

Report of the ISEE External Expert Evaluation in March 2026

Institute for Space - Earth Environmental Research

Nagoya University

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Report of the ISEE External Review Committee

March 11-13, 2026

The external review committee, consisting of five scientists from the research and applications communities, visited the International Space-Earth Environment Research Institute (ISEE) on March 11-13, 2026. The committee received overview presentations from the seven Divisions, the three Centers, and the two Offices. In addition, the committee held discussions with faculty members, postdoctoral researchers, and graduate students. As detailed below, the committee was highly impressed with the quality and breadth of the scientific research and the extensive network of active international collaboration. A high level of enthusiasm was clearly present throughout the organization along with a commitment to achieve the institute's high-level goal of understanding the complex space-Earth system in support of sustainable development, as human society utilizes and expands into space.

Executive Summary:

The International Space-Earth Environment Research Institute (ISEE) was formed in 2015, initially through the merger of three Nagoya University institutes: the Solar-Terrestrial Environment Laboratory, the Hydrosphere Atmospheric Research Center, and the Center for Chronological Research. In the 10 years since it was established, ISEE has developed into a mature and thriving interdisciplinary and international research institute with remarkable breadth and depth.

As ISEE's research and applications have developed, new programs have been established, such as the Office for the Development of Interdisciplinary Research Strategy in 2022 and the Office for Promoting the Formation of Transdisciplinary Network in 2025. Beginning in 2025, ISEE was accredited as an International Joint Usage/Research Center by MEXT, one of only nine such centers in Japan. ISEE is reviewed regularly within Japan and internationally and has received high recognition and praise for its scientific excellence and its interconnected and socially relevant programs.

The organizational structure and the intellectual excellence of the faculty, staff, and students provide an unprecedented opportunity to advance scientific knowledge and to disseminate this knowledge to the general public. Furthermore, ISEE is conducting research in key areas that can lead to direct societal benefit, such as extreme weather prediction, climate change, and space weather. The research groups within ISEE are also at the forefront of space-based and ground-based instrumentation, data science, numerical simulation, and theoretical understanding. All of these areas hold great

promise for near-term advances that will accelerate progress in our understanding of the coupled space-Earth system.

ISEE's recent achievements noted by the committee are included below, as well as overall recommendations. This is followed by brief assessments of each of the Divisions, Centers, and Offices.

Notable Accomplishments

Research achievements:

ISEE is currently at the forefront of scientific research with extensive participation in international collaborations and programs. A few representative recent research achievements include the following:

- Carrying out the world's largest simulation of the solar interior and modeling the large-scale solar flows;
- Detection of mesospheric ozone depletion associated with proton aurora due to radiation belt precipitation;
- Potential for one-day advanced warning when CMEs are observed by the interplanetary scintillation detectors;
- Elucidation of time, latitude and altitude dependence of trace gas concentrations;
- High-precision dating of cultural heritage sites (e.g., the Herat Old City Wall).

Uniqueness of research:

The research conducted within ISEE spans a remarkable diversity of topics, from paleo climate reconstruction to the search for dark matter. Research also focuses on highly relevant issues of direct societal importance, such as climate change, extreme weather events, and space weather impacts. The depth of scientific expertise within these diverse areas serves as a catalyst for discovery and enables expansion into new areas of promise.

Institutional enthusiasm and motivation:

The committee was impressed by the high level of enthusiasm throughout the entire institute, from students to junior faculty to senior faculty. The faculty and students are clearly excited by the activities occurring within ISEE and committed to research excellence. The committee also noted a strong culture of support for young researchers, through the availability, for example, of staff machinists to develop experimental instrumentation.

International connection:

ISEE clearly fosters and utilizes international collaboration to its fullest potential. ISEE-developed instrumentation has been deployed throughout the world, ISEE

researchers collaborate extensively in international projects, and ISEE supports and fosters international participation throughout its programs. In particular, the young staff spoke enthusiastically about the value of attending foreign conferences and workshops, working with foreign scientists, and being exposed to a large number of new ideas through the frequent visits by international collaborators to ISEE. This access to diverse ideas and collaborative opportunities is an important seed for future growth.

