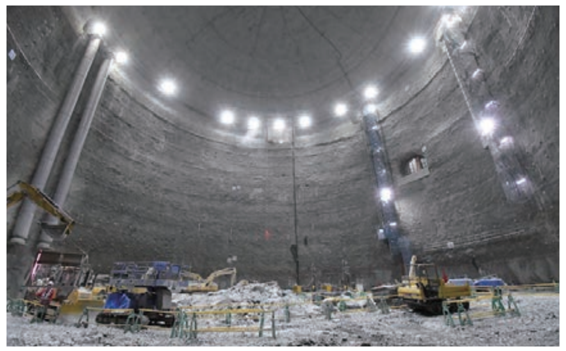
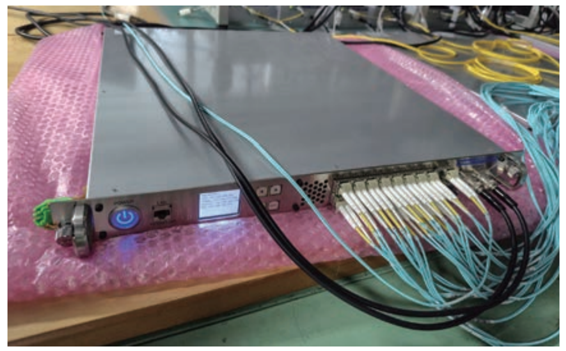
Discussion using graphic recordings at the FY2024 "Workshop on Interdisciplinary Research Strategy Projects: Promoting New Cross-Disciplinary Fusion and Industry-Government-Academia Collaboration"

International Symposium on Space-Earth Environment Research as Predictive Science in March 2025



The underground cavern under excavation for Hyper-Kamiokande (Credit: ICRR, Univ. of Tokyo)



Next-gen IPS digital backend completed after rigorous 2-year testing; supports 8 beams.

A low-latitude aurora was observed at the Moshiri and Rikubetsu Observatory of ISEE

Arctic aerosol sampling by the two samplers in Ny-Ålesund, Norway, in summer

Salmon swimming upstream in the Illiuk River in Unalaska, Alaska, and a bald eagle watching from a bridge. Salmon return transports nutrients from the ocean to the land ecosystem.

Children listening attentively to an explanation about granitic gneiss, dated to 2.05 Ga

Institute for Space–Earth Environmental Research, Nagoya University

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Edited by Public Relations and Outreach Committee, Institute for Space–Earth Environmental Research, Nagoya University
Published in October 2025

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

Institute for Space–Earth Environmental Research, Nagoya University

Annual Report FY2024

Institute for Space–Earth Environmental Research Nagoya University

Annual Report

FY2024

Foreword

Our mission is
to clarify the mechanisms and relationships
between the Earth, the Sun, and the cosmic space,
considering them as a seamless system.

The Institute for Space-Earth Environmental Research (ISEE) was established in October 2015. Since then, the ISEE has acted as a Joint Usage/Research Center assigned by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT). The ISEE received “S” ratings (the highest rating) from the MEXT in both the term-end evaluation of its third six-year term (2016–2021) as a Joint Usage/Research Center and the mid-term evaluation of its fourth six-year term (2022–2023). In the fourth six-year term, in addition to continuing the existing 12 joint research categories, we have introduced five new categories, mainly designed to support students and early-career scientists: “Aircraft Observation (Dropsonde),” “International Travel Support for Field and Laboratory Experiments by Students and Early-career Scientist,” “International Technical Exchange Program,” “ISEE International School Support,” and “International Travel Support for Students (International Presentation/Institutional Stay).” Thus, 17 Joint Usage/Research Programs, representing about 200 projects, are conducted each year. Ten of these programs are open to international applications from overseas researchers. In recognition of this extensive international activity, the ISEE will be newly accredited by the MEXT as an International Joint Usage/Research Center from FY2025. The ISEE is expected to further promote international collaborative research under its international leadership.

The ISEE has also strengthened its interdisciplinary research during the fourth six-year term. The mission of the ISEE is to clarify the mechanisms and relationships between the Earth, the Sun, and the cosmic space, considering them as a seamless system. Therefore, the ISEE has promoted activities that cultivate new research by fusing diverse fields related to the space–Earth environment. We established the Office for the Development of the Interdisciplinary Research Strategy (ODIRS) in August 2022 to promote the development of integrated research across diverse fields. In 2023 and 2024, we started 10 and 13 interdisciplinary research projects, respectively, in collaboration with various faculties and institutes at Nagoya University and Gifu University under the Tokai National Higher Education and Research System. Through these projects, we have not only fostered collaboration between space science and Earth science, but have also initiated new interdisciplinary research projects that connect the humanities and sciences, such as humanities and social sciences research using satellite imagery data, and pioneered database construction methods in collaboration with libraries. In addition, the ISEE is implementing four “Interdisciplinary Research Projects” based on proposals from young ISEE faculty members, funded by the Director’s Leadership Fund. These interdisciplinary research projects have been further developed into the new program “Transdisciplinary Network linking Space–Earth Environmental Science, History, and Archaeology,” approved by the MEXT as the Promotion of Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence (CURE) Program (JPMXP1324134720). This program was created in collaboration with five participating institutions: the National Museum of Japanese History, Yamagata University, Kyushu University, the Research Organization of Information and Systems, and the Center for Digital Humanities and Social Sciences at Nagoya University. Through this program, the ISEE will assess the impact of severe solar storms on modern civilization; promote novel developments in history and archaeology through new and accurate dating; contribute to the formation of a sustainable society that expands into space; prepare for space-related disasters, earthquakes, and volcanic disasters; and foster international human resources to lead the next generation.

These activities led to several outstanding scientific findings in 2024. For example, using their original precise prediction scheme for solar flares, Professor Kanya Kusano and his team at the Division for Integrated Studies have contributed to three international joint solar observation projects, conducted by Japan, the United States, Europe, and South Korea using rockets, balloons, and large ground-based telescopes, and successfully observed solar flares. This project has significantly contributed to understanding the mechanisms of solar flare generation. In addition, in conjunction with the solar maximum period, the ISEE Moshiri and Rikubetsu Observatories successfully observed low-latitude auroras seven times in FY2024. In the low-latitude aurora that was associated with a major magnetic storm on May 11, 2024, researchers from the ISEE, the University of Electro-Communications, and the Swedish Institute of Astrophysics collaborated to identify a prominent blue emission in addition to the red in the aurora, and succeeded in estimating its altitude and latitude ranges. This blue emission suggests that high-energy plasma associated with the aurora is penetrating to low latitudes near Japan, which is an important achievement for understanding the space environment during major magnetic storms.

When the 25th solar cycle reached its maximum, severe space storms occurred. In modern society, the potential risk of space-weather disasters is increasing, and as global warming continues, environmental changes and severe disasters are also increasing. Therefore, the role of the ISEE, which contributes to the solution of global environmental problems and the development of human society in space, is becoming even more significant. We wish to cooperate with collaborators in Japan and globally to develop further research activities that will unlock the future. I hope this annual report will provide you with an understanding of the activities of the ISEE in 2024. Thank you for your valuable support.

Kazuo Shiokawa
Director

ISEE Award

ISEE Award ceremony and commemorative lecture were held on March 6, 2025.

The 6th ISEE Award

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

The sixth ISEE Award was presented to Dr KD Leka (Senior Research Scientist, NorthWest Research Associates) and Dr. Sung-Hong Park (Researcher, Korea Astronomy and Space Science Institute) for their outstanding contribution to space-Earth environmental research through the prediction and understanding of solar flares. The award ceremony and commemorative lecture were held as follows:

Date: March 6, 2025
Venue: Noyori Conference Hall (Nagoya University)
Title: Grounding and Rebounding: Establishing some Hard Truths [about Solar Flare Forecasting] so that Progress can be (is being) Made!

ISEE Award 2024

Winners:
Dr. KD Leka (Senior Research Scientist, NorthWest Research Associates: NWRA)
Dr. Sung-Hong Park (Researcher, Korea Astronomy and Space Science Institute: KASI)


Dr. KD Leka


Dr. Sung-Hong Park

Title: Outstanding contribution to space-Earth environmental research through prediction and understanding of solar flares

Citation: To further develop solar flare prediction and space weather forecast, Drs. KD Leka and Sung-Hong Park organized the ISEE International Workshop "Benchmarks for Operational Flare Forecasts" in FY2017. This workshop produced excellent results, including the first quantitative comparison of solar flare forecast models operated around the world using a common method and the development of new indices to evaluate the time series of flare forecasts. All three papers of this workshop reported by Drs. KD Leka and Sung-Hong Park as principal authors have received high international acclaim and are playing a major role in improving solar flare prediction. Besides, Dr. KD Leka hosted the ISEE International Workshop “What is a Magnetic Flux Rope? Do we know it when we have one?” in FY2022 and developed a new methodology to identify magnetic flux ropes as precursors to solar eruptions. In addition, Drs. KD Leka and Sung-Hong Park have produced numerous research results and have also made significant contributions to the training of graduate students.

Career summary of the award winners:

Dr. KD Leka: Received Ph.D. at the University of Hawaiʻi in 1995. PD fellow at the National Center for Atmospheric Research (1994–1997), followed by Research Associate at National Oceanic and Atmospheric Administration, Space Environment Center (1997–1998), Research Scientist in NWRA (1998–2003), and the current position from 2003. Since 2017, she has concurrently served as a designated professor at ISEE.

Dr. Sung-Hong Park: Received Ph.D. at the New Jersey Institute of Technology in 2010. PD Researcher at KASI (2010-2014), the National Observatory of Athens (2014–2015), and Trinity College Dublin (2015–2017). Designated assistant professor at ISEE (2018–2021). Research scientist at Stanford University (2021–2022), and the current position from 2022.

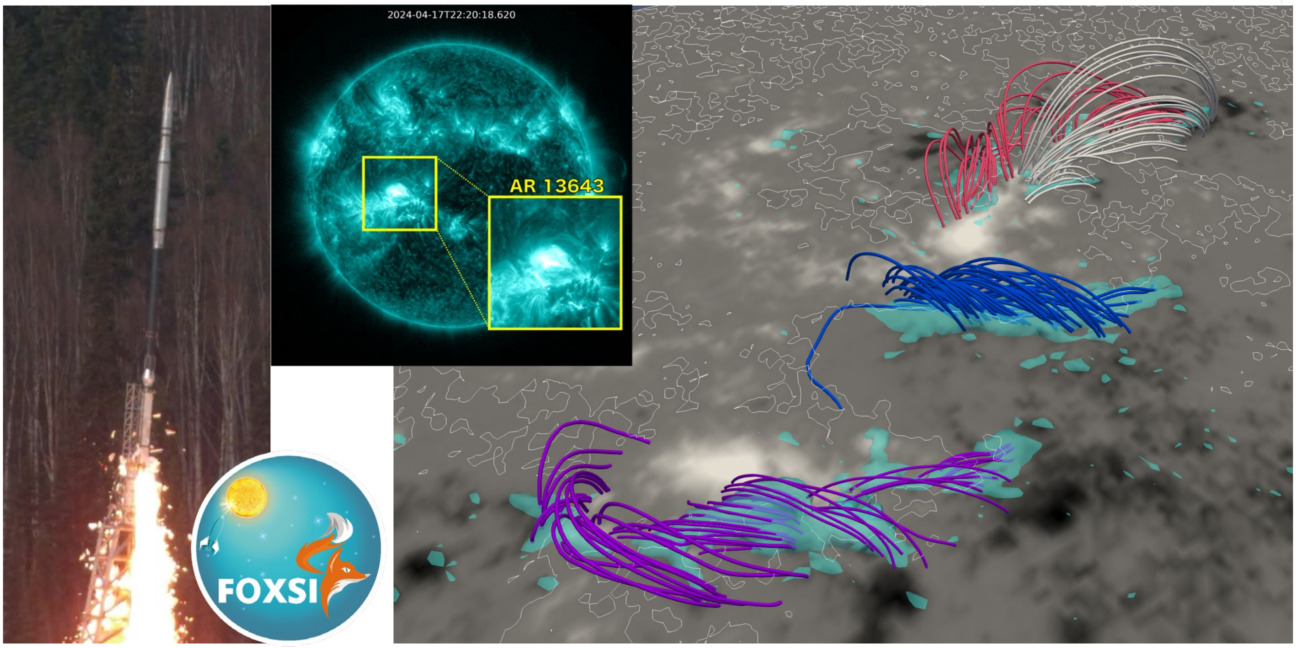


Fig.1

Contributions to Solar Observations with Flare Prediction

By utilizing the advanced solar flare prediction scheme developed by Professor Kanya Kusano, multiple international joint solar observation project teams have successfully observed the detailed dynamics of solar flares using sounding rockets, balloons, and large ground-based telescopes. These significant research initiatives will contribute to understanding solar flare onset mechanisms.

Large solar flares, which may affect the global environment and socio-economic infrastructure, are rare and abrupt phenomena. Therefore, it is a challenge to capture them using equipment like sounding rockets, which can only observe for a short period, or with high-precision but limited field-of-view equipment. However, Prof. Kusano, a researcher at this institute, has developed a new flare prediction scheme called the κ-scheme that can accurately predict the size and location of large solar flares.

In 2024, three international solar observation teams, the Japan–US joint solar flare X-ray sounding rocket experiment FOXSI-4 team, the Japan–US–Europe joint solar balloon observation experiment SUNRISE-III team, and the Korea–US–Japan joint observation team using the Goode Solar Telescope at Big Bear Observatory, successfully observed large solar flares by setting their observation fields in advance based on the flare size and location predicted by the κ-scheme. These observations yielded unprecedented and valuable data, such as X-ray spectral images of the solar corona and chromospheric magnetic fields before and after the flare. They are notable and significant observations that may help to elucidate the onset mechanisms of solar flares.

κ-scheme: Kusano et al. 2020, Science, DOI: 10.1126/science.aaz2511
FOXI-4: https://foxsi.umn.edu/
SUNRISE-III: https://solarwww.mtk.nao.ac.jp/sunrise-scip/en/
Goode Solar Telescope at Big Bear Observatory: https://www.bbso.njit.edu/

Fig. 2

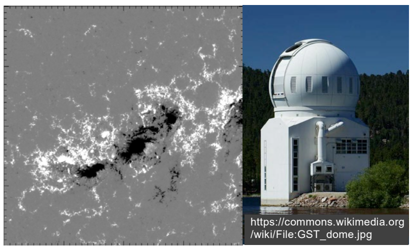


Fig. 3

Fig.1 : FOXSI-4 (left) observed the flare in active region (AR) 13643 (center: SDO/AIA observation image) and the 3D coronal magnetic field model based on the κ-scheme (right).

Fig.2: SUNRISE-III

Fig.3: Big Bear Observatory (right) observed the X-class flare in AR 13777 (left).

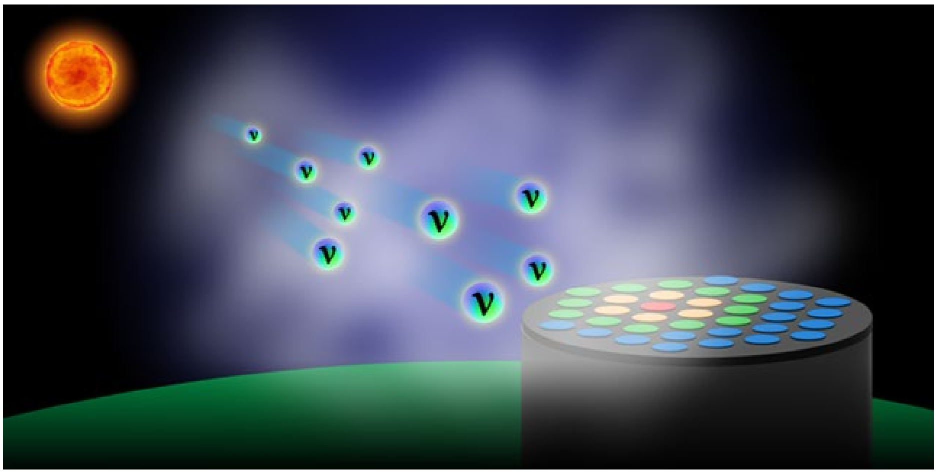


Fig.1

First Observation of Solar Neutrino–Nucleus Scattering by the XENONnT Experiment

The XENONnT experiment, involving Associate Professor Shingo Kazama (ISEE) and the cosmic-ray research group at Nagoya University, has achieved the world's first observation of solar neutrinos scattering off xenon nuclei. This groundbreaking result marks a major step forward in exploring low-energy neutrino physics and opens new possibilities in astrophysical research.

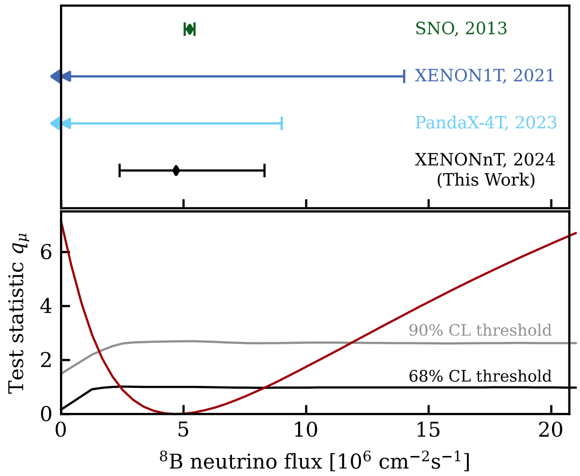


Fig.2

XENONnT is an international dark matter search experiment located deep underground at Italy's Gran Sasso National Laboratory. Using 8.6 tonnes of ultra-pure liquid xenon, the detector searches for rare particle interactions. It features a large water shield to block external radiation and a purification system that continuously removes radioactive impurities from the xenon, creating an ultra-low background environment. The collaboration analyzed about 3.5 tonne-years of data collected between July 2021 and August 2023. They observed low-energy nuclear recoils consistent with neutrinos produced from boron-8 (a radioactive isotope of boron) in the Sun. The signal had a statistical significance of 2.7 sigma, or a 0.35% chance of arising from background noise. This marks the first detection of coherent elastic neutrino–nucleus scattering (CEvNS) from an astrophysical source, and the first using xenon as the target. It demonstrates the exceptional sensitivity of the XENONnT detector. The result also marks the beginning of the "neutrino fog" era—where astrophysical neutrinos become an unavoidable background in dark matter searches, posing new challenges and opportunities for future discoveries.

Paper Information
Journal: *Phys. Rev. Lett.*, 133, 191002, 2024
Authors: Aprile, E., J. Aalbers, K. Abe et al. (**Y. Itow**, **S. Kazama**, **M. Kobayashi**)
Title: First indication of solar ^{8}B neutrinos via coherent elastic neutrino-nucleus scattering with XENONnT
DOI: 10.1103/PhysRevLett.133.191002

Fig.1: ^{8}B neutrino flux from the Sun (Credit: APS/Alan Stonebraker)

Fig.2: Constraints on solar ^{8}B neutrino flux.

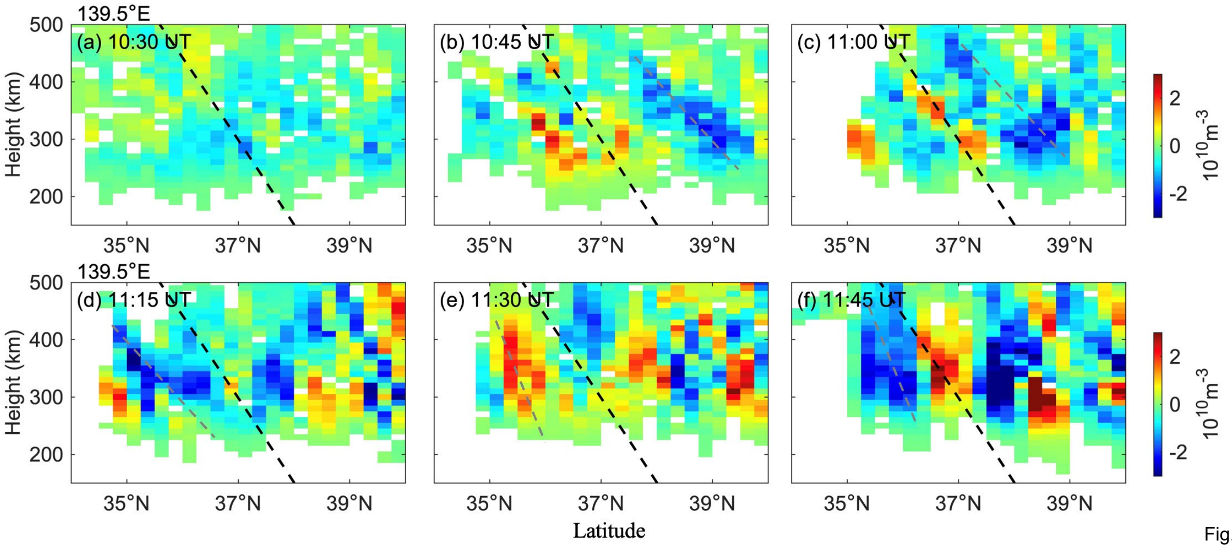


Fig.1

High-resolution 3-D Imaging of Ionospheric Disturbances Using Ultra-dense GNSS Observation Networks Over Japan

Dr Weizheng Fu (JSPS Postdoctoral Fellow) and Dr Yuichi Otsuka (Associate Professor) from the Division for Ionospheric and Magnetospheric Research developed a computerized ionospheric tomography algorithm for electron density perturbations using ultra-dense Global Navigation Satellite System (GNSS) observations over Japan in collaboration with the University of Oslo in Norway. For the first time, the detailed 3-D structure of ionospheric disturbances was reconstructed with a high spatiotemporal resolution (~30 km in latitude and longitude, 10 km in altitude).

The total electron content (TEC) is an important parameter in ionospheric studies, can be derived from dual-frequency GNSS measurements. However, the TEC represents an integrated value of electron density, only providing 2-D information about the ionosphere. To reconstruct the 3-D structure of ionospheric disturbances, we have developed a computerized ionospheric tomography algorithm. This algorithm focuses on electron density perturbations, enabling the imaging of disturbances with small amplitudes and scales. For the first time, we have successfully reconstructed the 3-D field-aligned structure of nighttime medium-scale traveling ionospheric disturbances (MSTIDs) with a high spatiotemporal resolution. In the future, we hope that this method can be applied to analyze the 3-D structure of ionospheric disturbances caused by various factors, such as the neutral atmosphere, contributing to novel advances in

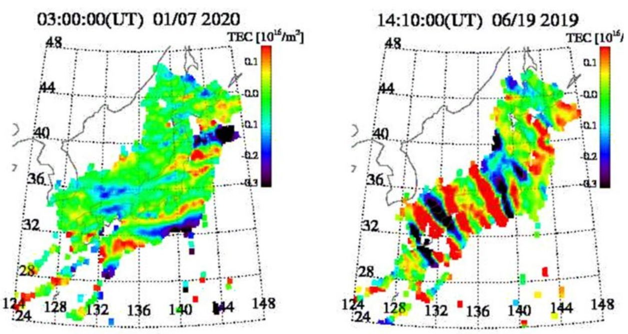


Fig. 2

Paper Information
Journal: *Earth Planets Space*, **76**, 102, 2024
Authors: **Fu, W.**, **Y. Otsuka**, and N. Ssessanga
Title: High-resolution 3-D imaging of electron density perturbations using ultra-dense GNSS observation networks in Japan: an example of medium-scale traveling ionospheric disturbances
DOI: 10.1186/s40623-024-02051-2

Fig.1: Electron density perturbations reconstructed from GNSS-TEC data using the developed computerized ionospheric tomography algorithm. The dashed lines represent the direction of the geomagnetic field line.

Fig.2: 2-D GNSS-TEC observations of (left) daytime and (right) nighttime MSTIDs.

Credit: Reiko Matsushita

Fig.1

Novel Dropsonde for Aircraft Observation

To explore the dynamic and thermodynamic structure and intensification process of typhoons via aircraft observations, Designated Associate Professor Sachie Kanada, Professor Kazuhisa Tsuboki, their colleagues, and Meisei Electric Co., Ltd., developed a novel meteorological dropsonde for aircraft observations. A comparison between the data obtained by the dropsonde (iMDS-17) and a radiosonde (iMS-100) confirmed the adequate performance of the iMDS-17.

The intensity of a tropical cyclone is closely related to its inner core structures and the atmospheric conditions in the vicinity of the storm center. Thus, observations in the vicinity of the storm-core region are important for improving tropical cyclone intensity estimations and forecasting. The Tropical Cyclone-Pacific Asian Research Campaign for the Improvement of Intensity Estimations/Forecasts (T-PARCII) has been running since 2017 to explore the dynamic and thermodynamic structure and intensification process of strong typhoons via aircraft observations. For this purpose, the ISEE and Meisei Electric Co., Ltd., developed a novel meteorological sonde for aircraft observations called a 'dropsonde'. Approximately the same technology as that in the Japan Meteorological Agency (JMA) operational radiosonde (iMS-100) was used, except that the pressure was measured directly with a pressure sensor. To evaluate the performance of the iMDS-17, intercomparison experiments were conducted on March 27 and 28, 2024, on the southern island of Japan using a balloon-borne shooter system. A dropsonde and radiosonde were lifted by the same balloon and released at altitudes between 9 and 13 km. A comparison between the resulting data confirmed the adequate performance of the iMDS-17 in temperature and wind observations at most altitudes from 9–2 km.

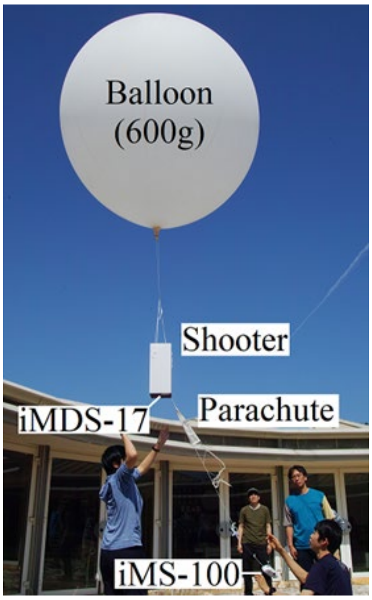


Fig.2

Paper Information
Journal: *SOLA,* **20**, 378-385, 2024
Authors: **Kanada, S.**, **M. Kato**, **K. Tsuboki**, T. Ohigashi, S. Hirano, K. Shimizu, R. Nozawa, **A. Yoshimura**, **Y. Goto**, and **K. Tsukagoshi**
Title: Evaluation of newly developed dropsonde for aircraft observation
DOI: 10.2151/sola.2024-050

Fig.1: Aircraft observation of a typhoon using the novel dropsonde.

Fig.2: The balloon-borne shooter system.

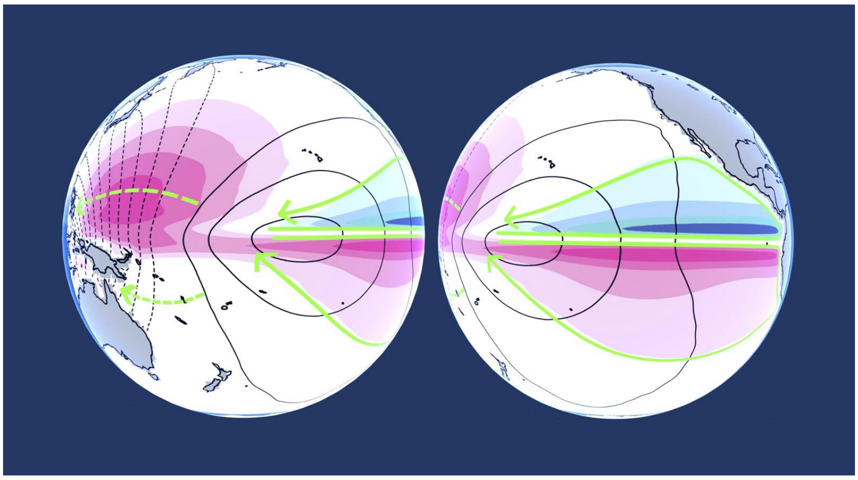


Fig. 1

Unraveling the Mysteries of El Niño through "Slow Waves" in the Upper Ocean

– *A New Perspective on Climate Variability via Energy Transport* – The mechanisms behind the El Niño and La Niña phenomena, which have traditionally been explained using sea surface temperature anomalies, can now be understood from a new angle—through the transport of energy by slow waves within the ocean interior. Researchers (Professor Hidenori Aiki et al.) have developed empirical formulas that estimate the strength of wave generation by equatorial winds and the extent of wave reflection, both inferred from sea surface temperature anomalies.

A research team from the Oceanography Group at ISEE, in collaboration with the Japan Agency for Marine-Earth Science and Technology and the Meteorological Research Institute, focused on the crucial role played by "slow waves" in the upper ocean in driving El Niño and La Niña events. Their study has successfully revealed a comprehensive picture of energy transmission mediated by these waves. By addressing the mathematical challenges posed by the equator as a singularity, the team developed an original diagnostic approach. This advancement allows for a more refined interpretation of El Niño and La Niña phenomena from the perspective of energy transport via slow waves, rather than relying solely on surface temperature anomalies. These findings are expected to contribute to a deeper understanding of climate dynamics, enhance the accuracy of climate predictions, and support the development of effective adaptation strategies for future climate change.

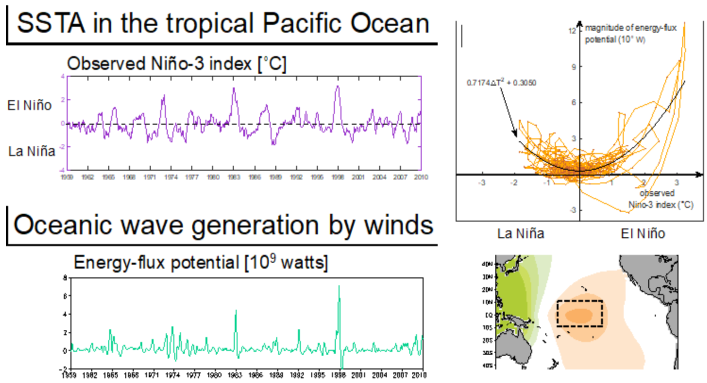


Fig. 2

Paper Information

Journal: *Clim. Dyn.*, **63**, 84, 2025

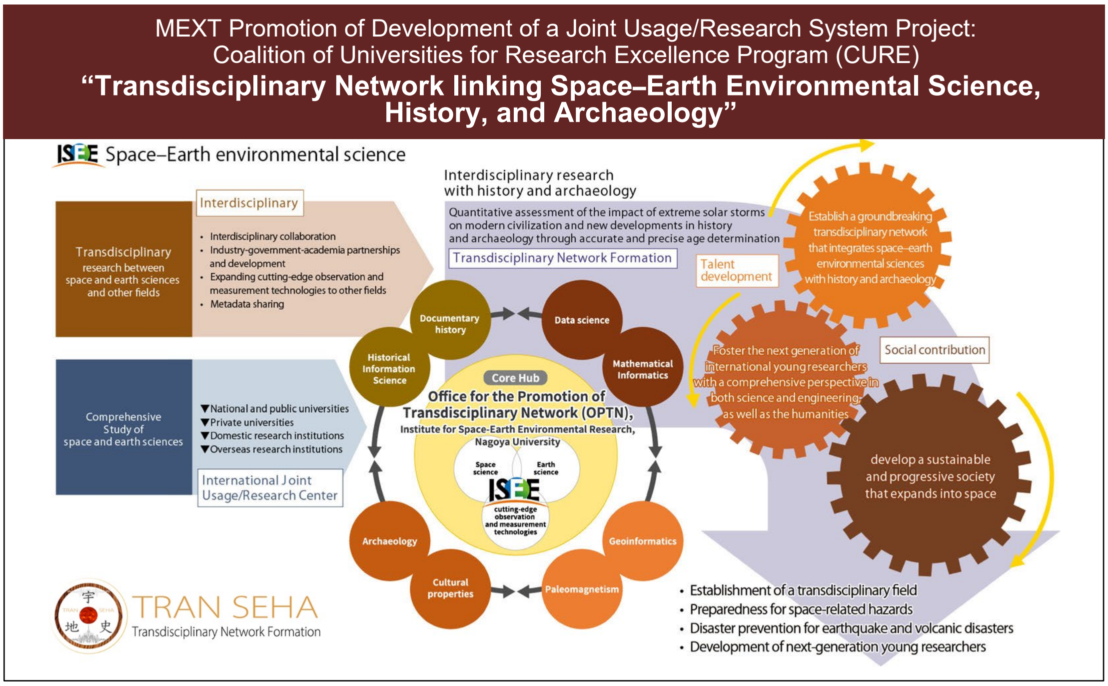
Authors: **Wu, B.**, **H. Aiki**, T. Toyoda, T. Ogata, and M. Nagura

Title: Energy circulation associated with interannual waves in the tropical-subtropical Pacific

DOI: 10.1007/s00382-024-07530-6

Fig.1: Generation (solid contours) and dissipation (dashed contours) areas of wave energy associated with interannual variations in the upper ocean, as identified by the diagnostic approach of this study. Red and blue shading represents the clockwise and anti-clockwise rotation of wave energy circulation, respectively.

Fig. 2: Time series of sea surface temperature anomalies (SSTAs) in the eastern tropical Pacific (upper left, unit: °C) and the strength of wave generation in the upper ocean by wind forcing (lower left, unit: GW). Phase trajectory of monthly SSTAs (horizontal axis) and wave generation strength (GW) from 1959 to 2010, along with the fitted function (upper right). Energy source and sink components associated with low-frequency waves in the upper ocean (lower right; orange indicates sources, green indicates sinks).



Integrating Space–Earth Environmental Science, History, and Archaeology

The ISEE launched the FY 2024 MEXT Promotion of Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence Program (CURE), titled "Transdisciplinary Network linking Space-Earth Environmental Science, History, and Archaeology." In this program, the ISEE serves as the central hub and, in collaboration with five participating institutions, works to establish a pioneering transdisciplinary network that integrates the natural sciences and the humanities.

The ISEE has launched a transdisciplinary network that connects space–Earth environmental science, history, and archaeology, in collaboration with five participating institutions: the National Museum of Japanese History; the Center for Accelerator Mass Spectrometry, Yamagata University; the Advanced Asian Archaeological Research Center, Kyushu University; the Joint Support-Center for Data Science Research, Research Organization of Information and Systems; and the Center for Digital Humanities and Social Sciences, Nagoya University.

This program focuses on four research groups: the Cataclysmic Disasters and Dating Group, the Archaeomagnetic Research Group, the Solar–Terrestrial Environmental History Group, and the Interdisciplinary Database Research and Development Group. By creating a transdisciplinary network linking space–Earth environmental science to the humanities and social sciences, the program aims to assess the impact of extreme space storms on modern civilization and promote novel developments in history and archaeology based on precise and accurate dating. It also aims to contribute to forming a sustainable, development-oriented society that extends into space and preparing for space-related hazards, earthquakes, and volcanic disasters, while developing the next generation of international human resources.

This program will run for up to 10 years, starting from FY2024. Through the integration of knowledge across disciplines, it aims to open new frontiers in academic research.

Fig.1

Fig.2

Fig.1: Kickoff research meeting held on February 27, 2025, in the 3rd-floor hall of Research Institutes Building II.

Fig.2: Large-capacity storage system introduced in FY 2024 for the construction of databases. This system will promote the development of interdisciplinary humanities–science databases.

Information

TranSEHA
Transdisciplinary Network Formation Website:
https://transeha.isee.nagoya-u.ac.jp/en

Contents

1. History

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

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

Solar-Terrestrial Environment Laboratory (STEL)

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.

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.

Hydrospheric Atmospheric Research Center (HyARC)

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

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

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

Center for Chronological Research (CCR)

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

Institute for Space–Earth Environmental Research (ISEE)

October, 2015	Institute for Space–Earth Environmental Research (ISEE) was established.
January, 2016	Approved as one of the Joint Usage/Research Centers.

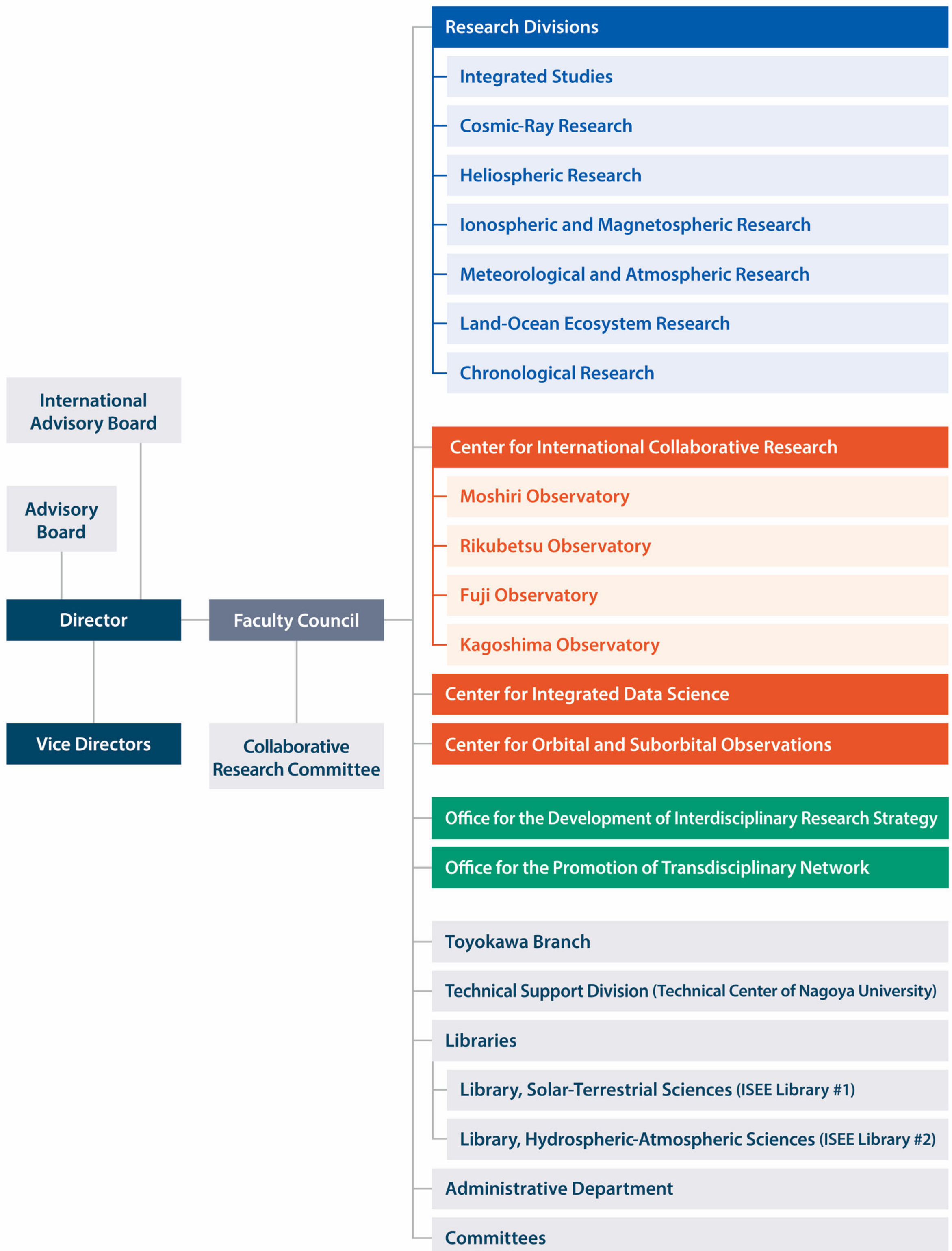
Past Directors

Oct. 1, 2015 – Mar. 31, 2017	Shinobu Machida
Apr. 1, 2017 – Mar. 31, 2023	Kanya Kusano
Apr. 1, 2023 –	Kazuo Shiokawa

Professors Emeritus

AY 2016	Ryoichi Fujii	Toshio Nakamura
AY 2018	Shinobu Machida	Yutaka Matsumi
AY 2019	Masaki Enami	
AY 2023	Munetoshi Tokumaru	
AY 2024	Joji Ishizaka	

2. Organization



3. Staff

Number of Faculty and Staff Members

March 31, 2025

	Male	Female	Total
Faculty Members	34	3	37
Technical Staff	17	12	29
Administrative Staff	5	43	48
Other	19	9	28
Total	75	67	142

＊"Technical Staff" Includes "Designated Technical Staff" and "Technical Assistant".

