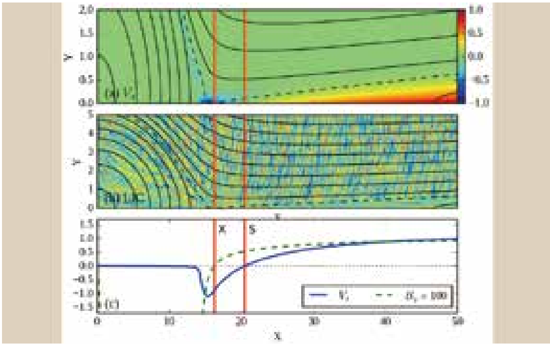
1st ISEE Award ceremony

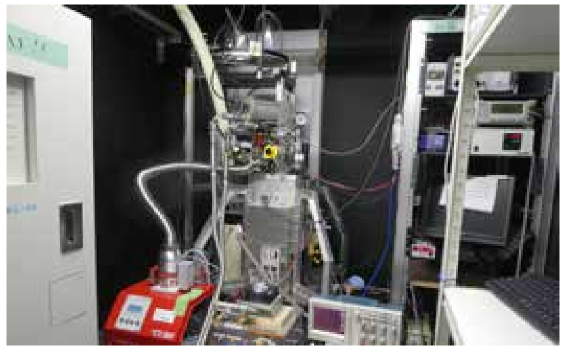


Computer simulation of non-steady Petschek-type reconnection (see p.25)

Group photograph at the inauguration of the SCT prototype on Jan 17, 2019 (Image credit: Deivid Ribeiro, Columbia University)

Radio telescope for IPS observations at Kiso

Aurora observation at Nain, Canada (September 11, 2018)



Millimeter-wave radiometer installed in Tromsø, Norway

A hydroclimatological study launched around the Rolwaling area of the Himalayas

Geologic field excursion at Mt. Apoi, Hokkaido – A window into the mantle

Institute for Space–Earth Environmental Research, Nagoya University

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NAGOYA UNIVERSITY

Institute for Space–Earth Environmental Research, Nagoya University

Annual Report FY2018

Institute for Space–Earth Environmental Research Nagoya University

Annual Report

FY2018

Institute for Space–Earth Environmental Research Nagoya University

Annual Report

Institute for
Space–Earth Environmental Research

April 2018–March 2019

Foreword

The Institute for Space-Earth Environmental Research (ISEE), as a representative institute of Nagoya University, actively continues research and education. ISEE was established in October 2015 by merging three institutes of Nagoya University: the Solar Terrestrial Environment Laboratory, the Center for Hydrospheric Atmospheric Research, and the Center for Chronological Research. The mission of ISEE is to clarify the mechanisms and mutual relationships of the Earth, the Sun, and cosmic space, treating them as a seamless system, and to benefit humanity by resolving issues in the global environment and contributing to the advances of space exploration. To this end, ISEE has continued to promote the development of new science fields in cooperation with various related communities. Its role as the Joint Usage/Research Center is one of its most important tasks. As the Joint Usage/Research Center, we operate various programs for the International Joint Research, Workshop and Symposium, high-performance computing, database management, and chronological analysis. In FY 2018, we conducted the joint research programs of 208 titles.

As this year is in the middle of the third-phase medium term of Japanese national universities, we conducted external evaluations of all ISEE activities by inviting the following world-leading scientists as the External Review Committee members: Prof. Daniel Baker (University of Colorado), Dr. Nat Gopalswamy (NASA), Prof. Feng Sheng Hu (The University of Illinois at Urbana-Champaign), Dr. Teruyuki Nakajima (JAXA), and Prof. Tuneyoshi Kamae (The University of Tokyo & Stanford University). Through this review, the ISEE activities are highly evaluated as follows:

> It is a clear and deeply held view of the External Review Committee that ISEE is performing at a remarkable level. The Institute comprises committed individuals who are not only passionate in their individual roles but also highly collegial in what they do. The leadership of ISEE is effective and enlightened in all key respects. The Institute and its members are successfully pursuing a wide range of space science, geophysical, and astronomical research themes in a highly integrative fashion. It is the Committee's consensus view that ISEE—even now at the midway of its six-year nominal lifetime—has already achieved the objective of interdisciplinary research on an impressive scale with strong international dimensions. The individual divisions and programs are synergistic and the whole of ISEE is much greater than the sum of its parts. The scope of their endeavors in space and Earth sciences is exceptional for an academic institute, putting Japan in a strong position to compete in this broad research arena on the global stage.

In FY 2018, the mid-term evaluation of the Joint Usage/Research Centers by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) was also conducted, and ISEE received rank-A evaluation, as ISEE is expected to contribute to the related communities through the integrated research linking space science and Earth science.

We are actively working to promote international joint research, and in this year, we have invited 219 foreign researchers to conduct joint research and seminars. In particular, we organized the 1st ISEE International Symposium on "Recent Progress in Heliospheric Physics by Direct Measurements of Unexplored Space Plasmas" from February 25 to 29, 2019, at Nagoya University. The ISEE International Symposium is the frag-ship meeting of more than 50 scientific meetings convened by ISEE every year. In addition, the ISEE International Workshop program produces various new international joint papers and books through the collaboration and discussion of experts from all over the world for each scientific subject, and the ISEE International Joint Research Program led by established scientists from various countries successfully continues.

Aiming to develop space‒earth environmental research, promoting interdisciplinary research, and exploring the new discipline of space‒earth environmental research, we established the ISEE Award for a prominent research activity that is based on the ISEE Joint Research Program. The first ISEE Award was awarded to Professor Hisao Takahashi of the National Institute for Space Research (INPE), Brazil, for his great contribution to space‒earth environmental research through studies of ionospheric disturbances in the equatorial region. The award ceremony and memorial lecture were held on February 27, 2019. We hope that the ISEE Award will further help the development of space‒earth environmental research in the future.

ISEE is organized by basic research divisions comprising seven research groups and three centers: the Center for International Collaborative Research, the Center for Integrated Data Science, and the Center for Orbital and Suborbital Observation. ISEE is currently promoting four interdisciplinary research projects: the Project for Solar-Terrestrial Climate Research, the Project for Space–Earth Environmental Prediction, the Project for the Interaction of Neutral and Plasma Atmosphere, and the Project for Aerosol and Cloud Formation. These projects are being carried out in cooperation with the following nationwide collaborative research: "Project for Solar-Terrestrial Environment Prediction (PSTEP) (PI: Kanya Kusano), "Study of Dynamical Variation of Particles and Waves in the Inner Magnetosphere using Ground-based Network Observations (PWING) (PI: Kazuo Shiokawa), "Tropical Cyclones-Pacific Asian Research Campaign for Improvement of Intensity Estimations/Forecasts (T-PARCII) (PI: Kazuhisa Tsubkoki), and "Changing Climate and Resident-Environment in the Migrations and Expansions of Homo Sapiens across the Continent of Asia" (PI: Hiroyuki Kitagawa), which are supported by the Grant-in-Aid for Scientific Research program of MEXT.

ISEE strives to nurture young minds through new perspectives and integrated and international partnerships. In particular, ISEE cooperates with the Graduate School of Science, Graduate School of Engineering, and Graduate School of Environmental Studies of Nagoya University to offer a unique educational opportunity in which graduate students from the three graduate schools collaborate on research of mutual interest. Through ISEE, these students also participate in international research activities.

At ISEE, we are actively working on outreach programs to promote public awareness of our research and contribute to science education. In FY 2018, we held an open lecture and conducted an open laboratory at the University Festival (Meidai-Sai) in June. In September, we conducted a public lecture in cooperation with the Council for Research Institutes and Centers of Japanese National Universities. In addition, we organized an open seminar on "Internationalized Astronomy Research" in conjunction with the Graduate School of Science, a summer school for elementary-school students in the Tokai region to learn about the history of the Earth, as well as an open house at the Kiso Observatory. We gave a presentation at the Nagoya University Homecoming Day event in October, and cooperated with organizers in presenting the Science Festival for Young People in the city of Tarumizu, Kagoshima Prefecture (the location of ISEE Observatory) in December. We created a video to explain ISEE research for the ISEE homepage and YouTube viewing, and distributed postcards providing information about video access to ISEE research, as well as scientific booklets for high-school students in Aichi Prefecture.

Modern society is undergoing drastic changes and civilization is rapidly evolving in an unprecedented manner at a global scale. ISEE views the Sun, Earth, and space as a seamless system because it is crucial to understand the delicate balance and mechanisms of this system to sustain humanity and develop mankind spreading throughout the solar system. ISEE will, therefore, continue with its mission to help resolve global issues and advance space exploration. We hope that this annual report can help you understand the recent ISEE activities.

Kanya Kusano

Director

The first award ceremony and memorial lecture was held on Feb.27, 2019.

Establishment of ISEE Award

Aiming to develop space-earth environmental research, promoting interdisciplinary research, and exploring the new discipline of space-earth environmental research, the ISEE is presenting an ISEE Award to a prominent research activity that is based on the ISEE Joint Research Program.

The first ISEE Award was given to Professor Hisao Takahashi of the National Institute for Space Research (INPE), Brazil, for his great contribution to space–earth environmental research through studies of ionospheric disturbances in the equatorial region. The award ceremony and memorial lecture was held as below.

Date: February 27, 2019, 16:00–17:30

Venue: ES hall of the ES building in the Nagoya University Higashiyama Campus

Title of the Award Lecture: Our Concern for Space Weather - Equatorial Ionospheric Plasma Bubbles

ISEE Award 2018

Winner : **Dr. Hisao Takahashi**

Professor of post-graduate course
INPE, Brazil

Title : Contribution to Space-Earth Environmental Research through Studies of Generation and Development of Equatorial Ionospheric Plasma Bubble

Citation: Dr. Takahashi has shown, for the first time, using GNSS data over South America that atmospheric waves launched from tropospheric convection are propagated to an altitude of 300 km, generating a wavy structure of the ionospheric plasma. He suggested that such waves can trigger plasma bubbles after sunset. During his visit to ISEE, Nagoya University, in 2016 as a visiting professor, he organized an international workshop and led a global discussion on the generation and development of plasma bubbles. The results of the workshop have been published in 13 scientific papers in a special issue of the international journal, Progress in Earth and Planetary Sciences.

Carrier of the winner: Dr. Takahashi received his Master of Science at Niigata University in 1970, and then received his PhD degree in INPE, Brazil, in 1980. Since then, he has been working at INPE as a research staff of Aeronomy Division, Head of Aeronomy Division, and General manager of Space weather Program of INPE. He has been carrying out measurements of Aurora and Airglow to study atmospheric waves and their impacts on the Earth's upper atmosphere.

Fig.1

Aircraft observation of supertyphoon Trami

Supertyphoon Trami caused a huge disaster over central Japan at the end of September 2018. The T-PARCII team performed an aircraft observation of Trami on September 25, when the storm was categorized as a supertyphoon. We penetrated the eye of Trami and made dropsonde observations successfully. The observation showed a central pressure of 918.8 hPa and the thermodynamic structure of the eye. The aircraft observation continued until September 28 and the time evolution of the storm was observed.

Since typhoon intensities are now estimated using satellite cloud images, there is a large uncertainty in the intensity data of a very intense typhoon, such as a supertyphoon. Accurate data and forecasts of typhoon intensity are very important for disaster prevention. The T-PARCII project aims to improve typhoon intensity estimations and forecasts. We performed aircraft observations of two supertyphoons in 2017 and 2018. The penetration observations provided accurate data of typhoon central pressure and thermodynamic structure of the typhoon's inner core. The assimilation of dropsonde data improved the track and intensity forecasts. In 2018, dropsonde data were successfully transmitted in real time to all forecast organizations in the world and contributed to operational forecast of a typhoon.

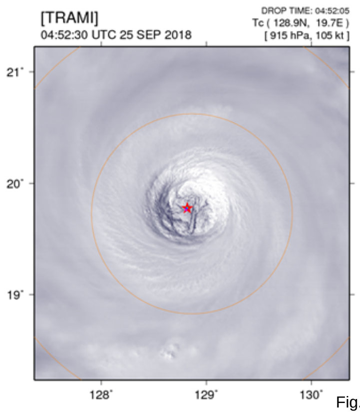


Fig.2

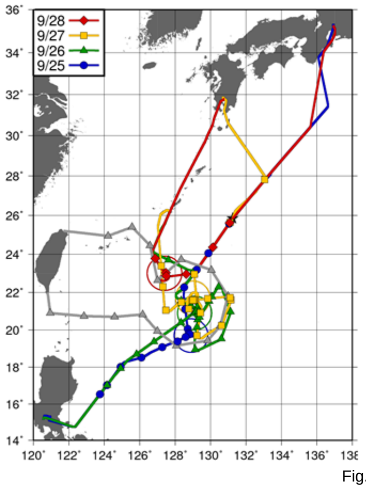


Fig.3

Fig. 1: Photograph of the eye of supertyphoon Trami from the aircraft at a height of 14 km on September 25, 2018: lower clouds and eye-wall cloud (Prof. H. Yamada of Univ. Ryukyus).

Fig. 2: Visible satellite image of Trami and dropsonde launching point on September 25, 2018.

Fig. 3: Flight passes of the aircraft observation during September 25–28, 2018. The gray line indicates the flight pass of Taiwan DOTSTAR. The circles indicate the position of the storm core.

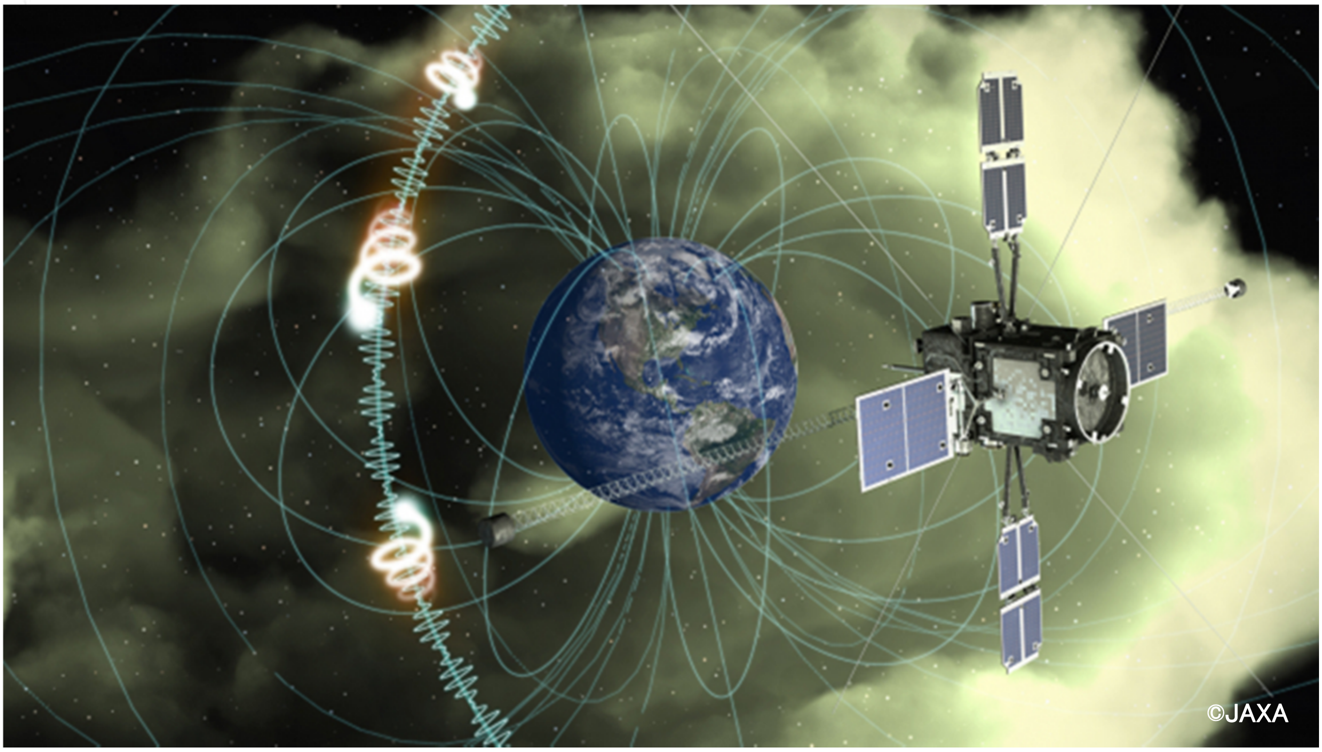


Fig.1

Direct observations of energetic electron accelerations by chorus waves

Dr. Satoshi Kurita and Prof. Yoshizumi Miyoshi of CIDAS and colleagues have analyzed the plasma waves and electron data from the Arase satellite and identified a rapid acceleration of energetic electrons by chorus waves.

Cross-energy coupling is a key concept for understanding the dynamical evolutions of the geospace, where plasma/particles with different energy ranges interact each other through wave−particle interactions. Accelerations of energetic electrons by plasma waves are one of the key processes in cross-energy coupling. Although it had been supposed that the day-order time scale is necessary to accelerate electrons, the new observations from Arase showed tens of keV of electron accelerations within 30 s after the enhancement of chorus waves, which is much shorter than that predicted in the traditional diffusion theory. This result was published in Geophysical Research Letters, American Geophysical Union. This study uses the data files and analysis software distributed by the ERG-Science Center, operated by ISAS/JAXA and ISEE.

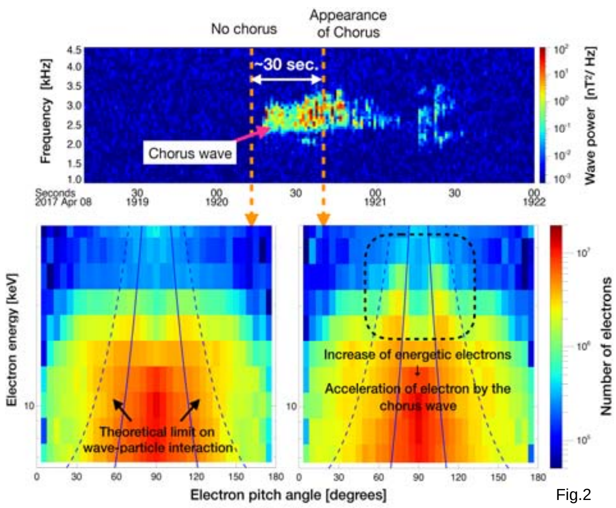


Fig.2

Fig.1: Arase satellite in Geospace.

Fig.2: Frequency-time diagram of chorus waves observed by Arase. (b) Energy spectrum of energetic electrons just before enhancements of chorus waves. (c) Same as (b) but after enhancements of chorus waves. Horizontal axis is the pitch angle, and the vertical axis is energy.

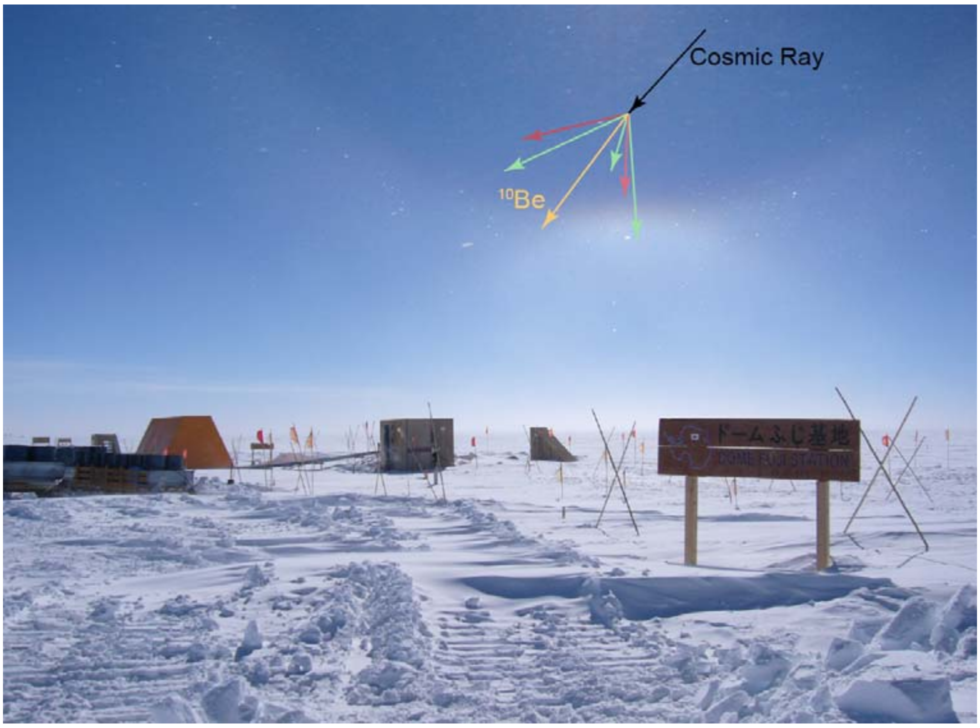


Fig.1

Origin of cosmic ray event confirmed by ^{10}Be analysis of ice cores

Miyake et al. analyzed ^{10}Be concentrations in the Antarctic Dome Fuji ice core with a high time resolution and showed that the origin of the cosmic ray event in 994 CE is consistent with an extreme Solar Proton Event (SPE). A signature of an extreme SPE, whose scale far exceeds the historically recorded events, was found in 775 CE; therefore, it is possible that such extreme SPEs occurred several times in the past.

A sudden increase in cosmic ray intensity was discovered in 993–994 CE from ^{14}C analyses of tree rings; however, its origin was not identified. It is important to analyze multiple cosmogenic nuclides such as ^{14}C and ^{10}Be to determine the origin of the event. We obtained quasi-annual ^{10}Be concentrations in Southern Hemisphere ice core for the first time and detected a ^{10}Be increase similar to that observed in the Northern Hemisphere (Greenland). This result supports a solar proton origin and indicates the occurrence of extremely large-scale SPEs at ~993–994 CE. We also proposed a method for detecting cosmic ray signals using Na ion data of the same ice core. It is expected that this will lead to a further search for cosmic ray events using ^{10}Be on a scale of hundreds of thousands of years in the future.

Fig.2

Fig.1: Dome Fuji station and an image of ^{10}Be production through an interaction between a cosmic ray and an atmospheric atom (Picture taken by Prof. Motoyama).
Fig.2: Ice core sample used for the analysis.

Paper information
Journal: Geophysical Research Letters, Vol.46(1), 11-18
Authors: F. Miyake, K. Horiuchi, Y. Motizuki, Y. Nakai, K. Takahashi, K. Masuda, H. Motoyama, and H. Matsuzaki
Title: ^{10}Be signature of the cosmic ray event in the 10th century CE in both hemispheres, as confirmed by quasi-annual ^{10}Be data from the Antarctic Dome Fuji ice core
DOI: 10.1029/2018GL080475

Fig.1

Rarefaction of the solar wind associated with weakening of solar activity

The current solar cycle (Cycle 24) is the weakest in 100 years. From long-term observations of interplanetary scintillation conducted at ISEE, Nagoya University, it has been revealed that the solar wind emanating from the Sun is significantly rarefied in Cycle 24.

Radio sources with a compact apparent size undergo "twinkling" by scattering of the solar wind plasma. This phenomenon is called interplanetary scintillation (IPS) and is used as a ground-based method for observing the solar wind. The division for heliospheric research of ISEE has been conducting multi-station IPS observations since 1980s using large radiotelescopes developed by them. The global properties of the solar wind and its response to solar activities have been investigated, being based on the IPS data. As a result, the occurrence of a rarefied solar wind is found to significantly increase in association with the weakening of the recent solar activity. This tendency is observed prominently for the slow solar wind with a speed of less than 350 km/s. The solar wind is known to consist of a fast stream with a low density and a slow stream with a high density. The fact revealed from the IPS observations suggests violation of this relation. While the cause for rarefaction of the slow solar wind by weakening of the solar activity remains an open question, it is considered to provide a clue to elucidate the unsettled mechanism of the solar wind formation.

Paper information
Journal： Journal of Geophysical Research – Space Physics, Vol. 123, 2520-2534
Authors： M. Tokumaru, T. Shimoyama, K. Fujiki, and K. Hakamada
Title： Rarefaction of the very-slow (<350 km/s) solar wind in Cycle 24 compared with Cycle 23
DOI： 10.1002/2017ja025014

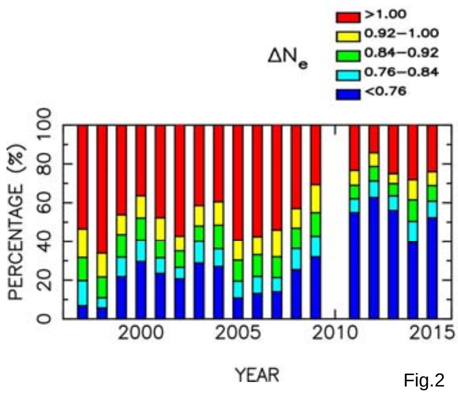


Fig.2

Fig.1： Radiotelescope dedicated for IPS observations at Toyokawa (SWIFT).
Fig.2： Percentage bar graph of the density occurrence of the solar wind at a speed of <350 km/s. Blue and red areas denote occurrence rates of low and high densities, respectively. As shown here, the occurrence rates of the low density have increased recently (cited from Tokumaru et al., 2018).

Contents

1. History

Solar-Terrestrial Environment Laboratory

May, 1949
Research Institute of Atmospherics, Nagoya University was established.

April, 1958
Cosmic-ray Research Laboratory, Faculty of Science, Nagoya University was established.

June, 1990
The Solar-Terrestrial Environment Laboratory (STEL) was established.

April, 1995
The Center for Joint Observations and Data Processing was organized.

April, 2003
The Rikubetsu Observatory was organized.

April, 2004
The Geospace Research Center was established.

March, 2006
Laboratory was relocated to the Higashiyama Campus.

April, 2010
Approved as one of the Joint Usage/Research Centers.

Hydrospheric Atmospheric Research Center (HyARC)

April, 1957
The Water Research Laboratory, Faculty of Science, Nagoya University was established.

September, 1973
The Water Research Institute (WRI), Nagoya University was organized.

April, 1993
The Institute for Hydrospheric-Atmospheric Sciences (IHAS), Nagoya University was organized.

April, 2001
The Hydrospheric Atmospheric Research Center (HyARC), Nagoya University was established.

April, 2010
Approved as one of the Joint Usage/Research Centers.

The Nagoya University Center for Chronological Research

February, 1981
The Tandetron Accelerator Laboratory was established in the Radioisotope Research Center of Nagoya University.

March, 1982
Installation of the Tandetron Accelerator Mass Spectrometry (AMS) machine No.1 was completed.

January, 1987
Inter-University Service of ^{14}C measurements was started with the Tandetron AMS machine No.1.

June, 1990
The Nagoya University Dating and Material Research Center was established.

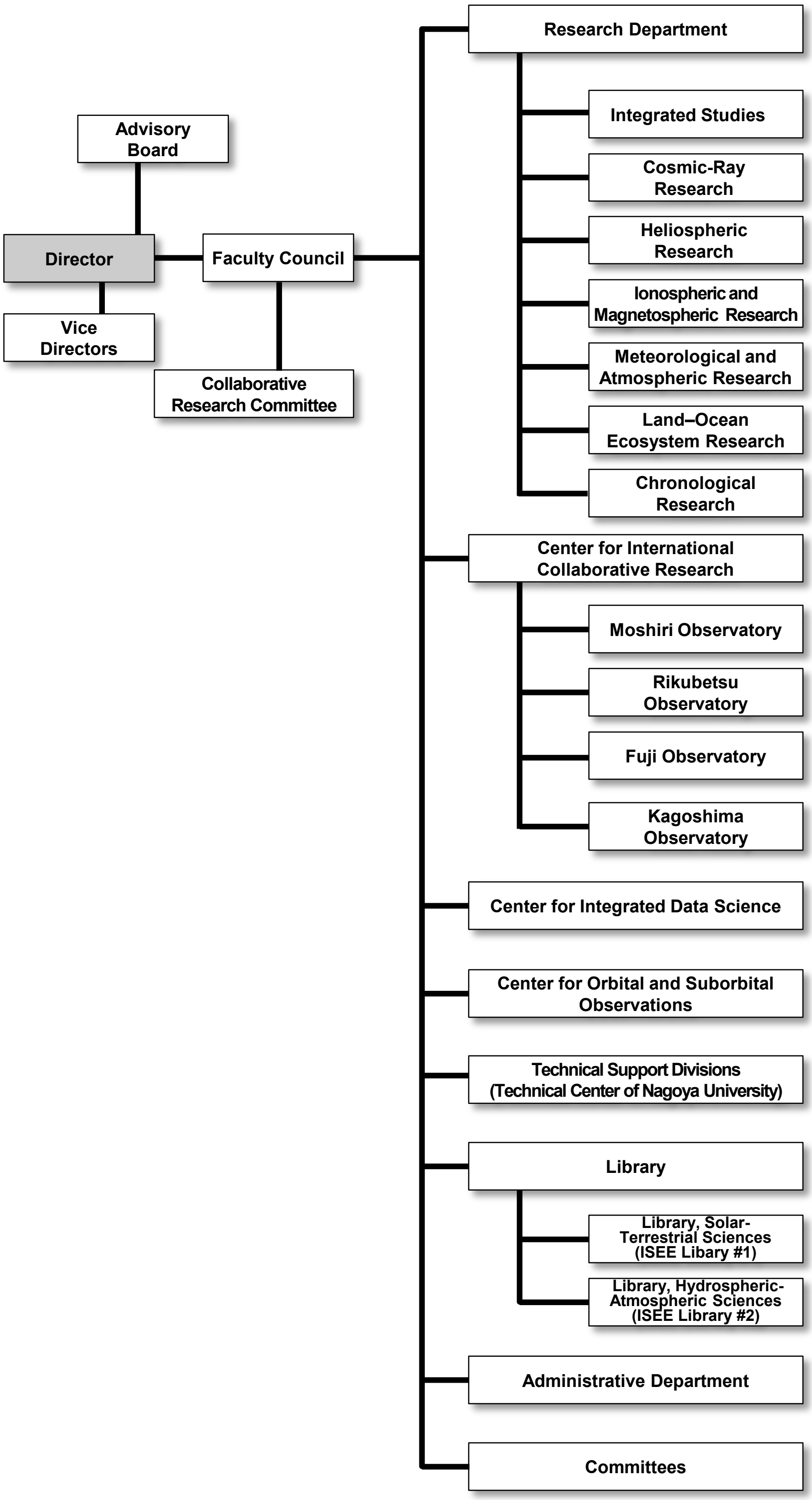
March, 1997
The Tandetron AMS machine No. 2 was newly introduced.

April, 2000
The Nagoya University Center for Chronological Research was organized.The CHIME dating system was transferred from the School of Science.

October, 2015,
Institute for Space–Earth Environmental Research (ISEE), merging the laboratory and two centers, was established.

January, 2016
ISEE was approved as one of the Joint Usage/Research Centers.

2. Organization



3. Staff

Director	Kanya Kusano
Vice Directors	Joji Ishizaka
Vice Directors	Kazuo Shiokawa

April 1, 2018–March 31, 2019
✱ : Concurrent post
▲: Left the Institute in the 2018 academic year
○: Joined the Institute in the 2018 academic year

Division for Integrated Studies

Professor	Kanya Kusano
Professor	Yoshizumi Miyoshi (✱)
Associate Professor	Satoshi Masuda
Associate Professor	Takayuki Umeda (✱)
Designated Associate Professor	Shinji Saito ▲(✱)
Lecturer	Shinsuke Imada
Assistant Professor	Akimasa Ieda
Researcher	Haruhisa Iijima
Researcher	Magnus Morton Woods ○▲
Research Institution Researcher	Shinnosuke Ishikawa ○▲

* Belongs to Graduate School of Science

Division for Cosmic-Ray Research

Professor	Yoshitaka Itow
Professor	Hiroyasu Tajima (✱)
Associate Professor	Yutaka Matsubara
Associate Professor	Fumio Abe (✱)
Associate Professor	Fusa Miyake
Lecturer	Akira Okumura
Assistant Professor	Hiroaki Menjo ○
Designated Assistant Professor	Shingo Kazama ○(✱)
Researcher	Yoshinori Sasai ▲
Researcher	Qidong Zhou ○▲
Technical Assistant	Naoya Hidaka ○▲
Technical Assistant	Kazuhiro Huruta ○
Technical Assistant	Kinji Morikawa

* Belongs to Institute for Advanced Research Section

Division for Heliospheric Research

Professor	Munetoshi Tokumaru
Associate Professor	Kazumasa Iwai
Assistant Professor	Ken-ichi Fujiki

Division for Ionospheric and Magnetospheric Research

Professor	Masafumi Hirahara
Professor	Kazuo Shiokawa (✱)
Associate Professor	Yuichi Otsuka
Associate Professor	Satonori Nozawa
Associate Professor	Masahito Nosé ○
Associate Professor	Nozomu Nishitani (✱)
Lecturer	Shin-ichiro Oyama
Designated Lecturer	Masaki Nishino (✱)
Designated Assistant Professor	Atsuki Shinbori
Researcher	Mitsuru Matsumura ▲
Research Institution Researcher	Neethal Thomas ▲
JSPS Research Fellowship	Shun IMAJO ○

* Belongs to Graduate School of Engineering

Division for Meteorological and Atmospheric Research

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Professor	Nobuhiro Takahashi (✱)
Professor	Kazuhisa Tsuboki (✱)
Associate Professor	Tomoo Nagahama
Associate Professor	Hirohiko Masunaga
Associate Professor	Taro Shinoda (✱)
Assistant Professor	Sho Ohata ○(✱)
Assistant Professor	Taku Nakajima
Designated Assistant Professor	Tenpei Hashino ○▲
Researcher	Yange Deng ○
Researcher	Fumie Furuzawa
Technical Assistant	Minrui Wang ○
Technical Assistant	Yoshiki Fukutomi ▲

* Belongs to Institute for Advanced Research Section

Division for Land–Ocean Ecosystem Research

Professor	Joji Ishizaka
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Associate Professor	Naoyuki Kurita
Lecturer	Hatsuki Fujinami
Assistant Professor	Yoshihisa Mino
Researcher	Shun Ohishi
Researcher	Akiko Mizuno ○
Research Institution Researcher	Zhu Yuanli ▲
Research Institution Researcher	Qingyang Song ○
JSPS Research Fellowship	Yuki Kanno ○

Divison for Chronological Research

Professor	Masaki Enami ▲
Professor	Hiroyuki Kitagawa
Associate Professor	Masayo Minami
Associate Professor	Takenori Kato (∗)
Assistant Professor	Hirotaka Oda
Researcher	Fumiko W. Nara
Research Institution Researcher	Masako Yamane
Designated Technical Staff	Masami Nishida
Designated Technical Staff	Yuriko Hibi

Center for International Collaborative Research

Director • Professor	Kazuo Shiokawa
Professor	Tetsuya Hiyama
Professor	Masaki Enami ▲(∗)
Professor	Akira Mizuno (∗)
Designated Professor (Cross Appointment)	Kimberly Dawn Leka
Designated Professor (Cross Appointment)	Lynn Marie Kistler
Associate Professor	Nozomu Nishitani
Associate Professor	Naoyuki Kurita (∗)
Associate Professor	Satonori Nozawa (∗)
Lecturer	Hatsuki Fujinami (∗)
Designated Assistant Professor	Masafumi Shoji
Designated Assistant Professor	Taro Nakai ▲
Designated Assistant Professor	Sung-Hong Park
Researcher	Hironari Kanamori

Foreign Visiting Research Fellow

Feb. 5 – July 31, 2018	Stephen Michael Playfer
Mar. 15 – June 14, 2018	Zhongping Lee
May 1 – July 31, 2018	Samuel Krucker
July 1 – Sept. 30, 2018	Nasreen Akter
Sept. 6 – Dec. 5, 2018	Daqing Yang
Jan. 15 – May 15, 2019	Vania Koleva Jordanova

Center for Integrated Data Science

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Professor	Joji Ishizaka (✱)
Professor	Kanya Kusano (✱)
Associate Professor	Fumio Abe
Associate Professor	Takayuki Umeda
Associate Professor	Takenori Kato
Associate Professor	Hidenori Aiki (✱)
Associate Professor	Satoshi Masuda (✱)
Associate Professor	Hirohiko Masunaga (✱)
Designated Associate Professor	Tomoaki Hori
Lecturer	Shinsuke Imada (✱)
Assistant Professor	Akimasa Ieda (✱)
Designated Assistant Professor	Satoshi Inoue
Designated Assistant Professor	Sachie Kanada
Designated Assistant Professor	Yasunori Tsugawa ○▲
Designated Assistant Professor	Tzu-Fang Chang ▲
Designated Assistant Professor	Mariko Teramoto ▲
Designated Assistant Professor	Takuma Matsumoto ▲
Researcher	Norio Umemura
Researcher	Masaya Kato
Researcher	Takafumi Kaneko
Researcher	Satoshi Kurita
Researcher	Satoki Tsujino ○▲
Researcher	Yoshiki Fukutomi ▲
Researcher	Yukie Moroda
Designated Technical Staff	Mariko Kayaba
Designated Technical Staff	Asayo Maeda
Designated Technical Staff	Takahiro Tsukamoto ▲
Technical Assistant	Takako Kondo ○
Technical Assistant	Hiroyasu Yonaha ○▲
JSPS Research Fellowship	Hidetaka Hirata

Center for Orbital and Suborbital Observations

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Professor	Hiroyasu Tajima
Designated Professor	Hidetaka Tanaka ○
Designated Professor	Masataka Murakami
Professor	Joji Ishizaka (✱)
Professor	Kazuhisa Tsuboki (✱)
Professor	Masafumi Hirahara (✱)
Associate Professor	Taro Shinoda
Associate Professor	Hidenori Aiki (✱)
Designated Associate Professor	Kazutaka Yamaoka ○
Designated Assistant Professor	Hiroyuki Tomita
Designated Assistant Professor	Mayumi Yoshioka ○
Researcher	Jung Woonseon ▲
Researcher	Yutaka Matsumi ○
Researcher	Youko Yoshizumi ○
Designated Technical Staff	Tomoko Tanaka