Leadership of broad community participation:

ISEE supports many interdisciplinary research projects within and outside Nagoya University. These projects are strengthening research both within and broadly outside Nagoya University. With limited resources, these programs are an excellent way to expand participation in interdisciplinary research and to augment the expertise within ISEE.

Comprehensive data acquisition and availability:

ISEE leads numerous impressive activities to develop innovative measurement techniques, to collect environmental measurements pertaining to diverse scientific investigations, and to make the observations broadly available to the scientific community. Strong experimental teams are improving detection methods that will likely lead to breakthrough scientific findings. Examples include the development of a solar neutron detector and a compact plasma sensor, both of which are being designed for small satellites. The extensive space-based and ground-based data sets are a solid foundation for ISEE's excellent research achievements and strong international collaborations.

Numerical modeling:

ISEE has developed and is utilizing a wide array of state-of-the-art numerical simulation models. This includes models of the solar interior, solar surface, solar atmosphere, coronal mass ejection trajectories, magnetosphere-ionosphere coupling, and atmospheric dynamics. These models are effectively used with available data to test hypotheses and elucidate physical connections throughout the interconnected space-Earth environment.

Recommendations

The committee found a number of areas where it had recommendations that could help to connect and enhance the broad and deep activities being conducted throughout the institute. The hope of the committee is that these recommendations can enhance the effectiveness of the institute and encourage new directions as opportunities arise.

Succession planning and general staffing needs

The committee was made aware of numerous upcoming retirements and personnel changes throughout ISEE. These staffing changes will present challenges for the continuity of key programs as well as opportunities to shift into new high priority research areas. As ISEE plans for its future staffing needs, the committee recommends a few specific areas to consider:

- Improving gender balance should be given top priority;
- Additional technical staff would be beneficial;
- Additional postdocs would accelerate research and take some pressure off faculty;
- It would be helpful to have research management personnel (University Research Administrators, URAs), as researchers in ISEE seem to have excessive non-research duties. URAs would be personnel who possess a certain level of understanding of research and development content while also managing tasks such as securing and administering research funding and managing and utilizing intellectual property.

Recruit more undergraduates:

The committee believes that promoting the relevance of its science and applications will serve to make ISEE more attractive to students. Young people in society today see the growing importance of space-based and environmental-based activities and can be attracted by the cultural and economic aspects of ISEE's diverse programs, in addition to the scientific excellence.

Societal benefit strategic planning:

The committee recommends that ISEE develop concrete plans to achieve additional societal benefit. Excellent examples of this are already occurring in ISEE, such as typhoon research, improving the forecasting of tropical storms, and forecasting the arrival of coronal mass ejections. The committee recommends that ISEE add additional areas where measurable benefits to "human society as it expands into space" can be demonstrated. The committee encourages ISEE to create several storylines and workplans to fill gaps among successful research areas in order to develop prediction systems of environmental impacts to the terrestrial system that are beneficial for society and contribute to societal studies, such as in the ISC/Future Earth program. In the years ahead, two key areas of development that will be essential for our growing space economy are the management of space traffic and debris in low-Earth orbit and the impacts of energetic particle radiation on human space travelers. These topics fall solidly within the scope of ISEE's programs and could be areas of expansion that would both attract young scientists and yield significant societal benefit. Research and applications in these areas could be accomplished either through expansion within ISEE or through collaboration with partner organizations within and outside Japan.

Strengthen modeling connections across the Sun-Earth system:

The ISEE divisions utilize various numerical models within the coupled solar wind-magnetosphere-ionosphere-atmosphere-ocean-land system, which enable integrated studies of the holistic system. The committee applauds this approach and recommends that ISEE initiate a long-range plan to fill current key gaps in the Sun-Earth chain and to initiate the documentation of specific metrics to establish the level of accuracy of their system-level modeling and to track progress over time. Collaborations can be used to include model components in areas that are outside the scope of ISEE's primary focus but are integral to the Sun-Earth chain.

Plan for upcoming changes in data availability:

The committee recommends that planning be initiated to transition to new satellite or ground-based data sources where existing sources may become unavailable. One example is the SOHO coronagraph, which is being used in active research today but will soon be unavailable.

