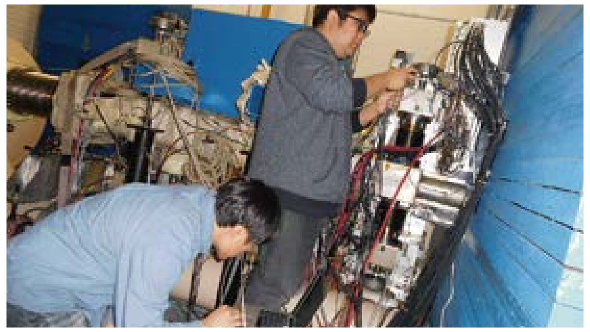
Launch of ERG (ARASE) aboard the second Epsilon Launch Vehicle

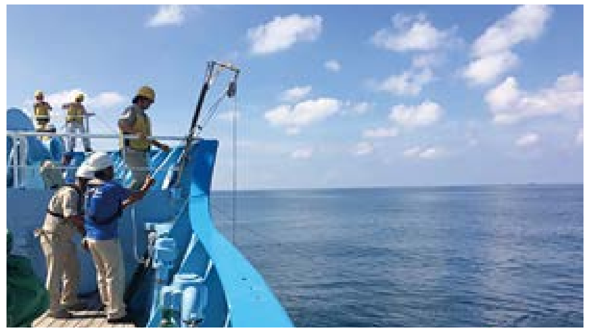


Graduate students testing the RHICf detector installed in the accelerator

Solar Wind Imaging Facility (SWIFT)

Pulsating auroral patches appeared above the HAARP site in Alaska

A small-sized PM2.5 detecter devised by Matsumi Lab.



Japan-China-Korea Cooperative Cruise in East China Sea

Drilling of sediment core in Vietnam

Special lecture on ISEE Open day

Institute for Space–Earth Environmental Research,
Nagoya University
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http://www.isee.nagoya-u.ac.jp/

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NAGOYA UNIVERSITY

Institute for Space–Earth Environmental Research, Nagoya University

Annual Report FY2016

Institute for Space–Earth Environmental Research Nagoya University

Annual Report

FY2016

Institute for
Space–Earth Environmental Research
Nagoya University

Annual Report

Institute for
Space–Earth Environmental Research

April 2016–March 2017

Contents

1. Foreword

In the 21st century, humanity is evolving both qualitatively and quantitatively at a rate that is not seen previously. Such developments include the accelerated growth of informatization, the space exploration throughout the solar system, and rapid climate change on a global scale that poses a threat to all biological species and the society as a whole. All these factors combine to result in the creation of a new world that is at the forefront of human experience. In order to address the challenges of this future, it is crucially important to develop science and technology from a novel perspective beyond the conventional framework.

The Institute for Space–Earth Environmental Research (ISEE), Nagoya University, is a new research institute established on October 1, 2015 through the consolidation of three institutes, namely, Solar-Terrestrial Environment Laboratory (STEL), Hydrospheric Atmospheric Research Center (HyARC), and the Center for Chronological Research. The mission of ISEE is to investigate the complex relationships that exist between the Earth, Sun, and Space by treating them as a continuous system and to contribute to solving issues related to global environment problems and the spread of humanity throughout space.

To realize these goals, ISEE has seven research divisions including Integrated Studies, Cosmic-Ray Research, Heliospheric Research, Ionospheric and Magnetospheric Research, Meteorological and Atmospheric Research, Land–Ocean Ecosystem Research, and Chronological Research. Furthermore, to facilitate collaborative research, ISEE comprises three research centers, namely, Center for International Collaborative Research, Center for Integrated Data Science, and Center for Orbital and Suborbital Observations. An advisory board comprising experts from relevant fields has also been established with the principle aim of incorporating the opinions of various communities into the strategy and management of the institute.

The main role of ISEE is to work as a hub for related research fields to foster scientific research through integration and communication and to contribute to the creation of new disciplines. To fulfill these roles ISEE has obtained support from the Ministry of Education, Culture, Sports, Science and Technology as the Joint Usage/Research Center for Space–Earth Environmental Research for 6 years starting from April 2016. To this end, ISEE promotes activities that build a research base for comprehensively understanding the space–earth environment. This is conducted by the collaboration of space and earth scientists in Japan and other parts of the world. As part of this joint and collaborative research ISEE performs the following programs: (1) ISEE International Joint Research Program, (2) ISEE/CICR International Workshop, (3) ISEE International Collaboration, (4) ISEE Joint Research, (5) ISEE Symposia /Workshops, (6) ISEE Joint Research for Young Scientists, (7) ISEE Computer Usage Joint Program, (8) ISEE Database Joint Program, and (9) ISEE Accelerator Mass Spectrometer Usage Joint Program.

To promote interdisciplinary research, four target research fields were selected as priority areas. The first priority area is the solar-terrestrial climate research with the main focus on understanding the mechanism of long-term influence of solar activity on climate. The second priority area is the interaction of neutral and plasma atmospheres. Here the dynamical and chemical interactions between various atmospheric layers are investigated using ground-based remote sensing techniques and in situ satellite measurements as well as global and regional high-resolution models of neutral-plasma interactions. The third priority area involves the study of cloud and aerosol formation that is crucially important to understanding the radiation budget of the Earth. The final priority area focuses on the earth–space environment where the principle aim is to develop next generation space weather forecasting systems through the development of synergistic interactions between predictive and scientific research of the solar-terrestrial environment.

The fiscal year 2016 was the first year of the ISEE joint research program. Although the start of the program was slightly delayed, it resulted in 245 collaborative studies being undertaken. In particular, foreign researchers from various countries using the joint program were invited and collaborative research and seminars took place not only in ISEE but also in various locations throughout Japan. These activities contributed greatly to the development of international communication and the enhancement of innovative research capabilities at ISEE.

Education and human resource development are also an important focus of ISEE. Each laboratory in ISEE belongs to one of three graduate schools, namely, the Graduate School of Science, the Graduate School of Engineering, or the Graduate School of Environmental Studies in Nagoya University. In ISEE, the graduate students from these three different graduate schools cooperate openly through interdisciplinary discussions. Such integrated graduate school education is a unique opportunity that aids in the development of flexible problem solving skills.

Many outreach activities were performed in FY2016 and included the open laboratory event as part of the Nagoya University Festival (June), public lectures on the theme of "Storms" in space and on Earth (July), the summer holiday event for elementary and junior high school that gave students the opportunity to learn about paleo-climate and long-term variation of solar activity through the analysis of tree rings and yearly sediment (August), the public lecture to mark the 10th anniversary of solar observation satellite "Hinode" (September), and the laboratory opening at Nagoya University Homecoming Day (October). Many research results were also actively published as press releases such as the discovery of a precursor solar flare phenomenon, the observation of extrasolar planets that highlighted important aspects of planetogenesis, the discovery of extreme cosmic rays events, the direct observation of oxygen traveling from the Earth to Moon, the development of new simulations for the prediction of magnetic storms, and the development of new measurement method of solar coronal magnetic field using radio waves. A citizen participation science event was also held in cooperation with ISEE laboratories located in Rikubetsu-cho, Hokkaido and Tarumizu-cho, Kagoshima. Through the activities citizens demonstrated their interest in the research taking place at ISEE facilities.

FY2016 is the second year of operation of ISEE and the first year of operation of the Joint Usage/Research center for Space–Earth Environmental Research. This annual report summarizes research results and important activities that have taken place at these facilities during this time. I took office as the director of ISEE on behalf of Prof. Shinobu Machida in April 2017. My personal vision is to extend the frontier of science through the invaluable contribution of all ISEE staff. As a new center of scientific excellence, we hope to play a vital through our contribution to the society. Therefore, with the aims and goals presented above, I would like to ask for your continued support and cooperation.

Kanya Kusano

Director

2. 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.

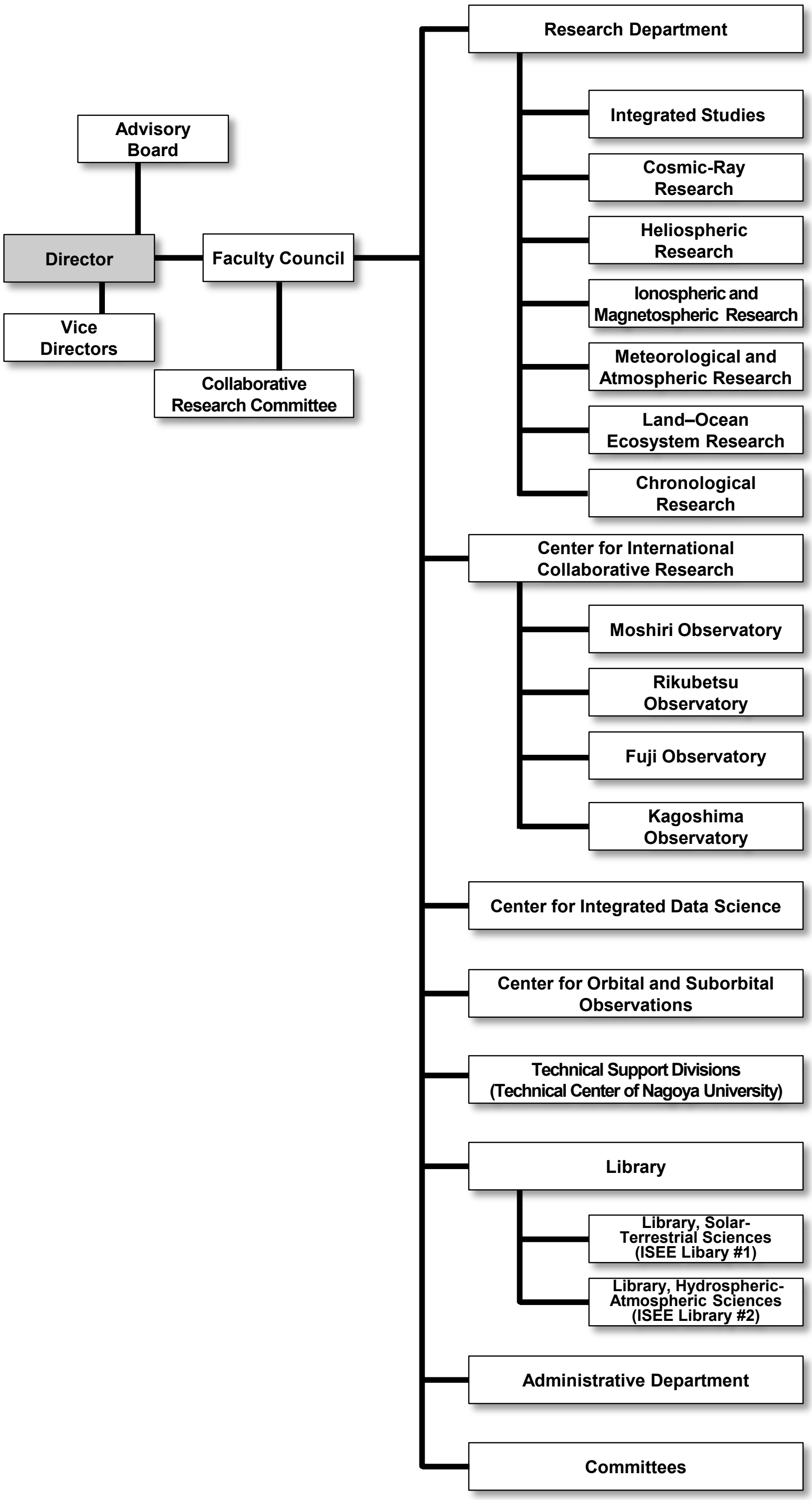
April, 2000
The Nagoya University Center for Chronological Research was organized.The CHIME dating system was transferred from the School of Science.

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.

3. Organization



4. Staff

April 1, 2016–March 31, 2017
∗ : Concurrent post
▲ : Left the Institute in the 2016 academic year
○ : Joined the Institute in the 2016 academic year

Director	Shinobu Machida
Vice Directors	Joji Ishizaka
Vice Directors	Kanya Kusano

Division for Integrated Studies

Professor	Shinobu Machida
Professor	Kanya Kusano (∗)
Associate Professor	Satoshi Masuda
Associate Professor	Yoshizumi Miyoshi (∗)
Designated Associate Professor	Shinji Saito *1
Lecturer	Takayuki Umeda (∗)
Assistant Professor	Akimasa Ieda
Assistant Professor	Shinsuke Imada
Researcher	Haruhisa Iijima ○
Research Institution Researcher	Yasunori Tsugawa
JSPS Research Fellowship	Satoshi Kurita ▲
JSPS Research Fellowship	Shoya Matsuda ○
Vsiting Academic Staff/Visiting Faculty Members	
Visiting Professor	Kiyoto Shibasaki

*1 Belongs to Graduate School of Science

Division for Cosmic-Ray Research

Professor	Yoshitaka Itow
Professor	Hiroyasu Tajima (∗)
Associate Professor	Kimiaki Masuda
Associate Professor	Yutaka Matsubara
Associate Professor	Fumio Abe (∗)
Designated Associate Professor	Kazutaka Yamaoka *1
Lecturer	Takashi Sako
Assistant Professor	Akira Okumura
Designated Assistant Professor	Fusa Miyake *2
Designated Assistant Professor	Hiroaki Menjo *1
Technical Assistant	Kinji Morikawa

*1 Belongs to Graduate School of Science
*2 Belongs to Institute for Advanced Research

Division for Heliospheric Research

Professor	Munetoshi Tokumaru
Assistant Professor	Ken-ichi Fujiki

Division for Ionospheric and Magnetospheric Research

Professor	Masafumi Hirahara
Professor	Kazuo Shiokawa (∗)
Designated Professor	Ryoichi Fujii ▲
Associate Professor	Yuichi Otsuka
Associate Professor	Satonori Nozawa
Associate Professor	Nozomu Nishitani (∗)
Lecturer	Shin-ichiro Oyama
Designated Assistant Professor	Masaki Nishino *1
Researcher	Atsuki Shinbori ○
Researcher	Mitsuru Matsumura ○
Research Institution Researcher	Tetsuo Motoba ▲
Vsiting Academic Staff/Visiting Faculty Members	
Visiting Associate Professor	Yasunobu Ogawa
Visiting Associate Professor	Yoshifumi Saito
Visiting Associate Professor	Ayako Matsuoka
JSPS Postdoctral Fellowship for Research in Japan	Cai Lei ○

*1 Belongs to Graduate School of Engineering

Division for Meteorological and Atmospheric Research

Professor	Akira Mizuno
Professor	Nobuhiro Takahashi (∗)
Professor	Kazuhisa Tsuboki (∗)
Professor	Yutaka Matsumi (∗)
Associate Professor	Tomoo Nagahama
Associate Professor	Hirohiko Masunaga
Associate Professor	Taro Shinoda (∗)
Lecturer	Tomoki Nakayama
Assistant Professor	Taku Nakajima
Designated Assistant Professor	Tadayasu Ohigashi
Researcher	Hirofumi Ohyama ▲
Researcher	Yoshiki Fukutomi ○
Researcher	Fumie Furuzawa
Technical Assistant	Kazuji Suzuki
Researcher Assistant	Maho Nakagawa ▲

Division for Land–Ocean Ecosystem Research

Professor	Joji Ishizaka
Professor	Tetsuya Hiyama (∗)
Associate Professor	Hidenori Aiki
Associate Professor	Tomo'omi Kumagai ▲
Lecturer	Hatsuki Fujinami
Assistant Professor	Yoshihisa Mino
Designated Assistant Professor	Taro Nakai
Researcher	Atsuhiro Takahashi ▲
Research Institution Researcher	Takami Saito ▲
Technical Assistant	Hirotaka Tsukamoto ▲
Researcher Assistant	Daisuke Hatsuzuka ▲

Divison for Chronological Research

Professor	Masaki Enami
Professor	Hiroyuki Kitagawa ○
Associate Professor	Masayo Minami
Associate Professor	Takenori Kato (∗)
Associate Professor	Kimiaki Masuda (∗)
Assistant Professor	Hirotaka Oda
Research Institution Researcher	Kaoru Kubota ▲
Research Institution Researcher	Naoyuki Kurita ○
Research Institution Researcher	Fumiko W. Nara
JSPS Research Fellowship	Tomoki Taguchi ▲
Technical Assistant	Masami Nishida
Technical Assistant	Yuriko Hibi ○
Technical Assistant	Miyo Yoshida

Vsiting Academic Staff/Visiting Faculty Members

Kazuhiro Suzuki ▲

Tsuyoshi Tanaka ▲

Toshio Nakamura

Center for International Collaborative Research

Director • Professor	Kazuo Shiokawa
Professor	Tetsuya Hiyama
Professor	Masaki Enami (∗)
Professor	Akira Mizuno (∗)
Designated Professor	Martin Gerard Connors ○
Designated Assistant Professor	Antti Ensio Kero ▲
Designated Assistant Professor	Joseph Benjamin Harold Baker ○
Designated Assistant Professor	Pavlo Ponomarenko ▲
Designated Assistant Professor	Jeongwoo Lee ▲
Associate Professor	Nozomu Nishitani
Associate Professor	Tomo'omi Kumagai (∗)▲
Associate Professor	Satonori Nozawa (∗)
Lecturer	Takashi Sako (∗)
Lecturer	Hatsuki Fujinami (∗)
Designated Assistant Professor	Yasunori Igarashi ▲
Researcher	Hironari Kanamori
Researcher	Masaki Nishino *1
Researcher	Chae-Woo Ju ▲
Researcher	Claudia Maria Martinez Calderon ▲

Vsiting Academic Staff/Visiting Faculty Members

Visiting Professor	Hiroyuki Shinagawa
Visiting Professor	Yoshinobu Harazono ○
Visiting Professor	Park Hotaek ○

Moshiri Observatory

Technical Assistant	Yuuji Ikegami
Technical Assistant	Masayuki Sera

Foreign Visiting Research Fellow (Visiting Professor)

Sept.15, 2016–Dec.14, 2016	Hisao Takahashi
Oct.1, 2016– Dec.31, 2016	Nanan Balan
Mar.1 2017–May.31 2017	Bernhard Kliem

*1 Belongs to Graduate School of Engineering

Center for Integrated Data Science

Director • Professor	Kanya Kusano
Professor	Kazuhisa Tsuboki
Professor	Joji Ishizaka (∗)
Professor	Shinobu Machida (∗)
Associate Professor	Fumio Abe
Associate Professor	Takenori Kato
Associate Professor	Yoshizumi Miyoshi
Associate Professor	Satoshi Masuda (∗)
Associate Professor	Hirohiko Masunaga (∗)
Designated Assistant Professor	Tomoaki Hori ▲
Lecturer	Takayuki Umeda
Assistant Professor	Akimasa Ieda (∗)
Assistant Professor	Shinsuke Imada (∗)
Designated Assistant Professor	Sachie Kanada
Designated Assistant Professor	Kunihiro Keika ▲
Designated Assistant Professor	Daikou Shiota ▲
Designated Assistant Professor	Masafumi Shoji
Designated Assistant Professor	Yukinaga Miyashita ▲
Designated Assistant Professor	Mayumi Yoshioka ▲
Designated Assistant Professor	Satoshi Inoue ○
Designated Assistant Professor	Mariko Teramoto ○
Researcher	Norio Umemura
Researcher	Masaya Kato ▲
Researcher	Tomoya Iju ○
Researcher	Mayumi Yoshioka ○
Researcher	Yukie Moroda ○
Technical Assistant	Mariko Kayaba
Technical Assistant	Asayo Maeda
Technical Assistant	Takahiro Tsukamoto
Researcher Assistant	Johan Muhamad ▲
Vsiting Academic Staff/Visiting Faculty Members	
Visiting Professor	Yoshiya Kasahara
Visiting Professor	Kanako Seki
Visiting Associate Professor	Ryouhei Kano
Visiting Associate Professor	Iku Shinohara
Visiting Associate Professor	Hirohisa Hara

Center for Orbital and Suborbital Observations

Director • Professor	Nobuhiro Takahashi
Professor	Hiroyasu Tajima
Professor	Yutaka Matsumi
Designated Professor	Masataka Murakami ○
Professor	Joji Ishizaka (∗)
Professor	Kazuhisa Tsuboki (∗)
Professor	Masafumi Hirahara (∗)
Associate Professor	Taro Shinoda
Designated Assistant Professor	Hiroyuki Tomita
Researcher	Takeharu Kouketsu ▲
Researcher	Woonseon Jung ○
Technical Assistant	Hiroshi Sasago
Technical Assistant	Tomoko Tanaka
Vsiting Academic Staff/Visiting Faculty Members	
Visiting Professor	Masahiro Kawasaki
Visiting Professor	Kunihiko Kodera
Visiting Professor	Yoshikatsu Kuroda
Visiting Associate Professor	Yasutaka Narusawa

Technical Center of Nagoya University

Senior Technical Specialist	Akiko Ikeda
Senior Technical Specialist	Yasusuke Kojima
Technical Specialist	Tetsuya Kawabata
Technical Specialist	Tomonori Segawa
Technical Specialist	Yosiyuki Hamaguchi
Technical Specialist	Yasushi Maruyama
Technical Specialist	Haruya Minda
Technical Specialist	Takayuki Yamasaki
Technical Specialist	Yuka Yamamoto
Technical Staff	Takumi Adachi
Technical Staff	Moeto Kyushima
Technical Staff	Ryuji Fujimori

Cooperating Research Fellow

Keiji Hayashi

Akiko Mizuno

Yoshiki Fukutomi ▲

Kumiko Hori ▲

Chae-Woo Ju ▲

Claudia Maria Martinez Calderon ○

Foreign Visiting Cooperation Researcher

Sept.1, 2016– Aug.31, 2017	Anglu Shen
Oct.1, 2016– Jan.31, 2018	Jie Ren
Dec.1, 2016–Dec.28, 2016	Sukumaran Nair Kumari Sumod
Jan.23, 2017–Feb.24, 2017	Neel Prakash Savani-Patel

Administration Department

Director, Administration Department	Sumio Murai
Manager, General Affairs Division	Tadashi Tsuboi ▲
Office Manager, Research Support Office	Tohru Kawai
Specialist, General Affairs Section	Norishi Sugiyama
Section Head, General Affairs Section 1	Naoki Kohsaka ▲
Section Head, General Affairs Section 2	Sayuri Morino
Section Head, Personnel Affairs Section	Shoji Asano
Section Head, Research Support Office	Naoki Fujiki ▲
Section Head, Research Support Office	Tadayosi ITO ○
Leader, General Affairs Section 1	Yumi Matsubara
Administrator	Eri Maai ▲
Administrator	Harumi Morishita
Administrator	Tsukina Ino ▲
Administrator	Anna Kato ○
Administrator	Yori Sato
Manager, Accounting Division	Toshihiro Sakaguti ▲
Specialist, Maintenance Section	Yoshiyuki Nakano ○
Section Head, Accounting Section	Hideki Kamada ▲
Section Head, Supplies Section	Noriaki Hiroi ○
Section Head, Supplies Section	Yuko Horinouchi ▲
Section Head, Supplies Section	Kiyoko hasegawa ○
Section Head, Maintenance Section	Shinichi Nakagawa
Leader, Accounting Section	Yumiko Kiso ▲
Leader, Supplies Section	Yuka Matsuoka ○
Administrator	Mio Kato
Administrator	Airi Ito ▲
Administrator	Ayaka Nakamura
Administrator	Hokuto Kamiya ▲

Toyokawa Branch

Technical Assistant	Kayoko Asano
Technical Assistant	Yasuo Kato

5. Committee of Other Organizations

Committee of Other Organizations

Contact Post	Job title	organizations	Name of Committee / Title
Kanya Kusano	Professor	International Astronomical Union (IAU)	Organizing Committee Member of Commission E3 Solar Impact throughout the Heliosphere
Yoshizumi Miyoshi	Associate Professor	Committee on Space Research (COSPAR)	Vice-chair of the Panel on Radiation Belt Environment Modeling (PRBEM)
Yoshizumi Miyoshi	Associate Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Campaign coordinator of VarSITI/SPeCIMEN
Yoshizumi Miyoshi	Associate 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)
Yoshizumi Miyoshi	Associate Professor	American Geophysical Union (AGU)	Guest Editor of Journal of Geophysical Research
Yoshizumi Miyoshi	Associate Professor	Annales Geophysicae	Editor
Yoshitaka Itow	Professor	Telescope Array collaboration	Telescope Array External Advisory committee
Hiroyasu Tajima	Professor	ISTS (International Symposium on Space Technology and Science) special issue	Associate Editor
Hiroyasu Tajima	Professor	Progress of Theoretical and Experimental Physics	Editor
Hiroyasu Tajima	Professor	The Scientific World Journal	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)
Kazuo Shiokawa	Professor	Annales Geophysicae	Guest editor for the 14th International Symposium of Equatorial Atmosphere (ISEA-14)
Kazuo Shiokawa	Professor	Journal of Atmosphere and Solar-Terrestrial Physics	Guest editor for the special issue of the 1st VarSITI General Symposium (VarSITI2016)
Kazuo Shiokawa	Professor	Earth, Planets and Space (EPS)	Guest Editor for Global Data Systems for the Study of Solar-Terrestrial Variability
Nozomu Nishitani	Associate Professor	Super Dual Auroral Radar Network	Executive Council
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Guest Editor for Global Data Systems for the Study of Solar-Terrestrial Variability
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Editor
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Vice Editors-in-Chief

Contact Post	Job title	organizations	Name of Committee / Title
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Guest Editor for the special issue of Coupling of the High and Mid Latitude Ionosphere and Its Relation to Geospace Dynamics
Yuichi Otsuka	Associate Professor	Journal of Astronomy and Space Sciences	Editor
Satonori Nozawa	Associate Professor	EISCAT Scientific Association	Council member
Hirohiko Masunaga	Associate Professor	World Climate Research Programme (WCRP) Global Energy and Water cycle Exchanges (GEWEX)	GEWEX Data and Assessments Panel (GDAP) member
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)
Joji Ishizaka	Professor	Journal of Oceanography	Editor-in-Chief
Tetsuya Hiyama	Professor	Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS), a core project of the Future Earth	Scientific Steering Committee (SSC) member
Hidenori Aiki	Associate Professor	American Meteorological Society (AMS)	Associate Editor of Journal of Atmospheric and Oceanic Technology (JAOT)
Toshio Nakamura	Vsiting Academic Staff/Visiting Faculty Members	Radiocarbon	Member of Editorial Board

6. Joint Research Programs

One of the major functions of the ISEE is to promote and conduct collaborative research on Space–Earth Environmental Science together with researchers from universities and institutes outside the ISEE. On January 14, 2016, the 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. One is the "Study of coupling processes in the solar–terrestrial system using ground-based observation network," and the other is 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 ten research programs were prepared for the application during the 2016 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 the ISEE. Joint research programs from 01) to 03), described above, will be managed by the Center for International Collaborative Research (CICR). 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.

Lists of Accepted Proposals

■ ISEE International Joint Research Program

Proposer	Affiliation*	Job title*	Corresponding ISEE researcher	Title of the research program
O. S. Bolaji	University of Lagos, Akoka-Yaba	Lecturer I	K. Shiokawa	The role of day-to-day plasma movement in triggering and modifying ionospheric irregularities
J. Huang	National Astronomical Observatories, Chinese Academy of Sciences	Associated Professor	S. Masuda	Joint investigation of solar activities by MUSER and NoRH
S. Gupta	Tata Institute of Fundamental Research	Senior Professor	Y. Matsubara	Study on dynamics of galactic cosmic rays in the heliosphere
J. Kota	The University of Arizona	Senior Research Scientist	Y. Matsubara	Study of Ground Based Cosmic Ray Observations - Start date: Sept. 15, 2016
H.-S. Yu	University of California, San Diego	Post-Doctoral Scholar	M. Tokumaru	Three-dimensional tomographic analysis using integrated global IPS data sets from MEXART and ISEE observations
K.-S. Park	Chungbuk National University	Invited Associate Professor/ Lecturer	Y. Miyoshi	The study of the magnetospheric phenomena for the dipole tilt effect by using a Global MHD simulation

* 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
Y. Iijima	Mie University	Associate Professor	T. Hiyama	International Workshop on Water-Carbon Dynamics in Eastern Siberia
H. Takahashi	Instituto Nacional de Pesquisas Espacias	Head of Aeronomy Division	Y. Otsuka	Ionospheric Plasma Bubble Seeding and Development
N. Nishitani	Nagoya University	Associate Professor	N. Nishitani	Review of the Accomplishments of the Mid-Latitude SuperDARN Network

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

List of Collaboration Resources

■ Instruments

Name	Contact Person
Fourier Transform Infrared (FT-IR) Spectrometer for Atmospheric Composition Measurements (Moshiri and Rikubetsu)	T. Nagahama
UV/Visible Spectrometer for Atmospheric Composition Measurements (Moshiri and Rikubetsu)	T. Nagahama
Heterogeneous Atmospheric Reaction Analysing System (Nagoya)	Y. Matsumi
Carbon Dioxide (CO_2) Isotope Measurement Instrument (^{13}C, ^{18}O) Using a Laser Spectroscopic Technique in the Mid-Infrared Region (Nagoya)	Y. Matsumi
Atmospheric Nitrogen Oxide (NO_2) and Ozone (O_3) Measurement Instrument (Nagoya)	Y. Matsumi
Optical Mesosphere Thermosphere Imagers	K. Shiokawa
Magnetometer Network	K. Shiokawa
ELF/VLF Network	K. Shiokawa
Sodium LIDAR (Tromsø)	S. Nozawa
Solar Neutron Telescope (Norikura Observatory, Institute for Cosmic Ray Research, the University of Tokyo)	Y. Matsubara
Low-Background Beta-Ray Counter	K. Masuda
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
Three-Dimensional Image Processing System (Nagoya)	T. Umeda
SuperDARN Hokkaido Radar (Rikubetsu)	N. Nishitani
Upper Air Sounding Systems (two sets)	K. Tsuboki
Polarimetric Radar Systems (two sets)	K. Tsuboki
Hydrometeor Video Sonde (HYVIS) System	K. Tsuboki

■ 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
Database of the Optical Mesosphere Thermosphere Imagers	K. Shiokawa
VHF Radar/GPS Scintillation (Indonesia)	Y. Otsuka
EISCAT Database (Longyearbyen, Tromsø, Kiruna, and Sondakylä)	S. Nozawa, S. Oyama
ELF/VLF Wave Data	K. Shiokawa
Interplanetary Scintillation Data	M. Tokumaru

Name	Contact Person
Solar Wind Speed Data	M. Tokumaru
Cosmic Ray Intensity Database	F. Abe
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 Radar 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

■ 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	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	Y. Matsumi
Facilities at Rikubetsu Observatory	A. Mizuno
Facilities at Kiso Station	M. Tokumaru
Facilities at Fuji Observatory	M. Tokumaru
Facilities at Kagoshima Observatory	K. Shiokawa

7. Governance

As of Mar 31, 2017

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Integrated Studies Technical Committee

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Hiroyasu Tajima	Institute for Space–Earth Environmental Research, Nagoya University
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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

8. 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 Scientific Research on Innovative Areas	6	79,240,000
Grant-in-Aid for Scientific Research (S)	2	88,530,000
Grant-in-Aid for Scientific Research (A)	9	86,710,000
Grant-in-Aid for Scientific Research (B)	13	54,600,000
Grant-in-Aid for Scientific Research (C)	9	14,170,000
Grant-in-Aid for Challenging Exploratory Research	11	16,400,000
Grant-in-Aid for Young Scientists (A)	3	16,380,000
Grant-in-Aid for Young Scientists (B)	5	4,875,000
Fund for the Promotion of Joint International Research (Fostering Joint International Research)	1	14,170,000
Specially Promoted Research	1	221,910,000

- Sixty research subjects listed in the table were supported by the JSPS Kakenhi.
- Thirty-eight research subjects received total 192,651,741 JPY and 498,500 USD from governmental funds except KAKENHI, and from other universities and companies. Twenty of them were collaborative researches between ISEE and companies, or national institutes.
- Eight research subjects received total 5,868,966 JPY of donation.

Library

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

Book

Japanese	3,004
Foreign	11,162

Journals

Japanese	3
Foreign	134

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

Book

Japanese	4,591
Foreign	8,828

Journals

Japanese	216
Foreign	228

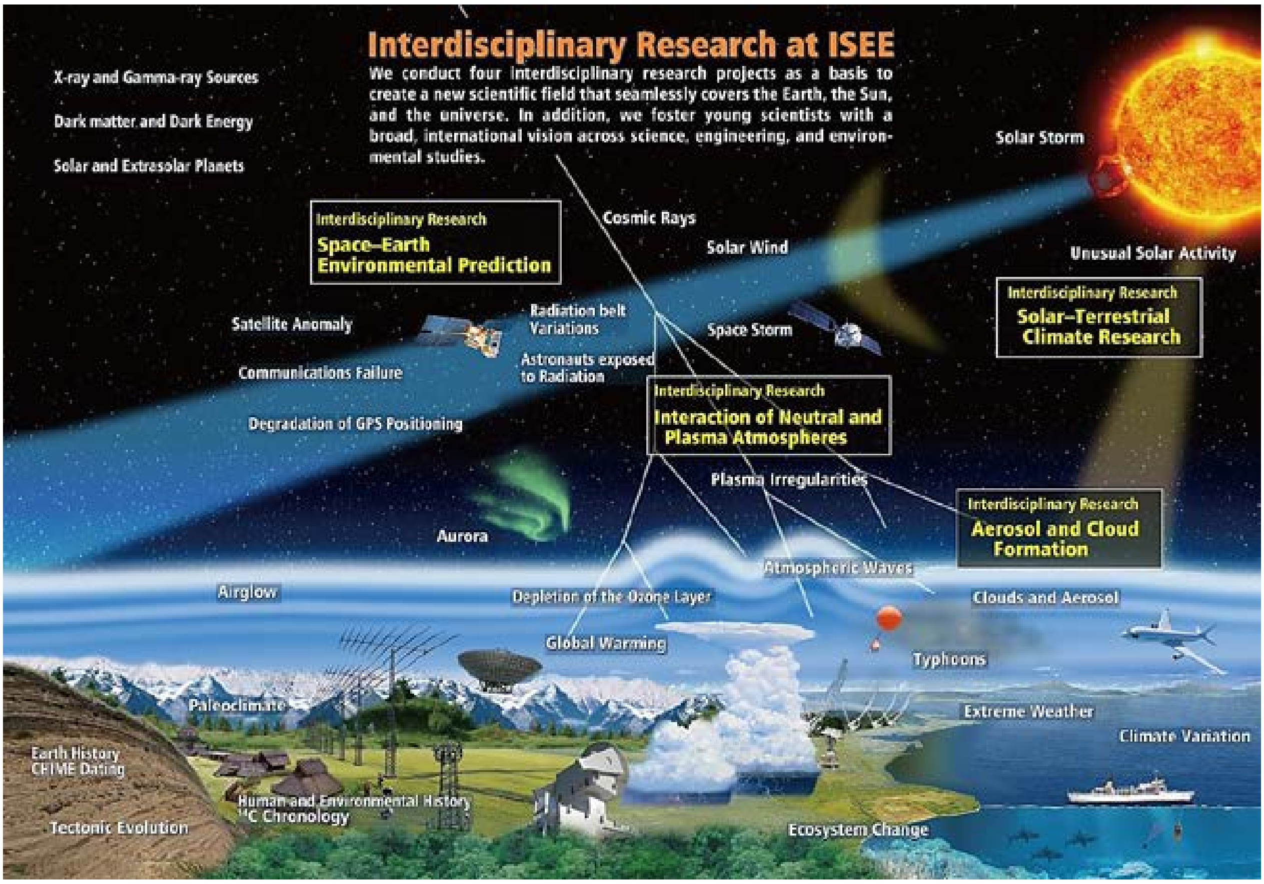
Properties

	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	33	Nagano
Kiso Station	6,240	66	Nagano
Total	336,031	17,246	

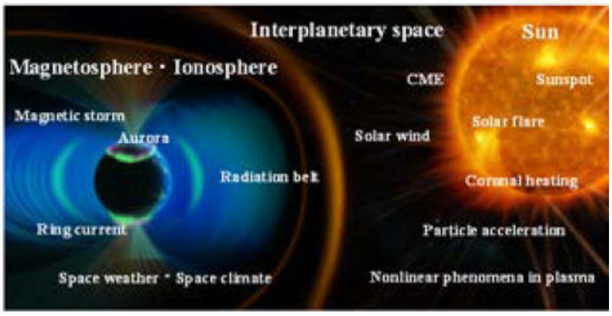
9. Research Topics

The mission of the Institute for Space–Earth Environmental Research (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 conducted 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 connection 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 via 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 with regard to 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.



9-1. Research Divisions Division for Integrated Studies



Research topics and keywords

- 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

Introduction to Division for Integrated Studies

The solar–terrestrial environment is a complex system that consists of nonlinear, non-equilibrium, and multi-scale interacting processes. The research activities in the Division for Integrated Studies are aimed at understanding the mechanisms and predicting the dynamics of various phenomena in the solar–terrestrial environment through data analyses and modeling studies. Some of the major results are introduced below.

Main Achievements in FY2016

1. Study of the onset mechanism and prediction of solar explosions

We advanced an integrated study to explore the mechanism of solar explosions, which are observed as solar flares and corona mass ejections (CMEs), through theory, simulation and observations. First, by analyzing the stability of the double-arc type current loop formed by magnetic reconnection of two magnetic loops carrying electric current, a new parameter, κ, consisting of the relative amount of reconnected magnetic flux and the magnetic twist was theoretically derived as a critical parameter for a new instability causing a solar explosion. The validity of the κ parameter was verified through re-analysis of the computer simulation results. In addition, we investigated the possibility of predicting flares by computing the upper limit of the κ parameter using a nonlinear force-free (NLFF) magnetic field based on solar magnetic field observation data. We also obtained observational evidence that a small magnetic flux of opposite polarity to the main polarity of a sunspot can play a crucial role in triggering large flares, as part of a collaborative research project with the Big Bear Observatory in the United States, using the New Solar Telescope, which is the world's largest solar telescope.

2. A study of the variation of the magnetic field structure of the CME early phase and validation of a solar wind speed model using MHD simulation

The prediction of velocity and magnetic field profiles of solar wind and CMEs is one of the most important tasks in space-weather forecasting. We recently developed a new three-dimensional magnetohydrodynamics (MHD) simulation of the propagation of solar wind and CMEs, called SUSANOO. The boundary conditions of solar wind in SUSANOO are calculated using empirical models obtained from past observations. In this study, we validated a new MHD simulation in which the boundary conditions of solar wind are specified with new models based on Interplanetary Scintillation (IPS) observations. We also studied the evolution of the magnetic field structure in the initial phase of a CME in the solar corona, and found that the rotation rate of the magnetic structure is proportional to the local magnetic field strength of the background field.