Visiting Academic Staff/Visiting Faculty Members

Visiting Professor	Yoshiya Kasahara
Visiting Professor	Tomoomi Kumagai
Visiting Professor	Yoshikatsu Kuroda
Visiting Professor	Hiroyuki Shinagawa
Visiting Professor	Kiyoto Shibasaki
Visiting Professor	Kanako Seki
Visiting Professor	Park Hotaek
Visiting Professor	Yoshinobu Harazono
Visiting Associate Professor	Yasunobu Ogawa
Visiting Associate Professor	Ryouhei Kano ▲
Visiting Associate Professor	Daiko Shiota
Visiting Associate Professor	Iku Shinohara
Visiting Associate Professor	Manabu Shiraiwa ○▲
Visiting Associate Professor	Yasutaka Narusawa
Visiting Associate Professor	Hirohisa Hara ▲
	Toshio Nakamura

Technical Center of Nagoya University

Senior Technician	Akiko Ikeda
Senior Technician	Yasusuke Kojima
Senior Technician	Haruya Minda
Technician	Tetsuya Kawabata
Technician	Tomonori Segawa
Technician	Yoshiyuki Hamaguchi
Technician	Ryuji Fujimori
Technician	Yasushi Maruyama
Technician	Takayuki Yamasaki
Technician	Yuka Yamamoto
Assistant Technician	Takumi Adachi
Assistant Technician	Moeto Kyushima

Cooperating Research Fellow

	Xiuchun Qin

Foreign Visiting Cooperation Researcher

May 1, 2018 – Mar.31, 2019	Christian Leipe
Aug. 6 – Sept. 29, 2018	Sergii Panasenko
Sept. 1 – Dec. 30, 2018	Qurnia Wulan Sari
Oct.1 – Oct. 31, 2018	Alexandre Vasilyevich Koustov
Oct. 1 – Nov. 30, 2018	Kateryna D. Aksonova
Oct. 14 – Nov. 19, 2018	Vladimir Borisovich Belakhovsky
Nov. 19 – Dec. 18, 2018	Michael Jürgen Kosch
Dec. 3, 2018 – Feb. 27, 2019	Sneda Yadav
Jan. 7 – Mar. 8, 2019	Artem Yu. Gololobov
Jan. 15 – Mar. 31, 2019	Navin Parihar

Administration Department

Director, Administration Department	Sumio Murai ▲
General Affairs Division	
Manager, General Affairs Division	Kazuhiko Tsukazaki ▲
Senior Specialist, Research Support Office	Toshiyuki Yokoi ○
Specialist, General Affairs Section	Norishi Sugiyama ▲
Specialist, General Affairs Section	Keisuke Yokoe ○
Section Head, General Affairs Section	Seiji Tsuruta
Section Head, General Affairs Section	Kazuhiro Yokoyama ○
Section Head, General Affairs Section	Shoji Asano
Section Head, Personnel Affairs Section	Munetika Mizuno ○
Section Head, Research Support Office	Tadayosi Ito
Leader, General Affairs Section	Yoko Nokura
Administrator	Harumi Morishita ▲
Administrator	Anna Kato
Administrator	Yuka Suzuki
Accounting Division	
Manager, Accounting Division	Hiroyuki Ichioka
Specialist, Maintenance Section	Yoshiyuki Nakano
Section Head, Accounting Section	Noriaki Hiroi ▲
Section Head, Accounting Section	Masashi Shimamura ○
Section Head, Supplies Section	Kiyoko Hasegawa
Section Head, Maintenance Section	Shinichi Nakagawa
Leader, Accounting Section	Youko Yasui
Leader, Supplies Section	Yuka Matsuoka
Administrator	Yuka Ito
Administrator	Kyohei Yamaguchi ▲
Designated Supervisor	Tadashi Tsuboi

Toyokawa Branch

Designated Technical Staff	Kayoko Asano
Technical Assistant (Research Support Facilitator)	Yasuo Kato

4. Committee of Other Organizations

Committee of Other Organizations

Contact Post	Job Title	Organizations	Name of Committee / Title
Joji Ishizaka	Professor	Journal of Oceanography	Editor-in-Chief
Joji Ishizaka	Professor	North Pacific Marine Science Organization (PICES)	Co-Chair of Advisory Panel for a CREAMS/PICES Program in East Asian Marginal Seas
Joji Ishizaka	Professor	North Pacific Marine Science Organization (PICES)	Member of Working Group 35: Third North Pacific Ecosystem Report
Joji Ishizaka	Professor	Northwest Pacific Action Plan (NOWPAP)	Focal Point of Center for Special Monitoring and Coastal Environmental Assessment Regional Active Center (CEARAC)
Yoshitaka Itow	Professor	IUPAP C4	Committee member
Yoshitaka Itow	Professor	J-PARC Program Advisory Committee	Committee member
Yoshitaka Itow	Professor	Scientific evaluation of the Karlsruhe Institite of Technology Research field Matter	Panel member
Yoshitaka Itow	Professor	Telescope Array collaboration	Telescope Array External Advisory committee
Kanya Kusano	Professor	International Astronomical Union (IAU)	Organizing Committee Member of Commission E3 Solar Impact throughout the Heliosphere
Kanya Kusano	Professor	Solar Physics	Editorial Board member
Kazuo Shiokawa	Professor	Committee on Space Research (COSPAR)	Chair of the COSPAR Sub-Commission C1 (The Earth's Upper Atmosphere and Ionosphere)
Kazuo Shiokawa	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Co-chair of the SCOSTEP VarSITI (Variability of the Sun and Its Terrestrial Impact)
Hiroyasu Tajima	Professor	B-factory Programme Advisory Committee	Committee member
Hiroyasu Tajima	Professor	Progress of Theoretical and Experimental Physics	Editor
Hiroyasu Tajima	Professor	The Scientific World Journal	Editorial Board member
Tetsuya Hiyama	Professor	Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS), a core project of the Future Earth	Scientific Steering Committee (SSC) member
Akira Mizuno	Professor	NDACC Steering committee	Japanese Representative
Yoshizumi Miyoshi	Professor	Annales Geophysicae	Editor

Contact Post	Job Title	Organizations	Name of Committee / Title
Yoshizumi Miyoshi	Professor	Committee on Space Research (COSPAR)	Vice-chair of the Panel on Radiation Belt Environment Modeling (PRBEM)
Yoshizumi Miyoshi	Professor	Earth and Planetary Physics	Editor
Yoshizumi Miyoshi	Professor	Geophysical Research Letter	Guest Editor
Yoshizumi Miyoshi	Professor	National Science Foundation, Geospace Environment Modeling	Steering Committee Member
Yoshizumi Miyoshi	Professor	Polar Research	Guest Editor
Yoshizumi Miyoshi	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Campaign coordinator of VarSITI/SPeCIMEN
Yoshizumi Miyoshi	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Co-leader of the SCOSTEP VarSITI (Variability of the Sun and Its Terrestrial Impact)/SPeCIMEN (Specification and Prediction of the Coupled Inner-Magnetospheric Environment)
Michihiro Mochida	Professor	Atmospheric Environment	Member of Editorial Advisery Board
Michihiro Mochida	Professor	Atmospheric Research	Associate Editor
Michihiro Mochida	Professor	International Commission on Atmospheric Chemistry and Global Pollution (iCACGP)	Comission member
Masataka Murakami	Designated Professor	AMS	Chair, Ccommittee on Planned and Inadvertent Weather Modification
Masataka Murakami	Designated Professor	World Meteorological Organization (WMO)	Member of Weather Modification Expert Team
Hidenori Aiki	Associate Professor	American Meteorological Society (AMS)	Associate Editor of Journal of Atmospheric and Oceanic Technology (JAOT)
Yuichi Otsuka	Associate Professor	Journal of Astronomy and Space Sciences	Editor
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Vice Editors-in-Chief
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Guest Editor for the special issue of Global Data Systems for the Study of Solar-Terrestrial Variability
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Guest Editor for the special issue of Recent Advances in MST and EISCAT/Ionospheric Studies – Special Issue of the Joint MST15 and EISCAT18 Meetings, May 2017
Nozomu Nishitani	Associate Professor	Super Dual Auroral Radar Network	Executive Council
Satonori Nozawa	Associate Professor	Earth, Planets and Space (EPS)	Guest editor for the special issue of the Recent Advances in MST and EISCAT/Ionospheric Studies – Special Issue of the Joint MST15 and EISCAT18 Meetings, May 2017

Contact Post	Job Title	Organizations	Name of Committee / Title
Satonori Nozawa	Associate Professor	EISCAT Scientific Association	Council member
Masahito Nosé	Associate Professor	Earth, Planets and Space (EPS)	Editor
Masahito Nosé	Associate Professor	Earth, Planets and Space (EPS)	Guest Editor for the special issue of “The 13th International Conference on Substorms”
Masahito Nosé	Associate Professor	International Association of Geomagnetism and Aeronomy (IAGA)	Division V DAT Working Group, Chair
Hirohiko Masunaga	Associate Professor	World Climate Research Programme (WCRP) Global Energy and Water cycle Exchanges (GEWEX)	GEWEX Data and Assessments Panel (GDAP) member
Shin-ichiro Oyama	Lecturer	Committee on Space Research (COSPAR)	Science Organizing Committee
Toshio Nakamura	Visiting Faculty	Radiocarbon	Member of Editorial Board

5. Joint Research Programs

One of the major functions of ISEE is to promote and conduct collaborative research on Space–Earth Environmental Science together with researchers from universities and institutes outside ISEE. On January 14, 2016, ISEE was certified as a core research institution of Space–Earth Environmental Science, which is a “Joint Usage/Research Center” as defined by MEXT of Japan. We prepared application forms for joint research programs focusing on the following two research issues: the “Study of coupling processes in the solar–terrestrial system using ground-based observation network” and the “Establishment of an international collaborative research hub to solve research issues in the global (terrestrial) environment and space applications based on comprehensive studies of the space–Sun–Earth system.” The former focuses on coupling processes in the solar–terrestrial system and the interactions of neutral and plasma components in the Earth’s atmosphere by establishing an international ground-based observation network ranging from low- to high- latitude regions, especially in Asia and Africa. The latter aims to establish an international collaborative research hub for comprehensive studies of the space–Sun–Earth system, space applications, space weather forecasting, and environmental problems such as global warming. The following 10 research programs were prepared for the application during the 2018 Japanese fiscal year.

01) Joint Research Program (International)
02) ISEE International Joint Research Program (*)
03) ISEE/CICR International Workshop
04) Joint Research Program (General)
05) Joint Research Program (Student Encouragement)
06) Joint Research Program (Symposium)
07) Joint Research Program (Computing Infrastructure)
08) Joint Research Program (Database Management)
09) Joint Research Program (Accelerator Mass Spectrometry Analysis)
10) Carbon 14 Analysis Service

(*) Applicable only to foreign researchers

These collaborative research programs will be executed using the instruments, software/databases, and facilities of ISEE. Joint research programs 01) to 03), described above, will be managed by the Center for International Collaborative Research (CICR), and those of 07) and 08) will be managed by the Center for Integrated Data Science (CIDAS) and 09) –10) will be managed by the Division for Chronological Research.

In 2018, the following two events should be noted. First, the first ISEE symposium was held at Nagoya University during February 25–29, 2019, entitled “Recent progress in heliospheric physics by direct measurements of unexplored space plasmas”. Distinguished researchers in the fields of heliospheric and cosmic ray physics were invited from all over the world and recent research results were presented in the symposium. Second, the first ISEE Award was awarded to Professor Hisao Takahashi of INPE, Brazil, for his great contribution to space–earth environmental research through studies of ionospheric disturbances in the equatorial region. The award ceremony and memorial lecture were held at Nagoya University on February 27, 2019.

Lists of Accepted Proposals

■ ISEE International Joint Research Program

Proposer	Affiliation*	Job title*	Corresponding ISEE researcher	Title of the research program
Asgari-Targhi, M.	Harvard Smithsonian Center for Astrophysics	Astrophysicist	Fujiki, K.	Comparison of the MHD modeling of solar wind with IPS observations
Koustov, A.	University of Saskatchewan	Professor	Nishitani, N.	Polar cap auroras and related ionospheric plasma flows
Zharkova, V.	Northumbria University	Professor of Mathematics	Kusano, K.	Multi-wavelength diagnostics of energetic particles in solar flares
Panasenko, S. V.	Institute of ionosphere NAS and MES of Ukraine	Head of Department	Otsuka, Y.	Artificially induced traveling ionospheric disturbances inferred from GPS and radar data
Vladimir, B.	Polar Geophysical Institute, Murmansk, Russia	Scientific Researcher	Shiokawa, K.	The study of wave-particle interaction in a near-Earth space as observed by the ERG satellite and PGI ground-based instruments
Parihar, N.	Indian Institute of Geomagnetism	Reader	Shiokawa, K.	Study of the behaviour of the ionosphere over mid-latitude stations using OI 777.4 and 630.0 nm emission
Buranapratheprat, A.	Burapha University, Faculty of Science	Assistant Professor	Ishizaka, J.	Detection and modeling of green Noctiluca bloom in the Gulf of Thailand using satellite ocean color
Nitta, N.	Lockheed Martin Advanced Technology Center	Senior Staff Physicist	Masuda, S.	Origins of Eruptive and Other Solar Flares as Diagnosed with Energetic Electrons
Kosch, M. J.	South African National Space Agency	Chief Scientist	Nishitani, N.	New radar method to observe thermospheric neutral density
Valdés Galicia, J. F.	Instituto de Geofisica, Universidad Nacional Autonoma de Mexico	Professor	Matsubara, Y.	Development of new and improved front end electronics for the SciBar Cosmic Ray Telescope
Tan, B.	National Astronomical Observatories, Chinese Academy of Sciences	Professor	Masuda, S.	Study of coronal magnetic fields from the joint observations of MUSER and NoRH
Savcheva, A.	Smithsonian-Astrophysical Observatory	Astrophysicist	Kusano, K.	Data-Driven Simulations of Active Region Eruptions

* Proposer's affiliation and job title are as of the proposal submission date.

■ ISEE/CICR International Workshop

Proposer	Affiliation*	Job title*	Corresponding ISEE researcher	Title of the research program
Usoskin, I.	University of Oulu	Professor, Vice-director of ReSoLVE	Miyake, F.	Extreme solar events: How hostile can the Sun be?
Cheung, M.	Lockheed Martin Solar & Astrophysics Laboratory	Staff Physicist	Kusano, K.	Data-driven models of the solar progenitors of space weather and space climate
Seki, K.	The University of Tokyo	Professor	Imada, S.	International workshop on relations between solar evolution and atmospheric escape from terrestrial planets

* Proposer's affiliation and job title are as of the proposal submission date.

List of Collaboration Resources

■ Instruments

Name	Contact Person
Fourier Transform Infrared (FTIR) Spectrometer for Atmospheric Composition Measurement (Rikubetsu)	T. Nagahama
Optical Mesosphere Thermosphere Imagers	K. Shiokawa
ISEE Magnetometer Network	K. Shiokawa
ELF/VLF Network	K. Shiokawa
Sodium LIDAR (Tromsø)	S. Nozawa
MF Radar (Tromsø)	S. Nozawa
Meteor Radar (Alta)	S. Nozawa
Solar Neutron Telescope (Norikura Observatory, Institute for Cosmic Ray Research, the University of Tokyo)	Y. Matsubara
Low-Background Beta-Ray Counter	N. Kurita
Multi-Station IPS Solar Wind Observation System (Toyokawa, Fuji, and Kiso)	M. Tokumaru
Nobeyama Radioheliograph	S. Masuda
Multi-Directional Cosmic Ray Muon Telescope (Nagoya)	F. Abe
SuperDARN Hokkaido Pair of (HOP) Radars (Rikubetsu)	N. Nishitani
Upper Air Sounding Systems (two sets)	K. Tsuboki
Polarimetric Radar Systems (two sets)	K. Tsuboki
Ka-Band Polarimetric Radar	K. Tsuboki
Hydrometeor Video Sonde (HYVIS) System	K. Tsuboki
ISEE Riometer Network	K. Shiokawa
Sea Spray Aerosol Optical Particle Counter	H. Aiki
Five-Wavelength Photometer (Tromsø)	S. Nozawa

■ Software/Databases

Name	Contact Person
Atmospheric Composition Data by FT-IR Measurements (Moshiri and Rikubetsu)	T. Nagahama
NO_2 and O_3 Data by UV/Visible Spectrometer Measurements (Moshiri and Rikubetsu)	T. Nagahama
Coordinated Magnetic Data Along 210° Magnetic Meridian (Moshiri, Rikubetsu, Kagoshima, and Overseas MM Stations)	K. Shiokawa
All-Sky Auroral Data (Canada, Alaska, and Siberia)	K. Shiokawa, Y. Miyoshi
Database of the Optical Mesosphere Thermosphere Imagers	K. Shiokawa
VHF Radar/GPS Scintillation (Indonesia)	Y. Otsuka
EISCAT Database	S. Nozawa, S. Oyama
ELF/VLF Wave Data	K. Shiokawa
Interplanetary Scintillation Data	M. Tokumaru
Solar Wind Speed Data	M. Tokumaru
Cosmic Ray Intensity Database	F. Abe

Name	Contact Person
MHD Simulation on the Magnetospheric Environment	T. Umeda
S-RAMP Database	F. Abe
CAWSES Database	F. Abe
Hinode Science Center, Nagoya University	K. Kusano
ERG Science Center	Y. Miyoshi
QL Plot Archive of Satellite Data for Integrated Studies	Y. Miyoshi
Remei Satellite Observation Database	M. Hirahara
MOA Database	F. Abe
SuperDARN Hokkaido Pair of (HOP) Radars Database	N. Nishitani
Numerical Simulation Codes for Plasma Kinetics	T. Umeda
Cloud Resolving Strom Simulator (CReSS)	K. Tsuboki
Satellite Data Simulator Unit (SDSU)	H. Masunaga
ISEE Riometer Network Database	K. Shiokawa
Energy Flux Diagnosis Code for Atmospheric and Oceanic Waves	H. Aiki

■ Facilities

Name	Contact Person
Computer System for Solar-Terrestrial Environmental Research (Supercomputer System)	F. Abe, T. Umeda
CHN Analyzer, Isotope Ratio Mass Spectrometer	Y. Mino
Tandetron Accelerator Mass Spectrometry	H. Kitagawa, M. Minami
Electron Probe Microanalyzer (EPMA)	T. Kato
Ion/Electron Beamline and Calibration Facility	M. Hirahara
Clean Room Facility for Instrument Development	M. Hirahara
Facilities at Moshiri Observatory	A. Mizuno
Facilities at Rikubetsu Observatory	A. Mizuno
Facilities at Kiso Station	M. Tokumaru
Facilities at Fuji Observatory	M. Tokumaru
Facilities at Kagoshima Observatory	K. Shiokawa
CIDAS System	S. Masuda, T. Umeda, Y. Miyoshi
X-Ray Fluorescence Spectrometer (XRF)	T. Kato
X-Ray Diffractometer (XRD)	T. Kato

ISEE Award

Winner	Title	Date of Award Ceremony
Hisao Takahashi Professor of post-graduate course, INPE, Brazil	Contribution to Space-Earth Environmental Research through Studies of Generation and Development of Equatorial Ionospheric Plasma Bubble	Feb. 27, 2019

6. Governance

As of Mar 31, 2019

Advisory Board

Mamoru Ishii	Space Environment Laboratory, Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology
Takaaki Kajita	Institute for Cosmic Ray Research, The University of Tokyo
Takeshi Kawano	Japan Agency for Marine-Earth Science and Technology
Nobuko Saigusa	Center for Global Environmental Research, National Institute for Environmental Studies
Yukari N. Takayabu	Atmosphere and Ocean Research Institute, The University of Tokyo
Takuji Nakamura	National Institute of Polar Research, Research Organization of Information and Systems
Tsuneto Nagatomo	Nara University of Education
Toru Hada	Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
Hironobu Hyodo	Research Institute of National Sciences, Okayama University of Science
Masahiro Hoshino	Graduate School of Science, The University of Tokyo
Kazuhisa Mitsuda	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Tetsuzo Yasunari	Research Institute for Humanity and Nature, National Institutes for the Humanities
Mamoru Yamamoto	Research Institute for Sustainable Humanosphere, Kyoto University
Junichi Watanabe	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Naoshi Sugiyama	Graduate School of Science, Nagoya University
Seiichi Miyazaki	Graduate School of Engineering, Nagoya University
Yasushi Yamaguchi	Graduate School of Environmental Studies, Nagoya University
Joji Ishizaka	Institute for Space–Earth Environmental Research, Nagoya University
Yoshitaka Itow	Institute for Space–Earth Environmental Research, Nagoya University
Masaki Enami	Institute for Space–Earth Environmental Research, Nagoya University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University
Munetoshi Tokumaru	Institute for Space–Earth Environmental Research, Nagoya University
Masafumi Hirahara	Institute for Space–Earth Environmental Research, Nagoya University

Collaborative Research Committee

Yusuke Ebihara	Research Institute for Sustainable Humanosphere, Kyoto University
Akira Kadokura	Polar Environment Data Science Center, Joint Support -Center for Data Science Research, Research Organization of Information and Systems
Kazuyuki Kita	College of Science, Ibaraki University
Yoko S. Kokubu	Tono Geoscience Center, Japan Atomic Energy Agency
Akinori Saitou	Graduate School of Science, Kyoto University
Takeshi Sakanoi	Graduate School of Science, Tohoku University
Shoichi Shibata	College of Engineering, Chubu University
Kanako Seki	Graduate School of Science, The University of Tokyo
Takashi Sekii	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Tsutomu Nagatsuma	Strategic Planning Office, National Institute of Information and Communications Technology
Yoichiro Hanaoka	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Atsushi Higuchi	Center for Environmental Remote Sensing, Chiba University
Ayako Matsuoka	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Hiroyuki Matsuzaki	The University Museum, The University of Tokyo
Akihiko Morimoto	Center for Marine Environmental Studies, Ehime University
Hiroyuki Yamada	Faculty of Science, University of the Ryukyus
Hidenori Aiki	Institute for Space–Earth Environmental Research, Nagoya University
Takenori Kato	Institute for Space–Earth Environmental Research, Nagoya University
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University
Taro Shinoda	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University
Kazuhisa Tsuboki	Institute for Space–Earth Environmental Research, Nagoya University
Munetoshi Tokumaru	Institute for Space–Earth Environmental Research, Nagoya University
Tomoo Nagahama	Institute for Space–Earth Environmental Research, Nagoya University
Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University
Masafumi Hirahara	Institute for Space–Earth Environmental Research, Nagoya University
Satoshi Masuda	Institute for Space–Earth Environmental Research, Nagoya University
Yutaka Matsubara	Institute for Space–Earth Environmental Research, Nagoya University
Masayo Minami	Institute for Space–Earth Environmental Research, Nagoya University
Joji Ishizaka	Institute for Space–Earth Environmental Research, Nagoya University
Yuichi Otsuka	Institute for Space–Earth Environmental Research, Nagoya University
Tetsuya Hiyama	Institute for Space–Earth Environmental Research, Nagoya University

Joint Research Technical Committee

Integrated Studies Technical Committee

Ayumi Asai	Graduate School of Science, Kyoto University
Yusuke Ebihara	Research Institute for Sustainable Humanosphere, Kyoto University
Iku Shinohara	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Kanako Seki	Graduate School of Science, The University of Tokyo
Takashi Sekii	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Akimasa Yoshikawa	Graduate School of Sciences, Kyushu University
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Satoshi Masuda	Institute for Space–Earth Environmental Research, Nagoya University
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University

Heliospheric and Cosmic-Ray Research Technical Committee

Masamitsu Ohyama	Faculty of Education, Shiga University
Chihiro Kato	Faculty of Science, Shinshu University
Shoichi Shibata	College of Engineering, Chubu University
Tomoko Nakagawa	Faculty of Engineering, Tohoku Institute of Technology
Tohru Hada	Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
Yoichiro Hanaoka	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Yoshitaka Itow	Institute for Space–Earth Environmental Research, Nagoya University
Munetoshi Tokumaru	Institute for Space–Earth Environmental Research, Nagoya University
Yutaka Matsubara	Institute for Space–Earth Environmental Research, Nagoya University

Ionospheric and Magnetospheric Research Technical Committee

Takumi Abe	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agenc
Yoshiya Kasahara	Information Media Center, Kanazawa University
Akinori Saito	Graduate School of Science, Kyoto University
Shin Suzuki	Faculty of Regional Policy, Aichi University
Liu Huixin	Faculty of Science, Kyush University
Yuichi Otsuka	Institute for Space–Earth Environmental Research, Nagoya University
Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University
Satonori Nozawa	Institute for Space–Earth Environmental Research, Nagoya University
Masafumi Hirahara	Institute for Space–Earth Environmental Research, Nagoya University

Meteorological, Atmospheric and Land-Ocean Ecosystem Research Technical Committee

Yoshizumi Kajii	Graduate School of Human and Environmental Studies, Kyoto University
Kenshi Takahashi	Research Institute for Sustainable Humanosphere, Kyoto University
Atsushi Higuchi	Center for Environmental Remote Sensing, Chiba University
Masafumi Hirose	Department of Environmental Science and Technology, Faculty of Science and Technology, Meijo University
Akihiko Morimoto	Center for Marine Environmental Studies, Ehime University
Hidenori Aiki	Institute for Space–Earth Environmental Research, Nagoya University
Tomoo Nagahama	Institute for Space–Earth Environmental Research, Nagoya University
Hirohiko Masunaga	Institute for Space–Earth Environmental Research, Nagoya University
Akira Mizuno	Institute for Space–Earth Environmental Research, Nagoya University

Chronological Research Technical Committee

Yoko S. Kokubu	Tono Geoscience Center, Japan Atomic Energy Agency
Wallis Simon	Graduate School of Science, The University of Tokyo
Motohiro Tsuboi	Department of Applied Chemistry for Environment, School of Science and Technology, Kwansei Gakuin University
Hiroyuki Matsuzaki	The University Museum, The University of Tokyo
Hiromi Yamazawa	Graduate School of Engineering, Nagoya University
Naoto Yamamoto	Graduate School of Letters, Nagoya University
Masaki Enami	Institute for Space–Earth Environmental Research, Nagoya University
Takenori Kato	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyuki Kitagawa	Institute for Space–Earth Environmental Research, Nagoya University
Masayo Minami	Institute for Space–Earth Environmental Research, Nagoya University
Fusa Miyake	Institute for Space–Earth Environmental Research, Nagoya University

Airplane Usage Technical Committee

Seiho Uratsuka	Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology
Kazuyuki Kita	College of Science, Ibaraki University
Makoto Koike	Graduate School of Science, The University of Tokyo
Akihiko Kondo	Center for Environmental Remote Sensing, Chiba University
Hiroyuki Yamada	Faculty of Science, University of the Ryukyus
Taro Shinoda	Institute for Space–Earth Environmental Research, Nagoya University
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Hiroyasu Tajima	Institute for Space–Earth Environmental Research, Nagoya University

Steering Committee of the Center for International Collaborative Research

Yusuke Ebihara	Research Institute for Sustainable Humanosphere, Kyoto University
Takashi Shibata	Graduate School of Environmental Studies, Nagoya University
Yoichiro Hanaoka	Solar Science Observatory, National Astronomical Observatory of Japan, National Institute of Natural Science
Hiroyuki Matsuzaki	The University Museum, The University of Tokyo
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University
Tetsuya Hiyama	Institute for Space–Earth Environmental Research, Nagoya University
Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University

Steering Committee of the Center for Integrated Data Science

Shin-ichiro Shima	Graduate School of Simulation Studies, University of Hyogo
Tohru Hada	Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
Masahiro Hoshino	Graduate School of Science, The University of Tokyo
Kazuhisa Mitsuda	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Koshi Yamamoto	Graduate School of Environmental Studies, Nagoya University
Junichi Watanabe	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Kazuhisa Tsuboki	Institute for Space–Earth Environmental Research, Nagoya University
Fumio Abe	Institute for Space–Earth Environmental Research, Nagoya University
Takenori Kato	Institute for Space–Earth Environmental Research, Nagoya University
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University

Steering Committee of the Center for Orbital and Suborbital Research

Riko Oki	Earth Observation Research Center, Japan Aerospace Exploration Agency
Kazuyuki Kita	College of Science, Ibaraki University
Masato Nakamura	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Hiroyuki Yamada	Faculty of Science, University of the Ryukyus
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyasu Tajima	Institute for Space–Earth Environmental Research, Nagoya University
Masafumi Hirahara	Institute for Space–Earth Environmental Research, Nagoya University
Yutaka Matsumi	Institute for Space–Earth Environmental Research, Nagoya University

7. Finance

External Funding and Industry–Academia–Government Collaborations

Researches of ISEE members as principle investigator were supported by the following external funds.

Kakenhi category	Number of subjects	Total amount (JPY)
Grant-in-Aid for Specially Promoted Research	1	61,880,000
Grant-in-Aid for Scientific Research on Innovative Areas	6	96,720,000
Grant-in-Aid for Scientific Research (S)	2	55,900,000
Grant-in-Aid for Scientific Research (A)	6	76,830,000
Grant-in-Aid for Scientific Research (B)	12	51,220,000
Grant-in-Aid for Scientific Research (C)	6	6,500,000
Grant-in-Aid for Challenging Exploratory Research	2	1,430,000
Challenging Research (Exploratory)	4	9,880,000
Grant-in-Aid for Young Scientists (A)	3	16,900,000
Grant-in-Aid for Young Scientists (B)	3	3,900,000
Early-Career Scientists	1	3,380,000
Grant-in-Aid for Publication of Scientific Research Results	2	2,600,000
Grant-in-Aid for JSPS Research Fellow	3	4,030,000
Fund for the Promotion of Joint International Research (International Group)	1	14,300,000
Fund for the Promotion of Joint International Research (Fostering Joint International Research (B)	3	10,010,000
Total	55	415,480,000

・fifty research subjects listed in the table were supported by the JSPS Kakenhi.
・Twenty-nine research subjects received total 144,458,194 JPY from governmental funds except KAKENHI, and from other universities and companies. eleven of them were collaborative researches between ISEE and companies, or national institutes.
・Six research subjects received total 6,359,160 JPY of donation.

Library

■ Library, Solar-Terrestrial Sciences (ISEE Libary #1)

Book

Japanese	2,837
Foreign	11,128

Journals

Japanese	46
Foreign	207

■ Library, Hydrospheric-Atmospheric Sciences (ISEE Library #2)

Book

Japanese	4,695
Foreign	8,892

Journals

Japanese	246
Foreign	224

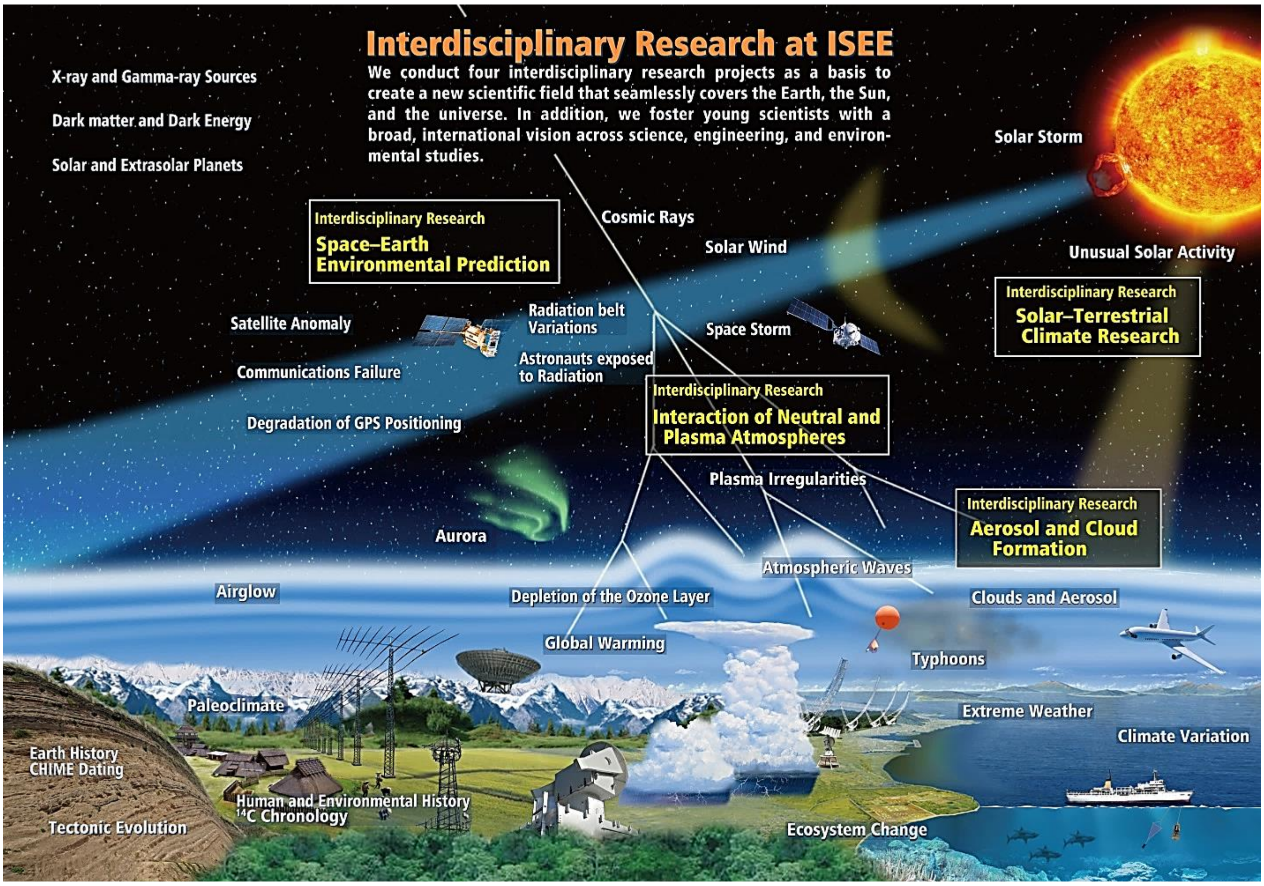
Properties

	Site (m^2)	Bulidings (m^2)	Location
Higashiyama Campus (Main campus of Nagoya University)	-	9,005	Nagoya
Toyokawa Campus	158,002	7,189	Toyokawa
Moshiri Observatory	110,534	325	Hokkaido
Rikubetsu Observatory	24,580	167	Hokkaido
Kagoshima Observatory	13,449	287	Kagoshima
Fuji Observatory	19,926	174	Yamanashi
Sugadaira Station	3,300	0	Nagano
Kiso Station	6,240	66	Nagano
Total	336,031	17,213	

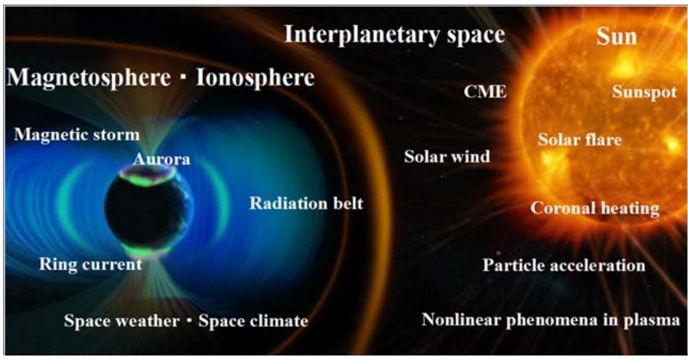
8. Research Topics

The mission of the ISEE is to understand the mechanisms and interactions of diverse processes occurring in the integrated space–Sun–Earth system to deal with global environmental problems and to contribute to human society in the space age. To develop this new research field, four subjects of Interdisciplinary Research are being studied with strong collaborations from seven Research Divisions (Divisions for Integrated Studies, Cosmic Ray Research, Heliospheric Research, Ionospheric and Magnetospheric Research, Meteorological and Atmospheric Research, Land–Ocean Ecosystem Research, and Chronological Research). The “Project for Space–Earth Environmental Prediction” aims to develop our understanding and predictive capabilities of the influences of solar dynamics and atmosphere–ocean activities on the global environment. The “Project for the Interaction of Neutral and Plasma Atmospheres” aims to improve our understanding of the relation between the Earth’s atmosphere and space using a global observation network of interactions between the upper plasma and middle atmosphere. The “Project for Solar–Terrestrial Climate Research” aims to observe the long-term variability in the solar activity over more than several thousands of years through radioisotopes and to examine the influences of the solar activity on the atmosphere using observations and models to understand the influence of solar activity on global climate variability. The “Project for Aerosol and Cloud Formation” aims to understand the processes that form cloud and precipitation particles from aerosol particles considering the influence of cosmic rays and the processes of scattering and absorption of radiation by clouds and aerosol particles using experiments, field observations, and simulations.

ISEE has also organized three Research Centers to contribute to national and international research development of the relevant disciplines in cooperation with the Research Divisions. The Center for International Collaborative Research (CICR) conducts extensive observations with four domestic observatories (Moshiri, Rikubetsu, Fuji, and Kagoshima) and a global observation network and enhances collaboration and joint research with domestic and international researchers and institutions. The Center for Integrated Data Science (CIDAS) conducts infrastructure and research development of intensive studies of the space–Sun–Earth system through the analysis of big data and advanced computer simulations. The Center for Orbital and Suborbital Observation (COSO) conducts planning and technological development of research using orbital and suborbital observation vehicles, such as aircraft, balloons, rockets, and satellites, with national and international networks.



