Regarding large-scale climate change in particular, Japan promotes global observation, prediction and influence evaluation. Japan also promotes the research and development of measures against large-scale natural disasters, in addition to the research and development of new resources, the survey and cyclical use of energy, and creation of alternative sources for the stable supply of resources and energy. Furthermore, Japan promotes research on the understanding of pathogens, and for the prevention, diagnosis, and treatment of emerging and reemerging infectious diseases.

1) Research and development on climate change

(i) Promotion of earth observation

In order to understand global warming status, nations and organizations across the world conduct various earth observations from satellites, land and sea. To make worldwide efforts to solve climate change problems even more effective, it is important to 1) link these information gained through these observations with international cooperation, 2) establish useful scientific knowledge as a basis of policy making in each nation through the consolidation and analysis of the information, and 3) establish an international system (Global Earth Observation System of Systems (GEOSS)) comprised of multiple systems that allow each nation and organization to easily access the observation data and scientific knowledge. An intergovernmental meeting Group on Earth Observations (GEO) was established as an international framework for the promotion and establishment of GEOSS. 155 nations and organizations participated, and Japan plays a leading role as one of the executive committee members of GEO.

a) Observation by satellites

Earth observation by satellites is an extremely effective observation method that enables repeated and continuous information gathering over a broad range. Therefore, Japan comprehensively promotes such observation in cooperation with domestic and overseas related organizations, in order to solve global environmental problems.

The Greenhouse gases Observing SATellite "IBUKI" (GOSAT) that was launched in January, 2009, has measured the concentration, distribution and changes of global greenhouse gasses and has performed global observations that are necessary to improve the estimation accuracy of the absorption and discharge of greenhouse gasses, all of which contribute to the further promotion of measures against global warming. IBUKI was highly successful in, for example, improving the understanding of global concentrations and distributions of carbon dioxide and methane and their seasonal deviations. The National Institute for Environmental Studies steadily operates the processing system of GOSAT (data process/provision and data verification).

Japan Aerospace Exploration Agency (JAXA) has performed observations with Advanced Land Observing Satellite "DAICHI" (ALOS) (the operation ended in May 2011) and conducts research on the reduction of greenhouse gas emissions, as originated from the reduction/deterioration of forests in developing countries Reducing Emissions from Deforestation and forest Degradation - plus (REDD+). JAXA also processes and provides the data acquired from the Precipitation Radar (PR) loaded on the Tropical Rainfall Measuring Mission (TRMM) and the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) (the operation ended in October 2011) loaded on the Earth Observation Satellite (Aqua). Furthermore, in order to further contribute to improvements in

climate-change prediction accuracy, JAXA promotes earth observations with the practical use of satellites, such as the research and development of the Global Change Observation Mission-Water "SHIZUKU" (launched in May 2012), and uses Earth observation satellites and sensors that can collect and provide various data from around the globe about Earth's environment, such as rainfall, clouds, aerosol, and vegetation.

The Ministry of the Environment promotes observation on the global circulation of carbon in order to help to understand climate change and its impacts in cooperation with related ministries, agencies and organizations. In concrete terms, the ministry performs continuous observations by aircraft and vessels and performs observations of forests, in addition to the development of techniques to observe global carbon dioxide and methane by GOSAT.

Greenhouse gases Observing SATellite "IBUKI" (GOSAT)
Courtesy of Japan Aerospace Exploration Agency (JAXA)

b) Observation with electromagnetic wave sensing

MIC drives the research and development of 1) aircraft-loadable, synthetic-aperture radar (Pi-SAR2) that can enable the understanding of the land surface situations of damaged areas whenever a disaster occurs, regardless of time or weather conditions, and 2) next-generation Doppler radar technology at the National Institute of Information and Communications Technology (NICT) that is effective for the observation and prediction of sudden and local disasters. The institute also developed the Superconducting, Submillimeter-Wave, Limb-Emission Sounder (SMILES[1]) that was loaded onto the exposed section of the Japanese Experiment Module (KIBO) of the International Space Station. Furthermore, the ministry conducts research and development on electromagnetic environments and the use of radio in the geosphere and in space, and in particular, has established an international platform focusing on Asia and Oceania, in order to comprehensively collect, manage, analyze and distribute space/earth environmental observation data. The minster also promotes development of space environment informatics[2] technology to upgrade observation/sensing technologies and numeric calculation technology, and to process great amount of data.

c) Ground observation and oceanographic observation

MEXT and the Japan Meteorological Agency make efforts to maintain the Advanced Ocean Observing

1 It measures the amount of ozone by directing its antenna toward the atmosphere rim to receive sub-millimeter wave (Radio of frequency between 200 GHz through 3,000 GHs is called sub-millimeter wave. SMILES uses sub-millimeter waves ranging from 624 GHz through 650 GHz) which are radiated from a very small amount of molecules in the atmosphere. A high sensitivity low noise receiver with a super-conduction sensor is used.