3. Next solar cycle prediction study

Predicting the next solar cycle is crucial for forecasting the solar–terrestrial environment. Construction of prediction schemes for the next solar cycle is a key component of long-term space weather studies. The relationship between the polar magnetic field at the solar minimum and subsequent solar activity has been a subject of intense discussion recently, and we have developed a new surface flux transport code, and investigated the predictability of the polar field strength using photospheric magnetograms from the last three sunspot cycles. We have observed that the new emergence of the magnetic flux in the last three years before each cycle minimum does not contribute to the polar magnetic field strength. This provides a new prediction scheme for the polar field strength, without the disadvantage of the details of the modeling of the flux emergence term in the surface flux transport. Based on the prediction scheme, we predict that the amplitude of the next sunspot cycle will be several tens of percent weaker than the current cycle. We have also attempted to obtain the meridional flow, differential rotation, and turbulent diffusivity from recent modern observations (Hinode and Solar Dynamics Observatory). These parameters will be used in the SFT models to predict the polar magnetic field strength at the solar minimum.

4. NoRH operated by an international consortium

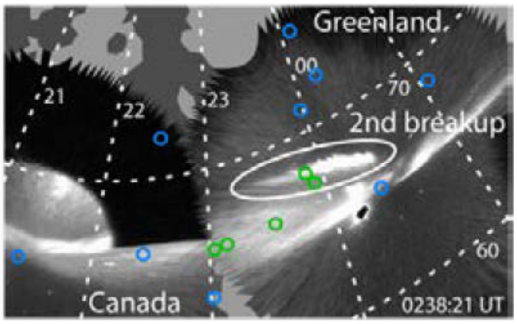
The Nobeyama Radioheliograph (NoRH) at Nagoya University, a representative of the International Consortium for the Continued Operation of the NoRH (ICCON; http://hinode.stelab.nagoya-u.ac.jp/ICCON/), has been operational since April 2015. The instrument itself worked well this year, and the web-based remote operation system is also working well. Using this system, 30 researchers in seven countries (USA, UK, Germany, Russia, China, Korea, and Japan) contributed to the operation of the NoRH. All NoRH data are stored at the National Astronomical Observatory of Japan (NAOJ) and at ISEE, Nagoya University, and freely available to the public. The data are used for a range of studies worldwide.

5. Study on the conditions for substorm onset using THEMIS probe data

Collaborating with a graduate student, the data obtained by THEMIS probes were analyzed for the cases of substorms and pseudo-substorms. The analysis results show that magnetic reconnection occurs in the near-Earth magnetotail in both cases. However, when a substorm occurs, the plasma pressure of the night-side magnetosphere is about seven to eight times the Earth's radius, approximately 1.4 times larger than that observed when a pseudo-substorm occurs. It has been clarified that plasma instability, such as the ballooning instability in the spatial gradient of the plasma pressure, is the key process for substorm onset development.

6. Stepwise tailward retreat of magnetic reconnection: THEMIS observations of an auroral substorm

Stepwise auroral breakups were clarified by investigating a multiple-onset substorm that occurred on February 27, 2009. Three successive auroral breakups were identified in all-sky images, occurring at approximately 10 min intervals. These breakups occurred stepwise; that is, later breakups were initiated at higher latitudes. Corresponding reconnection signatures were studied using THEMIS satellite observations from between 8 and 24 Re down the magnetotail. The three auroral breakups occurred simultaneously (within a few minutes) with three successive fast flows at 24 Re; thus, these were interpreted to be associated with impulsive reconnection episodes. These three fast flows consisted of a tailward flow and two subsequent earthward flows. The flow reversal at the second breakup indicated



Auroras in Canada and Greenland. The second auroral breakup was initiated at a latitude higher than the first breakup.

that a tailward retreat of the near-Earth reconnection site occurred during the substorm expansion phase. In addition, the earthward flow at the third breakup was consistent with the classic tailward retreat near the end of the expansion phase; therefore, the tailward retreat is likely to have occurred in a stepwise manner. We interpreted the stepwise characteristics of the tailward retreat and poleward expansion to be potentially associated by a stepwise magnetic flux pile-up.

7. Forecast of the AU index using real time data assimilation

We have developed a new system to forecast the AU index that uses the solar wind data from SUSANOO-SW. To improve forecasting skill, the developed system consists of two stages: the hindcast and the forecast. Data assimilation using the particle filter is implemented in the hindcast stage, which estimates parameters to reproduce the observed AU index. These estimated parameters are used to forecast the AU index in the forecast stage. The system is running to forecast the AU index in the SUSANOO system.

8. ULF wave-like signature of ionospheric flow seen by ionospheric radars during a magnetic storm

Ionospheric flow fluctuations at frequencies of ~mHz were observed by the Super Dual Auroral Radar Network (SuperDARN) at mid-latitudes during a magnetic storm in March, 2015. The radar data revealed that ultra-low-frequency (ULF)-like fluctuations propagated westward over ~90 degrees in longitude from the east coast of America through to the far east of Siberia. A detailed examination of the wave properties suggested that the ionospheric flow fluctuations are driven by wave-particle interactions with hot ions with energies of ~ several tens of keV drifting westward in the inner magnetosphere.

9. Observational study on oxygen pressure enhancements in the Earth's inner magnetosphere

We are studying enhancements in the oxygen pressure in the Earth's inner magnetosphere during magnetic storms, using *in-situ* observations made by Van Allen Probes. Multi-event case studies have confirmed that the oxygen pressure increase is temporally impulsive and spatially localized. We have also found that the oxygen-to-proton pressure ratio can reach ~1 during the early main phase and that warm oxygen (0.1–10 keV) supplied prior to a storm can be a source of storm-time energetic oxygen. The results indicate that the oxygen supply from the ionosphere prior to and/or during the early phase of a storm, which could be associated with sudden magnetospheric compression and/or substorm activity, plays an important role.

10. Relationship between acceleration and loss of relativistic electrons via chorus wave-particle interactions during geomagnetic storms

It has been suggested that the whistler mode chorus is responsible for both acceleration of MeV electrons and relativistic electron microbursts through resonant wave-particle interactions. Relativistic electron microbursts have been considered an important loss mechanism of radiation belt electrons. To understand the balance between acceleration and loss of relativistic electrons through chorus wave-particle interactions, we investigated the relationship between relativistic electron microbursts and flux variations of trapped MeV electrons during the storm of October 8–9, 2012 based on the SAMPEX and Van Allen Probe observations. Observations by the satellites show that relativistic electron microbursts correlate well with the rapid enhancement of trapped MeV electron fluxes by chorus wave-particle interactions, indicating that acceleration by chorus is much more efficient than losses by microbursts during the storm. It was also revealed that strong chorus wave activity without relativistic electron microbursts does not lead to significant flux variations of relativistic electrons. Thus, effective acceleration of relativistic electrons is caused by the chorus that can cause relativistic electron microbursts.

11. Wave vector analysis using multi-spacecraft *in-situ* observations

We calibrated wave telescope techniques using multi-spacecraft observations such as Cluster and MMS to estimate wave vectors of low-frequency waves in the foreshock and magnetosheath regions. We investigated the dependences of the parameters in the techniques on their estimate accuracies by use of synthetic data. The average interval of the cross-spectral density matrix and the n-parameter of extended MUSIC should be determined by reference to the wave duration. Based on the optimized techniques, we revealed frequency-wave vector distributions of characteristic low-frequency waves including ion cyclotron waves in the magnetosheath and geomagnetic pulsations.

12. Study on plasma wave measurements by PWE onboard the ERG (Arase) satellite

The Exploration of energization and Radiation in Geospace (ERG) satellite, which nickname is Arase, was launched on December 20, 2016, from the Uchinoura Space Center to clarify Van Allen radiation belt dynamics. It is suggested that the chorus waves and the Electromagnetic ion cyclotron (EMIC) waves around the inner magnetosphere play important roles in the acceleration and loss of relativistic electrons trapped in the radiation belt. The Plasma Wave Environment (PWE) instrument onboard the ERG (Arase) satellite measures such plasma waves. We are members of the PWE development and operation team, and successfully obtained the first light data observed by the instrument. We are also planning the nominal observation strategy for the PWE. In the next fiscal year, we will start to analyze the data obtained in earnest to understand the dynamics of the radiation belt.

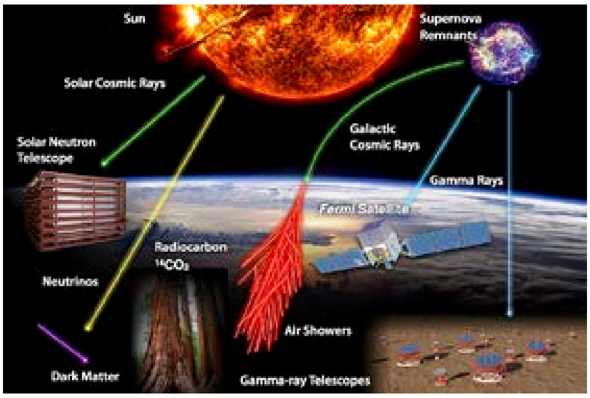
13. Simulation of electromagnetic ion cyclotron falling tone emissions

EMIC falling tone emissions have been observed in the inner magnetosphere. We have conducted a self-consistent hybrid simulation, successfully reproducing EMIC emissions with falling-tone frequencies. The hybrid simulation is implemented with a parabolic ambient magnetic field. In the simulation, strong oxygen band EMIC emissions are generated through nonlinear wave growth. The cold ion density is modulated by electrostatic structures that are induced by the forward and backward propagating oxygen band EMIC waves. Along with the growth of the oxygen band, the helium band waves also grow because of the initial linear growth followed by nonlinear growth. The nonlinear growth of the helium band waves is affected by cold plasma density modulation, and short wave packets of helium band emissions appear. The short wave packets entrap energetic protons efficiently, resulting in electromagnetic proton hills in the velocity phase space. The proton hill forms a nonlinear resonant current causing the falling frequency of the EMIC waves. We have observed strong deformation of the velocity distribution function of the energetic protons due to the proton hill being guided by the increasing resonance velocity.

14. Kinetic simulation of MHD-scale RTI

The nonlinear evolution of the Rayleigh-Taylor instability (RTI) at a density shear layer transverse to the magnetic field in collisionless plasma is investigated by means of a fully kinetic Vlasov simulation with two spatial and two velocity dimensions. The primary RTI in the MHD regime develops symmetrically in a coordinate axis parallel to gravity, as seen in the previous MHD simulations. Small-scale secondary instabilities are generated due to secondary velocity shear layers formed by the nonlinear development of the primary RTI. The secondary instabilities take place asymmetrically in the coordinate axis parallel to gravity. It is suggested that these secondary instabilities correspond to the electron Kelvin-Helmholtz instability generated by the electron velocity shear, whose development depends on the polarity of the inner product between the magnetic field and the vorticity of the velocity shear layer.

9-1. Research Divisions
Division for Cosmic-Ray Research



Research topics and keywords

- 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

Introduction to Division for Cosmic-Ray Research

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 (IMFs) 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), and 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 conduct the Large Hadron Collider forward (LHCf) and the Relativistic Heavy Ion Collider forward (RHICf) experiments to study hadronic interactions of ultra-high-energy CRs using accelerators such as the LHC or RHIC. This division also conducts neutrino physics research with the Super-Kamiokande experiment and participates in the XMASS liquid xenon experiment at the Kamioka Observatory in Japan to search for dark matter.

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 and gravitational wave events.

Main Achievements in FY2016

1. Search for the origin of cosmic rays with gamma-ray observations

The cosmic gamma ray is a good probe for investigating the properties and distributions of CRs and the interstellar medium, since gamma rays are produced by their interactions. Supernova remnants (SNRs) constitute the leading candidate for the origin of Galactic CRs. Past gamma-ray observations by the Fermi satellite confirmed that CR protons were accelerated to GeV (10^9 electron volts, eV) energies in SNRs with ages older than 105 years. However, we have not resolved the particle acceleration or the acceleration limits in younger SNRs. We have improved the image restoration technique of the Fermi data to account for the Galactic diffuse gamma-ray backgrounds, enabling image analysis of faint gamma-ray sources. As a result, we have found that gamma-ray intensity distributions may be different between GeV and TeV (10^{12} eV) energies in relatively young SNRs such as RX J1713.7−3946 and RCW 86.

This is somewhat different from the situation in IC 443 where the gamma-ray intensity is very similar between GeV and TeV energies.

Observations of Galactic diffuse gamma rays can also reveal the distribution of the interstellar gas since the gamma-ray intensity is well correlated with the gas density. Recent observations by the Planck satellite provide unprecedented measurements of all-sky dust distributions with 10-arcmin resolution using the attenuation coefficient for 353-GHz microwaves. Dust quantities are correlated with the amount of gas, which can be verified by measurement of the correlation between the dust and gamma rays. We found that the attenuation coefficient has a good correlation with the gamma-ray intensity in the MBM53–55, Pegasus Loop, Chamaeleon, and Orion regions. However, we also found non-linearity between those correlations.

We also made progress on the development of the Gamma-ray Cherenkov Telescope, which is one of the telescope designs for the CTA. We determined the best silicon photomultiplier by characterizing several candidates. We are making further measurements to improve the performance. We are also developing light concentrators to improve the light collection efficiencies of the Large-, Medium-, and Small-Sized Telescopes of the CTA and have demonstrated improved efficiencies using a prototype and simulations.

2. Research on the acceleration mechanism of solar energetic particles

Study of the acceleration mechanism of solar energetic particles is important for understanding the origin of CRs. It is particularly important to know the moment and the duration of the acceleration on the solar surface. It is preferable to observe neutrons produced on the solar surface by the interaction of accelerated ions with the solar atmosphere, rather than accelerated ions themselves, because neutrons are not reflected by the interplanetary magnetic field (IMF). The precise moment a neutron is emitted is determined by measuring the neutron energies. We have seven solar-neutron telescopes on high mountains at various longitudes to detect solar neutrons (>100 MeV) over an entire day.

In addition to this network, we have installed a new solar-neutron telescope, SciBar for Cosmic Ray Telescope (SciCRT), which has been used previously for accelerator experiments, on Sierra Negra, Mexico (4,600 m) in 2013. It uses 15,000 scintillator bars to measure particle tracks, providing much higher energy resolution and better particle discrimination than previous telescopes. Both solar neutrons and the variation of CR intensities are observed by SciCRT. Currently three-eighths of the whole detector is operational. The activity of solar cycle 24 has decreased since 2014, and no solar-neutron event has yet been detected. In FY 2016, the performance of SciCRT was better understood by Monte Carlo simulation and, as a result, the power-law index of the energy spectrum of solar neutrons was determined to an accuracy of 0.1. If an ambiguity of up to 1.0 of the power-law index is permitted, it is possible to discriminate the emission durations between 0 and >5 minutes.

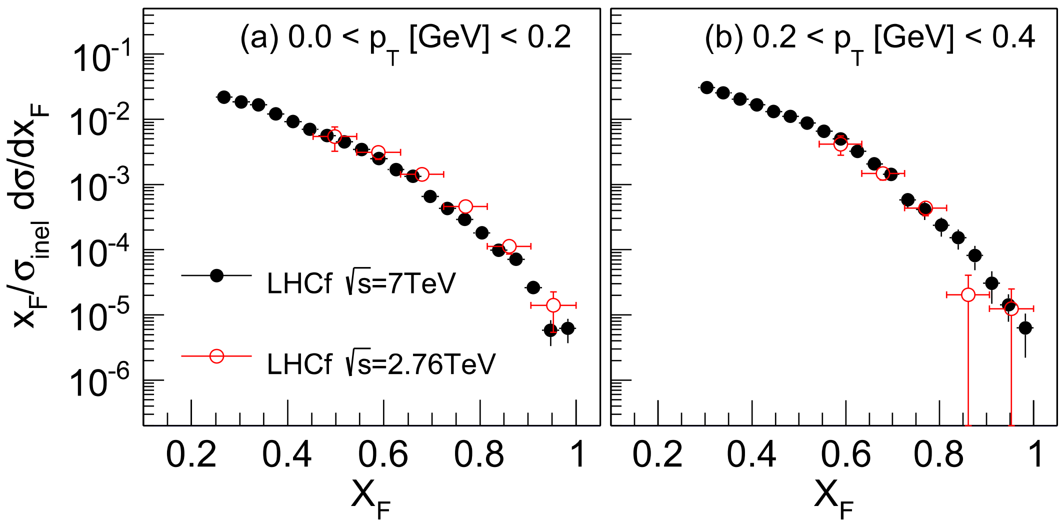
3. Study of cosmic neutrinos and dark matter

The neutrino is a neutral elementary particle with an infinitesimal mass, which is scattered only via the weak interaction. The strong penetrating power of neutrinos means information from the center of celestial bodies such as the Sun and the Earth can be determined. In addition, neutrino oscillation occurs, because of quantum state mixing between the three neutrino species. By observing this oscillation, we can explore unknown properties of neutrinos such as their masses, and hidden information such as the material density of celestial bodies. In addition to neutrinos, particle dark matter (weakly interacting massive particles, WIMPs) are thought to exist in space. In this FY, we have developed a new analysis technique to distinguish muon neutrinos and anti-muon neutrinos by using decay electrons, improving the sensitivity of the matter effect in atmospheric neutrino oscillations. We utilize negative muons produced by charged-current interactions of muon neutrinos in water causing a capture and absorption reaction by the oxygen nucleus. In addition, we have been promoting a next-generation ultra-large water Cherenkov detector, Hyper-Kamiokande, which has a volume 20 times greater than that of Super-Kamiokande. We have conducted a long-term underwater test of hybrid photo-sensors. The photon incident position dependence and a reconstruction method for incident position were also studied. We have also conducted the XMASS experiment for direct WIMP searching using an ultra-low background liquid-xenon detector. A measurement result for the scintillation luminescence time constant of liquid xenon for low-energy gamma rays has been published in this FY. In addition, for application to future large-scale dark-matter-search experiments, we have developed a liquid-xenon single-phase TPC. We developed a prototype detector using a wire electrode with which we have succeeded in detecting a delayed signal due to proportional scintillation in liquid xenon.

4. Cosmic-ray interaction-focused accelerator experiment

Very-high-energy CRs with energies far beyond the energy at manmade particle accelerators are hitting the Earth. They undergo repeated interactions in the atmosphere and are observed as particle clusters called air showers at the ground. Comparison between the air-shower data and Monte Carlo simulation is essential to extract the energy and type of the primary particle, and uncertainty in hadronic interaction modeling causes a major uncertainty in the interpretation. The world's largest accelerator, the LHC at European Organization for Nuclear Research (CERN), provides the best opportunity to study the hadronic interaction. Though the particle energy at the LHC is up to 7 TeV, the proton–proton collision at the LHC is equivalent to CRs of 10^{17} eV hitting the atmosphere.

In 2016, the LHCf-experiment collected data during proton–lead collisions at the LHC. In a quick analysis, we confirmed production of high-energy neutrons through interaction between protons and virtual photons around the lead nuclei. Production of neutral pi mesons and eta mesons was also confirmed. Using the data collected in 2015, production rates of photons in proton–proton collisions at $\sqrt{s} = 13$ TeV were presented. The analyses for neutral pi meson production, eta meson production, and joint analysis with the ATLAS experiment using the same data set are also ongoing. A summary of neutral pion production using the data taken before 2015 has been published, in which a scaling of the production cross sections at different collision energies was reported. The RHICf experiment using the RHIC at the BNL in the US was prepared for operation in 2017. RHICf will collect data for 0.51 TeV proton–proton collisions. Combined with the LHCf data, the hadronic interaction and its collision energy dependence will be studied at the CR equivalent energy from 10^{14} to 10^{17} eV.



Differential cross-section of forward neutral pions measured by the LHCf with p–p collisions at $\sqrt{s} = 2.76$ TeV and 7 TeV. The LHCf Collaboration, *Physical Review D*, 94, 032007 (2016).

5. Cosmic-ray intensity variation in the past with cosmogenic radioisotopes

The ^{14}C concentration in tree rings is a good proxy for the CR intensity reaching the Earth in the past. The CR flux may reflect high-energy phenomena such as supernovae near the solar system or arrival of solar CRs by extreme flares on the solar surface. Although CR variations in the past have been investigated by measurements of ^{14}C concentrations in tree rings with time resolutions of more than 10 years over the Holocene (the last 12,000 years), variations with 1 or 2-yr resolution have not been investigated and almost nothing has been clarified at the 1-yr resolution. The only exception is the CR increase events of AD775 and AD994, published by our group in 2012 and 2013.

To investigate whether similar events occurred in the last 12,000 years, we are searching for CR events in the last 104 years using American trees. We examined the standard decadal data of ^{14}C (IntCal) carefully and identified 15 ^{14}C rapid increase peaks with a rate larger than 0.3‰/yr. Concentrations of ^{14}C around the peaks were then measured at the 1-yr resolution. It has been shown that four peaks other than the AD775 peak did not represent rapid peaks at the 1-yr level. On the other hand, for one peak at BC5480, it was discovered that the concentration of ^{14}C increased rapidly by 20‰ over 10 years, though the increase was not observed at the 1-yr level. However, the amount of this increase was extremely large and its rate larger than those in grand solar minima such as the Maunder Minimum. The cause of this increase can be considered to be an extremely deep solar activity minimum or successive large flares, or a combination of both. The detailed cause is unclear.

^{14}C is useful for investigation of the characteristics of solar activity, such as its periodicity. In 2016, we measured the ^{14}C concentration variation around the Wolf Minimum, when annual data were lacking, to investigate the relationship between the length of the Schwabe cycle and solar activity minima. We confirmed a period somewhat longer than 11 years of the modern solar Schwabe cycle and a continuous 22 years of the Hale cycle. These characteristics show tendencies of both agreement and disagreement with other minima.

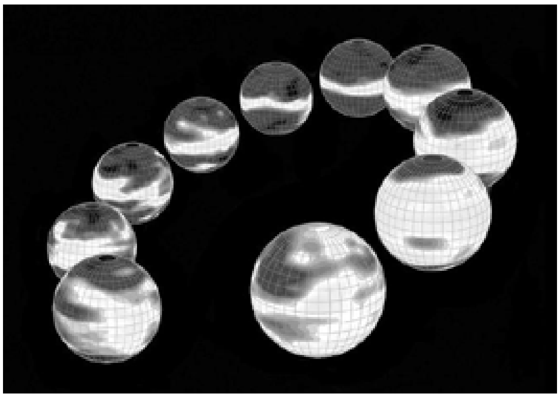
6. Verification of the cosmic-ray-induced cloud formation hypothesis

We aimed to verify the increase of cloud condensation nuclei due to galactic CRs, as one hypothesis for correlation mechanisms of solar activity and the global climate. We have investigated the relationship between the ionization density and the production efficiency of cloud nuclei formation with an atmospheric reaction chamber by irradiation of high-energy protons, nitrogen, and xenon ions at the Heavy Ion Medical Accelerator in Chiba (HIMAC) accelerator at National Institute of Radiological Sciences (NIRS). In 2016, the experimental data were carefully analyzed, showing that the particle density at the nanometer level in the atmosphere varies, corresponding to the ion density produced by high-energy heavy ions, and that they are possibly independent of the incident ion species, that is, the ionization density along the track. On the other hand, relatively high-production efficiency was obtained for protons.

7. Wide-field optical surveys for gravitational microlensing and gravitational sources

In 2016, we detected 618 microlensing events and issued real-time alerts to follow-up groups. From the preliminary analyses, we discovered five candidates for new exoplanets. Seven exoplanets were identified from analyses of past events. Follow-up observations are continuing for the gravitational wave alerts from the LIGO group.

9-1. Research Divisions
Division for Heliospheric Research



Research topics and keywords

- Solar wind
- CME
- Radio astronomy
- Interplanetary scintillation
- Global heliospheric structure
- Space weather forecast
- Development of instruments

Introduction to Division for Heliospheric Research

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 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.

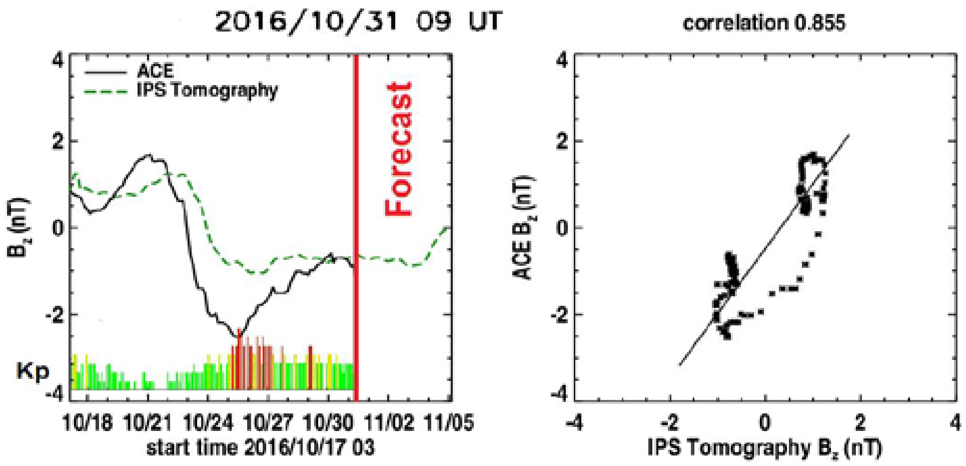
The solar wind varies dramatically with solar activity. In association with eruptive phenomena on the Sun's surface, a high-speed stream of the solar wind sometimes arrives at the Earth, and generates intense disturbances in geo-space and the upper atmosphere. Space environment conditions that significantly 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, space weather forecasting, the global structure of the heliosphere, and its variation. Also, laboratory and fieldwork experiments are performed for improving data quality and upgrading the instruments.

Main Achievements in FY2016

1. Solar wind observations using the IPS system

We have performed remote-sensing observations of the solar wind since the 1980s using the multi-station IPS system. The 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 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 the 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 sensitivities. These two antennas are located in mountainous areas, and are not used for observations during winter due to heavy snowfall. We collected solar wind speed data using the IPS system between March 31, when all three antennas became available, and December 9, when snowfall began in the mountains. Although some interruption of IPS observations occurred during this period due to mechanical troubles in the antennas, we obtained an abundance of solar wind data. Solar wind density fluctuations were derived from IPS observations at Toyokawa and were 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.



Comparison between the predicted IMF B_z from the TDT analysis of IPS data and the CSSS model calculation (dashed line) and observed data from the ACE spacecraft (solid line).

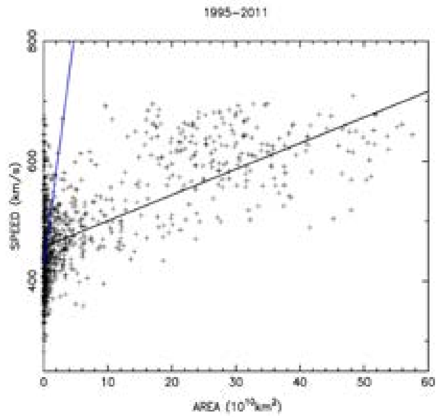
2. International collaboration for space weather forecast

We have conducted 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 the tomographic analysis of IPS observations over a long period. The time-dependent tomography (TDT) program was developed through this collaborative research. This program is now available on the web server of the NASA Community Coordinated Modeling Center (CCMC), and is running in realtime at the Korean Space Weather Center (KSWC) to predict the solar wind on Earth. A prediction system for the solar wind and IMF on Earth was also developed at KSWC, combining TDT analysis of IPS data with the ENLIL solar wind model (Dr. D. Odstrcil of GMU/NASA).

The B_z component of the IMF is known to strongly control the effect of solar wind disturbances on the Earth's magnetosphere, and reliable predictions of the IMF B_z are particularly needed. We studied improvements to IMF prediction on Earth from a combined analysis of IPS data and solar magnetic field data in collaboration with Dr. Jackson. As a result, we found that the radial and azimuthal components of the IMF predicted from the Current Sheet Source Surface (CSSS) model of the solar magnetic field agree well with observations. Predictions of the B_z component sometimes show good agreement with observations, so that further thorough verification is needed.

With a growing awareness of the utility of IPS observations for space weather forecasting, IPS observations are increasingly conducted at a number of places across the Earth. In addition to Japan, Russia, and India, where IPS observations have been conducted for a long time, new antennas dedicated to 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) were also conducted on a campaign basis. An integrated analysis using IPS data from these stations enables higher-resolution 3D reconstructions of the rapid variation in solar wind with solar activity. The establishment of the World-wide IPS Stations (WIPSS) was proposed at the IPS workshop held at Morelia, Mexico, in 2015. Comparison between IPS data at different stations is a key issue for realizing WIPSS. Hence, we performed a comparison between IPS data taken at ISEE and Mexico in collaboration with the UCSD group, and found that IPS data in Mexico were seriously contaminated by spiky noise, and that this is likely to cause significant discrepancies between IPS (g-value) data from the ISEE and from Mexico. Further investigation of the noise in Mexican IPS data is needed. In addition, the revision of the common data format for exchanging IPS data, IPSCDF Version 1.1, was discussed in the IPS workshop held at UCSD in December, 2016.

3. Relation between solar wind speed and coronal hole area

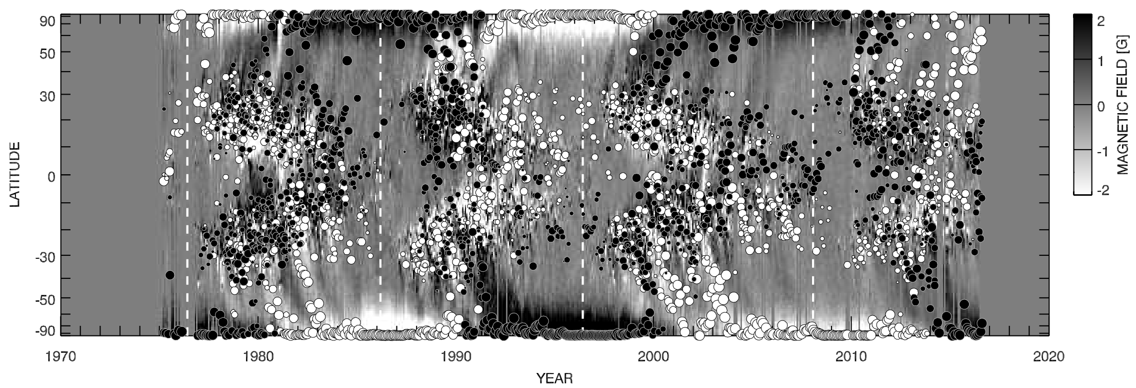


Relationship between coronal hole areas and solar wind speeds.

The coronal hole is a region where the solar magnetic field opens into interplanetary space, and also where the fast solar wind emanates. Earlier studies showed that there is a positive correlation between coronal hole areas and solar wind speeds. However, the speed data used in those studies were obtained from *in situ* measurements at the ecliptic plane (i.e., near the heliographic equator), and one-to-one correspondence between the speed data and the corona hole data was not firmly established. Therefore, we examined the relationship between solar wind speeds and coronal hole areas using ISEE IPS observations, which allowed determination of the global distribution of the solar wind speed. In this study, we established one-to-one correspondence between the solar wind speed data and the corona hole (open-field region) area data by tracing the field line from the source surface to the photosphere. The period analyzed here was from 1995 to 2011. As a result, we confirmed that a good positive correlation exists between the coronal hole area A and the solar wind speed V, and found that the slope in the A-V relation differs significantly from those reported in earlier studies. We also found that the correlation between A and V drops at solar maxima, and we ascribe this to the effect of the rapid time evolution of the solar wind and coronal structures at solar maxima. If data at solar maxima are excluded, the correlation coefficients between A and V are high and the slopes in the A-V relation are constant during the analysis period. We examined the relation between V and the inverse of the flux expansion factor f, which is a controlling parameter for the solar wind speed, and found that the correlation between A and V is as good as that between $1/f$ and V. We discovered that the relation between $A^{1/2}$ and V shows a higher correlation than that between A and V. This enables us to predict the solar wind speed more accurately from coronal hole observations, leading to improvement of the space weather forecast.

4. Long-term trend of coronal hole distribution and its relationship to galactic cosmic ray modulation

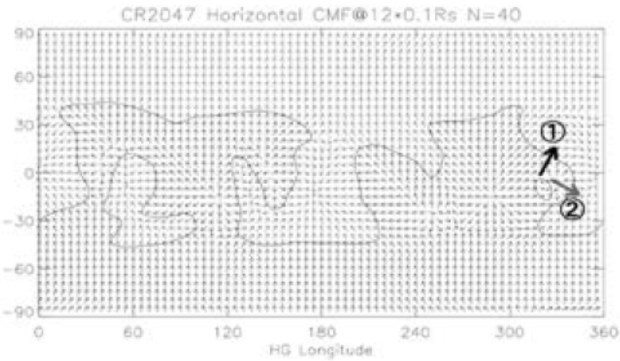
We developed an automated prediction technique for coronal holes using potential magnetic field extrapolation in the solar corona to construct a database of coronal holes appearing from February 1975 to July 2015 (Carrington rotations from 1625 to 2165). Coronal holes are labeled with the location, size, and average magnetic field of each coronal hole on the photosphere and source surface. As a result, we identified 3335 coronal holes and found that the long-term distribution of coronal holes shows a similar pattern known as the magnetic butterfly diagram, and polar/low-latitude coronal holes



Long-term trend of coronal-hole distribution. Black and white circles indicate negative and positive polarities, respectively, and their sizes are proportional to the areas of coronal holes. Background image is a magnetic butterfly map made from synoptic magnetograms from the Kitt-Peak National Solar Observatory.

end to decrease/increase in the last solar minimum relative to the previous two minima. We then compared the variations in the polar coronal-hole area and neutron monitor data obtained at Oulu. The cross-correlation function between those parameters takes a maximum value at a time lag of 13 CRs (~1 year), which is equivalent to the propagation time of the solar wind from the Sun to the termination shock. The area of the polar coronal hole is an observable indicator of the dipole component of the solar magnetic field, and might be a useful parameter of direct modulation of galactic cosmic rays.

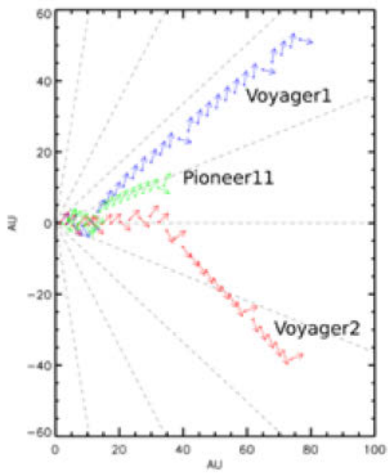
5. Relationship between north-south component of the magnetic field in sheath regions and coronal magnetic fields



Horizontal CMF component at 1.2 Rs. Thick arrows 1 and 2 indicate the directions of CMF at sub-Earth point and flaring point (estimate source of MC), respectively.

The occurrence of geomagnetic storms is controlled by the north-south (NS) component of the IMF. The majority of geomagnetic storms are associated with magnetic clouds (MCs) or sheath regions. It is therefore important to understand the NS component of the IMF associated with MCs and sheath regions for space weather forecasting. The origin and structure of MCs is becoming clear; however, the origin of the IMF at sheath regions is poorly understood, and it is still not clear how the IMF in sheath regions is related to coronal magnetic fields (CMFs). We investigated the relationship between the polarity of the NS component of CMFs and that of the IMF observed by the ACE at sheath regions, using the Potential Field Source Surface model and the UCSD time-dependent tomographic (UTDT) analysis. It was found that the polarity of the NS component of the CMFs at 1.1 solar radius (Rs) and 1.2 Rs agrees with ACE observations at the end time of the sheath region for all five analyzed events during 2006–2008. The result indicates that the coronal magnetic field (CMF) at low height erupts and the field is observed at the end time of the sheath region. We obtained similar results using the 1D hydrodynamic solar wind model instead of UTDT analysis.

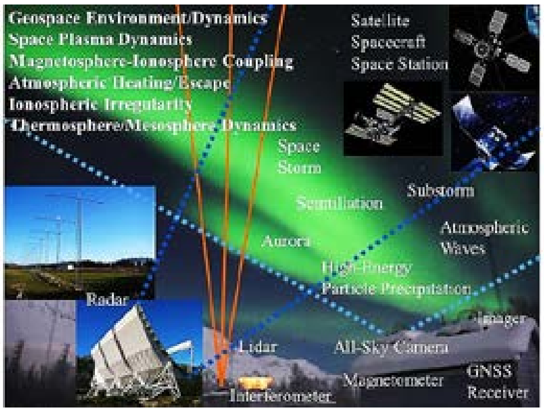
6. Study of the origin of the stationary normal component of the IMF



Yearly averaged direction of the B_n -component observed by Voyager 1, Voyager 2, and Pioneer 11. Upward and downward arrows indicate positive and negative B_n-components, respectively.

It is important to predict and analyze the normal component of the IMF for space weather. We analyzed two kinds of stationary normal component of the IMF, which is poorly understood. The first analysis was a statistical analysis of the magnetic data of various spacecraft and, in particular, we analyzed the relationship between the radial component (B_r) and the normal component (B_n) of the IMF. The results indicated that Br and B_n have a positive correlation in the north and a negative correlation in the south, from the equatorial plane. The second analysis was a comparative analysis between the CMF and the near Earth magnetic field. We used the PFSS model to calculate the CMF and UCSD time dependent tomography to estimate the solar wind between the Earth and the Sun. The results indicated that there is a significant correlation between the coronal B_r and B_n of the near Earth region. This was studied in cooperation with B. V. Jackson and H.-S. Yu from UCSD.