Division for Integrated Studies



- Solar flare · CME
- Inner-magnetosphere · Radiation belt
- Aurora substorm
- Space weather · Space storm
- Space climate · Long-term variations of the Sun
- Space plasma
- Computer simulation
- Data assimilation

In the Division for Integrated Studies, we conduct a study aiming at the comprehensive understanding and prediction of various phenomena in the solar-terrestrial system, using advanced computer simulation and data analysis. In particular, we promote studies leading to the elucidation of various phenomena, such as solar cycle, solar flares, coronal mass ejections (CMEs), geomagnetic storms, and aurora, where the nonlinear interaction and intercoupling reaction between different systems play an important role. We are leading a nationwide project for the understanding and prediction of solar-terrestrial environment variability and the various influences of these phenomena on social life based on the Grant-in-Aid for Scientific Research on Innovative Area from Ministry of Education, Culture, Sports, Science and Technology (MEXT). We are also promoting scientific projects of satellite missions (Hinode and ERG satellites) observing the Sun and geo-space in cooperation with the Institute of Space and Astronautical Science, JAXA, and National Astronomical Observatory of Japan. The faculty members of this division are responsible for the education in Graduate Schools of Science and Engineering at Nagoya University. The graduate students of both schools and the undergraduate students of the Engineering School cooperate in a multilateral way and advance the integrated study of the solar-terrestrial environment.

Main Activities in FY2018

Surface velocity estimation for solar cycle prediction

Predicting the next solar cycle is crucial for space weather studies. So far, we have developed the surface flux transport (SFT) code for predicting the solar cycle activity and improved the accuracy of parameters necessary for SFT calculation. In this fiscal year, we especially concentrate on obtaining the velocity field, which is a necessary parameter for this model calculation, through satellite observation. As a result, we found that the flow in the meridional plane in a strong-magnetic-field region is slower than that in a weak-magnetic-field region. This result has already been reported in Imada & Fujiyama, The Astrophysical Journal Letters, 864, L5, 2018.

Magnetic field characteristics related to the onset condition of solar flares

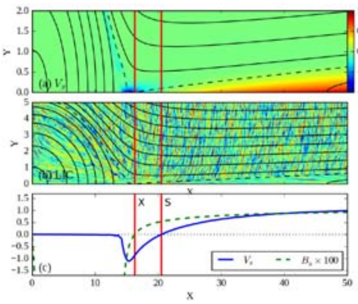
Coronal magnetic fields are responsible for the onset of solar flares and eruptions. However, the type of magnetic field parameters that can be used to measure the critical condition for a solar eruption is still unclear. As an effort to understand the possible condition for a solar flare, we examined the nondimensional parameter κ introduced by Ishiguro and Kusano (2017), which contains information about magnetic twist distribution and magnetic flux in an active region (AR). We introduced a new parameter κ^*, as a proxy for κ, and analyzed its evolution during the flaring period of AR NOAA 11158 using the nonlinear force-free field extrapolated from the photospheric vector magnetic field data. As a result, we found that κ^* increased to a certain level before two large flares and decreased significantly after their onset. The results suggest that κ^* can be used as an indicator of the necessary condition for the onset of a solar eruption in AR.

Based on this result, we propose a new method to assess the possibility of a large solar eruption from AR by combining the parameter κ* and information about the magnetic energy of AR. The result of this study was published in The Astrophysical Journal by Muhamad, et al. (2018).

MHD simulation of the largest solar flare observed in solar cycle 24

We performed a magnetohydrodynamic (MHD) simulation for the X9.3 flare, which is the largest solar flare in solar cycle 24. First, we found that the multiple magnetic flux ropes (MFRs), which are a bundle of twisted field lines, exit along the polarity inversion line at an early time. Once a part of the MFRs loses stability or equilibrium, a large and coherent MFR can be formed through a reconnection among the pre-erupting MFRs. The current sheet and post-flare loops are formed under the erupting MFR. As the simulation showed the rotation of the erupting MFR, we suggest that this rotation is related to the formation of a southward magnetic field, which exerted much influence on the geospace (Inoue et al., 2018, *The Astrophysical Journal*, 867, 83)

Mechanism of non-steady Petschek-type reconnection with uniform resistivity



(a) Outflow structure (vx), (b) line integral convolution plot of the flow, and (c) outflow and reconnected magnetic field profile along the current sheet. The vertical solid lines correspond to the location of the X- and S- points on the x-axis.

Recent findings on magnetic reconnection in high-Lundquist-number plasmas have indicated that a Sweet-Parker-type plasmoid chain reconnection can play a role in affecting fast reconnection. By contrast, it has proven difficult to achieve Petschek model reconnection in plasmas with uniform resistivity because sustaining it requires localization of the diffusion region. However, Shibayama et al. (2015) noted that Petschek-type reconnection can be achieved spontaneously in a dynamical manner even under uniform resistivity through the so-called "dynamical Petschek reconnection." In this new type of reconnection, Petschek-type diffusion regions can be formed in connection with plasmoids. In this study, we performed a two-dimensional resistive MHD simulation under uniform resistivity, which was undertaken to determine the diffusion region localization mechanism under dynamical Petschek reconnection. Through the simulation, we found that the separation of the X-point from the flow stagnation point (S-point) plays a crucial role in the localization of the diffusion region because the motion of the X-point is restricted by the strong flow emanating from the S-point. This mechanism suggests that dynamical Petschek reconnection is possible even in large systems such as the solar corona. The result of this study is published in Physics of Plasmas by Shibayama et al. (2019).

New electromagnetic linear dispersion solver for plasma with a drift across magnetic field

A current across the magnetic field is formed in various situations in plasma. The relative drift between ions and electrons due to the cross-field current becomes a source of various microscopic instabilities. A new fully electromagnetic and kinetic linear dispersion solver for plasma with a drift across the magnetic field is developed by assuming a uniform background plasma (Umeda and Nakamura, 2018, *Physics of Plasmas*, 25 (10), 102109).

Auroral substorm onset in satellite-based global images and ground-based all-sky images

The field of view (FOV) of ground-based all-sky images is limited. Thus, it is generally difficult to distinguish whether an observed substorm was initiated inside or outside FOV. Accordingly, satellite-based global images with a wider FOV have been supposed to be the most reliable dataset to identify substorm onsets. Although the sensitivity of satellite images is low, this caveat has not been supposed to have significant impacts because the identified onsets have been consistent with Pi2 geomagnetic pulsations. In the present study, we directly compared substorm onset signatures in global images and all-sky images for the first time. Accordingly, the onsets in global images and Pi2s were delayed relative to the onset in all-sky images, and in fact, agreed with poleward expansion.

Instantaneous frequency analysis of nonlinear EMIC emissions in the inner magnetosphere: Arase observation

In the inner magnetosphere, the Arase spacecraft has observed electromagnetic ion cyclotron (EMIC) emissions with both rising and falling frequencies. The instantaneous frequency analyses on the electromagnetic fields of the EMIC rising tone emission have been performed by the Hilbert-Huang transform. The time variation of the instantaneous frequency shows a good agreement with the nonlinear theory for the frequency evolutions. Rapid instantaneous frequency modulation is also found during the rising tone emission. We estimated the peak-to-peak time of fluctuation in the frequency, and found that it is caused around half of the particle-trapping time. From the motion of the phase-bunched particle around the resonant velocity, it is expected that the nonlinear resonant current that induces the falling frequency is formed in half the trapping time (Shoji et al., 2018, *GRL*).

Inter-channel comparison of the HEP instrument onboard the ERG satellite

A comprehensive inter-channel comparison of the detection efficiency of the high-energy electron experiment (HEP) instrument aboard the ERG satellite was made with in-orbit observation data obtained by the instrument. Evaluation of relative count ratios between directional channels of HEP revealed that the outermost channels of each detector show a nonlinear, varying response as compared to the other channels. Further correlation analyses indicated that the nonlinearity of count variation stemmed from a combined effect of the oblique incidence of electrons on the detectors and electron scattering by an aluminum plate mounted above the detectors.

Mode conversion to generate plasmaspheric EMIC waves

We identified generation of plasmaspheric EMIC waves via the mode conversion from Equatorial Noise that is X-mode whistler waves at the low altitudes. The existence of M/Q=2 ions are essential for this mode conversion, which changes the dispersion relation of the plasma waves. From estimation of cut-off and cross-over frequencies of X-mode whistlers and EMIC waves, we found that the maximum composition ratio of M/Q=2 ions are ~10% in the low altitudes.

Rapid loss of relativistic electrons by EMIC waves observed by ERG, Van Allen Probes, and ground stations

There has been increasing evidence for pitch angle scattering of relativistic electrons by EMIC waves. Theoretical studies have predicted that the loss time scale of MeV electrons by EMIC waves can be very fast, suggesting that MeV electron fluxes rapidly decrease in association with EMIC wave activity. We have found a unique event of rapid loss of MeV electrons in association with EMIC wave activity. During the event, the ERG satellite observed a signature of MeV electron loss by EMIC waves, and the satellite and ground-based observations constrained the spatial-temporal variations of the EMIC wave activity during the loss event. The multi-satellite observation of MeV electron fluxes showed that these fluxes substantially decreased within a few tens of minutes where the EMIC waves were present. The present study provides an observational estimate of the loss time scale of MeV electrons by EMIC waves.

Simulation study on internal velocity variation in eruptive prominence

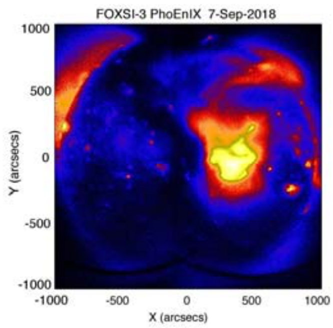
Recent observations by SMART/SDDI of Hida Observatory found an increase in velocity dispersion inside prominence prior to eruption (Seki et al., 2017). The precursory phenomenon can be helpful for developing a prediction scheme for prominence eruptions. To understand the physical mechanism of the phenomenon, we performed three-dimensional MHD simulations, including radiative cooling and thermal conduction. We modeled an eruptive prominence with a dynamic interior by combining the prominence formation model (Kaneko and Yokoyama, 2018) and the flare trigger model (Kusano et al., 2012). Our simulation quantitatively reproduced the observed increase in velocity dispersion. We found that the growth of upflows driven by magnetic forces sustaining prominence leads to an increase in velocity dispersion. We propose that plasma flows inside prominence locally enhance the current density, facilitating MHD instability (Kaneko and Yokoyama, 2018, *The Astrophysical Journal*, 869, 136).

Numerical studies on solar sunspot cycle

We studied the solar sunspot cycle using numerical simulations. In recent years, the SFT model has been used for predicting the solar sunspot cycle. A large assumption in the SFT model is that the large-scale magnetic field is nearly vertical (or radial) on the solar surface. We carried out direct MHD simulations to test the validity of this assumption by estimating the transport parameters through the thermal convection in the Sun. The numerical results showed the supporting evidence of the SFT model. We also studied the effect of asymmetry in the spatial size of the sunspot pair on polar field formation. Although the existence of this asymmetry has been a well-known feature of sunspot, very few studies have focused on its role in polar field formation or the sunspot activity cycle. We found that the asymmetry in the size of sunspots efficiently prevents polar field formation.

First soft X-ray imaging spectroscopy of the Sun with FOXSI-3 sounding rocket

On September 8, 2018, in JST (September 7 in local time), the third flight of the Focusing Optics Solar X-ray Imager (FOXSI-3) sounding rocket experiment was successfully performed from White Sands, New Mexico, USA. FOXSI is an international experiment for high-sensitivity X-ray observation of the Sun using X-ray focusing optics, and the Japanese team provides focal plane detectors. FOXSI-3 successfully observed the Sun for 6 min, as planned, during the ~15 min flight. One of the FOXSI-3 detectors is a high-speed X-ray CMOS camera developed by Ishikawa at ISEE, and the first ever soft X-ray imaging spectroscopy of the Sun in the 0.5–5 keV energy range was successfully performed with the new detector. The obtained data are qualitatively new as compared to those obtained by past instruments, and enable us to investigate the physical properties of coronal plasma.

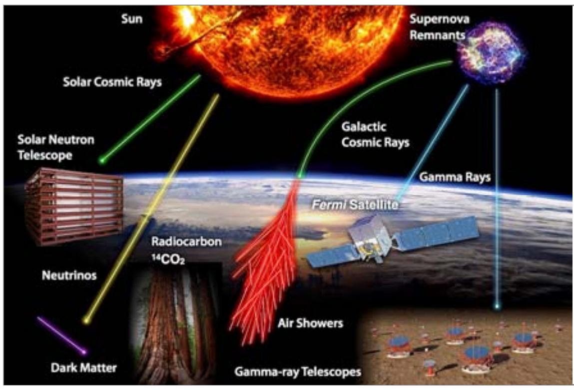


Soft X-ray image of the Sun obtained with FOXSI-3. We can create an X-ray spectrum at any point in the image.

International collaborative research between Nobeyama Radioheliograph and Chinese new solar radio telescope

We began international collaborative research in the earnest between Nobeyama Radioheliograph and the Chinese new solar radio telescope (MUSER). Researchers from Japan and China visited each other's partner country and learned the details of the instrument and data analysis method. At first, we began analyzing data of a solar flare that were simultaneously observed with these two telescopes. We are also discussing a plan to prepare MUSER’s data analysis environment in ISEE.

Division for Cosmic-Ray Research



- Acceleration and propagation of cosmic rays
  - Cosmic gamma-ray observations
  - Solar neutron observations
- Cosmic-ray interactions with the Earth's atmosphere
  - Hadron interactions of very-high-energy cosmic rays
  - Past solar activities probed by cosmogenic nuclides
- Particle astrophysics and non-accelerator physics
  - Dark matter and neutrino physics
- Wide-field transient survey by an optical telescope

Cosmic rays (CRs), which are mostly protons with small amounts of charged particles, such as electrons or nuclei, and neutral particles, such as gamma rays or neutrinos, are produced in space and propagate through interstellar and interplanetary magnetic fields before reaching the Earth. The Division for Cosmic-Ray Research performs cosmic gamma-ray observations using the Fermi Gamma-ray Space Telescope (Fermi satellite) and the Cherenkov Telescope Array (CTA), as well as high-altitude solar neutron observations, to reveal the CR acceleration mechanisms as common space plasma phenomena.

CRs also provide hints for ultra-high energy phenomena and unknown particles that cannot be explored in a laboratory. We conducted the Large Hadron Collider forward (LHCf) and the Relativistic Heavy Ion Collider forward (RHICf) experiments to study the hadronic interactions of ultra-high energy CRs using accelerators such as LHC or RHIC. This division also conducts neutrino physics research with the Super-Kamiokande experiment and promotes the Hyper-Kamiokande project as a future prospect. The group intensively works for direct dark matter searches in the XMASS liquid xenon experiment at the Kamioka Observatory and has recently started a new commitment to the XENONnT experiment in LNGS in Italy.

CRs deeply penetrate the atmosphere, producing ionization and cosmogenic nuclides. Our division studies past solar activities and sudden changes in CR flux that are recorded in the carbon-14 (^{14}C) fractions of ancient tree rings and other cosmogenic nuclides from Antarctic ice cores.

In addition, this division conducts the MOA experiment with a dedicated 1.8-m wide-field optical telescope at Mt. John University Observatory in Tekapo, New Zealand. It conducts surveys of gravitational microlensing due to massive astrophysical compact halo objects (MACHOs) or exoplanets and optical follow-up observations of gamma-ray bursts, super-nova neutrino detections, and gravitational wave events.

Main Activities in FY2018

Search for dark matter and research on the origin of cosmic rays with gamma-ray observations

Cosmic gamma rays are expected to be produced through interactions of dark matter, CRs, and the interstellar medium. It makes gamma rays good probes to search for dark matter and to investigate the properties and distributions of CRs and the interstellar medium.

We have been developing an image restoration technique for Fermi gamma-ray data. We improved this technique to account for the Galactic diffuse gamma-ray background. This enables image analysis of faint gamma-ray sources in the presence of the diffuse gamma-ray background. By applying this technique in the Galactic center region, we found possible new gamma-ray sources that have not been previously detected. This is a step forward for better understanding of backgrounds for dark-matter search in this region. We also applied this technique to image the supernova remnant, RX J1713.7–3946. We have found an image slightly different from that obtained by higher-energy gamma rays. These results are presented in the Fermi symposium 2019.

We are developing the next-generation gamma-ray observatory, the CTA, to observe gamma rays at higher energies than the Fermi satellite. We are in charge of the development of silicon photomultipliers (SiPMs) for the Gamma-ray Cherenkov Telescope, which is a CTA telescope. We systematically characterized SiPMs with different geometries and finalized the specifications based on the measurement results. We also developed calibration procedures for gain characterization and stabilization against temperature excursions.

Group photo at the inauguration of the SCT prototype on Jan. 17, 2019. (Image credit: Deivid Ribeiro, Columbia University)

In addition, we started studying the feasibility of replacing the photomultipliers (PMTs) with SiPMs for the medium-sized telescopes (MSTs) of the CTA. Originally, the PMT was selected as it was less expensive for covering the area required for the MST camera. As the SiPM cost became comparable to the PMT cost, the SiPM became an attractive alternative because it can operate under the moonlight, which can double the observation time of the MST. The simulation study that takes into account the wavelength dependence of the photon detection efficiencies of SiPMs and PMTs indicates that the overall efficiencies for Cherenkov photons are very similar between them. We are now verifying the properties (mainly angular and spectral dependence) of the SiPM and PMT to adjust the simulation.

We also contributed to the development of signal processing electronics for the Schwarzschild-Couder telescopes (SCTs) and light concentrators for photosensors of the large-sized telescopes (LSTs). Prototypes of the SCT and the LST were constructed and succeeded in taking Cherenkov images of air showers produced by interactions of cosmic rays.

Acceleration mechanism of solar energetic particles

The study of the acceleration mechanism of solar energetic particles is expected to provide key information for understanding the origin of CRs. To understand particle acceleration at the Sun, it is necessary to know the moment and duration of particle acceleration at the solar surface. Solar neutrons produced at the solar surface through the interaction of accelerated ions with the solar atmosphere are studied at ISEE. Neutrons are not reflected by the interplanetary magnetic field, and are thought to be preferable over accelerated particles themselves for studying the acceleration mechanism of solar energetic particles. The emission timing of neutrons can be determined from the neutron energies. ISEE has developed a worldwide network of solar neutron telescopes to detect solar neutrons (>100 MeV) over an entire day. Following the ceasing of the operation at Gornergrat in Switzerland in fiscal year (FY) 2017, the operation at Mauna Kea in Hawaii also ceased in FY2018.

Besides this network, a new solar neutron telescope was installed in Sierra Negra, Mexico (97°W, 4600 m), in 2013. The new detector was previously used for accelerator experiments, and uses 15,000 scintillator bars to measure particle tracks, providing much higher energy resolution and better particle discrimination than previous solar neutron telescopes. The new telescope was built with the support of Kyoto University, High Energy Accelerator Research Organization (KEK), and the National Autonomous University of Mexico, and the experiment was called the SciBar Cosmic Ray Telescope (SciCRT). Our Monte Carlo simulation study predicted that the power-law index of the solar-neutron energy spectrum can be determined to an accuracy of 0:1 if we know the duration of neutron production at the solar surface. Moreover, if an ambiguity of up to 1:0 of the power-law index is permitted, it is possible to discriminate between an instant emission and a continuous emission of longer than 5 min.

The activity of solar cycle 24 reached a maximum in February 2014 and has since decreased. No solar-neutron events were detected in FY2018. Significantly, two large solar flares occurred in September 2017, and their soft X-ray fluxes measured by the GOES satellite were the two highest values in solar cycle 24. Unfortunately, solar neutrons were not recorded in these flares, but we obtained four sigma excess of neutrons by SciCRT associated with a smaller solar flare, which occurred between these two large flares. Detailed analyses using information on particle tracks are underway.

This study was performed in collaboration with Chubu University, Shinshu University, the National Astronomical Observatory of Japan, RIKEN, the Institute for Cosmic Ray Research (ICRR) of the University of Tokyo, Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency (ISAS/JAXA), the Japan Atomic Energy Agency (JAEA), the National Defense Academy, the Aichi Institute of Technology, and many other institutions around the world.

Cosmic-ray interaction-focused accelerator experiment

Hadronic interactions of cosmic rays play many important roles from the aspect of astroparticle physics. They interact with interstellar matter and produce cosmic gamma rays or neutrinos, through which multi-messenger particles, various cosmic ray physics, and astrophysics are studied. In addition, high-energy cosmic rays repeat interactions in the atmosphere and are observed as particle clusters called "air showers" at the ground. To extract information of cosmic rays from "air showers," implication based on the correct knowledge of hadronic interactions is needed. They can be studied by various accelerator-based experiments. For example, hadron collider machines, such as the LHC at CERN or RHIC at Brookhaven National Laboratory (BNL), provide an opportunity to study hadronic interactions equivalent to cosmic rays of 10^{14} to 10^{17} eV.

In FY2018, we continued data analysis of the RHICf experiment obtained in 2017 run for the polarized proton–proton collisions at 510 GeV. We first reported transverse asymmetry in the very forward productions of neutral pions, which was a totally unexpected new phenomenon. We continued ATLAS-LHCf-combined analysis of proton–proton collision data at $\sqrt{s}$=13 TeV collected in 2015 at LHC and reported a detailed analysis of diffraction processes and its effect on air shower development. We also started discussion on the future data-taking plan of LHCf at LHC-RUN3 foreseen at 2021, especially from the aspect of the first combined data-taking of LHCf with ATLAS Roman-pot detectors.

Cosmic neutrinos and dark matter

A neutrino is a neutral elementary particle with an infinitesimal mass, which is scattered only through the weak interaction. The strong penetrating power of neutrinos means that information from the center of celestial bodies, such as the Sun and Earth, can be determined. In addition, neutrino oscillation occurs because of the quantum-state mixing between the three neutrino flavors. By observing this oscillation, we can explore unknown properties of neutrinos, such as their masses and mixing, and hidden information such as the material density of celestial bodies. Besides neutrinos, there are thought to be particle dark matter (weakly interacting massive particles, WIMPs) in the universe. Many experimental efforts elsewhere need to be conducted to detect its evidence for the first time.

In FY2018, we worked inside the Super-K tank after 13 years since the last access to the tank. Bad photomultipliers were replaced and the entire tank structure was cleaned up to prepare for the Gd-loading work foreseen for the next year. Since January 2019, Super-K has been filled up with pure water and resumed data-taking. As for the development of Super-K analysis, we continue development of the muon neutrino/muon anti-neutrino separation technique with the use of decay electrons from muon decays and neutron emission from neutrino interactions. We have been promoting a next-generation ultra-large water Cherenkov detector, Hyper-Kamiokande, with fiducial volume 8 times greater than that of Super-Kamiokande. A substantial effort for organization of the project has been continuously made as a member of the international Steering Committee.

We have conducted the XMASS experiment for direct WIMP searching using an ultra-low background liquid-xenon detector. The experiment has completed data-taking in January 2018 and now all the xenon has been collected. As a next step, we join the world's largest liquid xenon dark matter search experiment XENONnT from December 2017. We have started contribution to the development of a neutron veto detector by using the Ga-loading water Cherenkov technique and a liquid xenon purity monitor. In addition, we have developed a liquid-xenon single-phase TPC. We successfully observed the first S2 signal for the 13.9 keV line, which is the lowest energy ever reported for the single-phase detector. We also successfully achieved electron-recoil/nuclear-recoil separation using the S1/S2 ratio for the first time for the single-phase liquid xenon TPC.

Historic cosmic-ray intensity variation with cosmogenic radioisotopes

Cosmic rays falling on the Earth interact with the atmosphere and produce various secondary particles. Among them, long-lived cosmogenic nuclides, such as ^{14}C and ^{10}Be, are used as excellent proxies for cosmic-ray intensities in the past. We measured ^{14}C concentrations in tree rings and ^{10}Be concentrations in ice cores to investigate past cosmic-ray variations. In particular, we aim to clarify the frequency of extreme solar proton events, which would cause sudden and large increases in cosmic-ray flux to the Earth.

We discovered the annual cosmic-ray increase events in AD 775 and 994 from ^{14}C analyses of Japanese tree rings. The discovery of these events led to the accumulation of annual ^{14}C data during extended measurement periods as background to further event surveys. In this year, we have taken almost all continuous annual ^{14}C data for the past 3000 years. During this period, it has become apparent that there are at least three sharp increases in ^{14}C concentrations. In addition, we detected a sharp rise in ^{14}C concentrations around 800 BC and discussed the cause, as a collaboration research with the University of Arizona group. In addition, we elucidated the details of ^{14}C variations of the 775 and 994 events by using worldwide tree samples (COSMIC project; Büntgen et al. 2018). We clarified the regional differences of ^{14}C variations, event start dates, and ^{14}C production rates to explain ^{14}C variations of the two events with high accuracy. The obtained worldwide data showed a latitude dependence on ^{14}C concentrations, which suggests that the original particles are charged particles affected by the geomagnetic field, thus supporting the solar proton origin. To investigate the cause of the 994 event, we measured quasi-annual ^{10}Be concentrations in the Antarctic Dome Fuji ice core and showed that the detected ^{10}Be increment is consistent with the peaks found in the Greenland ice cores. Almost the same amount of ^{10}Be increases in both hemispheres suggests the charged particle origin for the 994 event.

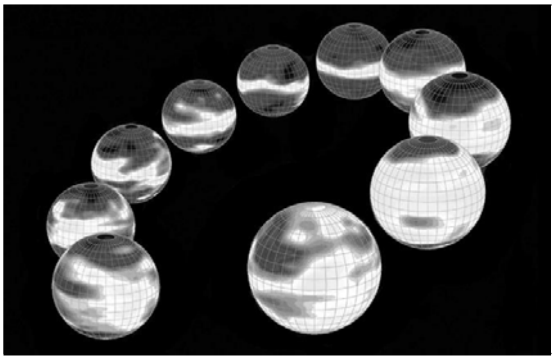
Cloud-formation experiment irradiated by heavy nuclei beams

As a conjecture for explaining the possible correlation between the Schwabe cycle of the Sun and the Earth climate, there has been discussion for possible cloud formation enhanced by galactic cosmic rays. We conducted an experiment using a small reaction chamber filled with air irradiated by ion beams such as protons, nitrogen, and xenon nuclei at the HIMAC accelerator in the National Institute of Radiological Science, Chiba, Japan. We analyzed the obtained data in detail to investigate the correlation between nuclear creation rates and ionization density (dE/dx). We found the nuclear creation rate simply scaled by the total dose to be irrelevant to the difference in the beams, i.e., ionization density. We are now summarizing an article to report it.

Wide-field optical surveys for gravitational microlensing and gravitational sources

In 2018, we detected 413 microlensing events and issued real-time alerts to follow-up groups. Several candidates of extrasolar planets have been found, and their analyses are in progress. The new gravitational wave observation period O3 will start in March 2019. Preparation for next gravitational observation is in progress.

Division for Heliospheric Research



- Solar wind
- Coronal mass ejection
- Interplanetary scintillation
- Global heliospheric structure
- Space weather forecast
- Radio astronomy
- Development of telescopes and instruments
- Pulsar

A supersonic (with a speed of 300–800 km/s) plasma flow, known as the solar wind, emanates from the Sun and permanently engulfs the Earth. While the magnetic field of the Earth acts as a barrier to protect the atmosphere from a direct interaction with the solar wind, a considerable fraction of its vast energy enters the near-surface layer via various processes. Thus, the solar wind acts as a carrier to transfer the Sun’s energy to the Earth.

The solar wind varies dramatically with solar activity. In association with eruptive phenomena on the Sun’s surface, a high-speed stream of the solar wind sometimes arrives at the Earth and generates intense disturbances in geospace and the upper atmosphere. Space environment conditions that significantly change with the solar activity are known as “space weather,” and are currently a topic of significant interest. An accurate understanding of the solar wind is needed to make reliable predictions of space weather disturbances.

We have observed solar wind velocity and density irregularities for several decades using three large antennas to investigate unsolved important issues such as acceleration and propagation mechanisms of the solar wind, space weather forecasting, global structure of the heliosphere, and its variation. In addition, laboratory and fieldwork experiments are performed for improving data quality and upgrading the instruments.

Main Activities in FY2018

Solar wind observations using the IPS system

We have been performing remote-sensing observations of the solar wind since the 1980s using the multi-station Interplanetary Scintillation (IPS) system. Tomographic analysis of IPS observations enables accurate determination of the global distribution of the solar wind speed and density fluctuations. IPS observations provide valuable information, particularly for high-latitude solar wind, where in situ observations are currently unavailable. The IPS system currently consists of three large antennas at Toyokawa, Fuji, and Kiso. The Toyokawa antenna (called the Solar Wind Imaging Facility Telescope, SWIFT) has the largest aperture and highest sensitivity among our three antennas and started daily observations in 2008. The Fuji and Kiso antennas were upgraded in 2013–2014 by installing new low-noise amplifiers (LNAs), which led to a great improvement in their sensitivity. These two antennas are located in mountainous areas and are not used for observations during winter due to heavy snowfall. Solar wind density fluctuations were derived from IPS observations at Toyokawa and measured throughout the year. The IPS data were made available to the public in real time via an ftp server, and were used for various international collaborations, as described below. In this FY, IPS observations were interrupted as the Fuji antenna was seriously damaged by two big typhoons that occurred in September. The designation of the radio astronomical facility for the ISEE IPS system expired in December. We submitted its renewal application to the Ministry of Internal Affairs and Communications, and obtained its extension for 10 years (up to 2028 December).

International collaboration for space weather forecast

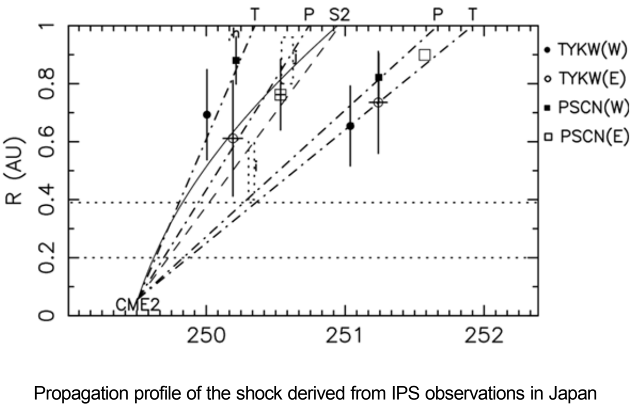
We performed collaborative research with Dr. B. V. Jackson and his colleagues at the University of California, San Diego (UCSD), on 3D reconstruction of the time-varying heliosphere using tomographic analysis of IPS observations over a long period. The time-dependent tomography program was developed through this collaborative research, and this program is now available on the web server of the NASA Community Coordinated Modeling Center (CCMC), and is running in real time at the Korean Space Weather Center (KSWC) to predict the solar wind at the Earth. The ISEE signed an agreement on research exchange and cooperation with KSWC in 2012 and renewed this in 2016. In this FY, we presented an invited talk on IPS observations of ISEE in the 8th Space Weather Conference (at Seoul, Korea) organized by KSWC. Three persons involved in KSWC visited ISEE in December and discussed with us the analysis method of IPS observations.

World-wide IPS Stations (WIPSS) Project

With the growing awareness of the utility of IPS observations for space weather forecasting, an increasing number of IPS observations has been conducted globally. Besides Japan, Russia, and India, where IPS observations have been conducted for a long time, new dedicated antennas for IPS observations have been constructed in Mexico and Korea and IPS observations using low-frequency large radio array systems, such as the low-frequency array (LoFAR) and the Murchison widefield array (MWA), have been conducted on a campaign basis. A construction project of a large-aperture antenna dedicated for IPS observations is in progress in China. An integrated analysis using IPS data from these stations enables higher-resolution 3D reconstructions of the solar wind rapidly varying with solar activity. Establishment of WIPSS was proposed at the IPS workshop held at Morelia, Mexico, in 2015. In this FY, we joined the IPS workshop held at Tongliao, China, in October. We also joined the MWA project meeting held at Nagoya University in December to present an invited talk on our IPS studies and discussed collaborations with Dr. John Morgan from the MWA project after that meeting. A party from the Chinese IPS group (four persons including Dr. Yihua Yan) visited ISEE in January and held a discussion on IPS observations and a field trip to the Toyokawa IPS antenna.

Coordinated observations of interplanetary disturbances in Japan and Russia

Traveling interplanetary disturbances associated with the halo coronal mass ejection (CME) events on September 4 and 6, 2017, were clearly detected in IPS observations at ISEE, Japan, and PRAO, Russia. The disturbances detected by IPS are ascribed to high-density plasmas associated with the shocks driven by those CMEs. As two observation stations are located at widely separated longitudes, a combined analysis of these IPS data enables high cadence tracking of the shock propagation. In this study, we derived g-values from PRAO IPS observations to compare with those derived from ISEE IPS observations. The g-value represents relative variation of solar wind density fluctuations along the line of sight (LOS), which becomes greater than 1 when a dense plasma intersects the LOS. We extracted data with $g > 1.5$ from ISEE and PRAO g-values and plotted the locations (distances from the Sun) of the LOS as a function of time to investigate the propagation process of the shocks driven by two halo CMEs between the Sun and the Earth orbit. The shock speeds inferred from the time-distance plots were much faster than those inferred

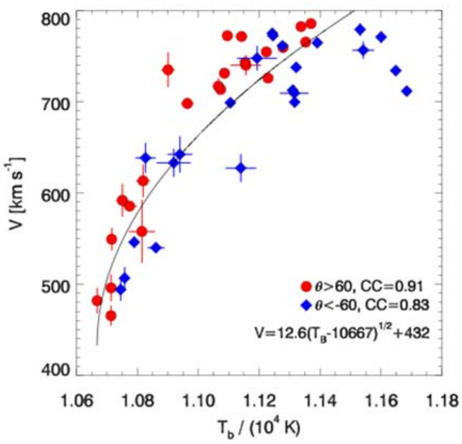


Propagation profile of the shock derived from IPS observations in Japan (Toyokawa, TYKW) and Russia (Pushchino, PSCN) for the September 6, 2017, halo CME event.

from the arrival time of the shocks at the Earth, which suggested that CMEs launched from the corona with a fast initial speed were rapidly decelerated in the interplanetary space. The IPS data also revealed the longitude dependence of the shock speed. IP disturbances propagating with a speed slower than the shock speed arriving at the Earth were observed for the September 9 CME event. No significant difference in the propagation speed was found between the east and west of these slow disturbances, suggesting that the disturbances expanded isotropically. While the origin of the slow disturbances remains an unsettled question, they may be ascribed to a wing portion of the shock.

Relationship between solar polar brightening and solar wind velocity

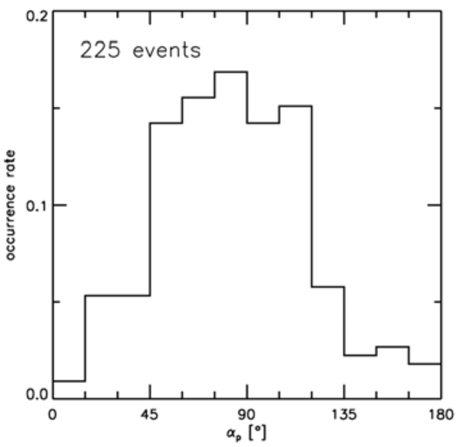
Solar polar brightening (PB) is an excess of brightness temperature (T_b) from a quiet disk level in the polar region, which is observed at frequencies between microwave and millimetric wavelengths. In this study, we compared the long-term variation (1992–2017) in PB observed with the Nobeyama Radioheliograph and polar V observed with interplanetary scintillation observations at the Institute for Space–Earth Environmental Research. By comparing V and T_b, we found good correlation coefficients (CCs) in the polar regions, CC = 0.91 (0.83) for the northern (southern) polar region. We derived an empirical formula of the V–T_b relationship as $V = 12.6(Tb–10{,}667)^{(1/2)}+432$, and then, analyzed the long-term variation of the PB and its relation with the area of the polar coronal hole (A). As a result, we found that the PB matches the probability distribution of the predicted coronal hole and that the CC between T_b and A is remarkably high (CC = 0.97). This result indicates that the PB is strongly coupled to the size of the polar coronal hole. Therefore, a reasonable correlation of V–T_b is explained by V–A. In addition, by considering the anti-correlation between A and f found in a previous study, we suggest that the V–T_b relationship is another expression of the Wang–Sheeley relationship in polar regions.



Relationships between V and T_b. Circle and diamond represent the data for north and south polar regions, respectively. Error bar represents one-sigma level.

Comparison of cylindrical interplanetary flux rope model fittings with different boundary pitch angle treatments

Interplanetary flux ropes (IFRs) are magnetic structures expelled from the Sun into interplanetary space. The magnetic field structure of an IFR comprises helical field lines around its axis. One of the most widely used methods for estimating this structure is the fitting of the Lundquist model. We evaluated two Lundquist model fitting methods by applying them to the magnetic obstacle events observed with the Wind and STEREO spacecraft and by comparing the results. In one method, the pitch angle of the magnetic field at the IFR boundary with respect to the axial direction is assumed to be 90°, and in the other method, this restriction is relaxed, and the pitch angle is handled as a free parameter α_p (hereinafter conventional and generalized methods, respectively). We found that the axis direction and magnetic flux of the IFR were significantly different. We also found that the statistical distribution of α_p, which was estimated using the generalized method, implies that a highly

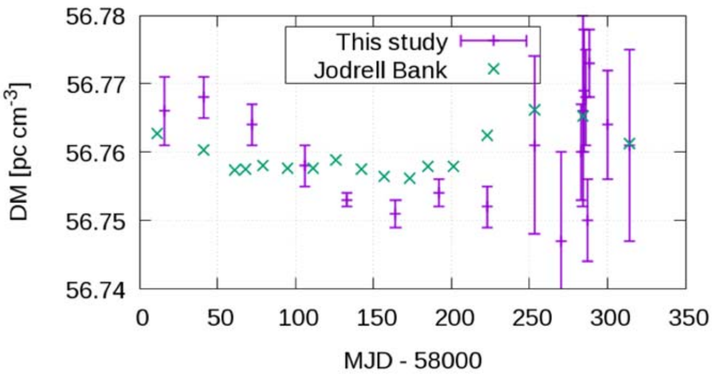


Histograms of pitch angle, α_p, as determined by the generalized method.

twisted magnetic field line surrounds the IFR surface for most of the events. These results prove that it is better to use the generalized method than the conventional method for solving the axis direction, magnetic flux, or pitch angle of the flux rope, which would lead to a more accurate derivation of the IFR properties.

