaction wheels for controlling attitude movement was working and we could not use the chemical engines at all. In any case, ion engines can only be used if a spacecraft's attitude is stable. Since we could not achieve this, we had to utilize a makeshift method of operation. At the start of the first phase of the trajectory maneuver operation, we were unable to obtain attitude stability. It felt a bit like herding cats—unresponsive—but we persisted nevertheless.

Eventually the team's efforts paid off when we were able to regain some attitude control by utilizing the tiniest amount of solar power. With this spin-stabilized state achieved, we were able to fire up the ion engines once more.

We then moved to begin the second phase of the trajectory maneuver operation in February 2009.

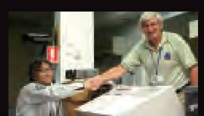
Ion engines shut down during return leg

In mid-October 2009, as Hayabusa was cruising on its return leg, we discovered high neutralizer voltage in one of the ion engines, which we suspected was caused degradation and which suggested the neutralizer was nearing the end of its operating life. Under normal circumstances, if either the neutralizer or thruster exhaust fails, it means that the ion engine can no longer be used. Our initial response was to try and delay the neutralizer's failure by carefully controlling engine output. However, on the night of November 3, the neutralizer voltage increased once again and the ion engine autonomously shut down due to this malfunction. Even though some of the team thought that this really was the end of the line for Hayabusa, we had one last trick up our sleeve. Ion engines comprise pairs of ion thrusters and neutralizers. Hence, our final work-around involved the "cross operation" of previously separate pairs of neutralizers and thrusters. In effect, we salvaged the parts that remained in working order

(continued on page 16)

Public viewing room at the Sagamihara Campus
More than 1,000 people gather late at night at the Sagamihara Campus to view and cheer on Hayabusa's fiery finale.

23:56
Capsule located in the Woomera Prohibited Area (WPA)
The capsule and parachute are sited by the helicopter search team.



WPA Control Center
Recovery team leader Professor Hitoshi Kuninaka and Woomera Test Range operations manager John McKevett shake hands on hearing the news of the capsule's discovery.

June 14

14:00 (approximate)
Heat shield located
The heat shield body and backplate are both found in the vicinity of the capsule's touchdown point.

Capsule retrieval
The recovery crew wear special protective equipment and clothing while rendering the capsule safe by cutting cables leading to the pyrotechnic mechanism (used to jettison the heat shield). They also take samples of sand at the landing spot for reference purposes during return-sample analysis.

The heat shield that protected Hayabusa's sample-return capsule

The separation of Hayabusa's sample-return capsule from the main spacecraft took place at 7:51 p.m. (Japan Standard Time) on June 13, 2010, just three hours before reentry into the Earth's atmosphere.

It is estimated that during reentry the capsule was exposed to temperatures in the range of 10,000–20,000˚C. Although the velocity of the capsule during descent through the atmosphere reached approximately 12 kilometers per second (km/s), or about 1.5 times its speed at reentry from its Earth orbit, it had to withstand more than 10 times the amount of heat compared with the reentry point. To protect the capsule from such extreme temperatures, it was equipped with a specially developed heat shield.

A simple way to describe the heat shield's basic two-piece structure would be as a "bowl with lid"—the bowl facing forward and the lid at the rear. The heat shield's two main constituent materials were carbon-fiber-reinforced plastic (CFRP)—which is used for such applications as high-end sports equipment and aircraft structural components—and carbon phenolic resin, one of many types of phenolic resin, which are commonly found in kitchen goods and household appliances.