9-1. Research Divisions
Division for Ionospheric and Magnetospheric Research



Research topics and keywords

- Understanding the process of energy transfer from the solar wind to the magnetosphere and ionosphere
- Understanding the magnetosphere–ionosphere–thermosphere coupled system
- Ground-based and network observation
- Space and planetary exploration

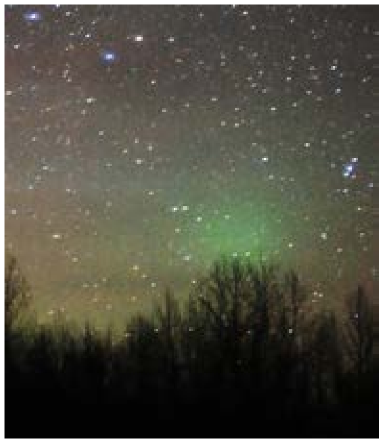
Introduction to Division for Ionospheric and Magnetospheric Research

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 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 Achievements in FY2016

1. Measurements of aurora and electromagnetic waves at subauroral latitudes

The PWING project started in the fiscal year 2016, with the support of the Japan Society for the Promotion of Science (JSPS), Grant-in-Aid for Specially Promoted Research. Under this project auroral imagers and electromagnetic wave receivers are deployed at eight stations (in Canada, Russia, Alaska, Finland, and Iceland) around the North Pole at magnetic latitudes of about 60^{o} to investigate the dynamics of plasma and waves in the inner magnetosphere. As initial results, one-to-one correspondence was obtained between the subpacket structures of Pc1 geomagnetic pulsations (EMIC waves). It is also suggested that the precipitation of MeV energy plasma into the stratosphere, associated with the heliospheric plasma sheet through the EMIC waves, may affect the dynamics of the middle atmosphere.



Isolated proton aurora observed at Athabasca, Canada.

2. Study of the upper atmosphere using optical imaging instruments

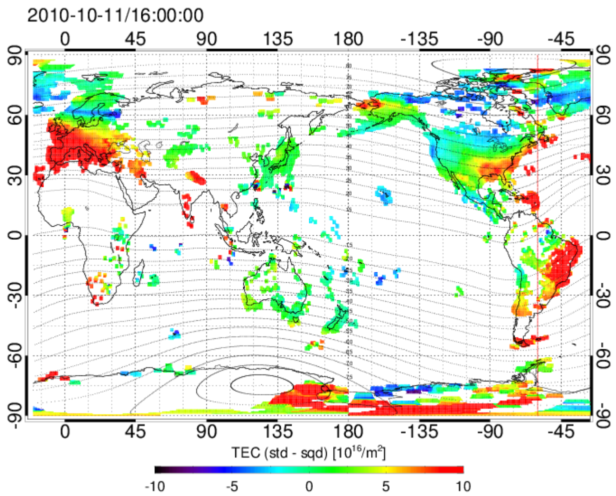
To investigate the dynamics of the mesosphere, thermosphere, and ionosphere, we routinely operate Optical Mesosphere Thermosphere Imagers (OMTIs), which consist of five sky-scanning Fabry-Perot interferometers (FPIs), 17 all-sky charge-coupled device (CCD) imagers, three tilting photometers, and three airglow temperature photometers. We have succeeded in taking all-sky airglow images of plasma bubbles over Africa for the first time. Long-term variations in atmospheric gravity waves in the mesopause region and traveling ionospheric disturbances in the ionosphere have been studied.

3. Response of the ionosphere and thermosphere to solar flares

We developed the GAIA, a coupled global model of the ionosphere and atmosphere, to simulate the ionospheric and thermospheric responses to solar flares, and the following process was observed. An X-class flare irradiance enhances the ionization on the dayside equatorial region and steepens the longitudinal gradient of the conductance at the morning and evening terminators. Consequently, the eastward electric current decreases/increases the polarization charge density in the morning/evening, and weakens/strengthens the eastward electric field in the post-sunrise/post-sunset sector.

4. Study of the plasmasphere and ionosphere using global GNSS receiver network

We investigated the temporal and spatial variations of the plasmasphere and ionosphere during geomagnetic storms using global absolute total electron content (TEC) data obtained from 5,600 GNSS receivers. We found that the enhancement of the TEC began in the daytime sub-auroral region about 2–3 hours after the onset of the storm main phase, and expanded over time. In the higher latitudes of the enhanced TEC, a TEC decrease corresponding to the ionospheric trough appeared, and moved in the equatorial direction as the geomagnetic storms developed. Moreover, the equatorial TEC showed a significant enhancement and depression during the storm main and recovery phases, respectively.



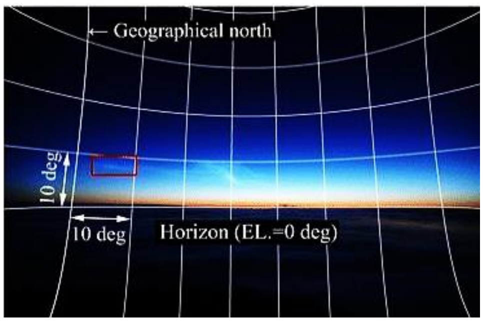
Global distribution of TEC obtained from GPS receivers.

5. Study on lunar plasma environment

A tenuous region called the wake forms behind the Moon in the solar wind, and plasma entry/refilling into the wake is a fundamental problem in lunar plasma science. We have made the first observation of bow-shock reflected protons by the Kaguya (SELENE) spacecraft in orbit around the Moon, confirming that solar wind plasma reflected at the terrestrial bow shock can easily access the deepest lunar wake when the Moon stays in the foreshock. We conclude that the impact of the bow-shock reflected ions and electrons raises the electrostatic potential of the lunar night-side surface through secondary electron emission.

6. SuperDARN Hokkaido HF Radars

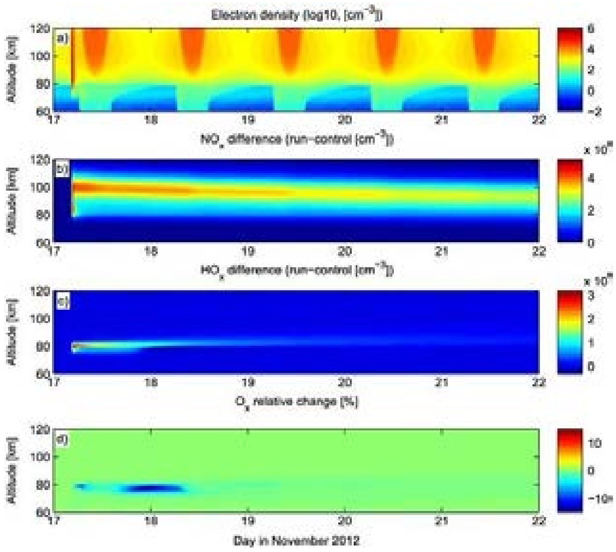
Using the SuperDARN Hokkaido HF East and West radars at Rikubetsu, Hokkaido, we studied the statistical characteristics of Sub-Auroral Polarization Streams (SAPS) and mesospheric echoes. We succeeded in imaging noctilucent clouds (for the first time in Japan) using a digital camera in Hokkaido, and concluded that they were generated as a result of transport of cold air masses to the equatorial direction from higher latitudes.



Noctilucent cloud taken from Rikubetsu, Hokkaido with estimated height of 83.9±0.1 km.

7. EISCAT project promotion: synthetic observations with collocated instruments

The EISCAT Radar Scientific Association is an international organization concentrating on the operation of radar systems in northern Scandinavia. We accumulated a variety of instruments around the EISCAT radars to conduct complementary and synthetic observations throughout the ionosphere, thermosphere, and upper mesosphere. In fiscal year 2016, 12 proposals for EISCAT special experiments were accepted by the Japanese EISCAT committee, and 11 of these were conducted in collaboration with the National Institute of Polar Research (NIPR). Several optical instruments, including the Na Lidar, and the FPI, were operated automatically at the EISCAT Tromsø site. An international session on "Study of coupling processes in the solar–terrestrial system", related to the EISCAT_3D project, was organized at Japan Geoscience Union (JPGU) 2016 with Research Institute for Sustainable Humanosphere (RISH), Kyoto University and NIPR. A domestic EISCAT workshop was held at NIPR in March 2017.



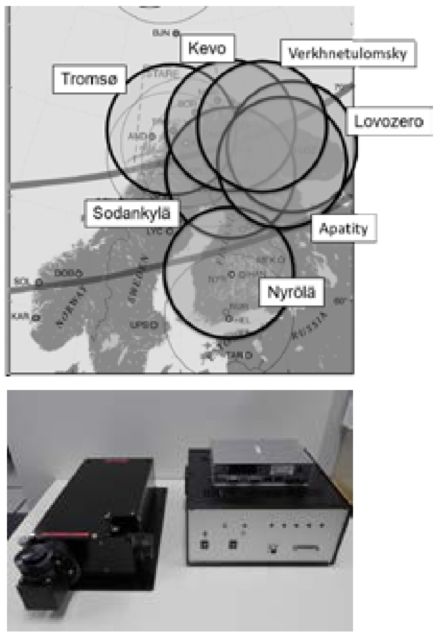
(a) Input of the five-day electron density with an artificial EEP for 30 minutes. The 30-min EEP causes long-lasting NO_x and HO_x increases (b and c), resulting in O_3 density depression around 75 km.

8. International collaboration to study impacts of the EPP on the 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 analyzed the EISCAT-measured electron density with the Sodankylä Ion Chemistry model, and presented the O_3 density depression by about 14% at an altitude of 75 km. We also conducted personnel exchanges between Japan and Finland to improve this study.

9. Ground-based optical/radio-wave observation network focusing on the wave-particle interaction

The inner magnetosphere and the plasmasphere consist of charged particles across a wide range of energies from 1 eV to 1 MeV. Interactions between plasma waves at frequencies of 0.1 Hz–10 Hz and charged particles cause acceleration or loss of particles in these regions. These particles penetrate the polar ionosphere, resulting in aurorae characterized by various spatiotemporal features and longitudinal distributions. We installed EMCCD cameras, a magnetometer, and a five-wavelength photometer in northern Scandinavia and North America to measure precipitating particle energies, plasma waves, and aurorae. We also made an energy estimation of the precipitation electrons using the photometer data.



Upper: Field-of-views of the cameras in Scandinavia.
Lower: (left) optical part and (right) control part and PC of the five-wavelength photometer.

10. Final calibration and testing of plasma particle instruments onboard the geospace exploration satellite, ERG (Arase)

The ERG (Arase) for *in-situ* observations of space plasma dynamics in the terrestrial radiation belt, carries six plasma particle instruments. We performed the final calibrations for two of these, i.e., the medium-energy ion and electron instruments, using high-energy ion and electron beamlines in our research division. We also conducted a final test of the low-energy ion instruments to check the reduction performance of the solar ultraviolet irradiation.

11. Planning and leading the space exploration mission using the formation flight configuration of polar-orbiting satellites for research into the Earth's magnetosphere–ionosphere–thermosphere

After the successful launch of, and initial observations from, ERG (Arase), we have commenced the planning and promotion of the next space exploration mission, with the aim of leading the next community mission in Japanese space physics, using the formation flight configuration of polar-orbiting satellites to investigate magnetosphere–ionosphere–thermosphere coupling mechanisms for the Earth. In particular, we are calling for the participation of core researchers in the community and also organizing regular meetings for discussions on the importance and objectives of the mission and the required observational instruments. These activities have enhanced the reality and feasibility of the whole mission, and provide a foundation for fruitful cooperation with domestic and overseas research institutes and manufacturers.

12. Development of the suprathermal ion instrument for the sounding rocket experiment for research into the Earth's polar ionosphere–magnetosphere

In preparation for the sounding rocket experiment for research into the Earth's polar ionosphere–magnetosphere planned for December 2017, we have just started the development of the suprathermal ion instrument. Initial performance tests and calibration of the energy analysis unit and the mass discrimination unit have been conducted using the suprathermal ion beamline in our institute. We also confirmed the experimental characteristics of the energy analysis unit, with reference to the black coating and the reduction in the solar ultraviolet irradiation.

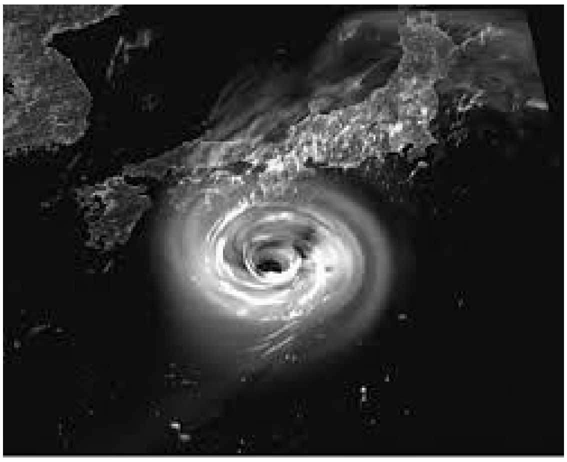
Suprathermal ion instrument for the sounding rocket experiment, set in the vacuum chamber of the beamline.

13. 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/
STEL magnetometer network	http://stdb2.isee.nagoya-u.ac.jp/magne/
STEL 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/

9-1. Research Divisions
Division for Meteorological and Atmospheric Research



Research topics and keywords

- Millimeter-wave/infrared interferometry of trace gases such as greenhouse gases and ozone depleting substances
- Precipitation measurements by advanced polarimetric radars and hydrometeor videosondes
- Laser/optical measurements and chamber data analysis of trace gases and aerosol properties
- Development of new instrumental technology
- Development of a numerical cloud model (CReSS) and meteorological studies with numerical simulations
- Clouds and precipitation observed by multiple satellites

Introduction to Division for Meteorological and Atmospheric Research

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 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 a number of research projects for exploring the atmosphere from a range of different angles.

Main Achievements in FY2016

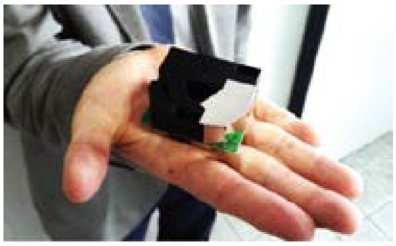
1. Ground-based observations of column-averaged mixing ratios of methane and carbon dioxide in the Sichuan Basin in China

Remote sensing of atmospheric greenhouse gases, methane (CH_4) and carbon dioxide (CO_2), contributes to our understanding of climate change. A portable ground-based instrument consisting of a desktop optical spectrum analyzer and a small sun tracker has been applied to measurement of the column-averaged mixing ratios of atmospheric CH_4 (XCH_4) and CO_2 (XCO_2) at the Yanting observation station in a mountainous paddy field in the Sichuan Basin from September to November. An increase in XCO_2 from September to November due to accumulation in the Basin was observed. In contrast, higher ratios of XCH_4 to XCO_2 were observed in September, which were likely to be due to large CH_4 emissions from rice fields in the Basin.

2. Observational studies on new particle formation at two suburban sites in Japan

New particle formation (NPF) and subsequent particle growth are crucial secondary formation processes of atmospheric aerosols. We have measured aerosol size distributions and precursor gaseous species, such as sulfur dioxide, monoterpenes, and toluene, at two distinct suburban sites in the cities of Kyoto and Hachioji, in summer, to elucidate factors controlling NPF processes. At Kyoto, increases in nucleation mode particles with diameters smaller than 30 nm were observed on more than half of the observation days. At Hachioji, although the concentrations of precursor gases were comparable or higher than those at Kyoto, no NPF event was observed. Concentrations of isoprene more than tenfold those elsewhere were observed in Hachioji due to emissions from deciduous trees around the observation site. These results imply that isoprene suppresses the NPF in suburban forest environments, where both anthropogenic and biogenic emissions are present.

3. Development and evaluation of a small PM2.5 instrument



Newly developed small PM2.5 sensor.

A new compact, palmtop sensor to measure PM2.5 (suspended particles with diameters less than 2.5 μm) has been developed in collaboration with the Panasonic Corporation. The sensor consists of an LED light source and photodiode detecting light scattering from aerosol particles. The results of laboratory tests suggest that the sensor can detect particles with diameters as small as 0.3 μm and can measure mass concentrations of PM2.5 up to at least 600 μg/m^3. In addition, the PM2.5 mass concentrations of ambient particles measured using the compact PM2.5 instrument agreed well with those measured using a standard (but expensive) beta attenuation monitoring instrument with correlation coefficients greater than 0.8.

4. Earth surface echo estimation by TRMM EOM special experimental data

In the end of mission (EOM) special experiment of the Tropical Rainfall Measuring Mission (TRMM), wide-swath experiments were conducted to acquire basic data for future spaceborne precipitation radar design. The main part of this experiment evaluated contamination of surface echoes in the precipitation echo, which is of concern for wide-swath operation. In the precipitation retrieval algorithm for the spaceborne precipitation radar, surface echoes are used as reference data for rain attenuation correction, so the strength and fluctuation of this signal are also needed. The analysis results showed that the incidence angle dependency of the surface echo intensity (normalized surface scattering cross section: σ 0) under the no-rainfall condition differs over ocean and over land. The value of σ 0 over ocean is smaller than the value of σ 0 of over land at larger incident angles. It is suggested, therefore, that the clutter height is suppressed over ocean, similar to the current spaceborne radar under strong precipitation. Small values of σ 0 at a large incident angle over ocean reduce the value of S/N, resulting in a limitation to the rain attenuation correction.

5. Radar observation of cirrus clouds in outflow layer of a typhoon

Cirrus clouds extend to the upper-level outflow layers of typhoons. Recent studies have shown that radiative heating associated with cirrus clouds in the outflow layers affects typhoon intensity, structure, and track. Information on the amount and distribution of liquid and ice cloud particles are required to estimate the radiative heating rate; however, clouds are insufficiently expressed in present numerical models because of uncertainties in cloud microphysical processes, especially ice nucleation processes. To measure typhoon outflow-layer clouds quantitatively, Nagoya University collaborated with the University of Ryukyus to install a Ka-band polarimetric radar at Sesoko Island in Okinawa, and observations were conducted from April to December, 2016. On October 3, Typhoon Chaba (2016) approached to a distance of 135 km from the radar during the most developed period. We obtained radar reflectivity, polarimetric parameters, and vertical Doppler velocity data, as well as information on fine structures in outflow-layer cirrus clouds over a long period of time. These results provide observational evidence for validation of microphysical processes in numerical models, and are expected to contribute to improvement of typhoon forecasts.

6. Relationship between distributions of graupel-dominant volumes and updraft properties in convective regions using multiple X-band polarimetric Doppler radars

A polarimetric Doppler radar network enabled us to compare distributions of 3-dimensional wind field and precipitation particles in a precipitation system. A strong updraft region is expected to correspond to the vertically extending graupel-dominant volumes in a precipitation cell. To confirm this working hypothesis, we analyzed distributions of graupel-dominant volumes and updraft regions in convective precipitation systems over the Tokai District using the multiple polarimetric Doppler radars of the Ministry of Land, Infrastructure, Transport and Tourism. Three-dimensional wind fields and graupel distributions can be obtained by a dual-Doppler analysis and a particle identification method, respectively. We selected two cases for the analysis: one is a graupel-dominant case in which the graupel-dominant volume extends from the melting level at a height of 5 km to 10 km observed on September 4, 2013, and the other is a less-graupel case which the graupel-dominant volume only exists around the melting level observed on September 25, 2014. The upper percentile of the vertical velocity that corresponds to the maximum updraft near the center of the convective cells of the graupel-dominant case is clearly greater than that of the less-graupel case below the melting level. However, the horizontal distribution of the column with the upper percentile of vertical velocity around the melting level is different from that of the reflectivity both in the graupel-dominant and less-graupel cases. The difference can be attributed to that of the stage of a precipitation cell: the upper percentile of vertical velocity (reflectivity) around the melting level corresponds to its developing (mature) stage. Thus, strong updraft is expected to be observed prior to high reflectivity by the formation of graupel particles around the melting level.

7. Observation of snow clouds using a Ka-band polarization radar

To clarify the relationship between polarimetric parameters obtained by a Ka-band radar and characteristics of solid hydrometers, we installed a radar at Ishikawa Prefectural University in the winter season of 2016–2017. We also installed several optical rain-gauges to observe the shape, size, and fall speed of hydrometeors at Kanazawa University located within the observation range of the radar. We confirmed the sensitivity of polarimetric parameters for the cases of coexisting graupels and snowflakes, and snowflake-dominant periods. We will construct a particle identification method for a Ka-band polarimetric radar by combining these observational cases.

8. Monitoring of stratospheric ozone, UV, and aerosols in the region of Patagonia, South America

We have continued a joint research project with Argentina and Chile called “Development of the Atmospheric Environmental Risk Management System in South America”, as a part of the Science and Technology Research Partnership for Sustainable Development (SATREPS) program operated by the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA). In 2016, with the cooperation of the National Meteorological Service of Argentina, an UV-measurement network was established over 30 sites in Argentina and Chile, and an IT platform for real-time circulation of the observation and prediction dataset with a common data format has been promoted. In addition, the 4th campaign observations were made during the period from October to December, coordinating with the ozone sondes, Brewer spectrometer and the millimeter-wave spectral radiometer. We continue to develop an aerosol-lidar network in collaboration with the National Institute for Environmental Studies (NIES), and seven of nine lidar-systems are operational. The remainder have been built, and preliminary measurements conducted.

9. Observations of chemical composition changes of the polar mesospheric atmosphere

In the polar mesospheric region, the chemical composition varies due to the precipitation of energetic particles along the magnetic field. To understand these processes more fully, the ISEE and the NIPR have carried out continuous monitoring of nitric oxide (NO) and ozone (O_3) spectra using a ground-based millimeter-wave spectral radiometer since January, 2012. In 2016, the ISEE also installed a new millimeter-wave spectral radiometer at Tromsø, Norway, in collaboration with the University of Tromsø, and preliminary measurements of NO and O_3 were conducted. Time series analyses of the observed NO column over Syowa and the fluxes of precipitating electron energies greater than 30 keV show a positive correlation in winter, suggesting that energetic electron precipitation plays an important role in NO production in the polar mesosphere in winter. Simultaneous measurements of NO in Syowa and Tromsø starting in the 2017 season will provide a comprehensive dataset of composition changes caused by energetic particle precipitation (EPP) in different UV and meteorological environments, leading to a better understanding of the relationship between EPP and changes in the atmospheric environment.

10. Analysis of stratospheric ozone variations due to dynamics in a mid-latitude region

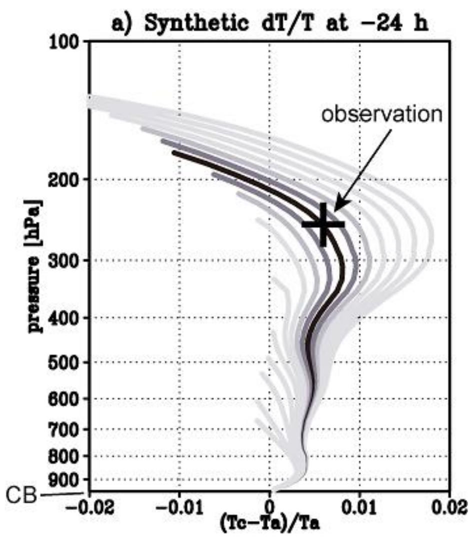
A campaign measurement in the Patagonia region as a part of the SATRPES program was conducted in 2016, and vertical profiles of the O_3 mixing ratio near the polar vortex in the stratosphere were obtained using ozone sondes launched daily from Punta Arenas, Chile. The observed vertical distribution of O_3 shows a complex of laminar structures whose width is typically a few km or below. This laminar structure is caused by displacement of the airmass due to gravity waves and horizontal transport due to Rossby wave breaking. We evaluated the influence of these processes on the O_3 distribution, and found that horizontal transport due to Rossby wave breaking is the most effective process. At Rikubetsu, millimeter-wave measurements of stratospheric O_3 distribution continue, and large variability in the O_3 mixing ratio was found in the upper stratosphere in December of 2015 and 2016; the typical change was up to about 50% of the average over a few days. Using the O_3 dataset with AURA/MLS and the meteorological dataset from MERRA-2, we found that the O_3 distribution in the upper stratosphere in winter coincides with that of the isentropic surface, which shows a large curvature toward the east-west and, as a result, the O_3 mixing ratio at the pressure level varies widely over a few days.

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

Research into new technologies at very short radio wavelengths, such as the millimeter, sub-millimeter, and terahertz bands, is important for developing scientific study in atmospheric science as well as radio astronomy. We have been developing a new receiver system on our atmospheric radiometers through collaborative research with the Advanced Technology Center (ATC) at the NAOJ since 2014. This year, we have designed a waveguide-type multiplexer in the 200 GHz band for monitoring observations of multi-line atmospheric molecules (O_3, NOx, HO_x, and ClO_x) in Antarctica with a 3D electromagnetic field simulator. This multiplexer can divide the radio frequency signal from 179 to 254 GHz into four frequency bands with low loss (insertion loss < 0.2 dB and return loss ~15 dB). In addition, a wide dynamic range superconducting device, which is the most important component for detectors in this frequency band, was also designed, and test devices were successfully fabricated in the cleanroom at ATC.

12. Convective and large-scale mass flux profiles determined from satellite observations

The vertical mass flux of the atmosphere is a key variable in meteorology but is difficult to measure. A new, satellite-based methodology has been developed to evaluate the convective mass flux and large-scale total mass flux. To derive the convective mass flux, candidate profiles of in-cloud vertical velocity are first constructed with a simple plume model under the constraint of ambient sounding and then narrowed down to the solution that matches satellite-derived cloud top buoyancy (right figure). Meanwhile, the large-scale total mass flux is provided separately from satellite soundings using a method developed previously. All satellite snapshots are sorted into a composite time series that delineates the evolution of a vigorous and organized convective system. The method developed in this study is expected to be of unique utility for future observational diagnosis of tropical convective dynamics and for evaluation of global climate model cumulus parameterizations on a global scale.



Plume model profiles. Darker curves represent more probable solutions than light-gray curves.

9-1. Research Divisions
Division for Land–Ocean Ecosystem Research

Research topics and keywords

- 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

Introduction to Division for Land–Ocean Ecosystem Research

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

On land, synthetic research is performed using *in-situ* observations, sophisticated coupled land–atmosphere models, atmospheric reanalysis data, and remote sensing, to understand the relationships between climate change and water/material cycles over land from the tropics to the north polar region. We observe precipitation, evapotranspiration, soil moisture, carbon dioxide, and the methane budget at multiple observation sites. We intensively investigate how anthropogenic forcing such as land-use and land-cover change, surface conditions such as sea-ice change and sea surface temperature, and the responses of vegetation, interact with local and global climate systems through the atmospheric water cycle.

Ocean research is performed using satellite remote sensing, numerical simulations, and *in-situ* observations. We perform synthetic studies of physical and biogeochemical processes in the ocean and their interactions with the atmosphere and climate. In particular, we investigate 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 also investigate how variations in ocean circulation, mixing processes, and air–sea fluxes influence marine ecosystems where phytoplankton is a primary producer. Moreover, we are interested in the possible impact of the marine ecosystem on physical processes and climate in the ocean and atmosphere.

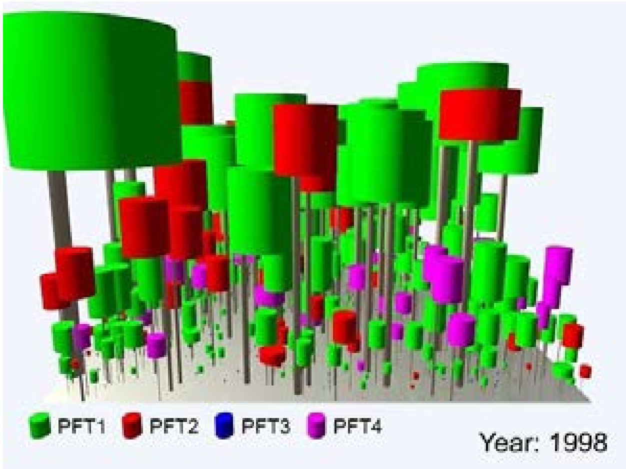
Main Achievements in FY2016

1. Assessments of greenhouse gas emissions from the Arctic terrestrial environment

Greenhouse gases, such a carbon dioxide and methane emitted from a poorly-drained black spruce forest over permafrost in Interior Alaska were measured. We used the micrometeorological measurements and eddy covariance measurement systems in an experimental forest at the University of Alaska, Fairbanks. From field measurements over 6-years it was observed that the thaw depth and the thickness of the anaerobic layer (groundwater level from the frozen soil) contributed significantly to methane emissions from the soil surface. In particular, flooding conditions led to a dramatic increase in the emission rate. We also measured methane concentrations in soil pores and soil waters, and showed that dissolved methane exists in soil waters. Soils were saturated in wet areas, however the dissolved methane concentration in soil waters near the surface layer was low, suggesting that the presence of deep soil is important for the production of methane.

2. Development of a Terrestrial Ecosystem Dynamics model and its application to a Bornean tropical rainforest

The threat from climate change to tropical rainforests is a topic of major interest. The main threat arises from drought. In the case of the Amazonian rainforest, the dry season has significantly lengthened since 1979, and the frequency of drought is projected to increase. In contrast, Bornean tropical rain forests are among the moistest biomes in the world, with abundant rainfall throughout the year, and considered to be vulnerable to a change in the rainfall regime; in this regard, high tree mortality was reported in such forests induced by a severe drought associated with the ENSO event in 1997–1998. The most significant parameter affecting mortality was tree size, with taller trees experiencing more mortality in periods of drought. To assess the risk of size-dependent mortality for trees in a Bornean tropical rainforest, we developed a new model named S-TEDy (SEIB-DGVM-originated Terrestrial Ecosystem Dynamics model), which mechanistically describes the "way of life" of each tree individually and simulates plot-scale dynamics of a forest. By using this S-TEDy model, individual tree transpiration and above-ground biomass were successfully reproduced for a Bornean tropical rainforest, including correct prediction of the high mortality of taller trees induced by the drought associated with the ENSO event.

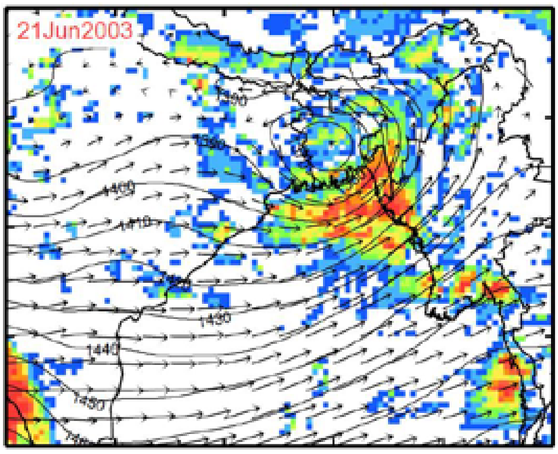


Example of the effect of drought on Bornean tropical rainforest simulated by S-TEDy.

3. Effects of two major intraseasonal modes on the genesis of low-pressure systems around Bangladesh

The effects of the quasi-biweekly oscillation (QBW) and the boreal summer intraseasonal oscillation (BSISO) on the genesis of low pressure systems (LPSs) such as vortex-type lows were investigated for the active phase, both with LPSs (LPS case) and without LPSs (non-LPS case) based on rainfall in the QBW over Bangladesh. In the QBW mode, westward propagation of an anticyclonic anomaly from the western Pacific to the Bay of Bengal (BoB) is common in both cases. In contrast, the BSISO mode shows an opposite phase between the two cases: a cyclonic (anticyclonic) anomaly propagating northward from the equator to the BoB in the LPS case (non-LPS case). In the LPS case, the cyclonic anomaly in the BSISO mode enhances the westerly (easterly) flow over the BoB (Bangladesh) in the active phase, resulting in the enhancement of cyclonic vorticity over the northern BoB and Bangladesh, in cooperation with the QBW mode. Thus, both the QBW and BSISO modes have a significant influence on the environmental conditions for LPS genesis.

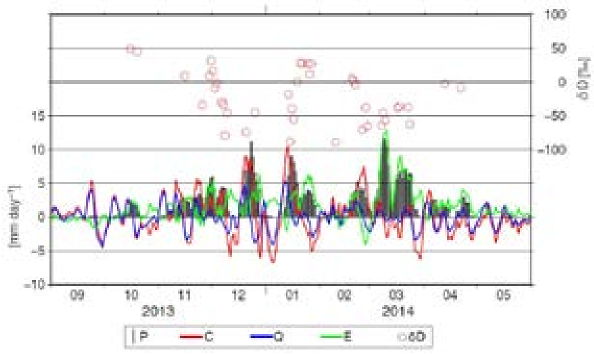
Reference: Hatsuzuka, D. and H. Fujinami (2017): Effects of the South Asian monsoon intraseasonal modes on genesis of low pressure systems over Bangladesh, *Journal of Climate*, **30**, 2481–2499, doi: 10.1175/JCLI-D-16-0360.1.



A vortex-type low (i.e., LPS case) associated with intraseasonal oscillations.

4. Analyzing the origin of rain- and subsurface water in seasonal wetlands of north-central Namibia

We investigated the origins of rain- and subsurface waters of north-central Namibia's seasonal wetlands, which are critical to the region's water and food security. The region includes the southern part of the Cuvelai system seasonal wetlands (CSSWs) of the Cuvelai Basin, a transboundary river basin covering southern Angola and northern Namibia. We analyzed stable water isotopes (SWIs) of hydrogen (HDO) and oxygen ($H_2{}^{18}O$) in rainwater, surface water and shallow groundwater. The isotopic ratios of HDO (δD) and $H_2{}^{18}O$ ($\delta^{18}O$) were analyzed in each rainwater sample and then used to derive the annual mean values of δD and $\delta^{18}O$ in precipitation weighted by each rainfall volume. Using delta diagrams (plotting δD vs. $\delta^{18}O$), we showed that the annual mean value was a good indicator of the origins of subsurface waters in the CSSWs. We also conducted atmospheric water budget analysis using TRMM multi-satellite precipitation analysis (TMPA) data and ERA-Interim atmospheric reanalysis data, to confirm the origins of rainwater and to explain the variations in isotopic ratios. The results showed that around three-fourths of the rainwater was derived from recycled water at local–regional scales. Satellite-observed outgoing longwave radiation (OLR) and complementary satellite data implied that the isotopic ratios in rainwater were affected by evaporation of raindrops falling from convective clouds. Consequently, integrated SWI analysis of rain-, surface and subsurface waters, together with the atmospheric water budget analysis, revealed that the shallow groundwaters of small wetlands in this region were very likely to be recharged from surface waters originating from local rainfall. This was also supported by tritium (^3H) counting of the current rain- and subsurface waters in the region.



Time series of atmospheric water budget components from September 1, 2013 to May 31, 2014 in the target region (17–18° S, 15–16° E). P is precipitation [mm d^{-1}], C is atmospheric moisture flux convergence [mm d^{-1}], Q is temporal change in precipitable water [mm d^{-1}], and E is evapotranspiration [mm d^{-1}].

Reference: Hiyama et al. (2017): Analysing the origin of rain- and subsurface water in seasonal wetlands of north-central Namibia. *Environmental Research Letters*, **12**, 034012, doi:10.1088/1748-9326/aa5bc8

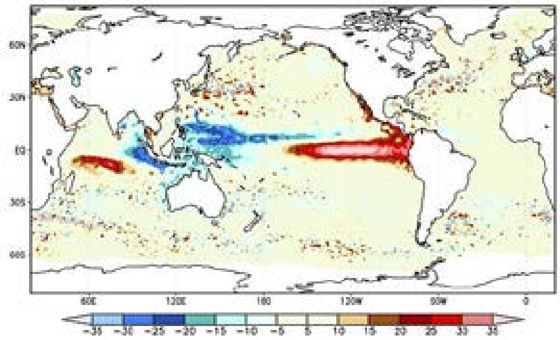
5. Estimation of ocean primary production by fast repetition rate fluorometer

Primary production by oceanic phytoplankton is important for understanding fish production and the global material cycle, such as carbon. Measurement of primary production has been conducted using the incubation method with carbon isotopes. This is time consuming, and it is difficult to obtain frequent data from a large area. Recently, modelling with satellite remote sensing data has been used to estimate primary production; however, it is necessary to obtain data to provide parameters for, and verify, the model. A Fast Repetition Rate fluorometer (FRRf) can be used to estimate the instantaneous electron transport rate (ETR) of photosystem II. If the electron requirement for carbon fixation (Kc) is known, it is possible to estimate primary production from the ETR. The short term Kc has been assumed to be constant in many studies, and no value of Kc for daily net primary production has yet been reported. In this study, ETR was observed every two hours during the day in Ariake Bay, and the daily ETR was calculated by integration. The net daily primary production was also measured using the incubation method, and the daily Kc estimated. Various environmental factors were compared, and it was found that the daily Kc was correlated with the daily photosynthetically active radiation (PAR). Similar observation and analysis was conducted in the East China Sea, and good correlation between daily Kc and PAR was verified, although the slope of the correlation was different for samples with different phytoplankton size compositions. For samples with a high abundance of large (>20 um) phytoplankton, the slope was steep, and the daily Kc was higher under similar PAR. This indicates that it is possible to convert FRRf ETR to primary production if a similar relationship can be estimated. However, the slope in Ariake

Bay, expected to be dominated by large phytoplankton, was shallower than that in the East China Sea, and this indicates that other factors, such as nutrients, may also play important roles in each area.

6. Tropical-extratropical interactions in the atmosphere and the ocean

For mid-latitude Rossby waves in the atmosphere, the expression for the energy flux for use in a model diagnosis, without relying on Fourier analysis or ray theory, has previously been derived using quasi-geostrophic equations and is singular at the equator. We have derived an exact universal expression for the energy flux that is able to indicate the direction of the group velocity of both equatorial and mid-latitude waves. This is achieved by introducing a streamfunction, as given by the inversion equation of Ertel's potential vorticity, a novel aspect for considering the energy flux. The connection of the equatorial and coastal waveguides has been successfully illustrated by the energy flux of the present study. This will allow for tropical-extratropical interactions in oceanic and atmospheric model outputs to be diagnosed in terms of an energy cycle in future work.

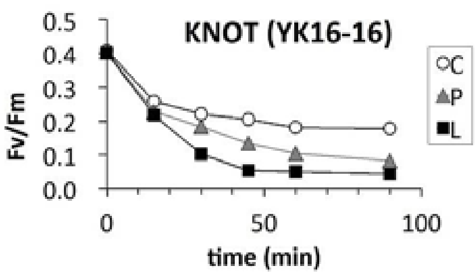


Satellite altimetry sea surface height data showing El Niño.