Estimation of solar coronal density using the Crab pulsar

In recent years, a decrease in solar wind density due to declining solar activity has been highlighted from IPS and spacecraft observations. The coronal observations, which provide the source of the solar wind, are important for investigating the solar activity. One method for estimating the coronal density is to observe the dispersion measure (DM) of radio pulses radiated by a pulsar. DM is a parameter that represents the frequency dispersion observed in the pulsar signal, as well as the integrated electron density along the LOS. By taking the difference between the DMs when the LOS of the pulsar is located close to and far from the Sun, the (integrated) coronal density can be determined. We investigated the coronal density using the DM of the Crab pulsar. The LOS of the Crab approaches the Sun in mid-June, to as close as five solar radii over the South Pole. The Crab also emits exceptionally bright pulses, called giant pulses, which enable rapid DM estimation. The coronal density obtained from our observation was roughly in agreement with the value seen in the past at the solar activity minimum, which is the current solar activity. However, the error of the obtained value was large and no significant change from the value obtained in the past solar activity cycle could be confirmed. We will continue this observation for a higher accuracy of coronal density estimation.

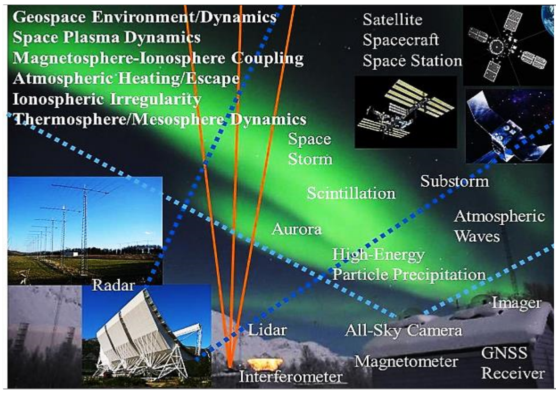


Daily variations of DMs from the Crab pulsar observed by ISEE (-) and Jodrell Bank observatory (X).

Coronal mass ejection arrival time forecasting system using IPS observations

CMEs cause disturbances in Earth's environment when they arrive at the Earth. However, the prediction of the arrival of CMEs remains a challenge. We developed an IPS estimation system based on a global magnetohydrodynamic (MHD) simulation of the inner heliosphere to predict the arrival time of CMEs, through a collaboration study with NICT, which has a Japanese space weather forecasting center. In this system, the initial speed of the CME is roughly derived from white-light coronagraph observations. Then, its propagation is calculated by a global MHD simulation. The IPS response is estimated by the three-dimensional density distribution of the inner heliosphere derived from the MHD simulation. The simulated IPS response is compared with the actual IPS observations performed by ISEE, and a good agreement is shown between them. We demonstrated how the simulation system works using a halo CME event generated by an X9.3 flare observed on September 5, 2017. We found that the CME simulation that best estimates the IPS observation can more accurately predict the time of arrival of the CME at the Earth. These results suggest that the accuracy of the CME arrival time can be improved if our current MHD simulations include IPS data. This system has been included in the real-time forecasting system in NICT.

Division for Ionospheric and Magnetospheric Research



- Energy transfer from the solar wind to the magnetosphere and ionosphere
- Magnetosphere-ionosphere-thermosphere coupled system
- Ground-based and network observation
- Space and planetary exploration

The plasma and energy carried by the solar wind to the Earth and other planets exert physical effects on the magnetosphere and ionosphere, known as the geospace. We study these effects and associated phenomena with international cooperation, primarily, through various observational approaches using ground-based instruments; for example, European Incoherent Scatter (EISCAT) radars, high-frequency (HF)/very high frequency (VHF) radars, Global Navigation Satellite System (GNSS) receivers, high-sensitivity passive/active optical instruments, magnetometers, and instruments onboard satellites/spacecraft, which are developed in our division. We also lead the way to future space exploration missions based on our expertise.

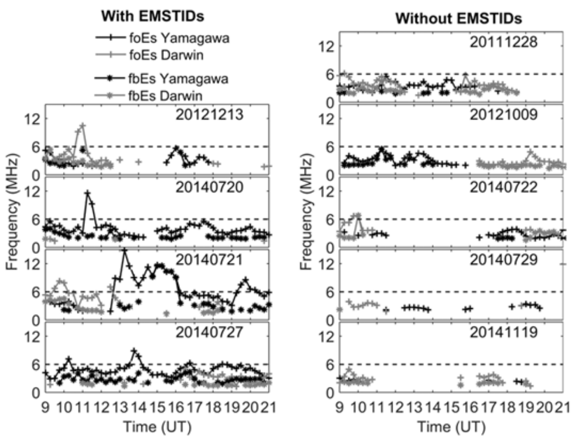
Main Activities in FY2018

PWING Project: Measurements of aurora and electromagnetic waves at subauroral latitudes

The PWING project operates aurora/airglow imagers and electromagnetic wave receivers at eight stations in Canada, Russia, Alaska, Finland, and Iceland around the North Pole at magnetic latitudes of about 60° to investigate the dynamics of plasma and waves in the inner magnetosphere. Various new results were obtained in FY2018. Using this longitudinal network, we found that the Pc1 geomagnetic pulsations (electromagnetic ion cyclotron waves) occur simultaneously over 13-h local times (~200°longitudes) at the arrival of the corotation interaction region (CIR) of the solar wind. We also found using simultaneous measurements by the Arase and Van Allen Probe satellites, that this wave contributes to a rapid loss of radiation belt electrons after the start of a CIR-associated storm.

Upper atmosphere using optical imaging instruments

To investigate the dynamics of the mesosphere, thermosphere, and ionosphere, we routinely operate Optical Mesosphere Thermosphere Imagers (OMTIs), which comprise five sky-scanning Fabry-Perot interferometers (FPIs), all-sky charge-coupled device (CCD) imagers, three tilting photometers, and three airglow temperature photometers. Various new results were obtained in FY2018. As an example, we conducted simultaneous measurements of nighttime medium-scale traveling ionospheric disturbances (MSTIDs) and the sporadic *E* layer, as well as thermospheric neutral wind,

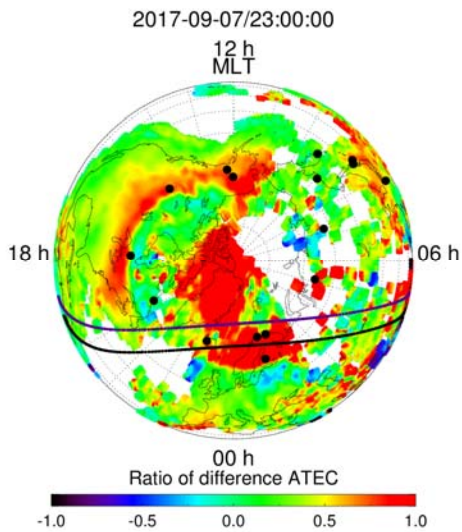


The values of foEs and fbEs, which indicates intensity of the sporadic *E* layer, for the nights with MSTIDs (left, 4 events) and without MSTIDs (right, 5 events). The values of foEs are clearly stronger for the nights with MSTIDs.

using OMTIs and ionosondes at northern and southern hemispheres in Japan and Australia, respectively. We successfully showed that the sporadic *E* layer contributes significantly to the generation of nighttime MSTIDs together with Perkins instability in the ionospheric *F* layer.

Temporal and spatial variations of the plasmasphere and ionosphere using GNSS receiver network

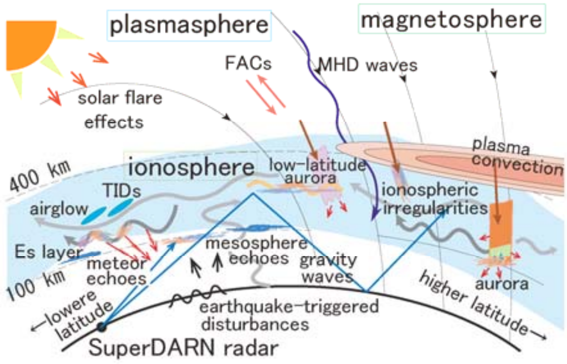
To clarify the characteristics of temporal and spatial variations of the plasmasphere and ionosphere during the development and decay of geomagnetic storms, as well as their physical mechanism, we collected the GNSS data obtained from dense regional GNSS networks extended globally and developed a database of long-term total electron content (TEC) observations, and an analysis tool. The analysis results with these analysis environments showed that an enhanced TEC region appears in the high-latitude regions from noon to afternoon within an hour after the onset of the main phase of geomagnetic storms. The enhanced TEC region expands to lower latitudes as geomagnetic storms develop. This observational fact suggests that the generation mechanism of the storm-time-enhanced TEC region is different from that of Storm Enhanced Density (SED) proposed previously. We also found that TEC perturbations caused by daytime MSTIDs decrease in case of sudden stratospheric warming. This result suggests that daytime MSTIDs can be caused by secondary gravity waves generated by the dissipation of the primary gravity waves in the stratosphere and mesosphere, where the zonal wind is intense.



Global TEC map in the northern hemisphere in geomagnetic coordinates.

SuperDARN Hokkaido HF Radars

Using the SuperDARN Hokkaido HF East and West radars at Rikubetsu, Hokkaido, we studied the statistical characteristics of Sub-Auroral Polarization Streams (SAPS) and the relationship with ionospheric conductivity determined by the solar zenith angle and geomagnetic activity. We also completed writing a comprehensive review paper on the mid-latitude SuperDARN, which was published in Earth and Planetary Science.



Schematic of natural phenomena that can be studied by SuperDARN radars (from mid-latitude SuperDARN review paper).

Investigation of FACTORS as the next-generation space exploration mission for the space–Earth coupling system

Toward the next-generation space exploration mission, FACTORS, for the space–Earth coupling system after the ERG (Arase) satellite mission led and realized by our institute for the terrestrial radiation belt exploration, we investigated the science subjects, the observational objectives and techniques, and the engineering subjects on the formation flight, the cluster launch method, and the operation of multiple satellites. Through these research activities, the formal working group for FACTORS has been approved and established in ISAS/JAXA.

Innovative design of double-shell-type energy analyzer as a next-generation technical development for *in situ* observations of space plasmas

For the miniaturization and mass reduction of the space plasma energy analyzer, we have been developing a double-shell-type energy analyzer that enables simultaneous measurements of ions and electrons with one sensor head. We designed the shapes of the collimator and the double dome-shaped electrodes so that the electrons and ions with targeted energies could be detected, and conducted numerical simulations to investigate the performance and characteristics of the analyzer. We confirmed that the electrons and ions can be analyzed with the same sensor head by only applying a negative high voltage to the electrodes.

Development of the monitoring system for the beamline calibration systems for particle analyzers in future space exploration missions

In the development of the new particle analyzers for the future terrestrial upper atmosphere explorations, we need to perform calibration tests of the analyzers using indoor beamline calibration systems. In doing so, we are developing a monitoring system for the beamline calibration systems. In this monitoring system, 2D cross-sectional distribution and energy-angle distribution of the ion beam used for the calibration of the particle analyzers can be measured. We performed performance tests of the beamline monitoring system using the beamline owned by our laboratory and acquired a 2D cross-sectional distribution profile and an energy-angle distribution profile.

International collaboration to study impacts of the EPP on atmospheric minor components

Energetic particle precipitation (EPP) can modify the density of atmospheric minor components such as NO_x and O_3, which affect the atmospheric temperature and dynamical field through chemical reactions. We organized an international collaborative team to study this topic, and analyzed data from ground-based instruments such as the EISCAT radar and optical cameras and instruments onboard satellites. For estimating the 2D map of EEP from the optical measurements, we analyzed data from the EISCAT radar and the collocated spectrograph. Then we concluded that the emission line at 844.6 nm would be more suitable for energy estimation than that at 777.4 nm, which might be mixed with other emissions sensitive to higher-energy electrons.

New five-wavelength photometer

A new five-wavelength photometer was developed and installed at the EISCAT Tromsø site (69.6°N, 19.2°E) in January 2017. The photometer consists of two units: an optical unit, and a control unit together with a PC. The photometer can simultaneously observe auroral emissions with five wavelengths. A uniqueness of the present system is its capability of precise pointing, which enables pointing the photometer at the field-aligned position using a star image obtained with a coaxial digital camera. Another uniqueness of the system is its capability of taking data at a sampling rate of 400 Hz. Some preliminary results including correlations between 427.8 and 557.7 nm, 630 nm, 777.4 nm, and 844.6 nm are presented. These comparisons are not significant unless all the five wavelength emissions emanate from exactly the same volume (i.e., magnetic zenith) in the ionosphere, which the present system has.

SDI-3D project: Development of SDI

The scanning Doppler imager (SDI) is a ground-based Fabry-Perot Doppler spectrometer, operating in an all-sky imaging mode with a separation scanned etalon to resolve Doppler spectra at heights of 90–400 km. Even a single station can estimate the horizontal wind vector and the temperature on the horizontal plane of 500 km diameter. We established an international team in 2018 with researchers of Japan, Scandinavian countries, and US. This team has started the "SDI-3D" project, which aims at developing three SDIs and deploying them in the same area as that for EISCAT_3D, which may start operation in 2022. For progressing this project, an international exchange program (or cross-appointment system) was concluded between the Nagoya University and University of Oulu (Finland) as the first case in Nagoya University. We participated in administrative-level meetings, organized by institutes to integrate the ground-based observation network in the areas of Finland, Norway, and Sweden. We asked them cooperation requests for achieving the SDI-3D project goal and obtained their consent.

Longitudinal structure of oxygen density enhancement in the inner magnetosphere

In the early 1980s, it was discovered that the O^+ density is sometimes enhanced in a limited range of altitude in the deep inner magnetosphere (~10,000- to 30,000-km altitude). This O^+ density enhancement was originally named the oxygen torus, which implies azimuthal symmetry of the density enhancement. However, its longitudinal structure remains poorly known. We investigated the longitudinal structure of the oxygen torus for the first time using simultaneous observations from the Arase and Van Allen Probe A satellites. We found that the oxygen torus does not extend over all longitudes but is localized to the dawn sector, indicating a crescent-shaped torus.

Development of a magnetometer system using Magneto-Impedance sensor

The magneto-impedance (MI) effect was discovered about 25 years ago, and a micro-sized magnetic sensor that utilizes this effect has now become commercially available. We made some modifications to the commercially available MI sensors as they can cover the range of the geomagnetic field. Experimental observations of geomagnetic field variations with the MI sensors were conducted at an observation site. The results showed that the MI sensor recorded geomagnetic variations with amplitudes of ~1 nT, which were also detected with a fluxgate magnetometer. This suggests that MI sensors are useful for researches in geomagnetism or space physics, although they are much less expensive than fluxgate magnetometers.

Data Archives

The following data archives are available to the public:

Database	Web site
OMTIs	http://stdb2.isee.nagoya-u.ac.jp/omti/
GPS scintillation	http://stdb2.isee.nagoya-u.ac.jp/QL-S4/
VHF (30.8 MHz) radar	http://stdb2.isee.nagoya-u.ac.jp/vhfr/
SuperDARN Hokkaido radar	http://cicr.isee.nagoya-u.ac.jp/hokkaido/
210-mm magnetic field data	http://stdb2.isee.nagoya-u.ac.jp/mm210/
ISEE magnetometer network	http://stdb2.isee.nagoya-u.ac.jp/magne/
ISEE VLF/ELF data	http://stdb2.isee.nagoya-u.ac.jp/vlf/
EISCAT radar, Sodium Lidar, MF/Meteor radar, Optics	http:// www.isee.nagoya-u.ac.jp/~eiscat/data/EISCAT.html
Reimei satellite data	http://reimei.stelab.nagoya-u.ac.jp/

Division for Meteorological and Atmospheric Research

- Precipitation measurements by advanced polarimetric radars and hydrometeor videosondes
- Development of new instrumental technology
- Clouds and precipitation observed by multiple satellites
- Millimeter-wave/infrared spectroscopy of green house gases and ozone-depleting substances
- Measurements and analyses of properties and behaviors of aerosols using advanced techniques

Ongoing global warming caused by increasing concentrations of carbon dioxide and other greenhouse gases will result in both gradual climate change and intensification of weather extremes and ecological catastrophes. Among the most urgent tasks for confronting global environmental problems more effectively is a close monitoring of the atmosphere using different observation methods and a better understanding of the atmosphere through theoretical insights and numerical modeling. To address these problems, the Division for Meteorological and Atmospheric Research is dedicated to several research projects for exploring the atmosphere from various angles.

Main Activities in FY2018

Characteristics of particle size distributions of a stratocumulus cloud undetected by a Ka-band radar

A Ka-band radar can observe smaller cloud particles by shorter wavelength than microwave-band radars. However, a Ka-band radar cannot sometimes detect stratocumulus and shallow cumulus clouds that we can clearly see with naked eyes. This study aims to confirm the characteristics of particle size distributions (PSDs) of a stratocumulus cloud undetected by a Ka-band radar by simultaneous observations using a cloud particle sounding: Hydrometeor Videosonde (HYVIS). A Ka-band radar was installed at Sesoko Research Facility, University of the Ryukyus. Stratocumulus and cumulus clouds frequently develop over Mt. Yae, whose height is 453 m above sea level and is located 6 km from the radar within the observation range. A balloon-borne sounding was launched from around the top of Mt. Yae into a stratocumulus cloud with thickness between 400 and 700 m at 1916 LST on June 10, 2017. Analyses of the soundings showed that the volume average and maximum diameters of PSDs in the lower two third of the cloud were 17.5 and 30.6 μm, respectively. In addition, the number concentration of particles was ~100 cm^{-3}. At that time, the Ka-band radar could not detect any echo related to the stratocumulus cloud. The equivalent reflectivity estimated by PSDs obtained by HYVIS was less than approximately -20 dBZ. This value is below the lowermost limit (-16.6 dBZ) obtained by the Ka-band radar in that situation. Assuming that the PSD shape does not change, the Ka-band radar should detect an echo in which the volume average particle size is greater than 23.8 μm.

Estimated PSD of an echo using the super droplet method

The Ka-band radar enables us to detect earlier the first echo, which shows the generation of cumulonimbus clouds. However, it is very difficult to observe PSDs of the first echo. For this purpose, we apply a sophisticated microphysical parameterization, i.e., a super droplet method with a cloud-resolving model (CReSS-SDM), which can track a particle development process from aerosols to cloud and precipitation particles by using the Lagrangian method. In the simulation result, a stratocumulus-like cloud is developed initially; however, an average particle size of less than 10 μm is too small in comparison with the sounding observation in Okinawa. After the development of active cumulus clouds, raindrops whose diameter is greater than 100 μm are formed by collision and coalescence processes and an equivalent first echo obtained by the Ka-band radar is detected when the maximum diameter of the particle is greater than 200 μm.

New rainfall observation tool: MP-PAWR

In the "Enhancement of societal resiliency against natural disasters" of the Cross-ministeral Strategic Innovation Promotion (SIP) program, the dual polarization multi-parameter phased array weather radar (MP-PAWR) was developed. As MP-PAWR can provide data about 10 times faster and a higher vertical resolution than conventional weather radars, it is suitable for observing severe weather, such as torrential heavy rainfall or tornado. Observation using MP-PAWR began in March 2018 and has succeeded in revealing new aspects of various precipitation phenomena. An example of the MP-PAWR observation on September 6 revealed the 3D structure of precipitation clouds that exist only 5 km or above and the MP-PAWR data enable the analysis of the characteristics precipitation particles as well as the kinematic characteristics of the cloud, such as quantitative estimation of not only the wind speed but also the vertical profiles of the divergence and deformation by using considerable elevation angle Doppler velocity data of MP-PAWR.

Thermodynamic mechanism for the maintenance of sharp tropical margins

The deep tropics characterized by moist air and deep convection are often separated from the dry, quiescent subtropics by a sharp horizontal gradient of moisture. Existing observations show that this margin of the moist tropics is a true PDF minimum along the column water vapor contour of ~48 mm in instantaneous data. Quasi-meridional statistical composites of observations across the poleward-most excursion of this sinuous contour retain the sharpness of the margin. In this paper, the 48-mm margin is first defined with Aqua AMSR-E observations. Observations from the CloudSat cloud radar and CALIPSO lidar are then analyzed to reconstruct the cloud and radiative heating profiles on both sides of the margin. Aqua AIRS temperature and humidity soundings are ingested into a water and energy budget analysis to find a remarkable contrast in the meridional structure of the thermodynamic state across the margin. These observed features are interpreted in terms of a simple conceptual theory from the moisture and heat budget perspectives. The findings offer a novel, "dynamic" view to characterize the tropical margin, urging an update of the conventional picture of the "static" tropical climate.

Continuous measurements of stratospheric ozone in the Patagonia region, South America

ISEE and the National Institute for Environmental Studies have implemented the "SAVER-Net project," a joint research project with Argentina and Chile as part of the SATREPS program, for 5 years since 2013. Although the project ended in March 2018, a cooperative research has continued using a facility for the ozone layer measurements in Rio Gallegos, Argentina, and an aerosol lidar network comprising nine lidars, developed by the SAVER-Net project, spread over the two countries. We advanced the retrieval analysis of vertical distribution of O_3 from the spectrum observed with a millimeter-wave spectral radiometer at Rio Gallegos from 2015 to 2017. Using the O_3 data, as well as the MERRA-2 dataset, in September and October, when the ozone hole often passes over the facility, we found a good correlation between potential vorticity and O_3 mixing ratio below the potential temperature of ~1000 K, corresponding to an altitude of 35 km. We also found temperature decrease and increase at altitudes of ~25 and ~35 km, respectively, when the ozone hole passed over the facility. These are due to the transport of polar airmass, suggesting that the potential vorticity and temperature are a good proxy of arrival of the ozone hole.

Observations of chemical composition change in the polar mesosphere

In the polar region, energetic particle precipitation (EPP) causes chemical composition changes in the atmosphere due to ionization and dissociation of nitrogen and oxygen molecules in the mesosphere. To understand these processes in detail, ISEE and NIPR conducted continuous monitoring of NO concentrations in the mesosphere and lower thermosphere using a ground-based millimeter-wave spectral radiometer installed at Syowa station, Antarctica, from January 2012 onward. In addition, the millimeter-wave measurements of NO at Tromsø, Norway, in collaboration with the University of Tromsø resumed after we fixed the issue of the FFT spectrometer in January 2019. Using the Syowa dataset, we found that the amplitude of the annual variation in NO in 2014 was significantly smaller than that in other years, and the flux of the energetic electron whose energy was larger than 1 MeV, measured with Van Allen Probes, was also significantly less than that in the other years, indicating that the flux of the energetic electron affects the seasonal and inter-annual changes in chemical composition in the mesosphere. Moreover, statistical analysis of O_3 depletion caused by precipitating protons has been performed using the O_3 dataset with AURA/MLS and the proton fluxes with GOES and POES since 2004, and a good correlation between O_3 depletion rate at 0.1 hPa (~60 km) and maximum flux of proton at solar proton events has been found.

Measurements of tropospheric and stratospheric minor constituents using infrared spectrometers

The measurements of atmospheric trace gases in the troposphere and stratosphere with a ground-based high-resolution Fourier Transform Infrared Spectroscopy (FTIR) instrument operated at Rikubetsu have been continued. Total column amounts and vertical profiles of 11 species, including O_3, CH_4, and CO, are retrieved from the observed solar absorption spectrum. Moreover, we analyze the vertical distribution of HCHO, which is associated with forest fires and biogenic volatile organic compounds, and find that the column amount of HCHO over Rikubetsu becomes a maximum in summer, and is close to the value in a remote area of the northern mid-latitude region throughout the season. We have also developed and evaluated an observation system using an optical spectrum analyzer (OSA). The observed values of the OSA system are highly correlated with those of the large FTIR whose accuracy has been validated, showing that the seasonal variation of the daytime column-averaged mixing ratios of atmospheric CO_2 (XCO_2) can be observed using it. We measured XCO_2 with it in the central area of Tokyo for 2 years, and found that the observed XCO_2 increased during south and southwest winds, suggesting that it was caused by large anthropogenic emissions of CO_2 from thermal power stations and traffic around the Tokyo central area.

Development of a wide-frequency-range and dynamic-range detector for a new radiometer system

Recently, millimeter–terahertz band technologies for application to information, telecommunication, and radio astronomy research have been developed rapidly. Based on these new technologies, we are developing a new receiver system for an atmospheric radiometer that is wide-band, highly sensitive, and highly accurate. We have also been developing a new millimeter-wave radiometer system to monitor multi-molecular lines such as O_3, NO_x, and HO_x. This year, we designed a frequency-independent optics, which covers a wide observation frequency range from 179 to 254 GHz. A new corrugated feed horn and some mirrors were fabricated and their propagation characteristics were measured. As a result, we confirmed good consistency between the design and experiment. Furthermore, we fabricated a new superconducting device for a millimeter-wave detector under collaborative research with the Advanced Technology Center at the National Astronomical Observatory of Japan (NAOJ). The measured noise temperature of this device is ~40 K, which is roughly two times the quantum noise limit, from 160 to 180 GHz. However, this resonance frequency is 60–80 GHz lower than that of the design, and we are attempting to investigate the reason behind this using simulators.

Development of a method for aerosol reaction experiments utilizing a gas-exchange technique

Aerosols in the atmosphere are considered to age through reactions with gas-phase oxidants. However, how the processes affect aerosol properties such as chemical structure and cloud condensation nucleus activity have not been clarified. For the atmospheric aerosol reaction experiments conducted to reveal this, we developed a reaction experiment system composed of a flow tube reactor with a double-tube structure and a gas-exchange device commercialized for use with ICP-MS. We calculated the gas flow in the flow tube reactor by computational fluid analysis and obtained the results regarding the diffusion of a reactive gas (ozone) and the residence time of aerosol particles, both of which are necessary for the analysis of data obtained from the reaction experiments. Furthermore, we performed an experiment in which atmospheric aerosol was passed through the gas-exchange device, followed by the conversion of the gas to argon and the introduction of aerosol to an aerosol mass spectrometer. The result shows that the argon conversion method has an advantage in the separation of ion signals from aerosol particles and those from gases. We will further evaluate the experimental system and perform reaction experiments for atmospheric aerosols.

Analysis of the relationship between size-resolved hygroscopicity distributions of atmospheric aerosols and their respiratory deposition

Aerosol is an atmospheric pollutant that has an adverse effect on human health through its deposition within the human body through respiration. Various aerosol particles with different sizes and compositions are present in the atmosphere, and the extent of their deposition in the human body is considered an important factor for clarifying the health effect of atmospheric aerosol quantitatively. We analyzed the relationship between dry-diameter/hygroscopicity distributions of aerosols and their deposition in the respiratory system based on the deposition fractions obtained from a respiratory deposition model, using data from the measurement of size-resolved hygroscopicity distributions of aerosols in the urban air of Nagoya in the past. We analyzed the data collected in June and August 2010 before this fiscal year, and this year, we performed an analysis using data obtained from an atmospheric observation in September 2009, when size-resolved hygroscopicity distributions were measured more frequently. We obtained the characteristics of the deposition of atmospheric aerosols in the respiratory system when a human inhaled them during the observation period. The variation in the deposition amount during the observation period should have been affected by the variations in the meteorologically controlled transport and aging of aerosols, besides the variation in the emission of aerosols and their precursors in the city. We will further study the deposition of aerosols in the respiratory system, to understand the connection of the deposition amount with these regulating factors.

Data analysis of black carbon aerosols observed in the Arctic

The Arctic is warming more rapidly than the rest of the globe. Besides contributions from greenhouse gases, forcing and feedback mechanisms associated with light-absorbing aerosols, such as black carbon (BC), also need to be elucidated. In this study, we analyzed the data of vertical profiles and microphysical properties (size distributions and mixing states) of BC particles in the Arctic. These data were obtained during an international aircraft observation campaign in March–April 2018, using an onboard instrument that is based on the laser-induced incandescence technique developed by the University of Tokyo group. A series of aircraft measurements were conducted from the northern tip of Greenland. From the data analysis, we found atmospheric pollution layers at altitudes of ~3.5 and 5 km, where BC mass concentrations were distinctly high. We also found that most BC particles were thickly coated with non-BC materials at all altitudes below 5 km. Furthermore, we analyzed long-term data of the surface BC mass concentrations at multiple sites in the Arctic to reveal their temporal and spatial variations. Currently, we are analyzing the emission sources and transport process of BC particles observed by these aircraft- and ground-based measurements.

Division for Land–Ocean Ecosystem Research

- Global warming and changes in terrestrial water-material cycles in the Arctic circumpolar region
- Effects of climate change and anthropogenic forcing on the terrestrial ecosystem
- Cloud/rainfall variability in Asian monsoon regions
- Dynamics of phytoplankton in marginal seas and coastal areas
- Climate variability and changing open ocean ecosystem dynamics and biogeochemical cycle
- Interaction between oceanic waves and climate variations

The Land–Ocean Ecosystem Research Division investigates regional and global energy, water and material cycles, and physical/biogeochemical processes in the land–ocean ecosystem.

The land research group contributes to advancing our understanding of the mechanisms of how on-going global warming and anthropogenic activity influence the terrestrial water cycle and ecosystem. Using field observations, satellite remote sensing, global meteorological data analysis, laboratory analysis, and model simulation approaches, our group works to understand the impact of global warming on hydrological and greenhouse gas cycles in the Arctic region, the dynamics of the continental scale water cycle, the processes that drive weather and climate over Asia, the interplay between the terrestrial ecosystem and the climate, and the detection of early signs of influence of global warming in Antarctica.

Ocean research is conducting using satellite remote sensing, numerical simulations, and in situ observations. We also performing synthesis studies of physical and biogeochemical processes in the ocean and their interactions with the atmosphere and climate. In particular, we are investigating the manner in which oceanic heat content, circulation, and surface waves interact with atmospheric environments and how they are linked to climate and meteorological phenomena such as tropical cyclones. We are also investigating how variations in ocean circulation, mixing processes, and air–sea fluxes influence marine ecosystems where phytoplankton is a primary producer. Moreover, we are interesting the possible impact of the marine ecosystem on physical processes and climate in the ocean and atmosphere.

Main Activities in FY2018

Hydrological variability in the Arctic circumpolar tundra and the large pan-Arctic river basins

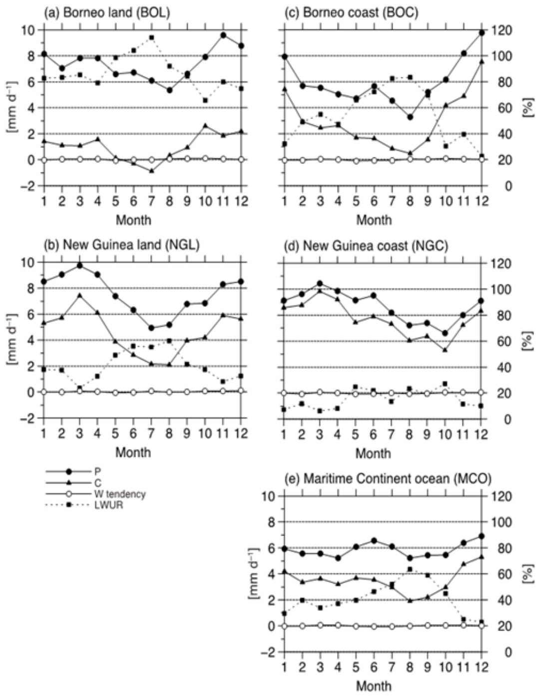
We analyzed spatiotemporal variations in the terrestrial water storage (TWS) of the Arctic circumpolar tundra region (ACTR) and those of the largest pan-Arctic river basins (Lena, Mackenzie, and Yukon), and utilized monthly Gravity Recovery and Climate Experiment data from 2002 to 2016. Together with the global land reanalysis and river runoff data, we identified declining TWS trends throughout the ACTR, mainly owing to increasing evapotranspiration driven by increasing summer air temperatures. In terms of regional changes, large and significant negative trends in TWS were observed mainly over the North American continent. In the Lena River basin, the autumnal TWS signal persisted until the spring of the following year, while in the Mackenzie River basin, the TWS level in the autumn and winter had no significant impact on the following year. These results are important for understanding future TWS trends, with ongoing climate change.

(Reference: Suzuki et al., 2018: Hydrological variability and changes in the Arctic circumpolar tundra and the three largest pan-Arctic river basins from 2002 to 2016. *Remote Sensing*, 10, 402, doi:10.3390/rs10030402.)

Precipitation maintenance mechanism over the Maritime Continent

This study investigated atmospheric water cycles over several time scales to understand the maintenance processes that control heavy precipitation over the islands of the Maritime Continent. Large island regions can be divided into land, coastal, and ocean areas based on the characteristics of both the hydrologic cycle and the diurnal variation in precipitation. Within the Maritime Continent, the major islands of Borneo and New Guinea exhibit different hydrologic cycles. Large-scale circulation variations, such as the seasonal cycle and the Madden–Julian oscillation, have a lesser effect on the hydrologic cycle over Borneo than over New Guinea because the effects depend on their shapes and locations. The impact of diurnal variations on both regional-scale circulation and water exchange between land and coastal regions is pronounced over both islands. The recycling ratio of precipitation, which can be related to stronger diurnal variation in the atmospheric water cycle that results from enhanced evapotranspiration over tropical rain forests, is higher over Borneo than that over New Guinea.

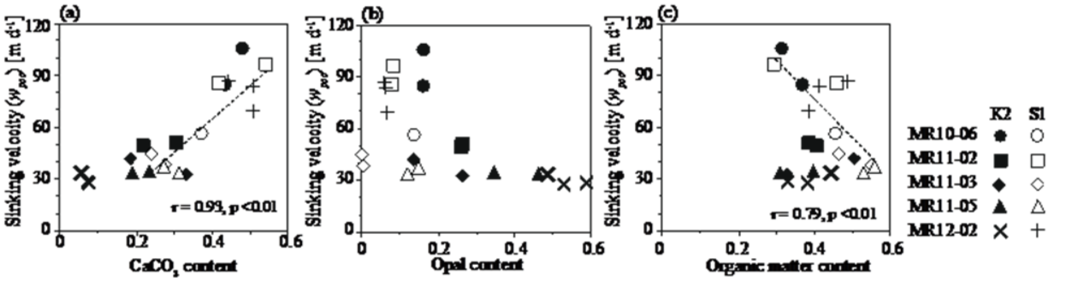
(Reference: Kanamori et al., 2018: Effect of long- and short-term atmospheric water cycles on the water balance over the Maritime Continent. *Journal of Hydrometeor.*, 19, 1413–1427, doi: 10.1175/Jhm-D-18-0052.1)



Monthly precipitation, moisture flux convergence, temporal change in precipitable water content and local water use ratio over Borneo and New Guinea regions.

Sinking velocities of particles in the subarctic and subtropical regions of the western North Pacific

The sinking of particulate matter in the ocean is one of the most important processes by which carbon and other biophilic elements are transported from the surface to the ocean interior, referred to as the "biological pump." Here, we examined sinking velocities of particles exported from the upper layer at two observation sites, K2 and S1, located in the subarctic and subtropical gyres in the western North Pacific, respectively. Sinking particles, collected by drifting sediment traps at 100–200 m, were fractionated in five ranges of sinking velocities between 5 and 1000 m day^{-1} using a elutriation system. The averaged sinking velocities (*wPOC*) calculated from the velocity distributions of POC were 31 ± 16 and 63 ± 26 m day^{-1} at K2 and S1, respectively, i.e., POC was exported faster at S1. For S1 particles, a positive correlation was found between *wPOC* and $CaCO_3$ contents. This indicates that particles containing heavy $CaCO_3$ sink



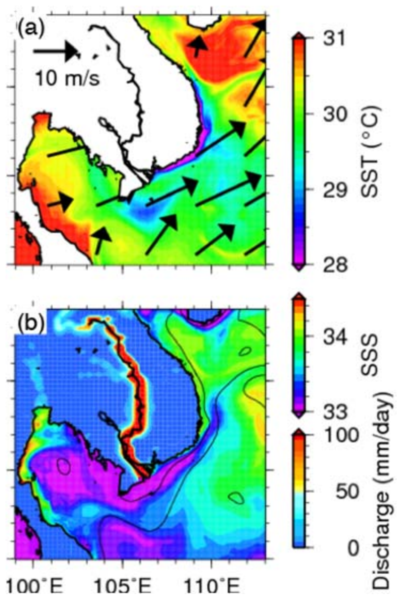
Relationships between sinking velocity and (a) calcium carbonate ($CaCO_3$) content, (b) opal content, and (c) organic matter content of particles.

faster than those containing lighter organic matter. Particles at K2, mainly composed of opal and organic matter, did not exhibit a clear relationship between *wPOC* and the denser opal. Instead, *wPOC* had a positive correlation with $\delta^{15}N$ of the sinking particles and was small (large) when the surface layer was stratified (well-mixed). These results implied that the upper water stability/mixing influences the growth/fragmentation of aggregates as well as their chemical composition, thereby affecting *wPOC*.
(Reference: Sukigara et al., 2019: Sinking dynamics of particulate matter in the subarctic and subtropical regions of the western North Pacific. Deep-Sea Res. I, doi: 10.1016/j.dsr.2018.11.004)

LETKF-based high-resolution ocean data assimilation system for the Asia-Oceania region

With the development of satellite observations and numerical models, high spatiotemporal variations in sea-surface temperature, salinity, and height associated with oceanic fronts and eddies have been detected. Satellite observations with infrared and microwave sensors can capture variables at the sea surface except for under cloud and heavy rainfall regions, respectively. In contrast, numerical models can provide 3D gridded outputs without missing values, but do not necessarily have perfect reproducibility because they include parameterizations. Data assimilation estimates statistically best states combining observations and outputs from numerical models, and therefore, may provide outputs with more high reproducibility.

