JAXA TODAY

Japan Aerospace Exploration Agency

January 2013 / No. 07

Special Feature

JAPAN'S SPACE LEADERS REVIEW 2012 AND LOOK TO THE FUTURE OF SPACE DEVELOPMENT

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 issue No. 07, our cover feature is an interview with three figures who fulfill key roles in space development globally—President of JAXA, Chairman of COPUOS and President of the IAF. We also present feature articles covering the latest research results based on observation data from two spacecraft—SHIZUKU and KAGUYA. We hope you will find these and other articles in this issue stimulating and informative.

Astronaut Akihiko Hoshide Makes a String-Figure Broom

On November 16, 2012, as part of an educational event, Astronaut Akihiko Hoshide played string games ("*ayatori*" in Japanese) inside the ISS' JEM Kibo Pressurized Module. *Ayatori* is a children's game played all over the world—including Japan—in which a looped length of string is manipulated using one's fingers to form various kinds of string figures, such as the "broom" shown in the photograph. With regards to how the string behaved in the microgravity environment, Astronaut Hoshide commented, "Since the string floats in the microgravity, it is quite difficult if one allows the string to go slack. However, as long as one keeps the string taut it is possible to make the string figures."

Cover Story

After completion of the interview featured on pages 1–6 of this issue, Japan's space development leaders gather around JAXA Public Affairs & International Relations Executive Advisor Midori Nishiura (second from right), who is seated on a stool. From left: Kiyoshi Higuchi, President of the IAF; Dr. Keiji Tachikawa, President of JAXA; and on the right Dr. Yasushi Horikawa, Chairman of COPUOS.

JAPAN'S LEADERS IN SPACE DEVELOPMENT SHARE THEIR VISION FOR THE FUTURE

From the perspective of their respective roles as President of JAXA, Chairman of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and President of the International Astronautical Federation (IAF), three of Japan's leading figures in the space field look back over 2012, offer their views on prospects for 2013 and discuss the future of space development.

Profiles

Dr. Keiji Tachikawa
(Center)
President, JAXA

Dr. Tachikawa earned an MBA from Massachusetts Institute of Technology (MIT) in 1978. After serving in such roles as CEO of NTT America, Inc., he was appointed President of NTT Mobile Communications Network, Inc. (presently NTT DOCOMO, Inc.), in 1998. On November 15, 2004, he was appointed President of JAXA. Prior to that, from 2001 to November 2004 he served as a member of the Japanese government's Space Activities Commission.

Dr. Yasushi Horikawa
(Right)
Technical Counselor, JAXA
Special Assistant to the Minister for Foreign Affairs
Chairman, COPUOS

In 1987, Dr. Horikawa began working on the development of the Japan Experiment Module (JEM) Kibo. From 2005 he served as an executive director of JAXA, and in 2009 was appointed Technical Counselor. In June 2012 he was appointed Chairman of COPUOS, and in October 2012 he became Special Assistant to the Minister for Foreign Affairs.

Kiyoshi Higuchi
(Left)
Vice President, JAXA
President, IAF

In June 1977, Mr. Higuchi earned a Master of Science degree in aeronautics and astronautics from MIT. He has been involved in system design for the H-I Launch Vehicle, and played a key role in Japan's participation in the International Space Station (ISS) program. From October 2003 he served as an executive director of JAXA, and in April 2010 became Vice President. In October 2012, he was elected President of the IAF.

Midori Nishiura

Midori Nishiura, an opinion leader, is the president of consulting firm Amadeus Inc., and JAXA's Executive Advisor for Public Affairs & International Relations. Ms. Nishiura is also a Visiting Professor of International Relations & Communications at Yamaguchi University. Among many other important roles, Ms. Nishiura has served on the Advisory Board of various major companies and also sits on committees organized by government ministries and agencies. The 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.


Photo by Hiro Arakawa


Photo by Hiro Arakawa

Theme 1 | 2012: A Milestone Year for Japan's Personnel Contributions in the International Arena

Nishiura: Let me begin by wishing you all a happy and fruitful New Year. In 2012, Yasushi—Horikawa-san—was appointed Chairman of COPUOS, and Kiyoshi—Higuchi-san—was elected President of the IAF. These were both momentous occasions for JAXA and the whole of Japan—coming in such quick succession, too!

Tachikawa: I feel extremely gratified that both of you were chosen to fill such key roles, and I think it can be seen as a milestone signifying Japan's ability to contribute top-quality people in the international arena. I look forward to the emergence of many more such accomplished individuals from Japan.

Horikawa, Higuchi: Thank you very much.

Nishiura: As the leader of Japan's space development program, I think I will ask KT—Tachikawa-san—to begin by telling us about JAXA's main activities during 2012.

Tachikawa: In the manned space program, Astronaut Akihiko Hoshide served a long-duration mission on the ISS as part of Expedition 32/33 from July to November 2012. He became the fourth JAXA astronaut to complete such an extended stay on the ISS.

Nishiura: In July last year, I saw Aki—Astronaut Hoshide—off at Baikonur Cosmodrome when he departed for the ISS. Three days later, when I saw him on a giant video screen at a Roscosmos facility, he looked fit and well after his arrival at the ISS, and I felt a sense of both relief and excitement that I shall never forget. In 2012, there were satellite launches from the Tanegashima Space Center, too.

Tachikawa: Yes, in May we saw the launch of Global Change Observation Mission 1st–Water "SHIZUKU" (GCOM-W1), and then in July we had the launch of the third H-II Transfer Vehicle, HTV3 (KOUNOTORI3)—our resupply spacecraft for the ISS. SHIZUKU, whose launch you also witnessed, Midori, is now conducting regular operations. Astronaut Hoshide operated the ISS' robotic arm to help perform the HTV3's docking manoeuver, and its cargo was successfully transferred to the ISS.

Nishiura: Within that payload there were five small satellites.

Tachikawa: That's right, Midori. Astronaut Hoshide used the JEM Remote Manipulator System (JEMRMS) to move the small satellites into deploy position before they were released into orbit. By using this method, the satellites do not have to endure environmental conditions—including sine vibration and acoustic vibration—as harsh as those associated with a normal rocket launch. From that perspective, this mission was quite revolutionary.

Horikawa: With the ISS having reached its near-fully assembled state in July 2011, it has now entered the phase of full-fledged utilization. As someone who was closely involved in the development of JEM Kibo, this is a very profound time for me—particularly since we have worked for so long to ensure that the ISS could produce tangible results for the benefit of humankind.

Nishiura: Since July last year, the technology deployed in Advanced Microwave Scanning Radiometer 2 (AMSR2) aboard SHIZUKU has continued to perform brilliantly. With data validation and calibration now in progress, I am thrilled that we are able to meet the high expectations of researchers worldwide.

SHIZUKU (GCOM-W1)

Astronaut Akihiko Hoshide

Nishiura: Yasushi, you compiled a discussion paper in preparation for your appointment as Chairman of COPUOS. Reading it, one can truly feel your enthusiasm as the first Chairman from Japan.

Horikawa: In 2011, COPUOS celebrated its 50th anniversary. Looking toward the next half century, the paper I submitted focuses on how we should proceed in the future. Under the title, "Next Phase in Global Governance for Space Research and Utilization," it was provided to Committee members as a summary of my thinking on the direction of worldwide space development. In June of last year, Midori, those of us—including yourself—who were in Vienna, each cooperated in fulfilling our roles. The Japanese Embassy's support was also greatly appreciated.

Nishiura: Would you be so kind as to give us a brief outline here of your discussion paper?

Horikawa: Of course, as you will recall, Midori, the paper proposed three main ideas: (1) to strengthen international cooperation through the United Nations; (2) to promote greater dialogue via the five regional groups that make up the United Nations and submissions based on this dialogue; and (3) to discuss each country's approach to moving toward a "green economy," one of the themes of the United Nations Conference on Sustainable Development (Rio+20) held in Rio de Janeiro, Brazil, in June 2012.

Nishiura: I remember you taking in stride all those long hours of travelling. Yasushi, you really are so fit, and keep yourself so by walking for miles, everyday! Would you once again reiterate the overall intent and objective of the discussion paper?

Horikawa: As the Committee enters its second half century, a key point on which we must focus is how well developed and developing countries can collaborate in their efforts to achieve progress in space development. In recent years, developing countries and various types of organizations, such as universities and ordinary business enterprises, have sought to actively participate in space development. I believe that this is something we should greatly and wholeheartedly welcome. However, the space environment has many limitations. How should we build a system of international cooperation that can be utilized on a long-term, sustainable basis by the myriad of organizations involved in space development? This is a vital question for COPUOS to address.

Theme 2 | COPUOS Chairman Yasushi Horikawa: Collaboration between Developed and Developing Countries Vital for Progress in Space


United Nations Office of Vienna (UNOV)


Photo by Hiro Arakawa

Photo by Hiro Arakawa

Theme 3 | IAF President Kiyoshi Higuchi: Emphasizing Japan's Role as "Most Reliable Partner" in the Space Field

Nishiura: Kiyoshi, can you fill in the background for us on your election to the IAF presidency?