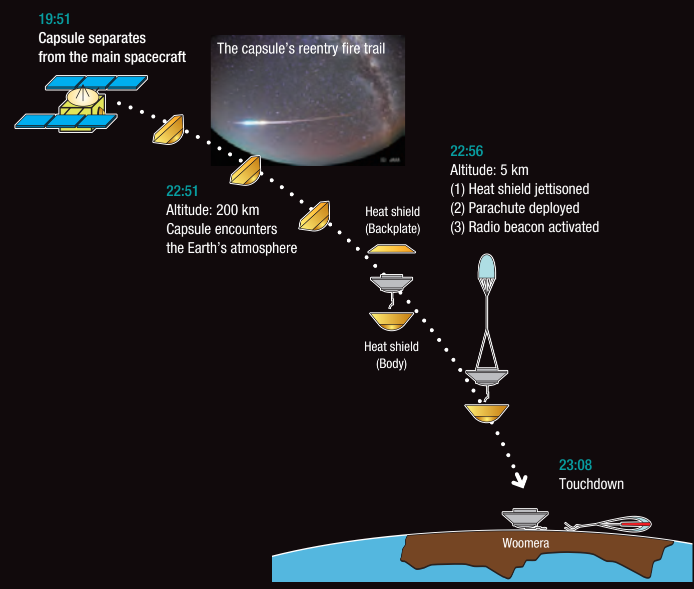
When carbon phenolic resin is exposed to extremely high temperatures, it becomes an ablative material—it gasifies and creates a thin boundary layer, which carries the heat away by convection. This provides the heat-shield effect, thereby preventing the capsule from heating above a certain temperature. Hayabusa's sample-return capsule was able to provide important data to verify what thickness the resin layer needed to be to withstand the extreme heat generated during atmospheric reentry.

During the capsule's descent, its velocity gradually decreased due to atmospheric resistance. When it reached a certain altitude, a pyrotechnic mechanism triggered the jettisoning of the heat shield from the sample-return capsule. The two pieces of the heat shield then fell to Earth separately while a parachute was deployed by the capsule to slow its final drop to the ground. The location of the capsule was then tracked using radar and an onboard radio beacon.

There was almost no wind in the landing area during the night of the capsule's return to Earth, making it possible to quickly identify the specific drop-point zone with a high degree of accuracy and narrow down the area in which the heat shield landed. The capsule was quickly located and recovery commenced during daylight hours the following day, and the heat shield components were also recovered.

After a seven-year, six-billion-kilometer journey through deep space, the recovery of the sample-return capsule, parachute and heat shield marked an important milestone in the history of mankind's space exploration. It meant that Hayabusa had become the first spacecraft to visit an asteroid and return to Earth. Moreover, the successful return has significant value from the perspective of future sample-return missions to bodies within the solar system. State-of-the-art reentry technology is an essential part of such missions, and through Hayabusa Japan has acquired—by its own efforts—first-hand evidence that can be utilized to further advance this field.

From capsule separation to touchdown



(All times are Japan Standard Time on June 13, 2010)

June 15

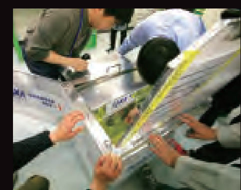
Capsule safety procedures
At a temporary clean room at the WPA Control Center; the photograph shows the capsule with its underside cover removed.

Heat shield retrieval

June 16

Surface cleaning and packing of the capsule
Temporary clean room at the WPA Control Center

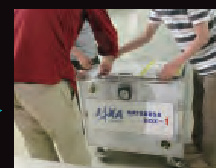
June 17



Packing of the capsule
WPA Control Center
Special container for transporting the capsule is filled with nitrogen gas.

Departure for Japan
A charter aircraft with the capsule on board departs from a nearby airport. The non-stop flight arrives at Haneda Airport, Tokyo, late the same evening.

June 18



2:15
Arrival at Sagamihara Campus
The capsule is taken into the planetary sample curation facility.

from among Hayabusa's four ion engines.

Leveraging the lessons from Hayabusa into new projects

We aimed to drop the sample-return capsule into the Woomera Prohibited Area (WPA) test range in South Australia. To enable this precise target to be achieved, we performed a trajectory correction maneuver on June 9, 2010, at a distance of 1.9 million kilometers from Earth. This maneuver marked the final task for the ion engines. On June 13, the sample-return capsule was released and three hours later the main body of Hayabusa encountered the Earth's atmosphere and burned up on reentry. The final sight of Hayabusa—lighting up the night sky over Australia—was both awe inspiring and humbling.

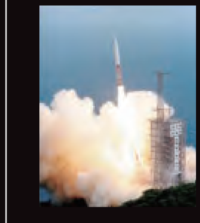
Initially we had contemplated purchasing the sample-return capsule's heat shield—needed to protect it from the extreme heat generated during reentry—from a manufacturer in the United States. However, after considering the core data the heat shield could provide, which would have a significant impact on future atmospheric reentry technology, we decided to develop the Hayabusa heat shield in-house. We believe that this decision has proved to be the right one.

