Data for Self-Assessment and External Review

Department

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The University of Tokyo

Department of Earth and Planetary Science

Graduate School of Science

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I. Introduction

1. Basic Principles and Objectives of Education and Research

(1) Basic Principles of Education and Research

The Department of Earth and Planetary Science has set its educational and research objectives on exploring the origin and evolution of the earth and other planets, their surface environments, and any associated lifeforms, as well as understanding the physical and chemical processes that control the multiple phenomena characterizing different domains of earth and other planets. Such phenomena occur over a wide range of temporal and spatial scales, as part of the complex systems of earth and other planets including interactions between different subsystems. In order to develop an understanding of such phenomena, it is important to focus research efforts on a limited number of suitable targets and at the same time, to consider how new insights can be integrated into a comprehensive understanding. Based on these principles, the department is divided into five groups: four of which are theme-focused and the other integration-focused. The Space and Planetary Science Group studies planets and satellites constituting the solar system and planetary space. The Atmospheric and Oceanic Science Group studies 'fluid earth' including the oceans and atmosphere. The Solid Earth Science Group studies 'solid earth' including the earth's crust, mantle and core. The Geosphere and Biosphere Science Group studies the biosphere that occupies a boundary domain between the solid and fluid parts of earth, and the Earth and Planetary System Science Group studies interactions between these research themes or subsystem on various temporal and spatial scales with the goal of comprehending their behaviors as part of an integrated and unified system. A large variety of different methods are used in the research activities of the department including field survey and observation, which are essential to quantitatively document the diversity and complexity of the phenomena to be studied; laboratory experiment; analysis and theory, which are an indispensable part of deriving universality from the observed diversity and to develop a comprehensive view of the phenomena. All the different research groups conduct education and research by making full use of these diverse research methods whilst at the same time developing collaboration with each other through studies of themes that cross the traditional research boundaries between the groups.

(2) Educational Objectives

The educational objectives of the graduate programs at the Department of Earth and Planetary Science are to foster researchers who can lead the new development of Earth and planetary science, as well as to train scientists who can contribute to society through practical application of their knowledge and respond to the demands of society, including direct responses to environmental problems and natural disasters. As the largest graduate program related to Earth and planetary science in Japan, we have a role to foster two different types of human resources. Firstly, in order to support and develop the expansion of research fields through the rapid development of Earth and planetary science and relevant scientific technology, it is necessary to continue the long-term nurturing of creative researchers who have a broad perspective, deep understanding of their specific fields and a broad international outlook. Secondly, in order to respond to the expanding roles of Earth and planetary science in general society and industry, it is indispensable to nurture scientists who possess both a high level of specialized knowledge and a broad multidisciplinary perspective.

Undergraduate programs represent the initial stage of our training and here students should gain good background knowledge and a good grasp of basic concepts and methods in Earth and planetary science. In order to systematically cover the wide range of basic skills required during and after

graduate studies, undergraduate education is divided into two separate programs. 'The Earth and Planetary Physics Program' aims to educate students in the fundamentals of physics and applied mathematical sciences. The 'Earth and Planetary Environmental Science Program' aims to educate students both in observation of Earth and planetary materials, their surface environments and lifeforms and the methodologies required to infer the associated environmental evolution and changes.

2. Objectives of Self-Assessment and External Review

The University of Tokyo is required to conduct self-assessment and external review to promote self-improvement and maintain accountability of our independent and autonomously endeavors to promote and improve standards of activities including academic research, cooperation with society and internationalization, which requires comprehension both of the current state and of future challenges of such activities. As part of the self-assessment and external review, we also aim to clarify the role of the University of Tokyo as an international center of education by disclosing the results and at the same time, to accommodate to the demands of society by carefully considering the comments and criticisms of the evaluation.

In principle, the Graduate School of Science conducts self-assessment and external review of each department and its affiliated institutions once every six years, with the previous reviews in FY2012 and FY2013. Six years later, in June 2019, at the Review Committee and the Planning Office Meeting of Graduate School of Science, it was decided to hold the next self-assessment and external reviews in FY2019 and FY2020. In the case of the Department of Earth and Planetary Science, this review will take place in FY2019 in conjunction with the closely related UTokyo Organization for Planetary and Space Science (UTOPS).

The purpose of this external review is for our department to carry out self-evaluation including summarizing the current states and issues of academic research, social cooperation, internationalization, and other activities in the Department of Earth and Planetary Science, and to disclose the results and to make use of the evaluation and criticism from outside the university for future activities.

As is more fully described below, external reviews were held in March 1999, a year before the department's establishment through the merger of four previous departments, and also in March 2006, two years after the incorporation of the university. The review committee in 1999 suggested that the undergraduate and graduate education system should be improved, the research activities should be more developed, term appointment of research associates should be introduced, employment of foreign and female faculty members and high technical support should be enhanced and relationship between affiliated institutions should be strengthened. In the meanwhile, the new department's plan was highly evaluated and it was suggested that the department should have regular external reviews. At the review held in 2006, six years after the new department's establishment, some of the aspects pointed out in 1999 were confirmed to have been improved and the department received high overall evaluation. However, the review committee also suggested that the cutting-edge research which would elevate international status should be strengthened, certain research fields should be selected for particular emphasis, the leadership role of the head of the department should be strengthened, screening standards for admission to the doctorate program and qualification for submission of doctoral dissertations should be improved and support for graduate students should be strengthened. In the external evaluation in 2013, interdepartmental collaboration, the role of the Earth and Planetary System Science Group, strengthening of the chemical field, reorganization of undergraduate education,

internationalization, diversity, and system for personnel employment were highlighted as areas in need of improvement. Details and responses are summarized in Chapter VII Current Issues and Measure.

II. History and Organization

1. History and Operation Policy

(1) History

The Department of Earth and Planetary Science was established in April 2000 through the merger of four previously independent departments (Earth and Planetary Physics, Geography, Geology, and Mineralogy) in the Graduate School of Science. The newly formed department was organized with two undergraduate programs, the Earth and Planetary Physics Program and the Earth Sciences Program, and the latter was subsequently reorganized as the Earth and Planetary Environmental Science Program in 2006.

The history of the Department of Earth and Planetary Science in the University of Tokyo goes back to 1876 when the university was founded and Department of Geology was established as one of eight departments constituting the Faculty of Science. The Department of Mineralogy was separated from the Department of Geology in 1907, and Department of Geography was newly established in 1919. Following the National School Establishment Law promulgated in 1949 after the Second World War, the Department of Earth Sciences consisting of three courses - Geology, Mineralogy and Geography - was established as one of five departments constituting the Faculty of Science of the University of Tokyo under the new system.

The predecessor of the Department of Earth and Planetary Physics was the Department of Seismology, which was originally established in 1893 as the Seismology course within the Department of Physics and became an independent department in December 1923 after the Great Kanto Earthquake. The Department of Geophysics was established in 1941 by the merger of the Department of Seismology and the Meteorology course in the Department of Physics. The Department of Physics was reorganized as a department consisting of three divisions - Physics, Astronomy and Geophysics - in 1949. The Geophysical Observatory and the Geophysical Research Institute were established in 1958 and 1964, respectively. As a result of the reorganization through expansion of Department of Physics in 1967, three divisions, which had previously constituted the department, became independent as the Departments of Physics, Astronomy and Geophysics. The Department of Earth and Planetary Physics and Center for Climate System Research were established through the reorganization of the Geophysical Institute and the Geophysical Research Institute in 1991.

In 1992 and 1993, in accordance with the university's new policy of focusing on graduate education, four departments (Earth and Planetary Physics, Geography, Geology and Mineralogy) were reorganized as the main bodies for research and education in Earth and planetary sciences.

At the same time as this re-organization, responsibility for an undergraduate program, the Earth and Planetary Physics Program was assigned to the Department of Earth and Planetary Physics, and responsibility for the Earth Sciences Program was assigned to the Department of Geology, Mineralogy and Geography. In 2000, in order to respond to the diversification of research themes in the field of earth and planetary science and changes in the demands of society, it was decided to establish a new framework for our educational and research system, and the four Departments of Earth and planetary sciences were integrated to one department. The Department of Earth and Planetary Science was established. The new department is comprised of four groups as follows: Atmospheric and Oceanic Science, Space and Planetary Science, Solid Earth Science, and Geosphere and Biosphere Science. These four groups have distinct research fields and purposes. In addition, we decided to establish an Earth and Planetary System Science Group with the task of considering the Earth and planets as a single system. Responsibility for the existing undergraduate programs, i.e., the Earth and Planetary

Physics Program and the Earth Sciences Program was assigned to the Department of Earth and Planetary Science. The Earth Sciences Program was reorganized into the Earth and Planetary Environmental Science Program in 2006 in order to enhance education in attractive new fields that have grown with the progress of Earth and planetary science research. In FY2017, the UTokyo Organization for Planetary and Space Science, which is led by a faculty member of this department, was established at the University of Tokyo and promotes research and education in cooperation with our department. Since the external review was conducted in 2013, important educational programs that support high-achieving students through their master degree to PhD were implemented as follows: Leading Graduate Course for Frontiers of Mathematical Sciences and Physics (since 2012), Program of Excellence in Photon Science (XPS) (since 2018) and International Graduate Program for Excellence in Earth-Space Science (IGPEES), (since 2018). There is also a program called World-leading Innovation Graduate Study program of the school of science (since 2016) for international students who study for Master and PhD degree at the University of Tokyo.

(2) Policy of Organizational Operation

The department operates five groups and all faculty members belong to one of the groups. Faculty members of each group share a common research goal. The number of the people in a group is about 10, which is an appropriate size for effective communication. Each group selects a member as a representative for the various departmental committees. Each group takes care of its own matters concerning graduate students' everyday school life such as collecting information, seating arrangements, school affairs, accounting and computer networking etc. The number of faculty members is fixed for each group, and an appointment of a new member is initiated by each group. However, collaboration between groups is actively pursued in research and education. Some seminars and events are organized at the departmental level.

The department takes control of every organizational operation, by holding the Department's Steering Committee, Educational Committee, Accounting Committee, Rooms Committee, Public Relations committee, Network Committee, Entrance Exam Committee, Library Committee, Scientific Instruments Committee, Safety Management Committee, and Fund & Alumni Committee. Because academic affairs should be discussed not only within the department itself but also with affiliated groups, the Department's Educational Conference is also organized. This conference consists of professors, associate professors, lecturers of core groups and affiliated institutions, and the head of the department and the chairperson of Educational Committee co-chair the conference. Undergraduate programs take key roles only in academic affairs such as preparation and implementation of the curriculums and advertisement of the programs. Each undergraduate program is led by the respective head of the department and has an educational committee. Following the advice of the external review conducted in 2013, the undergraduate educational committee holds a joint meeting between the two programs under a common chairperson responsible for undergraduate educational matters, with the aim of promoting exchange of information between the two departments.

The head of the department and the head of each undergraduate program are elected at the Department's Faculty Committee consisting of every faculty member of the five core groups. In order to promote the department including long-term perspectives and ensure a continuity of management, the term of the head of the department has been raised to 2 years since FY2012. The chairperson of Educational Committee and the chairperson of Accounting Committee also have two-year tenures. Operational continuity is maintained since their periods of office do not coincide with that of the head of the department. The head of the department chairs the Department's Steering Committee. Each of the other committees consists of the chairperson who is appointed by the head of the department and

one or two members per core group.

Policies and decisions regarding the organizational operation of the core groups are made at the Steering Committee. It consists of the head of the department, heads of the two undergraduate programs, and the chairperson of every committee. All the committees are open to all faculty members of the core groups. The Department's Steering Committee is held once a month and discusses the matters related to the whole department other than personnel affairs and academic affairs, and each committee chairperson also gives a report. The minutes are then circulated among all the faculty members and staff so that everyone has an overview on the current circumstances of the department.

Since the Department's Educational Committee deals with academic affairs arising from the whole department including the affiliated groups, it consists of the head, the head of the educational committee of the undergraduate programs, one educational committee member per core group, and one or two members from each affiliated institution. Academic affairs of the graduate programs are discussed and proposals drafted at the Department's Educational Committee before finally being decided at the Department's Educational Conference. The Educational Committees and the Educational Conferences are held about ten times a year and five times a year, respectively, where all kinds of academic affairs such as enrollment in and graduation from the master's and doctorate programs, entrance exam system and the curriculum of the graduate programs are discussed and decided.

(3) Appointment of Faculty Members

Following the policy decision of the University and the Graduate Schools of Science to reduce the number of academic positions, there is a strict cap on the number of faculty in the department by the total number of faculty members and the equivalent value of the full professors, and a planned reduction in numbers will be carried out by 2022. The total number of faculty members was 58 at the beginning of the department, but has decreased to 49 in FY2018 (a further decrease of 1 professor occurred on April 1, 2019 leaving 48). To make up for this shortage, various on-campus systems are used. Our department has been successful in obtaining discretionary posts from the University and the School of Science, in particular one associate professorship reserved for female applicants and one assistant professorship for a five-year term using the cross-appointment system. In FY2017, one professor position was allocated to the UTokyo Organization for Planetary and Space Science (UTOPS), which consists of other departments outside the Department of Earth and Planetary Science and research institutes both inside and outside the university. The future use of this position is decided in close consultation with this department. In addition, in FY2018, a five-year term professorship was assigned to the department as part of the departmental initiative "Field-based Observational Science" with the aim to creating a new approach to Earth sciences with strong links to future society. Since April 1st , 2019, the total the number of faculty members has been 52.

When there is a position available, the corresponding group proposes to the personnel committee consisting of all professors to start selection process, and the committee sets up a preparatory working group comprised of the members of the corresponding group and selected professors from other core groups. The working group discusses the appropriate research field for the available position, the role of the successful candidate within the departmental framework, prospective candidates, and so forth. The results of these discussion are reviewed at the personnel committee and an outline of the advertisement for the position is decided. All the appointments are done through open announcements including emails to the other universities and research institutions and advertisement via email lists and web sites. For each recruitment, a selection committee, consisting of members (whose posts should be equivalent or superior to the applicant) of the corresponding group and one each from other groups,

is made and has the responsibility of carefully processing the application. The tentative decision by the selection committee is further discussed by the personnel committee of professors where final decision is made. Although the number of applicants varies depending on the research field and position, the average numbers are 5 to 10 for professors, 10 to 20 for associate professors, and 30 for assistant professors, demonstrating a strong competition for all the appointments.

Each group of the Department of Earth and Planetary Science has four to six research fields. Each faculty member works independently for their research, the former 'small hierarchical groups' have been done away with. However, in order to promote education and research, especially when hiring a new member, it is important to create a loose group of two or three people, such as a combination of a professor and assistant professor(s) or an associate professor and assistant professor(s). An important criterion is the possibility of forming a research group that can be effective in research and education. Especially in the case of assistant professors, it is desirable for young researchers to develop through cooperation within the group and achieve promotion in about 5-10 years.

In line with this department policy, from FY2011, recruitment and announcements state that evaluation will be made in the fifth year after being hired as an assistant professor. Since FY2014, the "Assistant Professor Career Development Committee" has been established by professors to carry out a follow-up after employment. So far, six assistant professors have been evaluated after 5 years of recruitment, and provided with advice on future career directions. Gender equality is regarded as one of the most important issues of the University of Tokyo and is also taken into consideration when making new appointment.

All the recruitment announcement state that "The University of Tokyo is actively promoting gender equality," however the number of female applicants is generally limited. For this reason, we are actively recruiting professors with the applications restricted to women in 2015 and associate professors limited to women in 2019. However, the current situation is still insufficient, and in the future, we will seek new ways to act to improve gender equality. In terms of ensuring the diversity of departments, it is also important to appoint academics from overseas. The Job description is always written in Japanese and English, and is recruitment carried out internationally. About 30% of applicants are foreign nationals, but in the past seven years, only one has been employed.

2. Organization

(1) Core and Affiliated Groups and Affiliated Institutions

As shown in the table below, this department consists of five organically linked core groups (Atmospheric and Ocean Science, Space and Planetary Science, Earth and Planetary Systems Science, Solid Earth Science, and Geosphere and Biosphere Science), and affiliated groups, cooperating groups, and a group with personnel exchange.

The affiliated groups with link on campus are as follows: the Observational Solid Earth Science Group at the Earthquake Research Institute, Climate System Science Group and the Advanced Oceanic Science Group at the Atmosphere and Ocean Research Institute, and Super-High-Pressure Solid Physics Group at the Institute for Solid State Physics, and Earth Atmospheric Environment Science Group at the Research Center for Advance Science and Technology. The cooperating groups are located outside the university and are set up at the Japan Aerospace Exploration Agency (JAXA) and the Institute for Materials Structure Science as an Inter-Institutional Science Group. A group with personnel exchange is set up to link with the institutions outside the campus with a period of tenure of about 5 years and are currently established including the National Astronomical Observatory of Japan, National Institute of Advanced Industrial Science and Technology, Japan Agency for Marine-Earth

Science and Technology (JAMSTEC), and National Science Museum.

In addition to this, we are promoting education and research on Earth and planetary science, closely cooperating with faculty members belonging to organizations in the School of Science, such as UTokyo Organization for Planetary and Space Science (UTOPS), Geochemical Research Center, and Department of Physics, on-campus schools and institutes, such as Graduate School of Frontier Sciences, Graduate School of Arts and Sciences, Center for Spatial Information Science, and the University Museum. Amongst the organizations affiliated to the School of Science, the human resourses for the UTokyo Organization for Planetary and Space Science (UTOPS) are treated as parts of the Space and Planetary Science Group, a core group of our department. The UTOPS plays an important role in research and education in the space and planetary science field by strengthening links with the interdisciplinary areas and engineering of each School of Science department. Human resources for the Geochemical Research Center personnel are included as part of the human resources of the Department of Chemistry, but this center plays an important role in both research and education related to Earth's internal material chemistry and space chemistry in the Department of Earth and Planetary Science.

In this external review, only the five core groups are evaluated. The number of graduate students shows the overall data for all groups, but the numbers are given separately for the collaborating groups and related departments, graduate schools, research institutes (hereinafter referred to collectively affiliated groups), and core groups.

The Department of the Earth and Planetary Science

Core Groups	Atmospheric and Oceanic Science Group		
	Space and Planetary Science Group		
	Earth and Planetary System Science Group		
	Solid Earth Science Group		
	Geosphere and Biosphere Science Group		
Affiliated Groups		Observational Solid Earth Science Group	Earthquake Research Institute
		Climate System Science Group	Atmosphere and Ocean Research Institute
		Advanced Oceanic Science Group	
		Earth Atmospheric Environment Science Group	Research for Solid State Physics
Cooperating Group		Inter-Institutional Science Group	Japan Aerospace Exploration Agency (JAXA)
			Institute of Material Structure Science
Group with Personnel Exchange		National Astronomical Observatory National Institute of Advanced Industrial Science and Technology Japan Agency for Marine-Earth Science and Technology National Museum of Nature and Science	

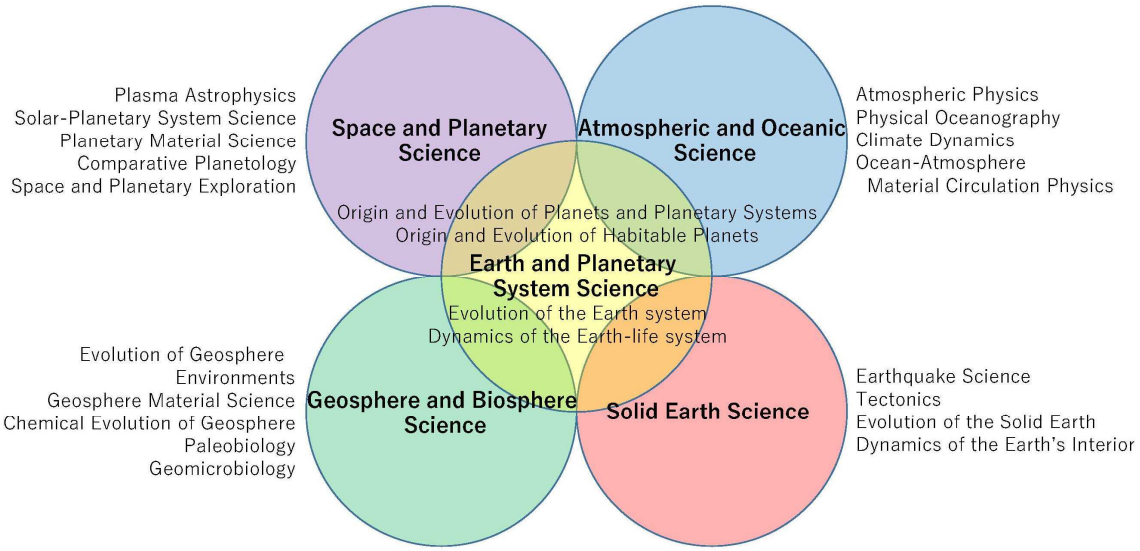
Related Departments, Graduate Schools, and Research Institutes

School of Science	Other Organizations on Campus	
UTokyo Organization for Planetary and Space Science	Graduate School of Frontier Sciences	Center for Spatial Information Science
Geochemical Research Center	Graduate School of Arts and Sciences	The University Museum
Department of Physics	School of Engineering	

(2) Fields and Their Objectives

In order to comprehend the complicated phenomena that occur in the earth and planets in a wide range of time and spatial scales and that interact intimately among different scales, it is indispensable to promote deeper understandings of each phenomenon, and at the same time, to integrate the phenomena into the seamless Earth and planetary system. Based on such concept, the department is divided into five groups Solid Earth Science Group, which studies 'solid earth', Atmospheric and Oceanic Science Group, which studies 'fluid earth' on the earth's surface, Space and Planetary Science Group, which studies the solar system and planetary space, Geosphere and Biosphere Science Group, which studies biosphere, and Earth and Planetary System Science Group which integrates studies conducted in all the other groups. Each group has its own education and research objectives, and pursues such activities by collaborating closely among the groups through their boundary regions

Science Fields: Department of Earth and Planetary Science



<Atmospheric and Oceanic Science Group>

Our planet Earth is covered by the atmosphere containing water vapor and the ocean occupies more than 70% of the global surface. It is one of the most unique characteristics of the earth that water exits in all three phases of vapor, liquid and solid. Water vapor in the atmosphere absorbs solar and terrestrial radiations quite effectively, and liquid water in the ocean has a large specific heat and is extremely solvent and fluid. Phase changes of the water associate with large latent heat also affect radiation budget significantly by changing planetary albedo through formations of clouds and sea ice. All those characteristics of the water introduce rich daily weather, seasonal changes and climate variations into our planet. Building a society less vulnerable to water-related natural disasters has been a major motive for our civilization. Moreover, the ozone layer which is maintained by global circulation in the atmosphere and protecting the earth biosphere from harmful solar UV radiation has been largely affected by human activities.

This group will be devoted to high-level education as well as research on those oceanic and atmospheric phenomena of various space and time scales from breaking internal waves to centennial global climate changes. The efforts will contribute to enhancing our basic knowledge on predictability of oceanic and atmospheric phenomena of great societal concern. To be more specific, this group, through data analysis, analytical methods, global modeling and field observations when necessary,

encourages development of our understanding of oceanic and atmospheric flows and turbulence, ocean-atmosphere coupled phenomena generating climate variations, circulation of various oceanic and atmospheric substances such as ozone, carbon and freshwater.

In order to fulfill above purposes, we introduce the following four research subgroups and proceed to realization of world leading research and education in the realm of oceanic and atmospheric science.

• **Atmospheric Physics:** In the Earth's atmosphere, interactions among physical processes including dynamical, radiative and cloud physics, and with the ocean produce various phenomena in a wide range of spatial and temporal scales. This group will devote its efforts to research and education with a special emphasis on the atmospheric dynamics by theoretical, observational, numerical modeling and data analysis approaches. Our definite objectives are to understand the dynamics of global circulations, waves, instabilities and turbulence in the troposphere through the lower thermosphere, and to understand the mechanisms of the cloud organization. Outcomes from this group will be particularly beneficial to the general society through assessment of the climate system as well as improvement of prediction models.

• **Physical Oceanography:** This research group will devote its major efforts to understanding and education of various physical processes such as eddy-eddy interaction, eddy-mean flow interaction and turbulent mixing in the ocean. Those processes that are crucial to accurate modeling of the large-scale ocean general circulation are clarified through analytical and numerical studies as well as data analyses and field observations. Areas of current particular interest are interaction between mesoscale eddies and global ocean currents, parameterization of diapycnal mixing processes caused by breaking internal waves, and advanced modeling of the ocean surface mixed layer to be embedded in next-generation general circulation models.

• **Climate Dynamics:** This research group is devoted to understanding of interannual climate variations such as El Niño/Southern Oscillation and the Indian Ocean Dipole, climate variations in decadal-to-centennial timescales, interactions among climate variations with different spatiotemporal scales, and interactions between low-latitudes and mid-high latitudes phenomena based on theoretical studies, observational data analyses, and general circulation model simulations. In particular, the group is intended to contribute to the society by advancing the predictability study of large-scale climate variation phenomena through improved understanding of their inherent interaction processes.

• **Ocean-Atmosphere Material Circulation Physics:** This research group focuses on studying atmospheric aerosols, clouds, and gaseous compounds that affect climate and air quality. Variations of these atmospheric constituents as well as their impacts on radiation and clouds are studied. This group wishes to create a new atmospheric science field by integrating atmospheric chemistry and physics. This group also studies oceanic thermohaline processes, water-mass formation and circulation of oceanic substances such as freshwater, salt, nutrients and carbon.

<Space and Planetary Science Group>

Our research fields are space physics, and planetary science for both solar-system bodies and exoplanets. We conduct research using various methods including precise analysis of extra-terrestrial materials such as meteorites, in situ measurements as well as remote-sensing observations from spacecraft, theoretical and numerical approaches, and laboratory experiments. In particular, we have close collaboration with JAXA for the development of scientific instruments, data analysis for spacecraft observations of the solar atmosphere, Earth's magnetosphere, and planetary exploration.

• **Plasma Astrophysics:** More than 99% of dilute, high-temperature gasses in space are in an ionized state called a plasma. Understanding of plasma physics is, therefore, critical in various aspects

of astrophysical phenomena. We consider the solar system as "a plasma physics laboratory in space" by paying a special attention to the ubiquitous plasma processes in the universe, and conduct research on, e.g., shock waves producing high-energy particles in interplanetary space and the Earth's bow shock, magnetic reconnection leading to explosive phenomena such as solar flares and aurora breakups. We apply the understanding of these elementary plasma physics obtained with the solar system plasma research to more general astrophysical phenomena. We also conduct fundamental physics research such as nonlinear physics and non-equilibrium physics that often become important in space and astrophysical plasmas.

• **Solar-Planetary System Science:** Planets in the solar system, including the Earth on which we live, are constantly influenced by the sun and the outer space surrounding the planets. From the sun, the solar radiation and plasma flows called as the solar wind are continuously emitted, and the latter significantly varies with the solar activity. In our research group, we investigate the sunspot variation, solar flares, and coronal heating problems, which are the energy sources of the solar-planetary system, by making full use of a large-scale simulation using supercomputers. We combine numerical simulations with satellite and ground-based observations in order to understand underlying physics in the space weather phenomena such as the aurora, radiation belt variations, and the geospace storms. Planets have different characteristics in various aspects, such as distance from the sun, size, intrinsic magnetic field, and atmosphere. Although the solar-planetary system is a complex system in which these interact intricately, studies of other planets with different conditions give us important insights on understand the influence of specific elements. For example, by studying Mars and Venus which do not have a strong global intrinsic magnetic field like the Earth, we can clarify the influence of the intrinsic magnetic field of the planet on the variation of the solar-planetary system and evolution of the planetary surface environment. In our research group, we conduct our studies in close collaboration with related satellite missions such as Hinode (solar observation), Hisaki (planetary telescope), MAVEN (Mars), and BepiColombo (Mercury).

• **Planetary Material Science:** Meteorites, interplanetary dust particles, and spacecraft returned samples record the origin and evolution of the Solar System and planets. We focus on the mineralogy, petrology, and isotope geochemistry of extraterrestrial materials to reveal the Solar System history. We also play a leading role in JAXA's asteroid sample return mission Hayabusa2 to obtain the first sample from a C-type asteroid Ryugu. We perform laboratory experiments and astronomical observation as well, both of which help us interpret the data from the analyses of extraterrestrial samples.

• **Comparative Planetology:** Knowing how and why nearby planets in the Solar System are different from the Earth is important for understanding the nature of the Earth. For such purposes, we study a variety of planets, satellites, comets, small bodies using various approaches, such as space exploration, telescopic observations, and laboratory experiments.

• **Space and Planetary Exploration:** We are opening a new door for a new style of planetary explorations using a ultra-small spacecraft, such as micro and cube satellites. The short-turn around cycle of such ultra-small spacecrafts allow students to experience the entire development processes, from the design of mission concepts to the launch and data analyses. Mission goals can cover the broad science interests in our department, e.g., solar and planetary evolutions, and the formation of high-energy astrophysical particles. These mission projects are conducted through, close collaboration with Graduate School of Engineering, Graduate School of Frontier sciences, and Japan Aerospace Exploration Agency (JAXA).

<Earth and Planetary System Science Group>

Planets consist of subsystems such as magnetosphere, atmosphere, hydrosphere, biosphere, mantle, and core. Such subsystems interact with each other through energy transfer and geochemical cycles with various degrees of feedback. The interactions among subsystems take place with different time constants, which results in non-linear complex responses for the entire system. Earth and Planetary System Science (EPSS) group aims at constructing a new science field of "Earth and planetary system science" which investigates the formation, structure, behaviors, stability/instability, and evolution of the Earth and other planets, and planetary systems including our solar system as huge complicated systems. This is an expansion of the "Earth system science" often used for studying the global change in the climate system of the Earth today. We are trying to have wide range of views and theoretical background of physics and chemistry to investigate the subjects from the perspective of system science. In order for graduate students to learn this concept, we organize three types of seminars; one is for the whole members of the EPSS group, the second type includes two seminars for subgroup, one for planetary system science and the other for Earth system science, and the third type is for individual research groups. Members of the EPSS group join these seminars that are held regularly.

Currently, we are carrying out following scientific topics.

• **Origin and Evolution of Planets and Planetary Systems:** Discovery of exoplanets has changed earth science to universal science. We are working on formation and evolution of planets and planetary systems from dust and gas, formation of atmosphere and ocean on the planets, and differentiation of planetary interiors, of which are fundamental processes of subsystem formation.

• **Origin and Evolution of Habitable Planets:** Planetary habitability is governed by several factors that include planetary orbit, atmospheric pressure and composition, presence and mass of oceans, stability of surface environments, distribution of continents, presence of plate tectonics, volcanic activity, and so on. We are investigating diversity of surface environments of terrestrial planets and their sensitivities to the above factors and explore the conditions for the habitable planets beyond our solar system.

• **Evolution of the Earth System:** Conditions of the Earth system have changed and evolved through the earth history owing to changes in internal and external forcing. The Earth system may have multiple stable modes and transitions among them are often associated with abrupt mode jumps. The mode jumps occur in various time scales, and even repeat with hysteresis or change irreversibly. We reconstruct evolution and changes of the Earth system environment in the past through field survey, laboratory works, and theoretical modeling, and explore mechanisms of such changes from the viewpoints of the Earth system science.

• **Dynamics of the Earth-life System:** Biosphere constitutes one of the key components of the Earth system. It receives human impacts and global and local environmental changes today. On the other hand, biosphere could affect the environment through biogeochemical cycles, surface albedo change, and so on. We evaluate roles of the biosphere and human impacts in the Earth system through field survey and laboratory experiments as well as theoretical modeling.

<Solid Earth Science Group>

The Solid Earth Science Group studies the physical and chemical state of the crust, mantle, and core on a variety of temporal and spatial scales. We seek a quantitative and comprehensive view of the Earth's present state and the processes by which this evolved and of the interactions between its constituent layers. Examples of the topics of our research are earthquakes and volcanoes; crustal deformation and the evolution of surface topography; the thermal state and material transport within the mantle; the formation, evolution and subduction of the oceanic crust; and core dynamics and the

generation of the Earth's magnetic field. To understand this complex system we use a wide variety of approaches, including continuum mechanics, theories of fracture and failure, geodynamics, studies of topography, structural geology, petrology, geochemistry, theoretical and experimental high pressure-high temperature mineral physics, magneto-hydrodynamics, seismic tomography and waveform inversion, earthquake source theory, large-scale numerical simulation, analyses of large datasets on a global scale, field studies, rock and mineral analyses and geochemistry.

A major goal of the group is to use the fundamental insights gained about the formation, evolution and the changes through geological time of the solid earth to predict its future. To achieve this goal, it is necessary to employ and develop a diverse range of approaches that can shine light on solid earth processes occurring on a wide range of temporal and spatial scales to comprehensively understand the evolution and change of the solid earth. By integrating the knowledge gained, we aim to develop holistic understanding of the evolution and dynamic changes of the solid earth. We have prepared the research fabric of the group with these goals in mind: a warp consisting of three groups of phenomena with distinct time scales and a weft of physics and chemistry, which we aim to weave seamlessly together by focusing our research on four research areas. These four areas are: Earthquake Science, encompassing seismogenesis occurring on time scales from seconds to hundreds of years; Tectonics, encompassing phenomena occurring within convergent margins on times scales from hundreds to millions of years; Evolution of the Solid Earth, encompassing chemical and physical phenomena involved in the formation and evolution of the Earth as a whole and occurring on times scales from millions to billions of years; and Dynamics of the Earth's Interior which aims to merge a wide variety of approaches to understand the dynamic processes of the Earth. More detail for each of these four research areas is given below.

• **Earthquake Science:** Comprehensive understanding of earthquake phenomenon. We research phenomena such as quasi-static buildup of elastic energy due to plate motion, the development of high velocity fracture slip on complex faults, radiation and propagation of seismic waves, after-slip on faults and stress relaxation in surrounding regions, and the ubiquitous presence of slow earthquake activity with the aim of gaining a unified understanding of the full range of earthquake phenomena. Also, by treating earthquake activity as the behavior as a complex system with temporal and spatial hierarchies, we aim to determine their statistical characteristics, and evaluate the possibility of predicting earthquake-related phenomena.

• **Tectonics:** Comprehensive understanding of orogenesis in subduction and continental collision zones. We seek a unified and quantitative understanding of the formation and dynamics of island arc-ocean trench systems, orogenesis and large-scale crustal deformation related to continental collision, and ocean floor spreading in back arc regions. In particular, we study the formation of topography and changes in the internal structure of plate boundary zones, with a focus on the interaction between physical and chemical endogenetic processes and exogenetic processes, such as erosion, transportation and deposition, that are mainly controlled by the surface environment.

• **Evolution of the Solid Earth:** Comprehensive clarification of the thermal and chemical evolution of the solid earth. We aim to understand the processes of cycling of heat and material in the Earth's interior that have led to its differentiation and formation of its structure—as exemplified by the formation of the crust and core—and to develop a unified and quantitative understanding of the interactions between the Earth's surface and the crust, the crust and the mantle, and the mantle and core. Through this work, we aim to develop a unified and quantitative understanding of the thermal and chemical evolution of the Earth throughout geological time.

• **Dynamics of the Earth's Interior:** Comprehensive clarification of material properties and their changes within the Earth. We use a combination of high-precision seismic wave analysis, measurement

and theoretical calculation of physical properties at ultra-high pressure, determination of phase diagrams, and fluid dynamics simulations to clarifying the structure, composition, state, and microstructure of layer boundaries and transition zones of the earth's interior. We use this knowledge to understand thermal convection of the mantle including the movement of plates; convective movements of magnetic fluid in the core that generate the earth's magnetic field; the thermal, mechanical, magnetic and material interactions along the core mantle boundary; interactions between the inner and outer cores and core dynamics; and the formation of the earth and its early evolution with the aim of elucidating the dynamics of the whole interior of the Earth.

<Geosphere and Biosphere Science Group>

Members of this group study and teach various aspects of formation of geosphere materials, evolution of the geosphere, the origins and evolution of life, and fundamental processes of geosphere-biosphere interactions. These studies are based mainly on field observations, analyses of geological, mineralogical, and paleontological samples, and laboratory experiments using various techniques such as transmission electron microscopy, scanning electron microscopy, atomic force microscopy, X-ray microanalyses, X-ray diffraction analysis, X-ray absorption spectroscopy, gas- and ICP-mass spectrometry, gas-chromatography, and amino-acid and DNA sequence analyses. The methodologies and objectives of the studies in this group are, therefore, partly common with those in other groups, especially the Earth and Planetary System Science and the Solid Earth Science, but we have stronger intention to explore the interdisciplinary field between earth and biological sciences than in other groups. Our research field is also related to human activities, since it focuses on the co-evolution between geosphere environments and life.

We study and teach in five subgroups as described below. These subgroups collaborate to achieve the above-mentioned objectives of this group.

• **Evolution of Geosphere Environments:** This subgroup aims to reconstruct environmental evolution of the geosphere (combination of the lithosphere, hydrosphere, and atmosphere) based on both field observations and laboratory experiments, from the viewpoints of sedimentology and historical geology. This subgroup's work has the overall aim of clarifying the interrelations among the geosphere and biosphere throughout the 4.6 billion years of the Earth's history. Important projects in this subgroup include elucidation of short-term and long-term evolution of the geosphere, with special reference to biomarker and stable isotope signals recovered from sedimentary rocks and various geological samples. Also, based on the observational science, this subgroup studies complex phenomena including understanding and prediction of natural hazards for the future of humanity and society.

• **Geosphere Material Science:** This subgroup investigates the structure of solid materials that constitute the Earth's surface using microscopic analytical techniques such electron microscopy and proposes their formation mechanisms, in order to discuss the relationship between these materials and biosphere environments or dynamics of specific elements. Besides, this subgroup tries to understand molecular mechanism of the interaction between biogenic macromolecules and inorganic substances, which is the fundamental process of biomineralization, at atomic scale.

• **Chemical Evolution of Geosphere:** This subgroup will study the origin and evolution of the chemical conditions of the geosphere and biosphere and laws of material cycles in relation to the evolution of life and present environment, through the analysis of chemical compositions, isotopic ratios, and chemical speciation in constituents of the geosphere and biosphere. Currently important subjects are 1) cycles of elements in geosphere and biosphere, 2) speciation of elements related to their cycling, toxicity, and bioavailability, and 3) proxy development for paleo-redox conditions and

material cycles.

• **Paleobiology:** Study in this subgroup concerns biological aspects of extinct or ancient life forms based on comparative analysis of fossils and extant organisms. Major goals are to better elucidate the tempo, mode and mechanism of morphological evolution of life throughout the Earth's history, and the role of life in the formation and evolution of the geosphere. Currently important subjects are 1) early evolution and phylogeny of marine invertebrates based on embryological, molecular biological, and paleontological data, 2) mechanisms and evolution of biomineralization especially of molluscan shells, 3) comparative anatomy of amniotes, with special emphasis on dinosaur evolution, 4) paleobiology of dinosaurs involving cutting-edge technologies, such as X-ray CT-scan, 5) molecular paleontology and paleogenomics based on both molecular fossils and the information stored in the genomes of extant organisms.