Higuchi: Thank you, Midori. The IAF is an international organization whose membership includes space agencies, academic societies, business corporations and non-profit organizations. On October 5, 2012, at the IAF General Assembly held in Naples, Italy, I received the endorsement of many space agencies and other members, and was chosen via an election process.

Nishiura: That was on the final day of last year's International Astronautical Congress (IAC), which I had the pleasure of attending with you. What do you think were the main reasons for Japan receiving such a large number of endorsements?

Higuchi: Firstly, Japan has won a high level of international trust among the advanced space nations. This is particularly so in such space fields as the ISS program, space science and Earth observation, through which Japan has built a reputation as "Most Reliable Partner." Secondly, an increasing number of countries in the Asia region—where economic development continues at a remarkable pace—are embarking on space development. In this context, many countries look to Japan to act as a bridge between such countries in Asia and the advanced space nations, including Europe, the United States and Russia, and skillfully coordinate the interests of all parties. These were the two principal reasons, in my view.

Nishiura: Absolutely, Kiyoshi. I agree with you completely. Can you tell us what aspirations you have as the newly elected president?

Higuchi: Yes, gladly, Midori. Actually, there was an opportunity for me to make a five-minute speech before the voting. So let me summarize here the key themes of that speech.

- "I love space": Since graduating from university, I have been involved in the space field for more than 40 years. So based on this experience I want to try and repay the kindness I have received from innumerable people throughout my career.
- As I mentioned earlier, Japan is in a unique position. We have won international trust in many space-related fields, and we are seen as capable of fulfilling the role of a bridge with the advanced space nations.
- "I love to support young professionals": In space development, one of our most crucial tasks is nurturing a new generation of professionals. This is something I am very keen to address.

I will, of course, undertake my normal duties as President of IAF, but I also envisage engaging in these areas as part of my role.

Horikawa: Indeed Kiyoshi, we all do. And education for young professionals in particular has been a lifework of mine.

Theme 4 | Preparing for the Start of a New Medium-Term Plan

Nishiura: From April 2013 JAXA will embark on its Third Medium-Term Plan, which will run for five years. First of all, KT, I would like you to provide us with an overview of your principal tasks during FY2013.

Tachikawa: My pleasure, Midori. One of our biggest projects in 2013 is the initial launch of the Epsilon Launch Vehicle, our new solid propellant rocket that is the technological successor to the M-V Launch Vehicle. The Epsilon Launch Vehicle autonomously conducts inspections of onboard devices, thereby streamlining inspection on the ground. This will allow launch control to be handled by a simple setup using notebook-sized personal computers connected to the network. Quite amazing, don't you think?

Nishiura: Yes, isn't it exciting! If launch vehicle control and operation can be simplified to this extent, it would be a great boost for space development in Japan and around the world. Related to this, do please introduce the plans you have for the development of new space transportation systems and satellites.

Tachikawa: As our core launch system, continuing on from the H-IIA and H-IIB launch vehicles, I would like us to get started on development of the H-III Launch Vehicle (provisional name). Another important task is the steady continuation of the development and launch of satellites that address environmental issues and disaster management needs. In the area of space probes, we have commenced development of Hayabusa2—the successor to Hayabusa—and are targeting a launch in 2014. While continuing our international collaborative approach, we also aim to carry out research and development for new X-ray and infrared astronomy satellites.

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Epsilon Launch Vehicle (artist's rendition)

©NASA

Astronaut Koichi Wakata

Nishiura: Isn't it tremendous? Here are so many projects to look forward to. Participating countries have pledged their commitment to extend operation of the ISS to 2020. In December 2013, Astronaut Koichi Wakata will begin a long-duration mission aboard the ISS as part of Expedition 39. With his becoming Japan's first ISS Commander on this mission, the entire country will be absolutely bubbling with excitement over this honor. We are all ecstatic!

Tachikawa: Yes, it's really fantastic news, Midori. Astronaut Wakata has the experience of being the first Japanese astronaut to complete a long stay on the ISS. That was from March to July 2009. On this occasion, it is a wonderful honor for JAXA to produce a new international leader—the ISS Commander.

Nishiura: I might add, Astronaut Soichi Noguchi—who is one of the members of the Executive Committee of the Association of Space Explorers (ASE)—has recently been appointed as the first ASE-Asia president.

Higuchi: Thirty-one years have passed since the ISS program was initiated in 1982. Staff members from the participating countries have built up long-term cooperative relationships over that time, and we've been able to play an active role internationally since we were quite young. How we go about creating opportunities and structures to hand on our know-how to the next generation is a major task for my colleagues and me at the IAF.

Theme 5 | Long Horizons: Space Development Over a 100-Year Span


Photo by Hiro Arakawa

Nishiura: I would like to make some comments myself to close our discussion, but before that may I ask each of you to share your thoughts—from your different perspectives—on what you believe is necessary for the future of space development? Yasushi, would you like to be the first?

Horikawa: All right, Midori. As I touched on earlier, the number of countries and organizations involved in space development is increasing significantly. I think it is important for each country and organization to disclose information in advance about the plans on which their space activities are based, and to avoid hindering each other's activities. In line with this, COPUOS has established the Working Group on the Long-term Sustainability of Outer Space Activities, which is preparing a set of guidelines.

Nishiura: What about you, Kiyoshi?

Higuchi: Thanks to my involvement in the ISS program from a young age, I have made many friends in Europe and the United States. Their endorsements greatly supported my election to the IAF presidency. If we bring all of humankind together more to pursue projects like the ISS, which require international cooperation, staff members from each country will develop stronger links among their peers internationally. We are Japanese, but at the same time we must maintain awareness that we are all inhabitants of planet Earth.

Nishiura: Precisely, you hit the nail on the head there. I couldn't agree with you more. That kind of shared consciousness would greatly enhance world peace. And KT?

Tachikawa: Space activity is a treasure trove of adventure and challenges into the unknown. We must look to the younger generation to take on these challenges. If we think of the future in terms of a long horizon—a 100-year span—there are many things for us to achieve. As we face the possibility of recession in the global economy, our current task is to seek cooperation among countries and to find ways to sustain our space programs. In the future, when we have overcome economic downturn, I believe that for the first time humankind will be able to unite to effectively harness space development.

Nishiura: I thank you all. Now, it's my turn. As an executive overseeing two departments, Public Affairs and International Relations, I hope that we can all truly think and act globally—particularly in communications. I know it can be counterintuitive at times, and not easy for some people with no bi-cultural education or background. However, we really need to get used to the idea of getting maximum mileage out of any situation by using high-level communication skills. By that, I don't mean just fluency in languages, but in minds. Another thing, I want engineers to be admired more in society. After all, where would we be without their ingenuity? I must stop before I start making a speech! Well, everyone, it was such fun talking with you today. Thank you so much.

Letter from Vienna

A New Serial, for JAXA TODAY (No. 2)

Warm greetings from Vienna, Austria! I am Toshiro Ozawa, the Ambassador Extraordinary and Plenipotentiary of the Permanent Mission of Japan to the International Organizations in Vienna.

Season's Greetings from Vienna!

The winter season in Vienna is dark and cold, but there are many events to enliven your spirits and cheer you up. The famous opera houses are in season and there are world-renowned events such as the Vienna Philharmonic's New Year's Concert and the Ball at the Hofburg Royal Palace. For those willing to brave the cold, ice-skating in front of the beautiful Rathaus (City Hall) or going skiing/snowboarding in the Austrian mountains makes for great winter fun. May you also find joy this holiday season.

Allow me to briefly introduce who we are and what we do at our office, the Permanent Mission of Japan to the International Organizations in Vienna. We are a medium-sized Mission, with 26 Japanese staff members. We represent the Japanese government in various international conferences held in Vienna and coordinate Japan's cooperation with the various international organizations that are based in Vienna. We cover many international organizations, such as the International Atomic Energy Agency (IAEA), the Comprehensive Test Ban Treaty Organization (CTBTO), the UN Office on Drugs and Crime (UNODC), the UN Industrial Development Organization (UNIDO) and the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), among others. All these international organizations are located on the east bank of the Danube River in a complex called the Vienna International Centre.

On space-related activities, our Mission interacts with the United Nations Office for Outer Space Affairs (UNOOSA). UNOOSA acts as the secretariat of the Committee on the Peaceful Uses of Outer Space (COPUOS) and is responsible for coordinating the execution of the Programme on Space Applications. At UNOOSA, you can find Dr. Takao Doi, former astronaut and now a desk chief at UNOOSA. His work is to coordinate and implement the programmes for space applications. In this regard, I am pleased to mention that the Japanese government is engaged in a number of cooperative projects with UNOOSA. To highlight just a few, the Kyushu Institute of Technology is conducting a UN/Japan Long-term Fellowship Programme on Nano-Satellite Technologies, Kyushu University hosts the International Center for Space Weather Science and Education and the University of Tokyo jointly organized a UN/Japan Nano-satellite Symposium last year in Nagoya.