Although we encountered innumerable problems along the way, after the completion of a seven-year, six-billion-kilometer journey and capping it off with a miraculous return to Earth, we think it is fair to say that Hayabusa was a space explorer endowed with great luck. Turning that luck into real-world capabilities is our job from now on. We hope that many people in Japan and around the world will support us in our new projects, which aim to leverage and build on the lessons and success of Hayabusa.

"Just in front of the scattering light trail made by Hayabusa, a single, small red light continued on—moving higher and higher—without disappearing. It could be clearly seen until it too faded out, just above the Southern Cross. That small red light was the capsule released by Hayabusa. I was sure that it had landed. Truly, an incredible journey."

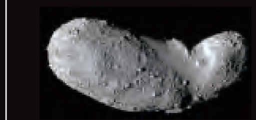
The text on page 10 and above is excerpted from:
Shohwakusei Tansaki Hayabusa no Daibouken
(Hayabusa's Great Journey: The Adventure Tale of Japan's Asteroid Probe)
by Kazuma Yamane
Published by Magazine House, Tokyo

Hayabusa: A seven-year journey

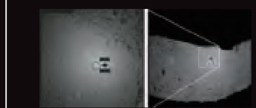


The M-V-5 Rocket lifts off at 13:29:25.

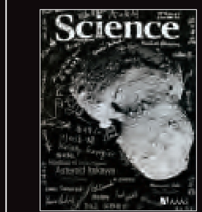
Hayabusa nears the Earth for its swing-by.
(Image by Akihiro Ikeshita)



Itokawa asteroid. Image captured on September 29, 2005.

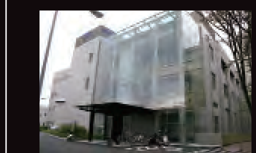


Hayabusa captures an image of the target marker (inside the marked circle to the left of Hayabusa's shadow).



Hayabusa and Itokawa feature on the cover of Science.

The 64-meter parabola antenna at Usuda Deep Space Center handled communications with Hayabusa.



Preparations are being carried out for initial analysis work at the planetary sample curation facility within JAXA's Sagamihara Campus.

2003

May 9: Launched from the Uchinoura Space Center. The probe is named "Hayabusa."

2004

May 19: Successful acceleration for orbit transfer using the ion engines and an Earth gravity-assist swing-by.

2005

July 26: JAXA Astronaut Soichi Noguchi lifts off aboard Space Shuttle Discovery (touchdown on August 9).
August 15: JAXA announces the failure of Hayabusa's X-axis reaction wheel.
September 12: Arrives at Itokawa asteroid. Commences scientific observations.
October 4: JAXA announces the failure of Hayabusa's Y-axis reaction wheel.
November 4, 9 and 12: Performs touchdown rehearsals.
November 20: Performs the first touchdown and release of a target marker.
November 26: Performs second touchdown. After taking off again, Hayabusa enters safe holding mode.
December 8: A fuel leak from a chemical engine causes a malfunction and loss of correct attitude. JAXA announces a three-year postponement of Hayabusa's return to Earth. Shortly thereafter, JAXA loses communication with the probe.

2006

January 26: JAXA reestablishes partial communications with Hayabusa.
March 6: Hayabusa's position and speed are precisely measured for the first time in three months.
June 2: *Science* runs a feature on asteroid Itokawa.

2007

January 18: Using the malfunctioning batteries, JAXA seals the sample-return capsule.
April: Commences the first phase of trajectory maneuver operation (continues until October) in preparation for return to Earth.

2009

February: Commences the second phase of trajectory maneuver operation
March 16: JAXA Astronaut Koichi Wakata lifts off aboard Space Shuttle Discovery (touchdown on July 31 aboard Space Shuttle Endeavor).
July 22: A total solar eclipse is observed in Japan for the first time in 46 years.
November 4: JAXA announces that all ion engines have shut down and reignition has not succeeded.
November 19: Succeeds in the cross operation of ion engines. Commences the return to Earth.
December 21: JAXA Astronaut Soichi Noguchi lifts off aboard Soyuz.