2 Technology used to process and extract information from great amounts and various data generated by simulations and observations on the space environment.

System (ARGO project) that constantly observes oceans around the world through international cooperation, and in order to monitor and understand the situation of world-wide oceans in real time. This project intends to build a system that constantly observes entire oceans by setting 3,000 units of observation equipment (ARGO float) into oceans all over the world. The ARGO float automatically floats up and sinks down between the surface of the sea and 2,000m of depth, observes water temperature and salt content, and reports the data through a satellite.

The Japan Meteorological Agency performs observations of greenhouse gasses in the atmosphere at three domestic observation-points and at the South Pole Showa Station. JMA also observes greenhouse gasses in the ocean atmosphere and in the surface water of the Northwest Pacific Ocean by using ocean-weather ships, and midair greenhouse gasses by using aircraft. Global-warming-related observed data, including the data mentioned above, is disclosed to the public along with analysis results. The observation of the ozone layer and ultra-violet rays is performed at four domestic observation points and the South Pole Showa Station.

Besides these activities, the Japan Meteorological Agency also collects and analyzes various observed data through vessels and through ARGO floats and satellites. JMA then announces information on the current situation and future prospects of Earth's environment as related to oceanic changes.

(ii) Promotion of research that contributes to the adaptation to climate change

The Meteorological Research Institute and Japan Meteorological Agency built a global-warming prediction, global-system model that can simulate the effects of aerosol on clouds, and the changes in ozone and carbon circulation. It also conducts near-future predictions of an approximately 10-year range in regard to climate changes and conducts long-term predictions based on an IPCC emission scenario. The institute also developed a precision cloud, local-climate model that possesses enough resolution to simulate Japan's unique local phenomena, and that can perform global-warming, regional predictions in specific details.

In order to understand the actual conditions of global warming and to take further administrative measures based on scientific knowledge, the Ministry of the Environment comprehensively promotes research on the elucidation of phenomena, future predictions, and on impact evaluations and measures by practical use of the fund for comprehensive environmental research promotion[1]. The following activities were conducted with the fund:

- "Comprehensive research on climate change scenarios for policy support and public awareness regarding global warming" (FY 2007 to FY 2011) in order to provide all levels of the Japanese public and the international community with information on climate change and global warming around the world and in Japan in a more accurate and simple manner.
- "Comprehensive research on the development and prevalence of methods to plan, predict and evaluate medium-to-long term policy options aimed at an Asian 'lower carbon society'" (FY 2009 to FY 2013 (planned)) in order to establish a low-carbon society in the Asian region and in order to achieve the

[1] Competitive research fund that is policy oriented with the purpose of contributing to environmental preservation and for the establishment of a sustainable society by the promotion of surveys, comprehensive research and technology development with all available researchers in various fields, from interdisciplinary and international perspectives, and based on the consideration that environmental problems can cause a critical and important impact to the foundations of human survival.

goal of keeping the global temperature increase within 2°C as compared to pre-industrialization levels, and to develop a load to realize the goal.

- "Comprehensive research on the impact assessment/adaptive policy regarding global warming"(FY 2010 to FY 2014 (planned) in order to realize a safe and secure climate-change-adaptive society by predicting the detailed impacts of global warming in Japan and Asia, and by avoiding/mitigating adverse impacts with adaptation measures.

In order to establish the recycling of food production in response to climate change, the Ministry of Agriculture, Forestry and Fisheries promoted 1) development of technology to reduce emissions and to improve absorption of greenhouse gasses, 2) development of a manufacturing technology system to realize low investment/recycled agriculture, 3) development of a system to support measures against the reduction/deterioration of forests in Asian tropical forests, and 4) development of a stable production technology and breeds of agricultural, forest and fishery products that are adapted to growing in a world affected by global warming.

National Institute for Land and Infrastructure Management (NILIM) is considering the establishment of applied, basic technology, in order to select and perform the optimal and practical measures of various types of river basins to reduce large-scale flood-disaster risks.