• **Geomicrobiology:** This subgroup has been conducting researches on the deep-sea and deep underground ecosystems that are considered to be the candidate places of life emergence. By developing state-of-the-art solid analysis methods and microbial analysis methods, life-water-mineral interactions are investigated to unveil metabolic activities and bio-signatures that are important on the early Earth before the emergence of phototrophic organisms.

(3) Faculty Members of Core Groups

As of October 1, 2019, the capacity of faculty members is 48: 18 professors, 19 associate professors, and 11 assistant professors. There are also extra capacity for one five-year term professor, one five-year assistant professor, and one female associate professor of School of Science. The actual number of faculty member is 46, including 17 professors, 15 associate professors, 1 lecture, 13 assistant professors, and 4 are currently being selected. The number of members by groups is: 8 in the Department of Atmospheric and Oceanic Science Group, 12 in Space and Planetary Science Group (including Professor Tachibana at UTokyo Organization for Planetary and Space Science), 12 in Solid Earth Science Group, 9 in Earth and Planetary System Science Group. In addition, there are three project assistant professors employed by external funds.

All the faculty members are listed below:

Faculty Members of Core Groups (As of October 1, 2019)

Name	Position	Specialty
Atmospheric and Oceanic Science Group		
SATO, Kaoru	P	Atmospheric Dynamics, Middle Atmosphere Sciences
HIBIYA, Toshiyuki	P	Ocean Dynamics, Deep Ocean Mixing, Ocean Wave Theory
MASUMOTO, Yukio	P	Climate Dynamics, Physical Oceanography
KOIKE, Makoto	AP	Atmospheric Environmental Science/Atmospheric Chemistry
TOZUKA, Tomoki	AP	Physical Oceanography, Climate Dynamics
MIURA, Hiroaki	A	Atmospheric Dynamics, Atmospheric Modeling
KOHMA, Masashi	RA	Middle Atmospheric Dynamics
TANAKA, Yuki	RA	Ocean Dynamics, Coastal Oceanography
Space and Planetary Science Group		
SUGITA, Seiji	P	Planetary Exploration, Planetary Science, Astrobiology
SEKI, Kanako	P	Space Physics
TACHIBANA, Shogo	P	Cosmochemistry
HOSHINO, Masahiro	P	Space and Astroplasma Physics
AMANO, Takanobu	AP	Space Physics, Plasma Astrophysics

KASAHARA, Satoshi	A	Planetary Science, Space-borne Instrumentation
HIYAGON, Hajime	AP	Planetary Science, Isotope Cosmochemistry, Meteoritics
MOROTA, Tomokatsu	AP	Planetary Science, Lunar and Planetary Exploration
YOKOYAMA, Takaaki	AP	Solar and Astrophysical Plasma Physics
OHIRA, Yutaka	RA	Astrophysics, Cosmic Ray Physics, Plasma Physics
KEIKA, Kunihiro	RA	Planetary magnetosphere Plasma Physics, Interplanetary Plasma Physics
CHO, Yuichiro	RA	Planetary Science
Earth and Planetary System Science Group		
KAYANNE, Hajime	P	Earth System Science (coral reef, coast, carbon cycle, global change, paleoenvironment)
TACHIBANA, Shogo	P	Cosmochemistry
TAJIKA, Eiichi	P	Earth and Planetary System Science, Comparative Planetology
IKOMA, Masahiro	AP	Theoretical Planetology, Exoplanetology
KAWAHARA, Hajime	RA	Exoplanets (characterization, analysis, and instruments)
TAKAHASHI, Satoshi	RA	Palaeontology, Geochemistry, Geology
MOTEKI, Nobuhiko	RA	Atmospheric Chemistry and Physics, Environmental Physics
FUKUI, Akihiko	PRA	Exoplanet Observation Research (Transit photometry, Gravitational Microlensing)
Solid Earth Science Group		
IDE, Satoshi	P	Earthquake Source Physics
SIMON, Wallis	P	Structural Petrology, Tectonics
OZAWA, Kazuhito	P	Petrology,
HIROSE, Kei	P	High-Pressure Geophysics, Study of Deep Earth Materials
ANDO, Ryosuke	AP	Earthquake Source Physics, Seismotectonics
IIZUKA, Tsuyoshi	AP	Geochemistry and Cosmochemistry
KAWAI, Kenji	AP	Global Seismology, Study of Earth's Deep Interior
TANAKA, Yoshiyuki	AP	Geodesy
TANAKA, Hidemi	L	Material Seismology, Structural Geology
SAKURABA, Ataru	RA	Geodynamics, Planetary Dynamos, Geomagnetism
SATO, Masahiko	RA	Paleomagnetism, Rock-Magnetism
NAGAYA, Takayoshi	RA	Structural Geology, Mineralogy Physics, Structural Seismology
KUWAYAMA, Yasuhito	PRA	High Pressure Geoscience
TO, Akiko	PRA	Seismology
Geosphere and Biosphere Science Group		
ENDO, Kazuyoshi	P	Molecular Palaeontology, Skeletogenesis
KANO, Akihiro	P	Sedimentology, Paleoclimatology, Geobiology
KOGURE, Toshihiro	P	Mineralogy, Material Science, Electron Microscopy, Crystallography
GOTO, Kazuhisa	P	Geology, Sedimentology, Tsunami Research
TAKAHASHI, Yoshio	P	Geochemistry, Environmental Chemistry, Radiochemistry
ITAI, Takaaki	AP	Environmental Geochemistry
SUZUKI, Yohey	AP	Geomicrobiology, Geochemistry, Nanomineralogy
OGIHARA, Shigenori	RA	Organic Geochemistry, Mineralogy
SUNAMURA, Michinari	RA	Geomicrobiology, Microbial Ecology,

P: Professor, AP: Associate Professor, L: Lecturer, RA: Research Associate/Assistant Professor, PAP;

Project Associate Professor, PRA: Project Research Associate/Project Assistant Professor.

The ages range from 42 to 64 (averaging 54.7) for professors, 37 to 63 (averaging 45.0) for associate professors, 31 to 59 (averaging 39.4) for assistant professors. Compared with 2012, average age decreased by 3 to 5 years in every job class.

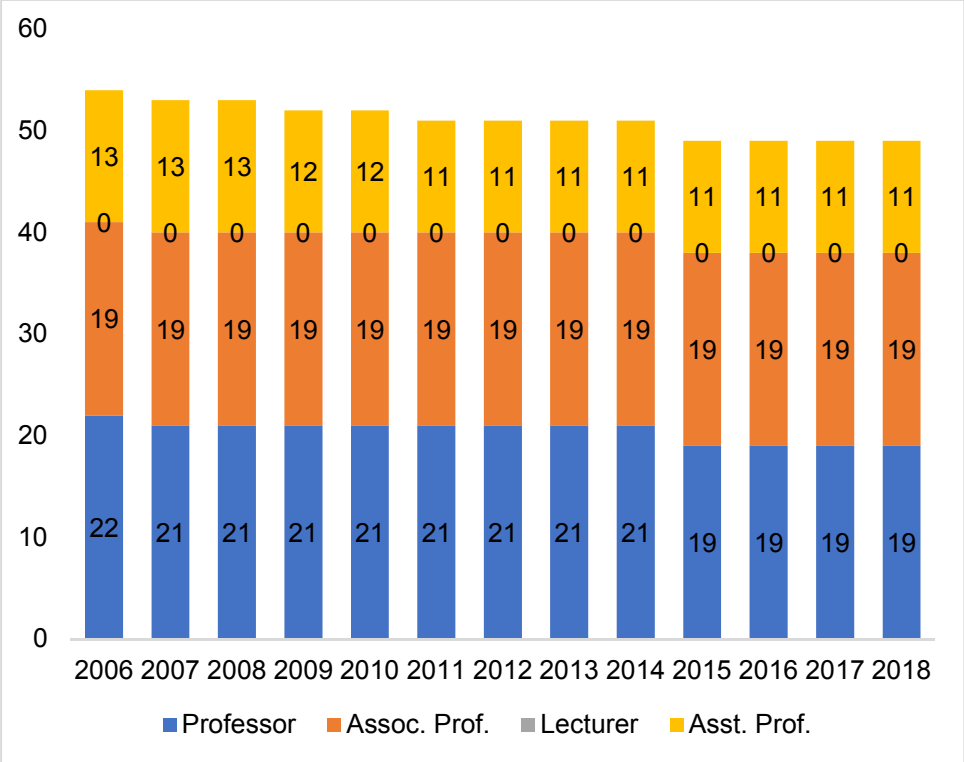
3. Changes in the Number of Faculty Members

(1) The Number of Faculty Members

Changes in the number of fixed positions managed by University of Tokyo that are available to the department are shown in the following tables and graphs. The long-term university plan to reduce the number of fixed position has had significant effect. In FY2006, the total number of positions was 54, and this decreased to 49 in FY2018 (a further decrease of 1 professor to 48 on April 1, 2019). In addition to these fixed positions, the department has been successful in obtaining one five-year term professorship, one five-year term assistant professorship, and one associate professorship restricted to female applicants.

Capacity of Faculty

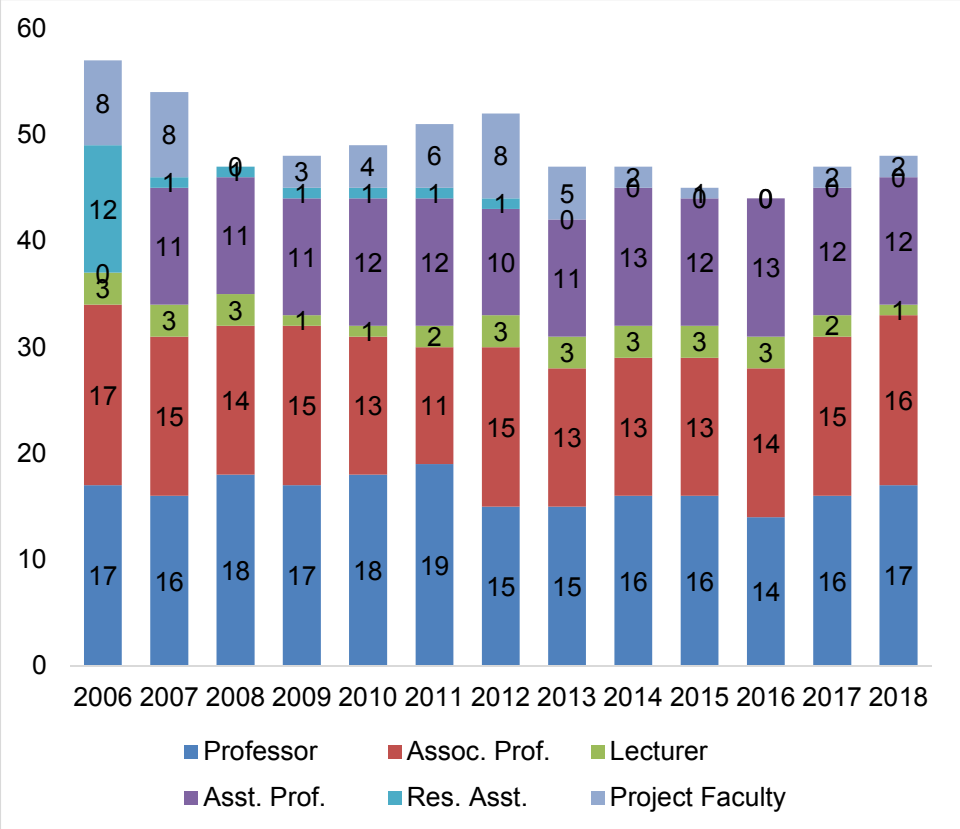
Position/year	2006	2012	2013	2014	2015	2016	2017	2018
Professor	22	21	21	21	19	19	19	19
Assoc. Prof.	19	19	19	19	19	19	19	19
Lecturer	0	0	0	0	0	0	0	0
Asst. Prof.	13	11	11	11	11	11	11	11
Total	54	51	51	51	49	49	49	49



Number of Faculty on 1st of April of every fiscal year

Position/year	2006	2012	2013	2014	2015	2016	2017	2018
Professor	17(2)	15(2)	15(2)	16(2)	16(2)	14(3)	16(2)	17(2)
Assoc. Prof.	17	15	13	13	13	14	15	16
Lecturer	3	3	3	3	3	3	2	1
Asst. Prof.	-	10(2)	11(2)	13(2)	12(1)	13(1)	12(1)	12
Research Asst.	12(1)	1	0	0	0	0	0	0
Total	49(3)	44(4)	42(4)	45(4)	44(3)	44(4)	45(3)	46(2)
Project Faculty	8	8	5	2	1	0	2	2

() Female faculty members



(2) Changes in the Number of Faculty Members

The table below shows the changes in the number of faculty after 2012. 29 new people were appointed and 24 left our department. Since the number of the faculty of the department is about 50, almost the half of them have been replaced. Only 6 people were internally promoted during this period. These data show our commitment to the employment of human resources from outside the University of Tokyo and the high mobility of the faculty members of the department. However, some of the faculty member have remained as assistant professors or associated professors for more than 10 years, with a potential risk for stagnation of the organization.

Date	Name	Position	Faculty Member Changes
2012.4.1	MIURA, Hiroaki	Associate Professor	From Atmosphere and Ocean Research Institute at the University of Tokyo (project assistant professor)
2012.4.1	TANAKA, Yuki	Associate Professor	New appointment
2012.5.31	MOCHIZUKI, Eiji	Research Assistant	Punitive dismissal
2012.11.1	KAWAHARA, Hajime	Assistant Professor	New appointment
2013.3.31	URABE, Tetsuro	Professor	Retirement
2013.3.31	MIYAMOTO, Masamichi	Professor	Retirement
2013.4.1	IWAGAMI, Naomoto	Professor	Promoted from associate professor
2013.4.1	IDE, Satoshi	Professor	Promoted from associate professor
2013.6.1	MASUMOTO, Yukio	Professor	From JAMSTEC (program director)
2013.8.1	NISHIDA, Keisuke	Assistant Professor	New appointment
2014.4.1	KOHMA, Masashi	Assistant Professor	New appointment
2014.4.1	TAKAHASHI, Yoshio	Professor	From Hiroshima University (professor)
2014.8.1	MOTEKI, Nobuhiro	Assistant Professor	Appointment from project assistant professor
2014.9.1	ANDO, Ryosuke	Associate Professor	From National Institute of Advanced Industrial Science and Technology (senior researcher)
2014.10.1	SUGITA, Seiji	Professor	Replaced from Graduate school of Frontier Science (professor)
2014.10.1	SEKINE, Yasuhito	Associate Professor	Promoted from a lecture at Graduate school of Frontier Sciences
2014.12.31	NAMIKI, Atsuko	Assistant Professor	To associate professor at Hiroshima University
2015.1.1	YOSHIKAWA, Ichiro	Associate Professor	To professor at Graduate school of Frontier Science
2015.3.31	FUNAMORI, Nobumasa	Associate Professor	To professor at High Energy Accelerator Research Origination
2015.3.31	SUGIURA, Naoji	Professor	Retirement
2015.3.31	KONDO, Yutaka	Professor	Retirement
2015.3.31	YAMAMOTO, Takashi	Assistant Professor	Retirement
2015.10.1	YOSHIOKA, Kazuo	Assistant Professor	From Rikkyo University (project assistant professor)
2015.10.16	SEKI, Kanako	Professor	From Nagoya University (associate professor)
2016.3.31	IWAGAMI, Naomoto	Professor	Retirement
2016.3.31	KIMURA, Gaku	Professor	Retirement
2016.3.31	MURAKAMI, Takashi	Professor	Retirement
2016.4.1	KAWAI, Kenji	Associate Professor	Promoted from assistant professor at Graduate School of Arts and Science
2016.5.1	TAJIKA, Eiichi	Professor	Replaced from Graduate school of Frontier Science (professor)
2016.8.1	AMANO Takanobu	Associate Professor	Promoted from assistant professor
2016.9.1	KOGURE, Toshihiro	Professor	Promoted from associate professor

2016.9.1	KASAHARA, Satoshi	Associate Professor	From Institute of Space and Astronautical Science (assistant professor)
2016.11.1	KEIKA, Kunihiro	Assistant Professor	From Nagoya University (project assistant professor)
2016.12.1	KANO, Akihiro	Professor	From Kyushu University (professor)
2016.12.31	MIURA, Akira	Assistant Professor	Early Retirement
2017.3.31	NAGAHARA, Hiroko	Professor	Retirement
2017.3.31	GELLER, Robert	Professor	Retirement
2017.3.31	IKEDA, Yasutaka	Associate Professor	Retirement
2017.4.1	HIROSE, Kei	Professor	From Tokyo Institute of Technology (professor)
2017.4.1	IIZUKA, Tsuyoshi	Associate Professor	Promoted from lecturer
2017.5.1	YOSHIOKA, Kazuo	Assistant Professor	To lecturer at Graduate school of Frontier Science
2017.9.1	ITAI Takaaki	Associate Professor	From National Institute for Minamata Disease (senior researcher)
2017.10.1	WALLIS, Simon	Professor	From Nagoya University (professor)
2017.10.1	TACHIBANA, Shogo	Professor	From Hokkaido University (associate professor) to UTokyo Organization for Planetary and Space Science
2018.1.1	ABE, Yutaka	Associate Professor	Deceased
2018.1.1	OHIRA, Yutaka	Assistant Professor	From Aoyama Gakuin University (project assistant professor)
2018.1.1	SATO, Masahiko	Assistant Professor	From National Institute of Advanced Industrial Science and Technology (researcher)
2018.2.1	TSUIHIJI, Takanobu	Associate Professor	Promoted from a lecture
2018.3.31	SHIMIZU, Ichiko	Assistant Professor	To associate professor at Kyoto University
2018.4.1	MIKOUCHI, Takashi	Associate Professor	Promoted to professor at The University Museum
2018.4.1	TANAKA, Yoshiyuki	Associate Professor	Replaced from Earthquake Research Institute (associate professor)
2018.5.31	SEKINE, Yasuhito	Associate Professor	To professor at Tokyo Institute of Technology
2018.6.16	CHO, Yuichiro	Assistant Professor	New appointment
2018.7.31	NISHIDA, Keisuke	Assistant Professor	Terminated a term, became project researcher
2019.3.31	TADA, Ryuji	Professor	Retirement
2019.4.1	GOTO, Kazuhisa	Professor	From Tohoku University (associate professor)
2019.4.1	TSUIHIJI, Takanobu	Associate Professor	To senior researcher at National Museum
2019.5.1	MOROTA, Tomokatsu	Associate Professor	From Nagoya University (Lecturer)
2019.9.1	NAGAYA, Takayoshi	Assistant Professor	New appointment

(3) Changes in the Number of Research Fellowship for Young Scientists, TA, RA

Teaching assistant (TA) posts are generally supported by the University of Tokyo to assist in classes, and the number of TA is dependent on our budget. Most of the TAs are graduate students.

Since FY2017, a 'TA system' restricted to doctoral students has stared, and the number of TA has increased accordingly.

Research assistant (RA) positions used to be financially supported by the Ministry of Education or other organizations such as Japan Society for the Promotion of Science (JSPS). Since 2018, some RAs have also been supported by 'School of Science support for PhD student' and 'The University of Tokyo support system for PhD research', which was originally started at the School of Science and spread out to the whole university. However, in recent years, RA support provided by these systems has been reduced, and an alternative source of support has been provided by World-leading Innovative Graduate Study Program (WINGS). From 2018, the International Graduate Program for Excellence in Earth-Space Science (IGPEES) and Program of Excellence in Photon Science (XPS) started to support both RA and TA.

TA, RA, and JSPS DC: The 1st of April at every fiscal year

Position/Year	2006	2012	2013	2014	2015	2016	2017	2018
TA	33	60	64	60	71	60	102	106
RA	45	52	71	80	77	86	56	65
DC	35	37	35	35	34	35	37	30

DC: Research Fellowship for Young Scientists, for Doctoral Students (JSPS)

(4) Changes in the Number of Staff

There has been a long-term decrease in the number of staff due to the centralization policy of administrative functions in the School of Science. Project researchers who are employed for specific projects, are also included as part-time staff in the table below. Around 2013, as a result of restructuring of the function of the department office, the number of part-time administrators in each program has decreased.

Number of Staff on the 1st of April for every fiscal year

Job Title/Year	2006	2012	2013	2014	2015	2016	2017	2018
Administrative Staff	6	5	5	5	4	4	4	3
Technical Staff	6	5	5	5	5	5	5	5
Part-time Staff	27	30	29	22	22	23	21	22
PD	7	3	4	3	4	4	2	2

PD: Research Fellowship for Young Scientists, for PostDoc (JSPS)

4. Information Regarding Facilities

(1) Areas

The School of Science Building 1 East Wing was completed the end of FY2017 and part of the Department of Earth and Planetary Science moved to from Building 3 to the new building. The department library which has been managed by this department was merged into the new science library in the Building 1, East Wing. Current major facilities of the department are located in Building 1, West Wing, Central Wing, East Wing and Building 4. Many facilities are located together in Building 1. The dimensions of each building are: 1,932 m^2 (Building 1, West Wing), 4,679 m^2

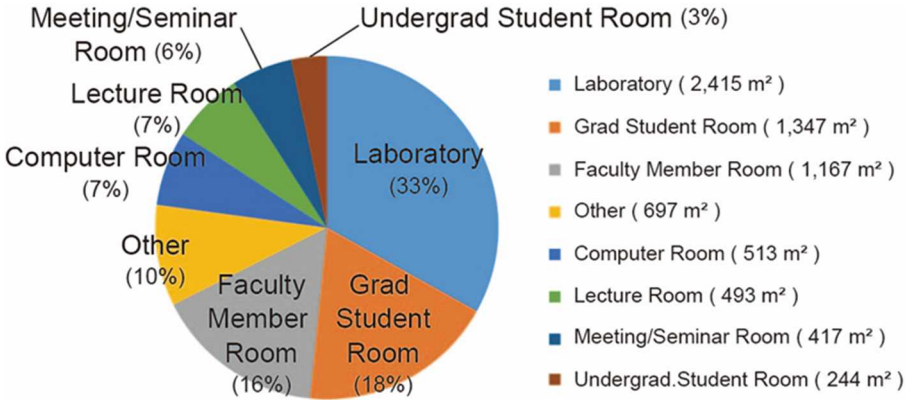
(Building 1, Central Wing), 260 m^2 Building 1, East Wing), and 366 m^2 (Building 4). The total area used by the Department of Earth and Planetary Science has decreased by about 15% compared to FY2012 and before. However, considering the merging of the department library with the science library, and other factors such as contributions to the establishment of common lecture rooms for the School of Science, the reeducation in our department area is not great. Rather the convenience of research and education has been improved by the fact that the department facilities have been brought together into one building.

Rooms and Space

		Bldg.1 West	Bldg.1 Central	Bldg.1 East	Bldg.3	Bldg.4	Total
Lecture Room	Number of rooms	2	3	0	0	0	5
	Area m^2	246	247	0	0	0	493
Meeting Room/Seminar Room	Number of rooms	5	8	0	0	0	13
	Area m^2	185	232	0	0	0	417
Laboratory	Number of room	1	49	6	1	6	63
	Area m^2	23	1,948	191	56	197	2,415
Faculty Members' Room	Number of rooms	21	32	0	0	2	55
	Area m^2	447	686	0	0	34	1,167
Undergraduates' Room/Graduate Students' Room	Number of rooms	11	15	0	0	0	26
	Area m^2	672	919	0	0	0	1,591
Computer Rooms	Number of rooms	2	4	2	0	1	9
	Area m^2	118	294	69	0	32	513
Other	Number of rooms	3	6	0	0	2	11
	Area m^2	241	353	0	0	103	697
Total	Number of rooms	45	117	8	1	11	182
	Area m^2	1,932	4,679	260	56	366	7,293

Area in m^2

Floor Space



(2) Equipment

The department has various analytical devices such as computers and servers as shared equipment. Computers for education are controlled by a management group run by graduate students. The Network Committee is in charge of the maintenance of the networks of the Department of Earth and Planetary Science which can be used for all related people who work in this department, another strongly protected network called “protracted network”, and mails and web servers of the department. Analytical devices are managed by the Scientific Equipment Committee, and nine devices are currently registered as shown below.

In FY2013, a laser ablation inductively coupled plasma mass spectrometer was established as a new shared facility. The analytical devices are used for graduate school programs, the ‘Laboratory experiments for instrumental analysis I & II’ courses and research that is carried out by undergraduate students, graduate students and members of faculty. Some of the analytical equipment is available on request for use by researchers from outside department, and there is a demand for researchers from inside and outside the country.

In addition to these shared facilities, there is much analytical equipment that is maintained and managed in each lab but this is not openly advertised, since they are for research purpose. Whereas most of the instruments for research are also used for educational purpose, some are managed as purely educational equipment by the relevant faculty members.

Shared Equipment List

- X-ray diffractometer for multiple sample analysis
- X-ray diffractometer
- High-Spatial Resolution Field Emission Scanning Electron Microscope
- Field Emission Scanning Electron Microscope
- Electron Probe Micro Analyzer
- Field Emission Electron Probe Micro Analyzer
- X-Ray Fluorescence
- Stable Isotope Mass Spectrometer
- Laser Ablation-Inductively Coupled Plasma Mass Spectrometer

5. Changes in Income

(1) Outline of the Department’s Budgeted Income

The annual income of the department is very variable. The central government grant for Management expenses grant has been continuously reduced since the establishment of the department. After the minimum in FY2014, the amount has increased slightly. However, the total amount is still less than half of that at the beginning, and the discretionary funds are still very limited. The amount of external funds shows great variability. Most of external funds are from Grants-in-Aid for Scientific Research. Over the past few years, the total amount of the funds and the number of grants has been slightly increasing. In particular, the number of joint projects have been rising, suggesting that many joint projects with other groups are progressing, probably reflecting some systematic changes in the system of the Grants-in-Aid for Scientific Research. Indirect expenses included in the Grants-in-Aid for Scientific Research and other external funds can be used for purposes not directly related to the research project, and together with the management expenses grant they are important to support the finances of the department.

Currently, the income shows a slight upward trend. However, if we look at the change over a long period of time, we can see that our income has decreased significantly. To improve the situation, it is important to receive external funds in various ways, including the diversification of financial resources, to activate our research and education.

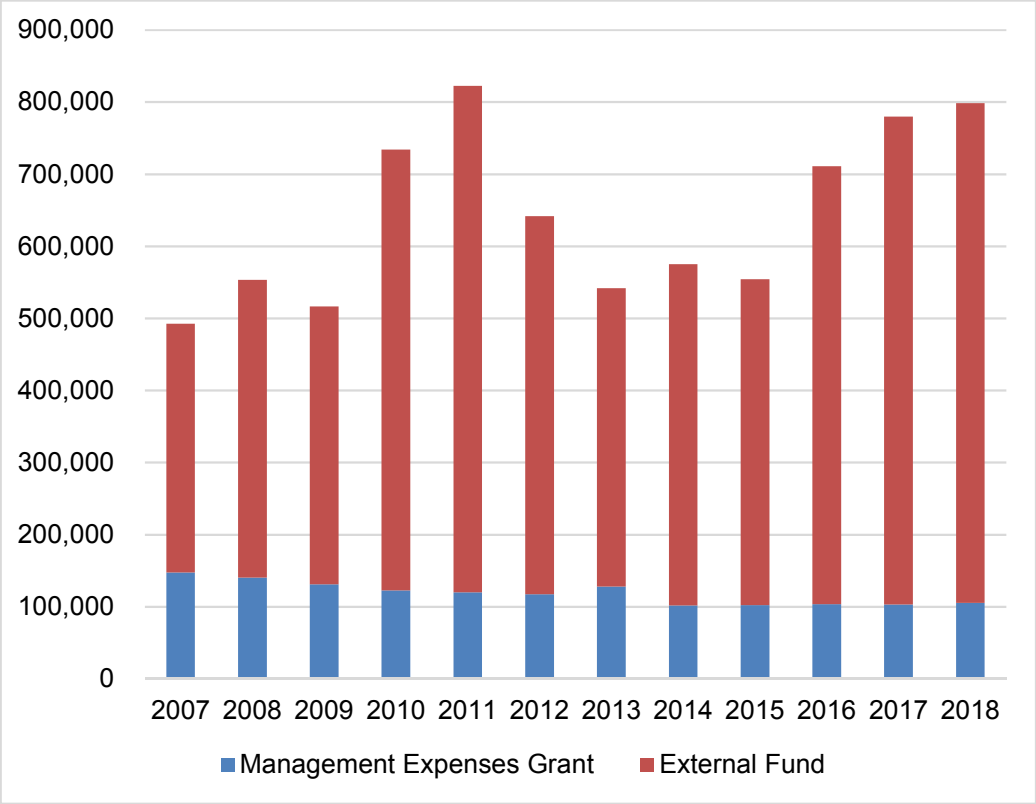
Management Expenses Grant (K Yen)

FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
117,474	127,826	101,530	102,382	103,406	102,979	105,268

External funds (K Yen)

	FY2012		FY2013		FY2014		FY2015		FY2016		FY2017		FY2018	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
Grant-in-Aid for Scientific Research (KAKENHI)	95	322,915	74	278,581	99	298,970	82	282,825	121	405,238	127	444,816	137	422,819
Scientific Research on Innovative Areas	9	87,400	7	61,900	5	76,800	3	80,200	6	126,400	8	90,340	8	53,231
Scientific Research on Priority Areas											1	82,250	1	48,900
Scientific Research (S)	3	101,700	3	80,900	4	71,700	2	27,600						
Scientific Research (A)	3	15,000	4	22,800	7	46,900	8	86,400	11	113,100	12	85,300	10	97,300
Scientific Research (B)	9	38,900	8	41,800	8	27,100	5	14,300	6	15,900	8	36,200	14	51,058
Scientific Research (C)	9	8,000	4	5,300	5	5,000	7	6,900	8	6,700	5	8,200	5	5,000
Exploratory Research	2	3,800	2	3,500	7	8,600	4	3,200	8	26,119	4	3,200	4	4,300
Young Scientists (A)	1	9,400	2	16,600	3	19,000	4	8,900	5	18,588	7	25,900	2	4,400
Young Scientists (B)	4	4,400	4	5,200	7	6,200	7	6,800	10	5,553	9	10,548	9	9,114
Research Activity Start-up	1	1,200	0	0	0	0			1	1,200	2	2,200	1	1,200
Promotion of Joint International Research													4	11,000
Grant-in-Aid for JSPS Research Fellow	27	20,700	24	20,376	19	18,100	22	21,500	25	21,339	28	38,206	25	23,486
Allocation for Co-investigator	27	32,415	16	20,205	34	19,570	20	27,025	41	70,339	43	62,472	54	113,830
Commission (Government)	15	114,405	29	106,203	14	139,326	12	124,967	13	130,299	15	161,988	16	169,287
Cooperative Research	3	56,720	2	367	3	6,168	4	1,904	2	12,840	4	8,910	8	30,590
Contract Researcher	5	7,054	6	6,069	1	1,795	2	2,015	10	18,461	10	23,550	11	25,187
Donation	4	2,300	9	6,600	11	11,312	20	22,989	11	20,403	7	7,452	21	14,801
Subtotal	122	503,394	120	397,820	128	457,571	120	434,700	157	587,241	163	646,716	193	662,684

Indirect Costs	21,002	16,293	15,801	17,287	20,423	29,869	30,534
Total	524,396	414,113	473,372	451,987	607,664	676,585	693,218

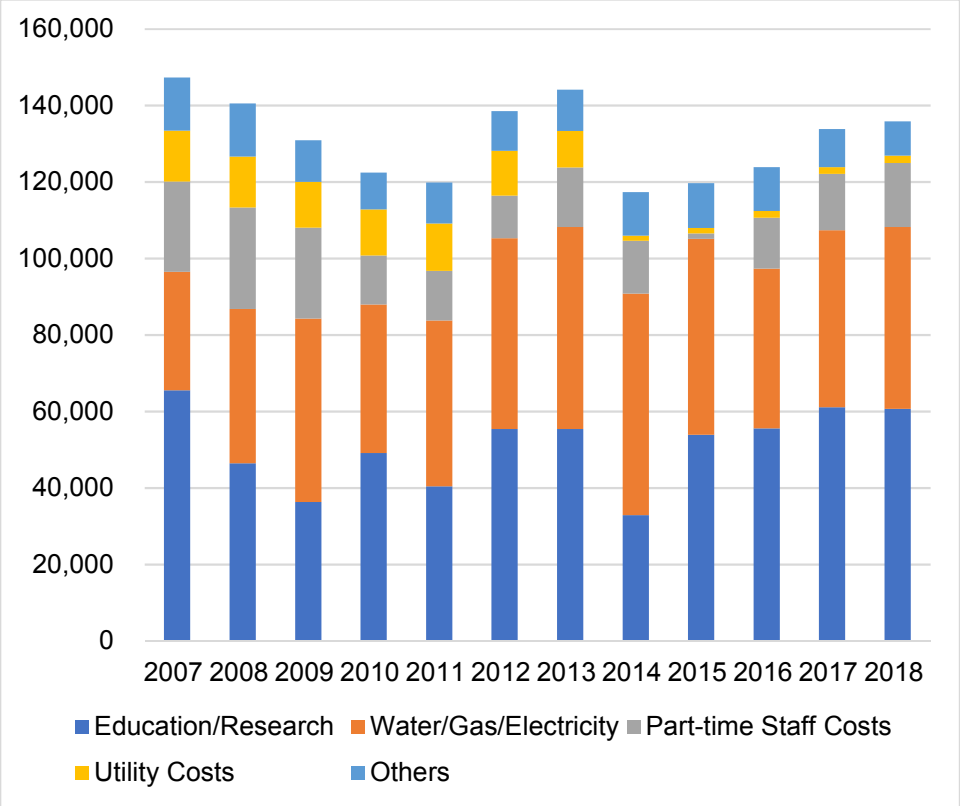


(2) Management Expenditure of the Department

Expenditure managed by the department is approximately 130 million yen, which includes the management expenses grant, external funds and indirect expenses. One third of the total is Educational and Research expenses. The cost of gas, electricity and water has increased. Despite the efforts by the whole School of Science to save electricity, such as replacement to energy-saving equipment and the disclosure of bills to all faculty members, the payment of the bills is still comparable to education and research expenses.

Expenditure by year for the assessment period (K Yen)

	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
Education and Research	55,374	55,382	32,832	53,867	55,529	61,102	60,645
Personnel costs for part-time staff	10,877	14,442	13,513	1,081	12,947	14,497	16,082
Travel expenses for part-time lecturers	330	1,160	263	364	344	246	658
Library maintenance	4,071	4,712	5,205	4,498	4,972	4,323	1,749
Water, gas and electricity bills	49,862	52,794	57,986	51,248	41,820	46,284	47,556
Communication charges/Freight	795	510	382	783	811	917	1,064
Utility costs	11,675	9,555	1,352	1,383	1,717	1,736	1,919
Computer charges	5,492	5,564	5,798	6,445	5,689	4,700	6,129
Total	138,476	144,119	117,331	119,669	123,829	133,805	135,802


160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
Education/Research
Water/Gas/Electricity
Part-time Staff Costs
Utility Costs
Others

III. Education

1. Education and Curriculum

(1) Objectives of Undergraduate Education

While the field of 'Earth and Planetary Science' tackles fundamental aspects of the behaviors of the earth and other planets, it also covers issues such as natural disasters, resource depletion, and global warming. Our study has many relations with general society. Our undergraduate students are some of the most able and motivated in Japan. Many students will follow the career paths where they utilize their specialized knowledge, such as becoming researchers. Specifically, about 90% will go on to the graduate school, and about 40% will receive a PhD.

Considering the percentage of the enrollment for the higher education, the main focus of undergraduate program is to gain a good grounding in the fundamentals of Earth and planetary science. It is indispensable to become familiar with complex phenomena of the natural world and to acquire analytical skills to understand these phenomena quantitatively. However, when aiming for education covering all fields of Earth and planetary science, it is very challenging to provide a comprehensive cover of the fundamentals of the various approaches needed for the curriculum in a single department. Therefore, by establishing two programs, the Earth and Planetary Physics Program and the Earth and Planetary Environment Program, we divide a wide range of contents into two disciplines. In each program, a systematic curriculum ensures that each undergraduate student can acquire the basic skill set needed for the student to progress and tackle a wide range of research topics in the next stage.

The Earth and Planetary Physics Program emphasizes acquisition of the fundamentals of physics and applied mathematical science in order to develop the ability to understand the basic behavior of various phenomena of the Earth and planets based on physical laws. On the other hand, the Earth and Planetary Environmental Program aims to understand the essence of complex phenomena of earth and to develop knowledge of dominant underlying processes. There are three important points: developing the observational skills needed to study specific objects such as earth materials, environment and life-forms; secondly, understanding the fundamental behavior of processes that occur on time scales relevant to the history of the earth and of solar space; and finally, acquiring the perspective to be able to carry out systematic integration of these studies. When students advance to the graduate school, they enter an integrated department of "Earth and Planetary Science". This department provides more advanced education. In order to promote cooperation and collaboration that start at the undergraduate level, all faculty members appointed since April 2015 have been affiliated to both programs, and the links between the Earth and Planetary Physics Program and the Earth and Planetary Environment Program have been strengthened.

We consider it is important not only for students to learn the basics of each discipline in the two programs but also to acquire a wider range of knowledge and perspectives as they progress with their training. Therefore, students are encouraged to attend lectures, practical studies, research, and field excursions of the other programs, and many students do so. (For example: A student from the Earth and Planetary Physics Program may join a field survey in the Earth and Planetary Environment Program). In the 4th year of undergraduate studies, it is possible that a student can select advisors from various choices for their "Senior Project/Research in Earth and Planetary Physics" (Graduation Research of the Earth and Planetary Physics Program) and "Research in Earth and Planetary Environmental Science" (Graduation Research of the Earth and Planetary Environment Program). These research projects are carried out in coordination with both programs, including the arrangement of the schedule for the final research presentations.

In addition, in order to promote communications between faculty members and students of both programs, various guidance and graduation ceremonies are also held together. Moreover, from FY2017, we have held a half day 'joint seminar' where faculty members and graduate students introduce the latest research progress in their fields. This assists undergraduate students who will choose their own specialty in the future to gain a good overview of activities in the department.

From FY2016, The University of Tokyo began a new entrance examination for specially selected candidates. The faculty of Science, in general, accepts applicants separately for each program. However, application to the Earth and Planetary Physics Program and the Earth and Planetary Environment Program are treated jointly. In this way, although there are many approaches and methods in the Earth and planetary science, every year we are able to select high achieving students who have a strong interest in Earth and planetary science. Students who enter the university by the examination for selected candidates will decide to join either of the two programs at the end of the first year. The time of this decision is earlier than other students.