In 2013, Dr. Horikawa, the COPUOS Chairman and Technical Counselor of JAXA, will begin his second year as Chairman. In the work of the Committee last year, his paper submitted for discussion entitled "Next Phase in Global Governance for Space Research and Utilization" was well received by many countries and, in response, the adoption of a new agenda item entitled "Space and sustainable development" is being considered by the Committee.

I believe that Chairman Horikawa is on a good track, and I am beginning to be confident that by the conclusion of his term in June 2014, Chairman Horikawa will leave a legacy of advancing COPUOS to a new level of activities. My staff and I are pleased to be able to work together with Dr. Horikawa, our friends in JAXA and the relevant officials of the Japanese government at a time when international governance of space activities are undergoing positive change. We look forward to the coming season of COPUOS.

Best wishes for the New Year!

Reaching for the Skies, Exploring Space

JAXA pursues the great potential of space with the aim of contributing to humanity's peace and happiness. Hence, JAXA undertakes a diverse array of research and development, exploration and space utilization activities.

JAXA's Long-Term Vision

In April 2005, JAXA proposed its ideal for the future of the aerospace field. This Long-Term Vision reinforces the organization's awareness of its responsibilities to society, and provides a vision of the aerospace field in Japan in 2025, which JAXA is striving to realize. Since then, JAXA has promoted a broad range of programs in line with its goal of turning this vision into reality.

Long-Term Vision		Applicable Contents
1. To build a secure and prosperous society through the utilization of aerospace technology	• Establishing a system for natural disaster management • Establishing a system for addressing global environmental issues	**P14–17** What is Happening in the Arctic? Arctic Climate Change Captured by SHIZUKU's First Observations
2. To help uncover answers to mysteries of the natural universe and to prepare for lunar utilization as a means of elucidating the origins of the Earth and humankind	• Making Japan the world's leading science center through experience gained in space observation and planetary exploration • Establishing technologies for future lunar utilization	**P18–21** SELENE Sheds Light on the Origin and Geological Evolution of the Moon
3. To realize world-class space transportation and Japan's home-grown space program	• Establishing space transportation systems, including launch vehicles and orbital transfer vehicles, with the world's best reliability and competitiveness • Establishing technologies that will make possible manned space activities	**P12–13** Reaffirming Our Commitment after 20 Years of Progress **C4** i-Ball Witnesses KOUNOTORI3's Last Moments
4. To develop aerospace as Japan's next key industry	• Promoting the space industry as an important part of Japan's future industrial base	**P10–11** "I feel so lucky to be born on such a beautiful planet!" Astronaut Hoshide Recalls His Busy Days in Space
5. To establish Japan's aircraft manufacturing industry and develop supersonic aircraft	• Revitalizing aircraft manufacturing as a key industry in Japan • Demonstrating technologies for hypersonic aircraft capable of Mach 5 speed that will be able to cross the Pacific in two hours	**P22–23** DREAMS Project—Developing the Next-Generation Air Traffic Management (ATM) System to Ensure Safe and Comfortable Global Aviation

"I feel so lucky to be born on such a beautiful planet!"

Astronaut Hoshide Recalls His Busy Days in Space

Astronaut Akihiko Hoshide served a long-duration mission on the ISS from July to November 2012 as a flight engineer on the crew of Expedition 32/33. In this two-page feature, we look back on some of the highlights of his mission, introduced together with excerpts from his popular Twitter feed.

Akihiko Hoshide

JAXA Astronaut

Akihiko Hoshide was born in Tokyo, Japan, in 1968. In June 2008, he flew to the ISS aboard the Space Shuttle Discovery as a member of the STS-124/1J mission. From July to November 2012, he served on a long-duration mission aboard the ISS as part of Expedition 32/33. His activities included berthing and separation of HTV3—Japan's resupply spacecraft for the ISS—and the technical verification mission for a small-satellite deployment system.

Note: Unless otherwise specified, all dates are shown in Japan Standard Time (JST).

Astronaut Hoshide's Twitter feed

July 27

"KOUNOTORI captured! It's a lovely spacecraft—so much Japanese technology to be proud of!"

HTV3 makes its rendezvous approach to the ISS (©JAXA/NASA)

Berthing KOUNOTORI3 (HTV3) and Transferring Pressurized and Unpressurized Cargo to the ISS

On July 27, Astronaut Hoshide, together with NASA Astronaut Joseph Acaba and other crew members, used the Space Station Remote Manipulator System (SSRMS) to grapple HTV3. During communications with the HTV control team on the ground, Astronaut Hoshide expressed his thoughts after becoming the first JAXA astronaut to greet the HTV in space: "Through the ISS window, KOUNOTORI looks very beautiful."

From July 28, the day after HTV3 docked with the ISS, the crew commenced the transfer of pressurized and unpressurized payload from HTV3 to the ISS. This included such items as food and other crew supplies, the Aquatic Habitat (AQH) experimental aquarium, the JEM-Small Satellite Orbital Deployer (J-SSOD), five small satellites to be deployed using J-SSOD and the Multi-mission Consolidated Equipment (MCE) to be used in experiments on JEM Kibo's Exposed Facility (EF).

Astronaut Hoshide's Twitter feed

October 5

"5 satellites deployed! It was a beautiful view out our window too!!"

Three small satellites in flight after deployment from the ISS (©JAXA/NASA)

Technical Verification Mission for the Small-Satellite Deployment System

The mission objective was to use the JEM Airlock and the JEM Remote Manipulator System (JEMRMS) to establish an operational procedure for the deployment of small satellites. Astronaut Hoshide and the JAXA Flight Control Team (JFCT) at the Tsukuba Space Center (TKSC) collaborated to carry out this mission. During the first set of deployments on October 4, Astronaut Hoshide performed operations from inside the JEM Kibo Pressurized Module (PM) to release two satellites—WE WISH (Meisei Electric Co., Ltd.) and RAIKO (Wakayama University / Tohoku University). During the second set of deployments on October 5, deployment commands were sent from the Kibo Mission Control Room (MCR) at TKSC to release three satellites—F-1 and TechEdSat, which were chosen by NASA after a public call for proposals, and FITSAT-1 (Fukuoka Institute of Technology). After fulfilling their respective missions for approximately 250 days while orbiting the Earth, the five small satellites will re-enter the Earth's atmosphere.

Astronaut Hoshide's Twitter feed

October 21

"Preparing medakas' house. They will arrive this week. We'll be waiting!"

Astronaut Hoshide transfers the medaka to the AQH experimental aquarium (©JAXA/NASA)

Astronaut Hoshide's Twitter feed

November 1

"EVA complete. Thanks to the GREAT team on the ground, and all who supported us!"

Astronaut Hoshide during the 2nd EVA (US EVA19) (©JAXA/NASA)

While inside the JEM Kibo PM, Astronaut Hoshide answers questions from students gathered at TKSC (©JAXA/NASA)

Aquatic Organism Experiment

On August 14, Astronaut Hoshide set up the AQH in the JEM Kibo PM. This apparatus will be used in a life science experiment titled, "Effect of microgravity on osteoclasts and the analysis of the gravity sensing system in medaka" (Medaka osteoclast). The objective of the experiment is to breed medaka (Oryzias latipes, a type of small freshwater fish) inside the ISS over a period of approximately two months, and—using medaka cells—analyze bone metabolism in the space environment, particularly in relation to bone mass decrease, which occurs in the space microgravity environment. This is the first time an experiment involving the breeding of aquatic organisms has been conducted on the ISS.

After switching on the power of the AQH on October 24, medaka brought to the ISS as part of the payload aboard Soyuz TMA-06M—which arrived on October 25—were transferred from the delivery container to the AQH experimental aquarium. Subsequently, the automatic feeding system of the AQH began providing food to the fish, hence marking the start of the experiment.

Extra-Vehicular Activity (EVA)

Together with NASA Astronaut Sunita Williams, Astronaut Hoshide performed three EVA during his long-duration mission aboard the ISS.

August 30: 1st EVA (US EVA18)

Tasks for Astronauts Hoshide and Williams included the replacement of one of the four US segment Main Bus Switching Units (MBSUs)—MBSU#1, which had malfunctioned. However, the astronauts experienced difficulty in removing connecting bolts of the old MBSU, and were unable to tighten up the bolts for the new unit. This meant that the MBSU replacement procedure would need to be completed during the next EVA.

September 5: 2nd EVA (US EVA19)

As a continuation of the work begun during the previous EVA, the astronauts successfully completed the replacement of MBSU#1 after performing cleaning procedures on the unit's bolts and stanchions to remove metal shavings that had adhered to the components, and applying grease to lubricate the bolts. They then carried out their next task, which had been postponed from the 1st EVA due to lack of time—replacing the SSRMS Boom B Camera Light Pan/Tilt Assembly (CLPA).

November 1–2: 3rd EVA (US EVA20)

This EVA was performed to fix an ammonia coolant leak in the Photovoltaic Thermal Control System (PVTCS) of one of the ISS solar arrays. Since it was thought that the leak was occurring in a radiator that is part of the PVTCS, Astronauts Hoshide and Williams reconfigured two ammonia jumpers to a backup radiator, and prepared the backup radiator for deployment. Subsequently, the backup radiator deployed normally after receiving commands from flight controllers on the ground.