Incorporate AI in research:

The committee encourages ISEE to promote the use of artificial intelligence (AI) in its activities. The committee was made aware of recent funding opportunities through the government of Japan. Also, the Division of Integrated Studies noted challenges of incorporating AI in their research. As AI tools become more mainstream and available for data analysis, environmental prediction, and for use within numerical simulations, it will be important to keep up with what will likely become standard international usage.

Division-Specific Comments**Division of Integrated Research****Overall Assessment**

The division of Integrated Research conducts integrated studies encompassing the entire Sun-Earth system, extending from the solar interior to Earth's upper atmosphere. This research is highly relevant both towards advancing our fundamental understanding of the solar-terrestrial environment as well as to develop accurate space weather forecasting. The division's integrated research takes advantage of numerous satellite missions, data analysis, and numerical models. Numerical simulations have been developed to address regional phenomena with high resolution as well as to conduct long-duration, multi-scale simulations of solar, solar wind, and geospace dynamics. The division also outlined plans to incorporate AI into its research, which the committee strongly encourages. The committee encourages the division to build on its foundation of numerical models and include additional models in the Sun-Earth chain and to

establish a long-range plan for developing specific output to address key space weather needs with validation metrics to demonstrate progress over time.

Research Achievements

Research advances span the full spectrum from the solar interior to Earth's upper atmosphere. These include:

- Carrying out the world's largest simulation of the solar interior and modeling the large-scale solar flows;
- Development of a comprehensive simulation of solar wind acceleration, including the solar convection zone, photosphere, chromosphere, and corona;
- Progress in understanding particle acceleration in solar flares and the triggering mechanisms of coronal mass ejections;
- Demonstration of the physical processes responsible for energetic particle precipitation into the atmosphere;
- Comparison of important magnetospheric phenomena at Mercury and Earth;
- Demonstration of the high sensitivity of the coupled magnetosphere-ionosphere-atmosphere system to impulsive external forcing during extreme events.

Education and Training

The division has a total of 17 designated positions and fellows and 21 students. Two faculty have recently departed the division, and four new members have joined. These recent staffing changes have resulted in a relatively young division, and they present the opportunity for new research directions to be established.

Future Perspectives

The division is well positioned for excellent scientific achievements and to make key contributions in areas where societal and economic benefit can be realized. The division is substantially involved in numerous domestic and international spacecraft missions that are providing data throughout the Sun-Earth system. The division has developed excellent solar, solar wind, and magnetosphere models that will be used in conjunction with the spacecraft data. With the foundation of numerical models currently available within the division, they now have the opportunity to expand into areas of the interconnected Sun-Earth system. To achieve the goal of studying the space-Earth environment as a single integrated system and to promote the sustainable development of human activities in space, the committee recommends that the division expand the coverage and interconnectedness of its numeral models. For example, whereas the division has models of solar surface dynamics and coronal mass ejections, it does not currently have models of solar energetic particles that pose significant risk to spacecraft and humans in space. The division also currently does not have models of

ionosphere-thermosphere-atmosphere dynamics that affect the trajectories of low-Earth orbiting spacecraft and that will become increasingly important for commercial space traffic management. Recognizing that the division has limited staff and resources, the committee encourages the division to consider collaborations with other modeling groups to include models that they do not have the capabilities to develop and support themselves. The committee encourages the division to initiate a long-term plan to develop an integrated system modeling capability and to identify a few key validation metrics where progress toward quantitative societal benefit can be demonstrated. The committee also strongly endorses the division's plans to utilize AI in its research.

Division for Land Ocean Ecosystem Research

Overall Assessment

The Division for Land–Ocean Ecosystem Research demonstrates a coherent and scientifically robust approach to investigating environmental variability across terrestrial, marine, and ecosystem domains. The division's emphasis on climate change, water-cycle processes, and the influences of human activities situates its research program firmly within the global scientific agenda focused on Earth system sustainability. Overall, the division exhibits notable strengths, a record of solid achievements, and meaningful potential for broader societal impact. At the same time, several areas warrant strategic enhancement to maximize the division's contributions to national and international research frameworks.

Research Achievements

Contributions to Greenhouse-Gas and Biogeochemical Research

The division has produced significant results related to methane and CO₂ emissions, nitrogen cycling, and atmosphere–land/ocean exchange processes. These studies support improved understanding of anthropogenic impacts on climate and contribute to policy-relevant environmental assessments.