2010

March 27: Completes the orbit transfer operation from Itokawa to Earth. Continuous operation of the ion engines is completed.
April 5: JAXA Astronaut Naoko Yamazaki lifts off aboard Space Shuttle Discovery (touchdown on April 20).
April 16: JAXA receives landing permission from the Australian government. Commences trajectory correction maneuver in preparation for reentry.
May 21: Launch of the Venus explorer Akatsuki and the small solar power sail demonstrator IKAROS.
June 2: JAXA Astronaut Soichi Noguchi touches down aboard Soyuz.
June 9: Completes trajectory correction maneuver in preparation for reentry. Operation of the ion engines is completed.
June 13: Sample-return capsule returns to Earth.

Dr. Keiji Tachikawa

President of the Japan Aerospace Exploration Agency (JAXA)

His previous roles have included President and CEO of NTT DoCoMo, Inc. He was appointed to his current position in November 2004.

Mr. Charles F. Bolden, Jr.

Administrator of the United States National Aeronautics and Space Administration (NASA)

He served on four missions aboard the space shuttle, including as commander. He was appointed to his current post in 2009.

Dr. Anatoly N. Perminov

Head of the Russian Federal Space Agency (FSA)

Prior to his current role, he served as Commander-in-Chief of the Russian Space Force. He has been Head of the FSA since 2004.

Mr. Jean-Jacques Dordain

Director General of the European Space Agency (ESA)

Previous posts have included Director of Launchers at the ESA. He has held the role of Director General since 2003.

Dr. Steve MacLean

President of the Canadian Space Agency (CSA)

In 1983, he was selected as one of Canada's first astronauts. He was appointed to his current post in 2008.

Tokyo hosts International Space Station (ISS) heads of agency (HOA) meeting

The panel discussion following the HOA meeting emphasized the importance of the partnership between the participating countries.

The heads of the ISS agencies from Japan, the United States, Russia, Europe and Canada met in Tokyo on March 11, 2010, to review ISS cooperation.

The meeting was attended by the five heads of agency, Dr. Keiji Tachikawa, President of JAXA; Mr. Charles F. Bolden, Jr., Administrator of the National Aeronautics and Space Administration (NASA); Dr. Anatoly N. Perminov, Head of the Russian Federal Space Agency (FSA); Mr. Jean-Jacques Dordain, Director General of the European Space Agency (ESA); and Dr. Steve MacLean, President of the Canadian Space Agency (CSA). With the assembly of the ISS nearing completion, a joint statement issued by the heads of agency following the meeting noted the outstanding opportunities now offered by the ISS for on-orbit research and discovery. They emphasized that this research will deliver benefits to humanity on Earth while preparing the way for future exploration activities beyond low-Earth orbit.

At the panel discussion that followed the HOA meeting, each of the agency heads offered their views on the significance of ISS cooperation and their outlook for the future. Dr. MacLean of CSA said, "The partnerships forged through ISS cooperation will become a model for the future." Mr. Dordain of ESA commented, "The ISS cooperation partnerships will continue beyond the ISS project." Commenting on the Obama administration's announcement that the fiscal year 2011 budget request includes funding to extend operation of the ISS to 2020, Mr. Bolden of NASA said, "If we extend the life of the ISS to 2020 or beyond, it will enable us to undertake the research necessary for Mars exploration."

Dr. Perminov of FSA stated, "We will utilize the Russian segment of the ISS effectively to conduct high-level space research." He also announced plans for the construction of the new Vostochny space port in the Amur region of Russia's Far East. Dr. Tachikawa of JAXA commented, "We will continue to build upon the technology developed through ISS cooperation. In the future, we hope to use the H-II Transfer Vehicle (HTV) for the return of cargo to Earth and we see potential for the HTV to become the basis for the development of a manned vehicle. In looking toward opportunities to expand the utilization of the ISS, we proposed international collaboration on experiments in such fields as biosciences." Mr. Dordain also said, "I believe that wonderful ideas for the use of the ISS will also emerge from countries that are not represented here today." The heads of agency all agreed on this point—they welcome participation in the ISS program from as many countries as possible.

JAXA promotes the use of space by countries in Asia and the Pacific: Space Cooperation Office for the Asia-Pacific Region

The successful conclusion of APRSAF-16 in Bangkok. APRSAF-17 is scheduled to take place in Melbourne, Australia, on November 23–26, 2010. APRSAF was established in 1993 in response to the declaration adopted by the Asia-Pacific International Space Year Conference (APIC) in 1992, to enhance the development of each country's space program and exchange views on future cooperation in space activities in the Asia-Pacific region.