Over the three EVA performed during this mission, Astronaut Hoshide spent a total of 21 hours and 23 minutes outside the orbiting space station, giving him the record for the longest aggregate EVA time by a Japanese astronaut. In addition, Japan now ranks third after the United States and Russia for cumulative EVA time.

Educational and Public Relations Activities

The final live communication event during this long-duration mission was titled, "Science Café on a Long Autumn Night @ Tsukuba Space Center." In Part I of the event, undergraduate and graduate students in space-related fields discussed such topics as the utilization of space and the ISS and the significance of manned space activities from their unique perspectives as students, and exchanged opinions on their hopes regarding future space activities.

Astronaut Hoshide closed the event with the following message: "Among the many experiences I have had over the last four months, although there have been difficulties along the way, I have a great bunch of colleagues in the Flight Control Team and in other roles on the ground, and I have really come to understand how important everyone's contribution is to making such a large-scale project successful. I wish you all the best in striving to make your dreams come true." The event was an excellent opportunity to foster interest in space among young people who may have not previously been attracted to the space field.

Reaffirming Our Commitment after 20 Years of Progress

Image courtesy of JAXA/NASA

JAXA Astronaut Akihiko Hoshide sent us a photograph he took during an extra-vehicular activity (EVA). Captured as reflections in his sun visor, we can see the International Space Station (ISS)—including the Japan Experiment Module (JEM) Kibo—as well as planet Earth.

On September 12, 1992, Astronaut Mamoru Mohri commenced the Fuwatto '92* space experiments aboard the Space Shuttle, which marked the beginning of Japan's manned space missions. Since then, Japan has acquired a diverse range of manned space technologies through such programs as the development, assembly and operation of JEM Kibo, and three consecutive successfully completed missions by the H-II Transfer Vehicle (HTV)—a resupply spacecraft for the ISS.

As humankind reaches an important juncture on its journey into the future, many problems must be addressed globally, while yet-unknown frontiers stretch out ahead of us in space. Having overcome many challenges over the past 20 years, Japan's manned space program reaffirms its determination to achieve even greater progress in the future.

*The Japanese name given to a space experiment project jointly conducted by Japan and the United States during Space Shuttle mission STS-47. In Japanese, "*fuwatto*" has such meanings as "floating" or "weightlessness," and refers to experiments relating to the microgravity environment. The NASA name for this mission was Spacelab-J (SL-J).

Mamoru Mohri

Thanks to Japan's large pool of scientists and engineers, even fields in which we had no experience whatsoever, after 20 years of manned space missions we have come to play a leadership role internationally in such areas as scientific and technological experiments in space as well as space-based observation. By steadily utilizing this experience, we can look forward to Japan making major contributions to solving the issues affecting all of humankind through the field of space development.

Chiaki Mukai

The total amount of time spent in space by Japan's astronauts now ranks as the third longest, after Russia and the United States. The technology and information accumulated over these 20 years will, I believe, significantly contribute to attaining a high level of autonomy and flexibility in Japan's future manned space program. Let us combine our efforts in the future and pursue "space development for the sake of humankind!"

Koichi Wakata

I believe that Japan's manned space program is progressing with sure strides thanks to the efforts of many people. This includes the development and operation of JEM Kibo and the HTV resupply spacecraft for the ISS. As a world technology powerhouse, Japan can further increase its contributions in the field of manned space development. I want to help make this a reality by further bolstering my own efforts together with our excellent team supporting a system to open up space frontiers.

Soichi Noguchi

As we commemorate the 20th anniversary of Astronaut Mohri's first Space Shuttle flight, I feel we are on the cusp of a major turning point. Based on the achievements of my predecessors, I want to devote myself to making further great progress together with all other currently serving JAXA astronauts.

Akihiko Hoshide

I am honored to be present on the ISS and represent the people of Japan on this auspicious occasion for Japanese manned space activity—the 20th anniversary of Fuwatto '92. As an astronaut, I hope I can contribute—even if only modestly—to an era in which many people are able to travel into space over the next 20 years.

Note: This message was written by Astronaut Hoshide during his long-duration mission on the ISS.

Kimiya Yui

Twenty years have passed since Astronaut Mohri made his first space flight. I can still remember the excitement and thrill I felt when I saw his first flight on television. I inherit the wonderful tradition built up by all those who have served before me over the past 20 years, and I want to exert my utmost efforts so that we can forge a new era.

Naoko Yamazaki

On the occasion of this great 20th anniversary, I would like to thank all the people who have shown such dedication over the course of many space missions. I sincerely hope for further progress so that Japan will continue on to make even more contributions in manned space programs.

Takuya Ohnishi

In 1992, I was still in high school. In the 20 years since then, Japan's manned space program has made steady progress. Inheriting the knowledge and experience of my seniors, I too want to give my best as we take new steps toward the future.

Satoshi Furukawa

In 2011, I spent five-and-a-half months aboard the ISS, during which time I conducted a diverse array of scientific experiments. Although there were times when problems meant that things did not go as originally planned, we were able to solve these problems thanks to the combined efforts of the ISS crew and the ground team. The expertise and skills of our ground team are as good as any in the world, and I believe that having nurtured these abundant human resources, Japan is strongly placed to leverage this as a key asset for future endeavors.

Norishige Kanai

Japan's manned space activities—which began when Astronaut Mohri served aboard the Space Shuttle—are now firmly in the ISS era. We must maintain a strong determination to lead the way forward over the next 20 years and further develop Japan's space technology. To realize this goal, I intend to undertake training, missions and many other tasks as energetically as possible.

What is Happening in the Arctic?

Arctic Climate Change Captured by SHIZUKU's First Observations

Keizo Nakagawa
Project Manager,
GCOM Project Team
Space Applications
Mission Directorate, JAXA

Sequential Start to Provision of Observation Data from SHIZUKU

As of January 2013, eight months have passed since the launch of GCOM-W1 (SHIZUKU) on May 18, 2012. During that time, AMSR2—carried by SHIZUKU—began the continuous acquisition of observation data on July 3, 2012. At present, we are carrying out calibration and validation of the data, and plan to provide calibrated data to general users in the research community through the GCOM-W1 data provision web site (http://gcom-w1.jaxa.jp). The release of Level 1 product (brightness temperature) is scheduled to begin in January 2013, followed in May 2013 by the commencement of Level 2 product release, which will comprise eight physical parameters, including precipitation, sea surface temperature, sea ice concentration and soil moisture content. Continuing on from SHIZUKU, we are currently moving ahead with the development of the GCOM project's next satellite, Global Change Observation Mission 1st–Climate (GCOM-C1).

Global Change Observation Mission 1st–Water (GCOM-W1; "SHIZUKU"), which commenced observations in July 2012, has captured data showing significant shrinkage in the extent of Arctic sea ice and surface melting across the entire Greenland ice sheet. Professor Hiroyuki Enomoto, director of the Arctic Environment Research Center (AERC) at the National Institute of Polar Research (NIPR), and Masahiro Hori, an associate senior researcher at JAXA/Earth Observation Research Center (EORC) who is verifying data from SHIZUKU, talk about Arctic climate change.

Sea Ice Cover in the Arctic Ocean Recedes to Smallest Since Satellite Observations Began

Hiroyuki Enomoto
Professor
Director, Arctic Environment Research Center (AERC)
National Institute of Polar Research (NIPR)

My research area focuses on observation of the condition of Arctic and Antarctic snow and ice, and explanation of changes in these conditions in combination with meteorological data.

Dramatic changes are occurring at present in Arctic sea ice. The Arctic is one of the most sensitive areas in the world to the impact of environmental changes—global warming in particular. Accompanying the average rise in global temperature, changes have rapidly appeared in Arctic sea ice. From the beginning of the 2000s, the pace of shrinkage suddenly began to accelerate. In 2007, a substantial decrease in ice cover took researchers by surprise. However, in 2012, ice shrinkage occurred at a much quicker pace, and Arctic sea ice cover shrank to the smallest area since observations began.

Furthermore, in glacier-covered areas of the Northern Hemisphere, large bodies of ice—including the Greenland ice sheet and glaciers in such places as Norway and Canada—are melting. While it is impossible to obtain a detailed understanding of the situation in each specific area without measurements from buried sensors within the glaciers, we do know that apart from ice sheet melting and the associated outflow, melt water is causing ice to slide off the Greenland ice sheet into the sea faster. Consequently, it is predicted that sea levels will rise at more than twice the rate previously forecast.

At present, we are conducting a research project on the Arctic region based on a five-year plan. We have placed sensors at many observation points in areas surrounding the Arctic, including Greenland, Canada, Alaska, Russia, Norway and Finland. The RV Mirai, an oceanographic research vessel operated by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), also conducted surveys in the Arctic in September–October 2012 as part of joint research based on observation data from SHIZUKU. Through such efforts, we are studying changes in snow and ice in the Arctic region and how these changes are affecting Arctic climate change.