2) Research and development aimed at a stable supply of resources and energy

The government promotes research and development on the survey and recycling of new resources and energy and on the creation of alternative resources aimed at creating a stable supply of resources and energy (refer to 1(1) and (3) in Part 2 Chapter 2 Section 2 ,and 1(2) in Part 2 Chapter 3 Section 1).

3) Research on emerging and reemerging infectious diseases

MEXT and the Ministry of Health, Labour and Welfare promote research on the understanding of pathogens, and on the prevention, diagnosis, and treatment of emerging and reemerging infectious diseases (refer to Part 2 Chapter 2 Section 3, 1(1)).

Table 2-3-6/ Major measures for contributions to solve global issues (FY 2011)

Ministries and agencies	Conducting organization	Conducting organization
MIC	National Institute of Information and Communications Technology (NICT)	Research and development of the platform technology of electromagnetic wave sensing
MEXT	MEXT	Promotion program of infectious-disease research via an international network
Ministry of Health, Labour and Welfare	MHLW	Research project on emerging and reemerging infectious diseases, such as novel influenza
METI	National Institute of Advanced Industrial Science and Technology (AIST)	Assessment of potential underground resources
		Strengthening and promotion of international cooperation in geological fields
MLIT	National Institute for Land and Infrastructure Management	Development of platform technology to support setting/selection of a set of measures against large-scale flood disaster caused by climate change

4 Conservation of the Foundation of the Nation's Existence

In order to maintain Japan's international leading position and to realize safety in the lives of the Japanese public, it is necessary for the government to promote R&D on the foundation of the nation's existence and to continuously accumulate its fruits extensively over a long-term.

(1) Strengthening national security and key technologies

The government promotes R&D of 1) technologies to develop and use space transportation and satellites that can contribute to national security and the realization of a safe life for the Japanese public through activities such as intelligence gathering and communication, 2) technologies on the early detection of earthquakes and tsunamis, and 3) high-performance computing technologies created and developed in Japan.

Regarding the R&D of nuclear power, necessary efforts are made by considering the direction of discussions on the review of Japan's nuclear power policies as well as by focusing on the efforts of recovering from the nuclear power disaster like the one which occurred at the TEPCO Fukushima Daiichi NPS. At the same time, the R&D are expected to contribute to the government's response in the case of an accident or trouble with extremely advanced and complicated technology systems used in cyber space and oceans. R&D is also expected to contribute to the safety of people's daily lives.

1) Space development and utilization as related to space transportation and satellites

In order to maintain Japan's complete national security and independence in space activities, it is important for Japan to secure its own ability to transport necessary satellites to desired spots in space whenever necessary. There are many advantages in regard to the practical use of satellites for disaster monitoring, earth observation, communication/broadcasting, and positioning, all of which are expected to contribute well to the realization of safety in the lives of the Japanese public. In the "Space Basic Plan" (Decision by Strategic Headquarters for Space Policy, June 2009), technologies related to the development of space transportation and satellites shall be regarded as R&D necessary for the foundation of the nation's existence and shall be aggressively promoted. Since these space transportation systems and satellites are huge technological systems, developing the level of the technology itself will lead to further development in the advancement of industry and economic growth.

(i) Space transportation system

Regarding Japan's space transportation technology, No.19 and No.20 of Japan's flagship rocket H-IIA were successful in nineteen of twenty flights resulting in a success rate of 95% (19 out of 20 flights). The success rate for the initial twenty flights reached world class levels and achieved the same high quality as the world's other leading major rockets. Now, the development of small-sized, solid rockets is being pursued, in order to meet future demands for small-sized satellites in a prompt and efficient manner.

(ii) Telecommunication satellites systems, positioning, navigation and timing (PNT) satellite systems, and satellite observation and monitoring systems

Regarding telecommunication satellites systems, MIC and MECT cooperate and conduct experiments

with 1) Engineering Test Satellite-VIII KIKU No.8" (ETS-VIII) in order to develop and verify large-scale satellite bus technology, Large-scale Deployable Reflectors and mobile satellite communications technology, and 2) Wideband InterNetworking engineering test and Demonstration Satellite "KIZUNA" (WINDS) in order to develop and verify Gigabit-rate satellite Internet communication technology.

Regarding the positioning, navigation and timing (PNT) of satellite systems, MIC, MEXT, METI and MLIT cooperate and conduct field tests with the Quasi-Zenith Satellite-1 "MICHIBIKI" which is capable of precision positioning without being affected by mountains or tall buildings.