＊"Administrative Staff" Includes "Designated Administrative Staff " and "Administrative Assistant".

＊"RA" and " Invited Faculty Members" are not Included.

＊"Other"…"Designated Professors", "Researcher (Full-time)", "Research Institution Researcher"

List of Faculty and Staff Members

(✱): Concurrent post

Director	Kazuo Shiokawa
Vice Director	Tetsuya Hiyama
Vice Director	Masayo Minami

Division for Integrated Studies

Professor	Kanya Kusano
Professor	Hideyuki Hotta
Professor	Yoshizumi Miyoshi (✱)
Associate Professor	Satoshi Masuda
Associate Professor	Haruhisa Iijima (✱)
Assistant Professor	Akimasa Ieda
Designated Assistant Professor	Hisashi Hayakawa (✱)*
JSPS research fellowship (PD)	Yoshiki Hatta
JSPS International Research Fellow	Sandeep Kumar
Technical Assistant	Ayatoshi Taniguchi

* Belongs to Institute for Advanced Research Section

Division for Cosmic-Ray Research

Professor	Yoshitaka Itow
Professor	Hiroyasu Tajima
Associate Professor	Fusa Miyake (✱)
Associate Professor	Shingo Kazama (✱)*
Designated Associate Professor	Kazutaka Yamaoka (✱)
Lecturer	Akira Okumura
Assistant Professor	Hiroaki Menjo
Designated Assistant Professor	Mitsunari Takahashi
Designated Assistant Professor	Masatoshi Kobayashi (✱)*
Designated Technical Staff	Kazuhiro Furuta

*Belongs to Kobayashi-Maskawa Institute for the Origin of Particles and the Universe

Division for Heliospheric Research

Professor	Kanya Kusano (✱)
Associate Professor	Kazumasa Iwai
Assistant Professor	Ken-ichi Fujiki

Division for Ionospheric and Magnetospheric Research

Professor	Masafumi Hirahara
Professor	Kazuo Shiokawa (✱)
Associate Professor	Yuichi Otsuka
Associate Professor	Satonori Nozawa
Associate Professor	Nozomu Nishitani (✱)
Associate Professor	Claudia Martinez (✱)
Lecturer	Shin-ichiro Oyama
Designated Assistant Professor	Geetashree Kakoti
JSPS International Research Fellow	Weizheng Fu

Division for Meteorological and Atmospheric Research

Professor	Akira Mizuno
Professor	Nobuhiro Takahashi (✱)
Professor	Kazuhisa Tsuboki (✱)
Professor	Michihiro Mochida (✱)
Associate Professor	Tomoo Nagahama
Associate Professor	Hirohiko Masunaga
Associate Professor	Taro Shinoda (✱)
Assistant Professor	Sho Ohata
Assistant Professor	Taku Nakajima
Researcher	Hirofumi Goto
Researcher	Fumie Furuzawa
Researcher	Limei Han
Research Institution Researcher	Bhagawati Kunwar
Technical Assistant (Research Support Facilitator)	Kazuji Suzuki
Technical Assistant	Michiko Nishizawa

Division for Land–Ocean Ecosystem Research

Professor	Hidenori Aiki
Professor	Tetsuya Hiyama
Associate Professor	Naoyuki Kurita
Designated Associate Professor	Yoshiki Fukutomi
Lecturer	Hatsuki Fujinami
Assistant Professor	Yoshihisa Mino
Technical Assistant	Zimeng Li

Divison for Chronological Research

Professor	Hiroyuki Kitagawa
Professor	Masayo Minami (✱)
Associate Professor	Takenori Kato (✱)
Assistant Professor	Hirotaka Oda
JSPS research fellowship (PD)	Sota Niki
Research Institution Researcher	Narges Daneshvar
Designated Technical Staff	Yuriko Hibi
Technical Assistant (Research Support Facilitator)	Jyunko Tamura
Technical Assistant	Sayaka Takasu
Technical Assistant	Masami Nishida

Center for International Collaborative Research

Director • Professor • Director of Moshiri Observatory	Michihiro Mochida
Professor	Kazuo Shiokawa
Professor	Tetsuya Hiyama (✱)
Professor • Director of Rikubetsu Observatory	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
Associate Professor • Director of Fuji Observatory	Kazumasa Iwai (✱)
Associate Professor • Director of Kagoshima Observatory	Yuichi Otsuka (✱)
Associate Professor	Naoyuki Kurita (✱)
Associate Professor	Satonori Nozawa (✱)
Lecturer	Hatsuki Fujinami (✱)
Assistant Professor	Hiroaki Menjo (✱)
Designated Assistant Professor	Denis Pavel Cabezas Huaman
Designated Assistant Professor	Milla Kalliokoski

Foreign Visiting Research Fellow

Feb. 1–May 31, 2024	Dong-in Lee
Jul. 1–Oct. 31, 2024	Balan Nanan
Nov. 6, 2024–Feb. 15, 2025	Samuel Krucker
Jan. 10–Apr. 25, 2025	Dedong Wang

Center for Integrated Data Science

Director • Professor	Yoshizumi Miyoshi
Professor	Kazuhisa Tsuboki
Professor	Hidenori Aiki (✱)
Professor	Yoshitaka Itow (✱)
Professor	Kanya Kusano (✱)
Professor	Hideyuki Hotta (✱)
Associate Professor	Haruhisa Iijima
Associate Professor	Takenori Kato
Associate Professor	Satoshi Masuda (✱)
Associate Professor	Hirohiko Masunaga (✱)
Designated Associate Professor	Sachie Kanada
Designated Associate Professor	Tomoaki Hori
Assistant Professor	Akimasa Ieda (✱)
Designated Assistant Professor	Naritoshi Kitamura
Designated Assistant Professor	Atsuki Shinbori
Designated Assistant Professor	Shota Chiba
Designated Assistant Professor	Takuma Matsumoto
Designated Assistant Professor	Kazuhiro Yamamoto
Designated Assistant Professor	Chae-Woo Jun
Designated Assistant Professor	YunHee Kang
Designated Assistant Professor	Shreedevi Radhakrishna Porunakatu
Researcher	Masaya Kato
Researcher	Tomohito Hioki
JSPS research fellowship (PD)	Tomotsugu Yamakawa
Research Institution Researcher	Kumar Pankaj Soni
Designated Technical Staff	Mariko Kayaba
Designated Technical Staff	Nanako Hirata
Designated Technical Staff	Kingi Morikawa
Technical Assistant	Tomoko Ito

Center for Orbital and Suborbital Observations

Director • Professor	Nobuhiro Takahashi
Professor	Hidenori Aiki (✱)
Professor	Hiroyasu Tajima (✱)
Professor	Kazuhisa Tsuboki (✱)
Professor	Masafumi Hirahara (✱)
Designated Professor	Joji Ishizaka
Associate Professor	Taro Shinoda
Designated Associate Professor	Kazutaka Yamaoka
Designated Associate Professor	Ryota Kikuchi (✱)
Assistant Professor	Sho Ohata (✱)
Designated Assistant Professor	Ryouichi Yoshimura
Designated Assistant Professor	Sopia Lestari
Designated Technical Staff	Ryoko Niizuma

Office for the Development of Interdisciplinary Research Strategy

Office Manager • Professor	Kazuo Shiokawa (✱)
Professor	Kanya Kusano (✱)
Professor	Nobuhiro Takahashi (✱)
Professor	Tetsuya Hiyama (✱)
Professor	Masayo Minami (✱)
Professor	Yoshizumi Miyoshi (✱)
Professor	Michihiro Mochida (✱)
Designated Professor (Cross Appointment)	Mamoru Ishii
Associate Professor	Claudia Martinez (✱)
Designated Associate Professor	Ryota Kikuchi
Lead Academic Specialist	Yasunori Mori

Office for the Promotion of Transdisciplinary Network

Office Manager • Professor	Masayo Minami
Professor	Hiroyuki Kitagawa (✱)
Professor	Kazuo Shiokawa (✱)
Professor	Yoshizumi Miyoshi (✱)
Associate Professor	Fusa Miyake
Associate Professor	Yuichi Otsuka (✱)
Associate Professor	Claudia Martinez (✱)
Designated Assistant Professor	Hisashi Hayakawa *
Lead Academic Specialist	Yasunori Mori (✱)
Designated Technical Staff	Shozo Ohta
Technical Assistant	Yasuko Ito

* Belongs to Institute for Advanced Research Section

Toyokawa Branch

Office Manager • Associate Professor	Kazumasa Iwai (✱)
Designated Technical Staff	Kayoko Asano
Technical Assistant (Research Support Facilitator)	Yasuo Kato

Visiting Academic Staff/Visiting Faculty Members

Visiting Professor	Yoshitaka Itow
Visiting Professor	Shinsuke Imada
Visiting Professor	Takayuki Umeda
Visiting Professor	Yusuke Ebihara
Visiting Professor	Yasunobu Ogawa
Visiting Professor	Yoshiya Kasahara
Visiting Professor	Yoshikatsu Kuroda
Visiting Professor	Chihiro Mitsuda
Visiting Professor	Takahisa Kobayashi
Visiting Professor	Daikou Shiota
Visiting Professor	Iku Shinohara
Visiting Professor	Kanako Seki
Visiting Professor	Hotaek Park
Visiting Associate Professor	Fumio Abe
Visiting Associate Professor	Fumikazu Ikemori
Visiting Associate Professor	Daisuke Ichihara
Visiting Associate Professor	Yuta Kato
Visiting Associate Professor	Shinji Saito
Visiting Associate Professor	Takuo Tsuda
Visiting Associate Professor	Hiroki Mizuochi
Visiting Associate Professor	Kikuko Miyata
Visiting Associate Professor	Shoichiro Yokota
Visiting Associate Professor	Shigeyuki Wakagi
(Emeritus Professor)	Yutaka Matsumi
Visiting Academic Staff	Shun Ohishi

Foreign Visiting Cooperation Researcher

Mar. 14–Apr. 16, 2024	Jih-Hong Shue
May 1–Jul. 31, 2024	Dessalegn Ayehu Mekuriaw
May 7–Aug. 4, 2024	Luiz Fillip Rodrigues Vital
Jun. 1–Jul. 2, 2024	Kishore Kumar Grandhi
Jun. 21–Jul. 24, 2024	Viswanathan Lakshmi Narayanan
Jul. 7–Nov. 30, 2024	Prayitno Abadi
Jul. 11–Sep. 9, 2024	HajiHossein Azizi
Sep. 30–Dec. 27, 2024	Ayushi Nema
Sep. 30–Dec. 27, 2024	Moheb Yacoub Saad
Oct. 15, 2024–Jan. 10, 2025	Jaeyoung Kwak
Oct. 18–Nov. 18, 2024	Jyrki Kalervo Manninen
Oct. 31–Dec. 2, 2024	Jih-Hong Shue
Oct. 31–Dec. 2, 2024	Pai-Sheng Wang
Oct. 31–Dec. 2, 2024	Wun-Jyun Lin
Nov. 14, 2024–Nov. 13, 2025	Lu Sheng
Dec. 23, 2024—Mar. 22, 2025	Dipjyoti Patgiri

Technical Center of Nagoya University

Senior Technician	Akiko Ikeda
Senior Technician	Tetsuya Kawabata
Senior Technician	Yasusuke Kojima
Senior Technician	Haruya Minda
Technician	Wataru Okamoto
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

Administration Department

Director, Administration Department	Makoto Ito

General Affairs Division

Manager, General Affairs Division	Masao Yamamori
Section Head, Personnel Affairs Section	Yuri Hsegawa
Specialist, General Affairs Section	Risa Oosawa
Section Head, General Affairs Section	Fumiko Kondo
Section Head, General Affairs Section	Takamasa Sato
Section Head, General Affairs Section	Kyoko Kamada
Section Head, General Affairs Section	Noriaki Tonouchi
Section Head, Budget Planning Section	Naoaki Harada
Leader, General Affairs Section	Ayako Tsukasaki
Leader, Personnel Affairs Section	Mihoko Hayashi
Administrator	Honami Ishizaki
Administrator	Tomoka Shibata
Administrator	Tomohiro Tanabe
Administrator	Kahori Nishi
Administrator	Kousei Motodoi
Designated Supervisor	Satoshi Furuhashi
Deputy Manager, Research Funding Division, Research Cooperation Department	Toshiyuki Yokoi

4. Committee of Other Organizations

Committee of Other Organizations

(34 in total)

Contact Post	Job Title	Organizations	Title / Name of Committee
Tetsuya Hiyama	Professor	International Arctic Science Committee (IASC)	Member, Terrestrial Working Group (TWG)
Hiroyuki Kitagawa	Professor	Geosciences	Editor
Yoshizumi Miyoshi	Professor	EISCAT Scientific Association	Council Member, Strategy Group on the Future of EISCAT
Yoshizumi Miyoshi	Professor	Committee on Space Research (COSPAR)	Chair, Panel on Radiation Belt Environment Modeling
Yoshizumi Miyoshi	Professor	Committee on Space Research (COSPAR)	Member, Task Group on Establishing a Constellation of Small Satellites (TGCSS) Sub-Group for Radiation Belt
Yoshizumi Miyoshi	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Bureau Member
Yoshizumi Miyoshi	Professor	National Science Foundation/ Geospace Environment Modeling (NSF/GEM)	Member, Steering Committee
Yoshizumi Miyoshi	Professor	Annales Geophysicae	Editor
Yoshizumi Miyoshi	Professor	Earth and Planetary Physics	Editor
Yoshizumi Miyoshi	Professor	Scientific Reports	Member, Editorial Board
Yoshizumi Miyoshi	Professor	Frontiers in Astronomy and Space Sciences	Associate Editor
Akira Mizuno	Professor	Network for the Detection of Atmospheric Composition Change	Member, Steering Committee (Japanese Co-Representative)
Michihiro Mochida	Professor	International Commission on Atmospheric Chemistry and Global Pollution (iCACGP)	Member
Michihiro Mochida	Professor	Atmospheric Environment	Member, Editorial Advisory Board
Kazuo Shiokawa	Professor	Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	President
Hiroyasu Tajima	Professor	Institute of Particle and Nuclear Studies, KEK	Member, B-factory Programme Advisory Committee
Hiroyasu Tajima	Professor	Progress of Theoretical and Experimental Physics	Executive Editor
Hiroyasu Tajima	Professor	The Scientific World Journal	Member, Editorial Board
Nobuhiro Takahashi	Professor	National Aeronautics and Space Administration (NASA)	Member, Global Precipitation Measurement (GPM) Joint Precipitation Science Team (JPST)
Nobuhiro Takahashi	Professor	National Aeronautics and Space Administration (NASA)	Member, Aerosol and Cloud, Convection and Precipitation (ACCP) Science and Application Transition Team (SATT)
Nobuhiro Takahashi	Professor	National Aeronautics and Space Administration (NASA)	Member, Aerosol and Cloud, Convection and Precipitation (ACCP) Algorithm Working Group (AWG)

Contact Post	Job Title	Organizations	Title / Name of Committee
Nobuhiro Takahashi	Professor	European Space Agency (ESA)	Member, Joint Mission Advisory Group for EarthCARE
Hirohiko Masunaga	Associate Professor	National Aeronautics and Space Administration (NASA)	Member, Atmosphere Observing System (AOS), Science and Applications Team (SAT), Algorithm Working Group (AWG)
Hirohiko Masunaga	Associate Professor	World Climate Research Programme (WCRP) Global Energy and Water cycle Exchanges (GEWEX)	Co-Chair / Member, GEWEX Data and Analysis Panel (GDAP)
Hirohiko Masunaga	Associate Professor	National Aeronautics and Space Administration (NASA) and JAXA	Member, Joint Precipitation Measurement Mission Science Team
Hirohiko Masunaga	Associate Professor	Sorbonne Université	Member, Ph.D. Monitoring Committee
Nozomu Nishitani	Associate Professor	Super Dual Auroral Radar Network (SuperDARN)	Vice Chair, Executive Council
Satonori Nozawa	Associate Professor	EISCAT Scientific Association	Council Member
Yuichi Otsuka	Associate Professor	Committee on Space Research (COSPAR)	Chair, Sub-Commission C1: The Earth’s Upper Atmosphere and Ionosphere
Yuichi Otsuka	Associate Professor	AGU: Geophysical Research Letters	Editor
Yuichi Otsuka	Associate Professor	Journal of Astronomy and Space Sciences	Editor
Hatsuki Fujinami	Lecturer	Climate and Ocean: Variability, Predictability and Change (CLIVAR)/ Global Energy and Water cycle Exchanges (GEWEX)	Member, Monsoons Panel Asian-Australian Monsoon Working Group
Hatsuki Fujinami	Lecturer	World Meteorological Organization (WMO)/ World Weather Research Programme (WWRP)	Member, Working Group on Tropical Meteorology Research (WG-TMR)
Hisashi Hayakawa	Designated Assistant Professor	International Association of Geomagnetism and Aeronomy (IAGA)	Co-Chair, Interdivisional Commission on History

5. Joint Research Programs

The ISEE was certified by the MEXT of Japan as a Joint Usage/Research Center for the fourth medium-term goal/planning period (FY2022 to FY2027) of national universities on October 29, 2021. During this period, we will promote and perform collaborative research on space–Earth environmental sciences with researchers from universities and institutes outside the ISEE. The ISEE will act as an international hub, connecting diverse fields to contribute to solving the global environmental issues affecting humankind and to developing human society. By understanding the Earth, the Sun, and space as a single system through the integration of space and Earth science, the mechanisms and interrelationships of the diverse phenomena occurring in the system can be elucidated. The program supports collaborative research in various forms, including ground, ocean, aircraft, and satellite observations, laboratory experiments, data analysis, and numerical simulations, and encompasses researchers affiliated with universities and research institutions in Japan and overseas, the related research community, and graduate students who will lead the future. Through this wide range of joint usage and research, we will contribute to solving issues related to global warming, extreme weather disasters such as typhoons and severe rain, and space-weather disasters that affect satellite operations, tele-communications, positioning systems, electrical power grids, and aviation control.

The following 17 categories of open-call joint research program were promoted: 00) ISEE International symposium, 01) International joint research, 02) Invited foreign researcher joint research, 03) International workshop, 04) General joint research, 05) Encouraged joint research for graduate students, 06) Research meetings, 07) Computing infrastructure, 08) Database management, 09) Accelerator mass spectrometry analysis, 10) Carbon-14 analysis, 11) SCOSTEP Visiting Scholar (SVS) Program, 12) Aircraft observations (dropsonde), 13) International travel support for field and laboratory experiments by students and early career scientists, 14) International technical exchange program, 15) International school support, and 16) International travel support for students (international presentation/institutional stay). During the fourth medium-term goal/planning period, we aimed to establish an International Joint Research Center to connect diverse disciplines by fostering young researchers, promoting international collaboration, and integrating different fields within the space and Earth sciences. Among these, 01), 02), 03), 11), and 13) to 16) are fully supported by the Center for International Collaborative Research (CICR), while 07) and 08) are supported by the Center for Integrated Data Science (CIDAS). In addition, the Division for Chronological Research and the Center for Orbital and Suborbital Observations (COSO), are promoting the joint research in 09) and 10), and 12), respectively. Concerning interdisciplinary research, four new projects led by the ISEE were selected through an internal call for proposals and initiated in 2021. In addition, since 2022, we have been calling for applications of bottom-up interdisciplinary/exploratory research proposed by researchers at institutions other than the ISEE.

Two ISEE Symposiums were held in 2024. The 7th ISEE Symposium “Data Rescue and Scientific Applications for Historical Solar-Terrestrial Environment Records” was jointly held with Space Climate Symposium 9 in Sakata and Hirata Hall, Nagoya University, from October 1 to 4, 2024. 161 participants from 25 countries attended the symposium to discuss solar activity and its impact on the Earth, particularly concerning extreme events, long-term variability, and data rescue. The 8th ISEE Symposium “Frontier of Space-Earth Environmental Research as Predictive Science” was held in the Noyori Conference Hall, Nagoya University, from March 5 to 7, 2025. 97 participants, representing 21 domestic and 19 foreign organizations, as well as the private sector, gathered to discuss space–Earth environmental predictions from various perspectives. Extensive discussions were held on advanced prediction methods and the developments necessary in the future to explore new research directions. In addition, at this symposium the 6th ISEE Award was presented to Dr KD Leka and Dr Sung-Hong Park for their “Outstanding contribution to space–Earth environmental research through prediction and understanding of solar flares”. They gave a commemorative lecture titled “Grounding and Rebounding: Establishing some Hard Truths [about Solar Flare Forecasting] so that Progress can be (is being) Made!”.

The annual ISEE Joint Usage/Research community meeting was held online on November 8, 2024. There were 72 participants. Special presentations were made on three projects picked from research categories 13) to 16), which were designed to foster young researchers and promote international collaboration, in addition to the presentations of results through regular joint research projects. Requests and opinions to improve the support for these categories were discussed, to make these initiatives more fruitful. A report on the activities of the Office for the Strategic Promotion of Interdisciplinary

Research and International Strategy (ODIRS) was presented, and the implementation plan of the “Transdisciplinary Network linking Space–Earth Environmental Science, History, and Archaeology” (TRAN SEHA) project, which was newly approved by the MEXT under the Coalition of Universities for Research Excellence (CURE) Program, was introduced and discussed. In addition, Director Shiokawa explained that the ISEE has been approved as a new International Joint Usage/Research Center from FY2025 and presented its specific implementation policies.

Regarding application procedures, the application form was changed from an Excel to a Word document, and the automatic applicant information reading system has improved the efficiency of the process, for example sorting the applications and sending them to reviewers. For applications made in FY2025, corresponding ISEE researchers can be selected from a list within the JROIS2-ISEE application/report web submission system.

List of Accepted Proposals

■ 02) ISEE International Joint Research Program (23 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Dating and chemical analysis of garnet in S-type granites for discriminating magma sources in western Iran	HajiHossein Azizi (Professor, University of Kurdistan, Iran)	Masayo Minami
Reconstruction of intense ENSO variability from dendrochronological records from Peru	Andrzej Rakowski (Professor, Silesian University of Technology, Poland)	Masayo Minami
Magnetoseismic investigation of heavy ions in the inner magnetosphere	Kazue Takahashi (Principal Professional Staff, The Johns Hopkins University, USA)	Yoshizumi Miyoshi
Dynamics & heating of the solar corona at the sites of small scale features (campfires and bright points) observed from Solar Orbiter/EUI and SDO/HMI	Rangaiah Kariyappa (Former Professor, Indian Institute of Astrophysics, India)	Satoshi Masuda
Evaluation of different techniques for deriving 3D wind fields from the PAWR observations and deriving precipitation from satellite observations	Chih-Chien Tsai (Associate Researcher, National Science and Technology Center for Disaster Reduction (NCDR), Taiwan)	Nobuhiro Takahashi
Identification of avian dietary change and its implications using isotopic technology	Xueqiang Lu (Professor, Nankai University, China)	Hiroyuki Kitagawa
Comparative studies on Earth’s and Mercury’s dynamic magnetospheres	Jih-Hong Shue (Professor, National Central University, Taiwan)	Masafumi Hirahara
Effects of ionospheric scintillation on the precision of GNSS precise point positioning (PPP) technique at low-latitude region	Prayitno Abadi (Researcher, Indonesian National Research and Innovation Agency (BRIN), Indonesia)	Yuichi Otsuka
Vortical plasma and magnetic structures in the solar atmosphere and beyond	Gary Verth (Senior Lecturer, The University of Sheffield (TUoS), UK)	Hideyuki Hotta
Estimation of quasi 2-day wave Momentum flux in the high latitude middle atmosphere	Grandhi Kishore Kumar (Assistant Professor, University of Hyderabad, India)	Satonori Nozawa
Nightside auroral outflows as source of the warm plasma cloak	Jing Liao (Adjunct Research Scientist, University of New Hampshire, USA)	Yoshizumi Miyoshi

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Solar and terrestrial effects in the 70-year long tritium and beryllium-10 record from the Dome Fuji in East Antarctica	Stepan Poluianov (Senior Researcher, University of Oulu, Finland)	Naoyuki Kurita
Relationship between gamma-ray flares and white light flares	Seiji Yashiro (Researcher, The Catholic University of America, USA)	Satoshi Masuda
Feasibility study of in situ and remote observations of the heliosphere and the Sun at the L4 point	Yukinaga Miyashita (Principal Researcher, Korea Astronomy and Space Science Institute, Korea)	Yoshizumi Miyoshi
Investigation of electromagnetic waves in the Earth’s magnetosphere using spacecraft and ground-based measurements	Ondrej Santolik (Head of the Department, Institute of Atmospheric Physics of the Czech Academy of Sciences (IAP), Czech Republic)	Yoshizumi Miyoshi
On the impact of geomagnetic disturbances in the gravity wave and tidal dynamics of the mesosphere in the auroral region	Viswanathan Lakshmi Narayanan (Assistant Professor, Krea University, India)	Satonori Nozawa
Conjugate observations of magnetospheric whistler-mode waves by KAN, PWING, and ERG/ARASE	Jyrki Manninen (Deputy Director, University of Oulu, Finland)	Claudia Martinez-Calderon
Comparing remote observations, in-situ measurements and simulations of the variation of the properties of coronal mass ejections Over 1–10° in longitude	Noé Lugaz (Research Professor, University of New Hampshire, USA)	Kanya Kusano
Reconstruction of physical properties of historical solar energetic particle events	Sergey Koldobskiy (Postdoctoral Researcher, University of Oulu, Finland)	Fusa Miyake
EISCAT – Arase study of energetic electron precipitation	Neethal Thomas (Postdoctoral Researcher, University of Oulu, Finland)	Yoshizumi Miyoshi
Investigating helicity transformation in coronal mass ejections using numerical simulations	Nada Al-Haddad (Research Associate Professor, University of New Hampshire, USA)	Kanya Kusano
Linking coronal mass ejections observed near the Sun and at 1 AU	Nariaki Nitta (Senior Staff Physicist, Lockheed Martin Solar and Astrophysics Laboratory, USA)	Kazumasa Iwai
Analysis of radial propagation of the solar wind in the inner heliosphere with multi space missions and SUSANOO propagation model	Sae Aizawa (CNRS Researcher, Laboratory of Plasma Physics, National Centre for Scientific Research (CNRS), France)	Yoshizumi Miyoshi

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

■ 03) ISEE International Workshop (3 in total)

Workshop title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Next Scientific Program (NSP) Committee meeting of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	Monica Laurenza (Research Scientist, Istituto Nazionale di Astrofisica (INAF), Italy)	Kazuo Shiokawa
Multi-satellite Observations and Modeling of the Earth’s Radiation Belts (MOMERB 1)	Jean Francois Ripoll (Director of Research, Commissariat à l’Energie Atomique (CEA), France)	Yoshizumi Miyoshi
Chemical Aeronomy in the Mesosphere and Ozone in the Stratosphere (CHAMOS) 2024 Workshop	Pekka T. Verronen (Professor, Finnish Meteorological Institute, Oulu University, Finland)	Tac Nakajima

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

■ 11) SCOSTEP Visiting Scholar (SVS) Program

(8 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
To investigate the role of storm/substorm time penetrated electric fields on triggering mechanism of nighttime electrified MSTIDs	Dipjyoti Patgiri（Graduate-course Student, Indian Institute of Technology Roorkee, India）	Yuichi Otsuka
SAR arc dynamics during high intensity long duration continuous AE activity (HILDCAA)	Ayushi Nema (Graduate-course Student, Sardar Vallabhbhai National Institute of Technology Surat, India)	Kazuo Shiokawa
A machine learning approach to predict equatorial plasma bubble parameters using All-Sky imager and C/NOFS	Moheb Yacoub Saad (Graduate-course Student, Egypt-Japan University of Science and Technology (EJUST), Egypt)	Kazuo Shiokawa
Research on magnetospheric processes corresponding to special dayside auroral structures	Huiting Feng (Graduate-course Student, Tongji University, China and GFZ, Germany)	Yoshizumi Miyoshi
Study on the generation and evolution of equatorial plasma bubbles under extreme weather, space weather, and natural hazard events and their connections to the mid-latitude processes	Dessalegn Ayehu (Graduate-course Student, Bahir Dar University, Ethiopia): ***declined***	Yuichi Otsuka
Modeling the Earth’s magnetic field using physics-informed neural networks	Ryoma Matsuura (Graduate-course Student, UCLA, USA): ***declined***	Yoshizumi Miyoshi
Pre-flare conditions of active regions and dynamics of the solar flares	Karla Franchesca Lopez Araujo (Graduate-course Student, Mackenzie Presbyterian University, Brazil)	Kanya Kusano
Investigation of post-midnight equatorial plasma bubbles: Observation and simulation	Luiz Fillip Rodrigues Vital (Graduate-course Student, National Institute for Space Research, Brazil)	Yuichi Otsuka

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

■ 13) International Travel Support for Field and Laboratory Experiments by Students and Early-carrier Scientists

(4 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Two-point simultaneous observation of subauroral optical emissions at Athabasca, Canada, using all-sky color cameras	Liwei Chen (Graduate Student, Nagoya University, Japan)	Kazuo Shiokawa
Spectroscopic measurement of ion upflow through Doppler shift of auroral 427.8-nm molecular nitrogen ion emission using a Fabry-Perot interferometer at Skibotn, Norway	Taiki Kikuchi (Graduate Student, Nagoya University, Japan)	Kazuo Shiokawa
Magnetospheric observations during pulsating aurora in Norway using the all-sky camera, EISCAT radar, and Arase satellite	Yuri Ito (Graduate Student, The Graduate University for Advanced Studies (SOKENDAI), Japan)	Yoshizumi Miyoshi
First light of Jupiter’s infrared aurora with the Tohoku University telescope at Haleakala, Hawaii	Ryota Kinoshita (Graduate Student, Tohoku University, Japan)	Yoshizumi Miyoshi

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

■ 14) International Technical Exchange Program

(4 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Development of high temporal resolution TEC database and plasma bubble detection method	Siti Aminah Binti Bahari (Research Officer, Universiti Kebangsaan, Malaysia)	Yuichi Otsuka
Exchange program in technical-knowledge and expertise in the field of Digital Phase Array and Signal Processing	Shin'ichiro Asayama (SKAO System Scientist, SKA Observatory, UK)	Kazumasa Iwai
Characterization of low-energy ion and neutral beamlines for development of space-borne particle analyzers	Manabu Shimoyama (Senior Scientist, Swedish Institute of Space Physics (IRF), Sweden)	Masafumi Hirahara
International exchange on chemical pretreatment and measurement techniques for high-precision isotope analysis of rock and sediment samples	Yoshihiro Asahara (Associate Professor, Nagoya University, Japan)	Masayo Minami

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

■ 15) ISEE International School Support

(2 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
School on Technical and Scientific Aspects of iMST Radar and Lidar	Jorge L. Chau (Head of Department, Leibniz Institute of Atmospheric Physics, Germany)	Kazuo Shiokawa
International Colloquium on Equatorial and Low Latitude Ionosphere (ICELLI)	Babatunde Rabiu (Professor/Executive Director, United Nations African Regional Centre for Space Science and Technology Education (UNARCSSTEE), Nigeria)	Kazuo Shiokawa

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

■ 16)-I (first term) International Travel Support for Students (International Presentation / Institutional Stay)

(3 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Poster presentation on estimation of size difference in solid precipitation particles at the International Conference on Clouds and Precipitation and participation in A Short Course on Cloud Microphysics and Radar Observations	Yusuke Goto (Graduate Student, Nagoya University, Japan)	Taro Shinoda
Presentation on the maintenance mechanisms of an orographic quasi-stationary convective band formed over the eastern part of Shikoku, Japan at the Asia Oceania Geosciences Society 21st Annual Meeting	Akira Nishii (Graduate Student, Nagoya University, Japan)	Taro Shinoda
Visit to NASA/GSFC for ground calibration tests of X-ray telescopes onboard a solar sounding rocket FOXSI-4	Koki Sakuta (Graduate Student, Nagoya University, Japan)	Yoshizumi Miyoshi

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

■ 16) -II (second term) International Travel Support for Students (International Presentation / Institutional Stay)

(4 in total)

Project title	Proposer (Job title*, Affiliation*)	Corresponding ISEE researcher
Presentations on the reproduction and evaluation of electron density variations in the lower ionosphere due to solar flares at AGU24 Annual Meeting	Shinnosuke Kitajima (Graduate Student, National Defense Academy, Japan)	Satoshi Masuda
Presentation of "Study on the spatio-temporal evolution of ICME approached by a multi-point comparison of Forbush decreases" at the 2024 Annual Meeting of the American Geophysical Union	Gaku Kinoshita (Graduate Student, The University of Tokyo, Japan)	Yoshizumi Miyoshi
Deep reaching wave energy-flux in the off-equatorial central and western regions of the Pacific Ocean during the El Nino and La Nina events	Borui Wu (Graduate Student, Nagoya University, Japan)	Hidenori Aiki
Presentation of 'Global electromagnetic field response during isolated substorms' at the AGU Fall Meeting 2024	Moe Hayashi (Graduate Student, Kyushu University, Japan)	Kazuo Shiokawa

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

Lists of Collaboration Resources

■ Instruments

(24 in total)

Name	Contact Person
Multi-Directional Cosmic Ray Muon Telescope (Nagoya)	Hiroaki Menjo
Multi-Station IPS Solar Wind Observation System (Toyokawa, Fuji, and Kiso)	Kazumasa Iwai
ELF/VLF Network	Kazuo Shiokawa
ISEE Magnetometer Network	Kazuo Shiokawa
ISEE Riometer Network	Kazuo Shiokawa
Optical Mesosphere Thermosphere Imagers	Kazuo Shiokawa
Sodium LIDAR (Tromsø)	Satonori Nozawa
MF Radar (Tromsø)	Satonori Nozawa
Five-Wavelength Photometer (Tromsø)	Satonori Nozawa
Meteor Radar (Alta)	Satonori Nozawa
SuperDARN Hokkaido Pair of (HOP) Radars (Rikubetsu)	Nozomu Nishitani
Upper Air Sounding Systems (two sets)	Kazuhisa Tsuboki
Polarimetric Radar Systems (two sets)	Kazuhisa Tsuboki
Ka-Band Polarimetric Radar	Kazuhisa Tsuboki
Hydrometeor Video Sonde (HYVIS) System	Kazuhisa Tsuboki
Fourier Transform Infrared (FTIR) Spectrometer for Atmospheric Composition Measurement (Rikubetsu)	Tomoo Nagahama
Sea Spray Aerosol Optical Particle Counter	Hidenori Aiki
Low-Background Beta-Ray Counter	Naoyuki Kurita
Water Isotope Analyzer (Picarro L2130-i)	Naoyuki Kurita
CHN Analyzer, Isotope Ratio Mass Spectrometer	Yoshihisa Mino
Aerosol Mass Spectrometer	Michihiro Mochida
CHNS Elemental Analyzer (vario MICRO cube, Elementar)	Masayo Minami
X-Ray Fluorescence Spectrometer (XRF)	Takenori Kato
X-Ray Diffractometer (XRD)	Takenori Kato

■ Software/Databases

(19 in total)

Name	Contact Person
Center for Heliospheric Science	Yoshizumi Miyoshi, Kanya Kusano
QL Plot Archive of Satellite Data for Integrated Studies	Yoshizumi Miyoshi
MHD Simulation on the Magnetospheric Environment	Yoshizumi Miyoshi
Interplanetary Scintillation Data	Kazumasa Iwai
Solar Wind Speed Data	Kazumasa Iwai
Remei Satellite Observation Database	Masafumi Hirahara
Coordinated Magnetic Data Along 210° Magnetic Meridian (Moshiri, Rikubetsu, Kagoshima, and Overseas MM Stations)	Kazuo Shiokawa

Name	Contact Person
Database of the Optical Mesosphere Thermosphere Imagers	Kazuo Shiokawa
ELF/VLF Wave Data	Kazuo Shiokawa
ISEE Riometer Network Database	Kazuo Shiokawa
All-Sky Auroral Data (Canada, Alaska, and Siberia)	Kazuo Shiokawa, Yoshizumi Miyoshi
VHF Radar/GPS Scintillation (Indonesia)	Yuichi Otsuka
EISCAT Database	Satonori Nozawa, Shin-ichiro Oyama
SuperDARN Hokkaido Pair of (HOP) Radars Database	Nozomu Nishitani
Cloud Resolving Strom Simulator (CReSS)	Kazuhisa Tsuboki
Atmospheric Composition Data by FTIR Measurements (Moshiri and Rikubetsu)	Tomoo Nagahama
NO_2 and O_3 Data by UV/Visible Spectrometer Measurements (Moshiri and Rikubetsu)	Tomoo Nagahama
Satellite Data Simulator Unit (SDSU)	Hirohiko Masunaga
Energy Flux Diagnosis Code for Atmospheric and Oceanic Waves	Hidenori Aiki

■ Facilities (10 in total)

Name	Contact Person
CIDAS System	Satoshi Masuda, Yoshizumi Miyoshi
Ion/Electron Beamline and Calibration Facility	Masafumi Hirahara
Clean Room Facility for Instrument Development	Masafumi Hirahara
Tandetron Accelerator Mass Spectrometry	Hiroyuki Kitagawa, Masayo Minami
Electron Probe Microanalyzer (EPMA)	Takenori Kato
Facilities at Moshiri Observatory	Michihiro Maochida
Facilities at Rikubetsu Observatory	Akira Mizuno
Facilities at Kiso Station	Kazumasa Iwai
Facilities at Fuji Observatory	Kazumasa Iwai
Facilities at Kagoshima Observatory	Yuichi Otsuka

ISEE Award

Award winners	Rationale	Ceremony
KD Leka (Senior Research Scientist, NorthWest Research Associates, USA) Sung-Hong Park (Researcher, Korea Astronomy and Space Science Institute, Korea)	Outstanding contribution to space–Earth environmental research through prediction and understanding of solar flares	Mar. 6, 2025

6. Governance

2024 Mid-Year Committee Changes: New Appointments: ○ / Resignations: ▲

Advisory Board

Masaki Fujimoto	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
Naomi Harada	Center for International and Local Research Cooperation, Atmosphere and Ocean Research Institute, The University of Tokyo
Yugo Kanaya	Earth Surface System Research Center, Japan Agency for Marine-Earth Science and Technology
Takaaki Kajita	Institute for Cosmic Ray Research, The University of Tokyo
Yukio Katsukawa	Solar Science Observatory, National Astronomical Observatory of Japan, National Institutes of Natural Sciences
Eiichi Nakakita	Disaster Prevention Research Institute, Kyoto University
Takuji Nakamura	National Institute of Polar Research, Research Organization of Information and Systems
Nobuko Saigusa	Earth System Division, National Institute for Environmental Studies
Kanako Seki	Graduate School of Science, The University of Tokyo
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Hideyuki Hotta	Institute for Space–Earth Environmental Research, Nagoya University
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Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Masayo Minami	Institute for Space–Earth Environmental Research, Nagoya University
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University
Akira Mizuno	Institute for Space–Earth Environmental Research, Nagoya University
Michihiro Mochida	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyasu Tajima ○	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University