Water gushes toward the sea from a glacier that has begun to melt
(Photo by Makoto Sugiyama)

Arctic Research Bolsters Understanding of the Earth's Climate System

The most hotly discussed topic in relation to Arctic climate change is the decrease in Arctic sea ice. The global benchmark data series that record this phenomenon were gathered by Advanced Microwave Scanning Radiometer for EOS (AMSR-E)—developed by JAXA and carried by NASA's Aqua (EOS PM-1) satellite—and Advanced Microwave Scanning Radiometer 2 (AMSR2), which is aboard SHIZUKU.

The microwave radiometric data from AMSR-E and AMSR2 utilizes a variety of frequency bands. By using data from a combination of bands, researchers are able not only to identify the extent of ice cover but also such conditions as ice thickness and the amount of surface water. Microwaves are extremely sensitive to the presence of water, hence even when a small amount of water forms on the snow surface the radiometer is able to clearly pick this up. Abnormalities and significant changes in meteorological phenomena nearly always occur during bad weather. Cloud-piercing microwave sensors are extremely useful for finding out what is happening below cloud cover. Since microwave radiometers are able to provide daily observations of the same location during both daytime and nighttime, all year round and in all weather conditions, this technology has become indispensable for observing fast-changing natural phenomena.

SHIZUKU provides us with this type of crucial data. However, it is also very important for us—as observers on the ground—to understand how the situation appears from an Earth observing satellite. For this reason, our polar research group is conducting an array of data-gathering activities with small sensors that use frequencies matched to those used by AMSR-E and AMSR2. Our sensors are taken to key locations by various means—for example, installed on icebreaker vessels navigating the Arctic Ocean or affixed to snowmobiles or helicopters.

Our Arctic research project runs for five years, from 2011 to 2016. In 2012 we commenced full-scale observations. Not only is this research significant for Japan—which is affected by Arctic air flows—but it will also lead to a better understanding of the Earth's overall climate system.

Small microwave radiometers are being used for mobile and fixed-location observations as well as observation experiments

Building Long-Term Data for Use in Climate Change Forecasts

Masahiro Hori
Associate Senior Researcher
EORC

Observing Rapid Decline in Arctic Sea Ice

After its launch on May 18, 2012, SHIZUKU captured its first observation data image on July 3. Previously, AMSR-E—carried by NASA's Aqua satellite—had carried out observations for almost 10 years. Unfortunately, its operations ended in October 2011. Hence, the data from AMSR2—part of SHIZUKU's payload—was awaited with great anticipation.

When observations commenced in July 2012, we were able to see conspicuous gaps already opening up in Arctic sea ice. Subsequently, the area of ice cover rapidly shrank. By the beginning of August, the ice began to decrease at an unprecedented speed. On September 16, the extent of Arctic sea ice receded to 3.49 million km^2—the smallest size ever recorded. The average temperature in the Arctic has shown a linear rising trend for the past 30 years. Hence, we may see a continuation of high sea surface temperatures. I believe that Earth observing satellites have a key role to play in investigating how this situation will develop in the future.

Researchers Worldwide Hold High Expectations for SHIZUKU Observation Data

Another startling situation revealed soon after observations by SHIZUKU began was surface melting across the entire Greenland ice sheet. Although we had previously observed melting on the periphery of the ice sheet, it was the first time we had seen the phenomenon of surface water on inland parts of the ice sheet. Even as recently as the AMSR-E era of observations we had not seen such an event. However, this took place for a period of two days around July 12, and subsequently the area expanded in which we observed surface refreezing.

As described above, SHIZUKU produced some remarkable results very quickly after the start of its observation mission. We expect calibration and validation of observation data to be completed by May 2013, and look forward to this data being widely used by the research community. Japan's microwave radiometer technology is the most advanced in the world. The full global observations being carried out daily provide data not only on ice cover but also such parameters as soil moisture content and sea surface temperature. To understand climate change, long-term data is absolutely essential. The data gathered by AMSR-E during nearly 10 years of observations and the data that will be accumulated by AMSR2 will, I believe, become global benchmark data series.

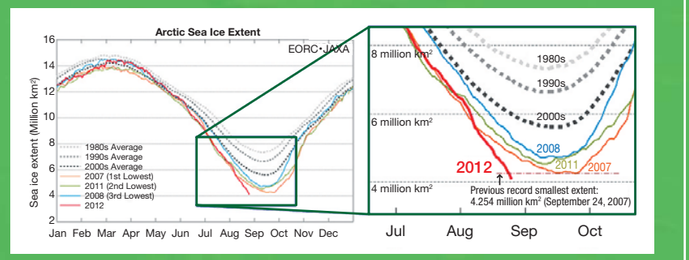
Images from SHIZUKU Provide a Snapshot of the Earth's Present State

Extent of Sea Ice in the Arctic Ocean Shrinks to Smallest on Record in the Satellite Era

On September 16, 2012, the extent of sea ice in the Arctic Ocean was measured at 3.49 million km^2, thus falling below four million km^2 for the first time since satellite observations began. Compared with the previous record of 4.25 million km^2 set in September 2007, the new record is equivalent to the loss of ice cover twice the area of the Japanese archipelago.

Left: Average distribution of sea ice minimum extent in September during the 1980s (based on analysis of data from microwave radiometers carried by U.S. satellites)

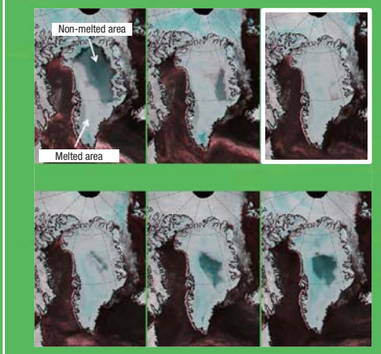
Right: Observation data captured on September 16, 2012, by AMSR2/SHIZUKU (data currently undergoing validation)



Seasonal change in the extent of Northern Hemisphere sea ice (as of August 24, 2012). Ice cover was 4.21 million km^2—the smallest extent ever recorded since satellite measurements began. The new record was a full month earlier than the previous record, which had been set on September 24, 2007.

Surface Melting Over the Entire Greenland Ice Sheet

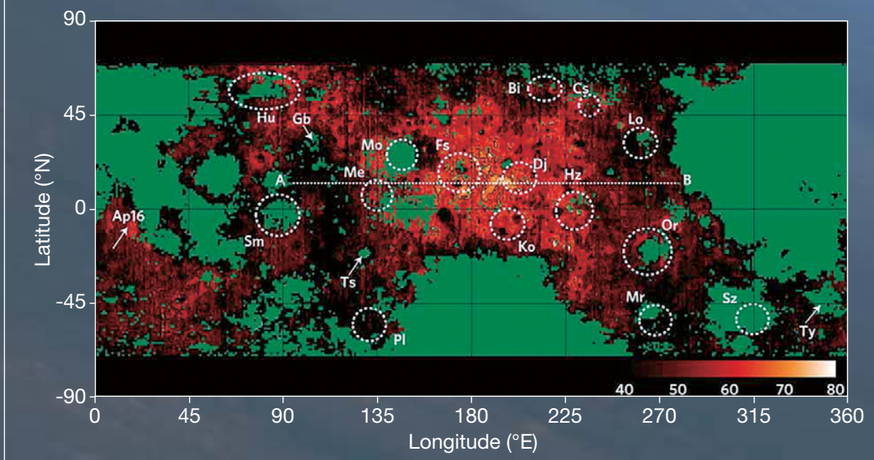
On July 12, 2012, data captured by SHIZUKU showed a rise in brightness temperature across almost the entire surface of the Greenland ice sheet. A high brightness temperature is thought to indicate the presence of water on the ice sheet surface (melted area). Normally, even during the summer months, the surface remains frozen on the inland parts of the Greenland ice sheet. These images indicate that there is a high probability surface melting occurred on inland parts of the ice sheet on this occasion.



SELENE Sheds Light on the Origin and Geological Evolution of the Moon

Japan's lunar explorer spacecraft, Selenological and Engineering Explorer (SELENE)—also known by its Japanese mission name "KAGUYA"—was launched on September 14, 2007, and proceeded to conduct detailed observations of the moon. The target of its observations included the lunar elemental composition, mineral composition, topography, subsurface structure and gravitational fields related to magnetic anomalies. At present, researchers worldwide are carrying out analysis of SELENE observation data, which has already led to the discovery of important clues that may help to unlock the mysteries of the moon's origin and geological evolution. In this article, Associate Professor Kazuto Saiki of Osaka University, who has been closely involved in the SELENE project, provides an introduction to some of the latest developments in lunar science.