Reference: Aiki et al. (2017): Towards a seamlessly diagnosable expression for both equatorial and mid-latitude waves. *Progress in Earth and Planetary Science*, **4**, 034012, doi 10.1186/s40645-017-0121-1

7. Phytoplankton strategy for coping with high light stress in the NW subarctic Pacific

Global warming leads to a shoaling of the oceanic surface mixed layer. This shoaling increases the light availability for phytoplankton; however, it also increases the potential risk of photo-damage to their PSII. Therefore, the response of phytoplankton to high light stress should be considered for the prediction of future changes in ocean productivity. Previous studies have shown that phytoplankton assemblages have lower susceptibility to PSII photoinactivation in the subarctic Pacific than those in the subtropic, implying more effective dissipation of excess excitation in the former. Recently, it has been suggested that parts of PSII-generated electrons are rerouted to oxygen as an alternative sink via a plastoquinol terminal oxidase (PTOX) pathway in oceanic phytoplankton. Here, for natural assemblages in the NW subarctic Pacific, we conducted high light challenge experiments in which short-term changes in the maximum quantum yield of PSII (Fv/Fm) were tracked using FRR fluorometry. The derived susceptibility to PSII photoinactivation was compared between the control and the sample treated with a PTOX inhibitor (Pgal), to address the function of PTOX in the cells under high light. All experiments showed lower Fv/Fm in Pgal-treated samples, i.e., more susceptibility to PSII phtoinactivation, than the control (figure). This suggests that the PTOX mediated electron flow alleviates excessive PSII excitation pressure, corresponding to a 20–35 % reduction in potential inactivation. In particular, for phytoplankton in the NW subarctic Pacific, under a relatively low iron availability, it would be possible to bypass the electron flow bottle-neck of PSI by up-regulation of PTOX as a photo-protection mechanism.



Fv/Fm during light challenge experiment for control (C), lincomycin (L), and Pgal (P, blocking PTOX pathway) treatments of phytoplankton collected in station KNOT in the NW subarctic Pacific.

9-1. Research Divisions
Division for Chronological Research

Research topics and keywords

- Accelerator mass spectrometry (AMS)
- Radiocarbon (^{14}C) dating
- Developing radiocarbon (^{14}C) pre-treatment and measurement techniques
- Analysis of cosmogenic nuclides
- Chemical U-Th total Pb isochron method (CHIME)
- Microanalysis and spectroscopy
- Geochronology
- Isotope analysis

Introduction to Division for Heliospheric Research

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, “dating”, is of great importance for predicting future states on Earth. Therefore, we conducted chronological studies on a broad range of subjects from events in the Earth’s history spanning approximately 4.6 billion years, including archeological materials, cultural properties, and modern cultural assets. The Tandetron dating group conducts interdisciplinary research that involves radiocarbon (^{14}C) dating using accelerator mass spectrometry (AMS) to understand changes in the Earth’s environment and the cultural history of humankind from approximately 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 micro-scale spatial dating group uses the chemical U-Th total Pb isochron method (CHIME), which was first developed at Nagoya University, to shed light on events in Earth’s history from the formation of Earth 4.6 billion years ago up to approximately 1 million years ago. With an electron probe microanalyzer (EPMA), non-destructive microanalyses of rocks and other samples are conducted to investigate records of complex events recorded in zircon, monazite, and other materials.

Main Achievements in FY2016

1. Understanding the climate and tectonic history in the Levant area

The area surrounding the Dead Sea (Levant) was the locus of humankind’s migration out of Africa and, thus, has been a home to people since the Stone Age. Understanding the climatic and tectonic history in the region provides valuable archeological insights and furthers studies of human history, helping us to gain a better picture of future climatic and tectonic scenarios. An International Continental Scientific Drilling program (ICDP) of deep drilling was performed in the deepest site in the Dead Sea in 2010/2011. The 455 m-long sediment core provided high-resolution records of the paleoclimate, paleoenvironment and paleoseismicity of the Dead Sea Basin. The upper 150 m-long section of the sediment core was dated using the AMS ^{14}C method. The historic climatic and tectonic events over the past 50 ka were examined, together with archeological evidence relating to human history.

Drilling of sediment core in the Dead Sea.

2. PaleoAsia

It is postulated that Homo sapiens (modern humans) emerged from the African continent approximately 200,000 years ago, and after the time expanded before 10,000–50,000 years with adaptation to diverse environments in the Eurasian continent, and then replaced more primitive species. A new project - "Cultural History of PaleoAsia - Integrative research on the formative processes of modern human cultures in Asia" was promoted. We conducted a systematic field survey at lake and archaeological sites in Asia (Vietnam, Mongolia, Oman, Iran and Jordan) to evaluate the residential environment and lifestyles of modern humans of PaleoAsia.

Drilling in Vietnam.

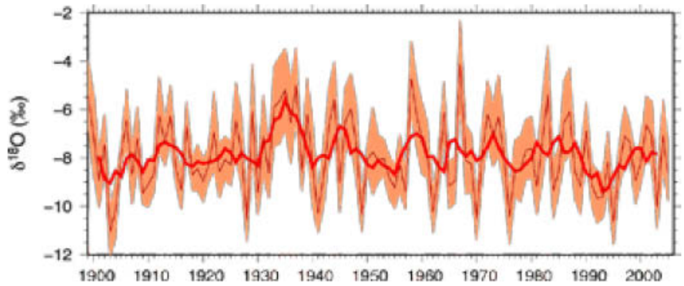
3. Paleoclimatic and paleoenvironmental studies on long-lived bivalve shells

Bivalves form a useful archive for paleoclimatology. A cold-water bivalve, Stimpson's hard clam (*Mercenaria stimpsoni*) in the Funakoshi Bay (Iwate, Japan) can live for more than 100 years and is, hence, very useful for obtaining paleoclimate records. One of the most important records is the "Bomb-^{14}C peak". The Bomb-^{14}C peak in the high-latitude North Pacific will contribute to a deeper understanding of marine carbon cycles and to large improvements in determining the chronology of dead specimens.

Live-specimen of *M. stimpsoni* collected from Funakoshi Bay.

4. Reconstruction of Baiu frontal activity using oxygen isotopic data in annual rings

The rainfall from the quasi-stationary front (Baiu front) has a lower $\delta^{18}O$ than that from other non-frontal precipitation. The $\delta^{18}O$ variability in summer rainfall is closely related to the Baiu frontal activity. We examined a mechanistic tree-ring isotope model to reconstruct a 106-year-long $\delta^{18}O$ of precipitation during the early rainy season based on the $\delta^{18}O$ in annual rings in Japanese cypress trees from central Japan. Our results show that the year-to-year $\delta^{18}O$ variations are associated with several teleconnection patterns that often lead to the Baiu precipitation anomalies in central Japan. This finding suggests that the influence of teleconnection patterns on Baiu precipitation variability has varied over inter-decadal time scales during the 20th century.



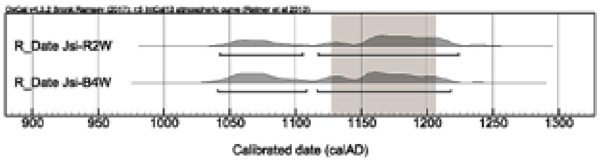
Time-series of $\delta^{18}O$ in precipitation reconstructed from tree-ring cellulose records from 1898 to 2005. The shaded envelope represents statistically significant at the 95% level. The thin line is the annual average value of $\delta^{18}O$ in precipitation. The solid thick line represents the 5-year running mean.

5. *In-situ* ^{10}Be measurements in exposed rocks from the shore of Lake Puma Yumco in Tibet

We conducted measurements of *in-situ* cosmogenic ^{10}Be values by Accelerator Mass Spectrometry for exposed rock samples from the shore of Lake Puma Yumco in Tibet to estimate erosion rates in the southern region of the Tibetan plateau. The ^{10}Be concentrations ranged from $5.0–6.8\times10^6$ atom/g, similar to those of the surface sediments of Lake Puma Yumco. The calculated erosion rates were 9.6−13.6 mm/kyr. This result shows the slow erosion rates in southern Tibet compared to those of northern Tibet.

Collecting the sample at the Tibetan plateau.

6. Radiocarbon dating and diet analysis of carbonate hydroxyapatite in cremated bones



Calibrated ages of the cremated bones of Jokei. The grey coloured belt shows the period of Jokei's life span (AD1155–1213).

Radiocarbon dating and dietary analysis were performed on cremated bone using the carbonate hydroxyapatite (CHa) fraction. The samples used were the remains of Jokei, a Buddhist monk (AD 1155–1213), collected in an urn at the Jisho-in Temple located in Nara Prefecture, Japan. The CHa in the white cremated bone that had been subjected to high temperatures showed ^{14}C dates similar to the period of Jokei's life span. The dietary reconstruction on Jokei's cremated bones using Sr/Ca and δ88Sr indicated his vegetarianism. The results indicate that CHa in cremated bones is effective for accurate ^{14}C dating and dietary analysis.

7. Radiocarbon dating of *kana-kohitsugire* calligraphies copied in the Insei period

Kana is said to have been created in the middle 11th century. In the elegant calligraphy of the Heian period, there is a case in which details of the inscription age are not clear. Such cases tend to involve calligraphy written in the Insei period; therefore, we performed radiocarbon dating for two calligraphies of the Insei period. The calibrated radiocarbon age of *Misyo-tirashi-uta-gire* was about AD1000; indicating that this is a rare example precedent to the Insei period. The calibrated radiocarbon age of *Minbu-gire* indicated that it originated from the middle 17th century; it is a copy or counterfeit.

Daihannyakyo of Karoku period.

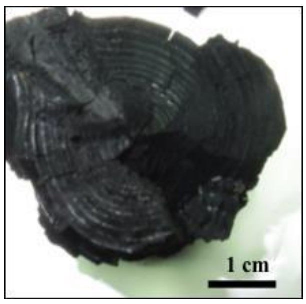
8. Possibility of radiocarbon dating of bronze implements

Verdigris, $CuCO_3 \cdot Cu(OH)_2$, is rust produced on bronze implements. The reactants are Cu in bronze and CO_2 from the atmosphere. Once verdigris is formed, it creates a close film and restricts generation of any new rust. Therefore, verdigris should preserve carbon from the atmosphere in which it was formed. The purpose of this study was to prove the possibility of radiocarbon dating of bronze. First, we clarified that $CuCO_3 \cdot Cu(OH)_2$ releases CO_2 by heating at 250°C for 1 hour. Then, we applied the method to archaeological samples of known age and measured the radiocarbon ages. The result shows that verdigris preserves carbon from atmosphere when it was formed and that verdigris is a suitable sample for radiocarbon dating.

Verdigris collected from a bronze implement.

9. Investigation into a pre-treatment method for charcoal for accurate ^{14}C dating

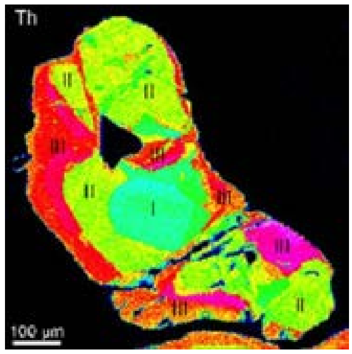
Reliable ^{14}C dating requires appropriate chemical treatment to remove post-deposition contamination from samples. We assessed two pre-treatments: acid–base–acid (ABA) treatment and acid–base–oxidation with stepped combustion (ABOx-SC) for reliable ^{14}C dating of charcoal samples. The ABA-treated samples yielded younger ^{14}C dates than the ABOx-treated ones, probably owing to the effects of remaining organic contaminants. Meanwhile, the ABA-SC treatment was able to reduce contaminants as effectively as the ABOx-SC treatment; this implies that stepped combustion (SC) can reduce the contaminant residue left after ABA and ABOx treatments.



Charred wood sample with ^{14}C age of about 44,000 BP.

10. Mogok metamorphic belt in Myanmar

The high temperature (T)/pressure (P) regional Mogok metamorphic belt in central Myanmar is an eastern continuation of the Himalayan orogen, and its geological and petrological data are important for understanding collision tectonics between the Eurasian Continent and the Indian subcontinent. The P-T conditions of peak metamorphism were estimated at 0.6–1.0 GPa/780–850°C, suggesting that that high-grade metamorphic rocks, from upper amphibolite to granulite facies, occur extensively in the Mogok metamorphic belt. These metamorphic rocks have been subsequently re-equilibrated under the conditions of 0.3–0.5 GPa/600–680°C during exhumation and hydration. The CHIME monazite age data indicated prograde and retrograde metamorphism of Late Eocene and Late Oligocene epochs.



Thorium X-ray map of a monazite grain.

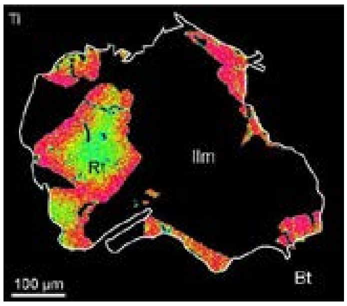
11. Mechanism of Ti substitution into biotite

Ti-rich biotite grains (up to 6.9 wt% TiO_2) from the Mogok metamorphic rocks in Myanmar were analyzed to examine the mechanisms of Ti-bearing substitutions. Ti contents of biotite are strongly related to the coexisting phases. The high Ti content of biotite in sillimanite-free samples is probably a result of $Ti\square R_{-2}$ substitution, where R is the sum of divalent cations and □ represents a vacancy in the octahedral sites. The biotite grains in the sillimanite-bearing sample showed a combination of $Ti\square R_{-2}$ and $TiRAl_{-2}$ substitutions.


Polarizing photomicrograph of a paragneiss containing Ti-rich biotite.

12. Mechanisms of Nb and Zr substitution into rutile

Rutile grains extensively occur as a main Ti-rich phase in high- temperature paragneisses of the Mogok metamorphic belt of Myanmar. Most rutile grains contain up to 3.7 wt% Nb_2O_5, which shows positive correlations with Fe and trivalent elements. Niobium substitutes for Ti by a coupled substitution with the trivalent cations (M^{3+}) of $Nb^{5+}M^{3+}Ti^{4+}_{-2}$. Fine rutile grains in ilmenite are distinctly poor in Nb (< 0.1 wt% as Nb_2O_5) and contain Fe concentrations of 1.7–3.2 wt% as Fe_2O_3, suggesting a vacancy-bearing substitution of $Fe^{3+}_{4}Ti^{4+}_{-3}\square_{-1}$, where □ indicates a vacancy. The equilibrium temperatures were estimated to be over 850°C using a Ti-in-rutile geothermometer.



Titanium X-ray map of a rutile-ilmenite composite grain.

13. Regeneration of the calibration curves for chemical analysis of rocks with XRF

The X-ray fluorescence spectrometer (XRF-1800, Shimadzu) was moved to Research Institute Building II from Furukawa Hall in 2016. Several parameters were recalibrated after movement. The calibration curves for rock samples were regenerated using 28 standard materials. The newly generated calibration curves cover wider ranges in chemical compositions and are applicable to chert and limestone in addition to major igneous and sedimentary rocks.


X-ray fluorescence spectrometer.

9-2. Research Centers

Center for International Collaborative Research (CICR)

Research topics and keywords

- 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

Introduction to CICR

The Center for International Collaborative Research (CICR) was established in October 2015 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 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. The CICR has taken over from the Geospace Research Center of the former Solar-Terrestrial Environment Laboratory, Nagoya University.

Cycle 24 of the 11-year solar cycle had the smallest maximum of the past 100 years, and world scientists in have a strong interest in this anomaly and its consequences for Earth's environment. Thus, SCOSTEP under the International Council for Science (ICSU) 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 part of the CICR, and is responsible for taking a lead in this program. The CICR publishes a VarSITI Newsletter every three months, operates a VarSITI mailing list that currently contains more than 800 VarSITI members from more than 60 countries, and coordinates international symposiums related to VarSITI. The 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, the CICR also takes part in/operates ground-based observation projects, i.e., the EISCAT radar project, OMTIs, the ISEE magnetometer network, the SuperDARN radar network including the Hokkaido HF radars, the ISEE VLF/ELF network, and the ArCS operation office.

The CICR is operating the new international collaborative research programs from fiscal year 2016. The CICR also holds four domestic observatories at Moshiri, Rikubetsu, Fuji, and Kagoshima, which make observations of the solar wind, the geomagnetic field, and the upper atmosphere. Some of these observations have been conducted for more than 30 years.

Participants in the first ISEE/CICR workshop "Ionospheric Plasma Bubble Seeding and Development".

Main Achievements in FY2016

VarSITI Newsletter vol. 11 (Nov. 2016).

In the FY2016, the CICR conducted the following international collaborative research programs: 01) Joint Research Program (International, 23 projects), 02) ISEE International Joint Research Program to invite six foreign researchers, and 03) three ISEE/CICR International Workshops, as well as inviting eight foreign designated professors and associate professors. The ISEE/CICR International Workshop is aimed at creating comprehensive discussions on a focused topic with 10–15 attendees over one week, and at summarizing the results into international journal papers and/or books.

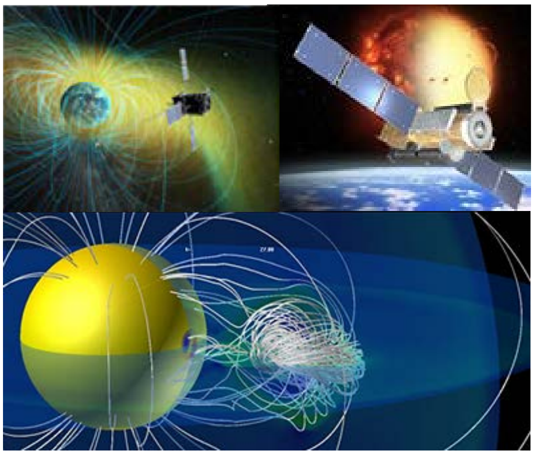
For the SCOSTEP/VarSITI program, we published four VarSITI newsletters in FY2016, in April, July, November and February. We also organized the 1st VarSITI General Symposium in Albena, Bulgaria, on June 6–10, 2016; additionally, we continue to operate the VarSITI mailing list and support the review of 16 international symposiums and four database constructions related to VarSITI.

Under the ICCON Project, 30 scientists from the US, UK, China, Korea, Russia, Germany, and Japan joined the operation of the NoRH. The data are openly available at the NAOJ and the Center for Integrated Data Science (CIDAS)/ISEE. The EISCAT Radar Project joined the operation of the EISCAT radar and the planning of the new EISCAT-3D radar. The new PWING Project was approved by JSPS in FY2016 in relation to the OMTIs, ISEE magnetometer and ELF/VLF network Projects, and eight ground stations at subauroral latitudes around the north magnetic pole were newly deployed. SATREPS/JST-JICA finished deploying seven lidars in South America to monitor volcanic ash in the atmosphere.

The four domestic observatories continued to operate in FY2016. The visible spectrometer and Fourier transform infrared spectrometer (FTIR) at Moshiri Observatory were moved to Nagoya; however, other electromagnetic instruments were kept running. 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. A new ELF atmospherics receiver (induction coil) was also installed. Multi-station IPS observations using Fuji, Kiso, and Toyokawa antennas were constructed at Fuji and other solar wind observatories on a daily basis during the period between March 31 and December 9, 2016 (IPS observations at Toyokawa were made throughout 2016). Various observations that utilize the regional characteristics at these observatories were also performed in collaboration with domestic researchers. Kagoshima Observatory and Sata Station also operate instruments for electromagnetic waves and an all-sky camera and a photometer for airglow.


UHF radio-telescope dedicated for IPS observations at Fuji Observatory.

9-2. Research Centers
Center for Integrated Data Science (CIDAS)



Research topics and keywords

- 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

Introduction to CIDAS

The aim of the Center for Integrated Data Science (CIDAS) was to construct infrastructure and conduct research and development to realize cutting-edge scientific study of the space–Earth environmental system through integrated analyses using various kinds of observational data and advanced computer simulations. CIDAS operates many projects in cooperation with the research divisions and the centers of the 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 the NAOJ and developed the database and analytical environment for the data provided by the Japanese solar observation satellite Hinode. 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 from ERG (Arase) and develops the data analysis software.

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, the NIPR, Kyoto University, Kyushu University, and Nagoya University to develop a metadata server and data analysis software. CIDAS is in charge of activities in the 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.

Main Achievements in FY2016

1. Development of ERG (Arase) data analysis tools

The data files of the ERG (Arase) satellite have been distributed from the ERG Science Center operated by both the ISEE and ISAS/JAXA. The ERG Science Center develops CDF files for ERG (Arase) science data as well as several plug-in tools for IDL/SPEDAS, a common data analysis platform in the solar–terrestrial physics community. CIDAS has also launched the CIDAS system, a computer resource for using IDL/SPEDAS, and researchers can use IDL/SPEDAS via an internet connection to the CIDAS system.

2. Development of a solar active region non-linear force-field model

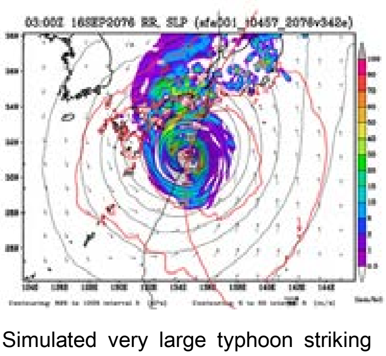
Solar flares and coronal mass ejections are explosive phenomena in which magnetic free energy stored in the magnetic field in the solar corona above active regions is transiently released. Because of the difficulty of direct observation of the coronal magnetic field, this needs to be extrapolated on the basis of observations of the magnetic field on the photosphere using a magnetic field model. A non-linear force-free field (NLFFF) model can extrapolate the three-dimensional magnetic field from the photospheric magnetic field data. We have developed software to calculate the NLFFF on the CIDAS supercomputer system, in which the IDL and SolarSoft library are available. The programs were used in the coordinated data analysis workshop on solar flares held at the ISEE in November 2016.

3. Development of the IUGONET database (http://search.iugonet.org/)

We have developed the STP database based on a new practical structure, rather than a conventional catalog type database. The new concept provides one-stop access for finding, understanding and examining data using only a web browser. We also develop and maintain analysis software to support high-level research. In addition, we organize many data analysis workshops in collaboration with VarSITI, WDS, and related research communities. Development and delivery of workshops for capacity building in developing countries is also a key role of IUGONET.

4. Development of a Cloud Resolving Storm Simulator and downscaling experiments on typhoons

Typhoons are the main source of weather disasters in East Asia including Japan, and recent studies have shown significant increases in typhoon intensity. This raises great concerns regarding any future changes in typhoon activity with climate change. We have developed a cloud-resolving model named CReSS, and improvements have been implemented. CReSS was used to perform high-resolution downscaling experiments of northward-moving typhoons in the near future climate and in the warmer climate of the late 21st Century (see Figure). The results showed intensities, tracks and structures of typhoons under each climate. The data will form part of the open access dataset at CIDAS. The Earth Simulator was used in this study as a “Strategic Project with Special Support”, with Japan Agency for Marine-Earth Science and Technology (JAMSTEC).

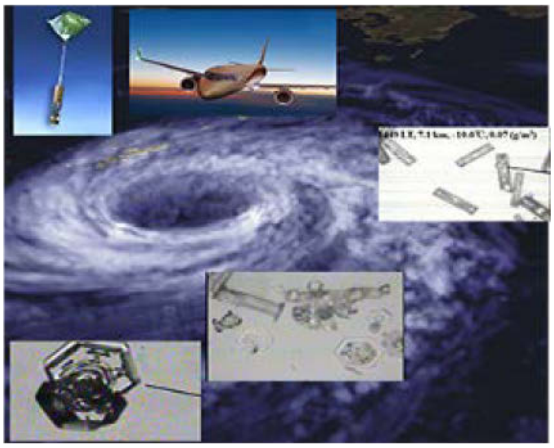


Simulated very large typhoon striking Japan like the typhoon Vera (1959) in the late 21st century.

5. Construction and operation of the CIDAS super computer system

A new supercomputer system for integrated data analysis (the CIDAS supercomputer system) was installed in April 2016. The system consists of 20 compute nodes, and each compute node has two Intel Xeon E5-2660 v3 CPUs and 256 GB memory. In the FY2016, a total of 80 researchers/students were registered as users of the CIDAS supercomputer system, and data analyses related to the Hinode Science Center and the ERG Science Center were conducted.

9-2. Research Centers
Center for Orbital and Suborbital Observations (COSO)



Research topics and keywords

- Establishment of a central base for aircraft observations
- Implementation of aircraft observations
- Development of CO_2 measurements with balloons
- Promotion of the ERG (Arase) mission
- Observation of polar ionosphere/magnetosphere by formation flight satellites
- Development of ChubuSat and promotion of its applications
- Climate systems research at a virtual laboratory (VL) under the collaboration of four universities

Introduction to COSO

The mission of COSO is to perform empirical and advanced research using observations by aircraft, balloons, sounding rockets, and spacecraft, and to lead technological developments through collaborations between industry, academia, and government. COSO plays a key role in aircraft observations in Japan, promoting aircraft Earth observation systems and future space exploration missions. We aim to advance observation capabilities for future orbital and suborbital observations. The Hydrospheric Atmospheric Research Laboratory in COSO contributes aircraft/balloon observations and satellite observations via two X- and Ka-band radars, together with observational and numerical model studies related to the VL.

Main Achievements in FY2016

1. Aircraft observations

COSO commenced research to improve typhoon intensity prediction by assimilating aircraft observations of the atmospheric field around a typhoon with a cloud resolving numerical model. The drop sonde receiver for this observation was installed on an aircraft, and aircraft observation will be carried out for four years, from 2017. Aircraft observation of hygroscopic particles over the UAE is scheduled for the summer of 2017 as part of the "Advanced Research on Precipitation Reinforcement in Dry/Semi-arid Regions". Ground observations started in January 2017. To establish central bases for aircraft observations, we proposed the "Promotion of Climate and Earth System Science Research by aircraft observation" in collaboration with the Japan Meteorological Society in the Master Plan 2017 of the Science Council of Japan.

2. Atmospheric and aerosol observations by small aircraft (drone, balloon)

We are attempting to measure particle size distributions using an optical particle counter (OPC) loaded on a large-sized drone (multicopter). To investigate the effect of sea salt particles on cloud formation, we performed flight observations at Nagoya Port and at Tarama Island in Okinawa. Figure shows a photograph of the drone flight experiments with the OPC instrument hanging from the drone. To avoid air turbulence from the drone propellers, the OPC was suspended 10 m below the drone fuselage. Analysis of the particle size distributions obtained in the flight experiments indicated that the relative concentrations of coarse-size particles decreased with increasing altitude.

Flight experiment with a drone and an OPC.

3. Development of a space plasma particle analyzer at geospace exploration satellite planning; ERG (Arase)

COSO contributes to the development of the space plasma particle analyzer installed on ERG (Arase) satellite by constructing the ion/electron beam line. The calibration experiments and tests of three analyzers were carried out in the clean room facility.

4. Promotion of the Earth electromagnetic thermosphere exploration plan by polar orbital formation flight satellites

We plan to conduct state-of-the-art measurements with high temporal and spatial resolution, and conduct integrated observations of auroral emissions, Earth's atmospheric particles, space plasma particles/waves, and electromagnetic fields using multiple exploration satellites. We have implemented mission-planning studies, such as significance/purpose, observation method and instrumental configuration as well as the feasibility of a cluster launch of multiple satellites by the Epsilon rocket.

5. Study and development of a compact satellite standard bus for application to the space science exploration mission

We have commenced study of the standard bus of a 100 kg class compact satellite that can be applied to future space science exploration. We conducted a feasibility study of the satellite by assuming observational instruments in terms of power, weight and thermal design.

6. Solar and Earth observation mission by micro-satellites

We are developing the ChubuSat-Z (50-kg class micro-satellite), which observes ozone using an infrared camera with multiple-band filters. The infrared band enables ozone observations during the night, which is essential for ozone observations of the polar region throughout winter. We have proposed a piggy-back opportunity, launching with GOSAT-2 in 2018. We are also developing a gamma-ray and neutron instrument that is suitable for nano-satellites, and will have more launch opportunities. The new instrument will be smaller and less power-consuming than the one onboard ChubuSat-2, launched in FY2015. This facilitates the use of more electronic channels with less power by employing new integrated circuits with 1/20th of the power per channel. With more electronic channels, we can expect a twofold increase in the spatial and energy resolutions. We completed the basic design of the instrument in FY2016 and have started to procure components for a prototype.

7. Promotion of Earth observation satellite observation

The future precipitation observation mission was studied in cooperation with JAXA. The third-generation dataset of thermal, momentum and freshwater flux between the atmosphere and the ocean in the global region, J-OFURO 3, was developed and released. We conducted research on Earth observation technology using GNSS ocean-reflected waves with small satellites, such as NASA's Cyclone Global Navigation Satellite System (CYGNSS).

9-3. Interdisciplinary Researches
Project for Solar–Terrestrial Climate Research

Introduction to Project for Solar–Terrestrial Climate Research

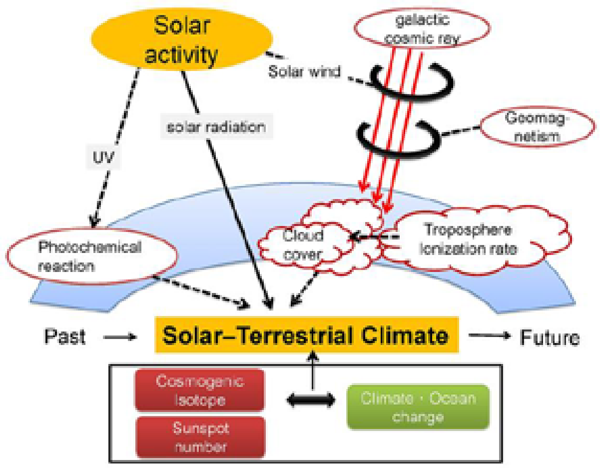
Do variations in solar activity influence our weather and climate? Researchers specializing in such fields as astronomy, solar physics, meteorology, climatology, paleoclimatology, and oceanography have grappled with this question for the past two hundred years or more. Two thousand years ago, astronomers of the Chinese imperial court chronicled sunspot activity for the purpose of studying variations in solar activity. In 1801 the British astronomer William Herschel discovered a significant correlation between the frequency of sunspot appearance and the market value of wheat in London and reported his findings in a paper published by the Royal Society. In the paper, he concluded that a reduction in the number of sunspots effected a change in climate that altered wheat yields and influenced the price of wheat as a result. This study is considered as the first attempt to examine correlations between 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.

Solar activity varies over an 11-year cycle and is also known to exhibit variability in periods ranging from decades to thousands of years. Through observations using satellites, we know that solar irradiance varies about 0.1% over an approximate 11-year cycle of solar variability. Theoretical calculations indicate that a 0.1% increase in solar irradiance raises the global temperature only about 0.05°C on average. From the correlations between observed temperatures of seawater at the ocean surface and past solar activity indicators and climate change indicators, it is evident that, along with variations in solar activity over an approximate 11-year cycle, atmospheric temperature fluctuates at an amplitude about twice that estimated from theoretical values. More research will be needed to find a scientific explanation for this reality.

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 over 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 a quieting of solar activity leads to a period of cooling, many researchers are of the opinion that variations in solar activity influence medium-to-long-term climate change. However, to obtain conclusive evidence it will be necessary to quantitatively reconstruct climate change and to continue accumulating data on annual variations in solar activity.

Radiocarbon (^{14}C) and Beryllium-10 (^{10}Be), known as cosmogenic isotopes, are produced at a rate that varies according to the intensity of incoming cosmic ray 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 have suggested the possibility that episodes of declining solar activity resembling the Maunder Minimum may have occurred repeatedly a total of twelve times throughout the Holocene, which spans the past ten thousand years. Comparing cosmogenic isotopes against paleoclimate data could dramatically help us understand solar-driven climate change on a long time scale.

No sunspots were observed in the period from March 7 to March 20, 2017. The cycle length of solar magnetic activity corresponding to the sunspot cycle is estimated at about 14 years during the Maunder Minimum. The projected sunspot cycle in Solar Cycle 24, which began in 2008, has grown to about 13 years, similar to the cycle length in the Maunder Minimum. This indicates that we may be entering a period of low solar activity, leading some



Project scheme for Solar–Terrestrial Climate Research.

to predict that cooling on a global scale could occur in the near future. In order to offer a qualified opinion on the likelihood of this prediction, we must examine diverse viewpoints on how solar activity affects climate.

We have accumulated evidence over the past quarter century that will be effective for 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 variability in solar activity, fostering an understanding of solar-driven Earth systems, and contributing to predictions of future global environments. Currently researchers from Japan and overseas with diverse areas of expertise are conducting joint research in close collaboration, with a focus on the following research topics.

Experimental and Empirical Studies on the Short- and Long-Term Climate Response Driven by Variations in Solar Activity

- Observing compounds (nitrogen oxides, hydroxides, etc.) produced by high-energy charged particles showering the Earth's atmosphere from space due to the occurrence of solar flares and auroras, and experimentally verifying mechanisms of their generation
- Reconstructing past variations in solar activity in detail based on analytic data of cosmogenic isotopes and assessing their effect on past climate changes.

Theoretical Research on the Characteristics and Mechanisms of Solar Activity Variability

- Clarifying the effects of solar radiation, high-energy charged particles, and cosmic rays related to solar activity on climate using Earth system models
- Clarifying mechanisms of variations in sunspot number by comparing computer simulations with various observation data
- Recreating past changes in total solar irradiance and spectral solar irradiance, which are closely related to climate change, and predicting future solar activity

Main Achievements in FY2016

Four international collaborative research projects and eleven general collaborative research projects related to the impact of solar activity on climate were conducted in the 2016 academic year. The following are the primary activities and findings of this research.

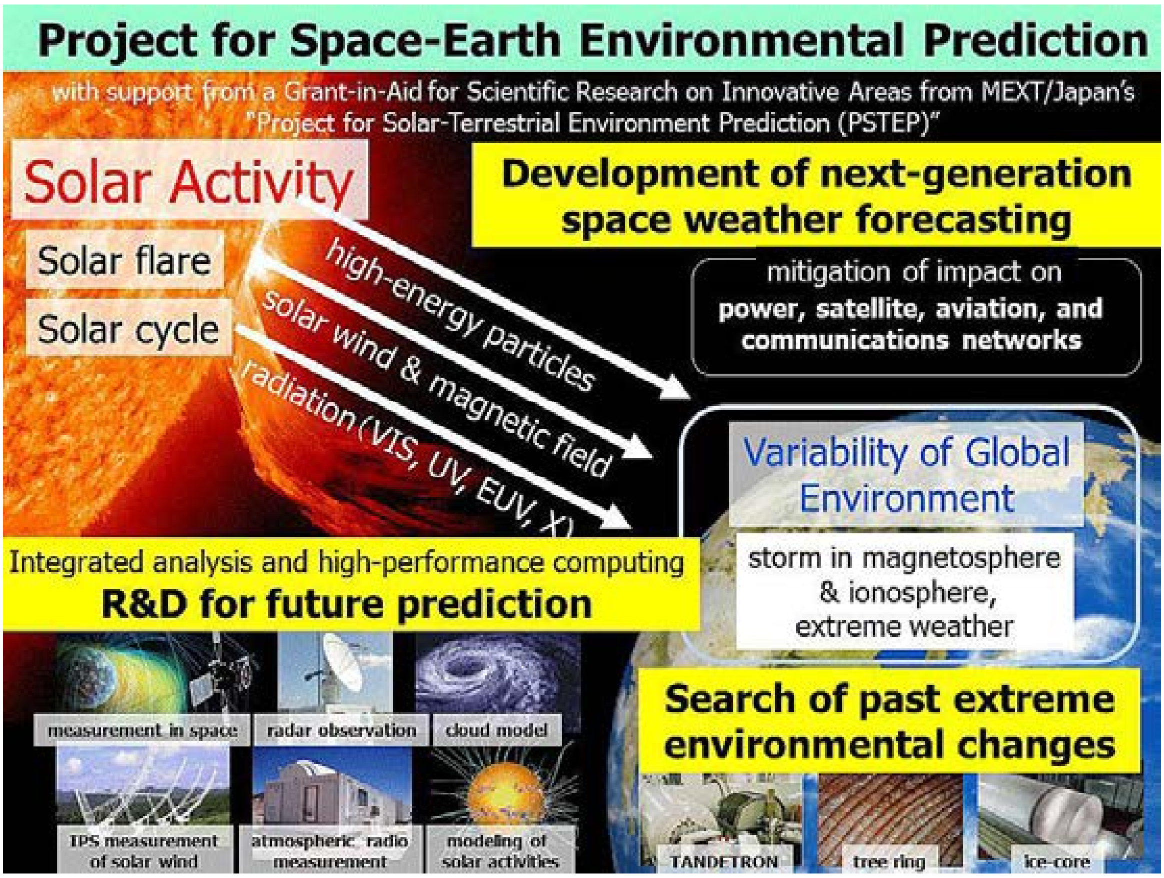
In the international collaborative research project "Potentialities of Permafrost Usage for Paleo-Environmental Reconstruction" (representative: Go Iwahana, University of Alaska), collection of permafrost samples in the northern region of Alaska and preliminary analyses were conducted, yielding valid information for investigating past climate change from permafrost. This preliminary research has potential to be expanded into a new study aimed at investigating past climate change in detail using permafrost. In the "Observation of Cosmogenic Nuclides at High, Mid, Low Latitude Sites during the 24th Solar Cycle" project (representative: Fuyuki Tokanai, Yamagata University), detailed studies were conducted on the relationship between the number of sunspots and concentration of the cosmogenic isotope ^{7}Be in the atmosphere at mid-to-high latitudes in the northern hemisphere, and the relationship between ^{7}Be concentration and ^{210}Pb concentration (originating in the ground) in the air above Bangkok. Carbon-14 dating was also conducted on tree rings of trees existing on Mt. Kinpu during the super solar flare that occurred in 1859 called the Carrington event. The findings from these studies are new knowledge that promotes understanding of year-to-year changes in past cosmogenic isotope, which are closely tied to solar activity.

The general collaborative research projects include remote observations of photochemical oxidant-related substances; empirical research in combination with technological development, such as flux observations and isotope analyses of greenhouse gases; and research on interpreting climatic signals recorded in tree rings and paleoclimate change. Compilation of these research findings from these studies is anticipated to be completed next academic year or later.

9-3. Interdisciplinary Researches
Project for Space–Earth Environment Prediction

Introduction to Project for Space–Earth Environment Prediction

Over the past 50 years, space exploration has expanded rapidly and has 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, called the Carrington Event, caused powerful magnetic storms. 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 the possibility of 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 a risk from severe space-weather disturbances, caused by just such solar explosions, and understanding and predicting variations in the space–Earth environment is both a scientific subject and a crucial issue for modern society. Furthermore, because the accurate prediction of complex phenomena is a common problem in science, this 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 and 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 the Ministry of Education, Culture, Sports, Science and Technology (MEXT)/Japan "Project for Solar-Terrestrial Environment Prediction (PSTEP)".