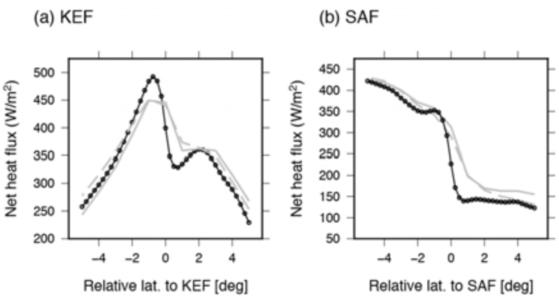
In this study, we established a one-way nest high-resolution ocean data assimilation system in the southeastern Asian coastal region [98°–115°E, 0°–22°N] with a horizontal resolution of 1/36° embedded in the large-scale western Pacific region [95°E–165°W, 50°S–50°N] with that of 1/12°. To consider spatiotemporal salinity variations, freshwater fluxes (the sum of evaporation, precipitation, and river discharge) were incorporated into the ocean model and satellite sea-surface salinity was assimilated. The southeastern Asian coastal system showed that in the summer wet season, when southwestern monsoon blows, the localized cool sea-surface temperatures along the Vietnam coast caused by coastal upwelling and northeastward advection of low-salinity water formed by freshwater discharge from the Mekong River. Thus, the system may enable us to gain insight from the connection between physical and biological oceanography and hydrology.



Monthly mean of (a) sea-surface temperatures and surface wind, (b) sea-surface salinity and river discharge, and sea-surface height in the southeast Asian coastal system in August 2015.

Satellite-derived global surface flux data set: J-OFURO3

Accurate estimations of surface heat, momentum, and freshwater fluxes over the global oceans are needed to understand the air−sea interactions in the climate system. It is difficult to estimate fluxes for global oceans by using in situ observations alone; therefore, it is necessary to estimate satellite-based observation. In this study, we newly developed satellite-derived air-sea flux estimation through multiple satellites, as well as advanced estimation techniques. Furthermore, the obtained estimated values were prepared as a

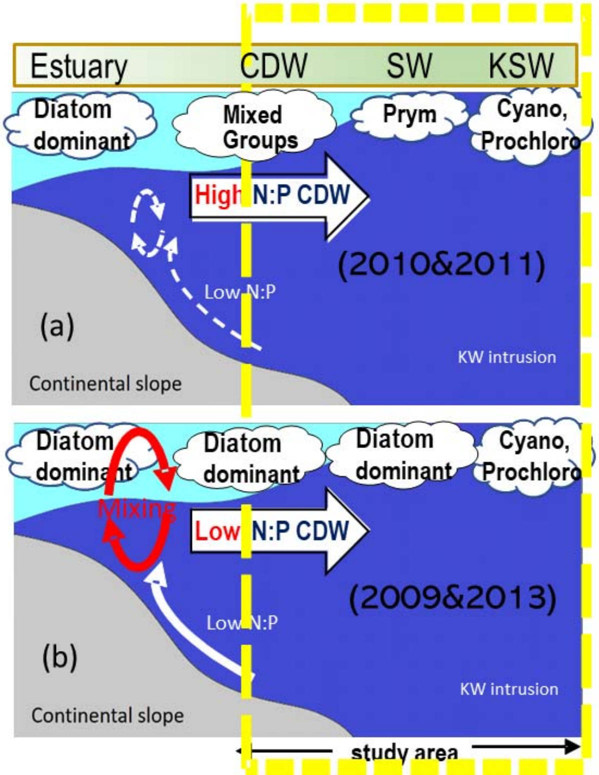


Air-sea flux changes in January climatological monthly mean in the North Pacific, (Left) Kuroshio front, and (right) subarctic front.

dataset and released to the public as J-OFURO3. The new dataset succeeded in more accurately capturing the regional surface flux changes associated with the oceanic meso-scale and fronts that could not be captured clearly in the previous studies (see figure p46). Furthermore, with the development of long-term data for 30 years (1988–2017), various investigations regarding climate change and global warming have started. This is also expected to contribute to research on ocean mixing and the impact on ocean ecosystems that have initiated air–sea interactions.
(Reference: Tomita et al., 2019: *J. Oceanogr.*, 75, 171, doi: 10.1007/s10872-018-0493-x)

Control of Phytoplankton Community Structure in East China Sea by Anthoropogenic Input of Nitrogen

It is indicated that the anthropogenic nutrient input from the large river Changjiang changes the ecosystem of the river mouth in East China Sea. However, the large-scale change in the phytoplankton community was not known in the middle of the East China Sea, which can be important for Japanese fisheries. In July 2009–2011 and 2013, the phytoplankton community structure was studied at the south of Jeju Island, Korea, to the Japanese side by T/V Nagasaki-Maru, Nagasaki University. Large diatoms dominated in 2009 and 2013, whereas small cyanobacteria and green algae dominated in 2010 and 2012. In the diatom-dominated years, the phosphate concentration and N/P ratio were high and low, respectively. Results of statistical analysis with other environmental parameters indicated that the influence of river discharge with high anthropogenic nitrogen was high for low-diatom years, while the phosphate input from non-Changjiang origin water was important in the diatom-dominated year. When upwelling and mixing near the Chinese coastal area supplied phosphate to the Changjiang Diluted Water, the influence of anthropogenic nitrogen became weaker and resulted in lower N/P ratio with diatom dominance. The results contrasted with those of Amazon plume, where diatom dominated with low anthropogenic nitrogen supply.



Influences of Changjiang river and upwelling water on phytoplankton community structure. Top: years with high anthropogenic nitrogen input from Changjiang river, Bottom: years with high influence of upwelling.

(Reference: Xu, Q., et al., 2019: Interannual changes in summer phytoplankton community composition in relation to water mass variability in the East China Sea. *J. Oceanogr.*, 75(1), 61–79, doi:10.1007/s10872-018-0484-y
: Gomes, H.d.R. et al., 2018: The Influence of Riverine Nutrients in Niche Partitioning of Phytoplankton Communities–A Contrast Between the Amazon River Plume and the Changjiang (Yangtze) River Diluted Water of the East China Sea. *Front. Mar. Sci*., doi: 10.3389/fmars.2018.00343)

Division for Chronological Research

- AMS-^{14}C dating
- Developing ^{14}C pre-treatment and measurement techniques
- Analysis of cosmogenic nuclides
- CHIME (chemical U-Th total Pb isochron method)
- Geochronology
- Isotope analysis
- Microanalysis and spectroscopy
- Paleoclimate reconstruction

Short- and long-term forecasts of global environmental changes and their countermeasures are issues of great urgency. Determining when an event occurred in the past, via "dating," is of importance understanding present and predicting future states of the Earth. We promote chronological studies on a broad range of subjects from events in Earth's history, spanning ~4.6 billion years, to archaeological materials, cultural properties, and modern cultural assets. The Tandetron dating group conducts interdisciplinary research involving radiocarbon (^{14}C) dating using accelerator mass spectrometry to understand changes in the Earth's environment and the cultural history of humankind from ~50,000 years ago to the present day. In addition, the group studies near-future forecasts of Earth and Space environments, focusing on spatiotemporal variations in cosmogenic nuclides, such as ^{14}C and ^{10}Be, and conducts research that integrates art and science through collaboration between researchers in archeology, historical science, and other fields. The microscale spatial dating group uses the chemical U-Th total Pb isochron method (CHIME), which was firstly developed at Nagoya University, to shed light on events in Earth's history from its formation 4.6 billion years ago up to approximately 1 million years ago. An electron probe microanalyzer (EPMA) have been used to perform nondestructive microanalyses of rocks and other materials to reveal records of complex events recorded in zircon, monazite, and other samples.

Main Activities in FY2018

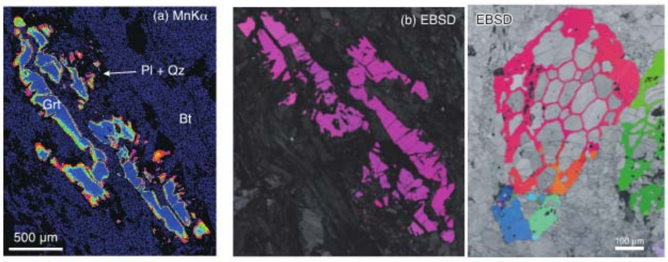
JASPAR – The Japan-Spain-Pakistan Archaeological Research Initiative

JASPAR is a new research initiative in the archaeology of Sindh, the southeast of Pakistan. It is an umbrella of projects dedicated to study the paleoenvironment, archaeology, and ethnoarchaeology of Sindh during the period from early humans (PaleoAsia project) to the Harappan Civilization (2600–1900 BC; RainDrops and ModAgrO projects). It has been promoted by the Shah Abdul Latif University (SALU, Khairpur, Sindh), the Endowment Fund Trust for Preservation of the Heritage of Sindh, the Universitat Pompeu Fabra (UPF, Barcelona, Spain), the Japanese Centre for South Asian Cultural Heritage (JCSACH, Tokyo, Japan), the University of Tokyo, Nagoya University, and the National Institute of Advanced Industrial Science and Technology (AIST). The first international collaborative survey of archaeological and paleoclimate studies in the Thar Desert, Pakistan's Sindh Province, was carried out from January to February 2018.

JASPAR survey in the Thar Desert, Pakistan's Sindh Province.

Analysis of crystallographic orientations of garnet grains in coesite - eclogite

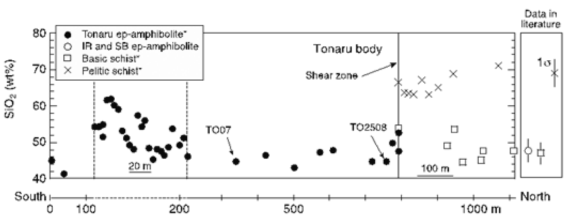
Various scales of deformation structures, such as folding, faulting, pressure shadows, lattice-preferred orientation, and dislocation phenomena, observed in metamorphic rocks and minerals clearly record the dynamic processes during metamorphism. To investigate the behavior of various metamorphic rocks in response to tectonism during prograde and retrograde metamorphic stages, the electron back scatter diffraction (EBSD) method and EPMA were employed in the analysis of crystallographic orientations of garnet grains in coesite-eclogite from the Sulu Belt, China; granulite in the Mogok Belt, Myanmar; and epidote-amphibolite and quartz schist of eclogite and non-eclogite units, respectively, in the Sanbagawa Belt, Japan. Most of the analyzed garnet grains showed segmentation texture formed by a hydration reaction during the exhumation stage. The segments that form an aggregate in each sample share similar crystallographic orientations, with misorientations of less than 3–4°. This suggests that the segmentation textures were not formed by deformational crush, but that the grains recorded a static environment during exhumation. A honeycomb garnet, which includes an abundance of quartz grains, in a quartz schist from a Sanbagawa non-eclogite unit also shows no evidence to suggest deformation processes. This grain formed by hydraulic fracturing of quartz and garnet recrystallization along the grain boundaries due to the dehydration reaction during the prograde stage of the epidote-amphibolite facies metamorphism. Thus, this sample might not have undergone significant deformation during exhumation from depths of 25–30 km (0.8–1.0 GPa) to the Earth's surface.



Left and Center: (a) EPMA MnKα and (b) EPSD maps of a segmented garnet in the Mogok granulite from Myanmar. Abbreviations for minerals: Bt, biotite; Grt, garnet; Pl, plagioclase; Qz, quartz.
Right: EBSD map of a honeycomb garnet in a Sanbagawa quartz schist.

Petrological and geochemical studies of Tonaru epidote-amphibolite and surrounding schists in the Sanbagawa Metamorphic Belt, central Shikoku

A subduction zone is a unique environment where various materials from the Earth's surface encounter mafic and ultramafic lithologies of the lower crust and mantle wedge. It can be inferred that mechanical (physical) and chemical interactions between these materials progress dynamically during the subduction process along the interface between the subducted slab and the crust-mantle zone beneath the arc-trench system. In the Besshi region of the Sanbagawa Metamorphic Belt in central Shikoku, SW Japan, there are extensive occurrences of various metamorphic rocks that have originated from different protoliths of peridotite, gabbro, basalt, shale-sandstone, and limestone. Field relationships between the Tonaru epidote-amphibolite body and the surrounding pelitic and basic schists are well-exposed along the Kokuryo River in the Tonaru area of the Sanbagawa Belt in the Besshi region. Layers and lenses of marble and pelitic schist occur in the southern part of the Tonaru body. However, the petrological and geochemical characteristics of these lithologies and their origins have not yet been elucidated in detail. The petrographic characteristics and variations in whole-rock compositions of the Tonaru epidote-amphibolite suggest that the Tonaru epidote-amphibolite is a metamorphosed composite body of layered gabbro and gabbro-sediment mixtures composed of mafic, ultramafic, and/or pelitic materials, likely derived from an oceanic island arc.



Variation of SiO_2 concentrations (wt%) in the Tonaru epidote-amphibolites along the Kokuryo River.

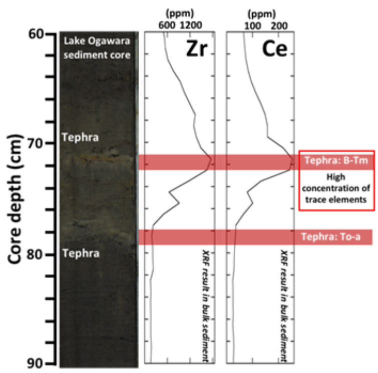
Drilling of marine sediment in the Amundsen Sea to detect melting events of West Antarctic ice sheet

Photo: D/V JOIDES Resolution.

A sector of the West Antarctic ice sheet draining into the Amundsen Sea is undergoing the largest ice loss in Antarctica today, and there is serious concern for the potential of large-scale ice collapse of this area due to global warming. The International Ocean Discovery Program (IODP) Expedition 379 drilled two sites in the Amundsen Sea area of the Southern Ocean using the D/V JOIDES Resolution, in January to March 2019. A researcher from ISEE participated in this expedition and measured the physical properties of marine sediment cores. It is expected that melting events of the West Antarctic ice sheet during the Plio-Pleistocene will be detected by future research.

Chemical characterization of B-Tm tephra (Millennium Eruption, Changbaishan volcano) of a lacustrine sediment core

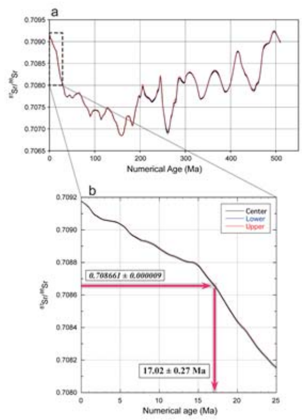
The absolute date of the Millennium Eruption (ME) from the Changbaishan volcano (also referred to as Mt. Paektu, Baegdusan, or Tianchi), located at the border between China and North Korea (128°03´E, 41°00´N), has been refined to 946 AD. This indicates that tephrochronology using widely dispersed B-Tm tephra deposits has great utility in obtaining a robust age constraint in the late Holocene period. Here, we present multiple geochemical datasets, such as those obtained by X-ray fluorescence, solution inductively coupled plasma-mass spectrometry, and laser ablation inductively coupled plasma-mass spectrometry, as well as EPMA, of bulk sediments and individual glass shard samples from the B-Tm tephra deposit layer retrieved from Lake Ogawara, Japan. Our results show that the B-Tm tephra layer has extremely high amounts of trace elements (e.g., Zr and Ce for 1,700 ppm and 230 ppm, respectively, in bulk sediments), which is comparable to the proximal B-Tm tephra deposit. Furthermore, the B-Tm tephra layer shows a distinctive chemical composition compared to those of other Japanese tephra. These results indicate that measurements of trace elements, including rare earth elements, have great utility in the identification and correlation of the B-Tm layer.



Depth profile of Zr and Ce in a core of Lake Ogawara sediment alongside a photograph of the core.

Accurate age determination using Sr isotope ratios of rapidly formed spherical carbonate concretions

Spherical carbonate ($CaCO_3$) concretions often occur in finer-grained marine sediments of varying geological ages. Recent studies have revealed that they form very rapidly under tightly constrained conditions. However, the formation ages of isolated spherical carbonate concretions have never been determined. Therefore, we used 87Sr/86Sr ratios of isolated spherical carbonate concretions to determine the formation ages. The strontium isotopic stratigraphy obtained using $^{87}Sr/^{86}Sr$ ratios of all concretions indicate age determinations with higher accuracy than those estimated using micro-fossils. The results imply that the $^{87}Sr/^{86}Sr$ ratios of isolated spherical carbonate concretions can be applied to determine the precise numerical age of marine sediments when the concretions form soon after sedimentation. The age determinations have high accuracy in cases even without any fossil evidence.



Sr isotopic stratigraphy and numerical age determinations from concretions (Yoshida et al., 2019)

Evaluation of matrix correction procedure in quantitative EPMA

The accuracy of quantitative EPMA of U, Th, and Pb is an essential factor in obtaining a reliable age of an analyzed mineral. Quantitative EPMA estimates chemical compositions from X-ray intensities of standard materials and unknown target, and those of standard materials through the matrix correction procedure. The accuracy of matrix correction depends on the chosen models and physical parameters, such as mass attenuation coefficients. CHIME ages of two standard monazites have been determined with various matrix correction models and physical parameters to evaluate the reliability of each model and parameter. A comparison of CHIME and isotopic ages shows that PAP, XPhi, and Bence-Albee method with correction factors by Kato (2005) give an accurate CHIME age, while other models give systematically older ages than isotopic ages.

Comparison of CHIME and LA-ICP-MS ages

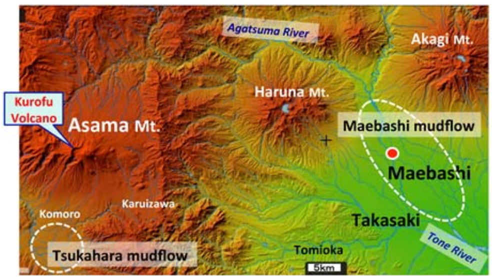
Skrzypek et al. (2018) analyzed monazite grains with both LA-ICP-MS and EPMA-CHIME. EPMA-CHIME dating gives smaller uncertainty and variation between samples than LA-ICP-MS U-Pb dating. However, EPMA-CHIME dating gives systematically younger ages than LA-ICP-MS dating. The result implies that EPMA-CHIME dating is sensitive to the difference between U-Pb and Th-Pb systems and the Th-Pb system is sensitive to the effect of retrograde metamorphism.

^{14}C dating of various carbon components in ground ice in Siberia


Outcrop of permafrost in Churapcha.

Recently, the ground ice in permafrost has received attention as a useful tool for paleoenvironment reconstruction. It is important to determine the formation age of ground ice to understand past climate changes and hydrological environmental changes preserved in the ground ice. To define which carbon component is most suitable for the determination of the formation ages of ground ice, we have measured ^{14}C ages of various components such as particulate organic carbon (POC), dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), and CO_2 gas in bubbles in ground ice from the outcrops of permafrost in Syrdakh and Churapcha, near Yakutsk City in Russia. The ^{14}C ages of POC in the ground ice samples were ~10,000 years older than ages of the plant remain, indicating that POC is not suitable for use in determining the age of ground ice formation . Meanwhile, the DIC and bubble CO_2 ages were ~10,000 years younger than the plant ages. The ^{14}C ages of DOC were different by molecular size: the 0.7 µm-10 kDa and 10 kDa-3 kDa fractions showed similar ages to those of plant remains, whereas the <3 kDa fraction showed younger ages, which were similar to those of DIC and bubble CO_2. The results obtained in this study led to the elucidation of formation processes of ground ice and paleoenvironmental reconstruction.

^{14}C ages of wood blocks from volcanic mudflow deposits: Examples for Maebashi and Tsukahara deposits



Expanded region of the Maebashi and Tsukahara mudflows.

Volcanic debris-flow avalanches and mudflows caused by the collapse of volcanic edifices are gravity currents that involve surface materials, including water, plants, rocks, and soils derived from stream sediments and near-surface deposits. Wood blocks are useful materials for ^{14}C dating to determine the age of events, especially hazardous events. However, reworked fragments from deposits of preceding events might provide older ages. Therefore, careful sampling and measurement of wood specimens are required for a correct evaluation of the history of volcanic edifices. We performed ^{14}C measurements for wood specimens from the Maebashi and Tsukahara mudflow deposits in central Japan. The results suggested that some collapses of the Asama volcano, although of unknown scale, occurred more than 10,000 years before and after the main event of ~27,000 years ago.

Radiocarbon dating of peach stones from Makimuku ruins, Nara Prefecture


Remnant peach stone excavated from the Makimuku archeological site.

High-precision radiocarbon dating was performed on 12 aliquots of 2,800 peach stones excavated at the Makimuku ruins, Nara Prefecture, Japan. The peaches were ripened, eaten, and disposed of during a period of ~100 years from 135 AD to 230 AD. This confirms that the Makimuku ruins is one of the more convincing candidate sites supporting the theory that Yamataikoku was located in Kinai region.

Center for International Collaborative Research (CICR)

- Internationally coordinated programs
- Ground-based observation networks and satellite projects
- Hosting international workshops
- International exchange of foreign and Japanese researchers and students
- Capacity building in developing countries through training courses and schools
- Observatories

To promote international collaborative studies for understanding physical mechanisms of the phenomena occurring in the space–Sun–Earth environmental system and their interactions with each other, the Center for International Collaborative Research (CICR) was established in October 2015 under ISEE. CICR provides leadership to encourage and promote internationally coordinated programs, such as those carried out by the Scientific Committee On Solar-Terrestrial Physics (SCOSTEP) and Future Earth, ground-based observation networks, international satellite projects, hosting of international workshops and conferences, international exchange of foreign and Japanese researchers and students, and capacity building in developing countries through training courses and schools. CICR has taken over from the Geospace Research Center of the former Solar-Terrestrial Environment Laboratory, Nagoya University.

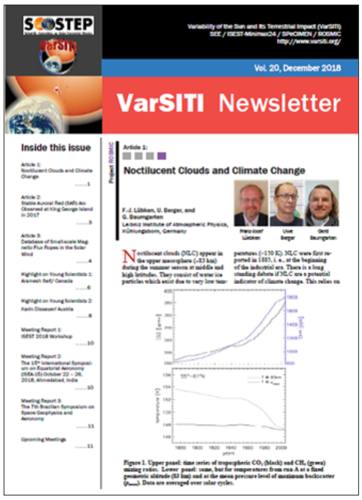
In the 11-year solar cycle of past 100 years, cycle 24 has the smallest maximum. World scientists have a strong interest in this anomaly and its consequences for Earth's environment. SCOSTEP under the International Science Council commenced a 5-year international program entitled "Variability of the Sun and Its Terrestrial Impact (VarSITI)" in 2014. One of the co-chairs of the VarSITI program is a member of CICR and responsible for taking lead in this program. CICR publishes a VarSITI Newsletter every three months, operates a VarSITI mailing list that currently contains ~1000 VarSITI members from ~70 countries, and coordinates international symposiums related to VarSITI. CICR also contributes to other international programs related to the space–Sun–Earth environment, such as Future Earth and Integrated Land Ecosystem-atmosphere Processes Study (iLEAPS). In relation to these international programs, CICR also participates in/operates ground-based observation projects, i.e., the EISCAT radar project, OMTIs, ISEE magnetometer network, SuperDARN radar network including the Hokkaido HF radars, ISEE VLF/ELF network, and ArCS operation office.

CICR has been operating the international collaborative research programs since 2016. It also holds four domestic observatories at Moshiri, Rikubetsu, Fuji, and Kagoshima, which conduct observations of the solar wind, geomagnetic field, and upper atmosphere. Some of these observations have been conducted for more than 30 years.

Observation sites and foreign collaborative institutions of ISEE.

Main Activities in FY2018

In FY2018, CICR conducted the following international collaborative research programs: 1) Joint Research Program (International, 31 projects), 2) ISEE International Joint Research Program to invite 12 foreign researchers, and 3) three ISEE/CICR International Workshops, inviting 6 foreign designated professors and associate professors. Two newly designated professors were hired through a 5-year cross appointment with US universities and institutions. The ISEE/CICR International Workshop aimed to facilitate comprehensive discussions on a focused topic with 10–15 attendees over one week, and summarize the results into international journal papers and/or books.



VarSITI Newsletter vol. 20 (Dec. 2018).

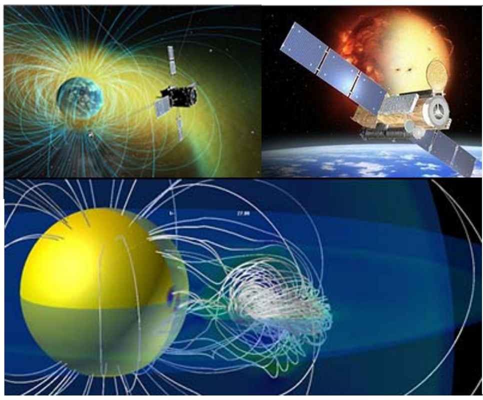
Twelve CICR colloquiums were held with senior foreign scientists from seven countries including the US, UK, Germany and Brazil. For the SCOSTEP/VarSITI program, we published four VarSITI newsletters in FY2018, in April, July, October and December. We also organized the 14th Solar-Terrestrial Physics Symposium in Toronto, Canada, in June 2018. We continue to operate the VarSITI mailing list, which contains ~1000 scientists from ~70 countries, and support selection of 18 international symposiums and 6 database constructions by VarSITI. In relation to the VarSITI project, we organized an international school on the equatorial atmosphere in Indonesia in March 2019. Two young scientists from India and Ukraine were invited to ISEE under the SCOSTEP Visiting Scholar (SVS) program for collaborative research on thermospheric and ionospheric dynamics.

Under the ICCON Project, 29 scientists from the US, UK, China, Korea, Russia, Germany, Switzerland, Belgium, and Japan joined the operation of the Nobeyama Radioheliograph. The data are openly available at NAOJ and CIDAS/ISEE. The EISCAT radar project was carried out under collaborations with an NIPR group: 12 EISCAT special experiments proposed by Japanese colleagues were conducted. Discussion about the EISCAT_3D radar has been made with other foreign EISCAT associate members. The PWING projects continued running 8 stations around the north pole at magnetic latitudes of ~60°, in relation with the OMTIs, ISEE magnetometer and ELF/VLF network projects.

The four domestic observatories continued to operate in FY2018. Moshiri Observatory became an ummanned observatory in FY2018, but continued running electromagnetic instruments, i.e., an auroral photometer, magnetometers, and VLF receivers. Rikubetsu Observatory operates several spectrometers for comprehensive measurements of ozone and other minor constituents in the atmosphere, all-sky imagers and photometers for aurora and airglow, and SuperDARN Hokkaido radars for ionospheric disturbances as well as a new ELF atmospheric receiver. A new induction magnetometer was also installed at Rikubetsu in October 2018. Multi-station interplanetary scintillation (IPS) observations using the Fuji, Kiso, and Toyokawa antennas were conducted in FY2018. IPS observations at Fuji were interrupted by serious damages by two big typhoons that occurred in September 2018. The Kiso Observatory was opened to the public on August 4–5, 2018. Kagoshima Observatory and Sata Station operated instruments for electromagnetic wave detection and an all-sky camera and a photometer for airglow.

Induction magnetometer sensor at Rikubetsu Observatory.

Center for Integrated Data Science (CIDAS)



- Hinode Science Center
- ERG Science Center
- Research and development of advanced simulations (SUSANOO, CReSS, Monte Carlo simulations for high-precision age calculations, etc.)
- Construction of various databases (IUGONET, WDS-CR, etc.)
- Operation of CIDAS supercomputer system
- Membership activity of HPCI consortium

The Center for Integrated Data Science (CIDAS) aimed to construct infrastructure and conduct research and development to realize a cutting-edge scientific study of the space–Earth environmental system through integrated analyses using various observational data and advanced computer simulations. CIDAS operates many projects in cooperation with the research divisions and centers of ISEE, as well as other universities and institutes.

Science centers for space missions: Hinode and ERG

The Hinode Science Center is operated as a joint project with NAOJ and developed the database and analytical environment for the data provided by the Japanese solar observation satellite Hinode. At the same time, it plays an important role in considering research topics of oncoming solar missions such as Solar-C EUVST. In addition, ERG Science Center operates as a joint research center in cooperation with the Institute of Space and Astronautical Science/Japan Aerospace Exploration Agency (ISAS/JAXA), which releases the data files from ERG (Arase) and ground-based observations. The ERG Science Center also develops the data analysis software. The CIDAS computer system has been used for the data analysis environment for Hinode and ERG projects.

Cooperative research program for database construction and supercomputing

CIDAS produces various databases for space–Earth environmental research and provides supercomputing facilities in collaboration with the Information Technology Center (ITC) of Nagoya University and other universities and institutes. CIDAS has also joined the inter-university network project (Inter-university Upper atmosphere Global Observation NETwork: IUGONET) with Tohoku University, NIPR, Kyoto University, Kyushu University, and Nagoya University to develop a metadata server and data analysis software. CIDAS is in charge of activities in ISEE as a member of the High-Performance Computing Infrastructure Consortium (HPCI) in Japan.

Research and development of advanced simulations

CIDAS plays a leading role in research and development of the following advanced computer simulation models: Space Weather Forecast Usable System Anchored by Numerical Operations and Observations (SUSANOO), the Cloud Resolving Storm Simulator (CReSS), and Monte Carlo simulations for accurate Th-U-Pb dating. The CReSS model is designed for all types of parallel computers to simulate a detailed structure of clouds and storms. CReSS is free to use for scientific community. It has been used for meteorological research and real-time weather forecast experiments, for example, simulation experiments of tropical cyclones, heavy rainfall events, snow clouds, tornados, and downscaling experiments of future tropical cyclones.

Main Activities in FY2018

Development of data analysis system for the ERG (Arase) project

The scientific data from the ERG (Arase) satellite, ground-network observations and modeling/simulation are archived at the ERG Science Center, which is operated by ISAS/JAXA and ISEE/Nagoya University. The format of these data files is CDF, which includes metadata of each file, which is a de facto format for the solar-terrestrial physics community. The Space Physics Environment Data Analysis System (SPEDAS), which is common software for the solar-terrestrial physics community can easily read and manipulate the CDF files. The ERG Science Center has developed CDF files for the ERG project, as well as a SPEDAS plug-in software for the ERG project. The ERG Science Center has organized the training sessions for SPEDAS in Japan and Taiwan, which provided important opportunities to learn SPEDAS and the ERG data. The ERG Science Center also develops a data analysis environment in the CIDAS system, and users can access the CIDAS system via the Internet and analyze the ERG project data using SPEDAS.

Coronal mass ejection arrival time forecasting system using IPS observations

CMEs cause disturbances in the environment around the Earth. CIDAS has installed a dedicated computing system for CME forecasting, and developed a CME forecasting system under a collaboration study with the Division for Heliospheric Research of ISEE and NICT. In this system, the propagation of CME is calculated by a global MHD simulation SUSANOO-CME. The IPS response is estimated by the 3D density distribution of the inner heliosphere derived from the MHD simulation. The simulated IPS response is compared with the actual IPS observations performed by the Division for Heliospheric Research, which gives a forecasting with better accuracy than before. This system will be included in the real-time forecasting system in NICT.

Activity of Inter-university Global Upper atmosphere Observation NETwork (IUGONET)

We have promoted the use and application of upper atmospheric observation data through database and analysis software in collaboration with other institutions (e.g., the Research Organization of Information and Systems (ROIS)), and developed a foundation for a universal infrastructure for disclosing and citing data rapidly. We also abstracted a database design and have now provided these developments to each institute and committee to promote data activity. We have held several international data analysis workshops in developing countries such as Indonesia, Malaysia, and Nigeria in collaboration with several international programs, VarSITI and World Data System (WDS) affiliated with the International Council for Science (ICSU), and supported the construction of infrastructure for disclosing data and data integrity to them.

Operation of the CIDAS supercomputer system

The CIDAS supercomputer system for integrated data analysis is under operation since FY2016. The system consists of 20 compute nodes, with each node having two Intel Xeon E5-2660 v3 CPUs and 256 GB memory. In FY2018, 150 researchers/students were registered as users of the CIDAS supercomputer system and data analyses related to the Hinode Science Center and ERG/Arase Science Center as well as computer simulation studies were conducted.

Development of CReSS model

The CReSS model has been developed and improved for physical processes. It is open for scientific research from CIDAS. CReSS is used for simulation experiments and daily weather forecast. The simulated data of the daily forecast are open at the website of the meteorological laboratory. It is also planned that the simulation output data using CReSS model will be open from CIDAS.

Center for Orbital and Suborbital Observations (COSO)

- Establishment of an aircraft of observing system and implementation of aircraft observations
- Development of validation equipment for Earth observing satellites
- Development of ChubuSat and promotion of its applications
- Observation of polar ionosphere/magnetosphere by formation of flight satellites
- Climate system research at a virtual laboratory (VL)

Based on ISEE research subjects, which encompass natural phenomena ranging from the Earth's surface to outer space, COSO is expected to perform empirical and advanced research through observation, especially through collaborations among industry, academia, and government, leading to remarkable technological developments for aircraft, balloons, sounding rockets, and spacecraft observations. COSO plays a key role in, and promotes, aircraft observations in Japan. We also investigate and promote future space exploration missions in collaboration with institutions in Japan and overseas to gain new insights into physical phenomena. We assist in advancing observation capabilities for future orbital and suborbital observations by developing an efficient common technological and development environment via interdisciplinary activities. The Hydrospheric Atmospheric Research Laboratory contributes to COSO's activities by using X-and Ka-band radars, together with numerical model studies under VL activities. The Space Exploration and Research Office (SERO) was newly established in 2018.

Main Activities in FY2018

Promotion of aircraft observation

We have been promoting the establishment of a core base for aircraft observation in collaboration with an external research institute. We also aim to contribute to research using aircraft observation, such as studies of aerosol–cloud interactions and those on the development processes of typhoons.

Continuing from 2017, using the G-II jet of Diamond Air Service Co., Ltd., we conducted six penetrations to Typhoon T1824 (TRAMI) in four days from September 25 to 28, 2018 (Fig. 1). We obtained meteorological elements near the center of the typhoon through drop sonde observation. The data acquired from drop sonde were sent to the operational meteorological agencies via the Global Telecommunication System (GTS), and used to predict the track and intensity of this typhoon.

The cloud-aerosol process study using the CReSS is implemented based on the aircraft observation conducted in 2017 as part of the Advanced Study on Precipitation Enhancement in Arid and Semi-arid Regions of the United Arab Emirates. We conducted numerical experiments to investigate the impact on precipitation efficieny.

In addition, we held an aircraft observation session of JpGU in collaboration with the Meteorological Society of Japan (MSJ), to promote the aircraft mission of COSO. The research plan for aircraft observation in collaboration with MSJ was revised for the preparation of the master plan 2020 proposal.

Fig.1: The picture of eye of Typhoon T1824 from aircraft on September 27, 2018.

Investigation and development of the standard bus system for micro-satellite applicable to space missions

We have been conducting investigations and developing the standard bus system for compact (100–200 kg) satellite missions in the future demonstrative space science. In cooperation with a domestic manufacturer having substantial achievements of instrumental developments in the previous space missions, rather than well-known space companies requiring enormous cost for a new satellite system, and the science/engineering teams of ISAS/JAXA, we have completed the investigations regarding facilities and environment necessary to the development/operation for future space exploration missions using multiple satellites by assuming concrete conditions.

Promotion of international collaborative developments of onboard observational instruments applied to space exploration missions for the space-Earth coupling research

We are promoting the international collaborative developments of onboard science instruments for the future space observation missions, to stimulate and contribute to demonstrative research in the space-terrestrial upper atmosphere coupling system, by realizing the integrated measurements of space plasmas, neutral particles, fields, waves, and emissions in space. In particular, we initiated the discussion and investigations toward the international collaborative developments of the upper atmospheric neutral particle instrument together with overseas research institutes.

Solar observation mission by nano-satellites

We are developing a solar neutron and gamma-ray detector intended for nanosatellites weighing less than 10 kg, which have more launch opportunities than the 50-kg class satellite, ChubuSat-2, launched in 2016. With the goal of launch in FY2021, we have started the design of a 3U CubeSat with dimensions 30 × 10 × 10 cm^3 and a weight of 4 kg by the SERO members. We have designed and fabricated a signal processing board with ASICs for the mission instrument to achieve very low power consumption.

Space Exploration and Research Office (SERO)

SERO is established as the first step toward forming a research center to consolidate all space-related activities in the university and promote hardware development and observational research for space exploration and science. Its main activities include development of micro- and nanosatellites, development of propulsion technologies, instrument development for satellite and/or space exploration projects at ISAS/JAXA, and administrations of training programs for space exploration. Staff members from the divisions of engineering, science and environmental studies, participated in these activities. We held a two-week training course for space applications in February (Fig.2).

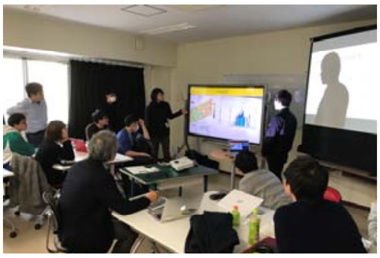


Fig.2: 2-week training course for space applications.

Promotion of observations using Earth observing satellites

The concept of the future spaceborne precipitation radar was studied and DPR-2, upgraded from the dual-frequency precipitation radar onboard the GPM core satellite, was proposed as the mission proposal to the Grand Design of the Earth Observation Satellite. We participated in the discussion of the NASA’s future cloud and precipitation observation mission.

Furthermore, we expanded J-OFURO3, the third-generation data set of heat, momentum and freshwater flux between the atmosphere and the ocean on the global basis, which is important for a precise understanding of the energy balance of the earth system and climate change. Research on the flux estimation under the severe weather conditions such as typhoons and bomb cyclones by using GNSS ocean reflection data from small satellites was started.