Kazuto Saiki
Associate Professor
Department of Earth and Space Science
Graduate School of Science
Osaka University



This figure—published in the British scientific journal *Nature Geoscience* (online edition) on April 29, 2012—shows spectroscopy data from SELENE. Rocks with high magnesium content (indicated by red coloration) are abundant on the lunar farside (central half of the figure; 90–270°E longitude), but become less abundant on the lunar nearside (left and right quarters of the figure; 0–90° and 270–360°E longitude). Although it is thought that a magma ocean covered the lunar surface during the moon's formative period, a likely scenario may be drawn under which the magma ocean during the early part of the period had high magnesium content relative to iron and the expanse of magma shrank during the latter part, hence cooling and crystallizing initially on the lunar farside.

Scenario of the Moon's Geological Evolution Developed from SELENE Observation Data

Current research on the moon's origin and geological evolution focuses on three main topics. The first topic relates to the magma ocean hypothesis, which posits that in the past a giant impact event caused melting to significant depth on the moon. It is thought that when the magma ocean cooled, plagioclase feldspars emerged, forming the lunar crust. Is this hypothesis correct? If so, we need to clarify the process through which the moon's crust and mantle were formed.

The second topic of research relates to the aforementioned giant impact hypothesis, which states that the moon was formed from debris left over from a collision between the Earth and a body the size of Mars approximately 4.5 billion years ago. Within the magma ocean hypothesis, there is the problem of what could have been the source of heat large enough to melt the moon to a depth of several hundred meters. However, under the giant impact hypothesis, the moon started out in a molten state, hence this problem does not require further explanation. Nevertheless, we must henceforth determine whether or not the giant impact hypothesis is correct.

The third topic is the lunar mantle overturn model. This model postulates that as the magma ocean cooled, the magma became heavier than the rock below it, leading to a reversal in position at some point and the formation of the present-day lunar crust and internal structure. We may also postulate that such a mantle overturn created the differences between the near and far sides of the moon.

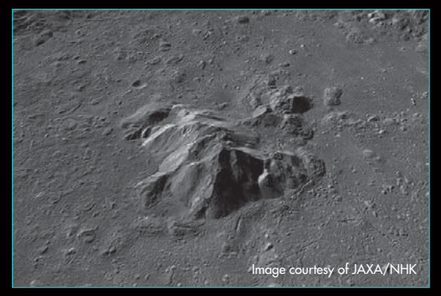
While researchers currently work to gather evidence that will prove which of these hypotheses are correct, as the calibration accuracy of SELENE observation data increases, new research results are constantly being announced. For example, a research paper—of which I am a co-author—led by Makiko Ohtake of JAXA's Institute of Space and Astronautical Science (ISAS) uses spectral profiler*1 data from SELENE to report on the relative ratio of iron to magnesium contained in rocks over the entire lunar surface. Based on the results of this analysis, we are able to build a scenario under which the lunar farside crust began to crystallize earlier than its nearside counterpart (please refer to the figure on page 18). I believe that this research represents one of the most important achievements to date from the SELENE project.

Candidate Landing Spots for the Next Lunar Explorer

I would also like to briefly discuss the candidate landing spots for SELENE-2, JAXA's proposed successor to KAGUYA. Thanks to the emergence of research results stemming from the SELENE project, I have been able to co-author research articles with experts from fields with which I previously had no contact. Hence, I believe SELENE has spurred a broadening of communication opportunities among scientists. I have been interested in utilizing such dialogue to discuss with a variety of scientific bodies what type of research scientists are hoping to do through the SELENE-2 project and find out preferred locations for such research

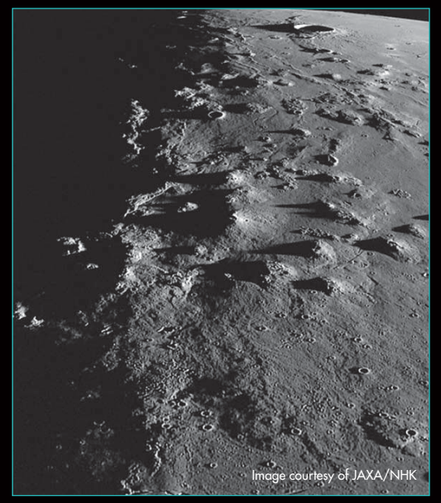
Lunar Exploration Points Highlighted by Associate Professor Saiki

Tycho Crater Central Peaks



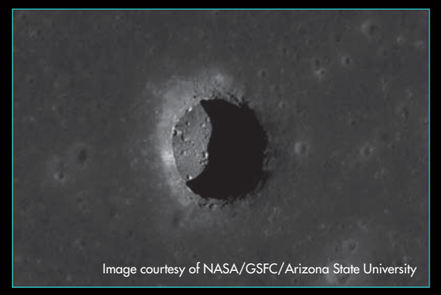
This is the central peak complex of the Tycho Crater, located in the southern hemisphere of the moon's nearside. The highest peak rises 2,480 meters above the crater floor. The peak complex is the result of upheaval from the impacting meteorite's rebound, and is thought to have exposed underground material from 5–30 kilometers deep. This makes it an important location for researching the moon's internal geology.

Marius Hills



The Marius Hills area encompasses several hundred small volcanic domes, which were formed by past volcanic activity. "It is believed that eruptions in this area included lava spouts. We hope to gain an understanding of the mechanism of volcanic activity involving volatile elements."

Lava Tube Skylight



This is one of the first ever discoveries of a lava tube skylight—reported by Assistant Professor Junichi Haruyama of ISAS. Its diameter is approximately 100 meters. This image was captured by NASA's Lunar Reconnaissance Orbiter (LRO) based on information from SELENE. "Since only three such skylights have been identified over the entire lunar surface, we would like to earmark at least one for Japan's manned lunar base."

on the moon's surface. Consequently, approximately 70 candidate landing spots were put forward for SELENE-2. Over a period of two years, this initial total was reduced to 10 candidate spots. From among these, I would like to introduce the main candidates.

The first candidate region encompasses the Copernicus, Tycho and Zucchius craters, whose investigation includes such objectives as elucidating the history of the formation of the lunar crust and differences between the near and far sides of the moon—or what may be termed the dichotomous nature of the lunar geology. The Copernicus and Tycho craters contain central peaks*2. Since it is thought that this area includes material that has risen up from deep underground, investigation of rocks here may provide valuable information on the moon's deep geology. Zucchius Crater is believed to contain remnants of the lunar crust from its earliest period.

Another candidate landing area is the Marius Hills, a set of small volcanic domes. Similar to such terrestrial volcanoes as Japan's Izu Oshima, they are thought to have formed where magma burst up through the surface. SELENE's Terrain Camera (TC)*3 found evidence of a skylight in a large underground lava tube, which may have significant value for future lunar exploration. This lava tube is believed to have formed during underground lava flows, and the tube's opening to the surface was probably created by a meteorite impact. The lava tube's walls are likely coated in glass, thereby providing an airtight enclosure. Since such an underground lava tube interior would also be shielded from cosmic radiation, it may be a candidate location for a future lunar base.

Revealing the Earth's History through Lunar Exploration

In the past, it was thought that the moon was a simple astronomical object and that its internal structure conformed to the concentric model. However, it is now known that the moon's structure is, in fact, very heterogeneous. The question of what happened on the moon is of very great scientific interest, and I believe that if we can answer this question satisfactorily it will be very useful for understanding the Earth's formative period. On the other hand, when I look back at my own reasons for pursuing research in this field, since childhood my dream has been to expand the boundaries of human activity. Although I was too young to have much memory of the Apollo program, which brought back to Earth rocks from the moon, I was fascinated by the images sent back by the Pioneer 10 and 11 space probes revealing many secrets of the outer planets. Such achievements convinced me that by the time I grew up, humans would be living on the moon. I am still keen to see the early construction of a colony on the moon, and hope that this will be the forerunner of more distant space endeavor by humanity.

*1: Spectral Profiler
This instrument measures the continuous spectrum of visible, near-infrared light reflected by the surface of the moon, which provides information on the mineral composition of the moon's geology.

*2: Central Peaks
Gravity causes an upheaval in the central part of a crater made by a meteorite impact, forming what is called a central peak complex. It is thought that material from deep within the moon's geology is exposed near the surface in such areas.

*3: Terrain Camera
This instrument captures topographic data using two high-resolution cameras to obtain stereoscopic images.

DREAMS Project—Developing the Next-Generation Air Traffic Management (ATM) System to Ensure Safe and Comfortable Global Aviation

Five Core Technology Areas

1 Weather information technology
2 Noise abatement technology
3 High-accuracy satellite navigation technology
4 Trajectory control technology
5 Disaster-relief/small aircraft operation technology

Air transportation is undergoing significant growth, driven particularly by development of the economies of China and Asia. It is predicted that in 2030 the global volume of air traffic will be double today's level. To avoid airspace congestion in the future, there is an urgent need to develop an innovative ATM system that addresses aircraft operational and safety issues. In this article, Project Manager Masatoshi Harigae explains the next-generation ATM system currently being researched and developed by JAXA, dubbed DREAMS ("Distributed and Revolutionarily Efficient Air-traffic Management System")*1.