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

Main Achievements in FY2016

1. International Symposium PSTEP-2 "Toward Solar-Terrestrial Environment Prediction as Science and Social Infrastructure"

Participants of International Symposium PSTEP-2.

The 2nd PSTEP International Symposium (PSTEP-2) “Toward Solar-Terrestrial Environment Prediction as Science and Social Infrastructure” was held at the seminar house of the Graduate School of Science, Kyoto University from March 23 to March 24, 2017. This conference followed the International Symposium PSTEP-1 held at Nagoya University in January, 2016. Eighty-four scientists participated in this symposium, including 11 world-leading researchers invited from Europe, the United States, Australia and East Asia. The following keynote talks were presented: “The economic impact of extreme space weather: Exploratory evidence” by Edward Ougton (University of Cambridge), “Understanding the mechanism of solar eruptions” by Bernhard Kliem (University of Potsdam & Nagoya University), “Exploration of energization and radiation in geospace ERG (Arase) mission” by Yoshizumi Miyosi (Nagoya University), and “Influence of the 11-year solar cycle on climate” by Lesley Gray (University of Oxford). In addition, 12 invited lectures, 20 contributed talks, and 22 poster presentations were held.

2. PSTEP science meeting “Perspectives of Modeling Research for Solar-Terrestrial Environment Prediction”

Science Meeting “Perspectives of Modeling Research for Solar-Terrestrial Environment Prediction at ISEE, Nagoya University.

The PSTEP science meeting “Perspectives of Model Research for Solar-Terrestrial Environment Prediction” was held at ISEE, Nagoya University, from January 26 to January 27, 2017, in co-operation with the PSTEP, which is supported by a Grant-in-Aid for Scientific Research on Innovative Areas from MEXT/Japan. In this workshop, we discussed various numerical models for predicting phenomena in the solar–terrestrial environment consisting of the Sun, solar wind, and the Earth’s magnetosphere, ionosphere, and atmosphere. A total of 72 researchers from various related fields participated. We conducted lectures and discussions on physics-based modeling for prediction.

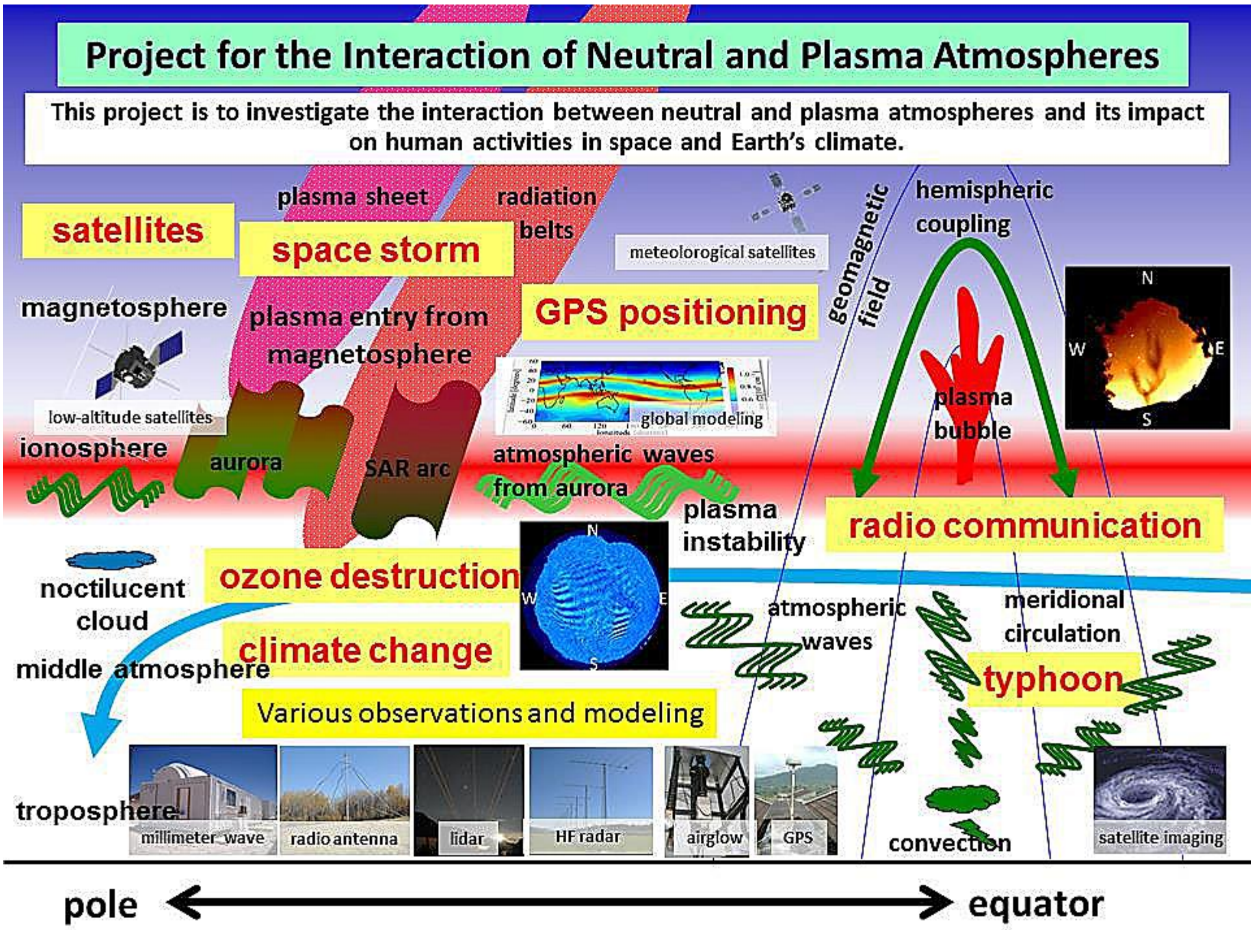
3. Research and development for new prediction of solar activity

We have developed new research to predict solar flares and solar cycle activity. While solar flare predictions have mainly been performed using empirical methods thus far, ISEE is promoting research to numerically predict the probability of solar flares using the magnetoydrodynamics simulations with observation data of the solar surface magnetic field. In addition, ISEE is developing the next solar cycle prediction by using the flux-transport model. The results suggest that the next cycle may be weakened by about several tens of percent compared to the current cycle.

9-3. Interdisciplinary Researches
Project for the Interaction of Neutral and Plasma Atmospheres

Introduction to Project for the Interaction of Neutral and Plasma Atmospheres

The Earth's 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 precipitation of high-energy plasma, which heats the upper atmosphere, and generates atmospheric waves and disturbances that propagate toward low latitudes. On the other hand, 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 Achievements in FY2016

In FY2016, we operated 11 international collaborative studies, eight domestic collaborative projects, and 18 meetings under ISEE. Various scientific results have been obtained through these collaborative projects.

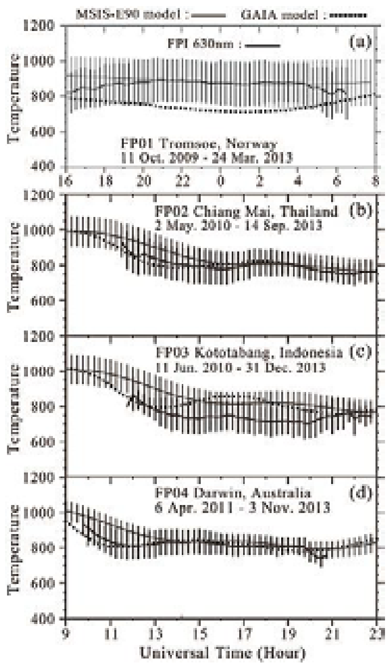
For the polar disturbances, the pulsating auroral patches were investigated in detail using a FPI, an all-sky camera, an EISCAT radar, a riometer, and satellite wave/particle instruments. We found that the patches developed when magnetospheric chorus waves occur, and electrons with energies of more than a few hundred electronvolts (eVs) precipitate into the patches. The patches have an electron density gradient that can create localized thermospheric wind around the patches.

Pulsating auroral patches observed in the polar region (March 21, 2017, Husafell, Iceland).

We also suggested that propagation of chorus waves to higher latitudes makes interaction between these waves and broad-energy electrons from keV to MeV possible. This suggestion, based on computer simulation, implies that the pulsating aurora and the microburst of high-energy electrons may be the same phenomenon. We further investigated the effect of these high-energy electrons on the middle atmosphere with scientists in Finland and suggested, based on the model calculations, that they can cause increases in HO_x and NO_x and decreases in ozone at altitudes of 70–80 km. In FY2016, we also succeeded in measuring middle-atmosphere ozone at Tromsø, Norway, using a newly-developed millimeter-wave spectrometer. Observations of pulsating auroral patches by multi-point high-speed EMCCD cameras have also commenced in northern Scandinavia.

The new scientific satellite ERG (Arase) was launched by ISAS/JAXA in December 2016, to investigate these wave-particle interactions between high-energy electrons and ions in the inner magnetosphere. We have carried out the first ERG (Arase)-ground campaign observation in March–April 2017, and campaign data analysis is ongoing.

At middle and low latitudes, we have succeeded in obtaining simultaneous measurements of field-aligned irregularities (FAIs) by the Equatorial Atmosphere Radar (EAR) and thermospheric wind and temperatures using a FPI. This measurement indicates that the midnight temperature maximum can contribute to the generation of post-midnight plasma bubbles through a RTI. We currently operate five FPIs in Norway, Japan, Thailand, Indonesia, and Australia. The FPI is unique since it is the only instrument that can monitor winds and temperatures in the thermosphere at altitudes of 200–300 km from the ground through the Doppler shift and the spectrum width, respectively, of airglow emissions. We compared the measured temperatures with those obtained from the MSIS and GAIA models to evaluate these models.

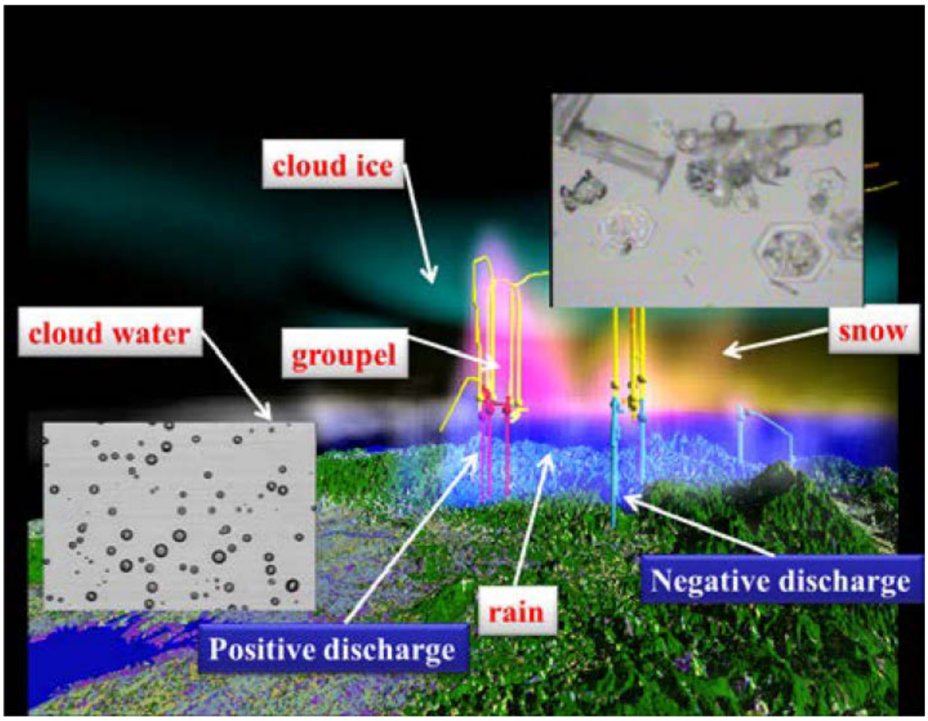


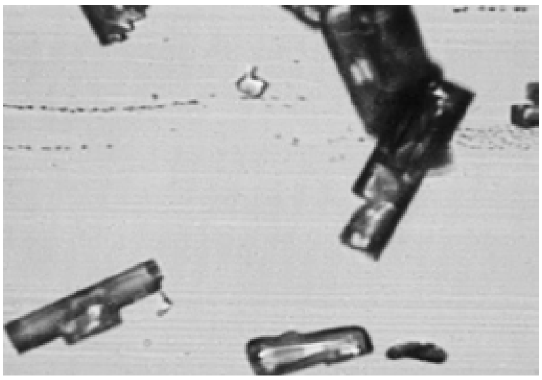
Thermospheric temperatures obtained by four FPIs at four stations from the polar region to the equator over 3–4 years, and comparison with temperatures of the MSIS/GAIA models.

9-3. Interdisciplinary Researches
Project for Aerosol and Cloud Formation

Introduction to 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. They are, however, some of the most unknown quantities in the atmosphere. So 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 the cloud-resolving model (CReSS), and the impact of aerosols on typhoon clouds will be studied.





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 Achievements in FY2016

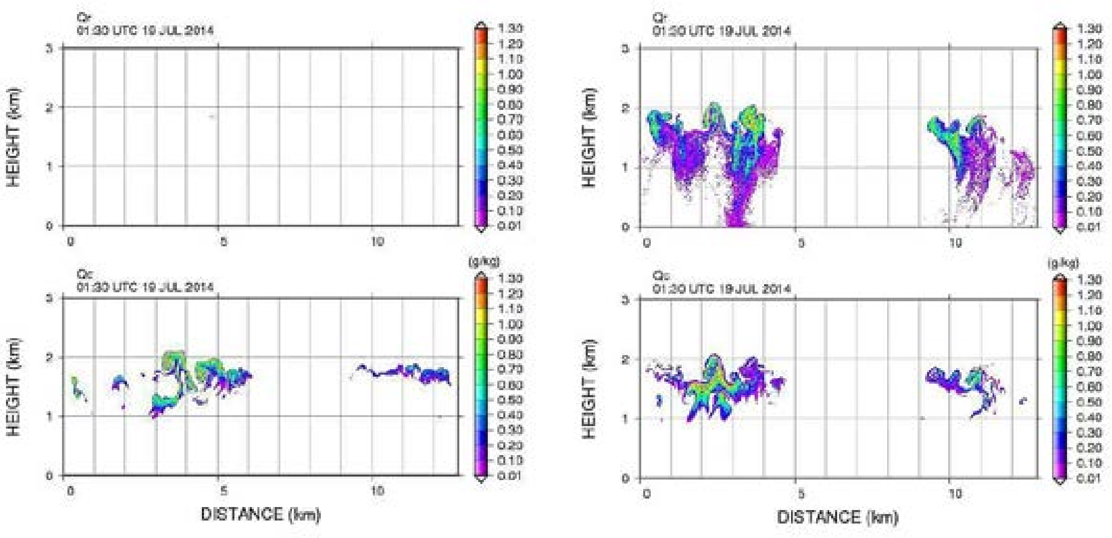
1. Drone observation of sea spray particles

Sea sprays are sources of water vapor and aerosols in the atmosphere. They could influence development of convective clouds. As a result, the structure and intensity of a typhoon will be affected by the amount of sea spray particles. The size distribution and number density are necessary for modeling sea spray particles. We conducted drone observation of sea spray particles in August 2016 at Tarama Island, Okinawa. The cloud particle sonde was lifted by the drone to 2 m above sea level and sea spray particles observed. Although the observation was made under weak wind conditions, sea spray particles were successfully observed.

The drone used in the observation (left panel) and the lifted sonde (right panel).

2. Super-Droplet Method with CReSS and impact experiments of aerosols on warm rain

The Super-Droplet Method (SDM) developed by Professor Shima of the University of Hyogo was coupled with the CReSS model and aerosol impact experiments were performed for warm rain. A significant difference was found in cloud and precipitation amounts according to the amount of aerosol. The maximum rainfall intensity reached more than 80 mm h^{-1} under a low aerosol density.



Results with high aerosol density (left column) and low density (right column). The upper panels are vertical cross sections of rain from the surface to 3 km in height and the lower panels are clouds.

10. Publications and Presentations

Papers (in refereed Journals, April 2016–March 2017)

Abbott, B. P., R. Abbott, T. D. Abbott, M. R. Abernathy, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, R. X. Adhikari et al. (**H. Tajima**, **F. Abe**), Localization and broadband follow-up of the gravitational-wave transient GW150914. *Astrophys. J. Lett*., 826(1), L13, Jul. 20, 2016 (10.3847/2041-8205/826/1/L13).

Abbott, B. P., R. Abbott, T. D. Abbott, M. R. Abernathy, F. Acernese, K. Ackley, C. Adams, T. Adams, P. Addesso, R. X. Adhikari et al. (**H. Tajima**, **F. Abe**), Supplement: "Localization and broadband follow-up of the gravitational-wave transient GW150914" (2016, ApJL, 826, L13). *Astrophys. J. Supplement Series*, 225(1), 8, Jul. 20, 2016 (10.3847/0067-0049/225/1/8).

Abdollahi, S., M. Ackermann, M. Ajello, A. Albert, W. B. Atwood, L. Baldini, G. Barbiellini, R. Bellazzini, E. Bissaldi, E. D. Bloom et al. (**H. Tajima**), Search for cosmic-ray electron and positron anisotropies with seven years of Fermi Large Area Telescope Data. *Phys. Rev. Lett*., 118(9), 091103, Mar. 3, 2017 (10.1103/PhysRevLett.118.091103).

Abe, K., K. Hiraide, K. Ichimura, Y. Kishimoto, K. Kobayashi, M. Kobayashi, S. Moriyama, K. Nakagawa, M. Nakahata, T. Norita et al. (**Y. Itow**, **R. Kegasa**, **K. Kobayashi**, **K. Masuda**, **H. Takiya**, **H. Uchida**), Detectability of galactic supernova neutrinos coherently scattered on xenon nuclei in XMASS. *Astropart. Phys.*, 89, 51–56, Mar. 2017 (10.1016/j.astropartphys.2017.01.006).

Abe, K., Y. Haga, Y. Hayato, M. Ikeda, K. Iyogi, J. Kameda, Y. Kishimoto, M. Miura, S. Moriyama, M. Nakahata et al. (**K. Choi**, **Y. Itow**, **T. Suzuki**), Search for proton decay via $p \rightarrow e^{+} \pi^{0}$ and $p \rightarrow \mu^{+} \pi^{0}$ in 0.31 megaton・years exposure of the Super-Kamiokande water Cherenkov detector. *Phys. Rev. D*, 95(1), 012004, Jan. 06, 2017 (10.1103/PhysRevD.95.012004).

Abe, K., K. Hiraide, K. Ichimura, Y. Kishimoto, K. Kobayashi, M. Kobayashi, S. Moriyama, K. Nakagawa, M. Nakahata, T. Norita et al. (**Y. Itow**, **R. Kegasa**, **K. Kobayashi**, **K. Masuda**, **H. Takiya**, **H. Uchida**), Search for two-neutrino double electron capture on Xe-124 with the XMASS-I detector. *Phys. Lett. B*, 759, 64–68, Aug, 2016 (10.1016/j.physletb.2016.05.039).

Abe, K., Y. Haga, Y. Hayato, M. Ikeda, K. Iyogi, J. Kameda, Y. Kishimoto, M. Miura, S. Moriyama, M. Nakahata et al. (**K. Choi**, **Y. Itow**, **G. Mitsuka**), Real-time supernova neutrino burst monitor at Super-Kamiokande. *Astropar. Phys*., 81, 39–48, Aug. 1, 2017 (10.1016/j.astropartphys.2016.04.003).

Abe, K., K. Hiraide, K. Ichimura, Y. Kishimoto, K. Kobayashi, M. Kobayashi, S. Moriyama, M. Nakahata, T. Norita, H. Ogawa et al. (**Y. Itow**, **R. Kegasa**, **K. Kobayashi**, **K. Masuda**, **H. Takiya**), Direct dark matter search by annual modulation in XMASS-I. *Phys. Lett., B*, 759, 272–276, Aug. 10, 2016 (10.1016/j.physletb.2016.05.081).

Abe, K., K. Haga, Y. Hayato, M. Ikeda, K. Iyogi, J. Kameda, Y. Kishimoto, M. Miura, S. Moriyama, M. Nakahata et al. (**Y. Itow**, **T. Suzuki**), Search for neutrinos in Super-Kamiokande associated with gravitational-wave events GW150914 and GW151226. *Astrophysi. J. Lett*., 830(1), L11, Oct. 06, 2016 (10.3847/2041-8205/830/1/L11).

Acero, F., M. Ackermann, M. Ajello, L. Baldini, J. Ballet, G. Barbiellini, D. Bastieri, R. Bellazzini, E. Bissaldi, R. D. Blandford et al. (**H. Tajima**), The first Fermi LAT supernova remnant catalog. *Astrophys. J. Suppl. Ser.*, 224(1), 8, May 16, 2016 (10.3847/0067-0049/224/1/8).

Acero, F., M. Ackermann, M. Ajello, A. Albert, L. Baldini, J. Ballet, G. Barbiellini, D. Bastieri, R. Bellazzini, E. Bissaldi et al. (**H. Tajima**), Development of the model of Galactic Interstellar Emission for Standard Point-Source Analysis of Fermi Large Area Telescope Data. *Astrophys. J. Suppl. Ser.*, 223(2), 26, Apr. 22, 2016 (0.3847/0067-0049/223/2/26).

Ackermann, M., M. Ajello, A. Albert, B. Anderson, M. Arimoto, W. B. Atwood, M. Axelsson, L. Baldini, J. Ballet et al. (**H. Tajima**), Fermi-LAT Observations of the LIGO Event GW150914. *Astrophys. J. Lett.,* 823(1), L2, May 20, 2016 (10.3847/2041-8205/823/1/L2).

Ackermann, M., A. Allafort, L. Baldini, G. Barbiellini, D. Bastieri, R. Bellazzini, E. Bissaldi, R. Bonino, E. Bottacini, J. Bregeon et al. (**H. Tajima**), Fermi-LAT observations of high-energy behind-the-limb solar flares. *Astrophys. J.*, 835(2), 219, Fab. 1, 2017 (10.3847/1538-4357/835/2/219).

Adriani, O., E. Berti, L. Bonechi, M. Bongi, R. D'Alessandro, M. Del Prete, M. Haguenauer, **Y. Itow**, T. Iwata, K. Kasahara, **K. Kawade**, **Y. Makino**, **K. Masuda**, **E. Matsubayashi**, H. Menjo, G. Mitsuka, **Y. Muraki**, P. Papini, A.-L. Perrot, S. Ricciarini, **T. Sako**, N. Sakurai, T. Suzuki, T. Tamura, A. Tiberio, S. Torii, A. Tricomi, W. C. Turner, **M. Ueno**, and **Q. D. Zhou**, (LHCf Collaboration), Measurements of longitudinal and transverse momentum distributions for neutral pions in the forward-rapidity region with the LHCf detector. *Phys. Rev. D*, 94(3), 032007, Aug. 22, 2016 (10.1103/PhysRevD.94.032007).

Aharonian, F. A., H. Akamatsu, F. Akimoto, S. W. Allen, L. Angelini, K. A. Arnaud, M. Audard, H. Awaki, M. Axelsson, A. Bamba et al (**H. Tajima**), Hitomi constraints on the 3.5 keV line in the Perseus galaxy cluster. *Astrophys. J. Lett.*, 837(1), L15, Mar. 1, 2017 (10.3847/2041-8213/aa61fa).

Aharonian, F., H. Akamatsu, F. Akimoto, S. W. Allen, N. Anabuki, L. Angelini, K. Arnaud, M. Audard, H. Awaki, M. Axelsson et al. (**H. Tajima**), The quiescent intracluster medium in the core of the Perseus cluster. *Nature*, 535, 117–121, Jul. 7, 2016 (10.1038/nature18627).

Aiki, H., R. J. Greatbatch, and M. Clau, Towards a seamlessly diagnosable expression for the energy flux associated with both equatorial and mid-latitude waves. *Prog. Earth. Planet. Sci*., 4, 11, Mar. 31, 2017 (10.1186/s40645-017-0121-1).

Ajith, K. K., S. Tulasi Ram, M. Yamamoto, **Y. Otsuka**, and K. Niranjan, On the fresh development of equatorial plasma bubbles around the midnight hours of June solstice. *J. Geophys. Res. Space Physics*, 121(9), 9051–9062, Sep. 17, 2016 (10.1002/2016JA023024).

Akiba, K., M. Akbiyik, M. Albrow, M. Arneodo, V. Avati, J. Baechler, O. Villalobos Baillie, P. Bartalini, J. Bartels, S. Baur et al. (**T. Sako**), LHC forward physics. *J. Phys. G: Nucl. Part. Phys.*, 43(11), 110201, Nov. 1, 2016 (10.1088/0954-3899/43/11/110201).

Bala, P. R., **T. Nakamura**, K. Sajeev, and R. Sukumar, High-resolution age-depth chronology from tropical montane minerotrophic peat in the Sandynallah valley, Western Ghats, southern India: Analytical issues and implications. *Quat. Geochronol.*, 34, 12–23, Aug. 2016 (10.1016/j.quageo.2016.03.003).

Balan, N., Y. Ebihara, R. Skoug, **K. Shiokawa**, I. S. Batista, S. Tulasi Ram, Y. Omura, T. Nakamura, and M.-C. Fok, A scheme for forecasting severe space weather. *J. Geophys. Res. Space Physics*, 122(3), 2824–2835, Mar. 31, 2017 (10.1002/2016JA023853).

Belgaman, H. A., K. Ichiyanagi, M. Tanoue, R. Suwarman, K. Yoshimura, S. Mori, **N. Kurita**, M. D. Yamanaka, and F. Syamsudin, 2016: Intraseasonal variability of δ^{18}O of precipitation over the Indonesian Maritime Continent related to the Madden–Julian Oscillation. *SOLA*, 12, 192–197, Aug. 3, 2016 (10.2151/sola.2016-039).

Bennett, D. P., S. H. Rhie, A. Udalski, A. Gould, Y. Tsapras, D. Kubas, I. A. Bond, J. Greenhill, A. Cassan, N. J. Rattenbury et al. (**F. Abe**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), The first circumbinary planet found by microlensing: OGLE-2007-BLG-349L(AB)c. *Astronom. J.*, 152(5), 125, Nov. 2016 (10.3847/0004-6256/152/5/125).

Bhattacharya, A., D. P. Bennett, I. A. Bond, T. Sumi, A. Udalski, R. Street, Y. Tsapras, **F. Abe**, M. Freeman, A. Fukui et al.

(**Y. Itow, K. Masuda**, **Y. Matsubara**, **Y. Muraki**), Discovery of a gas giant planet in microlensing event OGLE-2014-BLG-1760. *Astronom. J.*, 152(5), 140, Nov. 1, 2016 (10.3847/0004-6256/152/5/140).

Bisoi, S. K., D. Chakrabarty, P. Janardhan, R. G. Rastogi, A. Yoshikawa, **K. Fujiki**, **M. Tokumaru**, and Y. Yan, The prolonged southward IMF-Bz event of 2–4 May 1998: Solar, interplanetary causes and geomagnetic consequences. *J. Geophys. Res. Space Physics*, 121(5), 3882–3904, May 2016 (10.1002/2015JA022185).

Brutsaert, W., W. Li, **A. Takahashi**, **T. Hiyama**, L. Zhang, and W. Liu, Nonlinear advection-aridity method for landscape evaporation and its application during the growing season in the southern Loess Plateau of the Yellow River basin, *Water Resour. Res.*, 53(1), 270–282, Jan. 2017 (10.1002/2016WR019472).

Buhari, S. M., M. Abdullah, T. Yokoyama, **Y. Otsuka**, M. Nishioka, A. M. Hasbi, S. A. Bahari, and T. Tsugawa, Climatology of successive equatorial plasma bubbles observed by GPS ROTI over Malaysia. *J. Geophys. Res. Space Physics*, 122(2), 2174–2184, Feb. 2017 (10.1002/2016JA023202).

Cronin, M. F., N. A. Bond, J. T. Farrar, H. Ichikawa, S. R. Jayne, Y. Kawai, M. Konda, B. Qiu, L. Rainville, **H. Tomita**, Corrigendum to "Formation and erosion of the seasonal thermocline in the Kuroshio Extension Recirculation gyre" [Deep-Sea Res. II 85 (2013) 62–74]. *Deep-Sea Res. Part II-Top. Stud. Oceanogr.*, 132, 263–264, Oct. 2016 (10.1016/j.dsr2.2016.08.001).

de Mendonça, R. R. S., C. R. Braga, E. Echer, A. Dal Lago, K. Munakata, T. Kuwabara, M. Kozai, C. Kato, M. Rockenbach, N. J. Schuch et al. (**M. Tokumaru)**, Temperature effect in secondary cosmic rays (MUONS) observed at the ground: Analysis of the Global MUON Detector Network data. *Astrophys. J.*, 830(2), 88, Oct. 20, 2016 (10.3847/0004-637X/830/2/88).

Enami, M., T. Nagaya, and M. M. Win, An integrated EPMA-EBSD study of metamorphic histories recorded in garnet. *Am. Miner*., 102(1), 192–204, Jan. 03, 2017 (10.2138/am-2017-5666).

Fujiki, K., **M. Tokumaru**, **K. Hayashi**, **D. Satonaka**, and K. Hakamada, Long-term trend of solar coronal hole distribution from 1975 to 2014. *Astrophys. J. Lett*., 827(2), L41, Aug. 20, 2016 (10.3847/2041-8205/827/2/L41).

Fujiki, T., K. Sasaoka, K. Matsumoto, M. Wakita, and **Y. Mino**, Seasonal variability of phytoplankton community structure in the subtropical western North Pacific. *J. Oceanogr*., 72(3), 343–358, Jun. 2016 (10.1007/s10872-015-0346-9).

Fukuda, Y., R. Kataoka, **Y. Miyoshi**, Y. Katoh, T. Nishiyama, **K. Shiokawa**, Y. Ebihara, D. Hampton, and N. Iwagami, Quasi-periodic rapid motion of pulsating auroras. *Polar Sci.*, 10(3), 183–191, Sep. 2016 (10.1016/j.polar.2016.03.005).

Hamada, S., **T. Kumagai**, K. Kochi, **N. Kobayashi**, **T. Hiyama**, and Y. Miyazawa, Spatial and temporal variations in photosynthetic capacity of a temperate deciduous-evergreen forest. *Trees*, 30(4), 1083–1093, Aug. 2016 (10.1007/s00468-015-1347-4).

Harra, L. K., C. J. Schrijve, M. Janvie, S. Torium, H. Hudso, S. Matthews, M. M. Woods, H. Hara, M. Guedel, A. Kowalsk, R. Osten, **K. Kusano**, and T. Lueftinger, The characteristics of solar X-class flares and CMEs: A paradigm for stellar super flares and eruptions?. *Sol. Phys*., 291(6), 1761–1782, Aug. 2016 (10.1007/s11207-016-0923-0).

Hatsuzuka, D., and **H. Fujinami**, Effects of the South Asian monsoon intraseasonal modes on genesis of low pressure systems over Bangladesh. *J. Clim*., 30(7), 2481–2499, Mar.13, 2017 (10.1175/JCLI-D-16-0360.1).

Hayashi, K., **M. Tokumaru**, and **K. Fujiki**, MHD-IPS analysis of relationship among solar wind density, temperature, and flow speed. *J. Geophys. Res. Space Physics*, 121(8), 7367–7384, Aug. 2016 (10.1002/2016JA022750).

Henderson, C. B., R. Poleski, M. Penny, R. A. Street, D. P. Bennett, D. W. Hogg, B. Scott Gaudi, W. Zhu, T. Barclay, G. Barentsen et al. (**F. Abe**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**), Campaign 9 of the K2 Mission：

Observational parmeters, scientific drivers, and community involvement for a simultaneous space-andground-based microlensing survey. *Publ. Astron. Soc. Pac.*, 128(970), 124401, Dec. 1, 2016 (10.1088/1538-3873/128/970/124401).

Hirao, Y., A. Udalski, T. Sumi, D. P. Bennett, I. A. Bond, N. Rattenbury, D. Suzuki, N. Koshimoto, **F. Abe**, **Y. Asakura** et al. (**Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), OGLE-2012-BLG-0724Lb: A Saturn-mass Planet around an M Dwarf. *Astrophys. J.*, 824(2), 139, Jun. 20, 2016 (10.3847/0004-637X/824/2/139).

Hirata, H., R. Kawamura, **M. Kato**, and **T. Shinoda**, Response of rapidly developing extratropical cyclones to seasurface temperature variations over the western Kuroshio-Oyashio confluence region. *J. Geophys. Res. Atmos.*, 121(8), 3843–3858, Apr. 27, 2016 (10.1002/2015JD024391).

Hiyama, T., **H. Fujinami**, **H. Kanamori**, **T. Ishige**, and K. Oshima, Recent interdecadal changes in the interannual variability of precipitation and atmospheric circulation over northern Eurasia. *Environ. Res. Lett.*, 11(6), 065001, Jun. 2, 2016 (10.1088/1748-9326/11/6/065001).

Hiyama, T., **H. Kanamori**, J. R. Kambatuku, A. Kotani, K. Asai, H. Mizuochi, Y. Fujioka, and M. Iijima, Analysing the origin of rain- and subsurface water in seasonal wetlands of north-central Namibia. *Environ. Res. Lett.*, 12(3), 34012, Mar. 2, 2017 (10.1088/1748-9326/aa5bc8).

Honda, M. C., H. Kawakami, K. Matsumoto, M. Wakita, T. Fujiki, **Y. Mino**, **C. Sukigara**, T. Kobari, M. Uchimiya, R. Kaneko, and T. Saino, Comparison of sinking particles in the upper 200 m between subarctic station K2 and subtropical station S1 based on drifting sediment trap experiments. *J. Oceanogr.*, 72(3), 373–386, Jun. 2016 (10.1007/s10872-015-0280-x).

Horne, R. B., and **Y. Miyoshi**, Propagation and linear mode conversion of magnetosonic and electromagnetic ion cyclotron waves in the radiation belts. *Geophys. Res. Lett.*, 43(19), 10034–10039, Oct. 2016 (10.1002/2016GL070216).

Ieda, A., Y. Nishimura, **Y. Miyashita**, V. Angelopoulos, A. Runov, T. Nagai, H. U. Frey, D. H. Fairfield, J. A. Slavin, H. Vanhamäki, H. Uchino, **R. Fujii**, **Y. Miyoshi**, and **S. Machida**, Stepwise tailward retreat of magnetic reconnection: THEMIS observations of an auroral substorm. *J. Geophys. Res. Space Physics*, 121(5), 4548–4568, May 2016 (10.1002/2015JA022244).

Iino, T., **H. Ohyama**, Y. Hirahara, T. Takahashi, and T. Tsukagoshi, Submillimeter observation of Jupiter's stratospheric composition: Detection of carbon monosulfide (J = 7– 6) 19 years after the cometary impact. *Astronom. J.*, 152(6), 179, Dec. 2016 (10.3847/0004-6256/152/6/179).

Inoue, S., Magnetohydrodynamics modeling of coronal magnetic field and solar eruptions based on the photospheric magnetic field. *Prog. Earth. Planet. Sci.*, 3, 19, Jul. 4, 2016 (10.1186/s40645-016-0084-7).

Iriana, W., K. Tonokura, **M. Kawasaki**, **G. Inoue**, K. Kusin, and S. H. Limin, Measurement of carbon dioxide flux from tropical peatland in Indonesia using the nocturnal temperature-inversion trap method. *Environ. Res. Lett.*, 11(9), 095011, Sep. 16, 2016 (10.1088/1748-9326/11/9/095011).

Ishizawa, M., O. Uchino, I. Morino, M. Inoue, Y. Yoshida, K. Mabuchi, T. Shirai, Y.Tohjima, S. Maksyutov, **H. Ohyama**, S. Kawakami, A. Takizawa, and D. Belikov, Large XCH_4 anomaly in summer 2013 over northeast Asia observed by GOSAT. *Atmos. Chem. Phys.*, 16, 9149–9161, Jul. 26, 2016 (10.5194/acp-16-9149-2016).

Jackson, B. V., H.-S. Yu, A. Buffington, P. P. Hick, **N. Nishimura**, **N. Nozaki**, **M. Tokumaru**, **K. Fujiki**, and **K. Hayashi**, Exploration of solar photospheric magnetic field data sets using the UCSD tomography. *Space Weather*, 14(12), 1107–1124, Dec. 2016 (10.1002/2016SW001481).

Jun, C.-W., **K. Shiokawa**, M. Connors, I. Schofield, I. Poddelsky, and B. Shevtsov, Possible generation mechanisms for Pc1 pearl structures in the ionosphere, based on 6 years of ground observations in Canada, Russia, and Japan. *J. Geophys. Res. Space Physics*, 121(5), 4409–4424, May 2016 (10.1002/2015JA022123).

Jung, Y. K., A. Udalski, J. C. Yee, T. Sumi, A. Gould, C. Han, M. D. Albrow, C.-U. Lee, S.-L. Kim, S.-J. Chung et al. (**F. Abe**, **Y. Asakura**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), Binary source icrolensing event OGLE-2016- BLG-0733: Interpretation of a long-term asymmetric perturbation. *Astronom. J.*, 153(3), 129, Mar. 2017 (10.3847/1538-3881/aa5d07).

Kanada, S., and A. Wada, Different Climatological Characteristics, Inner-Core Structures, and Intensification Processes of Simulated Intense Tropical Cyclones between 20-km global and 5-km regional models. *J. Clim.*, 30(5), 1583–1603, Mar. 1, 2017 (10.1175/JCLI-D-16-0093.1).

Kanoh, R., T. Shimizu, and **S. Imada**, Hinode and IRIS observations of the magnetohydrodynamic waves propagating from the photosphere to the chromosphere in a sunspot. *Astrophys. J.*, 831(1), 24, Nov. 1, 2016 (10.3847/0004-637X/831/1/24).

Katayama, A., T. Kume, M. Ohashi, K. Matsumoto, M. Nakagawa, **T. Saito**, **T. Kumagai**, and K. Otsuki, Characteristics of wood CO_2 efflux in a Bornean tropical rainforest. *Agric. For. Meteorol.*, 220, 190–199, Apr. 15, 2016 (10.1016/j.agrformet.2016.01.140).