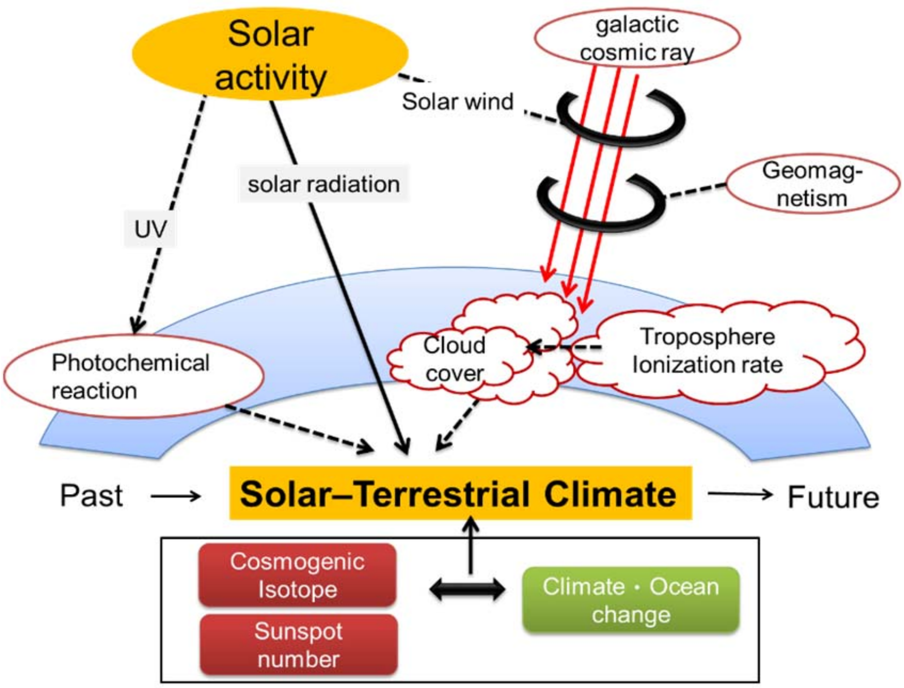
Project for Solar–Terrestrial Climate Research

Do variations in solar activity influence our weather and climate? Researchers specializing in fields such as astronomy, solar physics, meteorology, climatology, paleoclimatology, and oceanography have grappled with this question for the past two hundred years or more. Two thousand years ago, astronomers of the Chinese imperial court chronicled sunspot activity for exploring variations in solar activity. In 1801 the British astronomer William Herschel discovered a significant correlation between the number of sunspots and the market value of wheat in London and reported his findings in a paper published by the Royal Society. He concluded that a reduction in the number of sunspots affected a change in climate that altered wheat yields, and as a result, influenced the price of wheat. This study is considered as the first attempt to examine correlations among the Sun, climate, and society (human life). Even now, correctly identifying the characteristic variations of solar activity and investigating their effects on climate change and modern society remain important research topics in academics and society.

There is much evidence indicating that at least the Atlantic Ocean and surrounding areas, including Europe and North America, experienced significantly colder temperatures during the Maunder Minimum (a 70-year period from 1645 to 1715) in which very few sunspots were observed and solar activity appeared nearly stagnant. Historical records show that New York Harbor froze in the winter of 1780, enabling people to walk from Manhattan to Staten Island, and that sea ice surrounding Iceland extended for miles, closing the harbors and dealing a blow to the fishing industry and trade over a long period of time. While it is premature to conclude that the quieting of solar activity leads to a period of cooling, many researchers believe that variations in solar activity influence medium-to-long-term climate changes. However, to obtain conclusive evidence, it is necessary to reconstruct climate changes quantitatively and to continue accumulating data on annual variations in solar activity.

Very few sunspots were observed from March 7 to March 20, 2017. The cycle length of solar magnetic activity corresponding to the sunspot cycle was estimated at about 14 years during the Maunder Minimum. The sunspot cycle in Solar Cycle 24, which began in 2008, has grown to about 13 years, similar to that in the Maunder Minimum. This indicates that we are entering a period of low solar activity, where a cooling on a global scale can occur in the near future. To offer a qualified opinion on the likelihood of this prediction, we must examine diverse viewpoints on how solar activity affects climate.

The globally averaged surface temperature showed a clear upward trend after the latter half of the 20th century. However, it continued to increase in the temperature range of 0.03–0.05°C per ten years from 1998 to 2012, and the global warming pause or the global warming slowdown is called the "global warming hiatus." Nonetheless the atmospheric greenhouse gas concentration increases yearly, but a clear rise is not recognized in the observation of surface temperature. The topic "global warming hiatus" was taken up on the Internet news and blogs, went over the scientific community, and then had a huge impact on the



Project scheme for Solar–Terrestrial Climate Research.

general public. Based on a detailed analysis of the meteorological dataset from the land and ocean temperatures (e.g., HadCRUT3) and computer experiments with climate models such as MIRCO, it was indicated that the global warming hiatus was caused by natural characteristics. Although we still cannot provide sufficient explanation, it is evidenced that the decadal-centurial-time scale climate change is indirectly driven by secular variation in solar activity. Encouraging the understanding of the characteristics and mechanisms of short-term natural fluctuations that appear in the age of global warming will make the prediction of anthropogenic climate change more reliable. It is extremely important to draw up an environmental policy that stands on the influence on human society.

Radiocarbon (^{14}C) and Beryllium-10 (^{10}Be), known as cosmogenic isotopes, are produced at a rate that varies according to the intensity of the incoming cosmic rays to Earth, which in turn are influenced by solar activity. Analyzing ^{14}C in tree rings and ^{10}Be in ice cores is an effective way to study long-term variations in solar activity going back tens of thousands of years. Such analyses of ^{14}C and ^{10}Be suggest that episodes of declining solar activity resembling the Maunder Minimum have occurred repeatedly 12 times throughout the Holocene, which spans the past ten thousand years. Comparing cosmogenic isotopes against paleoclimate data can improve the understanding of solar-driven climate change on a long time-scale.

We have accumulated evidences over the past quarter century that will be effective in studying the mechanisms by which variations in solar activity affect climate and human society. The interdisciplinary project for Solar-Terrestrial Climate Research at ISEE integrates the latest knowledge in solar physics, meteorology, climatology, environmental studies, paleoclimatology, space physics, and cosmic ray physics with the aim of better understanding the variability in solar activity, fostering an understanding of solar-driven earth systems, and contributing to predictions of future global environments.

Main Activities in FY2018

ISEE International Collaborative Research Programs

In fiscal 2018, the international collaborative research on five issues related to the Interdisciplinary Research “Climate impact of solar activity” and general joint research on five subjects were conducted. In addition, 11 research meetings were held on various topics. New findings to understand the earth system driven by the sun were obtained by three and seven projects aiming at understanding the changes in climate and solar activity, respectively

Cosmic Ray Event in AD 993–994: Synchronicity in Northern and Southern Hemispheres

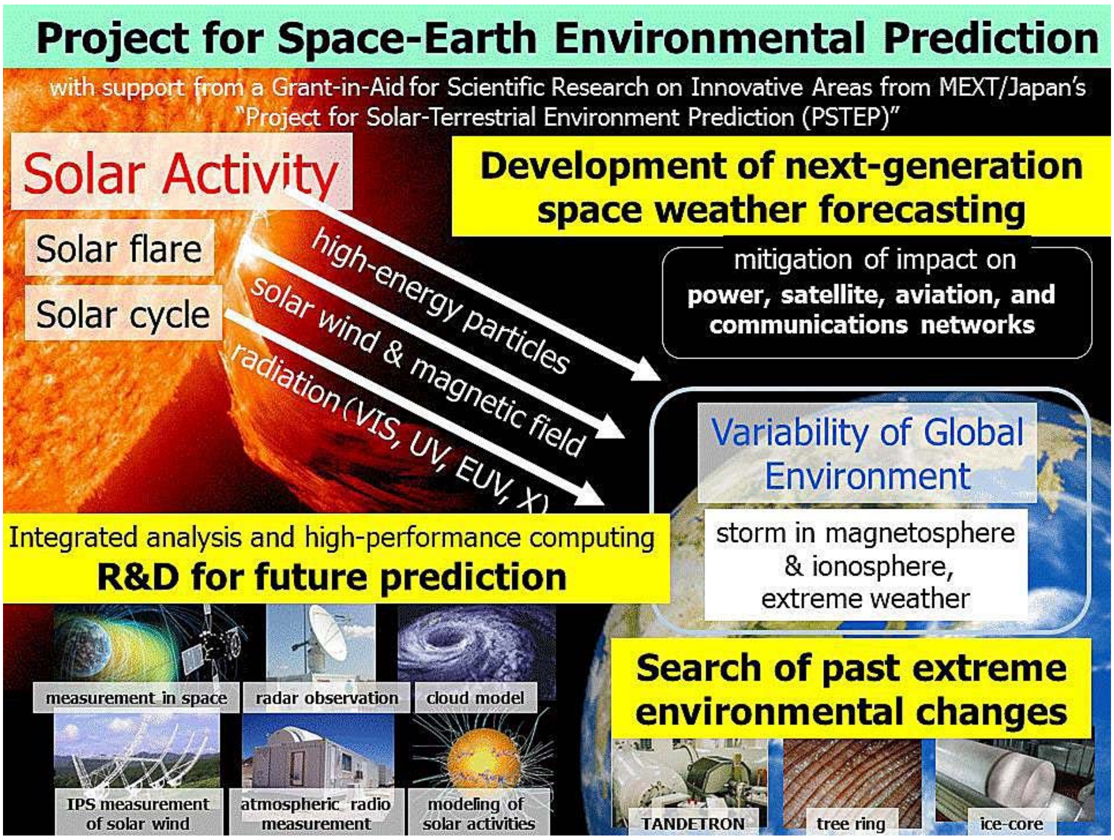
^{10}Be measurements at quasi-to-annual temporal resolution were conducted on the Dome Fuji ice core from Antarctica over the period in which the cosmic ray event in AD 994 would be expected. An approximately 50% increase in ^{10}Be concentration is consistent with that observed in the Greenland ice cores. Increases in ^{10}Be concentrations in both hemispheres support a solar origin of the AD 994 event.

Hydroclimatic changes in the Levant during the past 220000 years

The Dead Sea lake bottom sediments were collected by the Dead Sea Deep Drilling Program under the framework of the International Continental Scientific Drilling program. The sedimentary facies deposited during the past 220,000 years change synchronously with the solar radiation in the northern hemisphere’s midlatitude. It is new evidence that the hydroclimatic condition at the Dead Sea catchment area in the Levant can respond to specific circumstances in the North Atlantic and tropical zone which are partly affected by the solar radiation (Sun) changes.

Project for the Space–Earth Envionmental Prediction

Over the past 50 years, space exploration has expanded rapidly and now gone past the edge of the heliosphere. Consequently, it is known that solar activity and the dynamics of the space environment can significantly impact human socio-economic systems as well as the global environment. For example, the giant solar flare observed by the British astronomer Richard Carrington in 1859 caused powerful magnetic storms, called the Carrington Event. If such an event occurred in the modern era, power, satellite, aviation, and communication networks could possibly be damaged on a global scale. Moreover, analyses of the latest stellar observations and of cosmogenic isotopes in tree rings suggest even larger solar flares. However, the mechanisms of the onset of solar flares and their subsequent processes have not yet been fully explained. Thus, modern society is at risk from severe space-weather disturbances, caused by such solar explosions, and understanding and predicting variations in the space–Earth environment is both an important scientific subject and a crucial issue for modern society. Furthermore, because the accurate prediction of complex phenomena is a common problem in science, the prediction is also a crucial subject for various scientific disciplines. The Project for Space–Earth Environmental Prediction is a new joint research project aimed at synergistically developing our predictive capability for the space–Earth environment through the cooperation and interaction of solar physics, geomagnetism, space sciences, meteorology, climatology, space engineering, and other related fields. This project addresses the various issues shown in the figure below, based on ISEE Collaborative Research Programs and the support of a Grant-in-Aid for Scientific Research on Innovative Areas from MEXT Japan's "Project for Solar-Terrestrial Environment Prediction (PSTEP)."

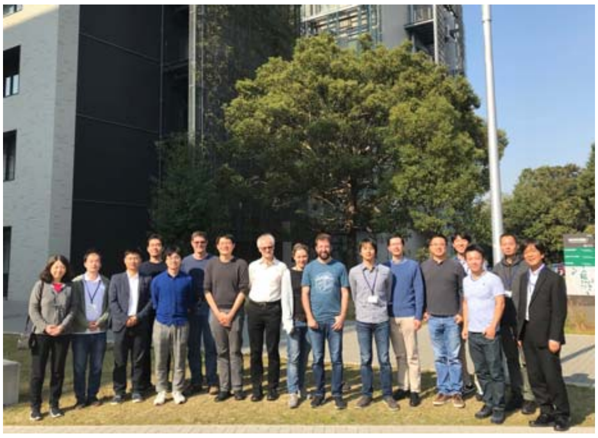


The objectives and subjects of the Project for Space–Earth Environmental Prediction.

Main Activities in FY2018

ISEE/PSTEP International Workshop on Data-Driven Models of the Solar Progenitors of Space Weather and Space Climate

T The increasingly dense observational coverage of the solar atmosphere has led to many important insights into the origins of solar activity. Simultaneously, the increasingly sophisticated numerical models of the interaction between plasma and magnetic fields have provided important lessons on the basic physical mechanisms underlying the observed behavior. State-of-the-art MHD models can now yield observational diagnostics that are in general agreement with the observations. Yet, if we wish to apply these lessons to forecasting space weather and space climate, many challenges remain. First, even with the aforementioned advances in MHD modeling, there remains a wide gap between numerical models and reality, as revealed by observations. As observational capacity – in terms of spectral, temporal, and spatial coverage – improves, so does the number of observables not explained by the current generation of models. One possible reason is the lack of certain physical ingredients in the models. In this ISEE/PSTEP International Workshop (November 6th to 9th 2018), many experts joined from Japan, US, Europa, and China, and we address the key problems remaining in using observational data to constrain and to drive MHD models of solar eruptions. Several new projects resulted from the discussions at this Workshop. We foresee more publications resulting from this effort appearing in late 2019 and in 2020.



The participants of ISEE/PSTEP International Workshop on Data-Driven Models of the Solar Progenitors of Space Weather and Space Climate.

ISEE/PSTEP Science Meeting on “Modeling Study for Solar-Terrestrial Environment Prediction”

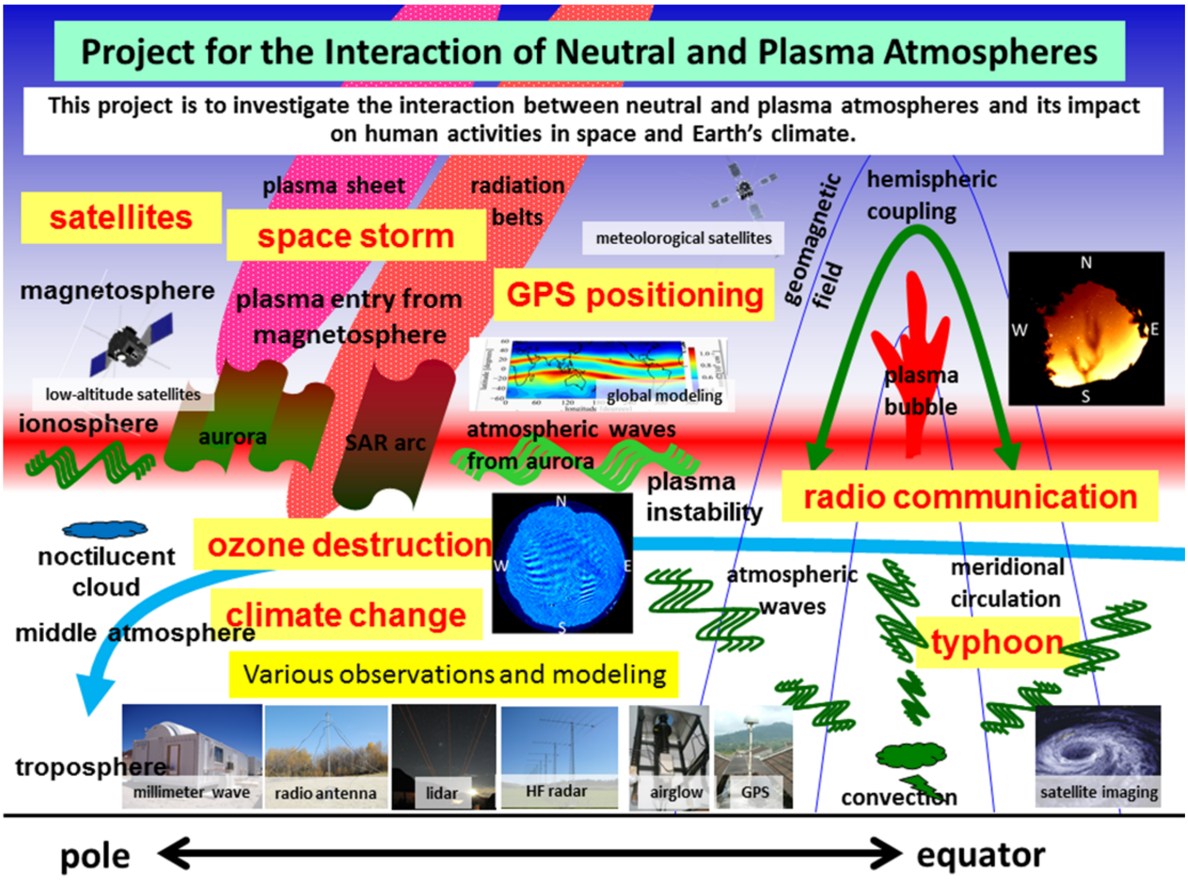
We conducted the ISEE/PSTEP Science Meeting on “Modeling Study for Solar-Terrestrial Environment Prediction” from January 17 to 18, 2019 at NICT, Tokyo, in cooperation with PSTEP. This meeting is to review the present status and prospects for the modeling prediction of the solar-terrestrial dynamics and has been held every year since 2017 for inter-disciplinary discussion.

In this year, we mainly discuss about what type of prediction is required to develop a space weather hazard map for public, based on the survey report of the social needs for each subject (electric power grid, satellite operation (charging/air drag), radio wave utilization, and aviation operation). We also organized a solar and heliospheric session in which the recent research results of the latest forecasting model of solar flares and CMEs were discussed. In particular, we confirmed that great progress has been made in research on the onset mechanism of solar flares and the realistic simulations of flares and CMEs using the real data. Because the next fiscal year (FY2019) is the final year of PSTEP, we will summarize the efforts for inter-connection of the element models and the advanced development of the prediction model in the future.

Science Meeting on “Modeling Study for Solar-Terrestrial Environment Prediction.”

Project for the Interaction of Neutral and Plasma Atmospheres

The Earth's upper atmosphere is partly ionized because of solar ultraviolet emissions, forming the ionosphere. Ionospheric plasma affects human activities in space, such as radio communications and GPS positioning. The consequences of climate change appear significantly in the upper atmosphere and ionosphere. As shown in the figure below, neutral-plasma interaction processes in the upper atmosphere and ionosphere can be observed as various phenomena occurring from high to low latitudes. The aurora in the polar region is caused by the precipitation of high-energy plasma, which heats the upper atmosphere and generates atmospheric waves and disturbances that propagate toward low latitudes. However, ionospheric plasma instability, known as plasma bubbles, occurs in the equatorial upper atmosphere, causing interference with satellite-ground communications and GPS positioning. These phenomena can be measured by various ground-based remote-sensing instruments, such as airglow imagers, magnetometers, radars and lidars, and millimeter wave telescopes. This interdisciplinary project investigates the interaction of neutral and plasma components of the Earth's atmosphere using various ground remote sensing techniques and in situ satellite measurements, as well as global and regional high-resolution modeling of the neutral-plasma interaction, and contributes to the reliable use of space by humans.



Research topics of the project for the interaction of neutral and plasma atmospheres.

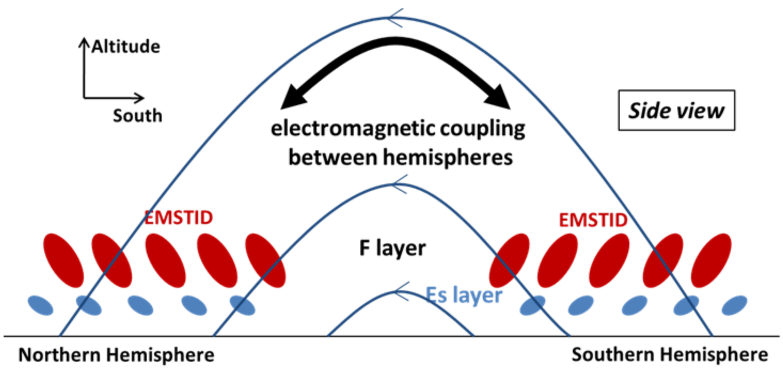
Main Activities in FY2018

Polar aurora as an indicator of the plasma-atmosphere interaction (photo taken at Nain, Canada on Sept.16, 2018, during a ERG-ground campaign observation).

In FY2018, we operated 11 international collaborative studies, 8 domestic collaborative projects, and 21 domestic meetings under ISEE. Various scientific results have been obtained through these collaborative projects.

As mentioned in the previous paragraph, interaction of neutral and plasma components is an essential and important issue for understanding the partially ionized atmosphere or the ionosphere and thermosphere. We are expecting a dramatic improvement in the ground-based ionospheric measurement accuracy with start in operation of EISCAT_3D in Scandinavia in 2022. In contrast, as the measurement of the neutral components in the thermosphere is impossible for EISCAT_3D in principle, preparation of diagnosing neutral components or the thermosphere has been perceived as an urgent issue. Then, we established an international project team (Japan, US, Finland, Sweden, and Norway) in 2018 with a view of deploying three SDIs, which are capable of measuring the thermospheric wind vector and temperature in 1000 km^2. Collaborations between the EISCAT_3D and 3 SDIs in Scandinavia will create an ideal environment of studying the polar ionosphere-thermosphere coupled system with the state-of-the-art ground-based instruments. We restarted the monitoring observation by the millimeter-wave spectrometer at Tromsø, Norway, after repair of the FFT processor in December 2018, to measure the NO that is produced by ion-chemistry due to the energetic particle precipitation. The new scientific satellite Arase (ERG) was launched by ISAS/JAXA in December 2016 to investigate wave–particle interactions between high-energy electrons and ions in the inner magnetosphere. We have conducted several ERG-ground campaign observations in FY2018. From the combined ground-satellite measurements, including EISCAT and newly installed high-speed EMCCD cameras, several science results, especially for wave–particle interactions, have been reported in scientific journals including Nature and Nature Communications. An ISEE researcher was hired by University of Oulu in Finland through a cross appointment and will conduct collaborative research related to this interdisciplinary project.

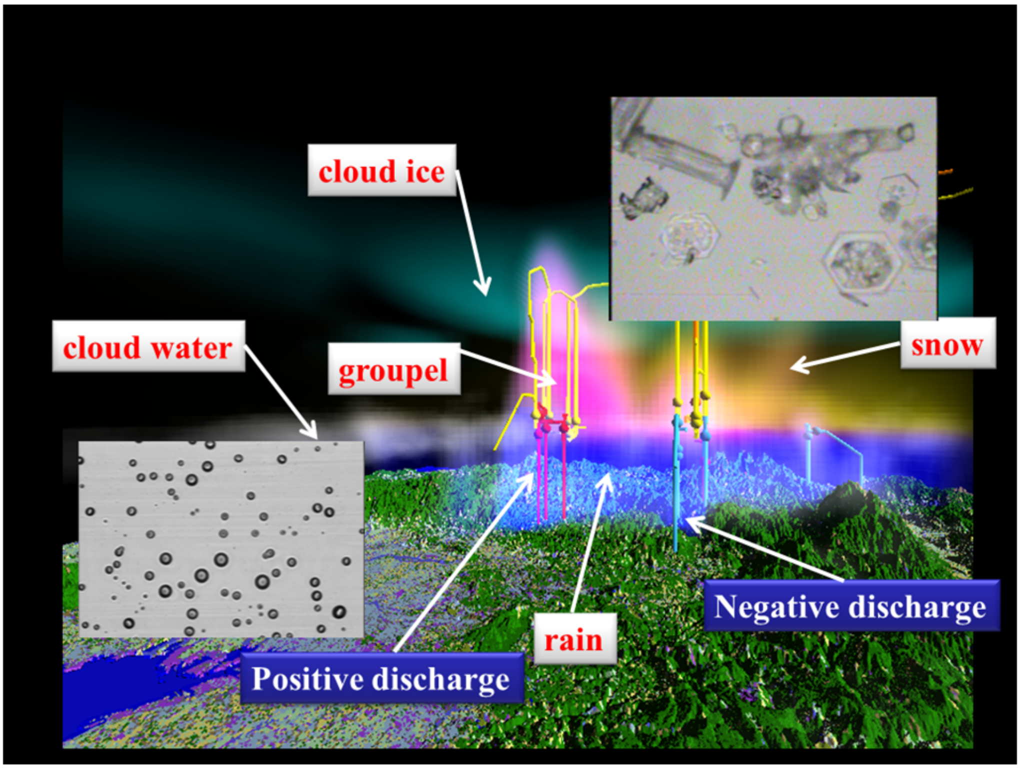
At middle and low latitudes, we studied MSTIDs using airglow imagers, Fabry-Perot interferometers, and ionosondes installed at geomagnetic conjugate points in Japan and Australia. We conclude that the sporadic E layer is the most effective in controlling the appearance/non-appearance of nighttime MSTIDs compared to neutral winds and ionospheric F-layer parameters. We have also studied long-term variation of gravity waves and MSTIDs using 16-year airglow images obtained at Shigaraki and Rikbetsu, Japan, and show latitudinal dependences of these phenomena in the mesosphere and ionosphere.

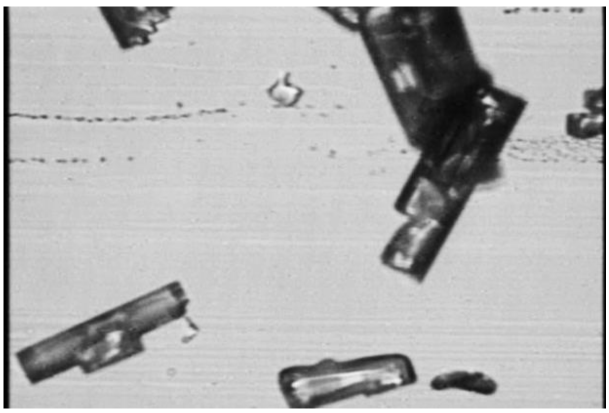


Schematic picture of hemispheric coupling of nighttime medium-scale traveling ionospheric.

Project for Aerosol and Cloud Formation

Hydrometeors and aerosols closely interact with each other in their generation and dissipation, and play important roles in atmospheric water circulation, formation of convective clouds and typhoons, as well as in the Earth radiation budget. However, they are some of the most unknown quantities in the atmosphere. Thus far, hydrometeors and cloud-precipitation systems have been studied in the Hydrospheric Atmospheric Research Center, whereas aerosols and related processes have been studied in the Solar-Terrestrial Environmental Laboratory. In the joint research program, researchers from both centers will cooperate to study the interaction between aerosols and hydrometeors, their variations in the formation of precipitation, and cloud-aerosol-radiation interactions by field observations and numerical simulations. On the basis of field observations, the numerical model will be improved for quantitative simulation of cloud and aerosol processes. In cooperation with the Center for Orbital and Suborbital Observations, we will conduct in situ observations of typhoons using an aircraft, balloons, and drones. This research will improve CReSS and study the impact of aerosols on typhoon clouds.



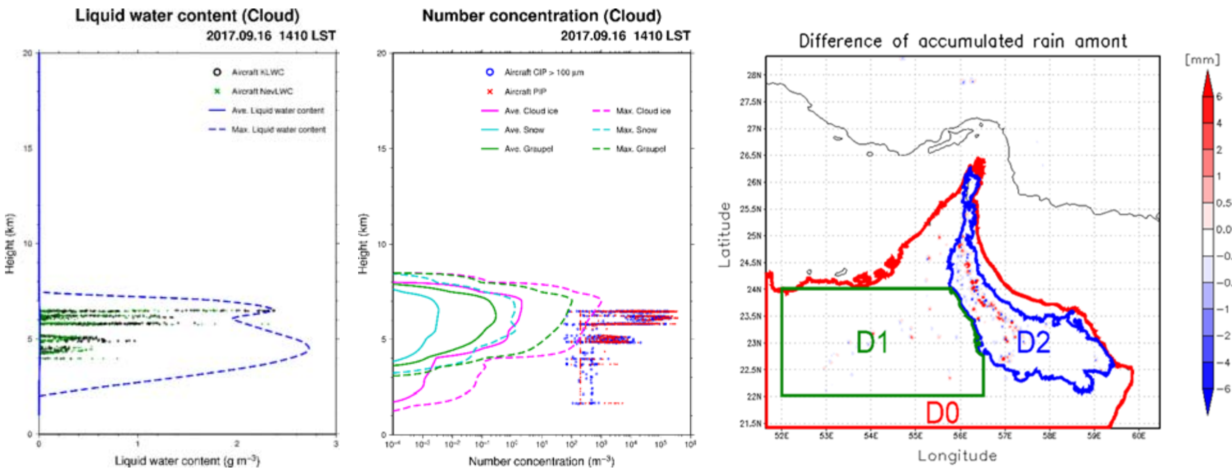


Upper: A mesoscale convective system and hydrometeors simulated by the CReSS model.
Lower: The superimposed images show hydrometeors expected to be present in the convective system. Balloon observation of typhoon clouds. Launching balloon (left) and observed hydrometeors (right).

Main Activities in FY2018

Cloud and aerosol observation in UAE and aerosol modeling

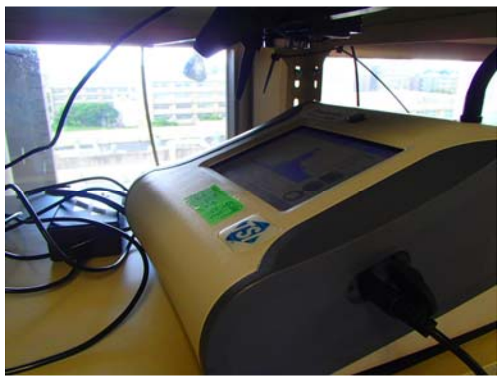
Physico-chemical properties of atmospheric aerosols and microphysical structures of diurnal convective clouds, which had been observed over the United Arab Emirates (UAE) using an instrumented aircraft in September 2017, were simulated by the CReSS model implemented with a new cloud microphysics scheme and a simplified cloud condensation nuclei (CCN)/ice nucleating particle (INP) scheme and the influence of CCN/INP abundance was also investigated. The CReSS well-simulated the diurnal convective clouds, except for high concentrations of ice crystals, which activated the mineral dust particles present at high concentrations in the boundary layer. Doubling the CCN number concentrations suppressed the conversion from cloud water to rainwater, and more cloud water was transported to upper subfreezing levels and froze there. The latent heat release invigorated the diurnal convective clouds, especially cumulus congestus clouds. We are planning to evaluate more accurately the impact of mineral dust particles acting as INP using an aerosol, cloud, and precipitation-integrated model currently being tested and improved.



Comparison of cloud water content (left) and snow particle number concentration (middle) obtained from aircraft observation (dotted line) and numerical simulation (dashed line). Increase and decrease of surface precipitation when CCN concentration is doubled from default value of 500 cm^{-3} (right).

Observation of aerosol particles during passage of typhoon through Okinawa

As part of the KAKENHI research project (PI: K. Tsuboki), we measured the size distribution of aerosol particles from August to October 2018, and PM2.5 mass concentrations continuously from August 2018, using an optical particle analyzer and a low-cost sensor, respectively (Fig.) at the Univ. of the Ryukyus in Okinawa. Two typhoons Trami and Kong-Rey passed 40 and 100 km west of the Okinawa Island on September 29 and October 4, respectively. The mass concentration of coarse-mode particles increased in proportion to the wind speed and the mass-based mode diameter was found to decrease as Trami approached. Chemical analyses of the aerosol particles collected on quartz filters before, during, and after the passage of these typhoons found that the mass and fraction of sea salt in the aerosols increased significantly during the passage of these typhoons.



Optical particle analyzer used during the observation at University of the Ryukyus.

9. Publications and Presentations

Papers (in refereed Journals, April 2018–March 2019)

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Three more books were published in Japanese.

Publication of Proceedings (April 2018–March 2019)

Title	Date of Publication
The Nagoya University Bulletin of Chronological Research, vol.3	Mar. 31, 2019

One more book was published in Japanese.