Projects Around the World Address Aviation's "2030 Problem"

In the foreseeable future, the world's current ATM system is likely to reach its capacity limit and be unable to cope with global air transport demand. According to aviation demand forecasts, not only will passenger and cargo traffic increase, but a shift from dominance by large aircraft to more small and medium-sized aircraft will contribute to 5% compound annual growth in aircraft movements (flights), leading to a doubling in flight numbers by 2030.

In 2003, the International Civil Aviation Organization (ICAO)—which sets the operational rules for the world's civil aviation sector—proposed the Global Air Traffic Management Operational Concept as a common future vision for integrated and globally harmonized ATM. Based on this concept, countries and regions around the world have commenced research and development of systems that respond to future growth in air traffic volume. For example, the United States is pursuing its Next Generation Air Transportation System (NextGen) program, while Europe is working on the Single European Sky ATM Research (SESAR) project.

In Japan, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) is leading efforts under the Collaborative Actions for Renovation of Air Traffic Systems (CARATS) program, a long-term vision to transform Japan's air traffic system, which sets such goals as enhanced safety and capacity expansion to handle future growth in air traffic volume. In collaboration with the CARATS program, JAXA is conducting research and development under the DREAMS project to establish technologies that will respond to future air traffic needs.

Five Core Technology Areas

DREAMS' objectives encompass five core technology areas—weather information, noise abatement, high-accuracy satellite navigation, trajectory control and disaster-relief/small aircraft operation.

1 Within **weather information technology**, DREAMS aims to increase risk prediction accuracy relating to wake turbulence and low-level wind disturbances. Wake turbulence refers to the air vortexes that flow backwards from the tips of aircraft wings, and if trailing aircraft come into contact with this turbulence it can lead to significant problems stemming from sudden changes in dynamic lift. By realizing more accurate predictions of risk of encounters with wake turbulence, it becomes possible to reduce the takeoff and landing interval between aircraft by an average of 10%. This would allow an airport to handle a greater number of flights.

2 **Noise abatement technology** reduces the impact of noise in areas close to aircraft flight paths. By calculating the optimum approach path based on such factors as wind direction and strength and atmospheric conditions, the aircraft can be guided so that noise impact is reduced.

Masatoshi Harigae
Project Manager
DREAMS Project Team

3 **High-accuracy satellite navigation technology** has the objective of providing an aircraft with the optimum flight course. Owing to the effects of such phenomena as plasma bubbles*2 that occur in the ionosphere, errors can arise in signals from Global Positioning System (GPS) and other satellites, which are used for aircraft navigation. By combining the use of satellite navigation systems with an onboard inertial navigation system, we are working to achieve greater navigation reliability.

4 **Trajectory control technology** aims to provide the optimum landing approach path for an aircraft. The technology assists manual pilot control or executes instrument control during a curved landing approach, thereby enhancing flight safety.

5 **Disaster-relief/small aircraft operation technology** principally focuses on increasing the efficiency and safety of helicopter dispatch and control operations. Unlike the other four technology areas covered by DREAMS, this technology is designed to be utilized in emergency situations. When a helicopter arrives in a disaster-affected area, necessary information is shared with other responding aircraft as well as the disaster management headquarters via onboard terminals in each aircraft. This enables the dispatcher to give precise instructions, thereby eliminating unnecessary idle time and reducing the risk of near-midair collisions. Although this type of technology is not being developed under the NextGen or SESAR programs, disaster management technology has an essential role to play in every country. Hence, if the technology's utility is recognized, it has the potential to become an original, Japanese-developed technology adopted worldwide.

Targeting 2015 for Establishment of New Technologies

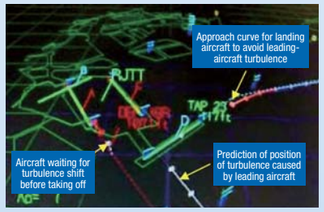
The DREAMS project will carry out large-scale, ongoing field testing of new technologies, and by 2015 aims to submit proposals to international standards bodies, and transfer technology to private-sector companies. If technology from the DREAMS project is successfully established, it will not only provide stimulus to the entire Japanese aviation industry but also contribute to the international community by making technology available to countries that lack such technology.

***1: Distributed and Revolutionarily Efficient Air-traffic Management System (DREAMS)**
By using a distributed system—under which some of the ATM functions previously handled by ground-based facilities are carried out by equipment onboard each aircraft—DREAMS technology development aims to realize efficient and safe operations.

***2: Plasma bubbles**
A phenomenon in which localized ionosphere irregularities lead to plasma density depletion in parts of the equatorial ionosphere. Since this phenomenon rises from the lower to the upper ionosphere, it is referred to as a bubble. Plasma bubbles can cause fluctuations in GPS radio wave signals.

Examples of DREAMS Project Technology Applications

//Expansion of Airport Flight Capacity//



Through the use of ATM instructions that take into account predictions of the risk of encounters with wake turbulence, we have confirmed that aircraft takeoff and landing intervals can be reduced by an average of 10%.

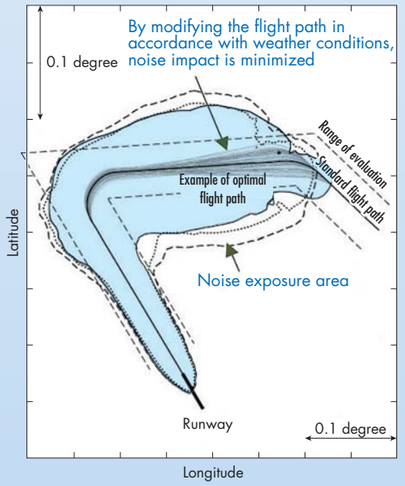
//Optimized Operation of Disaster-Relief Aircraft//

Based on helicopter flight data from disaster operations in response to the Great East Japan Earthquake, under a simulation using disaster-relief/small aircraft operation technology (D-NET*), we have confirmed that aircraft waiting time is reduced by 45% and operational efficiency (number of missions carried out) is increased by 46%.

*D-NET: Disaster Relief Network

	Number of missions carried out (Per aircraft)	Idle time (Hours per aircraft)			Near-midair collisions (Times per aircraft)
		Mission assignment waiting	In-air standby (Takeoff and landing waiting time, etc.)	Ground standby (Refueling waiting time, etc.)	
D-NET not utilized	3.0	5.29	0.24	1.25	6.8
D-NET utilized	4.4	3.42	0.09	0.19	3.0
Impact of D-NET utilization	+46%	–35%	–62%	–85%	–57%
		Total –45%			

//Low-Noise Flight Operation //



····· Flight traffic: current level; Non-optimized flight paths
– – – Flight traffic: 50% increase; Non-optimized flight paths
○ Flight traffic: 50% increase; Optimized flight paths

We have confirmed that even if flight traffic increases by 50%, the impact of noise will remain equivalent (solid line) to current levels (dotted line).

JAXA's Frontier

Astronaut Soichi Noguchi (left), who was appointed president of ASE-Asia

Association of Space Explorers (ASE) XXV Planetary Congress Ratifies Formation of ASE-Asia

The Planetary Congress—an international conference organized by the ASE—is held in a different host country each year. Comprising astronauts and cosmonauts from 35 countries, the ASE utilizes its members' experience of space flight to contribute to space development, encourage international cooperation in the human exploration of space, promote education in science and engineering, foster greater environmental awareness and realize other related objectives.

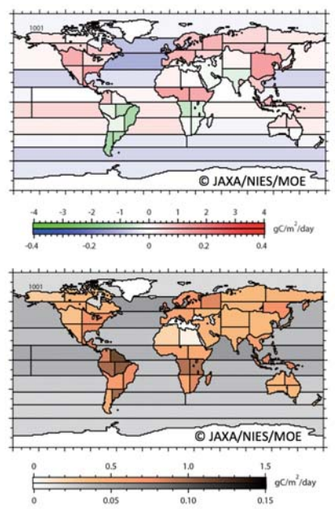
The ASE XXV Planetary Congress was held November 5–10, 2012, in Riyadh, Kingdom of Saudi Arabia. During ASE's annual assembly, ASE-Asia was formed as the newest regional chapter of ASE, and JAXA Astronaut Soichi Noguchi was appointed president of the chapter. Astronaut Noguchi commented that ASE-Asia would promote lively discussion with the aim of contributing to the Asia region through space development and utilization.

GOSAT (IBUKI)

Public Release of CO_2 Flux Estimates Based on GOSAT Observation Data

Greenhouse Gases Observing Satellite (GOSAT; Japanese mission name: "IBUKI") is the world's first and only satellite dedicated to greenhouse gas monitoring. Since it was launched on January 23, 2009, it has continued to carry out its objective of observing from space the densities of carbon dioxide and methane in the Earth's atmosphere.

Recently, JAXA and its partners—the National Institute for Environmental Studies (NIES) and Japan's Ministry of the Environment (MOE)—made a public release of global net CO_2 flux estimates on a monthly and regional basis for the 12-month period between June 2009 and May 2010. These CO_2 flux estimates combine data collected by ground-based observation sites with GOSAT observation data on CO_2 concentration, which provide increased accuracy through the use of refined data processing algorithms for modeling greenhouse gas densities. It is the first time worldwide that such data has been released to the public. These estimates quantitatively demonstrate the utility of CO_2 concentration data from satellite-based observation.