Integration of Observational and Modeling Approaches

The division demonstrates strong capability in combining field observations with numerical modeling. Research on river discharge variability, climate change in the Indian Ocean, coastal biogeochemical cycles, and cryosphere/land-surface processes in the Nepal Himalaya shows methodological rigor and appropriate interdisciplinarity.

Effective Utilization of Long-Term Research Assets

A notable strength is the division's continued use of long-term datasets, observational networks, and scientific expertise inherited from HyARC and earlier research groups. This continuity allows the division to address modern scientific challenges while maintaining methodological consistency and high data quality.

Funding and Publication Performance

The division's successful acquisition of competitive funding—such as the Pan-Arctic Water–Carbon Cycles (KAKENHI S) project and the HiPRECS international collaboration fund—and its publications in high-impact journals indicate a strong and healthy research environment. Continued growth in these directions is encouraged.

Future Perspectives

The division possesses clear potential to contribute more actively to major programs such as GEWEX and Future Earth, particularly in areas involving human–hydrosphere–climate interactions. Increased involvement would enhance the division's international visibility and scientific leadership.

The division is encouraged to deepen collaboration with national modeling groups and government agencies (e.g., Ministry of the Environment A-Plat, Fisheries Agency) and to expand contributions to international assessments such as the IPCC. Such engagements would broaden the societal reach of its research.

As part of the Tokai National Higher Education and Research System, the division is also encouraged to expand further cooperation with Gifu University. Although the disciplinary structures differ, meaningful collaboration is possible in areas such as river systems, forests, and geohazard-related environmental processes.

Summary

The Division for Land–Ocean Ecosystem Research has demonstrated strong research performance, strategic use of long-term scientific assets, and a commendable record of funding and publication. With enhanced efforts toward integration, collaboration, and policy-relevant contributions, the division is well-positioned to further increase its impact within national and international environmental research communities.

Division for Ionosphere-Magnetosphere Research

Overall Assessment

This division focuses on the critical interface between Earth and space by studying the upper atmosphere-ionosphere-magnetosphere dynamics. The division has developed and deployed an extensive array of ground-based instruments around the globe, including all-sky cameras, induction magnetometers, and flux-gate magnetometers. These instruments, together with participation in large-scale international projects such as SuperDARN and EISCAT-3D and the utilization of a dense network of GNSS receivers in Japan, are at the core of numerous research achievements and broad research collaborations throughout the world. The division has also designed a novel,

light-weight plasma sensor that promises to enable high-resolution measurements to be made on micro satellites. The committee finds the extent of international engagement led by this division and focused on this key interface between Earth and space to be remarkable. The division plans to use the recently expanded global ground-based and space-based observing network to more accurately characterize space weather events and to understand the dynamics in the polar thermosphere and the contribution to global atmospheric transport. The division also plans to deploy its newly designed plasma sensor on future cubesat missions to study the acceleration processes associated with magnetosphere-ionosphere coupling and the generation of aurora. Given the expertise within the division on topics of strong relevance to space weather, such as plasma bubble formation, which impacts GNSS accuracy, and thermospheric dynamics, which impact satellite orbits, the committee encourages this division to collaborate with the Division of Integrated Research to pursue specific applications in support of ISEE's goal of sustainable human development of space.

Research Achievements

This division's research achievements spanned a broad range of topics involving atmosphere-ionosphere-magnetosphere coupling. It utilized an extensive global array of ground-based instruments and satellite measurements, and involved wide international participation. Examples of recent research accomplishments include:

- Detection of mesospheric ozone depletion associated with proton aurora due to radiation belt precipitation;
- High-resolution tomographic imaging of electron density perturbations using a dense network of GNSS receivers, including disturbances associated with a large geomagnetic storm and with the 2022 Tonga volcanic eruption;
- Discovery of rapid electrical interhemisphere transmission of a volcanic disturbance prior to the arrival of the atmospheric pressure wave;
- Characterizing the impacts of geomagnetic storms on the polar ionosphere and thermosphere;
- Development of a novel light-weight space plasma sensor to enable high-resolution measurements on micro satellites;
- In-situ satellite observations of "auroral holes" due to structuring in the electrostatic potential generated through magnetosphere-ionosphere coupling.