Our education program places strong emphasis on the basic disciplines that forms the basis of a wide range of Earth and planetary science, whilst the same time encouraging students to cultivate a wide perspective and a good overall grasp of the Earth and planetary science. We believe our educational program is rare in the world, and contributes to nurturing academically able and intellectually robust students. Furthermore, as part of the globalization of students, many of students from both programs are actively studying overseas by using the Overseas Program (SVAP, UGRASP) of the Faculty of Science, it could be because of their characteristics of a field.

Recent Reorganization and Improvement of Curriculum

The department has maintained its efforts to strengthen and improve the undergraduate educational system in order to accomplish its educational principles. The Earth Sciences Program was reorganized into the Earth and Planetary Environmental Science Program in FY2006. The department has also reinforced the structure to organize, manage and implement basic education of the Earth and Planetary Physics Program and the Earth and Planetary Environmental Science Program in a unified manner. Drastic reorganization of the curriculum was conducted in Earth and Planetary Environmental Science Program to put more emphasis on field survey, observation of geological materials, as well as to include more elements of chemistry and biology relevant to Earth and planetary science. Concurrently, the department also conducted curriculum reorganization of Earth and Planetary Physics Program to put emphasis on basic education of physics and applied mathematics, compliment subjects which were not covered in previous curriculums of the two programs as well as to eliminate overlapping subjects, and to strengthen the linkage between them by setting introductory and basic subjects common to both programs.

The Earth and Planetary Environment Program was established in 2006, and graduates of the program have obtained a PhD degree since 2012. In this situation, we set up a 'curriculum working group' in FY2012 and have been working on evaluation and revision of the curriculum. In FY2017, in order to fill the areas that had been missing so far, we established lectures of "Space Geochemistry" and "Introduction to Solid Earth and Planets". We also changed the term in which "Structural Geology" courses held a lecture on the basic contents of geology, from 4th grade to 3rd grade. By deciding an adviser for Graduation Research earlier in June, it became possible to carry out some time-consuming tasks such as fieldwork in this research. In FY2016, we assigned two faculty advisors to all undergraduate students as well as the Earth and Planetary Physics Program, and set up a system (advisor system) that allows students to consult about their study and their life at any time.

There have been no major changes in the curriculum structure of the Earth and Planetary Physics

Program. The course “Exoplanets” was created in FY 2013 as a common program and “Exercise in Basic Earth and Planetary Physics III and IV” was also newly created for the purpose of improving mathematical physics in FY2016. In FY2015, we launched “Introduction for Earth and Planetary Physics” for the first and second year of undergraduate students, the new program transmits Physics’ appeal strongly to students. In “Senior Project in Earth and Planetary Physics”, we set students to select two different fields each of which they study for one ‘quarter term’ (a total of 1/2 year) and encouraged students to have a wide knowledge of difference fields.

Since FY2017, we have held a presentation on “Senior Research on Earth and Planetary Physics” at Koshiba Hall (main hall of Building 1), we can see improvements in their presentation skills and greater discussion between students. In the advisor system introduced in 2012, not only counseling related to courses, but also about studying abroad and career paths are carried out, and it is functioning effectively.

In FY2014, “Research Ethics” was added to a compulsory subject related to both programs as a countermeasure on research fraud, which has become a serious problem in recent years. All students are required to sign a written oath confirming compliance with the Code of Research Ethics after taking choice of lectures.

Curriculum of Earth and Planetary Physics Program FY2019

Code	Course Title	Teaching Staff	Credit	Grade	Semester
0526002	Exercise in Basic Earth and Planetary Physics I	YOKOYAMA Takaaki, KAWAHARA Hajime, KEIKA Kunihiro	2	2	A
0526003	Exercise in Basic Earth and Planetary Physics II	YOKOYAMA Takaaki, SAKURABA Ataru, TANAKA Yuki	2	2	A
0526005	Introduction to Earth and Planetary Physics	IDE Satoshi, YOKOYAMA Takaaki, TOZUKA Tomoki, IKOMA Masahiro	2	2	A
0526021	Meteorology	SATO Kaoru	2	4	S
0526022	Physical Oceanography	HIBIYA Toshiyuki	2	4	S
0526023	Physics of Ocean-atmosphere System	TOZUKA Tomoki, MIURA Hiroaki	2	4	A
0526027	Earthquake Physics	IDE Satoshi,	2	4	S
0526034	Mechanics of Elastic Bodies	ANDO Ryosuke	2	3	S
0526037	Geophysical Fluid Dynamics I	IGA Keita	2	3	S
0526038	Geophysical Fluid Dynamics II	MASUMOTO Yukio	2	3	A
0526065	Ocean and Atmosphere Material Circulation Physics	KOIKE Masato, YASUDA Ichiro	2	3	A
0526066	Space Science I	YOKOYAMA Takaaki	2	3	S
0526070	Space Science II	AMANO Takanobu	2	3	A
0526072	Solid Earth Mechanics	TANAKA Yoshiyuki	2	3	A
0526073	Exercises in Earth and Planetary Physics	MIURA Hiroaki, TO Akiko, TOZUKA Tomoki, AMANO Takanobu	4	3	S
0526074	Experiments in Earth and Planetary Physics	KOIKE Makoto, CHO Yuichiro, SATO Masahiko, KUWAYAMA Hiroyasu, HIROSE Kei, OZAWA	4	3	A

		Kazuhito, HIYAGON Hajime, SUGITA Seiji, TACHIBANA Shogo, ARAYA Akito, TAKEI Yasuko, YAMADA Tomoaki, NAKATANI Masao, OGAWA Tsutomu, NISHIDA Kiwamu, TAKAMORI Akiteru, KATO Aitaro, HIRAGA Takehiko, KASAHARA Satoshi, ISSE Takehi			
0526075	Experiments in Earth and Planetary Chemistry	KOIKE Makoto, CHO Yuichiro, SATO Masahiko, KUWAYAMA Hiroyasu, HIROSE Kei, OZAWA Kazuhito, HIYAGON Hajime, SUGITA Seiji, TACHIBANA Shogo, ARAYA Akito, TAKEI Yasuko, YAMADA Tomoaki, NAKATANI Masao, OGAWA Tsutomu, NISHIDA Kiwamu, TAKAMORI Akiteru, KATO Aitaro, HIRAGA Takehiko, KASAHARA Satoshi, ISSE Takehi	4	3	A
0526076	Senior Project in Earth and Planetary Physics	Professors in charge	4	4	S
0526077	Senior Research in Earth and Planetary Physics	Professors in charge	4	4	A
0526079	Material Science of Earth and Planetary Interiors	HIROSE Kei, FUNAMORI Nobumasa	2	4	S
0526080	Geo-electromagnetics	SHIMIZU Hisayoshi, UESHIMA Makoto	2	3	A
0526081	Theory of Elastic Wave Propagation	KAWAI Kenji	2	3	A
0526082	Geodynamics	IWAMORI Hikaru, ICHIHARA Mie	2	4	A
0526084	Numerical Analysis in Geophysics	MASUMOTO Yukio, YOKOYAMA Takaaki, TAKEUCHI Nozomu	2	4	S
0526085	Data Analysis in Geophysics	IDE Satoshi, KOSAKA Yu	2	4	A
0526086	Elementary Comparative Planetology	SUGITA Seiji, KASASHARA Satoshi, IKOMA Masahiro	2	4	S
0526087	Elementary Earth and Planetary System Science	IKOMA Masahiro	2	4	S
0526090	Observation Exercises in Earth and Planetary Physics	TANAKA Yoshiyuki, YOSHIKAWA Ichiro, YOSHIOKA Kazuo, MORI Toshiya, HIBIYA Toshiyuki, UESHIMA Makoto, SAKAI Shinichi, IDE Satoshi, AOKI Yosuke, KAYAMA Takao, TANAKA Yuki, MOTEKI Nobuhiro, KOIKE Makoto, SATO Kaoru, KOHMA Masashi	2	3	S
0526092	Planetary Aeronomy	SEKI Kanako, IMAMURA Takeshi	2	4	S
0526094	Exercise in Basic Earth and Planetary Physics III	KAWAI Kenji, SAKURABA Ataru, KOHMA Masashi	1	3	S
0526095	Exercise in Basic Earth and Planetary Physics IV	IKOMA Masahiro, OHIRA Yutaka, FUKUI Akihiko	1	3	S
0526801	Research Ethics	MASUMOTO Yukio	0.5	3・4	S

Curriculum of Earth and Planetary Environmental Science Program FY2019

Code	Course Title	Teaching Staff	Credit	Grade	Semester
0528001	Introductory Earth Environments	KAYANE Hajime, ITAI Takaaki, YOSHIMORI Masakazu	2	2	A
0528002	Introductory Earth System Evolution	TAJIKA Eiichi, HIROSE Kei, ENDO Kazuyoshi	2	2	A
0528003	Basic Earth and Planetary Material Science	MIKOUCHI Takashi, OZAWA Kazuhito	2	2	A
0528005	Basic Exercise on Earth and Planetary Environment	TAJIKA Eiichi	1	2	A
0528006	Introduction to Regional Geography	NAGATA Junji, MATSUBARA Hiroshi, KAJITA Shin	2	2	A
0528020	Lecture: Atmospheric and Oceanic Circulation	NAKAMURA Hisashi, MASUMOTO Yukio	2	3	S
0528021	Lecture: Paleobiology	TSUIHIJI Takanobu	2	3	S
0528022	Lecture: Earth and Planetary Physical Chemistry	OZAWA Kazuhito	2	3	S
0528023	Lecture: Solid Earth Science	HIROSE Kei, ANDO Ryosuke	2	3	S
0528025	Practical: Paleobiology	SASAKI Takenori, TSUIHIJI Takanobu	2	3・4	S
0528026	Practical: Geomorphology and Geology	KANO Akihiro, KAYANNE Hajime, TAKAHASHI Satoshi, SUGAI Toshihiko, YAMAGUCHI Asuka	2	3	S
0528027	Practical: Microscopic Observation of Rock-forming Minerals	SASAKI Takenori, TSUIHIJI Takanobu	2	3	S
0528028	Basic Exercise: Earth and Planetary Environmental Science II	TAJIKA Eiichi, OZAWA Kazuhito, MOTEKI Nobuhiro	2	3・4	S
0528029	Field Excursion: Earth and Planetary Environmental Science I	SUZUKI Yohey, SATO Masahiko, OGIHARA Shigenori, TAKAHASHI Yoshio	1	3	S
0528030	Lecture: Earth's Environmental Chemistry	TAKAHASHI Yoshio, ITAI Takaaki, KAWAHATA Hodaka	2	3	S
0528031	Lecture: Evolutionary Biology	ENDO Kazuyoshi, SUZUKI Yohey, TAKANO Yoshinori	2	3	A
0528032	Lecture: Global Geochemical Cycle	TAJIKA Eiichi, OGAWA Hiroshi	2	3	A
0528034	Practical: Earth's Environmental Chemistry	SUZUKI Yohey, ITAI Takaaki, SUNAMURA Michinari, MOTEKI Nobuhiro, TAKAHASHI Yoshio	2	3	S
0528035	Lecture: Crystallography	KOGURE Toshihiro	2	3	A
0528037	Research in Earth and Planetary Environmental Science	All faculty members, ITAI Takaaki	4	4	A
0528038	Field Exercise: Earth and Planetary Environmental Science I	KANO Akihiro, TSUIHIJI Takanobu, KURODA Junichiro	2	3	S
0528039	Field Exercise: Earth and Planetary Environmental Science II	OGUCHI Takashi, IIZUKA Kotaro, SUMAMURA Michinari	2	3	S
0528040	Field Exercise: Earth and Planetary Environmental Science III	OZAWA Kazuhito, MAENO Fukashi, IIZUKA Tsuyoshi, SUZUKI Yujiro, WALLIS Simon, KOYAGUCHI Takehiro	2	3	S

0528041	Practical: Earth and Planetary Environmental Science	TAKAHASHI Satoshi, MAENO Fukashi, KANO Akihiro, OZAWA Kazuhito, OGIHARA Shigenori, KAYANNE Hajime, IIZUKA Tsuyoshi, SUGAI Toshihiko, WALLIS Simon	2	3	A
0528042	Field Excursion: Earth and Planetary Environmental Science II	WALLIS Simon	1	3・4	A
0528043	Exercise: Earth and Planetary Environmental Science	Professor in charge, SUZUKI Yohey	2	4	S
0528045	Lecture and Practical: Biodiversity Science	SUZUKI Yohey, SHIMIZU Keisuke, OGIHARA Shigenori, ENDO Kazuyoshi, SUMAMURA Michinari, SASAKI Takenori, TAKANO Yoshinori	2	3・4	A
0528046	Lecture and Practical: Geo-ecology	KAYANNE Hajime, SASAKI Takenori	2	3・4	S
0528047	Exercise: Physical Chemistry in Earth and Planetary Science	OZAWA Kazuhito	2	3・4	A
0528048	Practical: Analyses of Rock Textures I	IIZUKA Tsuyoshi, WALLIS Simon	2	3・4	S
0528049	Practical: Analyses of Rock Textures II	OGIHARA Shigenori, KANO Akihiro, TAKAHASHI Satoshi	2	3・4	S
0528050	Lecture: Human and Environment System	SUGAI Toshihiko, OGUCHI Takashi, KAYANNE Hajime, ANAZAWA Katsuro	2	3	A
0528055	Lecture: Paleoclimatology and Paleoceanography	YOKOYAMA Yusuke, TAJIKA Eiichi	2	4	S
0528056	Lecture: Sedimentology	KANO Akihiro, KOMIYA Tsuyoshi	2	4	S
0528058	Lecture: Structural Geology	WALLIS Simon, YAMAGUCHI Asuka	2	3	A
0528059	Lecture: Geomorphology	SUGAI Toshihiko, OGUCHI Takashi	2	4	S
0528060	Lecture: Volcanology and Magmatology	KOYAGUCHI Takehiro, IIZUKA Tsuyoshi	2	4	S
0528061	Practical: Crystallography	KOGURE Toshihiro, MIKOUCHI Takashi, KOMATSU Kazuki	2	3	A
0528062	Lecture: Earth History	TAJIKA Eiichi, KURODA Junichiro	2	4	S
0528063	Lecture: Paleontology	ENDO Kazuyoshi, TSUIHIJI Takanobu	2	4	S
0528065	Lecture: Planetary Geology	MIYAMOTO Hideaki, NAMIKI Noriyuki	2	4	S
0528066	Aquatic Science	YAMAMURO Masumi	2	4	S
0528067	Conservation of Museum Collections	KUCHITSU Nobuaki	2	3・4	S
0528068	Lecture and Practice in Remote Sensing and Geographic Information System	OGUCHI Takashi, IIZUKA Kotaro, KAWAHARA Hajime	2	3・4	A
0528069	Evolution of space and planetary materials	HIYAGON Hajime, SUGITA Seiji	2	3	A
0528070	Resource Geology	KAWAHATA Hodaka, SUZUKI Yohey, TAKAHASHI Yoshio	2	3	A
0528072	Introduction to Solid Earth and Planetary Sciences	IIZUKA Tsuyoshi, SAKURABA Ataru, OKINO Kyoko	2	2	A

0528073	Basic Stratigraphy and Geology	KANO Akihiro, KOMIYA Tsuyoshi, WALLIS Simon	2	2	A
0528074	Physical Geography	SUGAI Toshihiko, OGUCHI Takashi, KAYANNE Hajime, ABE Ayako	2	2	A
0528075	Cosmo- and Geo-chemistry	TAKAHASHI Yoshio, ITAI Takaaki, NAKAI Shunichi, IIZUKA Tsuyoshi	2	3	A
0528076	Climate Dynamics	ABE Ayako, WATANABE Masahiro, OKA Akira, SUZUKI Kentaro, TAKAYABU Yukari	2	3	A
0528077	Instrumental Analyses of Solids	KOGURE Toshihiro, KAGI Hiroyuki, HIRATA Takafumi, TAKAHASHI Yoshio	2	3	S
0528078	Advanced Mineralogy	KOGURE Toshihiro, MIKOUCHI Takashi, SUZUKI Yohey, KAGI Hiroyuki	2	4	S
0528079	Earth and Planetary Environmental Science International Short Course I	YOKOYAMA Yusuke, IIZUKA Tsuyoshi, SUZUKI Yohey	1	3・4	A
0528080	Earth and Planetary Environmental Science International Short Course II	YOKOYAMA Yusuke, IIZUKA Tsuyoshi, SUZUKI Yohey	1	3・4	S2
0528801	Research Ethics	MASUMOTO Yukio	0.5	3・4	S

(2) Objectives of Graduate Education

As stated earlier, the educational objectives of the graduate programs at the Department of Earth and Planetary Science are to foster researchers with broad perspectives, deep expertise, an international perspective and creativity, as well as scientists with an understanding of practical issues, who can satisfy various social demands through broad and scientifically-based technical knowledge. In order to attain such objectives, based on education during the undergraduate programs, two years of master's program, or three years including the first year of the doctorate program, are used to acquire basic knowledge common to all areas of Earth and planetary science as well as basic knowledge of specific research fields that is essential to help student develop as independent researchers. Three years of doctorate program are used to nurture originality and creativity that are essential to promote cutting-edge sciences. Since more than half of master's students obtain undergraduate degrees from institutions other than the two undergraduate programs and may lack training in related fields, the department offers introductory courses in the master's program so that even the students with no background of Earth and planetary science can acquire basic knowledge common to all the specific fields of Earth and planetary science. On the other hand, selected and arranged basic courses together with higher level specific and advanced courses such as special lectures are provided so that students can systematically acquire basic knowledge in the specific fields that is necessary for conducting advanced research in the doctorate program. The department thus aims to attain the educational objectives by fostering students with both broad outlooks an expertise based on deep understanding of fundamental concepts and methods.

Furthermore, courses can be selected systematically depending on each student's career or educational path. That is, two courses are provided in the master's program. One is for students who aim to proceed to the doctorate program and become researchers, emphasizing advanced classes, whereas the other is for students who will use their scientific knowledge to contribute in more technology-based ways to society, and emphasize a wide range of basic classes. Each master's thesis

is presented and defended in front of more than ten faculty members at the department-wide defense and is closely reviewed by three faculty members in related fields including his/her academic advisor.

Education in the doctorate program aims to encourage flexible and creative way of thinking based on broad perspectives and deep knowledge in specific research fields acquired during the master's program and, through small-group seminars and instruction, to develop researchers who have capability of carrying out their original research and of presenting and discussing the results in the international community. In order to attain this objective, the department places a special emphasis on seminars and colloquiums in its doctorate curriculum so as to effectively train student autonomy. Seminars are not necessarily held by laboratory units, many seminars are held together with different laboratories, by groups or the entire department. By actively attending these seminars, students are improving their ability to contribute to development of the field of Earth and planetary science as a whole, and not just their own fields. In addition, in order to cultivate a wide range of academic skills beyond Earth and planetary science, it is recommended that students take the Science Cluster Lecture, the Introduction to the History of Modern Science, and academic Overview Lectures offered at the university as a common lecture of the Graduate School of Science. Moreover, the Department of Earth and Planetary Science employs highly-skilled native speakers who have experience in English education as part-time lecturers, mainly teaching English for first-year PhD students, and supporting them to write their theses in English. In this English education, students take a TOEFL exam in the first class, and then they are divided into two classes, Basic and Advanced based on their scores, and take small-group lessons with about 15 students each. Both classes focus on debate and English presentations, and emphasize strengthening their communications skills. Each class provides detailed contents that take into account the proficiency level of each student and their efforts are reflected in the improvement of the TOEFL exam score at the end of the year. The department aims to cultivate the ability of transmitting information internationally. For PhD candidates, it is required that students have at least one paper accepted in an international journal as first author to qualify to submit their doctoral dissertation. Also, the dissertation review has a rule that doctoral candidate's academic advisor could not be the chief examiner in the thesis review board and the preliminary defense is open to faculty members as well as students, and each dissertation is closely reviewed, ensuring objective and fair screening.

As a countermeasure against research fraud that has become a problem in recent years, all graduate students must take "Research Ethics" as a compulsory subject once during their time in the undergraduate, master's, and doctoral courses.

Curriculum of the Graduate School of Science FY2019

Course Code	Course title	Faculty Member	Credit	Semester	Category
35616-0001	Time Series Analysis	MOCHIZUKI Kimihiro, NISHIDA Kiwamu	2	A	B
35616-0002	Geophysical Data Analysis	IDE Satoshi, KOSAKA Yu	2	A	B**
35616-0003	Mathematical Methods in Geophysics	SHINOHARA Masanao, YAMANO Makoto	2	S	B
35616-0004	Numerical Analysis in Geophysics	MASUMOTO Yukio, YOKOYAMA Takaaki, TAKEUCHI Nozomu	2	S	B**
35616-0005	Mechanics of Elastic Body	ANDO Ryosuke	2	S	B**
35616-0006	Solid Earth Mechanics	TANAKA Yoshiyuki	2	A	B**
35616-0007	Geophysical Fluid Dynamics I	IGA Keita	2	S	B**
35616-0008	Geophysical Fluid Dynamics II	MASUMOTO Yukio	2	A	B**
35616-0009	Material Science of the Earth and Planetary Interiors	HIROSE Kei, FUNAMORI Nobumasa	2	S	B**
35616-0012	Planetary Aeronomy	SEKI Kanako, IMAMURA Takeshi	2	S	B**

35616-0014	Elementary Comparative Planetology	SUGITA Seiji, KASAHARA Satoshi, IKOMA Masahiro	2	S	B**
35616-0015	Elementary Earth and Planetary System Science	IKOMA Masahiro	2	S	B**
35616-0022	History of the Earth	TAJIKA Eiichi, KURODA Junichiro	2	S	B**
35616-0023	Solid Earth Science	HIROSE Kei, ANDO Ryosuke	2	S	B**
35616-0024	Cosmo-and Geo-chemistry	TAKAHASHI Yoshio, ITAI Takaaki, NAKAI Shunichi, IIZUKA Tsuyoshi	2	A	B**
35616-0025	Instrumental Analyses of solids	KOGURE Toshihiro, KAGI Hiroyuki, HIRATA Takafumi, TAKAHASHI Yoshio	2	S	B**
35616-1002	Atmospheric Physics II	SATOH Masaki, TAKAYABU Yukari	2	A	A
35616-1006	Climate Dynamics II	NAKAMURA Hisashi	2	A	A
35616-1022	Seismic Wave Theory I	NISHIDA Kiwamu, WATADA Shingo	2	S	A
35616-1023	Theory of Earth's Internal Structure	UESHIMA Makoto, TAKEUCHI Nozomu, HIRAGA Takehiro	2	A	A
35616-1025	Geo-electromagnetics	SHIMIZU Hisayoshi, UESHIMA Makoto	2	A	A**
35616-1026	Magma Science	YASUDA Atsushi	2	A	A
35616-1027	Elementary Volcanology	OHMINATO Takao, MAENO Fukashi, ICHIHARA Mie	2	S	A
35616-1028	Plate-Boundary Zone Tectonics	KINOSHITA Masataka, SATO Hiroshi	2	S	A
35616-1029	Earth's Rheology	TAKEI Yasuko, HIRAGA Takehiro	2	S	A
35616-1030	Ocean Floor Dynamics	OKINO Kyoko, KINOSHITA, Masataka	2	A	A
35616-1031	Theory of Geomorphic Evolution	TANAKA Yoshiyuki, SHISHIKURA Masanobu	2	Full Year	A
35616-1033	Earthquake Physics	IDE Satoshi	2	S	A**
35616-1034	Physics of Earthquake Generation	KAME Nobuki, TANAKA Hidemi	2	A	A
35616-1035	Evolution of Geosphere Environment	KANO Akihiro	2	A	A
35616-1037	Diffraction Crystallography	KOGURE Toshihiro	2	A	A**
35616-1042	Biomineralization	KOGURE Toshihiro, SHIRAI Kotaro, ENDO Kazuyoshi, SASAKI Takenori	2	A	A
35616-1044	Evolution of the Biosphere	ENDO Kazuyoshi, KOMIYA Tsuyoshi	2	S	A
35616-1051	Space Plasma Physics II	YOKOYAMA Takaaki, SHIMIZU Toshifumi	2	A	A
35616-1052	Physics of Magnetosphere II	SAITO Yoshifumi	2	A	A
35616-1053	Introduction to Ocean-Atmosphere Circulation	NAKAMURA Hisashi, MASUMOTO Yukio	2	S	A**
35616-1057	Paleoclimatology/ Paleooceanography	YOKOYAMA Yusuke, TAJIKA Eiichi	2	S	A**
35616-1058	Paleo-environmental Science	YOSHIMORI Masakazu, YOKOYAMA Yusuke	2	A	A
35616-1059	Environmental Biology	KAYANNE Hajime	2	S	A
35616-1062	Seismic Wave Theory II	Furumura Takashi, KATO Aitaro	2	A	A
35616-1063	Methodology of Solid Earth Observation	IIDAKA Takashi, TANAKA Yoshiyuki, SHIOBARA Hajime, MORITA Yuichi, YAMANO Makoto, UESHIMA Makoto, SAKAI Shinichi, ARAYA Akito	2	S	A
35616-1064	Evolutionary History of Life on Earth	TSUIHIJI Takanobu	2	S	A**

35616-1065	Evolutionary Biology	ENDO Kazuyoshi, SUZUKI Yohey, TAKANO Yoshinori	2	A	A**
35616-1066	Earth's Environmental Chemistry	TAKAHASHI Yoshio, ITAI Takaaki, KAWAHATA Hotaka	2	S	A**
35616-1071	Dynamics of Earth's Interior	IWAMORI Hikaru, ICHIHARA Mie	2	A	A**
35616-1073	Geomicrobiology	SUZIKI Yohey, TAKANO Shiori	2	A	A
35616-1074	Climate Dynamics	ABE Ayako, WATANABE Masahiro, OKA Akira, SUZUKI Kentaro, TAKAYABU Yukari	2	A	A**
35616-1075	Resource Geology	KAWAHATA Hodaka, SUZUKI Yohey, TAKAHASHI Yoshio	2	A	A**
35616-2001	Atmospheric Physics III	IGA Keita	2	S	A
35616-2003	Physical Oceanography III	HASUMI Hiroyasu	2	A	A
35616-2007	Ocean-Atmosphere Material Circulation Physics II	YASUDA Ichiro	2	S	A
35616-2013	Planetary Exploration Science I	KASAHARA Satoshi, USUI Tomohiro	2	A	A
35616-2016	Comparative Planetology II	MIYAMOTO Hideaki	2	S	A
35616-2018	Cosmic and Planetary Material Science II	HIYAGON Hajime	2	A	A
35616-2025	Geographical Information Science	OGUCHI Takashi	2	A	A
35616-2041	Special Lecture of Oceanic and Atmospheric Sciences V	HASEBE Fumio, KOIKE Makoto	1	S	S
35616-2043	Special Lecture of Space and Planetary Science V	FUJIMOTO Masaki	1	A	S
35616-2044	Special Lecture of Space and Planetary Science VI	NAMIKI Noriyuki	1	S2	S
35616-2045	Special Lecture of Earth and Planetary System Science V	SHIBUYA Takazo	1	A	S
35616-2049	Special Lecture of Geosphere and Biosphere Science V	MAEDA Haruyoshi	1	A	S
35616-2065	Earth and Planetary Environmental Science International Short Course I	YOKOYAMA Yusuke, IIZUKA Tsuyoshi, SUZUKI Yohey	1	Full yea r	S**
35616-2066	Earth and Planetary Environmental Science International Short Course II	YOKOYAMA Yusuke, IIZUKA Tsuyoshi, SUZUKI Yohey	1	S2	S**
35616-3001	Special Lecture of Oceanic and Atmospheric Science I	Not yet fixed	1	A1	S
35616-3005	Special Lecture of Space and Planetary Science I	EBIHARA Yusuke, KASAHARA Satoshi	1	S	S
35616-3014	Special Lecture of Solid Earth Science II	KANO Yasuyuki	1	A1	S
35616-3015	Special Lecture of Solid Earth Science III (Frictional Laws and Various Slip Modes)	NAKAMURA Michihiko	1	A	S
35616-3019	Special Lecture of Geosphere-Biosphere Science III	Arkadiusz DERKOWSKI	1	A	S
35616-3021	Special Lectures on Earth-Space Frontier Science I	HIROSE Kei, SUZUKI Kojiro, MURAYAMA Hitoshi, SUTO Yasushi, NAKASUKA Shinichi, ENDO Kazuyoshi, SUGITA Seiji, TACHIBANA Shogo, SUGA Hiroaki, IKOMA Masahiro, YAMAMOTO Satoshi, AIKAWA Yuri, HIGUCHI Hideo	2	A	S

35616-4001	Field Work in Earth Science	KANO Akihiro	1	S	E
35616-4002	Laboratory Experiments for Geophysical Observation	IIDAKA Takashi, TANAKA Yoshiyuki, MAENO Fukashi, SHIOBARA Hajime, MORITA Yuichi, YAMANO Makoto, UESHIMA Makoto, SAKAI Shinichi, MOCHIZUKI Kimihiro	1	S	E
35616-4006	Laboratory Experiments for Instrumental Analysis II	IIZUKA Tsuyoshi, OZAWA Kazuhito, OGIHARA Shigenori, KOGURE Toshihiro, YOKOYAMA Yusuke, SUZUKI Yohey, KAGI Hiroyuki	1	S	E
35616-4014	English for Scientific Researchers (English for Scientific Researchers III)	ITAI Takaaki	2	Full Year	E
35616-4015	Exercises in Earth-Space Frontier Science I	HIROSE Kei	1	A	E
35616-5001	Seminar of Current Scientific Literature I	Professors in charge	2	Full Year	C
35616-5003	Earth and Planetary Science Colloquium I	Professors in charge	2	Full Year	C
35616-5005	Research in Earth and Planetary Science I	Professors in charge	10	Full Year	C
35616-5006	Research in Earth and Planetary Science II	Professors in charge	10	Full Year	C
35616-5007	Seminar of Current Scientific Literature II	Professors in charge	2	Full Year	C
35616-5008	Earth and Planetary Science Colloquium II	Professors in charge	2	Full Year	C
35616-6001	Seminar in Marine Affairs I	MASUMOTO Yukio, HIBIYA Toshiyuki	4	Full Year	O
35616-6002	Advanced Course	HIBIYA Toshiyuki, SUZUKI Hideyuki, ASHI Juichiro, ENDO Kazuyoshi, KAYANNE Hajime, YOSHIDA Manabu, NIWA Yoshihiro, SUNAMURA Michinari, SUZUKI Yohey, KUROKAWA Daisuke, SHINOHARA Masanao, OGAWA Hiroshi, MIYAJIMA Toshihiro, NAGATA Toshi	2	A	O

Category; A: Advanced courses, A**: Advanced courses shared with Undergraduate Programs, B: Basic courses, B**: Basic courses shared with Undergraduate Programs, S: Special lectures, S**: Special lectures shared with Undergraduate Programs, E: Exercises and Experiments, C: Compulsory Courses, O: Interdisciplinary Education Program on Ocean Science and Policy (UT Ocean Alliance).

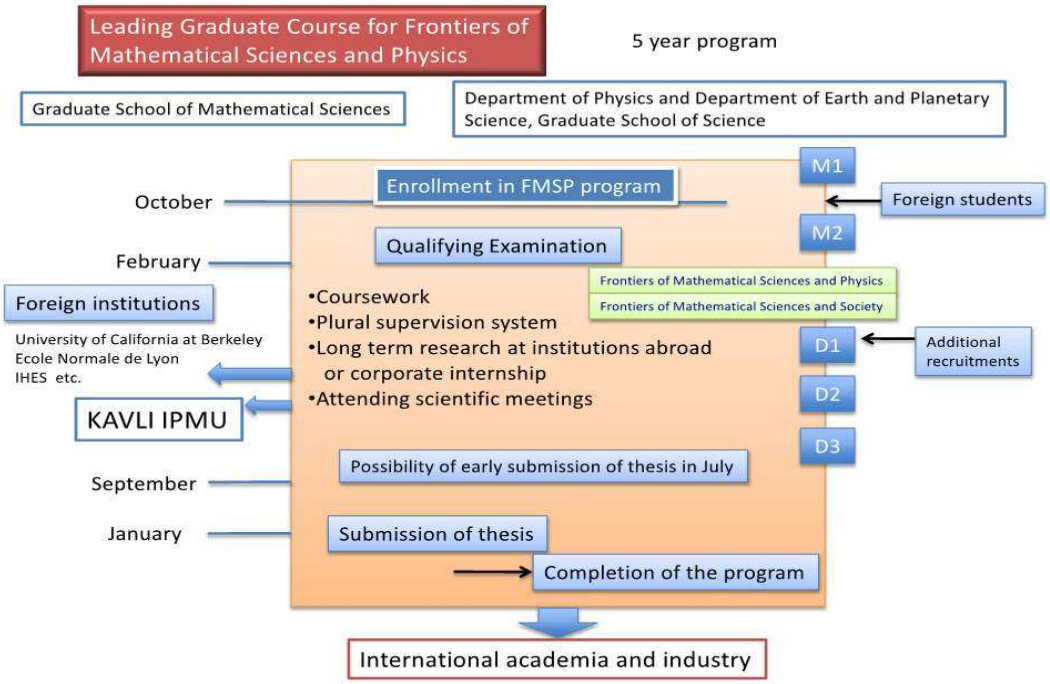
(3) Integrated Master – PhD Education Programs

Leading Graduate Course for Frontiers of Mathematical Sciences (FMSP)

This is one of the 'Programs for Leading Graduate Schools' set up by the Ministry of Education, Culture, Sports, Science and Technology from FY2011. This educational program launched in 2012 mainly by the Graduate School of Mathematical Sciences, Students could demonstrate mathematics with an open mind, not being bound by their fields. The purpose is to foster students who can become global leaders in the future, to contribute to our society and making substantial contributions through the progression of science and its application to industrial and environmental fields.

A few students are selected to the program from our department every year (See the table below) and receive financial support during a graduate program through to PhD. (Master: 150,000 yen/month, PhD: 200,000 yen/month as scholarship). As a requirement for completing the course, it is mandatory

to take the designated lectures (8 credits or more), select a secondary supervisor, receive interviews and guidance, and stay in an overseas laboratory in the short term for the doctoral program and conduct joint research. Although this program for leading graduate school was finished in 2018, it has continued as a World-leading Innovation Graduate Study for Frontiers of Mathematical Sciences and Physics (WINGS-FMSP) from FY2019.



International Graduate Program for Excellence in Earth-Space Science (IGPEES)

The University of Tokyo has started the "World-leading Innovation Graduate School Program (WINGS)" since FY2018 to develop PhD students who can play active roles internationally. IGPEES is one of WINGS, and it is a program centered on the field of the Graduate School of Science and the Department of Earth and Planetary Science. This is an integrated Master's-Doctoral program and the content is providing interdisciplinary education that aims to provide a seamless understanding from the beginnings of the universe to the origin of life (see figure below). Through this program, top-level students in Japan and overseas who have a solid foundation in their specialized field will acquire the following skills.

- Outstanding research capabilities in specialized fields related to space and earth sciences
- Ability to develop interdisciplinary research and new fields by discovering research themes that are integrated from different fields
- Communication skills and internationality that can interact with society and play an active role globally

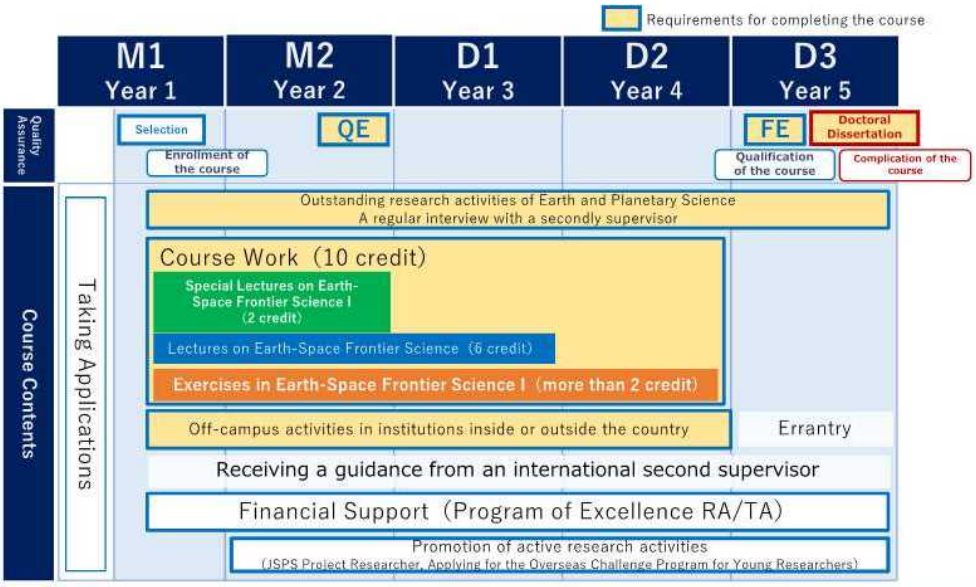
For this reason, selected students are required to:

- Select secondary supervisors and be interviewed about research progress every six months
- Join an overseas program of 2 weeks or more.
- Take lectures which are newly created in this program (10 credits).

Students who are selected as course students can perform research work in field of space and earth science and receive financial support as TAKUETSU (Excellence) Research Assistant. TA is highly recommended for graduate students. In addition to this, the following are required.

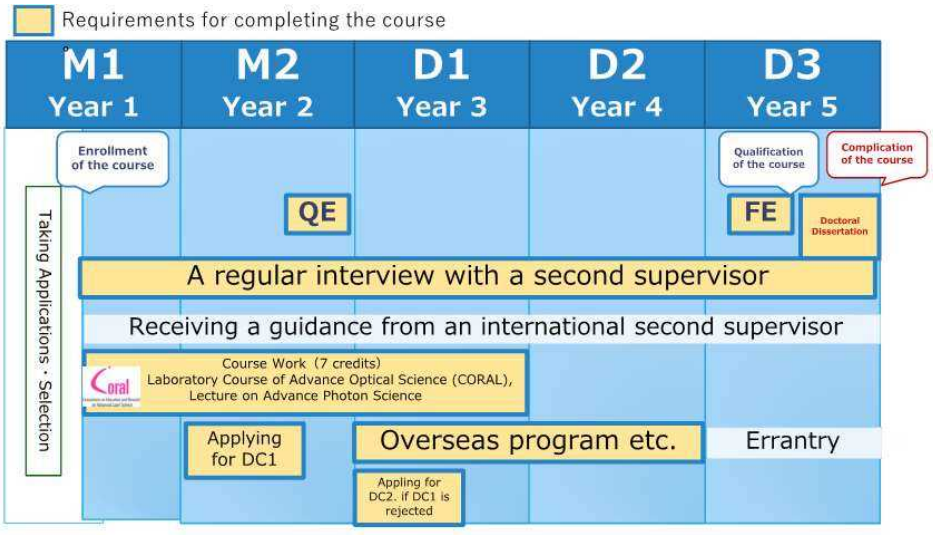
Current students in the program are from (number): Department of Physics (7), Department of

Astronomy (6), **Department of Earth and Planetary Science (20)**, Department of Chemistry (2), Department of Biological Sciences (2), Department of Aeronautics (2), Department of Advanced Energy (2).