Regarding satellite observation and monitoring systems, the Advanced Land Observing Satellite "DAICHI" (ALOS) was operated to observe areas hit by large-scale natural disasters, such as the GEJE and to provide disaster prevention related organizations with the observed images. "DAICH" ended its operation in May 2011, and R&D of Advanced Land Observing Satellite-2 (ALOS-2), whose radar performance is dramatically improved over that of "DAICHI," are in progress and the ALOS-2 satellite is to be launched in FY 2013.

(iii) Efforts to promote the use of space

Although the use of space is commonly used in the daily lives of the Japanese public in areas such as weather forecasting and communication/broadcasting, the use of space over a wider range is not necessary sufficient in other areas. In response to this situation, in FY 2009, MEXT created expenses for a commission on the promotion of space usage, in order to build a system to leverage a wide spectrum of knowledge from the industry, academia and government and with the aim of expanding the range of space usage, such as in the development of potential markets and applications using satellites. Then, MEXT continues R&D that contributes to the promotion of space usage through creation of markets related to the usage of space in various areas of industry, such as disaster prevention, agriculture, forestry, stockbreeding, hunting and fishing, medicine, and education.

METI promotes the R&D of high-performance small-size satellites and small-size ground systems that can realize better functionality, lower costs and quicker delivery than bigger satellites, thus improving the infrastructure of Japan's space industry. METI also drives the development of 1) sensors that contribute to mineral exploration by using remote sensing technology via the practical use of satellites and 2) technology to apply data processing/analysis technology to satellite technology.

2) Technology for dense observation and monitoring of ocean areas where efforts for early detection of earthquakes and tsunamis are underway

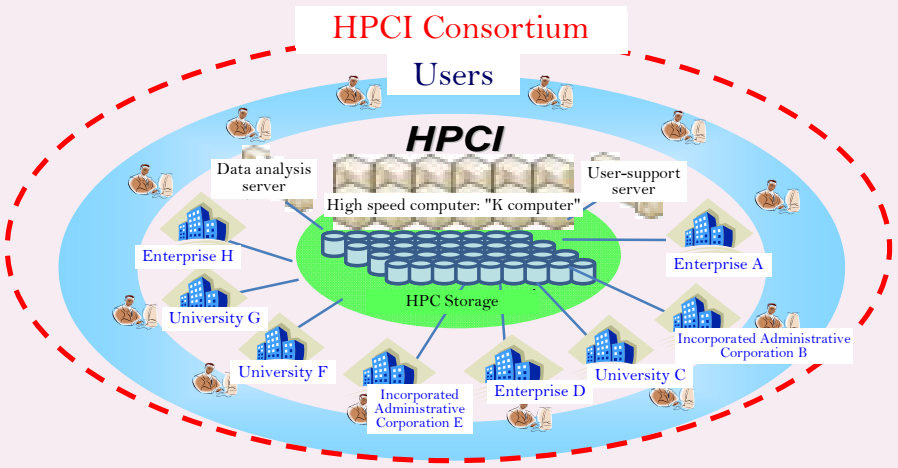
MEXT has progressed in the development of technology used to build and operate a submarine earthquake and tsunami monitoring network that focuses on the expected hypocentral regions of a Tonankai/Nankai earthquake and the hypocentral region of the 2011 off the Pacific coast of Tohoku Earthquake (Refer to 1(3) in Part 2 Chapter 2 Section 1, and 1(1) in Part 2 Chapter 2 Section 1).

3) Establishment of an Innovative High-performance Computing Infrastructure (HPCI)

Nowadays, simulation with a supercomputer is indispensable as a third method, used in addition to theory and experimentation. A supercomputer can perform a large-scale simulation at high speed and can be used for mitigation of damage by earthquakes and tsunamis, and for the development of new