Education and Training

The division currently has nine professors, researchers and lecturers and 20 students. The division will soon undergo significant transition, as four of the current seven faculty will retire in the next four years. The committee recognizes the importance of maintaining continuity in key observing programs, such as SuperDARN, while also taking advantage of upcoming hiring opportunities to target new initiatives.

Future Perspectives

Future research will utilize the extensive research collaborations they have established in Japan, Europe, and the United States. They will continue to maintain their extensive instrument network and continue their participation on international collaborations, including EISCAT, SuperDARN, the GNSS receiver network, all-sky cameras, magnetometers, VLF receivers and riometers. The division plans to take advantage of the recent expansion of their ground-based and space-based measurements to focus on space weather disturbances that drive global atmospheric transport involving heating and upwelling in the polar thermosphere. The new light-weight plasma sensor will be deployed on cubesat missions to further their research on particle acceleration associated with ionosphere-magnetosphere coupling. The committee applauds the excellent research achievements and the global leadership achieved through their extensive collaborations. With the division's excellent basic research as a foundation, the committee recommends that collaborations are formed within ISEE, and in particular with the Division of Integrated Research, to support the development of research results related to space weather impacts in support of sustainable development of human activity in space. An integrated strategy should be developed that takes advantage of the division's key strengths to provide quantitative information related to specific space weather impact areas.

Division for Heliospheric Research

This division uses ground based interplanetary scintillation (IPS) observations to study mass emission from the Sun. In particular, solar wind speed distribution in the heliosphere is obtained using IPS observations. The availability of IPS data to the scientific community is a great service to the scientific community. In addition to their three domestic IPS stations, the division uses external facilities such as LOFAR. The division also uses the SUSANOO model to track coronal mass ejections (CMEs) from Sun to Earth for some high-activity intervals. There is the potential for one-day advanced warning when CMEs are observed by IPS. It will be good to incorporate the IPS information into space weather modeling in CIDAS. The division has a good relationship with industry that is likely to benefit students graduating from the division. The lack of PhD students and postdocs seems significant given that ISEE is primarily a research institute.

Achievements

The Heliospheric Research division is engaged in advanced radio instrumentation to generate data on solar wind and solar wind transients, which play a key role in understanding how the mass emission from the Sun impacts Earth's space

environment. The division heavily contributes to the development of ISEE as a global hub for generating new knowledge on the Sun-Earth system.

The division has accumulated a wealth of solar wind data extending over half a century, which is a unique contribution to the global scientific community. The three-station interplanetary scintillation (IPS) system is the core capability of the division that will be further enhanced with the new system based on modern technology. The new 3-station is expected to increase the data volume by an order of magnitude and hence provide a wider coverage and better resolution of the solar wind. The development of the new IPS system is fueled by industry collaboration and increased student intake.

The division is leading the effort to coordinate with other IPS facilities in the world, which could provide around the clock monitoring of the solar wind. Such coordination is in line with ISEE's mission to be an international research hub.

The division is providing near real time IPS data to modelers thus enabling space weather forecasting. Excellent case studies illustrate how IPS data enhances modeling of CME propagation.

Future Perspectives

It is surprising that the division consists of only two faculty members and 1.5 technicians. Increase in the number of staff should be considered, in particular, in the areas of MHD modeling and CME observations. There is a significant overlap with the Division of Integrated Research in terms of the problems tackled and anticipated outcome (IP shocks, solar wind, CMEs, IP magnetic field, space weather prediction, numerical simulation). Possibilities should be explored for a closer collaboration with the two divisions to avoid duplication of efforts. The students are mostly at master's level. It is good that the students can get employment after completing their courses. However, the core activity is the promotion of research of the Sun-Earth system. It would be worthwhile to explore ways to increase the number of doctoral students. Some designated faculty/researchers in this division could potentially mitigate the situation.

Division for Cosmic-ray research

Overall Assessment

The division for cosmic-ray research conducts world class investigations in cosmic-ray origins, cosmic-ray effects on earth, accelerator experiments for cosmic-ray research and non-accelerator particle physics.

