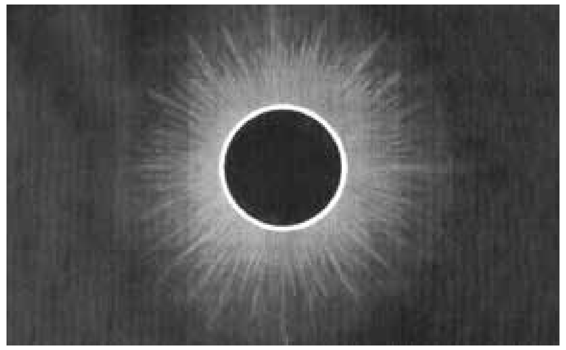
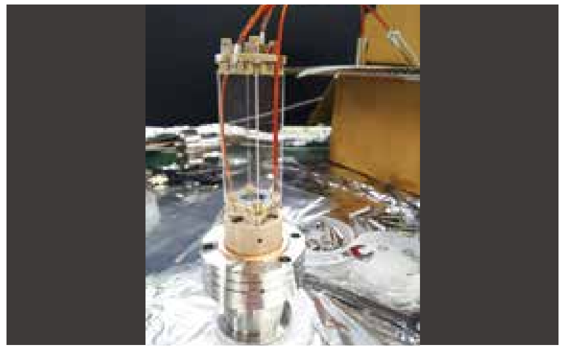
The 3rd ISEE Award Ceremony and Commemorative Lecture held online

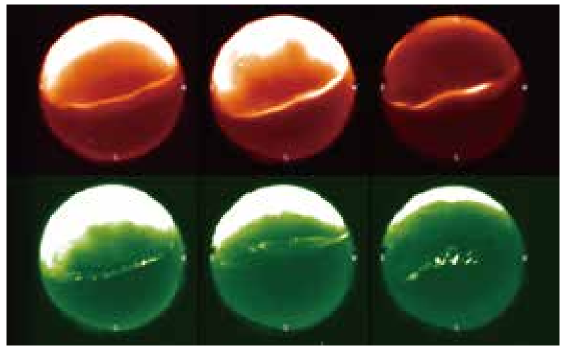


The solar coronal structure recorded in the 1806 total eclipse during the Dalton Minimum (Hayakawa et al., 2020, ApJ, 900, 114).

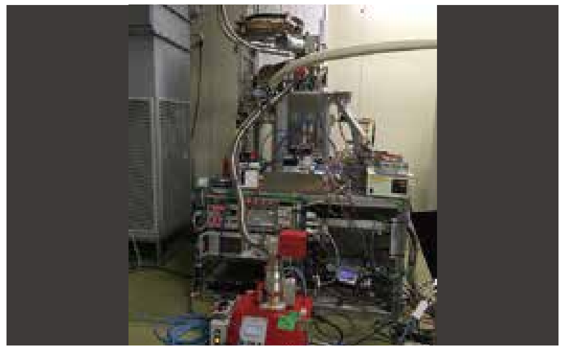


Technical verifier developed for a new TPC detector

IPrototype of a digital backend for the next generation IPS observation system

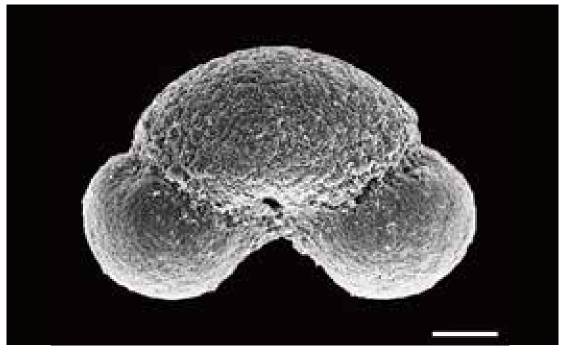


All-sky images of strong thermal emission velocity enhancement (STEVE) aurora taken at Athabasca, Canada



The upgraded multi-frequency millimeter-wave spectral radiometer at Syowa station, Antarctica

A scene in the oceanographic observation when the snow remains on the upper deck



Pine pollen in Lake Suigetsu, Central Japan (The scale bar indicates 10 microns)

Institute for Space–Earth Environmental Research, Nagoya University

Address: Furo-cho, Chikusa-ku, Nagoya, Aichi 464-8601, Japan
TEL: +81-52-747-6303, FAX: +81-52-747-6313, WEB: https://www.isee.nagoya-u.ac.jp

Edited by Public Relations and Outreach Committee, Institute for Space–Earth Environmental Research, Nagoya University
Published in September 2021

MAKE NEW STANDARDS. 東海国立大学機構 NAGOYA UNIVERSITY

Institute for Space–Earth Environmental Research, Nagoya University

Annual Report FY2020

ISEE

Institute for Space–Earth Environmental Research Nagoya University

Annual Report

FY2020

Institute for
Space–Earth Environmental Research
Nagoya University

Annual Report

April 2019–March 2020

Foreword

2020 was a year during which the entire world faced historical challenges due to the COVID-19 pandemic. At the Institute for Space–Earth Environmental Research (ISEE), the impact of the pandemic was not small, and we had to postpone many of the international joint research and international workshops conducted by invited researchers from other countries. However, we maintained our research activities and produced critical scientific results by holding online research meetings.

For example, we developed the first-ever physics-based model that accurately predicts giant solar flares and published a paper (Kusano et al. 2020) in *Science*. This research will significantly contribute to the elucidation of the onset mechanism of solar flares and the improvement of space weather forecasting.

The Heliospheric Research Division led by Prof. Tokumaru succeeded in measuring the plasma density of solar wind in the vicinity of the Sun by observing the frequency dispersion of radio waves emitted from pulsars in the Crab Nebula. This new observation will play a major role in unraveling the mystery of how solar wind is accelerated.

The Center for Integrated Data Science (CIDAS) cooperated with the Japan Aerospace Exploration Agency (JAXA) to promote the data science of the geospace explorer “Arase (ERG).” This year, Dr. Imajo from CIDAS (currently an assistant professor at Kyoto University) and his coworkers found that active auroral arcs are powered by electrons accelerated at altitudes exceeding 30000 km, based on the high-angular resolution electron observations achieved by the Arase satellite in the magnetosphere and optical observations of the aurora from the THEMIS ground-based all-sky imager (Imajo et al. 2021).

Furthermore, Dr. Yadav from the Ionospheric and Magnetospheric Research Division succeeded in observing a peculiar aurora called STEVE for the first time using multi-wavelength spectroscopic imaging (Yadav et al. 2020). STEVE is a mysterious luminescence phenomenon that is different from that of a normal aurora. This observation brings new discoveries, such as confirming that the emission of STEVE is continuous, unlike normal auroras. These studies will make an important contribution to unraveling the mystery of the auroras that color the night sky.

At this institute, we conduct four interdisciplinary research projects (Solar–Terrestrial Climate Research, Space–Earth Environmental Prediction, the Interaction of Neutral and Plasma Atmospheres, and Aerosol and Cloud Formation). This year, we worked on various topics of interdisciplinary studies: Restoration of the paleo solar–terrestrial environment using historical literature and analog records, Observative research on atmospheric composition fluctuations due to high-energy particle deposition in the polar regions, Estimation of the origin of snowfall in the southeastern pole region using cosmogenic nuclides (tritium), and Research on food habits and residential areas explored by multi-Sr isotope analysis of burial bones. The advantageous characteristics of this institute will be used to develop new research areas, including space, the Earth, and humans.

In addition, we are promoting efforts to utilize basic science in a wide range of societies. For example, CIDAS and the Cosmic Ray Research Division collaborated to release a meta-database (RADARC311) for information retrieval of radiation measurement data related to the Fukushima Daiichi nuclear accident. For the measurements made immediately after the nuclear accident, metadata related to the measured data, measurement location, date and time, and the access point of the data have been stored in a database so that you can search where and what type of data can be found. This database will be widely used in accident verification and countermeasures in the future.

Every year, our institute awards excellent research activities based on ISEE joint usage and research to develop space–Earth environmental research, integrate related fields, and develop new fields. In 2020, Professor Ilya Usoskin and Dr. Stepan Poluianov of the University of Oulu (Finland) were awarded the third ISEE award. Through the ISEE International Workshop and ISEE International Joint Research, they undertook a study on extreme solar particle events and their environmental and social impacts, and established a new paradigm for space–Earth environmental change events. The awards ceremony and commemorative lectures were held online on March 11, 2021, with more than 100 scientists worldwide participating. This award will continue to be held in the future, and we will call for recommendations from international scientific communities.

The ISEE has been certified by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) as a joint usage/research center for the third medium-term goal/planning period (FY2016–2021) of national universities. Based on proposals from researchers worldwide, we adopt approximately 200 research projects each year and continue active joint research activities. We are planning to continue and further strengthen these joint research activities during the fourth medium-term target and planning period that begins in 2022, and have applied the continuation certification of the Space and Global Environmental Research Center to the MEXT. We are deeply grateful to everyone who has supported us in this program.

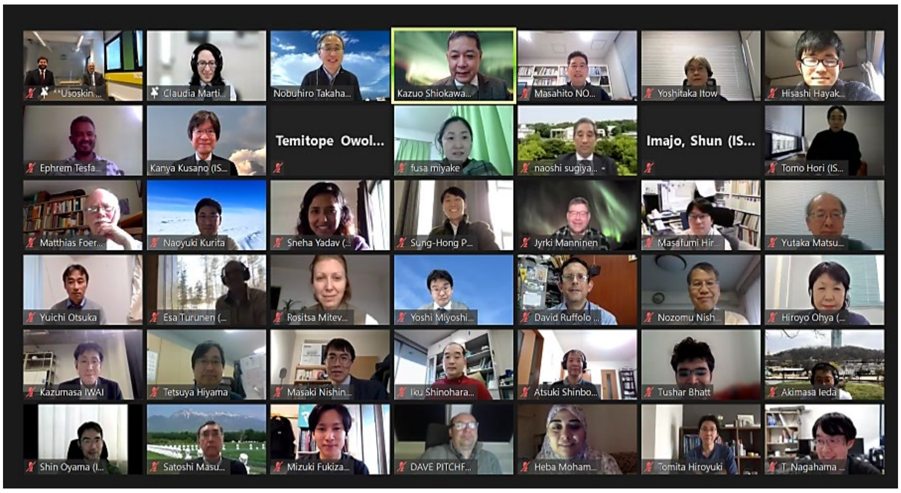
In this plan, we emphasized the (1) development of international research collaboration, (2) creation of new science through interdisciplinary studies, and (3) training of young researchers. We aim to add three types of international joint research support programs for young researchers to the existing 12 types of open-call joint research programs. Therefore, we have continued the operation of the three research centers (Center for International Collaborative Research, Integrated Data Science, and Orbital and Suborbital Observations) that promote joint usage and research projects, and established a system to continuously support their work. In particular, to strengthen the international joint research project, Associate Professor Martinez-Calderon Claudia, who has a wealth of international experience, joined the Center for International Collaborative Research. To cultivate new interdisciplinary research, we have started a director leadership project for researchers inside and outside the institute to collaborate and challenge emerging research issues that cross space science and Earth science. Through these new efforts, we aim to continue contributing to the development of related communities and creating new academic fields.

With the expansion of space development, space will become an active area of humankind in the near future. Private space exploration and space travel are already becoming a reality. Therefore, we believe that the perspective of this institute will become even more important. We will consider the Earth, the Sun, and space as one system, and challenge new research to contribute to the solution of global environmental problems and the development of human society expanding into space.

The COVID-19 virus has spread again at the time of writing this article (May 2021), and I think it will have a major impact on future scientific research. However, I would like to make efforts to overcome any related difficulties with the ingenuity of the staff and the people involved, and fully fulfill the role of the institute as a hub of different scientific communities. This annual report provides you with an understanding of the activities of the ISEE, and we appreciate your continued support and cooperation.

Kanya Kusano
Director

ISEE Award



The 3rd ISEE Award Ceremony and Commemorative Lecture ware held virtually on Mar. 11, 2021.

The 3rd ISEE Award

Aiming to develop space–Earth environmental research, promote interdisciplinary research, and explore this new research discipline, the ISEE presents an ISEE Award to a prominent research activity based on the ISEE Joint Research Program.

The third ISEE Award was awarded to Professor Ilya Usoskin (University of Oulu, Finland) and Doctor Stepan Poluianov (University of Oulu, Finland) for their great contribution to the space–Earth environmental research through international joint research on extreme solar particle events and their environmental and social impacts. The award ceremony and commemorative lecture were held online via ZOOM on the following date and times.

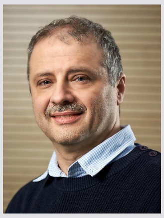
Date: March 11, 2021

ISEE Award Ceremony: 16:00–16:15

Commemorative Lecture: 16:15–17:15　　Speakers; Prof. Ilya Usoskin and Dr. Stepan Poluianov

Title; Extreme solar storms: what we know and what we guess

ISEE Award 2020



Prof. Ilya Usoskin

Dr. Stepan Poluianov

Winner: **Prof. Ilya G. Usoskin** (Professor, University of Oulu, Finland)
Dr. Stepan V. Poluianov (Senior Researcher, University of Oulu, Finland)

Title: **: Contribution to solar-terrestrial environmental research through international joint research on extreme solar particle events and their environmental and social impacts**

Citation: Prof. Usoskin and Dr. Poluianov have established a new paradigm for extreme events of space–Earth environmental change that have not been considered before, through the ISEE International Workshop Program (2018) and the ISEE International Joint Research Program (2019). The award winners are working with the ISEE research team to develop new research fields on extreme solar events and their effects from space and Earth scientific perspectives. These activities are consistent with the mission of ISEE to explore the space–Earth environment.

Career summary of award winners: Prof. Ilya Usoskin (Professor, Head of Oulu Cosmic Ray Station) received his PhD in astrophysics at the A. F. Ioffe Physical-Technical Institute in 1995. He is an expert in solar activity and the variability of cosmic rays and their atmospheric effects and is one of the founders of the space climate research field. Dr. Stepan Poluianov (Senior Researcher) received his PhD in space physics at the University of Oulu in 2016. He is an expert in cosmic rays and their interaction with matter, and has made significant contributions to developing a detailed model of cosmogenic nuclide production.

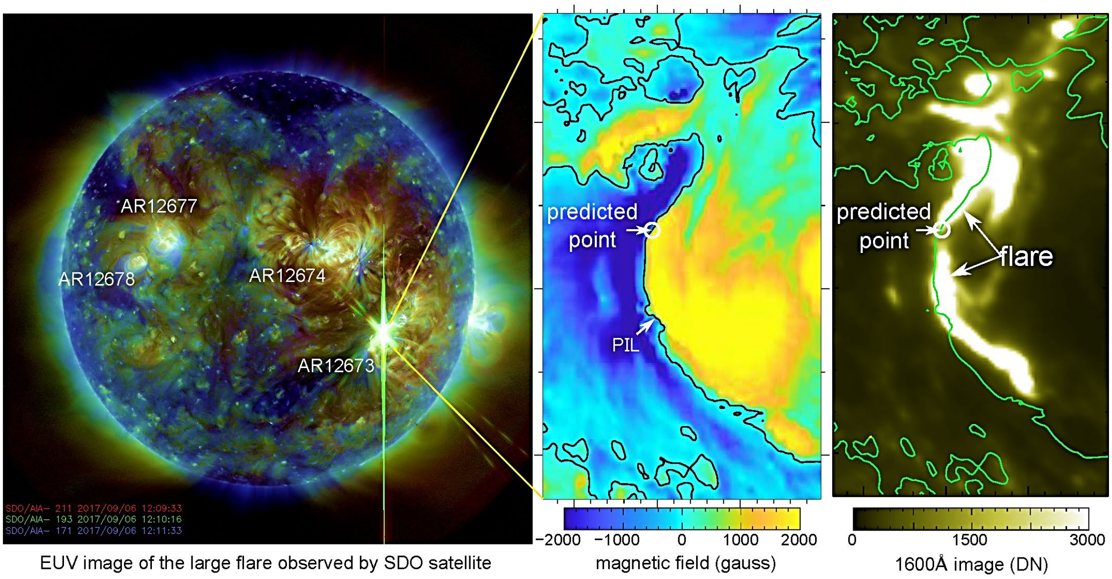


Fig.1

Physics-based prediction of large solar flares

Prof. Kanya Kusano, the director of ISEE, successfully developed a physics-based model that accurately predicts the occurrence of large solar flares based on the theory of magnetohydrodynamic (MHD) instability. This development will contribute to improving space weather forecasts and understanding of the explosive phenomena occurring in space.

Solar flares are the largest explosion phenomenon in solar systems and pose a potential threat not only to astronauts and artificial satellites, but also to social infrastructures such as communications, positioning, electric power, and aviation. Therefore, it is necessary to predict their occurrence in advance. However, conventional prediction relies on empirical methods, and its accuracy is not sufficient.

Prof. Kanya Kusano, the director of this institute, and his coworkers developed for the first time a method to predict large solar flares based on a new theory of MHD instability (double- arc instability). Furthermore, they demonstrated that their method could predict the precise location of the seven out of nine large flares that have occurred in the past 10 years. They also found a new physical quantity "magnetic twist flux density" that determines the occurrence of giant solar flares. This research will greatly advance the sophistication of space weather forecasts and the understanding of explosion phenomena in space.

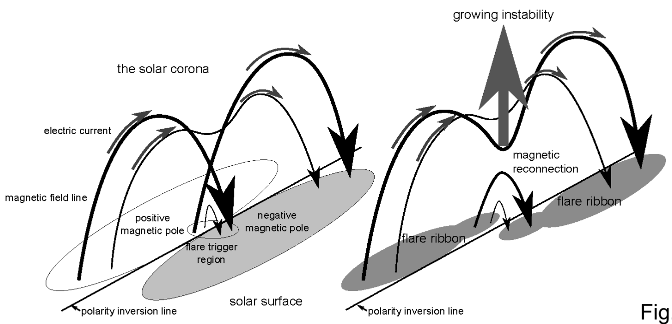


Fig. 2

Fig.1: Images of the large solar flare observed by the SDO satellite on September 1, 2017. Left is the solar disc image in EUV (193 Å). Center and right show the magnetic field and the EUV (1600 Å) images in the flaring region, respectively. The predicted point on the polarity inversion line (PIL) denoted by a circle is located at the center of the flare.

Fig.2: A magnetohydrodynamic model that can explain the onset mechanism of solar flares. Left and right show the magnetic field line structures before and after the onset of a solar flare, respectively. The small-scale magnetic reconnection between the two magnetic loops triggers the double-arc instability and a solar flare.

Paper information
Journal: *Science,* Vol. 369, Issue 6503, pp. 587-591, 2020
Authors: Kusano K, T. Iju Y. Bamba, and S. Inoue
Title: A physics-based method that can predict imminent large solar flares
DOI: 10.1126/science.aaz2511

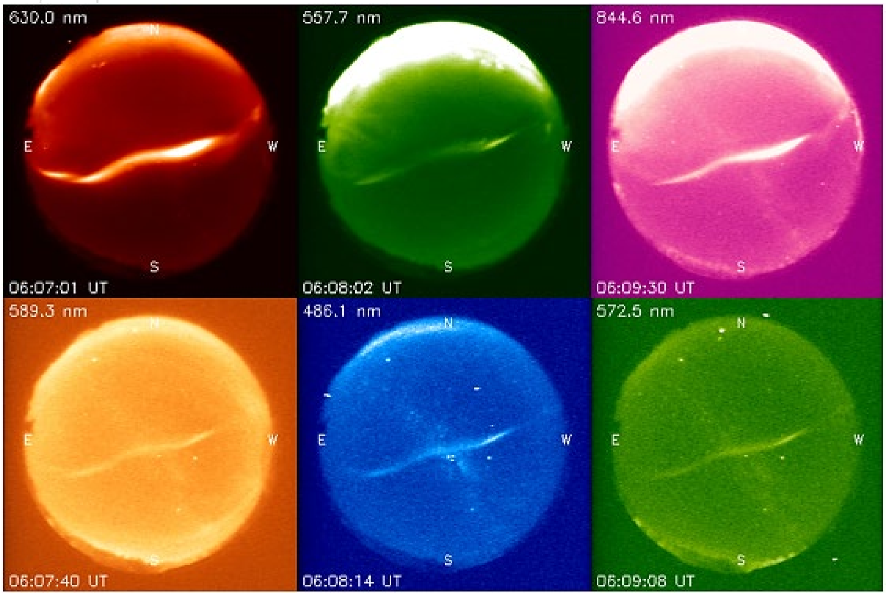


Fig.1

Multi-Wavelength Imaging Observations of STEVE at Athabasca, Canada

Yadav et al. (2021) have reported the first multi-wavelength imaging observations of strong thermal emission velocity enhancement (STEVE), which is a violet color mysterious aurora-like phenomenon in the upper atmosphere at subauroral latitudes.

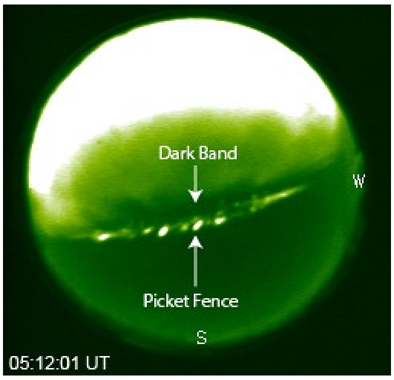


Fig.2

STEVE is distinctly different from traditional aurora and appears as a violet narrow luminous band extending over thousands of kilometers in the east-west direction. STEVE displays are often accompanied by narrow "streaks" of green color known as "picket fence" aurora. Using Optical Mesosphere Thermosphere Imager (OMTI) at Athabasca, Canada, STEVE emissions were observed for the first time at six specific wavelengths, including nominal background, confirming the continuum nature of STEVE. These monochromatic images unfold several unprecedented features of STEVE such as its evolution, detachment from the main auroral oval, ribbon-like motion, and sharp boundaries. One of its striking features is the presence of dark bands poleward of the picket fence structure, resembling the "black aurora." The results contribute to unravelling the mysteries associated with STEVE and the underlying physical mechanisms.

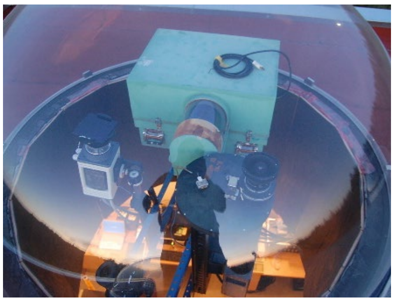


Fig.3

Paper information
Journal： *J. Geophys.Res. Space Physics,* Vol. 126, e2020JA028622, 2021
Authors： Yadav, S., K. Shiokawa, Y. Otsuka, M. Connors, and J.-P. St Maurice
Title： Multi-wavelength imaging observations of STEVE at Athabasca, Canada
DOI： 10.1029/2020JA028622

Fig.1: All-sky images of STEVE at multiple wavelengths on September 6, 2019.
Fig.2: All-sky image depicting "picket fence" structure in the green-line (557.7-nm) on May 2, 2019. The sharp decrease in emission intensity at the immediate poleward edge of picket fence appears as a "dark-band."
Fig.3: All-sky imager (OMTI) operating at Athabasca, Canada.

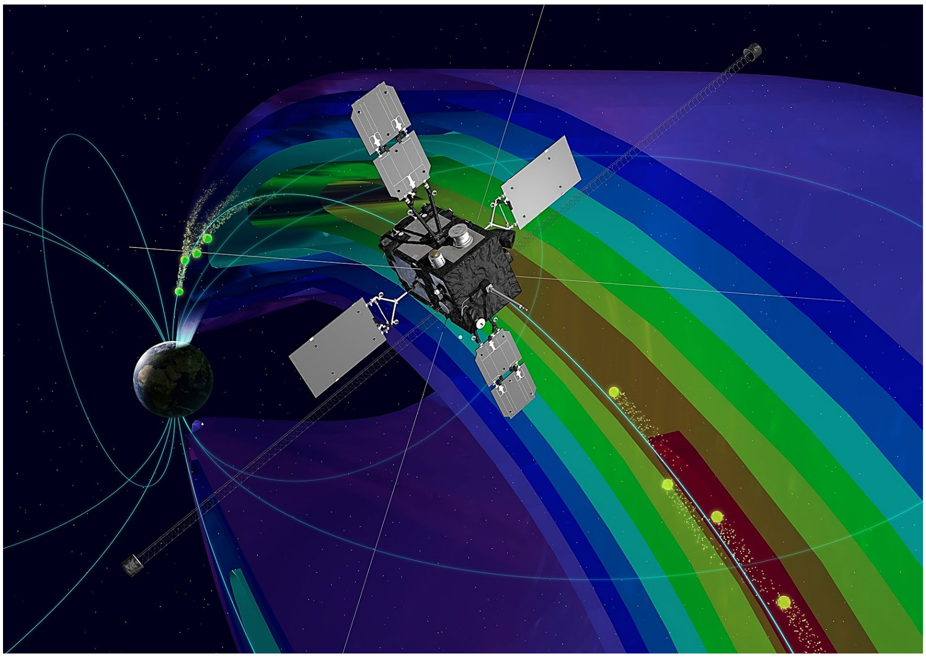


Fig.1

Very high altitude auroral acceleration region

The team at ISEE, led by Dr. S. Imajo, Dr. Y. Miyoshi, and Dr. K. Shiokawa, discovered a very high-altitude auroral acceleration region beyond ~30000 km above an auroral arc, using comprehensive particle and field observations (including high-angular resolution electron observations by LEPe) with the Arase satellite and high spatial-temporal resolution auroral observations with THEMIS ground-based imagers.

The generation mechanism of electrostatic-field-accelerating auroral electrons remains unknown. The altitude distribution of the electrostatic field might provide an important clue for understanding the generation mechanism. In this study, an unexpected discovery, in which auroral electrons were already accelerating at a very high altitude exceeding 30000 km, was made by the Arase satellite, which has a unique orbit and high-performance comprehensive instrument suite. This challenges a conventional view believed for over ~50 years in which the auroral electron is mostly accelerated at altitudes of a few thousand kilometers, and throws up a new mystery of the auroral particle acceleration.

Paper information
Journal：*Scientific Reports*, Vol.11, 1610, 2021
Authors：Imajo, S., Y. Miyoshi, Y. Kazama, K. Asamura, I. Shinohara, K. Shiokawa et. al.
Title：Active auroral arc powered by accelerated electrons from very high altitudes
DOI：10.1038/s41598-020-79665-5

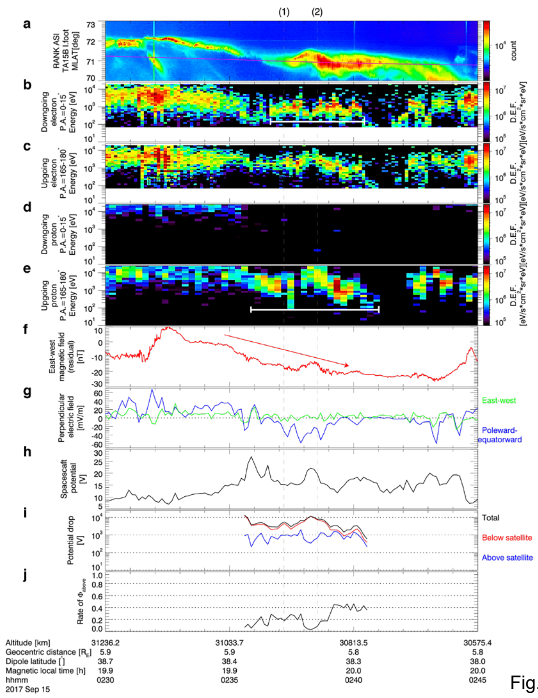


Fig.2

Fig.1: Schematic of the very high altitude electron acceleration powering an auroral arc. The accelerated electron from very high altitudes was observed by the Arase satellite and then precipitated into the auroral emission region.
Fig.2: Timeseries of the latitudinal distribution of auroral emissions and Arase observations. Characteristics of particles and electric and magnetic fields agree with the typical characteristics of the acceleration region observed by previous low altitude satellites.

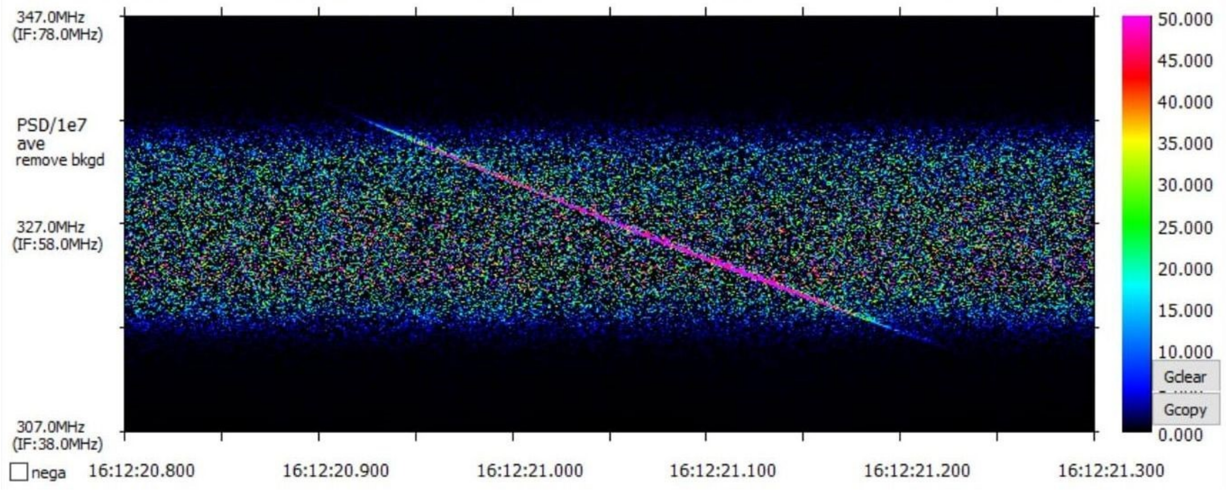


Fig.1

Determination of near-Sun plasma density from Crab pulsar observations

Tokumaru et al. (2020) measured the frequency dispersion of giant radio pulses from observations of the Crab pulsar in 2018 and determined the distribution of the plasma density near the Sun. The obtained results provide an important clue for unraveling the solar wind acceleration mechanism.

A pulsar is a celestial object that emits radio wave pulses at regular intervals. When radio waves from the pulsar are received on Earth, a frequency-dependent delay (frequency dispersion) caused by the plasma along the line of sight is observed. The plasma density of the propagation medium can be estimated from the magnitude of the frequency dispersion (dispersion measure, DM). In this study, the DM was measured for the pulsar in the Crab Nebula (Crab pulsar). The line of sight for the Crab pulsar approaches the Sun every June, and the minimum offset distance is approximately five solar radii. Therefore, DM measurements for the Crab pulsar in June enable the determination of the plasma density distribution near the Sun. The radial distance range between a few and 10 solar radii is a key region for elucidating solar wind acceleration. However, this region has never been explored *in-situ*, and its plasma density distribution is not well understood. Crab pulsar sporadically radiates very strong radio pulses, which are called giant radio pulses, allowing us to measure the DM accurately in a short time. Crab pulsar observations have been conducted since 2018 using the large radiotelescope at the Toyokawa Observatory of the ISEE. Mr. Kaito Tawara, a student in the Graduate School of Science at Nagoya University, made a significant contribution to the data analysis of this study.

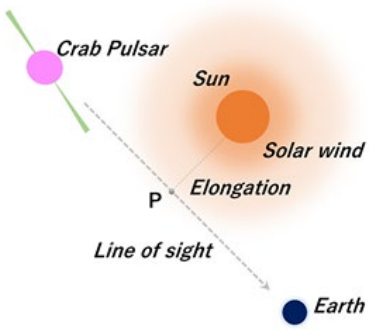


Fig.2

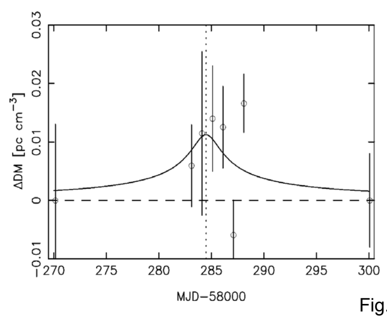


Fig.3

Paper information
Journal： *Solar Physics*, Vol. 295, 80, 2020
Authors： Tokumaru, M., K. Tawara, K. Takefuji, M. Sekido, and T. Terasawa
Title： Radio sounding measurements of the solar corona using giant pulses of the Crab pulsar in 2018
DOI： 10.1007/s11207-020-01644-w

Fig.1： Dynamic spectrum of GRP of Crab pulsar observed at Toyokawa (analyzed by Dr. T. Terasawa).
Fig.2： Schematic illustration of plasma density measurements near the Sun using a pulsar.
Fig.3： Increase in DM observed for the period around the closest approach of Crab pulsar line-of-sight to the Sun.

Contents

1. History

Solar-Terrestrial Environment Laboratory

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

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

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

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

April, 2003
The Rikubetsu Observatory was organized.

April, 2004
The Geospace Research Center was established.

March, 2006
Laboratory was relocated to the Higashiyama Campus.

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

Hydrospheric Atmospheric Research Center (HyARC)

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

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

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

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

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

The Nagoya University Center for Chronological Research

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

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

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

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

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

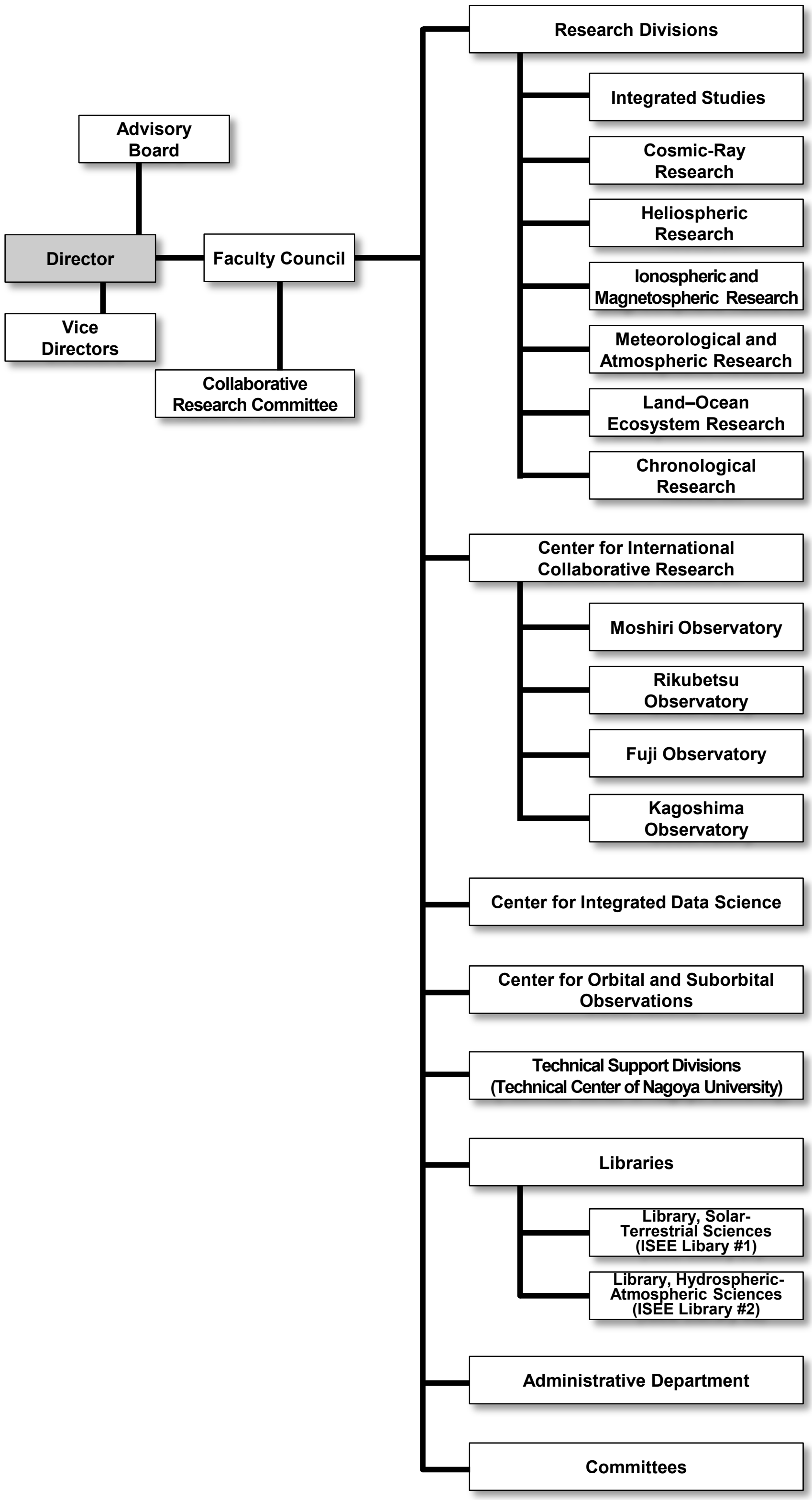
April, 2000
The Nagoya University Center for Chronological Research was organized.The CHIME dating system was transferred from the School of Science.

October, 2015

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

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

2. Organization



3. Staff

Director	Kanya Kusano
Vice Director	Kazuo Shiokawa
Vice Director	Nobuhiro Takahashi

April 1, 2020–March 31, 2021
✱: Concurrent post
▲: Left the Institute in the 2020 academic year
○: Joined the Institute in the 2020 academic year
※: Belongs to Institute for Advanced Research Section

Division for Integrated Studies

Professor	Kanya Kusano
Professor	Yoshizumi Miyoshi (✱)
Associate Professor	Satoshi Masuda
Associate Professor	Takayuki Umeda (✱)
Lecturer	Shinsuke Imada
Assistant Professor	Akimasa Ieda
Designated Assistant Professor	Yumi Bamba ※
Designated Assistant Professor	Takafumi Kaneko
Designated Assistant Professor	Hisashi Hayakawa ○※
Researcher	Hyangpyo Kim ○▲
Technical Assistant	Momoko Hattori ○▲
Technical Assistant (Research Support Facilitator)	Nanako Hirata

Division for Ionospheric and Magnetospheric Research

Professor	Masafumi Hirahara
Professor	Kazuo Shiokawa (✱)
Associate Professor	Yuichi Otsuka
Associate Professor	Satonori Nozawa
Associate Professor	Masahito Nosé
Associate Professor	Nozomu Nishitani (✱)
Associate Professor	Claudia Martinez-Calderon (✱)
Lecturer	Shin-ichiro Oyama
Designated Assistant Professor	Atsuki Shinbori
Designated Assistant Professor	Sneha Yadav ○
Researcher	Sivakandan Mani ○▲
JSPS Postdoctoral Fellowships for Research in Japan (Short-term)	Audrey Nathalie Ghislaine Schillings ▲

Division for Cosmic-Ray Research

Professor	Yoshitaka Itow
Professor	Hiroyasu Tajima (✱)
Associate Professor	Yutaka Matsubara
Associate Professor	Fusa Miyake
Designated Associate Professor	Masaki Yamashita ○▲
Lecturer	Akira Okumura
Assistant Professor	Hiroaki Menjo
Designated Assistant Professor	Shingo Kazama ※
Designated Assistant Professor	Kazufumi Sato
Technical Assistant	Kazuhiro Huruta

Division for Heliospheric Research

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

Division for Meteorological and Atmospheric Research

Professor	Akira Mizuno
Professor	Michihiro Mochida
Professor	Nobuhiro Takahashi (✱)
Professor	Kazuhisa Tsuboki (✱)
Associate Professor	Tomoo Nagahama
Associate Professor	Hirohiko Masunaga
Associate Professor	Taro Shinoda (✱)
Assistant Professor	Sho Ohata ※
Assistant Professor	Taku Nakajima
Researcher	Daichi Tsutsumi ▲
Researcher	Fumie Furuzawa
JSPS Postdoctoral Fellowships for Research in Japan (Standard)	Yunhua Chang ○
Technical Assistant (Research Support Facilitator)	Kazuji Suzuki ○

Division for Land–Ocean Ecosystem Research

Professor	Joji Ishizaka
Professor	Tetsuya Hiyama (✱)
Associate Professor	Hidenori Aiki
Associate Professor	Naoyuki Kurita
Lecturer	Hatsuki Fujinami
Assistant Professor	Yoshihisa Mino
Researcher	Akiko Mizuno ▲
Researcher	Mengmeng Yang ▲
Technical Assistant	Qingyang Song ▲

Divison for Chronological Research

Professor	Hiroyuki Kitagawa
Professor	Masayo Minami
Associate Professor	Takenori Kato (✱)
Assistant Professor	Hirotaka Oda
Designated Assistant Professor	Masako Yamane
Research Institution Researcher	Yukiko Kozaka ▲
Designated Technical Staff	Masami Nishida
Designated Technical Staff	Yuriko Hibi
Technical Assistant	Yuki Wakasugi ▲

Center for International Collaborative Research

Director • Professor	Kazuo Shiokawa
Professor	Tetsuya Hiyama
Professor	Akira Mizuno (✱)
Professor	Masayo Minami (✱)
Designated Professor (Cross Appointment)	K. D. Leka
Designated Professor (Cross Appointment)	Lynn Marie Kistler
Associate Professor	Nozomu Nishitani
Associate Professor	Claudia Martinez-Calderon
Associate Professor	Naoyuki Kurita (✱)
Associate Professor	Satonori Nozawa (✱)
Lecturer	Hatsuki Fujinami (✱)
Assistant Professor	Hiroaki Menjo (✱)
Designated Assistant Professor	Masafumi Shoji
Designated Assistant Professor	Hirohiko Nagano ○▲
Designated Assistant Professor	Sung-Hong Park
Researcher	Hironari Kanamori

Foreign Visiting Research Fellow

January 25 – May 31, 2020	Veenadhari Bhasakarapantula
January 1 – March 31, 2021	Chio Zong Cheng

Center for Integrated Data Science

Director • Professor	Kazuhisa Tsuboki
Professor	Yoshizumi Miyoshi
Professor	Joji Ishizaka (✱)
Professor	Kanya Kusano (✱)
Associate Professor	Takayuki Umeda
Associate Professor	Takenori Kato
Associate Professor	Hidenori Aiki (✱)
Associate Professor	Satoshi Masuda (✱)
Associate Professor	Hirohiko Masunaga (✱)
Designated Associate Professor	Tomoaki Hori
Lecturer	Shinsuke Imada (✱)
Assistant Professor	Akimasa Ieda (✱)
Designated Assistant Professor	Haruhisa Iijima
Designated Assistant Professor	Shun Imajo ▲
Designated Assistant Professor	Sachie Kanada
Designated Assistant Professor	Masahiro Kitahara ○
Designated Assistant Professor	Satoko Nakamura
Designated Assistant Professor	Chae-Woo Jun
Designated Assistant Professor	YunHee Kang
Researcher	Norio Umemura ▲
Researcher	Masaya Kato
Researcher	Yoshiki Fukutomi
Researcher	Yutaka Matsumi ▲
Researcher	Sandeep Kumar
Designated Technical Staff	Mariko Kayaba
Designated Technical Staff	Asayo Maeda
Designated Technical Staff	Kinji Morikawa
Technical Assistant	Luteru Agaalii Tauvale ○▲

Center for Orbital and Suborbital Observations

Director • Professor	Nobuhiro Takahashi
Professor	Hiroyasu Tajima
Designated Professor	Hidetaka Tanaka ▲
Designated Professor	Masataka Murakami
Professor	Joji Ishizaka (✱)
Professor	Kazuhisa Tsuboki (✱)
Professor	Masafumi Hirahara (✱)
Associate Professor	Taro Shinoda
Associate Professor	Hidenori Aiki (✱)
Designated Associate Professor	Kazutaka Yamaoka
Assistant Professor	Sho Ohata (✱)※
Designated Assistant Professor	Hiroyuki Tomita ▲
Designated Assistant Professor	Mayumi Yoshioka ▲
Designated Assistant Professor	Youko Yoshizumi
Research Institution Researcher	Takeharu Kouketsu
Research Institution Researcher	Ji Hyun Park ▲
Technical Assistant	Tomoko Tanaka ▲