Katsuta, J., I. Edahiro, S. Watanabe, H. Odaka, Y. Uchida, N. Uchida, T. Mizuno, Y. Fukazawa, K. Hayashi, S. Habata et al (**H. Tajima**), Study of the polarimetric performance of a Si/CdTe semiconductor Compton camera for the Hitomi satellite. *Nucl. Instr. Meth. A*, 840, 51–58, Dec. 21, 2016 (10.1016/j.nima.2016.09.057).

Kawaguchi, K., K. Kawaguchi, S. Muller, J. H. Black, T. Amano, F. Matsushima, **R. Fujimori**, Y. Okabayahsi, H. Nagahiro, Y. Miyamoto, and J. Tang, Detection of HF toward Pks 1831–211, search for interstellar H_2F^+, and laboratory study of H_2F^+ and H_2Cl^+ dissociative recombination. *Astrophys. J.*, 822(2), 115, May 12, 2016 (10.3847/0004-637X/822/2/115).

Kawana, K., **T. Nakayama**, and M. Mochida, Hygroscopicity and CCN activity of atmospheric aerosol particles and their relation to organics: Characteristics of urban aerosols in Nagoya, Japan. *J. Geophys. Res. Atmospheres*, 121(8), 4100–4121, Apr. 27, 2016 (10.1002/2015JD023213).

Kawana, K., **T. Nakayama**, N. Kuba, and M. Mochida, Hygroscopicity and cloud condensation nucleus activity of forest aerosol particles during summerin Wakayama, Japan. *J. Geophys. Res.Atmospheres*, 122(5), 3042–3064, Mar. 16, 2017 (10.1002/2016JD025660).

Kawano, H., A. S. Yukimatu, Y. Tanaka, S. Saita, **N. Nishitani**, and **T. Hori**, SC-triggered 1.6 mHz waves including an interval with latitude-dependent phase shift, observed by the SuperDARN Hokkaido East Radar in mid latitudes: Possible global magnetospheric cavity-mode waves and their field-line resonance with poloidal Alfven-mode waves. *Mem. Fac. Sci., Kyushu Univ., Ser. D, Earth ＆ Planet. Sci*, 34(1), 1–15, Nov. 23, 2016.

Kawarte, T., T. T. Ishii, Y. Nakatani, K. Ichimoto, A. Asai, S. Morita, and **S. Masuda**, Temporal evolution and spatial distribution of white-light flare kernels in a solar flare. *Astrophys. J.*, 833(1), 50, Dec. 2016 (10.3847/1538-4357/833/1/50).

Keika, K., K. Seki, M. Nosé, **S. Machida**, **Y. Miyoshi**, L. J. Lanzerotti, D. G. Mitchell, M. Gkioulidou, D. Turner, H. Spence, and B. A. Larsen, Storm time impulsive enhancements of energetic oxygen due to adiabatic acceleration of preexisting warm oxygen in the inner magnetosphere. *J. Geophys. Res. Space Physics*, 121(8), 7739–7752, Aug. 2016 (10.1002/2016JA022384).

Khabarova, O., H. M. Malova, R. A. Kislov, L. M. Zelenyi, V. N. Obridko, A. F. Kharashiladze, **M. Tokumaru**, J. M. Sokól, S. Grzedzielski, and **K. Fujiki**, High-latitude conic current sheets in the solar wind. *Astrophys. J.*, 836(1), 108, Feb. 10, 2017 (10.3847/1538-4357/836/1/108).

Kim, K.-H., J.-S. Park, Y. Omura, **K. Shiokawa**, D.-H. Lee, G.-J. Kim, H. Jin, E. Lee, and H.-J. Kwon, Spectral characteristics of steady quiet-time EMIC waves observed at geosynchronous orbit. *J. Geophys. Res. Space Physics*, 121(9), 8640–8660, Sep. 2016 (10.1002/2016JA022957).

Kim, W., J.-E. Moon, Y.-J. Park, and **J. Ishizaka**, Evaluation of chlorophyll retrievals from Geostationary Ocean Color Imager (GOCI) for the North-East Asian region. *Remote Sens. Environ.*, 184, 482–495, Oct. 2016 (10.1016/j.rse.2016.07.031)

Kodera, K., R. Thiéblemont, S. Yukimoto, and K. Matthes, How can we understand the global distribution of the solar cycle signal on the Earth's surface?. *Atmos. Chem. Phys.*, 16(20), 12925–12944, Oct. 19, 2016 (10.5194/acp-16-12925-2016).

Kodera, K., N. Eguchi, H. Mukougawa, T. Nasuno, and T. Hirooka, Stratospheric tropical warming event and its impact on the polar and tropical troposphere. *Atmos. Chem. Phys.*, 17(1), 615–625, Jan. 12, 2017 (10.5194/acp-17-615-2017).

Koshimoto, N., A. Udalski, J. P. Beaulieu, T. Sumi, D. P. Bennett, I. A. Bond, N. Rattenbury, A. Fukui, V. Batista et al. (**F. Abe**, **Y. Asakura**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), The first planet massmeasurement from only microlens parallax and lens flux. *Astronom. J.*, 153(1), 1, Jan. 1, 2017 (10.3847/1538-3881/153/1/1).

Kozai, M., K. Munakata, C. Kato, T. Kuwabara, M. Rockenbach, A. Dal Lago, N. J. Schuch, C. R. Braga, R. R. S. Mendonça, H. K. Al Jassar, M. M. Sharma, M. L. Duldig, J. E. Humble, P. Evenson, I. Sabbah, and **M. Tokumaru**, Average spatial distribution of cosmic rays behind the interplanetary shock -Global Muon Detector Network observations-. *Astrophys. J.*, 825(2), 100, Jul. 6, 2016 (10.3847/0004-637X/825/2/100).

Kumar, S., B. Veenadhari, S. T. Ram, S. Y. Su, and **T. Kikuchi**, Possible relationship between the equatorial electrojet (EEJ) and daytime vertical E x B drift velocities in F region from ROCSAT observations. *Adv. Space Res.*, 58(7), 1168–1176, Oct. 2016 (10.1016/j.asr.2016.06.009).

Kurita, N., T. Nakatsuka, K. Ohnishi, T. Mitsutani, and **T. Kumagai**, Analysis of the interdecadal variability of summer precipitation in central Japan using a reconstructed 106-year-long oxygen isotope record from tree-ring cellulose. *J. Geophys. Res. Atmospheres*, 121(20), 12089–12107, Oct. 27, 2016 (10.1002/2016JD025463).

Kurita, N., N. Hirasawa, S. Koga, J. Matsushita, H. C. Steen-Larsen, V. Masson-Delmotte, and Y. Fujiyoshi, Identification of air masses responsible for warm events on the East Antarctic coast. *SOLA*, 12, 307–228, 2016 (10.2151/sola.2016-060).

Kurita, N., N. Hirasawa, S. Koga, J. Matsushita, H. C. Steen-Larsen, V. Masson-Delmotte, and Y. Fujiyoshi, Influence of large-scale atmospheric circulation on marine air instruction toward the East Antaractic coast. *Geophys. Res. Lett.*, 43(17), 9298–9305, Sep. 16, 2016 (10.1002/2016GL070246).

Kurita, S., **Y. Miyoshi**, J. B. Blake, G. D. Reeves, and C. A. Kletzing, Relativistic electron microbursts and variations in trapped MeV electron fluxes during the 8–9 October 2012 storm: SAMPEX and Van Allen Probes observations. *Geophys. Res. Lett.*, 43(7), 3017–3025, Apr. 14, 2016 (10.1002/2016GL068260).

Lee, K.-S., **S. Imada**, K. Watanabe, Y. Bamba, and D. H. Brooks, IRIS, Hinode, SDO, and RHESSI observations of a white light flare produced directly by non-thermal electrons. *Astrophys. J.*, 36(2), 150, Feb. 20, 2017 (10.3847/1538-4357/aa5b8b).

Lin, F. F., C. Y. Wang, C. L. Su, **K. Shiokawa**, S. Saito, and Y. H. Chu, Coordinated observations of F region 3 m field-aligned plasma irregularities associated with medium-scale traveling ionospheric disturbances. *J. Geophys. Res. Space Physics*, 121(4), 3750–3766, Apr. 2016 (10.1002/2016JA022511).

Lyons, L. R., B. Gallardo-Lacourt, S. Zou, J. M. Weygand, Y. Nishimura, W. Li, M. Gkioulidou, V. Angelopoulos, E. F. Donovan, J. M. Ruohoniemi, B. J. Anderson, S. G. Shepherd, and **N. Nishitani**, The 17 March 2013 storm: Synergy of observations related to electric field modes and their ionospheric and magnetospheric Effects. *J. Geophys. Res. Space Physics*, 121(11), 10880–10897, Nov. 2016 (10.1002/2016JA023237).

Makino, Y., A. Tiberio, O. Adriani, E. Berti, L. Bonechi, M. Bongi, Z. Caccia, R. D'Alessandro, M. Del Prete, S. Detti et al. (**Y. Itow**, **K. Masuda**, **E. Matsubayashi**, **Y. Muraki**, **T. Sako**, **M. Ueno**, **Q. D. Zhou)**, Performance study for the photon measurements of the upgraded LHCf calorimeters with Gd2SiO5 (GSO) scintillators. *J. Instrum*., 12, P03023, Mar. 21, 2017 (10.1088/1748-0221/12/03/P03023).

Martinez-Calderon, C., **K. Shiokawa**, **Y. Miyoshi**, **K. Keika**, M. Ozaki, I. Schofield, M. Connors, C. Kletzing, M. Hanzelka, O. Santolik, and W. Kurth, ELF/VLF wave propagation at subauroral latitudes: Conjugate observation between the ground and Van Allen Probes A. *J. Geophys. Res. Space Physics*, 121(6), 5384–5393, Jun. 2016 (10.1002/2015JA022264).

Masunaga, H., and Z. J. Luo, Convective and large-scale mass flux profiles over tropical oceans determined from synergistic analysis of a suite of satellite observations. *J. Geophys. Res. Atmospheres*, 121(13), 7958–7974, Jul. 16, 2016 (10.1002/2016JD024753).

Masunaga, H., and **Y. Sumi**, A toy model convection with a moisture storage closure. *J. Adv. Model. Earth Syst*., 9(1), 647– 667, Mar. 23, 2017 (doi:10.1002/2016MS000855).

Masuoka, A., T. Takada, **M. Hirahara**, and K. Asamura, Database production and management of magnetometer GAS onboard Reimei Satellite: Estimation of field-aligned current. *Journal of Space Science Informatics Japan*, 6, 63–72, Mar. 17, 2017 (10.20637/JAXA-RR-16-007/0006).

Matsumoto, K., O. Abe, T. Fujiki, C. Sukigara, and **Y. Mino**, Primary productivity at the time-series stations in the northwestern Pacific Ocean: is the subtropical station unproductive? *J. Oceanogr*., 72(3), 359–371, Jun. 2016 (10.1007/s10872-016-0354-4).

Minda, H., T. Makino, N. Tsuda, and Y. Kaneko, Performance of a laser disdrometer with hydrometeor imaging capabilities and fall velocity estimates for snowfall. *IEEJ Trans. Electr. Electron. Eng.*, 11(5), 624–632, Sep. 2016 (10.1002/tee.22280).

Mino, Y., C. Sukigara, M. C. Honda, H. Kawakami, K. Matsumoto, M. Wakita, M. Kitamura, T. Fujiki, K. Sasaoka, O. Abe, J. Kaiser, and T. Saino, Seasonal variations in the nitrogen isotopic composition of settling particles at station K2 in the western subarctic North Pacific. *J. Oceanogr.*, 72(6), 819–836, Dec. 2016 (10.1007/s10872-016-0381-1).

Minoshima, T., T. Miyoshi, and **S. Imada**, Boosting magnetic reconnection by viscosity and thermal conduction. *Phys. Plasmas*, 23(7), 072122, Jul. 2016 (0.1063/1.4959852).

Miyake, F., A. J. T. Jull, I. P. Panyushkina, L. Wacker, M. Salzer, C. H. Baisan,T. Lange, R. Cruz, **K. Masuda**, and **T. Nakamura**, Large ^{14}C excursion in 5480 BC indicates an abnormal sun in the mid-Holocene. *Proc. Natl. Acad. Sci. USA*, 114(5), 881–884, Jan. 31, 2016 (10.1073/pnas.1613144114).

Miyoshi, Y., R. Kataoka, and Y. Ebihara, Flux enhancement of relativistic electrons associated with substorms. in *Waves, particles and storms in geospace*, edited by G. Balasis, et al., Oxford University Press, Oxford, UK, 333–353, Jan. 24, 2017 (10.1093/acprof:oso/9780198705246.003.0014).

Mizuochi, H., **T. Hiyama**, **H. Kanamori**, T. Ohta, Y. Fujioka, M. Iijima, and K. N. Nasahara, Water Storage Monitoring of Seasonal Wetlands in a Semi-Arid Environment by the Integrated Use of Long-Term Satellite Images and UAV Topography Measurement. *Journal of the Remote Sensing Society of Japan*, 36(2), 81–92, Oct. 28, 2016

(10.11440/rssj.36.81).

Mizuno, T., S. Abdollahi, Y. Fukui, K. Hayashi, **A. Okumura**, **H. Tajima**, and H. Yamamoto, Quantifying the interstellar medium and cosmic rays in the MBM 53, 54, and 55 molecular clouds and the Pegasus loop using Fermi-LAT gamma-ray observations. *Astrophys. J.*, 833(2), 278, Dec. 21, 2016 (10.3847/1538-4357/833/2/278).

Muraki, Y., D. Lopez, K. Koga, F. Kakimoto, T. Goka, L. X. González, **S. Masuda**, **Y. Matsubara**, H. Matsumoto, P. Miranda, O. Okudaira, T. Obara, J. Salinas, **T. Sako** et al., Simultaneous observation of solar neutrons from the International Space Station and high mountain observatories in association with a flare on July 8, 2014. *Sol. Phys.*, 291(4), 1241–1265, Apr. 21, 2016 (10.1007/s11207-016-0887-0).

Nagata, K., A. Matsubara, Y. Saito-Kokubu, and **T. Nakamura**, ^{14}C ages and calendar years of Japanese swords measured with accelerator mass Spectrometry. *Tetsu-to-Hagané*, 102(12), 736–741, Nov. 30, 2016 (10.2355/tetsutohagane.TETSU-2016-036).

Nakagawa, M., **T. Nakayama**, **H. Sasago**, **S. Ueda**, D. S. Venables, and **Y. Matsumi**, Design and characterization of a novel single-particle polar nephelometer. *Aerosol Sci Tech.*, 50(4), 392–404, Apr. 2, 2016 (0.1080/02786826.2016.1155105)

Nakamura, T. K. M., R. Nakamura, W. Baumjohann, **T. Umeda**, and I. Shinohara, Three-dimensional development of front region of plasma jets generated by magnetic reconnection. *Geophys. Res. Lett.*, 43(16), 8356–8364, Aug. 28, 2016 (10.1002/2016GL070215).

Narayanan, V. L., S. Gurubaran, and **K. Shiokawa**, Direct observational evidence for the merging of equatorial plasma bubbles. *J. Geophys. Res. Space Physics*, 121(8), 7923–7931, Aug. 2016 (10.1002/2016JA022861).

Narayanan, V. L., S. Gurubaran, **K. Shiokawa**, and K. Emperumal, Shrinking equatorial plasma bubbles. *J. Geophys. Res. Space Physics*, 121(7), 6924–6935, Jul. 2016 (10.1002/2016JA022633).

Narita, Y., R. Nakamura, W. Baumjohann, K. H. Glassmeier, U. Motschmann, B. Giles, W. Magnes, D. Fischer, R. B. Torbert, C. T. Russell, R. J. Strangeway, J. L. Burch, Y. Nariyuki, **S. Saito**, and S. P. Gary, On electron-scale whistler turbulence in the solar wind. *Astrophys. J. Lett.*, 827(1), L8, Aug. 2016 (10.3847/2041-8205/827/1/L8).

Nishikawa, H., Y. Tachibana, Y. Kawai, **M. K. Yoshioka**, and H. Nakamura, Evidence for SST-forced anomalous winds revealed from simultaneous radiosonde launches from three ships across the Kuroshio Extension front. *Mon. Wea. Rev.*, 144(10), 3553–3567, Oct. 2016 (10.1175/MWR-D-15-0442.1).

Nishimura, Y., **T. Kikuchi**, Y. Ebihara, A. Yoshikawa, S. Imajo, W. Li, and H. Utada, Evolution of the current system during solar wind pressure pulses based on aurora and magnetometer observations. *Earth Planets Space*, 68, 144, Aug. 2016 (10.1186/s40623-016-0517-y).

Nishino, M., **K. Shiokawa**, and **Y. Otsuka**, The first long-term all-sky imager observation of lunar sodium tail. *Icarus*, 280, 199–204, Dec. 2016 (10.1016/j.icarus.2016.08.004).

Nishitani, N., T. Nagatsuma, A. S. Yukimatu, H. Q. Hu, and T. Sakanoi, Special issue "Coupling of the high and mid latitude ionosphere and its relation to geospace dynamics". *Earth Planets Space*, 68, 168, Oct. 21, 2016 (10.1186/s40623-016-0543-9).

Nosé, M., **K. Keika**, C. A. Kletzing, H. E. Spence, C. W. Smith, R. J. MacDowall, G. D. Reeves, B. A. Larsen, and D. G. Mitchell, Van Allen Probes observations of magnetic field dipolarization and its associated O^+ flux variations in the inner magnetosphere at $L < 6.6$. *J. Geophys. Res. Space Physics*, 121(8), 7572–7589, Aug. 2016 (10.1002/2016JA022549).

Ogawa, S., Y. Setoguchi, K. Kawana, **T. Nakayama**, Y. Ikeda, Y. Sawada, **Y. Matsumi**, and M. Mochida, Hygroscopicity of aerosol particles and CCN activity of nearly hydrophobic particles in the urban atmosphere over Japan during summer. *J. Geophys. Res. Atmospheres*, 121(12), 7215–7234, Jun. 27, 2016 (10.1002/2015JD024636).

Ohigashi, T., **K. Tsuboki**, and M. Oue, Cloud-top supercooled liquid droplets in stratiform clouds observed during winter in inland Hokkaido, Japan. *SOLA*, 12, 140–145, Jun. 4, 2016 (10.2151/sola.2016-030).

Ohyama, H., S. Kawakami, K. Shiomi, I. Morino, and O. Uchino, Intercomparison of XH_2O data from the GOSAT TANSO-FTS (TIR and SWIR) and ground-based FTS measurements: Impact of the spatial variability of XH_2O on the intercomparison. *Remote Sens*., 9(1), 64, Jan. 2017 (10.3390/rs9010064).

Ohyama, H., S. Kawakami, O. Uchino, T. Sakai, I. Morino, T. Nagai, K. Shiomi, M. Sakashita, T. Akaho, H. Okumura, and K. Arai, Seasonal variation of the O_3-CO correlation derived from remote sensing measurements over western Japan. *Atmos. Environ*., 147, 344–354, Dec. 201 (10.1016/j.atmosenv.2016.10.027).

Oritz, E., J. F. Valdés-Galicia, **Y. Matsubara**, **Y. Nagai**, A. Hurtado, O. Musalem, R. García, M. A. Anzorena, L. X. González, **Y. Itow**, **T. Sako**, **D. Lopez**, **Y. Sasai** et al., Observation of cosmic ray hadrons at the top of the Sierra Negra volcano in Mexico with the SciCRT prototype. *Adv. Space Res*., 58(10), 2018–2025, Nov. 15, 2016 (10.1016/j.asr.2016.02.008).

Oyama, S.-I., **K. Shiokawa**, **Y. Miyoshi**, K. Hosokawa, B. J. Watkins, J. Kurihara, T. T. Tsuda, and C. T. Fallen, Lower thermospheric wind variations in auroral patches during the substorm recovery phase. *J. Geophys. Res. Space Physics*, 121(4), 3564–3577, Apr. 2016 (10.1002/2015JA022129).

Ozaki, M., **K. Shiokawa**, **Y. Miyoshi**, R. Kataoka, S. Yagitani, T. Inoue, Y. Ebihara, **C.-W Jun**, R. Nomura, K. Sakaguchi, **Y. Otsuka**, **M. Shoji**, I. Schofield, M. Connors, and V. K. Jordanova, Fast modulations of pulsating proton aurora related to subpacket structures of Pc1 geomagnetic pulsations at subauroral latitudes. *Geophys. Res. Lett.*, 43(15), 7859–7866, Aug. 16, 2016 (10.1002/2016GL070008).

Perwitasari, S., T. Sakanoi, T. Nakamura, M. K. Ejiri, M. Tsutsumi, Y. Tomikawa, **Y. Otsuka**, A. Yamazaki, and A. Saito, Three years of concentric gravity wave variability in the mesopause as observed by IMAP/VISI. *Geophys. Res. Lett.*, 43(22), 11528–11535, (10.1002/2016GL071511).

Racusin, J. L., E. Burns, A. Goldstein, V. Connaughton, C. A. Wilson-Hodge, P. Jenke, L. Blackburn, M. S. Briggs, J. Broida, J. Camp et al (**H. Tajima**), Searching the gamma-ray sky for Counterparts to gravitational wave sources: Fermi gamma-ray burst monitor and LAT observations of LVT151012 and GW151226. *Astrophys. J*., 835(1), 82, Jan. 20, 2017 (10.3847/1538-4357/835/1/82).

Ramasamy, S., A. Ida, C. Jones, S. Kato, H. Tsurumaru, I. Kishimoto, S. Kawasaki, Y. Sadanaga, Y. Nakashima, **T. Nakayama**, **Y. Matsumi**, M. Mochida, S. Kagami, Y. Deng, S. Ogawa, K. Kawana, and Y. Kaji, Total OH reactivity measurement in a BVOC dominated temperate forest during a summer campaign, 2014. *Atmos. Environ.*, 131, 41–54, Apr. 2016 (10.1016/j.atmosenv.2016.01.039).

Rattembury, N. J., D. P. Bennett, T. Sumi, N. Koshimoto, I. A. Bond, A. Udalski, Y. Shvartzvald, D. Maoz, U. G. Jorgensen, M. Dominik, et al. (**F. Abe**, **Y. Asakura**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), Faint-source-star planetary microlensing: the discovery of the cold gas-giant planet OGLE-2014-BLG-0676Lb. *Mon. Not. R. Astron. Soc.*, 466(3), 2710–2717, Apr. 2017 (10.1093/mnras/stw3185).

Richard, E., K. Okumura, K. Abe, Y. Haga, Y. Hayato, M. Ikeda, K. Iyogi, J. Kameda, Y. Kishimoto, M. Miura et al. (**K. Choi**, **Y. Itow**, **T. Suzuki**), Measurements of the atmospheric neutrino flux by Super-Kamiokande: Energy spectra, geomagnetic effects, and solar modulation. *Phys. Rev. D*, 94(5), 052001, Sep. 2, 2016 (10.1103/PhysRevD.94.052001).

Ritschel, B., F. Borchert, G. Kneitschel, G. Neher, S. Schildbach, T. Iyemori, Y. Koyama, A. Yatagai, **T. Hori**, M. Hapgood, A. Belehaki, I. Galkin, and T. King, Experiments using Semantic Web technologies to connect IUGONET, ESPAS and GFZ ISDC data portals. *Earth Planets Space*, 68, 181, Nov. 14, 2016 (10.1186/s40623-016-0542-x).

Rout, D., D. Chakrabarty, R. Sekar, G. D. Reeves, J. M. Ruohoniemi, T. K. Pant, B. Veenadhari, and **K. Shiokawa**, An evidence for prompt electric field disturbance driven by changes in the solar wind density under northward IMF Bz condition. *J. Geophys. Res. Space Physics*, 121(5), 4800–4810, May 26, 2016 (10.1002/2016JA022475).

Ruhunusiri, S., J. S. Halekas, J. P. McFadden, J. E. P. Connerney, J. R. Espley, Y. Harada, R. Livi, **K. Seki**, C. Mazelle, D. Brain, T. Hara, G. A. DiBraccio, D. E. Larson, D. L. Mitchell, B. M. Jakosky, and H. Hasegawa, MAVEN observations of partially developed Kelvin-Helmholtz vortices at Mars. *Geophys. Res. Lett.*, 43(10), 4763–4773, May 28, 2016 (10.1002/2016GL068926).

Rulten, C., A. Zech, **A. Okumura**, P. Laporte, and J. Schmoll, Simulating the optical performance of a small-sized telescope with secondary optics for the Cherenkov Telescope Array. *Astropart. Phys.*, 82, 36–48, Sep. 1, (10.1016/j.astropartphys.2016.05.002).

Saito, S., **Y. Miyoshi**, and K. Seki, Rapid increase in relativistic electron flux controlled by nonlinear phase trapping of whistler chorus elements. *J. Geophys. Res. Space Physics*, 121(7), 6573–6589, Jul. 2016 (10.1002/2016JA022696).

Sakai, T., T. Matsunaga, S. Maksyutov, S. Gotovtsev, L. Gagarin, **T. Hiyama**, and Y. Yamaguchi, Climate-induced extreme hydrologic events in the Arctic. *Remote Sens*., 8(11), 971, Nov. 2016 (10.3390/rs8110971).

Sasai, Y., **Y. Matsubara**, **Y. Itow**, **T. Sako**, **T. Kawabata**, **D. Lopez**, **R. Hikimochi**, **A. Tsuchiya**, M. Ikeno, T. Uchida et al., A faster and more reliable data acquisition system for the full performance of the SciCRT. *Nucl. Instr. Meth. A*, 857, 50–57, Jan. 3, 2017 (10.1016/j.nima.2016.12.060).

Sato, G., K. Hagino, S. Watanabe, K. Genba, A. Harayama, H. Kanematsu, J. Kataoka, M. Katsuragawa, M. Kawaharada, S. Kobayashi et al. (**H. Tajima**), The Si/CdTe semiconductor camera of the ASTRO-H Hard X-ray Imager (HXI). *Nucl. Instr. Meth. A*, 831, 235–241, Sep. 21, 2016 (10.1016/j.nima.2016.03.038).

Sato, K., **M. Minami**, O. Oshima, **K. Suzuki**, and K. Shibata, Source of a large andesite block, a natural monument at Iwagami in Maebashi, central Japan, inferred from ^{87}Sr / ^{86}Sr ratio: A preliminary report. *Bull. Gunma Mus. Natu. Hist.*, 21, 29–38, Mar. 2017.

Shiokawa, K., M-C. Fok, and M. Fujimoto, Special issue “The 12th International Conference on Substorms”. *Earth Planets Space*, 68, 87, May 24, 2016 (10.1186/s40623-016-0471-8).

Shukuya, D., and **K. Kusano**, Simulation study of hemispheric phase-asymmetry in the solar cycle. *Astrophys. J.*, 835(1), 84, Jan. 20, 2017 (10.3847/1538-4357/835/1/84).

Shvartzvald, Y., Z. Li, A. Udalski, A. Gould, T. Sumi, R. A. Street, S. Calchi Novati, M. Hundertmark, V. Bozza, C. Beichman et al. (**F. Abe**, **Y. Asakura**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), The first simultaneous microlensing observations by two space telescopes: *Spritzer* and *Swift* reveal a brown dwarf in event OGLE-2015-BLG-1319. *Astrophys. J.*, 831(2), 183, Nov. 7, 2016 (10.3847/0004-637X/831/2/183).

Shvartzvald, Y., D. Maoz, A. Udalski, T. Sumi, M. Friedmann, S. Kaspi, R. Poleski, M. K. Szymanski, J. Skowron, S. Kozlowski et al. (**F. Abe**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **Y. Wakiyama**), The frequency of snowline-region planets from four years of OGLE-MOA-Wise second-generation microlensing. *Mon. Not. R. Astron. Soc.*, 457(4), 4089–4113, Apr. 21, 2016 (10.1093/mnras/stw191).

Sukhodolo, T., I. Usoskin, E. Rozanov, E. Asvestari, W. T. Ball, M. A. J. Curran, H. Fischer, G. Kovaltsov, **F. Miyake**, T. Peter, C. Plummer, W. Schmutz, M. Severi, and R. Traversi, Atmospheric impacts of the strongest known solar particle storm of 775 AD. *Sci Rep.*, 7, 45257, Mar. 26, 2016 (10.1038/srep45257).

Sumi, T., A. Udalski, D. P. Bennett, A. Gould, R. Poleski, I. A. Bond, J. Skowron, N. Rattenbury, R. W. Pogge, T. Bensby et al. (**F. Abe**, **Y. Asakura**, **Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), The first neptune analog or super-Earth with a Neptune-like orbit:MOA-2013-BLG-605Lb. *Astrophys. J.*, 825(2), 112, Jul. 10, 2016 (10.3847/0004-637X/825/2/112).

Suzuki, D., D. P. Bennett, T. Sumi, I. A. Bond, L. A. Rogers, **F. Abe**, **Y. Asakura**, A. Bhattacharya, M. Donachie, M. Freeman et al. (**Y. Itow**, **K. Masuda**, **Y. Matsubara**, **Y. Muraki**, **H. Oyokawa**), The exoplanet mass-ratio function from the MOA-II survey: Discovery of a break and likely peak at a Neptune mass. *Astrophys. J.*, 833(2), 145, Dec. 20, 2016 (10.3847/1538-4357/833/2/145).

Suzuki, H., K. Sakanoi, **N. Nishitani**, T. Ogawa, M. K. Ejiri, M. Kubota, T. Kinoshita, Y. Murayama, and Y. Fujiyoshi, First imaging and identification of a noctilucent cloud from multiple sites in Hokkaido (43.2–44.4°N), Japan. *Earth Planets Space*, 68, 182, Nov. 14, 2016 (10.1186/s40623-016-0562-6).

Suzuki, K., K. Matsuo, and **T. Hiyama**, Satellite gravimetry-based analysis of terrestrial water storage and its relationship with run-off from the Lena River in eastern Siberia. *Int. J. Remote Sens*., 37(10), 2198–2210, Apr. 25, 2016 (10.1080/01431161.2016.1165890).

Taguchi, T., **M. Enami**, and Y. Kouketsu, Prograde evolution of Sulu UHP metamorphic rock in Yangzhuang, Junan region, deduced by combined Raman and petrological studies. *J. Metamorph. Geol.*, 34(7), 683–696, Sep. 2016 (10.1111/jmg.12203).

Takahashi, H., C. M. Wrasse, C. M. Denardini, M. B. Pádua, E. R. de Paula, S. M. A. Costa, **Y. Otsuka**, **K. Shiokawa**, J. F. Galera Monico, A. Ivo, and N. Sant'Anna, Ionospheric TEC weather map over South America. *Space Weather*, 14(11), 937–949, Nov. 2016 (10.1002/2016SW001474).

Takahashi, K., and **Y. Miyoshi**, Introduction to wave-particle interactions and their impact on energetic particles in geospace. in *Waves, particles and storms in geospace*, edited by G. Balasis, et al., Oxford University Press, Oxford, UK, 35– 50, Jan. 24, 2017 (10.1093/acprof:oso/9780198705246.003.0003).

Takahashi, N., H. Hanado, K. Nakamura, K. Kanemaru, K. Nakagawa, T. Iguchi, T. Nio, T. Kubota, R. Oki, and N. Yoshida, Overview of the end-of-mission observation experiments of Precipitation Radar onboard the Tropical Rainfall Measuring Mission Satellite. *IEEE Trans. Geosci. Remote Sens.*, 54(6), Jun. 2016 (10.1109/TGRS.2016.2518221).

Takahashi, T., K. Hosokawa, **S. Nozawa**, T. T. Tsuda, Y. Ogawa, M. Tsutsumi, Y. Hiraki, H. Fujiwara, T. D. Kawahara, N. Saito, S. Wada, **T. Kawabata**, and C. Hall, Depletion of mesospheric sodium during extended period of pulsating aurora. *J. Geophys. Res. Space Physics*, 122(1), 1212–1220, Jan. 2017 (10.1002/2016JA023472).

Taketani, F., Y. Kanaya, **T. Nakayama**, **S. Ueda**, **Y. Matusmi**, Y. Sadanaga, Y. Iwamoto, and A. Matsuki, Property of Black Carbon Particles Measured by a Laser-Induced Incandescence Technique in the spring at Noto Peninsula, Japan. *Earozoru Kenkyu*, 31(3), 194–202, Oct. 13, 2016 (10.11203/jar.31.194).

Tanaka, N., D. Levia, **Y. Igarashi**, N. Yoshifuji, K. Tanaka, C. Tantasirin, K. Nanko, M. Suzuki, and **T. Kumagai**, What factors are most influential in governing stemflow production from plantation-grown teak trees? *J. Hydrol*., 544, 10–20, Jan. 2017 (10.1016/j.jhydrol.2016.11.010).

Tanaka, T., M. Watanabe, M. Den, S. Fujita, Y. Ebihara, **T. Kikuchi**, K. K. Hashimoto, and R. Kataoka, Generation of field-aligned current (FAC) and convection through the formation of pressure regimes: Correction for the concept of Dungey's convection. *J. Geophys. Res. Space Physics*, 121(9), 8695–8711, Sep. 2016 (10.1002/2016JA022822).

Tao, C., T. Kimura, S. V. Badman, G. Murakami, K. Yoshioka, F. Tsuchiya, N. André, I. Yoshikawa, A. Yamazaki, **D. Shiota**,

H. Tadokoro, and M. Fujimoto, Variation of Jupiter's aurora observed by Hisaki/EXCEED: 1. Observed characteristics of the auroral electron energies compared with observations performed using HST/STIS. *J. Geophys. Res. Space Physics*, 121(5), 4041–4054, Spt. 2016 (10.1002/2015JA021271).

Terada, K., S. Yokota, Y. Saito, N. Kitamura, K. Asamura, and **M. N. Nishino**, Biogenic oxygen from Earth transported to the Moon by a wind of magnetospheric ions. *Nat. Astron.*, 1(2), 0026, Jan. 30, 2017 (10.1038/s41550-016-0026).

Thu, Y. K., **M. Enami**, **T. Kato**, and M. Tsuboi, Granulite facies paragneisses from the middle segment of the Mogok metamorphic belt, central Myanmar. *J. Mineral. Petrol. Sci.*, 112(1), 1–19, Feb. 2017 (10.2465/jmps.160526).

Thu, Y. K., **M. M. Win**, **M. Enami**, and M.Tsuboi, Ti-rich biotite in spinel and quartz-bearing paragneiss and related rocks from the Mogok metamorphic belt, central Myanmar. *J. Mineral. Petrol. Sci.*, 111(4), 270–282, Aug. 26, 2016 (10.2465/jmps.151020).

Tokumaru, M., **D. Satonaka**, **K. Fujiki**, **K. Hayashi**, and K. Hakamada, Relation between coronal hole areas and the solar wind speeds derived from interplanetary scintillation measurements. *Sol. Phys.*, 292(3), 41, Mar. 2017 (10.1007/s11207-017-1066-7).

Tomita, H., T. Senjyu, and M. Kubota, Evaluation of air-sea sensible and latent heat fluxes over the Japan Sea obtained from satellite, atmospheric reanalysis, and objective analysis products. *J. Oceanogr.*, 72(5), 747–760, Oct. 2016 (10.1007/s10872-016-0368-y).

Tomiyama, S., **M. Minami**, **T. Nakamura**, K. Mimura and H. Kagi, Changes of chemical structure and composition of charcoal by radiocarbon pre-treatments: Decontamination by ABA and ABOx treatments. *Radiocarbon*, 58(3), 565–581, Sep. 2016 (10.1017/RDC.2016.29).

Torii, K., Y. Hattori, K. Hasegawa, A. Ohama, T. J. Haworth, K. Shima, A. Habe, K. Tachihara, N. Mizuno, T. Onishi, **A. Mizuno**, and Y. Fukui, Triggered O star formation in M20 via cloud-cloud collision: Comparisons between high-resolution CO observations and simulations. *Astrophys. J.*, 835(2), 142, Feb. 1, 2016 (10.3847/1538-4357/835/2/142).

Tsuda, T., M. Yamamoto, H. Hashiguchi, **K. Shiokawa**, Y. Ogawa, **S. Nozawa**, H. Miyaoka, and A. Yoshikawa, A proposal on the study of solar-terrestrial coupling processes with atmospheric radars and ground-based observation network. *Radio Sci.*, 51(9), 1587–1599, Sep. 2016 (10.1002/2016RS006035).

Tsurutani, B. T., R. Hajra, T. Tanimori, A. Takada, B. Remya, A. J. Mannucci, G. S. Lakhina, J. U. Kozyra, **K. Shiokawa**, L. C. Lee, E. Echer, R. V. Reddy, and W. D. Gonzalez, Heliospheric plasma sheet (HPS) impingement onto the magnetosphere as a cause of relativistic electron dropouts (REDs) via coherent EMIC wave scattering with possible consequences for climate change mechanisms. *J. Geophys. Res. Space Physics*, 121(10), 10130–10156, Oct. 2016 (10.1002/2016JA022499),

Turunen, E., A. Kero., P. T. Verronen, **Y. Miyoshi**, **S.-I. Oyama**, and **S. Saito**, Mesospheric ozone destruction by high-energy electron precipitation associated with pulsating aurora. *J. Geophys. Res. Atmospheres*, 121(9), 852–861, Oct. 2016 (10.1002/2016JD025015).

Uchino, H., **S. Kurita**, Y. Harada, **S. Machida**, and V. Angelopoulos, Waves in the innermost open boundary layer formed by dayside magnetopause reconnection. *J. Geophys. Res. Space Physics*, 122(3), 3291–3307, Mar. 2017 (10.1002/2016JA023300)

Ueyama, M., N. Tahara, H. Iwata, E. S. Euskirchen, H. Ikawa, H. Kobayashi, H. Nagano, **T. Nakai**, and Y. Harazono, Optimization of a biochemical model with eddy covariance measurements in black spruce forests of Alaska for estimating CO_2 fertilization effects. *Agric. For. Meteorol.*, 222, 98–111, May 28, 2016 (10.1016/j.agrformet.2016.03.007).

Umeda, T., and K. Fukazawa, Hybrid parallelization of hyper-dimensional Vlasov code with OpenMP loop collapse directive in *Parallel Computing: On the Road to Exascale, Advances in Parallel Computing, 27*, edited by G. R. Joubert, H. Leather, M. Parsons, F. Peters, and M. Sawyer, IOS Press, Amsterdam, 265–274, Apr. 30, 2016 (10.3233/978-1-61499-621-7-265).