Collaborative Research Committee

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Kazuhito Ichii ○	Center for Environmental Remote Sensing, Chiba University
Akira Kadokura	Polar Environment Data Science Center, Joint Support-Center for Data Science Research, Research Organization of Information and Systems
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Yuto Katoh	Graduate School of Science, Tohoku University
Kazuyuki Kita	Graduate School of Science and Engineering, Ibaraki University
Yoko S. Kokubu	Tono Geoscience Center, Japan Atomic Energy Agency
Yuki Kubo	Radio Research Institute, National Institute of Information and Communications Technology
Shuichi Matsukiyo	Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
Takashi Minoshima	Research Institute for Value-Added-Information Generation, Japan Agency for Marine-Earth Science and Technology
Akihiko Morimoto	Center for Marine Environmental Studies, Ehime University
Takeshi Sakanoi	Graduate School of Science, Tohoku University
Kimikazu Sasa	Physics, Faculty of Pure and Applied Sciences, University of Tsukuba
Kanako Seki	Graduate School of Science, The University of Tokyo
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Hidenori Aiki	Institute for Space–Earth Environmental Research, Nagoya University
Tetsuya Hiyama	Institute for Space–Earth Environmental Research, Nagoya University
Kazumasa Iwai	Institute for Space–Earth Environmental Research, Nagoya University
Takenori Kato	Institute for Space–Earth Environmental Research, Nagoya University
Satoshi Masuda	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
Akira Mizuno	Institute for Space–Earth Environmental Research, Nagoya University
Michihiro Mochida	Institute for Space–Earth Environmental Research, Nagoya University
Tomoo Nagahama	Institute for Space–Earth Environmental Research, Nagoya University
Satonori Nozawa	Institute for Space–Earth Environmental Research, Nagoya University
Yuichi Otsuka	Institute for Space–Earth Environmental Research, Nagoya University
Taro Shinoda	Institute for Space–Earth Environmental Research, Nagoya University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University

Joint Research Technical Committee

Integrated Studies Technical Committee

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Iku Shinohara	Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency
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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

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Shuichi Matsukiyo	Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
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Kazumasa Iwai	Institute for Space–Earth Environmental Research, Nagoya University
Fusa Miyake	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyasu Tajima○	Institute for Space–Earth Environmental Research, Nagoya University

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Yoshiya Kasahara	Emerging Media Initiative, Kanazawa University
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Masahito Nosé	School of Data Science, Nagoya City University
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Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University
Satonori Nozawa	Institute for Space–Earth Environmental Research, Nagoya University
Yuichi Otsuka	Institute for Space–Earth Environmental Research, Nagoya University

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Akira Mizuno	Institute for Space–Earth Environmental Research, Nagoya University
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Tomoo Nagahama	Institute for Space–Earth Environmental Research, Nagoya University

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Hiroyuki Kitagawa	Institute for Space–Earth Environmental Research, Nagoya University
Masayo Minami	Institute for Space–Earth Environmental Research, Nagoya University

Airplane Usage Technical Committee

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Seiho Uratsuka	Radio Research Institute, National Institute of Information and Communications Technology
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Hiroyasu Tajima	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University

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Michihiro Mochida	Institute for Space–Earth Environmental Research, Nagoya University
Nozomu Nishitani	Institute for Space–Earth Environmental Research, Nagoya University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University

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Akimasa Yoshikawa	Faculty of Science, Kyushu University
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Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University
Kazuhisa Tsuboki	Institute for Space–Earth Environmental Research, Nagoya University

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Riko Oki	Earth Observation Research Center, Space Technology Directorate I, Japan Aerospace Exploration Agency
Hiroyuki Yamada ▲	Faculty of Science, University of the Ryukyus
Masafumi Hirahara	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyasu Tajima	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University

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Mamoru Ishii	Institute for Space–Earth Environmental Research, Nagoya University
Kazumasa Iwai	Institute for Space–Earth Environmental Research, Nagoya University
Tetsuya Hiyama	Institute for Space–Earth Environmental Research, Nagoya University
Ryota Kikuchi	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyuki Kitagawa	Institute for Space–Earth Environmental Research, Nagoya University
Kanya Kusano	Institute for Space–Earth Environmental Research, Nagoya University
Claudia Martinez	Institute for Space–Earth Environmental Research, Nagoya University
Masayo Minami	Institute for Space–Earth Environmental Research, Nagoya University
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Michihiro Mochida	Institute for Space–Earth Environmental Research, Nagoya University
Yasunori Mori	Institute for Space–Earth Environmental Research, Nagoya University
Kazuo Shiokawa	Institute for Space–Earth Environmental Research, Nagoya University
Hiroyasu Tajima	Institute for Space–Earth Environmental Research, Nagoya University
Nobuhiro Takahashi	Institute for Space–Earth Environmental Research, Nagoya University

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Yukiko Kawamoto	Center for Digital Humanities and Social Sciences, Nagoya University
Masao Ohno	Kyushu University
Minoru Sakamoto	National Museum of Japanese History
Fuyuki Tokanai	Yamagata University
Naoshi Hayakawa	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
Yoshizumi Miyoshi	Institute for Space–Earth Environmental Research, Nagoya University

International Advisory Board

David Gustafsson	Swedish Meteorological and Hydrological Institute, Sweden
Emi Ito	University of Minnesota, USA
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Rene Ong	University of California, USA
Claudia Stolle	Atmospheric Physics at University of Rostock, Germany
Ilya Usoskin	University of Oulu, Finland
Chaoxia Yuan	Nanjing University of Information Science and Technology, China

7. Finance

External Funding and Industry–Academia–Government Collaborations

Researchers 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 Transformative Research Areas (A)	1	23,113,958
Grant-in-Aid for Scientific Research (S)	3	237,128,307
Grant-in-Aid for Scientific Research (A)	8	90,070,000
Grant-in-Aid for Scientific Research (B)	6	26,520,000
Grant-in-Aid for Scientific Research (C)	8	7,670,000
Grant-in-Aid for Challenging Research (Pioneering)	1	4,810,000
Grant-in-Aid for Challenging Research (Exploratory)	5	10,270,000
Grant-in-Aid for Early-Career Scientists	3	4,680,000
Grant-in-Aid for Research Activity Start-up	2	1,820,000
Fund for the Promotion of Joint International Research (International Leading Research)	1	106,600,000
Fund for the Promotion of Joint International Research (Fostering Joint International Research (B))	1	4,550,000
Fund for the Promotion of Joint International Research (International Collaborative Research)	2	12,870,000
Grant-in-Aid for JSPS Fellows	4	12,470,000
Total	45	542,572,265

- Forty-five research subjects listed in the table were supported by the JSPS KAKENHI.
- Thirty-three research subjects received total 251,577,218 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.
- Five research subjects received total 52,244,425 JPY of donation.

Libraries

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

Books

Japanese	3,292
Foreign	11,171

Journals

Japanese	47
Foreign	207

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

Books

Japanese	4,552
Foreign	8,832

Journals

Japanese	281
Foreign	241

Properties

	Site (m^2)	Buildings (m^2)	Location
Higashiyama Campus (Main campus of Nagoya University)	-	8,442	Aichi
Toyokawa Campus	94,212	1,461	Aichi
Moshiri Observatory	110,534	325	Hokkaido
Rikubetsu Observatory	28,146	167	Hokkaido
Kagoshima Observatory	13,714	287	Kagoshima
Fuji Observatory	19,926	174	Yamanashi
Kiso Station	6,240	66	Nagano
Total	272,772	10,922	

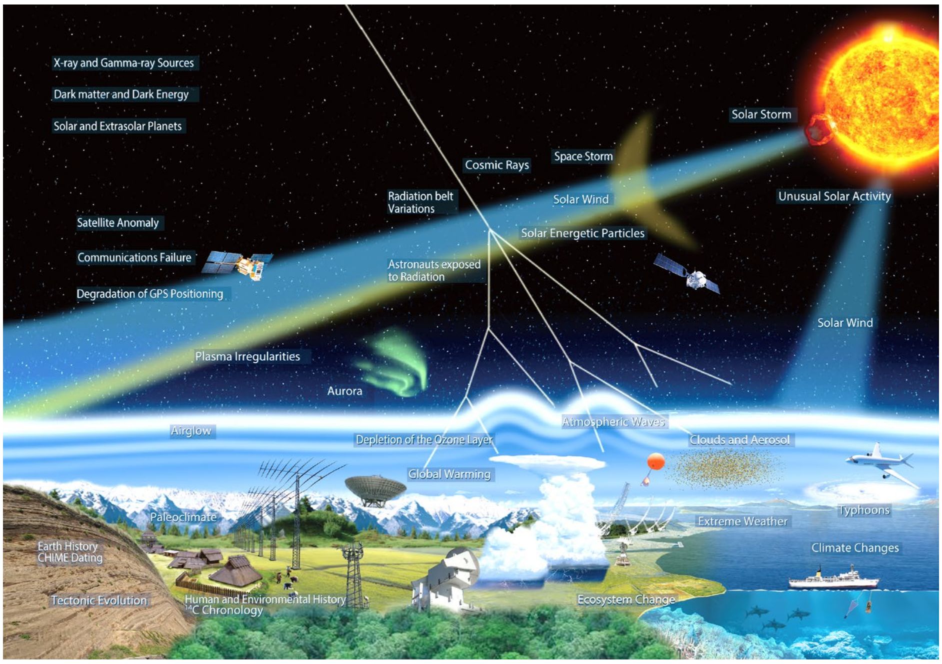
8. Research Topics

The mission of the ISEE is to comprehend the mechanisms and interactions of diverse processes occurring in the integrated space–Sun–Earth system to deal with global environmental problems and contribute to human society in the space age. Diverse research topics have been studied under seven research Divisions for Integrated Studies, Cosmic Ray Research, Heliospheric Research, Ionospheric and Magnetospheric Research, Meteorological and Atmospheric Research, Land–Ocean Ecosystem Research, and Chronological Research. Additionally, to develop new interdisciplinary research, the Institute will perform the following four interdisciplinary research projects in 2024 based on proposals from young faculty members using the director's Leadership Funds:

1) Energetic Particle Chain -Effects on the Middle/Lower Atmosphere from Energetic Particle Precipitations-
2) Direct Search for Dark Matter with Paleo-Detector
3) Data Rescues of the Analog Observational Records for the Past Solar-Terrestrial Environment
4) Changes in Surface Temperature at Dome-Fuji in East Antarctica from the Mid-Twentieth Century and the Impact of Solar Activity

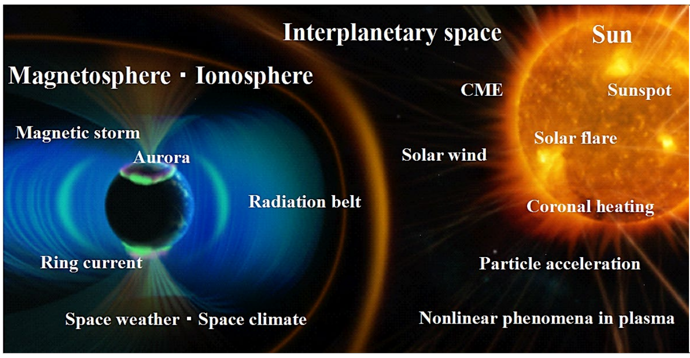
In this fiscal year, a new project titled "Transdisciplinary Network Linking Space–Earth Environmental Science, History, and Archaeology" was launched following its selection for the MEXT "Coalition of Universities for Research Excellence Program (CURE)" under the initiative for Promoting the Development of a Joint Usage/Research System. As a result, interdisciplinary research has made further progress. In conjunction with this initiative, our institute established the "Office for the Promotion of Transdisciplinary Network Formation" as a central hub to facilitate collaboration with the five participating institutions and formally launched its activities. The seven research divisions are introduced in Section 8-1. "Research Divisions," Office for the Development of Interdisciplinary Research Strategy and its interdisciplinary research projects are introduced in Section 8-3, and the Office for the Promotion of Transdisciplinary Network Formation is introduced in Section 8-4.

The ISEE also has three research centers that contribute to the 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 using four domestic observatories (Moshiri, Rikubetsu, Fuji, and Kagoshima) and a global observation network to enhance collaboration and joint research between domestic and international researchers and institutions. The Center for Integrated Data Science (CIDAS) is developing infrastructure and research for 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) performs planning and technological research using orbital and suborbital observation vehicles, such as aircraft, balloons, rockets, and satellites, with domestic and international networks. More information on these Research Centers can be found in "8-2. Research Centers."



Research Subjects at the ISEE

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
- Numerial simulation
- Data assimilation

The Division for Integrated Studies conducts scientific research that aims to comprehensively understand and predict phenomena in the solar–terrestrial and planetary system using advanced numerical simulations and data analyses. In particular, we promote studies designed to elucidate processes such as solar cycles, solar flares, coronal mass ejections (CMEs), geomagnetic storms, and auroras, in which nonlinear interactions and coupling between different systems play an important role. We also promote scientific satellite missions (Hinode, Arase, and Mio satellites) for observing the Sun, interplanetary space, Mercury, 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 also responsible for education in the School of Science, the School of Engineering, as well as the Graduate School of Science and the Graduate School of Engineering at Nagoya University.

Main Activities in FY2024

Inversion for inferring solar MC: a case with constraints on the AM transport inside the Sun

The meridional circulation (MC) in the Sun is an essential component of the solar dynamo mechanism. There have been several attempts to infer the internal solar MC profile, e.g., via time–distance helioseismology. However, the current understanding remains far from a convergence; it is unclear whether the MC profile is, overall, single-celled or double-celled. This is because it is difficult to invert measured travel times in which the solar MC signal is extremely small. To carry out MC inversion as robustly as possible, we propose conducting such inversion with a constraint—that the angular momentum (AM) transport of the MC is equatorward. Adding this constraint was motivated by previous numerical results (Hotta and Kusano, 2021) when solar equator fast rotation was reproduced without any manipulation. Inversion with this constraint resulted in a double-cell MC profile. However, we also confirmed that adding the constraint degraded the resolution of the averaging kernels, requiring us to be conservative and not to conclude that the solar MC profile is double-celled. Although we have thus not reached a definitive conclusion on the large-scale morphology of the solar MC profile, our attempts highlight the relevance of investigating the solar MC profile from both theoretical and observational perspectives.

Modeling the solar TR: effects of spatial resolution on the atmospheric structure, emissions, and non-equilibrium ionization

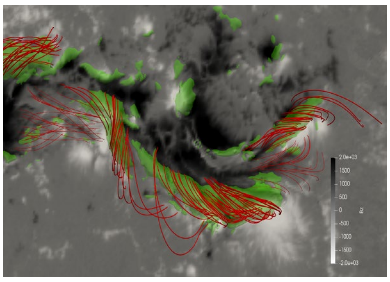
The solar transition region (TR) is a narrow interface between the chromosphere and corona, where the emitted radiation carries essential information about coronal heating processes. We performed two-dimensional (2D) radiation magnetohydrodynamics simulations with adaptive mesh refinement to capture both the fine structure of the TR and the large-scale dynamics driven by surface convection. Alongside the simulations, we computed the time evolution of ionization fractions for oxygen ions. The TR was resolved down to a minimum grid size of 1.25 km, allowing sufficient resolution of the upper TR ($\log_{10}T \gtrsim 5$), though the lower TR ($\log_{10}T \lesssim 5$) remained under-resolved. Doppler shifts and non-thermal line widths synthesized from TR emissions converged at grid sizes as coarse as 40 km, though some differences persisted between our results and the observed TR line properties. A significant enhancement in O VI emissions, which stabilized at a grid size of 2.5 km, revealed an intensity 1.2 times higher than expected under ionization equilibrium, likely due to shock interactions with the TR. While further model refinements are necessary, our ability to resolve the TR provides valuable insight into TR line formation under non-equilibrium ionization, contributing to a deeper understanding of the coronal heating problem.

Statistical study of microflares observed with the Nobeyama Radioheliograph

Taking advantage of the high sensitivity of the Nobeyama Radioheliograph to detect non-thermal emissions from the high-energy electrons produced by solar flares, we applied a newly developed detection algorithm and succeeded in automatically detecting extremely small solar flares (microflares) that have not been studied previously. We investigated the correlations between the radio peak flux and the radio emission duration, the spatial size of the radio emission region, and the soft X-ray peak flux for two groups of flares (the microflares and previously detected large and medium-sized flares). There were no significant differences in the properties of the two groups. We also proposed an interpretation that neatly explains the flare-scale dependence of the radio spectrum, which at first glance seems to contradict this result.

Predictive analyses of significant solar flares in active region NOAA 13664

Solar active region NOAA 13664 produced 12 X-class flares, causing severe space-weather events in May 2024. We systematically analyzed the evolution of the three-dimensional (3D) magnetic field of this active region using the nonlinear force-free field extrapolation technique. We also investigated the relationship between the magnetic field structure and the flares. Furthermore, we apply a physics-based prediction scheme, the κ-scheme (Kusano et al., 2020), to this region. Consequently, we found that the most notable feature of this region is the presence of multiple high free energy regions where the non-potential field intensity exceeds 1000 G. The large amount of free energy and the complex distribution of the high free energy regions was the leading cause of the consecutive large flares. We confirmed that the κ-scheme could predict these flares.



Distribution of the magnetic field of AR 13664 at 06:00 UT on May 10, 2024, just before the X3.9 flare.

Studying the MHD waves in the solar wind by comparing radio occultation observations with magnetohydrodynamic simulations

The solar wind accelerates rapidly ~700 km from the Sun. The possible mechanisms of this acceleration suggest that magnetohydrodynamic (MHD) waves, such as Alfvén and magnetosonic waves, play an important role in transferring energy from the photosphere to the corona. However, we have insufficient observational confirmation of this. To confirm the composition of the MHD waves in the accelerated region, we analyzed radio occultation data, a kind of remote sensing data based on radio waves, collected by the Akatsuki spacecraft. In this study, we compared the plasma density fluctuations observed by Akatsuki's radio occultation with MHD simulation data (Shoda et al., 2021) and investigated the properties of MHD waves with density fluctuations in the accelerated region. The results suggest that the plasma density fluctuations detected by the radio occultation include fast and slow magnetosonic waves. Based on these properties of the MHD waves, the energy transport in the solar corona will be investigated in further studies.

Reproducing the diversity of solar wind using 3D radiative magnetohydrodynamic simulations

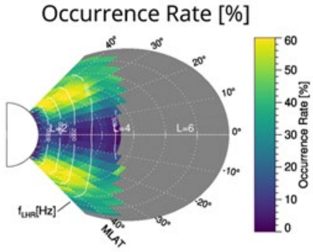
Solar wind characteristics vary significantly depending on observational location and timing. They are classified according to various parameters, such as wind speed, plasma density and temperature, Alfvén wave intensity, temporal variability, and elemental composition. A prominent example is their categorization into high-speed and low-speed solar winds. When these solar winds with different velocities collide in interplanetary space, they can trigger planetary magnetic disturbances. Understanding and predicting the impact of solar wind on the surrounding space environment requires clarifying the conditions and mechanisms responsible for its diversity. In this study, we conducted a comprehensive parameter survey using 3D radiative magnetohydrodynamic simulations running on the RIKEN supercomputer "Fugaku," solving the system consistently from the solar interior to solar wind acceleration. We successfully reproduced a wide variety of solar wind types, ranging from low-speed winds traveling at less than 300 km/s to high-speed winds exceeding 500 km/s.

Geospace variations associated with the extreme space storm in May 2024

In May 2024, an extreme geospace storm—the largest in nearly two decades—occurred, causing significant variations in the geospace environment. The Arase satellite successfully observed a dramatic increase (of more than three orders of magnitude) in relativistic electron fluxes inside the impenetrable barrier ($L < 3$), followed by a sustained decrease. This study focused on the decay phase of the electron fluxes and derived the energy dependence of the decay time constants. Furthermore, we compared the observed decay time constants with those expected from the plasma wave data obtained by Arase. The results suggest that whistler-mode hiss waves are responsible for the scattering of high-energy electrons in the low L-shell regions.

The ring-current ion composition during the May 2024 super geomagnetic storm, observed by the Arase satellite

The Arase satellite successfully obtained data on the ring-current ion composition in the inner magnetosphere during a super geomagnetic storm (SYM-H minimum: −518 nT) on May 10–11, 2024. These were the first in-situ observations of ring-current ions with simultaneous monitoring of upstream solar wind parameters during a large geomagnetic storm with a SYM-H minimum below −250 nT. Despite the high solar wind density, the majority of the energy density of the ring-current ions was carried by ions of terrestrial origin, such as oxygen ions. This suggests that the ions that carry the super-intense ring current are overwhelmingly of terrestrial origin, although the energy that drives super geomagnetic storms originates from the solar wind.



Latitudinal distribution of the occurrence rate of lower-hybrid-resonance band emissions detected by the Arase satellite.

Discovery of mid-latitude plasmaspheric LHR band emissions

The lower-hybrid-resonance (LHR) frequency (fLHR) is an essential parameter in plasma physics, as it influences the reflection of whistler mode waves and plasmaspheric hiss generation. LHR-band emissions, typically occurring near the fLHR, can heat electrons and ions via Landau resonance and contribute to particle acceleration at the magnetopause. Van Allen Probes have observed these emissions near the plasmapause, mainly around the magnetic equator, with proton ring distributions and density gradients as possible energy sources. The Arase satellite, with its high-inclination orbit, extends observations beyond the equatorial region, frequently detecting LHR-band emissions at mid-latitudes (|MLAT| > 20°) inside the plasmasphere. Statistical analysis of the Arase data showed that most such emissions occur at |MLAT| ~ 30° and L = 2–3 on the dayside, differing from previous equatorial observations. The study also revealed the varying energy sources of lightning whistlers and plasmaspheric hiss in different L-shells. The latitudinal distribution of the LHR-band emissions suggested a link to magnetospheric reflection. Ray-tracing analysis indicated that mode conversion from whistler to lower hybrid waves explained their distribution. This discovery highlights the role of mid-latitude LHR-band emissions in electron dynamics and their connection between the magnetosphere and atmosphere.

Studies of EMIC waves in the inner magnetosphere

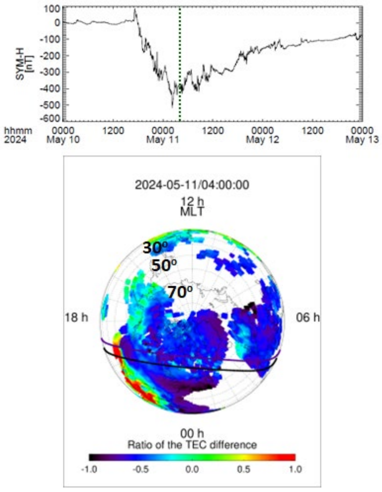
Electromagnetic ion cyclotron (EMIC) wave–particle interactions are believed to play a significant role in controlling the dynamics of energetic particles in the magnetosphere. In particular, nonlinear processes can cause rapid losses of relativistic electrons in the outer radiation belt. We demonstrated the impact of EMIC rising-tone emissions on relativistic electrons in the inner magnetosphere using data obtained from Van Allen Probes and the Arase satellite. The strong flux drop-out of relativistic electrons in directions parallel to the magnetic field, with energies of 0.2–4 MeV, were associated with intense EMIC rising-tone emissions that occurred during increases in solar wind pressure. We concluded that EMIC rising-tone emissions contribute not only to the rapid loss of MeV electrons through EMIC wave–particle interactions, while extending the resonance energy to a few MeV by broadening the bandwidth via nonlinear wave growth, but also to interactions with sub-MeV electrons through the non-resonant effect. During the May 2024 storm, the minimum Dst index was approximately −412 nT, marking the largest geomagnetic storm of the past decade. This event caused the inner edge of the ring current to deeply penetrate the inner magnetosphere during the main phase of the storm. We presented observations of high-frequency (HF) EMIC wave activity during this intense geomagnetic storm using data from the Arase satellite. The Arase observations showed that HF EMIC waves, with frequencies of 5–36 Hz at L ~2, occurred primarily during the main and early-recovery phases. The minimum resonance energy of the energetic protons and relativistic electrons associated with the HF EMIC waves suggested that they could cause the loss of relativistic electrons in low L-shell regions. Our observations provide new insight into the generation of EMIC waves and the dynamics of energetic particles in low L-shells in the inner magnetosphere.

Investigation of EMIC wave-particle interactions and proton precipitation during the May 27, 2017 storm

Geomagnetic storms generate plasma waves in the Earth's magnetosphere, including EMIC waves, which play a crucial role in magnetosphere–ionosphere coupling. EMIC waves can scatter ring-current protons, leading to their precipitation into the sub-auroral ionosphere. This study utilized the BATS-R-US + RAM-SCBE model to analyze EMIC wave evolution, their correspondence to proton precipitation, and the model's ability to reproduce observed wave–particle interactions. During the May 27, 2017, storm, EMIC waves were observed in the inner magnetosphere by the Arase and RBSP-A satellites. Concurrently, the DMSP and NOAA/MetOp satellites recorded significant proton precipitation in the dusk–midnight sector. Simulation results indicated that both H-band and He-band EMIC waves were excited near the plasmapause by strong temperature anisotropy. The simulated EMIC wave growth rates followed trends similar to the satellite observations, demonstrating the qualitative ability of the model to replicate EMIC wave activity. Furthermore, the model reproduced proton precipitation fluxes consistent with DMSP and NOAA/MetOp satellite observations, reinforcing the hypothesis that EMIC wave scattering of ring-current protons leads to precipitation in the sub-auroral ionosphere. These findings enhance our understanding of EMIC wave-driven proton precipitation and its implications in space-weather predictions, emphasizing the importance of coupling between the inner magnetosphere and ionosphere during geomagnetic storms.

Electron density variation in the plasmasphere and ionosphere during the May 2024 super geomagnetic storm

We analyzed total electron content (TEC) and Arase satellite observation data to elucidate electron density variations in the plasmasphere and ionosphere during the May 2024 storm. For identification of the electron density variation in the ionosphere, we calculated the TEC difference ratio (rTEC), defined as the difference from a quiet-day average TEC normalized by the average value. We also derived the electron density in the plasmasphere and inner magnetosphere from the upper limit frequency of the upper-hybrid resonance waves observed by the Arase satellite. An L-t diagram of the electron density showed shrinkage of the plasmasphere associated with storm onset. After the onset of the storm-recovery phase, the plasmasphere recovered to its level during geomagnetically quiet times on a 4-day scale; the time-scale of plasmaspheric refilling was much longer than that of other storms. Additionally, several polar maps of rTEC during the storm showed that a strong negative storm occurred globally owing to a neutral composition (O/N_2) change driven by energy input from the magnetosphere to the high-latitude thermosphere. Therefore, the contribution of negative storms to the plasmaspheric refilling process should be included in plasmaspheric and inner magnetospheric models.

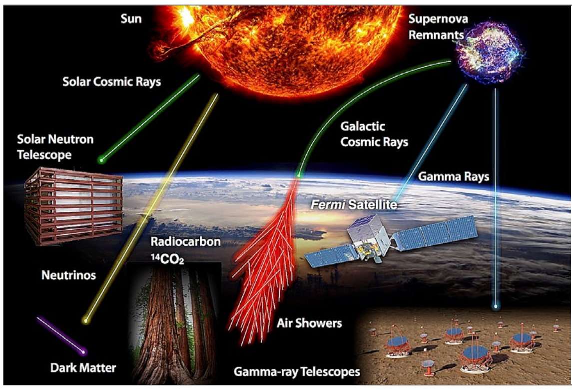


(Upper panel) Time-series plot of the geomagnetic index (SYM-H) during May 10–13, 2024. (Lower panel) Polar map of rTEC in the Northern Hemisphere. The vertical dashed line in the time-series plot indicates the time of the polar map.

Arase satellite observations of ring-current ions to estimate the O^+–H charge-exchange cross section during the recovery phase of the May 2024 magnetic storm

Magnetic storms are characterized by the ring current in the inner magnetosphere of Earth. Decay of the ring current is often associated with the decay of atomic oxygen ions (O^+) at 10–100 keV through charge–exchange reactions with geocoronal neutral hydrogen atoms (H). However, the corresponding charge–exchange cross section of this particle pair (O^+–H) has not been clarified at this energy range in laboratory experiments. In this study, we clarify this charge–exchange cross section using Arase satellite observations of the magnetosphere. For this analysis, we selected a non-substorm interval during the late recovery phase of the magnetic storm that occurred in May 2024. We compared 10–180 keV ions over a satellite pass and those of another pass 19 h later. The results of the comparison indicated that the obtained charge–exchange cross sections were approximately half of the traditional values. This result should be further evaluated in future statistical studies.

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 activity probed by cosmogenic nuclides
- Particle astrophysics and non-accelerator physics
  – Dark matter and neutrino physics

Cosmic rays (CRs), which primarily comprise protons and small amounts of charged particles, such as electrons or nuclei, and neutral particles, such as gamma-rays or neutrinos, are produced in space and propagate through interstellar and interplanetary magnetic fields (IMFs) before reaching the Earth. The Division for Cosmic Ray Research observes cosmic gamma-rays using the Fermi Gamma-ray Space Telescope (Fermi satellite), Cherenkov Telescope Array (CTA), and high-altitude solar neutron observations to elucidate 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 the laboratory. We conducted the Large Hadron Collider forward (LHCf) and the Relativistic Heavy Ion Collider forward (RHICf) experiments to study the hadronic interactions between ultra-high-energy CRs using accelerators such as the LHC and RHIC. This Division also conducted neutrino physics research using the Super-Kamiokande experiment and promoted the Hyper-Kamiokande project as a future prospect. The group intensively worked on direct dark-matter searches using the XENONnT experiment at the Gran Sasso National Laboratory (LNGS) in Italy.

CRs deeply penetrate the atmosphere, producing ionizing 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 obtained from Antarctic ice cores.

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Main Activities in FY2024

Search for dark matter and research on the CR origins using gamma-ray observations

Cosmic gamma rays are produced through interactions between dark matter, CRs, and the interstellar medium. Therefore, they can serve as indicators to search for dark matter and investigate the properties and distribution of CRs and interstellar media.

We are currently developing a next-generation gamma-ray observatory, called the CTAO, to observe cosmic gamma rays in the energy range from well below 100 GeV to above 100 TeV. This involves overseeing the development, procurement, and calibration of silicon photomultipliers (SiPMs) for small-sized telescopes (SSTs) installed in the CTA. Currently, we are building a camera for the first SST and have procured all the SiPM modules required for one camera and some spares. We also started procuring SiPMs for 5 more cameras since the lead time is more than one year including the international bidding process.

Since we plan to build more than 40 SSTs with 2048 SiPMs, it is important to understand their failure modes and rates. In an initial test, we measured the leakage current of two SiPM modules, totaling 128 SiPMs, for more than half a year. In this test, a SiPM exhibited a 10-hold increase in the leakage current, no visible increase was observed in its dark count rate, indicating that the increase was not caused by a higher dark count rate. Furthermore, the voltage dependence of the leakage current exhibited resistor-like behavior, verifying the existence of a current source parallel to the SiPMs.

Visual inspection of the surface of the SiPM found damages to the electrode, and temperature measurement by far-infrared verified localized ohmic heating in this region. From this evidence, we concluded that the damage to the aluminum electrode is the root cause of the large current increase. The manufacturer plans to screen out this kind of damage by automatic visual inspection in future productions.

The leakage current in 20% of the SiPMs jumped by fixed amounts and some SiPMs exhibited several jump modes. We speculate that these modal jumps are caused by the activation and deactivation of a certain defect, and that multimodal behavior is caused by multiple defects. In fact, we observed localized visual light emission from hot-carrier luminescence at these defect sites and found that the luminosity was proportional to the excess dark current, indicating that the majority of the excess dark current is caused by these emission sites. We also found that the jumps of the current coincide with the brightness changes of the emission sites. Observations by a photo-emission microscope revealed that there are many emission sites and bright spots are always located near the corner of microcells where the electric field is high. From these observations, we conclude that the excess dark currents are caused by defects. The electric field dictates the brightness and the dark current caused by defects. This indicates that we may be able to reduce excess dark current by lowering the field strength by the design improvement.

Historic CR-intensity variation measurements using cosmogenic radioisotopes

The CRs that reach Earth interact with the atmosphere to produce secondary particles. Among these, long-lived cosmogenic nuclides, such as ^{14}C and ^{10}Be, have been conventionally used as reliable proxies for reconstructing past CR intensities. To investigate variations in past CR flux, we measured ^{14}C concentrations in tree-rings and ^{10}Be concentrations in ice cores. These analyses revealed rapid CR-increase events during several periods, including 774/775 CE, 993/994 CE, and around 664 BCE. These events are considered to have been caused by solar energetic particle (SEP) events, with intensities estimated to be several tens of times greater than any recorded in the modern era. Such extreme SEP events pose a serious threat to the current space-exploration-dependent society. Therefore, we aim to identify additional CR events and estimate the frequency of extreme SEP events by conducting high-resolution ^{14}C measurements in tree-rings.

Over the past years, we have conducted a comprehensive search for extreme SEP events – such as the 774/775 CE event – by measuring ^{14}C concentrations in tree rings with annual resolution, covering the past ~10000 years. In the current fiscal year, we focused on tree samples sourced from within Japan and extended our investigation to the period spanning the second to first millennia BCE. In addition, to better understand the causes of seven ^{14}C spike events previously reported during the Holocene, we analyzed multiple cosmogenic radionuclides using the Dome Fuji ice core from Antarctica. In particular, we conducted high-resolution measurements of ^{10}Be and ^{36}Cl concentrations for the corresponding time periods.

In October, we organized the Joint Symposium of Space Climate 9 Symposium and ISEE Symposium at Nagoya University, where we presented these research findings.

Neutrino studies through underground experiments

Neutrinos are elementary particles that are electrically neutral, have extremely small masses, and interact only via the weak nuclear force, making them highly penetrating. There are three known types (flavors) of neutrinos – electron, muon, and tau – and they undergo a quantum mechanical phenomenon known as neutrino oscillation, through which their masses and other intrinsic properties can be investigated. The Cosmic Ray Research Division is engaged in neutrino studies using the Super-Kamiokande (SK) experiment, located in the Kamioka underground facility. In parallel, we are also advancing plans for the next-generation Hyper-Kamiokande (HK) experiment, which will feature a detector with an effective volume eight times larger than that of SK.

This fiscal year, we continued our efforts to enhance the sensitivity of the SK-based search for sterile neutrinos, a topic we began investigating last year. Sterile neutrinos are hypothesized as a fourth type of neutrino, distinct from the three known flavors, and their existence has been suggested by results from several other experiments. Taking advantage of their characteristic of not interacting via the weak force, we are conducting a search based on the up-down asymmetry of neutral current interactions induced by atmospheric neutrinos. In this search, detecting high-energy protons produced by neutral current interactions is essential. However, muons generated by charged current interactions pose a major source of background. To effectively isolate proton events with high efficiency and low background contamination, we are developing new event selection techniques incorporating machine learning methods.

Construction of the Hyper-Kamiokande detector is also progressing smoothly. As of 2024, excavation of the main cavern is underway. Upon completion, it will be the world's largest underground cavity. Inside, a massive cylindrical water tank measuring 68 meters in diameter and 71 meters in height will be installed for neutrino observation. Production of the new 20-inch Box & Line-type photomultiplier tubes (PMTs) to be mounted in the detector is also proceeding as planned. Over 10000 units have already been manufactured, and the total number is expected to reach approximately 20000. In addition, preparations for various other components and equipment required for the experiment are steadily advancing. Performance evaluations and final design decisions have been completed for items such as protective covers for the PMTs, optical modules combining numerous small PMTs, and electronics systems for data acquisition. Toward the scheduled completion of the detector in fiscal year 2027, we will continue full-scale production and preparation of these components.

Dark matter search using a liquid-Xenon detector

In outer space, there exists dark matter, a form of matter that interacts extremely weakly and is therefore difficult to observe. It is hypothesized to consist of as-yet-undiscovered elementary particles known as Weakly Interacting Massive Particles (WIMPs). In collaboration with the Kobayashi-Maskawa Institute for the Origin of Particles and the Universe (KMI) at our university, the Cosmic Ray Research Division is engaged in a direct search for dark matter using the Xenon experiment, which is being conducted at the underground laboratory of the Gran Sasso National Laboratory in Italy, utilizing liquid xenon. We are also participating in the development of detectors for the future DARWIN/XLZD experiment, a next-generation dark matter search project.

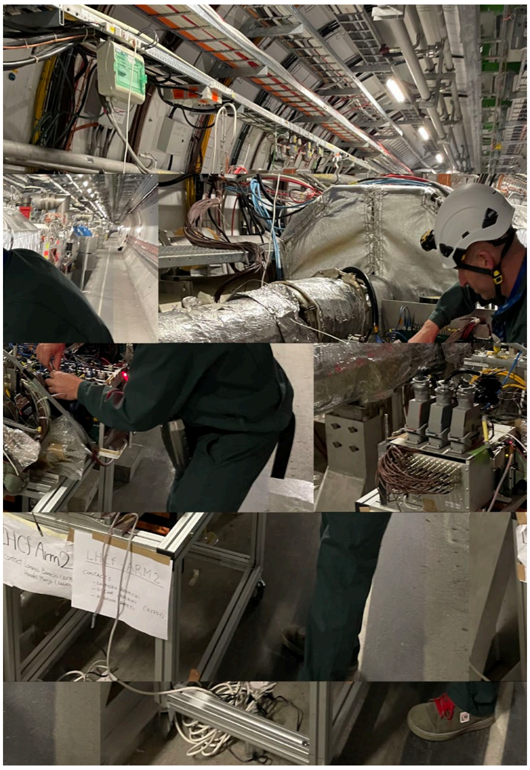
This year, we analyzed data obtained from the Xenon experiment collected between 2021 and 2023 to search for coherent elastic neutrino-nucleus scattering (Cans) signals caused by solar ^{8}B neutrinos. Since the energy of such signals is extremely low, this analysis required pushing the energy threshold lower than ever before. To efficiently suppress the resulting increase in background noise events, we developed event selection methods using machine learning techniques. As a result, we succeeded in observing solar neutrino signals with a statistical significance of 2.7σ. These results were published in Physical Review Letters. The nuclear recoil process induced by neutrinos is indistinguishable from that caused by low-mass dark matter, making it the ultimate background in future dark matter searches. Reaching this "neutrino fog" region for the first time represents a major milestone in the search for dark matter. The significance of this achievement was recognized through its selection for the Physical Review Letters Collection of the Year 2024.

In addition to the above results, we also reported outcomes directly related to dark matter searches. Using the same low-threshold analysis, we conducted a search for low-mass dark matter particles by treating the solar neutrino signal as a background consistent with the standard solar model. While no significant dark matter signal was detected, we established the world's most stringent upper limit on the spin-independent WIMP-nucleon cross section at 2.5×10^{-45} cm^2 for a WIMP mass of 6 GeV/c^2. We also extended the search for high-mass dark matter using roughly three times more data than previous studies. As a result, we obtained an upper limit of 1.7×10^{-47} cm^2 at a mass of 30 GeV/c^2. Although this constraint is slightly weaker than that reported by the competing LZ experiment, it represents an approximately twofold improvement over previous Xenon results.