Visiting Academic Staff/Visiting Faculty Members

Visiting Professor	Yoshiya Kasahara
Visiting Professor	Tomo'omi Kumagai
Visiting Professor	Yoshikatsu Kuroda
Visiting Professor	Yoko Kokubu
Visiting Professor	Hiroyuki Shinagawa
Visiting Professor	Nobuo Sugimoto
Visiting Professor	Kanako Seki
Visiting Professor	Hotaek Park
Visiting Associate Professor	Fumio Abe ○
Visiting Associate Professor	Christian Leipe
Visiting Associate Professor	Yasunobu Ogawa
Visiting Associate Professor	Shinji Saito
Visiting Associate Professor	Daikou Shiota
Visiting Associate Professor	Iku Shinohara
Visiting Associate Professor	Toru Tamura ○
Visiting Associate Professor	Yasutaka Narusawa
Visiting Associate Professor	Hiroki Mizuochi ○
(Emeritus Professor)	Toshio Nakamura
	Shun Ohishi ○

Technical Center of Nagoya University

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

Cooperating Research Fellow

	Satoshi Inoue ○▲
	Hiroatsu Sato ○▲

Foreign Visiting Cooperation Researcher

Jun 5, 2019 – May 29, 2020	Sneha Yadav
August 5, 2019 – August 4, 2020	Xia Yuan
September 16, 2019 – August 31, 2020	Hyangpyo Kim

Administration Department

Director, Administration Department	Takashi Murate ▲
General Affairs Division	
Manager, General Affairs Division	Mitsuyuki Hirokawa
Specialist, General Affairs Section	Hideaki Yano
Section Head, General Affairs Section	Kazuhiro Yokoyama ▲
Section Head, General Affairs Section	Shoji Asano ▲
Section Head, General Affairs Section	Tomoko Mizutani ○
Section Head, Personnel Affairs Section	Munetika Mizuno ▲
Section Head, Budget Planning Section	Mirei Miyao
Administrator	Yuka Ito ▲
Administrator	Junpei Okada ○
Administrator	Asana Goto
Administrator	Megumi Goto ○
Administrator	Hisako Watabe
Designated Supervisor	Tadashi Tsuboi

Toyokawa Branch

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

4. Committee of Other Organizations

Committee of Other Organizations

Contact Post	Job Title	Organizations	Name of Committee / Title
Joji Ishizaka	Professor	North Pacific Marine Science Organization (PICES)	Co-Chair of Advisory Panel for a CREAMS/PICES Program in East Asian Marginal Seas
Joji Ishizaka	Professor	North Pacific Marine Science Organization (PICES)	Member of Working Group 35: Third North Pacific Ecosystem Report
Joji Ishizaka	Professor	Northwest Pacific Action Plan (NOWPAP)	Focal Point of Center for Special Monitoring and Coastal Environmental Assessment Regional Active Center (CEARAC)
Yoshitaka Itow	Professor	International Union of Pure and Applied Physics	Commission C4 member
Yoshitaka Itow	Professor	Institute of Particle and Nuclear Studies, KEK	J-Parc Program Advisory Committee member
Yoshitaka Itow	Professor	International Symposium for Very High Energy Cosmic Ray Interactions	International Advisory Committee member
Yoshitaka Itow	Professor	Ultra High Energy Cosmic Ray Conference	International Advisory Committee member
Hiroyuki Kitagawa	Professor	International Continental Scientific Drilling Program (ICDP), Dead Sea Deep Sea Drilling Project (DSDDP)	Principal Investigator
Hiroyuki Kitagawa	Professor	Geosciences	Editor
Kazuo Shiokawa	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	President
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	Journal of Atmospheric and Solar-Terrestrial Physics	Chief guest editor for VarSITI/STP-14 Special Issue
Nobuhiro Takahashi	Professor	National Aeronautics and Space Administration (NASA)	ACCP Science Assessment Team (SIT-CCP) member
Hiroyasu Tajima	Professor	Institute of Particle and Nuclear Studies, KEK	B-factory Programme Advisory Committee member
Hiroyasu Tajima	Professor	Progress of Theoretical and Experimental Physics	Editor
Hiroyasu Tajima	Professor	The Scientific World Journal	Editorial Board member
Tetsuya Hiyama	Professor	International Arctic Science Committee (IASC)	Terrestrial Working Group (TWG) member
Yoshizumi Miyoshi	Professor	EISCAT Scientific Association	Strategy Group on the Future of EISCAT member

Contact Post	Job Title	Organizations	Name of Committee / Title
Yoshizumi Miyoshi	Professor	Committee on Space Research (COSPAR)	Chair of Panel on Radiation Belt Environment Modeling
Yoshizumi Miyoshi	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Bureau member
Yoshizumi Miyoshi	Professor	National Science Foundation/ Geospace Environment Modeling (NSF/GEM)	Steering Committee member
Yoshizumi Miyoshi	Professor	EU-Horizon 2020: SafeSpace	Advisory Panel
Yoshizumi Miyoshi	Professor	Annales Geophysicae	Editor
Yoshizumi Miyoshi	Professor	Earth and Planetary Physics	Editor
Yoshizumi Miyoshi	Professor	Earth, Planets and Space (EPS)	Guest editor for the special issue of "Solar-Terrestrial Environment Prediction: Toward the Synergy of Science and Forecasting Operation of Space Weather and Space Climate"
Yoshizumi Miyoshi	Professor	Polar Research	Guest editor
Michihiro Mochida	Professor	International Commission on Atmospheric Chemistry and Global Pollution (iCACGP)	Commission member
Michihiro Mochida	Professor	Atmospheric Environment	Editorial Advisory Board member
Yuichi Otsuka	Associate Professor	Journal of Astronomy and Space Sciences	Editor
Yuichi Otsuka	Associate Professor	Earth and Planetary Physics	Guest editor for the special issue of "Recent Advances in Equatorial Plasma Bubble and Ionospheric Scintillation"
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Vice editors-in-chief
Nozomu Nishitani	Associate Professor	Super Dual Auroral Radar Network (SuperDARN)	Vice chair of Executive Council
Nozomu Nishitani	Associate Professor	Polar Science	Guest editor for the special issue of "SuperDARN / Studies of Geospace Dynamics - Today and Future"
Nozomu Nishitani	Associate Professor	Earth, Planets and Space (EPS)	Guest editor for the special issue of 20th Anniversary Issue: Earth, Planetary, and Space Sciences in the Next Decade
Satonori Nozawa	Associate Professor	EISCAT Scientific Association	Council member
Masahito Nosé	Associate Professor	International Association of Geomagnetism and Aeronomy (IAGA)	Division V Chair

Contact Post	Job Title	Organizations	Name of Committee / Title
Masahito Nosé	Associate Professor	Earth, Planets and Space (EPS)	Editor（～December 31, 2020） Vice editors-in-chief（January 1, 2021～）
Masahito Nosé	Associate Professor	Earth, Planets and Space (EPS)	Guest editor for the special issue of "International Geomagnetic Reference Field - The Thirteenth Generation"
Hirohiko Masunaga	Associate Professor	National Aeronautics and Space Administration (NASA)	ACCP Science Community Cohort
Hirohiko Masunaga	Associate Professor	World Climate Research Programme (WCRP) Global Energy and Water cycle Exchanges (GEWEX)	GEWEX Data and Analysis Panel (GDAP) member
Toshio Nakamura	Visiting Faculty	Radiocarbon	Editorial Board member

5. Joint Research Programs

One of the major functions of ISEE is to promote and conduct collaborative research on Space–Earth Environmental Science together with researchers from universities and institutes outside the ISEE. On January 14, 2016, ISEE was certified as a core research institution of Space–Earth Environmental Science, a “Joint Usage/Research Center,” as defined by the MEXT of Japan. We prepared application forms for joint research programs focusing on the following two research issues: the “Study of the coupling processes in the solar–terrestrial system using ground-based observation networks” and the “Establishment of an international collaborative research hub to solve research issues in the global (terrestrial) environment and space applications based on comprehensive studies of the space–Sun–Earth system.” The former focuses on coupling processes in the solar–terrestrial system and the interactions of neutral and plasma components in the Earth’s atmosphere by establishing an international ground-based observation network ranging from low- to high-latitude regions, especially in Asia and Africa. The latter aims to establish an international collaborative research hub for comprehensive studies of the space–Sun–Earth system, space applications, space weather forecasting, and environmental problems such as global warming. The following 11 research programs, including the SCOSTEP Visiting Scholar program that was incorporated into joint use and research from FY2020, were prepared for application during the 2020 Japanese fiscal year. The ISEE symposium became an independent category from the ISEE/Center for International Collaborative Research (CICR) International Workshop, and the announcement for the ISEE symposium was made three months prior to other programs. In addition, we switched the proposed application process from an email-based to a web-based system with support from the Research Organization of Information and Systems. The new system was introduced for the FY2020 program applications.

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
11) SCOSTEP Visiting Scholar (SVS) Program (*)

(*) Applicable only to foreign researchers

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

In 2020, the third ISEE symposium was held online from March 8 to 12, 2021, entitled “International conference and school on dynamic variation of particles and waves in the inner magnetosphere and ionosphere using satellite and ground-network observations and modeling (PWING-ERG conference and school),” led by Professor Kazuo Shiokawa who is the vice director of ISEE. The third ISEE Award was awarded to Prof. Ilya G. Usoskin and Dr. Stepan V. Poluianov of the University of Oulu, Finland, for their great contribution to space–Earth environmental research through international joint research on extreme solar particle events and their environmental and social impacts. The award ceremony and memorial lectures were held online on March 11, 2021.

Due to the influence of COVID-19, the international joint research programs and international workshops of this fiscal year were canceled or postponed for the next year or implemented by changing the scope. Most symposiums and research meetings were conducted online.

In October, the community meeting that aims to share information about the ISEE’s joint research program across the field of study and discuss the future joint research program was held online with the participation of the joint research program participants.

Lists of Accepted Proposals

■ ISEE International Joint Research Program

Proposer	Affiliation*	Job title*	Corresponding ISEE researcher	Title of the research program
Kariyappa, Rangaiah	Indian Institute of Astrophysics	Former Professor	Imada, S.	Understand the EUV and UV (PROBA2/LYRA) and X-ray (GOES 1-8 A) irradiance variability from spatially resolved images of SDO/AIA/HMI & PROBA2/SWAP and Hinode/XRT instruments
Chen, Xingyao	National Astronomical Observatories, Chinese Academy of Sciences	Research Assistant	Masuda, S.	Quasi-periodic Pulsations from solar radio and microwave observations
Abadi, Prayitno	Indonesian National Institute of Aeronautics and Space	Researcher	Otsuka, Y.	Empirical Model of Equatorial Plasma Bubble Occurrence Rate in Southeast Asia deduced from GPS Receivers
Yuan, Xia	Nanjing Xiaozhuang University	Lecturer	Nozawa, S.	Winter sudden stratospheric warming (SSW) impact on mesosphere sodium layer observed at middle and high latitudes
Opgenoorth, Hermann	University of Umea	Professor Emeritus	Nishitani, N.	Study of sub-auroral storm time magnetic and convection disturbances
Shreedevi, Porunkatu Radhakrichna	Beihang University	Postdoctoral Researcher	Miyoshi, Y.	Understanding the role of EMIC wave scattering in causing ion precipitation into the ionosphere: Comparison of SWMF simulations with Arase and PWING observations
Lazzara, Matthew	University of Wisconsin-Madison	Senior Scientist	Kurita, N.	Creation of a new high-quality dataset of East Antarctic meteorological observations
Gordovskyy, Mykola	University of Manchester	Research Associate	Kusano, K.	Fluid-kinetic modelling of magnetic reconnection in solar flares and solar energetic particle escape into the heliosphere
Braga, Carlos Roberto	George Mason University	Senior Research Scientist	Kusano, K.	Predicting coronal mass ejections Time-of-arrival and magnetic field orientation in the Earth's vicinity using observations and MHD propagation
Azizi, Hajihossein	University of Kurdistan	Professor	Minami, M.	Beryllium-10 (^{10}Be)-Nd isotope analysis to investigate magma source of the Quaternary volcanoes in northwest Iran
Min, Kyungguk	Chungnam National University	Assistant Professor	Miyoshi, Y.	Understanding the Generation Process of Fast Magnetosonic Waves by Combining ERG Observations and PIC Simulations
Ren, Jie	Peking University	Assistant Researcher	Miyoshi, Y.	ULF Waves' Interaction with the Charged Particles and the Effects on the Whistler Mode Waves
Chen, Linjie	National Astronomical Observatories, Chinese Academy of Sciences	Associate Researcher/ Professor	Iwai. K.	Studying the solar wind with the multi-station Interplanetary Scintillation (IPS) Telescope
Krucker, Samuel	Fachhochschule Nordwestschweiz	Professor	Masuda, S.	The NoRH/RHESSI flare catalogue: time-dependent analysis
Mouikis, Christoforos	University of New Hampshire	Research Scientist	Miyoshi, Y.	The impact of storm-time ion composition changes in the near-earth plasma sheet on the ring current pressure development
Langematz, Ulrike	Freie Universität Berlin	Professor	Miyake, F.	Modeling the transport and deposition of cosmogenic isotopes of historical MIYAKE Events and recent decades

* 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
Gopalswamy, Nat	Goddard Space Flight Center	Astrophysicist	Masuda, S.	Origin of High-Energy Protons Responsible for Late-Phase Pion-Decay Gamma-Ray Continuum from the Sun

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

List of Collaboration Resources

■ Instruments

Name	Contact Person
Fourier Transform Infrared (FTIR) Spectrometer for Atmospheric Composition Measurement (Rikubetsu)	T. Nagahama
Optical Mesosphere Thermosphere Imagers	K. Shiokawa
ISEE Magnetometer Network	K. Shiokawa
ELF/VLF Network	K. Shiokawa
Sodium LIDAR (Tromsø)	S. Nozawa
MF Radar (Tromsø)	S. Nozawa
Meteor Radar (Alta)	S. Nozawa
Solar Neutron Telescope (Norikura Observatory, Institute for Cosmic Ray Research, the University of Tokyo)	Y. Matsubara
Low-Background Beta-Ray Counter	N. Kurita
Multi-Station IPS Solar Wind Observation System (Toyokawa, Fuji, and Kiso)	M. Tokumaru
Multi-Directional Cosmic Ray Muon Telescope (Nagoya)	Y. Matsubara
SuperDARN Hokkaido Pair of (HOP) Radars (Rikubetsu)	N. Nishitani
Upper Air Sounding Systems (two sets)	K. Tsuboki
Polarimetric Radar Systems (two sets)	K. Tsuboki
Ka-Band Polarimetric Radar	K. Tsuboki
Hydrometeor Video Sonde (HYVIS) System	K. Tsuboki
ISEE Riometer Network	K. Shiokawa
Sea Spray Aerosol Optical Particle Counter	H. Aiki
Five-Wavelength Photometer (Tromsø)	S. Nozawa
Water Isotope Analyzer (Picarro L2130-i)	N. Kurita

■ Software/Databases

Name	Contact Person
Atmospheric Composition Data by FT-IR Measurements (Moshiri and Rikubetsu)	T. Nagahama
NO_2 and O_3 Data by UV/Visible Spectrometer Measurements (Moshiri and Rikubetsu)	T. Nagahama
Coordinated Magnetic Data Along 210° Magnetic Meridian (Moshiri, Rikubetsu, Kagoshima, and Overseas MM Stations)	K. Shiokawa
All-Sky Auroral Data (Canada, Alaska, and Siberia)	K. Shiokawa, Y. Miyoshi

Name	Contact Person
Database of the Optical Mesosphere Thermosphere Imagers	K. Shiokawa
VHF Radar/GPS Scintillation (Indonesia)	Y. Otsuka
EISCAT Database	S. Nozawa, S. Oyama
ELF/VLF Wave Data	K. Shiokawa
Interplanetary Scintillation Data	M. Tokumaru
Solar Wind Speed Data	M. Tokumaru
Cosmic Ray Intensity Database	Y. Matsubara
MHD Simulation on the Magnetospheric Environment	T. Umeda
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
SuperDARN Hokkaido Pair of (HOP) Radars Database	N. Nishitani
Numerical Simulation Codes for Plasma Kinetics	T. Umeda
Cloud Resolving Strom Simulator (CReSS)	K. Tsuboki
Satellite Data Simulator Unit (SDSU)	H. Masunaga
ISEE Riometer Network Database	K. Shiokawa
Energy Flux Diagnosis Code for Atmospheric and Oceanic Waves	H. Aiki

■ Facilities

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

ISEE Award

Winner	Title	Date of Award Ceremony
Ilya G. Usoskin (Professor, University of Oulu, Finland) Stepan Poluianov (Senior Researcher, University of Oulu, Finland)	Contribution to solar-terrestrial environmental research through international joint research on extreme solar particle events and their environmental and social impacts	March 11, 2021

6. Governance

As of March 31, 2021

Advisory Board

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

Collaborative Research Committee

Akira Kadokura	Polar Environment Data Science Center, Joint Support-Center for Data Science Research, Research Organization of Information and Systems
Kazuyuki Kita	College of Science, Ibaraki University
Yuki Kubo	Applied Electromagnetic Research Institute, National Institute of Information and Communications Technology
Yoko S. Kokubu	Tono Geoscience Center, Japan Atomic Energy Agency
Akinori Saitou	Graduate School of Science, Kyoto University
Takeshi Sakanoi	Graduate School of Science, Tohoku University
Iku Shinohara	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Shoichi Shibata	College of Engineering, Chubu University
Kanako Seki	Graduate School of Science, The University of Tokyo
Yoichiro Hanaoka	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Atsushi Higuchi	Center for Environmental Remote Sensing, Chiba University
Hiroyuki Matsuzaki	The University Museum, The University of Tokyo
Takashi Minoshima	Japan Agency for Marine-Earth Science and Technology
Akihiko Morimoto	Center for Marine Environmental Studies, Ehime University
Hiroyuki Yamada	Faculty of Science, University of the Ryukyus
Yuichi Otsuka	Institute for Space–Earth Environmental Research, Nagoya University
Takenori Kato	Institute for Space–Earth Environmental Research, Nagoya University
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Naoyuki Kurita	Institute for Space–Earth Environmental Research, Nagoya University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University
Taro Shinoda	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University
Munetoshi Tokumaru	Institute for Space–Earth Environmental Research, Nagoya University
Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University
Masahito Nosé	Institute for Space–Earth Environmental Research, Nagoya University
Satoshi Masuda	Institute for Space–Earth Environmental Research, Nagoya University
Hirohiko Masunaga	Institute for Space–Earth Environmental Research, Nagoya University
Yutaka Matsubara	Institute for Space–Earth Environmental Research, Nagoya University
Masayo Minami	Institute for Space–Earth Environmental Research, Nagoya University
Kazuhisa Tsuboki	Institute for Space–Earth Environmental Research, Nagoya University

Joint Research Technical Committee

Integrated Studies Technical Committee

Ayumi Asai	Graduate School of Science, Kyoto University
Yuto Katoh	Graduate School of Science, Tohoku University
Iku Shinohara	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Kanako Seki	Graduate School of Science, The University of Tokyo
Hirohisa Hara	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Akimasa Yoshikawa	Graduate School of Sciences, Kyushu University
Takayuki Umeda	Institute for Space–Earth Environmental Research, Nagoya University
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Satoshi Masuda	Institute for Space–Earth Environmental Research, Nagoya University
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University

Heliospheric and Cosmic-Ray Research Technical Committee

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

Ionospheric and Magnetospheric Research Technical Committee

Takumi Abe	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Yoshiya Kasahara	Information Media Center, Kanazawa University
Akinori Saito	Graduate School of Science, Kyoto University
Shin Suzuki	Faculty of Regional Policy, Aichi University
Yuichi Otsuka	Institute for Space–Earth Environmental Research, Nagoya University
Satonori Nozawa	Institute for Space–Earth Environmental Research, Nagoya University
Masahito Nosé	Institute for Space–Earth Environmental Research, Nagoya University

Meteorological, Atmospheric and Land-Ocean Ecosystem Research Technical Committee

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

Chronological Research Technical Committee

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

Airplane Usage Technical Committee

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

Steering Committee of the Center for International Collaborative Research

Yusuke Ebihara	Research Institute for Sustainable Humanosphere, Kyoto University
Wallis Simon	Graduate School of Science, The University of Tokyo
Yoichiro Hanaoka	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Akihiko Morimoto	Center for Marine Environmental Studies, Ehime University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University
Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University
Tetsuya Hiyama	Institute for Space–Earth Environmental Research, Nagoya University

Steering Committee of the Center for Integrated Data Science

Shin-ichiro Shima	Graduate School of Simulation Studies, University of Hyogo
Tohru Hada	Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
Masahiro Hoshino	Graduate School of Science, The University of Tokyo
Kazuhisa Mitsuda	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Katsuyoshi Michibayashi	Graduate School of Environmental Studies, Nagoya University
Junichi Watanabe	National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Takayuki Umeda	Institute for Space–Earth Environmental Research, Nagoya University
Takenori Kato	Institute for Space–Earth Environmental Research, Nagoya University
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Kazuhisa Tsuboki	Institute for Space–Earth Environmental Research, Nagoya University
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University

Steering Committee of the Center for Orbital and Suborbital Research

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

7. Finance

External Funding and Industry–Academia–Government Collaborations

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

Kakenhi category	Number of subjects	Total amount (JPY)
Grant-in-Aid for Specially Promoted Research	1	58,890,000
Grant-in-Aid for Scientific Research on Innovative Areas	5	31,590,000
Grant-in-Aid for Scientific Research (S)	3	117,780,000
Grant-in-Aid for Scientific Research (A)	3	20,020,000
Grant-in-Aid for Scientific Research (B)	14	84,370,000
Grant-in-Aid for Scientific Research (C)	3	4,290,000
Grant-in-Aid for Challenging Research (Exploratory)	10	30,160,000
Grant-in-Aid for Early-Career Scientists	3	3,380,000
Grant-in-Aid for Research Activity Start-up	1	1,430,000
Fund for the Promotion of Joint International Research (Fostering Joint International Research (B)	4	15,860,000
Total	47	367,770,000

・Forty-seven research subjects listed in the table were supported by the JSPS Kakenhi.
・Thirty-one research subjects received total 128,603,299 JPY from governmental funds except KAKENHI, and from other universities and companies. Thirteen of them were collaborative researches between ISEE and companies, or national institutes.
・Three research subjects received total 5,500,000 JPY of donation.

Libraries

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

Books

Japanese	2,999
Foreign	11,140

Journals

Japanese	47
Foreign	207

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

Books

Japanese	4,534
Foreign	8,858

Journals

Japanese	273
Foreign	249

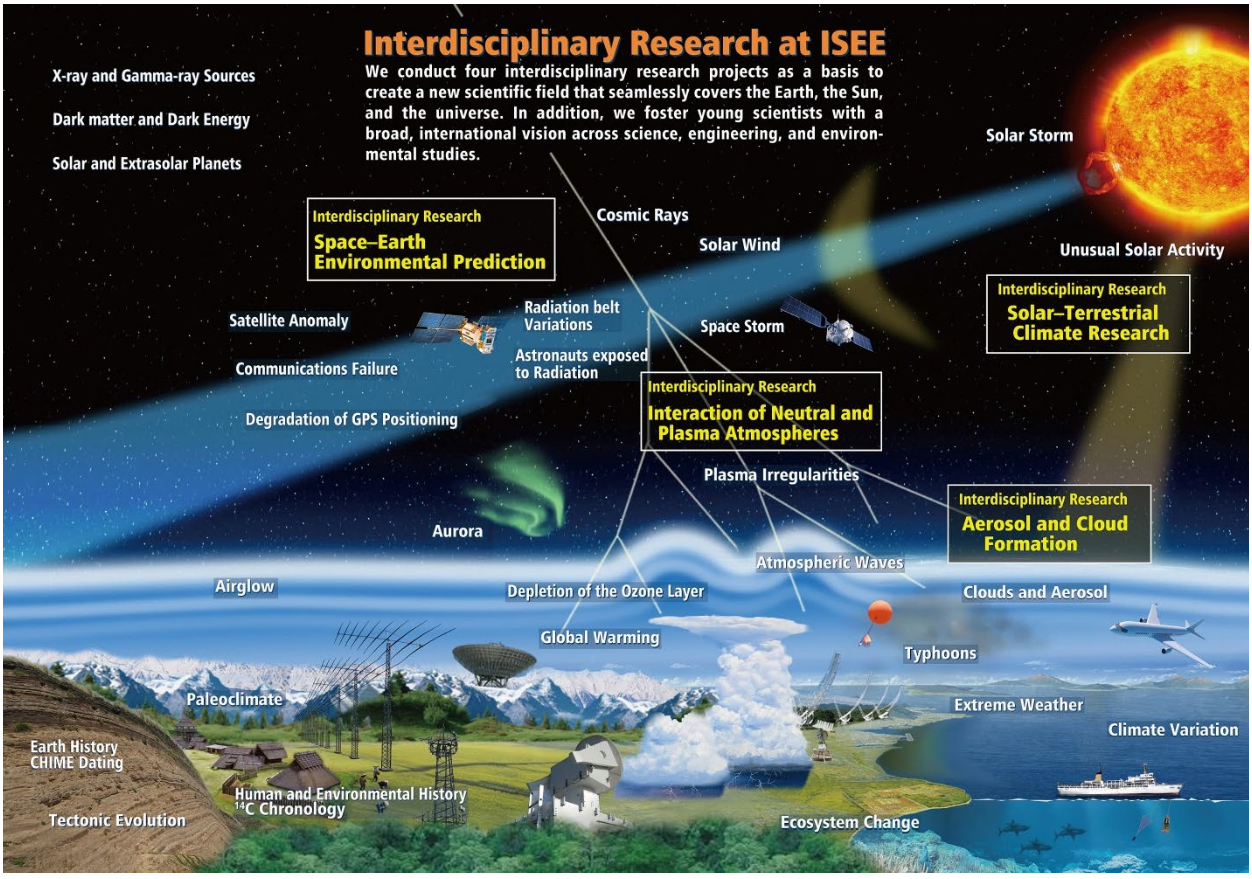
Properties

	Site (m^2)	Bulidings (m^2)	Location
Higashiyama Campus (Main campus of Nagoya University)	-	8,442	Nagoya
Toyokawa Campus	94,212	1,461	Toyokawa
Moshiri Observatory	110,534	325	Hokkaido
Rikubetsu Observatory	24,580	167	Hokkaido
Kagoshima Observatory	13,449	287	Kagoshima
Fuji Observatory	19,926	174	Yamanashi
Sugadaira Station	3,300	0	Nagano
Kiso Station	6,240	66	Nagano
Total	272,241	10,922	

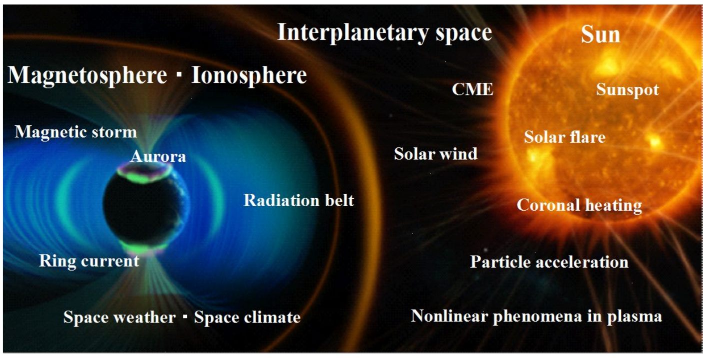
8. Research Topics

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

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



Division for Integrated Studies



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

In the Division for Integrated Studies, we conduct scientific research aimed at the comprehensive understanding and prediction of various phenomena in the solar–terrestrial system based on advanced computer simulations and data analyses. In particular, we promote studies to elucidate various phenomena, such as solar cycles, solar flares, coronal mass ejections (CMEs), geomagnetic storms, and aurora, where the nonlinear interaction and intercoupling between different systems play an important role. We also promote scientific projects of satellite missions (Hinode and ERG satellites) by observing the Sun and geospace in cooperation with the Institute of Space and Astronautical Science (ISAS)/JAXA, and the National Astronomical Observatory of Japan (NAOJ). The faculty members of this division are responsible for education in the Graduate Schools of Science and Engineering at Nagoya University.

Main Activities in FY2020

The first physics-based method for predicting large solar flares

Because large solar flares can cause severe space weather disturbances affecting the Earth, their occurrence must be predicted to mitigate their impact. The research team led by Professor Kanya Kusano succeeded in developing the first physics-based model to accurately predict imminent large solar flares. The predictive model was tested on active regions during solar cycle 24 from 2008 to 2019. With few exceptions, the new model predicted the most imminent solar flares and the precise location from which they will emerge. The researchers also discovered that a new parameter – the "magnetic twist flux density" close to a magnetic polarity inversion line on the solar surface – determines when and where solar flares probably occur and how large they are likely to be. This research was published in the journal *Science* on July 31, 2020 (Kusano et al., *Science*, 2020).

Exploring the HSP in solar cycle 24

Over the past decades, extensive solar observations have revealed that left-handed/right-handed helical structures appear more frequently in the northern/southern hemisphere of the Sun, independent of the solar cycle. This is the so-called hemispheric sign preference (HSP) of helicity. By analyzing the magnetic helicity flux in solar active regions (ARs), we found that 63% and 65% of the investigated AR samples in the northern and southern hemispheres, respectively, followed the HSP. The HSP gradually increases from 50%–60% up to 70%–80% for AR samples, which (1) appear at the earlier rising phase of solar cycle 24 or higher latitudes, and (2) have larger values of the total unsigned magnetic flux and the average plasma flow speed. Our observations support the enhancement of the HSP mainly by the Coriolis force acting on an expanding flux tube through the convection zone, and the differential rotation on the solar surface and alpha effect at the base of the convection zone. Future research should employ advanced solar convective dynamo simulations to investigate the HSP trends found in this study and use them for model validation (Park et al., *ApJ*, 2020).

Data-driven MHD simulation of successive solar plasma eruption

To predict solar flares and plasma eruptions with a physical understanding, the magnetic field information from the photosphere (the surface of the Sun) to the corona (the upper plasma atmosphere) is necessary. The photospheric vector magnetic fields were observed in detail, whereas the coronal magnetic fields can not be measured. Many numerical methodologies for inferring coronal magnetic fields have been developed together with an increase in the quality of photospheric magnetic data for decades. In this study, we developed a method of data-driven magnetohydrodynamic (MHD) simulation in which time-series observational data of the photospheric magnetic fields were incorporated in the bottom boundary condition of the MHD simulation. Using this method, the response of the coronal magnetic fields to the temporal evolution of the photospheric magnetic fields was reproduced. We demonstrated the feasibility of the newly developed data-driven method by reproducing successive solar plasma eruptions during an observation (Kaneko et al., *ApJ*, 2021).

Solar cycle-related variation in solar differential rotation and meridional flow in solar cycle 24

Predicting the next solar cycle is crucial for space weather studies. So far, we have developed the suface flux transport (SFT) code to predict solar cycle activity and improve the accuracy of the parameters necessary for SFT calculation. We concentrated on obtaining the velocity field, which is a necessary parameter for this model calculation, using satellite observations, and found that the flow in the meridional plane in solar cycle 24 was faster than that in cycle 23 (Imada et al., *Earth, Planets and Space*, 2020).

Reconstructions of the past solar–terrestrial environments with historical documents and analog records

To assess the long-term variability of solar–terrestrial environments, historical documents and analog records allow us to chronologically extend the insights of modern observations. Therefore, we are working on the quantitative reconstructions of short-term space weather events and long-term solar variability by analyzing their relevant historical records. During this fiscal year, we analyzed the extreme space weather events in October/November 1903 (Hayakawa et al., *ApJL*, 2020c), January 1938 (Hayakawa et al., *ApJ*, 2021b), February/March 1941 (Hayakawa et al., *ApJ*, 2021a), and March 1946 (Hayakawa et al., *MNRAS*, 2020d) to reconstruct their solar surface and temporal evolution and quantitatively evaluated the magnitude of the geomagnetic disturbances. We also analyzed the sunspot group number and solar coronal structure for long-term solar variability and contrasted the Maunder Minimum and Dalton Minimum (Hayakawa et al., *ApJ*, 2020b; Hayakawa et al., *ApJ*, 2020e; Hayakawa et al., *MNRAS*, 2020f; Silverman and Hayakawa, *JSWSC*, 2021).

Relativistic electron microbursts as high-energy tail of PsA electrons

We showed that subrelativistic/relativistic electron microbursts form the high-energy tail of a pulsating aurora (PsA). Whistler-mode chorus waves that propagate along the magnetic field lines at high latitudes cause precipitation bursts of electrons with a wide energy range from a few keV to several MeV (relativistic microbursts). The rising tone elements of chorus waves cause individual microbursts of subrelativistic/relativistic electrons and PsA internal modulation at a frequency of a few hertz. The chorus bursts for a few seconds, causing the microburst trains of subrelativistic/relativistic electrons and the main PsA pulsations. Our simulation studies demonstrated that both PsA and relativistic electron microbursts originated simultaneously from pitch angle scattering by chorus wave–particle interactions along the field line (Miyoshi et al., *GRL*, 2020).

Very high altitude auroral acceleration region captured by Arase-THEMIS/ASI conjugate observation

We found a very high altitude auroral acceleration region extending beyond 30000 km altitude using comprehensive particle and field observations (including a high-angular resolution electron detector LEP-e) with the Arase satellite and a THEMIS ground-based imager. This finding challenges the conventional view in which the auroral electron is mostly accelerated at altitudes of a few thousand kilometers, and brings new mysteries of auroral emission mechanisms. Understanding the detailed properties of the very high altitude auroral acceleration region is crucial for following the processes of discrete auroral emission on other planets and electron acceleration on extraterrestrial magnetospheres such as pulsars (Imajo et al., *Scientific reports*, 2021).

Effects of the IMF By on ring current asymmetry under southward IMF Bz conditions observed at ground magnetic stations: Case studies

The ring current is asymmetric during the main phase of a geomagnetic storm. In this study, we evaluated the role of the IMF By on the asymmetry of the ring current during the main phase of geomagnetic storms. To evaluate the ring current asymmetry, the mean H variations were calculated using 31 ground magnetic stations over magnetic latitudes of 9–45°. Further, the magnetic local time (MLT) variations in the H-component at these stations regarding the mean H were investigated for three cases of geomagnetic storms with varying southward interplanetary magnetic field (IMF) Bz and IMF By conditions. The primary role of IMF Bz on the asymmetry of the ring current was observed. For the first time, this study examined the additional role of IMF By in influencing the MLT distribution of the ring current at ground magnetic stations. Under southward IMF Bz conditions, based on the Super Dual Auroral Radar Network (SuperDARN) and the Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE) observations, IMF By altered the MLT distribution of the ring current under suitable conditions. The timescales of the IMF By also play a very important role in determining the asymmetry of the ring current. Under a steady convection state, the IMF By could rotate the convection cells based on its polarity, which changed the MLT distribution of the ring current observed at low-latitude ground stations. Thus, this study highlights the important role of IMF By on the asymmetric MLT distribution of the ring current under the southward IMF Bz (Kumar et al., *JGR*, 2020).

Tracking the source of the near-Earth plasma sheet

Recent research has used Arase data to determine how the composition of the plasma sheet changes during a storm. The contributions of ionospheric and solar wind to the magnetosphere can be determined by their composition. While both sources contain significant H^+ ions, the heavy ion species from the ionospheric source are generally singly ionized, whereas the solar wind heavy ions are highly ionized. Using composition data from multiple satellites, we tracked how the source of the plasma sheet changed during a storm. An initial study using Active Magnetospheric Particle Tracer Explorers (AMPTE)/Charge-Energy-Mass Spectrometer (CHEM) data, a dataset that included the full charge state distributions of major species, showed that the transition could occur quite sharply during storms, with the ionospheric contribution becoming dominant during the main storm phase (Kistler, 2020). However, during the AMPTE period, there were no continuous measurements of the upstream solar wind, and thus both the simultaneous solar wind composition and the driving solar wind and IMF parameters were not known. Using the LEPi and MEPi instruments on Arase, we used the He^{++}/H^+ ratio compared to that in the solar wind to determine the solar wind contribution. This allowed the determination of the ionospheric contribution to the H^+ population to measure the full ionospheric contribution. When the IMF turned southward during the main storm phase, the dominant source of the hot plasma sheet became ionospheric. This composition change explained why the storm-time ring current also had a high ionospheric contribution (Kistler, *GRL*, 2020).

Atomic oxygen ion-neutral collision frequency in the F-region ionosphere

The collision between atomic oxygen and its first positive ion plays a major role in the ionosphere of the Earth's F-region. An accurate corresponding collision frequency model is required to quantitatively understand the ionosphere. However, the widely used classic Banks theoretical model typically provides a collision frequency that is 30% lower than the expectation from ionospheric observations. Accordingly, the classic collision frequency is often adjusted by multiplying it by a constant known as the Burnside factor. This correction-factor model adopted the classic model as its basis because of the misunderstanding that the classic model was based on a laboratory experiment; that is, the correction factor was originally meant to compensate for laboratory contamination. In this study, a collision frequency model was constructed based on a laboratory experiment, and the resultant laboratory-based model was found to be consistent with ionospheric observations. In this construction, the impact of laboratory contaminations was determined to be small (7%) and was mostly canceled by misinterpreting conventional definitions of energy. Thus, the 30% difference was mainly caused by a theoretical error in the classic model. This error was energy-dependent and corrected using a later wide-energy theoretical model. Thus, the classic model could not be corrected by a temperature-independent constant and should be replaced by a later model (Ieda, *JGR*, 2021).

Ionospheric plasma density oscillation related to EMIC Pc1 wave

Based on the Swarm satellite observations, Kim et al. presented the first observational evidence of ionospheric plasma density oscillations coherent with electromagnetic ion cyclotron (EMIC) Pc1 waves. They compared the amplitudes of the density and magnetic field oscillations based on the MHD theory and found that the density power was much larger than the magnetic field power (Kim et al., *GRL*, 2020).

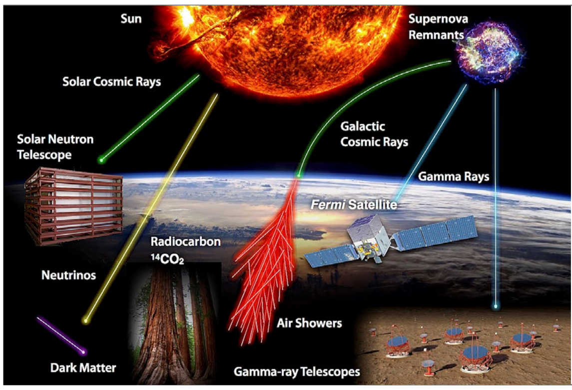
A novel calibration method for waveform signals and its application to Arase/PWE observations

Waveform data passing through a system comprising sensors, amplifiers, and filters should be calibrated in the frequency domain for use as scientific data. However, waveform data calibrated by conventional methods are distorted in the time domain when using a short-time window. To perform an accurate calibration with a short-time window, we proposed a novel calibration method to estimate the phase shifts of a window function from the gradient of a transfer function and remove the distortion by dividing the data by the shifted window functions at each frequency in the time domain. We applied this method to actual electric field data detected using plasma wave experiment (PWE)/waveform capture (WFC). Consequently, the proposed method reproduced seamless waveforms with 1% errors of the wave amplitude. We are currently applying for a patent using this novel calibration method (Japanese patent application number: P2020-206843).

In addition to the above topics, the following studies were conducted in FY 2020

- Statistical analysis of ion heating by EMIC waves via the wave–particle interaction method: Arase observation
- Characteristics of EMIC waves in the magnetosphere based on Van Allen Probes and Arase observations
- Spatio-temporal evolution of energetic electron injection in the inner magnetosphere observed by Arase and Van Allen Probes satellites
- Analyses of drift echo holes using the Arase satellite and ground-based observations

Division for Cosmic-Ray Research



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

Cosmic rays (CRs), which are mostly protons with small amounts of charged particles such as electrons or nuclei, and neutral particles, such as gamma rays or neutrinos, are produced in space and propagate through interstellar and 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 conducted large hadron collider forward (LHCf) and relativistic heavy ion collider forward (RHICf) experiments to study the hadronic interactions of ultra-high-energy CRs using accelerators such as the LHC or RHIC. This division also conducted neutrino physics research with the Super-Kamiokande experiment and promoted the Hyper-Kamiokande project as a future prospect. The group intensively worked on direct dark matter searches in the XMASS liquid xenon experiment at the Kamioka Observatory and has recently started a new commitment to the XENONnT experiment in Gran Sasso National Laboratory (LNGS) in Italy.

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

Main Activities in FY2020

Search for dark matter and research on the origin of CRs using gamma-ray observations

Cosmic gamma rays are produced through the interactions of dark matter, CRs, and the interstellar medium. Therefore, gamma rays are a useful probe to search for dark matter and investigate the properties and distribution of CRs and the interstellar medium.

We are developing a next-generation gamma-ray observatory, the CTA, to observe cosmic gamma rays in an energy range from well below 100 GeV to above 100 TeV. We oversee the development, procurement, and calibration of silicon photomultipliers (SiPMs) for the small-sized telescope in the CTA. One of the problems with the operation of the SiPM is optical crosstalk, which produces additional signals to the incident photon signal. In the past, we successfully reduced the optical crosstalk by more than an order of magnitude. To understand the origin of the remaining optical crosstalk, we studied delayed crosstalk, which is produced by a different mechanism from normal optical crosstalk. (Normal optical crosstalk coincides with the original signal, whereas the delayed crosstalk occurs approximately 10 ns later.) Precise measurements of the delay time distribution of the delayed crosstalk revealed that early delayed crosstalk was misidentified as normal crosstalk because the delay was too short to resolve the delayed signal from the original signal. We found that the misidentified delayed crosstalk rate accounted for almost all the remaining crosstalk. We are now discussing measures to reduce the delayed crosstalk with a manufacturer. We also studied the increase in the optical crosstalk in neighboring SiPM sensors due to reflection by the protection glass window of the camera. We found that the optical crosstalk increased by a factor of four or more owing to the presence of the protection window. We are currently investigating the effects of this crosstalk.

Acceleration mechanism of solar energetic particles

We studied the acceleration mechanism of solar energetic particles by observing solar neutrons with energies greater than 100 MeV on the ground. Solar energetic particles are accelerated in association with energetic solar flares. These accelerated ions produce neutrons through interactions with the solar atmosphere. It is expected that observing neutrons is better for understanding the acceleration mechanism of solar energetic particles than observing accelerated ions directly because neutrons are not reflected by the interplanetary magnetic field. Neutrons are attenuated in Earth's atmosphere. Therefore, the ISEE has developed a worldwide network of solar neutron detectors at high mountains in different longitudes.

Thus far, more than 10 solar neutron events have been obtained. The energy spectra of neutrons at the solar surface are obtained if we assume that neutrons are produced at the same time as electromagnetic waves produced in association with the same solar flares. The obtained spectra indicate that stochastic acceleration occurs when energetic neutrons are produced on the Sun. To derive a conclusive understanding of the acceleration mechanism, we need to observe a solar neutron event in which the energy spectrum of the neutrons can be determined without assuming the production time of the neutrons. The sensitivity to neutrons and energy resolution of the solar neutron detectors used in the worldwide network is not sufficient to conclude the acceleration mechanism of solar energetic particles.

A new solar neutron telescope was installed at the top of Sierra Negra (4580 m above sea level) in Mexico. The new detector is called the SciBar Cosmic Ray Telescope (SciCRT). SciBar was used in the accelerator experiments, and this installation was realized with support from Kyoto University, the High Energy Accelerator Research Organization, the National Autonomous University of Mexico, and the National Institute for Astrophysics, Optics and Electronics in Mexico. SciCRT uses 15000 scintillator bars to measure particle tracks, providing much better sensitivity to neutrons, better energy resolution, and particle discrimination. The performance of SciCRT was investigated using Monte Carlo simulation, and we can discriminate the production time of neutrons, whether it is instantaneous or continues for more than 5 min, while discriminating between shock and stochastic acceleration.