URL: http://www.aprsaf.org/

The 16th Session of the Asia-Pacific Regional Space Agency Forum (APRSAF-16) was held in Bangkok, Thailand, January 26–29, 2010. We interviewed Chu Ishida, who is the Director of the Space Cooperation Office for the Asia Pacific Region within JAXA's Space Applications Mission Directorate, about APRSAF-16 and his office's activities.

Space Technology Contributing to Solutions for a Broad Array of Issues

Q: What is the role of the Space Cooperation Office for the Asia Pacific Region?

Ishida: The office was established in 2007 primarily to coordinate and manage JAXA's cooperation activities in the Asia-Pacific region. Since then, our activities have included international cooperation in the field of small satellites, Sentinel Asia, and Space Applications for Environment (SAFE), which promotes new satellite applications relating to the environment. Natural disasters and environmental problems in Asia have an impact on Japan's economy and society. Hence, utilizing space technology in ways that can contribute to solutions is recognized as a very important part of JAXA's overall organizational mission.

Q: In your opinion, what were the particular highlights of APRSAF-16?

Ishida: JAXA plans to launch the first Quasi-Zenith Satellite

Mr. Chu Ishida

Director, Space Cooperation Office for the Asia Pacific Region, Space Applications Mission Directorate

"MICHIBIKI" in mid-2010. In doing so, Japan will join China and India as countries in Asia that operate global navigation satellite systems (GNSS). At APRSAF-16, we held a workshop on regional GNSS cooperation, which discussed potential applications combining the systems of countries in the region and beyond. As a result of this workshop, we are aiming to initiate a project on GNSS utilizing multiple satellites.

Sentinel Asia: Playing a Key Role in Disaster Monitoring

Q: Asia has a very large number of natural disasters compared with other regions of the world, which makes the role of Sentinel Asia particularly vital. Were there any previously existing frameworks for cooperation in this area?

Ishida: When a disaster occurs, it has been very difficult for individual countries to obtain timely and accurate information on the situation in affected areas. Information provided from the Advanced Land Observing Satellite (ALOS) is extremely useful in rapidly gathering disaster information over a broad geographic area. Immediately following the 2008 Sichuan earthquake in China, Japan led the world in providing the data on the devastated area, and China's disaster relief agencies expressed their appreciation for this assistance.

Q: What is JAXA's role in Sentinel Asia?

Ishida: JAXA plays a coordinating role in the overall concept planning

Images taken by ALOS of the area in Sichuan, China, devastated by a magnitude 7.9 earthquake in May 2008. The left-hand image was taken before the earthquake struck, and the right-hand image was taken shortly after the earthquake. The image reveals the extent to which the town shown was engulfed by a landslide.

http://www.jaxa.jp/pr/jaxas/pdf/jaxas031.pdf

and design of the Sentinel Asia system. This process aims to respond effectively to the needs identified by each participating country. JAXA is also tasked with implementing the system through collaboration with all of the participating agencies. JAXA's central role in Sentinel Asia reflects its position as the operator of ALOS, which provides high-quality data. There are already high expectations for ALOS2, the planned successor to ALOS.

An Expanding Range of Activities under the SAFE Project

Q: Please provide a brief overview of the SAFE project.

Ishida: SAFE is a project to facilitate the utilization of satellite data by governmental agencies in the area of environmental management. Participating countries use the data provided through SAFE to monitor environmental problems and to assist in the formulation of policy responses to such problems. SAFE was officially launched in 2008 at APRSAF-15, and has since expanded to cover a wide range of programs. These include water resource management in Cambodia, forest management in Laos, sea level rise risk profiling in Sri Lanka, and drought monitoring in Indonesia. I believe that the role of SAFE in contributing to solutions for regional environmental problems will continue to grow.

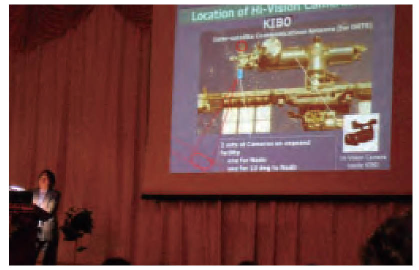
Q: How is the Satellite Technology for the Asia-Pacific Region (STAR) Program promoting the spread of basic technology for small satellites?