In parallel, we are advancing R&D efforts for future liquid xenon dark matter detectors. These include the development of a sealed-type liquid xenon Time Projection Chamber (TPC) using a quartz vessel to block radon intrusion from detector materials, and the development of low-background ultraviolet light detectors. This year, we demonstrated the radon shielding capability of the sealed liquid xenon TPC using xenon gas and confirmed that it achieved a suppression rate exceeding 99%. In the development of a single-phase liquid xenon TPC employing quartz-coated wire electrodes, we successfully conducted tests in liquid xenon and observed proportional scintillation signals. Further measurements, including gain per single electron, are planned for the near future. As part of the UV sensor development, we are working on low-dark-count Silicon Photomultipliers (Sims) and hybrid PMTs incorporating Sims. We particularly focused on establishing and testing the measurement setup for evaluating the photon detection efficiency (PDE) of these sensors.

CR interaction-focused accelerator experiments

"Where and how are high-energy cosmic rays accelerated? " To answer this fundamental question, a variety of observational methods are being pursued around the world. Observations of high-energy cosmic rays are conducted by detecting extensive air showers – cascades of secondary particles generated when cosmic rays interact with Earth's atmosphere. To extract information about the original cosmic ray from the observed air shower, it is essential to understand high-energy interactions between cosmic rays and atmospheric nuclei. A major challenge in this field is that interpretations of the observed data – particularly regarding the chemical composition of cosmic rays (e.g., protons vs. iron nuclei) – can vary significantly depending on the interaction model used. To address this issue, we are conducting experimental studies of high-energy hadronic interactions using the world's two largest particle accelerators: the LHC at the European Organization for Nuclear Research (CERN), and the RHIC at Brookhaven National Laboratory in the United States. These studies are carried out through the LHCf and RHICf experiments.

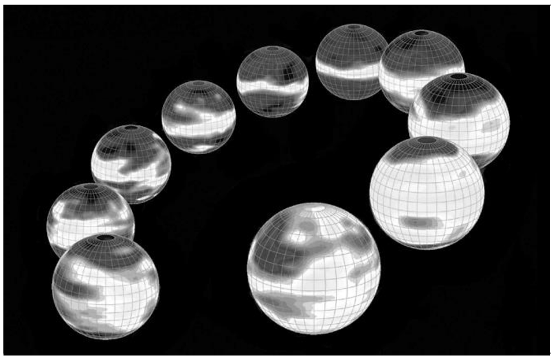


Final test of the detector in the LHC tunnel. One in the front side is the LHCf detector.

The LHCf experiment has conducted several operations. Most recently, in 2022, it recorded a high-statistics dataset of approximately 300 million proton-proton collision events at a center-of-mass energy of $\sqrt{s}$ =13.6 TeV. This energy corresponds to roughly 10^{17} eV in cosmic ray–atmosphere interactions. We are currently developing new analysis methods for this dataset. One such method involves reconstructing neutral K^0s mesons from events in which four photons enter the detector simultaneously. Discriminating four photons arriving within a few centimeters of each other is technically challenging, and the detection efficiency using conventional methods was only about 2%. However, by incorporating machine learning, we expect to improve this efficiency to around 40%. Another major advancement involves a joint analysis using the ATLAS-ZDC detector, which is located behind the LHCf detector. By combining measurements from both detectors to observe neutrons, we have demonstrated that the energy resolution can be improved from 40% to 20%.

Furthermore, a long-awaited measurement of proton-oxygen nucleus collisions – Ideal for studying cosmic ray interactions with atmospheric nuclei – is scheduled for 2025. This measurement has been strongly advocated by the cosmic ray research community, including our group, and was finally approved by the LHC committee. To ensure the success of this run, we carried out extensive preparation work at CERN in February and March 2025. This included the final operational check of the detector in the LHC tunnel, and conducting a joint data acquisition test with the ATLAS experiment. This upcoming run is the last operation of the LHCf experiment. As such, we are using all the expertise and technologies accumulated over the years to ensure a successful operation.

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 plasma flow (with a speed of 300–800 km/s), 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, protecting the atmosphere from interacting directly 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 that transfers 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, high-speed streams of solar wind can arrive at the Earth, generating intense disturbances in geospace and the upper atmosphere. Space environmental conditions that change significantly 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 important unsolved issues, such as the acceleration and propagation mechanisms of the solar wind, space-weather forecasting, the global structure of the heliosphere, and its variation. In addition, laboratory and fieldwork experiments have been performed to improve the data quality and upgrade the instruments.

Main Activities in FY2024

Solar wind observations using the IPS system

Remote-sensing observations of solar wind have been performed since the 1980s using a multi-station interplanetary scintillation (IPS) system. Tomographic evaluation 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, for which *in-situ* observations are currently unavailable. The IPS system comprises three large antennas: in Toyokawa, Fuji, and Kiso. The Toyokawa antenna (SWIFT), which has the largest aperture and highest sensitivity among the three antennas, began daily observations in 2008. The Fuji and Kiso antennas were upgraded in 2013–2014 by installing new receivers, which significantly improved their sensitivities. These two antennas are located in mountainous areas and are not used for observations during winter owing to heavy snowfall. Hence, solar wind speed observation data from the three stations were unavailable during winter. Instead, solar wind density fluctuations were derived from Toyokawa IPS observations, which were recorded throughout the year. The IPS data were made available to the public in real time via an FTP server and have been used for diverse international collaborations.

Observations for FY2024 commenced in early April at both the Fuji and Kiso sites, with three-station observations beginning on April 12. In August, the antenna control module at the Kiso station sustained lightning damage, resulting in a temporary suspension of observations. Concurrently, a ground fault occurred in the 200 V power lines within the observation building. In response to these incidents, countermeasures were implemented, including reworking the grounding system of the Kiso antenna.

Similarly, the Toyokawa station experienced lightning-induced malfunctions in both the amplifier and signal combiner, which also led to a halt in observations. Moreover, from late September through December, the Fuji station encountered recurring antenna failure. In light of these issues, the drive system at Fuji is scheduled for replacement in the next fiscal year.

International joint research

The Alfvén Wave Solar Model (Asom) is a magnetohydrodynamic simulation model of the heliosphere that can be solved continuously from the solar surface to interplanetary space. By modeling the propagation and dissipation of Alfven waves, solar wind acceleration can be reproduced in the model. Dr Nariaki Nitta and Dr Meng Jin of the Lockheed Martin Solar and Astrophysics Laboratory were invited to Japan under the ISEE International Joint Research Program to compare the solar wind acceleration results of this model with IPS observations. We also conducted a study comparing the Atom to the Space-weather-forecast Usable System Anchored by Numerical Operations and Observations (SUSANOO), a magnetohydrodynamic model for the heliosphere, during the same period. This led to the identification of many collaborative research opportunities, and it was agreed to continue this joint research.

Dr Asayama of the SKA Observatory (SKAO) in the UK was invited to Japan as part of an ISEE International Technical Exchange Program to study the development and performance evaluation of a next-generation solar wind observation system, applying knowledge obtained from the SKA project. During his stay, we installed the antenna array developed for the next-generation system in a parking lot of the research institute and conducted test observations.

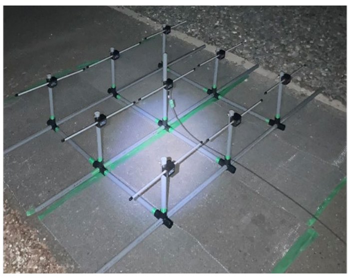
The future activities of the World IPS Stations (WIPSS), which aims to improve space-weather forecasting through the collaboration of global IPS stations to achieve 24-h observations of the solar wind, were discussed at the European Space Weather Week 2024, which was held in Coimbra, Portugal, in November 2024. It was decided that regular online meetings would be held to promote active international collaboration.

Next-generation solar wind observation system

We advanced the development of the next-generation solar wind observation system, which was proposed and approved as a Grant-in-Aid for Scientific Research (S) in FY2024. A total of 160 million yen was allocated to construct an antenna array at the Fuji Observatory, covering approximately one-third of the planned area (about 1200–1500 m^2). A flat reflector was designed, and 1.3 × 2 m mesh tiles were developed. Prototype tiles were delivered in March. While the antenna and receiver system performed as expected, the signal synthesizing system exhibited a high loss rate, requiring further investigation. Based on the test results, the digital backend was found to perform as expected, leading to the decision to move forward with mass production.

Development of a phased antenna array system for the next-generation solar wind observation system

We developed an antenna system as part of the next-generation solar wind observation system development project. The next-generation system plans to deploy 1024 subarrays on a metal reflector. A single subarray consists of 16 small antennas. Each subarray is equipped with phase delay control and enables 2D beam steering. Consequently, the beam scanning range, which determines the system's field of view, is restricted by the beamwidth of each subarray. Furthermore, deploying the antennas may reduce impedance matching owing to mutual coupling between antenna elements. To address this, the subarray and small antennas were developed with the aim of achieve a beamwidth of 120° × 7° (north–south × east–west) and a power transmission efficiency of at least 96%. By adjusting the antenna height from the metal reflector, a beamwidth of 140° × 5.7° was achieved when the height was set to 30 cm. Next, to evaluate impedance matching in the deployed antenna configuration, we tested a 3 × 3 array of half-wavelength dipole antennas tuned for impedance matching at the observed frequency. We measured the reflection coefficient S_{11} of the center antenna, which is the most strongly affected by mutual coupling. The antennas tuned for impedance matching allowed the system to maintain a power transmission efficiency of over 96% in the 3 × 3 array. We achieved an east–west beamwidth of 5.7°, but did not reach our target of 7°. However, even with this narrow beamwidth, the correlation time between base stations will be extended by about three-fold. Therefore, we expect that the performance will be sufficient for the correlation time. In the future, we must



3 x 3 array for impedance matching evaluation.

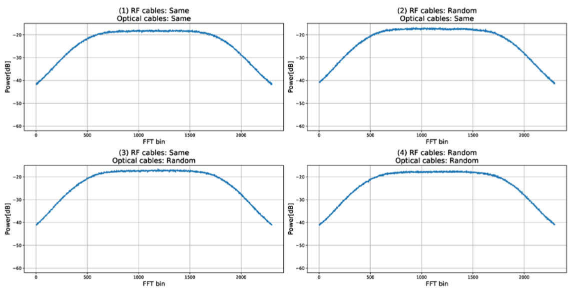
conduct practical tests on the receiver/backend. The results of this study are summarized in a 2024 Master's thesis titled "Development of a Phased Array Antenna System for Next-Generation Solar Wind Observation Equipment."

The development of an analog signal receiver system for the next-generation solar wind observation system

Configuration of the RX system, including a 16-port power combiner, two LNAs, and a BPF.

We developed an analog signal reception system (RX system) as part of the next-generation solar wind observation system. First, an estimation of the required performance revealed that the receiver noise temperature should be 97 K and the gain should be 70 dB. Next, a prototype of the RX system was built on a test bench, and its performance was evaluated. The evaluation results showed a receiver noise temperature of 281 K and a gain of 83 dB. The noise figure of the 16-signal combiner was minimized to 0.5 dB. However, the noise figure of the coaxial cable (4.6 m) and the low-noise amplifier in the front stage of the RX system exceeded 1 dB. This was found to be an important factor that degraded the overall performance of the RX system. By optimizing the RX system based on commercially available components, we estimate that the receiver noise temperature can be improved to approximately 130 K. The results of this study are summarized in a 2024 Master's thesis titled "Development of an Analog Signal Receiving System for Next-Generation Solar Wind Observation Equipment."

Development of a digital backend for the next-generation solar wind observation system



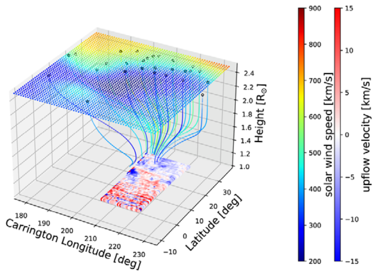
Experimental results for the phase compensation function. The horizontal axis of each graph represents the FFT bin number of the spectrum obtained by beamforming. The vertical axis represents the power spectrum [dBFS] of each FFT bin.

Under the Heliospheric Research Division, the development of a wide-field, large-aperture next-generation solar wind observation system that utilizes cutting-edge digital technology is underway. An eight-channel digital back end (prototype model) was developed as Phase-0, and a 64-channel digital back end (64-channel system) was developed as Phase-1. However, as a detailed performance evaluation had not been conducted, we undertook the identification of problems and solutions for mass production. The purpose of this study was to acquire the key technologies to realize a large-scale digital phased array system, and to discover the issues and solutions for mass production. Evaluation tests of a 64-channel system were conducted in the laboratory using a pseudo signal with white noise as the input signal. The observation system is equipped with a new function that uses digital technology to compensate for the system-induced phase and amplitude differences caused by cable length. In the experiment, the lengths of the RF cable connecting the antenna and A/D converter unit and the optical cable connecting the A/D converter unit and beamforming unit were changed and calibrated, and beamforming was performed 500 times for each condition. The correlations between the integrated results were compared. If phase compensation were performed correctly, all the results would have the same spectral shape in the Figure. As the correlation coefficients of all the measurement results were 0.99 or higher, this compensation function works as designed (Figure). Thus, this study demonstrates that the digital backend, including both the digital spectrometer and the digital multi-beamformer, has been constructed as designed and that mass production can begin. The results of this study are summarized in a 2024 Master's thesis titled "Development of a Digital Backend for Next-Generation Solar Wind Observation Equipment."

Source of the slow solar wind and acceleration mechanism of the solar wind studied by Hinode satellite and IPS

In this study, we focused on the plasma upflow observed in active regions of the Sun. We aimed to understand the source region of the slow solar wind and its acceleration mechanism by analyzing IPS observations from the Department of

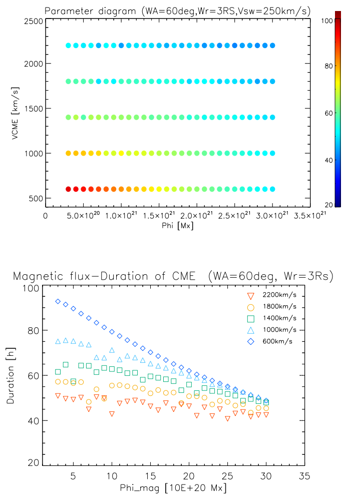
Heliospheric Sciences and the solar observation satellite Hinode. The figure shows an example of the Doppler velocity observed by the Hinode satellite (lower side) and the solar wind velocity obtained from IPS observations (upper side) connected by magnetic field lines. Here, the dark areas of the Doppler velocity on the lower side are the upflow, and the dark areas of the solar wind velocity on the upper side are the slow solar wind. The upflow is connected to the slow solar wind through magnetic field lines. After analyzing 51 datasets over one solar activity cycle from 2007 to 2022, we found that the upflow in 23 samples could be the source region of the slow solar wind (under 500 km/s). Furthermore, in samples where the expansion factor of magnetic flux tubes consisting of multiple magnetic field lines is relatively small, as shown in the figure, we found that Alfvén waves, which are magnetohydrodynamic waves, are likely to contribute to the acceleration of the solar wind. The results of this study are summarized in a FY2024 Master's thesis titled "Study of the source region of the slow solar wind and the acceleration mechanism of the solar wind using interplanetary scintillation and Hinode satellite observations."



Correspondence between solar wind velocities observed with IPS (top) and upflow velocities observed by the Hinode satellite (bottom).

Parameter survey of initial conditions for Earth arrival time of CME using SUSANOO-CME

We conducted a parameter survey employing the global heliospheric MHD model SUSANOO-CME, developed jointly by the ISEE and NICT, to investigate how variations in initial conditions affect the predicted arrival time of CMEs at Earth. CMEs are major drivers of disturbances in the solar–terrestrial environment, and improving the accuracy of arrival time and intensity predictions is essential. Current models still have significant room for improvement, and evaluating and calibrating individual components is considered an effective approach. In this study, we conducted a large number of simulations, independently varying initial parameters within typical ranges, and examined the resulting differences in the predicted arrival times. This is the first study to perform a parameter survey focused on the magnetic flux in the Spheromak model used in SUSANOO-CME. Our previous work introduced a parameter diagram illustrating how each initial parameter affects the predicted arrival time and suggested that magnetic flux contributes more to the prediction uncertainty than the other parameters. We extended the survey this year by adding simulations with finer variations in magnetic flux, enhancing the parameter diagram. We evaluated the relationship between magnetic flux and arrival time in greater detail and identified cases where flux has a strong impact, and others where it does not. These results are expected to support future developments in space-weather forecasting, particularly in probabilistic prediction and data assimilation, by helping to constrain ensembles of initial conditions.

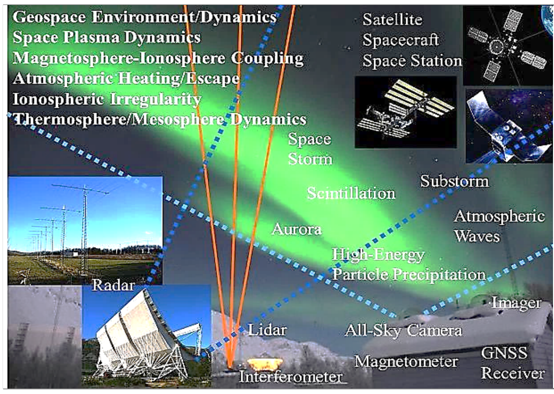


The upper panel shows an example of a parameter diagram, which indicates variations in arrival time due to initial velocity and magnetic flux using a color scale. The lower panel displays magnetic flux characteristics with respect to arrival time. Initial velocity dependence can be confirmed.

Initiation of research toward data assimilation of IPS observations into SUSANOO-CME

The SUSANOO-CME, employed in space-weather forecasting, currently uses an empirical solar wind model based on coronal magnetic field parameters as its inner boundary condition. In the current fiscal year, we initiated efforts to enhance the reproducibility of the background solar wind in SUSANOO-CME by incorporating IPS observations. As an initial step, we directly applied the 2D solar wind distribution derived from IPS observations as the inner boundary condition and assessed its performance by comparing the simulated solar wind at the L1 point with satellite measurements. This was conducted in parallel with simulations using the conventional boundary condition, allowing a comparative evaluation of accuracy. The results indicated a modest improvement in the reproducibility of high-speed solar wind; however, no significant enhancement was observed for low-speed components. These findings suggest that directly using IPS data, which reflect solar wind conditions in the 0.2–1.0 AU range, as the inner boundary condition may have limitations. Moving forward, we plan to advance our research toward assimilating IPS observations into SUSANOO-CME to realize more accurate solar wind modeling.

Division for Ionospheric and Magnetospheric Research



- Energy transfer from the solar wind to the magnetosphere and ionosphere
- Magnetosphere-ionosphere-thermosphere coupling system
- Ground-based and network observations
- 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, which are collectively called geospace. Leveraging international cooperation, we studied these effects and the associated phenomena. We primarily followed observational approaches using various 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 by our Division. We also paved the way for future space exploration missions based on our expertise.

Main Activities in FY2024

Auroral and electromagnetic-wave measurements at subauroral latitudes

Since 2016, aurora/airglow imagers and electromagnetic-wave receivers have been operating at stations around the North Pole at MLATs of ~60° in Canada, Russia, Alaska, Finland, and Iceland under the Study of Dynamical Variation of Particles and Waves in the Inner Magnetosphere using Ground-based Network Observations (PWING) project, which aims to investigate plasma and wave dynamics in the inner magnetosphere. Although this project concluded in FY2022, the instruments continued operation under the new PBASE program, and several new results were obtained in FY2024. Multi-event analyses have been performed using simultaneous observations of STEVEs and SAR arcs, which characteristically occur at subauroral latitudes, and the Arase satellite crossing the magnetospheric source region. The characteristics of the plasma and electromagnetic fields were clarified at the magnetospheric source regions of these auroras. Simultaneous observations using two color cameras at two different locations in Canada has led to the first measurement of the time variation of STEVE altitudes.

Upper-atmosphere imaging using OMTIs

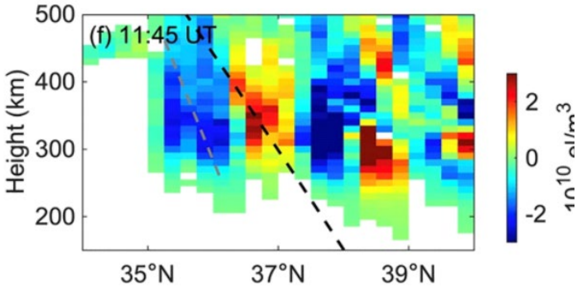
Optical mesosphere thermosphere imagers (OMTIs), which comprise five sky-scanning Fabry–Perot interferometers, 21 all-sky charge-coupled device imagers, three tilting photometers, and three airglow-temperature photometers, continue to be operated. They have been used to investigate the dynamics of the mesosphere, thermosphere, and ionosphere, and several new results were obtained from OMTI measurements in FY2024. This included the observation of seven low-latitude auroras associated with high

Low-latitude red aurora observed at the Hokkaido SuperDARN radar site in Rikubetsu on January 1, 2025.

solar activity at Moshiri and Rikubetsu in Hokkaido, Japan, and one at the Shigaraki MU radar site in central Japan. Long-term observations of airglow imaging at Tromsø, Norway, have revealed the characteristics of tidal bores near the mesopause region.

Ionospheric disturbances observed by GNSS networks

We developed a database of global 2D TEC maps with high temporal and spatial resolutions using more than 20 years of data. We also analyzed ultra-dense TEC data in Japan by incorporating data from approximately 3300 GNSS receivers maintained by SoftBank Corporation, in addition to the GNSS Earth Observation Network System (GEONET) of the Geospatial Information Authority of Japan. Using this TEC data, we developed a tomography method capable of precisely reconstructing the 3D structure of ionospheric electron density fluctuations at a higher spatial resolution (~30 km in latitude and longitude, and 10 km in altitude) than before. The findings demonstrated that the electron density perturbations caused by medium-scale traveling ionospheric disturbances during the nighttime exhibit structures aligned along the Earth's magnetic field lines.

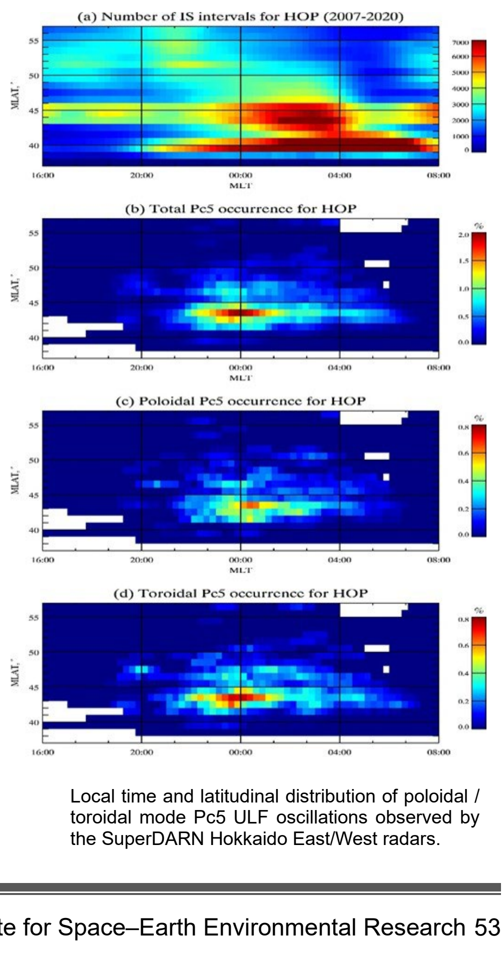


Electron density perturbations reconstructed from GNSS-TEC data using the developed computerized ionospheric tomography algorithm. The dashed black lines represent the direction of the geomagnetic field line (Fu et al., 2024).

Using three GNSS receivers located near the magnetic equator and separated by approximately 9°, 16°, and 25° in longitude over the Southeast Asian region, we investigated the longitudinal extent of ionospheric irregularities within equatorial plasma bubbles, which are localized electron density depletions in the ionosphere. Plasma bubbles generally occur between 19:00 and 01:00 LT, with a peak occurrence around 21:00 LT. The results showed that, under high solar activity conditions, the longitudinal extent over which ionospheric irregularities with spatial scales of approximately 3 to 30 km propagate becomes broader, reaching up to 25° eastward. These findings clarify the extent to which plasma bubbles can propagate and contribute to improving space-weather forecasting.

SuperDARN Hokkaido Pair of (HOP) HF radars

We established an algorithm to derive the main oscillation directions and azimuthal wavenumbers of Pc5 ULF waves, utilizing data from multiple beams of the SuperDARN Hokkaido East/West radars and other SuperDARN radars. We obtained the statistical characteristics of magnetohydrodynamic waves and found that most of the waves were caused by solar wind dynamic pressure variations or Kelvin–Helmholtz instabilities around the magnetopause. We also obtained mid-latitude ionospheric convection data that was collocated with low-latitude aurora precipitation regions for several events near the maximum solar activity. Furthermore, we have almost completed the development of the SuperDARN imaging receiver system and are preparing for the final tuning-up and testing of the system in the next fiscal year.



Local time and latitudinal distribution of poloidal / toroidal mode Pc5 ULF oscillations observed by the SuperDARN Hokkaido East/West radars.

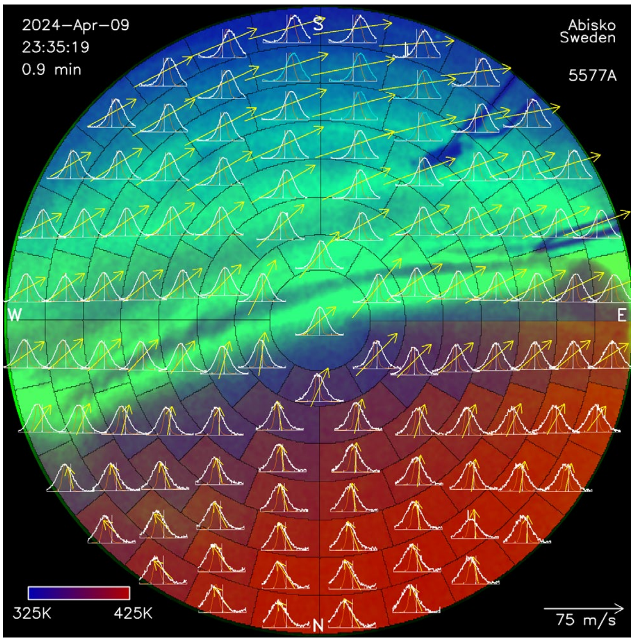
Promotion of EISCAT and EISCAT_3D projects

We conducted the EISCAT project in collaboration with National Institute of Polar Research that included the following: (1) seven EISCAT SP experiments for Japanese colleagues, (2) the EISCAT_3D project, and (3) a special session for the Future Academic Advancement Initiative (2023 Edition) proposed at the JpGU 2024. We also operated a sodium LIDAR, a photometer, an all-sky digital camera, an MF radar in Tromsø (69.6 °N, 19.2 °E), and a meteor radar in Alta, northern Norway. Additionally, we collaborated with Japanese and foreign colleagues in studies on auroral phenomena, gravity waves, mesoscale wind dynamics, and ion-neutral collision frequency in the MLT region.

Aurora above the LIDAR container installed in Tromsø, Norway on February 28, 2025. The orange line is a laser beam (wavelength 589 nm) emitted from the LIDAR.

SDI-3D project

The Scanning Doppler Imager (SDI) is a ground-based Fabry–Perot Doppler spectrometer operating in all-sky imaging mode with a separation-scanned etalon to resolve the Doppler spectra at heights of 90–400 km. A single station can estimate the horizontal wind vector and temperature on a horizontal plane with a 1000-km diameter. We established an international team in 2018 that included researchers from Japan, Scandinavian countries, and the United States. The team commenced the “SDI-3D” project to deploy three SDIs in the same area as EISCAT_3D. Additionally, an international exchange program (or cross-appointment system) was established between Nagoya University and the University of Oulu (Finland) in 2018. This was the first time that Nagoya University developed a framework to prepare for international collaboration by sending a faculty member to a foreign university. Since then, the development of SDIs has progressed satisfactorily, and they have been deployed at three locations (two in Finland and one in Sweden) through a grant awarded by the National Science Foundation in the United States. The first SDI was deployed in Sweden in this fiscal year. As a preliminary step toward simultaneous observations with EISCAT_3D and SDIs, measurements obtained through optical instruments (Fabry–Perot interferometer and all-sky imager), Dynasonde, and the EISCAT radar were evaluated. This study elucidated the thermospheric wind variations caused by geomagnetic activity, IMF conditions, and geomagnetic storms (Oyama et al., 2023a, 2023b, 2024).



First light from an SDI installed in Abisko, Sweden. The wind speed (arrows), brightness (green), and temperature (color bar) in each sector of the entire sky are shown.

Engineering model development and calibration of mechanical particle collimator for innovative measurements of space plasma and the upper atmosphere

A mechanical particle collimator is a common instrument used to define the field-of-view of particle instruments. We designed a collimator with a high angular resolution of ~7° and a large entrance area of 58 mm × 6 mm. The collimator consists of a stack of 12 slotted blades. This design helps to minimize the forward particle scattering inside the collimator assembly because of the small surface area parallel to the nominal particle velocity. We built an engineering model and tested its performance with ion beams in the beamline facility of the ISEE. The test results successfully showed that the angular response of the engineering model matched the performance expected from computer simulations.

Analysis of space plasma and auroral observations by an exploration microsatellite in the terrestrial polar region, coupling the ionosphere and the magnetosphere

We published the electron and ion energy distributions and auroral forms observed by a polar-orbiting microsatellite (Reimei) with high temporal and spatial resolution to address the earthward (geomagnetic field-aligned) acceleration mechanisms of electrons and ions in the space plasma that fill the geospace surrounding the Earth. The terrestrial intrinsic magnetic field and space plasma also connect the terrestrial polar ionosphere with the magnetosphere. We confirmed that energetic electrons or ions were accelerated by anti-earthward or earthward electric fields along geomagnetic field lines or by dispersive Alfvén waves. We investigated several types of discrete auroras caused by the different types of accelerated electrons and the relative locations of ion acceleration regions adjoining these discrete electron precipitation regions and auroras. Three research papers were published in international academic journals and two more are now under review.

Data archives

The following data archives are open 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	https://reimei.isee.nagoya-u.ac.jp/ https://reimei.isee.nagoya-u.ac.jp/sav/

Division for Meteorological and Atmospheric Research

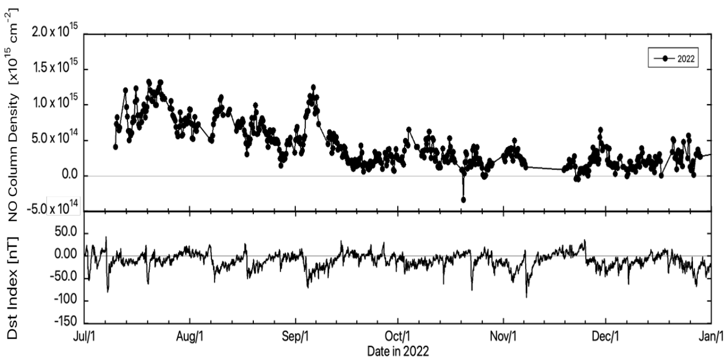
- Precipitation measurements by advanced polarimetric radars and hydrometeor videosondes
- Development of new instrumental technology
- Clouds and precipitation observed by multiple satellites
- Millimeter-wave/infrared spectroscopy of green house gases and ozone-depleting substances
- Measurements and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

The ongoing global warming caused by increasing concentrations of carbon dioxide and other greenhouse gases is expected to result in gradual climate changes, the intensification of weather extremes, and ecological catastrophes. To effectively address these environmental issues, meticulous atmosphere monitoring using different observation methods and gaining a better understanding of the atmosphere via theoretical insights and numerical modeling are urgently needed. The Division for Meteorological and Atmospheric Research is dedicated to several research projects that explore the atmosphere from various perspectives.

Main Activities in FY2024

Simultaneous multi-line observations in polar regions to understand atmospheric composition changes caused by energetic particle precipitation

Continuous observations have been conducted at Syowa Station in Antarctica and the EISCAT facility in Tromsø, Norway, using millimeter-wave spectral radiometers to understand the effects and mechanisms of composition changes in the middle atmosphere caused by energetic particle precipitation into the polar regions related to solar activity. At Syowa Station, simultaneous multi-line observations, including O_3, NO, and CO, have beenconducted since July 2022, when we upgraded the radiometer with our proprietary waveguide multiplexer and a broadband digital FFT spectrometer manufactured by RPG Inc. In 2024, the entire dataset of six hyperfine lines of nitrogen oxide (NO) brought back by Shirase was analyzed to derive the temporal variation of 12-h averaged column densities from July 2022 to December 2023. Comparing these results with the occurrence of magnetic storms and the temporal changes of energetic electron flux, 24 NO increasing events were identified out of the 35 magnetic storms with Dst indices exceeding −50 nT that occurred during this period. Concerning the retrieval of ozone vertical profiles analyzed in collaboration with the Tohoku University group, a decrease in the mesospheric ozone column was detected during the nighttime from May 10–11, probably due to energetic particle precipitation associated with



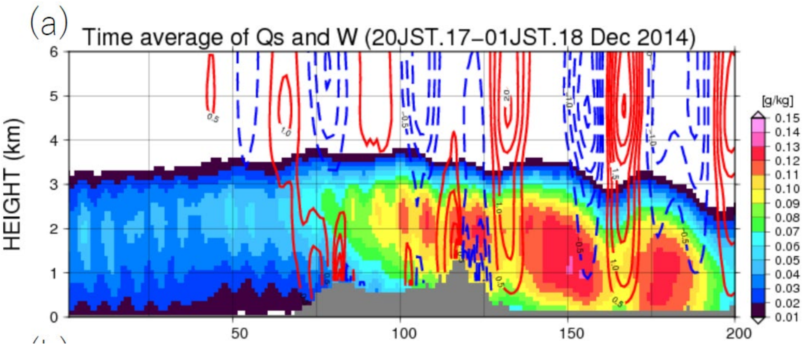
Variations of the 12-h averaged column density of the mesospheric nitrogen oxide (NO) (upper panel) and Dst index (lower panel) observed at Syowa Station in the latter half of 2022.

a large magnetic storm exceeding −400 nT.

In January 2025, operations at the EISCAT facility in Tromsø resumed for the first time since the COVID-19 pandemic and continued into March. In FY2025, we are planning an upgrade of the observing system to a multi-frequency receiver similar to the one at Syowa Station, with a newly developed mechanically cooled cold-load that does not require liquid nitrogen.

Mechanisms of snowfall enhancement in the Nobi Plain during cold-air outbreaks

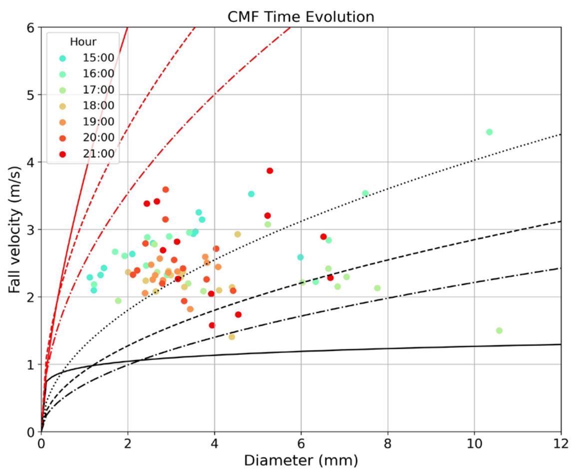
Most snowfall events in the Nobi Plain are caused by the intrusion of snow clouds from the Sea of Japan and enhancement of the clouds over the Nobi Plain during cold-air outbreaks. However, the mechanisms of this snowfall enhancement are not well understood. This study investigated the enhancement mechanisms of snowfall over the Nobi Plain in detail using the Cloud Resolving Storm Simulator (CReSS). Multiple case studies show that mountain waves are generated on the leesides of the Ryohaku (north of Gifu Prefecture) and Suzuka Mountains. Cloud water formed in the updraft region of the leeside mountain waves is rimed with snow particles. These rimed snow particles flow into the downdraft regions and reach the surface as snowfall, potentially enhancing the snowfall over the Nobi Plain. As mountain waves are more likely to develop under strong wind environments in the lower troposphere, this snowfall enhancement mechanism tends to occur during periods of strong cold-air outbreaks.



Vertical cross section of the time-averaged mixing ratio of snow (color shading) and its vertical velocity (contours; red solid and blue dashed lines show updrafts and downdrafts, respectively, at 0.5 m/s intervals starting from ±0.5 m/s) over a 5-h period from 20 JST on December 17 to 01 JST on December 18, 2014. The cross section extends from the Sea of Japan (left: 135.27°E, 35.94°N) to the Nobi Plain (right: 137.20°E, 35.06°N). The horizontal position near 75 km corresponds to the coastline of Wakasa Bay, while that near 175 km represents Nagoya.

Detection of melting precipitation periods using an optical disdrometer

An optical disdrometer is an instrument that measures the size and fall velocity of precipitation particles. A category of solid hydrometeors (such as snowflakes and graupel) precipitating in a certain period is identified by applying empirical relationships between particle size and density to the size–fall velocity distribution observed by a disdrometer. However, the identification method could not be applied to melting particles owing to the absence of an empirical relationship between their size and density. This study attempted to estimate the density of melting particles by calculating their drag coefficient, assuming that the fall velocity of each particle observed by a disdrometer corresponds to the terminal fall velocity, and to identify periods in which melting particles precipitate. The time-averaged center points, weighted by mass flux at 5-min intervals, of precipitation particles observed over 7 h from 15:00 to 22:00 JST on January 10, 2017, using a disdrometer

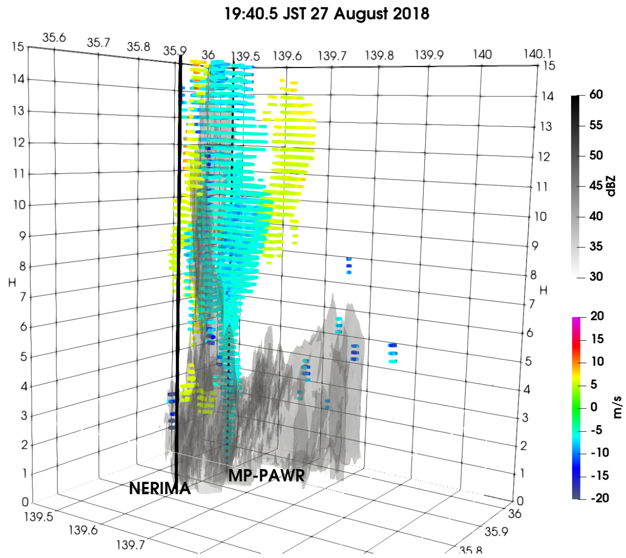


Time-averaged center points (colored points, color indicating observation time) weighted by mass flux of precipitation particles in size–fall velocity distributions observed every 5 min over 7 h from 15:00 to 22:00 JST on January 10, 2017, using a disdrometer (PARSIVEL) installed at Kanazawa University. The solid red and black lines represent the empirical relationships for rain and snow, respectively. The dashed and dash-dotted lines indicate the estimated boundaries between melting particles and rain or snow, respectively, based on previous studies.

(PARSIVEL) installed at Kanazawa University, are shown in the Figure. The boundary lines between melting particles and rain (red lines) or snow (black lines) are defined based on previous studies, and the points between these boundaries are recognized as the periods during which melting particles are dominant as precipitation. This identification method corresponds well to image observations of particles and the weather reports at Kanazawa Local Meteorological Observatory.