Program of Excellence in Photon Science (XPS)

This program was established in 2018 as one of the WINGS (World-leading INnovative Graduate Study), utilizing the achievements of "photon science" which is one of the strengths of the University. This program aims to nurture students who can cooperate with society and play an active role internationally to meet the demands of the next generation. Students and faculty members are from a wide range of departments such as Graduate of School Science including this department, Graduate School of Engineering. As a requirement for completing the course, students need to take courses work (one credit from Laboratory Course of Advance Optical Science I. II (CORAL), six credits from Lecture on Advanced Photon Science before finishing the first year of PhD), interview with a secondary supervisor, and join one of the following three: an overseas program, a company internship or carry out joint research in other university, inside or outside the country (see the picture below). If desired, students may be appointed as TAKUETSU (Excellence) Research Assistants (TRAs) and be paid to engage in research related to photon science. **There is one student who became TRA from the Department of Earth and Planetary Science.**



Global Science Graduate Course (GSGC)

The Global Science Graduate Course (GSGC) is an international graduate program in the Graduate School of Science at the University of Tokyo, which allows students to obtain their degrees in English. The Department of Earth and Planetary Science arranged to have lectures for the graduate school in English. The Earthquake Research Institute provides financial support for the students, and are involved in the course as advisors. Faculty members of the Solid Earth Science Group can also possible to become secondary advisors for the course. Currently **we have two international students who have joined FY2016 and FY2017.** GSGC provides monthly scholarship (180000 yen) during their time on the program.

(4) University-wide Graduate Education Program

UTokyo Ocean Alliance

This is an on-campus organization that integrates knowledge and human resources related to the oceans that the University of Tokyo has cultivated so far, and conducts and supports cross-organizational education and research activities across specialized fields in order to build a new environmentally friendly and sustainable relationship between the ocean and humanity. We provide education for students studying at undergraduate and graduate schools to comprehensively learn about marine science in general, and develop students who have well-balanced marine education and high expertise, and can challenge the world's marine issues beyond the boundaries of humanities and sciences. We offer an overseas internship program to send students to international organizations for two to three months. The Department of Earth and Planetary Science makes an important contribution in fundamental education through a scientific point of view on marine science and cooperation with various lectures and exercises.

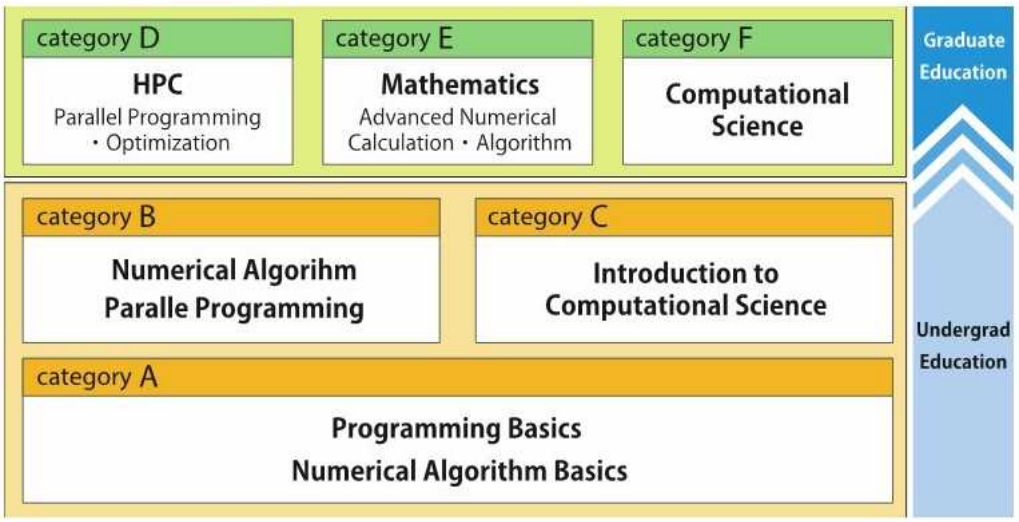
This educational program started in 2009, and **21 students joined from 2012 to 2018 from the Department of Earth and Planetary Science** and studied a wide range of integrated knowledge about the oceans. **So far, two students from our department have joined an overseas internship program**, this is an important achievement to show to foster students who have the ability network and be active on the international stage.

Computational Science Alliance

Computational Science Alliance（https://www.compsci-alliance.jp）was established in April 2016 as a research and education activity of the University of Tokyo in order to lead computational science research around the world by making full use of the accumulated wisdom of the University of Tokyo by linking and integrating aspects of fields such as computational physics including computational science, engineering, and information science. In order to make use of computational science methods in actual research and development, it is necessary to acquire a wide range of knowledge, including programming techniques, appropriate problem setting, algorithms, and computer hardware. Acquiring those wide ranges of knowledge, the Computational Science Alliance has launched lectures focusing on practical training in addition to the various lectures on computational science that have been conducted individually in each department and systematized as “Alliance Certified Lectures”. Alliance Certified Lectures are classified into three categories of undergraduate and graduate school depending on the content, and students can study computational science systematically and practically by taking courses according to the categories (see the picture below). The Department of Earth and Planetary Science has also participated since the beginning, and following lectures are registered as Alliance

Certified Lectures: Exercise in Basic Earth and Planetary Physics (Curriculum of Earth and Planetary Physics), Basic Exercise on Earth and Planetary Environment II (Curriculum of Earth and Planetary Environment), Programing for Parallel Computing (Curriculum of Earth and Planetary Science), Seminar on Advance Computing, and Numerical Analysis in Geophysics (Common lecture for undergraduate and graduate school).

One undergraduate student from the Earth and Planetary Physics Program in FY2017, and one undergraduate student from the Earth and Planetary Physics Program, and one graduate student from the Department of Earth and Planetary Science in FY2018 completed the course and received a certificate for completion. There is an oversea program to foster students to gain the high level of computational science and computer science abroad. One graduate student from the Department of Earth and Planetary Science was sent to the overseas program in FY2017.



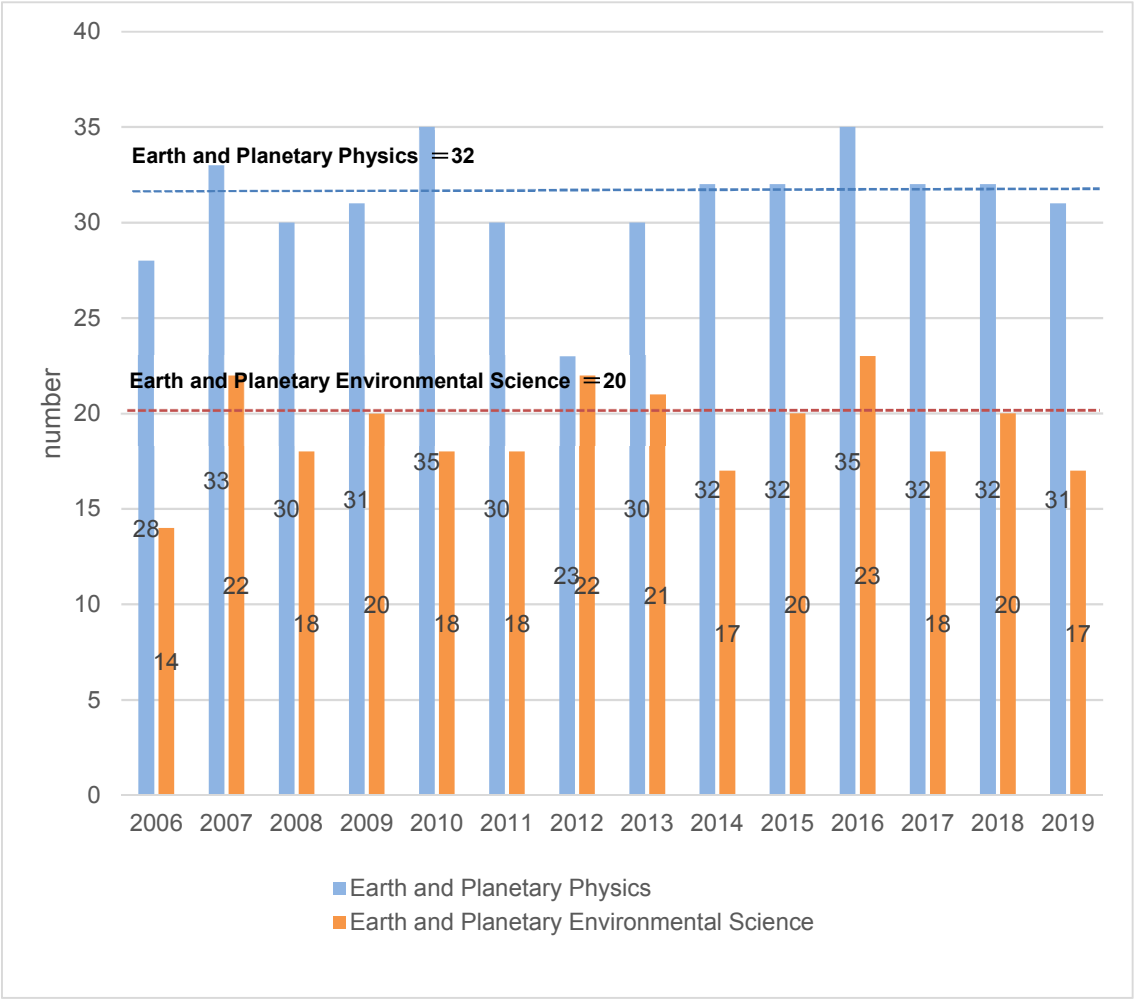
2. Changes in the Number of Students

The number of graduate students in the Department of Earth and Planetary Science was 109 master students and 53 doctoral students. When the Department of Biological Science was established in 2014, there was an adjustment of the number, and the master students became 99 from FY2015 and the doctoral students was 52 from FY2014. The number of undergraduate students in the Department of Earth and Planetary Physics is 32 and 20 in the Department of Earth and Planetary Science.

The number of third year undergraduate students entering the programs of our department from the general education program (first and second year) is shown below for each undergraduate program. The enrollments in master's and doctorate programs are also shown below, sorted by the core and affiliated groups and by students from our two undergraduate programs (Earth and Planetary Physics / Earth and Planetary Environmental Science Programs) and outside the department (other programs in the University of Tokyo / other universities).

(1) Number of Undergraduate Students from Junior to Senior Division

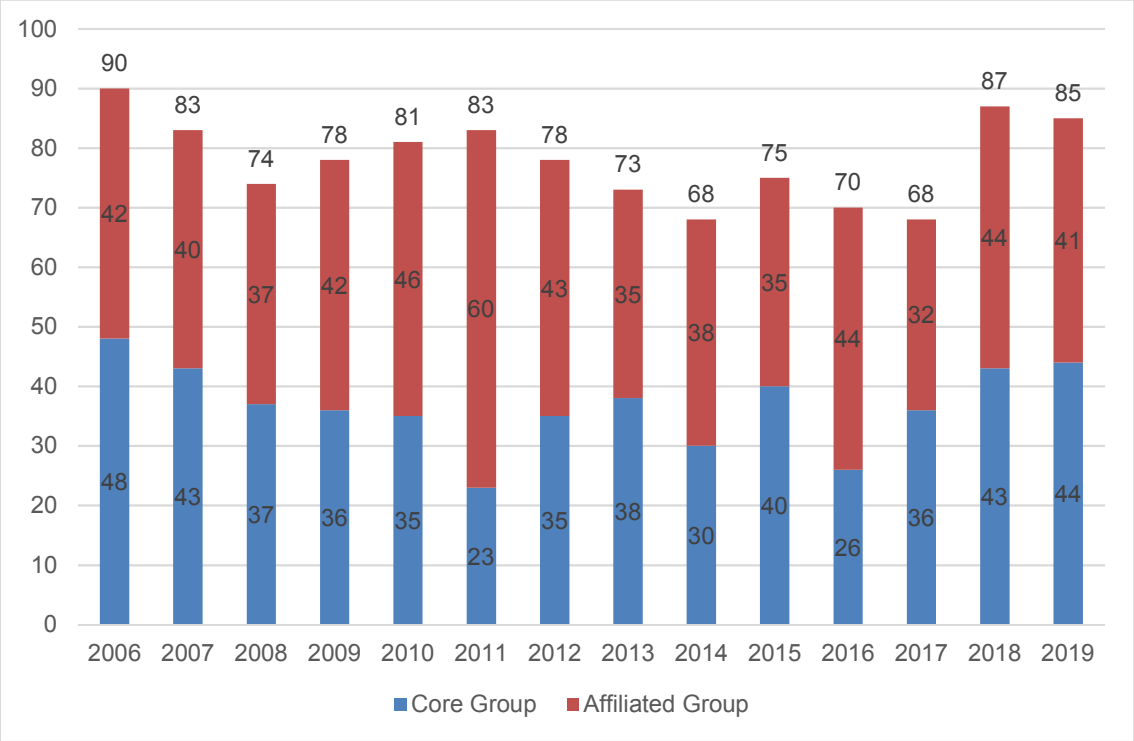
The enrollment numbers in the Earth and Planetary Physics Program were extremely low in FY2012. In recent years, the expected number of undergraduate students in both departments decided to go to the graduate school. Since some students do not enter after the placement to the program, the number of students frequently changes.



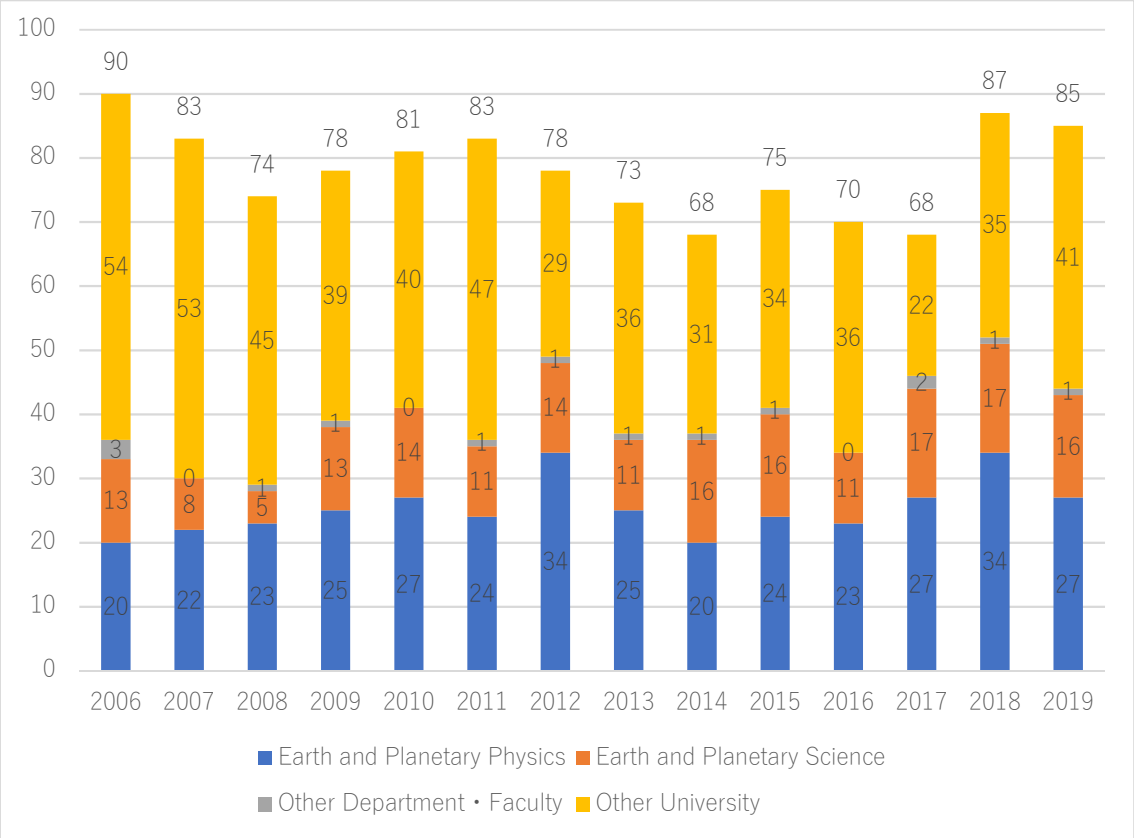
(2) Enrollment in Master's Program

The number of students enrolled in the master's program has been in the range of 70 to 90 in the past few years. The average number from FY2012 to FY2018 is 74.1. Since the pass rate of master's program entrance examination is almost constant, the variation is related to the number of examinees. The number of students enrolled was considerably lower than the capacity before FY2014 (the number of places was 109). After FY2015, the number of places was reduced to 99, which is a reasonable number, considering the academic ability of the examinees and the number of graduate students in the field of Earth and planetary science in Japan. After admission to the graduate school, about a half of students select an advisor from the core groups, and the other half have one from the affiliated groups. Almost a half of the students are from the Earth and Planetary Physics Program and the Earth and Planetary Environmental Science Program of the University of Tokyo. This is a reflection of the fact that most of the undergraduate students from these two programs proceed to the graduate school of our department after graduation.

Enrollment in Master's Program Sorted by Core Groups and Affiliated Groups



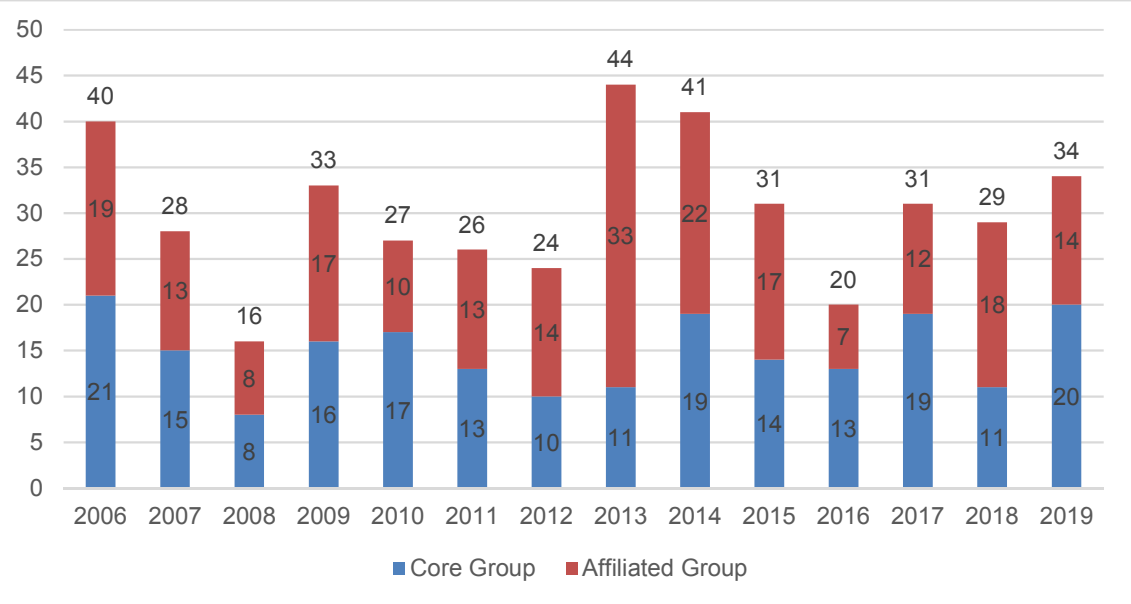
Enrollment in Master's Program Sorted by Students from within (E&P Physics and E&P Env. Science) and outside the Department (Univ. Tokyo and other universities)



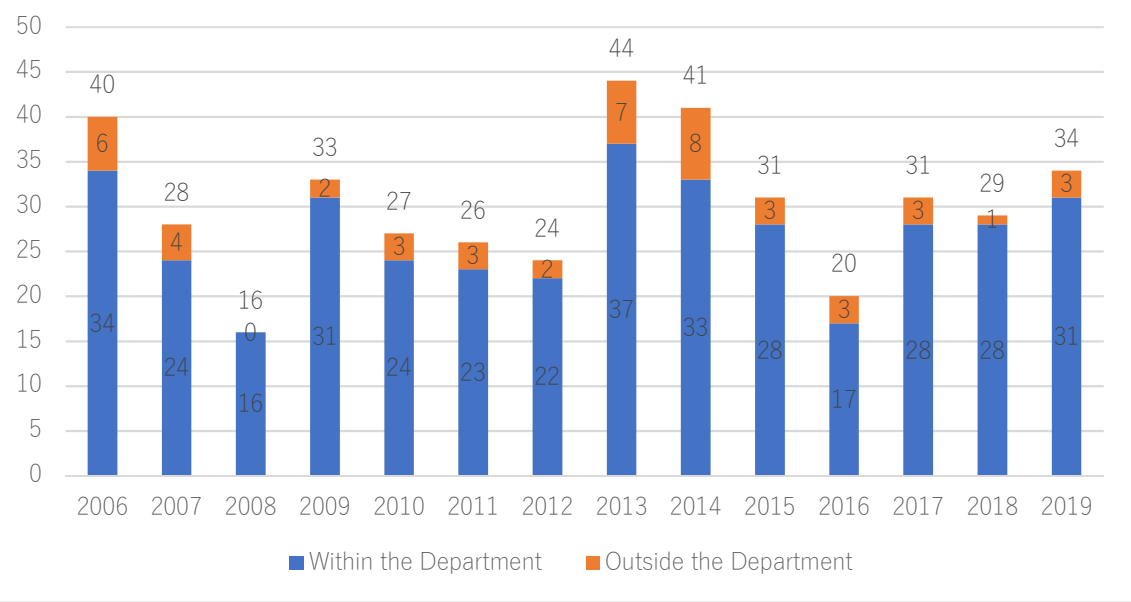
(3) Enrollment in Doctorate Program

The number of students enrolled in the doctoral program since 2012 has fluctuated significantly. The average number from 2012 to 2018 is 31.4. The number decreased from 2014 to 2016, but has recovered recently. However, it is still lower than the number of places and it is necessary to take some action. We consider that it is important to enhance Integrated Master's-Doctoral Programs with financial support. In the doctoral program, the majority of the students are internal graduates and the number of graduates from other universities is very small. The numbers of new students in the core and the affiliated groups are comparable, with some fluctuations. This is because most of the students from the master program will choose the same advisor in the doctoral program.

Enrollment in Doctorate Program Sorted by Core Groups and Affiliated Groups

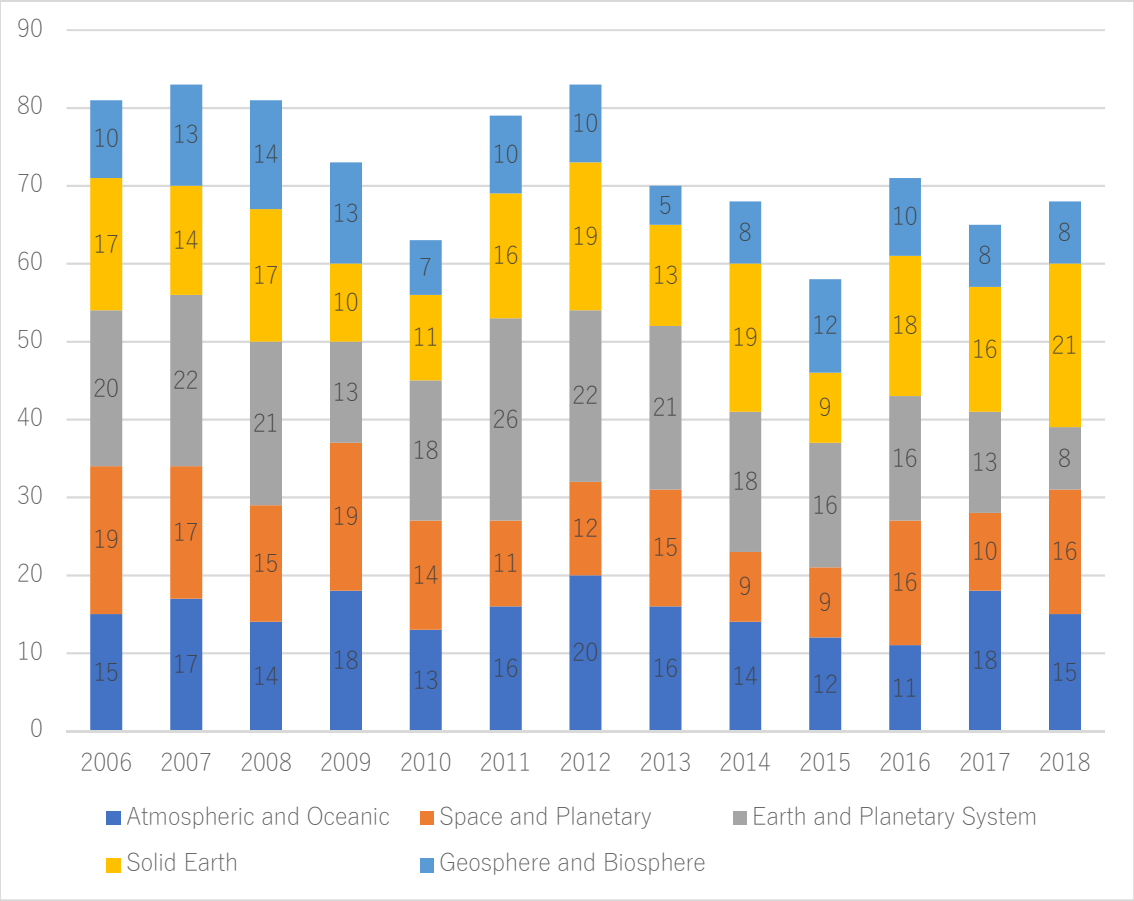


Enrollment in Doctorate Program Sorted by Students from within and outside the Department

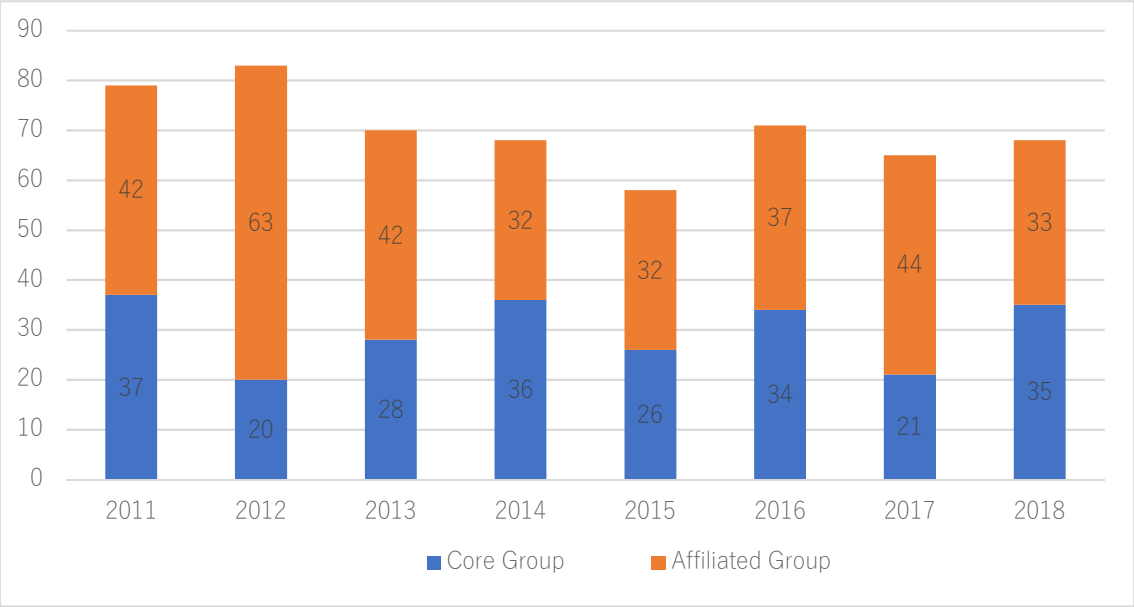


3. Master's Theses and Doctoral Dissertations

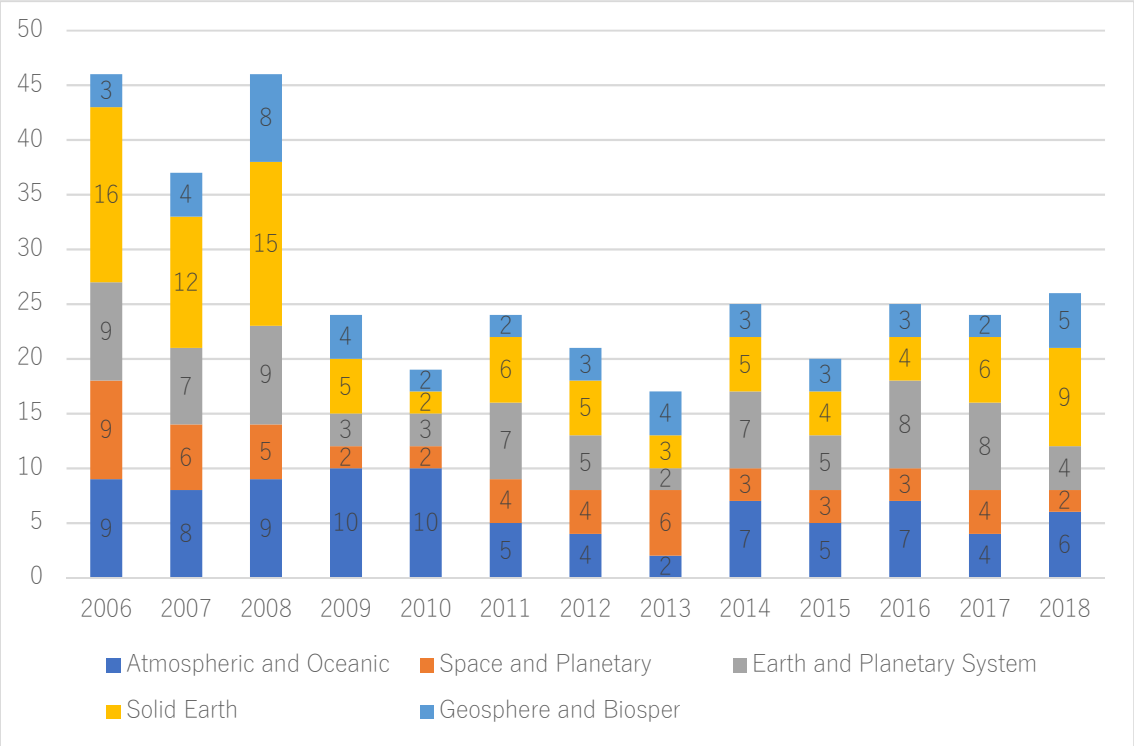
(1) Number of Master's Theses Sorted by Groups



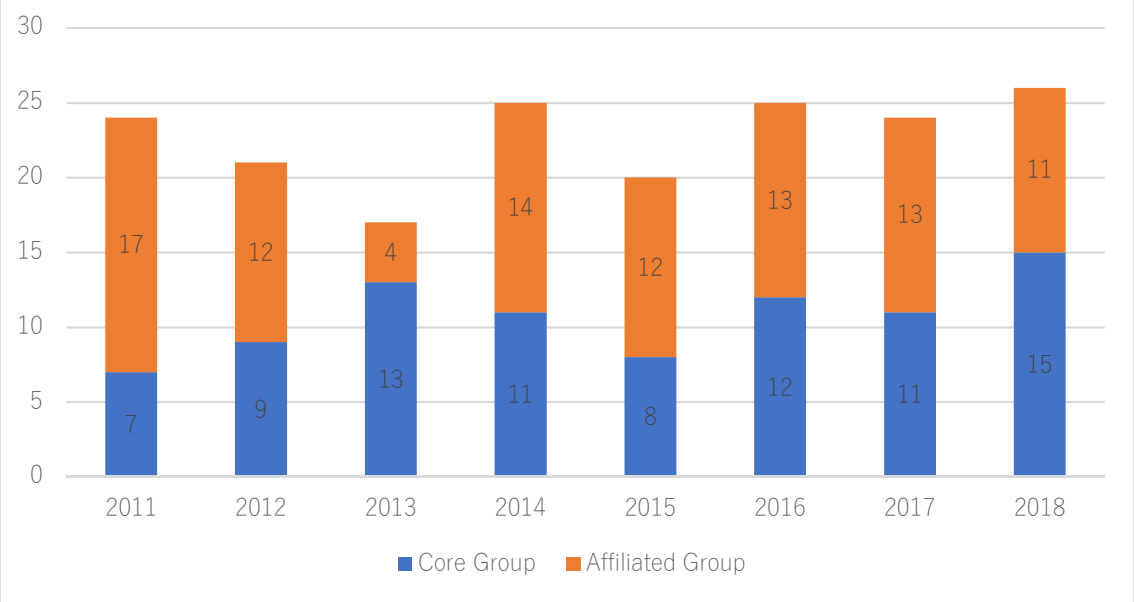
(2) Number of Master's Theses between the Core and Affiliated Groups



(3) Number of Doctoral Dissertations Sorted by Groups



(4) Number of Doctoral Dissertations between the Core and Affiliated Groups



4. Performances of the Graduate Students

(1) Conference Presentations and Published Papers

The master's and doctoral students of this department give oral and poster presentations at academic conferences in Japan and overseas. The number of presentations collected from students' self-reports is 2,810 at domestic conferences in the 7 years between 2012 to 2018 (yearly average 401.4), 680 at international conferences (yearly average 97.1). The average number of students enrolled in each year is about 270, therefore, each student has made 1.5 presentations at domestic conferences and 0.4 presentations at international conferences. In the report of previous external reviews, the number of presentation made was 1,544 at domestic conferences (yearly average 257.3), 541 at international conferences (yearly average 90.2). These figures show more presentations were made than before.

In the same period, 651 peer-reviewed articles were published with students as primary authors or co-authors, and 170 nonpeer-reviewed articles, 0.43 per student per year. This is almost the same number as previous external review report (0.42 per student per year).

(2) Awards

Various awards have been given for students' academic and research activities, especially for presentations at academic conferences. The main awards received by students in this department during 2012-2018 are summarized below.

Awards in the University of Tokyo

The Faculty of Science and Graduate School of Science giving Faculty of Science Award for Outstanding Students (Undergraduates) and Graduate-School-of-Science Award for Outstanding Students (Post graduates), for students who are highly achieved. Some students are given President's Award for Students from the prize winners.