Ishida: Responding to a high level of interest and growing needs in the Asia region relating to small satellites, Japan proposed the STAR Program in 2008. As a joint international project, the STAR Program got under way in June 2009 at JAXA's Sagamihara Campus. Several countries in the Asia-Pacific region are participating in this program, which is the first of its kind in the world. Specifically, the participating countries plan to cooperate in fostering their human resources through the actual development of small satellites.

Promoting the use of space in the Asia-Pacific region

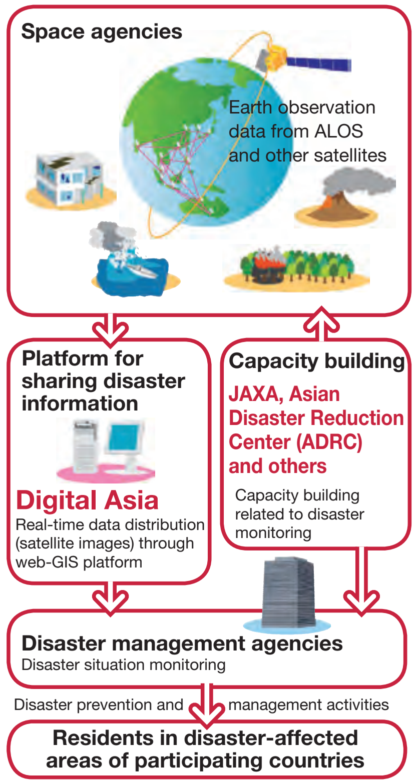
Q: Please outline your future goals for cooperation in Asia.

Ishida: Many countries in Asia wish to utilize space technology in such areas as disaster and environmental monitoring and land and resource management. As technology advances, we are seeing the burgeoning use of space in the Asia-Pacific region. Hence, JAXA aims to comprehensively promote the utilization of space throughout the region. This includes not only the use of images provided by Earth observation satellites but also response to needs across a broad range of fields, including telecommunications, GNSS, use of the space environment, and space education. To achieve our objectives, we will collaborate with relevant organizations throughout the region to formulate plans and bring these plans to fruition. Furthermore, we will monitor the progress of our activities to identify and implement improvements. We want to utilize the experience we gain in future projects. These efforts aim to systematize the overall promotion of space utilization.



APRSAF-16 discussed such issues as the use of satellites in dealing with environmental issues and promoting greater utilization of the space environment.

Overall Flow of Sentinel Asia



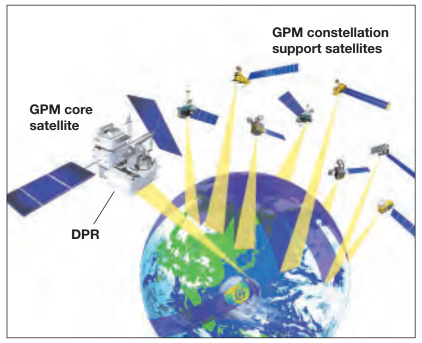
JAXA's frontier

Administrator Bolden (left) and President Tachikawa at the signing ceremony

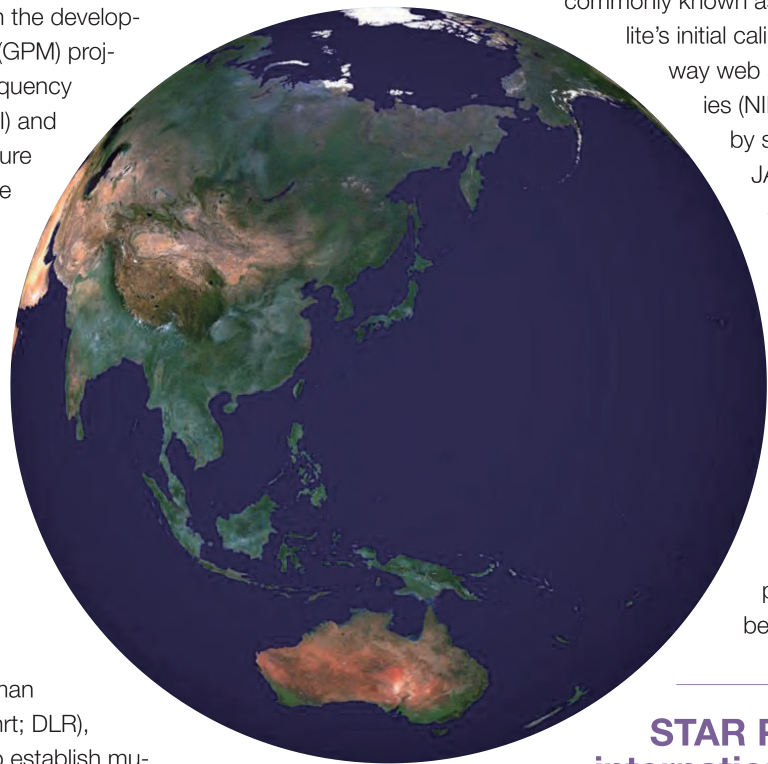
JAXA and NASA sign Memorandum of Understanding on Global Precipitation Measurement project