Development of calibration and analysis methods for the Phased Array Weather Radar

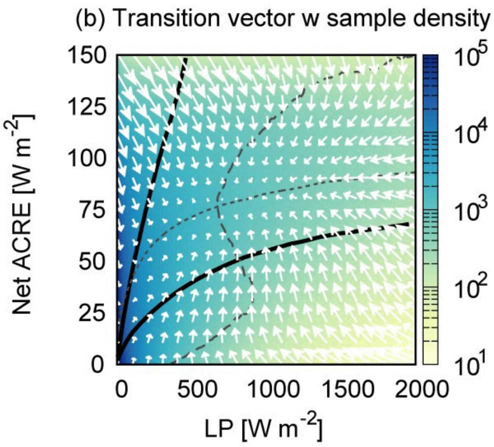
The Multi-parameter Phased Array Weather Radar (MP-PAWR), the latest radar technology, can now record high-speed 3D observations without gaps. In particular, observations at an elevation angle of 90° can capture the vertical speed of precipitation particles. These data can be used to estimate updrafts, which are important for understanding the development process of precipitation clouds. This idea was also applied to data with an elevation angle of less than 90°. The horizontal wind component contaminating the Doppler velocity was estimated by introducing the horizontal wind speed from ERA5, and the vertical component was calculated. An example of the results is shown in the figure on the right. This is a case in which a downburst was observed at the ground on August 27, 2018, and a downward motion exceeding 10 m/s was detected from the upper to the lower layer. The terminal fall velocity of the precipitation particles was considered, the downward air motion was estimated, and the results were consistent with observations on the ground. More accurate vertical air motion can be estimated in the future if we know the precipitation particle-type based on dual polarization observations.



3D image of the echoes observed by MP-PAWR (27 August 2018, 19:40:30). The shaded area indicates an echo region of 45 dBZ or more, and the vertical velocity (excluding ±5 m/s or less) is shown in color.

Thermodynamic state-to-state transitions of tropical convection

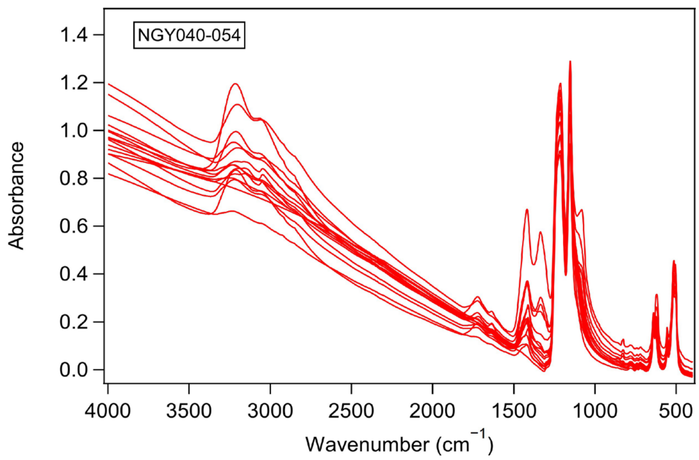
The tropical atmosphere tends to get wetter or drier when an upward or downward air motion occurs, and this effect can either intensify or diminish rain clouds, depending on how high the air motion reaches. Understanding vertical air motion patterns is thus key to better predicting tropical weather. Because vertical air motion is difficult to estimate from observations, this study instead analyzed precipitation and atmospheric radiation, available from satellite data, as a convenient measure of how high the upward air motion extended. The observations revealed that two contrasting states of upward motion—that confined to near-surface level and that peaking in the upper levels—each have a tendency to jump to an in-between state. This result elucidates a previously unknown aspect of the mechanism of how tropical weather is driven and maintained.



Hourly transitions (vectors) and sample density (color) in terms of precipitation (abscissa) and atmospheric cloud radiative effect (ordinate).

Analysis of the variability of urban atmospheric organic aerosols

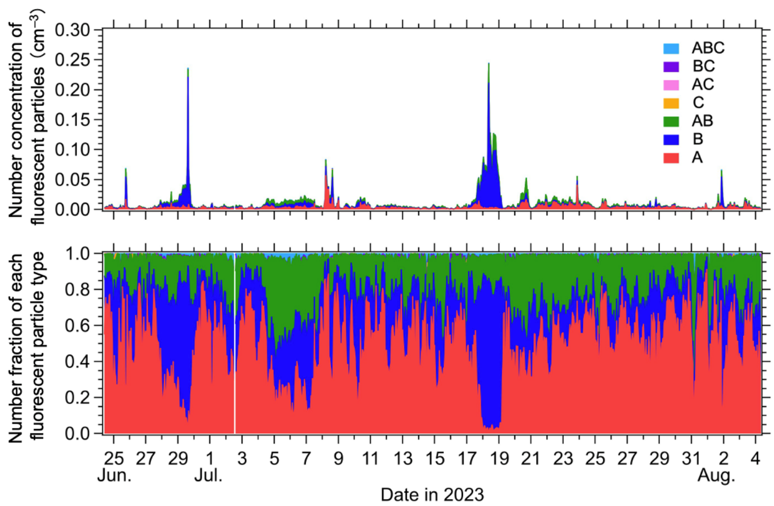
One of the major components of atmospheric aerosols is organic matter (organic aerosols); understanding their variability is important for understanding the influence of aerosols on climate and air quality. While previous studies have estimated the sources of organic aerosols based on the characteristics of their chemical structures, understanding the contribution of their secondary formation from gaseous precursors and atmospheric aging is particularly difficult. In this study, Fourier transform infrared spectroscopy (FTIR) and aerosol mass spectrometry, both of which can be used to analyze the chemical structural characteristics of organic aerosols, were applied to aerosol samples collected on filters in urban areas in the last fiscal year. FTIR analysis was performed for samples collected simultaneously in Nagoya and Osaka, and a preliminary analysis showed that a positive correlation was observed between the concentrations at the two sites, suggesting a common characteristic originated for example from regional transport. We will continue to analyze variations in the chemical structures of organics based on these techniques, and aim to clarify the contributions of the sources of organic aerosols by coupling this analysis with that of individual compounds and atmospheric model calculations.



Example of the FTIR analysis for atmospheric aerosol samples collected on PTFE filters in Nagoya.

Analyses of the behavior of bioaerosols in the Arctic

Bioaerosols, biological materials emitted as aerosols, can act as ice-nucleating particles even at temperatures above −15 °C. Understanding the behavior of bioaerosols in the rapidly warming Arctic region is important for quantitatively assessing the impact of aerosols on the Arctic climate. In this study, we analyzed data on fluorescent bioaerosols observed in Narsaq, southern Greenland, during the summer of 2023. The fluorescent particles were classified into seven types based on the wavelength dependence of their fluorescence intensities. Among the aerosols in the 0.8–30 µm size range, on average about 3% of the particles in number emitted autofluorescence. While the contribution of type A, which is considered mainly fungal spores, was significant overall, specific events were observed when particles of other types became dominant. The results showed the large variation in the number concentrations and types of fluorescent particles in southern Greenland during the observation period. Further analyses of other observational data and backward trajectories of air masses will lead to a better understanding of the factors causing these variations.



Time series of the number concentration and fraction of fluorescent particles in the 0.8–30 µm size range measured by a bioaerosol sensor (WIBS). Fluorescent particles were classified into seven types (types A, B, AB, C, AC, BC, and ABC).

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 the regional and global energy, water and material cycles, and physical/biogeochemical processes in the land–ocean ecosystem.

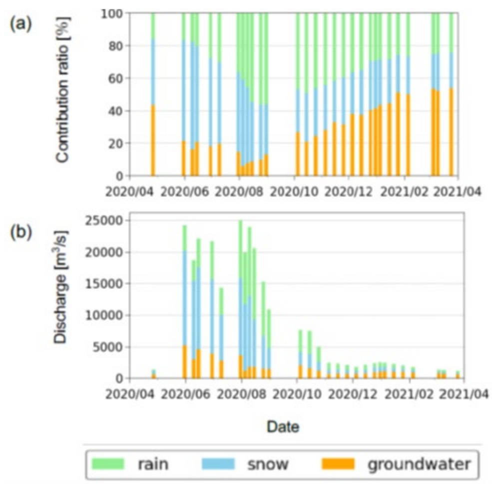
The land-research group contributes to advancing our understanding of the mechanisms through which global warming and anthropogenic activities influence the terrestrial water cycle. Using field observations, satellite remote-sensing, global meteorological data analysis, laboratory analysis, and model-simulation approaches, our group aims to understand the impact of global warming on the 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, and the interplay between terrestrial ecosystems and the climate, and to detect early signs of the influence of global warming in Antarctica.

Ocean research was conducted through satellite remote-sensing, numerical simulations, and i*n-situ* observations. We also conducted synthesis studies of the physical and biogeochemical processes in the ocean and their interactions with the atmosphere and climate. Specifically, we investigated the interactions of oceanic heat content, circulation, and surface waves with the atmosphere, and their associations with climate and meteorological phenomena, such as tropical cyclones. Additionally, we investigated the influences of ocean-circulation variations, mixing processes, and air–sea fluxes on marine ecosystems, wherein phytoplankton are the primary producers. Moreover, we are interested in clarifying the possible impact of marine ecosystems on physical processes and climate in the ocean and atmosphere.

Main Activities in FY2024

Separation of source water in sub-Arctic river discharge using end-member mixing analysis

The permafrost-dominated sub-Arctic rivers could have multiple water sources; rain, snow meltwater, groundwater, and ground-ice meltwater are the main source candidates. These different source waters could mix in varying proportions to form the streamflow, with seasonal variations; however, this process is not well understood quantitatively. In this study, end-member mixing analysis was applied using the stable isotope ratios of the water and tritium concentration as tracers, with the aim of quantitatively evaluating the seasonal changes in each source water in the discharge of the Lena River. River water samples, collected frequently from April 2020 to March 2021, were used to account for the spatiotemporal variability of the tracers. The analyses suggested that both the contribution ratio and discharge of rainwater were high in the warm season and those of snow meltwater were high in snow-melting season. The contribution ratio of groundwater was high in



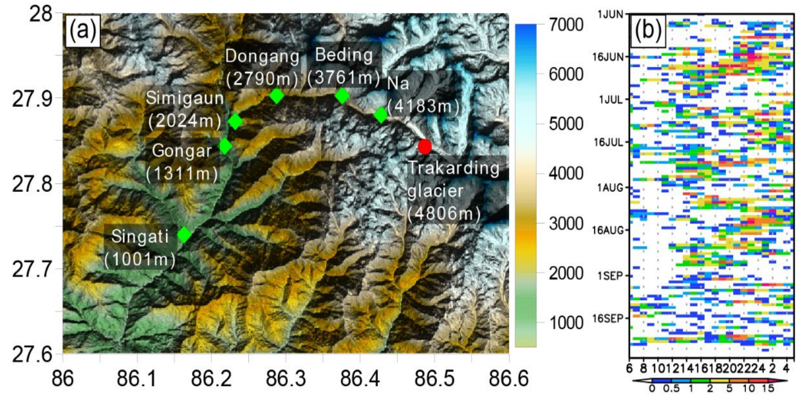
Seasonal changes in the (a) contribution ratio and (b) discharge of the source waters.

winter, while its discharge was high in the warm season. This could be because spring water (i.e., groundwater), which is stored above the surface as frozen water in winter, flows out in the next warm season after melting.

(Reference: Hiyama, T., A. Homma et al. (2024): Applying end-member mixing analysis (EMMA) to separate contributions of seasonal source waters to the Lena River discharge, Arctic Congress 2024, Bodo, Norway, May 30, 2024)

Modulation of the observed diurnal cycle of precipitation in the eastern Nepal Himalayas in summer

Abundant precipitation over the slopes of the Himalayas and glaciers at high elevations play an essential role in maintaining water resources for many people living in the basin. Understanding precipitation amounts and the characteristics of precipitation variability at high elevations is a critical issue. Our group has maintained a rain-gauge network in the Rolwaling region of the eastern Nepal Himalayas since 2019 and has continued observations (Fig. a). These observations reveal that the diurnal cycle of precipitation at high altitudes is characterized by two maxima, one in the daytime and the other in the nighttime. Recent studies have shown that the phase of this diurnal cycle modulates periodically, especially at high elevations. Figure b shows the seasonal variation of 1-h precipitation at Dongang during the summer of 2020. Rainfall tends to occur during both the daytime and nighttime, but the predominance of daytime and nighttime precipitation varies periodically over a period of ~30 days. This characteristic change can be observed from Dongang to the terminus of Trakarding glacier. In contrast, nighttime precipitation is dominant downstream of Simigaun, and the amplitude changes with a similar periodicity.

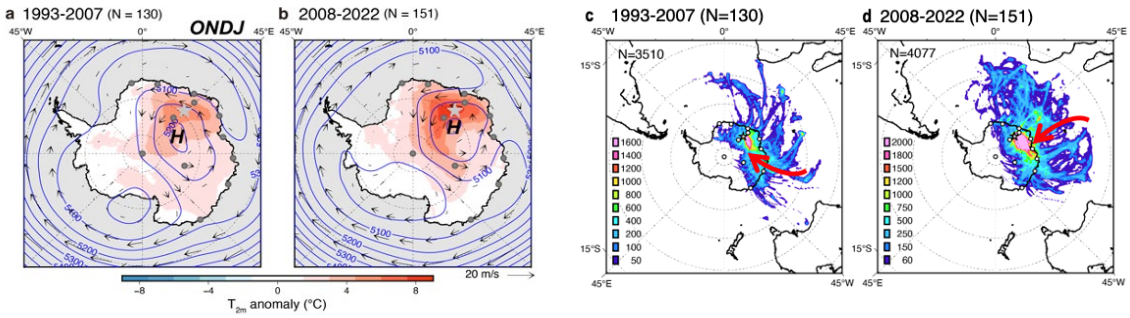


(a): Rain gauge distribution in the Rolwaling region in the eastern Nepal Himalaya.
(b): Seasonal variation of hourly precipitation at Dongang for the summer of 2020. The horizontal axis is local time.

(Reference: Fujinami, H. et al. (2024): Toward unraveling precipitation variability and precipitation systems around the glacierized catchment in the Himalayas in summer, 9th GEWEX Open Science Conference, Sapporo, Japan, July 9, 2024)

Changes in atmospheric circulation that amplify extreme warm events in the East Antarctic interior

The East Antarctic Ice Sheet is thought to be less sensitive to anthropogenic warming than other areas. However, a recent study showed that inland stations have experienced a statistically significant warming trend since 1993, with the most rapid warming occurring in the austral spring–summer. They also reported that the recent warming may be linked



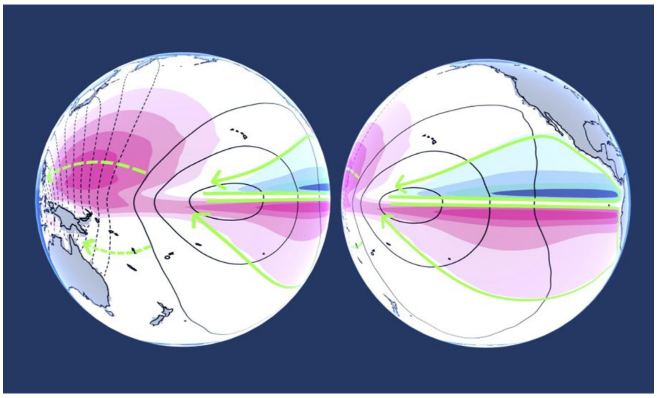
Mean composite of geopotential height and wind map at 500 hPa for extreme hot days at Relay Station from (a) 1993 to 2007 and from (b) 2008 to 2022. Same as (a) and (b), but showing 4-days back-trajectories.

to an increase in extremely hot days over inland Antarctica. Here, we examined the reason for the recent increase in extreme hot events, with a focus on changes in atmospheric circulation. Using daily mean temperature data observed at three sites (Mizuho, Relay Station, and Dome Fuji) over the past 30 years, we identified the extremely hot days and then examined both the weather patterns and air-mass trajectories that caused the extreme hot events. The results show that both the weather patterns and trajectories of the past (1993–2007) and recent (2008–2020) extreme hot events are markedly different. These changes seem to be attributed to recent changes in atmospheric circulation, in association with anthropogenic warming of the Indian Ocean.

(Reference: Kurita, N. et al. (2023): A regime shift in surface temperature over the East Antarctic Plateau in the twentieth century, IUGG 2023, Berlin, Germany, July 7, 2023)

Extracting the dynamical structure of climate variations in the tropical Pacific

The El Niño–Southern Oscillation (ENSO) is a prominent climate phenomenon centered in the tropical Pacific, with global-scale impacts. Accurate representation of ENSO is crucial for understanding and predicting climate variations in the mid-latitudes, where much of the world's population resides. As such, it has been the subject of extensive observational and theoretical studies, and remains a key target in operational seasonal forecasting. This study has investigated the role of oceanic upper-layer waves in ENSO by applying Helmholtz decomposition to elucidate the pathways of energy transfers. The diagnosis reveals that the primary source of wave energy (indicated by the solid black lines in Fig.) is located in the central equatorial Pacific, where synchronization between wind variability and oceanic wave frequencies is critical. In addition, wave energy circulations, both clockwise and counterclockwise (depicted in shading in Fig.), are identified in the western and eastern tropical North Pacific, respectively. This study has demonstrated that energy fluxes linked to oceanic wave activity during ENSO events increase in proportion to the square of sea surface temperature anomalies in the eastern tropical Pacific, namely the Niño 3 index. For example, the energy flux potential of waves driven by wind forcing in the central Pacific can be represented by the regression: $0.72\ \Delta T^2 + 0.31$ (GW), where ΔT denotes the sea surface temperature anomaly (in °C), with positive values corresponding to El Niño and negative values to La Niña. Similar regression formulas have been obtained for the rotational parts of the energy flux. Through this framework, this study proposes a new perspective for understanding climate variability—based not solely on sea surface temperature anomalies, but also on energy transport via oceanic (and atmospheric) waves.



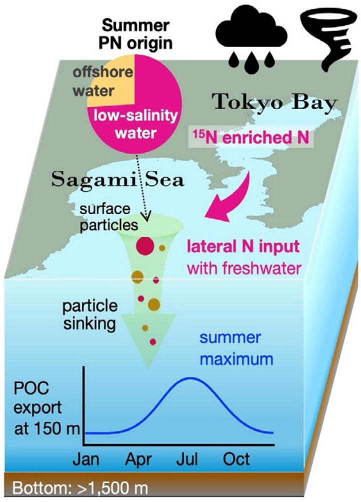
Generation (solid contours) and dissipation (dashed contours) areas of wave energy associated with interannual variations in the upper ocean, as identified by the diagnostic approach of this study. Shaded areas represent the rotational (vortical) part of wave energy circulation.

(Reference: Wu, B. et al. (2025): Energy circulation associated with interannual waves in the tropical subtropical Pacific. *Climate Dynamics*, 63, 84, doi:10.1007/s00382-024-07530-6)

Lateral nitrogen input during summer in Sagami Sea with a deep trough enhances particulate organic carbon export

In deep bays linked to the open ocean, efficient carbon sequestration occurs through the sinking of particulate organic matter produced in the euphotic zone. Nutrient conditions in the surface layer of temperate bays, which are crucial for particle production, are influenced by the lateral inflows of oligotrophic open water and freshwater containing terrestrial nutrients, in addition to seasonal mixing from below. This study, conducted through eight repeated observations in 2007–2008, investigated variations in surface water suspended particulate nitrogen (PN) isotope delta ($\delta^{15}N$) to examine upper layer PN and nutrient dynamics in Sagami Sea, located south of Tokyo Bay, with a seafloor depth exceeding 1500 m. While $\delta^{15}N_{PN}$ showed seasonal variations, such as low in winter and high in summer, its horizontal distribution in summer closely correlated with a significant salinity variation, alongside PN concentration. Analysis of the negative $\delta^{15}N_{PN}$-salinity relationship, using a conservative mixing model with the offshore water and the low-salinity water as endmembers, revealed that N with a high $\delta^{15}N$ was supplied to Sagami Sea through freshwater inflow from Tokyo Bay. This contributed on average 74 % of the summer suspended PN in coastal waters in Sagami Sea. The transport efficiency of this N input increases after heavy rain events, which greatly stimulates summer productivity in the bay. Consequently, summer N inputs may play a vital role in exporting particulate organic carbon to the mesopelagic zone and absorbing atmospheric carbon dioxide.

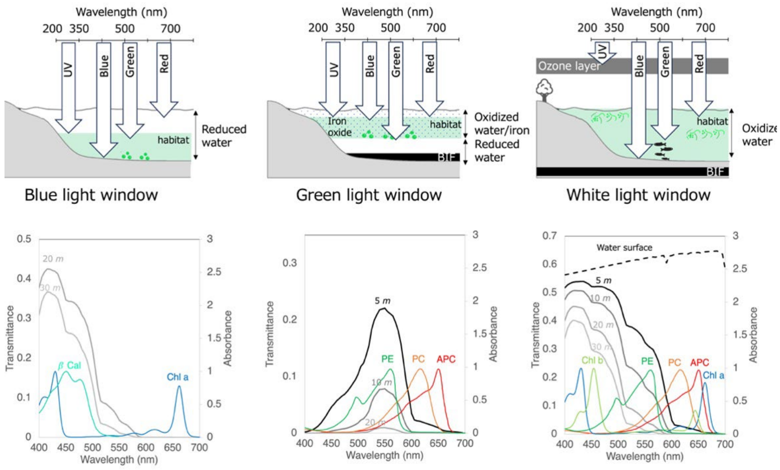
(Reference: Mino, Y. et al. (2025): Lateral nitrogen input during summer in Sagami Sea with a deep trough enhances particulate organic carbon export. *Marine Environmental Research*, 208, 107129, doi: 10.1016/j.marenvres.2025.107129)



Nitrogen supply to Sagami Sea during summer and carbon sequestration into the mesopelagic zone.

Archaean green-light environments drove the evolution of cyanobacteria’s light-harvesting system

The Cyanobacteria induced the great oxidation event around 2.4 billion years ago, probably triggering the rise in aerobic biodiversity. While chlorophylls are universal pigments used by all phototrophic organisms, cyanobacteria use additional pigments called phycobilins for their light-harvesting antennas—phycobilisomes—to absorb light energy at complementary wavelengths to chlorophylls. Nonetheless, an enigma persists: why did cyanobacteria need phycobilisomes? Here, we demonstrate through numerical simulations that the underwater light spectrum during the Archaean era was probably predominantly green owing to oxidized Fe (III) precipitation. The green-light environments, probably shaped by photosynthetic organisms, may have directed their own photosynthetic evolution. Genetic engineering of extant cyanobacteria, simulating past natural selection, suggests that cyanobacteria that acquired a green-specialized phycobilin called phycoerythrobilin could have flourished under green-light environments. Phylogenetic analyses indicate that the common ancestor of modern cyanobacteria embraced all key components of phycobilisomes to establish an intricate energy transfer mechanism towards chlorophylls using green light and thus gained strong selective advantage under green-light conditions. Our findings highlight the co-evolutionary relationship between oxygenic phototrophs and light environments that defined the aquatic landscape of the Archaean Earth and envision the green colour as a sign of the distinct evolutionary stage of inhabited planets.



Three light windows for the habitats of photosynthetic organisms.

(Reference: Matsuo, T. et al. (2025): Archaean green-light environments drove the evolution of cyanobacteria’s light-harvesting system. *Nature Ecology & Evolution*, 9, 599–612, doi:10.1038/s41559-025-02637-3)

Division for Chronological Research

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

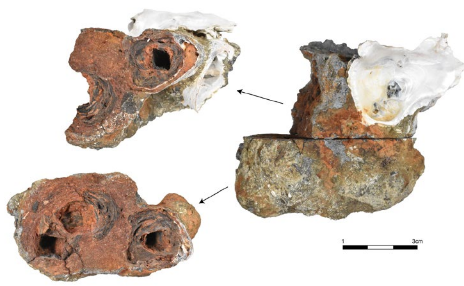
Both short- and long-term forecasts of global environmental changes, along with the development of countermeasures, represent pressing concerns. Determining the timing of past events through chronological methods is essential for understanding the Earth's present condition and predicting its future trends. The Division for Chronological Research promotes chronological studies on a broad range of subjects, ranging from geological phenomena spanning approximately 4.6 billion years to archeological materials, cultural properties, and modern cultural artifacts.

Our division conducts chronological research using carbon-14 (^{14}C) dating via accelerator mass spectrometry to investigate changes in the Earth's environment and the cultural history of humankind from approximately 50,000 years ago to the present. We also focus on developing advanced ^{14}C analytical techniques and dating methodologies. In parallel, we are advancing research aimed at elucidating the characteristics and dynamics of Earth and space environments by analyzing the spatiotemporal variations of cosmogenic nuclides such as ^{14}C and beryllium-10 (^{10}Be). Through the "MEXT Promotion of the Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence Program (CURE): Transdisciplinary Network linking Space–Earth Environmental Science, History, and Archaeology," we promote interdisciplinary collaboration with researchers in archaeology and history. Furthermore, by employing the chemical U–Th–total Pb isochron method (CHIME), originally developed at Nagoya University, alongside radiometric dating of long-half-life radioisotopes (Sr–Nd–Hf), we contribute to advancing the understandings of Earth's history, from its formation approximately 4.6 billion years ago to roughly one million years ago. Additionally, we perform nondestructive microanalyses of rocks and other materials to reveal complex geological records preserved in zircon, monazite, and other samples using an electron probe microanalyzer (EPMA).

Main Activities in FY2024

Radiocarbon dating of iron concretion enclosed artifacts from the Takashima Kouzaki Site

Some artifacts have been excavated from the underwater archaeological site off the eastern coast of Takashima, Matsu-ura City, Nagasaki Prefecture. These include anchors, wooden planks, and iron concretions, all believed to be remnants of a Mongol fleet that sank during the Kamakura period, likely due to a storm during the Mongol invasions. The iron concretions exhibit a distinctive structure; the shape of the iron objects has been preserved in a manner similar to a "mold" (see the photograph on the right). It is speculated that these iron concretions formed through chemical reactions between the iron, seawater, and surrounding sediments after the ship sank into the ocean. However, the precise mechanism and rate of formation are not yet fully understood. In this study, radiocarbon dating was conducted on the shells and wooden fragments attached to the iron



Iron artifacts enclosed in concretions excavated from the Takashima Kouzaki Site.

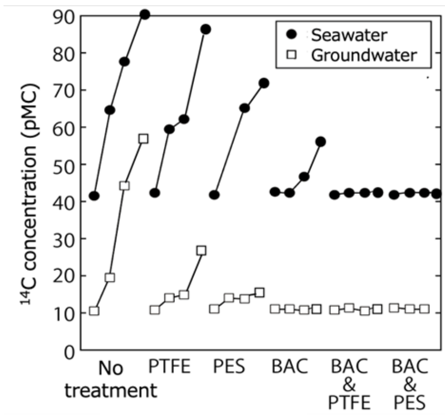
concretions to better understand the formation process. The results showed that the oyster shells on the surface dated to 1286–1475 cal AD, and the bivalves embedded inside dated to 1290–1479 cal AD, nearly the same time period. In contrast, the wood fragments yielded older dates, ranging from 1056–1268 cal AD. This discrepancy is likely due to the “old wood effect,” indicating that the wood was already aged when used in the fleet. These results suggest that the iron concretions formed relatively quickly after the Battle of Koan in 1281.

Searching for the origin of the “Silk Road of Northeast Asia”: radiocarbon dating of Ezo-nishiki silk fabrics by AMS

In Japan, silk fabrics called Ezo-nishiki are distributed throughout Hokkaido and northeastern Honshu. These fabrics feature elegant motifs of dragons, large snakes, peonies, and other animals or plants, laced with gold, silver, and colored threads. Silk fabrics were originally made only in China as cloth for the uniforms of government officials, but they were also given to the chieftains of tribes and villages in the Amur Basin and imported to Sakhalin Island over the Mamiya Strait. This trade was performed by the indigenous peoples of the Amur Basin and Sakhalin Island, collectively referred to as the Santan. Silk fabrics were then spread southward into Hokkaido by the Ainu people living on Sakhalin Island and Hokkaido. They finally reached Honshu through trade between the Ainu and the Matsumae clan, who ruled in southwest Hokkaido. This route from China to Japan via the Amur Basin and Sakhalin is called the “Silk Road of Northeast Asia,” and the trade is called the Santan trade. The Santan trade peaked in the latter half of the 18th century to the early 19th century, but its start date was unclear. This is largely because the Ainu and other people involved in this trade did not keep written records. Therefore, material analysis was an effective tool. In this study, we used accelerator mass spectrometry (AMS) to measure the radiocarbon ages of Ezo-nishiki remains in Hokkaido, Aomori Prefecture, Akita Prefecture, and Sakhalin Island. The results showed that the origins of the Silk Road of Northeast Asia date back to the end of the Yuan dynasty or the beginning of the Ming dynasty. Furthermore, we obtained physical evidence that the so-called “national isolation” of the Edo period was not limited to trade at Dejima in Nagasaki, but was a “maritime prohibition policy” that also included other routes.

Combining benzalkonium chloride addition and filtration to suppress changes in dissolved inorganic carbon in stored water samples

The The addition of benzalkonium chloride (BAC) has shown promise in preventing microbial activity in freshwater samples during the measurement of carbon isotope ratios ($\delta^{13}C$ and ^{14}C) of dissolved inorganic carbon (DIC). However, its effectiveness appears to be reduced in seawater, where BAC alone does not fully prevent changes in DIC (Takahashi and Minami, 2022). In this study, we evaluated the sterilizing effects of BAC addition, filtration (using 0.22 μm PTFE or 0.2–0.45 μm PES filters), and their combination on freshwater (groundwater from Tsukuba City; salinity < 0.05%) and brackish water (seawater from the Nagoya Fujimae tidal flats; salinity ~20%). In the freshwater samples, BAC addition alone effectively suppressed microbial activity, with no observed changes in DIC. In contrast, seawater samples treated with BAC alone showed alterations in DIC, indicating a limited sterilizing effect. However, when BAC addition was combined with filtration, no changes in DIC were detected. Even when microbial activity was artificially enhanced by adding beet sugar, the samples treated with both BAC and filtration showed only a minimal ^{14}C variation of 0.2–0.4 pMC over a 41-week period. These results suggest that the combined use of filtration and BAC is highly effective in suppressing biological alterations in DIC in both freshwater and seawater environments.



Changes in ^{14}C concentration during the storage of seawater (Nagoya Port) and groundwater (Tsukuba City) samples over 2 weeks, 4 weeks, and 18 weeks.

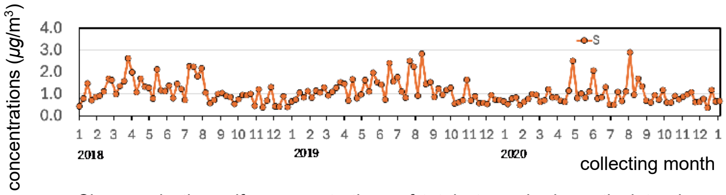
(Takahashi, H. A., and M. Minami (2025), *Ocean Science*, doi.org/10.5194/os-21-1395-2025).

Lithium potential in Urmia Lake, NW Iran: a geochemical investigation

Urmia Lake, NW Iran, Li, salt lake.

Urmia Lake in northwest Iran, the world's second-largest hypersaline lake, represents a potential lithium resource. Owing to the high solubility of lithium salts, their precipitation occurs primarily in extremely arid climates. To assess the lithium enrichment, sediment and salt samples from Urmia Lake were analyzed for trace elements and strontium (Sr) isotopes. Trace element concentrations were measured using inductively coupled plasma mass spectrometry (Agilent 7700x), while Sr isotope ratios were determined via thermal ionization mass spectrometry (GVI IsoProbe-T) at Nagoya University, Japan. The analysis of 28 sediment samples revealed lithium concentrations ranging from 10.5 to 45.1 ppm, with an average of 33.3 ppm. Geochemical proxies, including Sr/Cu vs. Ga/Rb ratios, suggested that a cold, arid climate contributed to lithium preservation. Elevated Sr/Ba ratios (0.447–7.39) further supported saline water precipitation as a key factor. The $^{87}Sr/^{86}Sr$ ratios in the sediments (0.70714–0.70913) and salt samples (0.70815–0.70820) closely matched those of surrounding Oligocene sediments, salt domes, and volcanic rocks, reinforcing a local lithogenic source. However, Urmia Lake's lithium content remains lower than that of other hypersaline systems, such as the Great Salt Lake (>100 ppm). This discrepancy may result from the cold regional climate, which likely limited lithium weathering and its subsequent fluvial transport into the lake.

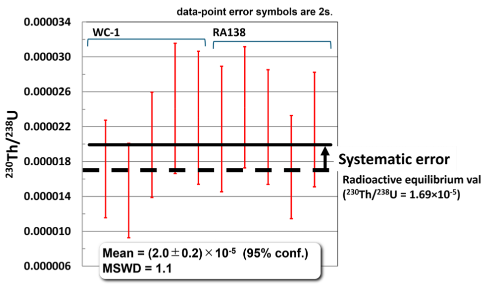
Impact of ship fuel oil regulations on sulfur and trace element concentrations in atmospheric aerosols in Nagoya



Changes in the sulfur concentrations of total atmospheric particulates in Nagoya City from 2018 to 2020.

In January 2020, the International Maritime Organization implemented the Global Sulfur Cap 2020 regulation, limiting the sulfur content of marine fuel oil used in general sea areas to 0.5% or less. Vanadium and nickel, known to be emitted during the combustion of heavy fuel oil, are believed to have decreased owing to this regulation. In this study, we analyzed the sulfur and metal elements in total suspended particulate matter collected in Nagoya City from 2018 to 2020 to investigate any changes in their concentrations. The results showed that the sulfur concentrations in 2018 exhibited an upward trend from January to the end of March, peaking in July. The average concentrations during the summer months (June to August) in 2018 and 2019 were 1.2 $\mu g/m^3$ and 1.5 $\mu g/m^3$, respectively. In comparison, the average summer concentration in 2020 was 1.1 $\mu g/m^3$, the lowest concentration over the three-year period. In the summers of 2018 and 2019, a strong correlation was observed between the sulfur and vanadium concentrations ($R = 0.93$ and $R = 0.76$, respectively), whereas their correlation was significantly lower in the summer of 2020 ($R = 0.37$). A similar trend was observed for nickel concentrations in relation to vanadium. These findings indicate that the ship fuel oil regulation has led to a reduction in anthropogenic emissions, with the impact evident in the concentrations of sulfur and trace elements in atmospheric aerosols in Nagoya.

Development of a localized ^{238}U–^{230}Th dating method for carbonate samples



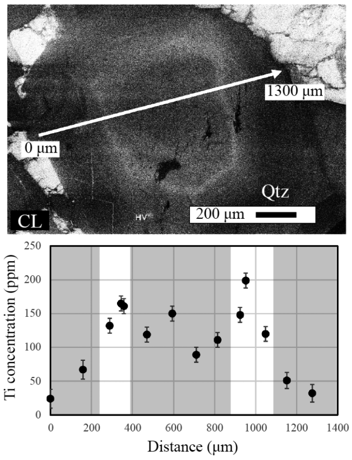
Results of $^{230}Th/^{238}U$ analysis for uranium-bearing carbonate reference materials (WC-1 and RA138). The solid line represents the weighted average of the 10 measurement results, and the dashed line represents the $^{230}Th/^{238}U$ ratio at secular equilibrium.

The accurate age determination of rock and mineral samples requires isotopic ratio measurements targeting microstructures that have not undergone secondary alteration and retain their primary chronological information. Therefore, a localized isotopic analysis method with high spatial resolution is essential. This study aimed to develop a localized ^{238}U–^{230}Th dating method for Quaternary carbonate samples. For the isotopic measurements, we employed laser ablation inductively coupled plasma mass spectrometry, which allows for high sensitivity and rapid analysis. To eliminate mass spectral interferences affecting ^{230}Th, we utilized collision

cell technology Using laser ablation over areas of 200 μm × 200 μm, we successfully detected ^{230}Th concentrations in the tens of pg g^{-1} range in uranium-bearing carbonate reference materials (WC-1 and RA138). Elemental fractionation for the Th/U ratio was corrected using a glass reference material. The weighted average of ten measurements yielded an analytical result of $^{230}Th/^{238}U = (2.0 \pm 0.2) \times 10^{-5}$. This value is systematically about 20% higher than the $^{230}Th/^{238}U$ ratio at secular equilibrium, indicating that more accurate isotopic measurements will require Th/U corrections using matrix-matched carbonate reference materials.
(Niki, S. et al., (2025), *Geostandards and Geoanalytical Research*, 46(4), 589–602)

Magma chamber processes of Okueyama granite, Kyushu, Japan: crystallization process of quartz

A combined analysis of cathodoluminescence and titanium concentrations was applied to thinly sectioned quartz, and multi-section analysis of separated quartz was used to determine its internal structure and growth mechanisms. From the cathodoluminescence images, two types of quartz were observed: oscillatory zoning quartz and homogeneous quartz. Furthermore, some of the quartz grains included zircon inclusions. This indicates that the quartz crystallized after zircon crystallization. This allows an estimation of the TiO_2 activity during quartz crystallization. TitaniQ geothermometry revealed that the oscillatory zoning quartz crystallized at 600–800°C, whereas the homogeneous quartz crystallized at 550–590°C. This indicates that variations in crystallization temperatures existed within the same granite body. Finally, a model of quartz crystallization with oscillatory zoning, resulting from local variations in TiO_2 activity in a cooling magma chamber, was obtained.
(Yuguchi, T. et al., (2024), *J. Asian Earth Sci.*, 265, 106091)



Backscattered electron and cathodoluminescence images of thinly sectioned quartz crystals with optical zoning patterns (grain No. BG-36: A and HGD-16: B) with continuous variations in titanium concentration along the scanning lines within the crystals. The scanning line is represented by the white arrow in the cathodoluminescence images.

FY2024 special program for regional contributions: “Let’s learn about Japan’s oldest rocks”

On August 6 and 7, 2024, a summer hands-on learning program was held for 32 upper-grade elementary school students from Aichi Prefecture (18 fourth graders, 10 fifth graders, and four sixth graders). The program included outdoor observation activities in Hichiso and Hirukawa, Gifu Prefecture. In Kamiaso, Hichiso Town, the banks of the Hida River expose the Kamiaso granite-gneiss, which contains granitoid gneiss formed approximately 2.05 billion years ago. These ancient rocks provide compelling evidence that Japan was once part of a continental landmass. The purpose of this program was to help students understand the formation process of the Japanese archipelago through direct observations of the Kamiaso granite-gneiss, complemented by indoor exercises and lectures. Participants were divided into five groups, each guided by one of 12 instructors, including faculty members and graduate students from our institute, and Prof. Makoto Takeuchi from the Graduate School of Environmental Studies at Nagoya University, a leading expert on the regional geology.

On the first day, a chartered bus transported the participants to the Hida River in Kamiaso, where they observed the geological features and characteristics of the Kamiaso granite-gneiss. Next, they visited the “Japan’s oldest rock museum”, where they observed Japan's oldest rocks, Earth’s oldest known stone, which was found in Canada, and rare minerals. Afterward, the participants visited the “Stone Museum Hakusekikan,” where they observed valuable minerals from around the world and various minerals produced in Hirukawa, one of Japan’s three major mineral-producing regions. On the second day, at Nagoya University, lectures on rocks, minerals, dating methods, and the evolution of the Island Arc of Japan were conducted. The students also performed polarizing microscope observations of rock thin sections, measured the density of rocks, and participated in a stratigraphy model experiment using gelatin to simulate sedimentation processes (such as mud, sand, gravel, and volcanic ash deposition). Finally, each group created a poster summarizing their field and indoor activities and presented their findings in a presentation session.