The activity of the solar cycle shifted from cycle 24 to cycle 25 in 2020. The data obtained by SciCRT amounted to approximately 1 Terra Byte per month. Researchers in Mexico City pick up data at Sierra Negra and carry the data to Mexico City every two to three months. In the fiscal year 2020, the COVID-19 pandemic occurred worldwide. People in Mexico City could not visit Sierra Negra for a long time, and the operation of SciCRT had to stop for approximately six months because the hard disk at the mountain was full. Finally, it became possible to visit Sierra Negra in February 2021. SciCRT has been continuously operated since then. Fortunately, the Sun was inactive during the fiscal year 2020, and no energetic solar flare occurred.

This study was performed in collaboration with Chubu University, Shinshu University, the Institute for Cosmic Ray Research of the University of Tokyo, ISAS/JAXA, the Japan Atomic Energy Agency, the National Defense Academy, the Aichi Institute of Technology, and many other institutions worldwide.

Study of neutrinos and dark matter in underground experiments

Neutrinos are neutral elementary particles that interact with matter only through weak interactions. The neutrino oscillations caused by the mixing of the three flavor states of neutrino can be useful tools to investigate their properties, such as their masses. The Cosmic Ray Research Division conducts neutrino research in Super-Kamiokande at the Kamioka Underground Observatory, and is also promoting the future Hyper-Kamiokande experiment, which has an eight times larger effective mass.

This year, the results of the search for neutrino-nonstandard interactions using atmospheric neutrino oscillations have finally been produced as a Ph.D. thesis for the joint degree program at the University of Edinburgh. We have also made efforts to upgrade the existing Honda flux, the atmospheric neutrino production model, using hadronic interaction data obtained from various accelerator-based experiments, and comparing their central values and systematic uncertainties.

Dark matter in the universe is considered as yet-undiscovered particles, which are heavy neutral particles that are difficult to observe owing to their weak interactions. Many experiments are underway globally to detect these particles. We directly searched for dark matter in the XENONnT experiment using a double-phase xenon time projection chamber (TPC) at the Gran Sasso underground laboratory in Italy. This year, the construction of the detector at the site was completed, and commissioning was successfully undertaken despite the COVID-19 pandemic. Although trips to the site were inhibited, we engaged in remote monitoring shifts of liquid xenon introduction and analysis of the commissioning data of the TPC and neutron veto detectors. We are also conducting various research and development studies for the future DARWIN project, which is planned to build a 40-ton double-phase xenon TPC. We have developed an electrode made of a quartz plate coated with a thin layer of high-resistivity transparent material. We successfully demonstrated electron drift using a small drift tube as a drift electrode. We also evaluated the performance of the SiPM photodetector at the liquid xenon temperature and developed a new hybrid photomultiplier tube using SiPM for photoelectron amplification.

Developing an electrode with a quartz plate using a thin layer of high-resistivity transparent material.

CR interaction-focused accelerator experiments

Where and how are CR particles accelerated to high energies? To answer this question, many observations and studies of CRs have been performed worldwide. CRs are observed using the air-shower technique, which involves observing particle cascades caused by interactions between CRs and atmospheric atomic nuclei using particle detectors or fluorescence telescopes. A precise understanding of the hadronic interactions between CR particles and the atmosphere is key to estimating the primary CR information from the observed air showers. The interpretation of chemical composition observables is strongly dependent on the hadronic interaction model used in the air-shower simulation. Therefore, we studied high-energy interactions of large particle colliders, LHC and RHIC, located at the European Organization for Nuclear Research and the Brookhaven National Laboratory.

We performed LHCf and RHICf experiments to observe energetic photons and neutrons produced in the very forward region of proton-proton collisions in the LHC and RHIC. Both experiments have been undertaken internationally. This year, we continued our analyses of the data obtained from these LHC and RHIC operations and accelerated preparation for our future operations. One of the data analyses, a combined analysis of LHCf with ATLAS, progressed well this year. The contribution of forward photon production to diffractive collisions was measured by selecting forward photon events without particle production in the central region. The result was largely inconsistent with some of the model predictions, and model improvement by fine-tuning it with our results is expected in the future.

For future operations, we are upgrading a new readout system with the Italian group in LHCf, and we started the design of a new detector using silicon pixels and pads for the next RHICf operation. COVID-19 has had an unavoidable impact on the schedules; however, we are trying to minimize this and accelerate the preparation of future research.

Historic CR intensity variation with cosmogenic radioisotopes

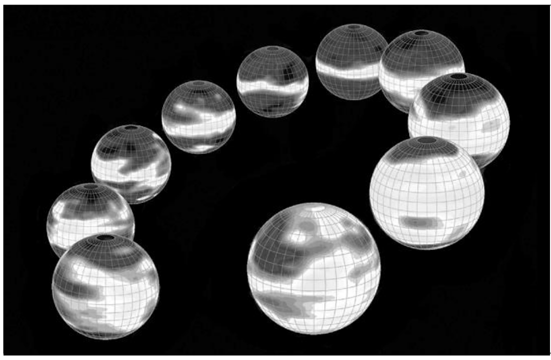
CRs falling on Earth interact with the atmosphere and produce various secondary particles. Among them, long-lived cosmogenic nuclides, such as ^{14}C and ^{10}Be, have been used as excellent proxies for CR intensities in the past. We measured ^{14}C concentrations in tree rings and ^{10}Be and ^{36}Cl concentrations in ice cores to investigate past CR variations. From such analyses of cosmogenic nuclides, we found increased CR events in 774/775 CE, 993/994 CE, and ~660 BCE. Possible causes of these CR events include solar energetic particle (SEP) events, and the scale of these SEP events is estimated to be tens of times larger than the largest event on record. However, intermediate-scale SEP events, which occur between extreme events found in cosmogenic nuclides and the largest events on record, have not yet been detected. To detect such an intermediate-scale SEP event using cosmogenic nuclides, improving the measurement uncertainty and isolating the nuclide variation due to other factors is essential. We aim to clarify the frequency of extreme SEP events by searching for other CR events and detecting such intermediate-scale SEP events.

This year, to detect such intermediate-scale SEP events, we succeeded in measuring ^{14}C concentrations in tree rings with 1/3-year resolution by adopting intra-annual separating methods for tree rings (microtome and plate-state cellulose extract methods). In addition, we performed a high-precision ^{14}C measurement around the Carrington event (1859) as a candidate for an intermediate-scale SEP event.

We also performed quasi-annual analyses of ^{10}Be and ^{36}Cl concentrations using the Antarctic Dome Fuji ice core for ~100 years at approximately 5480 BCE. We discussed the causes of the CR increase event reported around 5480 BCE by comparing the results with the ^{10}Be and ^{36}Cl variations around the 775 CE event.

We provided some of the annual ^{14}C data previously obtained by our research group on the age calibration curve IntCal20, which is used as the world standard value for ^{14}C (Reimer et al. 2020). The annual increase in ^{14}C, such as the 775 CE event, can be applied to ultra-high-precision dating as a time marker. IntCal20 focuses on ^{14}C events and annual resolution ^{14}C data. Our annual ^{14}C data for the SEP event search contributed significantly to the fields of dating and stratigraphy.

Division for Heliospheric Research



- Solar wind and heliosphere
- Interplanetary scintillation (IPS)
- Coronal mass ejection (CME)
- Long-term variation of the heliosphere
- Space weather forecast
- Radio astronomy
- Development of telescopes and instruments
- Pulsar

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

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

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

Main Activities in FY2020

Solar wind observations using the IPS system

We have been performing remote-sensing observations of the solar wind since the 1980s using a multi-station interplanetary scintillation (IPS) system. Tomographic analysis of IPS observations enables accurate determination of the global distribution of solar wind speed and density fluctuations. IPS observations provide valuable information, particularly for high-latitude solar winds, where *in-situ* observations are currently unavailable. The IPS system currently consists of three large antennas in Toyokawa, Fuji, and Kiso. The Toyokawa antenna (called the Solar Wind Imaging Facility Telescope: SWIFT) has the largest aperture and highest sensitivity among the three antennas and started daily observations in 2008. The Fuji and Kiso antennas were upgraded in 2013–2014 by installing new receivers, which significantly improved their sensitivity. These two antennas are in mountainous areas and are not used for observations during winter owing to heavy snowfall. Hence, the solar wind speed data from three-station observations were unavailable during winter. Instead, the solar wind density fluctuations were derived from the Toyokawa IPS observations, which were measured throughout the year. The IPS data were made available to the public in real time via an ftp server and used for various international collaborations, as described below. In this FY, three-station IPS observations were conducted between early April and early December using the Toyokawa, Fuji, and Kiso antennas. When restoration of the Kiso antenna was undertaken before starting IPS observations (on March 26, 2020), withered grass near the antenna caught fire from welding sparks and the surrounding area of 23100 m^2 burned. Fortunately, there was no serious damage to the observation facility owing to quick extinction by local firefighting services. Furthermore, the pillow block problem of the Kiso antenna was fixed on July 20–22. After stopping IPS observations at Kiso in December, we found that the pillow block was damaged, and we will restore it before starting IPS observations in the next FY. We noticed a breakdown of the reduction gear of the Fiji antenna on September 3, and restored it on September 7–8. For the Toyokawa antenna, we repaired the weed control sheet beneath the parabolic reflector and performed a calibration experiment on the receiver.

International collaboration for space weather forecast

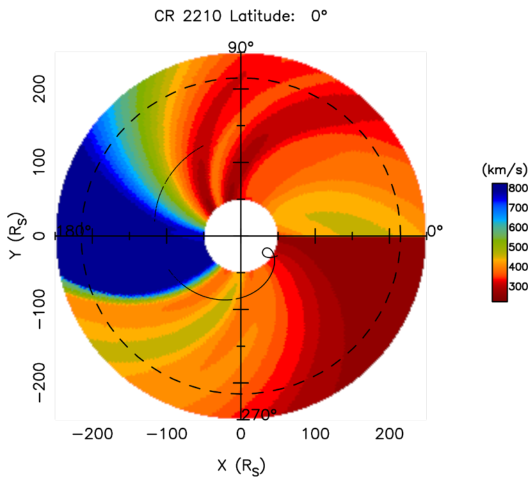
We have performed collaborative research with Dr. B. V. Jackson and his colleagues at the University of California, San Diego (UCSD) since 1996 on the 3-dimensional reconstruction of the time-varying heliosphere using tomographic analysis of IPS observations. A time-dependent tomographic program was developed through this collaborative study. Furthermore, a combined analysis system using IPS observations and the ENLIL solar wind model was developed to improve space weather forecasting through collaborative research. These programs are now available on the NASA Community Coordinated Modeling Center web server and are running in real time at the Korean Space Weather Center (KSWC) to predict the solar wind reaching the Earth. ISEE had a research exchange and cooperation agreement with KSWC to promote research on space weather forecasting using IPS data. Since this agreement will be terminated during this FY, a researcher at KSWC visited ISEE to discuss future actions. At the Met Office, which is a space weather forecast agency of the UK, a proposal for installing the IPS data analysis programs of UCSD was discussed for this FY.

With the growing awareness of the utility of IPS observations for space weather forecasting, an increasing number of IPS observations have been conducted globally. In addition to Japan, Russia, and India, where IPS observations have been conducted for a long time, new dedicated antennas for IPS observations were constructed in Mexico and Korea, and IPS observations using low-frequency large radio array systems, such as the low-frequency array (EU) and the Murchison Widefield Array (Australia), were conducted on a campaign basis. A construction project with a large-aperture antenna dedicated to IPS observations is in progress in China. The integrated analysis of IPS data from these stations enables higher-resolution 3-dimensional reconstructions of the solar wind, which varies rapidly with solar activity. Therefore, the establishment of an international IPS observation network called the World IPS Station was proposed. To promote this project, we conducted a comparison study of solar wind speeds derived from IPS observations in Russia and ISEE during this FY. As a result, we found that they were in general agreement.

Mr. Sejin Park (right) from KSWC, who visited ISEE on November 5, 2020.

Comparison with PSP observations

To elucidate the solar wind acceleration mechanism, Parker Solar Probe (PSP) was launched in August 2018. The PSP has a heliocentric orbit, whose perihelion gradually approaches the Sun and eventually reaches the radial distance of approximately 9.86 solar radii (Rs). Research on solar wind acceleration is expected to progress significantly, owing to observations with PSP. The key point is to distinguish between radial and horizontal (latitude/longitude) solar wind variations. Although it is difficult to achieve this only from PSP observations, it becomes possible by combining global observations by IPS. In this FY, we compared the IPS and PSP observations for Orbits 1 and 2, which occurred in November–December 2018 and March–April 2019, respectively. The former period corresponds to just before the three-station IPS observations ended, and the latter corresponds to when the IPS observations started. Therefore, the amount of IPS data was relatively small, and a meaningful comparison between PSP and IPS observations was limited to Orbit 1. The minimum distance of IPS observations for this period was approximately 36 Rs and the solar wind acceleration was considered to be completed by this distance. Therefore, the solar wind speeds measured by the PSP should agree with those measured by the IPS. We compared the solar wind speeds measured by PSP and IPS, considering PSP latitude and longitude time variations, and found that they were in good agreement (correlation coefficient 0.68). Further, we determined the distributions of speed, density, and temperature in the inner heliosphere from IPS observations using the 1-dimensional hydrodynamic code and compared them with the PSP observations. We found that the data derived by the IPS were generally consistent with those measured by the PSP. These results are meaningful for further extensive comparisons of PSP and IPS observations.



Distribution of the solar wind speed derived from IPS observations using the 1-dimensional hydrodynamic code in the heliographic equation for Carrington rotation (CR) 2210: Orbit 1. Solid and dashed lines indicate the orbits of PSP and the Earth, respectively.

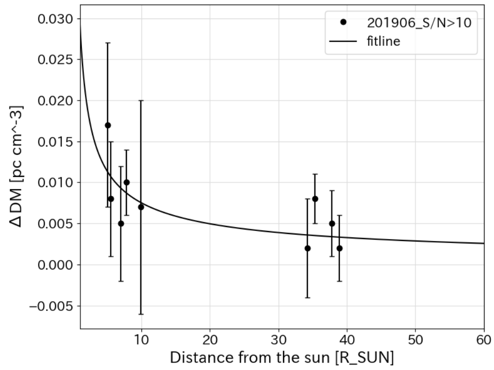
Toward a comparative study of *in-situ* and IPS observations of the inner heliosphere

A coronal hole is a low-density region where the magnetic field lines are open to the interplanetary space. This region is the main source of high-speed solar wind and the main driver of geomagnetic activity.

The PSP is currently observing the solar wind in its orbit, which is gradually approaching the closest perihelion (several solar radii), so that *in-situ* observations of the solar wind acceleration mechanism are being realized. Because our IPS observations do not cover the solar wind acceleration region, it is difficult to directly compare with PSP. Therefore, as a preparatory study, we began a numerical simulation of the solar wind acceleration along the open magnetic flux tube, which is compared to PSP measurements in collaboration with the Harvard-Smithsonian Center for Astrophysics. Simulations were performed using the reduced-MHD simulation (RMHD) code recently developed by our collaborators at the Harvard-Smithsonian Center for Astrophysics, and the coronal hole observed on November 1, 2018 and the solar wind structure within 20 Rs were calculated. In the future, we will expand the computational domain of this simulation to 30–40 Rs to perform a comparative study between PSP and IPS observations and elucidate the solar wind acceleration mechanism.

Estimating the solar wind density structure using Crab pulsar observations

Frequency dispersion can be seen when observing pulsar radio waves on Earth. The magnitude of the frequency dispersion is called the dispersion measure (DM), which represents the integral amount of electron density in the line of sight from the pulsar to the Earth. We measured the plasma density of the solar corona from the DM of the pulsar using the radio telescope SWIFT in Toyokawa. The solar wind density has significantly decreased in response to declining solar activity for some years. Therefore, a remarkable change has likely occurred in the solar corona, which is the source region of the solar wind. The target of our observations was the Crab pulsar. The Crab pulsar's line of sight approaches the Sun every June at a distance of approximately 5 Rs, so it is possible to examine the electron density near the Sun. In addition, the Crab pulsar has a giant pulse that can be used to determine the DM based on short-term observations. Since June 2018, we have been investigating the electron density of the solar corona using DM, and the same observations were made in 2019 and 2020. In June 2020, we could not obtain high-precision DM measurements; however, 2019 showed the same trend as 2018, with DM increasing as the Crab pulsar's line of sight approached the Sun. This analysis changed the criteria for selecting the pulses used to estimate and analyze the background effects of the interstellar medium, which was obtained from observations from September to March, when the Sun's elongation was large. This increased the amount of data used to determine the background effect. There was a tendency for the pulses to decrease with the approach of the Sun throughout the three years. Therefore, the decrease in the number of observations was compensated for by lowering the selection criteria for the pulses. It was expected that the accuracy of DM would decrease when the selection criteria were lowered; however, the accuracy of DM improved due to the increase in the number of analyses, and the expected decrease in accuracy was not observed. From the increased DM obtained, we fitted a spherically symmetric density model to investigate the plasma distribution of the solar corona. The 2019 fit results were consistent with the solar minimum characteristics observed in previous studies. Looking at the Large Angle and Spectrometric Coronagraph Experiment (LASCO) coronagraph data, this is expected to be due to the typical minimum period of solar activity continuing from 2018. The estimation error was reduced to approximately one-third of the 2018 result, showing an improvement in the accuracy of the fit results because the DM accuracy was improved by lowering the selection criteria for the pulses to be analyzed. Therefore, it is desirable to use the year's criteria for future analysis. We will continue to undertake pulsar observations to measure the plasma density of the solar corona, aiming to improve the accuracy of density measurement by capturing large changes when approaching.



It shows the increase in DM with the approach of the Sun. The black dots represent the increase in DM from the background effect of the interstellar medium, and the solid line shows the fitted corona density model.

Space weather forecasting system using IPS data

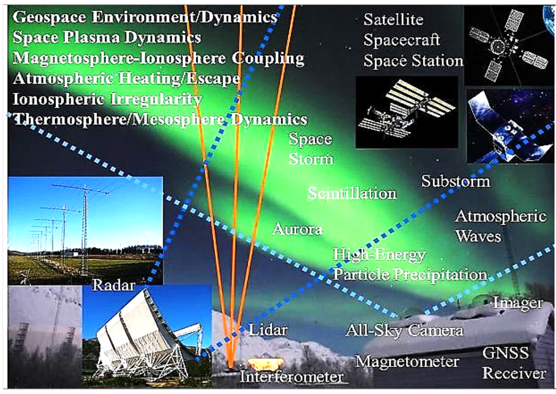
We developed a 3-dimensional MHD simulation based on IPS observations to predict the arrival of CMEs and validated their accuracy using 12 halo CME events. The average absolute arrival-time error of the IPS-based MHD forecast is approximately 5.0 h, which is one of the most accurate predictions that has been validated, whereas that of MHD simulations without IPS data, in which the initial CME speed is derived from white-light coronagraph images, is approximately 6.7 h. Therefore, the assimilation of IPS data into MHD simulations can improve the accuracy of CME arrival-time forecasts. This result was published by *Earth, Planets and Space*. The press release of this result has been reported in several newspapers and online media.

Next-generation IPS observation system

We investigated the scientific requirements and design of next-generation IPS observation instruments. The main scope of the next system is to elucidate the acceleration mechanisms of the solar wind. To achieve this, we considered a flat phased-array antenna system consisting of multiple dipole antennas with digital phased-array devices to obtain solar wind data 10 times that of conventional radio instruments. We also developed a prototype of a digital backend. We added an automated calibration sequence to the Field Programmable Gate Array (FPGA) of the digital backend to quickly calibrate the amplitude and phase differences of the antennas and receivers. In the laboratory experiments, we confirmed that the calibration system worked as expected. Based on these results, we submitted a proposal of the next-generation IPS observation system to the Grant-in-Aid for Specially Promoted Research.

Prototype of a digital backend for the next generation IPS observation system.

Division for Ionospheric and Magnetospheric Research



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

The plasma and energy carried by the solar wind to the Earth and other planets exert physical effects on the magnetosphere and ionosphere, known as the geospace. We studied these effects and associated phenomena with international cooperation, primarily through various observational approaches using ground-based instruments, such as 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 were developed in our division. We also led the way to future space exploration missions based on our expertise.

Main Activities in FY2020

Measurements of aurora and electromagnetic waves at sub-auroral latitudes (PWING project)

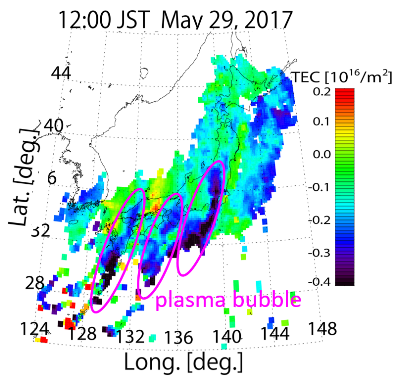
Aurora/airglow imagers and electromagnetic wave receivers have been involved in the PWING project at eight stations around the North Pole, at MLATs of approximately 60° (in Canada, Russia, Alaska, Finland, and Iceland) since 2016. They were used to investigate the plasma and wave dynamics in the inner magnetosphere. New results were obtained in FY2020. For example, the plasma and field characteristics of discrete and diffuse auroras in the inner magnetosphere were revealed based on a conjugate measurement by the Arase satellite and at Nain, Canada. This observation also showed that the field-aligned potential difference that creates discrete auroral arcs extended at altitudes more than 30000 km. Another four conjugate ground–satellite measurements revealed that the source mechanism of the stable auroral red arcs was mainly Coulomb collisions between ring current ions and plasmaspheric electrons.

Upper atmosphere imaging using the OMTIs

The optical mesosphere thermosphere imagers (OMTIs) consist of five sky-scanning Fabry-Perot interferometers, 21 all-sky charge-coupled device imagers, three tilting photometers, and three airglow temperature photometers, which are used to investigate the dynamics of the mesosphere, thermosphere, and ionosphere. New results were obtained from OMTI measurements in FY2020. For example, we reported the first multi-wavelength images of STEVE auroras at sub-auroral latitudes. The images showed that the STEVE auroras contain ordinary auroral green and red emissions, and background continuum emissions in almost the same arc shape in the images.

Ionospheric disturbances using GNSS receiver network

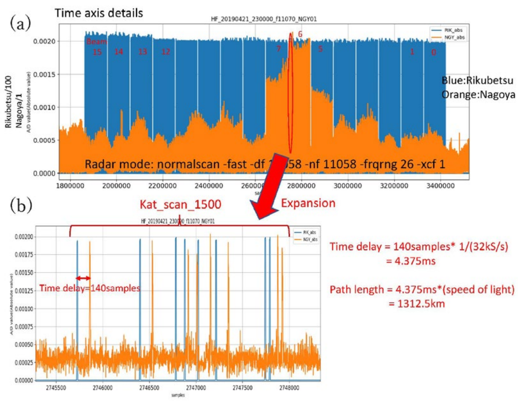
We developed a database that provides global 2-dimensional maps of the total electron content (TEC) with high temporal and spatial resolutions. The TEC data were obtained from more than 9000 GNSS receivers worldwide. Using the TEC database, we studied the generation mechanism of storm-enhanced density (SED) and found that the major cause of the midlatitude broad SED is the upward motion of the ionosphere by the enhanced convection electric field. The TEC maps also revealed that plasma bubbles over Japan survived until the afternoon during the recovery phase of a geomagnetic storm, although plasma bubbles usually disappeared at sunrise.



Map of TEC over Japan during a geomagnetic storm. Plasma bubbles can be seen as TEC depletions.

SuperDARN Hokkaido HF radars

Using the SuperDARN Hokkaido HF East and West radars at Rikubetsu, Hokkaido, and other SuperDARN radars, we studied the statistical occurrence characteristics of sub-auroral polarization streams, and found that the sub-auroral polarization stream occurrence rate depends not only on the season, magnetic latitude/local time, and geomagnetic activity, but also on the geographical longitude. In addition, we installed a 4-ch subset imaging receiver system at the Hokkaido East radar site and obtained some initial scientific results. The results of the operation of the HF radar remote receiver at Nagoya University's main campus were accepted for publication.



Sample plots of the SuperDARN Hokkaido East radar remote receiver data (Nagoya University main campus).

Promotion of FACTORS as the next space exploration mission realizing *in-situ* observations by formation flight in the space–Earth coupling system

The new space exploration mission, FACTORS, which is next to the ERG (Arase) satellite mission led by our institute for terrestrial radiation belt exploration, is being promoted for simultaneous multi-point *in-situ* observations by multi-satellite formation flight in the near-Earth space and terrestrial upper atmosphere. During this fiscal year, to maintain satellite distances of 1–50 km in the polar orbit at altitudes ranging from 400 to 4000 km, we numerically simulated two types of formation flight operations using the conventional thruster method with propellant and a newly proposed aerodynamics method with precise satellite attitude controls near the perigee. The results indicated that the aerodynamics method was more applicable because the required high-level accuracy could be achieved better with a small and stable atmospheric reaction, rather than the thruster operation, whose main purpose is large orbital control.

Improvement of charged particle beamline system used in a calibration experiment of analyzers mounted on space exploration satellites

In the clean room of our institute, we modified the charged particle beamline system required for the calibration experiment in the development processes of particle analyzers for future space exploration. The filament from which the electron emissions produce the ions and electrons in the neutral gas source was changed from a tungsten to a high-emission type of iridium filament coated by Y_2O_3, and thus the beamline could be operated with lower power (1.7 A/1.65 V/2.8 W) than before (4.71 A/2.55 V/12 W). The ion beam mass discrimination profile of the 90-degree course line was also improved by adjusting the electromagnet position and changing the magnetic field strength.

Floating-mode APD experiments using 10s-keV electrons and ^{241}Am

To lower the lowest limit of the energy range of electron energy analyses using avalanche photodiodes (APDs) as alternative space-qualified detectors of microchannel plates, we applied a floating voltage to the APD to accelerate electrons by the electric field generated around it, and then analyzed the electron energies. First, we performed experimental tests to confirm the basic features of APD with alpha particles and gamma rays radiated by ^{241}Am; thus, we removed the noise originating from the floating voltage with a low-pass filter and analyzed the energies of the accelerated electrons. The next step was to perform energy analyses of electrons whose original energies were much less than 5 keV before the APD acceleration after significantly reducing the background noise level by modifying the electrical circuit.

Promotion of EISCAT and EISCAT_3D projects

We proceeded with the EISCAT project in collaboration with National Institute of Polar Research (NIPR) and undertook the following: (1) Seven EISCAT Special Program experiments for Japanese colleagues; (2) EISCAT_3D project; and (3) a special session for the Master Plan 2020 in JpGU2020. We have also operated a photometer, an MF radar, and a meteor radar in northern Scandinavia, and have collaborated with Japanese and foreign colleagues in studies on atmospheric stability, gravity waves, sporadic sodium layers, and vertical winds. We conducted statistical studies of the lower thermosphere wind and the atmospheric stability of the polar winter mesopause region.

Oxygen density enhancement and EMIC waves in the inner magnetosphere

The O^+ density is sometimes enhanced in a limited range of altitudes in the deep inner magnetosphere and is referred to as the oxygen torus. We investigated the longitudinal structure of the oxygen torus using simultaneous observations from the Arase and Van Allen Probes satellites. We found that the oxygen torus was localized to the dawn sector, indicating a crescent-shaped torus. It was newly found that an EMIC wave in the H^+ band coincided with the oxygen torus. The linearized dispersion relation of EMIC waves showed that the growth rate was higher in the oxygen torus than in the adjacent regions in the plasma trough and plasmasphere. We concluded that the oxygen torus in the inner magnetosphere might play an important role in the excitation of EMIC waves. These results were published in Earth Planets and Space (Nosé et al., 2020).

Development of a low-cost magnetometer using a MI sensor

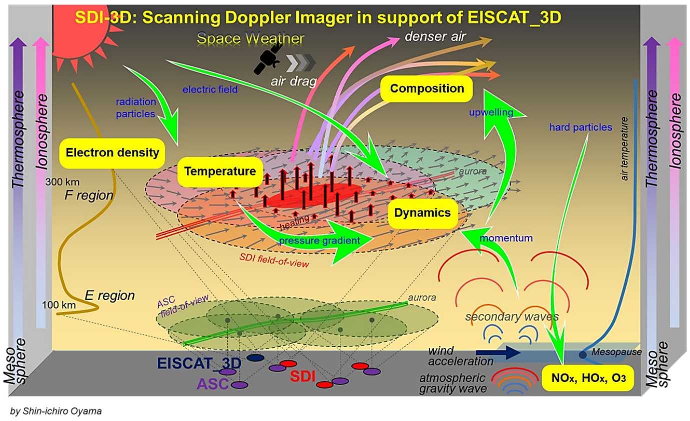
The magneto-impedance (MI) effect was discovered approximately 25 years ago, and a micro-sized magnetic sensor that utilizes this effect has now become commercially available. We made some modifications to the commercially available MI sensors, as they cover the range of the geomagnetic field (±70000 nT). We developed an instrument for ground measurements including MI sensors, a Raspberry Pi-based data logger, and an A/D converter, which is only ~1/10 of the usual cost of a fluxgate magnetometer. Experimental observations showed that the MI sensors could detect geomagnetic variations such as Sq variations, geomagnetic storms, and geomagnetic pulsations. This instrument could be used for continuous field measurements over a few months. We are also developing an onboard instrument for future sounding rockets.

Japan-Russia bilateral project

Several universities and institutes in Japan, including ISEE, Nagoya University have deployed optical and radio wave instruments in northern Scandinavia to collaborate with magnetospheric satellites such as the Arase satellite. We promoted a Japan-Russia bilateral project with the Polar Geophysical Institute (PGI) in Apatity (Murmansk, Russia) to expand the collaborative observation region and encourage cooperation with Magnetosphere-Ionosphere researchers in Russia using the Japan Society for the Promotion of Science budget. The bilateral project extended the ground-based observation network to further eastward of Scandinavia and met with many conjunctions with the Arase satellite. Thirteen researchers from Japan, including students and 10 researchers from Russia participated in the project. Remote workshops (September 2020 and March 2021) were held, and we published several papers based on discussions during the workshops. For example, we studied the ionospheric trough and auroral activity, which appeared during an interval between two high-speed solar wind events, analyzing measurements from all-sky cameras deployed in Scandinavia and Russia, and satellites crossing over the cameras. An auroral arc emerged for only 7 min immediately after the substorm onset, but in the ionospheric trough, which appeared at higher latitudes than usual. This finding on a possible moment of the stable auroral red (SAR) arc birth was published in the *Journal of Geophysical Research Space Physics* (Oyama et al., 2020).

SDI-3D project

The scanning doppler imager (SDI) is a ground-based Fabry-Perot Doppler spectrometer operating in an all-sky imaging mode with a separation scanned etalon to resolve Doppler spectra at heights of 90–400 km. A single station can estimate the horizontal wind vector and temperature on the horizontal plane with a diameter of 1000 km. We established an international team in 2018 with researchers from Japan, Scandinavian countries, and the US. This team commenced the “SDI-3D” project to deploy three SDIs in the same area as the EISCAT_3D, which might begin operation in 2023. To progress this project, in 2018, an international exchange program (or a cross-appointment system) was concluded between Nagoya University and the University of Oulu (Finland) as the first case in Nagoya University, and a faculty member stayed in Oulu for one month in 2020. A proposal submitted to the National Science Foundation in the USA was awarded in 2020, and the development of optical and radio wave instruments, including three SDIs, began. We officially participated in administrative-level meetings with the Memorandum of Understanding, integrating the ground-based observation network in Finland, Norway, and Sweden.



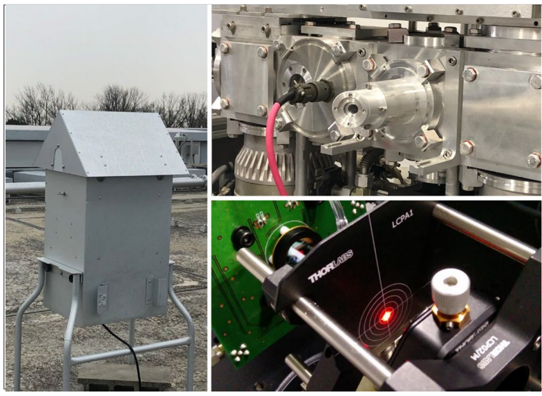
Schematic drawing of the SDI-3D project. The three SDIs will begin operation in fall 2023 and perform collaborative experiments with the EISCAT_3D radar, optical instruments and radio wave receivers that are deployed in the same area. This project aims at wide and high-resolution measurements of the ionosphere and thermosphere in association with intensive inputs of energy and particles into the polar region during periods of geomagnetic activity.

Data archives

The following data archives are available to the public:

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

Division for Meteorological and Atmospheric Research



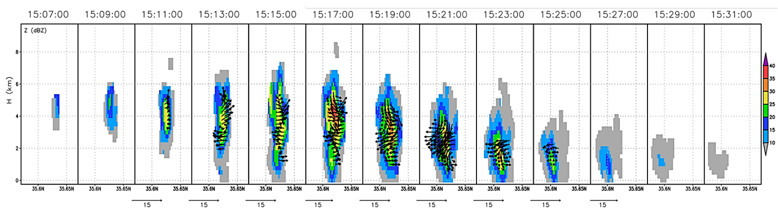
- Precipitation measurements by advanced polarimetric radars and hydrometeor videosondes
- Development of new instrumental technology
- Clouds and precipitation observed by multiple satellites
- Millimeter-wave/infrared spectroscopy of green house gases and ozone-depleting substances
- Measurements and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

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

Main Activities in FY2020

New understanding of precipitation from MP-PAWR observations

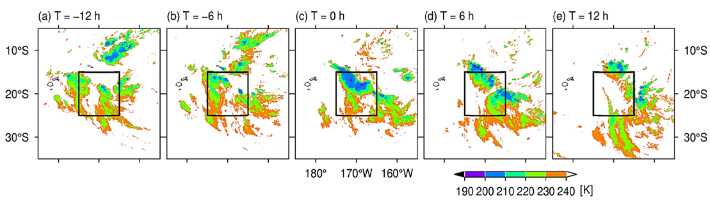
Analytical research using a multi-parameter phased array weather radar (MP-PAWR) was conducted by taking advantage of MP-PAWR's “high-speed three-dimensional” observation, and studying the life cycle of isolated cumulonimbus clouds. The high temporal resolution observation data obtained from the MP-PAWR describe the life cycle of the cumulonimbus from the developing to the dissipating stage of the clouds; updraft was predominant in the entire cloud in the developing stage, and the maturity stage was characterized when the downdraft began to appear in the lower layer. During the mature stage, a core with high radar reflectivity was formed in the upper layer, which fell to the ground and produced heavy rain. Wet graupels were also present in the cores.



Life cycle of an isolated precipitation system with wind field.

Transient aggregation of convection: Observed behavior and underlying processes

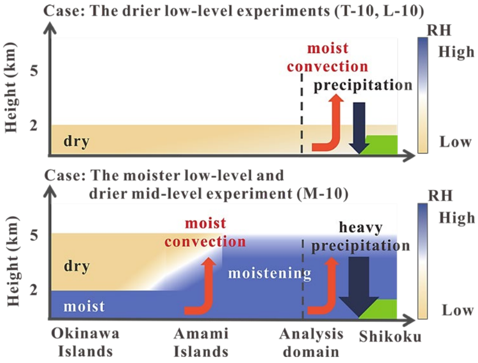
Convective self-aggregation is among the most striking feature emerging from radiative-convective equilibrium simulations; however, its relevance to convective disturbances observed in the real atmosphere remains debatable. This study examined the observational signals of convective aggregation intrinsic to the life cycle of cloud clusters. The statistical evolution obtained from the satellite imagery showed that cloud clusters were gathered into fewer members during ±12 h as precipitation picked up. The high cloud cover per cluster expanded as the number of clusters



A series of snapshots of infrared brightness temperature illustrating an example of transient aggregation.

decreased, suggesting a transient occurrence of convective aggregation. An additional energy budget analysis was performed to explore the physical mechanisms of transient aggregation.

Impact of vertical profiles of water vapor in the upstream region of a heavy rainfall event in July 2018 in Japan

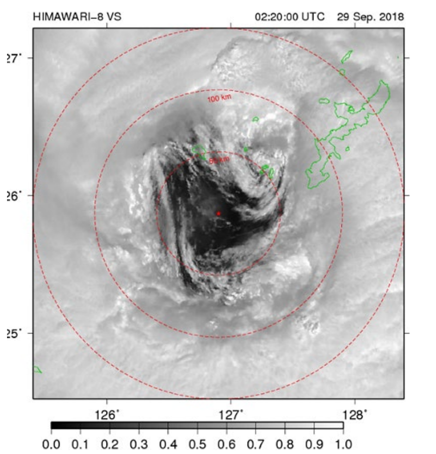


Schematic illustrations of impacts of vertical profiles of water vapor in the upstream region (around Okinawa Island) during the heavy rainfall event in western Japan.

Vertical profiles of water vapor play a crucial role in rainfall amounts. A heavy rainfall event occurred in western Japan at the beginning of July 2018. The Japan Meteorological Agency (JMA) report showed that the convective activity in the upstream region over the East China Sea, approximately 1000 km away from the heavy rainfall region, should be moistening the middle troposphere, and a deep moist air-mass intrusion should have an important role in forming the event. This study explored the impact of vertical profiles of water vapor in the upstream region on the rainfall amount in western Japan using a Cloud Resolving Storm Simulator (CReSS) with a horizontal resolution of 2 km.

The simulation captured the rainfall amount and its horizontal distribution well in western Japan. Trajectory analyses showed that the air mass intruding into western Japan had its origin in the upstream region around Okinawa Island. Sensitivity experiments that increase (decrease) the amount of water vapor in the lower troposphere in the upstream region showed the increasing (decreasing) rainfall amount in western Japan. However, no significant change in the rainfall amount in western Japan appeared in the sensitivity experiments that changed the amount of water vapor in the middle troposphere. In the drier experiment, convective activities along the trajectory moistened the middle troposphere, whereas in the moister experiments, convective activities along the trajectory removed water vapor in the middle troposphere by convective precipitation, and rainfall regions shifted to the upstream side. Therefore, precipitable water amounts in both the drier and moister experiments were approximately equal in western Japan. The results showed that the water vapor observation, especially in the lower troposphere, in the upstream region is important for forecasting the rainfall distribution and amount.

Observational study on the mesoscale structure inside an eye of a typhoon accompanying strong winds

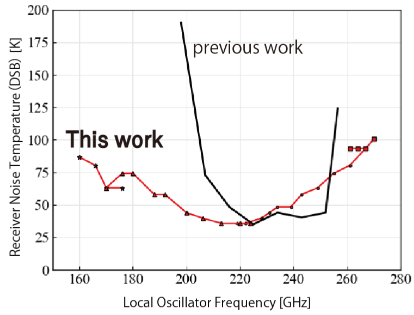


Visible image of the eye of the typhoon Trami obtained by the Geostationary Meteorological Satellite (Himawari-8) at 1120 JST on September 28, 2018. The shape of the eye is polygonal and a meso-vortex is located in the west of Okinawa Island.

Mesoscale structures, such as meso-vortices and polygonal eyes, have been observed inside the eye of typhoons in recent years and are an important topic for disaster prevention. When typhoon Trami (T1824) passed near Okinawa Island, the detailed structure inside its eye was observed using a polarimetric radar and phased-array radar. High wind was observed with a decreasing mixing ratio of water vapor in the vicinity of the eyewall clouds inside the eye, and the high wind region was in the polygonal eyewall clouds. Downward wind was estimated in the vicinity of the eyewall clouds inside the eye using Doppler analysis. The dry air above the inversion layer inside the eye should descend and transport a large momentum air-mass close to the eyewall clouds, and high wind with decreasing humidity should be observed inside the eye, and should be one of the formation mechanisms of high winds around the surface inside the eye.

Development of a new millimeter-wave superconducting device for multi-line observation in polar regions

We developed a new millimeter-wave superconducting mixing device for an observation project called "multi-line simultaneous observation of minor atmospheric molecules" in the polar regions via collaborative research with the Advanced Technology Center, NAOJ. The tuning circuit in the device was designed to match the characteristic impedance between the feed point and the superconducting tunnel junction in the frequency range of 180–250 GHz using an electromagnetic field and electrical circuit simulators. The devices were fabricated at the Advanced Technology Center, and their performances were measured in the laboratory at Nagoya University. The receiver noise temperature was lower than 50 K and 75 K from 200 to 240 GHz and 170 to 255 GHz, respectively. Therefore, we successfully developed a low-noise and wide-band device that was two times wider than previously in this frequency range.



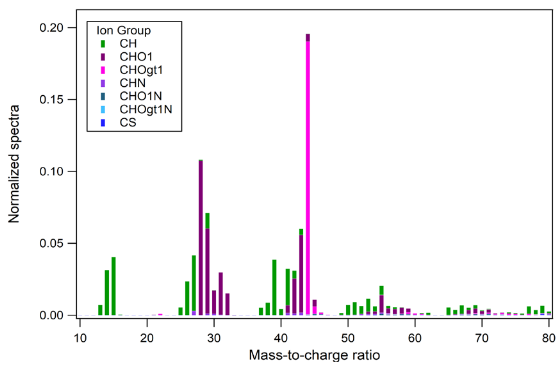
The noise temperature characteristics of the new millimeter-wave band superconducting receiver.

Observational studies on atmospheric composition changes caused by energetic particle precipitation in polar regions

To quantitatively understand the effects and mechanisms of the atmospheric composition changes caused by precipitating energetic charged particles into the middle atmosphere along the magnetic field due to solar activity, the ISEE installed millimeter-wave spectral radiometers at Syowa station in Antarctica and the EISCAT Tromsø site in Norway, and atmospheric minor constituents in the stratosphere and mesosphere were measured. At Syowa station, we have been conducting monitoring of nitric oxide (NO) and ozone (O_3) since January 2012 in collaboration with the NIPR. In 2020, a multi-frequency millimeter-wave spectral radiometer equipped with a waveguide multiplexer, a new IF circuit, and a 2-GHz band fast fourier transformation (FFT) spectrometer were established on-site, and simultaneous observations of O_3, NO, HO_2, and CO began in November 2020. This performance was confirmed adequate for monitoring. In February 2021, two microwave signal generators failed because of a sudden power failure, and after that, we observed O_3, NO, and HO_2. For the observations in Norway, in FY2020 we were unable to visit the site due to COVID-19 and could not conduct observations.

Understanding the relationships among chemical structure, sources, and atmospheric organic aerosol properties

For a precise understanding of the influences of atmospheric aerosols on air quality and climate, it is important to clarify the behaviors and properties of organic aerosol components, which have been poorly characterized to date. Studies focusing on the relationships among the chemical structure, sources, and atmospheric organic aerosol properties were performed. The relationship between the hygroscopic growth factor and the chemical structure of humic-like substances (HULIS) in aerosols collected in an urban area was analyzed, and the results suggest an association of the hygroscopicity parameter of HULIS

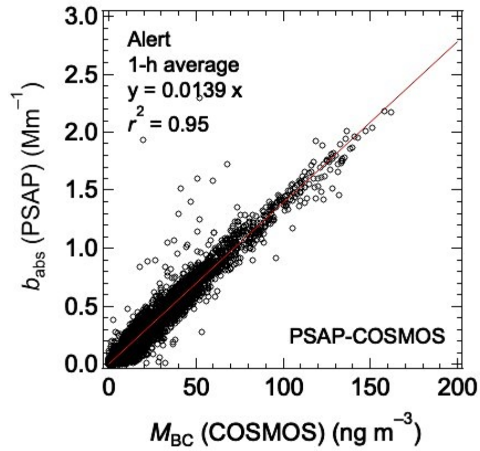


Aerosol mass spectrum obtained from the measurement of atomized atmospheric aerosol extract (HULIS) using an aerosol mass spectrometer. Information on chemical components can be obtained from the mass distribution measurement of ions generated by the collision of electrons with molecules in aerosol extract. The sample was collected at Tomakomai Experimental Forest, Hokkaido University. (The sample was provided by Dr. Miyazaki in Hokkaido University.)

with the chemical structure and source. The atmospheric concentrations of respective fractions in organic aerosol components were calculated based on the aerosol mass spectrometry of three fractions (e.g., HULIS) extracted from aerosol samples collected in a forest area. Precipitation and atmospheric aerosol samples were collected in an urban area, and the samples were subjected to excitation-emission matrix fluorescence spectroscopy and ultraviolet-visible spectroscopy, and the optical properties of the samples were analyzed. From chemical analysis of atmospheric aerosol samples collected in Australia, the atmospheric concentrations of chemical components were calculated, and basic data to analyze, for example, the properties of organic aerosols from forest fires were obtained. Ozonolysis experiments for ambient aerosols were performed to understand the aging of organic aerosols in the atmosphere, which is crucial for elucidating their atmospheric behaviors and properties.