The University of Tokyo President's Award for Outstanding Students

FY2015 TASHIRO Takayuki

The University of Tokyo, School of Science Award for Outstanding Students

FY2012 TAKAGI Yu, SUGAI Shuto
FY2013 MIYAZAKI Yoshinori, ENDO Ryo
FY2014 SEKIZAWA Shion, INOU Kohei
FY2015 KOSHIN Dai, BEKKI Yuto, MAEDA Ayumi
FY2016 BABA Satoru, MIZUTANI Yuta, UEDA Hirochika
FY2017 SUZUKI Yudai, YAMAZAKI Kazuya, ISHIKAWA Hiroki
FY2018 YUMOTO Koki, KATO Shota, YOSHIOKA Junpei

The University of Tokyo, Graduate-School-of-Science Award for Outstanding Students (Master's program),

FY2012 HARADA Mariko, SEKI Arisa, YASUDA Yuki
FY2013 ONUKI Yohei, YABE Suguru, SHIBUYA Ryosuke
FY2014 NISHIKAWA Tomoaki, KAWASHIMA Yui, NITTA Akira
FY2015 TASHIRO Takayuki, KANOU Ryuichi
FY2016 TAKASUKA Daisuke, INO Kohei, KURISU Minako
FY2017 BEKKI Yuto, KIMURA Masaya, MIURA Hikaru
FY2018 YAMAGUCHI Akiko, OZAWA So, YAMAYA Rina

The University of Tokyo, Graduate-School-of-Science Award for Outstanding Students (Doctor Course),

FY2012 KAMATA Shunichi, YOKOTA Yusuke
FY2013 HOTTA Hideyuki, TAKEO Akiko
FY2014 OHATA Sho, WAKABAYASHI Daisuke
FY2015 AKUHARA Takeshi, IJICHI Takashi
FY2016 YABE Suguru, ONUKI Yohei
FY2017 SHIBUYA Ryosuke, KOIKE Mizuho
FY2018 SHOUDA Munehito, BORGEAUD DIT AVOCAT Anselme Francois Emile

Awards of Academic Societies

Japan Geoscience Union, Award for Excellent Presentations

FY2012 KAGOSHIMA Takanori, KAMEGATA Nanako, OKAMOTO Kota, SHIBUYA Ryosuke, NAKAMURA Atsunori, MASUNAGA Ryusuke, NISHIKAWA Yasuhiro, HIRANO Shiro, DEGUCHI Takehiro, MORITA Masaaki, NOGUCHI Rina
FY2013 OKAMOTO Kota, TSUCHIYA Chikara, YASUDA Yuki, TAKATA Nirei, TERUSAWA Shoji, SUGAI Shuto, SHIMIZU Keisuke, TAKEO Akiko, FUJII Masakazu, HARADA Mariko
FY2014 KANEKO Takafumi, SATOU Tatsuhiko, SAKASHITA Wataru, NITTA Akira, OHATA Sho, SHIBUYA Ryosuke, TAKANO Yuki, FUJII Masakazu, YABE Suguru, IZUMI Kentaro, BELL Tomoko
FY2015 MORI Tatsuhiro, SUZUKI Yoshiaki, KOBAYASHI Hidetaka, KUROKAWA Shunsuke, IIJIMA Haruhisa, OISHI Katahiro, KARASUDA Akinori, SHIMIZU Hiroyuki, YABE Kosuke, KANNO Yo, YAMAUCHI Hatsuki, YABE Suguru, AKUHARA Takeshi, FURUKAWA Hikaru, TASHIRO Takayuki, HARADA Mariko
FY2016 KIDO Shoichiro, TAKAHASHI Anne, YASUI Ryosuke, KIMURA Takafumi, HIBIYA Yuki, SHODA Munehito, UEHARA Keita, OBASE Takashi, KOBAYASHI Hidetaka, MUTO Shun, OKAMOTO Atsuro, OKUTSU Natsumi, SASAKI Yuto, TAKAGI Yu, SANDANBATA Osamu
FY2017 IMAMURA Shoko, MUTO Keishiro, KINO Kanon, SHIBUYA Ryosuke, NAKAJIMA Shun, YAMAGAMI Yoko, YOSHIDA Atsuhi, WU Yifei, SANDANBATA Osamu, OKUDA Hanaya, OKUDA Takashi, KANEKO Risa, SATO Daisuke, SUEYOSHI Kenta, NISHIKAWA Tomoaki, MUKAI Yurie, MORISATO Fumitoshi, YABE Kosuke, ISAJI Yuta, MUTO Shun
FY2018 NAKAMURA Maya, SAKUMA Aki, SUEMATSU Tamaki, TAKAHASHI Anne, MINAMIHARA Yuichi, YAMAGUCHI Akiko, SANDANBATA Osamu, BORGEAUD DIT AVOCAT Anselme Francois, OHASHI Masatoshi, KAWANO Yuki, UEDA Hirochika

Award for Excellent Presentations, Seismological Society of Japan

FY2012 NAKATANI Hiroyuki
FY2013 ASO Naofumi, NISHIKAWA Tomoaki, TAKEO Akiko
FY2015 ARAMASA Michi, AKUHARA Takeshi
FY2016 KUSAKABE Tetsuya, YABE Suguru, OKUDA Takashi, KIMURA Masaya
FY2017 OZAWA So, KANAYA Nozomi, KURIHARA Ryo, SUZUTANI Yuta
FY2018 SANDANBATA Osamu, HIKITA Akira

Aurora Medal, SGEPSS

FY2013 SHIMIZU Kenya
FY2015 SHIBUYA Ryosuke, MIYAMOTO Mayu, KATO Daiba

FY2016 FUKUDA Yoko
FY2018 KATO Daiba, SHODA Munehito, IWAMOTO Masanori

The Oceanographic Society of Japan 'Young Researchers Outstanding Presentation Award'
FY2015 ONUKI Ryohei, OKAJIMA Satoru
FY2016 ONUKI Ryohei

Paleontological Society of Japan 'Outstanding Poster Award'
FY2013 HATTORI Soki, TAKEDA Yusuke
FY2014 HANAI Tomoya
FY2015 ISHITSUKA Mana

Paleontological Society of Japan
FY2013 SATO Kei

Japan Association of Mineralogical Sciences 'Award for Excellent Research Presentation'
FY2016 KIMURA Takafumi, KIKUCHI Ryosuke
FY2018 KIMURA Takafumi

Japan Society for Environmental Chemistry, Environmental Chemistry Discussion Group 'Award for Outstanding Students'
FY2016 MIYAMOTO Chihiro
FY2015 KURISU Minako

Peleosciences Society 'Best Presentation Award'
FY2016 SEKI Arisa
FY2017 WATANABE Yasuto

Japan Association of Mineralogical Sciences 'JMPS Student Paper Award'
FY2017 KIKUCHI Ryosuke

Japan Society of Atmospheric Chemistry, Atmospheric Chemistry Discussion Group 'Award for Outstanding Students
FY2017 YOSHIDA Atsushi

The Geochemical Society of Japan 'Award for Outstanding Students'
FY2016 KURISU Minako

Japan Society of Atmospheric Chemistry, Atmospheric Chemistry Debate 'Award for outstanding students'
FY2014 OZAWA Yuya

Society of Evolutionary Studies, Japan 'Young Scientist Oral Presentation Award'
FY2013 SHIMIZU Keisuke

Japan Association for Quaternary Research 'Young Presentation Award'
FY2014 KUBOTA Yoshimi

The Clay Science Society Of Japan 'The 'Asian Cray' Scientific Promotion Award'
FY2012 INOUE Sayako

The Japan Society of High Pressure Science and Technology, High Pressure Discussion 'Poster Award'
FY2012 WAKABAYASHI Daisuke

The Japan Science Society 'Sasakawa Scientific Research Award'
FY2012 SEKI Arisa

Awards in International Conferences and Workshops

American Geophysical Union "Outstanding Student Paper Awards"
FY2013 ASO Naofumi

FY2017 KANEKO Risa, SASAKI Yuto

FY2018 TAGAWA Shou

American Geophysical Union “Student Travel Grant”

FY2015 SUEMATSU Tamaki

Asia Oceania Geosciences Society “Best Student Poster Award”

FY2016 SANDANBATA Osamu

The America Meteorological Society's 21th Symposium on Boundary Layers and Turbulence, “Best Student Oral Presentation Award”

FY2014 SHIBUYA Ryosuke

Asian Clay Conference “Award for the Best Poster”

FY2012 INOUE Sayako

Clay Mineral Society “Student Oral Presentation Award”

FY2013 INOUE Sayako

Euroclay “Best Student Oral Presentation”

FY2015 INOUE Sayako

WCRP SPARC2014 “Best Poster Award”

FY2014 KOHMA Masashi

AAPPS-DPP “Poster Prize”

FY2018 WANG Yikang

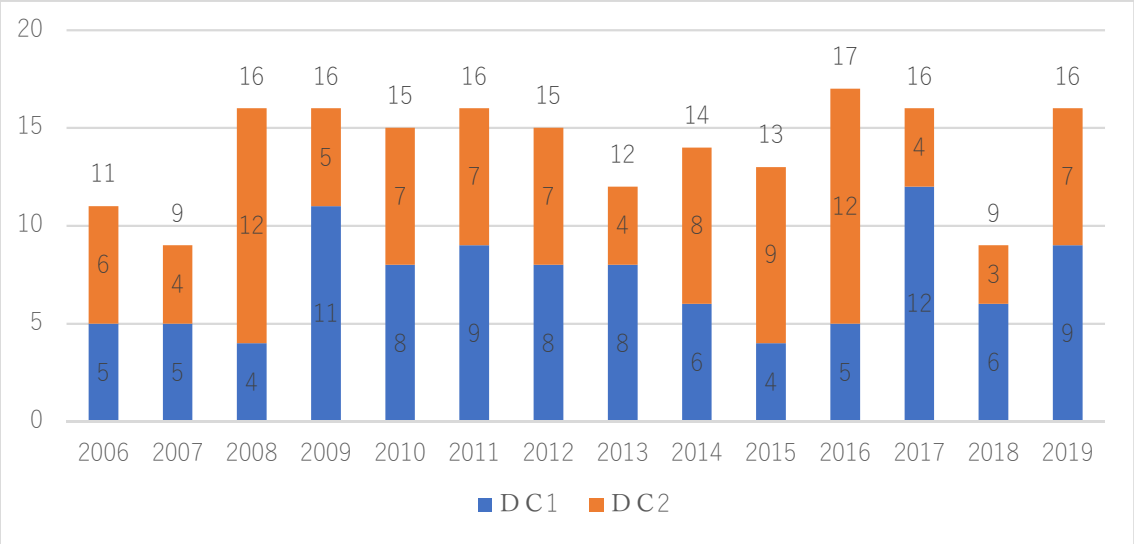
International Association of Radiolarists “XV Best presentation award”

FY2017 MUTO Shun

IODP Exp.341 Cruise, D/V JOIDES Resolution “Best Attitude Award”

FY2013 KIOKA Arata

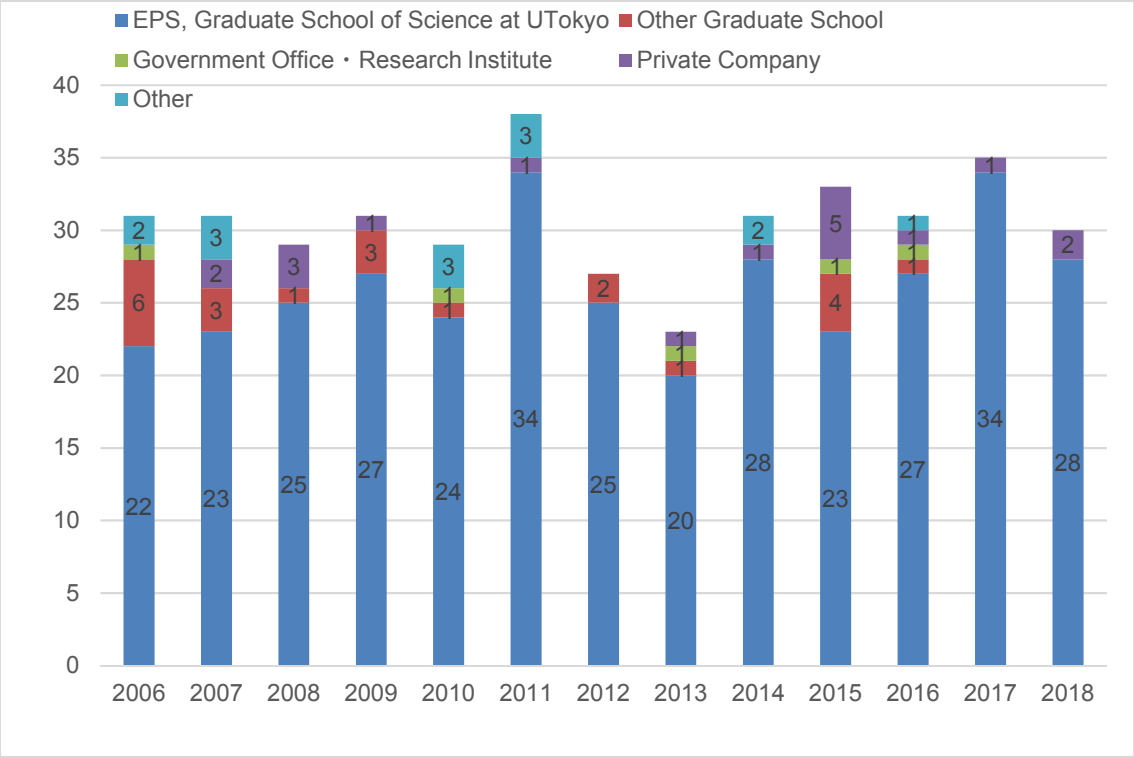
(3) JSPS Fellowships



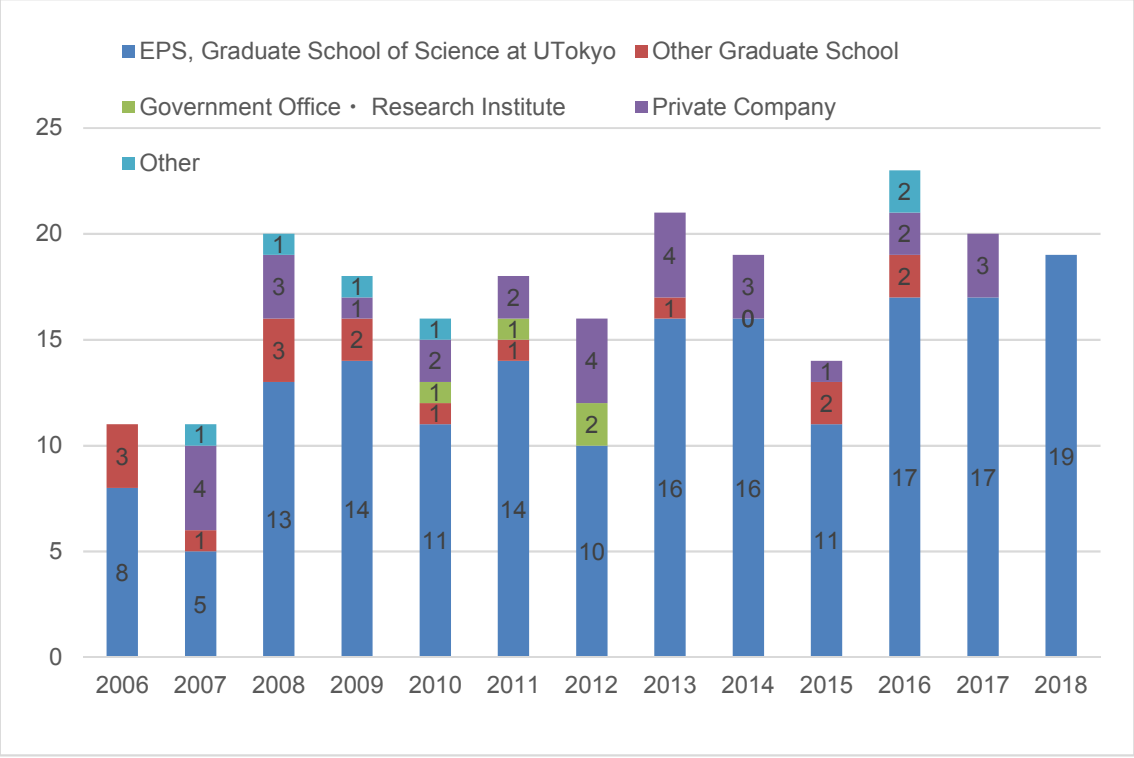
5. Career / Educational Path after Graduation

(1) Career / Educational Path of Undergraduate Students

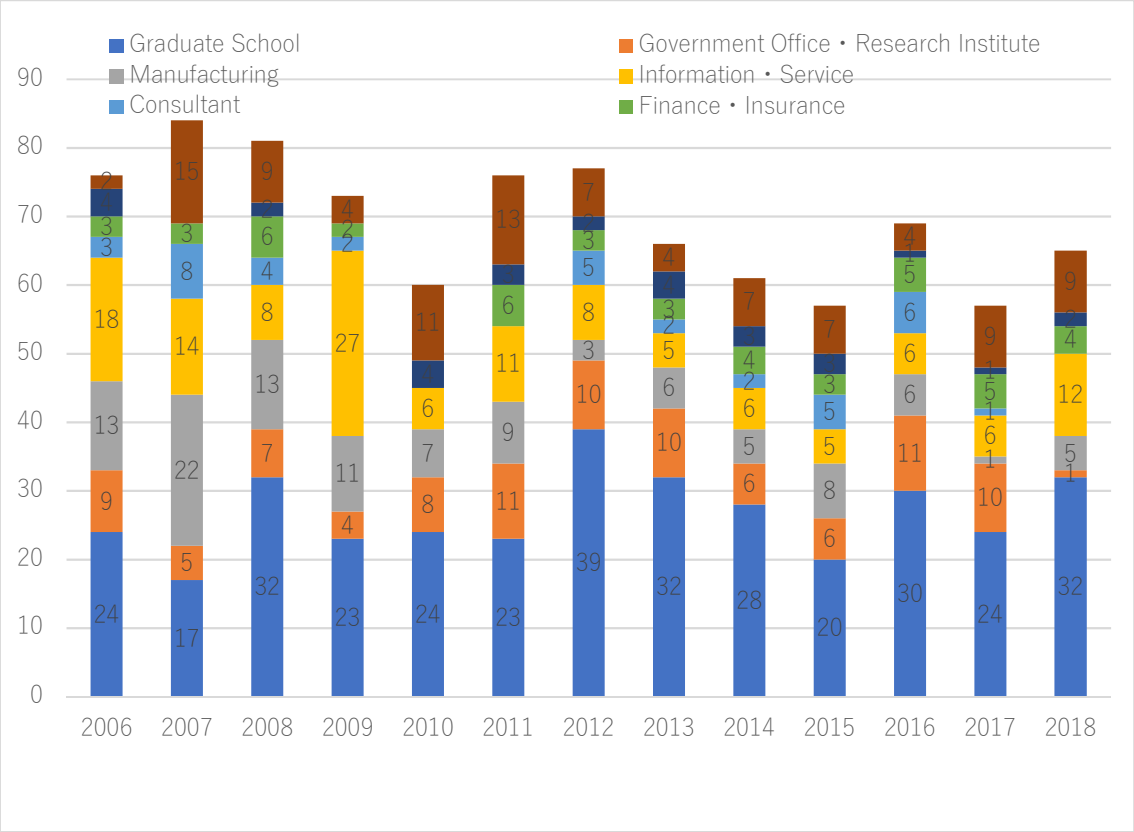
Earth and Planetary Physics Program



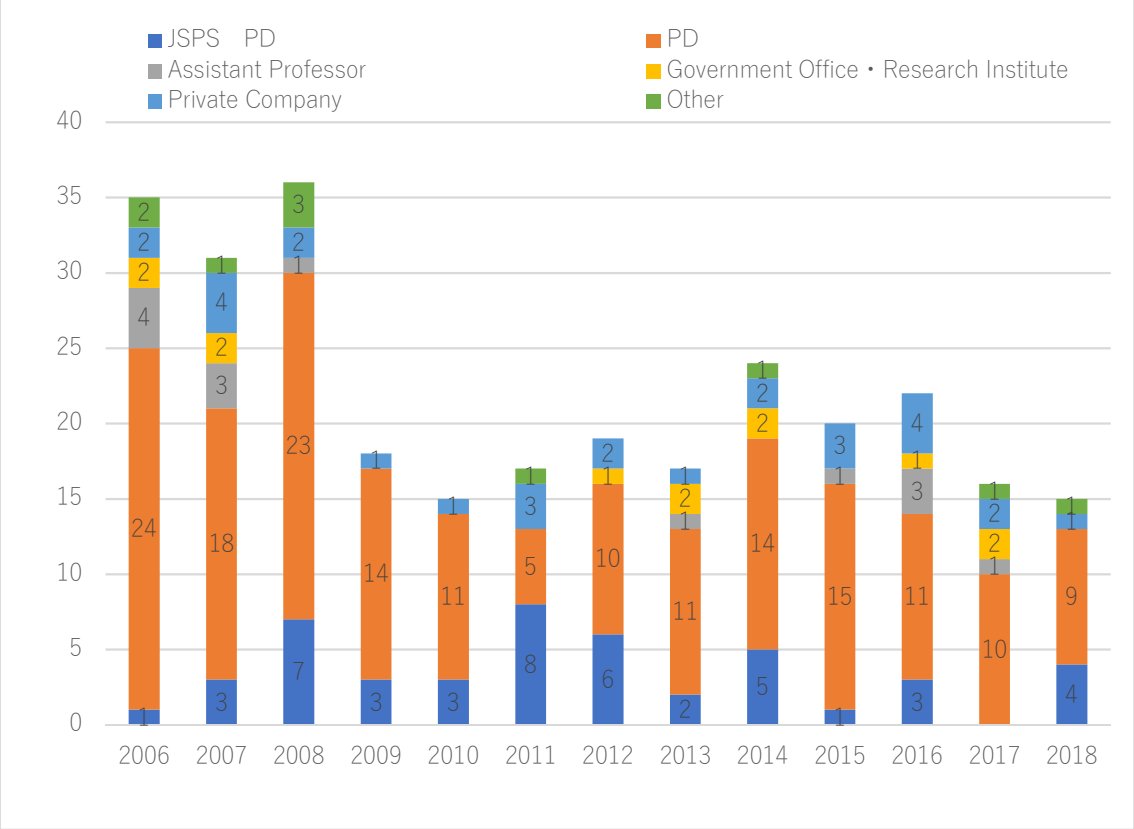
Earth and Planetary Environmental Science Program



(2) Career / Educational Path of Master's Students



(3) Career / Educational Path of Doctoral Students



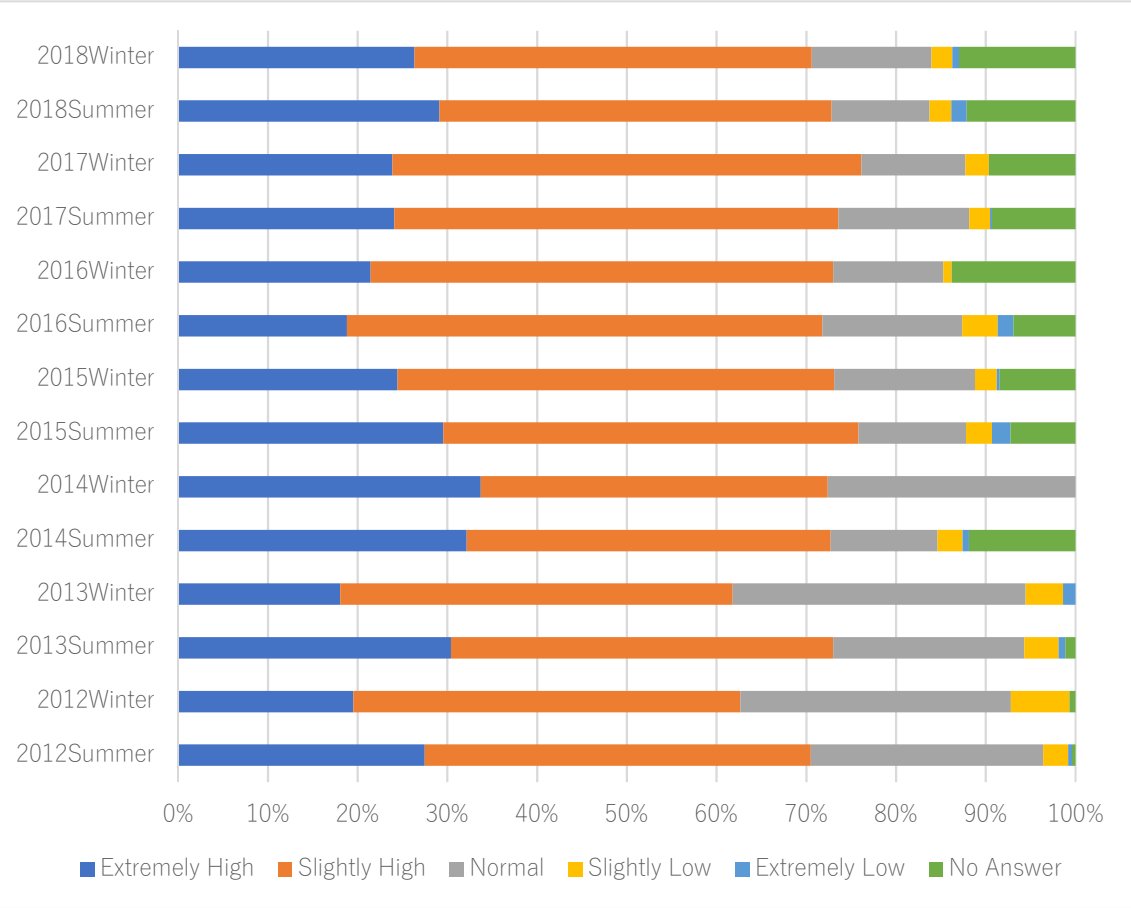
6. Evaluation on Undergraduate Courses by Students

In the Graduate School of Science/Faculty of Science, evaluation is made by students on courses (classes, experiments, exercises and practices) provided in the undergraduate programs. Questionnaire items for classes are as follows. (Similar items are prepared for experiments, exercises and practices.)

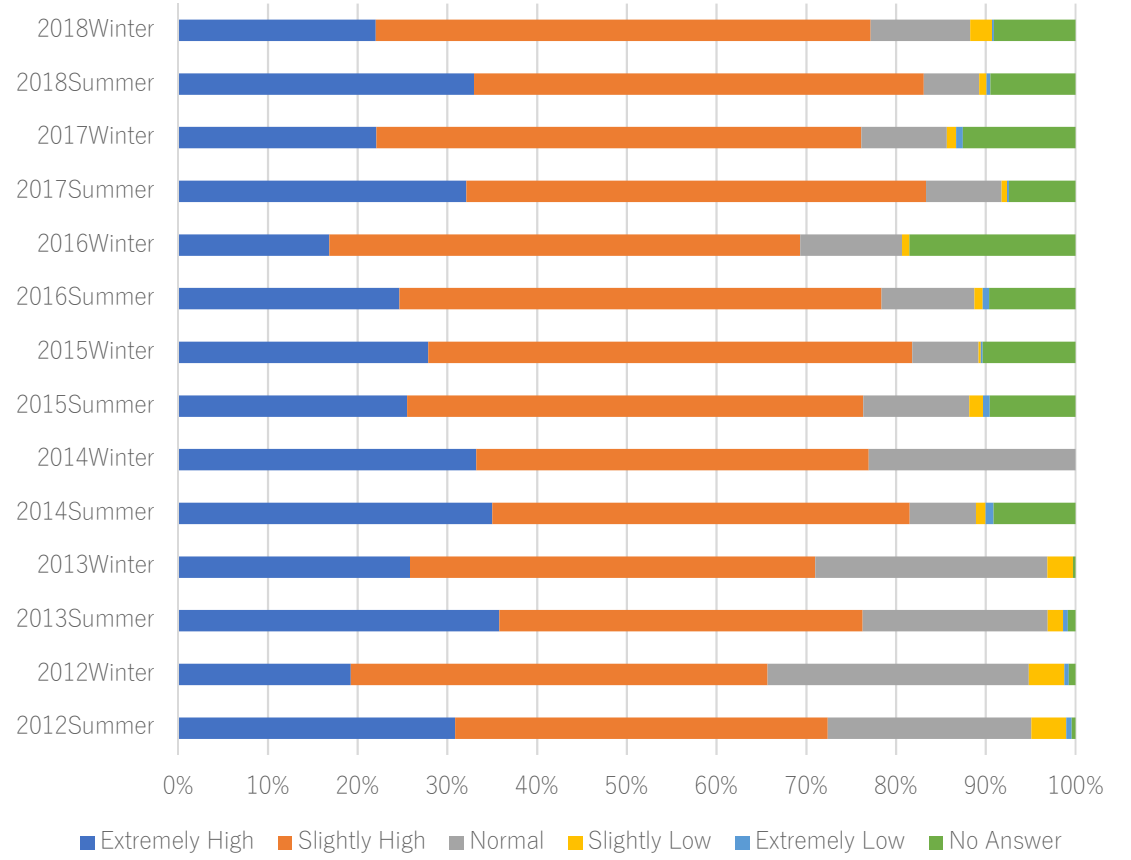
- Student's attendance rate
- Student's efforts in the class
- Student's interest in the class
- Enthusiasm of the teacher for giving lecture
- Degree of difficulty of the class
- Degree of progression and time management of the class
- Teaching techniques (clearness of descriptions and writings on blackboard) of the teacher
- Preparation for the class of the teacher
- If syllabus were useful to take the class
- Organization of equipment and facilities for experimentation
- Safety for experimentation
- Overall evaluation

As the amount of questionnaire results is enormous, only the overall evaluation is shown below. Currently, graduate classes in the Department Earth and Planetary Science are not evaluated by students.

Earth and Planetary Physics Program



Earth and Planetary Environmental Science Program



IV. Research Achievement of Staff

(1) Papers, Books, Patents, and Keynote or Invited Lectures

The following list is collected from the Data for Self-Assessment and External Review of Individual Member. It does not correspond to all research activities of our department in the past seven years. As a reference, from our department, there were 1,005 peer reviewed papers for six years in the previous external review. Considering that the evaluation period is one year longer than the previous evaluation, we consider that the research activities of the current faculty members are at a satisfactory level.

Name	Peer Reviewed Journals	Non-Peer Reviewed Articles	Review Papers	Books	Others	Patents	Keynote / Invited Lectures
SATO, Kaoru	49	1	3	2	3	0	30
HIBIYA, Toshiyuki	28	2	2	1	0	0	14
MASUMOTO, Yukio	35	0	0	0	7	0	7
KOIKE, Makoto	31	0	1	0	0	0	5
TOZUKA, Tomoki	35	0	3	2	0	0	6
MIURA, Hiroaki	19	0	0	0	1	0	12
KOHMA, Masashi	13	0	0	1	0	0	2
TANAKA, Yuki	10	0	5	0	0	0	0
Subtotal	220	3	14	6	11	0	76
SUGITA, Seiji	52	0	7	2	0	0	5
SEKI, Kanako	67	0	0	1	0	0	16
TACHIBANA, Shogo	48	1	4	4	4	0	16
HOSHINO, Masahiro	36	0	5	0	0	0	53
AMANO, Takanobu	29	0	1	0	0	0	18
KASAHARA, Satoshi	34	0	1	0	0	0	8
HIYAGON, Hajime	5	0	1	0	1	0	0
MOROTA, Tomokatsu	26	0	2	0	0	0	1
YOKOYAMA, Takaaki	39	0	0	0	0	0	27
OHIRA, Yutaka	33	0	1	0	2	0	12
KEIKA, Kunihiro	28	0	1	0	0	0	12
CHO, Yuichiro	9	0	2	0	2	0	1
Subtotal	406	1	25	7	9	0	169
KAYANNE, Hajime	31	3	10	12	5	5	11
TAJIKA, Eiichi	15	2	5	20	19	0	13
IKOMA, Masahiro	22	0	2	1	1	0	19
KAWAHAWA, Hajime	25	11	0	1	1	0	6
TAKAHASHI, Satoshi	18	0	0	0	2	0	3
MOTEKI, Nobuhiro	39	0	4	1	0	1	2
FUKUI, Akihiko	10	0	0	0	1	0	4
Subtotal	160	16	21	35	29	6	58
IDE, Satoshi	45	0	2	2	4	0	19
WALLIS, Simon	36	3	0	3	1	0	3
OZAWA, Kazuhito	14	1	3	1	2	0	7
HIROSE, Kei	69	0	1	1	6	0	16
ANDO, Ryosuke	12	0	0	0	1	0	2
IIZUKA, Tsuyoshi	21	0	2	0	3	0	7
KAWAI, Kenji	26	0	0	0	0	1	11
TANAKA, Yoshiyuki	17	1	0	1	0	0	6
TANAKA, Hidemi							
SAKURABA, Ataru	3	0	0	0	0	0	3

SATO, Masahiko	19	0	0	0	0	0	3
NAGAYA, Takayoshi	9	0	0	0	0	0	0
KUWAYAMA, Yasuhito	17	0	0	0	1	0	4
TO, Akiko	5	0	0	0	0	0	0
Subtotal	293	5	8	8	18	1	81
ENDO, Kazuyoshi	18	0	3	1	0	0	6
KANO, Akihiro	27	0	8	1	2	0	3
KOGURE, Toshihiro	57	0	6	3	0	0	16
GOTO, Kazuhisa	65	5	16	2	21	0	13
TAKAHASHI, Yoshio	123	3	17	14	1	4	85
ITAI, Takaaki	27	0	4	0	3	0	4
SUZUKI, Yohey	19	0	3	2	2	1	5
OGIHARA, Shigenori	3	0	3	1	0	0	0
SUNAMURA, Michinari	15	1	0	3	0	0	1
Subtotal	354	9	57	27	29	5	133
Total	1476	34	134	84	96	12	517

(2) External Funds

The total amount of research expenses for the external review period (FY2012-2018) is as follows. For more details, please refer to Chapter II and Data of Individual Members.

Grants-in-Aid for Scientific Research:	735	Total	2,456,164,000 yen
Cooperative Research:	26	Total	117,499,000 yen
Contract Research:	45	Total	84,131,000 yen
Government Research Contract:	114	Total	946,475,000 yen

(3) Distinguished Achievements

In the following we list the published research papers from FY2012 to 2018 which were selected as highly achieving representative research of the Faculty of Science and the School of Science. Names of our department faculty members are underlined. The number of citations as of October 2019 in Web of Science is shown in [].

Hibiya, T., Furuichi N., & Robertson, R. (2012). Assessment of fine-scale parameterizations of turbulent dissipation rates near mixing hotspots in the deep ocean. Geophysical Research Letters, 39, L24601, 2012, https://doi.org/10.1029/2012GL054068M [WoS 15]

Parameterizations of turbulent dissipation near mixing hotspots in the deep ocean: On the basis of the results from simultaneous microscale and fine-scale observations in the various regions in the North pacific, we have assessed the applicability of the existing fine-scale parameterizations of turbulent dissipation rates to the real ocean and confirmed that the Gregg-Henyey-Polzin parameterization most accurately estimates turbulent dissipation rates by compensating for deviations of internal wave spectra from Garrett-Munk in terms of the information of both fine-scale shear and strain.

Moteki, N., Kondo, Y., Oshima, N., Takegawa, N., Koike, M., Kita, K., Matsui, H., & Kajino, M. (2012). Size dependence of wet removal of black carbon aerosols during transport from the boundary layer to the free troposphere. Geophysical Research Letters, 39, 13. https://doi.org/10.1029/2012GL052034 [WoS 43]

Climatological effects of atmospheric aerosol: We statistically clarified from aircraft observation data over East Asia that during the process of upward transport of aerosols in the atmospheric boundary with moist convention, the smaller particles are transported at a higher efficiency into the free troposphere. By using the mass data of each single particle of black carbon whose particle size does not change in the atmosphere, for the first time it became possible to research the particle size dependence of aerosol transport efficiency in moist convection. The observation from removal efficiency of particle size dependence shows similarity to the estimate of the particle size dependence of the cloud condensation nucleus of the particle. It suggests that the cloud droplet activation rate of aerosols in the clouds controls the efficiency of transport and removal.

Ikoma, M., & Hori, Y. (2012). In situ accretion of hydrogen-rich atmospheres on short-period super-Earths: implications for the Kepler-11 planets. The Astrophysical Journal, 753(1), ID66. https://doi.org/10.1088/0004-637X/753/1/66 [WoS 74]

Composition and origin of exoplanets: In order to elucidate the bulk composition and origin of exoplanets with small mass (several times the Earth) and low density (about 1 g/cc), which are often called low-density super-Earths, orbiting near host stars (about 0.1 AU), we conducted theoretical research on the gravitational capture process of protoplanetary disk gas by protoplanets near the central star. Then, we showed the possibility that the low-density super-Earths with short orbital periods could be rocky planets with thick hydrogen atmospheres, and also gave constraints on the temperature and pressure conditions of the protoplanetary disk where those planets were formed.

Hamano, K., Abe, Y., & Genda, H. (2013). Emergence of two types of terrestrial planet on solidification of magma ocean. Nature, 497, 607-610. https://doi.org/10.1038/nature12163 [WoS 126]

Formation mechanism of terrestrial planet: It is believed that almost all of the terrestrial planet was covered by the magma ocean soon after the formation. In this research, the process until the planet solidified with the formation and evolution of the atmosphere that occur in parallel with the solidification was examined consistently. As a result, it was clarified for the first time in the world that there are two types of planet as fellow: a planet that solidifies in a short time and forms a sea on the border of a certain orbit (type I), and a planet that takes a very long time to solidify and loses water during the solidification (type II).

Sato, K., Tsutsumi, M., Sato, T., Nakamura, T., Saito, A., Tomikawa, Y., Nishimura, K., Kohma, M., Yamagishi, H., & Yamanouchi, T. (2014). Program of the Antarctic Syowa MST/IS Radar (PANSY). J. Atmos. Solar-Terr. Phys.,118, Part A 42050. https://doi.org/10.1016/j.jastp.2013.08.022 [WoS 30]

Polar atmosphere structure and variation revealed by the Antarctic atmospheric radar: The first Antarctic large atmospheric radar was constructed at Syowa Station. The development of high-efficiency power amplifier technology and lightweight high-endurance antennas has enabled construction work in the short summer season and continuous operation with minimal power consumption. The restriction of antenna distribution due to complex terrain was overcome by introducing adaptive signal processing technology. As a result of initial observations, new scientific knowledge on the characteristics of the vertical wind fluctuations during severe snow storms, the appearance of the multiple tropopauses, the local time dependence and spatial structure of the summer polar mesosphere echoes was obtained.

Ide, S., Yabe, S., & Tanaka, Y. (2016). Earthquake potential revealed by tidal influence on earthquake size–frequency statistics.Nature Geoscience, 9(11), 834. https://doi.org/10.1038/NGEO2796 [WoS 24]

Earthquake potential revealed by tidal influence on earthquake size–frequency statistics: The possibility that tidal stress can trigger earthquakes is long debated. In this study, we investigated the correspondence between the magnitude-frequency distribution of earthquakes and tidal phase of stress in the subduction zones worldwide. The frequency distribution varies depending on the variation of tidal stress amplitude related to the synodic period. This result supports the hypothesis that the phase of tidal stress controls the growth probability of the earthquake rupture through the slow slip processes at the plate boundary.

Takahashi, Y., Fan, Q., Suga, H., Tanaka, K., Sakaguchi, A., Takeichi, Y., Ono, K., Mase, K., Kato, K., & Kanivets, V. V. (2017). Comparison of solid-water partitions of radiocesium in river waters in Fukushima and Chernobyl areas. Scientific Reports, 7, 12407. https://doi.org/10.1038/s41598-017-12391-7 [WoS 5]

Analysis of dissolved fraction of radiocesium in river waters caused by the Fukushima Daiichi Nuclear Power Plant accident and its comparison with Chernobyl: As for the water solubility of radio cesium in river water, it was found that adsorption of radio cesium was inhibited by the influence of natural organic matter (humic substances) in rivers in the Chernobyl region, which is a peatland, and water solubility increased. On the other hand, in Fukushima area, the percentage of the dissolved concentration of radio cesium was low due to the formation of inner-sphere complex within the interlayer of clay minerals. This is an important point view to consider the transfer radio cesium to biota and the ecosystem.

Hirose, K., Sinmyo, R., & Hernlund, J. (2017). Perovskite in Earth's deep interior. Science, 358(6364), 734-738. https://doi.org/10.1126/science.aam8561 [WoS 9]

Physical properties of the main mineral "Perovskite" in the lower mantle: Perovskite structure is well known as one of the dense crystal structure. Perovskite-structured materials include high-temperature superconductivity and ferroelectricity, and other minerals that contains for about half of the earth's volume are also perovskite-structured phases. This reviews various physical properties of the main minerals in the lower mantle of the earth and discusses the phase transition to the post-perovskite phase.

Moteki, N., Adachi, K., Ohata, S., Yoshida, A., Harigaya, T., Koike, M., & Kondo, Y. (2017). Anthropogenic iron oxide aerosols enhance atmospheric heating. Nature Communications, 8, 15329. https://doi.org/10.1038/ncomms15329 [WoS 21]

Dynamics and radiation effects of anthropogenic iron oxide particles in the troposphere: Particles made of black material of the fine particles floating in the earth's atmosphere heats the atmosphere and frozen snow surfaces by absorbing sunlight. In the past, only carbon particles such as soot were recognized as black particles of anthropogenic that contribute to the heating of the climate system. In this thesis, we discovered that anthropogenic black iron oxide particles (magnetite aggregates) are floating at mass concentrations comparable to carbonaceous particles in the troposphere region and contribute to atmospheric heating by aircraft observations with original developed equipment.

Kasahara, S., Miyoshi, Y., Yokota, S., Mitani, T., Kasahara, Y., Matsuda, S., Kumamoto, A., Matsuoka, A., Kazama, Y., Frey, H. U., Angelopoulos, V., Kurita, S., Keika, K., Seki, K., & Shinohara, I. (2018). Pulsating aurora from electron scattering by chorus waves. Nature, 554(7692), 337-340. https://doi.org/10.1038/nature25505 [WoS 24]

Electron pitch angle scattering and pulsating aurora generation by magnetospheric chorus waves: A pulsating aurora is a speckled aurora that blinks (pulsates) every few seconds to several tens of seconds, but its formation was a mystery. In this study, we analyzed the magnetospheric observation data of the ERG satellite launched by JAXA at the end of 2016, and obtained direct evidence that the pitch angle scattering of electrons by Heusler waves caused the pulsating aurora. Electron pitch angle scattering by waves is considered to be a universal phenomenon in space plasma, and it is extremely significant that it has been proved observably.