energy-saving semiconductor materials. MEXT establishes innovated computing environment (HPCI: Hi-Performance Computing Infrastructure) that supports various needs of users by having its "K computer," a supercomputer with world-leading computing performance, as the core of supercomputing so that Japan will continue to lead the world in various areas, such as S&T, academic research, industry, and medicine. MEXT also promotes the use of the supercomputer and urges strategically important organizations to conduct "R&D" in the strategic areas[1] and the "establishment of a system to promote S&T based on computation" with the aim of (i) creating innovative results and (ii) the formation of a leading-edge computing research and education center (Figure 2-3-7). "K computer" achieved its performance target of 10 PFLOPS[2] in November 2011 and is currently under development and enhancement with a completion target of June 2012 and an aim to begin service at the beginning of fall in the same year. Efforts are steadily taken to create fruits with the "K computer," and some of its results were ranked as the best-in-the-world according to the supercomputer performance ranking, TOP500 in June and November 2011. For example, its results in the area of "First principles calculation of electronic states of a silicon nanowire with 100,000 atoms on the K computer," implemented for test use in November of that year was awarded r the Sustained Performance Prize of Gordon Bell Prize[3]. The investment of R&D on future high-performance computing technology aims at continuous promotion of R&D from long-term perspectives and the accumulation of world class results so that Japan can further its development of future computational S&T (refer to 5(2) in Part 2 Chapter 2 Section 1).

Figure 2-3-7/ Conceptual diagram of Innovative High-performance Computing Infrastructure (HPCI)



Source: Created by MEXT

1 As a field where the maximum use of HPCI having K computer as a core can lead to innovative results and bring great breakthrough socially and academically, five fields are listed. Field 1: Prediction of life science, medical and drug development platform. Field 2: New material, energy creation. Field 3: Prediction of earth change contributing to disaster prevention/mitigation. Field 4: Next generation manufacturing. Field 5: Origin and structure of substance and space.

2 Computing performance of 10^{16} operations per second

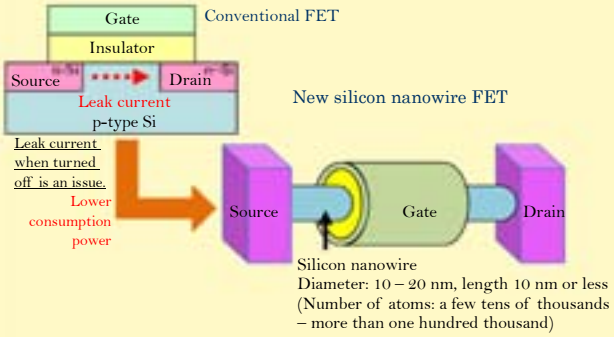
3 The Sustained Performance Prize of Gordon Bell Prize: Prizes awarded annually the best report in hardware and application development by the Association for Computing Machinery (ACM). Among these prizes, the Sustained Performance Prize in actual performance category is supposed to be the most honorable prize

Column 2-4

Computation results of silicon nanowire by K computer was awarded Gordon Bell Prizes

At a supercomputer conference in the U.S (SC11) held by the Association for Computing Machinery (ACM) in November 2011, "First principles calculation of electronic states of a silicon nanowire with 100,000 atoms on the K computer" reported by a team of RIKEN, Tsukuba University, Tokyo University and Fujitsu was awarded the Sustained Performance Prize of Gordon Bell Prize. It was the first remarkable achievement for Japan in seven years since 2004.

The Sustained Performance Prize is to be awarded for research that realizes the world's highest performance in a practical application, and it is the result of a high evaluation of the practical value of the K computer, which has the world's best performance.



Conceptual diagram of next generation semiconductor using silicon nanowire
Courtesy of RIKEN and University of Tsukuba

Here is the research in greater detail.

The improvement of semiconductor performance which supports IT technology has been achieved by the miniaturization of the Field-Effect Transistor (refer to the upper part in the figure above). Although the further miniaturization is currently being investigated, there is a problem that arises, in that the power cannot be effectively used with an approximately 20 nm sized transistor due to leakage of the electrical current. As a promising method for solving the current leakage problem caused by miniaturization, one suggested idea is the use of a silicon nanowired transistor whose gate surrounds the nanowire (refer to the bottom of the figure above).

When the diameter of the silicon nanowire reaches as short as approximately 20 nm, the flowing electrons will not leak out but will, instead, remain inside of the wire. To estimate this effect, it is required to calculate an electron orbit of approximately 100,000 silicon atoms that configure the silicon nanowire. If previous computers or calculation methods were used for this calculation, it would take more than 30 years, making a realistic calculation impossible. Thus, the team developed a new calculation method to calculate the density of electrons around a few atoms with one CPU of the K computer that was based on first principles (called RSDFT). It took only a week to perform this calculation of 100,000 atoms by using the RSDFT running on the, K computer, which realizes super high parallel computing with more than 80,000 CPU and has 10 PFLPS (10^{16} operations per second) (the world's best-class calculation performance. The results revealed that the current flow very well depends on the cross-sectional shape and that electrons flow more through a rectangular section than through a square section. It was the world's first proof by calculation.