Evaluation of methods to measure BC aerosols in the Arctic

In the Arctic, where the surface temperature increases more rapidly than the global average, forcing and feedback mechanisms associated with black carbon (BC) aerosols need to be elucidated. Most ground-based measurements of BC in the Arctic have been made using filter-based absorption photometers, such as particle soot absorption photometers (PSAP) and multi-angle absorption photometers (MAAP). These instruments measure the aerosol absorption coefficient (b_{abs}) and convert it to BC mass concentration (M_{BC}) by assuming the value of the mass absorption cross section (MAC). However, the accuracy of the conversion of babsbabs to M_{BC} has not been adequately assessed. In this study, we evaluated the MAC values at four Arctic sites by comparing b_{abs} measured by these instruments with M_{BC} independently measured by the continuous soot monitoring system (COSMOS). The accuracy of M_{BC} measured by the COSMOS has been previously demonstrated to be approximately 15% in the Arctic. We successfully estimated the MAC values for these instruments, which can be used to obtain error-constrained estimates of M_{BC} from babs measured at these sites, even in the past when COSMOS measurements were not made.



Correlation between M_{BC} (COSMOS) and b_{abs} (PSAP) at the observatory at Alert, Canada during 2018–2019. The slope of the least-squares fitted line represents the MAC value.

Division for Land–Ocean Ecosystem Research

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

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

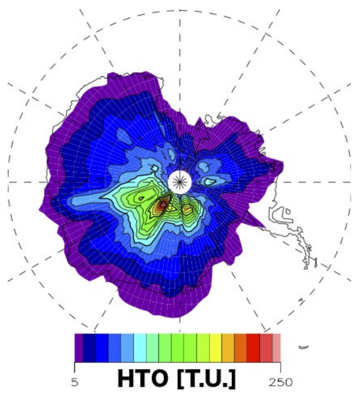
The land research group contributes to advancing our understanding of the mechanisms by which ongoing global warming and anthropogenic activity influence the terrestrial water cycle and ecosystem. Using field observations, satellite remote sensing, global meteorological data analysis, laboratory analysis,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

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

Main Activities in FY2020

Estimation of clear-sky precipitation over the East Antarctica using the tritium tracer technique

In the Antarctic plateau, precipitation falling from clear skies (known as diamond dust) occurs almost daily; however, a few major synoptic events can produce a significant fraction of the annual accumulation. Thus, the contribution of clear-sky precipitation to the total accumulation on the plateau is not clear. Here, we introduced an alternative method for partitioning between synoptic and clear-sky precipitation: tritiated water (^{3}HHO). Tritium (^{3}H) is a cosmogenic nuclide that is mainly produced in the upper atmosphere of Antarctica. After ^{3}HHO generation, it follows the hydrological cycle pathway, with only small perturbations owing to the fractionation effect during phase changes. Consequently, ^{3}HHO concentrations in diamond dust formed by the condensation of local Antarctic water are characterized by higher ^{3}HHO than synoptic precipitation accompanied by moisture transported from the surrounding ocean. This is supported by the observations seen: a gradual increasing trend from the coast to the plateau region and a rapid increase in ^{3}HHO toward inland plateau



Simulated ^{3}HHO of the annual precipitation over Antarctica. A gradual increasing trend toward inland was simulated.

areas. In this study, an atmospheric circulation model incorporated into ^{3}HHO was developed to quantitatively understand the observations. A gradual increasing trend of ^{3}HHO toward the inland area was successfully simulated by the new model. The model showed that the seasonal ^{3}HHO variation was linked to the precipitation amount. The highest ^{3}HHO corresponded to a month with a weak precipitation flux. In contrast, the months with a large precipitation flux due to the frequent passage of synoptic systems were characterized by lower ^{3}HHO values.

(Reference: Kurita et al. (2020): Application of tritium tracer technique to the partitioning between clear-sky and synoptic precipitation over the Antarctic plateau, The 11th Symposium on Polar Science, on-line meeting, Nov. 16–Dec. 18, 2020)

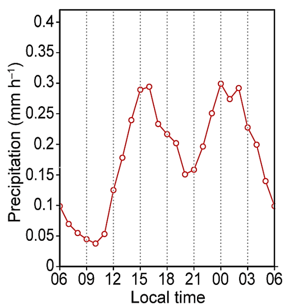
Groundwater age of spring discharges under changing permafrost conditions: A vulnerability assessment of permafrost in the Khangai Mountains, central Mongolia

To detect the permafrost thaw and ground ice melt in the permafrost zone of Mongolia, groundwater ages of several spring discharges were determined using two transient tracers: 3H and chlorofluorocarbons (CFCs). Spring water samples were collected seasonally from 2015 to 2019 at seven spring sites around the Khangai Mountains, central Mongolia. The sites included two thermokarst landscapes on the northern and southern sides of the mountains. The 3H and CFC concentrations in the spring water in the thermokarst landscapes were very low, and the estimated mean groundwater age for these sites was older than that of the other sampled springs. Consequently, the young water ratios of the thermokarst sites were lower than those of the other springs. However, this ratio gradually increased with time, indicating that recently recharged rainwater began to contribute to the spring discharge at the thermokarst sites. An atmospheric water budget analysis indicated that the net recharge from current precipitation to shallow groundwater during the summer season was almost zero on the southern side of the mountains. Thus, spring water at the thermokarst sites on the southern side of the mountains contained large amounts of ground ice-melt water. Although long-term sampling was not performed, evidence was obtained to show that the groundwater in the region is highly vulnerable because of permafrost thaw and ground ice melt, primarily due to ongoing climate change.

(Reference: Hiyama, T. et al. (2021): Groundwater age of spring discharges under changing permafrost conditions: the Khangai Mountains in central Mongolia. *Environmental Research Letters*, 16, 015008, doi:10.1088/1748-9326/abd1a1)

Diurnal precipitation cycle in the high-elevation area over the Himalayas

The diurnal precipitation cycle is important for the hydroclimate in the Himalayas during summer. However, features of the diurnal cycle affecting precipitation from the foothills to glacierized, high-elevation areas are poorly understood. In this study, we investigated the diurnal precipitation cycle in summer using data from three years (2016–2018) of *in-situ* observations from an automatic weather station, which is close to a glacier at 4809 m asl in the Rolwaling Valley in the eastern Nepal Himalayas. We identified two daily precipitation maxima, corresponding to daytime and nighttime peaks, in the diurnal cycle of the three summers. More than 80% of the total precipitation fell with a weak intensity of < 1 mm h–1; however, it had a high occurrence frequency of approximately 50%. The daytime peak resulted from upslope flows driven by the surface heating of the slopes. These upslope flows carry moist air that cools adiabatically as it travels up the slope, promoting condensation. However, the surface meteorological variables do not explain why precipitation reached a maximum in the middle of the night, suggesting that a change in large-scale atmospheric circulation might be responsible for the nighttime precipitation peak, rather than a change in the surface meteorological variables.

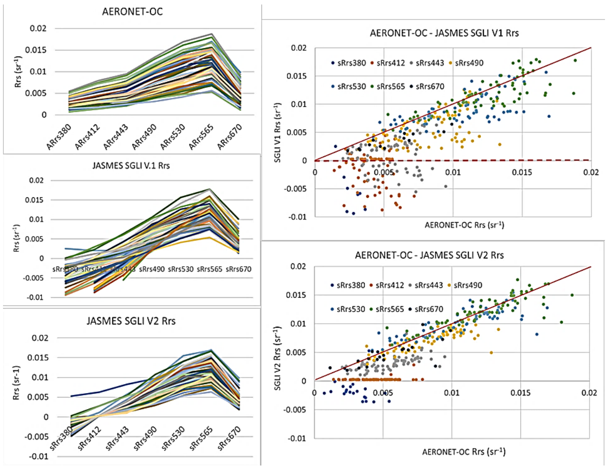


Three-year mean diurnal precipitation cycles during summer (June–September) at the automatic water station.

(Reference: Fujinami, H. et al. (2021): Twice-daily maxima of summer precipitation in high-altitude areas of the Himalayas: Two contrasting land surface effects, AGU Fall Meeting 2020, online meeting, 1–17 December, 2020)

Variation of GCOM-C Remote Sensing Reflectance in Ariake Bay using AERONET-OC data

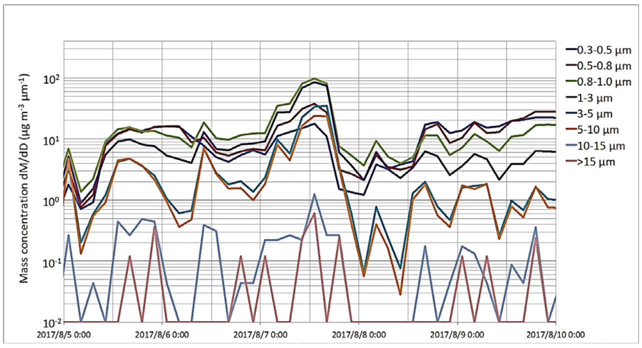
Global Change Observation Mission-Climate (GCOM-C) was launched in December 2017, and global data of visible and infrared radiation, including ocean areas, with 250 m resolution have been accumulated. The version 2 data around Japan has been disseminated from the JAMSES (https://www.eorc.jaxa.jp/gi-bin/jasmes/sgli_nrt/index.cgi) site from June 2020. To use ocean color data, it is necessary to have frequent sea-truthing data, although this is difficult to obtain. Aerosol Robotic Network-Ocean Color (AERONET-OC) is a global network of spectral radiometers, which was modified from the radiometer developed to observe aerosols from land and sea surface radiance. For GCOM-C validation, ISEE set a JAXA-owned AERONET-OC on the Ariake Tower of Saga University in April 2018, and the data were available at the AERONET-OC site (https://aeronet.gsfc.nasa.gov/). Versions 1 and 2 GCOM-C remote-sensing reflectance (Rrs) data were verified using AERONET-OC data (see figure). Most of the AERONET-OC Rrs data peaked at 565 nm. GCOM-C Rrs data had a similar shape, although many of the Version 1 Rrs values in the 380–443 nm range were negativebecause of the absorptive aerosol in this area, which was confirmed by aerosol observations. Version 2 of Rrs (380), Rrs (412), and Rrs (443) were negative, zero, and positive, respectively, after adjustment. Version 2 Rrs was close to AERONE-OC Rrs at 490–670 nm because of this adjustment. Therefore, Version 2 Rrs was reasonably accurate at more than 490 nm, although an atmospheric correction algorithm is required to improve Rrs for short wavelengths.



Rrs of each wavelength from AERONET-OC (left-top) and GCOM-C version 1 (left-middle) and version 2 (left-bottom), and the scattering diagrams (version 1: right-top, version 2: right-bottom).

Marine wave boundary layer observation using an optical particle counter with 10-Hz temporal resolution

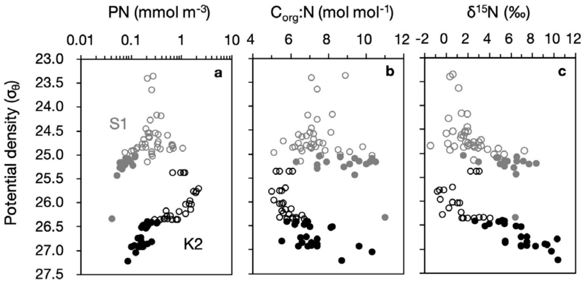
A sea spray optical particle counter (SSOPC) with high temporal resolution and a large sample air flow rate was developed in this study to investigate the dynamics and distribution of marine aerosols within a height of approximately 10 m from the sea surface. SSOPC measures the number of particles with eight channels in the range of 0.3–15 μm. The instrument weighs 2.5 kg and has an external dimension of 25 (H) × 17.5 (W) × 16 (D) cm. It can be mounted on a moored buoy to measure the vicinity of the sea surface or collocated with an ultrasonic anemometer on the tower of an observation vessel. In the circulation system inside the enclosure, sample and sheath air are hermetically separated from ambient air so that water does not accumulate inside the SSOPC owing to the humidity of the sample air or spray inflow. To estimate the sea salt flux by the eddy covariance, a flag signal cable to inform the operation status of the SSOPC is connected to the data logger of the ultrasonic anemometer, considering that the instrument will be installed on observation vessels in the future.



Mass concentration dM/dD ($\mu gm^{-3} \mu m^{-1}$) of aerosol particles before and after the passage of tropical cyclone Noru (2017) measured by an SSOPC set up at 12.5 m above the mean water level of the marine observation tower in Tanabe Bay, Wakayama Prefecture, Japan).

(Reference: Aiki, H., F. Kondo, M. Konda, K. Tanaka, and T. Fujita (2020): Marine wave boundary layer observation using an optical particle counter with 10-Hz temporal resolution, *Earozoru Kenkyu*, 35(3), 160–169, doi:10.11203/jar.35.160)

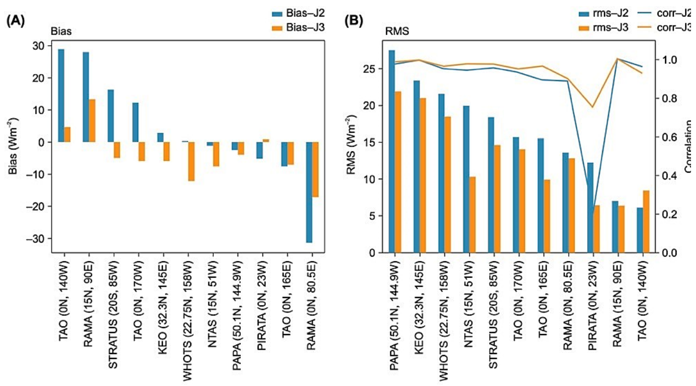
Mesopelagic particulate nitrogen dynamics in the subarctic and subtropical regions of the western North Pacific



Vertical profiles of (a) PN concentrations, (b) C_{org}:N, and (c) PN-δ^{15}N of suspended particles with respect to the density anomaly σθ at K2 (47°N, 160°E: black) and S1 (30°N, 145°E: gray) stations. Open and closed circles indicate data from the surface and mesopelagic layers, respectively.

The dynamics of mesopelagic particulate nitrogen (PN) were investigated at two time-series stations in the subarctic (K2) and subtropical (S1) regions of the western North Pacific Ocean. This was undertaken during seven seasonal cruises between 2010 and 2012, where the nitrogen isotope delta (δ^{15}N) and organic carbon to nitrogen ratio (C_{org}:N) of suspended and settling particles were obtained. The suspended PN concentration was 2.2 times higher on average at K2 than at S1. Similar vertical increases in δ^{15}N by 4–5 per mil and C_{org}:N by 3–4 were found at 100–500 m at both stations, attributable to heterotrophic PN degradation. We applied these increases to a model assuming steady-state conditions for δ^{15}N to assess the degradation of the upper mesopelagic PN pool and its particle source composition. We assumed that two source particles would enter the mesopelagic pool: surface layer suspended particles (SUS0) and fragmented particles from sinking aggregates (SINK0). The relative contributions from SUS0 were estimated to be 55% and 22% at K2 and S1, respectively. The PN input by SUS0 particles was seven times greater at K2 than at S1. Efficient SUS0 particle transport at K2 was likely associated with deep (> 100 m) convective mixing over four months. In contrast, active particle recycling within the surface layer at oligotrophic S1 hindered the export of SUS0 particles. The undegraded PN fraction, f, was estimated as 0.26–0.69 and 0.34–0.76 at K2 and S1, respectively. Lower f values were estimated at K2 through the mesopelagic column, indicating that the source particles underwent greater degradation. Furthermore, 78% of the mesopelagic degradation occurred between 100 and 200 m at this station. The lower microbial degradation rate at 200–500 m is likely due to a lower oxygen concentration than that in the upper column of K2. These estimations of mesopelagic PN degradation provide insight into biological carbon sequestration in the deep sea.

Evaluation of satellite-derived global net ocean surface heat flux



Comparison of (A) bias, (B) RMS, and correlation coefficient (lines) of J-OFURO3 V1.1 (J3) and old generation data (J2) among 11 *in-situ* buoys. Bias and RMS are in descending order based on J2.

Accurate global estimation of net ocean surface heat flux is essential for understanding the nature of air–sea interactions in the climate system. A research project on surface heat flux estimation based on satellite observation J-OFURO has released global flux data for the past 30 years using multiple satellite observation data and the development of advanced estimation technology (J-OFURO3 V1.1). The surface heat flux consists of four components (latent heat, sensible heat fluxes, and shortwave and longwave radiation), and the accuracy of each component has been evaluated so far; however, the evaluation of the net surface heat flux reliability of was insufficient. In this study, we collected data from 11 *in-situ* buoy sites by observing all four heat flux components and comprehensively evaluated the net surface heat flux. It was clarified that the average bias was only 5.8 W/m^2, and the bias variation and root-mean-square error (RMSE) were smaller than those of the old generation data.
(Reference: Tomita, H., K. Kutsuwada, M. Kubota, and T. Hihara (2021): *Front. Mar. Sci.*, doi.: 10.3389/fmars.2021.612361)

Division for Chronological Research

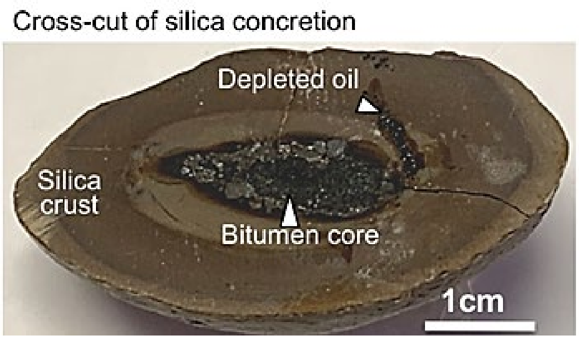
- Anthropogenic history and geochronology
- Accelerator mass spectrometry
- Electron probe microanalysis
- Paleoclimate reconstruction and future Earth
- Geosphere stability
- Isotope geoenvironmental chemistry
- CHIME dating
- Development of new analytical methods

Short- and long-term forecasts of global environmental changes and their countermeasures are issues of great urgency. Determining when an event occurred in the past, via "dating," is important for understanding the present and predicting the future state of the Earth. We promote chronological studies on a broad range of subjects from events in Earth's history, spanning 4.6 billion years, to archeological materials, cultural properties, and modern cultural assets. The Tandetron dating group conducts interdisciplinary research involving radiocarbon (^{14}C) dating using accelerator mass spectrometry to understand changes in the Earth's environment and the cultural history of humankind from approximately 50000 years ago to the present day. In addition, the group studies near-future forecasts of Earth and space environments, focusing on spatio-temporal variations in cosmogenic nuclides, such as ^{14}C and ^{10}Be, and conducts research that integrates art and science through collaborations between researchers in archeology, historical science, and other fields. The microscale spatial dating group uses the chemical U-Th total Pb isochron method (CHIME), which was first developed at Nagoya University, to shed light on events in Earth's history from its formation 4.6 billion years ago up to approximately 1 million years ago. An electron probe microanalyzer (EPMA) has been used to perform nondestructive microanalyses of rocks and other materials to reveal records of complex events recorded in zircon, monazite, and other samples.

Main Activities in FY2020

Elucidation of the formation of silica concretions containing petroleum

In collaboration with Dr. Yoshida's group at the Nagoya University Museum, this research division studies the formation mechanisms of spherical concretions made of calcium carbonate or iron oxide. This research investigated the formation process of spherical silica concretions (SiO_2) containing petroleum from Utah, USA. Silica dissolved in groundwater precipitated rapidly by the neutralization reaction of alkaline groundwater in the stratum around fish feces (organic matter) acidified through corrosion and the trapped organic matter was converted into petroleum during subsequent geological maturation. Until now, the exact cause and formation timing of silica-based concretions have been unknown; however, this study revealed that the corrosion of biogenic organic matter and the associated neutralization reaction are essential for silica concentration. The results of this study have been published in Scientific Reports (Yoshida et al., 2021).



Photograph of the cross-cut of spherical silica concretion. The black area in the center is the organic core containing petroleum (Yoshida et al., 2020).

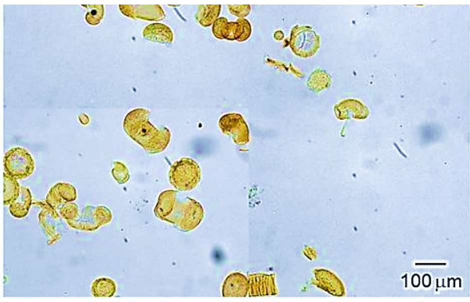
ICP-MS analysis of trace elements in mantle-derived olivine

Hand-picking of olivine grains from crashed rock-sample under an optical microscope.

Chemical characterization of trace elements in the mantle is important for understanding the mantle-crust interactions associated with subduction and igneous activity. Quantitative analysis of trace elements by laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) has been reported (De Hoog et al., 2010); however, the number of target elements is limited. In particular, Pb, Th, and U have low abundance in olivine and are difficult to quantify by LA-ICP-MS; thus, their concentration ranges remain unknown. Quantitative analysis of trace elements, including Pb, Th, and U, in olivine was performed with ICP-MS using the solution method. Mantle-derived olivine was separated under an optical microscope after rock crushing. The Pb, Th, and U concentrations in olivine were low, ranging from 5 to 61 ng/g, 0.1 to 67 ng/g, and 0.1 to 38 ng/g, respectively, and all olivine contained measurable amounts of these elements. Therefore, U and Pb measurements of olivine, combined with high-precision analysis of Pb isotope ratios, might allow us to estimate the formation ages of olivine, the major constituent mineral of the mantle (Kozaka et al., submitted).

Fossil pollen sorting for radiocarbon dating using a newly developed large particle on-chip sorter

Radiocarbon dating of plant remains, such as seeds and wood chips, is effective for building the chronology of lake sediment cores. However, plant remains used for radiocarbon dating are not preserved in sediment cores (e.g., from Lake Biwa). A novel on-chip sorting method utilizing traveling vortices generated by on-demand micro-jet flows was developed in collaboration with the Department of Micro-Nano Mechanical Science and Engineering, Nagoya University. Using this new sorting method, we succeeded in sorting pollen particles in sediments. Radiocarbon dates of fossil pollen concentrates derived from sorting are a good method to enhance building of chronologies for paleoenvironmental records. The method can also address the urgent need for high-throughput large particle sorting in genomics, metabolomics, and regenerative medicine.



Photograph of pollen particles sorted by on-chip sorting method.

.

Source changes in atmospheric PM2.5 carbon components before and after refraining from going outside due to coronavirus infection spread

Among carbonaceous aerosol particles, which are the main component of atmospheric PM2.5, secondary organic aerosol particles (secondary OA) have a tremendous environmental impact. However, their sources and formation mechanisms remain unclear. Because of the complexity of their sources and formation mechanisms, detailed domestic sources of OA and their contribution to transboundary pollution are not well understood. Carbon-14 analysis is a powerful method that can divide OA into two origins (biogenic and fossil fuels) and quantify them. In April 2020, the spread of the new coronavirus infection led to a worldwide request to remain indoors. The transboundary pollution of OA and the impact of regional human activities were reduced. Because the amount of OA has been continuously observed in Nagoya from approximately 2017 to the recent refraining from going outside, it is possible to examine in detail the changes in the contribution rates of biogenic and fossil fuel OA sources before and after the voluntary restraint following the coronavirus outbreak by measuring the monthly carbon-14 in PM2.5. The carbon analysis results showed that the OA concentration in Nagoya was lower than usual from January to September 2020. The ratio of fossil to biogenic OA did not change significantly after March 2020, when the new coronavirus infection spread in Japan. Therefore, there was no significant decrease in anthropogenic fossil fuel carbon.

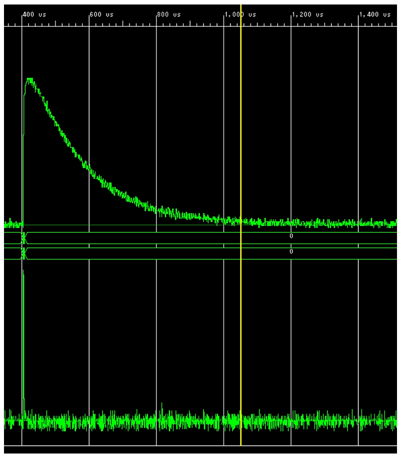
Validation of the stability of the West Antarctic ice sheet using geochemical analysis of the Amundsen Sea sediment core

A sector of the West Antarctic ice sheet draining into the Amundsen Sea is experiencing the largest ice loss in Antarctica today, and there is a serious concern of large-scale ice collapse in this area caused by global warming. The International Ocean Discovery Program Expedition 379 drilled two sites in the Amundsen Sea area in the Southern Ocean using the D/V *JOIDES Resolution* from January to March 2019. We reconstructed the melting history of the West Antarctic ice sheet using the fluctuation of beryllium-10 concentration in the sediment core, and verified the stability of the ice sheet during the past warm periods. Further research in the future should clarify the linkage between the West Antarctic ice sheet changes and climate change.

Iceberg in the Amundsen Sea.

Development of a low-noise X-ray detection system for the EPMA

In the wavelength-dispersive spectrometer of the EPMA, the output of the proportional counter was processed using a charge-sensitive amplifier and waveform shaper. The observed signal is the sum of characteristic X-rays, continuum X-rays, and noise. According to the manufacturer's specifications, the noise must be less than 1 cps. During analysis of trace elements, the characteristic X-ray intensity might be of the order of 1 cps or less. Under such conditions, the required signal is buried in the noise and cannot be detected. Therefore, we used a waveform shaper based on a digital circuit to reduce the noise. The original waveform shaper is a pseudo-Gaussian filter without undershoot compensation using an R-C circuit with an operational amplifier. In this case, the S/N was approximately 1.8 times worse than that of an ideal cusp-type filter. We decided to use a trapezoidal filter to convert the output of the charge-sensitive amplifier to A/D. With a trapezoidal filter, the S/N can be suppressed to approximately 1.1 times lower than a cusp-type filter. The filter circuit was implemented on an FPGA. The prototype device was connected to an existing JEOL JCXA-733 and applied to the FY2020 joint research project. We succeeded in quantitatively analyzing the aluminum contained in quartz formed near the solidus temperature of granite magma with sufficient accuracy.



Input signal (upper) and output signal (lower) of the pulse-shaper.

Radiocarbon dating of samples at the Middle to Upper Paleolithic transition

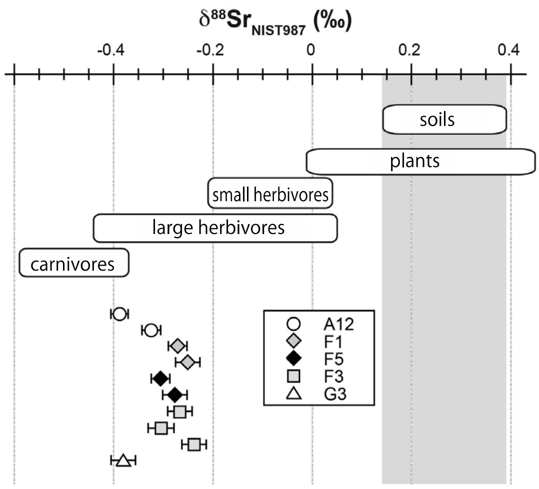
The Middle to Upper Paleolithic transition dates back to ~40000 years ago, corresponding to the timing of the replacement of Neanderthals by modern humans. Radiocarbon dating of samples during this period requires a scrupulous pretreatment method because this period is close to the measurement limit of radiocarbon dating (~50,000 years ago). In the framework of the PaleoAsia project, archeological excavations in the Arabian Peninsula, Central Asia, Southern Asia, and Northern Asia have been conducted. We applied cutting-edge radiocarbon dating methods to samples collected from this project and evaluated the reliability of the radiocarbon dating results. We contribute to a deeper understanding of the cultural history and migration of modern humans to Asia through the construction of a more reliable chronology.

Establishment of a new method for high-precision carbon-14 analysis of water samples

The carbon-14 concentration of dissolved inorganic carbon (DIC) in water samples is an important indicator for understanding carbon dynamics in the environment, especially the anthropogenic carbon cycle and for water dating. In the carbon-14 analysis of DIC in this research division, we used a method in which DIC is precipitated as carbonate and reacted with phosphoric acid to extract CO_2. However, this method is complicated, time-consuming, and sometimes fails to produce precipitation, which is easily contaminated by atmospheric CO_2. In this study, we improved the headspace method, which has been widely used in recent years for the $\delta^{13}C$ measurement of DIC, to suit the actual situation and a processing system that can be applied to water samples with a wide range of DIC concentrations to extract CO_2 efficiently without using a carrier gas. Basic experiments were performed to verify the reproducibility of the analytical values, the change in analytical values due to differences in extraction efficiency, and the background, and established a new method that is simple, efficient, and highly reliable with low background and no atmospheric CO_2 contamination. This has established a new foundation for the research department for carbon-14 analysis of water samples (submitted to *Radiocarbon*).

Multi-Sr isotope analysis of cremated bones reveals food habits and settlement areas

This research group has been conducting research to clarify the residential area and food habits of buried people using high-precision analysis of multi-Sr isotope ratios, including radiogenic Sr isotopes ($^{87}Sr/^{86}Sr$) and stable Sr isotopes ($\delta^{88}Sr$) of bioapatite, which is an inorganic component of bones excavated from archeological sites. This year, we conducted research on cremated bones excavated from the Ishibotoke-dani grave site at the Binman-ji Temple in Taga Town, Shiga Prefecture (multiple graves exist in eight research areas from A to G). Based on the type of pottery excavated and descriptions in ancient documents, it was estimated that the monks of Binman-ji and local residents were buried in the Ishibotoke-dani grave site during the 12th–15th centuries. The results of the multi-Sr isotope analysis of the cremated bones revealed that people who lived around Binman-ji Temple were buried in the Ishibotoke-dani site, and that people buried in Sections A and G were more carnivorous than those buried in Section F. Because the ^{14}C ages and grave styles differed depending on the study area, this difference in diet may indicate age or status differences. The results obtained in this study suggest that multi-Sr isotope analysis of cremated bone bioapatite is useful as an indicator for reconstructing diet and residential areas. In Japan, where many cremated bones have been excavated from archeological sites, multi-Sr isotope analysis of cremated bones will be a powerful tool for reconstructing historical living environments (Sawada et al., Presentation at the 2020 Annual Meeting of the Geochemical Society of Japan; Minami and Wakaki, Report on the investigation of cremated bones excavated from the Ishibotoke-dani site, Binman-ji Temple).



Sr stable isotope ratio ($\delta^{88}Sr$) of cremated bones excavated from the Ishibotoke-dani grave site.

Center for International Collaborative Research (CICR)

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

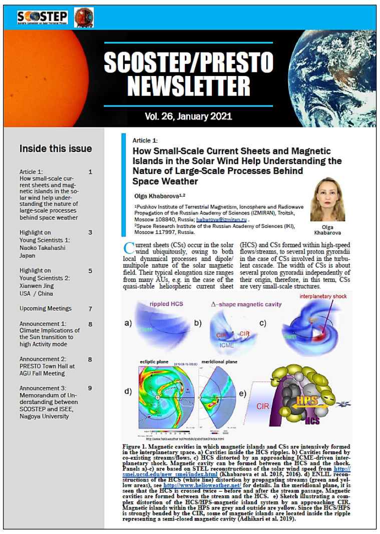
To promote international collaborative studies to understand the physical mechanisms of phenomena occurring in the space–Sun–Earth environmental system and their interactions, ISEE established the Center for International Collaborative Research (CICR) in October 2015. The CICR provides leadership to promote internationally coordinated programs, such as those undertaken by the Scientific Committee on Solar–Terrestrial Physics (SCOSTEP) and Future Earth. The CICR encourages programs for developing ground-based observation networks and international satellite projects, and hosting of international workshops and conferences. It also supports international exchanges of overseas and Japanese researchers and students, and builds capacity 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 of Nagoya University.

The phenomena contained in solar activity have various timescales, from solar flares and coronal holes, to the 11-year cycle, and further long-term variations. World scientists are greatly interested in these types of solar activities and their consequences on the Earth's geospace environment and climate change. SCOSTEP, under the International Science Council, commenced a 5-year international program entitled "Predictability of the variable Solar–Terrestrial Coupling (PRESTO)" for 2020–2024. The main objective of this program is to identify the predictability of the variable solar–terrestrial coupling performance metrics using modeling, measurements, and data analysis while strengthening the communication between scientists and users. The President of SCOSTEP is also a member of the CICR and is responsible for operating this international program. On January 8, 2021, ISEE and SCOSTEP exchanged a Memorandum of Understanding to define the conditions under which ISEE will contribute to SCOSTEP activities. In agreement with this Memorandum of Understanding, the CICR publishes the SCOSTEP/PRESTO newsletter every three months, organizes online seminars and capacity-building lectures, and coordinates international symposiums related to SCOSTEP/PRESTO. The CICR also contributes to other international programs related to the space–Sun–Earth environment, such as Future Earth and the Integrated Land Ecosystem-atmosphere Processes Study. Since 2016, the CICR has participated in or operates ground-based observation projects, such as the EISCAT radar project, OMTIs, the ISEE VLF/ELF and magnetometer network, SuperDARN radar network (including the Hokkaido HF radars), and the Arctic Challenge for Sustainability operation office. It also has four domestic observatories at Moshiri, Rikubetsu, Fuji, and Kagoshima, which conduct observations of the solar wind, geomagnetic field, and upper atmosphere. Some of these observations have been conducted for more than 30 years.

Observation sites and foreign collaborative institutions of ISEE.

Main Activities in FY2020

In FY2020, the CICR conducted the following international collaborative research programs: 1) Joint Research Program (international, 29 projects); 2) ISEE International Joint Research Program inviting 16 researchers from overseas; and 3) an ISEE/CICR International Workshop, including two designated professors from overseas who were hired through a 5-year cross-appointment with US universities and institutions. However, programs 2) and 3) and the employment of the designated professors were postponed to FY2021 due to COVID-19. In collaboration with SCOSTEP, we published four newsletters in FY2020 (April, July, October, and January). We also published a paper summarizing VarSITI activity as an output of the VarSITI Workshop in 2019. Two students from Indonesia and Ethiopia were invited to ISEE for collaborative research under the SCOSTEP Visiting Scholar program. However, these invitations were postponed to FY2021 due to COVID-19.



SCOSTEP/PRESTO Newsletter vol. 26 (January 2021).

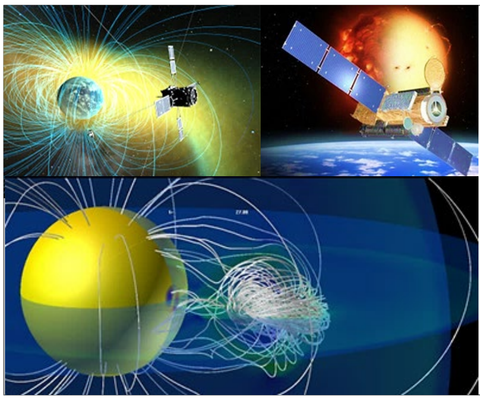
The EISCAT radar project was undertaken in collaboration with an NIPR group, and seven EISCAT special experiments proposed by Japanese colleagues were conducted. Discussions about the EISCAT_3D radar were organized with foreign EISCAT associate members. The PWING project continued running eight stations around the North Pole at MLATs of ~60° connecting the OMTIs, ISEE magnetometer, and ELF/VLF networks. A research project entitled "Pan-Arctic Water-Carbon Cycles (PAWCs)" was newly funded for 2019–2024. PAWCs are designed to integrate atmospheric–terrestrial water and carbon cycles in northern Eurasia, for which very limited data on the fluxes of greenhouse gases exist.

The four domestic observatories continued to operate in FY2020. The Moshiri Observatory became an unmanned observatory in FY2018; however, it continued to run electromagnetic instruments, that is, an auroral photometer, magnetometers, and VLF receivers. The 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 monitoring, the SuperDARN Hokkaido radars for ionospheric disturbances, and a new ELF atmospheric receiver. A new induction magnetometer was installed at Rikubetsu in October 2018.

Multi-station IPS observations using the Fuji, Kiso, and Toyokawa antennas were conducted between April and December 2020. When the Kiso antenna was restored before the IPS observations started, a fire occurred in the observatory area. Fortunately, there was no serious damage to the observation facility owing to quick containment by local firefighters. The Kiso Observatory opened up to high school students on December 2, 2020. The Kagoshima Observatory and Sata Station operate an all-sky camera, a photometer for airglow detection, VLF/LF radio wave receivers, and induction magnetomaters in collaboration with Tohoku University, the University of Electro-Communications, Chiba University, and Georgia Tech.

Moshiri Observatory.

Center for Integrated Data Science (CIDAS)



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

The Center for Integrated Data Science (CIDAS) aimed to construct infrastructure and conduct research and development to perform a cutting-edge scientific study of the space–Earth environmental system through integrated analyses using various observational data and advanced computer simulations. CIDAS operates many projects in cooperation with ISEE research divisions and centers and 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 a database and analytical environment for the data provided by the Japanese solar observation satellite Hinode, and plays an important role in considering the research topics of oncoming solar missions such as Solar-C EUVST. In addition, the ERG Science Center operates as a joint research center in cooperation with the ISAS/JAXA, which releases data files from ERG (Arase) and ground-based observations. The ERG Science Center also develops the data analysis software. The CIDAS computer system was used for the data analysis environment for the Hinode and ERG projects.

Cooperative research program for database construction and supercomputing

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

Research and development of advanced simulations

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

Main Activities in FY2020

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

Scientific data from the ERG (Arase) satellite, ground-network observations, and modeling/simulations were archived at the ERG Science Center, which is operated by ISAS/JAXA and ISEE/Nagoya University. The format of these data files is CDF, and includes the metadata of each file. This is a de facto format in the solar–terrestrial physics community. The Space Physics Environment Data Analysis System (SPEDAS), a commonly used software in the solar–terrestrial physics community, can easily read and manipulate CDF files. The ERG Science Center has developed CDF files and SPEDAS plug-in software for the ERG project. We also joined the International Heliosphere Data Environment Alliance to discuss common data formats in the international framework. The ERG Science Center has organized training sessions for SPEDAS in Japan and Taiwan, providing important opportunities to learn to use SPEDAS and ERG data. The ERG Science Center is also developing a data analysis environment for the CIDAS system. Users can access the CIDAS system via the internet and analyze ERG project data using SPEDAS (https://ergsc.isee.nagoya-u.ac.jp/research/index.shtml.en).

Energy-consistent finite difference schemes for compressible (magneto-)hydrodynamics

When the magnetic or kinetic energies overwhelm the internal energy of the plasma, numerical simulations of the (magneto-)hydrodynamic equations become strongly unstable, sometimes causing unphysical solutions. Unfortunately, such situations can be found all over the universe, for example, in the solar atmosphere above sunspots. A new finite difference formulation has been proposed to overcome this difficulty, focusing on the consistency among the internal, kinetic, and magnetic energy equations in the discrete sense. Traditionally, the total energy equation is solved. The time variation of the internal energy was calculated by subtracting the kinetic and magnetic energies from the total energy. However, the resultant internal energy can be erroneous from the discretization error in stringent situations, such as the solar corona. In this study, the discrete versions of the product rule were effectively used to implicitly satisfy the internal, magnetic, and kinetic energy equations without directly solving them. The resultant formulation was implemented as spatial second- and fifth-order schemes. The numerical tests showed the extremely high robustness of these schemes for most stringent problems under high Mach number and low plasma beta conditions (Iijima, 2021, *Journal of Computational Physics*).

Activity of IUGONET

IUGONET has been promoting the use and application of upper atmospheric observation data by providing database and analysis tools in collaboration with other institutions (e.g., the Research Organization of Information and Systems (ROIS)) and has been developing a foundation for a universal infrastructure to disclose and cite data. IUGONET has held several international data analysis workshops in collaboration with several international organizations, such as SCOSTEP and the World Data System (WDS) affiliated with the International Science Council (ISC) and supported the construction of infrastructure for disclosing data and data integrity (http://www.iugonet.org/).

Operation of the CIDAS supercomputer system

A new computer system for integrated data analysis (CIDAS computer system) was installed on April 2021. The system consists of 16 compute nodes, each of which has two Intel Xeon Gold 6230R CPUs and 384 GiB memory. In FY2020, 190 researchers/students were registered as users of the CIDAS supercomputer system. Data analyses related to the Hinode Science Center and ERG/Arase Science Center and computer simulation studies were conducted.

Development of the CReSS model

The CReSS model was developed and improved for physical processes. It is available for scientific research from CIDAS. The CReSS model was used for the simulation experiments and daily weather forecasts. The simulated daily forecast data were openly available from the meteorological laboratory website. CIDAS also plans to make available the simulation output data from the CReSS model.

Center for Orbital and Suborbital Observations (COSO)

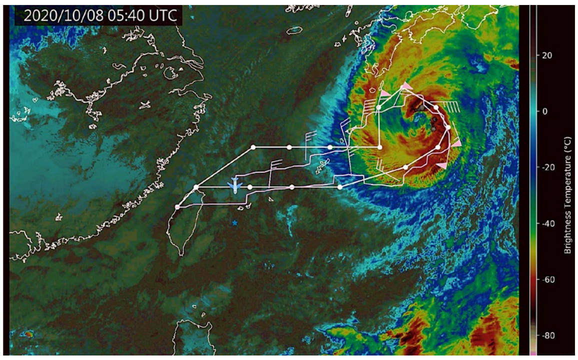
- Establishment of an aircraft observing system
- Aircraft observations of cloud, aerosol and typhoon
- Promotion of ERG mission
- Solar observation missions using micro satellites
- Study of the simultaneous development of multiple satellites for future space science
- Human resource development for space applications

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

Main Activities in FY2020

Promotion of aircraft observations

We conducted dropsonde observations targeting typhoons and stationary linear precipitation systems in cooperation with DOTSTAR from Taiwan near the Okinawa area. The water vapor amount from dropsonde data in the FY2019 observations was utilized to verify the numerical weather prediction experiment. Joint observations with the United States and Taiwan for the Baiu front and typhoons have been postponed until 2022; however, ground observation equipment such as radar has already been installed on Yonaguni Island and commenced observations. The research results of the United Arab Emirates Precipitation Enhancement Science Program, which was completed in 2018, have been summarized as an article. Aircraft observations under the Ministry of Land, Infrastructure, Transport and Tourism program were postponed to 2022 or 2023. In addition, we conducted data analysis of light-absorbing aerosols obtained from aircraft observations in Greenland in FY2018.



Flight path for the typhoon Chan-Hom observation.

We started to organize the aircraft observation system in COSO based on the aircraft observation proposal by the Meteorological Society of Japan, the Japan Society of Atmospheric Chemistry, and the Japan Society for Aeronautics and Astronautics, which was selected as a priority theme of the Master Plan 2020 of the Science Council of Japan.

Numerical investigations on a simultaneous launch configuration for multiple satellites with weights of 150–200 kg for future space exploration missions

We numerically investigated a simultaneous launch configuration using a single Epsilon rocket for multiple compact satellites of 150–200 kg weight for future space explorations by cooperating with a domestic manufacturer achieving space-borne component developments for previous space missions. The quantitative evaluations showed the possibility of launch configuration by vertically stacking multiple satellites, which has not yet been realized in Japan in contrast to overseas heritages, via several improvements on the structures of both satellites and payload attachment fitting systems.