Ozaki, K., Tajika, E., Hong, P. K., Nakagawa, Y., & Reinhard, C. T. (2018). Effects of primitive photosynthesis on Earth's early climate system. Nature Geoscience, 11(1), 55-59. https://doi.org/10.1126/10.1038/s41561-017-0031-2 [WoS 6]

Amplification of the methane cycle by anoxygenic photosynthesis countered the faint young Sun: In this study, we clarified the quantitative mechanism for the first time that the warm climate condition was maintained on the ancient Earth, which had about 80 % of the current solar insolation, by the greenhouse effect of carbon dioxide and methane in the atmosphere, with applying a coupled model of atmospheric photochemistry - marine microbial ecosystem – and marine biogeochemical cycle. We found that methane flux required forming the warm climates can be made only when more than two different species of photosynthetic bacteria coexist actively in the primitive marine microbial ecosystems, which gives rise to a strong nonlinear amplification of methane cycle.

(4) Awards and Prizes

The following lists show the award achievements (awardees, award names, etc.) in the annual report of each department and Data of Individual Members. ※Indicates the award before the appointment of this department.

FY2012

SUGIURA Naoji, The Geochemical Society of Japan Award
KONDO Yutaka, Medal with Purple Ribbon
KONDO Yutaka, 40th Geochemical Research Association Academic Award, Miyake Award
IKOMA Masahiro, Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, The Young Scientist's Prize
TAKAHASHI Satoshi, The Japanese Association of Organic Geochemists Taguchi Research Award for Young Scientists
KIMURA Gaku, The Geological Society of Japan Award
※TANAKA Yoshiyuki, The Geodetic Society of Japan, Tsuboi Award
※GOTO Kazuhisa and others, Japan Society for Natural Disaster Science Academic Award

FY2013

HIBIYA Toshiyuki, The Oceanographic Society of Japan, the Hidaka Outstanding-Publication Award
KONDO Yutaka, The Meteorological Society of Japan, Fujiwara Award

KONDO Yutaka, Toray Science Foundation, Toray Science and Technology Prize
NAGAHARA Hiroko, Japan Association of Mineralogical Sciences, Mineralogical Sciences Award
MOTEKI Nobuhiro, The Meteorological Society of Japan, Yamamoto Shono Award for Outstanding Papers
IDE Satoshi, Japan Society for the Promotion of Science Prize
IDE Satoshi, Japan Academy Medal
KOGURE Toshihiro, Mineralogical Society of America, Fellow
※KEIKA Kunihiro, NASA Group Achievement Award
※WALLIS Simon and others, The Geological Society of Japan, Island Arc Award
※GOTO Kazuhisa, Marine Geology, Most Cited Paper Award 2009-2012

FY2014

SATO Kaoru, Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Prize for Science and Technology
HIBIYA Toshiyuki, The Oceanographic Society of Japan, the Hidaka Outstanding-Publication Award
TOZUKA Tomoki, American Geophysical Union, 2013 Editor's Citation for Excellence in Refereeing for Journal of Geophysical Research-Oceans
NAGAHARA Hiroko, Geochemical Society Fellow
ABE Yutaka, Japan Geoscience Union Fellowship
TAKAHASHI Satoshi, Paleosciences Society, Award for Young Researchers
※MORODA Tomokatsu, Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, The Young Scientists' Prize
※WALLIS Simon and others, Japan Association of Mineralogical Sciences, Outstanding Papers Awards
※HIROSE Kei, European Association of Geochemistry and Geochemical Society, Geochemical Fellow
※GOTO Kazuhisa, Marine Geology, Most Cited Paper Award 2013-2014

FY2015

The Antarctic Syowa MST/IS Radar Team, 8th Award for contributions to Maritime Studies, Prime Minister's Award
AMANO Takanobu, Society of Geomagnetism and Earth, Planetary and Spence Sciences Obayashi Early Career Scientist Award
NAGAHARA Hiroko, National Academy of Science, John Lawrence Smith Medal
TAKAHASHI Yoshio, The Geochemical Society of Japan Award
TAKAHASHI Yoshio, Kochi Publication Academic Award
※KEIKA Kunihiro, Society of Geomagnetism and Earth, Planetary and Spence Sciences Obayashi Early Career Scientist Award
※WALLIS Simon and others, The Geological Society of Japan Award, Outstanding Paper Award
※TANAKA Yoshiyuki, International Association of Geodesy, Guy Bomford Prize
※GOTO Kazuhisa and others, Coastal Engineering Journal, Citation Award of 2014
※ITAI Takaaki, The Geochemical Society of Japan Award for Young Researchers

FY2016

MIURA Hiroaki, Japan Geoscience Union Progress in Earth and Planetary Science, Most Accessed

Paper Award
KOHMA Masashi, The Meteorological Society of Japan, Yamamoto Award
SEKI Kanako, NASA Group Achievement Award
HOSHINO Masahiro, NASA Group Achievement Award
HOSHINO Masahiro, American Geophysical Union, Fellow
YOSHIOKA Kazuo, Society of Geomagnetism and Earth, Planetary and Spence Sciences Obayashi Early Career Scientist Award
NAGAHARA Hiroko, Medal with Purple Ribbon
NAGAHARA Hiroko, The Meteoritical Society Leonard Medal
SEKINE Yasuhito, Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, The Young Scientist's Prize
ABE Yutaka, Japan Association of Science & Technology Journalists Award
TAKAHASHI Yoshio, Japan Society for Environmental Chemistry, Environment Chemistry Academic Award
IDE Satoshi, American Geophysical Union, Fellow
IIZUKA Tsuyoshi and others, The Geological Society of Japan, Island Arc Award
TAKAHASHI Yoshio, The Association of American Publishers PROSE Subject Category Award: the Encyclopedia of Geochemistry
TACHIBANA Shogo, Geochemical Society & European Association of Geochemistry, The Paul W. Gast Lectureship
※OHIRA Yutaka, Young Scientist Award of the Physical Society of Japan
※HIROSE Kei, Fujiwara Foundation of Science, Fujiwara Award

FY2017
MIURA Hiroaki, The Geoscience Union Progress in Earth and Planetary Science, Most Cited Paper Award
MIURA Hiroaki, The Meteorological Society of Japan, SOLA Award
KASAHARA Satoshi, Society of Geomagnetism and Earth, Planetary and Spence Sciences Obayashi Early Career Scientist Award
IKOMA Masahiro Japan Geoscience Union, Nishida Award
KAWAHARA Hajime and others, The Astronomical Society of Japan, Publications of the Astronomical Society of Japan
IDE Satoshi, Yomiuri Techno Forum, 23rd Gold Medal Award
HIROSE Kei, Japan Geoscience Union Fellowship
KURISU Shinji, Japan Cartographers Association 12th Best Paper Award
※WALLIS Simon and others, The Geological Society of Japan, Island Arc Award
※WALLIS Simon, The Geological Society of Japan Award

FY2018
SATO Kaoru, The Meteorological Society of Japan, Fujiwara Award
SATO Kaoru, AOGS Atmospheric Sciences Section Distinguished Lecturer
MASUMOTO Yukio, American Geophysical Union, 2018 Editor's Citation for Excellence in Refereeing for Journal of Geophysical Research-Oceans
SEKI Kanako, NASA Group Achievement Award
AMANO Takanobu, Association of Asia Pacific Physical Societies, Division of Plasma Physics, Young Researcher Award

KASAHARA Satoshi, Society for Promotion of Space Science, Space and Science Young Researchers Award

CHO Yuichiro, NF Foundation, Research Encouragement Award

KAYANNE Hajime and others, The Japanese Coral Reef Society, Best Paper Award

TAKAHASHI Satoshi, The Geological Society of Japan, Contribution Prize

SATO Masahiko, Society of Geomagnetism and Earth, Planetary and Spence Sciences Obayashi Early Career Scientist Award

V. International Exchange Activities

1. Internationalization of education

(1) Curriculum for Internationalization

For both undergraduate and graduate students, the improvement of English language ability is extremely important issue. In the 4th year, 'Senior Project in Earth and Planetary Physics' in the Earth and Planetary Physics Program and 'Exercise: Earth and Planetary Environmental Science' in the Earth and Planetary Environment Program run small size literature reading groups, where students receive advice to help understand contents of text books and papers accurately. 'Earth and Planetary Environmental Science International Short Course' of the Earth and Planetary Environmental Science Program is an overseas field excursion to China, Australia and Italy, etc. It is a rare subject in the Faculty of Science that provides work experience and international setting together, and most students of the department join.

At the graduate school, as we explained in III education, for the purpose of improving English, a curriculum of "English for Scientific Researchers" is held for first-year doctoral students, and students are strongly encouraged to take the course. In this exercise, students are divided into two levels and debates and presentation-based exercises are performed by a native English speaking part-time lecturer. Currently, undergraduate lectures are conducted in Japanese generally, however, in graduate courses if there are any students who wish to attend lectures in English, the lecture is hold in English. Therefore, international students who speaks English could take our curriculums without any problem.

(2) Hosting International Students

There are not many international students in our two undergraduate programs as well as other programs in the university. In the graduate school, an entrance examination called Special Selection for International Applicants is conducted separately from the normal entrance examination system. In this entrance examination, applicants are judged based on the statement of purpose, TOEFL and GRE Subject Test results, and interviews. From FY2012 to 2018, there were 519 students enrolled in general entrance examinations for the master's program, 14 (2.7%) enrolled in the Special Selection for International Applicants and 17 (7.7%) in the total of 220 enrollments of the doctoral program. Many of international students received financial support from Japanese Government (Monbukagakusho: MEXT) Scholarship and The University of Tokyo Fellowship Special Scholarship Program for International Students. The school of Science has an International Liaison Office which provides support for international students including needs of their daily life, issues related to their studies and residence registration etc.

2. Internationalization of education

(1) Overview of Hosting and Sending

The total number of international students that our department faculty member received and educated is 85 during the period of external review. This number includes students who used program of the School of Science (described in detail later) as well as from external funds such as scientific research funds. In addition, there are a total of 70 international researchers who have stayed for a certain period of time by using the system for visiting collaborative researcher or project researcher position. Please refer to the data of the individual member for the details. The numbers of international students and researchers were 35 and 37, respectively. These figures show a significant increase compared to the previous external review.

On the other hand, the number of students we have sent to overseas from our department was 128, and the number of researchers was 42. The number of students has risen from 91 in the previous review, indicating that students actively use on-campus programs and external funds to gain international experience. However, due to the limitations of available programs and time, the number of researchers has decreased from 49 in the previous external review. The number of overseas visitors is 371 for those attending seminars and meetings of up to a few days.

(2) Sending Students and Faculty Members by On-Campus Program

Sending students

Currently, many students travel to various countries every year using educational programs related to our department. Some of them travel for a purpose of academic presentation, and some of them are staying for research activity for long period. The following list shows the record of sending (excluding travel only for academic presentation) and the supporting source by year. Program name abbreviations are as follows.

- **FMSP:** Leading Graduate Course for Frontiers of Mathematical Sciences（Refer to III Education）
- **Computational Science**：Computational Science Alliance（Refer to III Education）
- **ESSVAP:** Elite Science Study Visit Abroad Program, implemented until FY2013. This was a program that sent a group of selected 3rd and 4th year undergraduate students who are highly achieved to universities and research institutions in abroad.
- **SVAP:** Study and Visit Abroad Program, Sending 3rd and 4th year students of the School of Science for internship and short summer school in universities and research institutions from two weeks to three months.
- **GRASP:** Graduate Research Abroad in Science Program, For selected high-achieving graduate school students to go abroad for a joint research in universities and research institutions.
- **UGRASP:** Undergraduate Research Abroad in Science Program, For the last half term of 4th year undergraduate students to go abroad for joint research with local researchers and professors in universities and research institutions.

Year	Name	Grade	Country	Research Institution	Days	Program
2013	YABE Suguru	M2	USA	SSA, Miami University	15	FMSP
2013	YASUDA Yuki	D1	USA	Woods Hole Oceanographic Institution	73	FMSP
2013	MATSUI Yuki	D2	UK, Switzerland	University of Cambridge, ISSI	86	FMSP
2013	KATAOKA Takahito	D2	USA	Scripps Institution of Oceanography	65	FMSP
2014	MATSUI Yuki	D3	UK	University of Cambridge	86	FMSP
2014	IIJIMA Haruhisa	D2	Norway	University of Oslo	61	FMSP
2014	KATAOKA Takahito	D3	France	LOCEAN-IPSL	58	FMSP
2014	MATSUI Yuki	D3	Czech, UK, Russia	Solar and Stellar Flares, University of Cambridge, 40th COSPAR	51	FMSP
2014	YABE Suguru	D1	USA	University of Washington	71	FMSP
2014	KANEKO Takafumi	D1	Belgium	University of Leuven	92	FMSP
2014	YASUDA Yuki	D2	France	École normale supérieure de Lyon	87	FMSP
2015	AMEMIYA Arata	D1	Germany	Max Planck Institute for Meteorology	36	FMSP
2015	KANEKO Takafumi	D2	UK, Belgium	Hinode-9 International Science Meeting, KU Leuven	22	FMSP
2015	OKAJIMA Satoru	D2	USA	Texas A&M University, NCAR	43	FMSP
2015	WATANABE Shunichi	D3	UK	University of Reading	30	FMSP

2016	KAWASHIMA Yui	D2	USA,Canada	University of California Santa Cruz, ExoClimes2016	49	FMSP
2016	Wang Shuoyang	D2	USA	Princeton University	39	FMSP
2016	NISHIKAWA Tomoaki	D2	USA	Stanford University, AGU Fall Meeting	36	FMSP
2016	SHIBUYA Ryosuke	D3	USA	NCAR	30	FMSP
2016	YAMAGAMI Yoko	D2	USA	University of Hawaii at Manoa, AGU Fall Meeting	56	FMSP
2017	IWAMOTO Masanori	D1	China	Shandong University	14	FMSP
2017	BEKKI Yuto	M2	USA	High Altitude Observatory (HAO)	61	FMSP
2017	SHODA Munehito	D1	USA	Smithsonian Center for Astrophysics	71	FMSP
2017	KAWABATA Yusuke	D2	Spain	Instituto de Astrofisica de Canarias	37	FMSP
2017	YAMAYA Rina	M1	USA	University of California Berkeley	33	FMSP
2017	AOYAMA Yuhiko	D2	Switzerland	University of Bern	48	FMSP
2018	KIDO Shoichiro	D2	USA	Department of Atmospheric and Oceanic Science, University of Colorado	61	FMSP
2018	SUZUKI Yuki	D2	USA	Arizona State University	34	FMSP
2018	TAKAHASHI Anne	D2	UK	University of Southampton	51	FMSP
2018	FUKUZAWA Katsutoshi	D2	Canada	Institute of Ocean Sciences, Sidney, BC,	36	FMSP
2018	SHIBATA Sho	D1	Switzerland	University of Zurich	72	FMSP
2012	MIYAZAKI Yoshinori	B3	USA	Yale University, Princeton University	10	ESSVAP
2013	TABATA Haruhisa	B3	USA	University of California Santa Barbara, Caltech, University of California Los Angeles	10	ESSVAP
2015	BEKKI Yuto	B4	USA	University of Maryland	52	SVAP
2015	KOBAYASHI Ayuko	B3	UK	University of Cambridge	19	SVAP
2016	ARAI Hiroki	B4	USA	University of Miami	30	SVAP
2016	SUKO Yasushi	B4	France	University of Rennes 1	33	SVAP
2016	SUZUKI Nanami	B4	UK	University of Cambridge	57	SVAP
2016	WAKUI Megu	B4	USA	Ohio University	49	SVAP
2017	KOBAYASHI Masato	B4	Italy	Universita d'Annunzio	49	SVAP
2017	HIKOSAKA Kotaro	B3	USA	Johns Hopkins University	58	SVAP
2018	TOMIDA Ryota	B4	USA	Carnegie Institution of Washington	62	SVAP
2018	ISHIMARU Kana	B4	USA	University of Arizona	79	SVAP
2018	SHIMIZU Yusuke	B4	USA	Tulane University	90	SVAP
2017	WAKUI Megu	M1	Vietnam	Vietnam National Museum of Nature, Vietnam Academy of Science and Technology	14	GRASP
2017	ASO Miki	M2	USA	United States Geological Survey, University of California Berkeley	35	GRASP
2017	YAMAGUCHI Yuta	M2	Germany	Max Planck Institute for Dynamics and Self-Organization (University of Göttingen)	47	GRASP
2017	AMEKAWA Shota	D1	Taiwan	National Taiwan University	31	GRASP
2017	OHNO Haruka	D1	Belgium	Université Libre de Bruxelles	51	GRASP
2017	KURISU Minako	D1	USA	University of South Florida	16	GRASP
2017	KIKUCHI Ryosuke	D2	Poland	Institute of Geological Sciences, Polish Academy of Science	31	GRASP
2017	HANAI Tomoya	D2	China	Institute of Vertebrate Paleontology and Paleoanthropology / Geological Museum of China	18	GRASP
2018	JINNO Takuya	M2	Germany	Max Planck Institute for Meteorology	36	GRASP

2018	WANG Yuchen	M2	Chile	CIDIGEN Research Center for Integrated Disaster and Risk Management	30	GRASP
2018	KOMORI Junki	D1	Singapore	Nanyang Technological University	91	GRASP
2018	TADA Toshihiro	D1	UK	Lancaster University	95	GRASP
2018	HIKIDA Reina	D2	USA	University of Colorado	16	GRASP
2018	ISHIKAWA Hiroki	M1	USA, Canada	Royal Ontario Museum, Canadian Museum of Nature, The Academy of Natural Sciences of Drexel University, Natural History Museum of Utah, Royal Tyrrell Museum, University of Alberta	41	GRASP
2018	WAKUI Megu	M2	Belgium, Germany	Senckenberg Museum, Frankfurt, Royal Belgian Institute of Natural Sciences, Brussels	16	GRASP
2018	KAJITA Hiroto	D1	China	Yunnan University, Research Center for Earth System Science	27	GRASP
2018	AMEKAWA Shota	D2	Taiwan	National Taiwan University	22	GRASP
2018	NISHIYAMA Gaku	B4	France	Institut de Physique du Globe de Paris	32	UGRASP
2018	HAMAMOTO Masaki	B4	USA	University of California San Diego	32	UGRASP
2018	MASUDA Koki	B4	UK	University of Oxford	22	UGRASP
2018	YUMOTO Koki	B4	USA	California Institute of Technology	20	UGRASP
2018	YOKOO Shunpei	B4	France	Sorbonne Universite	45	UGRASP
2018	TADA Seishiro	B4	USA	Ohio University	29	UGRASP
2018	FUKUDA Yoshihiro	B4	USA	University of Hawaii at Manoa	45	UGRASP
2018	YOSHIOKA Yunpei	B4	USA	Brown University	22	UGRASP

Sending Faculty Member

A common issue for all the departments in the University of Tokyo is that only a few professors take sabbatical for long term overseas experience. It is also true in our department and there are not many professors go on abroad for long term. To solve this situation, from FY2017 UTokyo Global Activity Support Program for Young Researchers has started as a university-wide project. Soon after our department used this program and sent Satoshi Takahashi, Assistant Professor to University of Leeds in England from August 2018 to September 2019.

(3) Hosting Students and Researchers by On-campus Programs

・GSGC (Global Science Graduate Course) Project Professor/Project Associate Professor

World-leading Innovative Graduate Study Program (Refer to III Education) employ researchers from oversea as project faculty members, and conduct joint research and request special lectures for students. The list below shows faculty members who joined the programs.

Group	Name	Period of Stay	Country	Institution/Position
Space and Planetary	BÜCHNER, Jörg	2017.3.2～2017.3.31	Germany	Max Planck Institute for Solar System Research, Professor
System	ZHENG, Hongbo	2017.2.1～2017.3.28	China	Yunnan University, Research Center for Earth System Science, Director, Professor
Space and Planetary	KISTLER, Lynn Marie	2017.9.17～2017.11.16	USA	University of New Hampshire, Space Science Center, Director, Professor
Solid Earth	OCCHIPINTI, Giovanni	2018.5.1～2018.7.31	France	Université Paris Diderot - Institut de Physique du Globe de Paris Associate Professor
Space and	BRAIN, David	2019.1.1～	USA	University of Colorado Boulder, Associate

Planetary	Andrew	2019.3.31		Professor

・UTRIP (University of Tokyo Research Internship Program)

This is a summer program of the School of Science for undergraduate student from overseas. We accept them to join in our laboratories to make research projects for six weeks between June to August. There are many applications every year and the positions are oversubscribed by about 30 times.

Year	Name	University	Country	Group
2012	SHUKLA, Shikhar	Indian Institute of Technology, Roorkee	India	Solid Earth
2012	BENYO, Krisztian	Eotvos Lorand University	Hungary	Solid Earth
2012	TAM, Evan	University of Connecticut	USA	Solid Earth
2012	WU, Yifei	Peking University	China	Solid Earth
2013	MO, Lan	National University of Singapore	Singapore	Biosphere
2013	NG, Yuting	University of Illinois at Urbana-Champaign	USA	Space Planet
2013	RAVI, Prabhat Kumar	Indian Institute of Technology, Kanpur	India	Solid Earth
2013	CAVIN, John	Saint Louis University	USA	Solid Earth
2013	MARTIN, Juliette	University of York	UK	System
2013	ZHANG, Ailin	Peking University	China	Solid Earth
2014	DIWAKAR, Prince	Indian Institute of Technology BHU	India	Solid Earth
2014	LI, Jiaxuan	Peking University	China	Solid Earth
2014	LI, Tianyi	Peking University	China	Solid Earth
2014	JONGARAM-RUNGRUNG, Siraput	University of Cambridge	UK	Solid Earth
2015	KNUEPFER, Kristina	The University of Dundee	UK	Biosphere
2015	WALIA, Nehpreet Kaur	Guru Nanak Dev University	India	Space Planet
2015	CHANG, Ta-Wei	National Central University	Taiwan	Solid Earth
2015	CHIORINI, Sutton Christine	University of Maryland	USA	Solid Earth
2015	ESASHI, Yuka	Reed College	USA	Solid Earth
2015	WANG, Yuchen	Peking University	China	Solid Earth
2016	KIRLOSKAR, Mihir Milind	Indian Institute of Technology, Kharagpur	India	Solid Earth
2016	LEE, Shu-Yu	The University of Hong Kong	China	Space Planet
2016	DAS, Duttatreya	Indian Institute of Technology, Kharagpur	India	Solid Earth
2016	NAHAR, Gurkirat Singh	Indian Institute of Technology, Roorkee	India	Solid Earth
2016	ZHOU, Yi	University of California, Berkeley	USA	Biosphere
2016	CHAN, Hong Pou	University of Edinburgh	UK	Space Planet
2017	RAMOS, Laura Garcia	University of Oviedo	Spain	Solid Earth
2017	DEMETRIOU, Evi	Kingston University	UK	Solid Earth

2017	BEREZINA Polina	Taras Shevchenko National University of Kyiv	Ukraine	Solid Earth
2017	SU, Heng-Yi	National Central University	Taiwan	Solid Earth
2017	STREANGA, Iulia Madalina	University of Edinburgh	UK	Biosphere
2018	SCOTT, Jennifer Ann	University of Edinburgh	UK	Biosphere
2018	PITA SLLIM, Olivia Dianara	National Autonomous University of Mexico	Mexico	Solid Earth
2018	CHOUDHARY, Ashutosh	Indian Institute of Technology, Roorkee	India	Solid Earth

・UCEAP（University of California Education Abroad Program）

We have a partnership to exchange students with The University of California for a study abroad program.

Year	Name	University	Country	Group
2017	Zian, Yang	University of California, Irvine	USA	Biosphere

・STEPS（Students and Researchers Exchange Program in Sciences）

This is a summer program of the School of Science for undergraduate student from overseas. We accept them to join in our laboratories to make research projects for six weeks between June to August. There are many applications every year and the positions are oversubscribed by about 30 times.

Year	Name	University	Country	Group
2015	Dina Giliazetdinova	Moscow University	Russia	Solid Earth
2016	Aleksei Mishchenko	Moscow University	Russia	Space Planet
2016	Pavel Akaev	Moscow University	Russia	Space Planet
2016	Tara Ahmadi	Saint-Petersburg University	Russia	Space Planet
2016	Ivan Zaitsev	Saint-Petersburg University	Russia	Space Planet
2016	Elizaveta Pankova	Moscow University	Russia	Biosphere
2016	Kirill Sementsov	Moscow University	Russia	Solid Earth
2017	Alena Kolesnikova	Moscow University	Russia	System
2017	Arina Falaleeva	Moscow University	Russia	System
2017	Elena Mironenko	Moscow University	Russia	Biosphere
2017	Nikita Zorin	Moscow University	Russia	Solid Earth
2012	WU, Yifei	Peking University	China	Solid Earth

3. Contribution to International Community

Faculty members in the department play various roles in international community. The list below shows contributions of our faculty member as editorial committee members of international journals, board members of international conferences and organizing committee members of international conferences. Please refer to Data of Individual Members for more contributions.

(1) Editorships for International Journals

Name	Editorships for International Journals, Period of time
HIBIYA Toshiyuki	*Frontiers in Marine Science*, Editor, 2018- *Progress in Earth and Planetary Science*, Editor, 2013- *Geoscience Letters*, Editor, 2012-2016 *Journal of Oceanography*, Editor-in-Chief, 2011-2015
MASUMOTO Yukio	*Ocean Dynamics*, Guest Editor, 2013
TOZUKA Tomoki	*Journal of Climate*, Associate Editor, 2016- *Frontiers in Atmospheric Science*, Review Editor, 2013-
HOSHINO Masahiro	*Europhysics Letters*, Editor, 2012-2017
TACHIBANA Shogo	*Geochemical Journal, Associate Editor, 2008-* *Geochemical Journal, Guest Editor, 2013, 2018* *Space Science Reviews, Guest Editor, 2018-*
IKOMA Masahiro	*Earth, Planets and Space*, Steering Committee, 2015-2018
IDE Satoshi	*Journal of Geophysical Research: Solid Earth*, Associate Editor, 2010- *Tectonophysics*, Guest Editor, 2013
WALLIS Simon	*Royal Society-Open Science*, Editorial Committee, 2014- *Progress in Earth and Planetary Science*, Editorial Committee, 2014- *Island Arc*, Editorial Committee Advisor, 2008-
HIROSE Kei	*Science*, Reviewing Editor, 2009-2015 *Physics of the Earth and Planetary Interiors*, Editor, 2010-
ANDO Ryosuke	*Earth, Planets and Space*, Associate Editor, 2017-2018
TANAKA Yoshiyuki	*Earth, Planets and Space,* Steering Committee, 2014-2018
TO Akiko	*Marine Geophysical Research,* Advisory Board, 2016-2017
KANO Akihiro	*Island Arc,* Editorial Committee, 2016-2018 *Sedimentary Geology*, Advisory Board Member, 2018
KOGURE Toshihiro	*Clay Science*, Editorial Committee, 2012-2018
GOTO Kazuhisa	*Earth-Science Reviews (Special issue)*, Lead Guest Editor, 2018 *Island Arc (Special issue)*, Guest Editor, 2016 *Marine Geology (Special issue)*, Lead Guest Editor, 2014 *Planetary and Space Science (Special issue)*, Guest Editor, 2014 *Sedimentary Geology (Special issue)*, Guest Editor, 2012 *Earth, Planets and Space (Special issue)*, Lead Guest Editor, 2012 *Marine Geology*, Editorial Board, 2012
TAKAHASHI Yoshio	*Geosystem Engineering,* Editorial Committee, 2010-2018 *Geochemical Journal,* Guest Editor, 2012, 2018
SUNAMURA Michinari	*Microbes and Environment,* Editorial Secretary, 2017-2018

(2) International Academic Societies and Meetings

Name	President/Vice President/Committee Chair of International Societies and Conferences
SATO Kaoru	SCOSTEP (Scientific Committee on Solar-Terrestrial Physics), CAWSES (Climate And Weather or the Sun-Earth System) / CAWSES-II, Promotion Team Members, 2012-2013 WCRP (World Climate Research Programme), WDAC member, 2013-2015 WCRP(World Climate Research Programme), SPARC (Stratosphere-troposphere Processes And their Role in Climate), SSG member, 2013-2018 WCRP(World Climate Research Programme) / SPARC(Stratosphere-troposphere Processes And their Role in Climate), Gravity waves, activity leader, 2014-2018
HIBIYA Toshiyuki	IAPSO, Exective Committee member, 2011-2019 AOGS, Ocean Science Section, President, 2012-2014 AOGS, Ocean Science Section, Vice President, 2011-2012, 2014-2015
MASUMOTO Yukio	IOC/SCOR/GOOS IIOE-2, Science Theme 2 Co-chair, 2016-2018 IOC/SCOR/GOOS IIOE-2, Working Group 1 Member, 2016-2018 TPOS2020, SC member, 2014-2017 TPOS2020, Modelling and Data Assimilation Task Team Member, 2014-2017 CLIVAR/IOGOOS Indian Ocean Panel, Member, 2012-2013
KOIKE Makoto	Arctic Council, AMAP, SLCF, Task Force Member, 2012-2017
TOZUKA Tomoki	CLIVAR Indian Ocean Regional Panel, Member, 2014-2018
TANAKA Yuki	AOGS, Ocean Science Section, Section Secretaries, 2013-2014
SEKI Kanako	ISSI(International Space Science Institute), Science Committee, 2018-
TACHIBANA Shogo	Meteoritical Society, Nominating Committee, 2017– Meteoritical Society, 82nd Annual Meeting LOC, 2017–2019 NASA, Laboratory Analysis of Returned Samples (LARS) Program Review Panel NASA, Research Opportunities in Space and Earth Sciences (ROSES) Review Panel NASA, Emerging World Review Panel
HOSHINO Masahiro	International Space Science Institute, Switzerland, Science Committee, 2012-2014 Space Research Institute, Austrian Academy of Sciences, Science Advisory Board, 2018
IDE Satoshi	IASPEI, Commission on Earthquake Source Mechanics, Chair, 2017- American Geophysical Union, Union Fellow Committee, 2018 Seismological Society of America, Nominating Committee, 2017
WALLIS Simon	American Geophysical Union, Committee for International Participation, 2014–2018
HIROSE Kei	European Association of Geochemistry/Geochemical Society, Geochemical Fellow Committee, 2012-2013
TANAKA Yoshiyuki	IAG, Commission WG1.3.2 (4D deformation models for reference frame), Member, 2012-2018 IAG, GGOS (Global Geodetic Observation System) Science Panel Member, 2017-present IAG, Inter-Commission Committee on Theory, JSG 0.21 Geophysical modelling of time variations in deformation and gravity, Chair, 2015-present
ENDO Kazuyoshi	International Paleontological Association, Paleontological Society of Japan, Representative 2012-2018
KOGURE Toshihiro	AIPEA（International Clay Union）Nomenclature Committee, Japanese representative, 2012-2018

GOTO Kazuhisa	IUGS Task Group on Geohazards, Secretary General, 2017 AOGS Publication Committee, 2017 AOGS Regional Advisory Committee, 2017 AOGS Interdisciplinary Geoscience section, President, 2016-2018 AOGS Interdisciplinary Geoscience section, Vice President, 2015-2016, 2018-
SUZUKI Yohey	COSPAR Sample Safety Assessment Protocol Working Group, member, 2018
SUNAMURA Michinari	InterRidge Steering Committee, member, 2012-2014

VI. Public Partnership, Contribution to Societies and Outreach Activities

The faculty members of this department contribute to society by serving domestic academic societies and other organizations as committee members. We also conduct outreach activities through outreach activity, public symposiums, seminars, and visiting lectures, and coverage of research results by mass media such as newspapers and television. We will introduce some of main activities below which are described in the Data of Individual Members. Please refer to the Data of Individual Members for more details and other activates which are not introduced here.

(1) Contribution to Academic Societies

The faculty members of this department play important roles in various academic societies of Earth and planetary science, including the Japan Geoscience Union (JpGU), which is the largest Earth and planetary science society in Japan.

Since the establishment of the Japan Geoscience Union (founded in 2005, with approximately 12,000 members), many of faculty members from our department have been mainly involved in its operation. The number of members who are involved as fellow: two former presidents (HAMANO, Yozo/ KIMURA, Gaku), two current vice-presidents (TAJIKA, Eiichi / WALLIS, Simon), six directors between FY2012 to FY2016 and 12 representatives. Almost half of our faculty members are involved if we include steering members of Japan Geoscience Union meeting held in May every year, and editorial of public magazine and academic journals published by Japan Geoscience Union（Progress in Earth and Planetary Science / Earth, Planets, and Space）.

The board of directors meeting is usually also held in the meeting room of our department. Over all we believe that our department makes a generous contribution both in human resources and material support.

Academic conferences in which the faculty members of our department were involved as officers between FY2012 to FY2018 are as follows: The Meteorological Society of Japan (established in 1882, approximately 3300 members), The Geological Society of Japan (in 1893, 3700), The Seismological Society of Japan (in 1929, 1900), The Oceanographic Society of Japan (in 1941, 1400), Japan Association of Mineralogical Sciences (1928, 900), The Japanese Association for Petroleum Technology (in 1993, 1800), Paleontological Society of Japan (in 1935, 600), The Geochemical Society of Japan (in 1953, 900), Society if Geomagnetism and Earth, Planetary and Space Science (in 1947, 600), The Geodetic Society of Japan (1954, 500), The Sedimentological Society of Japan (in 1951, 400), The Clay Science Society of Japan (in 1957, 300), The Japanese Society for Planetary Sciences (in 1992, 600), The Japanese Coral Reef Society (in 1997, 500), The Japan Society of Nuclear and Radiochemical Sciences (in 1999, 300)

The above is the contribution of only current faculty member whose details are described in the Data of Individual Members. The contributions of past faculty members are also significant.in the department conduct cooperative research with companies and deliver lectures in cooperation with society.

(2) Contribution to public organizations, government, and various organizations

There are faculty members in our department who are involved in various public institutions, including many who are involved in the Science Council of Japan. This Council represents the Japanese science community ranging over all fields of sciences and has responsibility for making policy recommendations to the government and public statements. It is also involved in many international activities, the promotion of scientific literacy, and the establishment of networks among

scientists.

Professor Tajika is currently a Council Member of the Section III (Physical Sciences and Engineering) of the Science Council of Japan, and our department has two associate members, three specially appointed associate members and seven members of the subcommittee are involved in the operation. Because of the characteristics of the field of Earth and planetary science that relate to society, there are many faculty members working at the committees of government offices and local governments: The committee of Central Ministries - Cabinet Offices (4), Ministry of Education, Culture, Sports, Science and Technology (2), Ministry of Land, Infrastructure, Transport and Tourism, the Japan Meteorological Agency (2), the Ministry of Economy, Trade and Industry (1), Ministry of Foreign Affairs (1). Many faculty members also serve on committees at other departments, other universities and commissions implemented at institutions. In addition, there are more contributions to other universities and various organizations, please refer to the Data of Individual Members for the details.

(3) Public Lectures

The faculty members of our department give numerous lectures for the public in various places. As the School of Science of the University of Tokyo, we also hold various lecture events as below. Please refer to the Data of Individual Members for more details.