Children being taught about the Kamiasao granite-gneiss by Prof. Takeuchi.

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, the Center for International Collaborative Research (CICR) provides leadership to comprehend the physical mechanisms of phenomena occurring in the space–Sun–Earth environmental system and their interactions. The CICR encourages programs for developing ground-based observation networks and international satellite projects, and for hosting international workshops and conferences. It also supports international exchanges between foreign and Japanese researchers and students, and encourages capacity-building activities in developing countries through training courses and schools. The CICR has taken over the Geospace Research Center of the former Solar–Terrestrial Environment Laboratory at Nagoya University. It was initially established in October 2015 for a fixed 5-year term until FY2020; however, another 5-year term (FY2021–2025) was approved by Nagoya University to allow their activities to continue.

The phenomena in solar activity have various timescales, from solar flares and coronal holes to the 11-year cycle and further long-term variations. Scientists across the globe are greatly interested in these types of solar activities and their effects on Earth's geospace environment and climate change. The Scientific Committee on Solar–Terrestrial Physics (SCOSTEP), under the International Science Council (ISC), commenced a 5-year international program titled "Predictability of the variable Solar–Terrestrial Coupling (PRESTO)" for 2020–2024. The main objective of this program was to identify the predictability of the variable solar–terrestrial coupling performance metrics through modeling, measurements, and data analysis while strengthening communication between scientists and users of space around the Earth. The President of SCOSTEP is also a member of the CICR and is responsible for running this international program. On January 8, 2021, the ISEE and SCOSTEP signed a Memorandum of Understanding to define the conditions under which the ISEE will contribute to SCOSTEP activities. Based on 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 (iLEAPS). Since 2016, the CICR has participated in or operated ground-based observation projects, such as the EISCAT radar project, OMTIs, the ISEE VLF/ELF and magnetometer network, and the SuperDARN radar network (including the Hokkaido HF radars). It also has four domestic observatories in Moshiri, Rikubetsu, Fuji, and Kagoshima that conduct solar-wind, geomagnetic-field, and upper-atmosphere observations, with some of them being conducted over 30 years.

Observation sites and ISEE's overseas collaborating organizations compiled by CICR.

Main Activities in FY2024

In FY2024, the CICR approved the following international collaborative research as the projects of Joint Usage/Research Center and conducted/supported them: 1) twenty International Joint Research programs for domestic scientists; 2) twenty-three ISEE International Joint Research programs, inviting researchers from overseas; 3) four ISEE/CICR International Workshops; 13) four International Travel Support programs for field and laboratory experiments by students and early-career scientists; 14) four International Technical Exchange programs; 15) two ISEE International School Support programs; and 16) seven International Travel Support programs for students. Further, researches by two designated professors from the United States, who were hired through cross-appointments, and two designated assistant professors were promoted. In collaboration with SCOSTEP, the CICR hosted six international online seminars and one online lecture for students. It has also supported ten graduate students for presentations at international conferences and visits to foreign institutions. Through the PRESTO program (2020–2024), the CICR published four newsletters in FY2024 (in April, July, October, and January). Additionally, the CICR supported two international schools, in Nigeria and Germany. Five students from India, Egypt, China, and Brazil visited the ISEE for three months for collaborative research under the SCOSTEP Visiting Scholar Program. Six English-speaking staff members in total provided administrative support for these activities.

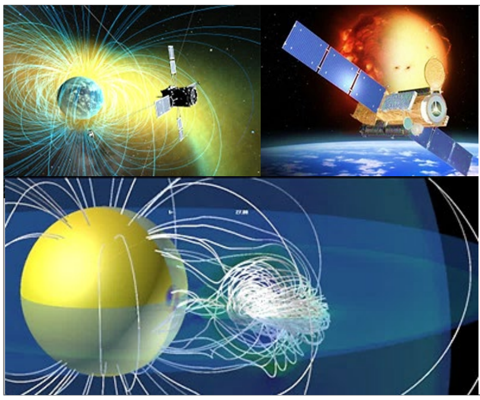
SCOSTEP/PRESTO Newsletter vol. 42 (January 2025)

The EISCAT radar project was undertaken in collaboration with a group from the NIPR, and seven EISCAT special experiments proposed by Japanese colleagues were conducted. Discussions regarding the EISCAT_3D radar were organized with foreign members of the EISCAT associate countries. More than 20 stations were operated around the North Pole at MLATs of ~60° and at mid- and low-latitudes under the OMTIs and ISEE magnetometer/ELF/VLF networks. Additionally, an observational study of urban atmospheric aerosols was conducted under the JSPS International Joint Research Program.

Moshiri Observatory became an unmanned station in FY2018, but is still supported for observations. The observatory has continued to operate fluxgate and induction magnetometers, auroral photometers, and ELF/VLF receivers. Additionally, continuous measurements of atmospheric black carbon were initiated in FY2022. Observations of low-latitude auroras were achieved successfully seven times in FY2024. Rikubetsu Observatory operates several spectrometers for the comprehensive measurement of ozone and other minor constituents in the atmosphere, all-sky imagers and photometers for aurora and airglow monitoring, SuperDARN Hokkaido EAST/WEST radars for ionospheric disturbances, and an ELF atmospheric receiver. In FY2024, six observations of low-latitude auroras were successful. Additionally, multi-station IPS observations were conducted at the Fuji, Kiso, and Toyokawa Observatories from April to December. In May 2024, IPS observations successfully detected CMEs that caused significant geomagnetic storms. An open-house event was held at Kiso Observatory on August 3–4 in cooperation with the Kiso Observatory at the University of Tokyo. Kagoshima Observatory and Sata Station operate an all-sky camera, a photometer for airglow detection, VLF/LF radiowave receivers, and induction magnetometers. Electromagnetic waves were observed at the Kagoshima Observatory in collaboration with Tohoku University, the University of Electro-Communications, Chiba University, and the Georgia Institute of Technology. Moreover, visual IoT-based monitoring and infrasound observations of the Sakurajima Volcano were performed in collaboration with the National Institute of Information and Communications Technology.

Atmospheric black carbon is measured at Moshiri Observatory.

Center for Integrated Data Science (CIDAS)



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

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

Center for Heliospheric Science: Arase, Mio, Hinode, and SOLAR-C

The Center for Heliospheric Science (CHS), which is responsible for the development and release of integrated analysis tools and data from the Arase, Mio, Hinode, and SOLAR-C satellites, as well as ground-based observations and simulations, is run by the ISEE, Nagoya University, ISAS/JAXA, and NAOJ. The CHS operates the Integrated Data Science Computer System (CIDAS system) that provides an analysis environment for researchers.

Cooperative research program for database construction and supercomputing

The 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. Additionally, it mints DOIs for ISEE research data (DOI prefix: 10.34515) to ensure permanent accessibility and promote data reusability. The CIDAS also joined an inter-university network project (the Inter-university Upper Atmosphere Global Observation Network: IUGONET) with Tohoku University, NIPR, Kyoto University, Kyushu University, and Nagoya University to develop a metadata database server and data-analysis software. Moreover, it is responsible for ISEE activities as a member of the High-Performance Computing Infrastructure Consortium in Japan. The CIDAS developed and operated the metadata database RADARC0311, which was released to facilitate searches for radiation data related to the Fukushima Daiichi Nuclear Power Plant accident in 2011.

Research and development of advanced simulations

The CIDAS leads the research and development of advanced computer simulation models designed to understand and predict the Earth–Sun system, including the Space-Weather Forecast Usable System Anchored by Numerical Operations and Observations (SUSANOO), Cloud-resolving Storm Simulator (CReSS), and Monte Carlo simulations for accurate Th–U–Pb dating. The CReSS was designed for all types of parallel computers to simulate the detailed structures of clouds and storms and can be used freely by the scientific community. It has been used for meteorological research and real-time weather forecast experiments, including tropical-cyclone, heavy-rainfall event, snow-cloud, and tornado simulations, as well as downscaling experiments on future tropical cyclones.

Main Activities in FY2024

Development of a data-analysis system for the ERG (Arase) and Mio (BepiColmbo/MMO) projects

Scientific data from the ERG (Arase) satellite, ground-network observations, and modeling/simulations are archived at the CHS, which is operated by ISAS/JAXA and the ISEE/Nagoya University. These files are in CDF format, which is the de facto format used by the solar–terrestrial physics community, and the metadata of each file is included. The Space Physics Environment Data Analysis System (SPEDAS), software commonly used by the solar–terrestrial physics community, can easily read and manipulate CDF files. The CHS 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 within an international framework. The CHS has organized SPEDAS training sessions in Japan and Taiwan, providing crucial opportunities for learning the methods required to use SPEDAS and ERG data. Additionally, it is developing a data-analysis environment for the CIDAS system, which can be accessed by users via the Internet and used to analyze ERG project data using SPEDAS (https://ergsc.isee.nagoyau.ac.jp/research/index.shtml.en). The CHS is also working toward the development of Mercury magnetospheric orbiter "Mio" (MMO) data files and related tools based on the heritage of the ERG project.

Databases related to solar research

The Hinode Science Center promotes solar research by using precise data from Hinode and developing a database and analysis environment in collaboration with NAOJ and ISAS/JAXA. It continues to maintain, manage, and publish a list of dissertations employing data from Hinode (104 Doctoral and 70 Master's theses), a flare event catalog (approximately 27500 events since October 2006), a 3D magnetic-field database of active regions in the corona, a polar magnetic-field database, an EUV emission line full-disk mosaic database, and a soft X-ray/EUV irradiance variability database. In addition, in preparation for the SOLAR-C, we have begun numerical modeling and simulation research on ionized non-equilibrium plasma in the solar outer atmosphere.

IUGONET

IUGONET has been promoting the use and application of upper-atmospheric observation data by providing metadata databases and analysis tools in collaboration with other institutions (e.g., the Research Organization of Information and Systems), and has been developing a universal infrastructure to disclose and cite such data. The SPASE metadata schema, which is widely used as a standard in the field of space physics, has repeatedly incorporated original extensions developed by IUGONET during its updates. We defined and implemented a mapping from the SPASE metadata schema to a general schema used for academic information distribution and converted our metadata. These efforts have been carried out in collaboration with the Nagoya University Library and are now expanding to include partnerships with Kyushu University and Kyoto University. The converted metadata were registered in the Nagoya University institutional repository to ensure that various communities can access them. We also developed a web-based XML file-input system that allows data providers to easily create metadata to mint DOIs.

Operation of the CIDAS supercomputer system

A new computer system for integrated data analysis (the CIDAS supercomputer system) was installed in April 2021. It comprises 16 computer nodes, each of which has two Intel Xeon Gold 6230R CPUs and 384 GB of RAM. In FY2024, 110 researchers/students were registered as users of the system. Data analyses related to the Hinode Science Center and ERG/Arase Science Center, as well as computer simulations, have been conducted.

Development of the CReSS model

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

Center for Orbital and Suborbital Observations (COSO)

- Establishment of an aircraft-based observation system
- Aircraft observations of clouds, aerosols, and typhoons
- Solar-observation missions using micro satellites
- Promotion of observations using unmanned aerial vehicles
- Human resource development for space applications
- Promotion of Earth-observing satellites

Based on the ISEE research objectives, which encompass natural phenomena ranging from the Earth's surface to outer space, COSO is expected to conduct empirical and advanced research through observations, especially via industry–academia–government collaborations. This has resulted in remarkable technological developments in aircraft, balloons, sounding rockets, and spacecrafts. COSO aims to be at the core of aircraft-based observations in Japan. It investigates and promotes future space-exploration missions to obtain new knowledge regarding physical phenomena through cooperation with domestic and foreign research institutions. By promoting interdisciplinary activities and the efficient development of common technology, COSO can improve observational capabilities for future orbital and suborbital missions. The Hydrospheric Atmospheric Research Laboratory contributed to the Virtual Laboratory, along with four universities, using X- and Ka-band radars together with numerical modeling studies. The Space Exploration and Research Office (SERO) is undertaking nanosatellite and human resource development programs for space applications, whereas the Aircraft Observation Promotion Office was established to promote aircraft-based observations.

Main Activities in FY2024

Promotion of aircraft observations

The Tropical Cyclones–Pacific Asian Research Campaign for the Improvement of Intensity Estimations/Forecasts (T-PARCII) is currently being conducted with funding from the Grant-in-Aid for Scientific Research (S) (PI: Kazuhisa Tsuboki). This year, we conducted aircraft-based dropsonde observations of Typhoon 19 (Barijat). This typhoon developed at mid-latitudes and subsequently transitioned into an extratropical cyclone. This observation marks the first observed case of the formation and weakening of a typhoon at such high latitudes. In this observation, we introduced the latest improved version of the dropsonde (with a modified GPS module and board layout: developed in 2024) and conducted prior calibration of the relative humidity for all dropsondes to ensure data reliability. The observed data were transmitted in real time to the Japan Meteorological Agency and other organizations worldwide and were utilized in weather forecasts by meteorological agencies in various countries.

We analyzed data from aircraft observations of mineral dust particles over the western North Pacific during the summer of 2022. We revealed that the number concentrations of the observed dust were 2 to 3 orders of magnitude lower than those previously reported near major dust sources in East Asia, and that larger dust particles were more efficiently removed during transport.

Research and development of microalgae production technology using drones

We have joined the NEDO Green Innovation Fund project "Establishment of a Global Industry Based on Direct Utilization of CO_2 through Photosynthesis" (Chitose Institute Co., Ltd.) and have commenced the development and demonstration of microalgae manufacturing technology in Malaysia.

Aircraft Observation Promotion Office

As a platform for information exchange within the community, we conducted nine online aircraft observation seminars, each attracting between 20 and 50 participants. This year, in addition to lectures on weather observations using aircraft, we also held presentations on drone observations and the use of aircraft in archaeology.

In response to the growing use of drones in the Earth sciences, we held our first drone training session in September 2024, supported by the Director's Leadership budget. The session was open to faculty members and students within the institute. We invited a private drone observation company to provide classroom instruction, hands-on experience with small drones (using the wind tunnel facility in the Graduate School of Engineering), and demonstration flights in the field.

Hydrospheric Atmospheric Research Laboratory

The X-band weather radar owned by the ISEE was moved to the MU radar site owned by Kyoto University, and joint observations were continued to investigate the dynamic and microphysical vertical structure of precipitation. The combination of Doppler velocity from a vertically facing weather radar and vertical air motion detected by an MU radar enabled the accurate measurement of precipitation particle sizes.

A workshop for the Virtual Laboratory, organized by four universities, was held at Chiba University this year. The ISEE dispatched nine students and three faculty members to participate in the workshop.

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 preferred due to their increased launch opportunities compared to larger satellites like ChubuSat, which weigh 50-kg. Currently, we are fabricating an engineering model that will be proposed for the JAXA Innovative Satellite Technology Demonstration-5 program. We have successfully tested the functionality and performance of the signal processing boards and have made some modifications to them. Additionally, we are actively developing software for the onboard computer.

Space Exploration and Research Office (SERO)

SERO was established as the first step toward forming a research center to consolidate all space-related activities at the university. Its primary objectives include promoting hardware development and observational research for space exploration and space science. Nanosatellites development is a critical research activities for SERO. Educational activities are also crucial to SERO's mission. We held a basic 2-week training course in August and an advanced 2-week training course in March. The basic course attracted 31 applicants, while the advanced course had 69 applicants. Notably, approximately 95% of the applicants came from outside Nagoya University and over 50% were from industries. SERO plans to revamp the training course to emphasize the execution of balloon projects from the planning stage. We began renting a thermal vacuum test system and a vibration test system since last fiscal year. The number of users of the thermal vacuum system has increased significantly since last fall and the revenue has exceeded 5 million JPY. This revenue will be sufficient to fund the revised training course.

Promotion of observations using Earth−observing satellites

The EarthCARE satellite, a joint mission between Japan and Europe, was launched in May 2024. EarthCARE is equipped with the world's first Doppler cloud profiling radar, and this fiscal year, we evaluated the performance of the radar by analyzing the initial observation data. Through scientific discussions about the AOS-storm mission, a joint mission between Japan, the United States, and France, we confirmed the direction of algorithm development.

Office for the Development of Interdisciplinary Research Strategy (ODIRS)

A primary objective of the ISEE is to encourage the development of new interdisciplinary research by merging space and Earth sciences. The Office for the Development of the Interdisciplinary Research Strategy (ODIRS), established in August 2022, promotes interdisciplinary studies in cooperation with scientists from related fields, based on their specialties across diverse ISEE research topics. Additionally, the ODIRS benefits from the ISEE's involvement as a Joint Usage/Research Center, facilitating the promotion of interdisciplinary research in numerous institutions and faculties both inside and outside of Nagoya University.

The ODIRS staff comprises the Director and Deputy Director of the Institute, the directors of three affiliated centers, and a foreign faculty member from the Center for International Collaborative Research. In addition to one designated associate professor, one designated professor and a lead academic specialist were appointed in April 2024. The ODIRS also has a steering committee comprising faculty members from related departments of Nagoya University and some external members. The Committee is working to formulate a new strategy for interdisciplinary research encompassing various fields.

Furthermore, a call for proposals for Interdisciplinary Research Strategy Projects was advertised to explore and promote new interdisciplinary research linking space and Earth sciences and other diverse fields. After review, 10 and 13 Interdisciplinary Research Strategy Projects were adopted in FY2023 and FY2024, respectively. Additionally, under the leadership of the Institute's Director, the following four projects were promoted:

1) Energetic Particle Chain -Effects on the Middle/Lower Atmosphere from Energetic Particle Precipitations-
2) Direct Search for Dark Matter with Paleo-detector
3) Data Rescues of the Analog Observational Records for the Past Solar-Terrestrial Environment
4) Changes in Surface Temperature at Dome-Fuji in East Antarctica from the Mid-Twentieth Century and the Impact of Solar Activity

Interdisciplinary Research Strategy Projects FY2024

Principal Investigator (Affiliated Department, Institution)	Responsible Faculty	Research Project Title
Seiji Kadowaki (Nagoya University Museum, Nagoya University)	Masayo Minami	Geochemical analysis and radiocarbon dating of metal weapons from Mongol invasions to Japan: Towards the establishment of "concretion archaeology"
Taro Matsuo (Graduate School of Science, Nagoya University)	Yoshihisa Mino	Green sea hypothesis: Measurement of light environment and phototrophs under water around Iwo Island
Sachie Tanaka (Nagoya University Library, Nagoya University)	Yoshizumi Miyoshi	Investigation of the possibility of fusion research of humanities and sciences using digital data
Kazuhiro Nakazawa (KMI, Nagoya University)	Yoshizumi Miyoshi	Space-Earth science fusion on albedo X/gamma rays and neutrons observed from ISS
Hideki Tomita (Graduate School of Engineering, Nagoya University)	Masayo Minami	Study on quantitative evaluation of radiocarbon analysis based on laser spectroscopy
Michihiro Mochida (ISEE, Nagoya University)	Michihiro Mochida	Investigation of air pollution associated with space developments
Satomi Kanno (Institute for Advanced Research, Nagoya University)	Yoshitaka Itow ⇒Hiroyasu Tajima	Application of CMOS image sensors to element imaging systems in living cells
Yukinori Utsumi (Faculty of Education, Gifu University)	Tetsuya Hiyama	Development of a climate change curriculum oriented to the development of decision-making skills to survive in an uncertain society
Carlos Mendez (Graduate School of International Development, Nagoya University)	Nobuhiro Takahashi	Integrating satellite and socioeconomic data for monitoring sustainable development
Sei-ichiro Watanabe (Graduate School of Environmental Studies, Nagoya University)	Takenori Kato	Advances in solar system chronology and integration with studies of the radiation environmental changes
Tomo-Hiko Watanabe (Graduate School of Science, Nagoya University)	Yoshizumi Miyoshi	Interdisciplinary research on nuclear fusion theory and HPC modeling of magnetospheric plasma
Hiroyuki Muraoka (Center for Environmental and Societal Sustainability, Gifu University)	Tetsuya Hiyama	Visioning workshop on Future Earth research challenges for environmental and societal sustainability in the Asian Green Belt
Shigeru Sunada (Graduate School of Engineering, Nagoya University)	Ryota Kikuchi	Investigation of possibility of usage of a helicopter for monitoring

Main Activities in FY2024

Call for proposals and promotion of Interdisciplinary Research Strategy Projects

We initiated a call for proposals for Interdisciplinary Research Strategy Projects linking space and Earth sciences with other fields, and 13 new projects were adopted in FY2024. These projects cover a wide range of topics, including collaborative initiatives with the School of International Development, engineering-related device and product development projects, novel ideas that have not yet been explored, and projects aimed at further enhancing the capabilities of the Tokai National University system. These efforts will continue into FY2025 and beyond, with the goal of fostering collaboration among researchers from different fields to generate new knowledge and solutions, pushing the boundaries beyond space and Earth sciences to explore unknown territories and create new research areas.

Promoting Interdisciplinary Research Projects and opening-up new academic fields

Under the leadership of the Institute's Director, four interdisciplinary research projects were promoted: "Energetic Particle Chain -Effects on the Middle/Lower Atmosphere from Energetic Particle Precipitations," "Direct Search for Dark Matter using a Paleo-detector," "Data Rescue of Analog Observational Records of the Past Solar-Terrestrial Environment," and "Changes in Surface Temperature at Dome-Fuji in East Antarctica from the Mid-Twentieth Century and the Impact of Solar Activity".

Hosting workshops to promote interdisciplinary research across various fields

Workshops involving researchers from Interdisciplinary Research Strategy Projects and stakeholders within the institution were also conducted. These workshops not only introduced the research undertaken in the Interdisciplinary Research Strategy Projects but also broadly considered the formation of a vision for promoting interdisciplinary research, as well as the development of support and promotion structures, transcending institutional and disciplinary boundaries.

Promotion of joint research projects with corporations

Centered on the Interdisciplinary Research Strategy Office, we actively worked on strengthening industry-government-academia collaborations. For example, through a partnership with Fujitsu Limited, we explored the various challenges associated with space activities and promoted innovative projects related to space-weather forecasting. Additionally, in collaboration with Chitose Laboratory Corp., we promoted research on developing and optimizing production systems that utilize microbes for material production from CO_2. These efforts are crucial for creating a model wherein industries, academia, and the government work together to generate new insights and technological innovations that contribute to society. In the future, we will continue to strengthen the collaboration between various industries, governmental bodies, and academia by actively promoting joint projects for the exploration and practical application of new research areas.

Collaboration in Joint Usage/Research Programs

The Joint Usage/Research Programs of the ISEE related to interdisciplinary research included one ISEE Symposium, 10 international collaborative research projects, 10 general collaborative research projects, 32 research meetings, and two instances of facility usage (i.e., offering the accelerator mass spectrometer for joint use), thereby promoting collaboration with the ISEE's Joint Usage/Research Programs.

Collaboration and promotion of joint projects with Industry-Government-Academia Collaboration Departments within the Institution

In cooperation with the Office for the Promotion of Academic Research/Industry-Government-Academia Collaboration of the Tokai National Higher Education and Research System, we will continue to plan workshops with corporations and advance the consideration of plans for promoting joint research.

Energetic Particle Chain -Effects on the Middle/Lower Atmosphere from Energetic Particle Precipitations-

Research aims and background

Energetic particle precipitation (EPP) due to solar activity, such as solar proton events and magnetic storms, occurs in polar regions. EPP particles create odd nitrogen (NOx) and hydrogen (HOx), which can affect the neutral chemistry in the middle atmosphere and the ozone (O_3) concentration. This is related to a key question in the SCOSTEP/PRESTO program: "What is the chemical and dynamical response of the middle atmosphere to solar and magnetospheric forcing?" To answer this question, it is important to understand the behavior of energetic particles in the magnetosphere, ionosphere, and upper/middle atmosphere as a causal chain reaction system (Fig. 1) based on observations from each region and comprehensive simulations.

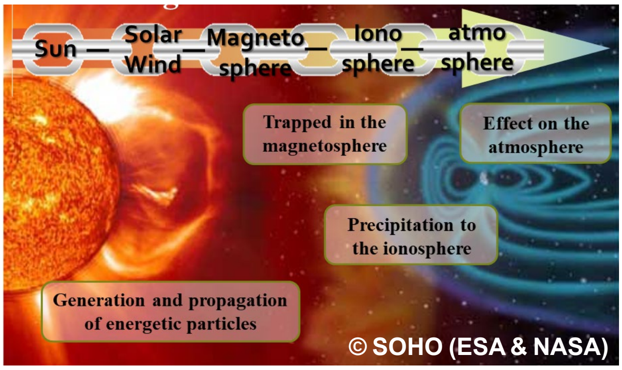


Fig. 1: Image of a causal chain reaction system.

In this context, we initiated a new research project called the Energetic Particle Chain, which aims to conduct multipoint and long-term observations of the trapped particles in the magnetosphere using data from the Arase satellite, EEP-induced ionization in the ionosphere observed through the EISCAT_3D radar and riometers, and the variations in atmospheric molecules from the lower thermosphere to the upper stratosphere determined through millimeter (mm)-wave spectroradiometers in the polar region of the Northern Hemisphere (Fig. 2). These measurement data will be used as inputs and constraints when creating models, such as integrated simulation codes for the EPP, ion chemistry in the atmosphere, and global dynamics/temperature fields. These measurements will also be useful for assessing the validity of the model outputs.

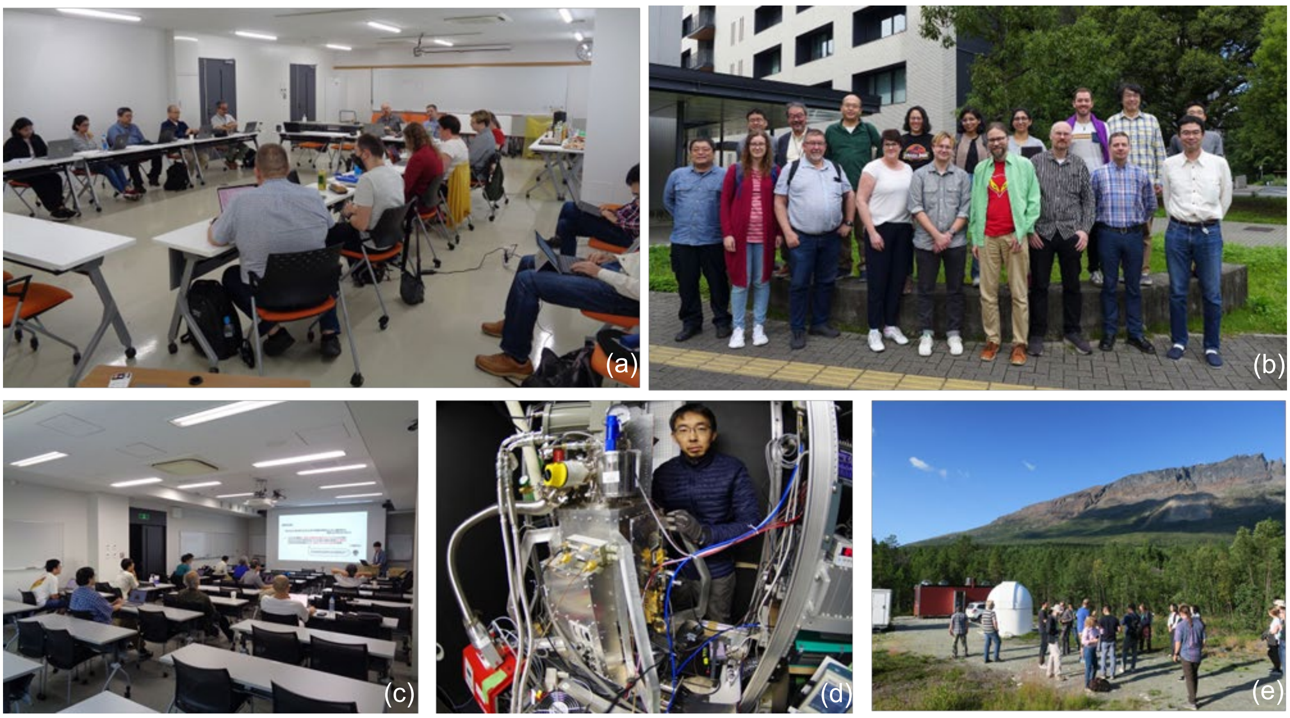


Fig. 2: (a): CHAMOS international workshop at Nagoya University. (b): Group photo of the CHAMOS Workshop, (c): Domestic consortium members' workshop for data analysis of magnetic storm events at ISEE. (d): Maintenance of the mm-wave spectral radiometer for monitoring observations of ozone and carbon monoxide molecules at Tromsø, Norway. (e): During the EISCAT Symposium in Skibotn, Norway, held in July-August 2024, attendees had the opportunity to tour the facility where optical cameras and other equipment are operated.

Main Activities in FY2024

Phase 2 (full-study phase) of the Interdisciplinary Research Project

This is the second year of Phase 2 (full-study phase) of the ISEE Interdisciplinary Research Project. We are carrying out observations with the Arase satellite, EISCAT radar, spectral riometer, sodium lidar, all-sky EMCCD imagers, and mm-wave radiometers in polar regions. Based on these datasets, we have started to compare the results of some observational and theoretical studies to identify significant magnetic storm events. For this purpose, a data analysis workshop was held for domestic researchers and students on September 4.

The CHAMOS Workshop 2024 in Japan

We organized the Chemical Aeronomy in the Mesosphere and Ozone in the Stratosphere (CHAMOS) Workshop 2024 as an ISEE International Workshop held at Nagoya University from October 28 to November 1. The CHAMOS is a scientific collaboration focusing on energetic particle precipitation and related atmospheric effects. Twenty-one participants from Finland, New Zealand, and Japan joined, and we gathered for a week of face-to-face collaboration, discussions, and presentations. The topics ranged from new solar particles forcing datasets to studies on long-term impacts on the atmosphere and climate.

Simultaneous observations of multiple molecular species by millimeter-wave radiometer

Since July 2022, simultaneous observations of O_3, nitrogen oxides (NO, NO_2), hydrogen oxide (HO_2), and carbon monoxide (CO) have been conducted at Syowa Station using a multi-frequency mm-wave spectroradiometer. Six hyperfine structure lines of NO, around 250 GHz, were analyzed from July 2022 to the end of December 2023. Comparing the temporal variation of NO column density with magnetic storms and energetic particle fluxes, we found that out of the 35 magnetic storms with a Dst index exceeding −50 nT that occurred during this period, 24 NO-increasing events occurred, which corresponds to 69% of the total. In addition, an analysis with the Tohoku University group found a significant decrease in mesospheric ozone during an intense magnetic storm event in May 2024. Through comparisons with NO data from the mm-wave spectroradiometer and precipitating energetic particle data obtained by various instruments such as riometers, PANSY, TEC, POES, and GOES, we have shown that the ozone decrease was most likely caused by energetic protons falling on Syowa Station during a period when the auroral oval moved to lower latitudes.

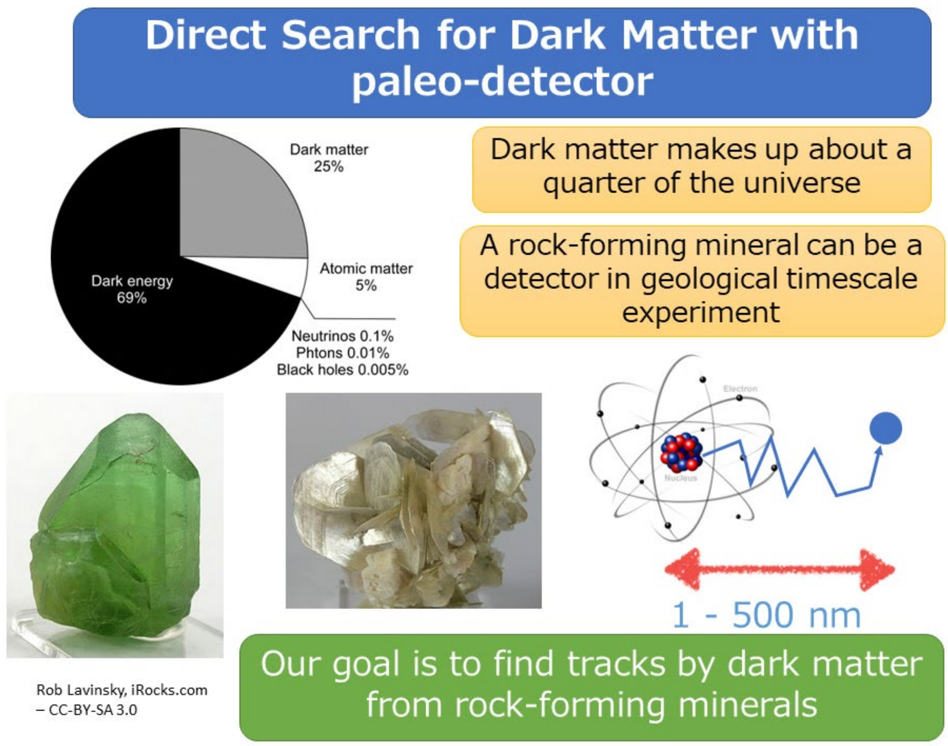
- The mm-wave spectroradiometer at Tromsø, Norway was repaired in January and February 2025, and observations of NO in the middle atmosphere were conducted from February to March. In addition, the development of a new radiometer system for the simultaneous observation of multiple molecular species in the Arctic has started in a new laboratory at Nagoya University.
- In 2024, the spectral riometers in Finland continued to function effectively, maintaining the North–South and East–West SR networks in collaboration with the Sodankylä Geophysical Observatory. Concurrent observations were conducted using cameras and VLF receivers, primarily operated in the same area by the Japanese team, along with the Arase satellite and EISCAT radars. These datasets were well-utilized; for example, to examine the spatial distribution of energetic electron precipitation during the super geomagnetic storm on May 10, 2024.
- We conducted data-driven WACCM simulations using data from the Arase satellite in collaboration with Dr. Pekka Verronen, who was a visiting professor at ISEE. We compared the simulation results with NO observations at Syowa Station. The results showed that while the radiation belt electrons observed by Arase have a significant impact on ionization in the mesosphere, their influence on NO column density is secondary.

Direct Search for Dark Matter with Paleo-Detectors

Dark matter constitutes approximately one-quarter of the universe and plays a vital role in the formation of galaxies, stars, and other large-scale cosmic structures. However, dark matter cannot be detected through optical means, and its true nature remains elusive. Identifying dark matter is expected to provide vital insights into physics beyond the Standard Model and into the origin and history of the universe. Various experimental efforts are underway globally to reveal its identity. This project focused on ultra-heavy dark matter candidates with masses above 10^{15} GeV, such as charged Q-balls.

Because astronomical observations provide estimates of the total amount of dark matter, more massive particles imply a lower number density and corresponding lower fluxes. Therefore, detecting such rare events would require an extremely long exposure time. Paleo-detectors—natural minerals that have accumulated exposure over geological timescales—are attracting attention as a promising solution.

This project is a collaborative effort involving researchers within and beyond the ISEE, combining expertise in petrology, geochronology, particle astrophysics, X-ray spectroscopy, electron microscopy, and analytical chemistry, to pursue the direct detection of dark matter and other unknown particles using paleo-detectors. Although paleo-detector-based direct searches in the 1980s—such as magnetic monopole searches with muscovite and the Q-ball search by Snowden-Ifft et al. (1995)—did not yield discoveries, interest in paleo-detectors has been resurging, with theoretical studies and proof-of-concept experiments being conducted worldwide. Our project aims to establish methods for detecting ultra-heavy dark matter, achieve world-leading sensitivity using a high-speed automatic track-readout system, and to initiate new searches for unknown particles through collaboration with domestic and international research groups, leveraging the latest knowledge and techniques from each field.



Direct search for dark matter using paleo-detector.

Main Activities in FY2024

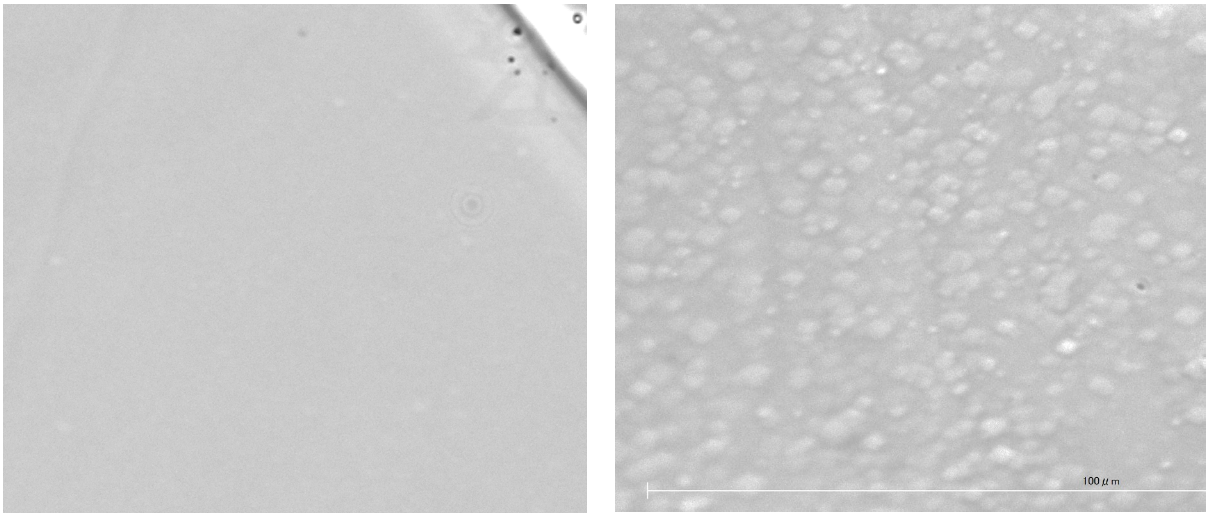
Track formation threshold and efficiency

When using muscovite as a detector for charged Q-balls, it is essential to determine:

1. Whether such tracks can be observed at all
2. The threshold for track formation
3. The efficiency of track formation

To address these questions, irradiation experiments were conducted at the Tandem Accelerator Facility of the Japan Atomic Energy Agency in Tokai. Muscovite samples—annealed to erase alpha-recoil tracks—were irradiated with 50–100 keV xenon ions, simulating the expected stopping power of a charged Q-ball. The samples were then etched with hydrofluoric acid and observed using optical microscopy and atomic force microscopy.

Track formation was confirmed in both the optical microscopy and atomic force microscopy images. By comparing the track densities with irradiation conditions, the track formation efficiency was determined to be nearly 100%. These findings suggest that a charged Q-ball traversing muscovite would almost certainly leave a detectable track.



Optical micrographs of muscovite before (left) and after (right) irradiation.