Dr. Keiji Tachikawa, President of JAXA, and Charles F. Bolden, Jr., Administrator of the National Aeronautics and Space Administration (NASA), signed a Memorandum of Understanding (MOU) on July 31, 2009 (Japan Standard Time; JST), at the Kennedy Space Center in Florida, the United States, for cooperation on the development and operation of the Global Precipitation Measurement (GPM) project. Under the GPM project, a core satellite will carry Dual-frequency Precipitation Radar (DPR) and a GPM Microwave Imager (GMI) and a constellation of satellites will carry GMI instruments to measure global rainfall and other precipitation. The data obtained will be analyzed to provide more accurate global precipitation estimates than have been available to date.

For further details, please refer to information provided on the JAXA web site:
http://www.jaxa.jp/press/2009/08/20090803_gpm_e.html



Constellation of satellites in the GPM project



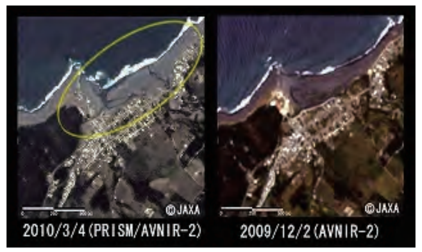
JAXA and the German Aerospace Center initiate cooperation in satellite-based disaster monitoring

Dr. Tachikawa (left) and Prof. Wörner sign the Letter of Intent at a ceremony in Tokyo.

JAXA President Dr. Keiji Tachikawa and Prof. Dr.-Ing. Johann-Dietrich Wörner, Chairman of the Executive Board of the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), signed a Letter of Intent (LOI) in Tokyo on August 21, 2009, to establish mutual cooperation on using satellites for disaster monitoring. The two agencies plan to pursue cooperation by utilizing their respective on-orbit satellites, JAXA's Advanced Land Observation Satellite (ALOS) and DLR's TerraSAR-X. JAXA and DLR will examine the potential for exchanging Synthetic Aperture Radar (SAR) data and pursue collaborative research on SAR data application technology. SAR has the ability to provide Earth observation data during both day and night and under nearly all weather conditions.

For further details, please refer to information provided on the JAXA web site:
http://www.jaxa.jp/press/2009/08/20090824_dlr_e.html

Emergency observations by ALOS following the February 2010 earthquake in Chile



By comparing the area marked by a yellow ellipse—shown in the left-hand photograph above—with the pre-earthquake image on the right-hand side, it is possible to observe changes in the shape of the shoreline, which are thought to be the result of the earthquake and subsequent tsunami.

A major earthquake measuring a magnitude of 8.8 occurred off the coast of central Chile, approximately 325 kilometers southwest of the capital city of Santiago, on February 27, 2010, at 3:34 p.m. (JST). The earthquake occurred at an estimated depth of 35 kilometers. In response, JAXA performed emergency observations on February 27, March 1 and March 4 (all JST) using its Advanced Land Observing Satellite (ALOS). JAXA provided the observation data taken by ALOS of an area approximately six kilometers southwest of the coastal town of Pelluhue to overseas agencies responding to the disaster. The provision of disaster information is facilitated by JAXA's membership in the International Charter Space and Major Disasters.

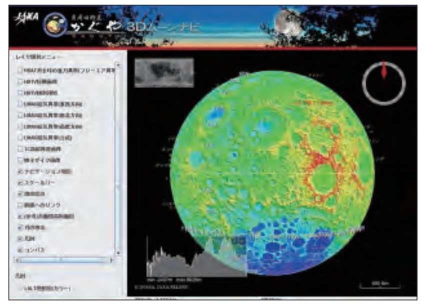
Public release of observation data from GOSAT and SELENE

GOSAT User Interface Gateway operated by the National Institute for Environmental Studies (NIES) (http://data.gosat.nies.go.jp)

JAXA has commenced the release of data to general users from one of its Earth observation satellites, Greenhouse Gasses Observing Satellite (GOSAT), and its lunar explorer Selenological and Engineering Explorer (SELENE).