The University of Tokyo, Public Lecture

MASUMOTO, Yukio, Predicting changing climate, October 2013

KONDO, Yutaka, Climate change and aerosols, October 2013

IDE, Satoshi, Understanding of earthquakes changed by slow earthquakes, October 2013

KAYANNE, Hajime, Dilemma of sinking atoll countries caused by global warming, June 2018

The University of Tokyo, Orientation for High School Female Students

SATO, Kaoru, Exploring the earth climate system from the Antarctic, September 2015

The School of Science, The University of Tokyo, Public Lecture

KIMURA, Gaku, New image of a subduction-zone earthquake, November 2012

IKEDA, Yasutaka, The 2011 off the Pacific coast of Tohoku Earthquake viewed on a geological time scale April 2013

NAMIKI, Atsuko, Why does the same volcano erupt in various ways? November 2013

MASUMOTO, Yukio, The sea is a natural blender: Spreading of substances in the Sea, April 2104

GELLER, Robert, The current state and limits of seismology, expect the unexpected, November 2015

SEKINE, Yasuhito, Exploring the furthest research of the Solar System, March 2108

The School of Science, the University of Tokyo, Spring Holiday Lecture for High School Students

HIBIYA, Toshiyuki, Global overturning circulation driven by the Moon – Challenge to the mystery in the deep ocean, April 2013

IKOMA, Masahiro, Many types of planets outside the solar system, April 2014

SEKINE, Yasuhito, Exploring the universe! Life supporting planets, April 2016

The School of Science, The University of Tokyo, Summer Holiday Lecture for High School Students

NAGAHARA, Hiroko, How the solar system has evolved, July 2013

MURAKAMI, Takashi, Oxygen and carbon dioxide billions of years ago –To became a habitable environment for human-, July 2013

SUGIURA, Naoji, The Chelyabinsk great fireball, August 2013

OZAWA, Kazuhito, A hot letter from inside the earth –Reading the thermal history of earth and the future of earth, July 2104

TOZUKA, Tomoki, The key to understanding the mystery of extreme weather, August 2014

IWAGAMI, Naomoto, Launching a camera to Venus, August 2015

TAJIKA, Eiichi, Conditions for a habitable planet - A relationship between planetary environment and life-, August 2016

The School of Science, The University of Tokyo, Winter Holiday Lecture for High School Students

TSUIHIJI, Takanobu, Dinosaur Research –From field work to comparisons with modern life, December 2012

TAKAHASHI, Yoshio, Molecular geochemistry: Facing environmental and resource issues from the molecular level, December 2015

ANDO Ryosuke, How to investigate earthquakes: Digging holes, looking closely and calculating, December 2017

KANO, Akihiro, Looking caves for evidence of climate change and the life stage of early Japanese, December 2018

The University of Tokyo, Open Campus

SATO, Kaoru, Exploring the mechanism of the earth climate from the Antarctic, December 2105

IKOMA, Masahiro, What exoplanets are telling us, August 2012

SUZUKI, Yohey, An oasis where creatures eat the earth, August 2012

MIKOUCHI, Takashi, The history of the solar system, exploring from meteorites, August 2013

GELLER, Robert, How seismologists view nuclear safety issues – living together with risks, August 2013

KOIKE, Makoto, Global warming and aerosols: Do fine particles change the climate? August 2104

KOGURE, Toshihiro, Seeing micro minerals with an electron microscope, August 2014

KOHMA, Masashi, Ozone holes and stratospheric clouds in high latitudes, August 2015

YOKOYAMA, Takaaki, Dynamic Sun, August 2105

IKOMA, Masahiro, The wonders of the solar system learned from exoplanets, August 2015

IDE, Satoshi, Why earthquake prediction is difficult? August 2015

TAJIKA, Eiichi, A frozen earth – snowball earth events have promoted biological evolution?, August 2016

ANDO, Ryosuke, Breaking of the earth, Focusing on the mystery of Kumamoto earthquake 2016,

August 2016

KOGURE, Toshihiro, Seeing the world of minerals with an electron microscope, August 2016

MIURA, Hiroaki, Weather forecasts and climate forecasts: A way to know the future and its limitations, August 2017

HIYAGON, Hajime, Exploring the formation process of the solar system from micro analysis, August 2017

HIROSE, Kei, Formation and early evolution of the Earth, August 2017

TANAKA, Yuki, The Kuroshio large mender: Mysteries of the great ocean currents, August 2018

IKOMA Masahiro, We want to know more about exoplanets, August 2018

IDE, Satoshi, Earthquakes without shaking, August 2018

SUGITA, Seiji, Seeing the asteroid Ryugu by: the view from the 'Hayabusa 2' probe

(4) Public Lectures

FY2102

SATO, Kaoru (Professor) (Cooperation) 'PANSY radar, the largest Antarctic atmospheric radar, begins observation with its full system'

KAYANNE, Hajime (Professor) 'First list of coral species in an isolated remote island of Okinotorishima'

YAMADA, Akinori (PhD student) (Cooperation) 'Enables to identify large-scale volcanic eruptions that cause global cooling – Elucidating the mechanism of stable) sulfur isotope recorded in ice sheet sulfuric acid-'

INOUE, Shihori (PhD student) / KAYANNE, Hajime (Professor) / YAMAMOTO, Masashi (PhD student) (Cooperation) 'Changing from hard to soft coral!? - Corals disappear by ocean acidification-'

FY2013

HAMANO, Keiko (Project Researcher) / ABE, Yukata (Associate Professor) / GENDA, Hidenori (Project Assistant Professor) (Cooperation) 'Are Earth and Venus different types of planets?- Elucidation of two evolutionary types of terrestrial planets-'

SATO, Kaoru (Professor) (Cooperation) 'A new theory describing the three-dimensional structure of atmospheric general circulation'

KUROSAKI, Kenji (PhD student) / IKOMA, Masahiro (Associate Professor) (cooperation) 'Fine weather on a super earth? - First observation of the atmosphere of the low-mass exoplanet GJ3470b-'

IDE, Satoshi (Professor) 'Is it a dangerous region where earthquakes occur so often? - Relationship between the seismicity rate and plate motion –'

AMANO, Takanobu (Associate Professor) / HOSHINO, Masahiro (Professor) (Cooperation) 'Successful simulation of super-high Mach number Plasma shock wave'

GELLER, Robert (Professor) 'Developing the method and application for estimating the three-dimensional structure of the earth's interior with high resolution –Viewing the structure of the lowest mantle under Central America-'

FY2014

HOTTA, Hideyuki (ex-graduate student) / YOKOYAMA, Takaaki (Associate Professor) (cooperation) 'Achievement the world's highest resolution of the sun convection layer calculation using the

supercomputer “K”’

MIURA, Hiroaki (Associate Professor) (Cooperation) ‘Demonstrating possible one-month prediction of Madden-Julian oscillations in the thermal zone – supercomputer K x Next-generation ultra-precision meteorological model-’

NAKAJIMA, Yasuhisa (ex-graduate student) / IZUMI Kentaro (PhD Student) (Cooperation) ‘Discovery of vertebrates coprolites in Japan's oldest early Mesozoic era - Evidence of the reactivation of the marine ecosystem after the mass extinction at the end of Paleozoic era-’

NISHIKAWA, Tomoaki (Graduate student) / IDE, Satoshi (Professor) ‘New Plates often make large earthquakes -Plate buoyancy determines earthquake size distribution-’

GELLER, Robert (Professor) (Cooperation) ‘Bottom mantle structure under the western Pacific by waveform inversion -Approaching the origin of the Caroline hotspot-’

KOGURE Toshihiro (Associate Professor) (Cooperation) ‘Identification of radioactive fine particles in soil and elucidation of radioactivity distribution in fine particles of Fukushima radioactive contamination’

SUZUKI, Yohey (Associate Professor) ‘Searching metabolic activity of microorganisms living deep underground’

MIYAMOTO, Mayu (PhD student) (Cooperation) ‘How is the solar wind made? - Solar wind acceleration revealed by Venus probe Akatsuki-’

HOSHINO, Masahiro (Professor) ‘Active gas drops and cosmic ray generation in disks surrounding black holes’

FUNAMORI, Nobumasa (Associate Professor) ‘The possibility of neutral hydrogen atoms in rocks of the deep earth - A new stone for studying the hydrogen cycle of earth’s interior-’

YAMASHITA, Momo (PhD student) (Cooperation) ‘New findings on the evolution and adaptation of the eye of the marine reptile mosasaurus’

AMANO, Takanobu (Associate Professor) / Hoshino Masahiro (Professor) (Cooperation) ‘Cosmic ray acceleration revealed by the supercomputer “K”- Presenting new theory of high-energy electron generation mechanism in astronomical shock waves -’

SUNAMURA, Michinari (Associate Professor) (Cooperation) ‘Discovery of the ultra-deep sea and trench biosphere - Unique microbial ecosystem in ultra-deep water mass in the Mariana Trench-’

SEKINE, Yasuhito (Associate Professor) (Cooperation) ‘Submarine hydrothermal activity in the undersea of the Saturn's Moon Enceladus! - Discovering a habitable environment in space-’

SUZUKI, Yohey (Associate Professor) (Cooperation) Discovery of oxygen-filled ultra-low-nutrient biosphere in deep sea sediment of the open ocean’

HARADA, Mariko (PhD student) / SEKINE, Yasuhito (Associate Professor) (Cooperation) / TAJIKA Eiichi (Professor, the school of Science joint affiliation) ‘Snowball Earth event resulted in a rise of oxygen in the atmosphere!? – A theoretical approach to elucidate mechanism of a rise of oxygen in the atmosphere -’

FY2015

SATO, Kaoru (Professor) (Cooperation) ‘Precise research of the Antarctic atmosphere enabled by the first Antarctic Mesosphere-Stratosphere-Troposphere (MST) radar (the PANSY radar)’

IIZUKA, Tsuyoshi (Lecturer) ‘Existence of a nutrient-rich crust on the earth just after its birth.’

SEKINE, Yasuhito (Associate Professor) (Cooperation) ‘The rock composition of Saturn's satellite Enceladas is similar to meteorites!? –A unique hydrothermal environment different from earth-’

KOGURE, Toshihiro (Associate Professor) (Cooperation) ‘Clarifying the real nature of radioactive particles that fell from the Fukushima Daiichi nuclear reactor to the ground’

MUKAI, Hiroki (Project Researcher) / KOGURE, Toshihiro (Associate Professor) (cooperation)

‘Identifying minerals that strongly adsorb cesium by experiments simulating radioactive contamination in Fukushima’

SUZUKI, Yohey (Associate Professor) ‘Discovery of applicable long-term fixation mechanism for contamination purification by radioactive elements’

YOKOYAMA, Takaaki (Associate Professor) (Cooperation) ‘Solving the oldest mystery of the sun - The world's highest resolution calculation by the supercomputer “K computer” elucidates the magnetic field generating mechanism of the sun for the first time in the world-’

FY2016

MIRURA, Hiroaki (Associate Professor) (Cooperation) ‘Elucidation of the transport mechanism of soot to the Arctic’

SATO, Kaoru (Professor) (Cooperation) Elucidation of the momentum transport characteristics of mesosphere gravity waves by long-term observation of the large Antarctic Mesosphere-Stratosphere-Troposphere (MST) radar’

SEKINE, Yasuhito (Associate Professor) (Cooperation) ‘Whale pattern of Pluto was a trace of the giant-impact that made the satellite Karon’

FY2017

KOUDUKA Mariko (Project Researcher)/ SUZUKI, Yohey (Associate Professor) ‘Successful DNA decoding of 100,000-year-old organisms stored in marine sediments’

ANDO, Ryosuke (Associate Professor) (Cooperation) ‘The recurrence interval of the Genroku Kanto Earthquake is 500 years at the shortest instead of 2000 years’

MOTEKI, Nobuhiro (Assistant Professor) (Cooperation) ‘Discovery of atmospheric heating effect by anthropogenic black iron oxide particles’

QIN Haibo (program for visiting overseas researchers) / TAKAHASHI, Yoshio (Professor) and other ‘Elucidating the factors of dominating environmental behavior of tellurium which is harmful but rare metal’

IDE, Satoshi (Professor) (Cooperation) ‘Observation of repeating slow slip in the vicinity of the trench axis of the Nankai megathrust earthquake zone - Results of 365th research cruise by Chikyu IODP’

TADA, Ryuji (Professor) (Cooperation) ‘Terrestrial environmental changes of Mesozoic warm earth associated with astronomical cycles recorded on deep sea charts - Is the Mega Monsoon in the Supercontinent Pangaea Involved-?’

KUWAYAMA, Yasuhiro (Project Assistant Professor) (Cooperation) ‘Discovery of a new stable iron hydroxide under ultra-high pressure – A paper regarding to the water circulation in the deep earth is published in Nature-’

KEIKA, Kunihiro (Assistant Professor) / KASAHARA, Satoshi (Associate Professor) (Cooperation) ‘Success in identifying the moment when radio waves are born from space plasma’

SUZUKI, Yohey (Associate Professor) (Cooperation) ‘Successful elucidation of deep underground ecosystems that do not depend on energy from photosynthesis’

AMANO, Takanobu (Associate Professor)/ HOSHINO, Masahiro (Professor) (Cooperation) ‘Focusing on the elucidation of the birth process of cosmic rays / The world’s first elucidation of the three-dimensional structure of a strong astronomical shock wave by a 1 trillion particle simulation using the supercomputer “K computer”’

TAKAHASHI, Yoshio (Professor) ‘Elucidating the difference in solubility of radioactive cesium in water of rivers between Chernobyl and Fukushima areas’

TACHIBANA, Shogo (Professor) (Cooperation) ‘Discovery of ice that behaves like liquid at - 220 to -120 Celsius – A step towards elucidating the process of the birth in space of molecules building

blocks of life and planets-’

TACHIBANA, Shogo (Professor) (Cooperation) ‘Aluminum oxide formation triggers speeding up stellar wind from dying stars - The mystery of the mass-ejection star with poor silicate dust revealed by ALMA-’

TACHIBANA, Shogo (Professor) (Cooperation)

Successful nondestructive analysis of meteorites containing organic matter by continuous beam of elementary particle muons!’

GELLER, Robert (Professor emeritus) / KAWAI, Kenji (Associate professor)/ BORGEAUD, Anselme (PnD 2nd year) and other ‘The first confirmation of subduction to the core of old plate and mantle boundary’

TAJIKA, Eiichi (Professor) (Cooperation) ‘Amplification of the methane cycle by anoxygenic photosynthesis counted the faint young Sun–’

MIYAMOTO, Chihiro (PhD Student) (Cooperation) ‘Arctic nitrate aerosols remain high despite NOx emission control - Changes in the Arctic Atmosphere NO3-Flux recorded on the Greenland Ice Sheet in the past 60 years-’

KASAHARA, Satoshi (Associate Professor) (Cooperation) ‘ERG satellite clarifies the origin of the aurora flashing - Clarifying the behavior of electrons that flow with the chorus of space secretly-’

MIKOUCHI, Takashi (Associate Professor) (Cooperation) ‘An iron meteorite discovered in Nagara, Gifu City, named “Nagara Meteorite”’

FY2018

KAJITA, Hiroto (PhD student) (Cooperation) ‘Rapid cooling event that caused destruction of the world's oldest rice cultivation civilization’

KAWAI, Kenji (Associate Professor) (Cooperation) ‘Clarifying the origin of friction of clay minerals from the atomic scale - Dominated by electrostatic force between atoms, expected as a guidance for elucidating the mechanism of fault motion-’

TAKAHASHI, Yoshio (Professor) / SUGA Hiroki (Researcher) (Cooperation) ‘Discovery of a huge amount of ‘micro manganese particles’ in submarine sediment - An amount of manganese equivalent to on land reserves exists under the sea-’

MOTEKI, Nobuhiro (Assistant Professor) (Cooperation) ‘Successful observation of “supersaturation of rain clouds” controlling global aerosol concentration’

SATO, Kaoru (Professor) (Cooperation) ‘Electrons of the Van Allen belt invade down to the atmosphere at the 65 km height when an aurora explosion happens’

KOGURE, Toshihiro (Professor) / OKUMURA, Taiga (Researcher) (Cooperation) ‘Clarifying the dissolution behavior of radioactive particles scattered by the Fukushima nuclear power plant accident’

KOIKE, Makoto (Associate Professor) (Cooperation) ‘Dust from the Arctic land generates ice formation in clouds’

TAJIKA, Eiichi (Professor) (Cooperation) ‘Boring billion years was an age of hunger and lack of oxygen - Ancient Earth views obtained from geological records and theoretical models-’

VII. Current Issues and Future Plans on Education and Research

(1) Problems and Actions of the Department

1-1. Outline of the points concerning the department raised in the external review in January 2013

(1) One of the common problems concerning research in the Department of Earth and Planetary Science at the University of Tokyo is the lack of synergy. This hinders the ability to obtain large research funds and may also limit the potential for research development.

(2) In contrast to most of the research groups which are defined by research subjects, the Earth and Planetary System Science Group is defined by approaches. Research subjects of different sub-group in that group are so diverse that collaboration among members in that group seems not extensive. Rather, collaborations seem to be made mostly among the scientists in the other group whose research subjects are common. System science approach is important in most areas of Earth and planetary sciences, and it is time to re-consider the structure of groups particularly the role of Earth and Planetary System Science Group.

(3) As pointed out in the external review in 2006, there is still a problem that department expertise in chemistry-related fields lacks sufficient depth. New appointment should be considered to address this weakness.

(4) It is not appropriate for undergraduate education to continue be divided into the two programs of Earth and Planetary Physics and Earth and Planetary Environmental Science, despite the merging of the Departments of Geophysics, Geology, Mineralogy, and Geography in 2000.

(5) As well as graduate school education, education at the undergraduate level should further promote cooperation with related research institutes. In addition, consideration should be given to using the part-time lecturer system, to ask faculty members of other universities to given to help provide to a wide range of education that cannot at present be covered by the department at the University of Tokyo alone. (6) Regarding education at the graduate level, it seems that there is a lack of a system to help students achieve broader-based academic knowledge. In addition to acquiring some basic 'skills' necessary to study the subjects of a particular field, a system (curriculum) should be developed to provide a wide range of education so that students can acquire a good background understanding related to their own study as well as to broader fields of Earth and planetary science.

(7) It would be good idea to introduce a mentoring system for young faculty members. These faculty members are the future leaders of the department, and they have many concerns regarding research and education. Assigning two mentors for each assistant professor may be a suitable approach.

(8) There are only few international and female faculty member and students. The number of overseas students has dropped. This is against the trend to greater internationalization, and this aspect needs to be addressed. The lack of international students may be linked to the incomplete coverage of English websites for all the research groups and the lack of appropriate homepages for many faculty members prepared. In addition to this, it might be necessary to run undergraduate classes in English as done in the Department of Chemistry.

(9) The department has been active in sending students and researchers from overseas (e.g. attend international conferences and for short-term training). However, there are relatively few people who go abroad for research as postdocs or play active roles in overseas research institutes, and long-term overseas expansion is very limited.

(10) To keep high achieving faculty members, it is necessary to establish an appropriate promotion system and to maintain a good research environment. Moreover, with regard to human resources,

the department as a whole should have control over a certain number of positions, and the decision how to distribute these positions to the different group should be made by the entire department with due consideration to progress and changes in the field.

(11) Another problem about open human resources is the fact that about 80% of the faculty members in the department are from the University of Tokyo. This has the danger that it may lead to the stagnation of research and education. Also, from the global point of view the number of female faculty members is small from the global point of view.

(12) With regard to the important management matters such as human resources, the authority of the head of the department and term of office should be reviewed. It was good that the term of office of the head of the department has been increased to two years from one year, although we feel that the two-year term is still short. We suggest that the head of the department should have more authority and extend the term to three years. As a group that supports the activities of the head of the department, we advise to make a consultative meeting consisting of representatives from each department group, and create department discretionary expenses to assist the activities of the department.

(13) We have the impression that the department as a whole has a lack of social exchange between different fields. One way of improving this would be to have colloquiums (calling researchers from outside our department) and cross-field presentations for the entire department once a week? We understand that young researchers have begun to experiment with this approach and we feel this should be actively promoted.

(14) Financial support from the government has decreased after turning state-run universities into corporations, and this makes it difficult to manage the universities. In particular, the decrease the number of technical staff is a major obstacle to promoting experimental and observational research. Chronic shortage of full-time technical staff who are responsible for the maintenance and management of large equipment may cause difficulties for everyday education and research activities.

1-2 Department-level response to the issues raised in the external review of January 2013.

In the following, we summarize the action undertaken to accommodate the external review under the leadership of the Departmental heads, Professor OZAWA, 2012-2013, Professor MASUMOTO, 2014-2016 and Professor TAKAHASHI, 2017-2018.

2012-2013

The points and recommendations of external review were summarized and shared at the Faculty Committee in February-March 2013 and the department faculty Meeting on March 26, 2013 as fellow.

(1) Weak synergy between researchers and groups (2) In appropriateness for undergraduate education in the two programs. (3) Need for greater involvement of related research institutes at undergraduate level. (4) Lack of suitable system to promote broad-based leaning at the graduate level. (5) Lack of foreign and women faculty in the department and the decrease in numbers of foreign students. (6) Use of human resources including the departmental control over positions. (7) The authority and term tenure of the head of the department. (8) Lack of interaction between different fields in the department. (9) The decrease the number of technical staff.

At the Faculty Committee on 15th May 2013, we discussed how to address the above issues and the following policy was established. We considered that the most important issues were (i) point 6, introduction of departmental control over a certain number of positions with decision of how to distribute the positions to the five different groups made at the departmental level taking into account

progress and changes in the field and (ii) point 2, inappropriateness of dividing system of undergraduate education into the Earth and Planetary Physics Program and Earth and Planetary Environmental Science Program which runs contrary to the purpose of integrating the department. We shared the recognition that these two related issues are difficult to tackle with the former problem particularly difficult to resolve. If we try to resolve this problem with the current situation, each field is likely to insist on their own idea and there is no clear path to an easy conclusion. Other issues were focused on helping to strengthen the department as a center of education and research, and we agreed these problems formed part of the background to the two important issues mentioned above. As a result of these discussions, we decided to focus our discussions on addressing issues (6) and (2)

At the Faculty Committee on 23 October 2013, the head of the department proposed integration of the two undergraduate programs. Although several contrary opinions were expressed, the suggestion received a generally positive reception and it was emphasized that the department of Earth and Planetary Science in the University of Tokyo is one of the main organizations able to carry out large-scale research in the field of Earth and planetary sciences and that the establishment of the Department of Earth and Planetary Science and the Japan Geoscience Union represent trends of greater integration in Earth and planetary science in Japan. As a result of the discussions, it was emphasized that there are merits of having two undergraduate programs and ways of preserving these advantages after any integration need to be considered. A consensus was reached to continue discussions of what would be a suitable type of integration and what are the key problems that need to be addressed.

At the Faculty Committee on 13th November 2103, a proposal was made to establish an intermediate or integrated course in addition to existing programs or courses as a way of furthering the integration of the undergraduate programs. Many objections were raised to the plane including the lack of visibility of the proposed three courses. It was necessary to make a decision early if the process of integration is to be achieved in time for the new academic calendar, and it was agreed to collect and collate the opinions expressed, to gather information about undergraduate education at overseas universities, and to establish a clearer vision for the intermediate or integrated courses. A decision on further integration of the programs will be made in December.

At the Faculty Committee meetings of 11th and 18th December 2013 and 8th January 2014, discussions were held on developing responses to the external review and Professor Ide, the chairperson of the Education Committee, will take the lead in considering appropriate actions concerning undergraduate and graduate education. These discussions will take into account responses to the survey on the progress of graduate school reform within the framework of the central government Guidelines Regarding Promotion of the Graduate School Education Policy. To examine how to promote educational reform including issues of cooperation both between the two undergraduate programs, and between the undergraduate and graduate schools, and how to respond to changes in the curricula and structure of the new academic calendar, we established the Promotion of Education Reform Working Group. At the Faculty Committee meeting on 15th January, Professor Ide made detailed proposals on how to establish and manage the Promotion of Education Reform WG, and it was decided to carry out a questionnaire and individual interviews to gather the opinions of the faculty members prior to the launch of the WG. At the Faculty Committee on 12th February 2014, it was decided that the head of the department (head of the graduate school) will also serve as the head of one of the undergraduate programs, and the vice head of the department will serve as head of the other undergraduate program. The term of office of vice head of the department is one year.

FY2014–2016

The Promotion of Education Reform WG was held 12 times from 26th March to 26th June 2104,

with discussions about joint activities of the undergraduate programs, integrating the curricula for the two programs, and organizing activities related to the 1–2 year system run at the Komaba campus, department publicity, the selection of 3rd year students, and the first year education as the main topics. Regarding the possibility of joint activities of the undergraduate programs, our discussion focused on identifying key issues taking into account the aims and future direction of Earth and planetary science and how basic education can help promote research in these areas. Then we had the consensus of the idea that we need to set a course system if we integrated programs for desirable undergraduate education system that student to learn basic topics during limited period of time and gain the ability to pursue key issues. Various ideas were proposed for setting the course system, it was suggested that the three-course system based on the academic field related to earth science was reasonable in terms of scale and content. Regarding the contents of the three-course system, a separate discussion was placed for each course, and the curriculum plan was examined. In addition, we examined the advantages and disadvantages of both maintaining the present two-program system and merging them to forma a single program.

In parallel with these discussions, we examined the possibility of suitable reforms within the present two-program structure including organization of undergraduate thesis and practical classes, issues related to students joining the department from the Komaba course, organization of first-year seminars, and departmental publicity. An outline of the WG discussions was shared with faculty members of the five core groups and also reported in the Steering Committee that all faculty members are able to attend. In addition, we held a faculty meeting on 17th October 2014 to consider the proposed integration of programs as discussed by the WG. We also conducted a survey for faculty members and students regarding the idea of establishing a multiple course system within a single unified undergraduate program, to gather a wide spectrum of opinions.

As a result of these discussions, various opinions were given concerning whether to integrate the programs or to continue with the current two program system but there was no clear consensus. As a way forward that reflects the range of opinions expressed, we agreed to establish a cooperative system between the two programs within the current system, focusing on lectures, experiments, excises and academic events, with the view to possible the future integration. Furthermore, notwithstanding the existence of two separate programs, it was agreed that faculty members of both programs were jointly responsible for the education of both programs, and the faculty members who arrive after FY2014 are affiliated to both departments.

FY2017-2018

To review the reforms carried out up to FY2016, the Faculty Committee meeting of April-May in 2017 provided an opportunity for discussion about the issues of both undergraduate and graduate education and their links in response to the comments of the external review. We concluded that the two undergraduate programs should coexist to facilitate effective education of the basics of the respective discipline under the condition of strengthening close interaction and cooperation to promote the cultivation of a broad perspective by establishing joint lectures, experiments, and exercises. We agreed that the communication between faculty members should be improved as a key foundation to reform the department. Interaction between associate and assistant professors tends to be restricted to within their groups, which is in contrast to full professors who regularly meet at the Professor Meeting held twice a month. In order to improve this situation and to encourage more interaction outside of specific research programs, we established a ‘Departmental Integrated Seminar’ open to all faculty members, students, and staff in our department, which was held for the first time on August 9, 2017. We also encouraged young faculty members to attend the Steering Committee meeting, strengthened

the lunch seminar, and established a mentoring system for faculty members at the assistant professor level. We discussed the role of the Earth and Planetary System Science Group in the department, and although there was agreement that a significant achievements have been made in developing studies related to the interactions between multispheres of the earth and planets, we also discussed the need to promote interdisciplinary research including applications for funds to support major new research initiatives with special government funds, the coordination of the existing committee meetings to reduce the burden of administrative load, ways to increase the number of international students, and ideas for obtaining additional faculty posts from the University of Tokyo.

Other activities in FY2017 were clarification of the roles of the Steering Committee in the department, enhancement of the organization of the alumni association, a more systematic approach to short-term recruitment of international faculty members through the GSGC program, an increase in the number of fixed-term (up to a few years) faculty members for education and research from other universities and research institutes in Japan, proposal to the university headquarters for establishment of a course of ‘Field-based Observational Earth Science by merging two separate applications in the previous year, strengthening of the educational system by involvement in three international graduate programs, WINGS.

In FY2018, we continued to deepen cooperation between the two undergraduate programs, establish alumni organization, discuss ways of operating the sabbatical system, and promote assistant professor mentoring. The application to the university headquarters in the previous year was successful and we were successful in being assigned a full professor position in the field of "Field-Based Observational Earth Science" was assigned to out department without specifying the group. We expanded the role of the Departmental Integrated Seminar started in the previous year by opening it to departmental alumni, who were sent invitation letters. We agreed to establish a research and education support fund based on endowment to diversify financial resources, which are used to enhance student education. The fund is operated in cooperation with University of Tokyo Organization for Planetary Space Science (UTOPS), We promoted discussions on the increase of GSGC international graduate students, and confirmed that we can secure students in the core courses if budget is available. With regard to the "Field-Based Observational Earth Science" which led to the acquisition of a full professor post in the previous fiscal year, we worked on a proposal for "Field-Based Observational Science" to obtain a special government grant in cooperation with the Department of Biological Sciences and the Geochemical Research Center.

1-3. Specific responses of our department to the external review in January 2103

Regarding to each suggestion and identification of (1) – (14), we have been making efforts as follows.

(1) Concerning ‘the lack of synergy hinders the ability to obtain large research funds and may also limit the potential for research development’, we started a department-wide seminar entitled ‘Earth and Planetary Science Lunch Seminar’, which was developed from Seminars for Students’ held for the past few years for undergraduate students, expecting that the seminar helps to improve a link between all the members and deepen mutual understanding of a wide-range research fields in Earth and planetary science. In addition, we have started a ‘Departmental Integration Seminar’ once a year from FY2018, to which all the members of the department attend. A budget request was made based on discussions of issues of common concern to the department as a whole, which resulted in the successful acquisition of a five-year professor position in the field of "Field-based Observational Earth Science". This new departmental appointment will help develop links throughout the different groups. As a result of the promotion of joint research beyond the individual groups, funds for new academic fields of research ("Creation of Water

Planetary Science" and "Science od Slow Earthquake") were selected with faculty members in this department forming the core members of these major new research initiatives and involving researchers from other institutions across the country.

(2) Concerning the issues related to 'the significance of Earth and Planetary System Science Group', the role of the group in the entire department was reviewed at several opportunities and we have reached the following evaluation. The method of 'system science approach' is quite unique in that its thinking and methodology go beyond the classical approaches in Earth and planetary science. System science views the earth and planets as synthesis of multiple subsystems and puts a focus on the relationship between subsystems to understand the overall behavior of the entire system of earth and planets. It should never be just a collection of different scientific methods. There is a general consensus that maintaining such a research group is important for the department. But there are opinions that the role of System Science Group must be reexamined in the future under in view of the long-term departmental strategy related to the expected future reduction in faculty members. Regarding the comments of 'weak cooperation between two subgroups: earth's surface environment and planetary science, we have made efforts to promote mutual understanding and collaboration by holding a regular meeting among the group faculties, monthly seminars for all the group members, interim presentations of master's theses and doctoral dissertations, field excursions and seminar training camps, and meeting at the end of the year for reporting research and educational activities of each member of the group. The latter two are held once a year since FY2016. These attempts are effective and essential for comprehension of the concept of system science and for sharing the research subjects between the two subgroups. We hired associate Professor Yasuhito Sekine (currently professor at Tokyo Institute of Technology) in 2014, and Professor Eiichi Tajika in 2016. They are engaged in research and education across the two subgroups to promote intimate cooperation between the two subgroups. Professor Shogo Tachibana, who was appointed as a professor of the University of Tokyo Organization for Planetary Space Science (UTOPS) since 2017, has been working between groups of Earth and Planetary System Science and Space and Planetary Science promoting cooperation with other groups in the department.

(3) Regarding the comment of 'the weakness of chemistry-related approaches and research fields', professor Yoshio Takahashi, who has strong background in chemistry, has been appointed from Hiroshima University to the Geosphere and Biosphere Science Group in FY2014. He has been conducting many joint research programs with faculty members using geochemical methods. The results of the cooperative research have already been presented in papers not only with members in the Geosphere and Biosphere Science Group (six papers), but also members of the Atmospheric and Oceanic Science group (3 papers), the Earth and Planetary Systems Science Group (4), and the Solid Earth Science group (2). Associate Professor Itai, who specializes in environmental geochemistry and biogeochemistry, was appointed in FY2017. In addition, Tsuyoshi Iizuka studying Earth and planetary solid material with geochemical methods in the Solid Earth Science Group was promoted to Associate Professor in FY2017 from lecturer through public recruitment. In FY2012, ICP-MS analytical equipment was introduced as basic analytical equipment for the department by obtaining grant in aid for establishing a center for outstanding graduate studies. Moreover, we cooperate with Professor Hirata, who was appointed from Kyoto University to the Geochemical Research Center in FY2016. The cooperation strengthens geochemical science research and strengthens our ability to make proposals for special grant applications to purchase geochemical analytical equipment in collaborate with other organizations in the University of Tokyo.

(4) Regarding 'undergraduate education based on the Earth and Planetary Physics Program and Earth and Planetary Environmental Science Program, which is contrary to the purpose of integrating the graduate schools as a unified department of Earth and Planetary Science', we started

discussion soon after the previous external review. We established “Promotion of Education Reform WG” in FY2014 to consider the new academic curriculum and calendar, the cooperation between the two program, and the cooperation between undergraduate and graduate schools. As a result of the discussions over a year, we have reached a consensus that it is essential to systematically acquire the basic academic ability of Earth and planetary science in undergraduate education and that it is difficult to learn the basics of a wide range of fields and approaches in Earth and planetary science in a single curriculum. Therefore, we decided to keep the current two undergraduate programs to enable each student to learn systematically the basics of an individual discipline. The establishment of the strong basic education in undergraduate schools would allow for each student to develop an understanding of a wider range of research fields in the graduate school. We believe that this is not inconsistent with the philosophy of the unified graduate school of Earth and planetary science and that it would lead to strengthening our department.

We are deepening cooperation through various ways to lower the barrier between the two undergraduate programs as follows. First, faculty members who have arrived after FY2016 are affiliated to both the programs of Earth and Planetary Physics and Earth and Planetary Environmental Science; this has become a foundation for the cooperation between the two programs. Second, students are encouraged to take lectures, excises and field excursions of the other program and many students do so. For example, students from the Earth and Planetary Physics Program join a field excursion of the Earth and Planetary Environmental Science Program. In the 4th year of undergraduate, it is possible that a student can select advisors from various choices for “Senior Project/Research in Earth and Planetary Physics” (Graduation Research of the Earth and Planetary Physics Program) and “Research in Earth and Planetary Environmental Science” (Graduation Research of the Earth and Planetary Environmental Science Program). These researches are carried out in coordination by both programs, including the arrangement of the schedule for the final research presentations. In addition, in order to promote communications between faculty members and students of both programs, various guidance presentations and graduation ceremonies are now held jointly.

From FY2016 The University of Tokyo began a new entrance examination for specially selected candidates. The Faculty of Science, in general, accepts applicants separately for each program. However, application to the Earth and Planetary Physics Program and the Earth and Planetary Environment Program are treated jointly. We are able to select high achieving students, who have a strong interest in the subject of study, though there are many viewpoints and methods in the Earth and planetary science. We believe that our educational programs that focus on developing a firm grounding in the fundamental disciplines that form the basis of Earth and planetary science while at the same time cultivating a wide perspective to grasp an overview of the Earth are planets rare in the world and make a lasting contribution to the ability of our graduates to see how their work links with other fields.

(5) Regarding the comment of ‘education at the undergraduate level should be organized to have further cooperation with the related research institutes to provide a wide range of education that cannot be covered by the faculty member’, we already have faculty members of the Earthquake Research Institute making significant contributions to the curriculum of laboratory experiment of the Earth and Planetary Physics Program. Faculty members from the cooperative research institutes are requested to participate in teaching the core courses for undergraduate and graduate students, if the courses cannot be maintained when faculty members are retired we have requested researchers from other universities and research institutes in Japan to give undergraduate and graduate lectures. Interdisciplinary science agreements with JAXA and the Institute of Materials Structure Science, which was recently established, help to expand fields of education for undergraduate and graduate students. The number of lecturers who are able to join the education of our department temporarily has been raised from 3 professors and 1 associate professor to 3

professors and 2 associate professors. This will help expand the subject and topics in teaching for both undergraduate and graduate students. We requested a former associate professor of our department, Dr. Tsuihiji, who has a strong background in dinosaur study but was promoted in the National Science Museum, to participate in education for the relevant fields. This is a further example of our use of a variety of pathways to expand our use of the available educational resources.

(6) Regarding 'education at the graduate level lacking the system for student to be able to learn academic knowledge broadly', we examined the cooperation between undergraduate and graduate school education with Promotion of Education Reform WG, and reviewed the lectures common for undergraduate and graduate schools when the academic calendar of the university was renewed. We continue to make efforts to cultivate a broad perspective of students through the enhancement of the "Earth and Planetary Science Lunch Seminar" and the launching of the 'Departmental Integration Seminar'. Moreover, two of the GSGC overseas faculty members who are invited every year for about three months since FY2017, are asked to give intensive lectures for the entire department, so that students can expand their studies and gain an international perspective. We also aim to promote field work that students of the whole department can participate in.

(7) Regarding the comment of 'It would be good idea to have the mentoring system of young faculty member', Professor Geller has been chair since 2014 and the "Assistant professor Career Development Committee" has been set up. Professor Hibiya has been in charge since FY2018, and promoting mentoring activities such as providing advice on research activities and career advancement of assistant professors. We provide advice on assistant professors hired after FY2011, and the evaluation after five years is written as a condition for the recruitment of assistant professors hired from FY2014. So far five people were evaluated by the review committee, which was created for the evaluation. There have been two cases in which assistant professors in this department have been promoted to associate professor positions in other institutes. There have been cases where a lecturer was hired on the condition of evaluation after five years. So far, we have promoted two such lecturers to associate professors by public recruitment.

(8) Regarding the comment 'The numbers of female faculty members and students are small on an international level and the number of oversea students has been dropping, which is against the trend to greater internationalization', we understand the importance of this issue and we have been continuing to improve the situation. Professor Wallis was appointed in 2017 after the retirement of Professor Geller in 2016. Professor Kanako Seki was appointed as the female professor in 2015. In FY2017, Assistant Professor Tomoko Shimizu moved to Kyoto University, and Professor Hiroko Nagahara has retired. In FY2019, we made a recruitment and announcement for a female associate professor of Earth and Planetary System Science Group, and are preparing to appoint one. The ratio of female undergraduate and graduate students to enter the university during the external review period is about 15% for undergraduate students, 22% for graduate students, and 17% for doctoral students. The percentage of international student is only about 3% of graduate students and 8% of doctoral course students. Even so, there are overseas students who join the UTRIP (University of Tokyo Research Internship Program) conducted by the Graduate School of Science in the seven years from 2012 to 2018. We accepted 33 oversea undergraduate students (including those joined in the research institute) as interns. Since FY2017, two international researchers have been invited as GSGC (Global Science Course) international faculty members for about three months, and we advised them to interact with many faculty members and students. We have also participated in the recruitment of students by the Global Science Graduate Course (GSGC) of the Graduate School of Science which started in 2016, and are ready to accept a few oversea students. Regarding the reason of remaining a small

number of international students as was pointed out in the previous review, that English websites for all research group and homepage of faculty members were not prepared and we have been making efforts to improve the situation, An English version of the page in the department website introducing faculty members was made, and more English homepages of individual faculty members have also been added. Regarding to the recommendation for conducting classes in English as done in graduate school lectures of the Department of Chemistry, we have established a rule that lectures for graduate students must be made in English if there is one international student. This is not necessarily the case for undergraduate lectures, but we make special efforts for international students, such as preparing presentation and handouts in English.

(9) Regarding the remark of the limited number of people who go abroad for a research as postdocs playing an active role in overseas research institutes, we have been making efforts to get funds from the University of Tokyo for sending young faculty members abroad, though the cases are actually not so many. For example, Assistant Professor Takahashi went to the United Kingdom for one year funded by the "International Development Project of Young Researchers" of the University of Tokyo. Associate Professor Ando is visiting New Zealand for six months in this fiscal year supported by the same fund. We continue to apply for funds to send young faculty members overseas. There are also some cases that students become overseas postdoctoral researchers soon after receiving a PhD. Our department highly values overseas post-doc experience, and the two new appointments of Assistant Professors Nagaya and Cho have arrived from overseas postdoctoral positions, which, we hope, will be a message to young researchers.

(10) Regarding the comment of ‘The number of faculty positions for each group should not be fixed. The number of faculty positions for each group must be flexible, and the distribution of faculty members among different groups should be discussed by all faculty members’, we have made various efforts to break the barrier between groups in the recruitment of faculty members. We have been trying to increase the number of faculty by submitting proposals to the University of Tokyo for the interdisciplinary fields in Earth and planetary science. Professor Tachibana was hired in this way in FY2017 as a professor of UTOPS, which is new organization joined by many institutions not only of the University of Tokyo but also outside of the university. He is affiliated to both the Space and Planetary Science Group and Earth and Planetary System Science Group. Professor Goto was hired also in this way In FY2018 as a professor in the field of "Field-based Observational Earth Science," which is related to all the field of Earth and planetary science. In the application to the university headquarters, we emphasized the importance of on-site observational study of various phenomena of the earth and planets, which will foster human resources who can solve the problems of the global environment and pave the way for the future of human society.

(11) Regarding the identification of ‘about 80% of the faculty members are the graduates of University of Tokyo, which could stagnate the research activities’, we have carried out appointments that maintain the quality of human resources with due consideration to increasing the diversity of department. As a result, there are 21 members who graduated from the University of Tokyo all through undergraduate and graduate schools, 12 members from the University of Tokyo enrolled in part of undergraduate or graduate school, and 16 members who have never been enrolled at the University of Tokyo. The faculty members who have never been enrolled at the University of Tokyo is 32 %, and those who were enrolled in other universities for at least part of their undergraduate or graduate education is 56 %. There has been a significant improvement in the diversity of the academic backgrounds of the faculty members, which was once biased to the University of Tokyo.

(12) Regarding the comment of ‘In order to secure the leadership of a chair, the role of the chair and his/her term should be re-considered. It was good that the term of office of the head of the department has been two years from one year, although we consider that two-year term is still

short. Also, it is important to allocate discretionary funds for a chair to help his/her activities', we have kept the two-year term of the head of the department, which began in the last external review year. We now have the vice head of the department to help the chair and the two chairs serve concurrently and respectively as heads of the two undergraduate departments. In order to secure the leadership of the head of the department, we assigned a discretionary fund from the department budget. The fund has been used for student support, promotion and planning of departmental seminars, and support for the administrative office. We have set a room for the head of the department near the administrative office since FY2017 to strengthen links between the head of the department and the office. This has resulted in a clear improvement in the efficiency of operations, and the room is in effective use for the management of the department.