Promotion of international collaborations in micro-satellite exploration missions in the terrestrial upper atmosphere

We have been promoting some possibilities for space observation missions using multiple microsatellites. One candidate is an integrated observation mission for space plasmas, upper atmospheric particles, plasma waves, electric/magnetic fields, and auroral emissions in the terrestrial magnetosphere/ionosphere/thermosphere in collaboration with the Swedish Research Institute. Based on the heritage and achievements of the Swedish *in-situ* scientific instruments for space plasma density and temperature and the past Japan-Sweden collaborations, we discussed possible collaborative research organizations and expected benefits by email and real-time online meetings.

Solar observation mission using nanosatellites

We are developing a solar neutron and gamma-ray detector intended for nanosatellites weighing less than 10 kg. Nanosatellites are chosen because they have more launch opportunities than 50-kg satellites, such as ChubuSat. We plan to launch an engineering prototype in FY2022 and a satellite with scientific instruments in FY2023 or later, in time for the next solar maximum. In FY2020, we established signal processing and calibration procedures for the $Gd_3Al_3Ga_3O_{12}$ (GAGG) scintillator used for gamma-ray energy measurements and achieved an energy resolution of 6% (full width at half maximum, FWHM). We also evaluated the position resolution of the plastic scintillator used for proton tracking scattered by incident neutrons. The position resolution was less than 3 mm, which satisfies the requirement for the mission.

SERO

The SERO was established as the first step toward forming a research center to consolidate all space-related activities at the university, and promote hardware development and observational research for space exploration and science. The development of nanosatellites is one of the most crucial SERO activities. Educational activities are also important at SERO. We held two weeks of basic and advanced training courses in August/September and February/March. To cope with COVID-19, we conducted lectures and group-work courses online. Because of this change, we had 51–58 applicants for the basic courses and 41–47 applicants for the advanced courses. Approximately half of the applicants were from outside Nagoya University in August/September, and about 90% of the applicants were from outside Nagoya University in February and March.

Promotion of observations using Earth-observing satellites

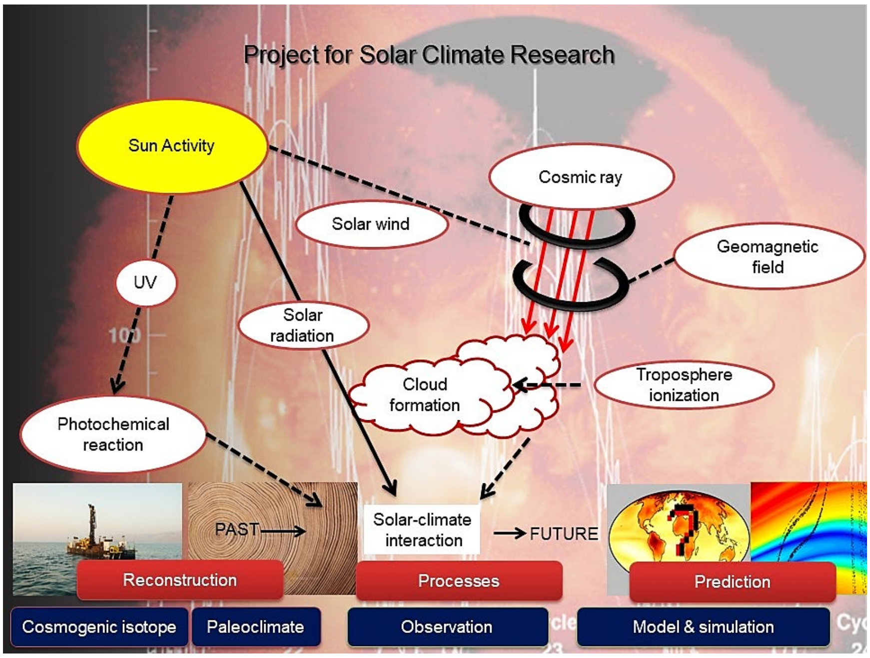
A study on the Doppler velocity observation from the space-borne precipitation radar was implemented and participated in discussing the future cloud/precipitation observation mission by NASA and JAXA. Validation of JAXA's Climate Change Mission (GCOM-C) and the development of a classification algorithm for red tide species were conducted. The 30-year global data of J-OFURO3, the third-generation dataset of heat, momentum, and freshwater flux between the atmosphere and ocean, which is important for a more accurate understanding of the energy balance and climate change of the Earth system, are registered on the DIAS and APDRC systems to obtain the DOI. The J-OFURO algorithm was improved to handle data around typhoons and bomb cyclones.

Project for Solar–Terrestrial Climate Research

Do variations in solar activity influence weather and climate? Researchers specializing in astronomy, solar physics, meteorology, climatology, paleoclimatology, and oceanography have addressed this question for the past 200 years or more. Two thousand years ago, astronomers of the Chinese Imperial Court chronicled sunspot activity to explore variations in solar activity. In 1801, British astronomer William Herschel discovered a significant correlation between the number of sunspots and the market value of wheat in London and reported his findings in a paper published by the Royal Society. He concluded that a reduction in the number of sunspots affected a change in climate that altered wheat yields, and influenced the price of wheat. This study is considered the first attempt to examine correlations among the Sun, climate, and society (human life). Even now, correctly identifying the characteristic variations of solar activity and investigating their effects on climate change and modern society remain important research topics in academia and society.

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

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



A scheme of the ISEE project for Solar–Terrestrial Climate Research. The latest developments in solar physics, meteorology and climatology, environmental studies, paleoclimatology, geomagnetism, and cosmic ray physics are integrated.

The globally averaged surface temperature showed a clear upward trend after the latter half of the 20th century. However, it continued to increase in the temperature range of 0.03–0.05°C per10 years from 1998 to 2012, and the global warming pause or the global warming slowdown is called the "global warming hiatus." Nonetheless, the atmospheric greenhouse gas concentration increases yearly; however, a clear rise is not recognized in the surface temperature observation. The topic "global warming hiatus" was taken up by the internet news and blogs, moved over the scientific community, and then had a considerable impact on the public. Based on a detailed analysis of the meteorological dataset from the land and ocean temperatures and computer experiments with climate models, the global warming hiatus was caused by natural characteristics. Although we still cannot provide sufficient explanation, the decadal-centurial-time scale climate change is indirectly driven by secular variation in solar activity. Encouraging the understanding of the characteristics and mechanisms of short-term natural fluctuations appearing in the age of global warming will predict anthropogenic climate change more reliable. It is extremely important to develop an environmental policy that influences human society.

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

We have accumulated evidence over the past quarter century that will be effective in studying the mechanisms by which variations in solar activity affect climate and human society. The interdisciplinary project for Solar–Terrestrial Climate Research at ISEE integrates the latest knowledge in solar physics, meteorology, climatology, environmental studies, paleoclimatology, space physics, and CR physics to better understand the variability in solar activity, foster an understanding of solar-driven Earth systems, and contribute to predicting future global environments.

Main Activities in FY2020

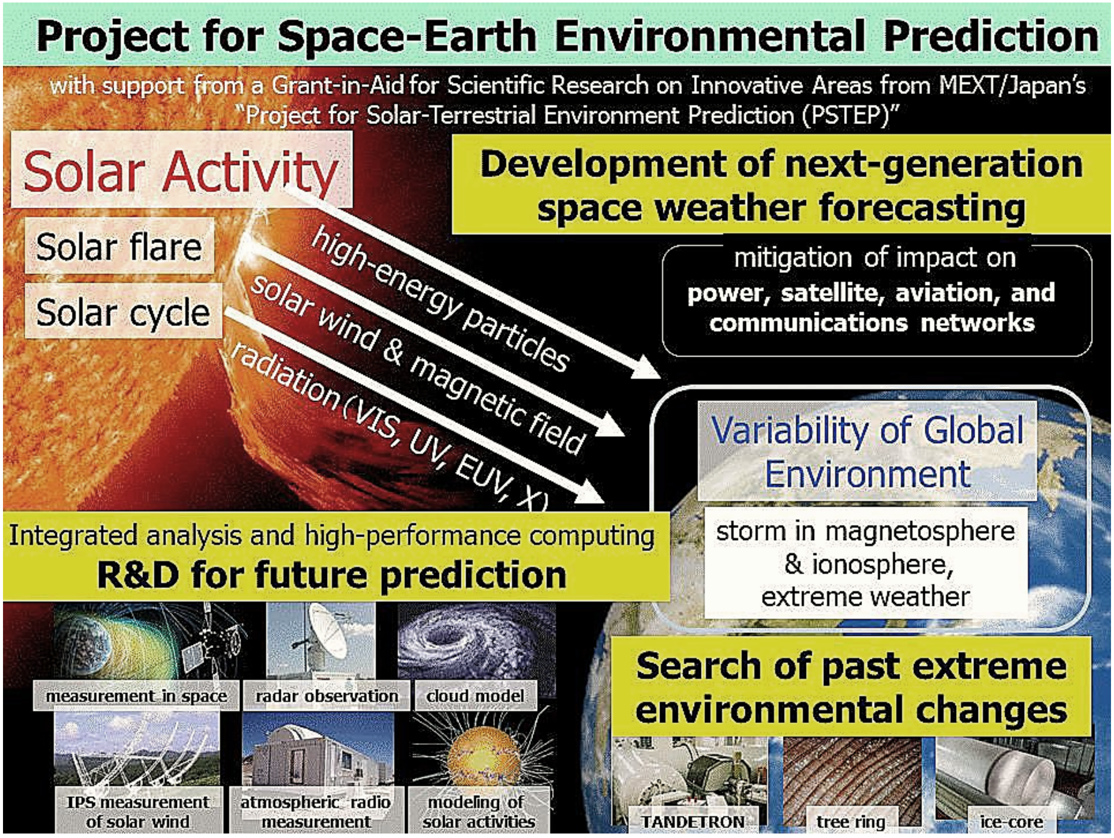
To reveal the details of the secular change of ^{14}C content that fluctuates with the CR intensity affected by solar activity, it is necessary to improve the accuracy (e.g., ± 0.2% level) and throughput of the accelerator mass spectrometry. The maintenance of the Tandetron ^{14}C measurement system of High Voltage Engineering of the Netherlands, which is operated by the ISEE, Nagoya University, has been performed. With the maximum performance of this system, it is possible to perform high-precision ^{14}C measurements of more than 3000 samples per year. In addition, the sample preparation efficiency was improved. We designed and developed an automatic sample preparation system for graphite preparation and improved the efficiency of separating cellulose from wood samples to undertake ^{14}C measurements of a huge number of samples.

Tandetron accelerator mass spectrometer (ISEE, Nagoya Univ.).

In 2020, the IntCal20 dataset was reported to contain annual resolution ^{14}C data for the last 5000 years (starting in 1950 AD). While improving the accuracy of these data, we plan to reveal the details of secular ^{14}C changes.

Project for the Space–Earth Envionmental Prediction

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



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

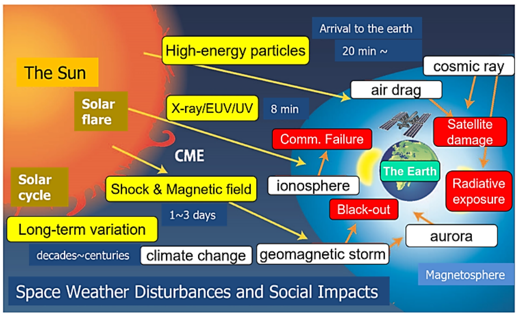
Main Activities in FY2020

Scientific assessment of the impact of space weather phenomena on Japanese society

As a scientific activity of PSTEP supported by a Grant-in-Aid for Scientific Research on Innovative Areas from MEXT/Japan, the report "Assessment of the impact of space weather phenomena on society for scientific recommendations" was released by the National Institute of Information and Communications Technology (https: /www2.nict.go.jp/spe/benchmark/).

This report examines the effects of various space weather phenomena shown in the figure on society by making full use of scientific knowledge. In particular, we summarized the extent to which space weather phenomena and disasters can occur in Japan in the future, and how they can have a social impact at that time, along with specific examples. This is the first report in Japan that comprehensively summarizes the direction of research and countermeasures for future space weather disasters. The table of contents of the report is as follows.

1. Space weather phenomenon
2. Estimating the scale of space weather phenomena (solar flares, CMEs, solar high-energy particles, solar radio bursts, radiation belts, geomagnetic storms, substorms, ionospheric disturbances)
3. Social impact of space weather phenomenon
4. Social impact of space weather phenomenon in the electric power grid
5. Impact of space weather phenomena on satellite operations
6. Social impact of space weather phenomenon on communications and broadcasting
7. Social impact of space weather phenomenon on a positioning system
8. Social impact of space weather phenomena in aviation operations
9. Social impact of space weather phenomena in manned space operations
10. Social impact of space weather phenomena on ground life
11. Remaining issues
12. Summary



ISEE research meeting "Prospects of model research for solar–terrestrial environment prediction"

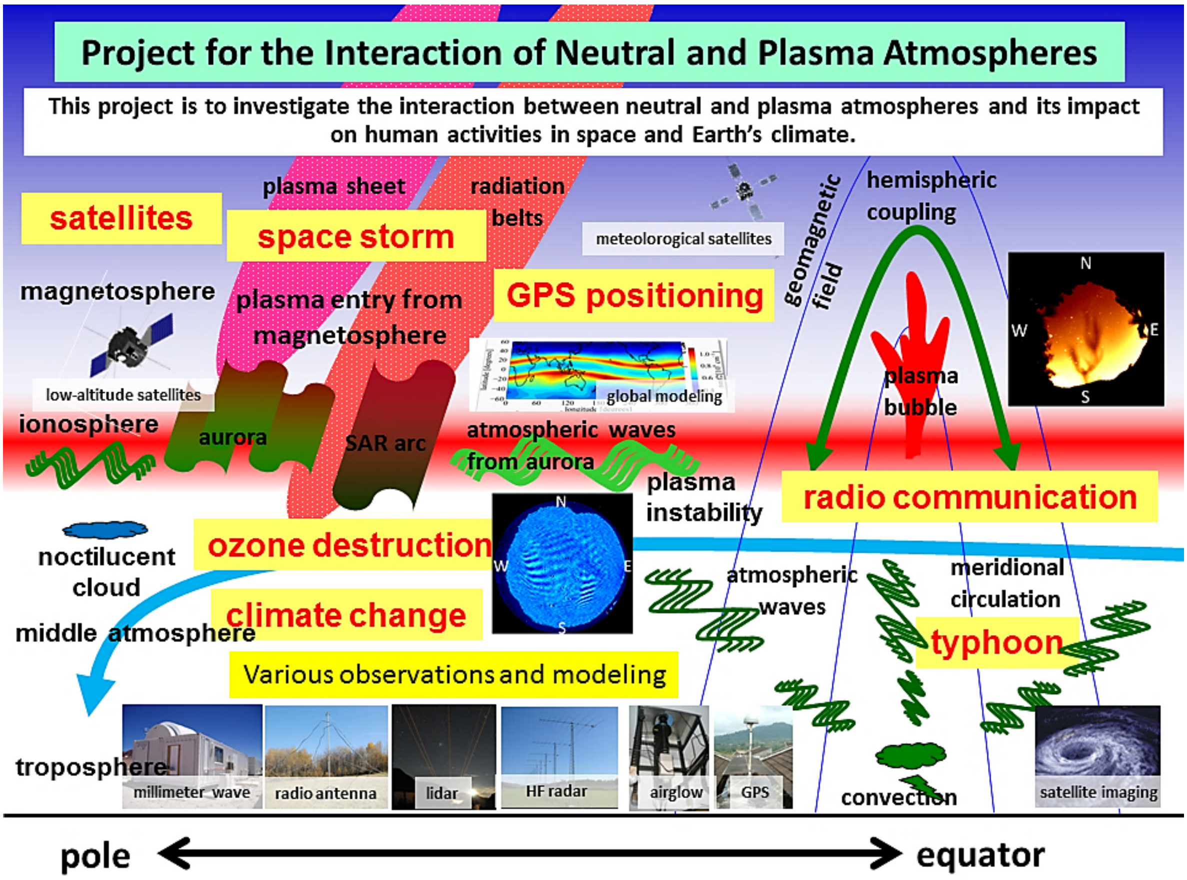
The 2020 ISEE Research Meeting "Prospects for Model Research for Solar–Terrestrial Environment Prediction" was held online from March 25 to 26, 2021. This research meeting is held every year to broadly discuss the current status and issues of the solar–terrestrial environment prediction model and its prospects across fields. This year, we focused on new technologies related to various models, model evaluation efforts, computational methods, and future plans for model research, centered on invited lectures in related fields. Dr. Muneto Shoda (NAOJ) reviewed the observation results of NASA's solar approach mission "Parker Solar Probe" and Dr. Hideyuki Hotta (Chiba Univ.) gave a presentation of his high-resolution simulation of the internal dynamics of the Sun using the supercomputer "Fugaku." This were a good opportunity to consider the direction and goals of the future scientific target for the next solar cycle (Cycle 25), which is expected to reach its maximum in 2025.

Solar–Terrestrial Environment Prediction Open Textbook (PSTEP Open Textbook)

We produced the PSTEP Open Textbook, which comprehensively summarizes the current status and issues of research on predicting the solar–terrestrial environment. This textbook will be released free during the first half of 2021 as a Nagoya University repository for reference by graduate students and young researchers who will study related fields.

Project for the Interaction of Neutral and Plasma Atmospheres

The ionosphere is part of the Earth's upper atmosphere and is partly ionized by solar ultraviolet emissions. The peak altitudes of plasma density in the ionosphere are 300–400 km, where most low-altitude space vehicles fly. Thus, ionospheric plasma significantly affects human activities in space, such as radio communications and positioning by Global Navigation Satellite System (GNSS). The consequences of climate change are significant 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 regions is caused by the precipitation of high-energy plasma, which heats the upper atmosphere and generates atmospheric waves and disturbances that propagate toward low latitudes. However, ionospheric plasma instabilities, known as plasma bubbles, occur in the equatorial upper atmosphere, interfering with satellite–ground communication and GNSS positioning. These phenomena can be measured using various ground-based remote-sensing instruments, such as airglow imagers, magnetometers, radars, lidars, and millimeter-wave telescopes. This interdisciplinary project investigates the interactions between the neutral and plasma components of the Earth's atmosphere, using various ground remote-sensing techniques and *in-situ* satellite measurements, and global and regional high-resolution modeling of neutral–plasma interactions. The project contributes to the reliable use of space by humans and our understanding of possible plasma effects on Earth's climate change.



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

Main Activities in FY2020

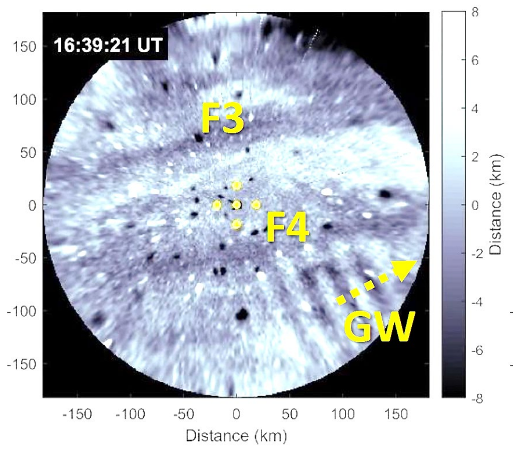
In FY2020, we conducted 14 international collaborative studies, 13 domestic collaborative projects, and 22 domestic meetings for the ISEE. Various scientific results have been obtained from these collaborative projects.

The interaction of neutral and plasma components is an essential and important issue for understanding the partially ionized atmosphere, ionosphere, and thermosphere. We expect a dramatic improvement in ground-based ionospheric measurement accuracy with the initiation of EISCAT_3D in Scandinavia in 2022. However, as the measurement of neutral components in the thermosphere is theoretically impossible for EISCAT_3D, preparation for diagnosing neutral components or the thermosphere is an urgent issue. The international project team (SDI-3D: established in 2018 by Japan, the US, Finland, Sweden, and Norway) has made budget requests to deploy three SDIs that are capable of measuring thermospheric wind vectors and temperatures within 1000 × 1000 km^2. This proposal was approved by the National Science Foundation in the USA in the summer of 2020. Collaboration between the EISCAT_3D and the three SDIs in Scandinavia will create an ideal environment for studying coupled polar ionosphere–thermosphere systems with state-of-the-art ground-based instruments. We developed a multi-frequency millimeter-wave spectrometer to simultaneously observe spectral lines of O_3, CO, NO, NO_2, and HO_2 within a 230–255 GHz range. At the end of FY2020, the new spectrometer was shipped and is now being re-assembled at Syowa station to steadily monitor these atmospheric molecules.

Polar aurora as an indicator of plasma–atmosphere interactions (after Shiokawa et al., 2020).

The new scientific satellite Arase (ERG) was launched by ISAS/JAXA in December 2016 to investigate wave–particle interactions between high-energy electrons and ions in the inner magnetosphere. We have conducted several ERG-ground campaign observations in FY2020. From the combined ground–satellite measurements, including EISCAT and newly installed high-speed EMCCD cameras, interesting results, especially concerning stable auroral red arcs and wave–particle interactions, have been reported in various scientific journals. Collaborative researches have been made with University of Oulu in Finland through a cross-appointment related to this interdisciplinary project.

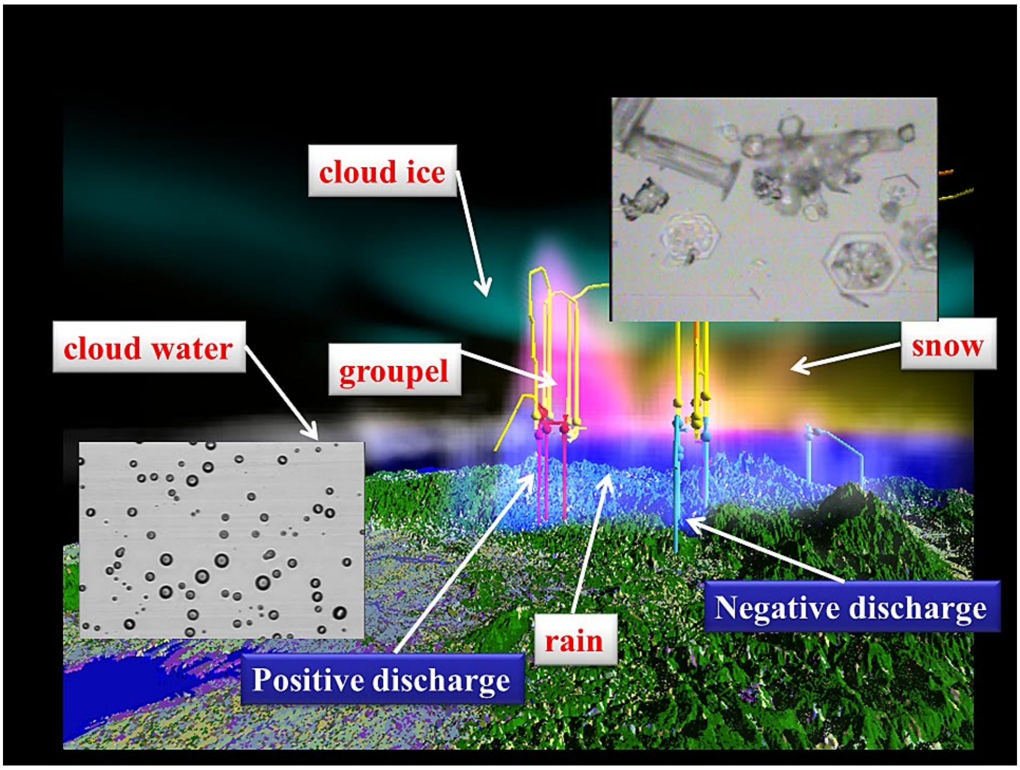
Using multi-point airglow imaging measurements, exciting scientific outputs were obtained in FY2020. As an example, collaborative measurements of an airglow imager and a sodium lidar were conducted in Tromsø, Norway. The formation of a sporadic sodium layer was observed to be associated with the passage of mesospheric tidal bores in airglow images.

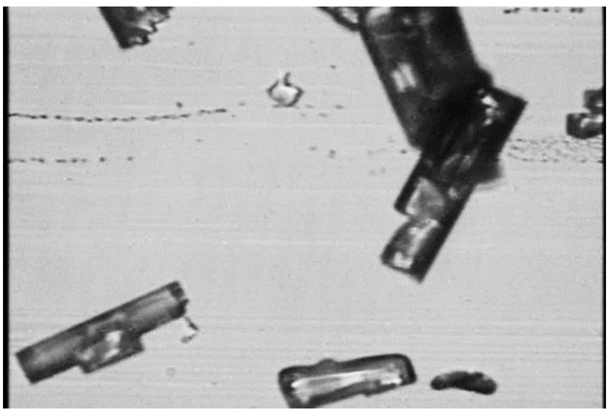


OH airglow images obtained at Tromsø, Norway, on December 19, 2014. North is upward and east is to the right. Northward-propagating east-west tidal bore (F3 and F4) and eastward-propagating gravity waves (GW) are simultaneously observed associated with a sporadic sodium layer appearance measured by a collocated sodium lidar (after Narayanan et al., 2021).

Project for Aerosol and Cloud Formation

Hydrometeors and aerosols interact closely in their generation and dissipation, and play important roles in atmospheric water circulation, the formation of convective clouds and typhoons, and the Earth's radiation budget. However, they are some of the most unknown quantities in the atmosphere. Thus far, hydrometeors and cloud-precipitation systems have been studied at the Hydrospheric Atmospheric Research Center, and aerosols and related processes have been studied at the Solar–Terrestrial Environmental Laboratory. In a 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 the 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 aircraft, balloons, and drones. This research will improve CReSS and study the impact of aerosols on typhoon clouds.





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

Main Activities in FY2020

Cloud and aerosol observations in the United Arab Emirates and modeling of aerosol-cloud interaction

We have developed CReSS-4ICE-AEROSOL, which implements aerosol-cloud-precipitation integrated microphysics parameterization with various aerosols (sea salt, mineral dust, sulfate, organic carbon (OC), black carbon (BC), and so on) in the atmosphere and in hydrometeors as prognostic variables. Idealized experiments of cumulonimbus clouds with strong updrafts were conducted to investigate the effect of the amount of anthropogenic aerosols (sulfate, OC, BC) on the microphysical structure of the cloud (Fig. 1). It has been shown that increasing anthropogenic aerosols by an order of magnitude increases the number concentration and mixing ratio of cloud ice in the anvil associated with the cumulonimbus cloud by several times (Fig. 2). In the future, we plan to incorporate aerosol information from the global aerosol model SPRINTARS as initial and boundary conditions to investigate the effects of atmospheric aerosols over the UAE on the formation of diurnal convective clouds and subsequent precipitation formation processes.

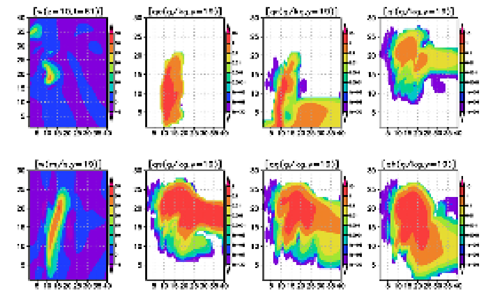


Figure 1: Results of idealized experiments investigating the effect of aerosols on convective precipitating clouds (vertical cross-sections that pass through the center of the clouds except for the horizontal cross-section at an altitude of 5 km in the upper left panel). From the upper left to lower right, vertical velocity, cloud water, rainwater, cloud ice number concentrations, vertical velocity, snow, graupel, hail number concentrations (/ kg).

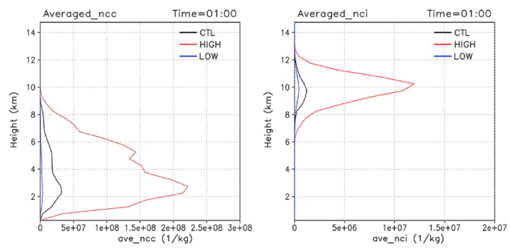


Figure 2: Vertical distribution of cloud water number concentration (left) and cloud ice number concentration (right) averaged over the model domain. HIGH is the result of a sensitivity experiment in which the number concentrations of anthropogenic aerosols are 10 times that of CTL, and LOW is 1/10.

Observation of aerosol particles in Okinawa

Observations were conducted in collaboration with the University of Ryukyus and Nagasaki University from 2018 to 2020. The size distribution of the aerosol particles was measured from June to October 2020 using an optical particle analyzer. Figure 3 (left panel) shows the relationship between average wind speed and mass concentration of aerosol particles with diametrs between 0.3 and 10 μm during the 11 typhoons passing near the observation. In most cases, a similar relationship between wind speed and mass concentration of aerosol particles was observed. Therefore, wind speed plays a critical role in determining the number of sea salt particles around typhoons. In addition, scanning electron microscopy/energy dispersive X-ray spectrometry was used to analyze sea salt collected when two typhoons (Typhoon No. 24, 2018 and Typhoon No. 13, 2019) approached Okinawa. As shown in Figure 3 (a) and (b), the colored particles overlap with Na and Cl, that is, sea salt. Typhoon No. 24, with a maximum wind speed of 53 m/s and sea salt of 32 μg/m^3, contained many fine square-shaped particles. In contrast, Typhoon No.13, with a maximum wind speed of 27 m/s and sea salt of 10 μg/m^3 contained relatively large (ca. 300 μm) complex-shaped particles but few smaller particles.

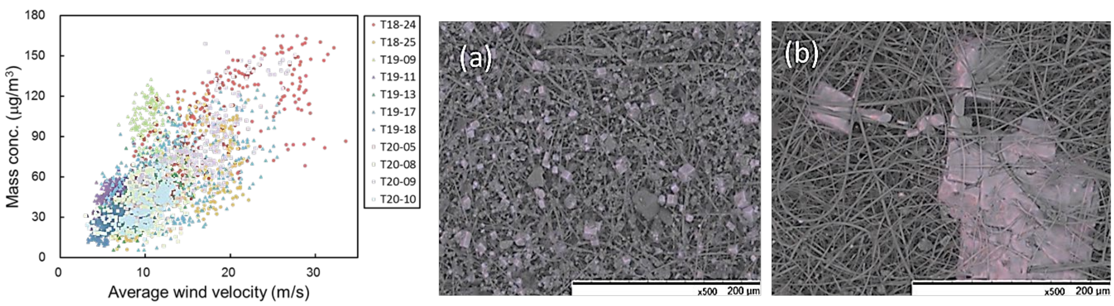


Figure 3 Left: Relation of mass concentration of aerosol particles with diameters between 0.3 and 10 μm and wind speed during the passage of 11 typhoons. Right: Electron microscope images for aerosol particles collected during approaching of the Typhoons (a) No. 24, 2018 and (b) No. 13, 2019.

9. Publications and Presentations

Papers (in refereed Journals, April 2020–March 2021)

Abe, K., Y. Chen, K. Hiraide, K. Ichimura, S. Imaizumi, N. Kato, K. Kobayashi, M. Kobayashi, S. Moriyama, M. Nakahata et al. (**Y. Itow**, **K. Kanzawa**), Search for exotic neutrino-electron interactions using solar neutrinos in XMASS-I. *Phys. Lett. B*, **80**, 135741, Oct. 10, 2010 (10.1016/j.physletb.2020.135741).

Abe, K., Y. Chen, K. Hiraide, K. Ichimura, S. Imaizumi, N. Kato, Y. Kishimoto, K. Kobayashi, M. Kobayashi, S. Moriyama et al. (**R. Ishii**, **Y. Itow**, **K. Kanzawa**, **K. Masuda**), Development of low-background photomultiplier tubes for liquid xenon detectors. *J. Instrum.*, **15(9)**, P09027, Sep. 18, 2020 (10.1088/1748-0221/15/09/P09027).

Abe, K., C. Bronner, Y. Haga, Y. Hayato, M. Ikeda, S. Imaizumi, H. Ito, K. Iyogi, J. Kameda, Y. Kataoka et al. (**Y. Itow**, **H. Menjo**, **G. Mitsuka**, **M. Murase**, **F. Muto**, **T. Niwa**, **K. Sato**, **T. Suzuki**, **M. Taani**, **M. Tsukada**), Indirect search for dark matter from the Galactic Center and halo with the Super-Kamiokande detector. *Phys. Rev. D*, **102(7)**, 072002, Oct. 9, 2020 (10.1103/PhysRevD.102.072002).

Abe, K., C. Bronner, Y. Hayato, M. Ikeda, S. Imaizumi, H. Ito, J. Kameda, Y. Kataoka, M. Miura, S. Moriyama et al. (**Y. Itow**, **H. Menjo**, **T. Niwa**, **K. Sato**, **M. Tsukada**), Neutron-antineutron oscillation search using a 0.37 megaton-years exposure of Super-Kamiokande. *Phys. Rev. D*, **103(1)**, 012008, Jan. 21, 2021 (10.1103/PhysRevD.103.012008).

Abe, K., Y. Chen, K. Hiraide, K. Ichimura, S. Imaizumi, N. Kato, K. Kobayashi, M. Kobayashi, S. Moriyama, M. Nakahata et al. (**Y. Itow**, **K. Kanzawa**, **K. Masuda**), Search for event bursts in XMASS-I associated with gravitational-wave events. *Astropart. Phys*., in press (10.1016/j.astropartphys.2021.102568).

Acharyya, A., R. Adam, C. Adams, I. Agudo, A. Aguirre-Santaella, R. Alfaro, J. Alfaro, C. Alispach, R. Aloisio, R. Alves Batista et al. (**A. Okumura**), Sensitivity of the Cherenkov Telescope Array to a dark matter signal from the Galactic centre. *J. Cosmol. Astropart. Phys.*, **2021(01)**, 57, Jan. 2021 (10.1088/1475-7516/2021/01/057).

Adachi, K., N. Oshima, **S. Ohata**, A. Yoshida, N. Moteki, and M. Koike, Compositions and mixing states of aerosol particles by aircraft observations in the Arctic springtime, 2018. *Atmos. Chem. Phys*., **21(5)**, 3607–3626, Mar. 9, 2021 (10.5194/acp-21-3607-2021).

Adams, C., G. Ambrosi, M. Ambrosio, C. Aramo, W. Benbow, B. Bertucci, E. Bissaldi, M. Bitossi, A. Boiano, C. Bonavolontá et al. (**A. Okumura**), Status of the development of NUV SiPMs for INFN optical modules for the SCT medium sized telescope proposed for the CTA observatory. *Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip*., **982**, 164486, Dec. 1, 2020 (10.1016/j.nima.2020.164486).

Adams, C., G. Ambrosi, M. Ambrosio, C. Aramo, W. Benbow, B. Bertucci, E. Bissaldi, M. Bitossi, A. Boiano, C. Bonavolontá et al. (**A. Okumura**), Verification of the optical system of the 9.7-m prototype Schwarzschild-Couder Telescope. *Proc. SPIE*, **11488**, 1148805, Aug. 20, 2020 (10.1117/12.2568134).

Adams, C., R. Alfaro, G. Ambrosi, M. Ambrosio, C. Aramo, T. Arlen, P. I. Batista, W. Benbow, B. Bertucci, E. Bissaldi et al. (**A. Okumura, H. Tajima**), Detection of the Crab Nebula with the 9.7 m prototype Schwarzschild-Couder telescope. *Astropart. Phys*., **128**, 102562, Mar. 2021 (10.1016/j.astropartphys.2021.102562).

Adithya, H. N., **R. Kariyappa**, **S. Imada**, **K. Kusano**, J. Zender, L. Damé, G. Gabriel, E. DeLuca, and M. Weber, Solar soft X-ray irradiance variability, I: Segmentation of Hinode/XRT full-disk images and comparison with GOES (1 – 8 Å) X-ray flux. *Sol. Phys*., in press (10.1007/s11207-021-01785-6).

Adriani, O., E. Berti, L. Bonechi, M. Bongi, R. D'Alessandro, S. Detti, M. Haguenauer, **Y. Itow**, K. Kasahara, **H. Menjo**, **Y. Muraki**, **K. Ohashi** et al. (**K. Sato**, **M. Ueno**), Measurement of energy flow, cross section and average inelasticity of forward neutrons produced in $\sqrt{s}$ = 13 TeV proton-proton collisions with the LHCf Arm2 detector. *J. High Energy Phys.*, **2020(7)**, 16, Jul. 2, 2020 (10.1007/JHEP07(2020)016).

Ahmed, N., **N. Kurita**, M. A. M. Chowdhury, J. Gao, S. M. Q. Hassan, M. A. Mannan, M. A. K. Mallik, S. A. Choudhury, M. A. Q. Bhuiyan, and M. M. Karim, Atmospheric factors controlling stable isotope variations in modern precipitation of the tropical region of Bangladesh. *Isot. Environ. Health Stud.*, **56(3)**, 220–237, Jun. 1, 2020

(10.1080/10256016.2020.1770245).

Aiki, H., F. Kondo, M. Konda, K. Tanaka, and T. Fujita, Marine wave boundary layer observation using an optical particle counter with 10-Hz temporal resolution. *Earozoru Kenkyu,* **35(3)**, 160–169, Sep. 20, 2020 (10.11203/jar.35.160). [in Japanese]

Ajello, M., W. B. Atwood, M. Axelsson, L. Baldini, G. Barbiellini, M. G. Baring, D. Bastieri, R. Bellazzini, A. Berretta, E. Bissaldi et al. (**H. Tajima**), High-energy emission from a magnetar giant flare in the Sculptor galaxy. *Nat. Astron*., in press (10.1038/s41550-020-01287-8).

Amory-Mazaudier, C., S. Radicella, P. Doherty, S. Gadimova, R. Fleury, B. Nava, E. Anas, M. Petitdidier, Y. Migoya-Orué, K. Alazo, and **K. Shiokawa**, Development of research capacities in space weather: A successful international cooperation. *J. Space Weather Space Clim*., Mar. 31, 2021 (10.1051/swsc/2021006).

Anzorena, M., R. Garcia, J. F. Valdes-Galicia, **Y. Matsubara**, **Y. Itow**, T. Sako, **T. Kawabata**, E. Ortiz, R. Taylor, A. Hurdo et al., Simulation and experimental validation of optimum read-out electronics design for scintillator bar cosmic ray telescope. *Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip*., **991**, 165019, Mar. 1, 2021 (10.1016/j.nima.2021.165019).

Aprile, E., J. Aalbers, F. Agostini, M. Alfonsi, L. Althueser, F. D. Amaro, V. C. Antochi, E. Angelino, J. R. Angevaare, F. Arneodo et al. (**Y. Itow**, **S. Kazama**), Excess electronic recoil events in XENON1T. *Phys. Rev. D*, **102(7)**, 072004, Oct. 12, 2020 (10.1103/PhysRevD.102.072004).

Aprile, E., J. Aalbers, F. Agostini, M. Alfonsi, L. Althueser, F. D. Amaro, V. C. Antochi, E. Angelino, J. R. Angevaare, F. Arneodo et al. (**Y. Itow**, **S. Kazama**, **M. Yamashita**), Projected WIMP sensitivity of the XENONnT dark matter experiment. *J. Cosmol. Astropart. Phys*., **11**, 031, Nov. 2020 (10.1088/1475-7516/2020/11/031).

Aprile, E., J. Aalbers, F. Agostini, S. Ahmed Maouloud, M. Alfonsi, L. Althueser, F. D. Amaro, S. Andaloro, V. C. Antochi, E. Angelino et al. (**Y. Itow**, **S. Kazama**, **M. Yamashita**), Search for coherent elastic scattering of solar B-8 neutrinos in the XENON1T dark matter experiment. *Phys. Rev. Lett*., **126(9)**, 091301, Mar. 1, 2021 (10.1103/PhysRevLett.126.091301).

Aprile, E., J. Aalbers, F. Agostini, M. Alfonsi, L. Althueser, F. D. Amaro, S. Andaloro, E. Angelino, J. R. Angevaare, V. C. Antochi et al. (**Y. Itow**, **S. Kazama**, **M. Yamashita**), Search for inelastic scattering of WIMP dark matter in XENON1T. *Phys. Rev. D*, **103**, 063028, Mar. 19, 2021 (10.1103/PhysRevD.103.063028).

Aprile, E., J. Aalbers, F. Agostini, M. Alfonsi, L. Althueser, F. D. Amaro, V. C. Antochi, E. Angelino, J. R. Angevaare, F. Arneodo et al. (**Y. Itow**, **S. Kazama**, **M. Yamashita**), ^{222}Rn emanation measurements for the XENON1T experiment. *Eur. Phys. J. C.*, in press (10.1140/epjc/s10052-020-08777-z).

Ariunsaikhan, A., S. Chonokhuu, and **Y. Matsumi**, Mobile measurement of PM2.5 based on an individual in Ulaanbaatar city. *Int. J. Environ. Res. Public Health*, **17(8)**, 2701, Apr. 15, 2020 (10.3390/ijerph17082701).

Asaoka. S., S. Nakada, A. Umehara, **J. Ishizaka**, and W. Nishijima, Estimation of spatial distribution of coastal ocean primary production in Hiroshima Bay, Japan, with a geostationary ocean color satellite. *Estuar. Coast. Shelf Sci.*, **244**, 106897, Oct. 5, 2020 (10.1016/j.ecss.2020.106897).

Azizi, H, Y. Asahara, **M. Minami,** and R. Anma, Sequential magma injection with a wide range of mixing and mingling in Late Jurassic plutons, southern Ghorveh western Iran. *J. Asian Earth Sci.*, **200**, 104469, Sep. 15, 2020 (10.1016/j.jseaes.2020.104469).

Azizi, H., A. Maghsoudloo, F. Nouri, Y. Asahara, K. Yamamoto, **M. Minami**, and M. Tsuboi, Investigation of rare earth elements (REEs) as exploration potential in Intrusive bodies in the northern Sanandaj-Sirjan zone (Kurdistan area), western Iran. *Geochem. J*., **54(4)**, 221–232, Aug. 27, 2020 (10.2343/geochemj.2.0584).

Azizi, H., N. Daneshvar, A. Mohammadi, Y. Asahara, S. A. Wattam, M. Tsuboi, and **M. Minami**, Early Miocene post-collision andesite in the Takab area, northwest Iran. *J. Petrol.*, in press (10.1093/petrology/egab022).

Bamba, Y., **S. Inoue**, and **S. Imada**, Intrusion of magnetic peninsula toward the neighboring opposite-polarity region that triggers the largest solar flare in solar cycle 24. *Astrophys. J.*, **894(1)**, 29, May 1, 2020 (10.3847/1538-4357/ab85ca).

Belakhovsky, V. B., **K. Shiokawa**, A. Matsuoka, Y. Kasahara, I. Shinohara, **Y. Miyoshi**, S.-Y. Wang, Y. Kazama, S. Kasahara, and S. Yokota, The long-lasting QP emissions observed on Arase satellite and Lovozero station. in *Conference Proceedings: 2021 XXXIIIrd General Assembly and Scientific Symposium of the International Union of Radio Science*, *IEEE*, **9232442**, 1–4, Oct. 20, 2020 (10.23919/URSIGASS49373.2020.9232442).

Bennett, D. P., A. Udalski, I. A. Bond, **F. Abe**, R. K. Barry, A. Bhattacharya, M. Donachie, **H. Fujii**, A. Fukui, Y. Hirao, **Y. Itow** et al. (**Y. Matsubara**, **Y. Muraki**), A gas giant planet in the OGLE-2006-BLG-284L stellar binary system. *Astron. J.*, **160(2)**, 72, Jul. 17, 2020 (10.3847/1538-3881/ab9cb9).

Bhaskar, A., **H. Hayakawa**, D. M. Oliveira, S. Blake, S. M. Silverman, and Y. Ebihara, An analysis of Trouvelot's auroral drawing on 1/2 March 1872: Plausible evidence for recurrent geomagnetic storms. *J. Geophys. Res. Space Phys*., **125(10)**, e2020JA028227, Oct. 10, 2020 (10.1029/2020JA028227).

Blumenstock, T., F. Hase, A. Keens, D. Czurlok, O. Colebatch, O. Garcia, D. W. T. Griffith, M. Grutter, J. W. Hannigan, P. Heikkinen et al. (**T. Nagahama)**, Characterization and potential for reducing optical resonances in Fourier transform infrared spectrometers of the Network for the Detection of Atmospheric Composition Change (NDACC). *Atmos. Meas. Tech*., **14(2)**, 1239–1252, Feb. 17, 2021 (10.5194/amt-14-1239-2021).