Development of a high-speed automatic track-reading system

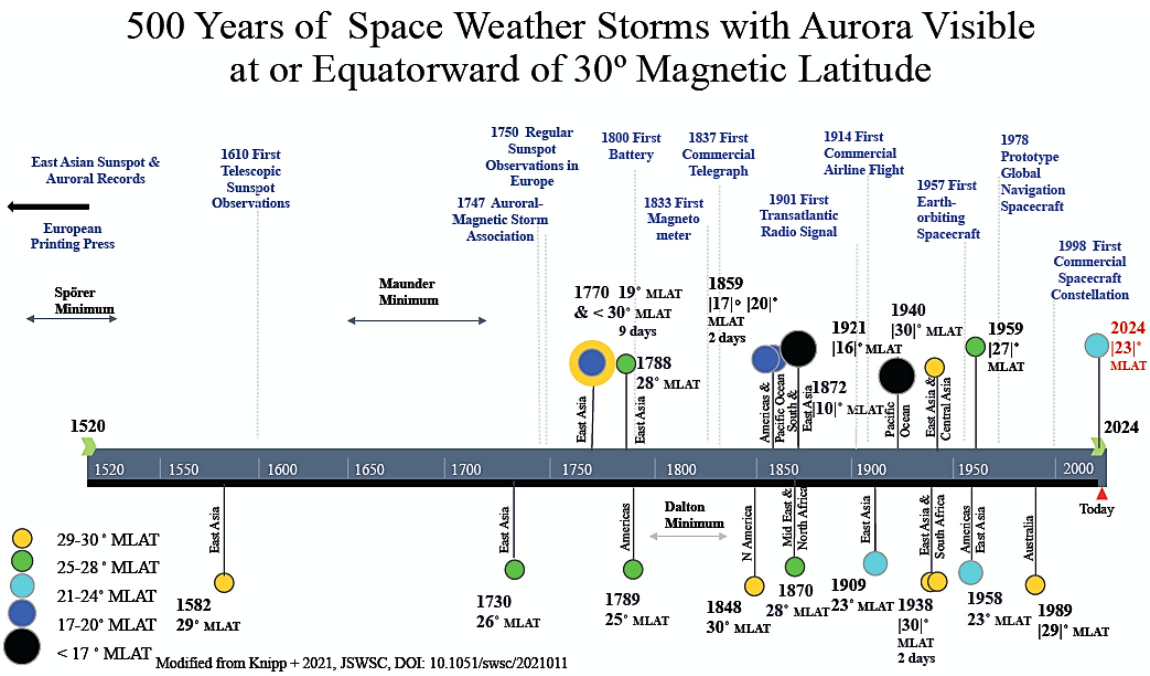
To enable large-area surveys, we continued the development of a high-speed automatic track-reading system (QTS) in collaboration with the Graduate School of Science. Hardware enhancements, including improvements to the Z-axis (focus) drive system, are steadily progressing. However, a key remaining challenge is discrimination between dark matter-induced tracks and background tracks, primary arising from alpha-recoil tracks. To improve the signal-to-noise ratio, we are combining advanced etching techniques with improvements in image recognition algorithms, aiming to achieve low-noise, automatic track detection.

QTS in development

Data Rescues of the Analog Observational Records for the Past Solar-Terrestrial Environment

The variations and disturbances in the solar–terrestrial environment influence terrestrial environments and modern civilization, both in long-term (space-climate) and short-term (space-weather events). Occasionally, extreme solar eruptions trigger especially strong geomagnetic storms and considerably impact ground-based infrastructure. However, the modern scientific databases have limitations in their chronological coverage and face challenges in capturing long-term variation and rare and extraordinary disturbances. Many of the modern scientific datasets have been systematically developed from the International Geophysical Year (1957–1958) and form the basis of a number of scientific models. Data from before this time are not readily available in a machine-readable format in many cases. Therefore, our team is aiming to collect, investigate, digitize, and analyze analog records of sunspots, solar eruptions, cosmic rays, geomagnetic variations, and auroral activity in the past, to reconstruct the long-term solar activity and extreme solar storms.

To overcome these challenges, this project works toward preserving, sorting, and recalibrating past analog records and their metadata and aims to quantitatively reconstruct the history and extremities of solar activity and geomagnetic disturbances.

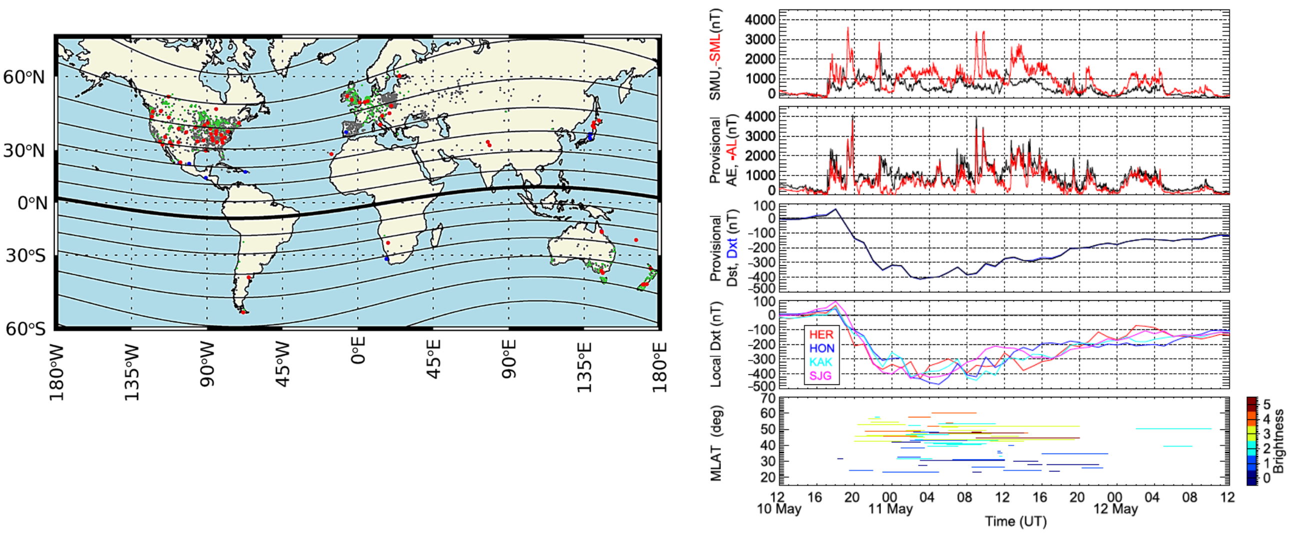


Spatial extent of the auroral visibility of the most significant low-latitude aurorae in the past 5 centuries (Hayakawa et al., 2025).

Main Activities in FY2024

This fiscal year witnessed numerous astronomical spectacles, such as the total solar eclipseand great auroral storm that both occurred in April and May 2024, respectively. The latter was the result of a series of solar eruptions from a gigantic active region and developed an intense geomagnetic storm and ground-level enhancement. This solar storm has attracted considerable scientific attentio, as exemplified by suggestions of campaign event analyses in the SCOSTEP's Next Scientific Program Committee 2024. This solar storm was so impressive that some media outlets exaggerated its significance, especially immediately after its occurrence.

Therefore, this team collected, analyzed, and quantified data on multiple aspects of this solar storm series, including source sunspot active regions, solar flares, CMEs, cosmic-ray variations, magnetospheric compressions, geomagnetic storms, low-latitude aurorae, and ionospheric storms, and compared them with various historical solar storm data. The comparison confirmed that this geomagnetic storm was one of the most intense in the last two decades, but was not likely

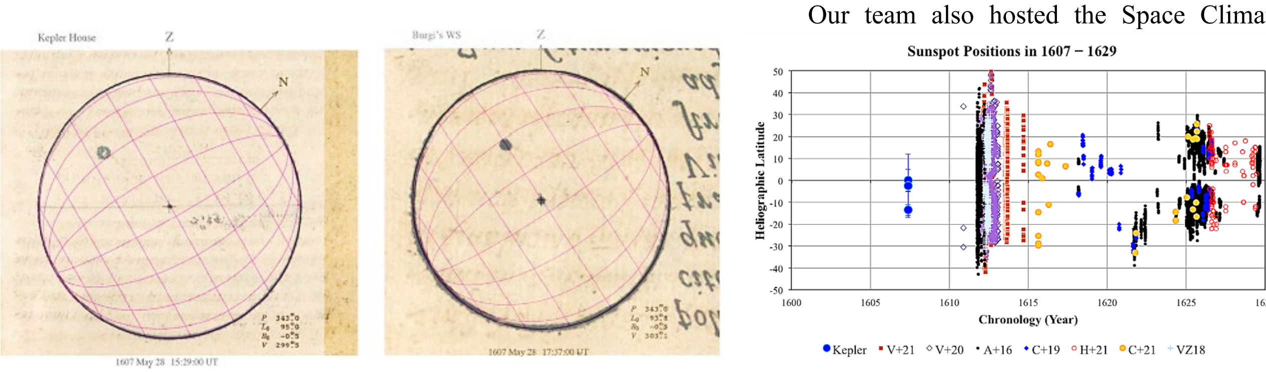


The auroral visibility and geomagnetic variations of the May 2024 storm (Hayakawa et al., 2025).

unique over a longer timespan. This study also confirmed a difference in the spatial extent of auroral visibility in terms of naked-eye and camera observations. It is not easy to compare camera-based data for modern storms with naked-eye-based data for historical storms (Hayakawa et al., 2025).

Our team also achieved some progress in space climatology. We reconstructed the latitudinal sunspot distribution at the beginning of the 17th century, analyzing Kepler's solar observations in comparison with other early sunspot observations. This analysis allowed us to extend their data coverage back to 1607, beyond the limit of the chronological coverage in previous studies (1610). Our analyses have narrowed the heliographic latitude of the sunspot group that Kepler captured and misinterpreted as Mercury crossing the Sun to +12°– −17° (Figure below). Based on modern statistics on Spörer's Law, this sunspot group was most likely located in the late phase of the previous solar cycle against sunspot groups that Harriot and Galilei observed in early telescopic observations, with ~80% probability. This result allowed us to locate the beginning of the first telescopic solar cycle in 1607–1610. This elucidates the recent debates on the length of the first telescopic solar cycle, which may have had an anomalously long duration of 16 years (1606–1622) or a normal duration of 11 years (1609–1620). Previously, some scientists associated the former interpretation with a possible precursor of the Maunder Minimum. Our result supports the latter interpretation, and indicates that the solar-cycle duration was rather normal at the beginning of the 17th century.

Our team also hosted the Space Climate



Analyses of Kepler's solar drawings and contextualization with the data of the early telescopic observations (Hayakawa et al., 2024).

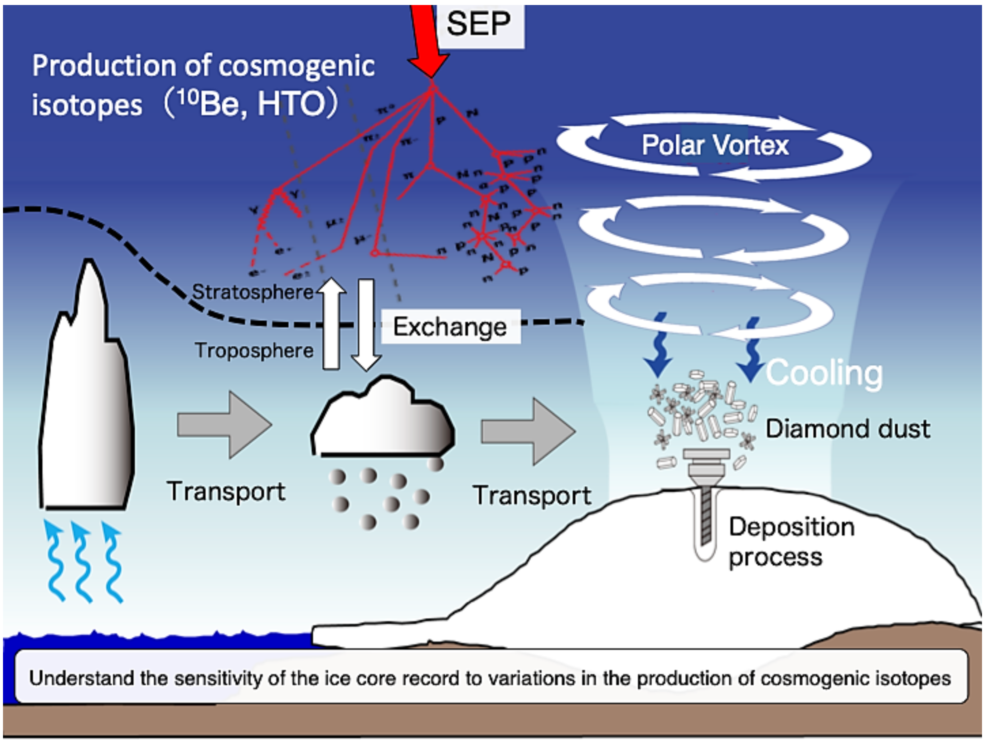
9/ISEE Joint Symposium at Nagoya University on October 1–4, 2024, with 161 registered participants from 25 countries, 103 talks, and 77 posters, in addition to the IAU Inter-Division B-E WG Coordination of Synoptic Observations of the Sun on September 30, 2024.

Changes in Surface Temperature at Dome Fuji in East Antarctica from the Mid-Twentieth Century and the Impact of Solar Activity

As society has become more sophisticated, changes in the space–earth environment have significantly impacted social life. For example, a solar eruptive event in 1989 generated severe magnetic storms, resulting in the failure of several satellites. The 2017 solar eruptive event affected the GPS, increasing positioning errors. Solar activity is constantly monitored using satellites, and space weather forecasts have been initiated. However, our knowledge of solar eruptive events is limited because our observational history encompasses only a few decades and excludes extreme events. To improve our understanding of solar events and enhance their predictability, it is essential to reveal the long-term history of solar eruptive events using paleo-proxy methods.

Past intense solar eruptive events are thought to have been recorded as positive anomalies of cosmogenic isotopes (e.g., ^{10}Be) in paleoarchives, such as ice cores. The cosmogenic isotope method has been widely used to detect past extreme solar events. The extreme solar events of 774 and 993 AD were recorded as abnormal ^{10}Be peaks in ice-core records. However, the strength of these events, reconstructed using the cosmogenic isotope method, is uncertain because the cosmogenic isotopes archived in the ice cores reflect not only changes in the production of cosmogenic isotopes in the upper atmosphere but also transport and deposition processes at the site. Therefore, to reconstruct the strength of past solar eruptive events, it is essential to understand the sensitivity of ice-core records to variations in the production of cosmogenic isotopes in the upper atmosphere.

In this study, we attempted to estimate the sensitivity of the cosmogenic isotope method for detecting extreme solar eruptive events by collaborating with researchers from diverse disciplines, including solar physics, geo-electromagnetics, meteorology/climatology, and glaciology. Currently, we are focusing on the East Antarctic region to understand recent climate change in association with global warming and its influence on the cosmogenic isotopes (^{10}Be and HTO) in ice cores. We are also developing a new indicator to reflect changes in the production rate of cosmogenic isotopes.

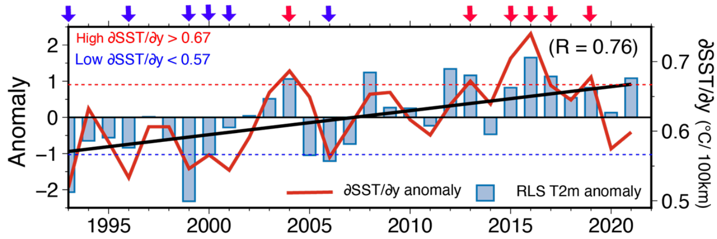


Objectives and research subjects of the project.

Main Activities in FY2024

Anthropogenic summer warming in the East Antarctic interior

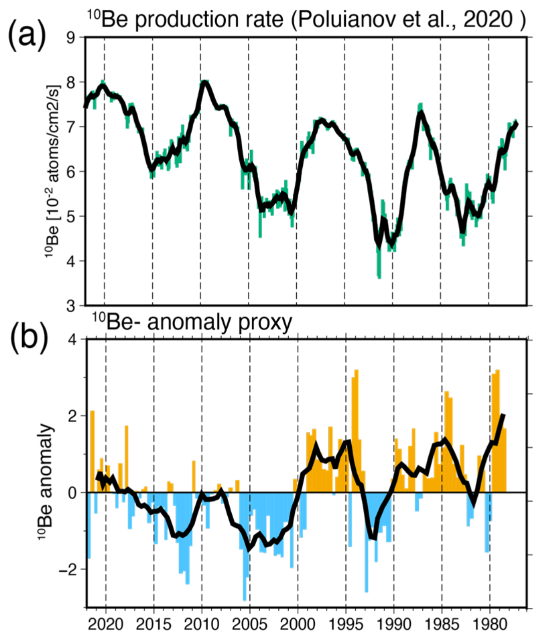
Summer warming over the East Antarctic Ice Sheet (EAIS) could have a large impact on global sea level. Despite the extensive research on temperature variations in coastal regions, those in the interior, covered by a vast ice sheet, remain uncertain. This is because long-term near-surface temperature observations in the interior region are limited and the available dataset has significant gaps. Here, we present a complete temperature record from three inland stations (Mizuho, Relay Station, and Dome Fuji), where gaps have been filled with corrected reanalysis data. At all stations, the record revealed a statistically significant warming in annual mean temperature from 1993 to 2022, with the most rapid warming occurring during the half-year mean from October to March. At the same time, a rapid warming of sea surface temperature (SST) in the Southern Indian Ocean (SIO), attributed to anthropogenic heat uptake, strengthened the SST fronts over the Subtropical Frontal Zone, resulting in a meridional dipole response in the atmosphere and an increased advection of warm air into the interior of the EAIS. Our results reveal that the SIO warming driven by anthropogenic forcing has altered the East Antarctic climate, rendering it more vulnerable to global climate change.



Time-series of the warm half-year mean anomalies of air temperature at Relay Station (blue bar) and meridional SST gradient in the subtropical frontal zone in the Southern Indian Ocean (red line). The correlation between Relay Station's temperature and the SST gradient for the 1993–2021 period is given in parentheses on the upper right.

A novel ^{10}Be-anomaly proxy assessment

Past intense solar eruptions are thought to have been recorded as positive anomalies of cosmogenic isotopes (e.g., ^{10}Be) in paleoarchives, such as ice cores. However, the reconstruction of such solar events using the cosmogenic isotope method is uncertain because the cosmogenic isotopes archived in the ice cores reflect not only changes in their production in the upper atmosphere but also atmospheric transport and deposition processes at the site. Therefore, the development of a new proxy for changes in the production rate of cosmogenic isotopes is essential for the reconstruction of past solar eruptions. To remove the influence of atmospheric circulation changes, we calculated the ^{10}Be anomaly from the regression line between deuterium and ^{10}Be and defined it as the ^{10}Be-anomaly proxy. Next, we assessed the reliability of this new proxy by comparing the results with simulated changes in the ^{10}Be production rate. As shown in Fig., the ^{10}Be-anomaly proxy shows a clear cycle associated with the solar cycle, although it could not reproduce the maximum peaks of solar cycles 24 and 25. This suggests that, for the ^{10}Be-anomaly proxy to become a reliable indicator of changes in the ^{10}Be production rate, further development is necessary.



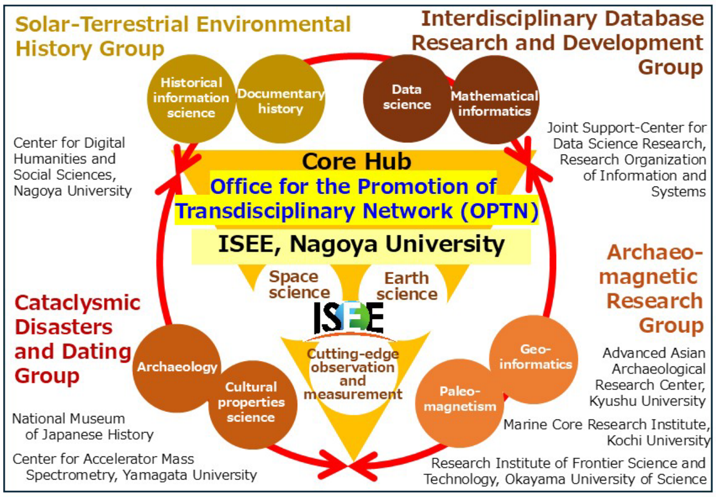
Time-series of (a) simulated ^{10}Be production rate changes and (b) ^{10}Be-anomaly proxy from a snow pit sampled at Dome Fuji.

Office for the Promotion of Transdisciplinary Network（OPTN）

In September 2024, the ISEE launched the MEXT Promotion of Development of a Joint Usage/Research System Project: Coalition of Universities for Research Excellence Program (CURE) titled “Transdisciplinary Network linking Space–Earth Environmental Science, History, and Archaeology”. The CURE program is scheduled to run for up to 10 years (see the highlight article in this report). To promote and coordinate the program, the Office for the Promotion of the Transdisciplinary Network (OPTN) was established on February 1, 2025. The OPTN serves as the central hub for collaboration with five participating institutes: the National Museum of Japanese History; the Center for Accelerator Mass Spectrometry, Yamagata University; the Advanced Asian Archaeological Research Center, Kyushu University; the Joint Support-Center for Data Science Research, Research Organization of Information and Systems; and the Center for Digital Humanities and Social Sciences, Nagoya University. The OPTN staff comprises the Vice Director of the ISEE, eight ISEE faculty members (including the Director), one Lead Academic Specialist, and two administrative assistants. To strategically advance the program, a Steering Committee was established, consisting of five representatives from the participating institutions and four faculty members from relevant departments in the ISEE. The OPTN aims to foster a collaborative network of four research groups, as illustrated in the figure below: the Cataclysmic Disasters and Dating Group, the Archaeomagnetic Research Group, the Solar–Terrestrial Environmental History Group, and the Interdisciplinary Database Research and Development Group. By leveraging the unique strengths and accomplishments of each group, the OPTN strives to build new interdisciplinary collaborations from a transdisciplinary perspective. Moreover, by drawing upon the accomplishments of the various joint usage/research programs conducted to date, as well as joint research projects with related institutions, and with the cooperation of relevant communities, the OPTN plays a leading role in bringing this initiative to fruition.

In FY2024, the official website for the project (https://transeha.isee.nagoya-u.ac.jp) was launched. Two designated assistant professors and two postdoctoral researchers were appointed as coordinators for the transdisciplinary network within each group. In addition, four doctoral students pursuing new interdisciplinary research were recruited from across the country and appointed as research assistants. A new “Transdisciplinary Network Formation” category was introduced within the ISEE open-call joint research program, and a call for proposals was issued. A total of 15 proposals were received from Japan and abroad. After review by the OPTN, discussion at a general meeting, and deliberation by the Steering Committee, all 15 proposals were accepted (one International joint research, three Invited foreign researcher joint research, seven General joint research, two Research meetings, one Database management, and one International technical exchange program). These selected proposals cover a wide range of transdisciplinary topics, such as organizing and integrating Japan–Korea archaeomagnetic data to build a high-precision archaeomagnetic intensity curve, conducting global dendrochronology to achieve “zero-year” precision in dating sudden natural disaster events, and converting metadata to enable enhanced visualization and searching across multidisciplinary datasets for institutional repositories.

On February 27, 2025, a kick-off workshop was held. Following presentations on project plans and research topics from each group, an open and lively discussion took place to confirm the direction for creating a transdisciplinary network linking Space–Earth Environmental Science, History, and Archaeology. Under this initiative, the ISEE and the five participating institutions will take turns hosting an annual workshop to foster the transdisciplinary integration of the humanities and sciences. The FY2025 workshop is scheduled to be held at Kyushu University.



Four Research Groups for Promoting the Transdisciplinary Network Formation

9. Publications and Presentations

Papers (in refereed Journals, April 2024–March 2025)

(258 in total, incl. 23 articles in press)

Abadi, P., **Y. Otsuka**, S. Saito, M. Yamamoto, S. Perwitasari, I. N. Muafiry, A. Y. Putra, and A. Faturahman, Longitudinal range of the eastward-traveling equatorial plasma bubble inducing ionospheric scintillation. *Space Weather*, **22(8)**, e2024SW003908, Aug. 2024 (10.1029/2024SW003908).

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Publication of Proceedings (April 2024–March 2025)

Title	Date of Publication
iLEAPS-Japan 2024 Workshop: Book of Abstracts	Sep. 26, 2024
The 29th Symposium on Atmospheric Chemistry, Book of Abstracts	Oct. 2024

Conference Presentations (April 2024–March 2025)

■ International Conferences

*Session Conveners

Title	Venue	Date	Organizers	Number of Presentations			
				Staff and PDs	Students	Total	Invited
Triennial Earth-Sun Summit (TESS) 2024	Dallas, TX, USA	Apr. 7–12, 2024	0	1	0	1	0
Atmosphere and Ocean Dynamics 2024	Kiel, Germany	Apr. 11–12, 2024	0	1	0	1	0
EGU General Assembly 2024	Hybrid Conference/ Vienna, Austria	Apr. 14–19, 2024	0	2	1	3	0
2nd UN Ocean Decade Regional Conference & 11th WESTPAC International Marine Science Conference	Bangkok, Thailand	Apr. 22–25, 2024	0	2	0	2	0
Laser Solutions for Space and the Earth 2024	Yokohama, Japan	Apr. 22–26, 2024	1	1	0	1	1
IAU Symposium 388: Solar and Stellar Coronal Mass Ejections	Kraków, Poland	May 5–10, 2024	0	3	0	3	2
2024 URSI Atlantic Radio Science Conference (URSI AT-RASC 2024)	Gran Canaria, Spain	May 19–24, 2024	1*	1	0	1	0
SuperDARN Workshop	Beijing, China	May 19–24, 2024	0	4	0	4	1
20th International Conference on Calorimetry in Particle Physics (CALOR 2024)	Tsukuba, Japan	May 20–24, 2024	0	1	1	2	0
Japan Geoscience Union Meeting 2024	Hybrid Conference/ Chiba, Japan	May 26–31, 2024	2 8*	46	28	74	4
Arctic Congress 2024	Bodø, Norway	May 29–Jun. 3, 2024	0	2	0	2	0
International Magnetosphere Coupling IV (IMC-IV) Workshop	Potsdam, Germany	Jun. 2–7, 2024	1*	3	0	3	2
CEDAR Workshop	San Diego, CA, USA	Jun. 9–14, 2024	0	0	2	2	0
The 19th Workshop on Antarctic Meteorology and Climate (WAMC) / 8th Year of Polar Prediction in the Southern Hemisphere (YOPP-SH)	Hybrid Conference/ Columbus, USA	Jun. 10–14, 2024	0	1	0	1	0
The 2024 Quadrennial Ozone Symposium	Boulder, CO, USA	Jun. 15–19, 2024	0	0	1	1	0
Workshop on Global Storm-Resolving Analysis Bridging Atmospheric and Cloud Dynamics	Hakone, Japan	Jun. 17–19, 2024	0	1	0	1	0
14th International Workshop on Modeling the Ocean (IWMO)	Sapporo, Japan	Jun. 17–20, 2024	0	1	1	2	0
SCOSTEP's Next Scientific Program Committee 2024	Nagoya, Japan	Jun. 18–21, 2024	1	2	0	2	2
Asia Oceania Geosciences Society 21st Annual Meeting (AOGS2024)	Pyeongchang, Korea	Jun. 23–28, 2024	0	8	1	9	5
SoSpIM Science Meeting	Davos, Switzerland	Jun. 24–26, 2024	0	1	0	1	1
18th WRCP/BSRN Scientific Review and Workshop	Hybrid Conference/ Tokyo, Japan	Jul. 1–5, 2024	0	1	0	1	0
ASTRONUM 2024	La Rochelle, France	Jul. 1–5, 2024	1	1	0	1	1
European Workshop on Laser Ablation 2024	Ghent, Belgium	Jul. 1–5, 2024	0	1	0	1	0

Title	Venue	Date	Orga-nizers	Number of Presentations			
				Staff and PDs	Students	Total	Invited
9th Global Energy and Water Exchanges (GEWEX) Open Science Conference	Sapporo, Japan	Jul. 7–12, 2024	1 1*	6	1	7	0
22nd International Symposium on Very High Energy Cosmic Ray Interactions (ISVHECRI 2024)	Hybrid Conference/ Puerto Vallarta, Mexico	Jul. 8–12, 2024	1	1	0	1	1
International Symposium on History of Astronomy 2024	Gyeongju, Korea	Jul. 10–11, 2024	0	1	0	1	1
COSPAR 2024	Busan, Korea	Jul. 13–19, 2024	1 1*	15	5	20	4
International Conference on Clouds and Precipitation (ICCP2024)	Jeju, Korea	Jul. 14–19, 2024	0	0	1	1	0
11th Workshop of International Precipitation Working Group (IPWG-11)	Tokyo, Japan	Jul. 15–18, 2024	0	1	0	1	0
GPM 10th Anniversary Symposium “Unraveling precipitation from satellites”	Hybrid Conference/ Tokyo, Japan	Jul. 19, 2024	0	1	0	1	1
ISSI-BJ Workshop	Beijing, China	Jul. 22–26, 2024	1	2	0	2	0
Hinode-17 / IRIS-15 / SPHERE-3 Joint Science Meeting	Hybrid Conference/ Bozeman, MT, USA	Jul. 23–27, 2024	0	2	0	2	2
International Colloquium on Equatorial and Low Latitude Ionosphere (ICELLI)	Hybrid Conference/ Makogi Oba, Nigeria	Jul. 29–Aug. 2, 2024	1	1	0	1	0
EISCAT symposium	Tromsø, Norway	Jul. 29–Aug. 2, 2024	0	2	0	2	0
GA 2024: XXXII IAU General Assembly	Hybrid Conference/ Cape Town, South Africa	Aug. 6–15, 2024	0	2	0	2	1
11th SCAR Open science conference	Pucón, Chile	Aug. 19–23, 2024	0	2	0	2	0
Stellar Convection: Modelling, Theory, and Observations	Hybrid Conference/ Stockholm, Sweden	Aug. 26–Sep. 20, 2024	1	1	0	1	0
New Trends of High-Energy and Low-x Physics	Sfantu Gheorghe, Romania	Sep. 1–5, 2024	0	1	0	1	1
The 4th DMNet symposium: Revealing Dark matter in the Universe with Multidisciplinary Approaches in Particle Physics and Astrophysics	Daejeon, Korea	Sep. 5–7, 2024	3	1	1	2	1
iCACGP-IGAC Conference 2024	Hybrid Conference/ Kuala Lumpur, Malaysia	Sep. 9–13, 2024	0	0	1	1	0
12th European conference on RADar in meteorology and hydrology (ERAD 2024)	Hybrid Conference/ Rome, Italy	Sep. 9–13, 2024	0	2	0	2	0
the 4th International Radiocarbon in the Environment Conference	Lecce, Italy	Sep. 22–27, 2024	0	1	0	1	0
Unveiling the Interiors of the Stars to Grasp Stellar Populations	Cefalu, Italy	Sep. 23–27, 2024	0	1	0	1	0
Solar Orbiter Science Working Groups	online	Sep. 26, 2024	0	1	0	1	1
VERSIM2024	Breckenridge, CO, USA	Sep. 30–Oct. 4, 2024	0	2	0	2	1
ISSI Workshop 2024	Hybrid Conference/ Bern, Switzerland	Oct. 1–3, 2024	0	2	0	2	2
Joint Symposium of Space Climate 9 Symposium and ISEE Symposium	Nagoya, Japan	Oct. 1–4, 2024	3	17	4	21	2

Title	Venue	Date	Orga-nizers	Number of Presentations			
				Staff and PDs	Students	Total	Invited
Goal 8 International Symposium on Weather Controllability 2024	Hybrid Conference/ Tokyo, Japan	Oct. 6–7, 2024	0	1	0	1	0
The 7th AOSWA (Asia-Oceania Space Weather Alliance) Workshop	Bangkok, Thailand	Oct. 8–11, 2024	1	1	0	1	1
PMOD Seminar	Davos, Switzerland	Oct. 11, 2024	0	1	0	1	0
SCOSTEP's Next Scientific Program Committee Meeting	Rome, Italy	Oct. 14–17, 2024	1	0	0	0	0
International Conference on Mesoscale Convective System 16 (ICMCS-XVI)	Gyeongju, Korea	Oct. 14–17, 2024	1	4	0	4	0
The 3rd INFN School on Underground Physics	Bertinoro, Italy	Oct. 14–18, 2024	0	0	2	2	0
21st Korea-Japan / 12thAsia Ocean Color Workshop (KJWOC/AWOC)	Denpasar, Indonesia	Oct. 21–25, 2024	0	1	0	1	0
The 16th International Conference on Accelerator Mass Spectrometry (AMS-16)	Guilin, China	Oct. 21–26, 2024	1*	1	0	1	1
Chemical Aeronomy in the Mesosphere and Ozone in the Stratosphere (CHAMOS) workshop 2024	Hybrid Conference/ Nagoya, Japan	Oct. 28–Nov. 1, 2024	1	3	0	3	0
AAPPS-DPP 2024	Malacca, Malaysia	Nov. 3–8, 2024	0	2	0	2	2
European Space Weather Week (ESWW) 2024	Coimbra, Portugal	Nov. 4–8, 2024	1*	3	0	3	2
The 6th Asia Pacific Solar Physics Meeting	Guangzhou, China	Nov.11–15, 2024	1	1	0	1	0
International Symposium on the 40th Anniversary of the MU Radar	Hybrid Conference/ Uji, Japan	Nov.18–21, 2024	1	1	1	2	0
GPM/PMM session of the joint PI meeting of JAXA Earth Observation Missions FY2024	Tokyo, Japan	Nov. 18–22, 2024	0	7	0	7	2
6th International Workshop on new Photon-Detectors	Vancouver, Canada	Nov. 19–21, 2024	0	4	0	4	0
International Workshop on Typhoon Science and Technology Research Center 2024	Yokohama, Japan	Nov. 27–28, 2024	1	0	1	1	0
The 15th Symposium on Polar Science	Hybrid Conference/ Tachikawa, Japan	Dec. 3–5, 2024	0	3	0	3	0
AGU Fall Meeting 2024	Hybrid Conference/ Washington, DC, USA	Dec. 9–13, 2024	0	18	5	23	1
25th East Asia Submillimeter-wave Receiver Technology Workshop	Hybrid Conference/ Daejeon, Korea	Dec. 12–13, 2024	0	0	2	2	0
Macau International Forum on Space and Planetary Sciences	Macau, China	Jan. 7–10, 2025	1	0	0	0	0
SGO Observatory Days	Sodankylä, Finland	Jan. 8–10, 2025	0	1	0	1	0
3rd General Assembly of International Science Council	Hybrid Conference/ Muscat, Oman	Jan. 12–17, 2025	0	1	0	1	0
2025Xiamen Symposium on Marine Environmental Sciences	Xiamen, China	Jan. 14–17, 2025	0	0	2	2	0
United Nations Committee on Peaceful Uses of Outer Space - Science and Technical Subcommittee, 62nd Session	Vienna, Austria	Feb. 3–14, 2025	0	1	0	1	0

Title	Venue	Date	Orga-nizers	Number of Presentations			
				Staff and PDs	Students	Total	Invited
International Space Weather Initiative Annual Meeting	Hybrid Conference/ Vienna, Austria	Feb. 7, 2025	0	1	0	1	0
GEWEX SSG-37	Hybrid Conference/ Wellington, New Zealand	Feb. 10–14, 2025	0	1	0	1	1
COSPAR ISWAT 2025 Working Meeting	Cape Canaveral, FL, USA	Feb. 10–14, 2025	0	1	0	1	0
BepiColombo Young Scientist Study Group workshop	Hybrid Conference/ Madrid, Spain	Feb. 17–19, 2025	1	1	0	1	0
17th Vienna Conference on Instrumentation	Vienna, Austria	Feb. 17–21, 2025	1	0	0	0	0
EPFL Environmental engineering seminar series	Hybrid Conference/ Lausanne, Switzerland	Feb. 25, 2025	0	1	0	1	1
ISEE Symposium “Frontier of Space-Earth Environmental Research as Predictive Science”	Nagoya, Japan	Mar. 5–7, 2025	17	16	10	26	1
The 6th KMI International Symposium (KMI2025)	Nagoya, Japan	Mar. 5–7, 2025	2	0	3	3	0
Space Weather Modeling Framework (SWMF) User Meeting	Hybrid Conference/ Ann Arbor, MI, USA	Mar. 6–7, 2025	0	1	0	1	0
FIERCE Isotope Short Course2025	Frankfurt, Germany	Mar. 11–14, 2025	0	1	0	1	0
2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop	Hybrid Conference/ Rome, Italy	Mar. 17–20, 2025	1	2	0	2	0
2025 Workshop on Ocean and Atmosphere Simulations	Sagamihara, Japan	Mar. 27–28, 2025	0	0	2	2	0
Total (83 conferences)			47 14*	227	77	304	49

■ Domestic Conferences

*Session Conveners

Number of Conferences	Organizers	Number of Presentations			
		Staff and PDs	Students	Total	Invited
89	49 6*	176	106	282	22

■ Lectures for Researchers

Date	Title	Number of Participants
Jun 10, 2024 Jul. 11, 2024 Oct. 17, 2024 Oct. 21, 2024 Oct. 22, 2024 Oct. 23, 2024 Jan. 22, 2025 Feb. 12, 2025 Feb. 19, 2025	ISEE/CICR colloquium (75th–83rd)	13 36 8 22 19 13 29 7 11
Feb. 25, 2025	SCOSTEP Online Capacity Building Lecture (21st)	71

Date	Title	Number of Participants
Apr. 29, 2024 Jul. 30, 2024 Sep. 23, 2024 Oct. 9, 2024 Nov. 8, 2024 Feb. 10, 2025	SCOSTEP/PRESTO Online Seminar (21st–26th)	56 77 17 85 52 68
Apr. 30, 2024 Jun. 25, 2024 Jul. 30, 2024 Sep. 24, 2024 Oct. 29, 2024 Nov. 26, 2024 Dec. 24, 2024 Feb. 10, 2025 Mar. 25, 2025	Seminar on Aircraft Observation	46 46 36 42 34 37 43 29 36
Jun. 3, 2024 Jun. 24, 2024 Jul. 22, 2024 Oct. 21, 2024 Nov. 8, 2024	Seminar of the Division for Meteorological and Atmospheric Research	Approx. 30 participants per session
Total	30	1083

Awards

■ Staff and PhD

(10 in total)

Award Winners	Date	Awards	Title
Yuichi Otsuka	Apr. 5, 2024	Research.com Earth Science in Japan Leader Award	The 2024 Award for Outstanding Earth Science Scientist in Japan by Research.com
Kazuo Shiokawa	Apr. 5, 2024		
Kanya Kusano	Jun. 3, 2024	74th Radio Day Commendation by the Minister for Internal Affairs and Communications	In response to growing concerns over space weather, he chaired a government study group and contributed to its report, helping advance public awareness and response measures.
Sota Niki	Jul. 4, 2024	EWLA2024 Upcoming Talent Award	Online multiple-isotope analysis of individual nanoparticles generated through femtosecond laser ablation
Sho Ohata	Oct. 10, 2024	JpSAC Young Scientist Award	Development of measurement techniques for solid aerosols and studies on their atmospheric behaviors
Tetsuya Hiyama	Oct. 12, 2024	Science Award of the Japanese Association of Hydrological Sciences (JAHS)	Awarded for contributions to research on climate change and water/material cycles in high-latitude regions, and for promoting international collaboration in the field
Yoshizumi Miyoshi	Nov. 15, 2024	2024 Kristian Birkeland Medal for Space Weather and Space Climate	Awarded for significantly advancing space weather science and forecasting by significantly improving our understanding of the physics of the radiation belts and their impact on the atmosphere, as well as the development of practical space weather applications derived from his research
Ryota Kikuchi	Nov. 21, 2024	Certificate of Merit for Best Presentation, 37th Annual Meeting of Computational Mechanics Division in Japan Society of Mechanical Engineers	Development of an Improvement Advisory System for the Digital Twin of Biogas Power Generation Facilities
Kazuhiro Yamamoto	Nov. 21, 2024	Obayashi Early Career Scientist Award	Study of the coupling between magnetohydrodynamic waves and ions in the Earth's magnetosphere through satellite and ground observations
Yuichi Otsuka	Mar. 5, 2025	Excellent Reviewer 2024, Earth, Planets and Space	Important contribution as a reviewer of the journal "Earth, Planets and Space"