(13) Regarding the remark of 'Mutual interaction among various sub-groups is not active. We suggest that a weekly seminar series where hot issues on various branches of Earth and planetary science are discussed,' we have upgraded 'the student seminar' focused on undergraduate students to 'the Earth and Planetary Science Lunch Seminar' for all the members of the department. Since then, it has been held 10 times every year. 'The Departmental Integrated Seminar' is also held once a year to promote interaction. Dates and contents of seminars and interim report of master and doctoral students of each group are announced to all the members of the department through e-mails The dissertation presentations for doctoral students are also announced to all members of the department in the home page. These promote scientific and educational exchanges across the different groups.

(14) Regarding the remark of 'The reduction of support for technical personnel is serious in research areas where the operation and/or maintenance of large-scale equipment is critical, and efforts are needed to improve the situation through internal and/or external funding,' we have considerable difficulty in recruiting any new technical staff. This is a serious issue common to the other universities in Japan. We have five technical staff, who now belong to the Technical Division of the Graduate School of Science continue and are assigned to our department. They work with us and support laboratory experiments and departmental instrumental analysis. A faculty member is assigned to liaise with each technician and work together toward to their promotion. As a result, most of the technical staff has been promoted. One of the technical staff members in the department served as the head of the Technical Division of the Graduate School of Science. He is also active in the Division for Technical Staff Network of the University of Tokyo, which is the organization of technical staff in the entire university.

(2) Current Issues and Measures on Each Group

<Atmospheric and Oceanic Science Group>

Comments from the previous external review are listed as below.

(1) All four sub-groups in this group are world leaders in this area. However, currently there are only eight faculty members that may not be enough. In this sense, it is critical to identify appropriate faculty members for the open positions and the reorganization of this group might be considered.

(2) In any case, since there are not enough researchers in this group, it is recommended that faculty of this group conduct more collaborations with other scientists in this department as well as scientists in other institutions.

Our responses are as follows.

(1) Dealing with a small number of researchers

For vacant positions of a professor in the field of Climate Dynamics and an assistant professor in the field of the Atmospheric Physics in FY2012, we processed the personnel selection from the

viewpoint of whether he/she can create new research fields with the existing members of the Atmospheric and Oceanic Science, not only from the viewpoint of whether he/she can lead the research in his/her own specialized field.

(2) Cooperation between related institutions inside and outside the university

We have tried to keep our research levels and secure the quantitative research results by promoting and strengthening joint research with both inside and outside the department as shown below;

- In cooperation with a cross-campus organization, the UTokyo Ocean Alliance, we promoted the mega-tsunami project and obtained important research results from the viewpoint of social contribution.
- We obtained important new knowledge about deep-ocean turbulent mixing by promoting a research project with a large KAKENHI (Grant-in-Aid for Scientific Research on Innovation Areas) in collaboration with faculty members of the Atmosphere and Ocean Research Institute in the University of Tokyo.
- Together with researchers in the Japan Agency for Marine-Earth Science and Technology where several faculty members in our group work as invited senior researchers, we promoted a large research project based on numerical simulations and oceanographic field observations.
- Through the promotion of joint research with the National Institute of Polar Research in Antarctic observation, we contributed to the development of interdisciplinary research in the fields of informatics and super-high-rise atmospheric physics, and international collaborative observational research using the Global Radar Network.

<Space and Planetary Science Group>

Comments from the previous external review are listed as below.

(1) In theoretical simulation research, the "plasma" group has global achievements in the elucidation of particle acceleration mechanisms in the magnetosphere and analysis of solar surface magnetic fields. We have also achieved results in the nurturing of graduate students.

(2) The atmospheric group has not obtained some of the expected data from the Venus Exploration Program became the space probe Akatsuki aimed at optical exploration of Venus failed to enter the Venus orbit, but it hopes that it will re-enter the Venus orbit in the future.

(3) Although the "solid" group has achieved certain results in research on the earliest material evolution of the solar system using meteorites, it is clear that the Stardust and Hayabusa projects are taking the lead in the field.

Actions and measures taken by the group

(1) Although there was no specific indication for the "plasma" group, since the last external review, research in the fields of magnetosphere physics (data analysis) and astrophysics (theoretical simulation) has been strengthened by the appointment of two assistant professors from other universities. We are promoting education and research in the interdisciplinary field of Cosmo plasma from earth to space.

(2) In the "Atmosphere" group, there are no faculty members who are directly involved in the plan to explore Venus because the faculty members who were promoting the Venus Exploration Program (Akatsuki) have retired. A professor who is leading the Venus Exploration Program was appointed to a collaborative program, the Graduate School of Frontier Sciences from JAXA and worked to strengthen graduate school education as before by cooperation with core programs and

collaborative programs. In addition, a female professor has been appointed as a replacement for the above-mentioned retired faculty member and participates in NASA's MAVEN exploration plan to advance the study of the evolution of the Martian atmosphere. We are also developing educational research on planetary atmospheres that interact with the solar wind.

(3) The “Solid Planet” group had a major turnover in personnel because of retirement of members etc. Two professors, two associate professors, and one assistant professor were appointed from other graduate schools, other universities and other institutions. Those professors are working together to develop the world's first C-type asteroid sample return mission, as the science principal investigator (PI) of optical multi-band cameras onboard JAXA’s Hayabusa 2 and as the science principal investigator (PI) of its sampler system and analysis of asteroid samples. The two associate professors and the one assistant professor are also main members of the camera team. In addition, in order to advance planetary exploration over the world, the group began developing science instrument, such as mass spectrometry in cooperation with the “plasma” group. Furthermore, we established the UTokyo Organization for Planetary and Space Science (UTOPS)* for promoting collaboration between planetary science and aerospace engineering with emphasis on planetary exploration using ultra-small satellites. We are expanding our academic fields through studying planetary habitability and, exoplanets. *: A university-wide organization called “Collaborative Research Organization for Space Science and Technology (CROiSSanT)” has been established on October, 2019.

<Earth and Planetary System Science Group>

Comments from the previous external review are listed as below.

(1) One limitation that we recognize is the fact that the collaboration among faculty members in this group has not been extensive.

(2) It is unclear to the review committee how this group has established their group as a leader to promote system science style of studies in collaboration with faculty members in other groups. In order to make the presence of this group as a unique resource in the department, department-wide discussions are essential to help grow this potentially important group.

Actions and measures taken by the group

(1) In order to increase the number of overlapping research topics between professors, the group has appointed Associate Professor Yasuhito Sekine (currently a professor at the Tokyo Institute of Technology) since 2014, and Professor Eiichi Tajika since 2016. Associate Professor Sekine studied the evolution of the earth and other planetary surface system using hybrid approaches such as field research, laboratory experiments and chemical analysis, and contributed greatly to the collaboration, research and education of both planetary science and surface environment subgroups. Professor Tajika is a leading researcher on modeling the Earth and other planetary surface systems. In cooperation with Professor Tada, he has led a strong research and education group that combined field research and modeling on the variation of the Earth's surface systems. Professor Tajika is also conducting research on environmental systems of habitable planets in the exoplanetary system, and plays a main role in the “system science approach” of our group, promoting research and education in collaboration between subgroups. Furthermore, in order to promote mutual understanding among the group faculty members and to enhance the group activity, we have started to go to filed excursion and seminar camp in summer, in which all members of the group participated. Also a one-day discussion meeting has been held at the end of the fiscal year where all the group faculty members introduce their research and education

activities of the year, discuss the results, and exchange ideas. In addition, from this fiscal year, we have received the budget from the Center for Ocean Literacy and Education, Graduate School of Education, The University of Tokyo and launched the "Formation of aqua planets and coevolution of life end - environment" project and we are making efforts to further promote collaboration among faculty members and students in the group. We believe that such opportunities greatly enhance mutual understanding of research and ongoing projects in the group, and discussion of potential collaborations.

(2) Although discussion at the departmental level is not always sufficient, it has led to the annual department seminar being established is one of the outcomes, where all the department members discuss their researches. In addition, Associate Professor Sekine from the Earth and Planetary Systems Science Group obtained Grant-in-Aid for Scientific Research on Innovative Areas “Aqua Planetology” in which faculty members of different groups participated. It can be the embodiment of one of the roles expected in the System Science Group. Furthermore, Professor Shogo Tachibana of UTOPS (joined the group as an assistant professor until 2011) also served both the Earth and Planetary System Science Group and the Space and Planetary Science Group. It is a new attempt in the department to promote space and planetary science from the view point of system science. Through these achievements, we plan to promote mutual understanding and joint research in the future.

<Solid Earth Science Group>

Comments from the previous external review are listed as below.

(1) It is necessary to develop a leadership that can formulate future research directions not only for solid earth science but for Earth and planetary science in general.

(2) There should be a clear pathway to developing closer links with researchers in diverse fields with the aim of proposing and testing new hypotheses in earth science and through linking of different disciplines developing a new view of the earth.

(3) It is necessary to have a close working relationship with the Earthquake Research Institute and its many affiliated researchers in both education and research

Actions and measures taken by the group

(1) We had a big change of the members of the solid group in the past seven years. We have strengthened our leadership by appointing Professor Hirose who served as the director of the Institute of International Research at Tokyo Institute of Technology, Professor Wallis who played a main role in international expansion at Nagoya University, and young associate professors and assistant professors who have developed researches across different fields.

(2) The new academic field "Science of Slow Earthquake" involving Professor Ide, Professor Wallis, Associate Professor Ando, and Associate Professor Tanaka is a project aimed at reconstructing earthquake science and tectonics through collaboration between researchers from different fields. In addition, Professor Hirose's special promotion research "Behavior of high pressure liquids and early earth evolution" and the new academic field research "Core mantle interaction and coevolution nuclear-mantle" involving Associate Professor Kawai have also created new developments in earth’s interior dynamics and earth evolution. Those activities are definitely movements that lead to a new perspective of the earth that we are proceeding with. At the monthly faculty meetings, we are discussing the future perspectives of solid earth science.

(3) The solid group has been working closely with the Earthquake Research Institute, and we have further strengthened the cooperation in recent years. Students from the Earthquake Research

Institute are able to attend in the mid-term presentations of master's and doctoral students at the Solid Earth Forum, where all faculty members and students of Solid Earth Science Group attend. Students are also educated at multiple seminars including those run by the faculty members of the Earthquake Research Institute. Appointment of associate professor Tanaka from the Earthquake Research Institute has also helped to strengthen cooperation.

<Geosphere and Biosphere Science Group>

Comments from the previous external review are listed as below.

(1) It will be necessary to set a common goal for the whole group and to research on several themes toward the purpose. For example, there are themes such as biomineralization, origin of life, and early life evolution.

(2) It will be necessary to use some of the human resources we planned for an opportunity to form new fields. In particular, it is the key to take researchers related to biogeochemistry, which can be a common language in the field.

(3) It is also important from the viewpoint of making a community to aim for active cooperation with related fields necessary for field formation. Without being closed within the University of Tokyo, we will consider positive social exchanges with universities or research institutions leading the field in inside and outside the country.

Actions and measures taken by the group

(1) Regarding mineralization, Professors Endo and Kogure of this group, together with Associate Professor Takenori Sasaki of the University Museum, The University of Tokyo, who is a cooperative faculty member of our group have been conducting integrated activities at the Biomineralization Study Group of the University of Tokyo. In addition to holding irregular seminars on campus, this study group organizes a nationwide "Biominerization Workshop" every year, attracting more than 100 participants each time, and functions as an "academic society" in effect. In 2017, the members of the study group led the 14th International Biomineralization Symposium (Biomin14) in Tsukuba, and had an active discussion in the place. The results were published as a collection of open access papers.

Associate Professor Suzuki and Assistant Professor Sunamura have been leading the study of the origin of life and the evolution of early life from the viewpoint of microbial earth science. Especially, together with discovering small prokaryotes of cell and genome size are dominant in the deep underground of granite whose existence is known from geological records at the time of the birth of life, in collaboration with a group of Professor Banfield at the University of California, Berkeley, we constructed a genome-based universal phylogenetic tree, and showed the possibility that prokaryotes in the deep underground could leave a strong original feature. On the other hand, we consider that the seafloor hydrothermal area of the deep sea plays an important role in the origin of life and the early life evolution, and we have conducted joint research on the deep sea hydrothermal area through JAMSTEC and new academic field research. In 2015 Springer published a collection of open access papers about the result we achieved.

(2) Recognizing the importance of the field of biogeochemistry as the core of the formation of new fields, we welcomed Professor Takahashi in 2014 and Professor Kano as new members in 2016. In 2017, Associate Professor Itai was appointed for the further development of "Environmental Geochemistry," which includes biogeochemistry mainly led by Professor Takahashi. In this field, we are working on solving current material cycles, including biological and human activities on the earth surface, and the past and future problems of earth using new geochemical probes such

as trace element concentrations and isotope ratios. Particularly, environmental geochemistry and biogeochemistry rooted in understanding the variation of elemental concentrations and isotope ratios based on geochemical analysis at the atomic and molecular level are a field that will lead geochemistry in terms of applying a ubiquitous principle to various systems. There are many keynote lectures and invited lectures at international meetings, and we are opening up new fields around the world. Professor Kano has also applied stable isotopes to ancient geological records to address the unsolved issues of global environment and biological evolution. Moreover, Professor Goto who is paired with Professor Kano joined the post in 2019 as a seed for the formation of new fields separate from geochemistry. We are developing a completely new interdisciplinary research of "field-based observational earth science and field-based observational science" that directly faces complex phenomena such as climate change and natural disasters.

(3) Regarding the above mentioned biomineralization, in collaboration with the group of Okinawa Institute of Science and Technology Graduate School, Professor Endo of this group who leads the field of marine genomics conducted research of genomic decoding of akoyagai (mollusks) and shamisengai (brachiopoda animals) which are the important model for biominerization research in 2012 and 2015. In this joint research, not only the science fields such as geology, mineralogy, zoology, and bioinformatics, but also researchers from various fields including agricultural fields such as agrochemistry and fisheries from inside and outside the country participated the research and formed a new community of researchers.

Furthermore, from 2018, Associate Professor Suzuki and Assistant Professor Sunamura joined in the Collaborative Research Institute for Innovative Microbiology (CRIIM), which was established mainly by the Graduate School of Agriculture and Life Sciences of the University of Tokyo and member of 10 faculties and private companies participate.

We are conducting research of bioinformatics and technical exchange. We are conducting research on microenvironment measurement, culture technology, bioinformatics related to microbiological research and promoting technology exchange.

(3) Future Plan and Development in Research and Education of Each Core Group

Based on the achievement so far, the Department of Earth and Planetary Science aims to further improvement of our researches and education together maintaining the system of five groups. Each of the five groups has established its own objective, assignment to be resolved and future plan as below.

<Atmospheric and Oceanic Science Group>

The primary goal of the AOS group is to attain achievements at a high international level in each subgroup's research as well as cooperative research not only between the AOS subgroups but also with the Affiliated Institutions (the Atmospheric and Ocean Research Institute, the Research Center for Advanced Science and Technology), national institutions (the Japan Agency for Marine-Earth Science and Technology, the National Institute of Polar Research, the National Institute for Environmental Studies, the Meteorological Research Institute, RIKEN, etc.), and foreign institutions (University of Hawaii, University of Washington, Princeton University, National Oceanic and Atmospheric Administration, Alfred Wegener Institute, etc.). Through these research efforts, the AOS group aims to enhance knowledge on predictability of oceanic and atmospheric phenomena of great societal concern and provide leading figures in various fields of oceanic and atmospheric sciences.

• **Atmospheric Physics:** With the aid of the development of super-computer and observational

techniques, gravity waves, clouds, and turbulence which have been treated as subgrid-scale phenomena in most climate models are becoming explicitly resolved phenomena. Moreover, climate data since International Geophysical Years (1957-58) having sufficient quality to be analyzed by modern schemes are being accumulated. By combination of high-resolution numerical models (such as NICAM and KANTO), high-resolution observations, and large amount of data, and development of new theories which are needed for understanding these small-scale phenomena, advanced research and education will be made, in particular, regarding wave dynamics in terms of generation, propagation and dissipation, three-dimensional structure and variation of global material circulation induced by wave-mean flow interaction, and organization mechanisms of cloud systems.

• **Physical Oceanography:** Although we have succeeded in re-formulating the fine scale parameterizations of turbulent dissipation rates in the surface mixed layer, in the interior ocean, and over rough seafloor topography, respectively, their validations are still limited. We therefore plan to deploy a free-fall microstructure profiler that can profile turbulent dissipation rates from the sea surface down to the seabed at ~5000 m. Once validated, these parameterizations, incorporated with fine-scale parameters for each domain in the global oceans, would supplement the global distribution of diapycnal diffusivities needed to improve the model's capability and skill to predict future climate changes.

• **Climate Dynamics:** In addition to the research and education being conducted on air-sea interaction processes that are essential in climate variation phenomena, this group plans to enhance understanding of interactions among various climate variation phenomena, relation with various ocean and atmosphere processes, interactions among phenomena with different spatio-temporal scales, based on high-resolution model simulation, big data analysis, and in situ observations. Also, due to the recent climate change associated with the global warming, frequency and amplitude of climate modes may have been changing. This group will examine future projections of those climate modes, clarify relations between global warming and climate variations, and provide scientific knowledge that is necessary to achievement of the Sustainable Development Goals (SDGs) by evaluating the above impacts on marine and terrestrial ecosystems.

• **Ocean-Atmosphere Material Circulation Physics:** In order to create a new atmospheric science field by integrating atmospheric chemistry and physics, elementary processes (dynamic, physical, and chemical processes) will be studied through observations and integration of the system will be realized by developing numerical models that describe the elementary processes. Variability and circulations of oceanic substances will be also investigated by actively interacting with physical oceanography and other groups.

<Space and Planetary Science Group>

Plasma Astrophysics: By focusing on universal plasma processes that happen not only in the near-Earth space but also in the universe beyond Heliosphere, we will conduct research and education on plasma dynamics and its associated particle acceleration and plasma heating. Our specific theoretical and observational research targets are as follows: (1) the interplay between the global dynamics of the Earth's magnetosphere and magnetic reconnection initiated as a local process, (2) the plasma transport from solar wind into the magnetosphere, and plasma escape from ionosphere, (3) magnetic energy dissipation and plasma heating mechanism of magnetic reconnection in the Earth's magnetosphere and the pulsar magnetosphere, (4) several unresolved problems on non-thermal, high energy particle acceleration observed in the Earth's bow shock and the supernova shocks (e.g., magnetic field amplification, shock injection problem for Fermi acceleration, cosmic ray acceleration in partially ionized plasmas, escape of cosmic rays, large-amplitude precursor waves in relativistic shock waves).

(5) an angular momentum transport in accretion disks around black holes, and relativistic jets from black holes and neutron stars, (6) the interplay between cosmic ray acceleration and generation of magnetic field in the early universe, (7) nonlinear waves in relativistic plasmas, and (8) the development of novel algorithms of plasma simulations.

• **Solar-Planetary System Science:** In order to understand the energy source of the solar-planetary system, the solar dynamo and the surface magneto-convection are our new subjects. The goal of this study is to understand the generation of magnetic flux in the interior, its appearance on the surface and the formation of sunspots leading to the solar activities such as flares and CMEs. For understanding of dynamic phenomena in the solar-terrestrial system, we have been tackled with demonstrative approaches by combination of numerical modeling with ground-based and satellite observations. We will lead research activities of the theory/modeling/integrated studies team of the ERG project so as to understand fundamental phenomena to understand geospace environment such as the acceleration and loss mechanisms of the radiation belt particles and plasma escape processes from Earth. Comparative planetary studies to understand space environment around Mars and Mercury, effects of solar activity on the planetary surface environment are also important targets of our researches. We would also like to expand our study by applying our knowledge in the solar-system planets to exoplanets. Furthermore, we push development of scientific instruments for future planetary exploration missions, based on the heritage of our missions such as ERG.

• **Planetary Material Science:** We aim at revealing the origin and evolution of Solar System through the analysis of extraterrestrial materials, including the sample from asteroid Ryugu that will be returned by Hayabusa2 at the end of 2020. We especially focus on (1) The Solar System forming environment: The chemical state of the Sun's parent molecular cloud and the formation/evolution of dust in the Galaxy prior to the delivery to the Solar System, (2) The Sun's protoplanetary disk: Material evolution in the disk, the physicochemical condition of the disk, the chemical diversity of terrestrial planets, (3) Small bodies: Chemical process(es) within planetesimals and its consequence for minerals, water, and organics, and (4) Comparison with material evolution in other planetary systems: Material evolution around evolved starts, inside molecular clouds, and in protoplanetary disks (observation by ALMA and the University of Tokyo Atacama Observatory).

• **Comparative Planetology:** The central topic is analyses of the data on the small asteroid Ryugu obtained by Hayabusa-2 spacecraft. Data analyses on the asteroid Bennu from NASA's OSIRIS-REx mission and the Mars' moon Phobos from JAXA's MMX mission will also be conducted in parallel. Comparison of these data will provide important views on the formation and evolution of asteroids. Furthermore, based on a variety of in-situ observation data and comparison of such data among individual planet/moon/asteroid/comet, we will aim at systematic understanding of solar system bodies.

• **Space and Planetary Exploration:** We play a leading role in solar-system explorations by ultra-small spacecraft in collaboration with JAXA as well as the departments of engineering and frontier sciences of the University of Tokyo. We also get involved in JAXA's small and medium class missions through providing scientific payloads. For 2020s (and later), several missions are proceeding or under consideration, such as a comet flyby mission, moon landing missions, and a Mars orbiting mission. Toward these explorations, we develop payloads such as mass spectrometers and laser-based spectrometers for composition measurements of surface and neutral/ionized atmospheres. In addition to these in-situ observations, return sample analyses will also be an essential tool for the study on the origin and evolution of the solar system in 2020s and beyond.

<Earth and Planetary System Science Group>

The purpose of the Earth and Planetary System Science (EPSS) Group, when it was founded in 2000, was "to establish a new scientific field which stresses the viewpoint of studying the planet Earth as well as other planets as a single system composed of intimately coupled multiple domains. We will treat individual phenomenon on and within the earth and other planets from this point of view to understand stability, variability, and evolutionary trends of the planetary system and their surface environment." This aim has been still important, but development of the new science fields of exoplanetology and astrobiology widens the coverage and scope of EPSS. The target of the EPSS should include not only the Earth and other planets in our solar system, but also exoplanets and exoplanetary systems, and extending further to star forming regions, and in the Galaxy. We should reorganize these subjects from the viewpoints of the system science, and investigate to understand the formation, interactions, feedback mechanisms, stability and variability, evolution, and dynamics of these systems. Current issues of the EPSS group are summarized below.

- Construction of evolution model of precursor materials of planets and life in protoplanetary disks.
- Understanding the birth environment of the Solar System through astronomical observation, analysis of extraterrestrial materials, and laboratory experiments
- Development of observational methods for evaluating the diversity of surface environments of exoplanets
- Understanding atmospheric chemistry in exoplanets from ground-based observations
- Understanding diversity and universality of exoplanets from analysis of satellite data
- Understanding the diversity of planetary composition and internal structure by both theoretical and observational approaches
- Extending theories of planetary evolution for understanding the diversity of climates of terrestrial planets
- Understanding the common and unique properties of the Earth among various planets in and beyond the solar system
- Understanding the co-evolution of the Earth's surface environment and ecosystem
- Understanding the catastrophic global changes and their mechanisms during the Earth history
- Understanding the influences of the catastrophic global changes in the ecosystem, and recovery from the changes
- Response of coral reef to the global changes as a model ecosystem and its restoration.
- Mitigation and adaptation of Ocean Acidification based on innovative monitoring technology
- Observation and modeling ecosystem resilience against environmental stresses.
- Evaluation of the properties and radiative effects of aerosols and clouds based on aircraft and surface observations using advanced measurement technologies

The EPSS group is and will be an unique and international leading team of individual field of (1) material formation and evolution in the Galaxy, formation and evolution of planets and planetary systems, diversity of exoplanets and exoplanetary systems, (2) theoretical constraints on habitability and habitable planets, their evolution and diversity, characterization of the atmosphere and surface environment of exoplanets, (3) the evolution and history of the Earth system, interactions and feedback mechanisms among atmosphere, ocean, biosphere, continents, and interiors, behaviors of the Earth system at the catastrophic events, and (4) dynamics of the Earth's surface environment and response of ecological system.

For the research and education in the subject of global change in the Earth system today and in the last glacial period, we closely cooperate with the Earth and Planetary System Science Group at the Atmosphere Ocean Research Institute, and also at the Research Center for Advanced Science and Technology of the University of Tokyo. Education of the Earth and planetary system science and

development of graduate students is the crucial issue for us. Graduate students in the EPSS group are expected to learn abilities to understand behaviors of the system as a whole, and to analyze detailed relationship among subsystems at the same time. Such abilities are important for being a researcher and also for working in society. In order for that, we provide opportunities such as the entire EPSS group seminar and two subgroup seminars, in addition to the individual seminars, for graduate students to interact with each other. We also encourage graduate students not to confine themselves to their laboratories, but to interact with other faculty members in the Department of Earth and Planetary Science, as well as with researchers in other universities and institutes in Japan and foreign countries.

Between 2012 and 2018, three professors (Profs. Yutaka Kondo, Hiroko Nagahara, and Ryuji Tada) retired, and one associate professor (Prof. Yutaka Abe) passed away and another (Prof. Yasuhito Sekine) moved. During the same period, however, only one professor position has been filled (Prof. Eiichi Tajika). Currently, the number of faculty members belong to EPSS group is thus minimal. For that reason, we asked Prof. Shogo Tachibana (UTOPS) to belong concurrently to the EPSS group, in addition to the Space and Planetary Science Group. Personnel affairs of two positions for associate professor are now in progress. Hence, we will be able to recover the number of faculty and strengthen the EPSS group in research and education of graduate students after 2020.

<Solid Earth Science Group>

In the Solid Earth Science Group, we conduct quantitative wide-ranging studies concerning the physical and chemical state, structure—including the related processes of formation and evolution that occur on a variety of temporal and spatial scales—and the physical and chemical interactions between the Earth's surface, crust, mantle and core with the aim of understanding the future state of the solid Earth. To achieve this goal, we divide our activities into four groups with their own research goals: earthquake science, tectonics, evolution of the solid earth, and dynamics of the earth's interior. In addition to the activities of the four groups, to develop a unified understanding of the solid Earth, we also collaborate with researchers in other institutes both domestic and overseas.

• **Earthquake Science:** We aim to develop models of seismic rupture and slip phenomena based on an understanding of the fundamental physical processes operating on the microscale in the seismogenic zone and the nature of multiscale structural heterogeneity and thereby tackle the problem of evaluating the predictability of earthquakes and related phenomena occurring under long-term stress loads. In order to achieve this, we are deepening our knowledge of fault material science on a wide range of different scales: large-scale structural studies of topography in zones of crustal deformation and of natural material, laboratory characterization of materials, and numerical simulations at the atomic scale. We will strengthen the theoretical basis for understanding earthquake generation by carrying out collaborative studies with workers in the fields of statistical physics and computer science combined with the analysis of high-quality high-volume seismic and geodetic data and high efficiency numerical simulation to elucidate the laws and physical conditions relevant to the seismogenic zone. Using this approach, we will develop a methodology to express the development of normal and slow earthquakes under a variety of different external conditions including appropriate uncertainties. We will pursue an integrated style of research that synthesizes observations, experiments, data analyses, and numerical modelling and explore ways in which we can interact with other researchers both inside and outside of the group including those working in overseas institutions to develop a universal understanding of the field.

• **Tectonics:** We aim to develop an integrated understanding of the internal structure, material behavior, and dynamics of subduction zones that dominate plate convergence tectonics. To achieve this goal, we combine studies of ancient tectonics, based on observation and analysis of natural

samples and field work, with studies of modern tectonics, based on real-time data from seismology and geodesy. Research topics include clarifying long-term stress conditions and changes in fluid pressure in paleo subduction zones, which are now represented by metamorphic belts, and, by linking these to the observations of phenomena such as slow earthquakes, to elucidate the physical and chemical behavior of fluids in subduction zones. We also aim to estimate the rheology of fault rocks, including mylonite, on a variety of temporal scales and to combine this information with results from geodesy and seismology to determine the way in which faults and shear zones influence crustal tectonics. In cooperation with research groups in the United Kingdom, Switzerland, and New Zealand, we use information from plutonic and metamorphic rocks combined with geophysical observations to evaluate the role of magma formation and flow in zones of plate convergence.

• **Evolution of the Solid Earth:** We aim to use studies of the history of the Earth over geological time to elucidate the dynamic evolution of material and heat transport in the Earth. At present, we are conducting geological, mineralogical and geochemical studies of crustal and mantle rocks and minerals with ages ranging from 4.4 Ga to the present with the aim of determining the formation processes of the rocks and minerals and by combining these results with determination of high-resolution spatial and temporal scales, we can use these results to determine the thermal and chemical evolution over time of the crust and mantle. We extend the techniques used to examine Earth rock and minerals to study meteorites, which preserve information on the primitive material of the Earth and other planets, with the aim of determining the early thermal evolution and large-scale chemical differentiation of the Earth and other planets. By combining information extracted from studies of natural samples with insights derived from high-pressure experiments and numerical forward modeling, we aim to determine the parameters that control the formation and evolution of the Earth. In addition, through combining our research results, with knowledge obtained from fields of seismology, tectonics, and geodynamics, we aim to develop a more comprehensive understanding of the solid earth evolution. In addition to the Earthquake Research Institute and the Atmospheric and Ocean Research Institute, both associate groups of the Department, we also cooperate with other research institutes in Japan and overseas such as the Japan Agency for Marine-Earth science and Technology, and research groups in Australia and China. Exchanges between graduate students and young researchers help develop an active international research portfolio.

• **Dynamics of the Earth's Interior:** Our group carries out high-precision three-dimensional determination of the structure in the deep earth based on inversion of seismic body wave data, development of elastic wave theory for the purpose of estimating the structure of media with short wavelength heterogeneities, and modeling of magnetic polarity inversion by numerical simulation of the low viscosity and high magnetic energy region of the metal core. Also, while taking into account the forefront of theoretical understanding of planetary formation, we aim to construct a chemical model for the composition of the core based on studies such as determining a chemical phase diagram for liquid iron alloys and the distribution between metal and silicates. We aim to understand the dynamics and chemical heterogeneity of the Earth's mantle based on studying chemical heterogeneity related to crystallization from the magma ocean. For these studies, it is important to determine the valence of elements under high pressure, and we are conducting related joint research with the Takahashi Laboratory of the geosphere and biosphere group. We interpret the record of planetary magnetic fields recorded by natural samples and elucidate the magnetic field evolution and the internal dynamic evolution of terrestrial planets. To further develop research in the topics above, we collaborate with the Earth-Life Science Institute of the Tokyo Institute of Technology, the Volcanoes and Earth's Interior Research Center of the Japan Agency for Marine-Earth science and Technology, the Geodynamics Research Center at Ehime University and research groups from France and Italy.

<Geosphere and Biosphere Science Group>

Promoting research and education on geosphere-biosphere interactions will continue to be the major aim in our group. The faculty members in our group have been changed greatly during the last few years in order to encompass innovative fields in geosphere and biosphere science. Establishment of a new collaborative regime within the group is of prime importance for each member of the group to achieve better research and education and proceed closer to the ultimate goal. Research collaborations with scholars from other fields, such as agricultural scientists, chemists, and biologists started in 2000, and are equally important: the study themes cover various research fields including biomineralization, interface processes between organic and inorganic compounds, microbiological and chemical processes from deep-sea hydrothermal vents to near-surface environment, organic geochemistry, climate changes, long-range mutual biological interactions and evolution, life-water-rock-air interactions, and environmental problems. It should be noted that these studies contain various seeds for new research fields, and we will continue to make many of them flourish as an integral part of the earth science in the next several years. We believe that one of the fundamental aspects of our group resides in the primary data acquisition on the basis of fieldwork, analyses on natural specimens, laboratory experiments, and measurements. We will pursue this direction both on our research and education. Also, prediction of complex natural phenomena such as climate change and natural hazards are important issues for the future of human society. To solve these issues, we will recast observational science and pursue interdisciplinary researches in collaboration with other departments.

We aim to take the leadership in research and education of the geosphere and biosphere science in Japan. In order to achieve this goal, we will organize large projects through cooperation with other research groups in our department, the Atmosphere and Ocean Research Institute, and the University Museum of the University of Tokyo, as well as JAMSTEC and the Geological Survey of Japan (AIST), and try to make an international contribution to this important research field.

VIII. UTokyo Organization for Planetary and Space Science

1. Philosophy

The organization is established to promote astronomy and planetary science and in particular to explore planets related to the earth and planetary science. We aim to build an education and research organization that combines excellence and diversity beyond individual departments and facilities, and develops the next generation who can actively contribute to flagship projects in Japan. In particular, we aim to take advantage of 'scale merit', of our graduate school of science which has many members who can take leading roles in preparing a common infrastructure related to space science engineering and promote the development of new fields through interdisciplinary collaboration. We also aim to enhance our research capabilities and continue to contribute more than ever to understand the universe and planets, which are fundamental themes of humanity.

2. History

In recent years, there have been remarkable developments of space science and engineering in Japan, including direct imaging of exoplanets by the Subaru Telescope and direct observation of the cause of pulsating aurora by the geospace exploration satellite "Arase". We have played leading roles in observation and sample collection at the C-type asteroid Ryugu with "Hayabusa 2". In the field of microsatellites, we have helped develop instruments in collaboration with the Graduate School of Engineering and succeeded in launching and operating the microsatellites. We are leading the world in this field, especially the successful operation of the world's first 1 kg satellite and a 50 kg class deep space probe. The members at the Graduate School of Frontier Sciences have taken a central role in installing an antenna for receiving data from artificial satellites on the Kashiwa campus, and its operation has started. In ground observation, we have developed a wide-field camera for asteroid and meteor exploration in the Kiso Schmidt Telescope, and we are building the 6.5-m TAO telescope in Chile that will lead the world in infrared observations of planets and exoplanets. In terms of education, the Graduate School of Frontier Sciences has a deep space exploration education program, and the foundation of an education and research system based on collaboration between science and engineering is being constructed. Based on that, in 2017 this organization was established for the purpose of comprehensive promotion of planetary science and astronomy focusing on planetary exploration related to earth and planetary science and the development of young human resources. Moreover, in FY2018, the International Graduate Program for Excellence in Earth-Space Science was established as an integrated graduate school education program of the Graduate School of Science and Engineering. The members of our organization also made a great contribution to the educational and research activities of the program.

3. Member and Organization

The organization consists of four specialized sections: Solid planetary observations division, Astromical observations division, Theoretical research division, Engineering division as Research Centre for Ultra-small spacecraft exploration (Cooperative research center with JAXA). We conduct research and education activities that go beyond the boundaries of the graduate school we belong.

Director: Professor Masahiro Hoshino (Department of Earth and Planetary Science, Graduate School of Science)

<u>Solid Planetary Observations Division</u>

Prof. Shogo Tachibana (UTOPS /GSS)
Prof. Seiji Sugita（GSS）
Prof. Ichiro Yoshikawa（GSFS）
Prof. Takefumi Hirata（GSS）
Prof. Hideaki Miyamoto（GSE）
Assoc. Prof. Hajime Hiyagon（GSS）
Assoc. Prof. Satoshi Kasahara（GSS）
Assoc. Prof. Kentaro Nakamura（GSE）
Assoc. Prof. Tomokatsu Morota (GSS)
Lecturer Kazuo Yoshioka（GSFS)

Astronomical Observations Division
Prof. Mamoru Doi（GSS）
Prof. Motohide Tamura（GSS）
Prof. Kotaro Kohno（GSS）
Prof. Takashi Miyata（GSS）
Prof. Naohiko Sugita（GSE）
Assoc. Prof. Masuo Tanaka（GSS）
Assoc. Prof. Kazuhiro Shimasaku（GSS）
Assoc. Prof. Naoto Kobayashi（GSS）
Assoc. Prof. Kentaro Motohara（GSS）
Assoc. Prof. Takeo Minesaki（GSS）

Theoretical Research Division
Prof. Masahiro Hoshino（GSS）
Prof. Yuri Aikawa（GSS）
Prof. Kanako Seki（GSS）
Prof. Eiichi Tajika（GSS）
Prof. Tomonori Totani（GSS）
Prof. Takeshi Imamura（GSFS）
Prof. Yasushi Ono（GSS）
Assoc. Prof. Takaaki Yokoyama（GSS）
Assoc. Prof. Masahiro Ikoma（GSS）
Assoc. Prof. Hideyuki Umeda（GSS）
Assoc. Prof. Takanobu Amano（GSS）
Assoc. Prof. Michiko Fujii（GSS）

Research Centre for Ultra-small Spacecraft Exploration
(Cooperative research centre with JAXA): Engineering Division
Prof. Kojiro Suzuki（GSFS）
Prof. Shinichi Nakasuka（GSE）
Prof. Kimiya Komurasaki（GSE）
Assoc. Prof. Hiroyuki Koizumi（GSFS）
Assoc. Prof. Ryu Funase（GSE）

GSS: Department of Earth and Planetary Science, Graduate School of Science

GSFS: Graduate School of Frontier Sciences
GSE: School of Engineering
UTOPS: UTokyo Organization for Planetary and Space Science

4. Outreach Activities

The UTOPS actively engages in various outreach activities such as lectures and events. A list of events contributed to by the Organization as follow. For outreach activities such as public symposiums, seminars, media appearances, and newspaper coverage, please refer to the external review of individual members of the department.

Open discussion event: What can learn through 'Hayabusa 2'? –Let's have a discussion with researchers!- at Hongo campus in the University of Tokyo, 21st August 2018, Sponsored.

Exhibition: The University Museum, School Mobile Museum, 'Black asteroid', Bunkyo-ku Education Center, 17th July 2018-30th March 2019, Co-sponsored

Lecture and exhibition explanation: The 20th anniversary of the Gamagori Network Research Center Natural History Museum –Sea of Life-, Hayabusa day coming soon! Lecture 2019, 'Hayabusha-2' Exploring Ryugu the Gamagori Network Research Center Natural History Museum –Sea of Life- (Gamagori City in Aichi), 9th June 2019, Cooperation

Astronomy training: Let's measure the age of the universe at Hongo campus at University of Tokyo, 27th -28th July 2019, Co-sponsored

Open discussion event: What's Hayabusa-2 doing now? - Let's have a discussion with researchers!- at Hongo campus in the University of Tokyo, 23rd August 2019, Sponsored

Operation of web page: Scientific description page of Ryugu images taken by Hayabusa 2, http://pub.haya2.sys.t.u-tokyo.ac.jp/ from June 2018 to Present, Cooperation

5. Future development

We have gathered top-level researchers in various fields from within the university, and based on close collaboration between the graduate courses of Science, Engineering and Frontier Sciences, we aim to use our studies of exoplanet atmospheres and the university-based project 'micro satellite planetary exploration' to create new academic fields. To achieve these goals, at present we are working towards establishing a new University of Tokyo Collaborative Research Organization.