The new calculation method of RSDFT as conducted with the K computer is expected to contribute to the design and performance estimations of higher speeds, more functionality and energy savings in next-generation devices whose fine structure is smaller than a few tens of nm such as nanowire.

4) R&D of nuclear power

Regarding the R&D of nuclear power, and based on the Accident at TEPCO Fukushima Daiichi Nuclear Power Plant, efforts were made on R&D and human resources development to support the safety of nuclear power and for the recovery from the nuclear power disaster. Regarding Fast Breeder Reactor technologies, efforts were made to focus on the further improvement of safety and on the maintenance/management of facilities with a consideration as to the direction of discussions about the review of Japan's nuclear power policies. Also necessary efforts were made for the R&D of nuclear fusion. Furthermore, the R&D of technologies related to nuclear nonproliferation and nuclear security was improved. (refer to 1(1) in Part 2 Chapter 2 Section 2 for Fast Breeder Reactor and for the R&D of nuclear fusion), (refer to 2(2) in Part 2 Chapter 3 Section 3 for technologies on nuclear nonproliferation and nuclear security).

5) Promotion of R&D in regard to information security

The "National Information Security Policy Council" (chairman: deputy chief cabinet secretary) was established to promote information security measures by consolidated and cross-sectional public-private sectors. The council developed the "Information Security R&D Strategy" (July 2011) and the "Program of Development of Human Resources for Information Security" (July 2011), and now promotes the R&D of technologies on active and highly reliable (dependable) information security as well as promoting the development of human resources who will lead its R&D in information security.

Based on the information security R&D strategy, and in cooperation with other nations, MIC established an international network to gather intelligence on cyber attacks and malwares[1] with help from domestic and overseas Internet providers and universities, and is now making efforts on R&D, as well as verification of technologies, that enable both prediction and a prompt response against cyber attacks. Regarding cloud technology, which is useful for securing work continuity when disaster occurs, because issues related to information security, such as information leakage have been pointed out, MIC is planning the promotion and expansion of this technology and making efforts to research, develop and verify a new information security technology that can prevent information leakage and other issues. METI conducts research to prevent damages related to information security by protecting against new threats and research to enhance the environment and allow people to use IT safely, by taking actions such as the establishment of a cyber security test bed[2] which is a security verification site for control systems.

6) Research on the development and upgrading of safety evaluation methods for offshore structures and on the environmental impact reduction method

The National Maritime Research Institute conducts the development and upgrading of safety evaluation methods for offshore structures and an environmental impact reduction method that is the basis of platform technologies for marine resources and energy development.

(2) Establishment of S&T platforms for the development of a new frontier

The government promotes both theoretical and experimental study, as well as the R&D of a survey observation and analysis, in order to establish a platform for the development of a new frontier in intelligence, such as the comprehensive understanding and elucidation of oceans, earth and space.

1) Promotion of R&D in maritime fields

Oceans are still a frontier for human beings because of their vast expanse and because of the difficulties in accessing them. Driven by an intellectual desire to understand the unknown, various surveys and research have been conducted on oceans. These efforts have resulted in the discovery of unused energy and mineral resources and in the oceans' involvement in changes to the earth's environment, such as climate change. Thus, it is necessary to seek and understand the theories on various ocean phenomena in order to solve critical problems that have to do with the future of human beings, such as solutions to global environment problems, responses to trench-type huge earthquakes, and the development of ocean

1 Malicious software that damages computers and users, for example, computer virus, warm and spyware
2 A facility that performs an evaluation and verification of security through simulated cyber attacks against an indispensable control system that controls equipment in a plant

resources.

(i) Development of ocean survey and exploration technology

MEXT conducts the development of advanced and fundamental technology required to perform observations and surveys of oceans and uses the developed technology for survey and research. In FY 2011, MEXT succeeded in developing a small-sized, high-performance inertial navigator required by unmanned research vessels to know the position and direction of movement during their voyages. Regarding ocean mineral resources, under the "Ocean resource use promotion technology development program," universities drive the development of sensors and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) conducts 1) development of unmanned research vessels to survey the deep-sea floor, and 2) research to discover the origin of ocean resources. In September 2011, concrete ideas in R&D, as well as schedules, were investigated at the Ocean Resources Development Subcommittee of the Council for Science and Technology (CST) to develop an "Ocean Resource Exploration Technology Verification Plan" as a five-year medium to long-term technology verification plan. R&D are conducted based on the plan. Further, a new autonomous underwater vehicle (AUV) was completed in FY 2011. Since environmental changes such as global warming are influenced by oceans significantly, continuous survey is necessary. Therefore, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) conducts the technical development of observation buoys and performs observations all over the world. The agency also performs predictions and simulations with those results.