The division is exceptionally productive, providing key, enabling contributions, across a broad range of ground and space-based facilities. The division has a strong publication record and research output, exceptional hardware and experimental contributions and internationally recognized leadership.

Research Achievements

The Cosmic-ray division has 4 broad thematic areas:

Origin, acceleration, and propagation of cosmic rays

In this area, the division focuses on the development of future gamma-ray observatories that will provide revolutionary insights into the astrophysical origins of cosmic-rays. The division has made exceptional contributions to the soon to be commissioned Small-Sized Telescopes of the Cherenkov Telescope Array Observatory - cementing ISEE (and Japan's) role in the next generation, state-of-the-art ground based gamma-ray observatory. members of the division also play a central role in developing instrumentation for next-generation space based observatories. Their work on maturing the "AstroPix" detectors is a particularly notable contribution.

Cosmic-ray effects on Earth

The division is studying cosmogenic isotopes ^{14}C in tree rings and ^{10}Be in Antarctic ice cores to explore the past cosmic-ray variations. These revealed significant spikes over the past few thousand years, likely caused by Solar Energetic Particle events with magnitudes estimated to be tens of times larger than any recorded in the modern era.

Non-accelerator particle physics

The division conducts data analysis and development for current and future direct dark matter and neutrino experiments. This is an exceptionally interesting, and productive area in high energy physics. XENONnT provides one of the most sensitive direct WIMP searches, and pushed through to the neutrino "floor" with the detection of solar neutrinos. This is a testament to the sensitivity of the WIMP search, and brings this class of experiment into a new realm of neutrino studies. The division has also made significant contributions to upgrades and improvements at super-Kamiokande. These set the stage for a new era of discovery in neutrino high energy physics (and perhaps astrophysics, if we are lucky to have a nearby supernova).

Accelerator experiments for cosmic-ray research

The division has completed the final data taking phase of LHCf, using the LHC to study hadron interactions at energies relevant to ultra-high-energy cosmic-ray air showers. This is especially important as the interpretation of data from ground-based cosmic-ray experiments is currently limited by knowledge of the interactions during the development of an extensive air-shower when an ultra-high-energy cosmic-ray enters

the Earth's atmosphere. The precision of these studies revealed that no existing hadronic interaction model could reproduce the data, and spurred the division to develop improved reconstruction methods to further exploit the data.

Papers

The division has authored a large number of papers, which is typical for groups which are members of large collaborations. In this field many papers have author lists in alphabetical order, so the number of lead author papers is not a relevant metric. In addition to the large number of collaboration papers, the members of the division have been particularly effective at writing papers documenting their key hardware contributions.

Education and training

The division has been steadily increasing enrollment of doctoral candidates, from 0 in 2022 to 7 in 2025. This is a very healthy trend. The number of masters students is between 12 and 18 students per year. With 3 postdocs, 3 assistant professors and 4 associate professors the group is well balanced with a good distribution of seniority and experience. This improves the research productivity for all.

Leadership and impact

Of particular note are the leadership roles held by members of the division within the large scientific collaborations with whom they work. This includes long term service on the collaboration board, selection as analysis coordinator and more. This is clear evidence of the technical and leadership contributions of the division are recognised and valued by the international scientific community.

Division for Meteorological and Atmospheric Research

Overall Assessment

This division covers important research and education in atmospheric science and meteorology. The committee recognizes their unique and successful efforts for establishing both observation and modeling facilities of world class with an emphasis on remote sensing methods. With the research tools thus developed, they have made various scientific achievements regarding characteristics and transport processes of trace gases, aerosols, clouds, water vapor, and precipitation including the typhoon system.

Research Achievements

This division's outstanding research achievements include the following:

- Elucidation of time, latitude and altitude dependence of trace gas concentrations;

- Detection of correlations of trace gas changes in the upper atmosphere with the solar activity based on their new and long-term observation data;
- Improved evaluation of light absorption of carbonaceous aerosols and others in polar and urban areas;
- Improved evaluation of hygroscopicity and characterization of cloud condensation nuclei (CCN);
- Establishment of real-time observation systems of hydrometeors useful for weather monitoring and satellite validation;
- Successful typhoon observation and high resolution simulations that created wide national and international collaborations.