■ Students

(9 in total)

Award Winners	Date	Awards	Title
Hirofumi Isogai	Jun. 1, 2024	JpGU 2024 Outstanding Student Presentation Award in Space and Planetary Sciences Section	Validation of initial Parameter dependence of CME Propagation and its Time of Arrival at Earth in SUSANOO-CME
Keita Morishima			Relationship between slow solar wind and plasma-upflow obtained from interplanetary scintillation observation, Hinode/EIS observation and PFSS model
Harune Sekido			Relaxation of the Courant condition and reduction of numerical errors in the explicit Finite-Difference Time-Domain Method
Harune Sekido	Aug. 7, 2024	Gold Student Poster Award, ISSS-15 + IPELS-16	Low-cost magnetometers using magneto-impedance (MI) sensors

Award Winners	Date	Awards	Title
Hinako Fujii	Oct. 28, 2024	Outstanding Presentation Award of the Japanese Association of Hydrological Sciences (JAHS)	Summer precipitation characteristics over Mongolia revealed using GPM-DPR data
Mao Shidara			Interannual variability of atmospheric water vapor transport in the Arctic: consideration of its seasonality and regional characteristics
Riku Okada	Nov.28, 2024	Excellence Award, Chubu Lokal Office, Meteorological Society of Japan	Revisiting of ice microphysical processes in cloud resolving model using a polarimetric radar simulator
Yusuke Goto	Dec.17, 2024	Matsuno Award, 2024 Autumn Meeting of the Meteorological Society of Japan	Estimation of Raindrop Size Distribution Using Vertical Pointing Observations of Ground-Based X-Band Radar
Nozomi Tamura			Improvement of Simulation of Typhoon Inner Core Structure thought Data Assimilation of a Single Dropsonde Sounding in the Eye

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 offers the graduate course for the space-earth physics in the Department of Physics (Division of Particle and Astrophysical Science before the 2021 Academic Year) 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 Natural Science					Department of Electrical Engineering		Department of Earth and Environmental Sciences						
		Department of physics (space–earth physics group)					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		●		●						●	●	●		●
	Office for the Development of Interdisciplinary Research Strategy			●			●	●	●			●	●	●	
	Office for the Promotion of Transdisciplinary Network				●		●	●	●	●					

*Before the 2021 Academic Year：Heliospheric and Geospace Physics, Division of Particle and Astrophysical Science

Faculty Members

2024 Mid-Year Committee Changes: New Appointments: ○ / Resignations: ▲

■ Department of physics, Division of Natural Science / Division of Particle and Astrophysical Science, Graduate School of Science

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Department of physics (space-earth physics group)	Akira Mizuno	Tomoo Nagahama		
	Masafumi Hirahara	Satonori Nozawa	Shin-ichiro Oyama	
	Kanya Kusano	Satoshi Masuda		Akimasa Ieda
	Hideyuki Hotta			
	Yoshitaka Itow ▲	Fusa Miyake	Akira Okumura	Hiroaki Menjo
	Hiroyasu Tajima	Shingo Kazama*		
		Kazumasa Iwai		Ken-ichi Fujiki

* Kobayashi-Maskawa Institute for the Origin of Particles and the Universe

■ Department of Electrical Engineering, Graduate School of Engineering

Field/Topics	Professor	Associate Professor	Lecturer	Assistant Professor
Space Electromagnetic Environment	Kazuo Shiokawa	Nozomu Nishitani		Taku Nakajima
		Yuichi Otsuka		
		Claudia Martinez		
	Yoshizumi Miyoshi	Haruhisa Iijima○		

■ 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	
	Hidenori Aiki			Yoshihisa Mino
Earth and Planetary Sciences Course Chronology and Natural History	Masayo Minami	Takenori Kato		
	Hiroyuki Kitagawa			Hirotaka Oda

Number of Students supervised by ISEE Staff

(April 1, 2024–March 31, 2025)

	M1	M2	D1	D2	D3	Undergraduate Students	Non-regular students	Total	Master's Degree	Doctor's Degree
Graduate School of Science	8	23	3	3	2	-	0	39	19	1
Graduate School of Engineering	9	6	3	0	1	-	0	19	6	2
Graduate School of Environmental Studies	12	12	3	5	7	-	1	40	11	1
School of Science	-	-	-	-	-	13	-	13	-	-
School of Engineering	-	-	-	-	-	12	1	13	-	-
ISEE	-	-	-	-	-	-	0	0	-	-
Total	29	41	9	8	10	25	2	124	36	4

Cumulative total in AY 2024

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 2024 Academic Year, The Following Courses were offered;

- Astrophysics III
- Earth and Planetary Science Seminar I
- Electric Circuits with Exercise
- Environmental Chemistry
- Experimental Physics
- Experiments in Physics - Advanced Course
- Experiments on Electrical, Electronic and Information Engineering 2
- First Year Seminar
- Frontier of Earth and Planetary Sciences
- Fundamentals of Earth Science II
- Geology Experiments
- Graduation Thesis A・B
- Introduction to Electrical, Electronic and Information Engineering for Automobiles
- Introduction to Physics I・II
- Laboratory in Physics
- Linear Circuit with Exercises
- Mathematics I and Tutorial A・B
- Meteorology
- Physics Experiments I・II
- Probability Theory and Numerical Analysis with Exercises
- Remote sensing
- Solar System Science
- Topics in Advanced Physics

11. International Relations

Academic Exchange

(27 in total)

Institution	Country/Region	Establishment
Bangladesh University of Engineering & Technology, Department of Physics	Bangladesh	Mar. 4, 2008
Institute of High Energy Physics, Chinese Academy of Sciences	China	Feb. 20, 2001
Polar Research Institute of China	China	Nov. 11, 2005
Pukyong National University, College of Fisheries Sciences	Korea	Oct. 2, 2006
Korea Institute of Ocean Science and Technology, Korea Ocean Satellite Center	Korea	Apr. 17, 2014
Institute of Geography and Geoecology of the Mongolian Academy of Sciences	Mongolia	Mar. 6, 2024
Department of Atmospheric Sciences, National Taiwan University	Taiwan	Oct. 30, 2009
Center for Weather Climate and Disaster Research, National Taiwan University	Taiwan	Sep. 3, 2014
Geophysical Institute, University of Alaska Fairbanks	USA	Jul. 16, 1990
Space Environment Center, National Oceanic and Atmospheric Administration	USA	Dec. 15, 1992
National Geophysical Data Center, National Oceanic and Atmospheric Administration	USA	Jan. 5, 1993
Haystack Observatory, Massachusetts Institute of Technology	USA	October 24, 1994
Center for Astrophysics and Space Sciences, University of California at San Diego.	USA	Dec. 22, 1997
Center for Space Science and Engineering Research, Virginia Polytechnic Institute and State University	USA	Jan. 23, 2013
Chacaltaya Cosmic Ray Observatory, Faculty of Sciences, Universidad Mayor de San Andres, La Paz	Bolivia	Feb. 20, 1992
National Institute for Space Research	Brazil	Mar. 5, 1997
Yerevan Physics Institute	Armenia	Oct. 18, 1996
Department of Geophysics, Finnish Meteorological Institute	Finland	Oct. 21, 1994
Faculty of Science, UiT The Arctic University of Norway	Norway	May 3, 2019 (since Oct. 8, 1993)
Institute of Cosmophysical Research and Radiowave Propagation, Far Eastern Branch, Russian Academy of Sciences	Russia	Apr. 14, 2007
Institute of Solar-Terrestrial Physics, Siberian Branch of the Russian Academy of Sciences	Russia	Oct. 28, 2008
Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy, Siberian Branch of the Russian Academy of Sciences	Russia	Nov. 28, 2012
The Polar Geophysical Institute, Murmansk	Russia	Mar. 13, 2017
Swedish Institute of Space Physics	Sweden	Sep. 1, 2005 (since Mar. 25, 1993)
National Institute of Water and Atmospheric Research	New Zealand	Jul. 26, 1989
Centre for Geophysical Research, University of Auckland	New Zealand	Dec. 7, 1992
Faculty of Science, University of Canterbury	New Zealand	Jul. 30, 1998

Number of exchanges: visitors:8, going abroad:6

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

Other Exchange

Institution	Country/Region	Establishment
Scientific Committee on Solar-Terrestrial Physics (SCOSTEP)	International Science Council	Jul. 30, 2019

Observation Sites and Foreign Collaborative Institutions

（As of May 2024）

Name	Country/Region	Institution	Obs. Site	Latitude	Longitude
SuperDARN Executive Council	(UK)	●		—	—
Syowa Station	Antarctic		●	-69	39.59
Atmospheric Observatory of Austral Patagonia	Argentine		●	-51.62	290.8
Lasar Application and research Center	Argentine		●	-33.5	301.9
Darwin	Australia		●	-12.44	130.96
Kakadu Observatory, Geoscience Australia	Australia	●		− 12.69	132.47
Athabasca University	Canada	●		54.7	246.7
Athabasca	Canada		●	54.6	246.36
Resolute	Canada		●	74.73	265.07
Eureka	Canada		●	80	274.1
Kapuskasing	Canada		●	49.39	277.81
Atacama highland	Chile		●	-23	292.3
Egypt-Japan University of Science and Technology	Egypt	●	●	30.867	29.583
Nyrola	Finland		●	62.34	25.51
Sodankyla	Finland		●	67.4	26.6
Kevo	Finland		●	69.76	27.01
VLF receiver at Oulujarvi, Finland (OUJ)	Finland		●	64.51	27.23
University of Oulu	Finland	●		65.1	25.5
Kilpisjarv	Finland		●	69.07	20.75
Zugspitze	Germany		●	47.42	10.98
Husafell	Iceland		●	64.67	338.97
Decan College	India	●		18.55	73.9
Observation Site for Methane in Sonepat, India	India		●	29	77
National Research and Innovation Agency (BRIN)	Indonesia	●		-6.2	106.8
Kototabang	Indonesia		●	-0.2	100.32
University of Kurdistan	Iran	●		35.2	46.6
Mexican Array Radio Telescope, Universidad Nacional Autonoma de Mexico	Mexico		●	19.32	261
Top of the Sierra Negra volcano, National Institute of Astrophysics, optics, and electonics	Mexico		●	18.98	262.7
Kathmandu University (KU)	Nepal	●		27.62	85.54
International Centre for Integrated Mountain Development (ICIMOD)	Nepal	●		27.65	85.32
Nepal Academy of Science and Technology (NAST)	Nepal	●		27.66	85.32
The Rolwaling valley in the Himalayas (six places)	Nepal		●×6	27.9	86.38
National Space Research and Development Agency	Nigeria	●		8.99	7.38
Abuja	Nigeria		●	8.99	7.38
University Centre in Svalbard (UNIS)	Norway	●		78.2	15.63
Alta	Norway		●	69.9	23.3
Tromsø	Norway		●	69.59	19.227
Skibotn	Norway		●	69.35	20.36
Ny-Ålesund	Norway		●	78.9	11.9
Muntinlupa	Philippines		●	14.373	121.02

Name	Country/Region	Institution	Obs. Site	Latitude	Longitude
Institute for Biological Problems of Cryolithozone, Siberian Branch of Russian Academy of Sciences	Russia	●		62.25	129.2
Pushchino Radio Astronomy Observatory, Lebedev Physical Institute	Russia		●	54.82	37.63
Istok	Russia		●	70.03	88.01
Zhigansk	Russia		●	66.78	123.37
Magadan	Russia		●	60.05	150.73
Paratunka	Russia		●	52.97	158.248
EISCAT Scientific Association	Sweden	●		67.8	20.4
European Organization for Nuclear Research	Switzerland	●		46.2	6
Chiang Mai University	Thailand	●		18.79	98.92
Chiang Mai	Thailand		●	18.79	98.92
Chumphon	Thailand		●	10.73	99.37
Brookhaven National Laboratory	USA	●		40.9	287.1
The University of Arizona	USA	●		32.2	249
Gakona	USA		●	62.39	214.78
University of Alaska, Fairbanks, Poker Flat Research Range	USA		●	65.1	213
Ishigaki	Japan		●	24.4	124.1
Sata	Japan		●	31.02	130.68
Shigaraki	Japan		●	34.8	136.1
Toyokawa	Japan		●	34.84	137.37
Kiso	Japan		●	35.8	137.63
Chihara Campus, University of the Ryukyus	Japan		●	26.3	127.8
SuperDARN Hokkaido East	Japan		●	43.5	143.6
SuperDARN Hokkaido West	Japan		●	43.5	143.6
Kamioka Observatoty, Institute for Cosmic Ray Research, University of Tokyo	Japan		●	36.1	137.55
Kunigami	Japan		●	26.76	128.21
Inabu Crustal Deformation Observatory	Japan		●	35.2	137.53
Kawatabi Observatory, Graduate School of Science, Tohoku University	Japan		●	38.75	140.76
The Shirakami Natural Science Park, Hirosaki University	Japan		●	40.52	140.22
Moshiri	Japan		●	44.37	142.27
Kagoshima	Japan		●	31.48	130.72
Fuji	Japan		●	35.43	138.64
Rikubetsu	Japan		●	43.5	143.8
Total 77	23 countries exc. Japan	19	59*	–	–

*Including 17 domestic sites

Research Projects

■ Major International Collaborative Projects

(82 in total)

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Modeling Study of Inner Magnetosphere	Yoshizumi Miyoshi	USA	1	Los Alamos National Laboratory
Collaborative Study on ERG Project	Yoshizumi Miyoshi	Taiwan	1	Academia Sinica Institute of Astronomy and Astrophysics
International Heliophysics Data Environment Alliance	Yoshizumi Miyoshi	USA Europe (Member States of ESA)	23	NASA (SPDF, SDAC, HPDE, SPASE, CCMC) ESA, Centre National d'Études Spatiales
Experiment of Geomagnetic Field with Sounding Rocket LAMP	Yoshizumi Miyoshi	USA	1	NASA, University of Iowa, University of New Hampshire, Dartmouth College
Collaborative Researches Based on Solar Radio Observations with MUSER	Satoshi 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	Satoshi Masuda	USA UK 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
Solar Flare Research with Hard X-Ray Spectral Imaging Observations	Hiroyasu Tajima	USA	1	UCB, MSFC/NASA, Air Force Research Laboratory
Solar Flare Research with Gamma-Ray Spectral Imaging Observations with Polarimetry	Hiroyasu Tajima	USA	1	UCB, Lawrence Berkeley National Laboratory, GSFC/NASA
Research on Origin of Cosmic Rays with CTA (Cherenkov Telescope Array)	Hiroyasu Tajima	Germany France Italy Spain Switzerland UK USA *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	Hiroyasu Tajima	USA 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
Research on Origin of Cosmic Rays with MAGIC Telescope	Hiroyasu Tajima	Spain Germany Italy Switzerland Bulgaria Croatia	6	Institute for High Energy Physics (IFAE), University of Barcelona, Complutense University of Madrid Max Planck Institute for Physics, TU Dortmund University, University of Würzburg University of Padova, University of Siena, University of Udine CERN Institute for Nuclear Research and Nuclear Energy Croatian MAGIC Consortium
Search for Cosmic-Ray Excursions in the Past by Single-Year Measurements of ^{14}C in Tree Rings	Fusa Miyake	USA Switzerland	2	The University of Arizona Swiss Federal Institute of Technology Zürich
Research and Development for the Next Generation Water Cherenkov Detector, Hyper-Kamiokande	Hiroaki Menjo	USA Korea China UK 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 in Interaction of Very High Energy Cosmic Rays by using Large Hadron Collider	Hiroaki Menjo	Italy France Switzerland USA Germany	5	University of Florence, Catania University École Polytechnique CERN Lawrence Berkeley National Laboratory Humboldt University of Berlin

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Study in Interaction of Very High Energy Cosmic Rays by using Relativistic Heavy Ion Collider	Hiroaki Menjo	Italy USA Korea	3	University of Florence, Catania University Brookhaven National Laboratory Korea University
Study in Cosmic Neutrinos by using a Large Water Cherenkov Detector	Hiroaki Menjo	USA Canada UK 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 of Dark Matter and Solar Neutrinos using a 2-Phase Liquid Xenon TPC Detector	Shingo Kazama	Germany Italy Switzerland USA 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*
Observations of Interplanetary Disturbances using the International IPS Network	Kazumasa Iwai	UK 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	Kazumasa Iwai	USA	1	CASS/UCSD
Study of the Heliospheric Boundary Region using Observations of Interplanetary Scintillation	Kazumasa Iwai	USA	1	Interstellar Boundary Explorer, IMAP
Study of Interplanetary Coronal Mass Ejections Propagation in the Inner Heliosphere Combining MHD Modeling, Ground Based Observations, and *in-situ* Multi-spacecraft Data	Kazumasa Iwai	France UK Netherland USA	4	CNRS, Laboratoire de Physique des Plasmas University of Leicester European Space Research and Technology Centre/ESA UCB
Space Weather Modeling using Interplanetary Scintillation Observations	Kazumasa Iwai	USA	1	Lockheed Martin Solar and Astrophysics Laboratory
Study of Unusual Slow Solar-wind Events Using Interplanetary Scintillation Observation	Ken-ichi Fujiki	India	1	Physical Research Laboratory, National Institute of Technology, National Atmospheric Research Laboratory
Study of Acceleration Mechanisms of the Slow Solar-wind by Using 2.5D MHD simulation	Ken-ichi Fujiki	USA	1	Harvard-Smithsonian Center for Astrophysics

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Radio Occultation Observations of Compact Radio Sources through Comet C/2023 A3 (Tsuchinshan-ATLAS)'s Tail	Ken-ichi Fujiki	India	1	National Institute of Technology, Physical Research Laboratory, Pune University, National Centre for Radio Astrophysics
Research and Development of the Plasma/Particle Instrument Suite for the Mercury Magnetospheric Exploration Mission	Masafumi Hirahara	France Sweden UK USA 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
Study on Science Subjects and Developmental Techniques of Observational Instruments toward Future Spacecraft Exploration Missions for the Space-Earth Coupling System	Masafumi Hirahara	Sweden	1	Swedish Institute of Space Physics
Comparative Study of the Space Plasma Dynamics in the Earth's and Mercury's Magnetospheres	Masafumi Hirahara	Taiwan	1	National Central University
PRESTO（Predictability of Variable Solar-Terrestrial Coupling）	Kazuo Shiokawa	U.S.A., France, Germany, U.K., Italy, Canada, Australia, India, China, *and other countries*	36	SCOSTEP
High-Sensitive Imaging Measurements of Airglow and Aurora and Electromagnetic Waves in Canadian Arctic	Kazuo Shiokawa	USA 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	Kazuo Shiokawa	Australia	1	IPS Radio and Space Service
Comparison of Dynamical Variations of the Mesosphere, Thermosphere, and Ionosphere between Asian and Brazilian Longitudes	Kazuo Shiokawa	Brazil	1	INPE
Ground and Satellite Measurements of Geospace Environment in the Far-Eastern Russia	Kazuo 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	Kazuo 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	Kazuo Shiokawa	Russia	1	Institute of Cosmophysical Research and Aeronomy/SB RAS, ISTP/SB RAS
Study of the Low-latitude and Equatorial Ionosphere at Eastern Africa	Kazuo Shiokawa	Egypt Ethiopia	2	Egypt-Japan University of Science and Technology (E-JUST) Bahir Dar University
Study of the Middle Latitude Ionosphere at Ukraine	Kazuo Shiokawa	Ukraine	1	Institute of Ionosphere (IION)
Observations of the Mid-Latitude Ionosphere in Germany	Kazuo Shiokawa	Germany	1	National Aeronautics and Space Research Centre of the Federal Republic of Germany (DLR)
Study of the Polar/Midlatitude Ionosphere and Magnetosphere using the SuparDARN HF Radar Network	Nozomu Nishitani	USA UK 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, National Space Science Center

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Study of the Polar Upper Atmosphere using the EISCAT Radars and Other Instruments	Satonori Nozawa	Norway Sweden, Finland, Germany, UK, China	6	UiT The Arctic University of Norway EISCAT Scientific Association
Collaborative Research and Operation in the Field of Space Weather Observations	Yuichi Otsuka	Indonesia	1	BRIN
Observations and Researches of Ionosphere and Upper Atmosphere in Thailand	Yuichi 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	Yuichi Otsuka	China Indonesia Thailand	3	Institute of Geology and Geophysics Chinese Academy of Sciences BRIN King Mongkut's Institute of Technology Ladkrabang
Global Study of Midlatitude Plasma Bubbles using Multi-instrument Observations and Models	Yuichi Otsuka	South Africa	1	South African National Space Agency
Study of Ionospheric Disturbances in East Asia: Impacts on GNSS Positioning at Low and Mid-Latitudes	Yuichi Otsuka	China	1	National Astronomical Observatory of China
SDI-3D Project	Shin-ichiro Oyama	USA Finland Sweden Norway	4	Geophysical Institute of the University of Alaska Fairbanks University of Oulu, Finnish Meteorological Institute, Sodankylä Geophysical Observatory The Swedish Institute of Space Physics UiT The Arctic University of Norway
Study of Auroral Energetic Electron Precipitation (EEP) Impacts on the Upper/Middle Atmosphere	Shin-ichiro Oyama	Finland New Zealand UK Norway USA	5	University of Oulu, Finnish Meteorological Institute University of Otago British Antarctic Survey University Centre in Svalbard University of Alaska Fairbanks
Study of Aerosols and Atmospheric Trace Gases by using SAVER-Net Observation Network in South America	Akira 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
Optical Property of Atmospheric Organic Aerosol in Beijing	Michihiro Mochida	China	1	Tianjin University
Characterization of Atmospheric Aerosols in Central Europe	Michihiro Mochida	Czech	1	Institute of Chemical Process Fundamentals
Diagnosing Air Pollution by Organic Aerosol: toward Air Quality Management in the Emerging Era of Organic Haze	Michihiro Mochida	Switzerland	1	Swiss Federal Institute of Technology in Lausanne
Characterizing Organics and Aerosol Loading over Australia (COALA)	Michihiro Mochida Sho Ohata	Australia	1	University of Wollongong, Commonwealth Scientific and Industrial Research Organisation, Australian Nuclear Science and Technology Organisation, University of Melbourne
Characterization of Atmospheric Organic Aerosol Over a Boreal Forest in Northern Europe	Michihiro Mochida Sho Ohata	Finland	1	University of Helsinki

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Long-Term Observation of Black Carbon Aerosols in the Arctic	Sho Ohata	Norway USA Canada Finland	4	Norwegian Polar Institute National Oceanic and Atmospheric Administration Government of Canada Finnish Meteorological Institute
Energetic Particle Chain -Effects on the Middle/Lower Atmosphere from Energetic Particle Precipitations-	Taku Nakajima	Finland Norway Sweden	3	University of Oule, Finnish Meteorological Institute UiT The Arctic University of Norway EISCAT Scientific Association
Continuous Observation of Methane at a Paddy Field in Northern India	Yutaka Matsumi	India	1	University of Delhi
Observation of PM2.5 in Ulan Bator	Yutaka Matsumi	Mongolia	1	National University of Mongolia
Observation of PM2.5 in Hanoi	Yutaka Matsumi	Vietnam	1	Hanoi University of Science and Technology
Tropical Cyclones-Pacific Asian Research Campaign for Improvement of Intensity Estimations/Forecasts (T-PARCII)	Kazuhisa Tsuboki Taro Shinoda Nobuhiro Takahashi	Taiwan USA	2	National Taiwan University Atmospheric Sciences Colorado State University
Technology Exchange on the State-of-art Weather Radar Data Analysis	Nobuhiro Takahashi	Taiwan	1	National Taiwan University
Academic Exchange of Weather Radar Research and Application Experiences between ISEE and NCDR	Nobuhiro Takahashi	Taiwan	1	National Science and Technology Center for Disaster Reduction (NCDR)
EarthCARE Mission	Nobuhiro Takahashi	Europe (Member States of ESA)	23	ESA
Evaluation of Different Techniques for Deriving 3D Wind Fields from the PAWR Observations and Deriving Precipitation from Satellite Observations	Nobuhiro Takahashi	Taiwan	1	National Science and Technology Center for Disaster Reduction (NCDR)
Global Precipitation Measurement Mission (GPM)	Nobuhiro Takahashi Hirohiko Masunaga	USA	1	NASA
Satellite Algorithm Development for Tracking Precipitating Clouds	Hirohiko Masunaga	USA	1	NASA Jet Propulsion Laboratory
Development and Validation of a Satellite-Based Scheme to Estimate In-Cloud Vertical Velocity	Hirohiko Masunaga	USA	1	City University of New York
The Mutual Evolution of Satellite-Observed Atmospheric Moisture, Clouds, and Precipitation	Hirohiko Masunaga	USA	1	UC Davis
Study on Carbon Storage in Coastal Seagrass Meadows in Thailand	Yoshihisa Mino	Thailand	1	Burapha University
Observational Study of Vegetation, Energy and Water in Eastern Siberia Towards Elucidation of Climate and Carbon Cycle Changes	Tetsuya Hiyama	Russia	1	Institute for Biological Problems of Cryolithozone/SB RAS
Arctic Challenge for Sustainability II (ArCS II) Project	Tetsuya Hiyama	USA	1	International Arctic Research Center of the University of Alaska Fairbanks
Estimating Permafrost Groundwater Age in Central Mongolia	Tetsuya Hiyama	Mongolia	1	Institute of Geography and Geoecology of the Mongolian Academy of Sciences

Research Project	ISEE Representative	Collaborating Country/Region		Collaborating Organization
Asian Precipitation Experiment (AsiaPEX)	Hatsuki 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*
An International Study on Precipitation Variability in High-Altitude Areas of the Himalayas in Nepal	Hatsuki Fujinami	Nepal	1	Kathmandu University, Tribhuvan University
International Continental Scientific Drilling Program - Dead Sea Deep Drilling Project (ICDP-DSDDP)	Hiroyuki Kitagawa	Israel USA Germany Switzerland	4	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	Hiroyuki Kitagawa	Vietnam	1	Vietnam Academy of Science and Technology
Geochronology and Geochemistry of Apatite Grains in Granitic Rocks as a New Method for Discrimination of Tectonic Setting	Masayo Minami	Iran	1	University of Kurdistan
Establishment of Master Dendrochronological Calibration Curve Around 660 BC using Annual Tree Ring Samples from Poland	Masayo Minami	Poland	1	Silesian University of Technology
Technical Exchange for Accurate and Precise ^{14}C Measurement by Accelerator Mass Spectrometer	Masayo Minami	Korea	1	Korea Institute of Geoscience and Mineral Resources
Geochemistry and ^{14}C Dating of Guano Deposits in Kurdistan, Iran: Implication for Paleoenvironment	Masayo Minami	Iran Mexico	2	University of Kurdistan National Autonomous University of Mexico
Measurements of Cosmic-Ray-Produced ^{14}C in Iron Meteorites	Masayo Minami	USA	1	UCB
Geochronological Research on the Basement Rocks in Japan and Korea	Takenori Kato	Korea	1	Korea Institute of Geoscience and Mineral Resources
Development of New Analytical Techniques and Accurate Quantification of Electron Microprobe Analysis	Takenori Kato	Korea	1	Pusan National University

Visitors from Foreign Institutes

(April 1, 2024–March 31, 2025)

Country/Region		Number of Visitors	
Asia (7)	China	5	39
	India	12	
	Indonesia	5	
	Korea	5	
	Malaysia	1	
	Nepal	1	
	Taiwan	10	
North America (2)	Canada	1	22
	USA	21	
Latin America and the Caribbean (2)	Argentina	1	3
	Brazil	2	
Europe (10) (Including New Independent States)	Czech	2	37
	Finland	11	
	France	3	
	Germany	3	
	Italy	1	
	Poland	1	
	Russia	2	
	Sweden	3	
	Switzerland	4	
	UK	7	
Oceania (1)	New Zealand	1	1
Middle East (2)	Iran	1	2
	Iraq	1	
Africa (2)	Egypt	1	2
	Ethiopia	1	
Total	26	106	

Funding Source	Number of Visitors
Ministry of Education, Culture, Sports, Science and Technology	3
Japan Society for the Promotion of Science	9
Nagoya University	74
Self-funding	7
Other funding sources	13
Total	106

Purpose	Number of Visitors
Conferences/Symposiums	24
Joint Research	71
Others	11
Total	106

Overseas Business Trips of Faculty

(April 1, 2024–March 31, 2025)

Country/Region		Number of Travelers	
Asia (9)	Cambodia	2	54
	China	7	
	India	1	
	Indonesia	5	
	Korea	23	
	Malaysia	6	
	Taiwan	4	
	Thailand	5	
	Vietnam	1	
North America (2)	Canada	3	31
	USA	28	
Latin America and the Caribbean (2)	Chile	1	2
	Mexico	1	
Europe (18) (Including New Independent States)	Austria	6	83
	Belgium	2	
	Czech	3	
	Estonia	1	
	Finland	9	
	France	3	
	Germany	12	
	Hungary	1	
	Italy	10	
	Norway	14	
	Poland	3	
	Portugal	2	
	Romania	1	
	Slovakia	1	
	Spain	3	
	Sweden	4	
	Switzerland	7	
	UK	1	
Oceania (1)	New Zealand	2	2
Middle East (1)	Oman	1	1
Africa (4)	Namibia	1	5
	South Africa	2	
	Zambia	1	
	Zimbabwe	1	
Other (1)	Antarctica	1	1
Total	38	179	

Seminars by Foreign Scientists

Date	Name	Affiliation	Title	Number of Participants
Apr. 29, 2024	Hanli Liu	High Altitude Observatory, USA	21st SCOSTEP/PRESTO Online Seminar/It's YES for NO, O/N_2 and e: Perturbative and Transport Effects by Gravity Waves in the Mesosphere, Thermosphere and Ionosphere	56
May 1, 2024	Yuto Bekki	Max Planck Institute for Solar System Research, Germany	ISEE Solar Seminar/ Baroclinically-unstable Modes as an Essential Component of the Sun's Convection Zone Dynamics	17
Jun. 10, 2024	Martha Arbayani Zaidan	University of Helsinki, Finland	75th ISEE/CICR colloquium/ AI Technologies for Enhancing Sensor Networks: Accuracy, Reliability, and Autonomy	13
Jul. 10, 2024	Alexander Pevtsov	National Solar Observatory, USA	ISEE Solar Seminar/ The Simplest Magnetograph, ngGONG, and other projects at the US National Solar Observatory	19
Jul. 11, 2024	Balan Nanan	Shandong University, China	76th ISEE/CICR colloquium/ Fresh Look at the Intensity and Impulsive Strength of Geomagnetic Storms Having Positive MPO	36
Jul. 30, 2024	Nat Gopalswamy	GSFC NASA, USA	22nd SCOSTEP/PRESTO Online Seminar/ Space Weather Consequences of a Weak Heliospheric State	77
Sep. 23, 2024	Man Hua	UCLA, USA	23rd SCOSTEP/PRESTO Online Seminar/ Upper Limit of Earth's Outer Radiation Belt Electron Fluxes: How Intense Can It Get and Why?	17
Oct. 9, 2024	Manuela Temmer	Institute of Physics, University of Graz, Austria	24th SCOSTEP/PRESTO Online Seminar/ Structure and Dynamics of the Heliosphere – a Better Understanding for Better Space Weather Forecasting	85
Oct. 17, 2024	Puthenveettil Narayana Menon Vinayachandran	Centre for Atmospheric and Oceanic Sciences, India	77th ISEE/CICR colloquium/ Features of the Southern Bay of Bengal from Bay of Bengal Boundary Layer Experiment (BoBBLE)	8
Oct. 21, 2024	C. C. Tsai	National Science and Technology Center for Disaster Reduction, Taiwan	78th ISEE/CICR colloquium/ An Update of Radar-related Research Progress in NCDR	22
Oct. 22, 2024	Y.-C. Chen	National Science and Technology Center for Disaster Reduction, Taiwan	79th ISEE/CICR colloquium/ Applications of Meteorological Satellite Data in Disaster Prevention by NCDR	19
Oct. 23, 2024	H.-H. Lin	National Science and Technology Center for Disaster Reduction, Taiwan	80th ISEE/CICR colloquium/ Application of Big Data and Visualization Technique on Disaster Warning System	13
Nov. 8, 2024	Jie Zhang	George Mason University, Virginia, USA	25th SCOSTEP/PRESTO Online Seminar/ Solar Eruptions: Initiation, Propagation and Their Earth Impact	52
Dec.11, 2024	Muriel Stiefel	FHNW, Switzerland	ISEE Solar Seminar/ Using Solar Orbiter/STIX as a Proxy for the GOES Flare Class	15
Jan. 15, 2025	Donghui Son	Kyung Hee University, Korea	ISEE Solar Seminar/ A Comparative Analysis of High-Resolution Shock Capturing Schemes for Two-Dimensional MHD Simulation of Flux Emergence in the Solar Atmosphere	16
Jan. 22, 2025	Samuel Krucker	FHNW, Switzerland and UCB, USA	81st ISEE/CICR colloquium/ Catching Solar Flares with ESA's Solar Orbiter Mission	29
Feb. 7, 2025	Nada Al-Haddad	University of New Hampshire, USA	ISEE Solar Seminar/ Magnetic Configuration of Coronal Mass Ejections: Topological Analysis	18

Date	Name	Affiliation	Title	Number of Participants
Feb. 10, 2025	Noé Lugaz	University of New Hampshire, USA	ISEE Solar Seminar/ Simultaneous Multi-Point Measurements of CMEs: Physical Insights and Consequences for Future Heliophysics and Space Weather Missions	16
Feb. 10, 2025	Jan Lastovicka	Institute of Atmospheric Physics, Czech	26th SCOSTEP/PRESTO Online Seminar/ Long-term Trends in Ionospheric and Thermospheric Climate	68
Feb. 12, 2025	Yi-Xian Li	Monash University, Australia	82nd ISEE/CICR colloquium/ Extreme Precipitation Follows Two Key Pathways in Tropical Convection Evolution	7
Feb. 13, 2025	Neethal Thormas	Sodankylä Geophysical Observatory, Finland	ISEE Solar Seminar/ Studies of EISCAT-VHF Incoherent Scatter Spectral Measurements in the Mesosphere Lower-Thermosphere Altitudes	14
Feb. 19, 2025	Matthias Förster	FZ German Research Centre for Geosciences, Germany	83rd ISEE/CICR colloquium/ The Geomagnetic Superstorm Event of 10–11 May 2024	11
Feb. 25, 2025	Claudio Cesaroni	National Institute of Geophysics and Volcanology, Italy	21st SCOSTEP Online Capacity Building Lecture/ Machine Learning-Based Techniques for Ionospheric Forecasting	71
Mar. 6, 2025	KD Leka*	NorthWest Research Associates, USA	The 6th ISEE Award Commemorative Lecture/ Grounding and Rebounding: Establishing some Hard Truths [about Solar Flare Forecasting] so that Progress can be (is being) Made!	80
	Sung-Hong Park	Korea Astronomy and Space Science Institute, Korea		
Mar. 12, 2025	KD Leka*	NorthWest Research Associates, USA	Solar Seminar/ Solar Flare Forecasting in the Solar Dynamics Observatory Era: Where Has “Big Data” Brought Us?	14
Total:		25		793

* Foreign Visiting Staff

< Abbreviations >

BRIN:	Badan Riset dan Inovasi Nasional
CASS:	Center for Astrophysics and Space Sciences
CCMC:	Community Coordinated Modeling Center
CEA:	Commissariat à l'Energie Atomique et aux Energies Alternatives
CEILAP:	Centro de Investigaciones en Láseres y Aplicaciones
CENS:	Centre d'Études Nucléaires de Saclay
CERN:	European Organization for Nuclear Research
CESR:	Centre d'Etude Spatiale des Rayonnements
CETP:	Centre d'Etude des Environnements Terrestres et Planétaires
CNRS:	Centre National de la Recherche Scientifique
EISCAT:	European Incoherent Scatter Scientific Association
ESA:	European Space Agency
FHNW:	University of Applied Sciences and Arts Northwestern Switzerland
GSFC:	Goddard Space Flight Center
HPDE:	Heliophysics Data Environment
IFSI:	Istituto di Fisica dello Spazio Interplanetario
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
LoFAR:	Low Frequency Array
LPC2E:	Laboratoire de Physique et Chimie de l'Environnement et de l'Espace
MAGIC:	Major Atmospheric Gamma-ray Imaging Cherenkov Telescope
MSFC:	Marshall Space Flight Center
NASA:	National Aeronautics and Space Administration
RAS:	Russian Academy of Sciences
SB:	Siberian Branch
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
UCB:	University of California, Berkeley
UC Davis:	University of California, Davis
UCI:	University of California, Irvine
UCLA:	University of California, Los Angeles
UCSC:	University of California, Santa Cruz
UCSD:	University of California, San Diego
UiT:	University of Tromsø

12. Outreach

Public Lectures, Open Labs, and School Visits

The ISEE organizes a variety of outreach events and activities, held either online, in person, or in a hybrid format. Specifically, we conducted three public lectures, two school outreach visits, six student facility tours, two open-laboratory events, two training courses for young researchers, a five-day university student tour, a children's workshop, and a combined field trip and workshop for children. In addition, ISEE members contributed to public education by giving a total of 30 public talks.

We also published a series of Japanese-language booklets addressing 50 questions on various topics, along with several comic books focused on space–Earth themes. These resources aim to support science education for both the general public and students. All materials are available for download from the ISEE website (https://www.isee.nagoya-u.ac.jp/hscontent/books.html). The comic books have been translated into English through collaboration with SCOSTEP's CAWSES program (https://www.isee.nagoya-u.ac.jp/en/outreach.html), and translations in other languages can be found on the SCOSTEP website (https://scostep.org/space-science-comic-books/).

Additionally, we published two newsletters and shared selected research findings, event reports, and English-language columns.

The ISEE website continues to provide public access to the latest updates on our scientific activities and laboratory research (https://www.isee.nagoya-u.ac.jp/en/).

Visiting lecture at an elementary school in Hokkaido (November 24, 2024).

Addresses of Facilities

Name		Address	TEL/FAX
①	Institute for Space–Earth Environmental Research	Research Institutes Buildings I/II, Furo-cho, Chikusa-ku, Nagoya, Aichi 464-8601	TEL:+81-52-747-6303 FAX:+81-52-747-6313
②	Toyokawa Branch	3-13 Honohara, Toyokawa-shi, Aichi 442-8507	TEL:+81-533-89-5206 FAX:+81-533-86-3154
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
		58-2, 78-1, 78-5, 129-1, 129-4 Pontomamu, Rikubetsu-cho, Ashoro-gun, Hokkaido 089-4300	TEL:+81-156-27-4011
⑤	Fuji Observatory	1347-2 Fujigane, Fujikawaguchiko-machi, Minamitsuru-gun, Yamanashi 401-0338	TEL:+81-555-89-2829
⑥	Kagoshima Observatory	3860-1 ShimoHonjo Honjo, Tarumizu-shi, Kagoshima 891-2112	TEL:+81-994-32-0730