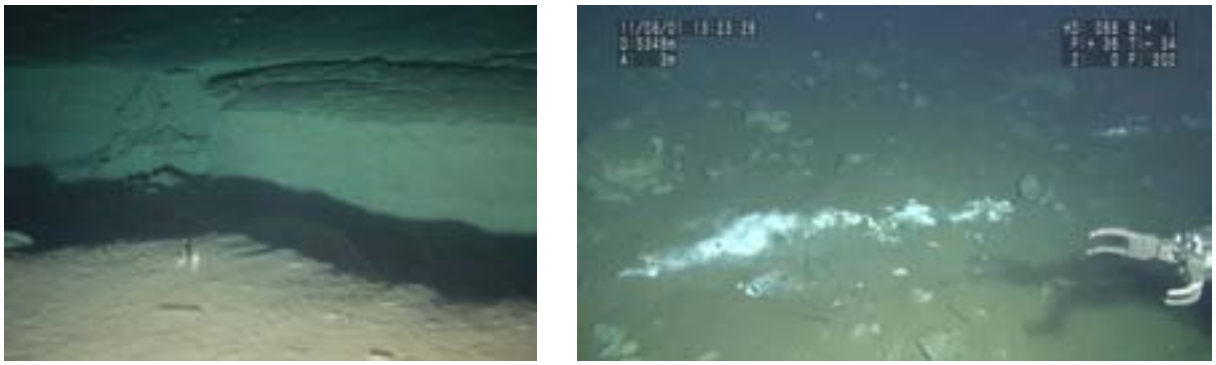
(ii) Development of interior-earth exploration technology

It is necessary to conduct surveys and research beneath the seafloor in order to discover earthquake occurrence mechanisms. The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) conducted a survey of the 2011 earthquake which occurred off the Pacific coast of Tohoku with a deep-sea research ship, "KAIREI," and discovered that fault destruction along the plate boundary had reached the trench axis of the Japan trench, and that the area around the trench axis experienced the biggest earthquake change--a 50 m shift toward the east-southeast and a 10m bulge. The agency also promotes the development of a seafloor monitoring network system that links many sensors with undersea cables and it also promotes the development of excavation technology for the deep sea drilling vessel, "CHIKYU." The seafloor network-monitoring system, "Earthquake/Tsunami Observation and Monitoring System" (DONET), located offshore from Kumanonada, near the Kii Peninsula, was completed and started full service in August 2011. Under the framework of Integrated Ocean Drilling Program (IODP), the deep sea drilling vessel "CHIKYU" has conducted a Nankai-trough earthquake occurrence zone excavation program and has provided results, such as the discovery of physical evidence identifying that the fault was active in the 1944 Tonankai earthquake and the discovery of marks from fault activities that caused a massive tsunami.

(iii) Development of technology to secure marine organism resources

Recently, it has become obvious that marine organisms are influenced by human activities, such as global warming, the environmental destruction of oceans, and overhunting. Therefore, research that contributes to the preservation of marine biodiversity and the realization of sustainable use of resources is required

now, more than ever. To meet this requirement, in FY 2011, MEXT conducted an Ocean Resource Use Promotion Technology Development Program that included 1) R&D that lead to innovative production by understanding the physiology of marine organisms, and 2) R&D to comprehensively understand ecological systems with the aim of accurately predicting change in the amount of marine organism resources. MEXT also started the R&D of observation/monitoring technology as part of the JST Strategic Basic Research Programs conducted by the Japan Science and Technology Agency. In September 2011, MEXT also summarized and established "The Way of Research on Marine Organism" at an Ocean Resources Development Subcommittee of the Council for Science and Technology (CST).



Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Crack on the seafloor in the hypocentral region of the GEJE (left) and bacterium bred in large quantities due to spring water from under the seafloor (right). Both photographs were taken with the Manned Research Submersible "SHINKAI 6500."
Courtesy of Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

2) Promotion of R&D in the space field

Human beings' search for unknown frontiers is advanced by 1) intellectual activity to understand "the origin and ruling laws of space", 2) sources of innovative and emerging technologies that can bring new opportunities in space development, and 3) a necessary growth in Japan's space development that supports a platform of space development and its use.