JAXA began releasing radiance spectra data and image data from GOSAT—commonly known as "Ibuki" in Japanese—following the completion of the satellite's initial calibration. After registering at the GOSAT User Interface Gateway web site operated by the National Institute for Environmental Studies (NIES), users may retrieve and order observation data of interest by specifying the observation area and period.

JAXA has also commenced the public release of processed observation data through the Internet from SELENE—known by its nickname "Kaguya" in Japan"—gathered by the explorer during its nominal operation phase from December 21, 2007 to October 31, 2008. Since JAXA is distributing calibrated and validated data from SELENE's science-mission instruments, the agency hopes that the data will become a valuable resource for researchers in lunar science-related fields. Simultaneously, JAXA began providing "KAGUYA 3D Moon NAVI" services, which deliver data from SELENE via the Internet using a three-dimensional (3-D) geographic information system (GIS). JAXA plans to expand the public release of data on an ongoing basis as more data become available.



KAGUYA 3D Moon NAVI (http://wms.selene.jaxa.jp/3dmoon_e/index_e.html)
SELENE Data Archive (http://www.soac.selene.isas.jaxa.jp/archive/index.html.en)

STAR Program gets underway as a joint international project for small satellite development

STAR Program participants use a simulator during a workshop on satellite attitude control systems.

Since June 2009, the Satellite Technology for the Asia-Pacific Region (STAR) Program has been running at JAXA's Sagamihara Campus near Tokyo. The program so far has attracted the participation of engineers from the space agencies of Indonesia, India, Vietnam, Thailand, Malaysia, South Korea and Japan. The program's main objectives are

- to provide an opportunity for space agencies in the Asia-Pacific region to build their human resources in the field of satellite development: and
- to increase the number of satellites available for Earth observation in the Asia-Pacific region, and respond to anticipated regional needs for future Earth observation.

As part of the program, the participating countries plan to develop and launch small satellites. The program looks forward to the participation of more engineers from space agencies throughout the region, and welcomes inquiries regarding participation.

For a detailed overview of the STAR Program, please refer to the following presentation material from APRSAF-16 (January 2010):
http://www.aprsaf.org/data/aprsaf16_data/D3-1600-1_AP16_STAR.pdf

For inquiries regarding participation in the STAR Program, please contact:
Mr. Masanobu Tsuji, STAR Program Office
tsuji.masanobu@jaxa.jp
Tel: +81-50-3362-4883

The Earth Seen from Space

Hayabusa's sample-return capsule swoops down over Australia

Hayabusa released its sample-return capsule over the South Australian desert, and shortly afterward the capsule landed inside the Woomera Prohibited Area. There are high expectations that the capsule may contain a sample of material from the asteroid Itokawa.

Australia is a country blessed with a diverse array of natural beauty, from inland deserts to rainforests and beaches. Fraser Island (pictured) is one such natural wonder.

Photo taken by Advanced Land Observing Satellite (ALOS) (Daichi)/JAXA on September 28, 2008

Fraser Island, located in the middle of the east coast of Australia, is formed of sand. Sand from the east coast of Australia, eroded by heavy rain more than 140,000 years ago, was deposited off the east coast and created the "Sand Island." (There is another view that the sands came from Antarctica.)

Fraser Island, with an area of 184,000 hectares, is 120 kilometers long from north to south, and 25 kilometers wide, east to west. It is located about 250 kilometers north of Brisbane, the third largest city in Australia. The island is mostly covered by tropical rainforests and looks green. Long sandy beaches surrounding the island and dotted sand dunes reveal that the island is made of sand.

JAXA
Japan Aerospace Exploration Agency

Public Affairs Department

Marunouchi Kitaguchi Bldg.3F,
1-6-5 Marunouchi, Chiyoda-ku,
Tokyo 100-8260, Japan

Phone: +81-3-6266-6400
Fax: +81-3-6266-6910

JAXA Web Site

http://www.jaxa.jp/index_e.html

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