Active dissemination of the research findings was made through publication of a large number of papers, a textbook, and conference presentations in the last five years.

Infrastructure Development

The work within this division resulted in the construction of facilities for various in situ and remote sensing measurements and in their application, as well as a fine-resolution typhoon modelling system:

- High resolution IR spectrometers for multi-molecular observation;
- Optical counting systems for aerosol measurements of radiatively effective size and shape, hygroscopicity, and supersaturation of CCN;
- Millimeter and phased array radar systems for fine structure and realtime observation of atmospheric convection and hydrometeors;
- Measurement system and CReSS modeling system for typhoon system analysis that can be operated on the university and RIKEN's FUGAKU supercomputers.

Education and Training

The division has recruited 30 to 40 graduate students in the last five years, which indicates the attraction of their research and education programs. These programs are also found to be attractive for undergraduate students. The committee encourages further promotion of fostering the next generation of scientists as a division of the Nagoya graduate university and the Tokai National Higher Education and Research System.

Collaborations, Future Perspectives, Succession and Knowledge Transfer

The committee sees active collaborations of the division with other divisions and COSO center on studies of atmospheric composition and water cycle. As members of the Tokai National Higher Education and Research System, Nagoya University and Gifu University are expected to co-develop numerical modelling, to which ISEE can make significant contributions with their research and education resources. They also generated successful initiatives of next generation numerical atmospheric modeling on

the RIKEN's FUGAKU supercomputer and in the Moonshot program. By extending this close collaboration, the committee sees the strong potential of the division to create a new storyline and work plan with other divisions for developing a system for prediction of the Earth-system dynamics, including solar radiation and high energy particle precipitation that can impact the Earth's radiation budget, clouds and climate system.

User Accessibility and Facility Management

Extensive databases that include both observational and simulation data have been established and are opened to the science community and public. Those data are being used in the validation studies in the remote sensing community and by satellite operation agencies.

International Visibility

They showed high international contributions and national and international leadership in in-situ measurements and modeling activities, including the following:

- International collaboration of trace gas measurements in the upper atmosphere;
- International standardization campaign of black carbon concentration measurement technique;
- Contribution to the international validation campaigns for Earth observation satellite missions, i.e. GPM, EarthCARE, and other international missions;
- Aircraft campaign of typhoon tracking having international collaborative aircraft measurements;
- Division members are involved in international assessment activities of climate change such as SCOSTEP, IPCC etc.

Societal Engagement

Their research is directly connected to societal benefits such as the study and prediction of air pollution, global warming, extreme weather events, and typhoons.

Summary

The committee concludes that the achievements and plans for future development of the division are high. In particular, the committee found a high potential for the division to create a future core with other divisions for the development of data assimilation and prediction systems of the impact of solar and cosmic rays to the terrestrial system. Fund raising is also very active and healthy. The committee recommends creation of a new storyline and work plan with the other divisions for developing a system for prediction of the Sun-Earth system. It also recommends fostering the next generation of scientists and the dissemination of the division's achievements to the public, as the division's research is closely linked with societal impacts due to changes in Earth's environment.

Division of Chronological Research

Overall Assessment

The Division of Chronological Research represents an impressive example of interdisciplinary integration, bringing together expertise in geochronology, archaeology, environmental science, isotope geochemistry, and cultural studies. The division has continued to generate distinctive and impactful research outputs while operating sophisticated analytical systems that have supported its work for many years. This sustained productivity reflects both the technical skill and the dedication of the staff. Looking ahead, thoughtful planning for the future development and renewal of key infrastructure would further support the division's ability to maintain its leading role in chronological research.

Research Achievements

Between FY2022 and FY2025, the division produced 35 peer-reviewed publications across a broad range of disciplines. Representative achievements include:

- High-precision dating of cultural heritage sites (e.g., the Herat Old City Wall);
- Reconstruction of Paleolithic chronologies in Central Asia;
- Advances in continuous age-depth modelling and micro-sample Accelerator Mass Spectrometry (AMS) analysis;
- Methodological innovations in cremated bone dating and water-sample preservation;
- Radiocarbon-based evaluation of CO₂ sequestration in concrete;
- EPMA customisation and progress in paleodetector research;

These accomplishments demonstrate the division's strong analytical expertise and its ability to address diverse scientific and societal questions. The wide range of activities also highlights the ambition of the research program. Continued consideration of how best to balance research scope with available personnel and facility capacity may help sustain this high level of productivity over the long term.