It is also expected that research results can be created the special environments of space, that new scientific knowledge can be acquired and that growth of new industry activities will occur as a result of the technologies leveraged with those results.

(i) Solar system exploration, space astronomy observation

In the space science field, the Japan Aerospace Exploration Agency (JAXA) has led the launch of scientific satellites with the participation of researchers, such as universities nationwide and its achievements have ranked “best-in-class” throughout the world. Japan promotes a scientific satellite plan as an important R&D subject. The asteroid explorer “Hayabusa” returned to earth from the asteroid "Itokawa" and brought tiny particles whose investigation is still in progress. In August 2011, a report to summarize the initial analysis results of the tiny particles was published in a special edition of the U.S. academic journal, "Science." An exhibition of the returned capsule was held

Tiny particle from Itokawa
Courtesy of JAXA

across the nation and had over 800,000 visitors, and movies were produced that featured "Hayabusa" and made "Hayabusa" a social phenomenon. A successor, "Hayabusa-2," is being developed to launch in FY 2014. Furthermore, a solar astronomical satellite, Hinode, and an X-ray astronomy satellite, Suzaku, are being operated through international cooperation and continued observation. Both contribute to scientific research. Also, the Interplanetary Kite-craft Accelerated by Radiation of the Sun, "IKAROS," performed a reverse spin operation as a latter term mission in October 2011. The Venus Climate Orbiter, "AKATSUKI," performed an orbit control in November of that year and is trying to achieve a circular orbit of Venus again. JAXA also leads to make progress on the development of an X-ray astronomy satellite, "ASTRO-H," which had the world's best performance and Mercury exploration project (Bepi Colombo) in an international cooperation with European space organizations.

(ii) Acquisition of manned space technology with the International Space Station Program

The International Space Station (ISS) Program is an international project in cooperation with five regions: Japan, U.S. Europe, Canada and Russia. Japan's role in the project is to develop and operate the Japan Experiment Module, "KIBO," and an unmanned cargo transfer spacecraft H-II Transfer Vehicle, "KOUNOTORI"(HTV), and Japan conducted an operation of "KIBO" that was completed in July 2009 Also, there was a long-term stay at ISS by a Japanese astronaut and a shipment of supplies with "KOUNOTORI." Following "KOUNOTORI1" in September 2009, "KOUNOTORI2" succeeded in achieving a safe docking with ISS. In addition, a Japanese astronaut, Furukawa, completed a long-term stay at the ISS from June through November 2011, and he performed various medical experiments by leveraging his expertise as a physician.

Column 2-5

Long-term stay at the international space station by Astronaut Furukawa

Astronaut Dr. Satoshi Furukawa of JAXA boarded the Russian Soyuz spacecraft and took off to the International Space Station (ISS from the Baikonur Space Center in the Republic of Kazakhstan on June 8, 2011. The astronaut Furukawa stayed in space for 167 days by he returned on November 22, 2011. This stay set a record as the longest stay in space among all Japanese, for a one-flight mission, and Furukawa's long-term stay also made Japan the third nation, after Russia and the U.S., to accumulate several days of staying in space.

ISS is operated through international cooperation among the U.S., Russia, Europe, Canada and Japan, and is the only facility in which human beings can work in space. The astronaut Furukawa performed various medical experiments by taking advantage of his capabilities as a physician, in addition to conducting maintenance/operation and experiments of the Japan Experiment Module "KIBO." Examples of these experiments include 1) a protein crystal growth experiment for the efficient development of an all-purpose cure against influenza, and 2) an experiment on medical research in space by his taking of medicine for osteoporosis. Some of the results are expected to lead to preventive measures against osteoporosis and feeble muscle that are critical for a society with a graying population.

Activities by the astronaut allowed Japan to learn about the operation of manned spacecraft, which Japan has no experience in developing and they allowed for the accumulation of medical data in a space environment by having the astronaut himself/herself participate as a test subject. Continuous long-term stay at the ISS by a Japanese astronaut is essential for Japan to experience and accumulate data that are necessary for Japan to realize the activities of manned spacecraft in the future. Moreover, some experiments, which can only be performed in space, may lead to improvements in our lives and contribute to solving problems.

More fruits are expected through the future activities of Japanese astronauts.

Launch of Soyuz spacecraft that transported the astronaut Furukawa
Courtesy of JAXA

International Space Station
Courtesy of JAXA

The astronaut Furukawa is checking how zero gravity space affects his body.
Courtesy of JAXA