Conference Presentations (April 2018–March 2019)

■ International Conferences

* Session Conveners

Title	Country/ Region	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	Invited
European Geosciences Union General Assembly	Vienna, Austria	Apr. 8–13, 2018	0	2	0	2	0
33th Conference on Hurricanes and Tropical Meteorology	Florida, USA	Apr.16–20, 2018	0	1	0	1	0
EISCAT_3D User Meeting 2018	Uppsala, Sweden	May 8–9, 2018	0	1	0	1	0
14th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS-14)	Toronto, Canada	May 8–10, 2018	0	0	1	1	0
The 3rd PSTEP International Symposium (PSTEP-3) “Toward the Solar-Terrestrial Environment Prediction as Science and Social Infrastructure”	Tokyo, Japan	May 16–18, 2018	2	9	0	9	2
20th International Symposium on Very High Energy Cosmic Ray Interactions (ISVHECRI 2018)	Nagoya, Japan	May 21–25, 2018	4	3	2	5	1
12th International Conference on High Energy Density Laboratory Astrophysics (HEDLA)	Kurashiki, Japan	May 27–Jun. 1, 2018	0	1	0	1	1
2nd URSI Atlantic Radio Science Conference (URSI AT-RASC 2018)	Gran Canaria, Spain	May 28–Jun. 1, 2018	0	5	0	5	1
AOGS 2018	Hawaii, USA	Jun. 3–8, 2018	6 *	14	3	17	5
SuperDARN 2018 Workshop	Banyuls-sur-Mer, France	Jun. 4–8, 2018	0	3	0	3	0
19th International Science Team Meeting (GHRSST XIX)	Darmstadt, Germany	Jun. 4–8, 2018	0	1	0	1	0
7th International HEPPA-SOLARIS Workshop	Virginia, USA	Jun. 11–14, 2018	0	1	0	1	1
International Conference on the Advancement of Silicon Photomultipliers	Schwetzingen, Germany	Jun.11–15, 2018	0	1	0	1	0
NDACC-IRWG and TCCON Annual Meeting 2018	Cocoyoc, Mexico	Jun.11–15, 2018	0	2	0	2	0
Planetary Atmospheric Erosion Europlanet Workshop 2018	Murighiol, Romania	Jun.11–15, 2018	0	1	0	1	1
The 23rd International Radiocarbon Conference	Trondheim, Norway	Jun.17–22, 2018	0	5	0	5	1
17th RHESSI workshop	Dublin, Ireland	Jun.18–23, 2018	0	1	0	1	0
10th International Workshop on Modeling the Ocean (IWMO2018)	Santos, Brazil	Jun.25–28, 2018	0	2	0	2	0
ASTRONUM-2018: 13th International Meeting on Numerical Modeling of Space Plasma Flows	Florida, USA	Jun.25–29, 2018	0	2	0	2	0
The 10th European Conference on Radar in Meteorology and Hydrology (ERAD2018)	Ede, Netherland	Jul. 1–6, 2018	0	2	0	2	0
The Joint WCRP Grand Challengeon Weather and Climate Extremes/GEWEX Global Data and Analysis Panel workshop on Precipitation Extremes	Offenbach, Germany	Jul. 9–11, 2018	0	1	0	1	0
15th Conference on Cloud Physics/15th Conference on Atmospheric Radiation	Vancouver, Canada	Jul. 9–13, 2018	0	1	0	1	0
The Fourteenth Edition of the Solar-Terrestrial Physics Symposium (STP14)	Toronto, Canada	Jul. 9–13, 2018	0	4	1	5	1
The 8th Space Weather Conference	Seoul, Korea	Jul. 10–11, 2018	0	1	0	1	1
42nd COSPAR Scientific Assembly	California, USA	Jul. 14–22, 2018	0	12	2	14	9

Title	Country/ Region	Date	Orga- nizers	Number of Presentations			
				Staffs and PDs	Students	Total	Invited
2018 International Geoscience and Remote Sensing Symposium (IGARSS)	Valencia, Spain	Jul. 22–27, 2018	0	1	0	1	0
NOEMA/30m Workshop	Tokyo, Japan	Jul. 24–25, 2018	0	1	0	1	0
8th East-Asia School and Workshop on Laboratory, Space, and Astrophysical Plasmas	Daejeon, Korea	Jul. 30–Aug. 3, 2018	1	2	0	2	2
HAO Summer Workshop “Model Coupling and Data Driven Simulations of Solar Eruptions”	Colorado, USA	Aug. 13–16, 2018	0	1	0	1	0
45th Annual European Meeting on Atmospheric Studies by Optical Methods (45AM)	Kiruna, Sweden	Aug. 27–31, 2018	0	2	0	2	1
10th International Aerosol Conference (IAC 2018)	Missouri, USA	Sep. 2–7, 2018	0	1	0	1	1
MR2018	New Jersey, USA	Sep. 4–8, 2018	0	1	1	2	2
13th International Symposium for Space Simulations (ISSS-13)	California, USA	Sep. 6–14, 2018	1	1	0	1	0
Hinode-12	Granada, Spain	Sep. 10–13, 2018	0	2	1	3	1
4th International Workshop on Heterogeneous Kinetics Related to Atmospheric Aerosols	Takamatsu, Japan	Sep. 24, 2018	1	0	0	0	0
2018 joint 14th iCACGP Quadrennial Symposium/15th IGAC Science Conference	Takamatsu, Japan	Sep. 25–29, 2018	1	3	1	4	0
Stratosphere-troposphere Processes And their Role in Climate (SPARC) 2018 General Assembly	Kyoto, Japan	Oct. 1–5, 2018	0	1	0	1	0
2nd Nordic Observatory Meeting	Abisko, Sweden	Oct. 2–3, 2018	0	1	0	1	0
ISEE International workshop “Extreme solar events: How hostile can the Sun be?”	Nagoya, Japan	Oct. 2–6, 2018	1	2	0	2	1
Ultra High Energy Cosmic Rays 2018	Paris, France	Oct. 8–12, 2018	0	1	0	1	0
The extreme Universe viewed in very-high-energy gamma rays 2018	La Palma, Spain	Oct. 12, 2018	0	1	0	1	1
Eighth International Fermi Symposium	Maryland, USA	Oct. 14–19, 2018	0	1	0	1	0
The Workshop on Solar Radio and IPS Data Analysis	Inner Mongolia, China	Oct. 15–18, 2018	0	2	0	2	0
15th International Symposium on Equatorial Aeronomy (ISEA-15)	Ahmedabad, India	Oct. 22–26, 2018	0	2	0	2	0
11th GEOSS Asia-Pacific Symposium	Kyoto, Japan	Oct. 24–26, 2018	0	2	0	2	2
18th Asia Simulation Conference (AsiaSim2018)	Kyoto, Japan	Oct. 27–29, 2018	0	1	0	1	0
2018 Korean Meteorological Society Autumn Meeting	Jeju, Korea	Oct. 29–31, 2018	0	0	1	1	0
2018 Solar Dynamics Observatory Workshop	Ghent, Belgium	Oct. 29–Nov. 2, 2018	0	1	0	1	0
International School for AstroParticle Physics 2018-LHC meets Cosmic Rays	Geneve, Switzerland	Oct. 29–Nov. 2, 2018	0	1	2	3	1
2nd International Symposium “Ocean Mixing Processes: Impact on Biogeochemistry, Climate and Ecosystem”	Kashiwa, Japan	Nov. 4, 2018	0	1	0	1	0
International Workshop on GNSS Ionosphere (IWGI2018)	Shianghai, China	Nov. 4–6, 2018	0	1	0	1	0
9th Workshop of the International Precipitation Working Group (IPWG)	Seol, Korea	Nov. 5–9, 2018	0	1	0	1	0
ISEE Internaional Workshop “Data-Driven Models of the Solar Progenitors of Space Weather and Space Climate”	Nagoya, Japan	Nov. 6–9, 2018	1	0	0	0	0
3rd Korea-Japan Joint Workshop on Iotope-Ratio Mass Spectrometry	Daejeon, Korea	Nov. 8–10, 2018	1*	2	0	2	0

Title	Country/ Region	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	Invited
International Workshop on Data Science 2018 - Present & Future of Open Data & Open Science -	Mishima, Japan	Nov. 12–15, 2018	0	1	0	1	1
THE 11TH annual ACRE meeting, ACRE Japan, ACRE SE Asia-2, ACRE China-3, and C3S data rescue service (DRS) workshops	Tokyo, Japan	Nov. 12–16, 2018	0	1	0	1	0
2nd Asia-Pacific Conference on Plasma Physics (AAPPS-DPP2018)	Kanazawa, Japan	Nov. 12–17, 2018	0	3	0	3	0
8th International Conference on Quarks and Nuclear Physics	Tsukuba, Japan	Nov. 13–17, 2018	0	1	0	1	1
Workshop on Interstellar Matter 2018	Sapporo, Japan	Nov. 14–16, 2018	0	1	0	1	0
ISSI-BJ Forum on "The Next Scientific Program of SCOSTEP	Beijing, China	Nov. 14–16, 2018	0	2	0	2	1
The Second annual symposium of the innovative area "Gravitational Wave Physics and Astronomy: Genesis"	Kyoto, Japan	Nov. 26–28, 2018	0	1	1	2	0
2018 GEWEX Data and Analysis Panel (GDAP) Meeting	Lisboa, Portugal	Nov. 26–29, 2018	0	1	0	1	0
5th International Workshop on New Photon-Detectors	Tokyo, Japan	Nov. 27–29, 2018	1	1	2	3	0
MWA project meeting	Naogoya, Japan	Dec. 3, 2018	0	1	0	1	1
The 6th Asian / 15th Korea-Japan Workshop on Ocean Color (6th AWOC/ 15th KJWOC)	Yokohama, Japan	Dec. 3–5, 2018	0	2	6	8	0
Science at Low Frequency V (SALF V) at Nagoya	Nagoya, Japan	Dec. 4–6, 2018	0	1	0	1	0
The Ninth Symposium on Polar Science	Tokyo, Japan	Dec. 4–7, 2018	0	4	1	5	0
Partnership between Norway and Japan for excellent Education and Research in Weather and Climate Dynamics (NORPAN) Workshop on Air-Sea Interaction Processes	Bergen, Norway	Dec. 5–7, 2018	0	1	0	1	0
AGU fall meeting 2018	California, USA	Dec. 10–14, 2018	2*	19	8	27	2
19th East Aisa Sub-mm-wave Receiver Technology Workshop	Nishinomiya, Japan	Dec. 11–13, 2018	1	1	1	2	0
East Asian ALMA Development Workshop 2018	Sakai, Japan	Dec. 14–15, 2018	0	1	0	1	0
PaleoAsia International Workshop 2018	Kyoto, Japan	Dec. 16–18, 2018	0	2	0	2	0
East Asian ALMA Science Workshop 2018	Osaka, Japan	Dec. 17–19, 2018	0	1	0	1	0
International workshop on "extreme severe storms and disaster mitigation strategies"	Bandarsindri, India	Dec. 24–26, 2018	0	1	1	2	0
Observatory Days 2019	Sodankyla, Finland	Jan. 9–11, 2019	0	1	1	2	0
The Joint PI Meeting of JAXA Earth Observation Missions FY2018	Tokyo, Japan	Jan. 21–25, 2019	0	1	0	1	0
23rd International Microlensing Conference	New York, USA	Jan. 28–30, 2019	0	1	0	1	0
Chapman Conference on Scientific Challenges Pertaining to Space Weather Forecasting Including Extremes	California, USA	Feb.11–15, 2019	1	2	0	2	1
NORPAN Closing Workshop	Hakone, Japan	Feb.12–15, 2019	0	1	0	1	0
The 10th International workshop on Very High Energy Particle Astronomy (VHEPA2019)	Kashiwa, Japan	Feb.18–20, 2019	0	1	0	1	1
The 4th KMI international Symposium	Nagoya, Japan	Feb.18–20, 2019	1	1	1	2	0

Title	Country/ Region	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	Invited
Max-Planck/Princeton Center for Plasma Physics (MPPC) Workshop 2019	Tokyo, Japan	Feb.18–21, 2019	0	1	0	1	1
Symposium on Planetary Science 2019	Sendai, Japan	Feb.18–21, 2019	2	2	0	2	1
15th Vienna Conference on Instrumentation	Vienna, Austria	Feb.18–22, 2019	1	0	0	0	0
PSTEP A04 International Workshop	Kyoto, Japan	Feb.19–20, 2019	0	1	0	1	1
ASLO 2019 Aquatic Science Meeting	San Juan, Puerto Rico	Feb. 23–Mar. 2, 2019	0	1	0	1	0
IBS brainstorm meeting	Muju, Korea	Feb. 25–26, 2019	0	1	0	1	1
Recent progress in heliospheric physics by direct measurements of unexplored space plasmas	Nagoya, Japan	Feb. 25–28, 2019	2	3	0	3	1
4th International Joint Workshop on Computationally-Intensive Modelling of the Climate System and 9th OFES International Workshop	Kasuga, Japan	Feb. 28–Mar. 1, 2019	0	4	1	5	0
Conference on Mesoscale Convective System and High Impact Weather (ICMCS-XIII)	Naha, Japan	Mar. 6–8, 2019	2	3	2	5	1
International Workshop on Forward Physics and Forward Calorimeter Upgrade in ALICE	Tsukuba, Japan	Mar. 7–9, 2019	0	1	0	1	0
2019 URSI Asia-Pacific Radio Science Conference	New Delhi, Inida	Mar. 9–15, 2019	0	1	0	1	1
Mesospheric Dust – Project Meeting	Tromsö, Norway	Mar. 14–15, 2019	0	2	0	2	0
Flux Emergence Workshop 2019	Tokyo, Japan	Mar. 18–22, 2019	0	3	0	3	0
20th Pacific Asian Marginal Seas (PAMS 2019)	Kaohsiung, Taiwan	Mar. 19–22, 2019	0	2	0	2	0
Workshop for Atmospheric Neutrino Production in the MeV to PeV range	Naogya, Japan	Mar. 20–22, 2019	2	2	0	2	1
Second CEARAC Expert Meeting on Eutrophication Assessment in the NOWPAP Region	Vladivostok, Russia	Mar. 22, 2019	0	1	0	1	1
International Workshop on Relations Between Solar Evolution and Atmospheric Escape from Terrestrial Planets	Nagoya, Japan	Mar.26–29, 2019	1	0	0	0	0
Total			35	194	40	234	53

■ Domestic Coferences

Number of Conferences	Organizers	Number of Presentations			
		Staff and PDs	Student	Total	invited
100	76	295	97	392	43

■ Lectures for Researchers

Date	Title	Number of Paticipants
Apr. 5, 2018, May 15, 2018, Jul. 24, 2018, Aug. 28, 2018, Spt. 26, 2018, Nov. 5, 2018, Nov. 29, 2018, Jan. 8, 2019, Feb. 15, 2019 Mar.12, 2019	PSTEP Seminar	60 a time on average
May 1, 2018, May 8, 2018, May 14,2018 Jul. 5, 2018, Oct. 3, 2018, Oct. 12, 2018, Nov. 2, 2018, Nov. 20, 2018, Nov. 30, 2018, Dec. 25, 2018, Jan. 8, 2019, Feb. 15, 2019, Mar. 1, 2019	ISEE/CICR Colloquium	20 a time on average
Apr. 26, 2018, May 10, 2018, May 24, 2018, May 31, 2018, Jun. 7, 2018	ROOT Training Workshop 2018	100
Aug. 2–Aug. 10, 2018	Satellite Oceanography Training Course	31
Aug. 8, 2018	ISEE special seminar on "Gamma-ray emission from thunder clouds"	30
Aug. 31–Sep. 2, 2018	Meteorology Summer School 2018	84
Feb. 12, 2019	Joint Meeting of ISEE Technical Support Division and JAXA/ISAS Advanced Machining Technology Group	30
Mar. 14, 2019	“Australian-Japanese Comparative Analysis of Urban Water-Food-Energy Security Nexus” MLFP project workshop	12
Mar. 15, 2019	Cloud and Precipitation Climatology Lab Guest Seminar	15
Mar. 18–22, 2019	1st International School on Equatorial Atmosphere 2019	170
Mar. 26, 2019	ArCS “Study atmospheric climate forcers in the Arctic” meeting	22

Awards

■ Staffs and PDs

Date	Awards	Award Winners	Title
Apr. 17, 2018	The Young Scientists’ Prize, The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology	Tomoki Nakayama (now at Nagasaki University)	Research on optical properties of atmospheric fine particles using laser spectroscopic techniques
Apr. 17, 2018	JSME Medal for Outstanding Paper	Yoshizumi Miyoshi	A. Takeuchi, H. Fujii, A. Yamashita, M. Tanaka, R. Kataoka, Y. Miyoshi, , et al. (2016), Aurora 3d-measurement from whole-sky time series image using fish-eye stereo camera. *Transactions of the JSME*, 82(834), 15-00428, doi:10.1299/transjsme.15-00428
May 21, 2018	EPS Excellent Paper Award 2017	Masaki Nishino	Y. Saito, M. N. Nishino, M. Fujimoto, T. Yamamoto, S. Yokota, et al. (2012), Simultaneous observation of the electron acceleration and ion deceleration over lunar magnetic anomalies, *Earth Planets Space*, 64:4, 83–92, doi:10.5047/eps.2011.07.011
May 29, 2018	URSI AT-RASC 2018 Young Scientist Award	Shoya Matsuda (now at JAXA)	Strategy of EMIC Wave Observation by Arase/PWE and its Initial Results

Date	Awards	Award Winners	Title
July 8, 2018	12th Outstanding Paper Award, Japan Society for Scientific Studies on Cultural Properties	Hirotaka Oda	H. Oda, and K. Nakamura (2018), Radiocarbon dating of Ezo-nishiki silk fabrics by accelerator mass spectrometry: Searching for the origin of the "Silk Road of Northeast Asia". *Archaeology and natural science*, **75**, 41–58
Jul. 31, 2018	Outstanding Reviewer, Japan Society for the Promotion of Science	Kazuhisa Tsuboki	Research Fellowships for Young Scientists
Aug. 2018	Top Reviewers of 2017	Yuichi Otsuka	Advances in Space Research
Nov.16, 2018	2nd Asia-Pacific Conference on Plasma Physics (AAPPS-DPP2018) Poster Prize	Takayuki Umeda	T. Umeda, and Y. Wada, Non-MHD effects in the nonlinear development of the MHD-scale Rayleigh-Taylor instability
Nov.26, 2018	SGEPSS Frontier Award	Masayoshi Kojima Munetoshi Tokumaru Ken'ichi Fujiki	Development of the observation system of the global solar wind using interplanetary scintillation
Jan. 9, 2019	AMS Editor's Award 2019	Hidenori Aiki	Journal of Physical Oceanography
Feb. 15, 2019	2018 SOLA Award	Kazuhisa Tsuboki Taro Shinoda	K. Ito, et al. (2018), Analysis and forecast using dropsonde data from the inner-core region of tropical cyclone Lan (2017) obtained during the first aircraft missions of T-PARCII, *SOLA*, **14**, 105–110, doi:10.2151/sola.2018-018

■ Students

Date	Awards	Award Winners	Title
May 19, 2018	Young Scientist Award of the Physical Society of Japan	Qidong Zhou (Graduated in FY2017)	Study of contributions of diffractive processes to forward neutral particle production in p–p collisions at $\sqrt{s}$ = 13 TeV with the ATLAS-LHCf detector (published as his PhD thesis)

10. Education

The Institute for Space–Earth Environmental Research primarily offers graduate programs in three schools: Science, Engineering, and Environmental Studies at Nagoya University. The institute has its own graduate course program for Heliospheric and Geospace Physics as part of the Division of Particle and Astrophysical Science in the Graduate School of Science. It also cooperates with the Department of Electrical Engineering through the Space Electromagnetic Environment group in the Graduate School of Engineering and the Department of Earth and Environmental Sciences as a group in the Earth and Planetary Sciences Course and the Hydrospheric–Atmospheric Sciences Course in the Graduate School of Environmental Studies, by teaching/training graduate students in disciplines related to Space–Earth Environmental Research.

Our graduate students use various approaches and techniques, such as ground observations, fieldwork, laboratory experiments, radioactive dating, numerical simulations and modeling, and theoretical research. Their research includes the development of satellites and balloon and aircraft instruments, as well as analysis of observational data. As this institute conducts research that involves the analysis of data taken by the instruments inside and outside of the country and/or collaborative research with foreign researchers, our students are active in pioneering new research fields by working with researchers through international collaborations and conducting interdisciplinary research. Their work is published as master's or doctoral theses in academic journals and presented at international workshops and conferences. We nurture researchers who can apply their knowledge to benefit society and who have a broad perspective and an international mindset.

Staff association between the research divisions in the ISEE and the graduate schools

	Graduate School of Science					Graduate School of Engineering		Graduate School of Environmental Studies						
	Division of Particle and Astrophysical Science					Department of Electrical Engineering and Computer Science		Department of Earth and Environmental Sciences						
	Heliospheric and Geospace Physics					Electrical Engineering Course Space Electromagnetic Environment		Earth and Planetary Sciences Course Earth History Study		Hydrospheric-Atmospheric Sciences Course Global Water Cycle				
Institute for Space–Earth Environmental Research	Atmospheric and Environmental Science (AM)	Space Science – Experiment (SS_E)	Solar and Space Physics - Theory (SS_T)	Cosmic-Ray Physics (CR)	Heliospheric Plasma Physics (SW)	Space Observation	Information Engineering	CHIME	Tandetron AMS	Meteorology	Cloud and Precipitation Sciences	Atmospheric Chemistory	Hydroclimatology	Oceanography
Integrated Studies			●				●							
Cosmic-Ray Research				●										
Heliospheric Research					●									
Ionospheric and Magnetospheric Research		●				●								
Meteorological and Atmospheric Research	●					●				●	●	●		
Land–Ocean Ecosystem Research													●	●
Chronological Research								●	●					
Center for International Collaborative Research	●	●		●		●		●					●	
Center for Intergrated Data Science			●	●			●	●		●	●			●
Center for Orbital and Suborbital Observations	●	●		●						●	●			●

Number of Students Supervised by ISEE Staff

(April 1, 2018–March 31, 2019)

	M1	M2	D1	D2	D3	Undergraduate Students	Non-regular students	Total
Graduate School of Science	14	15	4	3	10	-	1 *1	47
Graduate School of Engineering	5	8	0	1	1	-	-	15
Graduate School of Environmental Studies	9	9	2	7	8	-	-	35
School of Science	-	-	-	-	-	10	-	10
School of Engineering	-	-	-	-	-	7	-	7
ISEE	-	-	-	-	-	-	1 *2	1
Total	28	32	6	11	19	17	2	115

* cumulative total in FY 2018, *1 Special Research Student, *2 Research Student

Faculty Members

(April 1, 2018–March 31, 2019)

■ Graduate School of Science Division of Particle and Astrophysical Science

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Solar-Terrestrial Chemistry	Akira Mizuno	Tomoo Nagahama		
Solar-Terrestrial Relationships	Masafumi Hirahara	Satonori Nozawa	Shin-ichiro Oyama	
		Yuichi Otsuka		
	Kanya Kusano	Satoshi Masuda		Akimasa Ieda
Solar-Terrestrial Physics	Yoshitaka Itow	Fumio Abe	Akira Okumura	Hiroaki Menjo
	Hiroyasu Tajima	Yutaka Matsubara		
		Fusa Miyake		
	Munetoshi Tokumaru	Kazumasa Iwai		Ken-ichi Fujiki

■ Graduate School of Engineering Department of Electrical Engineering and Computer

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Space Electromagnetic Environment	Kazuo Shiokawa	Nozomu Nishitani		Taku Nakajima
		Masahito Nosé		
	Yoshizumi Miyoshi	Takayuki Umeda	Shinsuke Imada	

■ Graduate School of Environmental Studies Department of Earth and Environmental

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Hydrospheric-Atmospheric Sciences Course Global Water Cycle	Kazuhisa Tsuboki	Taro Shinoda		
	Nobuhiro Takahashi	Hirohiko Masunaga		
	Michihiro Mochida			Sho Ohata
	Tetsuya Hiyama	Naoyuki Kurita	Hatsuki Fujinami	
	Joji Ishizaka	Hidenori Aiki		Yoshihisa Mino
Earth and Planetary Sciences Course Earth History Study	Masaki Enami	Takenori Kato		
	Hiroyuki Kitagawa	Masayo Minami		Hirotaka Oda

Undergraduate Education

Based on demand, the faculty of the institute offers numerous undergraduate courses in the School of Science, the School of Engineering, and in other departments and at other universities in the adjacent area.

■ During the 2018 Academic Year, The Following Courses were Offered;

- Astrophysics and Space Science
- Astrophysics III
- Atmospheric and Hydrospheric Sciences
- Electric Circuits with Exercise
- Electromagnetic Wave Engineering
- Environmental Earth Sciences (Geosphere Environmental Chemistry)
- Experimental Physics
- Experiments in Physics - Advanced Course
- First Year Seminar A
- First Year Seminar B
- From the Big Bang to the Present-day Human Society
- Fundamentals of Atmospheric and Hydrospheric Sciences
- Geochemical Analysis II and Experiments
- Geology Experiments
- Introduction to Earth Science
- Introduction to Physics I, II
- Isotope Geochemistry
- Laboratory in Physics
- Mathematics 1 with Exercises A/B
- Petrology
- Petrology Experiments
- Physics Experiments I, II
- Probability Theory and Numerical Analysis with Exercises
- Science of Atmospheric-Hydrospehric Environment
- Solar System Science
- Topics in Advanced Physics

11. International Relations

Academic Exchange

(28 in total)

Institution	Country/Region	Establishment
Indonesian National Institute of Aeronautics and Space	Indonesia	May 31,1988
Korean Space Weather Center	Korea	December 24, 2012
Korea Institute of Ocean Science and Technology, Korea Ocean Satellite Center	Korea	April 17, 2014
Pukyong National University, College of Fisheries Sciences	Korea	October 2, 2006
Institute of High Energy Physics, Chinese Academy of Sciences	China	February 20, 2001
Polar Research Institute of China	China	November 11, 2005
Department of Atmospheric Sciences, National Taiwan University	Taiwan	October 30, 2009
Center for Weather Climate and Disaster Research, National Taiwan University	Taiwan	September 3, 2014
Bangladesh University of Engineering & Technology, Department of Physics	Bangladesh	March 4, 2008
National Institute of Water and Atmospheric Research	New Zealand	July 26, 1989
Centre for Geophysical Research, University of Auckland	New Zealand	December 7, 1992
Faculty of Science, University of Canterbury	New Zealand	July 30, 1998
Geophysical Institute, University of Alaska Fairbanks	U.S.A.	July 16, 1990
Space Environment Center, National Oceanic and Atmospheric Administration	U.S.A.	December 15, 1992
National Geophysical Data Center, National Oceanic and Atmospheric Administration	U.S.A.	January 5, 1993
Haystack Observatory, Massachusetts Institute of Technology	U.S.A.	October 24, 1994
Center for Astrophysics and Space Sciences, University of California at San Diego .	U.S.A.	December 22, 1997
Center for Space Science and Engineering Research, Virginia Polytechnic Institute and State University	U.S.A.	January 23, 2013
Chacaltaya Cosmic Ray Observatory, Faculty of Sciences, Universidad Mayor de San Andres, La Paz	Bolivia	February 20, 1992
National Institute for Space Research	Brazil	March 5, 1997
Swedish Institute of Space Physics	Sweden	September 1, 2005 (since March 25, 1993)
Faculty of Science, University of Tromsø	Norway	April 2, 2003 (since October 8, 1993)
Department of Geophysics, Finnish Meteorological Institute	Finland	October 21, 1994
Yerevan Physics Institute	Armenia	October 18, 1996
Institute of Cosmophysical Research and Radiowave Propagation, Far Eastern Branch, Russian Academy of Sciences	Russia	April 14, 2007
Institute of Solar-Terrestrial Physics, Siberian Branch of the Russian Academy of Sciences	Russia	October 28, 2008
Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy, Siberian Branch of the Russian Academy of Sciences	Russia	November 28, 2012
The Polar Geophysical Institute, Murmansk	Russia	March 13, 2017

Note: The List includes the academic exchanges established in the former organizations before ISEE.

Research Projects

■ Major International Collaborative Projects

(78 in total)

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Study of the Onset Mechanism of Solar Eruptions	K. Kusano	Germany	University of Potsdam
Observational Study of the Onset Mechanism of Solar Eruptions	K. Kusano	U.S.A China	New Jersey Institute of Technology University of Science and Technology of China
Study of Modeling of Solar Eruptions	K. Kusano	U.S.A.	Harvard-Smithsonian Center for Astrophysics
Study of Triggering Mechanism of Solar Flares	K. Kusano	U.K.	UCL-Mullard Space Science Laboratory
Study of Magnetic Reconnection	K. Kusano	U.K.	University of Manchester
Solar Researches with Nobeyama Radioheliograph	S. Masuda	U.S.A. China Korea Russia U.K. Germany Switzerland Belgium	GSFC/NASA, Catholic University of America, New Jersey Institute of Technology National Astronomical Observatories, Chinese Academy of Sciences KASI, Seoul National University Russian Academy of Sciences University of Warwick Georg-August-Universität Göttingen University of Applied Sciences and Arts Northwestern Switzerland Katholieke Universiteit Leuven
Radiation Belt Storm Probes (RBSP) Project	Y. Miyoshi	U.S.A.	NASA, JHUAPL
Modeling Study of Inner Magnetosphere	Y. Miyoshi	U.S.A.	Los Alamos National Laboratory
Pulsating Aurora as a Manifestation of Non-Linear Wave Particle	Y. Miyoshi	U.S.A China Finland Czech	UCLA Peking University Sodankylä Geophysical Observatory: SGO Czech Academy of Sciences
Collaborative study on ERG project	Y. Miyoshi	Taiwan	Institute of Astronomy and Astrophysics, Academia Sinica
A Search for Dark Objects Using the Gravitational Microlensing Effect	F. Abe	New Zealand U.S.A.	University of Auckland, University of Canterbury, Victoria University of Wellington, Massey University University of Maryland, NASA
Study in Cosmic Neutrinos by Using a Large Water Cherenkov Detector	Y. Itow	U.S.A. Canada U.K. Spain Korea China Poland	Boston University, Brookhaven National Laboratory, UCI, Duke University, George Mason University, University of Hawaii, Indiana University, Los Alamos National Laboratory, University of Maryland, State University of New York, University of Washington University of British Columbia, University of Toronto, TRIUMF Queen Mary University of London, Imperial College London, University of Liverpool, University of Oxford, University of Sheffield Complutense University of Madrid Chonnam National University, Seoul National University, Sungkyunkwan University Tsinghua University University of Warsaw

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Study in Interaction of Very High Energy Cosmic Rays by Using Large Hadron Collider	Y. Itow	Italy France Switzerland U.S.A.	University of Florence, Catania University École Polytechnique CERN Lawrence Berkeley National Laboratory
Study of Dark Matter and Solar Neutrinos Using a Liquid Xenon Detector	Y. Itow	Korea	Seoul National University, Sejong University, Korea Research Institute of standards and Science
Research and Development for the Next Generation Water Cherenkov Detector, Hyper-Kamiokande	Y. Itow	U.S.A. Korea China U.K. Italy France Switzerland Spain Poland Brazil *Canada, Russia Portugal*	Boston University, Brookhaven National Laboratory, UCI, Duke University, George Mason University, Indiana University, University of Hawaii, Los Alamos National Laboratory, University of Maryland, State University of New York, University of Washington Chonnam National University, Seoul National University, Sungkyunkwan University Tsinghua University Imperial College London, Lancaster University, University of Oxford, Queen Mary University of London, University of Sheffield, Rutherford Appleton Laboratory INFN Sezione di Bari, INFN Sezione di Napoli, INFN Sezione di Padova, INFN Sezione di Roma CEA Saclay, École Polytechnique University of Bern, Swiss Federal Institute of Technology Zurich Autonomous University of Madrid University of Warsaw University of São Paulo *and other Institutions*
Study of Dark Matter and Solar Neutrinos Using a 2-phase Liquid Xenon TPC Detector	Y. Itow	Germany Italy Switzerland U.S.A Sweden Israel Portugal *France, UAE, Netherlands*	Max-Planck-Institut, Albert-Ludwigs-Universität Freiburg INFN, Università di Bologna University of Zurich Columbia University, University of Chicago, Purdue University, UCSD Stockholms universitet Weizmann Institute of Science Universidade de Coimbra *and other institutions*
Study in Interaction of Very High Energy Cosmic Rays by Using Relativistic Heavy Ion Collider	Y. Itow	Italy U.S.A.	University of Florence, Catania University Brookhaven National Laboratory
Study of Solar Neutrons	Y. Matsubara	Bolivia Armenia China Switzerland U.S.A. Mexico	Research Institute of Physics, University of San Andrés Yerevan Physics Institute Institute of High Energy Physics, Chinese Academy of Sciences University of Bern University of Hawaii National Autonomous University of Mexico
Search for Cosmic-ray Excursions in the Past by Single-year Measurements of ^{14}C in Tree Rings	F. Miyake	U.S.A. Switzerland	The University of Arizona Swiss Federal Institute of Technology
Solar Flare Research with Hard X-ray Spectral Imaging Observations	H. Tajima	U.S.A.	UCB, MSFC/NASA, Air Force Research Laboratory
Solar Flare Research with Gamma-ray Spectral Imaging Observations with Polarimetry	H. Tajima	U.S.A.	UCB, Lawrence Berkeley National Laboratory, GSFC/NASA

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Research on Origin of Cosmic Rays with Fermi Satellite	H. Tajima	U.S.A. France Italy Sweden	Stanford University, SLAC National Accelerator Laboratory, GSFC/NASA, U.S. Naval Research Laboratory, UCSC, Sonoma State University University of Washington, Purdue University, Ohio State University, University of Denver CENS, CNRS, École Polytechnique INFN, Italian Space Agency, IFSI Royal Institute of Technology, Stockholm University
Research on Origin of Cosmic Rays with CTA (Cherenkov Telescope Array)	H. Tajima	Germany France Italy Spain Switzerland U.K. U.S.A. *Brazil, Argentina, Poland, Armenia, Australia, Czech, Bulgaria, Croatia, Finland, Greece, Sweden Slovenia, India, Ireland, South Africa*	Deutsches Elektronen-Synchrotron, Max-Planck-Institut, Heidelberg University CENS, École Polytechnique, University of Paris INFN, IFSI University of Barcelona, Complutense University University of Zürich Durham University, University of Leicester, University of Leeds SLAC National Accelerator Laboratory, Argonne National Laboratory, University of Washington, Iowa State University, UCLA, UCSC, University of Chicago, Smithsonian Observatory *and other institutions*
Observations of Interplanetary Disturbances Using the International IPS Network	M. Tokumaru	U.K. Russia India Mexico Australia	LOFAR-UK Lebedev Physical Institute Tata Institute of Fundamental Research National Autonomous University of Mexico Murchison Widefield Array
Study of 3-D Solar Wind Structure and Dynamics Using Heliospheric Tomography	M. Tokumaru	U.S.A.	CASS/UCSD
Study on the Application of Interplanetary Scintillation Observations to Space Weather Forecast	M. Tokumaru	Korea	Korean Space Weather Center
Study of the Heliospheric Boundary Region Using Observations of Interplanetary Scintillation	M. Tokumaru	U.S.A.	Interstellar Boundary Explorer, IMAP
Ionosphere and Upper Atmosphere Research, Observations and Monitoring	Y. Otsuka	Thailand	Chiang Mai University
Variation of the Thermosphere and Ionosphere owing to the Energy of Atmospheric Waves	Y. Otsuka	Indonesia	LAPAN
SDI-3D project: Development of SDI	S. Oyama	U.S.A Finland Sweden	Geophysical Institute/UAF University of Oulu, Finnish Meteorological Institute, Sodankylä Geophysical Observatory, Lappeenranta-Lahti University of Technology The Swedish Institute of Space Physics (IRF), KTH Royal Institute of Technology
Study of Auroral Energetic Electron Precipitation (EEP) Impacts on the Upper/Middle Atmosphere	S. Oyama	Finland New Zealand U.K. Norway U.S.A.	Sodankylä Geophysical Observatory, University of Oulu, Finnish Meteorological Institute University of Otago British Antarctic Survey University Centre in Svalbard University of Alaska Fairbanks

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
VarSITI (Variability of the Sun and Its Terrestrial Impact)	K. Shiokawa	U.S.A., France, Germany, U.K., Italy, Canada,	SCOSTEP
Magnetic Conjugate Observations of Midlatitude Thermospheric Disturbances	K. Shiokawa	Australia	Radio and Space Service/IPS
High-Sensitive Imaging Measurements of Airglow and Aurora and electromagnetic waves in Canadian Arctic	K. Shiokawa	U.S.A. Canada	University of California, Augsburg College Virginia Polytechnic Institute and State University University of Calgary, Athabasca University
Comparison of Dynamical Variations of the Mesosphere, Thermosphere, and Ionosphere between Asian and Brazilian Longitudes	K. Shiokawa	Brazil	INPE
Ground and Satellite Measurements of Geospace Environment in the Far-Eastern Russia	K. Shiokawa	Russia	Institute of Cosmophysical Research and Radiowave Propagation, Far Eastern Branch, Russian Academy of Sciences
Observations of the Equatorial Ionosphere in South-East Asia and West Africa	K. Shiokawa	Nigeria Cote d'Ivoire	National Space Research and Development Agency, Federal University of Technology, Akure Université Félix Houphouët-Boigny
Observations of Waves and Particles in the Inner Magnetosphere in the Siberian Region of Russia	K. Shiokawa	Russia	IKFIA/SB RAS, ISTP/SB RAS
Study of the Polar/Midlatitude Ionosphere and Magnetosphere Using the SuparDARN HF Radar Network	N. Nishitani	U.S.A. U.K. France South Africa Australia Canada	JHUAPL, Virginia Polytechnic Institute and State University University of Leicester LPC2E/CNRS University of KwaZulu-Natal La Trobe University University of Saskatchewan
Study of the Polar Upper Atmosphere Using the EISCAT Radars and Other Instruments	S. Nozawa	Norway Sweden, Finland, Germany, U.K., China	University of Tromsø EISCAT Scientific Association
Derivation of substorm index from low-latitude geomagnetic field data	M. Nosé	Australia Turkey Germany Spain Denmark U.S.A.	Geoscience Australia Boğaziçi University Ludwig-Maximilians-Universität München Universitat Ramon Llull Technical University of Denmark United States Geological Survey (USGS)
Future Satellite Mission for the Terrestrial Magnetosphere-Ionosphere-Thermosphere Explorations by Formation Flight Observations and its Feasibility Study and Collaboration of the Satellite and Ground-Based Observations	M. Hirahara	Sweden	Swedish Institute of Space Physics (IRF), Swedish National Space Board
Research and Development of the Plasma/Particle Instrument Suite for the Mercury Magnetospheric Exploration Mission	M. Hirahara	France Sweden U.K. U.S.A. Switzerland	CESR-CNRS, CETP-IPSL Institute for Solar Physics of the Royal Swedish Academy of Sciences Rutherford Appleton Laboratory Boston University University of Bern
Study on Science Subjects and Developmental Techniques of Observational Instruments toward Future Spacecraft Exploration Missions for the Space-Earth Coupling System	M. Hirahara	U.S.A. Canada Sweden	University of Colorado Boulder, UCB University of Calgary Swedish Institute of Space Physics (IRF)
Continuous Observation of Methane at a Paddy Field in Northern India	Y. Matsumi	India	University of Delhi
Observation of PM2.5 in Hanoi	Y. Matsumi	Vietnam	Hanoi University of Science and Technology

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Observation of PM2.5 in Ulan Bator	Y. Matsumi	Mongolia	National University of Mongolia
Study of aerosols and armospheric trace gases by using SAVER-Net observation network in South America	A. Mizuno	Argentina Chile Bolivia	CEILAP, Servicio Meteorológico Nacional Argentina University of Magallanes (UMAG), Dirección Meteorológica de Chile University of La Frontera, Universidad Mayor de San Andrés
High Energy Particles in Geospace: the Acceleration Mechanism and the Role in Earth's Climate	A. Mizuno	U.S.A. Norway Sweden	University of Colorado Boulder, UCLA, University of Arizona University of Tromsø EISCAT Scientific Association
Source Apportionment of Organic Aerosols in Beijing	M. Mochida	China	Tianjin University
Aircraft observation of aerosols and clouds in the Arctic	S. Ohata	Germany	Alfred Wegener Institute, Universität Leipzig
Long-term observation of black carbon aerosols in the Arctic	S. Ohata	Norway U.S.A Canada Russia	Norwegian Polar Institute National Oceanic and Atmospheric Administration Government of Canada Arctic and Antarctic Research Institute
Global Precipitation Measurement Mission (GPM)	H. Masunaga N. Takahashi	U.S.A.	NASA
Tropical Rainfall Measuring Mission	N. Takahashi	U.S.A.	NASA
Study on tropical convective-radiative interactions	H. Masunaga	France	Laboratoire de Meteorology Dynamique/CNRS
Study on tropical-subtropical atmospheric dynamics	H. Masunaga	U.S.A.	University of Miami
Tropical Cyclones-Pacific Asian Research Campaign for Improvement of Intensity Estimations/Forecasts (T-PARCII)	K. Tsuboki T. Shinoda	Taiwan	National Taiwan University Atmospheric Sciences
Advanced Study on Precipitation Enhancement in Arid and Semi-Arid Regions	M. Murakami	United Arab Emirates	National Centre of Meteorology, Khalifa University
Study of Equatorial Waves in the Atmosphere and Ocean	H. Aiki	Germany	GEOMAR Helmholtz Centre for Ocean Research Kiel
Validation of GOCI Products and Application to Environmental Monitoring of Japanese Coastal Waters	J. Ishizuka	Korea	Korea Institute of Ocean Science and Technology
Collection of Validation Dataset of GCOM-C Coastal Products	J. Ishizaka	Korea U.S.A. Taiwan Thailand China Estonia	Korea Institute of Ocean Science and Technology Columbia University, East Carolina University National Cheng Kung University Burapha University First Institute of Oceanography, Nanjing, University of Science and Technology University of Tartu
Sea Surface Nitrate and Nitrate Based New Production - two innovative research products from SGLI on board GCOM-C	J. Ishizaka	U.S.A.	Columbia University
Investigating the optical characteristics of red tides in the upper Gulf of Thailand	J. Ishizaka	Thailand	University of Burapa, Kasetsart University
Validation of ocean color products in the western North Pacific and Japanese coastal waters：Collaboration with JAXA GCOM-C project	J. Ishizaka	Germany	European Organisation for the Exploitation of Meteorological Satellites
Towards a Deeper understanding of Tropical Isoscapes	N. Kurita	Australia	James Cook University, Cairn