Umeda, T., and K. Fukazawa, Performance comparison of Eulerian kinetic Vlasov code between flat-MPI parallelism and hybrid parallelism on Fujitsu FX100 supercomputer. *Proceedings of the 23rd European MPI Users' Group Meeting*, 218–221, Sep. 25, 2016 (10.1145/2966884.2966891).

Umeda, T., and **Y. Wada**, Secondary instabilities in the collisionless Rayleigh-Taylor instability: Full kinetic simulation. *Phys. Plasmas*, 23(11), 112117, Nov. 2016 (10.1063/1.4967859).

Umeda, T., **N. Yamauchi**, **Y. Wada**, and **S. Ueno**, Evaluating gyro-viscosity in the Kelvin-Helmholtz instability by kinetic simulations. *Phys. Plasmas*, 23(5), 054506, May 2016 (10.1063/1.4952632).

Umemura, N., **T. Segawa**, **Y. Miyashita**, **K. Keika**, **Y. Miyoshi**, **T. Hori**, **M. Shoji**, Y. Tanaka, K. Seki, and I. Shinohara, Development and future plans of the web based data analysis tool ERGWAT. *Journal of Space Science Informatics Japan*, 6, 25–38, Mar. 2017 (10.20637/JAXA-RR-16-007/0003).

Usui, H., Y. Miyake, **M. N. Nishino**, T. Matsubara, and J. Wang, Electron dynamics in the minimagnetosphere above a lunar magnetic anomaly. *J. Geophys. Res. Space Physics*, 122(2), 1555–1571, Feb. 2017(10.1002/2016JA022927).

Veneziani, M., E. Schisano, D. Elia, A. Noriega-Crespo, S. Carey, A. Di Giorgio, Y. Fukui, B. M. T. Maiolo, Y. Maruccia, **A. Mizuno** et al., An analysis of star formation with Herschel in the Hi-GAL Survey - II. The tips of the Galactic bar. *Astron. Astrophys*., 599, A7, Mar. 2017 (10.1051/0004-6361/201423474).

Wada, R., **Y. Matsumi**, S. Takanashi, Y. Nakai, **T. Nakayama**, **M. Ouchi**, **T. Hiyama**, Y. Fujiyoshi, T. Nakano, **N. Kurita**, K. Muramoto, and N. Kodama, *In situ* measurement of CO_2 and water vapour isotopic compositions at a forest site using mid-infrared laser absorption spectroscopy. *Isotopes Environ. Health Stud*., 52(6), 603–618, Dec. 2016 (10.1080/10256016.2016.1147441).

Wakita, M., M. C. Honda, K. Matsumoto, T. Fujiki, H. Kawakami, S. Yasunaka, Y. Sasai, **C. Sukigara**, M. Uchimiya, K. Kitamura, T. Kobari, **Y. Mino**, A. Nagano, S. Watanabe, and T. Sain, Biological organic carbon export estimated from the annual carbon budget observed in the surface waters of the western subarctic and subtropical North Pacific Ocean from 2004 to 2013. *J. Oceanogr.*, 72(5), 665–685, Oct. 2016 (10.1007/s10872-016-0379-8).

Wang, H., C. Liu, K. Ahn, Y. Xu, J. Jing, N. Deng, N. Huang, R. Liu, **K. Kusano**, G. D. Fleishman, D. E. Gary, and W. Cao, High-resolution observations of flare precursors in the low solar atmosphere. *Nat. Astron*., 1(5), 0085, Mar. 29, 2017 (10.1038/s41550-017-0085).

Wang, J. B., L. P. Zhu, Y. Wang, P. Peng, Q. F. Ma, T. Haberzettl, T. Kasper, T. Matsunaka, and **T. Nakamura**, Variability of the ^{14}C reservoir effects in Lake Tangra Yumco, Central Tibet (China), determined from recent sedimentation rates and dating of plant fossils. *Quat. Int*., 430(B), 3–11, Feb. 12, 2017 (10.1016/j.quaint.2015.10.084).

Wang, S., C. Xiao, **J. Ishizaka**, Z. Qiu, D. Sun, **Q. Xu**, **Y. Zhu**, Y. Huan, and Y. Watanabe, Statistical approach for the retrieval of phytoplankton community structures from *in situ* fluorescence measurements. *Opt. Express*, 24(21), 23635–23653, Oct. 17, 2016 (10.1364/OE.24.023635).

Wiegert, P., **M. Connors**, and C. Veillet, A retrograde co-orbital asteroid of Jupiter. *Nature*, 543(7647), 687–689, Mar. 29, 2017 (10.1038/nature22029).

Yanase, M., A., K. Yasunaga, and **H. Masunaga**, Relationship between the direction of diurnal rainfall migration and the ambient wind over the Southern Sumatra Island. *Earth Space Science*, 4(3), 117–127, Mar. 3, 2017 (10.1002/2016EA000181).

Yatagai, A., and **S.-I. Oyama**, Notes and Correspondence. Thermospheric nocturnal wind climatology observed by Fabry-Perot interferometers over the Asia-Oceania region. *J. Meteorol. Soc. Jpn. Ser. II*, 94(6), 525–536, Jan. 10, 2017 (10.2151/jmsj. 2016-026).

Yoshida, M., Y. Utsumi, N. Tominaga, T. Morokuma, M. Tanaka, **Y. Asakura**, K. Matsubayashi, K. Ohta, **F. Abe**, S. Chimasu et al., J-GEM follow-up observations of the gravitational wave source GW151226. *Publ. Astron. Soc. Japan*, 69(1), 9, Feb.2017 (10.1093/pasj/psw113).

Zhu, Y., **J. Ishizaka**, S. C. Tripathy, S. Wang, **Y. Mino**, T. Matsuno, and D. J. Suggett, Variation of the photosynthetic electron transfer rate and electron requirement for daily net carbon fixation in Ariake Bay, Japan. *J. Oceanogr,*. 72(5), 761–776, Oct. 2016 (10.1007/s10872-016-0370-4).

Zou, Y., Y. Nishimura, L. R. Lyons, and **K. Shiokawa**, Localized polar cap precipitation in associationwith nonstorm time airglow patches. *Geophys. Res. Lett.*, 44(2), 609–617, Jan. 28, 2017 (10.1002/2016GL071168).

Zou, Y., Y. Nishimura, J. K. Burchill, D. J. Knudsen, L. R. Lyons, **K. Shiokawa**, S. Buchert, S. Chen, M. J. Nicolls, J. Ruohoniemi, K. A. McWilliams, and **N. Nishitani**, Localized field-aligned currents in the polar cap associated with airglow patches. *J. Geophys. Res. Space Physics*, 121(10), 1017–10189, Oct. 2016 (10.1002/2016JA022665).

Zwart, C., N. C. Munksgaarda, **N. Kurita**, and M. I. Bird, Stable isotopic signature of Australian monsoon controlled by regional convection. *Quat. Sci. Rev.*, 151, 228–235, Nov. 1, 2016 (10.1016/j.quascirev.2016.09.010).

Five more Papers were published in Japanese.

Books (April 2016–March 2017)

Kumagai, T., H. Kanamori, and N. A. Chappell, Tropical forest hydrology. *Forest Hydrology: Processes, Management and Assessment*, edited by D. M. Amatya, T. M. Williams, L. Bren, and C. de Jong, 308pp, CAB International, Wallingford, UK, Sep. 2016 (doi:10.1079/9781780646602.0017).

Five more books were published in Japanese.

Publication of Proceedings

Title	Date of Publication
Proceedings of 22th Symposium on Atmospheric Chemistry	Oct. 12, 2016
Proceedings of 21th Workshop on Lidar Observation of Atmosphere	Feb. 14, 2017
Meeting on Perspectives in Computational Atmosphere and Ocean Science and 8th OFES International Workshop	Mar. 1, 2017
The Nagoya University Bulletin of Chronological Research, vol.1	Mar. 31, 2017

Two more proceedings were published in Japanese.

Conference Presentations (April 2016–March 2017)

■ International Conferences

Title	Country/ Region	Date	Orga- nizers	Number of Presentations			
				Staffs and PDs	Students	Total	invited
Space Climate 6 Symposium	Levi, Finland	Apr. 4–7, 2016	0	1	0	1	1
2016 SHIELDS Workshop: Shielding Society from Space Weather	Santa Fe, New Mexico, U.S.A.	Apr. 4–8, 2016	0	1	0	1	0
The 8th CCMC Community Workshop	Annapolis, Maryland, U.S.A.	Apr. 11–15, 2016	0	1	0	1	1
Van Allen Probes, Science Working Group Meeting	Laurel, Maryland, U.S.A.	Apr. 13–22, 2016	0	2	0	2	0
European Geosciences Union General Assembly 2016	Vienna, Austria	Apr. 17–22, 2016	0	3	1	4	0
AMS 32nd Conference on Hurricanes and Tropical Meteorology	San Juan, Puerto Rico	Apr. 17–22, 2016	0	1	1	2	0
International Conference on Mesoscale Convective System and High-Impact Weather (ICMCS-XI), BEXCO	Busan, Korea	Apr. 25–28, 2016	1	4	1	5	0
ImPACT International Symposium on InSECT 2016	Nagoya, Japan	Apr. 26–27, 2016	0	1	1	2	1
Space Weather Workshop 2016	Broomfield, Colorado, U.S.A.	Apr. 26–29, 2016	0	1	0	1	1
QCD at Cosmic Energies VII	Chalkida, Greece	May 16–20, 2016	0	1	0	1	1
International Ocean Vector Wind Science Team Meeting 2016	Sapporo, Japan	May 17–19, 2016	0	1	0	1	0
Theoretical and Observational Approaches to the Solar Magnetic Field: Achievements and Remaining Problems Conference in Honor of Prof. Takashi Sakurai's Career	Tokyo, Japan	May 27, 2016	0	1	0	1	0
SuperDARN 2016 Workshop	Fairbanks, Alaska, U.S.A.	May 29–Jun. 3, 2016	0	4	0	4	0
Japan-Norway Young Scientists Forum	Tokyo, Japan	Jun. 1, 2016	0	0	1	1	0
Japan-Norway Arctic Science and Innovation Week 2016	Tokyo, Japan	Jun. 2–3, 2016	0	1	0	1	0
9th International Workshop on Aerosol and Cloud Physics	Daegu, Korea	Jun. 2–3, 2016	0	1	0	1	1
1st VarSITI General Symposium	Varna, Bulgaria	Jun. 6–10, 2016	1	5	0	5	2
12th International Workshop on Greenhouse Gas Measurements from Space (IWGGMS)	Kyoto, Japan	Jun. 7–9, 2016	0	3	1	4	0
6th international HEPPA-SOLARIS workshop	Helsinki, Finland	Jun. 13–17, 2016	0	1	0	1	0
53rd Association for Tropical Biology and Conservation (ATBC) 2016 Annual Meeting	Montpellier, France	Jun. 19–23, 2016	0	1	0	1	0
IRIS-6: The Chromosphere	Stockholm, Sweden	Jun. 20–23, 2016	0	1	0	1	0
27th Symposium on Plasma Physics and Technology	Prague, Czech	Jun. 20–23, 2016	0	1	0	1	0
GEM Summer Workshop 2016	Santa Fe, New Mexico, U.S.A.	Jun. 20–24, 2016	0	1	0	1	0
XI. International Conference on Permafrost (ICOP)	Potsdam, Germany	Jun. 20–24, 2016	0	1	0	1	0
The 26th Goldschmidt Conference	Yokohama, Japan	Jun. 26–Jul. 1, 2016	1	7	2	9	1
18th International Congress on Plasma Physics (ICPP 2016)	Kaohsiung, Taiwan	Jun. 26–Jul. 1, 2016	0	1	0	1	1
International Beacon Satellite Symposium (BSS) 2016	Trieste, Italy	Jun. 26–Jul. 1, 2016	0	0	1	1	0

Title	Country/ Region	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	invited
European Week of Astronomy and Space Science	Athens, Greece	Jul. 4–8, 2016	0	1	0	1	0
The XXVII International Conference on Neutrino Physics and Astrophysics (Neutrino 2016)	London, U.K.	Jul. 4–9, 2016	0	0	1	1	0
6th East-Asia School and Workshop on Laboratory, Space, and Astrophysical plasmas (EASW2016)	Tsukuba, Japan	Jul. 11–16, 2016	1	1	2	3	1
International Workshop: Dynamics and Interactions of the Ocean and the Atmosphere	Sendai, Japan	Jul. 13–15, 2016	0	1	0	1	0
9th International Cloud modeling Workshop	Exeter, U.K.	Jul. 18–22, 2016	0	1	0	1	0
The 2016 Leverhulme Trust International Network Meeting on Waves and Turbulence	Cambridge, U.K.	Jul. 13–26, 2016	0	1	0	1	0
The 15th Symposium of Study of the Earth's Deep Interior (SEDI2016)	Nantes, France	Jul. 25–29, 2016	0	2	0	2	0
17th International Conference on Clouds and Precipitation	Manchester, U.K.	Jul. 25–29, 2016	0	1	0	1	0
6th IAGA/ICMA/SCOSTEP Workshop on Vertical Coupling in the Atmosphere-Ionosphere System	Taipei, Taiwan	Jul. 25–29, 2016	0	0	1	1	0
15th RHESSI workshop	Graz, Austria	Jul. 26–30, 2016	0	1	0	1	0
Recent Advances in Paleoclimate Studies	Kashiwa, Japan	Jul. 27–Aug. 2, 2016	0	1	0	1	0
Beyond the Standard Model with Neutrino Detectors (BSMND 2016)	Suwon, Korea	Jul. 28–29, 2016	0	1	0	1	1
The 6th International Maar Conference (IMC)	Changchun, China	Jul. 30–Aug. 3, 2016	0	1	0	1	0
Asia Oceania Geosciences Society (AOGS) 13th Annual Meeting	Beijing, China	Jul. 31–Aug. 5, 2016	0	8	2	10	3
JSPS Core-to-Core Program (B. Asia-Africa Science Platforms), Collaborative Research between Mongolia, China and Japan on Outbreaks of Asian Dust and Environmental Regime Shift, Third JSPS Seminar	Ulaanbaatar, Mongolia	Aug. 7–12, 2016	0	1	0	1	0
Scientific Committee on Antarctic Research (SCAR) 2016 Open Science Conference	Kuala Lumpur, Malaysia	Aug. 20–30, 2016	0	1	0	1	0
URSI Asia-Pacific Radio Science Conference 2016	Seoul, Korea	Aug. 21–25, 2016	0	3	0	3	3
19th International Symposium on Very High Energy Cosmic Ray Interactions (ISVHECRI 2016)	Moscow, Russia	Aug. 22–27, 2016	1	2	0	2	1
Quadrennial Ozone Symposium 2016	Edinburgh, U.K.	Sep. 4–9, 2016	0	3	0	3	0
Hinode-10 Science Meeting	Nagoya, Japan	Sep. 5–8, 2016	5	8	3	11	1
Japan-Norway Meeting on Offshore Energy Systems: Wing Power and HVDC Grids	Trondheim, Norway	Sep. 7–9, 2016	0	1	0	1	0
Solar-C Science Meeting	Nagoya, Japan	Sep. 8, 2016	0	1	0	1	1
Solar Physics with Radio Observations -Continued Operation of Nobeyama Radioheliograph-	Nagoya, Japan	Sep. 9–10, 2016	1	1	0	1	0
International Symposium on Recent Observations and Simulations of the Sun–Earth System III	Varna, Bulgaria	Sep. 12–16, 2016	0	1	0	1	1
International Symposium on the Whole Atmosphere (ISWA)	Tokyo, Japan	Sep.14–16, 2016	0	1	1	2	1
7th Biennial VERSIM Symposium	Hermanus, South Africa	Sep. 19–23, 2016	0	1	0	1	1
23rd European MPI Users' Group Meeting (EuroMPI2016)	Edinburgh, U.K.	Sep. 25–28, 2016	0	1	0	1	0

Title	Country/ Region	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	invited
GSA 2016 Annual Meeting	Denver, Colorado, U.S.A.	Sep. 25–28, 2016	0	2	0	2	0
2016 Iran-Japan Joint International Workshop on Isotope Geology	Kurdistan, Iran	Oct. 1–2, 2016	0	2	0	2	2
2016 International Conference on Ultra-High Energy Cosmic Rays (UHECR2016)	Kyoto, Japan	Oct. 11–14, 2016	2	2	2	4	1
SDO 2016: Unraveling the Sun’s Complexity	Burlington, Vermont, U.S.A.	Oct. 17–21, 2016	0	1	0	1	0
American Association for Aerosol Research (AAAR) 34th Annual Conference	Portland, Oregon, U.S.A.	Oct. 17–21, 2016	0	1	0	1	0
2016 The 4th AOSWA Workshop Asia Oceania Space Weather Alliance	Jeju, Korea	Oct. 24–27, 2016	0	3	0	3	3
2nd Annual Last Millennium Reanalysis Workshop	Seattle, Washington, U.S.A.	Oct. 25–26, 2016	0	1	0	1	0
The 35th JSST Annual Conference International Conference on Simulation Technology (JSST2016)	Kyoto, Japan	Oct.27–29, 2016	0	1	0	1	0
The IX International Symposium in Yakutsk “C/H_2O/Energy Balance and Climate over the Boreal and Arctic Regions with Special Emphasis on Eastern Eurasia”	Yakutsk, Russia	Nov. 1–4, 2016	0	1	0	1	1
PICES 2016 Annual Meeting	San Diego, California, U.S.A.	Nov. 2–13, 2016	0	0	1	1	0
13th APPC-AIP Congress	Brisbane, Australia	Nov. 4–8, 2016	0	1	0	1	1
4th THEMIS-Cluster Workshop	Palm Spring, California, U.S.A.	Nov. 7–12, 2016	0	1	0	1	1
BepiColombo Science Working Team Meeting	Tokyo, Japan	Nov. 8–10, 2016	0	1	0	1	0
9th European Conference on Radar in Meteorology and Hydrology (ERAD2016)	Antalya, Turkey	Nov. 10–14, 2016	0	1	0	1	0
13th European Space Weather Week (ESWW13)	Oostende, Belgium	Nov. 14–18, 2016	0	1	0	1	0
Chemical Aeronomy in the Mesosphere and Ozone in the Stratosphere (CHAMOS) meeting	Luosto, Finland	Nov. 28–Dec. 2, 2016	0	2	0	2	0
The Seventh Symposium on Polar Science	Tokyo, Japan	Nov. 28–Dec. 2, 2016	0	4	2	6	0
ISEE Workshop on Ionospheric Plasma Bubble Seeding and Development	Nagoya, Japan	Nov. 29–Dec. 2, 2016	2	2	0	2	2
UiT Space Physics seminar	Tromsø, Norway	Nov. 30, 2016	0	1	0	1	1
International Symposium on GNSS 2016	Tainan, Taiwan	Dec. 5–7, 2016	0	1	0	1	1
AGU Fall Meeting 2016	San Francisco, California, U.S.A.	Dec. 12–16, 2016	0	17	13	30	1
The 29th International Superconductivity Symposium	Tokyo, Japan	Dec. 13–15, 2016	0	0	1	1	0
The 4th Asian/13th Korea-Japan Workshop on Ocean Color (4th AWOC/13th KJWOC)	Chon Buri, Thailand	Dec. 13–16, 2016	0	1	3	4	0
UCSD 2016 IPS workshop	San Diego, California, U.S.A.	Dec. 18–20, 2016	1	3	0	3	3
A Japan-Thailand Joint Seminar on Marine Environment in the Gulf of Thailand	Chon Buri, Thailand	Dec. 21, 2016	0	1	0	1	0
Symposium on “New development in astrophysics through multimessenger observations of gravitational wave sources”	Kyoto, Japan	Dec. 26–28, 2016	0	1	1	2	0
The 3rd KMI International Symposium on “Quest for the Origin of Particles and the Universe” (KMI2017)	Nagoya, Japan	Jan. 5–7, 2017	0	2	3	5	1

Title	Country/ Region	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	invited
International Workshop "Review of the accomplishments of the mid-latitude SuperDARN network"	Nagoya, Japan	Jan. 10–14, 2017	1	0	0	0	0
Solarnet IV Meeting	Lanzarote, Spain	Jan. 16–20, 2017	0	1	0	1	0
The First International Research Progress Workshop	Abu Dhabi, UAE	Jan. 18–19, 2017	0	2	0	2	1
Joint PI meeting of Global Environment Observation Mission 2016	Tokyo, Japan	Jan. 23–27, 2017	0	2	0	2	0
Workshop on “Application of Ocean and Climate Predictions”	Yokohama, Japan	Jan. 25–26, 2017	0	1	0	1	0
Swedish Space Plasma Physics Meeting	Kiruna, Sweden	Feb. 14–15, 2017	0	1	0	1	0
Weather Modification Scientist Training Course	Bangkok, Thailand	Feb. 20–23, 2017	0	3	0	3	3
International workshop for climate variability and related studies over North East Indian subcontinent	Nagoya, Japan	Feb. 21–22, 2017	0	2	0	2	0
айнской кулхътры срелневековъя и Нового времени	Hakodate, Japan	Feb. 25–26, 2017	0	1	0	1	0
2nd GEOlab-RISH Joint workshop on GNSS and SAR Technologies for Atmospheric Sensing The 331st Symposium on Humanosphere Science	Kyoto, Japan	Mar. 6–9, 2017	0	1	1	2	1
2nd International Workshop on Cloud Turbulence	Nagoya, Japan	Mar. 8–10, 2017	0	1	0	1	0
22nd NEXT Workshop	Kyoto, Japan	Mar. 9–10, 2017	0	1	0	1	1
Meeting on Perspectives in Computational Atmosphere and Ocean Science and 8th OFES International Workshop	Nagoya, Japan	Mar. 13–14, 2017	1	2	0	2	0
First CCore-RENSEA Seminar on Coastal Ecosystems in Southeast Asia	Selangor, Malaysia	Mar. 14–16, 2017	0	1	0	1	0
MR2017	Matsuyama, Japan	Mar. 19–23, 2017	0	0	1	1	1
Russia-Japan Workshop on Arctic Research 2017	Moscow, Russia	Mar. 20–21, 2017	0	1	0	1	0
The 2nd PSTEP International Symposium (PSTEP-2)	Kyoto, Japan	Mar. 23–24, 2017	1	11	0	11	1
Total			19	176	47	223	50

■ Domestic Conferences

Number of Conferences	Organizers	Number of Presentations			
		Staff and PDs	Student	Total	invited
120	77	294	155	449	30

■ Lectures for Researchers

Date	Titel	Number of Participants
Apr. 21, 2016, May 21, 2016, Jun. 21, 2016, Jul. 12, 2016, Aug. 23, 2016, Sep. 29, 2016, Oct. 20, 2016, Nov. 25, 2016, Dec. 5, 2016, Jan.19, 2017, Feb.14, 2017, Mar. 21, 2017	PSTEP Seminar	60 a time on average

Date	Titel	Number of Participants
Jun. 15, 2016, Aug. 3, 2016, Sep. 12, 2016, Sep. 15, 2016, Sep. 27, 2016, Oct. 7, 2016, Oct. 12, 2016, Oct. 14, 2016, Oct. 18, 2016, Nov. 1, 2016, Nov. 11, 2016, Nov. 30, 2016, Feb. 3, 2017, Feb. 10, 2017, Feb. 17, 2017, Mar. 27, 2017	ISEE/CICR colloquium	20 a time on average
Apr.12–13, 2016	Mini-workshop on “Towards a collaboration for ocean research from space between Vietnam and Japan”	11
Apr. 20, 2016, Apr. 2, 2016, May 25, 2016, Jun. 1, 2016, Jun. 8, 2016, Jun. 15, 2016	ROOT Training Workshop 2016	70
Jun. 6–10, 2016	First VarSITI General Symposium	115
Jul. 6, 2016	Labo Seminar “Laboratory of Meteorology Hydrospheric Atmospheric Research Center”	25
Sep. 12, 2016	Labo Seminar “Laboratory of Meteorology Hydrospheric Atmospheric Research Center”	16
Oct. 25, 2016	46th Mesoscale Meteorology Workshop	130
Nov. 10–Dec.10, 2016	26th IHP Training Course	39
Dec.18–12, 2016	UCSD IPS Workshop 2016	22
Dec. 27, 2016	Guest Seminar “Unrealistically pristine air in the Arctic produced by current global scale models”	24
Jan. 20, 2017	Guest Seminar “Frontogenesis and frontolysis in the Agulhas Return Current region”	
Feb. 1, 2017	Guest Seminar “Multi satellite-derived global ocean surface wind vector data set: construction and validation”	
Feb. 20, 2017	Atmosphere-Ocean Seminar “Importance of ocean for tropical cyclone activity in 60 km-AGCM/AOGCM”	
Feb. 23, 2017	Guest Seminar “Verification of a positive feedback process with respect to the rapid development of extratropical cyclones over warm currents”	16
Feb. 24, 2017	Guest Seminar “Solar wind interaction with the Moon”	25
Feb. 27, 2017	SELIS Seminar	24
Mar. 15, 2017	Institute Lecture on Ocean Environment	21

Awards

■ Staffs and PDs

Date	Awards	Award Winners	Title
Jun. 28, 2016	NASA Group Achievement Award (GAA)	Nobuhiro Takahashi	TRMM End of Mission Team
Jul. 27, 2016	Doornbos Memorial Prize, The Committee on Study of Earth's Deep Interior (SEDI), the International Union of Geodesy and Geophysics (IUGG)	Kumiko Hori	For outstanding work on theoretical and numerical studies of waves and dynamos in the core dynamics
Sep. 16, 2016	Scholarly Publishing Award of the Japan Society of Hydrology and Water Resources	Tetsuya Hiyama	"Siberia, Water and Social Environments in the Warming Far North" *Published in Japanese.
Nov. 1, 2016	Best Poster Award WWEC2016 Tokyo	Kazuhisa Tsuboki Masaya Kato	Wind Power Simulation and Analysis Incorporating Highly-Resolved Weather Prediction and Measurement Data of Japan *The Award was shared by six scientists.

Additionally, one domestic award.

■ Students

Date	Awards	Award Winners	Title
May 31, 2016	JpGU - AGU Joint Meeting 2017 Outstanding Student Presentation Award	Takuya Shibayama	Fast magnetic reconnection supported by sporadic small-scale Petschek-type shocks
		Heqiucen Xu	Statistical Analysis of Severe Magnetic Fluctuations in the near-Earth Magnetotail Observed by THEMIS-E
Jul. 1, 2016	International HPC Summer School 2016 "Parallel Programming Challenge" First Prize	Takuya Shibayama	
Jul. 6, 2016	Nagoya University Outstanding Graduate Student Award	Takuya Shibayama	
Sep. 24, 2016	Japan Association of Mineralogical Sciences "Journal of Mineralogical and Petrological Sciences" Best Paper Award for Student Scientists 2015	Tomoki Taguchi	Coexistence of jadeite and quartz in garnet of the Sanbagawa metapelite from the Asemi-gawa region, central Shikoku, Japan. Journal of Mineralogical and Petrological Sciences, 109-4, 169–176, 2014.
Nov. 11, 2016	Mass Spectrometry Society of Japan Isotope-ratio Mass Spectrometry 2016 Outstanding Student Presentation Award	Hikari Mukumoto	An attempt on ^{14}C dating and reconstruction of diet for cremated remains of Jokei, a Buddhist monk
Dec. 1, 2016	SGEPSS Student Presentation Award (Aurora Medal) 2016	Daiki Takeo	Long-term variation of phase velocity spectra of mesospheric and thermospheric waves observed in airglow images at Shigaraki
Jan. 8, 2017	Institute of Electronics, Information and Communication, Engineers Electronics Society, Technical Committee on Electron Devices 2016 Outstanding Student Paper Award	Naoki Akiyama	Linearity measurement of SIS(Superconductor-Insulator-Superconductor) mixer for millimeter-wave radiometer

11. Education

The Institute for Space–Earth Environmental Research primarily offers graduate programs in three schools, i.e., Science, Engineering, and Environmental Studies; however, it also provides opportunities for both undergraduate and postdoctoral experiences in these schools. In addition to the academic staff of the faculties, specially appointed members also contribute to education via graduate and undergraduate courses. Graduates are enrolled in the doctoral programs. Academic members are responsible for guiding the progress of the students' thesis projects. The students studying at the institute also have opportunities to attend seminars and discussions with foreign researchers and to participate in international meetings/conferences and observations/experiments.

Graduate Programs

The institute has its own graduate course program for Heliospheric and Geospace Physics as a part of the Division of Particle and Astrophysical Science in the Graduate School of Science at Nagoya University.

In addition, it cooperates with the Department of Electrical Engineering and Computer Science via the Space Electromagnetic Environment group (http://www.nuee.nagoya-u.ac.jp/soshiki/electrical-e.php) 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 http://www.env.nagoya-u.ac.jp/english/dept/index.html) in the Graduate School of Environmental Studies by teaching/training graduate students in disciplines related to Space–Earth Environmental Research. They also teach core and topical courses.

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			
		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	Hydroclimatology	Oceanography
Institute for Space–Earth Environmental Research	Integrated Studies			●				●						
	Cosmic-Ray Research				●									
	Heliospheric Research					●								
	Ionospheric and Magnetospheric Research		●				●							
	Meteorological and Atmospheric Research	●					●				●	●		
	Land–Ocean Ecosystem Research												●	●
	Chronological Research				●				●	●				

Number of Students Supervised by ISEE Staff

(April 1, 2016–March 31, 2017)

	M1	M2	D1	D2	D3	Undergraduate Students	Research Students	Total
Graduate School of Science	16	19	6	3	10	-	-	54
Graduate School of Engineering	8	10	0	0	1	-	-	19
Graduate School of Environmental Studies	7	9	1	5	7	-	3	32
School of Science	-	-	-	-	-	3	-	3
School of Engineering	-	-	-	-	-	12	-	12
Total	31	38	7	8	18	15	3	120

* cumulative total in FY 2016

Faculty Members

■ Graduate School of Science Division of Particle and Astrophysical Science

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Solar-Terrestrial Chemistry	Yutaka Matsumi		Tomoki Nakayama	
	Akira Mizuno	Tomoo Nagahama		
Solar-Terrestrial Relationships	Masafumi Hirahara	Satonori Nozawa	Shin-ichiro Oyama	
	Kazuo Shiokawa	Yuichi Otsuka		
	Kanya Kusano	Satoshi Masuda		Akimasa Ieda
Solar-Terrestrial Physics	Yoshitaka Itow	Kimiaki Masuda	Takashi Sako	Akira Okumura
	Hiroyasu Tajima	Fumio Abe		
		Yutaka Matsubara		
	Munetoshi Tokumaru			Ken-ichi Fujiki

■ Graduate School of Engineering Department of Electrical Engineering and Computer Science

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

■ Graduate School of Environmental Studies Department of Earth and Environmental Sciences

Field/Topics	Professor	Associate Professor	Lecture	Assistant Professor
Hydrospheric-Atmospheric Sciences Course Global Water Cycle	Kazuhisa Tsuboki	Taro Shinoda		
	Nobuhiro Takahashi	Hirohiko Masunaga		
	Tetsuya Hiyama	Tomo'omi Kumagai	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 2016 Academic Year, The Following Courses were Offered;

- First Year Seminar A
- Foundations of Electromagnetics I, ll
- Laboratory in Physics
- Fundamentals of Earth Science I
- Astrophysics and Space Science
- Science of Atmospheric-Hydrospehric Environment
- Introduction to Earth Science
- Experimental Physics
- Physics Experiments I/ll
- Introduction to Physics I
- Experiments in Physics - Advanced Course
- Astrophysics III
- Solar System Science
- Atmospheric and Hydrospheric Sciences
- Petrology
- Geochemical Analysis I and Experiments
- Environmental Earth Sciences
- Electromagnetic Wave Engineering
- Electric Circuits with Exercise
- Probability Theory and Numerical Analysis with Exercises
- Mathematics 1 with Exercises A/B

12. International Relations

Academic Exchange

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 andAtmospheric 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 Projects

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, Australia, India, China, *and other countries*	SCOSTEP
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 Italy Russia China	JHUAPL, Virginia Polytechnic Institute and State University University of Leicester LPC2E/CNRS University of KwaZulu-Natal La Trobe University University of Saskatchewan IFSI ISTP/SB RAS Polar Research Institute of China
Project for Development of the Atmospheric Environmental Risk Management System in South America	A. Mizuno	Argentina Chile	CEILAP University of Magallanes(UMAG)

■ International Collaborative Project

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Solar Researches with Nobeyama Radioheliograph	S. Masuda	U.S.A. China Korea Russia U.K. Germany	GSFC/NASA, Catholic University of America National Astronomical Observatories Chinese Academy of Sciences, Shandong University KASI, Seoul National University Russian Academy of Sciences University of Warwick Georg-August-Universität Göttingen
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
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 Notre Dame
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 Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
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 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 Solar Neutrons	Y. Matsubara	Bolivia Armenia China Switzerland U.S.A. Mexico	Research Institute of Physics, University of San Andres 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
Study in Interaction of Very High Energy Cosmic Rays by Using Relativistic Heavy Ion Collider	T. Sako	Italy U.S.A.	University of Florence, Catania University Brookhaven National Laboratory
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. India Mexico	LOFAR-UK Tata Institute of Fundamental Research National Autonomous University of Mexico
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.	CSPAR/University of Alabama in Huntsville
Magnetic Conjugate Observations of Midlatitude Thermospheric Disturbances	K. Shiokawa	Australia	Radio and Space Service/IPS
Variation of the Thermosphere and Ionosphere owing to the Energy of Atmospheric Waves	K. Shiokawa	Indonesia	LAPAN
High-Sensitive Imaging Measurements of Airglow and Aurora in the Canadian Arctic	K. Shiokawa	U.S.A. Canada	University of California, Augsburg College University of Calgary, Athabasca University
Ionosphere and Upper Atmosphere Research, Observations and Monitoring	K. Shiokawa	Thailand	Chiang Mai 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

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
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
Research and Development of the Low-Energy Electron Instrument Onboard the ERG Satellite	M. Hirahara	Taiwan	Academia Sinica Institute of Astronomy and Astrophysics, National Cheng Kung University
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 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
Study of Pulsating Aurora Using AMISR and Optical Instruments	S. Oyama	U.S.A.	University of Maryland, College Park, University of Alaska Fairbanks, SRI International
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
Laboratory Studies on Atmospheric Fate Processes of Hydrofluorocarbons	Y. Matsumi	U.S.A.	Ford Research Laboratory
Laboratory Studies on Elementary Reactions of Atmospheric Minor Constituents	Y. Matsumi	U.K.	University of Bristol
Application of the Cavity Ring Down (CRD) Spectroscopy to Atmospheric Measurements	Y. Matsumi	U.S.A.	Geophysical Institute, University of Alaska Fairbanks
Research on Optical Properties of Atmospheric Aerosol Particles	Y. Matsumi	Ireland	University College Cork
Continuous Observation of Methane at a Paddy Field in Northern India	Y. Matsumi	India	University of Delhi
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
Global Precipitation Measurement Mission (GPM)	H. Masunaga	U.S.A.	NASA
Tropical Cyclones-Pacific Asian Research Campaign for Improvement of Intensity Estimations/Forecasts (T-PARCII)	K. Tsuboki T. Shinoda	Taiwan	National Taiwan University Atmospheric Sciences
Study of Equatorial Waves in the Atmosphere and Ocean	H. Aiki	Germany	GEOMAR Helmholtz Centre for Ocean Research Kiel

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
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 Thai 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
Flood- and Drought-Adaptive Cropping Systems to Conserve Water Environments in Semi-arid Regions	T. Hiyama	Namibia	University of Namibia
Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS), a CoreProject of the Future Earth Program	T. Hiyama	Sweden, Finland, U.K., China, *and other countries*	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
Understanding How Drought Affects the Risk of Increased Mortality in Tropical Rain Forests	T. Kumagai	U.K. Malaysia U.S.A.	Natural Environment Research Council *and other institutes*
Biodiversity And Land-use Impacts on Tropical Ecosystem Function (BALI) - A Multidisciplinary Consortium Exploring the Biogeochemical Impacts of Tropical Forest Degradation, Agricultural Conversion and Biodiversity Loss	T. Kumagai	U.K.	Natural Environment Research Council
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)
Stable Isotopes in Precipitation and Paleoclimatic Archives in Tropical Areas to Improve Regional Hydrological and Climatic Impact Models	N. Kurita	U.S.A., Australia, Argentina, Brazil, Bangladesh, China, *and other counties*	International Atomic Energy Agency (IAEA)
Towards a Deeper understanding of Tropical Isoscapes	N. Kurita	Australia	James Cook University, Cairn
Comparison Between 1 MV AMS and 5 MV AMS on Precision and Accuracy of ^{10}Be Measurement	M. Minami	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)

Research Project	ISEE Representative	Collaborating Country/Region	Collaborating Organization
Radiocarbon Dating of Kraftu Cave Guano Deposit in Kurdistan, Iran	M. Minami	Iran	University of Kurdistan
High Precision Radiocarbon Measurements of Tree Annual Rings	T. Nakamura	U.S.A.	Department of Geosciences, University of Arizona
Radiocarbon Measurement of Peat Sediments in Aleutian Islands, Alaska, North America	T. Nakamura	U.S.A.	The Museum of the Aleutians, Unalaska
Eruption History of the Calderas Located in Bali, Indonesia	T. Nakamura	Indonesia	Department of Geological Engineering, Gadjah University
Investigation on Bottom Topography and the Formation Ages of Maar Lakes in Philippines Using the Lake Sediments	T. Nakamura	Philippine	Philippine Institute of Volcanology and Seismology
Heidelberg pure CO_2 Intercomparison Project	T. Nakamura	Germany	Heidelberg University
Study on History of Palaeo-Environmental Changes Based on Radiocarbon Ages of Cored-Sediment Samples from a Wetland in South India	T. Nakamura	India	Indian Institute of Science, Banglore
Study on Radiocarbon Chronology of Buddhistic Archaeological Remains at the Bamiyan Site, Islamic Republic of Afghanistan	T. Nakamura	France	Directeur de la Mission Archéologique Française
Study of Grand-Water Circulation Based on ^{14}C Ages of Underground Water and Hot-Spring Water Samples from Korea	T. Nakamura	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)
Research and Development on Geochemical Proxies of Isotope and Trace Element for Understanding of Earth and Universe Evolution Processes	G. Tanaka	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)