Boocock, C., **K. Kusano**, and D. Tsiklauri, The effects of oscillations and collisions of emerging bipolar regions on the triggering of solar flares. *Astrophys. J.*, **900(1)**, 65, Sep. 1, 2020 (10.3847/1538-4357/aba61a).

Carter, B. A., J. Retterer, T. Dao, R. Pradipta, R. Caton, K. Groves, **Y. Otsuka**, T. Yokoyama, K. Hozumi, T. Le Truong, and M. Terkildsen, On the generation of an unseasonal EPB over South East Asia. *J. Geophys. Res. Space Phys*., **126(2)**, e2020JA028724, Feb. 2021 (10.1029/2020JA028724).

Case, N. A., D. P. Hartley, A. Grocott, **Y. Miyoshi**, A. Matsuoka, **S. Imajo**, S. Kurita, I. Shinohara, and M. Teramoto, Inner magnetospheric response to the interplanetary magnetic field B_y component: Van Allen Probes and Arase observations. *J. Geophys. Res. Space Phys*., **126(1)**, e2020JA028765, Jan. 2021 (10.1029/2020JA028765).

Chakraborty, S., J. M. Ruohoniemi, J. B. H. Baker, R. Fiori, K. Zawdie, S. Bailey, **N. Nishitani**, and D. Drob, Sluggishness of the ionosphere: Characteristic time-lag in response to solar flares. in *Conference Proceedings: 2021 XXXIIIrd General Assembly and Scientific Symposium of the International Union of Radio Science, IEEE,* **9232206,** 1–4, Oct. 20, 2020 (10.23919/URSIGASS49373.2020.9232206).

Chashei, I. V., V. R. Lukmanov, S. A. Tyulbashev, and **M. Tokumaru,** Comparison of solar wind speed estimates from nearly simultaneous IPS observations at 327 and 111 MHz. *Sol. Phys*. in press (10.1007/s11207-021-01804-6).

Chian, A. C. L., S. S. A. Silva, E. L. Rempel, L. R. Bellot Rubio, M. Gošić, **K. Kusano**, and **S.-H. Park**, Lagrangian chaotic saddles and objective vortices in solar plasmas. *Phys. Rev. E*, **102(6)**, 060201(R), Dec. 3, 2020 (10.1103/PhysRevE.102.060201).

Cliver, E. W., **H. Hayakawa**, J. J. Love, and D. F. Neidig, On the size of the flare associated with the solar proton event in 774 AD. *Astrophys. J.*, **903(1)**, 41, Nov. 1, 2020 (10.3847/1538-4357/abad93).

Collins, D. S., V. L. Nguyen, T. K. O. Ta, L. Mao, Y. Ishii, **H. Kitagawa**, R. Nakashima, T. H. Q. Vo, and T. Tamura, Sedimentary evolution of a delta-margin mangrove in Can Gio, northeastern Mekong River delta, Vietnam, *Mar. Geol.*, **443**, 106417, Mar. 2021 (10.1016/j.margeo.2020.106417).

Colpitts, C., **Y. Miyoshi**, Y. Kasahara, G. L. Delzanno, J. R. Wygant, C. A. Cattell, A. Breneman, C. Kletzing, G. Cunningham, M. Hikishima et al., First direct observations of propagation of discrete chorus elements from the equatorial source to higher latitudes, using the Van Allen Probes and Arase satellites. *J. Geophys. Res. Space Phys.*, **125(10)**, e2020JA028315, Oct. 2020 (10.1029/2020JA028315).

Crosta, X., S. K. Shukla, O. Ther, M. Ikehara, **M. Yamane**, and Y. Yokoyama, Last Abundant Appearance Datum of Hemidiscus karstenii driven by climate change. *Mar. Micropaleontol.*, **157**, 101861, May 2020, (10.1016/j.marmicro.2020.101861).

Dao, T., M. L. Huy, B. Carter, Q. Le, T. T. Trinh, B. N. Phan, and **Y. Otsuka**, New observations of the total electron content and ionospheric scintillations over Ho Chi Minh city. *Vietnam Journal of Earth Sciences*, **42(4)**, 320–333, Jul. 13 2020 (10.15625/0866-7187/42/4/15281).

Dhaka, S. K., Chetna, V. Kumar, V. Panwar, A. P. Dimri, N. Singh, P. K. Patra, **Y. Matsumi**, M. Takigawa, T. Nakayama et al., $PM_{2.5}$ diminution and haze events over Delhi during the COVID-19 lockdown period: an interplay between the baseline pollution and meteorology. *Sci Rep.*, **10(1)**, 13442, Aug. 10, 2020 (10.1038/s41598-020-70179-8).

Enami, M., S. Huang, M. Tsuboi, and **Y. Wakasugi**, Petrological and mineralogical contrasts of basic lithologies between eclogite and non-eclogite units along the Kokuryo River of the Sanbagawa belt, Central Shikoku, Japan. *J. Mineral. Petrol. Sci.*, **115(6)**, 457–470, Dec. 2020 (10.2465/jmps.181107a).

Ezoe, Y., R. Funase, H. Nagata, **Y. Miyoshi**, S. Kasahara, H. Nakajima, I. Mitsuishi, K. Ishikawa, J. Hiraga, K. Mitsuda et al., GEO-X (GEOspace x-ray imager). *Proc. SPIE*, **11444**, 1144428, Dec.13, 2020 (10.1117/12.2560780).

Fan, Y., W. Li, N. Chen, J.-H. Ahn, Y.-J. Park, S. Kratzer, T. Schroeder, **J. Ishizaka**, R. Chang, and K. Stamnes, OC-SMAR: A machine learning based data analysis platform for satellite ocean color sensor. *Remote Sens. nviron.*, **253**, 112236, Feb. 2021 (10.1016/j.rse.2020.112236).

Feng, C., **J. Ishizaka**, K. Saitoh, T. Mine, and H. Yamashita, A novel method based on backscattering for Discriminating Summer blooms of the raphidophyte (Chattonella spp.) and the diatom (Skeletonema spp.) using MODIS images in Ariake Sea, Japan. *Remote Sens.*, **12(9)**, 1504, May 8, 2020 (10.3390/rs12091504).

Fujiki, T., R. Inoue, M. C. Honda, M. Wakita, **Y. Mino**, C. Sukigara, and O. Abe, Time-series observations of photosynthetic oxygen production in the subtropical western North Pacific by an underwater profiling buoy system. *Limnol. Oceanogr.*, **65(5)**, 1072–1084, May 2020 (10.1002/lno.11372).

Fukizawa, M., T. Sakanoi, **Y. Miyoshi**, Y. Kazama, Y. Katoh, Y. Kasahara, S. Matsuda, A. Matsuoka, S. Kurita, **M. Shoji**, M. Teramoto, **S. Imajo** et al., Pitch-angle scattering of inner magnetospheric electrons caused by ECH waves obtained with the Arase satellite. *Geophys. Res. Lett.*, **47(23)**, e2020GL089926, Oct. 29, 2020 (10.1029/2020GL089926).

Ghosh, P., **Y. Otsuka**, **S. Mani**, and H. Shinagawa, Day-to-day variation of pre-reversal enhancement in the equatorial ionosphere based on GAIA model simulations. *Earth Planets Space*, **72**, 93, Jul. 6, 2020 (10.1186/s40623-020-01228-9).

Goldstein S. L., Y. Kiro, A. Torfstein, **H. Kitagawa**, J. Tierney, and M. Stein, Revised chronology of the ICDP Dead Sea deep drill core relates drier-wetter-drier climate cycles to insolation over the past 220 kyr. *Quat. Sci. Rev.*, **244**, 106460, Sep. 15, 2020 (10.1016/j.quascirev.2020.106460).

Goodwin, L. V., Y. Nishimura, A. J. Coster, S. Zhang, **N. Nishitani**, J. M. Ruohoniemi, B. J. Anderson, and Q.-H. Zhang, Dayside polar cap density enhancements formed during substorms. *J. Geophys. Res. Space Phys.*, **125(10)**, e2020JA028101, Oct. 2020 (10.1029/2020JA028101).

Gordovskyy, M., P. K. Browning, **S. Inoue**, E. P. Kontar, **K. Kusano**, and G. E. Vekstein, Forward modelling of particle acceleration and transport in an individual solar flare. *Astrophys. J.*, **902(2)**, 147, Oct. 23, 2020 (10.3847/1538-4357/abb60e).

Hagino, K., H. Odaka, G. Sato, T. Sato, H. Suzuki, T. Mizuno, M. Kawaharada, M. Ohno, K. Nakazawa, S. B. Kobayashi et al. (**H. Tajima**, **K. Yamaoka**), Origin of the in-orbit instrumental background of the Hard X-ray Imager onboard Hitomi. *J. Astron. Telesc. Instrum. Syst.*, **6(4)**, 046003, Oct. 2020 (10.1117/1.JATIS.6.4.046003).

Han, B., J. Niang, H. Rao, N. Lyu, **H. Oda**, S. Sakamoto, Y. Yang, and M. Sablier, Paper fragments from the Tibetan Samye Monastery: Clues for an unusual sizing recipe implying wheat starch and milk in early Tibetan papermaking. *Journal of Archaeological Science: Reports*, in press (10.1016/j.jasrep.2021.102793).

Han, C., C.-U. Lee, A. Udalski, A. Gould, I. A. Bond, V. Bozza, M. D. Albrow, S.-J. Chung, K.-H. Hwang, Y. K. Jung et al. (**F. Abe**, **H. Fujii**, **Y. Itow**, **Y. Kamei**, **Y. Matsubara**, **Y. Muraki**, **T. Yamakawa**), Candidate brown-dwarf microlensing events with very short timescales and small angular Einstein radii. *Astron. J.*, **159(4)**, 134, Apr. 2020 (10.3847/1538-3881/ab6f66).

Han, C., D. Kim, Y. K. Jung, A. Gould, I. A. Bond, M. D. Albrow, S.-J. Chung, K.-H. Hwang, C.-U. Lee, Y.-H. Ryu et al. (**F. Abe**, **H. Fujii**, **Y. Itow**, **Y. Matsubara**, **Y. Muraki**), One planet or two planets? The ultra-sensitive extreme-magnification microlensing event kmt-2019-blg-1953. *Astron. J.*, **160(1)**, 17, Jul. 2020 (10.3847/1538-3881/ab91ac).

Hashimoto, K. K., **T. Kikuchi**, I. Tomizawa, K. Hosokawa, J. Chum, D. Buresova, **M. Nose**, and K. Koga, Penetration electric fields observed at middle and low latitudes during the 22 June 2015 geomagnetic storm. *Earth Planets Space*, **72**, 71, May 26, 2020 (10.1186/s40623-020-01196-0).

Hayakawa, H., M. J. Owens, M. Lockwood, and M. Sôma, The solar corona during the total eclipse on 1806 June 16: Graphical evidence of the coronal structure during the Dalton minimum. *Astrophys. J.*, **900(2)**, 114, Sep. 10, 2020 (10.3847/1538-4357/ab9807).

Hayakawa, H., K. Schlegel, B. P. Besser, and Y. Ebihara, Candidate auroral observations during the major solar-terrestrial storm in May 1680: Implication for space weather events during the Maunder Minimum. *Astrophys. J.*, **909(1)**, 29, Mar. 2021 (10.3847/1538-4357/abb3c2).

Hayakawa, H., T. Iju, K. Murata, and B. P. Besser, Daniel Mögling's sunspot observations in 1626–1629: A manuscript reference for the solar activity before the Maunder Minimum. *Astrophys. J.*, **909(2)**, 194, Mar. 17, 2021 (10.3847/1538-4357/abdd34).

Hayakawa, H., J. R. Ribeiro, Y. Ebihara, A. P. Correia, and M. Sôma, South American auroral reports during the Carrington storm. *Earth Planets Space*, **72**, 122, Aug. 26, 2020 (10.1186/s40623-020-01249-4).

Hayakawa, H., Y. Ebihara, A. A. Pevtsov, A. Bhaskar, N. Karachik, and D. M. Oliveira, Intensity and time series of extreme solar-terrestrial storm in 1946 March. *Mon. Not. Roy. Astron. Soc.*, **497(4)**, 5507–5517, Oct. 2020 (10.1093/mnras/staa1508).

Hayakawa, H., M. Lockwood, M. J. Owens, M. Sôma, B. P. Besser, and L. Driel-Gesztelyi, Graphical evidence for the solar coronal structure during the Maunder minimum: comparative study of the total eclipse drawings in 1706 and 1715. *J. Space Weather Space Clim.*, **11**, 1, Jan. 22, 2021 (10.1051/swsc/2020035).

Hayakawa, H., S. P. Blake, A. Bhaskar, K. Hattori, D. M. Oliveira, and Y. Ebihara, The extreme space weather event in February/March 1941. *Astrophys. J.*, **908(2)**, 2019, Feb. 2021 (10.3847/1538-4357/abb772).

Hayakawa, H., T. Iju, **S. Uneme**, B. P. Besser, S. Kosaka, and **S. Imada,** Reanalyses of the sunspot observations of Fogelius and Siverus: Two "Long-Term" observers during the Maunder Minimum. *Mon. Not. Roy. Astron. Soc.*, in press (10.1093/mnras/staa2965).

Hayakawa, H., C. Kuroyanagi, V. M. S. Carrasco, **S. Uneme**, B. P. Besser, M. Sôma, and **S. Imada,** Sunspot observations at the Eimmart Observatory and in its neighborhood during the late Maunder Minimum (1681–1718). *Astrophys. J.*, **909(2)**, 166, Mar. 15, 2021 (10.3847/1538-4357/abd949).

Hayakawa, H., K. Hattori, A. A. Pevtsov, Y. Ebihara, M. A. Shea, K. G. McCracken, I. A. Daglis, A. T. Bhaskar, P. Ribeiro, and D. J. Knipp, The intensity and evolution of the extreme solar and geomagnetic storms in 1938 January. *Astrophys. J.*, **909(2)**, 197, Mar. 17, 2021 (10.3847/1538-4357/abc427).

Hayakawa, H., Y. Fujii, K. Murata, Y. Mitsuma, Y. Cheng, N. Nogami, K. Ichikawa, H. Sano, K. Tsumura, Y. Kawamoto, and M. Nishino,Three case reports on the cometary plasma tail in the historical documents. *J. Space Weather Space Clim.*, **11**, 21, Mar. 8, 2021 (10.1051/swsc/2020045).

Hayakawa, H., P. Ribeiro, J. M. Vaquero, M. C. Gallego, D. J. Knipp, F. Mekhaldi, A. Bhaskar, D. M. Oliveira, Y. Notsu, V. M. S. Carrasco et al., The extreme space weather event in 1903 October/November: an outburst from the quiet Sun. *Astrophys. J. lett.*, **897(1)**, L10, Jul. 1, 2020 (10.3847/2041-8213/ab6a18).

Hendry, A. T., O. Santolik, **Y. Miyoshi**, A. Matsuoka, C. J. Rodger, M. A. Clilverd, C. A. Kletzing, **M. Shoji**, and I. Shinohara, A multi-instrument approach to determining the source-region extent of EEP-driving EMIC waves. *Geophys. Res.*

Lett., **47(7)**, e2019GL086599, Apr. 16, 2020 (10.1029/2019GL086599).

Hirade, N., H. Takahashi, N. Uchida, M. Ohno, K. Torigoe, Y. Fukazawa, T. Mizuno, H. Matake, K. Hirose, S. Hisadomi et al. (**K. Yamaoka**), Annealing of proton radiation damages in Si-PM at room temperature. *Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip*., **986**, 164673, Jan. 11, 2021 (10.1016/j.nima.2020.164673).

Hirao, Y., D. P. Bennett, Y.-H. Ryu, N. Koshimoto, A. Udalski, J. C. Yee, T. Sumi, I. A. Bond. Y. Shvartzvald, **F. Abe** et al. (**Y. Itow**, **Y. Matsubara**, **Y. Muraki**), OGLE-2017-BLG-0406: Spitzer microlens parallax reveals Saturn-mass planet orbiting M-dwarf host in the inner galactic disc. *Astron. J.*, **160(2)**, 74, Aug. 2020 (10.3847/1538-3881/ab9ac3).

Hirasawa, N., H. Motoyama, K. Yamada, K. Sugiura, and **N. Kurita**, Temporal variations in Antarctic ice sheet surface accumulation observed with snow depth sensors in automatic weather stations. *Journal of the Japanese Society of Snow and Ice,* **83(1)**, 67–77, Jan. 2021.

Hisamochi, R., Y. Watanabe, **N. Kurita**, and T. Tagami, Climate response of oxygen isotopic compositions in tree-ring cellulose in Java: Evaluation using a proxy system model. *Atmosphere*, **12(3)**, 310, Mar. 2021 (10.3390/atmos12030310).

Hiyama T., A. Dashtseren, K. Asai, **H. Kanamori**, Y. Iijima, and M. Ishikawa, Groundwater age of spring discharges under changing permafrost conditions: the Khangai Mountains in central Mongolia. *Environ. Res. Lett.*, **16(1)**, 015008, Jan. 2021 (10.1088/1748-9326/abd1a1).

Hiyama, T., M. Ueyama, A. Kotani, H. Iwata, T. Nakai, M. Okamura, T. Ohta, Y. Harazono, R. E. Petrov, and T. C. Maximov, Lessons learned from more than a decade of greenhouse gas flux measurements at boreal forests in eastern Siberia and interior Alaska. *Polar Sci*.,**27**, 100607, Mar. 2021 (10.1016/j.polar.2020.100607).

Hosokawa K., M. Nagata, **K. Shiokawa**, and **Y. Otsuka**, What controls the luminosity of polar cap airglow patches?: Implication from airglow measurements in Eureka, Canada in comparison with SuperDARN convection pattern. *Polar Sci*., in press (10.1016/j.polar.2020.100608).

Hosokawa, K., K. Takami, S. Saito, Y. Ogawa, **Y. Otsuka**, **K. Shiokawa**, C.-H. Chen, and C.-H. Lin, Observations of equatorial plasma bubbles using a low-cost 630.0-nm all-sky imager in Ishigaki Island, Japan. *Earth Planets Space*, **72**, 56, May 6, 2020 (10.1186/s40623-020-01187-1).

Hosokawa, K., **Y. Miyoshi**, **S.-I. Oyama**, Y. Ogawa, S. Kurita, Y. Kasahara, Y. Kasaba, S. Yagitani, S. Matsuda, M. Ozaki et al., Over-darkening of pulsating aurora. *J. Geophys. Res. Space Phys.*, in press (10.1029/2020JA028838).

Hotta, H., and **H. Iijima**, On rising magnetic flux tube and formation of sunspots in a deep domain. *Mon. Not. Roy. Astron. Soc.*, **494(2)**, 2523–2537, May 2020 (10.1093/mnras/staa844).

Huang, F., J. Lei, **Y. Otsuka**, X. Luan, Y. Liu, J. Zhong, and X. Dou, Characteristics of medium-scale traveling ionospheric disturbances and ionospheric irregularities at mid-latitudes revealed by the total electron content associated with the Beidou geostationary satellite. *IEEE Trans. Geosci. Remote Sensing*, in press (10.1109/TGRS.2020.3032741).

Ieda, A., Atomic oxygen ion-neutral collision frequency models at ionospheric temperatures. *J. Geophys. Res. Space Phys.*, **126(1)**, e2020JA028441, Jan. 2021 (10.1029/2020JA028441).

Iijima, H., Energy-consistent finite difference schemes for compressible hydrodynamics and magnetohydrodynamics using nonlinear filtering. *J. Comput. Phys.*, in press (10.1016/j.jcp.2021.110232).

Iino, T., H. Sagawa, T. Tsukagoshi, and **S. Nozawa**, A belt-like distribution of gaseous hydrogen cyanide on Neptune's equatorial stratosphere detected by ALMA. *Astrophys. J. lett*., **903(1)**, L1, Nov. 1, 2020 (10.3847/2041-8213/abbb9a).

Imada, S., **S. Kato**, and **M. Fujiyama**, Statistical analysis of asymmetric sunspot decay observed by Hinode. *Sol. Phys.*, **295(11)**, 154, Nov. 9, 2020 (10.1007/s11207-020-01724-x).

Imada, S., **K. Motoba**, **M. Fujiyama**, and **H. Iijima**, Solar cycle-related variation in solar differential rotation and meridional flow in solar cycle 24. *Earth Planets Space*, **72**, 182, Nov. 26, 2020 (10.1186/s40623-020-01314-y).

Imajo, S., **M. Nosé**, M. Aida, N. Higashio, H. Matsumoto, K. Kiyokazu, C. Smith, R. J. MacDowall, and A. Yoshikawa, Evolution of field-aligned current in the meridional plane during substorm: multipoint observations from satellites and ground stations. *Earth Planets Space*, **72**, 58, May 7, 2020 (10.1186/s40623-020-01182-6).

Imajo, S., **Y. Miyoshi**, Y. Kazama, K. Asamura, I. Shinohara, **K. Shiokawa**, Y. Kasahara, Y. Kasaba, A. Matsuoka, S.-Y. Wang et al. (**C. W. Jun**, **M. Shoji**, **S. Nakamura**, **M. Kitahara, T. Hori)**, Active auroral arc powered by accelerated electrons from very high altitudes. *Sci. Rep*., **11**, 1610, Jan. 18, 2021 (10.1038/s41598-020-79665-5).

Imayama, T., H. Ueda, T. Usuki, **M. Minami**, Y. Asahara, and T. Nagahashi, Variability of protoliths and pressure-temperature conditions of amphibolites from the Ohmachi Seamount (Izu-Bonin-Mariana arc): evidence of a fossil subduction channel in a modern intra-oceanic arc. *Mineral. Petrol*., **14(4)**, 305–318, Aug. 2020 (10.1007/s00710-020-00705-z).

Inaba, Y., **K. Shiokawa**, **S.-I. Oyama**, **Y. Otsuka**, A. Oksanen, **A. Shinbori**, A.Y. Gololobov, **Y. Miyoshi**, Y. Kazama, S.-Y. Wang et al. (**T. Hori, M. Shoji**), Plasma and field observations in the magnetospheric source region of a Stable Auroral Red (SAR) arc by the Arase satellite on 28 March 2017. *J. Geophys. Res. Space Phys.*, **125(10)**, e2020JA028068, Oct. 2020 (10.1029/2020JA028068).

Inaba, Y., **K. Shiokawa**, **S. Oyama**, **Y. Otsuka**, M. Connors, I. Schofield, **Y. Miyoshi**, **S. Imajo**, **A. Shinbori**, A. Y. Gololobov et al. (**T. Hori**, **M. Shoji**, **M. Kitahara**, **S. Nakamura**), Multi-event analysis of plasma and field variations in source of stable auroral red (SAR) arcs in inner magnetosphere during non-storm-time substorms. *J. Geophys. Res.*, in press (10.1029/2020JA029081).

Inada, T., S. Fukami, K. Noda, M. Chikawa, M. Kagaya, H. Katagiri, D. Mazin, K. Obara, **A. Okumura**, T. Saito et al., Design and production of segment mirrors for the Large-Sized Telescopes of the Cherenkov Telescope Array. *Proc. SPIE*, **11451**, 114510G, Dec. 13, 2020 (10.1117/12.2562111).

Iwai, K., D. Shota, **M. Tokumaru**, **K. Fujiki**, M. Den, and Y. Kubo, Validation of coronal mass ejection arrival-time forecasts by magnetohydrodynamic simulations based on interplanetary scintillation observations. *Earth Planets Space*, **73**, 9, Jan. 6, 2021 (10.1186/s40623-020-01345-5).

Jackson, B. V., A. Buffington, L. Cota, D. Odstrcil, M. M. Bisi, R. Fallows, and **M. Tokumaru**, Iterartive tomography: A key to providing time-dependent 3-D reconstructions of the inner heliosphere and the unification of space weather forecasting techniques. *Front. Astron. Space Sci.*, **7**, 568429, Nov. 25, 2020 (10.3389/fspas.2020.568429).

Jeyaratnam, J., Z. J. Luo, S. E. Giangrande, D. Wang, and **H. Masunaga**, A satellite-based estimate of convective vertical velocity and convective mass flux: Global survey and comparison with radar wind profiler observations. *Geophys. Res. Lett.*, **48(1)**, e2020GL090675, Jan. 16, 2021 (10.1029/2020GL090675).

Jung, Y. K., A. Gould, A. Udalski, T. Sumi, J. C. Yee, C. Han, M. D. Albrow, S.-J. Chung, K.-H. Hwang, Y.-H. Ryu et al. (**F. Abe**, **Y. Itow**, **Y. Matsubara**, **Y. Muraki**), OGLE-2018-BLG-1269Lb: A Jovian planet with a bright $I = 16$ host. *Astron. J.*, **160(3)**, 148, Sep. 2, 2020 (10.3847/1538-3881/abacc8).

Jung, Y. K., A. Udalski, W. Zang, I. A. Bond, J. C. Yee, C. Han, M. D. Albrow, S.-J. Chung, A. Gould, K.-H. Hwang et al. (**F. Abe**, **H. Fujii**, **Y. Itow**, **Y. Kamei**, **Y. Matsubara**, **Y. Muraki**, **T. Yamakawa)**, KMT-2019-BLG-0842Lb: A cold planet below the Uranus/Sun mass ratio. *Astron. J.*, **160(6)**, 55, Dec. 2020 (10.3847/1538-3881/abbe93).

Kanada, S., **H. Aiki**, **K. Tsuboki**, and I. Takayabu, Future changes of a slow-moving intense typhoon with global warming: A case study using a regional 1-km-mesh atmosphere–ocean coupled model. *SOLA*, **17A**, 14–20, Jan. 28, 2021 (10.2151/sola.17A-003).

Kaneko, T., **S.-H. Park**, and **K. Kusano**, Data-driven MHD simulation of successive solar plasma eruptions. *Astrophys. J.*, **909(2)**, 155, Mar. 2021 (10.3847/1538-4357/abe414).

Kasai, Y., **C. Leipe**, M. Saito, **H, Kitagawa**, S. Lauterbach, A. Brauer, P. E. Tarasov, T. Goslar, F. Arai, and S. Sakuma, Breakthrough in purification of fossil pollen for dating of sediments by a new large-particle on-chip sorter. *Sci. Adv.*, in press (10.1126/sciadv.abe7327).

Kataoka, R., Y. Asaoka, S. Torii, S. Nakahira, H. Ueno, S. Miyake, **Y. Miyoshi**, **S. Kurita**, **M. Shoji**, Y. Kasahara et al., Plasma waves causing relativistic electron precipitation events at International Space Station: Lessons from conjunction observations with Arase satellite. *J. Geophys. Res. Space Phys.*, **125(9)**, e2020JA027875, Sep. 2020 (10.1029/2020JA027875).

Kawabata, Y., **S. Inoue**, and T. Shimizu, Extrapolation of three-dimensional magnetic field structure in flare-productive active region with different initial conditions. *Astrophys. J.*, **895(2)**, 105, Jun. 2020 (10.3847/1538-4357/ab8ea9).

Kawabata, Y., A. Ramos, **S. Inoue**, and T. Shimizu, Chromospheric magnetic field: A comparison of He I 10830 Å observations with nonlinear force-free field extrapolation. *Astrophys. J.*, **898(1)**, 32, Jul. 2020 (10.3847/1538-4357/ab9816).

Kawai, T., and **S. Imada**, Energy distribution of small-scale flares derived using a genetic algorithm. *Astrophys. J.*, **906(1)**, 2, Jan. 2021 (10.3847/1538-4357/abc9ae).

Kawai, T., **S. Imada**, S. Nishimoto, K. Watanabe, and T. Kawate, Nowcast of an EUV dynamic spectrum during solar flares. *J. Atmos. Sol.-Terr. Phys.*, **205**, 105302, Sep. 1, 2020 (10.1016/j.jastp.2020.105302).

Kawamura, Y., K. Hosokawa, **S. Nozawa**, Y. Ogawa, **T. Kawabata**, **S. Oyama**, **Y. Miyoshi**, S. Kurita, and R. Fujii, Estimation of the emission altitude of pulsating aurora using the five-wavelength photometer. *Earth Space Sci.*, **72**, 96, Jul. 10, 2020 (10.1186/s40623-020-01229-8).

Kawate, T., T. Tsuzuki, T. Shimizu, **S. Imada**, Y. Katsukawa, H. Hara, Y. Suematsu, K. Ichimoto, T. Hattori, and S. Narasaki, A sensitivity analysis of the updated optical design for EUVST on the Solar-C mission. *Proc. SPIE*, **11444**, 114443J, Dec. 13, 2020 (10.1117/12.2560573).

Kazama, Y., H. Kojima, **Y. Miyoshi**, Y. Kasahara, S. Kasahara, H. Usui, B.-J. Wang, S.-Y. Wang, S. W. Y. Tam, T.-F. Chang et al. (**M. Shoji**), Extremely collimated electron beams in the high latitude magnetosphere observed by Arase. *Geophys. Res. Lett.*, **48(5)**, e2020GL090522, Mar. 21, 2021 (10.1029/2020GL090522).

Kihara, K., Y. Huang, **N. Nishimura**, N. V. Nitta, S. Yashiro, K. Ichimoto, and A. Asai, Statistical analysis of the relation between coronal mass ejections and solar energetic particles. *Astrophys. J.*, **900(1)**, 75, Sep. 1, 2020 (10.3847/1538-4357/aba621).

Kihara, W., K. Munakata, C. Kato, R. Kataoka, A. Kadokura, S. Miyake, M. Kozai, T. Kuwabara, **M. Tokumaru**, R. R. S. Mendonça et al., A peculiar ICME event in August 2018 observed with the global muon detector network. *Space Weather*, **19(3)**, e2020SW002531, Mar. 2021 (10.1029/2020SW002531).

Kikuchi, H., T. Suezawa, T. Ushio, **N. Takahashi**, H. Hanado, K. Nakagawa, M. Osada, T. Maesaka, K. Iwanami, K. Yoshimi et al., Initial observations for precipitation cores with X-band dual polarized phased array weather radar. *IEEE Trans. Geosci. Remote Sensing*, **58(5)**, 3657–3666, May 2020 (10.1109/TGRS.2019.2959628).

Kikuchi, T., J. Chum, I. Tomizawa, K. K. Hashimoto, K. Hosokawa, Y. Ebihara, K. Hozumi, and P. Supnithi, Penetration of the electric fields of the geomagnetic sudden commencement over the globe as observed with the HF Doppler sounders and magnetometers, *Earth Planets Space*, **73**, 10, Jan. 2021 (10.1186/s40623-020-01350-8).

Kim, G.-J., K.-H. Kim, H.-J. Kwon, **K. Shiokawa**, K. Takahashi, and J. Hwang, Long-lasting ground-satellite high coherence of compressional dayside Pc3–Pc4 pulsations. *J. Geophys. Res. Space Phys.*, **125(8)**, e2020JA028074, Aug. 2020 (10.1029/2020JA028074).

Kim, H., **K. Shiokawa**, J. Park, **Y. Miyoshi**, J. Hwang, and A. Kadokura, Ionospheric plasma density oscillation related to EMIC Pc1 waves. *Geophys. Res. Lett.*, **47(15)**, e2020GL089000, Aug. 16, 2020 (10.1029/2020GL089000).

Kim, H., **K. Shiokawa**, J. Park, **Y. Miyoshi**, C. Stolle, and S. Buchert, Statistical analysis of Pc1 wave ducting deduced from Swarm satellites. *J. Geophys. Res. Space Phys.*, **126(3)**, e2020JA029016, Mar. 2021 (10.1029/2020JA029016).

Kim, H., **K. Shiokawa**, J. Park, **Y. Miyoshi**, Y. Miyashita, C. Stolle, K.-H. Kim, J. Matzka, S. Buchert, T. Fromm, and J. Hwang, Modulation of Pc1 wave ducting by equatorial plasma bubble. *Geophys. Res. Lett.*, **47(9)**, e2020GL088054, May 16, 2020 (10.1029/2020GL088054).

Kim, M. H., O. Adriani, E. Berti, L. Bonechi, R. D'Alessandro, Y. Goto, B. Hong, **Y. Itow**, K. Kasahara, J. H. Lee et al. (**Y. Makino**, **H. Menjo**, **K. Sato**, **M. Ueno**, **Q. D. Zhou**), Transverse single-spin asymmetry for very forward neutral pion production in polarized $p + p$ collisions at $\sqrt{s}$ =510 GeV. *Phys. Rev. Lett.*, **124(25)**, 252501, Jun. 26, 2020

(10.1103/PhysRevLett.124.252501).

Kim, Y. H., S.-J. Chung, A. Udalski, I. A. Bond, Y. K. Jung, A. Gould, M. D. Albrow, C. Han, K.-H. Hwang, Y.-H. Ryu et al. (**F. Abe**, **Y. Itow**, **Y. Matsubara, Y. Muraki**), OGLE-2017-BLG-1049: Another giant planet microlensing event. *J. Korean Astron. Soc*., **53(6)**, 161–168, Dec. 2020 (10.5303/JKAS.2020.53.6.161).

Kitamura, N., Y. Omura, **S. Nakamura**, T. Amano, S. A. Boardsen, N. Ahmadi, O. Le Contel, P.-A. Lindqvist, R. E. Ergun, Y. Saito et al., Observations of the source region of whistler mode waves in magnetosheath mirror structures. *J. Geophys. Res. Space Phys*., **125(5)**, e2019JA027488, May 2020 (10.1029/2019JA027488).

Kliem, B., J.-W. Lee, R. Liu, S. M. White, C. Liu, and **S. Masuda**, Non-equilibrium flux rope formation by confined flares preceding a solar coronal mass ejection. *Astrophys. J.*, **909(1)**, 91, Mar. 2021 (10.3847/1538-4357/abda37).

Knipp, D. J., V. Bernstein, K. Wahl, and **H. Hayakawa**, Timelines as a tool for learning about space weather storms. *J. Space Weather Space Clim*., in press (10.1051/swsc/2021011).

Kobayashi, T., M. Nomura, A. Adachi, S. Sugimoto, **N. Takahashi**, and H. Hirakuchi, Retrieval of attenuation profiles from the GPM 5 dual-frequency radar observations. *J. Meteorol. Soc. Jpn.*, in press(10.2151/jmsj.2021-030).

Kobe, F., E. V. Bezrukova, **C. Leipe**, A. A. Shchetniko, T. Gosla, M. Wagner, S. S. Kostrova, and P. E. Tarasov, Holocene vegetation and climate history in Baikal Siberia reconstructed from pollen records and its implications for archaeology. *Archaeological Research in Asia*, **23**, 100209, Sep. 2020 (10.1016/j.ara.2020.100209).

Koike, M., K. Goto-Azuma, Y. Kondo, H. Matsui, T. Mori, N. Moteki, **S. Ohata**, H. Okamoto, N. Oshima, K. Sato et al., Studies on Arctic aerosols and clouds during the ArCS project. *Polar Sci*., **27**, 100621, Mar. 2021 (10.1016/j.polar.2020.100621).

Kolpak, V. I., M. M. Mogilevsky, D. V. Chugunin, A. A. Chernyshov, I. L. Moiseenko, A. Kumamoto, F. Tsuchiya, Y. Kasahara, **M. Shoji**, **Y. Miyoshi**, and I. Shinohara, Statistical properties of auroral kilometer radiation: based on ERG (Arase) satellite data. *Solar-Terrestrial Physics*, **7(1)**, 11–16, Mar. 29, 2021 (10.12737/stp-71202102).

Krucker, S., **S. Masuda**, and S. M. White, Microwave and hard X-ray flare observations by NoRH/NoRP and RHESSI: peak-flux correlations. *Astrophys. J.*, **894(2)**, 158, May 18, 2020 (10.3847/1538-4357/ab8644).

Kumar, S., B. Veenadhari, D. Chakrabarty, S. Tulasi Ram, T. Kikuchi, and **Y. Miyoshi**, Effects of IMF By on ring current asymmetry under southward IMF Bz conditions observed at ground magnetic stations: Case studies. *J. Geophys. Res. Space Phys.*, **125(10)**, e2019JA027493, Oct. 2020 (10.1029/2019JA027493).

Kusano, K., T. Iju, **Y. Bamba**, and **S. Inoue**, A physics-based method that can predict imminent large solar flares. *Science*, **369(6503)**, 587–591, Jul. 31, 2020 (10.1126/science.aaz2511).

Kwon, J.-O., K.-H. Kim, H. Jin, H.-J. Kwon, G. Jee, **K. Shiokawa**, and M. Connors, Statistical study of EMIC Pc1-Pc2 waves observed at subauroral latitudes. *J. Atmos. Sol.-Terr. Phys*., **205**, 105292, Sep. 1, 2020 (10.1016/j.jastp.2020.105292).

Lee, E.-J., **S.-H. Park**, and Y.-J. Moon, Time series analysis of photospheric magnetic parameters of flare-quiet versus flaring active regions: Scaling properties of fluctuations. *Sol. Phys*., **295(9)**, 123, Sep. 7, 2020 (10.1007/s11207-020-01690-4).

Lee, J., S M. White, X. Chen, Y. Chen, H. Ning, B. Li, and **S. Masuda**, Microwave study of a solar circular ribbon flare. *Astrophys. J. lett*., **901(1)**, L10, Sep. 20, 2020 (10.3847/2041-8213/abb4dd).

Lee, K.-S., H. Hara, K. Watanabe, A. D. Joshi, D. H. Brooks, **S. Imada**, A. Prasad, P. Dang, T. Shimizu, S. L. Savage et al., A solar magnetic-fan flaring arch heated by nonthermal particles and hot plasma from an X-ray jet eruption. *Astrophys. J.*, **895(1)**, 42, May 2020 (10.3847/1538-4357/ab8bce).

Leipe, C., S. Kuramochi, M. Wagner, and P. E. Tarasov, Ritual practices and social organisation at the Middle Yayoi culture settlement site of Maenakanishi, eastern Japan. *Archaeol Anthropol. Sci*., **12(7)**, 134, Jul. 20, 2020 (10.1007/s12520-020-01098-y).

Leipe, C., T. Long, M. Wagner, T. Goslar, and P. E. Tarasov, The spread of rice to Japan: Insights from Bayesian analysis of direct radiocarbon dates and population dynamics in East Asia. *Quat. Sci. Rev.*, **244**, 106507, Sep. 15, 2020 (10.1016/j.quascirev.2020.106507).

Leipe, C., E. Endo, S. Kuramochi, M. Wagner, and P. E. Tarasov, Crop cultivation of Middle Yayoi culture communities (fourth centurybce-first centuryce) in the Kanto region, eastern Japan, inferred from a radiocarbon-dated archaeobotanical record. *Veg. Hist. Archaeobot*., in press (10.1007/s00334-020-00791-1).

Li, G., B. Ning, **Y. Otsuka**, M. A. Abdu, P. Abadi, Z. Liu, L. Spogli, and W. Wan, Challenges to equatorial plasma bubble and ionospheric scintillation short-term forecasting and future aspects in East and Southeast Asia. *Surv. Geophys*., **42(1)**, 201–238, Jan. 2021 (10.1007/s10712-020-09613-5).

Li, J., Y. Sakamoto, N. Kohno, T. Fujii, K. Matsuoka, M. Takemura, J. Zhou, M. Nakagawa, K. Murano, Y. Sadanaga et al. (**T. Nakayama**), Total hydroxyl radical reactivity measurements in a suburban area during AQUAS–Tsukuba campaign in summer 2017. *Sci. Total Environ.*, **740**, 139897, Oct. 20, 2020 (10.1016/j.scitotenv.2020.139897).

Li, X., M. Li, L. O. Amoudry, R. Ramirez-Mendoza, P. D. Thorne, **Q. Song**, P. Zheng, S. M. Simmons, L.-B. Jordan, and S. J. McLelland, Three-dimensional modelling of suspended sediment transport in the far wake of tidal stream turbines. *Renew. Energy*, **151**, 956–965, May 2020 (10.1016/j.renene.2019.11.096).

Lin, P. H., **K. Kusano**, D. Shiota, **S. Inoue**, **K. D. Leka**, and Y. Mizuno, A new parameter of the photospheric magnetic field to distinguish Eruptive-flare producing solar active regions. *Astrophys. J.*, **894(1)**, Apr. 20, 2020 (10.3847/1538-4357/ab822c).

Lutsch, E., K. Strong, D. B. A. Jones, T. Blumenstock, S. Conway, J. A. Fisher, J. W. Hannigan, F. Hase, Y. Kasai, E. Mahieu et al. (**T. Nagahama**), Detection and attribution of wildfire pollution in the Arctic and northern midlatitudes using a network of Fourier-transform infrared spectrometers and GEOS-Chem. *Atmos. Chem. Phys*., **20(21)**, 12813–12851, Nov. 5, 2020 (10.5194/acp-20-12813-2020).

Ly, B. T., **Y. Matsumi**, T. V. Vu, K. Sekiguchi, T.-T. Nguyene, C.-T. Pham, T.-D. Nghiem, I.-H. Ngo, Y. Kurotsuchi, T.-H. Nguyen, and T. Nakayama, The effects of meteorological conditions and long-range transport on PM2.5 levels in Hanoi revealed from multi-site measurement using compact sensors and machine learning approach. *J. Aerosol. Sci.*, **152**, 105716, Feb. 2021 (10.1016/j.jaerosci.2020.105716).

Mangano, V., M. Dósa, M. Fränz, A. Milillo, J. S. Oliveira, Y. J. Lee, S. McKenna-Lawlor, D. Grassi, D. Heyner, A. S. Kozyrev et al. (**K. Iwai**, **Y. Miyoshi**), BepiColombo science investigations during cruise and flybys at the Earth, Venus and Mercury. *Space Sci. Rev*., **217**, 23, Feb. 22, 2021 (10.1007/s11214-021-00797-9).

Marti, L., M. Ikeda, Y. Kato, Y. Kishimoto, M. Nakahata, Y. Nakajima, Y. Nakano, S. Nakayama, Y. Okajima, A. Orii et al. (**F. Muto**), Evaluation of gadolinium's action on water Cherenkov detector systems with EGADS. *Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip*., **959**, 163549, Apr. 11, 2020 (10.1016/j.nima.2020.163549).

Martinez-Calderon, C., F. Němec, Y. Katoh, **K. Shiokawa**, C. Kletzing, G. Hospodarsky, O. Santolik, Y. Kasahara, S. Matsuda, A. Kumamoto et al. (**M. Shoji**, **Y. Miyoshi**, **N. Nishitani)**, Spatial extent of quasiperiodic emissions simultaneously observed by Arase and Van Allen Probes on 29 November 2018. *J. Geophys. Res. Space Phys.*, **125(9)**, e2020JA028126, Sep. 2020 (10.1029/2020JA028126).

Martinez-Calderon, C., Y. Katoh, J. Manninen, O. Santolik, Y. Kasahara, S. Matsuda, A. Kumamoto, F. Tsuchiya, A. Matsuoka, **M. Shoji** et al. (**K. Shiokawa, Y. Miyoshi**), Multievent study of characteristics and propagation of naturally occurring ELF/VLF waves using high-latitude ground observations and conjunctions with the Arase satellite. *J. Geophys. Res. Space Phys*., **126(2)**, e2020JA028682, Feb. 2021 (10.1029/2020JA028682).

Masunaga, H., and B. E. Mapes, A mechanism for the maintenance of sharp tropical margins. *J. Atmos. Sci*., **77(4)**, 1181–1197, Apr. 2020 (10.1175/JAS-D-19-0154.1).

Masunaga, H., C. E. Holloway, H. Kanamori, S. Bony, and T. H. M. Stein, Transient aggregation of convection: Observed behavior and underlying processes. *J. Clim.*, **34(5)**, 1685–1700, Mar. 2021 (10.1175/JCLI-D-19-0933.1).

Matsuda, S., T. Hasegawa, A. Kumamoto, F. Tsuchiya, Y. Kasahara, **Y. Miyoshi**, Y. Kasaba, A. Matsuoka, and I. Shinohara, Detection of UHR frequencies by a convolutional neural network from Arase/PWE data. *J. Geophys. Res. Space*

Phys., **125(10)**, e2020JA028075, Oct. 2020 (10.1029/2020JA028075).