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS), one of the Global Research Projects (GRPs) of the Future Earth	T. Hiyama	U.K., India, Finland, New Zealand, China, Koria *and others*	iLEAPS/Future Earth
Observational Study of Vegetation, Energy and Water in Eastern Siberia Towards Elucidation of Climate and Carbon Cycle Changes	T. Hiyama	Russia	Institute for Biological Problems of Cryolithozone /SB RAS
Arctic Challenge for Sustainability (ArCS) Project	T. Hiyama	U.S.A.	International Arctic Research Center of the University of Alaska Fairbanks (IARC)
Estimating Permafrost Groundwater age in Central Mongolia	T. Hiyama	Mongol	Institute of Geography and Geoecology of the Mongolian Academy of Sciences
Study of methane flux observation in Eastern Siberia and the obtained data analysis	T. Hiyama	Russia	Institute for Natural Science, North Eastern Federal University
Radiocarbon dating of bronze wares excavated from Indian archeological site	H. Oda	India	Deccan College
Radiocarbon dating of bronze wares excavated from Russian archeological site	H. Oda	Russia	Institute of Ethnology and Anthropology Russian Academy of Science
Geochronological Research on the Basement Rocks in Japan and Korea	T. Kato	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)
Development of New Analytical Techniques and Accurate Quantification of Electron Microprobe Analysis	T. Kato	Korea	Pusan National University (PNU)
Climate change reconstruction of the Central Highlands in Vietnam	H. Kitagawa	Vietnam	Vietnam Academy of Science and Technology
International Continental Scientific Drilling Program - Dead Sea Deep Drilling Project （ICDP-DSDDP)	H. Kitagawa	Israel U.S.A Germany Switzerland	Geological Survey of Israel, Hebrew University of Jerusalem Columbia University, University of Minnesota German Research Centre for Geosciences, Max-Planck-Institute Mainz for Chemistry Université de Genève
Study of Grand-Water Circulation Based on ^{14}C Ages of Underground Water and Hot-Spring Water Samples from Korea	M. Minami	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)
Climate reconstruction using travertine from Takht-e-Soleyman area in Kurdistan, Iran	M. Minami	Iran	University of Kurdistan

Visitors from Foreign Institutes

(219 in total)

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Mark Looper	U.S.A.	The Aerospace Corporation	Apr. 15 - 20, 2018	Visitor
Jianwei Lin	Taiwan	National Taiwan University	Apr. 16 - 20, 2018	Foreign Collaborative Researcher
Bernhard Kliem	Germany	University of Potsdam	Apr. 17 - May 3, 2018	Visitor
Antonia Savcheva	U.S.A.	Smithsonian Observatory	Apr. 18 - May 3, 2018	Visitor
Naomi Maruyama	U.S.A.	Univ. of Colorado	May 13 - 19, 2018	Participant in the Symposium
Joaquim E R Costa	Brazil	National Institute for Space Research	May 13 - 25, 2018	Participant in the Symposium
Felix Riehn	Portugal	Laboratório de Instrumentação e Física Experimental de Partículas	May 14 - 20, 2018	Participant in the Symposium
Reinhard Friedel	U.S.A.	Los Alamos National Laboratory	May 14 - 20, 2018	Participant in the Symposium
Juan Americo Gonzales Esparza	Mexico	National Autonomous University of Mexico	May 14 - 24, 2018	Participant in the Symposium
Sebastien Rougerie	France	Centre National d'Études Spatiales	May 14 - 24, 2018	Participant in the Symposium
Joel T Dahlin	U.S.A.	NASA Goddard Space Flight Center	May 14 - 25, 2018	Participant in the Symposium
Brett Anthony Carter	Australia	RMIT University	May 15 - 26, 2018	Participant in the Symposium
Changhyu Ko	Korea	Korean Space Weather Center	May 16 - 18, 2018	Participant in the Symposium
Charles Lin	Taiwan	National Cheng Kung University	May 16 - 18, 2018	Participant in the Symposium
Danny Summers	Canada	Memorial University of Newfoundland	May 16 - 18, 2018	Participant in the Symposium
Jangsuk Choi	Korea	Korean Space Weather Center	May 16 - 18, 2018	Participant in the Symposium
Jiyoung Kim	Korea	Korea Meteorological Administration	May 16 - 18, 2018	Participant in the Symposium
Marcin Marek Latocha	Austria	Seibersdorf Laboratories	May 16 - 18, 2018	Participant in the Symposium
Suhaila Binti M Buhari	Malaysia	Universiti Teknologi Malaysia	May 16 - 18, 2018	Participant in the Symposium
Xiaoxin Zhang	China	China Meteorological Administration	May 16 - 18, 2018	Participant in the Symposium
Michael Terkildsen	Australia	Bureau of Meteorology	May 16 - 24, 2018	Participant in the Symposium
Gerald David Stedge	U.S.A.	Abt Associates	May 18 - 25, 2018	Participant in the Symposium
Gupta Sunilkumar	India	Tata Institute of Fundamental Research	May 19 - 25, 2018	Participant in the Symposium
Semen Khokhlov	Russia	NRNU MEPhI	May 19 - 25, 2018	Participant in the Symposium
Ke Fang	U.S.A.	University of Maryland	May 19 - 26, 2018	Participant in the Symposium
Alexander Iakovlev	Kazakhstan	Nazarbayev University	May 19 - 27, 2018	Participant in the Symposium
Juan Carlos Arteaga-Velazquez	Mexico	Universidad Michoacana	May 19 - 27, 2018	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Igor Petrov	Russia	Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy	May 20 - 26, 2018	Participant in the Symposium
Akihiko Monnai	France	Institut de Physique Théorique, CNRS/CEA	May 21 - 25, 2018	Participant in the Symposium
Alberto Oliva	Switzerland	Centro de Investigaciones Energéti cas Medioambientales y Tecno	May 21 - 25, 2018	Participant in the Symposium
Alexander Borisov	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Alexander Lidvansky	Russia	INR RAS	May 21 - 25, 2018	Participant in the Symposium
Anatoli Fedynitch	Germany	Deutsches Elektronen-Synchrotron	May 21 - 25, 2018	Participant in the Symposium
Anatoly Ivanov	Russia	Shafer Institute for Cosmophysical Research and Aeronomy	May 21 - 25, 2018	Participant in the Symposium
Andrea Chiavassa	Italy	Università degli studi & INFN Torino	May 21 - 25, 2018	Participant in the Symposium
Anton Lukyashin	Russia	NRNU MEPhI	May 21 - 25, 2018	Participant in the Symposium
Artur Tkachenko	Russia	INR RAS	May 21 - 25, 2018	Participant in the Symposium
Bryan Pattison	Switzerland	CERN	May 21 - 25, 2018	Participant in the Symposium
Cunfeng Feng	China	Shandong University	May 21 - 25, 2018	Participant in the Symposium
Daniel Garcia-Fernandez	France	Subatech	May 21 - 25, 2018	Participant in the Symposium
Daniel Biehl	Germany	Deutsches Elektronen-Synchrotron	May 21 - 25, 2018	Participant in the Symposium
Dennis Soldin	U.S.A.	University of Delaware and Bartol Research Institute	May 21 - 25, 2018	Participant in the Symposium
Dmitriy Beznosko	Kazakhstan	Nazarbayev University	May 21 - 25, 2018	Participant in the Symposium
Donghwa Kang	Germany	Karlsruhe Institute of Technology	May 21 - 25, 2018	Participant in the Symposium
Edison Hiroyuki Shibuya	Brazil	University of Campinas	May 21 - 25, 2018	Participant in the Symposium
Eduardo De La Fuente Acosta	Mexico	Universidad de Guadalajara	May 21 - 25, 2018	Participant in the Symposium
Eli Waxman	Israel	Weizmann Institute	May 21 - 25, 2018	Participant in the Symposium
Ervin Kafexhiu	Germany	Max-Planck-Institute for Nuclear Physics	May 21 - 25, 2018	Participant in the Symposium
Etienne Parizot	France	APC, University of Paris	May 21 - 25, 2018	Participant in the Symposium
Fiorenza Donato	Italy	Torino University	May 21 - 25, 2018	Participant in the Symposium
Frank Schroder	Germany	Karlsruhe Institute of Technology	May 21 - 25, 2018	Participant in the Symposium
Gernot Maier	Germany	Deutsches Elektronen-Synchrotron	May 21 - 25, 2018	Participant in the Symposium
Hans Dembinski	Germany	Max-Planck-Institute for Nuclear Physics	May 21 - 25, 2018	Participant in the Symposium
Hermes Leon Vargas	Mexico	National Autonomous University of Mexico	May 21 - 25, 2018	Participant in the Symposium
Il Park	Korea	Sungkyunkwan University	May 21 - 25, 2018	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Janusz Kempa	Poland	Warsaw University of Technology	May 21 - 25, 2018	Participant in the Symposium
Javier Gonzalez	U.S.A.	University of Delaware	May 21 - 25, 2018	Participant in the Symposium
Jing Huang	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
Kenichi Sakai	U.S.A.	GSFC/NASA	May 21 - 25, 2018	Participant in the Symposium
Kfir Blum	Switzerland	Weizmann Institute & CERN	May 21 - 25, 2018	Participant in the Symposium
Klaus Werner	France	Université de Nantes	May 21 - 25, 2018	Participant in the Symposium
Krzysztof Wieslaw Wozniak	Poland	Poland Academy of Science	May 21 - 25, 2018	Participant in the Symposium
Leif Lonnblad	Sweden	Lund University	May 21 - 25, 2018	Participant in the Symposium
Lev Timofeev	Russia	The Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy SB RAS	May 21 - 25, 2018	Participant in the Symposium
Maria Lavrova	Russia	Joint Institute for Nuclear Research	May 21 - 25, 2018	Participant in the Symposium
Markus Ackermann	Germany	Deutsches Elektronen-Synchrotron	May 21 - 25, 2018	Participant in the Symposium
Mauricio Bustamante	Denmark	Niels Bohr Institute	May 21 - 25, 2018	Participant in the Symposium
Mikhail Kuznetsov	Russia	INR RAS	May 21 - 25, 2018	Participant in the Symposium
Minho Kim	Korea	Korea University	May 21 - 25, 2018	Participant in the Symposium
Nikolay Topchiev	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Paschal Coyle	France	Centre de Physique des Particules de Marseille	May 21 - 25, 2018	Participant in the Symposium
Ralf Matthias Ulrich	Germany	Karlsruhe Institute of Technology	May 21 - 25, 2018	Participant in the Symposium
Ralph Engel	Germany	Karlsruhe Institute of Technology	May 21 - 25, 2018	Participant in the Symposium
Raul Ribeiro Prado	Germany	Deutsches Elektronen-Synchrotron	May 21 - 25, 2018	Participant in the Symposium
Rim Mirzafatikhov	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Rostislav Kokoulin	Russia	NRNU MEPhI	May 21 - 25, 2018	Participant in the Symposium
Sebastian Baur	Germany	Karlsruhe Institute of Technology	May 21 - 25, 2018	Participant in the Symposium
Sergey Ostapchenko	Germany	Frankfurt Institute for Advanced Studies	May 21 - 25, 2018	Participant in the Symposium
Sergey Shaulov	Russia	Frankfurt Institute for Advanced Studies	May 21 - 25, 2018	Participant in the Symposium
Sergey Suchkov	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Sergey S. Borisov	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Sergio Petrera	Italy	Gran Sasso Science Institute and INFN Laboratori Nazionali del Gran Sasso	May 21 - 25, 2018	Participant in the Symposium
Soomin Jeong	Korea	Sungkyunkwan University	May 21 - 25, 2018	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Spencer Klein	U.S.A.	UCB	May 21 - 25, 2018	Participant in the Symposium
Stefan Ohm	Germany	Deutsches Elektronen-Synchrotron	May 21 - 25, 2018	Participant in the Symposium
Sunny Seo	Korea	Institute of Basic Science	May 21 - 25, 2018	Participant in the Symposium
Tanguy Pierog	Germany	Institute for Nuclear Physics/IKP	May 21 - 25, 2018	Participant in the Symposium
Thorsten Glusenkamp	Germany	Erlangen Center for Astroparticle Physics	May 21 - 25, 2018	Participant in the Symposium
Tileubek Uakhitov	Kazakhstan	Nazarbayev University	May 21 - 25, 2018	Participant in the Symposium
Vera Georgievna Sinitsyna	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Vera Yurievna Sinitsyna	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Vladimir Ryabov	Russia	Lebedev Physical Institute	May 21 - 25, 2018	Participant in the Symposium
Wen Yin	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
William Hanlon	U.S.A.	University of Utah	May 21 - 25, 2018	Participant in the Symposium
Xu Chen	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
Ying Zhang	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
Yuhui Lin	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
Zbigniew Plebaniak	Poland	National Centre for Nuclear Research	May 21 - 25, 2018	Participant in the Symposium
Zbigniew Wlodarczyk	Poland	Jan Kochanowski University, Kielce	May 21 - 25, 2018	Participant in the Symposium
Zhe Li	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
Zhen Cao	China	Institute of High Energy Physics, Chinese Academy of Sciences	May 21 - 25, 2018	Participant in the Symposium
Zohra Bouhali	Algeria	Badji Mokhtar University	May 21 - 25, 2018	Participant in the Symposium
Kohta Murase	U.S.A.	Pennsylvania State University	May 21 - 26, 2018	Participant in the Symposium
Asgari-Targhi Mahboubeh	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Jun. 10 - 20, 2018	Participant in the Symposium
Mikinori Kuwata	Singapore	Nanyang Technological University	Jul. 2, 2018	Participant in the Symposium
Erica Lastufka	Switzerland	University of Applied Sciences and Arts Northwestern Switzerland	Jul. 2 - 13, 2018	Visitor
Khan-Hyuk Kim	Korea	National Space Science Center, Chinese Academy of Science	Jul. 5, 2018	Visitor
Bernard Jackson	U.S.A.	University of California San Diego	Jul. 6, 2018	Visitor
V. Lakshmi Narayanan	India	National Atmospgeric Research Laboratory	Jul. 8 - 15, 2018	Participant in the Symposium
Hai Guo	China	The Hong Kong Polytechnic University	Jul. 9, 2018	Participant in the Symposium
Exner Willi	Germany	Technische Universität Braunschweig	Jul. 11 - 13, 2018	Visitor

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Hyomin Kim	U.S.A.	New Jersey Institute of Technology	Jul. 21 - Aug. 3, 2018	Visitor
Marcos Anzorena	Mexico	National Autonomous University of Mexico	Jul. 23 - Sep. 20, 2018	Visitor
Rocio Garcia Ginez	Mexico	National Autonomous University of Mexico	Jul. 23 - Sep. 20, 2018	Visitor
Hajihossein Azizi	Iran	University of Kurdistan	Aug. 1 - Sep. 1, 2018	Visitor
Mitsuo Oka	U.S.A.	UCB	Aug. 3 - 10, 2018	Participant in the Symposium
Nariaki Vincent Nitta	U.S.A.	Lockheed Martin Advanced Technology Center	Aug. 4 - 11, 2018	Participant in the Symposium
Seiji Yashiro	U.S.A.	The Catholic University of America	Aug. 4 - 12, 2018	Participant in the Symposium
Joseph Benjamin Harold Baker	U.S.A.	Virginia Polytechnic Institute and State University	Aug. 6, 2018	Visitor
Jonathan Abbatt	Canada	University of Toronto	Sep. 22 - 24, 2018	Participant in the Symposium
Hartmut Herrmann	Germany	Leibniz Institute for Tropospheric Research	Sep. 22 - 25, 2018	Participant in the Symposium
Florian Billy Alexis Mekhaldi	Sweden	Lund University	Sep. 27 - Oct. 6, 2018	Participant in the Symposium
Edward Cliver	U.S.A.	National Solar Observatory	Sep. 29 - Oct. 6, 2018	Participant in the Symposium
Clive Dyer	U.K.	CSDRAD Consultancy	Sep. 30 - Oct. 7, 2018	Participant in the Symposium
Evgueni Rozanov	Switzerland	Physical Meteorological Observatory in Davos/ World Radiation Centre	Sep. 30 - Oct. 7, 2018	Participant in the Symposium
Ilya Usoskin	Finland	University of Oulu	Sep. 30 - Oct. 7, 2018	Participant in the Symposium
Lukas Wacker	Switzerland	Ion Beam Physics, ETH Zurich	Sep. 30 - Oct. 7, 2018	Participant in the Symposium
Markku Oinonen	Finland	Finnish Museum of Natural History	Sep. 30 - Oct. 7, 2018	Participant in the Symposium
Stepan Poluianov	Finland	University of Oulu	Sep. 30 - Oct. 7, 2018	Participant in the Symposium
Dmitry Sokolov	Russia	Moscow State University	Oct. 1 - 5, 2018	Participant in the Symposium
Fayin Wang	China	Nanjing University	Oct. 1 - 6, 2018	Participant in the Symposium
Anthony John Timothy Jull	U.S.A.	The University of Arizona	Oct. 1 - 7, 2018	Participant in the Symposium
Milija Zupnaski	U.S.A.	Colorado State University	Oct. 3, 2018	Participant in the Symposium
Aaron Hendry	Czech	Institute of Atmospheric Physics AS CR	Oct. 12 - 20, 2018	Foreign Collaborative Researcher
Benjamin Grison	Czech	Institute of Atmospheric Physics AS CR	Oct. 12 - 20, 2018	Foreign Collaborative Researcher
Ivana Kolmasova	Czech	Institute of Atmospheric Physics AS CR	Oct. 12 - 20, 2018	Foreign Collaborative Researcher
Ondrej Santolik	Czech	Institute of Atmospheric Physics AS CR	Oct. 12 - 20, 2018	Foreign Collaborative Researcher
Ulrich Taubenschuss	Czech	Institute of Atmospheric Physics AS CR	Oct. 12 - 20, 2018	Foreign Collaborative Researcher
Nariaki Vincent Nitta	U.S.A.	Lockheed Martin Advanced Technology Center	Oct. 14 - 21, 2018	Foreign Collaborative Researcher

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Chihyu Chiang	Taiwan	National Cheng Kung University	Oct. 21 - 27, 2018	Visitor
Jeffrey D. Hawkins	U.S.A.	Naval Research Laboratory	Oct. 23 - 30, 2018	Visitor
Cheng-Yu Chen	Taiwan	National Taiwan University	Oct. 25, 2018	Visitor
Hua Hsu	Taiwan	National Taiwan University	Oct. 25, 2018	Visitor
Hung Chi Kuo	Taiwan	National Taiwan University	Oct. 25, 2018	Visitor
Hungjui Yu	Taiwan	National Taiwan University	Oct. 25, 2018	Visitor
Yu Han Chen	Taiwan	National Taiwan University	Oct. 25, 2018	Visitor
Feng Chen	U.S.A.	University of Colorado Boulder	Nov. 1 - 10, 2018	Participant in the Symposium
Margaret Shanafield	Australia	Flinders University	Nov. 2, 2018	Participant in the Symposium
Okke Batelaan	Australia	Flinders University	Nov. 2, 2018	Participant in the Symposium
Saskia Noorduijn	Australia	Flinders University	Nov. 2, 2018	Participant in the Symposium
Matthias Rempel	U.S.A.	National Center for Atmospheric Research	Nov. 3 - 10, 2018	Participant in the Symposium
Yuhong Fan	U.S.A.	National Center for Atmospheric Research	Nov. 3 - 11, 2018	Participant in the Symposium
Georgios Chintzoglou	U.S.A.	LMSAL	Nov. 4 - 10, 2018	Participant in the Symposium
Mark Derosa	U.S.A.	LMSAL	Nov. 4 - 10, 2018	Participant in the Symposium
Mark Cheung	U.S.A.	LMSAL	Nov. 4 - 10, 2018	Participant in the Symposium
Meng Jin	U.S.A.	LMSAL	Nov. 4 - 10, 2018	Participant in the Symposium
Sanja Danilovic	Sweden	Stockholm University	Nov. 4 - 10, 2018	Participant in the Symposium
Xudong Sun	U.S.A.	University of Hawaii	Nov. 4 - 10, 2018	Participant in the Symposium
Chaowei Jiang	China	Harbin Institute of Technology, Shenzhen	Nov. 5 - 10, 2018	Participant in the Symposium
Han He	China	National Astronomical Observatories Chinese Academy of Sciences	Nov. 5 - 10, 2018	Participant in the Symposium
Sandric Chee Yew Leong	Singapore	National University of Singapore	Nov. 6 - 7, 2018	Participant in the Symposium
Go Iwahana	U.S.A.	University of Alaska Fairbanks	Nov. 11 - 14, 2018	Participant in the Symposium
Hyyangpyo Kim	Korea	Korea Astronomy & Space Science Institute	Nov. 11 - 14, 2018	Participant in the Symposium
Yukinaga Miyashita	Korea	Korea Astronomy & Space Science Institute	Nov. 11 - 14, 2018	Visitor
Takanobu Yamaguchi	U.S.A.	University of Colorado Boulder	Nov. 20, 2018	Visitor
Takuma Nakamura	Austria	Austrian Academy of Sciences	Nov. 21 - 29, 2018	Foreign Collaborative Researcher
Tong Phuoc Hoang Son	Vietnam	Institute of Oceanography, Vietnam Academy Science and Technology	Dec. 1 - 6, 2018	Foreign Collaborative Researcher

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Playfer Stephen Michael	U.K.	University of Edinburgh	Dec. 3 - 19, 2018	Foreign Collaborative Researcher
Nariaki Vincent Nitta	U.S.A.	Lockheed Martin Solar and Astrophysics Laboratory	Dec. 6 - 18, 2018	Foreign Collaborative Researcher
John Morgan	Australia	Curtin University	Dec. 7, 2018	Foreign Collaborative Researcher
Kamorn Bandudej	Thailand	National Astronomical Research Institute of Thailand	Dec. 21, 2018	Foreign Collaborative Researcher
Pattarapong Phasukkit	Thailand	King Mongkut's Institute of Technology Ladkrabang	Dec. 21, 2018 - Dec. 21, 2019	Foreign Collaborative Researcher
Bjorn Stevens	Germany	Max-Planck Institute for Meteorology	Dec. 25 - 26, 2018	Foreign Collaborative Researcher
Magnus Woods	U.K.	Mullard Space Science Laboratory, University College London	Jan. 5 - 18, 2019	Foreign Collaborative Researcher
Baolin Tan	China	National Astronomical Observatories Chinese Academy of Sciences	Jan. 7 - 25, 2019	Visitor
Valentina Zharkova	U.K.	Northumbria University	Jan. 10 - Feb. 1, 2019	Visitor
Fei Liu	China	National Astronomical Observatories Chinese Academy of Sciences	Jan. 21 - 25, 2019	Visitor
Linjie Chen	China	National Astronomical Observatories Chinese Academy of Sciences	Jan. 21 - 25, 2019	Visitor
Wei Wang	China	National Astronomical Observatories Chinese Academy of Sciences	Jan. 21 - 25, 2019	Visitor
Yihua Yan	China	National Astronomical Observatories Chinese Academy of Sciences	Jan. 21 - 25, 2019	Visitor
Zhijun Chen	China	National Astronomical Observatories Chinese Academy of Sciences	Jan. 21 - 25, 2019	Visitor
Yoichi Kazama	China	Academia Sinica Institute of Astronomy and Astrophysics	Feb. 1, 2019	Visitor
Chengming Tan	China	National Astronomical Observatories Chinese Academy of Sciences	Feb. 1 - 12, 2019	Visitor
Hisao Takahashi	Brazil	INPE	Feb. 22 - Mar. 3, 2019	Visitor
Gupta Sunilkumar	India	Tata Institute of Fundamental Research	Feb. 23 - Mar. 1, 2019	Visitor
John Richardson	U.S.A.	Massachusetts Institute of Technology	Feb. 23 - Mar. 1, 2019	Visitor
Justyna Sokolov	Poland	Poland Academy of Science	Feb. 23 - Mar. 16, 2019	Visitor
Daniel Verscharen	U.K.	University College London	Feb. 24 - Mar. 1, 2019	Visitor
Ming Zhnag	U.S.A.	Florida Institute of Technology	Feb. 24 - Mar. 1, 2019	Visitor
Zhongwei Yang	China	Chinese Academy of Sciences	Feb. 24 - Mar. 1, 2019	Visitor
Asgari-Targhi Mahboubeh	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Feb. 24 - Mar. 2, 2019	Visitor
Marco Velli	U.S.A.	UCLA	Feb. 25 - Mar. 2, 2019	Visitor
Lee Kun-Han	Taiwan	Institute of Earth Sciences, Academia Sinica	Mar. 1, 2019	Visitor
Kristen Lani Rasmussen	U.S.A.	Colorado State University	Mar. 5 - 10, 2019	Visitor
Robert Fulton Rogers	U.S.A.	National Oceanic and Atmospheric Administration	Mar. 5 - 10, 2019	Visitor

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Deanna Alicia Hence	U.S.A.	University of Illinois	Mar. 5 - 11, 2019	Visitor
Michael Monroe Bell	U.S.A.	Colorado State University	Mar. 5 - 11, 2019	Visitor
Ming-Jen Yang	Taiwan	National Taiwan University	Mar. 5 - 11, 2019	Visitor
Wen-Chau Lee	U.S.A.	National Center for Atmospheric Research	Mar. 5 - 11, 2019	Visitor
Anthony Carl Didlake	U.S.A.	Pennsylvania State University	Mar. 7 - 10, 2019	Visitor
Anukul Buranapratheprat	Thailand	Burapha University	Mar. 8 - 14, 2019	Visitor
Yukinaga Miyashita	Korea	Korea Astronomy & Space Science Institute	Mar. 14 - 19, 2019	Visitor
Daniel Billett	U.K.	Lancaster University	Mar. 15, 2019	Visitor
Akira Konaka	Canada	TRIUMF (Canada's particle accelerator centre)	Mar. 18 - 22, 2019	Visitor
Tanguy Pierog	Germany	Karlsruhe Institute of Technology	Mar. 18 - 23, 2019	Visitor
Giles Barr	U.K.	University of Oxford	Mar. 19 - 22, 2019	Visitor
Jie Cheng	China	Institute of High Energy Physics, Chinese Academy of Sciences	Mar. 19 - 22, 2019	Visitor
Ryuji Takeishi	Korea	Sungkyunkwan University	Mar. 19 - 22, 2019	Visitor
Jitraporn Phaksopa	Thailand	Kasetsart University	Mar. 19 - 27, 2019	Visitor
Boaz Lazar	Israel	Hebrew University of Jerusalem	Mar. 20 - 31, 2019	Visitor
Moti Stein	Israel	Institute of Earth Sciences	Mar. 20 - 31, 2019	Visitor
Antonia Savcheva	U.S.A.	Smithsonian Observatory	Mar. 21 - 29, 2019	Visitor
Anatoli Fedynitch	Canada	University of Alberta	Mar. 23, 2019	Visitor
Stephan Meighen-Berger	Germany	Technische Universität München	Mar. 23, 2019	Visitor
Felix Riehn	Portugal	Laboratório de Instrumentação e Física Experimental de Partículas	Mar. 23 - 29, 2019	Visitor
Aline De Almeida Vidotto	Ireland	Trinity College Dublin	Mar. 24 - 30, 2019	Participant in the Symposium
Stephen A. Ledvina	U.S.A.	UCB	Mar. 24 - 30, 2019	Participant in the Symposium
Yingjuan Ma	U.S.A.	UCLA	Mar. 24 - 30, 2019	Participant in the Symposium
David Andrew Brain	U.S.A.	University of Colorado Boulder	Mar. 25 - 29, 2019	Participant in the Symposium

Seminars by Foreign Visitors

(31 in total)

Date	Name	Affiliation	Title	Number of Participant
April 5, 2018	Fulvia Pucci	Princeton University	Solar Seminar/ Energy transfer and electron energization in collisionless magnetic reconnection for different guide-field intensities	13
May 1, 2018	Zhongping Lee∗	University of Massachusetts Boston	34th ISEE/CICR colloquium / Remote sensing of basin-scale primary production: Abandoning the use of chlorophyll concentration	12
May 8, 2018	Stephen Michae Playfer∗	University of Edinburgh	35th ISEE/CICR colloquium / Matter antimatter asymmetries	22
May 14, 2018	Samuel Krucker∗	University of Applied Sciences Northwestern Switzerland	36th ISEE/CICR colloquium / Hard X-ray Observations as Diagnostics of Particle Acceleration in Solar Flares	21
July 2, 2018	Mikinori Kuwata	Nanyang Technological University	Seminar/ Atmospheric chemistry of wildfire in tropical Asia induced by peatland fire	unknown
July 5, 2018	Khan-Hyuk Kim	School of Space Research, Kyung Hee University, South Korea	37th ISEE/CICR colloquium/ Large and small scale geomagnetic perturbations	12
July 9, 2018	Hai Guo	The Hong Kong Polytechnic University	Seminar/ High-resolution analysis of vehicle-related organic aerosols observed at a roadside site in Hong Kong with the application of TAG-GC-Tof-MS	Unknown
July 9, 2018	Erica Lastufka	University of Applied Sciences Northwestern Switzerland	Solar seminar/ Occulted Flare of May 1, 2013 and the MiSolFA Hard X-ray Imager	17
July 13, 2018	Willi Exner	Technische Universität Braunschweig	special seminar/ Mercury's magnetosphere in strict positive and negative Bz	12
July 23, 2018	K. D. Leka∗	NorthWest Research Associates	Solar seminar/ Understanding and Forecasting the Solar Origins of Space Weather	18
August 2, 2018	Hyomin Kim	New Jersey Institute of Technology	Special seminar/ ULF Wave Observations Using Van Allen Probes and Ground-Based Interhemispheric Magnetometer Arrays	14
October 3, 2018	Milija Zupanski	Colorado State University	38th ISEE/CICR colloquium/ New directions for development of high-dimensional data assimilation	13
October 12, 2018	Alexandre Vasilyevich Koustov∗	University of Saskatchewan	39th ISEE/CICR colloquium/ Contributions of coherent radars to studies of the near Earth's environment	30
November 2, 2018	Daqing Yang∗	Environment and Climate Change Canada	40th ISEE/CICR colloquium/ Arctic hydroclimatic regimes and changes in a warming climate	18
November 2, 2018	Okke Batelaan	Flinders University	Urban Water-Food-Energy Nexus workshop in Nagoya University/ Introduction of the MLFP project	8
November 5, 2018	Feng Chen	University of Colorado, Boulder	Solar seminar/ Solar eruptions during magnetic flux emergence from the convection zone to the corona	19
November 10, 2018	Yukinaga Miyashita	Korea Astronomy & Space Science Institute	Special seminar/ Dipolarization observed by Arase	18

Date	Name	Affiliation	Title	Number of Participant
November 10, 2018	Hyyangpyo Kim	Korea Astronomy & Space Science Institute	Special seminar/ EMIC waves observed from various satellites	18
November 20, 2018	Takanobu Yamaguchi	NOAA ESRL	41st ISEE/CICR colloquium/ Role of vertical wind shear in aerosol-cloud interactions in marine shallow cumulus clouds	21
November 30, 2018	Michael Jürgen Kosch✱	South African National Space Agency	42nd ISEE/CICR colloquium/ Sprites research in Africa	29
December 6, 2018	Qurnia Wulan Sari✱	Sriwijaya University	Oceanography Seminar/ The variability of the surface chlorophyll-a in the Karimata Strait	14
December 17, 2018	K. D. Leka✱	NorthWest Research Associates	Solar seminar/ Photospheric Magnetic Field Properties of Flareing vs. Flare Quiet Active Regions, V: Results from HMI	19
December 17, 2018	Nariaki Vincent Nitta	Lockheed Martin Advanced Technology Center	Solar seminar/ CMEs as the Dominannt Player of Space Weather	18
December 25, 2018	Bjorn Stevens	Max Planck Institute for Meteorology/ University of Hamburg	43rd ISEE/CICR colloquium / Shallow clouds and circulations	23
January 16, 2019	Valentina Zharkova	Northumbria University	CICR colloquium/ Acceleration and transport of energetic particles in flaring atmospheres and their diagnostics from HXR and MW emission	13
January 21, 2019	Baolin Tan	National Astronomical Observatories Chinese Academy of Sciences	Solar seminar/ Solar radio spectral fine structures and diagnostics of nonthermal processes	18
March 1, 2019	Hisao Takahashi	National Institute for Space Research	45th ISEE/CICR colloquium/ Equatorial Plasma Bubble Occurrence under Propagation of MSTIDs and MGWs	16
March 1, 2019	Lee Kun-Han	Institute of Earth Sciences, Academia Sinica	Special seminar/ Voyager 1 observations of interstellar electron turbulence spectrum	11
March 15, 2019	Daniel Billett	Lancaster University	Special seminar/ The role of neutral winds, plasma convection, and aurora on high-latitude thermosphere-ionosphere coupling	9
March 18, 2019	Anukul Nranapratheprat	Burapha University	Oceanography Seminar/ Detection and modeling of green Noctiluca bloom in the Gulf of Thailand using satellite ocean color	14
March 25, 2019	Jitraporn Phaksopa	Kasetsart University	Oceanography Seminar/ Dr.Fridtjof Nansen Andaman Expedition in October 2019: water masses, currents and internal wave of the Andaman Sea	14

✱ Foreign Visiting Staff

<Abbreviations>

AS CR:	Academy of Sciences of the Czech Republic
CASS:	Center for Astrophysics and Space Sciences
CERN:	Conseil Européen pour la Recherche Nucléaire, European Organization for Nuclear Research
CESR:	Centre d'Etude Spatiale des Rayonnements
CETP:	Centre d'étude des Environnements Terrestre et Planétaires
CNRS:	Centre National de la Recherche Scientifique
EISCAT:	European Incoherent Scatter Scientific Association
GSFC:	Goddard Space Flight Center
IBEX:	Interstellar Boundary Explorer
IFSI:	Istituto di Fisica dello Spazio Interplanetario
iLEAPS:	Integrated Land Ecosystem-Atmosphere Processes Study
IKFIA:	Institute of Cosmophysical Research and Aeronom
IMAP:	Interstellar Mapping and Acceleration Probe
INFN:	Istituto Nazionale di Fisica Nucleare
INPE:	Instituto Nacional de Pesquisas Espaciais, Brazilian Institute of Space Research
INR RAS:	Institute for Nuclear Research of the Russian Academy of Sciences
IPS:	Ionospheric Prediction Services
IPSL:	Institut Pierre-Simon Laplace
ISTP:	Institute of Solar-Terrestrial Physics
JHUAPL:	Johns Hopkins University Applied Physics Laboratory
KASI:	Korea Astronomy and Space Science Institute
LAPAN:	Lembaga Penerbangan dan Antariksa Nasional, National Institute of Aeronautics and Space
LMSAL:	Lockheed Martin Solar and Astrophysics Laboratory
LOFAR:	Low Frequency Array
LPC2E:	Laboratoire de Physique et Chimie de l'Environnement et de l'Espace
MSFC:	Marshall Space Flight Center
MWA:	Murchison Widefield Array
NASA:	National Aeronautics and Space Administration
NOAA:	National Oceanic and Atmospheric Administration
NRNU MEPhI:	National Research Nuclear University Moscow Engineering Physics Institute
SB RAS:	Siberian Branch, Russian Academy of sciences
SCOSTEP:	Scientific Committee on Solar Terrestrial Physics
SLAC:	Stanford Linear Accelerator Center
UCB:	University of California, Berkeley
UCI:	University of California, Irvine
UCLA:	University of California, Los Angeles
UCSC:	University of California, Santa Cruz
UCSD:	University of California, San Diego

12. Outreach

Public lectures, open labs, and school visits

ISEE members have contributed to public education through 19 lecture visits, seven public lectures at the university, three open laboratory events, four public laboratory demonstrations, one field trip for children, and four high-school student visits.

ISEE held open laboratory sessions and special lectures for the public on June 9 and 10 during the 2018 Nagoya University Festival, and a half-day public lecture meeting on September 29, 2018.

ISEE and the former STEL have maintained a close relationship with the town of Rikubetsu in Hokkaido since 2003. Public lectures were held on November 9, 2018 at Rikubetsu Elementary School and Rikubetsu Junior High School. Public laboratory demonstrations were presented on November 10, 2018 at the Rikubetsu Space Earth Science Museum.

ISEE distributes a series of booklets that answer 50 questions on various topics, as well as informative comic books related to space–Earth subjects for the public.

A English version of the video introducing ISEE for young students and the public was produced, and is available on the ISEE website (http://www.isee.nagoya-u.ac.jp/).

The ISEE website continues to publish the most up-to-date activities and outcomes of laboratory science to the public. The digitized booklet series can also be browsed at this site.

Public lecture on the ISEE open laboratory (June 9, 2018).

Addresses of Facilities

Location		Name	Address	TEL/FAX
Nagoya	①	ISEE Research Institutes Buildings I/II	Furo-cho, Chikusa-ku, Nagoya, Aichi 464-8601	TEL:+81-52-747-6303 FAX:+81-52-747-6313
Toyokawa	②	Toyokawa Branch	3-13 Honohara, Toyokawa-shi, Aichi 442-8507	TEL:+81-533-89-5206 FAX:+81-533-86-3154
Hokkaido	③	Moshiri Observatory	Moshiri, Horokanai, Uryu, Hokkaido 074-0741	TEL:+81-165-38-2345 FAX:+81-165-38-2345
	④	Rikubetsu Observatory	345 Uenbetsu, Rikubetsu-cho, Ashoro-gun, Hokkaido 089-4301	TEL:+81-156-27-8103
			58-1, 78-1, 78-5, 129-1, 129-4 Pontomamu, Rikubetsu-cho, Ashoro-gun, Hokkaido 089-4300	TEL:+81-156-27-4011
Yamanashi	⑤	Fuji Observatory	1347-2 Fujigane, Fujikawaguchiko-machi, Minamitsuru-gun, Yamanashi 401-0338	TEL:+81-555-89-2829
Kagoshima	⑥	Kagoshima Observatory	3860-1 Honjo, Tarumizu-shi, Kagoshima 891-2112	TEL:+81-994-32-0730