These figures show net CO_2 fluxes in January 2010 for 64 regions (top) and their uncertainties (bottom), estimated from both ground-based monitoring data and GOSAT data. The upper and lower color-coded scales are for land and oceanic regions, respectively. The unit presented is $gC/m^2/day$—a unit used to measure net CO_2 flux. It expresses the net amount of CO_2, converted into the amount of carbon exchanged between the biosphere and atmosphere in one square meter of surface in one day. Positive values indicate net emission, and negative values indicate net absorption.

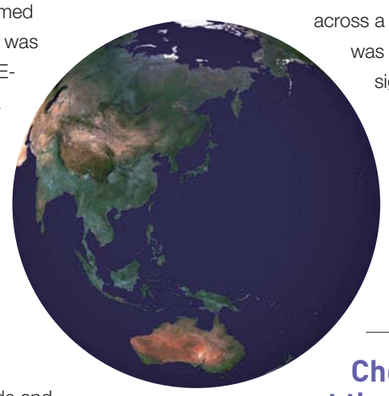
IKAROS Recognized by GUINNESS WORLD RECORDS™*

JAXA's Small Solar Power Sail Demonstrator IKAROS—launched on May 21, 2010—and its two DCAM deployable cameras (subsatellites) have received recognition from GUINNESS WORLD RECORDS™. The two records certified are as follows.

1. IKAROS: First interplanetary solar sail spacecraft
2. DCAM1 and DCAM2: Smallest interplanetary subsatellites

Message from Osamu Mori, IKAROS project leader:

The IKAROS name itself reflects the determination we had in overcoming the difficult technical challenges presented by this project. Since our primary objective was to demonstrate the world's first solar sail, we are very proud to receive this recognition.



Message from Hirotaka Sawada, engineer in charge of DCAM development:

The most exciting moments for me during my involvement with the IKAROS project were when we received the images sent back to Earth by the DCAM deployable cameras.

*GUINNESS WORLD RECORDS is a trademark of Guinness World Records Limited.

IKAROS project leader Osamu Mori (left) and engineer Hirotaka Sawada hold the GUINNESS WORLD RECORDS™ certificates while standing in front of a scale model of IKAROS.

JAXA and RWTH Aachen University of Germany Sign Collaboration Agreement

JAXA and RWTH Aachen University of Germany have agreed to promote collaboration across a comprehensive range of research and education fields. The partnership was formalized through the Framework Agreement for Cooperation, which was signed by representatives of the two organizations on September 28, 2012. It marks JAXA's first comprehensive cooperation agreement with an overseas university. RWTH Aachen University has been recognized as a University of Excellence by the German Research Foundation (DFG) for two five-year periods beginning in 2007 and 2012. The university has a particularly strong reputation in engineering and science fields. The agreement partners have set up a liaison council to promote such activities as collaborative research and various exchange programs.

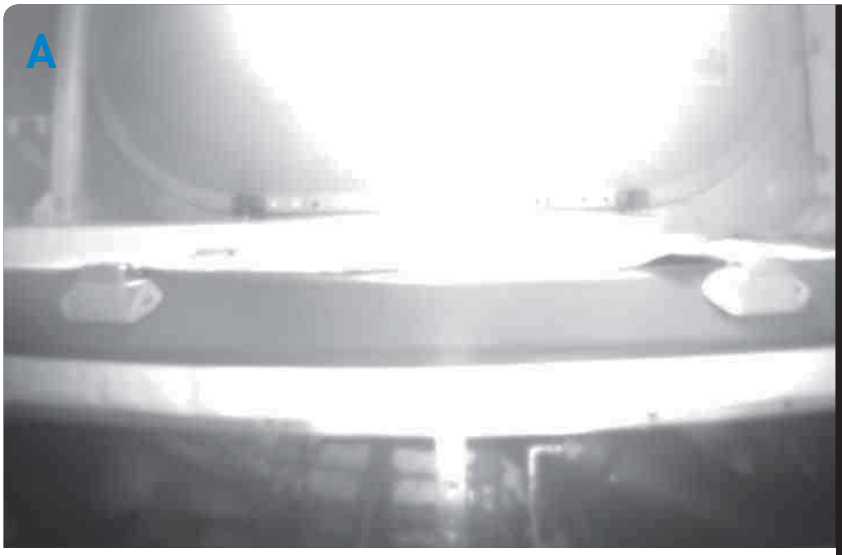
President of JAXA Dr. Keiji Tachikawa (left) and Rector of RWTH Aachen University Professor Ernst Schmachtenberg at the agreement signing ceremony in Aachen, Germany

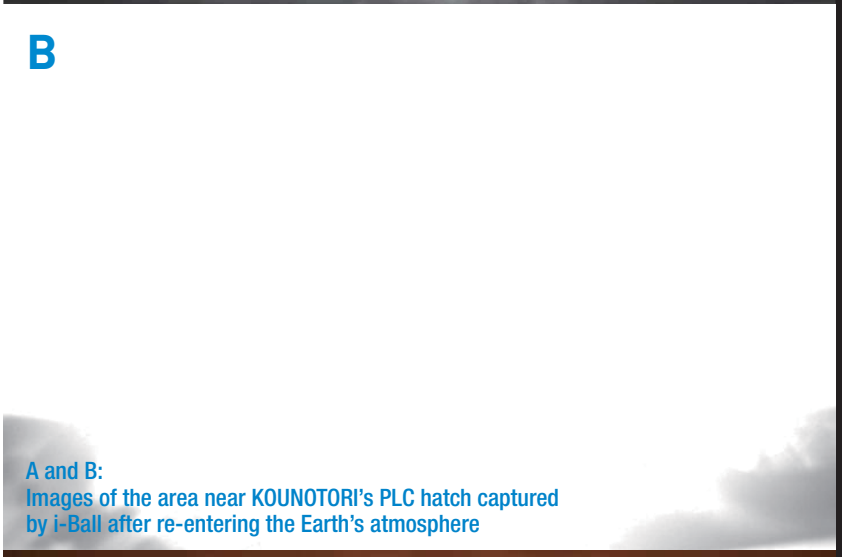
Chopin—The Space Concert Wins Grand Prix at the Angel Film Awards–Monaco International Film Festival

The feature documentary film Chopin—The Space Concert won the ANGEL TROPHY for Best Film of The Festival at the 2012 Angel Film Awards–Monaco International Film Festival. As an international collaboration contributing to friendship between Poland, the United States and Japan, the film also took away the Best Feature Documentary award at the festival. JAXA Astronaut Soichi Noguchi was integrally involved in the making of the documentary as a member of the Expedition 22 crew aboard the ISS. As well as appearing in some scenes, Astronaut Noguchi actually shot much of the footage on the ISS. Although Noguchi was unable to attend the festival, he was represented by Midori Nishiura, Executive Advisor for JAXA Public Affairs & International Relations. The Chairman of COPUOS Dr. Yasushi Horikawa was also in attendance. The Angel Film Awards–Monaco International Film Festival is a well-established, independent event celebrating peace and cultural unity, and particularly aims to promote non-violent films.

Chopin—The Space Concert, directed by Adam Ustynowicz of Poland, follows the crew of Space Shuttle Endeavour STS-130 and the ISS Expedition 22 crew as they install the ISS' Italian-built Tranquility node and the seven-window Cupola module in February 2010. The work of the astronauts and cosmonauts was accompanied by the music of the greatest poet of piano—Fryderyk Chopin. The Endeavour had brought a recording of Chopin played by Tomasz Radziwonowicz especially for this task, and the crews were energized by the emotional, pure art form of Chopin's music.

At the awards ceremony, from left: Midori Nishiura, the director's daughter Natalia Ustynowicz, Adam Ustynowicz and Dr. Yasushi Horikawa





A and B:
Images of the area near KOUNOTORI's PLC hatch captured by i-Ball after re-entering the Earth's atmosphere

C and D:
Images of part of KOUNOTORI's fuselage captured by i-Ball's rear camera
Images courtesy of JAXA/IHI Aerospace Co., Ltd.

i-Ball Witnesses KOUNOTORI3's Last Moments

i-Ball Captures Images and Data during Atmospheric Re-entry by KOUNOTORI3 (HTV3)

On September 14, 2012 (JST), the i-Ball Re-entry Data Recorder—carried aboard KOUNOTORI3—successfully captured images of the atmospheric re-entry by JAXA's unmanned resupply spacecraft for the ISS. After splashing down in the South Pacific Ocean off the coast of Chile, i-Ball sent data totaling approximately 1.7MB to a waiting team in Hokkaido. This valuable data will be useful in the future for such purposes as the precise targeting of recovery zones for re-entry vehicles and the design and development of extremely reliable manned spacecraft.

i-Ball (right) with its storage container

i-Ball loaded onto an HTV Resupply Rack (HRR) in the Pressurized Logistics Carrier (PLC)

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