McComas, D. J., M. Bzowski, M. A. Dayeh, R. DeMajistre, H. O. Funsten, P. H. Janzen, I. Kowalska-Leszczyńska, M. A. Kubiak, N. A. Schwadron, J. M. Sokół et al. (**M. Tokumaru**), Solar cycle of imaging the global heliosphere: Interstellar Boundary Explorer (IBEX) observations from 2009–2019. *Astrophys. J. Suppl. Ser*., **248(2)**, Jun. 26 2020 (10.3847/1538-4365/ab8dc2).

Mengist, C. K., **S. Yadav**, K. Kotulak, A. Bahar, S.-R. Zhang, and K.-H. Seo, Validation of International Reference Ionosphere model (IRI-2016) for F-region peak electron density height (hmF2): Comparison with Incoherent Scatter Radar (ISR) and ionosonde measurements at Millstone Hill. *Adv. Space Res*., **65(12)**, 2773–2781, Jun. 15, 2020 (10.1016/j.asr.2020.03.017).

Millilo, A., M. Fujimoto, G. Murakami, J. Benkhoff, J. Zender, S. Aizawa, M. Dosa, L. Griton, D. Heyner, G. Ho et al. (**M. Hirahara**), Investigating Mercury's environment with the two-spacecraft BepiColombo mission. *Space Sci. Rev*., **216(5)**, 93, Aug. 2020 (10.1007/s11214-020-00712-8).

Min, K., K. Liu, R. E. Denton, F. Němec, S. A. Boardsen, and **Y. Miyoshi**, Two-dimensional hybrid particle-in-cell simulations of magnetosonic waves in the dipole magnetic field: On a constant L-shell. *J. Geophys. Res. Space Phys*., **125(10)**, e2020JA028414, Oct. 2020 (10.1029/2020JA028414).

Mino, Y., C. Sukigara, M. C. Honda, H. Kawakami, M. Wakita, K. Sasaoka, C. Yoshikawa, O. Abe, J. Kaiser, K. Kimoto et al., Seasonal and interannual variations in nitrogen availability and particle export in the northwestern North Pacific subtropical gyre. *J. Geophys. Res.-Oceans*, **125(5)**, e2019JC015600, May 2020 (10.1029/2019JC015600).

Miyashita, T., H. Ohya, F. Tsuchiya, A. Hirai, M. Ozaki, **K. Shiokawa**, **Y. Miyoshi**, **N. Nishitani**, M. Teramoto, M. Connors et al. (**M. Shoji**), ULF modulation of energetic electron precipitations observed by VLF/LF radio propagation. *URSI Radio Science Bulletin*, **2020(372)**, 29–40, Oct. 26, 2020 (10.23919/URSIRSB.2020.9240099).

Miyashita, Y., K. Seki, K. Sakaguchi, Y. Hiraki, **M. Nosé**, **S. Machida**, Y. Saito, and W. R. Paterson, On the transition between the inner and outer plasma sheet in the Earth's magnetotail. *J. Geophys. Res. Space Phys.*, **125(4)**, e2019JA027561, Apr. 2020 (10.1029/2019JA027561).

Miyoshi, Y., S. Saito, S. Kurita, K. Asamura, K. Hosokawa, T. Sakanoi, T. Mitani, Y. Ogawa, **S. Oyama**, F. Tsuchiya et al., Relativistic electron microbursts as high-energy tail of pulsating aurora electrons. *Geophys. Res. Lett*., **47(21)**, e2020GL090360, Nov. 16, 2020 (10.1029/2020GL090360).

Mizuochi, H., Y. Iijima, **H. Nagano**, A. Kotani, and **T. Hiyama**, Dynamic mapping of subarctic surface water by fusion of microwave and optical satellite data using conditional adversarial networks. *Remote Sens*., **13(2)**, 175, Jan. 2021 (10.3390/rs13020175).

Mori, T., Y. Kondo, **S. Ohata**, Y. Zhao, P. R. Sinha, N. Oshima, H. Matsui, N. Moteki, and M. Koike, Seasonal variation of wet deposition of black carbon in Arctic Alaska. *J. Geophys. Res. Atmos*., **25(16)**, e2019JD032240, Aug. 27, 2020 (10.1029/2019JD032240).

Murakami, G., H. Hayakawa, H. Ogawa, S. Matsuda, T. Seki, Y. Kasaba, Y. Saito, I. Yoshikawa, M. Kobayashi, W. Baumjohann et al. (**M. Hirahara**), Mio—First comprehensive exploration of Mercury's space environment: Mission overview. *Space Sci. Rev*., **216(7)**, 113, Oct. 5, 2020 (10.1007/s11214-020-00733-3).

Muraki, Y., J. F. Valdes-Galicia, L. X. Gonzalez, K. Kamiya, Y. Katayose, K. Koga, H. Matsumoto, **S. Masuda**, **Y. Matsubara**, Y. Nagai et al., Possible detection of solar gamma-rays by grond-level detectors in solar flares on 2011 March 7. *Publ. Astron. Soc. Jpn*., **72(2)**, 18, Apr. 2020 (10.1093/pasj/psz141).

Muramiya, Y., H. Yoshida, K. Kubota, and **M. Minami**, Rapid formation of gigantic spherical dolomite concretion in marine sediments. *Sediment. Geol*., **404**, 105664, Jul. 2020 (10.1016/j.sedgeo.2020.105664).

Murata, K., K. Ichikawa, Y. I. Fujii, **H. Hayakawa**, Y. Cheng, Y. Kawamoto, and H. Sano, Cometary records revise Eastern Mediterranean chronology around 1240 CE. *Publ. Astron. Soc. Jpn*., **73(1)**, 197–204, Feb. 2021 (10.1093/pasj/psaa114).

Naemura, K., C. Erdenejargal, T. O. Javkhlan, **T. Kato**, and T. Hirajima, Geochronology and tectonic implications of the Urgamal eclogite, Western Mongolia. *J. Mineral. Petrol. Sci*., **115(4)**, 357–364, Aug. 2020 (10.2465/jmps.191126).

Nagatsuma, T., A. Nakamizo, Y. Kubota, M. Nakamura, K. Koga, **Y. Miyoshi**, and H. Matsumoto, Development of space environment customized risk estimation for satellites (SECURES). *Earth Space Sci*., **73**, 26, Jan. 25, 2021 (10.1186/s40623-021-01355-x).

Naito, Y. I., **M. Yamane**, and **H. Kitagawa**, A protocol for using attenuated total reflection Fourier-transform infrared spectroscopy for pre-screening ancient bone collagen prior to radiocarbon dating. *Rapid Commun. Mass Spectrom*., **34(10)**, e8720, May 30, 2020 (10.1002/rcm.8720).

Nakagawa, M., **T. Nakayama**, **H. Sasago**, **Y. Kuruma**, **H. Yai**, **S. Ogawa**, **Y. Deng**, **M. Mochida**, and **Y. Matsumi**, Assessment of the sphericity characteristics of submicron particles using a single-particle polar nephelometer at an urban site in Japan. *Aerosol Air Qual. Res*., **20(11)**, 2474–2484, Nov. 2020 (10.4209/aaqr.2020.01.0023).

Nakajima, T., **K. Haratani**, **A. Mizuno**, **K. Suzuki**, T. Kojima, Y. Uzawa, S. Asayama, and I. Watanabe, Waveguide-type multiplexer for multiline observation of atmospheric molecules using millimeter-wave spectroradiometer. *J. Infrared Millim. Terahertz Waves*, **41(12)**, 1530–1555, Sep. 11, 2020 (10.1007/s10762-020-00740-z).

Nakano, S., **T. Hori**, K. Seki, and **N. Nishitani**, A framework for estimating spherical vector fields using localized basis functions and its application to SuperDARN data processing. *Earth Planets Space*, **72**, 46, Apr. 7, 2020 (10.1186/s40623-020-01168-4).

Nakano, Y., K. Ichimura, H. Ito, T. Okada, H. Sekiya, Y. Takeuchi, S. Tasaka, and **M. Yamashita**, Evaluation of radon adsorption efficiency values in xenon with activated carbon fibers. *Prog. Theor. Exp. Phys*., **2020(11)**, 113H01, Nov. 2020 (10.1093/ptep/ptaa119).

Nara, F. W., T. Yokoyama, S.-I. Yamasaki, **M. Minami**, Y. Asahara, T. Watanabe, K. Yamada, N. Tsuchiya, and Y. Yasuda, Characteristics in trace elements compositions of tephras (B-Tm and To-a) for identification tools. *Geochem. J*., in press (10.2343/geochemj.2.0619).

Narayanan, V. L., **S. Nozawa**, **S. Oyama**, I. Mann, **K. Shiokawa**, **Y. Otsuka**, N. Saito, S. Wada, T. D. Kawahara, and T. Takahashi, Formation of an additional density peak in the bottom side of the sodium layer associated with the passage of multiple mesospheric frontal systems. *Atmos. Chem. Phys*., **21(4)**, 2343–2361, Feb. 18, 2021 (10.5194/acp-21-2343-2021).

Nilam, B., S. T. Ram, **K. Shiokawa**, N. Balan, and Q. Zhang, The solar wind density control on the prompt penetration electric field and equatorial electrojet. *J. Geophys. Res. Space Phys.*, **125(9)**, e2020JA027869, Sep. 2020 (10.1029/2020JA027869).

Nishimoto, S., K. Watanabe, **S. Imada**, T. Kawate, and K.-S. Lee, Statistical and observational research on solar flare EUV spectra and geometrical features. *Astrophys. J.*, **904(1)**, 31, Nov. 20, 2020 (10.3847/1538-4357/abbacb).

Nishimoto, S, K. Watanabe, **T. Kawai**, **S. Imada**, and T. Kawate, Validation of computed extreme ultraviolet emission spectra during solar flares. *Earth, Planets and Space*, **73**, 79, Mar. 25, 2021 (10.1186/s40623-021-01402-7).

Nishimura, Y., E. F. Donovan, V. Angelopoulos, and **N. Nishitani**, Dynamics of auroral precipitation boundaries associated with STEVE and SAID. *J. Geophys. Res. Space Phys*., **125(8)**, e2020JA028067, Aug. 2020 (10.1029/2020JA028067).

Nishimura, Y., J. Yang, J. M. Weygand, W. Wang, B. Kosar, E. F. Donovan, V. Angelopoulos, L. J. Paxton, and **N. Nishitani**, Magnetospheric conditions for STEVE and SAID: Particle injection, substorm surge, and field-aligned currents. *J. Geophys. Res. Space Phys*., **125(8)**, e2020JA027782, Aug. 2020 (10.1029/2020JA027782).

Nishimura, Y., S. R. Zhang, L. R. Lyons, Y. Deng, A. J. Coster, J. I. Moen, L. B. Clausen, W. A. Bristow, and **N. Nishitani**, Source region and propagation of dayside large-scale traveling ionospheric disturbances. *Geophys. Res. Lett*., **47(19)**, e2020GL089451, Oct. 16, 2020 (10.1029/2020GL089451).

Nishitani, N., **Y. Hamaguchi**, and **T. Hori**, Development of remote HF wave receiver in the backlobe direction of the SuperDARN Hokkaido East radar: Initial observations. *Polar Sci*., in press (10.1016/j.polar.2021.100669).

Nobashi, D., **K. Yamaoka**, **H. Tajima**, and K. Ito, Performance evaluation of GAGG(Ce)/LFS scintillator plus MPPC array readout with ASIC. *Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip*., **986**, 164811, Jan. 11, 2021 (10.1016/j.nima.2020.164811).

Nosé, M., A. Matsuoka, A. Kumamoto, Y. Kasahara, M. Teramoto, S. Kurita, J. Goldstein, L. M. Kistler, S. Singh, A. Gololobov, **K. Shiokawa**, **S. Imajo** et al. (**M. Shoji**, **Y. Miyoshi**), Oxygen torus and its coincidence with EMIC wave in the deep inner magnetosphere: Van Allen Probe B and Arase observations. *Earth Planets Space*, **72(1)**, 111, Aug. 3, 2020 (10.1186/s40623-020-01235-w).

Ohashi, K., **H. Menjo**, **Y. Itow**, T. Sako, and K. Kasahara, Simulation study on the effects of diffractive collisions on the prediction of the observables in ultra-high-energy cosmic-ray experiments. *Prog. Theor. Exp. Phys*., **2021(3)**, 033F01, Mar. 2021 (10.1093/ptep/ptab013).

Ohigashi, T., **K. Tsuboki**, **Y. Suzuki,** H. Yamada, and K. Nakagawa, Characteristics of upper-tropospheric outflow-layer clouds of Typhoon Francisco (2013) observed by hydrometeor videosonde. *Atmos. Res*., **235**, 104736, May 1, 2020 (10.1016/j.atmosres.2019.104736).

Okamoto, K., Y. Nakano, **S. Masuda**, **Y. Itow**, M. Miyake, T. Terasawa, S. Ito, and M. Nakahata, Development of a method for determining the search window for solar flare neutrinos. *Sol. Phys.*, **295(10)**, 133, Oct. 6, 2020 (10.1007/s11207-020-01706-z).

Oliveira, D. M., E. Zesta, **H. Hayakawa**, and A. T. Bhaskar, Estimating satellite orbital drag during historical magnetic superstorms. *Space Weather*, **18(11)**, e2020SW002472, Nov. 2020 (10.1029/2020SW002472).

Oliveira, D. M., **H. Hayakawa**, A. Bhaskar, E. Zesta, and G. Vichare, A possible case of sporadic aurora observed at Rio de Janeiro. *Earth Planets Space*, **72**, 82, Jun. 6, 2020 (10.1186/s40623-020-01208-z).

Orikasa, N., **M. Murakami**, T. Tajiri, Y. Zaizen, and **T. Shinoda**, In situ measurements of cloud and aerosol microphysical properties in summertime convective clouds over eastern United Arab Emirates. *SOLA*, **16**, 185–191, Oct. 17, 2020 (10.2151/sola.2020-032).

Orikasa, N., A. Saito, K. Yamashita, T. Tajiri, Y. Zaizen, Y. T. H. Kuo, W. C. Kuo, and **M. Murakami**, Seasonal variations of atmospheric aerosol particles focused on cloud condensation nuclei and ice nucleating particles from ground-based observations in Tsukuba, Japan. *SOLA*, **16**, 212–219, Sep. 23, 2020 (10.2151/sola.2020-036).

Otsuka, Y., **A. Shinbori**, T. Tsugawa, and M. Nishioka, Solar activity dependence of medium-scale traveling ionospheric disturbances using GPS receivers in Japan. *Earth Planets Space*, **73(1)**, 22, Jan. 20, 2021 (10.1186/s40623-020-01353-5).

Oyama, S., **A. Shinbori**, Y. Ogawa, M. Kellinsalmi, T. Raita, A. Aikio, H. Vanhamäki, **K. Shiokawa**, I. Virtanen, L. Cai et al. (**M. Shoji**), An ephemeral red arc appeared at 68° ML at a pseudo breakup during geomagnetically quiet conditions. *J. Geophys. Res. Space Phys*., **125(10)**, e2020JA028468, Oct. 2020 (10.1029/2020JA028468).

Ozaki, K., S. Kazama, **M. Yamashita**, **Y. Itow**, and S. Moriyama, Characterization of new silicon photomultipliers with low dark noise at low temperature. *J. Instrum*., **16(3)**, P03014, Mar. 8, 2021 (10.1088/1748-0221/16/03/P03014).

Ozaki, M., **K. Shiokawa**, R. B. Horne, M. J. Engebretson, M. Lessard, Y. Ogawa, K. Hosokawa, **M. Nosé**, Y. Ebihara, A. Kadokura et al. (**Y. Miyoshi**, **C.-W. Jun**), Magnetic conjugacy of Pc1 waves and isolated proton precipitation at subauroral latitudes: Importance of ionosphere as intensity modulation region. *Geophys. Res. Lett*., **48(5)**, e2020GL091384, Mar. 16, 2021 (10.1029/2020GL091384).

Pahlevan, N., A. Mangin, S. V. Balasubramanian, B. Smith, K. Alikas, K. Arai, C. Barbosa, S. Bélanger, C. Binding, M. Bresciani et al (**J. Ishizaka**), ACIX-Aqua: A global assessment of atmospheric correction methods for Landsat-8 and Sentinel-2 over lakes, rivers, and coastal waters. *Remote Sens. Environ*., in press (10.1016/j.rse.2021.112366).

Pancheva, D., P. Mukhtarov, C. Hall, C. Meek, M. Tsutsumi, N. Pedatella, **S. Nozawa**, and A. Manson, Climatology of the main (24-h and 12-h) tides observed by meteor radars at Svalbard and Tromsø: Comparison with the models CMAM-DAS and WACCM-X. *J. Atmos. Sol.-Terr. Phys.*, **2017**, 105339, Oct. 1, 2020 (10.1016/j.jastp.2020.105339).

Park, J. H., T. Inamori, R. Hamaguchi, K. Otsuki, J. E. Kim, and **K. Yamaoka**, RGB image prioritization using convolutional neural network on a microprocessor for nanosatellites. *Remote Sens*., **12(23)**, 3941, Dec. 3, 2020 (10.3390/rs12233941).

Park, S. H., An observational test of solar plasma heating by magnetic flux cancellation. *Astrophys. J*., **897(1)**, 49, Jul. 1, 2020 (10.3847/1538-4357/ab93ca).

Park, S. H., **K. D. Leka**, and **K. Kusano**, Magnetic helicity flux across solar active region photospheres. I. hemispheric sign preference in solar cycle 24. *Astrophys. J.*, **904(1)**, 6, Nov. 2020 (10.3847/1538-4357/abbb93).

Park, S. H., **K. D. Leka**, and **K. Kusano**,Magnetic helicity flux across solar active region photospheres. II. association of hemispheric sign preference with flaring activity during solar cycle 24. *Astrophys. J.*, in press (10.3847/1538-4357/abea13).

Person, M. J., A. S. Bosh, C. A. Zuluaga, A. A. Sickafoose, S. E. Levine, J. M. Pasachoff, B. A. Babcock, E. W. Dunham, I. S. McLean, J. Wolf, **F. Abe** et al., Haze in Pluto's atmosphere: Results from SOFIA and ground-based observations of the 2015 June 29 Pluto occultation. *Icarus*, **356**, 113572, Mar. 1, 2021 (10.1016/j.icarus.2019.113572).

Pevtsov, A. A., Y. Liu, I. Virtanen, L. Bertello, K. Mursula, **K. D. Leka**, and A. L. H. Hughes, On a limitation of Zeeman polarimetry and imperfect instrumentation in representing solar magnetic fields with weaker polarization signal. *J. Space Weather Space Clim.*, **11**, 14, Feb. 2021 (10.1051/swsc/2021003).

Poleski, R., D. Suzuki, A. Udalski, X. Xie, J. C. Yee, N. Koshimoto, B. S. Gaudi, A. Gould, J. Skowron, M. K. Szyanski et al. (**F. Abe**, **H. Fujii**, **Y. Itow**, **Y. Kamei**, **Y. Matsubara**, **Y. Muraki**, **T. Yamakawa**), A Wide-orbit Exoplanet OGLE-2012-BLG-0838Lb. *Astron. J.*, **159(6)**, 261, Jun. 2020 (10.3847/1538-3881/ab8a49).

Reimer, P., W. E. N. Austin, E. Bard, A. Bayliss, P. G. Blackwell, C. B. Ramsey, M. Butzin, H. Cheng, R. L. Edwards, M. Friedrich et al. (**F. Miyake**), The IntCal20 Northern Hemisphere radiocarbon age calibration curve (0-55 cal kBP). *Radiocarbon*, **62(4)**, 725–757, Aug. 12, 2020 (10.1017/RDC.2020.41).

Rees-Crockford, T., D. S. Bloomfield, E. Scullion, and **S.-H. Park**, 2D and 3D analysis of a torus-unstable quiet-Sun prominence eruption. *Astrophys. J*., **897(1)**, 35, Jul. 1, 2020 (10.3847/1538-4357/ab92a0).

Robertson, F. R., J. B. Roberts, M. Bosilovich, A. Bentamy, C. A. Clayson, K. Fennig, M. Schröder, **H. Tomita**, G. P. Compo, M. Gutenstein et al., Uncertainties in ocean latent heat flux variations over recent decades in satellite-based estimates and reduced observation reanalyses. *J. Clim*., **33(19)**, 8415–8437, Oct. 1, 2020 (10.1175/JCLI-D-19-0954.1).

Sasaki, H., S. Kida, R. Furue, **H. Aiki**, N. Komori, Y. Masumoto, T. Miyama, M. Nonaka, Y. Sasai, and B. Taguchi, A global eddying hindcast ocean simulation with OFES2. *Geosci. Model Dev*., **13(7)**, 3319–3336, Jul. 22, 2020 (10.5194/gmd-13-3319-2020).

Sato, K., **M. Yamashita**, K. Ichimura, **Y. Itow**, S. Kazama, S. Moriyama, **K. Ozaki**, T. Suzuki, and **R. Yamazaki**, Development of a dual-phase xenon TPC with a quartz chamber for direct dark matter searches. *Prog. Theor. Exp. Phys.*, **2020(11)**, 113H02, Nov. 13, 2020 (10.1093/ptep/ptaa141). [in Japanese]

Sato, K., **M. Minami**, and **T. Nakamura**, ^{14}C ages of wood fragments found in drill cores from two sites in Takasaki City and their bearing on the history of Late Pleistocene strata in Takasaki-Maebashi area, central Japan. *Bull.Gunma Mus.Natu.Hist.,* **25**, 81–90, Mar. 31, 2021. [in Japanese]

Sato, K., **M. Minami**, H. Abe, **T. Nakamura**, and I. Musha, ^{14}C ages of wood blocks from the Maebashi mudflow deposits in a riverbed of theTone River in Maebashi, central Japan. *Bull.Gunma Mus.Natu.Hist.,* **25**, 75–80, Mar. 31, 2021. [in Japanese]

Sato, K., **M. Minami**, H. Abe, **T. Nakamura**, and I. Musha, ^{14}C ages of wood blocks buried in the volcanic debris avalanche deposits in the upper reaches of the Agatsuma River, north of Asama volcano, central Japan: A preliminary study. *Bull.Gunma Mus.Natu.Hist.,* **25**, 91–100, Mar. 31, 2021.

Sato, K., **M. Minami**, S. Ikeda, H. Abe, I. Musha, and **T. Nakamura**, Origin of Oenga-iwa, a large block of andesitic pyroclastic rock in Shikishima Park in Maebashi, central Japan. *Bull.Gunma Mus.Natu.Hist.,* **25**, 65–74, Mar. 31,

2021. [in Japanese]

Sato, N., T. Ogawa, H. Yamagishi, A. S. Yukimatu, **N. Nishitani**, T. Kikuchi, K. Nozaki, K. Igarashi, and T. Nagatsuma, History of Japanese SuperDARN: Initiation of SENSU Syowa radars and progress of Japanese radar project. *Polar Sci.*, in press (10.1016/j.polar.2021.100671).

Seto, S., T. Iguchi, R. Meneghini, J. Awaka, T. Kubota, T. Masaki, and **N. Takahashi**, The precipitation rate retrieval algorithms for the GPM Dual-frequency Precipitation Radar. *J. Meteorol. Soc. Jpn*., in press (10.2151/jmsj.2021-011).

Schubert, A., S. Lauterbach, **C. Leipe**, V. Scholz, A. Brauer, and P. E. Tarasov, Anthropogenic and climate controls on vegetation changes between 1500 BCE and 500 CE reconstructed from a high-resolution pollen record from varved sediments of Lake Mondsee, Austria. *Paleogeogr. Paleoclimatol. Paleoecol*., **559**, 109976, Dec. 1, 2020 (10.1016/j.palaeo.2020.109976).

Scourfield, M., S. García-Burillo, A. Saintonge, F. Combes, A. Fuente, C. Henkel, A. Alonso-Herrero, N. Harada, S. Takano, **T. Nakajima** et al., ALMA observations of CS in NGC 1068: chemistry and excitation. *Mon. Not. Roy. Astron. Soc.*, **496(4)**, 5308–5329, Aug. 2020 (10.1093/mnras/staa1891).

Shimizu, T., **S. Imada**, T. Kawate, Y. Suematsu, H. Hara, T. Tsuzuki, Y. Katsukawa, M. Kubo, R. Ishikawa, T. Watanabe et al., Solar-C (EUVST) mission: the latest status. *Proc. SPIE*, **11444,** 114440N, Dec. 4, 2020 (10.1117/12.2560887).

Shinbori, A., **Y. Otsuka, T. Sori,** T. Tsugawa, and M. Nishioka, Temporal and spatial variations of total electron content enhancements during a geomagnetic storm on 27 and 28 September 2017. *J. Geophys. Res. Space Phys*., **125(7)**, e2019JA026873, Jul. 2020 (10.1029/2019JA026873).

Shiokawa, K., and K. Georgieva, A review of the SCOSTEP's 5-year Scientific program VarSITI - Variability of the Sun and Its Terrestrial Impact. *Prog. Earth. Planet. Sci.*, **8**, 21, Mar. 9, 2021 (10.1186/s40645-021-00410-1).

Shiokawa, K., **M. Nosé**, **S. Imajo**, Y.-M. Tanaka, **Y. Miyoshi**, K. Hosokawa, M. Connors, M. Engebretson, Y. Kazama, S.-Y. Wang et al. (**T. Hori**, **M. Shoji**), Arase observation of the source region of auroral arcs and diffuse auroras in the inner magnetosphere. *J. Geophys. Res. Space Phys*., **125(8)**, e2019JA027310, Aug. 2020 (10.1029/2019JA027310).

Silverman, S. M., and **H. Hayakawa**, The Dalton Minimum and John Dalton's auroral observations. *J. Space Weather Space Clim.*, **11**, 17, Feb. 18, 2021 (10.1051/swsc/2020082).

Sivakandan, M., S. Mondal, S. Sarkhel, D. Chakrabarty, M. V. Sunil Krishna, P. Pavan Chaitanya, A. K. Patra, R. K. Choudhary, T. K. Pant, A. K. Upadhayaya, and **T. Sori**, Mid-latitude spread-F structures over the geomagnetic low-mid latitude transition region: An observational evidence. *J. Geophys. Res. Space Phys.*, **125(5)**, e2019JA027531, May 2020 (10.1029/2019JA027531).

Sivakandan, M., **Y. Otsuka**, P. Ghosh, H. Shinagawa, **A. Shinbori**, and Y. Miyoshi, Comparison of seasonal and longitudinal variation of daytime MSTID activity using GPS observation and GAIA simulations. *Earth Planets Space*, **73**, 35, Feb. 4, 2021 (10.1186/s40623-021-01369-5).

Sokół, J. M., D. J. McComas, M. Bzowski, and **M. Tokumaru**, Sun–Heliosphere Observation-based Ionization Rates Model. *Astrophys. J*., **897(2)**, 179, Jul. 16, 2020 (10.3847/1538-4357/ab99a4).

St.-Maurice, J.-P., and **N. Nishitani**, On the origin of far-aspect angle irregularity regions seen by HF radars at 100-km altitude. *J. Geophys. Res. Space Phys*., **125(6)**, e2019JA027473, Jun. 2020 (10.1029/2019JA027473).

Suematsu, Y., T. Shimizu, H. Hara, T. Kawate, Y. Katsukawa, K. Ichimoto, **S. Imada**, K. Nagae, A. Yamazaki, and T. Hattori, Thermal design of the solar-C (EUVST) telescope. *Proc. SPIE*, **11444**, 114443K, Dec. 13, 2020 (10.1117/12.2560941).

Sugo, S., O. Kawashima, S. Kasahara, K. Asamura, R. Nomura, **Y. Miyoshi**, Y. Ogawa, K. Hosokawa, T. Mitani, T. Namekawa et al. (**T. Hori**), Energy-resolved detection of precipitating electrons of 30–100 keV by a sounding rocket associated with dayside chorus waves. *J. Geophys. Res. Space Phys.*, **126(3)**, 2020JA028477, Mar. 2021 (10.1029/2020JA028477).

Sun, Y.-H., and O. M. Sun, Inertia and diurnal oscillations of Ekman layers in atmosphere and ocean. *Dyn. Atmos. Oceans*, **90**, Jun. 2020 (101144, 10.1016/j.dynatmoce.2020.101144).

Sun, Y., C. Liu, L. Zhang, M. Palm, J. Notholt, H. Yin, C. Vigouroux, E. Lutsch, W. Wang, C. Shan, T. Blumenstock, **T. Nagahama** et al., Fourier transform infrared time series of tropospheric HCN in eastern China: seasonality, interannual variability, and source attribution. *Atmos. Meas. Tech*., **20(9)**, 5437–5456, May 11, 2020 (10.5194/acp-20-5437-2020).

Suzuki, K., **T. Hiyama**, K. Matsuo, K. Ichii, Y. Iijima, and D. Yamazaki, Accelerated continental-scale snowmelt and ecohydrological impacts in the four largest Siberian river basins in response to spring warming. *Hydrol. Process*., **34(19)**, 3867–3881, Sep. 15, 2020 (10.1002/hyp.13844).

Takahashi, H., M. Lebsock, Z. J. Luo, **H. Masunaga**, and C. Wang, Detection and tracking of tropical convective storms based on globally gridded precipitation measurements: Algorithm and Survey over the Tropics. *J. Appl. Meteorol. Climatol*., **60(3)**, 403–421, Mar. 2021 (10.1175/JAMC-D-20-0171.1).

Takahashi, H., C. M. Wrasse, C. A. O. B. Figueiredo, D. Barros, I. Paulino, P. Essien, M. A. Abdu, **Y. Otsuka**, and **K. Shiokawa**, Equatorial plasma bubble occurrence under propagation of MSTID and MLT gravity waves. *J. Geophys. Res. Space Phys.*, **125(9)**, e2019JA027566, Sep. 2020 (10.1029/2019JA027566).

Takahashi, H., N. Hirade, N. Uchida, K. Hirose, T. Mizuno, Y. Fukazawa, **K. Yamaoka**, **H. Tajima**, and M. Ohno, Silicon photomultiplier (Si-PM) comparisons for low-energy gamma ray readouts with BGO and CsI (Tl) scintillators. *Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip*., **989**, 164945, Feb. 11, 2021 (10.1016/j.nima.2020.164945).

Takahashi, N., Analysis of surface cross-sectional data taken during the 90° yaw experiment of the TRMM precipitation radar. *IEEE Trans. Geosci. Remote Sensing*, **58(8)**, 5729–5738, Aug. 2020 (10.1109/TGRS.2020.2969192).

Takenaka, A., K. Abe, C. Bronner, Y. Hayato, M. Ikeda, S. Imaizumi, H. Ito, J. Kameda, Y. Kataoka, Y. Kato et al. (**Y. Itow**, **H. Menjo**, **T. Niwa**, **K. Sato**, **M. Taani**, **M. Tsukada**), Search for proton decay via $p \rightarrow e^{+}\pi^{0}$ and $p \rightarrow \mu^{+}\pi^{0}$ with an enlarged fiducial volume in Super-Kamiokande I-IV. *Phys. Rev. D*, **102(11)**, 112011, Dec. 22, 2020 (10.1103/PhysRevD.102.112011).

Takeshita Y., **K. Shiokawa**, **Y. Miyoshi**, M. Ozaki, Y. Kasahara, **S. Oyama**, M. Connors, J. Manninen, V. K. Jordanova, D. Baishev et al., Study of spatiotemporal development of global distribution of magnetospheric ELF/VLF waves using ground-based and satellite observations, and RAM-SCB simulations, for the March and November 2017 storms. *J. Geophys. Res. Space Phys*., **126(2)**, 2020JA028216, Feb. 2021 (10.1029/2020JA028216).

Takigawa, M., P. K. Patra, **Y. Matsumi**, S. K. Dhaka, T. Nakayama, K. Yamaji, M. Kajino, and S. Hayashida, Can Delhi's pollution be affected by crop fires in the Punjab region?. *SOLA*, **16**, 86–91, Apr. 6, 2020 (10.2151/sola.2020-015).

Thomas, N., **K. Shiokawa**, **Y. Miyoshi**, Y. Kasahara, I. Shinohara, A. Kumamoto, F. Tsuchiya, A. Matsuoka, S. Kasahara, S. Yokota, K. Keika, **T. Hori** et al., Investigation of small-scale electron density irregularities observed by the Arase and Van Allen Probes satellites inside and outside the plasmasphere. *J. Geophys. Res. Space Phys.*, **126(3)**, e2020JA027917, Mar. 2021 (10.1029/2020JA027917).

Tian, H. Z., K. Xu, J. I. Goes, Q. Liu, H. R. Gomes, and **M. Yang**, Shoreline changes along the coast of mainland China-time to pause and reflect? *ISPRS Int. Geo-Inf*., **9(10)**, 572, Oct. 2020 (10.3390/ijgi9100572).

Tokumaru, M., **K. Tawara**, K. Takefuji, M. Sekido, and T. Terasawa, Radio sounding measurements of the solar corona using Giant Pulses of the Crab pulsar in 2018. *Sol. Phys*., **295(6)**, 80, Jun. 19, 2020 (10.1007/s11207-020-01644-w).

Tolstikov, M. V., A. V. Oinats, I. V. Medvedeva, and **N. Nishitani**, Method for estimating neutral wind azimuth using 2D TID propagation parameters. *Proc. IEEE*, **9232189**, Aug. 2020 (10.23919/URSIGASS49373.2020.9232189).

Tomita, H., M. F. Cronin, and S. Ohishi, Asymmetric air-sea heat flux response and ocean impact to synoptic-scale atmospheric disturbances observed at JKEO and KEO buoys. *Sci Rep*., **11(1)**, 469, Jan. 11, 2021 (10.1038/s41598-020-80665-8).

Toyoda, T., H. Nakano, **H. Aiki**, T. Ogata, **Y. Fukutomi**, Y. Kanno, L. Urakawa, K. Sakamoto, G. Yamanaka, and M. Nagura, Energy flow diagnosis of ENSO from an ocean reanalysis. *J. Clim*., in press (10.1175/JCLI-D-20-0704.1).

Tsuda, T. T., C. Li, S. Hamada, K. Hosokawa, **S.-I. Oyama**, **S. Nozawa**, **T. Kawabata**, **A. Mizuno**, J. Kurihara, T. Nishiyama, and M. J. Kosch, OI 630.0 nm and N2 1PG emissions in pulsating aurora events observed by an optical spectrograph at Tromsø, Norway. *J. Geophys. Res. Space Phys.*, **125(12)**, e2020JA028250, Dec. 2020 (10.1029/2020JA028250).

Tsujino, S., and **K. Tsuboki**, Intensity change of Typhoon Nancy (1961) during landfall in a moist environment over Japan: A numerical simulation with spectral nudging. *J. Atmos. Sci*., **77(4)**, 1429–1454, Apr. 1, 2020 (10.1175/JAS-D-19-0119.1).

Tsujino, S., **K. Tsuboki**, H. Yamada, T. Ohigashi, K. Ito, and N. Nagahama, Intensification and maintenance of a double warm-core structure in Typhoon Lan (2017) simulated by a cloud-resolving model. *J. Atmos. Sci.*, **78(2)**, 595–617, Feb. 1, 2021 (10.1175/JAS-D-20-0049.1).

Tsujino, S., T. Horinouchi, T. Tsukada, H.-C. Kuo, H. Yamada, and **K. Tsuboki**, Inner-core wind field in a concentric eyewall replacement of Typhoon Trami (2018): A quantitative analysis based on the Himawari-8 satellite. *J. Geophys. Res. Atmos*., in press (10.1029/2020JD034434).

Tulasi Ram, S., K. K. Ajith, T. Yokoyama, M. Yamamoto, K. Hozumi, **K. Shiokawa**, **Y. Otsuka**, and G. Li, Dilatory and downward development of 3-m scale irregularities in the funnel-like region of a rapidly rising equatorial plasma bubble. *Geophys. Res. Lett*., **47(13)**, e2020GL087256, Jul. 16, 2020 (10.1029/2020GL087256).

Uchida, H. A., R. Kataoka, A. Kadokura, K. Murase, A. S. Yukimatu, **Y. Miyoshi**, **K. Shiokawa**, Y. Ebihara, K. Hosokawa, A. Matsuoka et al., Asymmetric development of auroral surges in the Northern and Southern Hemispheres. *Geophys. Res. Lett*., **47(13)**, e2020GL088750, Jul. 16, 2020 (10.1029/2020GL088750).

Uchikawa, Y., L. Cowley, **H. Hayakawa**, D. M. Willis, and F. R. Stephenson, Provenance of the cross sign of 806 in the Anglo-Saxon Chronicle: A possible lunar halo over continental Europe? *Hist. Geo- Space Sci*., **11(1)**, 81–92, Apr. 20, 2020 (10.5194/hgss-11-81-2020).

Umeda, T., Paradigm shift in program structure of particle-in-Cell simulations. *Advances in Parallel Computing*, **36**, 455–464, Apr. 2020 (10.3233/APC200072).

Vigouroux, C., B. Langerock, C. A. B. Aquino, T. Blumenstock, Z. Cheng, M. De Mazière, I. De Smedt, M. Grutter, J. W. Hannigan, N. Jones et al. (**T. Nagahama**), TROPOMI–Sentinel-5 Precursor formaldehyde validation using an extensive network of ground-based Fourier-transform infrared stations. *Atmos. Meas. Tech.*, **13(7)**, 3751–3767, Jul. 10, 2020 (10.5194/amt-13-3751-2020).

Vissers, G. J. M., S. Danilovic, J. de la Cruz Rodriguez, J. Leenaarts, R. Morosin, C. J. Diaz Baso, A. Reid, J. Pomoell, D. J. Price, and **S. Inoue**, Non-LTE inversions of a confined X2.2 flare: I. The vector magnetic field in the photosphere and chromosphere. *Astron. Astrophys*., **645**, A1, Dec. 21, 2020 (10.1051/0004-6361/202038900).

Wacker, L., E. M. Scott, A. Bayliss, D. Brown, E. Bard, S. Bollhalder, M Friedrich, M. Capano, A. Cherkinsky, D. Chivall et al. (**F. Miyake, T. Nakamura**), Findings from an in-depth annual tree-ring radiocarbon intercomparison. *Radiocarbon*, **62(4)**, 873–882, Sep. 4, 2020 (10.1017/RDC.2020.49).

Wada, A., **H. Tomita**, and S. Kako, Comparison of the third-generation Japanese ocean flux data set J-OFURO3 with numerical simulations of Typhoon Dujuan (2015) traveling south of Okinawa. *J. Oceanogr*., **76**, 419–437, Dec. 2020 (10.1007/s10872-020-00554-6).

Wada, R., K. Tonokura, S. Koba, T. Imamura, K. Nakai, H. Ushiyama, K. Yamashita, **Y. Matsumi**, S. Enami, and P. W. Seakin, Theoretical study on the enthalpies of adduct formation between alkyl iodides and chlorine atoms. *Chem. Phys. Lett.*, **762**, 138140, Jan. 2021 (10.1016/j.cplett.2020.138140).

Wada, Y., T. Enoto, M. Kubo, K. Nakazawa, **T. Shinoda**, D. Yonetoku, T. Sawano, T. Yuasa, T. Ushio, Y. Sato, G. S. Diniz, and H. Tsuchiya, Meteorological aspects of gamma-ray glows in winter thunderstorms. *Geophys. Res. Lett*., in press (10.1029/2020GL091910).

Wakasugi, Y., S. Wakaki, Y. Tanioka, K. Ichino, M. Tsuboi, Y. Asahara, and A. Noda, A chronological and geochemical study of the Tadamigawa older-stage granites: Igneous activity in the west of the Tanakura Tectonic Line (TTL) of northeastern Japan. *Geochem. J.*, **54(4)**, 203–220, Aug. 27, 2020 (10.2343/geochemj.2.0603 2020/8/27).

Wang, C.-C., K.-Y. Lin, C. A. Davis, S.-Y. Huang, S. C.-S. Liu, **K. Tsuboki**, and B. J.-D. Jou, A modeling study on the impacts of Typhoon Morakot's (2009) vortex structure on rainfall in Taiwan using piecewise potential vorticity inversion. *J. Meteorol. Soc. Jpn*., **98(4)**, 707–733, Aug. 18, 2020 (10.2151/jmsj.2020-036).

Wang, C.-C., Y.-H. Chen, M.-C. Li, H.-C. Kuo, and **K. Tsuboki**, On the separation of upper and low-level centres of tropical storm Kong-Rey (2013) near Taiwan in association with asymmetric latent heating. *Q. J. R. Meteorol. Soc.*, **147(735)**, 1135–1149, Jan. 2021 (10.1002/qj.3963).

Wang, Y. B., L. M. Kistler, C. G. Mouikis, J. C. Zhang, J. Y. Lu, D. Welling, L. Rastaetter, S. Bingham, Y. W. Jin, L. Wang, and **Y. Miyoshi**, Formation of the low-energy "Finger" ion spectral structure near the inner edge of the plasma sheet. *Geophys. Res. Lett.*, **47(22)**, e2020GL089875, Nov. 28, 2020 (10.1029/2020GL089875).

Wang, Y., Z. Cao, Z.-Y. Xing, Q.-H. Zhang, P. T. Jayachandran, K. Oksavik, N. Balan, and **K. Shiokawa**, GPS scintillations and TEC variations in association with a polar cap arc. *J. Geophys. Res. Space Phys*., **126(3)**, e2020JA028968, Mar. 2021 (10.1029/2020JA028968).

Watanabe, K., H. Jin, S. Nishimoto, **S. Imada**, **T. Kawai**, T. Kawate, **Y. Otsuka**, **A. Shinbori**, T. Tsugawa, and M. Nishioka, Model-based reproduction and validation of the total spectra of a solar flare and their impact on the global environment at the X9.3 event of September 6, 2017. *Earth Planets Space*, in press (10.1186/s40623-021-01376-6).

Watanabe, T., N. Tsuchiya, S. Yamasaki, Y. Sawai, N. Hosoda, F. W. Nara, **T. Nakamura**, and T. Komai, A geochemical approach for identifying marine incursions: Implications for tsunami geology on the Pacific coast of northeast Japan. *Appl. Geochem.*, **118**, 104644, Jul. 2020 (10.1016/j.apgeochem.2020.104644).

Xia, Y., **S. Nozawa**, J. Jiao, J. Wang, F. Li, X. Cheng, Y. Yang, L. Du, and G. Yang, Statistical study on sporadic sodium layers (SSLs) based on diurnal sodium lidar observations at Beijing, China (40.5 °N, 116 °E). *J. Atmos. Sol.-Terr. Phys*., **212**, 105512, Jan. 2021 (10.1016/j.jastp.2020.105512).

Xu, H., and **K. Shiokawa**, Severe magnetic fluctuations in the near-Earth magnetotail: Spectral analysis and dependence on solar activity. *J. Geophys. Res. Space Phys.*, **125(7)**, e2020JA027834, Jul. 2020 (10.1029/2020JA027834).

Yadav, S., **K. Shiokawa**, **Y. Otsuka**, M. Connors, and J.-P. St Maurice, Multi-wavelength imaging observations of STEVE at Athabasca, Canada. *J. Geophys. Res. Space Phys*., **126(2)**, e2020JA028622, Feb. 2, 2021 (10.1029/2020JA028622).

Yadav, S., R. K. Choudhary, J. Kumari, S. Sunda, P. R. Shreedevi, and T. K. Pant, Reverse fountain and the nighttime enhancement in the ionospheric electron density over the equatorial region: A case study. *J. Geophys. Res. Space Phys.*, **125(5)**, e2019JA027286, May 2020 (10.1029/2019JA027286).

Yamakawa, T., K. Seki, T. Amano, N. Takahashi, and **Y. Miyoshi**, Excitation of internally driven ULF waves by the drift-bounce resonance with ring current ions based on the drift-kinetic simulation. *J. Geophys. Res. Space Phys*., **125(11)**, e2020JA028231, Nov. 2020 (10.1029/2020JA028231).

Yamamoto, K., T. Kubota, **N. Takahashi**, K. Kanemaru, T. Masaki, and K. Furukawa, A feasibility study on wide swath observation by spaceborne precipitation radar. *IEEE J. Sel. Top. Appl. Earth Observ. Remote Sens*., **13**, 3047–3057, Jun. 1, 2020 (10.1109/JSTARS.2020.2998724).