Visitors from Foreign Institutes

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Tong Phuoc Hoang Son	Viet Nam	Institute of Oceanography, Vietnam Academy of Science and Technology	Apr. 11–17, 2016	Participant in the Symposium
Nguyen Huu Huan	Viet Nam	Institute of Oceanography, Vietnam Academy of Science and Technology	Apr. 11–17, 2016	Participant in the Symposium
Tran Van Chung	Viet Nam	Institute of Oceanography, Vietnam Academy of Science and Technology	Apr. 11–17, 2016	Participant in the Symposium
Nguyen Khoa Son	Viet Nam	Vietnamese National Space Program	Apr. 11–17, 2016	Participant in the Symposium
David Tsiklauri	U.K.	Queen Mary University of London	May 20, 2016	Visitor
Takanobu Yamaguchi	U.S.A.	NOAA Earth System Research Laboratory	Jun. 15–16, 2016	Visitor
Andrew Hillier	U.K.	University of Cambridge	Jun. 21, 2016	Visitor
Maria D. Kazachenko	U.S.A.	UCB	Jun. 30, 2016	Visitor
Chin-Ho Tsai	Taiwan	National Dong Hwa University	Jul. 2–8, 2016	Foreign Collaborative Researcher
Bernard V. Jackson	U.S.A.	CASS, UCSD	Jul. 4–5, 2016	Foreign Collaborative Researcher
Shin-Yi Huang	Taiwan	National Taiwan Normal University	Jul. 4–15, 2016	Visitor
Chih-Sheng Chang	Taiwan	National Taiwan Normal University	Jul. 4–15, 2016	Visitor
Hua Hsu	Taiwan	National Taiwan Normal University	Jul. 4–22, 2016	Visitor
Chien-Chang Huang	Taiwan	National Taiwan Normal University	Jul. 4–22, 2016	Visitor
Yu-Han Chen	Taiwan	National Taiwan Normal University	Jul. 4–22, 2016	Visitor
Shih-How Lo	Taiwan	National Taiwan Normal University	Jul. 4–Aug. 28, 2016	Visitor
Bing Zhang	China	Chinese Academy of Sciences	Jul. 25, 2016	Foreign Collaborative Researcher
Liping Lei	China	Chinese Academy of Sciences	Jul. 25, 2016	Foreign Collaborative Researcher
Deung-Lyong Cho	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)	Jul. 29–Aug. 9, 2016	Foreign Collaborative Researcher
Michael Bell	U.S.A.	University of Hawaii at Manoa	Aug. 3–5, 2016	Participant in the Symposium
Satoshi Inoue	Germany	Max Planck Institute for Solar System Research	Aug. 24–Sep. 23, 2016	Participant in the Symposium
Stephen White	U.S.A.	USAF Air Force Research Laboratory	Aug. 31–Sep. 24, 2016	Foreign Collaborative Researcher
Anglu Shen※	China	Chinese Academy of Fishery Sciences (CAFS)	Aug. 31–Sep. 1, 2016	Foreign Collaborative Researcher
Sanjiv K. Tiwari	U.S.A.	MSFC, NASA	Sep. 2–10, 2016	Participant in the Symposium
Andrew Hillier	U.K.	University of Cambridge	Sep. 3–9, 2016	Participant in the Symposium
Bernhard Fleck	U.S.A.	GSFC, NASA/ESA	Sep. 3–9, 2016	Participant in the Symposium
Viggo H. Hansteen	Norway	University of Oslo	Sep. 3–9, 2016	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Krishna Mooroogen	U.K.	Northumbria University	Sep. 3–9, 2016	Participant in the Symposium
Graham Barnes	U.S.A.	NorthWest Research Associates	Sep. 3–9, 2016	Participant in the Symposium
Ivan Sharkin	Russia	Space Research Institute of Russian Academy of Sciences	Sep. 3–9, 2016	Participant in the Symposium
Kathy Reeves	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Sep. 3–10, 2016	Participant in the Symposium
James A. Klimchuk	U.S.A.	NASA	Sep. 3–10, 2016	Participant in the Symposium
Luis Bellot Rubio	Spain	Instituto de Astrofísica de Andalucía	Sep. 3–10, 2016	Participant in the Symposium
Sami K. Solanki	Germany	Max Planck Institute of Solar System Research	Sep. 3–10, 2016	Participant in the Symposium
Patrick Antolin	U.K.	University of St. Andrews	Sep. 3–10, 2016	Participant in the Symposium
Paul J. Wright	U.K.	University of Glasgow	Sep. 3–10, 2016	Participant in the Symposium
Dominik Utz	Belgium	Centre for mathematical Plasma Astrophysics, KU Leuven	Sep. 3–10, 2016	Participant in the Symposium
Kirill Kuzanyan	Russia	IZMIRAN、Russian Academy of Sciences	Sep. 3–10, 2016	Participant in the Symposium
Sergiy Shelyag	U.K.	Northumbria University	Sep. 3–10, 2016	Participant in the Symposium
Tanmoy Samanta	India	Indian Institute of Astrophysics	Sep. 3–10, 2016	Participant in the Symposium
Girjesh R. Gupta	India	Inter-University Centre for Astronomy and Astrophysics	Sep. 3–10, 2016	Participant in the Symposium
Alberto Sainz Dalda	U.S.A.	High Altitude Observatory of National Center for Atmospheric Research	Sep. 3–10, 2016	Participant in the Symposium
Edward E. Deluca	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Sep. 3–11, 2016	Participant in the Symposium
Mark Weber	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Sep. 3–11, 2016	Participant in the Symposium
Ted Tarbell	U.S.A.	Lockheed Martin	Sep. 3–11, 2016	Participant in the Symposium
Valery M. Nakariakov	U.K.	University of Warwick	Sep. 4–8, 2016	Participant in the Symposium
Göran B. Scharmer	Sweden	Stockholm University	Sep. 4–8, 2016	Participant in the Symposium
Ada Ortiz Carbonell	Spain	Instituto de Astrofísica de Andalucía	Sep. 4–8, 2016	Participant in the Symposium
Inigo Arregui	Spain	Instituto de Astrofísica de Canarias	Sep. 4–9, 2016	Participant in the Symposium
David R. Williams	Spain	European Space Astronomy Centre, European Space Agency	Sep. 4–9, 2016	Participant in the Symposium
Artem Ulyanov	Russia	P. N. Lebedev Physical Institute of the Russian Academy of Sciences	Sep. 4–9, 2016	Participant in the Symposium
Giulio Del Zanna	U.K.	University of Cambridge	Sep. 4–9, 2016	Participant in the Symposium
Adam Kobelski	U.S.A.	University of Alabama in Huntsville	Sep. 4–10, 2016	Participant in the Symposium
Harry P. Warren	U.S.A.	Naval Research Laboratory	Sep. 4–10, 2016	Participant in the Symposium
Alphonse C. Sterling	U.S.A.	NASA	Sep. 4–10, 2016	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Stephane Regnier	U.K.	Northumbria University	Sep. 4–10, 2016	Participant in the Symposium
Navin C. Joshi	Korea	Kyung Hee University	Sep. 4–10, 2016	Participant in the Symposium
Krishna Prasad Sayamanthula	U.K.	Queen's University Belfast	Sep. 4–10, 2016	Participant in the Symposium
Pradeep Kayshap	India	Inter-University Centre for Astronomy and Astrophysics	Sep. 4–10, 2016	Participant in the Symposium
Tiago M. D. Pereira	Norway	University of Oslo	Sep. 4–10, 2016	Participant in the Symposium
Yoshiaki Kato	Norway	University of Oslo	Sep. 4–10, 2016	Participant in the Symposium
Zhao Wu	China	Shandong University	Sep. 4–12, 2016	Participant in the Symposium
Andreas Lagg	Germany	Max Planck Institute of Solar System Research	Sep. 5–8, 2016	Participant in the Symposium
George Doschek	U.S.A.	Naval Research Laboratory	Sep. 5–8, 2016	Participant in the Symposium
Iain G. Hannah	U.K.	University of Glasgow	Sep. 5–8, 2016	Participant in the Symposium
Marc L. DeRosa	U.S.A.	Lockheed Martin Solar and Astrophysics Laboratory	Sep. 5–8, 2016	Participant in the Symposium
Georgios Chintzoglou	U.S.A.	Lockheed Martin Solar and Astrophysics Laboratory	Sep. 5–8, 2016	Participant in the Symposium
Mark Cheung	U.S.A.	Lockheed Martin Solar and Astrophysics Laboratory	Sep. 5–8, 2016	Participant in the Symposium
David Brooks	U.S.A.	College of Science, George Mason University,	Sep. 5–8, 2016	Participant in the Symposium
Louise Harra	U.K.	Mullard Space Science Laboratory, University College London	Sep. 5–8, 2016	Participant in the Symposium
Deborah Baker	U.K.	Mullard Space Science Laboratory, University College London	Sep. 5–8, 2016	Participant in the Symposium
John Culhane	U.K.	Mullard Space Science Laboratory, University College London	Sep. 5–8, 2016	Participant in the Symposium
Antonia Savcheva	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Sep. 5–8, 2016	Participant in the Symposium
Stanislav Gunár	Czech	Astronomical Institute of the Czech Academy of Sciences	Sep. 5–8, 2016	Participant in the Symposium
Elena Dzifcakova	Czech	Astronomical Institute of the Czech Academy of Sciences	Sep. 5–8, 2016	Participant in the Symposium
Charalambos Kanella	Norway	University of Oslo	Sep. 5–8, 2016	Participant in the Symposium
Pia Zacharias	Norway	University of Oslo	Sep. 5–8, 2016	Participant in the Symposium
Jack Carlyle	Norway	University of Oslo	Sep. 5–8, 2016	Participant in the Symposium
Susanna Parenti	France	Institut d'Astrophisique Spatiale	Sep. 5–8, 2016	Participant in the Symposium
Miho Janvier	France	Institut d'Astrophysique Spatiale	Sep. 5–8, 2016	Participant in the Symposium
Eun-Kyung Lim	Korea	Korea Astronomy and Space Science Institute	Sep. 5–8, 2016	Participant in the Symposium
Seiji Yashiro	U.S.A.	The Catholic University of America	Sep. 5–8, 2016	Participant in the Symposium
Navdeep K. Panesar	U.S.A.	MSFC, NASA	Sep. 5–8, 2016	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Melania Cubas Armas	Spain	Instituto de Astrofísica de Canarias	Sep. 5–8, 2016	Participant in the Symposium
K. D. Leka	U.S.A.	NorthWest Research Associates	Sep. 5–8, 2016	Participant in the Symposium
Dae Jung Yu	Belgium	Catholic University of Leuven	Sep. 5–8, 2016	Participant in the Symposium
Steven H. Saar	U.S.A.	Smithsonian Astrophysical Observatory	Sep. 5–8, 2016	Participant in the Symposium
Neal Hurlburt	U.S.A.	Lockheed Martin Advanced Technology Center	Sep. 5–8, 2016	Participant in the Symposium
Jeffrey W. Reep	U.S.A.	Naval Research Laboratory	Sep. 5–8, 2016	Participant in the Symposium
Nariaki Nitta	U.S.A.	Lockheed Martin Solar and Astrophysics Laboratory	Sep. 5–8, 2016	Participant in the Symposium
Alan Title	U.S.A.	Lockheed Martin Advance Technology Laboratory	Sep. 5–8, 2016	Participant in the Symposium
Sabrina Savage	U.S.A.	MSFC, NASA	Sep. 5–8, 2016	Participant in the Symposium
David E. Mckenzie	U.S.A.	MSFC, NASA	Sep. 5–8, 2016	Participant in the Symposium
Scott Mclntosh	U.S.A.	High Altitude Observatory of National Center for Atmospheric Research	Sep. 5–8, 2016	Participant in the Symposium
Hugh Hudson	U.S.A.	Space Sciences Laboratory, UCB	Sep. 5–12, 2016	Participant in the Symposium
Elena Kupriyanova	Belgium	Catholic University of Leuven	Sep. 5–12, 2016	Participant in the Symposium
Yingna Su	China	Purple Mountain Observatory, Chinese Academy of Sciences	Sep. 6–9, 2016	Participant in the Symposium
Lyndsay Fletcher	U.K.	University of Glasgow	Sep. 6–10, 2016	Participant in the Symposium
Alexander Morgachev	Russia	Pulkovo Astronomical Observatory	Sep. 9, 2016	Participant in the Symposium
Sergei Kuznetsov	Russia	Pulkovo Astronomical Observatory	Sep. 9, 2016	Participant in the Symposium
Hongyu Liu	China	Shandong University	Sep. 9–10, 2016	Participant in the Symposium
Victor F. Melnikov	Russia	Pulkovo Astronomical Observatory	Sep. 9–10, 2016	Participant in the Symposium
Leonid V. Filatov	Russia	Nizhny Novgorod State University of Architecture and Civil Engineering	Sep. 9–10, 2016	Participant in the Symposium
Jing Huang	China	National Astronomical Observatories of the Chinese Academy of Sciences	Sep. 9–10, 2016	Participant in the Symposium
Chengming Tan	China	National Astronomical Observatories of the Chinese Academy of Sciences	Sep. 9–10, 2016	Participant in the Symposium
Yihua Yan	China	National Astronomical Observatories of the Chinese Academy of Sciences	Sep. 9–10, 2016	Participant in the Symposium
Jean-Pierre Raulin	Brazil	Centro de Rádio Astronomia e Astrofísica Mackenzie (CRAAM), Presbyterian Mackenzie University	Sep. 9–10, 2016	Participant in the Symposium
Nat Gopalswamy	U.S.A.	GSFC, NASA	Sep. 9–10, 2016	Participant in the Symposium
Jorge Chau	Germany	Leibniz-Institute for Atmospheric Physics	Sep. 10–13, 2016	Visitor
Jozsef Kota	U.S.A.	University of Arizona	Sep. 14–Oct. 15, 2016	Foreign Collaborative Researcher
Rene A. Ong	U.S.A.	UCLA	Sep. 15, 2016	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Jie Ren※	China	School of Earth and Space Sciences, Peking University	Oct. 1, 2016– Jan. 31, 2018	Foreign Collaborative Researcher
Sunil Gupta	India	Tata Institute of Fundamental Research	Oct. 3–22, 2016	Foreign Collaborative Researcher
Pravata K. Mohanty	India	Tata Institute of Fundamental Research	Oct. 3–22, 2016	Foreign Collaborative Researcher
Nader Siklawi	Lebanon	Ministry of Culture, Directorate General of Antiquities, Lebanon	Oct. 4, 2016	Foreign Collaborative Researcher
Syun-Ichi Akasofu	U.S.A.	University of Alaska Fairbanks	Oct. 18, 2016	Participant in the Symposium
Mahboubeh Asgari-Targhi	U.S.A.	Harvard-Smithsonian Center for Astrophysics	Oct. 20–Nov. 7, 2016	Foreign Collaborative Researcher
Seung-Gu Lee	Korea	Korea Institute of Geoscience and Mineral Resources (KIGAM)	Nov. 10–11, 2016	Foreign Collaborative Researcher
Chio Z. (Frank) Cheng	Taiwan	National Cheng Kung University	Nov. 11, 2016	Participant in the Symposium
Grigory Vekstein	U.K.	University of Manchester	Nov. 20–Dec. 6, 2016	Foreign Collaborative Researcher
Segun Bolaji	Nigeria	University of Lagos	Nov. 22–Dec. 14 2016	Foreign Collaborative Researcher
Roland Takuya Tsunoda	U.S.A.	Center for Geospace Studies, SRI	Nov. 26–Dec. 3, 2016	Participant in the Symposium
Chen-Tung Arthur Chen	Taiwan	National Sun Yat-sen University	Nov. 27–Dec. 1, 2016	Visiting Lecturer
Tulasiram Sudarsanam	India	Indian Institute of Geomagnetism	Nov. 27–Dec. 3, 2016	Participant in the Symposium
Chaosong Huang	U.S.A.	Air Force Research Laboratory	Nov. 27–Dec. 3, 2016	Participant in the Symposium
Mangalathayil Ali Abdu	Brazil	INPE	Nov. 27–Dec. 3, 2016	Participant in the Symposium
Fabiano Da Silveira Rodrigues	U.S.A.	William B. Hanson Center for Space Sciences, The University of Texas at Dallas	Nov. 27–Dec. 3, 2016	Participant in the Symposium
Christina Eunjin Kong	Korea	Korea Institute of Ocean Science and Technology	Nov. 27–Dec. 10, 2016	Foreign Trainee
Huanxin Li	China	Ocean University of China	Nov. 27–Dec. 10, 2016	Foreign Trainee
Eunbyeol Cho	Korea	Seoul National University	Nov. 27–Dec. 10, 2016	Foreign Trainee
Anna Sergeevna Vazhova	Russia	Pacific Fisheries Research Center (TINRO)	Nov. 27–Dec. 10, 2016	Foreign Trainee
Thai Duy To	Viet Nam	Marine Physic Department, Institute of Oceanography	Nov. 27–Dec. 10, 2016	Foreign Trainee
Phattaranakorn Nakornsantiphap	Thai	Hydro Power Plant, Electrisity Generating Authority of Thailand	Nov. 27–Dec. 10, 2016	Foreign Trainee
Qurnia Wulan Sari	Indonesia	Environmental Science, University of Sriwijaya	Nov. 27–Dec. 10, 2016	Foreign Trainee
Tatiana Aleksandrovna Mikhailik	Russia	V. I. Il'ichev Pacific Oceanological Institute - Laboratory of Hydrochemistry	Nov. 27–Dec. 10, 2016	Foreign Trainee
Jerome Wai Kit Kok	Singapore	National University of Singapore	Nov. 27–Dec. 10, 2016	Foreign Trainee
Keun-Ok Lee	France	Pierre and Marie Curie University, Paris 6	Nov. 28–Dec. 1, 2016	Visitor
Brett Carter	Australia	SPACE Research Centre, School of Science, Royal Melbourne Institute of Technology University	Nov. 28–Dec. 3, 2016	Participant in the Symposium
Guozhu Li	China	Institute of Geology and Geophysics, Chinese Academy of Science	Nov. 28–Dec. 3, 2016	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Sukumaran Nair Geerha Kumari Sumod ※	India	Department of Physics (Research & PG DEPT.), Sacred Heart College, Mahatma Gandhi University	Dec. 1–28, 2016	Foreign Collaborative Researcher
James Anderson Wild	U.K.	Lancaster University	Jan. 8–15, 2017	Participant in the Symposium
Mark Lester	U.K.	University of Leicester	Jan. 8–15, 2017	Participant in the Symposium
John Michael Ruohoniemi	U.S.A.	Virginia Polytechnic Institute and State University	Jan. 8–15, 2017	Participant in the Symposium
Gareth Chisham	U.K.	British Antarctic Survey	Jan. 8–15, 2017	Participant in the Symposium
Alexandre Vasilyevich Koustov	Canada	University of Saskatchewan	Jan. 9–15, 2017	Participant in the Symposium
Aurelie Aude Marchaudon	France	Institute de Recherche en Astrophysique et Planétologie, CNRS	Jan. 9–15, 2017	Participant in the Symposium
Evan Grier Thomas	U.S.A.	Dartmouth College	Jan. 9–15, 2017	Participant in the Symposium
Simon George Shepherd	U.S.A.	Dartmouth College	Jan. 9–15, 2017	Participant in the Symposium
Roman Makarevich	U.S.A.	University of Alaska Fairbanks	Jan. 10–17, 2017	Participant in the Symposium
Hsiu-Shan Yu	U.S.A.	CASS, UCSD	Jan. 13–20, 2017	Foreign Collaborative Researcher
Bernard V. Jackson	U.S.A.	CASS, UCSD	Jan. 13–20, 2017	Foreign Collaborative Researcher
Kyung Sun Park	Korea	Chungbuk National University	Jan. 15–21, 2017	Foreign Collaborative Researcher
Trofim Maximov	Russia	Institute for Biological Problems of Cryolithozone, SB RAS	Jan. 15–29, 2017	Participant in the Symposium
Baolin Tan	China	National Astronomical Observatories, Chinese Academy of Sciences	Jan. 17–23, 2017	Foreign Collaborative Researcher
Chengming Tan	China	National Astronomical Observatories, Chinese Academy of Sciences	Jan. 17–23, 2017	Foreign Collaborative Researcher
Aleksei Desiatkin	Russia	Institute for Biological Problems of Cryolithozone, SB RAS	Jan. 18–25, 2017	Participant in the Symposium
Aleksandr Fedorov	Russia	Melnikov Permafrost Institute, SB RAS	Jan. 18–25, 2017	Participant in the Symposium
Jing Huang	China	National Astronomical Observatories, Chinese Academy of Sciences	Jan. 23–30, 2017	Foreign Collaborative Researcher
Neel Prakash Savani-Patel※	U.S.A.	GSFC, NASA	Jan. 23–Feb. 24, 2017	Foreign Collaborative Researcher
Sébastien Rougerie	France	Centre national d'études spatiales	Jan. 26–27, 2017	Participant in the Symposium
Seiji Yashiro	U.S.A.	The Catholic University of America	Feb. 2–3, 2017	Foreign Collaborative Researcher
Nasir Ahmed	Bangladesh	Atomic Energy Research Establishment	Feb. 8–17, 2017	Foreign Trainee
Nasreen Akter	Bangladesh	Bangladesh University of Engineering and Technology	Feb. 19–24, 2017	Participant in the Symposium
Shakhawat Hossain	Bangladesh	Jahangiragar University	Feb. 19–24, 2017	Participant in the Symposium
Rahul Mahanta	India	Cotton University	Feb. 21, 2017	Participant in the Symposium
Abdul Mannan	Bangladesh	Bangladesh Metrological Department	Feb. 21, 2017	Participant in the Symposium
A. Q. M. Mahbub	Bangladesh	University of Dhaka	Feb. 21, 2017	Participant in the Symposium

Name	Country/ Region	Affiliation	Period	Status at Nagoya University
Saraju Baidya	Nepal	Department of Hydrology and Meteorology	Feb. 21, 2017	Participant in the Symposium
Roberto Bruno	Italy	Institute di Astrofisica Planetologia Spaziali, Istituto Nazionale di Astrofisica	Feb. 27–Mar. 9, 2017	Participant in the Symposium
Hsiu-Shan Yu	U.S.A.	CASS, UCSD	Feb. 28–Mar. 4, 2017	Foreign Collaborative Researcher
Bernard V. Jackson	U.S.A.	CASS, UCSD	Feb. 28–Mar. 4, 2017	Foreign Collaborative Researcher
Matthias Rempel	U.S.A.	High Altitude Observatory of National Center for Atmospheric research	Mar. 1–3, 2017	Foreign Collaborative Researcher
Zoltán Vörös	Austria	Space Research Institute, Austrian Academy of Sciences	Mar. 1–4, 2017	Participant in the Symposium
Yasuhito Narita	Austria	Space Research Institute, Austrian Academy of Sciences	Mar. 1–4, 2017	Participant in the Symposium
Horia Comisel	Germany	Technische Universität Braunschweig	Mar. 1–4, 2017	Participant in the Symposium
Sergey Ostapchenko	Germany	Frankfurt Institute for Advanced Studies	Mar. 7–16, 2017	Visitor
Erik van Sebille	U.K.	Imperial College of London	Mar. 10–16, 2017	Participant in the Symposium
Daniel Neil Baker	U.S.A.	University of Colorado, Boulder	Mar. 11–15, 2017	Participant in the Symposium
Jianping Gan	Hong Kong	The Hong Kong University of Science and Technology	Mar. 13–14, 2017	Participant in the Symposium
Yuchun Lin	Taiwan	National Central University	Mar. 13–14, 2017	Participant in the Symposium
Shih-Ming Huang	Taiwan	National Central University	Mar. 13–14, 2017	Participant in the Symposium
Kelvin Richards	U.S.A.	International Pacific Research Center, University of Hawaii	Mar. 13–14, 2017	Participant in the Symposium
Niklas Schneider	U.S.A.	International Pacific Research Center, University of Hawaii	Mar. 13–14, 2017	Participant in the Symposium
Esa Turunen	Finland	Sodankylä Geophysical Observatory, University of Oulu	Mar. 13–17, 2017	Foreign Collaborative Researcher
Pekka Verronen	Finland	Finnish Meteorological Institute	Mar. 13–17, 2017	Foreign Collaborative Researcher
Sung-Hong Park	Ireland	Trinity College Dublin	Mar. 19–25, 2017	Participant in the Symposium
Michel Wheatland	Australia	University of Sydney	Mar. 20–25, 2017	Participant in the Symposium
Hsiu-Shan Yu	U.S.A.	CASS, UCSD	Mar. 21–28, 2017	Foreign Collaborative Researcher
Engenio Berti	Itary	University of Florence	Mar. 21–Apr. 9, 2017	Visitor
Cesar La Hoz	Norway	University of Tromsø	Mar. 24–29, 2017	Foreign Collaborative Researcher
Kyung Sun Park	Korea	Chungbuk National University	Mar. 27–31, 2017	Foreign Collaborative Researcher

※Foreign Visiting Staff

Seminars by Foreign Visitors

Date	Name	Affiliation	Title	Number of Participant
Apr. 12, 2016	Nguyen Khoa Son	Vietnam National Space Program	Mini-workshop on "Towards a collaboration for ocean research from space between Vietnam and Japan" "Vietnam national program for space research: some results of the first phase and plans of the second phase that will be started in 2016"	11
Apr. 12, 2016	Nguyen Huu Huan	Institute of Oceanography, Vietnam Academy of Science and Technology	Mini-workshop on "Towards a collaboration for ocean research from space between Vietnam and Japan" "Introduction of human resources and some results of oceanography researches focused on modelling and remote sensing"	11
Apr.12, 2016	Tong Phuoc Hoang Son	Institute of Oceanography, Vietnam Academy of Science and Technology	Mini-workshop on "Towards a collaboration for ocean research from space between Vietnam and Japan" "Study on marine ecosystems by remote sensing technologies in VietNam for focused on Ninh Thuan – Binh Thuan waters"	11
Apr. 13, 2016	Tran Van Chung	Institute of Oceanography, Vietnam Academy of Science and Technology	Mini-workshop on "Towards a collaboration for ocean research from space between Vietnam and Japan" "Study on oceanography modelling in the Institute of Oceanography focus on hydrodynamical characteristics in the upwelling waters of South of VietNam"	11
May 20, 2016	David Tsiklauri	Queen Mary University of London, U.K.	Special Seminar "Damping of Alfven waves and associated particle acceleration in the inhomogeneous coronal and solar wind plasmas"	15
Jun. 15, 2016	Takanobu Yamaguchi	Earth System Research Laboratory of National Oceanic and Atmospheric Administration, U.S.A.	6th ISEE/CICR Colloquium "Stratocumulus to cumulus transition in the presence of elevated smoke layers"	16
Jun. 21, 2016	Andrew Hiller	University of Cambridge, U.K.	ISEE Solar Meeting "Variations in the Axisymmetric Transport of Magnetic Elements on the Sun"	15
Jun. 30, 2016	Maria D. Kazachenko	Space Sciences Laboratory, UCB, U.S.A.	Special Solar Seminar at ISEE "Electric Fields on the Sun: How Can We Determine Them and Why Should We Care?"	15
Jul. 7, 2016	Chin-Ho Tsai	National Dong Hwa University, Taiwan	Structural Petrology Group Seminar "Tailuko and Yuli metamorphic belts of Taiwan"	14
Jul. 8, 2016	Lei Cai※	JSPS Postdoctoral Fellowships for Research in Japan	Friday Seminar of Division for Ionospheric and Magnetospheric Research "Electromagnetic energy input to the high-latitude ionosphere"	29
Jul. 25, 2016	Zhang Bing	Chinese Academy of Sciences	Institute Seminar "Introduction of Optical Remote Sensing Research in RADI"	13
Aug. 3, 2016	Michael Bell	University of Hawaii at Manoa, U.S.A.	7th ISEE/CICR Colloquium "Aircraft Observations of Tropical Cyclones: Past, Present, and Future"	29
Aug. 4, 2016 Aug. 5, 2016	Michael Bell	University of Hawaii at Manoa, U.S.A.	Typhoon Seminar 2016 "Aircraft Observations of Tropical Cyclones: Past, Present, and Future!"	32
Sep. 12, 2016	Jorge Chau	Leibniz Institute of Atmospheric Physics at the Rostock University, Germany	8th ISEE/CICR Colloquium "Unusual 5-m E region field-aligned irregularities observed from Northern Germany during the magnetic storm of March 17, 2015"	25
Sep. 15, 2016	Rene A. Ong	UCLA, U.S.A.	9th ISEE/CICR Colloquium "The Future of Very High Energy Astrophysics"	30
Sep. 27, 2016	Hisao Takahashi※	INPE, Brazil	10th ISEE/CICR Colloquium "Ionospheric Plasma Bubble Study in Brazil: Today's Aspect"	22

Date	Name	Affiliation	Title	Number of Participant
Oct. 10, 2016	Nanan Balan※	University of Sheffield, U.K.	11th ISEE/CICR Colloquium “Severe space weather and its relevance to the High-Tech society (1/2) ”	29
Oct. 12, 2016	Jozsef Kota	University of Arizona, U.S.A.	12th ISEE/CICR Colloquium “Voyager 1 observations in the interstellar space”	20
Oct. 14, 2016	Antti Ensio Kero※	Sodankylä Geophysical Observatory University of Oulu, Finland	13th ISEE/CICR Colloquium “D-region ionization characteristics inverted from ground based electron density measurements”	22
Oct. 18, 2016	Syun-Ichi Akasofu	International Arctic Research Center (IARC), University of Alaska Fairbanks, U.S.A.	Substorm Seminar “No direct connection: The magnetotail and auroral substorms”	20
Oct. 18, 2016	Syun-Ichi Akasofu	International Arctic Research Center (IARC), University of Alaska Fairbanks, U.S.A.	14th ISEE/CICR Colloquium “The future of global warming and the forthcoming Big Ice Age”	25
Oct. 25, 2016	Mahboubeh Asgari-Targhi	Harvard-Smithsonian Center for Astrophysics, U.S.A.	ISEE Solar Seminar “Characterizing the modeling and observations of coronal heating”	13
Oct. 28, 2016	Nanan Balan※	University of Sheffield, U.K.	Friday Seminar of Division for Ionospheric and Magnetospheric Research “Severe space weather and its relevance to the High-Tech society(2/2) ”	20
Nov. 1, 2016	Jeongwoo Lee※	Seoul National University, Korea	15th ISEE/CICR Colloquium “Study of solar flares inside a large magnetic fan structure with NoRH observations”	18
Nov. 11, 2016	Chio Z. (Frank) Cheng	National Cheng Kung University, Taiwan	16th ISEE/CICR Colloquium “Driven magnetic reconnection processes”	16
Nov. 25, 2016	Segun Bolaji	University of Lagos, Nigeria	Friday Seminar of Division for Ionospheric and Magnetospheric Research “SSW connects the lower with upper atmosphere and modelling efforts”	27
Nov. 30, 2016	Keun-Ok Lee	Université Pierre-et-Marie-Curie, Psaris 06, France	17th ISEE/CICR Colloquium “Heavy precipitation events around Mediterranean Sea and field campaign“	16
Nov. 30, 2016	Chen-Tung Arthur Chen	National Sun Yat-sen University, Taiwan	26th IHP Training Course, Key Note Lecture “Melting Tibetan Ice Shield”	39
Dec. 9, 2016	Hisao Takahashi※	INPE, Brazil	Friday Seminar of Division for Ionospheric and Magnetospheric Research “Ionospheric plasma bubbles and MSTID: what we learned from the ISEE workshop”	20
Dec. 16, 2016	Sukumaran Nair Geerha Kumari Sumod※	Department of Physics (Research & PG DEPT.) Sacred Heart College, Mahatma Gandhi University, India	Friday Seminar of Division for Ionospheric and Magnetospheric Research “Coupling processes in the equatorial upper atmosphere”	18
Jan. 20, 2017	Baolin Tan	National Astronomical Observatories, Chinese Academy of Sciences	Special Seminar “Solar microwave type III bursts and the diagnostics of flaring source regions”	6
Jan. 20, 2017	Chengming Tan	National Astronomical Observatories, Chinese Academy of Sciences	Special Seminar “Study of the radio quiet Sun”	6
Jan. 20, 2017	Kyung Sun Park	Chungbuk Nationa University, Korea	Special Seminar “A small scale magnetic flux ropes in solar wind; early stages of the research”	15

Date	Name	Affiliation	Title	Number of Participant
Jan. 24, 2017	Jing Huang	National Astronomical Observatories, Chinese Academy of Sciences	Special Seminar “The study on the emission of energetic electrons by using the observations of MUSER and NoRH”	5
Feb. 3, 2017	Pavlo Ponomarenko※	University of Saskatchewan, Canada	18th ISEE/CICR Colloquium “Effects of refractive index of the ionosphere on characteristics of SuperDARN echoes”	29
Feb. 10, 2017	Martin Connors※	Athabasca University, Canada	19th ISEE/CICR Colloquium “Inversion and Interpretation of Ground Magnetic Data, Including Impulsive Events”	25
Feb. 17, 2017	Joseph Benjamin Harold Baker※	Virginia Polytechnic Institute and State University, U.S.A.	20th ISEE/CICR Colloquium “Large-Scale Structure and Dynamics of the Sub-Auroral Polarization Stream (SAPS)”	30
Feb. 21, 2017	Nasreen Akter	Bangladesh University of Engineering and Technology	International workshop for climate variability and related studies over North East Indian subcontinent “Climatology of Indian dry line and its effect on cyclogenesis over the Bay of Bengal”	20
Feb. 21, 2017	Shakhawat Hossain	Jahangirnagar University, Bangladesh	International workshop for climate variability and related studies over North East Indian subcontinent “Climatic variability, extreme rainfall events and landslide hazards in the south-eastern folded part of Bangladesh”	20
Feb. 21, 2017	Rahul Mahanta	Cotton University, India	International workshop for climate variability and related studies over North East Indian subcontinent “Rainfall variability and extremes in northeast India”	20
Feb. 21, 2017	Abdul Mannan	Bangladesh Meteorological Department	International workshop for climate variability and related studies over North East Indian subcontinent “Prediction of Heavy Rainfall associated with a landfalling cyclone ‘Roanu’ in Bangladesh”	20
Feb. 21, 2017	A. Q. M. Mahbub	University of Dhaka, Bangladesh	International workshop for climate variability and related studies over North East Indian subcontinent “Disaster Management Education Training & Research at Tertiary Level : Challenges of Regional and International Cooperation and Networking”	20
Feb. 21, 2017	Saraju Baidya	Department of Hydrology and Meteorology, Nepal	International workshop for climate variability and related studies over North East Indian subcontinent “Nepal monsoon rainfall variability, its teleconnection and predictability”	20
Feb. 22, 2017	Neel Prakash Savani-Patel※	GFSC, NASA, U.S.A.	Integrated Studies Seminar “Skill testing of SUSANOO forecasting and how to use NASA iSWA data forresearch”	30
Mar. 2, 2017	Matthias Rempel	High Altitude Observatory of National Center for Atmospheric Research, U.S.A.	Special Seminar “Coronal extension of the MURaM radiative MHD code: From quiet sun to flare simulations”	18
Mar. 8, 2017	Sergey Ostapchenko	Frankfurt Institute for Advanced Studies, Germany	CR Group Seminar “LHC results and cosmic ray composition problems”	15
Mar. 15, 2017	Erik van Sebille	Imperial College London, U.K.	Ocean Environment Guest Seminar “Our plastic oceans: sources, risks and possible solutions of marine litter”	21
Mar. 27, 2017	Eugenio Berti	University of Florence, Italy	CR Group Seminar “CaloCube: a new approach for the detection of high energy cosmic rays in space”	9
Mar. 27, 2017	Cesar La Hoz	UiT The Arctic University of Norway	21th ISEE/CICR Colloquium “Tutorial on PMSE and PMSE modification by RF heating including recent results”	9

※Foreign Visiting Staff

＜Abbreviations＞

APL:	Applied Physics Laboratory
CASS:	Center for Astrophysics and Space Sciences
CEA;	French Alternative Energies and Atomic Energy Commission
CEILAP:	Centro de Investigaciones en Láseres y Aplicaciones
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 terrestres et planétaires
CNRS:	Centre National de la Recherche Scientifique
EISCAT:	European Incoherent Scatter Scientific Association
ESA:	European Space Agency
GSFC:	Goddard Space Flight Center
IFSI:	Istituto di Fisica dello Spazio Interplanetario
IKFIA:	Institute of Cosmophysical Research and Aeronom
INFN:	Istituto Nazionale di Fisica Nucleare
INPE:	Instituto Nacional de Pesquisas Espaciais/Brazilian Institute of Space Research
IPS:	Ionospheric Prediction Services
IPSL:	Institut Pierre-Simon Laplace
ISTP:	Institute of Solar-Terrestrial Physics
IZMIRAN:	Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation
JHU:	Johns Hopkins University
KASI:	Korea Astronomy and Space Science Institute
LAPAN:	Lembaga Penerbangan dan Antariksa Nasional/National Institute of Aeronautics and Space
LOFAR:	Low Frequency Array
LPC2E:	Laboratoire de Physique et Chimie de l’Environnement et de l’Espace
MSFC:	Marshall Space Flight Center
NASA:	National Aeronautics and Space Administration
SB RAS:	Siberian Branch, Russian Academy of sciences
SCOSTEP：	Scientific Committee on Solar Terrestrial Physics
UCB:	University of California, Berkeley
UCI:	University of California, Irvine
UCLA:	University of California, Los Angeles
UCSC:	University of California, Santa Cruz
UCSD:	University California, San Diego

13. Outreach

Public Lectures, Open Labs, and School Visits

ISEE members have contributed to public education through 39 lecture visits, 7 public lectures at the university, 6 open laboratory events, 9 receipts of high-school student visits.

ISEE and former STEL have continued a close relationship with the town of Rikubetsu in Hokkaido since 2003. Public lectures were held on November 11, 2016 at Rikubetsu Elementary School and on November 26, 2016 at Rikubetsu Junior High School. Public laboratory demonstrations were presented on November 12, 2016 at the Rikubetsu Space Earth Science Museum.

Two public lectures took place in foreign countries. One public lecture was held on September 9, 2016 at École Secondaire Cité des Jeunes, Ontario, Canada as a part of the PWING project, and Jannuary 26, 2017, a lecture for junior-high school student was held at Jens Haven Memorial School, Newfoundland and Labrador, Canada.

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

The website of ISEE (http://www.isee.nagoya-u.ac.jp/) continues to publish the most up-to-date activities and outcomes of the laboratory science to the public.

Public lecture on the ISEE open laboratory (June 4, 2016).

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:+81-533-86-0811
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