Yamasaki, D., **S. Inoue**, S. Nagata, and K. Ichimoto, Evolution of the nonpotential magnetic field in the solar active region 12673 based on a nonlinear force-free modeling. *Astrophys. J.*, **908(2)**, 132, Feb. 18, 2021 (10.3847/1538-4357/abcfbb).

Yang, M. M., F. A. Khan, H. Tian, and Q. Liu, Analysis of the monthly and spring-neap tidal variability of satellite chlorophyll-a and total suspended matter in a turbid coastal ocean using the DINEOF method. *Remote Sens.*, **13(4)**, 632, Feb. 10, 2021 (10.3390/rs13040632).

Yang, M. M., J. I. Goes, H. Tian, E. D. Maúre, and **J. Ishizaka**, Effects of spring–neap tidal cycle on spatial and temporal variability of satellite chlorophyll-a in a macrotidal embayment, Ariake Sea, Japan. *Remote Sens*, **12(11)**, 1859, Jun. 2020 (10.3390/rs12111859).

Yoshida, A., N. Moteki, **S. Ohata**, T. Mori, M. Koike, Y. Kondo, H. Matsui, N. Oshima, A. Takami, and K. Kita, Abundances and microphysical properties of light-absorbing iron oxide and black carbon aerosols over East Asia and the Arctic. *J. Geophys. Res. Atmos*., **125(15)**, e2019JD032301, Aug. 16, 2020 (10.1029/2019JD032301).

Yoshida, H., **R. Kuma**, H. Hasegawa, N. Katsuta, S. Sirono, **M. Minami**, S. Nishimoto, N. Takagi, S. Kadowaki, and R. Metcalfe, Syngenetic rapid growth of ellipsoidal silica concretions with bitumen cores. *Sci Rep*., **11(1)**, 4230, Feb. 19, 2021 (10.1038/s41598-021-83651-w).

Yoshioka, K., **Y. Miyoshi**, S. Kurita, M. Teramoto, F. Tsuchiya, A. Yamazaki, G. Murakami, T. Kimura, H. Kita, I. Yoshikawa, and Y. Kasaba, Long-term monitoring of energetic protons at the bottom of Earth's radiation belt. *Space Weather*, **19(1),** e2020SW002611, Jan. 2021 (10.1029/2020SW002611).

Yue, C., Q. Ma, **C.-W. Jun**, J. Bortnik, Q. Zong, X. Zhou, E. Jang, Ge. D. Reeves, H. E. Spence, and J. R. Wygant, The modulation of plasma and waves by background electron density irregularities in the inner magnetosphere. *Geophys. Res. Lett*., **47(15)**, e2020GL088855, Aug. 16, 2020 (10.1029/2020GL0888559).

Yuguchi, T., Y. Ogita, **T. Kato**, R. Yokota, E. Sasao, and T. Nishiyama, Crystallization processes of quartz in a granitic magma: Cathodoluminescence zonation pattern controlled by temperature and titanium diffusivity. *J. Asian Earth Sci.*, **192**, 104289, May 2020 (10.1016/j.jseaes.2020.104289).

Zharkova, S., S. Matthews, V. Zharkov, M. Druett, **S. Inoue**, I. E. Dammasch, and C. Macrae, Sunquake with a second bounce, other sunquakes, and emission associated with the X9.3 flare of 6 September 2017: I. Observations. *Astron. Astrophys*., **639**, A78, Jul. 10, 2020 (10.1051/0004-6361/201936755).

Zharkova, V., S. Zharkov, M. Druett, S. Matthews, and **S. Inoue**, Sunquake with a second bounce, other sunquakes, and emission associated with the X9.3 flare of 6 September 2017: II. Proposed interpretation. *Astron. Astrophys*., **639**, A79, Jul. 10, 2020 (10.1051/0004-6361/202037885).

Books (April 2020–March 2021)

Hiyama T., D. Yang, and D. L. Kane, Permafrost Hydrology: Linkages and Feedbacks. 471–491, in *Arctic Hydrology, Permafrost and Ecosystems*, edited by D. Yang, and D. L. Kane, 914pp, Springer, Cham, Switzerland, Aug. 29, 2020 (10.1007/978-3-030-50930-9_16).

Kummerow, C. D., S. Tanelli, **N. Takahashi**, K. Furukawa, M. Klein, and V. Levizzan, Plans for Future Missions. 99–119, in S*atellite Precipitation Measuremen: vol. 1 (Advances in Global Change Research, vol. 67),* edited by V. Levizzani, C. Kidd, D. Kirschbaum, C. Kummerow, K. Nakamura, and F. Turk, 521pp, Springer, Cham, Switzerland, Apr. 11, 2020 (10.1007/978-3-030-24568-9_6).

Two more books were published in Japanese.

Publication of Proceedings (April 2020–March 2021)

Title	Date of Publication
The Nagoya University bulletin of chronological research Vol. 4	Jun. 19, 2020
The 25th Symposium on Atmospheric Chemistry: Book of Abstracts	Nov. 2020
The Nagoya University bulletin of chronological research Vol. 5	Mar. 31, 2021

Conference Presentations (April 2020–March 2021)

■ International Conferences

＊Session Conveners

Title	Venue	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	Invited
EGU General Assembly 2020	Online	May 4–8, 2020	0	3	0	3	0
JpGU – AGU Joint Meeting 2020－Virtual	Online	Jul.12–16, 2020	1 9*	56	31	87	8
Goldschmidt Virtual 2020	Online	Jul. 21–26, 2020	0	0	1	1	0
IBS and KMI Joint Workshop 2020	Online	Aug. 24–26, 2020	0	1	0	1	0
Technology for Next Generation Space-Earth Environmental Radio Science	Online	Aug. 24–26, 2020	1	4	0	4	2
Convection-Permitting Modeling for Climate Research Current and Future Challenges	Online	Sep. 2–4, 2020	0	1	0	1	1
XI International Conference "Solar-Terrestrial Relations and Physics of Earthquakes Precursors"	Paratunka, Russia/ Online	Sep. 22–25, 2020	1	1	0	1	0
International Symposium on Data Science 2020	Online	Sep. 23–25, 2020	1	0	0	0	0
4th Workshop of WESTPAC WG06: A framework for cooperative studies in the Western Pacific Marginal Seas: Energy and materials exchange between land and open ocean	Online	Oct. 6–7, 2020	0	1	0	1	0
NASA PMM Science team meeting	Online	Oct. 19–23, 2020	0	1	0	1	0
CHAMOS workshop 2020	Online	Oct. 20–22, 2020	0	1	0	1	0
4th Asia-Pacific Conference on Plasma Physics	Online	Oct. 26–31, 2020	0	2	1	3	1
The 29th International Toki Conference on Plasma and Fusion Research	Online	Oct. 27–30, 2020	0	2	0	2	1
UJI Reconnection Workshop (URW) 2020	Online	Nov. 5, 2020	0	2	0	2	1
Kashiwa Dark Matter symposium 2020	Online	Nov. 16–19, 2020	1	0	0	0	0
The 9th VERSIM Workshop	Online	Nov. 16–20, 2020	5	9	1	10	2
The 11th Symposium on Polar Science	Online	Nov. 16–Dec.18, 2020	0	6	3	9	0
The 21st EA Sub-mm-wave Receiver Technology Workshop	Online	Nov. 24–25, 2020	0	1	0	1	0
AGU Fall Meeting	Online	Dec. 1–17, 2020	0	19	11	30	0
The extreme Universe viewed in very-high-energy gamma rays 2020	Online	Dec. 3–4, 2020	1	0	0	0	0
YITP workshop "Connecting high-energy astroparticle physics for origins of cosmic rays and future perspectives"	Kyoto, Japan/Online	Dec. 7–10, 2020	1	0	1	1	0
Approaches for Hydrospheric-Atmospheric Environmental Studies in Asia-Oceania	Online	Dec. 17–18, 2020	1	1	0	1	0
The 8th Asian/17th Korea-Japan Workshop on Ocean Color 2020	Online	Dec. 21–23, 2020	0	1	3	4	0
2nd Workshop for Atmospheric Neutrino Production in the MeV to PeV range	Online	Jan.12–13, 2021	3	1	0	1	0
43rd COSPAR Scientific Assembly	Online	Jan. 28–Feb. 4, 2021	0	10	1	11	6

Title	Venue	Date	Orga-nizers	Number of Presentations			
				Staffs and PDs	Students	Total	Invited
New perspective of inner heliosphere studies ~ Toward Solar Cycle 25 ~	Online	Feb. 15–16, 2021	1	1	0	1	1
ISEE International Joint Research Program “Modeling the transport and deposition of cosmogenic isotopes of historical MIYAKE Events and recent decades”	Online	Mar. 2–3, 2021	0	1	0	1	0
International conference and school on dynamic variation of particles and waves in the inner magnetosphere and ionosphere using satellite and ground-network observations and modeling (PWING-ERG conference and school)	Online	Mar. 8–12, 2021	2	7	0	7	2
The 44th annual apatity seminar, Physics of Auroral Phenomena	Online	Mar. 15–19, 2021	0	3	0	3	1
1st Workshop for Interplay of Neutrino and Dark matter Experiments and Exotics Searches (INDEES 2021)	Online	Mar. 18–19, 2021	1	2	0	2	2
Total			20 9*	137	53	190	28

■ Domestic Coferences

＊Session Conveners

Number of Conferences	Organizers	Number of Presentations			
		Staffs and PDs	Students	Total	Invited
52	33 8*	151	67	217	5

■ Lectures for Researchers

Date	Title	Number of Paticipants
May 26, 2020 Jul. 20, 2020 Sep. 10, 2020 Nov. 17, 2020 Jan. 14, 2021 Jan. 19, 2021	SCOSTEP/PRESTO Online Seminar (1st–6th)	83 168 19 96 100 65
Jan. 22, 2021 Mar. 5, 2021 Mar. 29, 2021	SCOSTEP Online Capacity Building Lecture (1st–3rd)	40 47 50
Feb. 3, 2021	CICR colloquium	27
Mar. 8, 2021 Mar. 9, 2021	PWING school on the inner magnetosphere and data analysis tool	100

Awards

■ Staffs and PDs

Award Winners	Date	Awards	Title
Yuichi Otsuka	Apr. 2020	Advances in Space Research Top Reviewer 2019	One of the 10 Top Reviewers in 2019 by the journal "Advances in Space Research"
Shoya Matsuda	Aug. 3, 2020	The 2019 Earth, Planets and Space (EPS) Young Researcher Award	Matsuda et al., Onboard software of Plasma Wave Experiment aboard Arase: instrument management and signal processing of Waveform Capture/Onboard Frequency Analyzer. *Earth Planets Space*, 70, 75, 10.1186/s40623-018-0838-0a, 2018
Fumio Abe (F.A. Masaomi Tanaka)	Sep. 9, 2020	PASJ Excellent Paper Award	Tanaka et al., Kilonova from post-merger ejecta as an optical and near-Infrared counterpart of GW170817. *Publications of the Astronomical Society of Japan*, 69(6), 102, 10.1093/pasj/psx121, 2017
Kazumasa Iwai	Nov. 3, 2020	Obayashi Early Career Scientist Award, SGEPPS	Studies on solar atmosphere and heliosphere based on the development of leading-edge radio telescopes
Masafumi Hirahara (F.A. Satoshi Kasahara)	Nov. 3, 2020	SGEPSS Outstanding Paper Award	Medium-energy particle experiments-electron analyzer (MEP-e) for the exploration of energization and radiation in geospace (ERG) mission, *Earth, Planets and Space*, 70, 69, 10.1186/s40623-018-0847-z, 2018
Yuichi Otsuka	Jan. 2021	Excellent Reviewer 2020, Earth Planets and Space	Important contribution as a reviewer of Earth Planets and Space
Yoshizumi Miyoshi	Feb. 4, 2021	Inoue Prize for Sceince	Study on accelerations and scattering of the energetic electrons in Geospace as an elementary process of space weather

Additionally, one domestic award

■ Students

Award Winners	Date	Awards	Title
Hiroki Ito	May 28, 2020	Society of Geomagnetism and Earth, Planetary and Space Sciences (SGEPSS) Student Presentation Award (Aurora Medal)	Flux decrease of outer radiation belt electrons associated with solar wind pressure pulse: A code coupling simulation
Yudai Inaba			First plasma and field observations in the magnetospheric source region of Stable Auroral Red (SAR) arc by the Arase satellite
Yuichiro Asakura (F.A. Masaomi Tanaka)	Sep. 9, 2020	PASJ Excellent Paper Award	Tanaka et al., Kilonova from post-merger ejecta as an optical and near-Infrared counterpart of GW170817. *Publications of the Astronomical Society of Japan*, 69(6), 102, 10.1093/pasj/psx121, 2017
Yudai Inaba	Feb. 21, 2021	Outstanding Student Presentation Award (OSPA), AGU Fall Meeting 2020	Multi-event analysis of plasma and field variations in the source of Stable Auroral Red (SAR) arcs in the inner magnetosphere during non-storm time substorms

Additionally, two domestic awards

10. Education

The Institute for Space–Earth Environmental Research (ISEE) primarily offers graduate programs in the Science, Engineering, and Environmental Studies schools of Nagoya University. The ISEE has its own graduate course for Heliospheric and Geospace Physics in the Division of Particle and Astrophysical Science of the Graduate School of Science. ISEE also cooperates with the Department of Electrical Engineering, through the Space Electromagnetic Environment group in the Graduate School of Engineering, and the Department of Earth and Environmental Sciences, through the Chronology and Natural History, and Global Water Cycle groups, in the Graduate School of Environmental Studies, by teaching / training graduate students in disciplines related to space–earth environmental research.

Our graduate students use various methodologies and techniques, including ground observation, fieldwork, laboratory experiments, radioactive dating, numerical simulations and modeling, and theoretical research. Their work includes the development of satellite, balloon, and aircraft instruments—and the analysis of observational data. As ISEE members conduct research that involves analyzing data captured by both domestic and international instrument platforms, and / or by collaborative research with foreign researchers, our students are actively pioneering new research fields, through their involvement with other scholars in international collaborations, and in interdisciplinary research. Their studies mature as MSc or PhD theses, which are presented at international workshops and conferences, and published in academic journals. We nurture researchers who can apply their knowledge to benefit society, who have a broad perspective, and who demonstrate an international perspective.

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 Chronology and Natural History		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	Geochronology	Environmental History	Meteorology	Cloud and Precipitation Sciences	Atmospheric Chemistry	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								●	●					
	Center for International Collaborative Research	●	●		●		●		●					●	
	Center for Intergrated Data Science			●				●	●		●	●			●
	Center for Orbital and Suborbital Observations		●		●						●	●	●		●

Number of Students supervised by ISEE Staff

(April 1, 2020–March 31, 2021)

	M1	M2	D1	D2	D3	Undergraduate Students	Non-regular students	Total
Graduate School of Science	11	9	3	2	6	-	0	31
Graduate School of Engineering	11	8	0	0	0	-	0	19
Graduate School of Environmental Studies	11	18	3	1	7	-	6 *1 *2	46
School of Science	-	-	-	-	-	7	0	7
School of Engineering	-	-	-	-	-	11	2*2	13
ISEE	-	-	-	-	-	-	2*2	2
Total	33	35	6	3	13	18	10	118

Cumulative total in FY 2020 *1 Special Research Student, *2 Research Student

Faculty Members

(April 1, 2020–March 31, 2021)

■ Division of Particle and Astrophysical Science, Graduate School of Science

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

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

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

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

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Hydrospheric-Atmospheric Sciences Course Global Water Cycle	Kazuhisa Tsuboki	Taro Shinoda		
	Nobuhiro Takahashi	Hirohiko Masunaga		
	Michihiro Mochida			Sho Ohata
	Tetsuya Hiyama	Naoyuki Kurita	Hatsuki Fujinami	
	Joji Ishizaka	Hidenori Aiki		Yoshihisa Mino
Earth and Planetary Sciences Course Chronology and Natural History	Masayo Minami	Takenori Kato		
	Hiroyuki Kitagawa			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 2020 Academic Year, The Following Courses were offered;

- Astrophysics and Space Science
- Astrophysics III
- Earth and Planetary Science Seminar I
- Electric Circuits with Exercise
- Electromagnetic Wave Engineering
- Electronic and Information Engineering
- Electronic and Information Engineering for Automobiles
- Environmental Chemistry
- Experimental Physics
- Experiments in Physics - Advanced Course
- First Year Seminar A
- Frontier of Earth and Planetary Sciences
- Geochemical Analysis II and Experiments
- Geology Experiments
- Graduation Thesis A・B
- Introduction to Electrical
- Introduction to Electrical Electronic and Information Engineering
- Introduction to Physics I
- Introduction to Physics II
- Isotope Geochemistry
- Laboratory in Physics
- Mathematics I and Tutorial A
- Mathematics I and Tutorial B
- Mathematics II and Tutorial
- Meteorology
- Physics Experiments I
- Physics Experiments II
- Probability Theory and Numerical Analysis with Exercises
- Remote sensing
- Science of Atmospheric-Hydrospehric Environment
- Solar System Science
- Topics in Advanced Physics
- View of Advanced Electrical

11. International Relations

Academic Exchange

(29 in total)

Institution	Country/Region	Establishment
Indonesian National Institute of Aeronautics and Space	Indonesia	May 31,1988
Pukyong National University, College of Fisheries Sciences	Korea	October 2, 2006
Korean Space Weather Center	Korea	December 24, 2012
Korea Institute of Ocean Science and Technology, Korea Ocean Satellite Center	Korea	April 17, 2014
Institute of High Energy Physics, Chinese Academy of Sciences	China	February 20, 2001
Polar Research Institute of China	China	November 11, 2005
Department of Atmospheric Sciences, National Taiwan University	Taiwan	October 30, 2009
Center for Weather Climate and Disaster Research, National Taiwan University	Taiwan	September 3, 2014
Bangladesh University of Engineering & Technology, Department of Physics	Bangladesh	March 4, 2008
National Institute of Water and Atmospheric Research	New Zealand	July 26, 1989
Centre for Geophysical Research, University of Auckland	New Zealand	December 7, 1992
Faculty of Science, University of Canterbury	New Zealand	July 30, 1998
Geophysical Institute, University of Alaska Fairbanks	U.S.A.	July 16, 1990
Space Environment Center, National Oceanic and Atmospheric Administration	U.S.A.	December 15, 1992
National Geophysical Data Center, National Oceanic and Atmospheric Administration	U.S.A.	January 5, 1993
Haystack Observatory, Massachusetts Institute of Technology	U.S.A.	October 24, 1994
Center for Astrophysics and Space Sciences, University of California at San Diego.	U.S.A.	December 22, 1997
Center for Space Science and Engineering Research, Virginia Polytechnic Institute and State University	U.S.A.	January 23, 2013
Chacaltaya Cosmic Ray Observatory, Faculty of Sciences, Universidad Mayor de San Andres, La Paz	Bolivia	February 20, 1992
National Institute for Space Research	Brazil	March 5, 1997
Yerevan Physics Institute	Armenia	October 18, 1996
Swedish Institute of Space Physics	Sweden	September 1, 2005 (since March 25, 1993)
Faculty of Science, UiT The Arctic University of Norway	Norway	May 3, 2019 (since October 8, 1993)
Department of Geophysics, Finnish Meteorological Institute	Finland	October 21, 1994
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
Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	International Science Council	July 30, 2019

Visitor : 1／Going Abroad : 0

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

Research Projects

■ Major International Collaborative Projects

(85 in total)

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Study of the Onset Mechanism of Solar Eruptions	K. Kusano	Germany	1	University of Potsdam
Observational Study of the Onset Mechanism of Solar Eruptions	K. Kusano	U.S.A. China	2	New Jersey Institute of Technology University of Science and Technology of China
Study of Modeling of Solar Eruptions	K. Kusano	U.S.A.	1	Harvard-Smithsonian Center for Astrophysics
Study of Triggering Mechanism of Solar Flares	K. Kusano	U.K.	1	UCL Mullard Space Science Laboratory
Study of Magnetic Reconnection	K. Kusano	U.K.	1	University of Manchester
Radiation Belt Storm Probes Project	Y. Miyoshi	U.S.A.	1	NASA, JHUAPL
Modeling Study of Inner Magnetosphere	Y. Miyoshi	U.S.A.	1	Los Alamos National Laboratory
Collaborative Study on ERG Project	Y. Miyoshi	Taiwan	1	Academia Sinica Institute of Astronomy and Astrophysics
International Heliophysics Data Environment Alliance	Y. Miyoshi	U.S.A. Europe (Member States of ESA)	23	NASA (SPDF, SDAC, HPDE, SPASE, CCMC) European Space Agency (ESA), Centre National d'Études Spatiales
Collaborative Researches Based on Solar Radio Observations with MUSER	S. Masuda	China Korea	2	National Astronomical Observatory of China KASI
Physics of Energetic and Non-Thermal Plasmas in the X (= magnetic reconnection) Region (PhoENiX) Mission	S. Masuda	U.S.A. U.K. Switzerland Hungary Germany Austria	6	NASA, UCB, University of Minnesota, University of Colorado, New Jersey Institute of Technology, Southwest Research Institute, Princeton University Northumbria University, University of Glasgow University of Applied Sciences and Arts Northwestern Switzerland Eötvös Loránd University Leibniz Institute for Astrophysics Potsdam Austrian Academy of Sciences
Study in Cosmic Neutrinos by using a Large Water Cherenkov Detector	Y. Itow	U.S.A. Canada U.K. Spain Korea China Poland	7	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
Study in Interaction of Very High Energy Cosmic Rays by using Large Hadron Collider	Y. Itow	Italy France Switzerland U.S.A.	4	University of Florence, Catania University École Polytechnique CERN Lawrence Berkeley National Laboratory

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Study of Dark Matter and Solar Neutrinos using a Liquid Xenon Detector	Y. Itow	Korea	1	Seoul National University, Sejong University, Korea Research Institute of standards and Science
Study in Interaction of Very High Energy Cosmic Rays by using Relativistic Heavy Ion Collider	Y. Itow	Italy U.S.A.	2	University of Florence, Catania University Brookhaven National Laboratory
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*	13	Boston University, Brookhaven National Laboratory, UCI, Duke University, George Mason University, Indiana University, University of Hawaii, Los Alamos National Laboratory, University of Maryland, State University of New York, University of Washington Chonnam National University, Seoul National University, Sungkyunkwan University Tsinghua University Imperial College London, Lancaster University, University of Oxford, Queen Mary University of London, University of Sheffield, Rutherford Appleton Laboratory INFN Sezione di Bari, INFN Sezione di Napoli, INFN Sezione di Padova, INFN Sezione di Roma CEA Saclay, École Polytechnique University of Bern, Swiss Federal Institute of Technology Zurich Autonomous University of Madrid University of Warsaw University of São Paulo *and other Institutions*
Study of Dark Matter and Solar Neutrinos using a 2-Phase Liquid Xenon TPC Detector	Y. Itow	Germany Italy Switzerland U.S.A. Sweden Israel Portugal *France, UAE, Netherlands*	10	Deutsches Elektronen-Synchrotron, Albert-Ludwigs-Universität Freiburg Max-Planck-Institut INFN, Università di Bologna University of Zurich Columbia University, University of Chicago, Purdue University, UCSD Stockholm University Weizmann Institute of Science University of Coimbra *and other institutions*
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*	22	Deutsches Elektronen-Synchrotron, Max-Planck-Institut, Heidelberg University CENS, École Polytechnique, University of Paris INFN, IFSI University of Barcelona, Complutense University of Madrid 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*

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	4	Stanford University, SLAC National Accelerator Laboratory, GSFC/NASA, U.S. Naval Research Laboratory, UCSC, Sonoma State University, University of Washington, Purdue University, University of Denver CENS, CNRS, École Polytechnique INFN, Italian Space Agency, IFSI Royal Institute of Technology, Stockholm University
Solar Flare Research with Hard X-Ray Spectral Imaging Observations	H. Tajima	U.S.A.	1	UCB, MSFC/NASA, Air Force Research Laboratory
Solar Flare Research with Gamma-Ray Spectral Imaging Observations with Polarimetry	H. Tajima	U.S.A.	1	UCB, Lawrence Berkeley National Laboratory, GSFC/NASA
Study of Solar Neutrons	Y. Matsubara	Bolivia Armenia China Mexico	4	Research Institute of Physics, University of San Andrés Yerevan Physics Institute Institute of High Energy Physics, Chinese Academy of Sciences 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	2	The University of Arizona Swiss Federal Institute of Technology Zürich
A Search for Dark Objects using the Gravitational Microlensing Effect	F. Abe	New Zealand U.S.A.	2	University of Auckland, University of Canterbury, Victoria University of Wellington, Massey University University of Maryland, NASA
Observations of Interplanetary Disturbances using the International IPS Network	M. Tokumaru	U.K. Russia India Mexico Australia	5	LOFAR-UK Lebedev Physical Institute Tata Institute of Fundamental Research National Autonomous University of Mexico Murchison Widefield Array
Study of 3-D Solar Wind Structure and Dynamics Using Heliospheric Tomography	M. Tokumaru	U.S.A.	1	CASS/UCSD
Study on the Application of Interplanetary Scintillation Observations to Space Weather Forecast	M. Tokumaru	Korea	1	Korean Space Weather Center
Study of the Heliospheric Boundary Region using Observations of Interplanetary Scintillation	M. Tokumaru	U.S.A.	1	Interstellar Boundary Explorer, IMAP
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	5	CESR-CNRS, CETP-IPSL Institute for Solar Physics of the Royal Swedish Academy of Sciences Rutherford Appleton Laboratory Boston University University of Bern
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	1	Swedish Institute of Space Physics, Swedish National Space Board
Study on Science Subjects and Developmental Techniques of Observational Instruments toward Future Spacecraft Exploration Missions for the Space-Earth Coupling System	M. Hirahara	U.S.A. Canada Sweden	3	University of Colorado Boulder, UCB University of Calgary Swedish Institute of Space Physics
PRESTO（Predictability of Variable Solar-Terrestrial Coupling）	K. Shiokawa	U.S.A., France, Germany, U.K., Italy, Canada, Australia, India, China, *and other countries*	30	SCOSTEP

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
High-Sensitive Imaging Measurements of Airglow and Aurora and Electromagnetic Waves in Canadian Arctic	K. Shiokawa	U.S.A. Canada	2	University of California, Augsburg College, Virginia Polytechnic Institute and State University University of Calgary, Athabasca University
Magnetic Conjugate Observations of Midlatitude Thermospheric Disturbances	K. Shiokawa	Australia	1	IPS Radio and Space Service
Comparison of Dynamical Variations of the Mesosphere, Thermosphere, and Ionosphere between Asian and Brazilian Longitudes	K. Shiokawa	Brazil	1	INPE
Ground and Satellite Measurements of Geospace Environment in the Far-Eastern Russia	K. Shiokawa	Russia	1	Institute of Cosmophysical Research and Radiowave Propagation, Far Eastern Branch, RAS
Observations of the Equatorial Ionosphere in South-East Asia and West Africa	K. Shiokawa	Nigeria	1	National Space Research and Development Agency, Federal University of Technology Akure, Tai Solarin University of Education
Observations of Waves and Particles in the Inner Magnetosphere in the Siberian Region of Russia	K. Shiokawa	Russia	1	Institute of Cosmophysical Research and Aeronomy/SB RAS, ISTP/SB RAS
Collaborative Research and Operation in the Field of Space Weather Observations	Y. Otsuka	Indonesia	1	LAPAN
Observations and Researches of Ionosphere and Upper Atmosphere in Thailand	Y. Otsuka	Thailand	1	Chiang Mai University, King Mongkut's Institute of Technology Ladkrabang
Study on the Occurrence Characteristics of Ionospheric Irregularity and its Day-to-Day Variability over Southern China and Southeast Asia Regions	Y. Otsuka	China Indonesia Thailand	3	Institute of Geology and Geophysics Chinese Academy of Sciences LAPAN King Mongkut's Institute of Technology Ladkrabang
Study of the Polar Upper Atmosphere using the EISCAT Radars and Other Instruments	S. Nozawa	Norway Sweden, Finland, Germany, U.K., China	6	UiT The Arctic University of Norway EISCAT Scientific Association
Derivation of Substorm Index from Low-Latitude Geomagnetic Field Data	M. Nosé	Australia Turkey Germany Spain Denmark U.S.A.	6	Geoscience Australia Boğaziçi University Ludwig-Maximilians-Universität München Universitat Ramon Llull Technical University of Denmark United States Geological Survey
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	9	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
SDI-3D Project: Development of SDI	S. Oyama	U.S.A. Finland Sweden	3	Geophysical Institute of the University of Alaska Fairbanks University of Oulu, Finnish Meteorological Institute, Sodankylä Geophysical Observatory, Lappeenranta-Lahti University of Technology The Swedish Institute of Space Physics, KTH Royal Institute of Technology
Study of Auroral Energetic Electron Precipitation (EEP) Impacts on the Upper/Middle Atmosphere	S. Oyama	Finland New Zealand U.K. Norway U.S.A.	5	University of Oulu, Finnish Meteorological Institute University of Otago British Antarctic Survey University Centre in Svalbard University of Alaska Fairbanks

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Study of Aerosols and Atmospheric Trace Gases by using SAVER-Net Observation Network in South America	A. Mizuno	Argentina Chile Bolivia	3	CEILAP, Servicio Meteorológico Nacional University of Magallanes, Dirección Meteorológica de Chile University of La Frontera, Universidad Mayor de San Andrés
High Energy Particles in Geospace: the Acceleration Mechanism and the Role in Earth's Climate	A. Mizuno	U.S.A. Norway Sweden	3	University of Colorado Boulder, UCLA, University of Arizona UiT The Arctic University of Norway EISCAT Scientific Association
Source Apportionment of Organic Aerosols in Beijing	M. Mochida	China	1	Tianjin University
Characterizing Organics and Aerosol Loading over Australia (COALA)	M. Mochida S. Ohata	Australia U.S.A. U.K.	3	University of Wollongong, Commonwealth Scientific and Industrial Research Organisation, Australian Nuclear Science and Technology Organisation, NSW Department of Planning, Industry and Environment Georgia Institute of Technology, UCI Lancaster University
Tropical Rainfall Measuring Mission	N. Takahashi	U.S.A.	1	NASA
Global Precipitation Measurement Mission (GPM)	H. Masunaga N. Takahashi	U.S.A.	1	NASA
Tropical Cyclones-Pacific Asian Research Campaign for Improvement of Intensity Estimations/Forecasts (T-PARCII)	K. Tsuboki T. Shinoda	Taiwan	1	National Taiwan University Atmospheric Sciences
Advanced Study on Precipitation Enhancement in Arid and Semi-Arid Regions	M. Murakami	United Arab Emirates	1	National Centre of Meteorology, Khalifa University
Study on Tropical Convective-radiative Interactions	H. Masunaga	France	1	Laboratoire de Meteorology Dynamique/ CNRS
Study on Topical-subtropical Atmospheric Dynamics	H. Masunaga	U.S.A.	1	University of Miami
Observational Study on Convective Self-Aggregation	H. Masunaga	U.K.	1	City University of New York
Satellite Algorithm Development for Tracking Precipitating Clouds	H. Masunaga	U.S.A.	1	NASA Jet Propulsion Laboratory
Development and Validation of a Satellite-Based Scheme to Estimate In-Cloud Vertical Velocity	H. Masunaga	U.S.A.	1	City University of New York
Long-Term Observation of Black Carbon Aerosols in the Arctic	S. Ohata	Norway U.S.A. Canada Russia	4	Norwegian Polar Institute National Oceanic and Atmospheric Administration Government of Canada Arctic and Antarctic Research Institute
Continuous Observation of Methane at a Paddy Field in Northern India	Y. Matsumi	India	1	University of Delhi
Observation of PM2.5 in Ulan Bator	Y. Matsumi	Mongolia	1	National University of Mongolia
Observation of PM2.5 in Hanoi	Y. Matsumi	Vietnam	1	Hanoi University of Science and Technology
Validation of GOCI Products and Application to Environmental Monitoring of Japanese Coastal Waters	J. Ishizuka	Korea	1	Korea Institute of Ocean Science and Technology
Sea Surface Nitrate and Nitrate Based New Production - Two Innovative Research Products from SGLI on board GCOM-C	J. Ishizaka	U.S.A.	1	Columbia University

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Collection of Validation Dataset of GCOM-C Coastal Products	J. Ishizaka	Korea U.S.A. Taiwan Thailand China Estonia	6	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
Validation of Ocean Color Products in the Western North Pacific and Japanese Coastal Waters: Collaboration with JAXA GCOM-C Project	J. Ishizaka	Member States of EUMETSAT: Germany, U.K., France, Italy, Spain, Netherlands *and others countries*	30	European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT)
Investigating the Optical Characteristics of Red Tides in the Upper Gulf of Thailand	J. Ishizaka	Thailand	1	University of Burapa, Kasetsart University
Integrated Land Ecosystem - Atmosphere Processes Study (iLEAPS), one of the Global Research Projects (GRPs) of the Future Earth	T. Hiyama	U.K., India, Finland, New Zealand, China, Koria *and others countries*	6	iLEAPS/Future Earth
Observational Study of Vegetation, Energy and Water in Eastern Siberia Towards Elucidation of Climate and Carbon Cycle Changes	T. Hiyama	Russia	1	Institute for Biological Problems of Cryolithozone/SB RAS
Arctic Challenge for Sustainability II (ArCS II) Project	T. Hiyama	U.S.A.	1	International Arctic Research Center of the University of Alaska Fairbanks
Estimating Permafrost Groundwater Age in Central Mongolia	T. Hiyama	Mongol	1	Institute of Geography and Geoecology of the Mongolian Academy of Sciences
Study of Methane Flux Observation in Eastern Siberia and the Obtained Data Analysis	T. Hiyama	Russia	1	Institute for Natural Science, North Eastern Federal University
Study of Equatorial Waves in the Atmosphere and Ocean	H. Aiki	Germany	1	GEOMAR Helmholtz Centre for Ocean Research Kiel
An International Study on Precipitation Variability in High-Altitude Areas of the Himalayas in Nepal	H. Fujinami	Nepal	1	Kathmandu University, Nepal Academy of Science and Technology, International Centre for Integrated Mountain Development
Asian Precipitation Experiment (AsiaPEX)	H. Fujinami	India Nepal China Korea Bangladesh	5	India Meteorological Department, Indian Institute of Tropical Meteorology, University of Rajasthan International Centre for Integrated Mountain Development, Nepal Academy of Science and Technology, Kathmandu University Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Tsinghua University Pusan National University *and other institutions*
International Continental Scientific Drilling Program - Dead Sea Deep Drilling Project (ICDP-DSDDP)	H. Kitagawa	Israel U.S.A. Germany Switzerland	3	Geological Survey of Israel, Hebrew University of Jerusalem Columbia University, University of Minnesota Twin Cities GFZ Helmholtz Centre Potsdam, Max Planck Institute for Chemistry University of Geneva
Climate Change Reconstruction of the Central Highlands in Vietnam	H. Kitagawa	Vietnam	1	Vietnam Academy of Science and Technology
Climate Reconstruction using Travertine from Takht-e-Soleyman Area in Kurdistan, Iran	M. Minami	Iran	1	University of Kurdistan

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Study of Grand-Water Circulation Based on ^{14}C Ages of Underground Water and Hot-Spring Water Samples from Korea	M. Minami	Korea	1	Korea Institute of Geoscience and Mineral Resources
Establishment of Master Dendrochronological Calibration Curve Around 660 BC using Annual Tree Ring Samples from Poland	M. Minami	Poland	1	Silesian University of Technology
Measurements of Cosmic-Ray-Produced ^{14}C in Iron Meteorites	M. Minami	U.S.A.	1	UCB
Geochronological Research on the Basement Rocks in Japan and Korea	T. Kato	Korea	1	Korea Institute of Geoscience and Mineral Resources
Development of New Analytical Techniques and Accurate Quantification of Electron Microprobe Analysis	T. Kato	Korea	1	Pusan National University
International Ocean Discovery Program (IODP) Expedition 379: Amundsen Sea West Antarctic Ice Sheet History	M. Yamane	U.S.A. Germany U.K. France Sweden Norway China Korea India New Zealand	10	University of Houston, Texas A&M University, Appalachian State University, U.S. Army Engineer Research and Development Center, University of Massachusetts, University of South Florida, Montclair State University, University of Florida, Northern Illinois University, Colorado College Alfred Wegener Institute for Polar and Marine Research, University of Bremen, University of Kiel, Museum für Naturkunde University of Southampton, University of Birmingham, British Antarctic Survey Université de Perpignan Stockholm University UiT The Arctic University of Norway China University of Geosciences, Tongji University Korea Institute of Geoscience and Mineral Resources National Centre for Antarctic and Ocean Research GNS Science

Visitors from Foreign Institutes

(April 1, 2020–March 31, 2021)

<table>
<tr><th colspan="4">Country/Region</th></tr>
<tr><td rowspan="3">Asia (3)</td><td>India</td><td>1</td><td rowspan="3">5</td></tr>
<tr><td>Korea</td><td>2</td></tr>
<tr><td>China</td><td>2</td></tr>
<tr><td rowspan="2">Europe (2)
(Including New
Independent States)</td><td>England</td><td>1</td><td rowspan="2">2</td></tr>
<tr><td>Sweden</td><td>1</td></tr>
<tr><td>Total</td><td>5</td><td colspan="2">7</td></tr>
</table>

Funding Source	
Government-funding	2
Nagoya University	1
Self-funding	4
Total	7

Purpose	
Joint Research	7
Total	7

Online Seminars by Foreign Scientists

(14 in total)

Date	Name	Affiliation	Title	Number of Participant
July 20, 2020	Ilya Usoskin	University of Oulu, Finland	2nd SCOSTEP/PRESTO Online Seminar/ Extreme solar events: A new paradigm	168
September 10, 2020	Joe Borovsky	Space Science Institute, U.S.A.	3rd SCOSTEP/PRESTO Online Seminar/ Developing a highly predictable geomagnetic index to gauge magnetospheric activity and space weather	19
September 28, 2020	Abraham Chian	University of Adelaide, Australia INPE, Brazil	Solar Seminar/ Nonlinear dynamics of space plasmas	15
November 17, 2020	Thomas Immel	UCB, U.S.A.	4th SCOSTEP/PRESTO Online Seminar/ The ionospheric connection explorer - Results from the first year on orbit	96
January 14, 2021	Qiugang Zong	Peking University, China	5th SCOSTEP/PRESTO Online Seminar/ Magnetospheric response to interplanetary shocks: ULF wave-particle interaction perspective	100
January 18, 2021	KD Leka*	NorthWest Research Associates, U.S.A.	Solar Seminar/ Improving the inputs (and outputs) for MHD models: how do we know what we know?	20
January 19, 2021	Mateja Dumbović	University of Zagreb, Croatia	6th SCOSTEP/PRESTO Online Seminar/ Utilizing galactic cosmic rays as signatures of interplanetary transients	65
January 22, 2021	David G. Sibeck	GSFC/ NASA, U.S.A.	1st SCOSTEP Online Capacity Building Lecture/ Motivation for soft X-ray imaging and plans for the STORM global imaging mission	40
February 3, 2021	Chio Zong Cheng*	Princeton University, U.S.A.	62nd ISEE/CICR colloquium (online)/ Physics of magnetic reconnection	27
March 5, 2021	Ulrich Taubenschuss	Institute of Atmospheric Physics, AS CR, Czechia	2nd SCOSTEP Online Capacity Building Lecture/ Processing of electric and magnetic signals onboard the THEMIS spacecraft and applications of polarization analysis	47
March 8, 2021	Ondrej Santolik	Institute of Atmospheric Physics, AS CR, Czechia	PWING School on the inner magnetosphere/ Spacecraft measurements of whistler mode waves as a tool for investigation of the inner magnetosphere	107
March 8, 2021	Esa Turunen	Director Emeritus of Sodankylä Geophysical Observatory, University of Oulu, Finland	PWING School on the inner magnetosphere/ High-energy particles - atmosphere interaction	107
March 9, 2021	Vania Jordanova	Los Alamos National Laboratory, U.S.A.	PWING School on the inner magnetosphere/ Inner Magnetosphere Plasma and Field Dynamics	100
March 29, 2021	Jacob Bortnik	UCLA, U.S.A.	3rd SCOSTEP Online Capacity Building Lecture/ Machine-learning based reconstruction of the inner magnetosphere	50

* Foreign Visiting Staff

＜Abbreviations＞

AS CR:	Academy of Sciences of the Czech Republic
CASS:	Center for Astrophysics and Space Sciences
CCMC:	Community Coordinated Modeling Center
CEILAP:	Laser and Applications Research Center
CENS:	Centre d'Etudes Nucleaire de Saclay France
CERN:	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
GSFC:	Goddard Space Flight Center
HPDE:	Heliophysics Data Environment
IBEX:	Interstellar Boundary Explorer
IFSI:	Istituto di Fisica dello Spazio Interplanetario
iLEAPS:	Integrated Land Ecosystem-Atmosphere Processes Study
IMAP:	Interstellar Mapping and Acceleration Probe
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
JHUAPL:	Johns Hopkins University Applied Physics Laboratory
KASI:	Korea Astronomy and Space Science Institute
LAPAN:	Lembaga Penerbangan dan Antariksa Nasional, National Institute of Aeronautics and Space
LOFAR:	Low Frequency Array
LPC2E:	Laboratoire de Physique et Chimie de l'Environnement et de l'Espace
MSFC:	Marshall Space Flight Center
MWA:	Murchison Widefield Array
NASA:	National Aeronautics and Space Administration
RAS	Russian Academy of Sciences
SB RAS:	Siberian Branch, Russian Academy of sciences
SCOSTEP:	Scientific Committee on Solar Terrestrial Physics
SDAC:	Solar Data Analysis Center
SLAC:	Stanford Linear Accelerator Center
SPASE:	Space Physics Archive Search and Extract
SPDF:	Space Physics Data Facility
TRIUMF:	Canada's Particle Accelerator Centre
UCB:	University of California, Berkeley
UCI:	University of California, Irvine
UCL:	University College London
UCLA:	University of California, Los Angeles
UCSC:	University of California, Santa Cruz
UCSD:	University of California, San Diego

12. Outreach

Public Lectures, Open Labs, and School Visits

ISEE contributed to the public through various means, including nine visiting lectures, 18 online lectures, six online workshops, four online training courses for young researchers, and one virtual tour for college students. We had to cancel some annual outreach events and activities or hold these online due to the COVID-19 pandemic. For example, one of the popular events, special lectures, and open laboratory to the public during the Nagoya University Festival was called off. ISEE and the former STEL have maintained a close relationship with the town of Rikubetsu in Hokkaido since 2003, after which we held visiting lectures for students of Rikubetsu Elementary School and Rikubetsu Junior High School. However, these annual visiting lectures were canceled.

We distributed a series of booklets in Japanese that answered 50 questions on various topics and informative comic (manga) brochures. They are related to space–Earth subjects for science education and are suitable for the public and school children. They can also be browsed and downloaded from the ISEE website (https://www.isee.nagoya-u.ac.jp/). A promotional video of our research activity to young people is also available at this site.

Left: Promotional video of ISEE. Right: Latest issue of the Japanese booklet series “50 questions”.

Addresses of Facilities

Location		Name	Address	TEL/FAX
Nagoya	①	ISEE Research Institutes Buildings I/II	Furo-cho, Chikusa-ku, Nagoya, Aichi 464-8601	TEL:+81-52-747-6303 FAX:+81-52-747-6313
Toyokawa	②	Toyokawa Branch	3-13 Honohara, Toyokawa-shi, Aichi 442-8507	TEL:+81-533-89-5206 FAX:+81-533-86-3154
Hokkaido	③	Moshiri Observatory	Moshiri, Horokanai, Uryu, Hokkaido 074-0741	TEL:+81-165-38-2345 FAX:+81-165-38-2345
	④	Rikubetsu Observatory	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 ShimoHonjo Honjo, Tarumizu-shi, Kagoshima 891-2112	TEL:+81-994-32-0730