Facility Operation

The division operates several highly specialised analytical systems, including a long-serving AMS and a heavily customised EPMA. Maintaining and operating such instruments requires considerable technical expertise, and the staff's ability to sustain these systems is commendable. The division has also established productive collaborations with external AMS facilities (including Yamagata University, KIGAM, JAEA Mutsu, and NIES), which provide useful flexibility and expand analytical opportunities. Over the longer term, continued discussion of infrastructure development

strategies may help ensure that the division retains both operational stability and analytical independence.

Education and Training

The division provides excellent interdisciplinary training opportunities for both domestic and international students. Particularly notable is the emphasis on hands-on experience and the integration of documentary and historical approaches with scientific dating techniques. This educational approach equips students with a rare combination of analytical and interpretative skills. As research and facility activities continue to expand, consideration of sustainable workload distribution among technical staff and early-career researchers may further support the long-term vitality of the training program.

Future Perspectives

Infrastructure development

Major analytical systems such as AMS and EPMA represent long-term investments requiring careful planning and preparation. Developing a phased strategy for future upgrades or replacement could help ensure continuity of research activities and provide a clear roadmap for the division's infrastructure development.

Succession and knowledge transfer

As with many long-established research units, upcoming generational transitions provide an opportunity to consider strategies for knowledge transfer and future recruitment. Documenting specialised analytical expertise and fostering mentorship within the division would help ensure continuity in key techniques.

User accessibility and facility management

The division serves as an important shared research facility. Continued efforts to enhance transparency in booking systems, waiting-time management, and communication with users would further support the efficient use of these valuable resources.

International visibility

The division possesses several capabilities that are internationally distinctive, including micro-sample AMS, cremated bone dating, and advanced EPMA applications. Increased visibility through international outreach, collaboration, and dissemination may help highlight these strengths and further enhance global recognition.

Societal engagement

Activities such as forensic age estimation for individuals without legal identity

demonstrate the broader societal relevance of the division's expertise. Communicating these contributions more widely may help illustrate the important role that chronological science can play in addressing societal needs.

Summary

Overall, the Division of Chronological Research demonstrates strong scientific performance, productive interdisciplinary collaboration, and meaningful contributions to education and society. Continued attention to long-term infrastructure planning, knowledge transfer, and strategic visibility will further support the division's capacity to sustain and expand its leadership in geochronology and related research fields.

Center for International Collaborative Research

The Center for International Collaborative Research (CICR) is a core component of ISEE serving as a global hub for cross-disciplinary science. CICR performs and supports the activities of ISEE as a "Joint Usage/Research Center", by contributing to international programs and projects, promoting international exchange, and supporting international collaborative research. International visiting scholars, Designated Professors, and researchers work on-site at CICR.

Achievements include the following: typically, two dozen international joint research projects have been conducted; three to four international workshops are held each year; travel funding is provided to ISEE/international students to attend scientific conferences; many schools have been organized to promote Sun-Earth system research; CICR is a sought-out place for SCOSTEP Visiting Scholars; CICR holds the record of hosting the largest number of scholars per year; CICR is determined to promote all its activities by providing scientific and administrative support. The committee is pleased with the progress.

Center for Integrated Data Science

The primary driver behind CIDAS is the need for a holistic understanding of the Earth-Sun system, breaking down barriers between solar physics, geophysics, and meteorology. This center develops and builds infrastructure to support science operations, advanced simulations, databases, and the operation of supercomputer resources. CIDAS contributes to ISEE's Joint Usage/Research Center functions by supporting international research collaboration and enabling effective use of observational and computational resources. CIDAS aims to develop space weather predictive capabilities. This provides critical cross-cutting support that acts as a force multiplier for science return across a broad range of activities in ISEE. There may be an opportunity to strengthen the modeling activities of CIDAS by including modeling with IPS data that was described in the presentation

of the heliophysics division.

Center for Orbital and Suborbital Observations

The committee recognizes this center has unique functions among the Japanese university centers to provide research and educational services for carrying out airborne and satellite observation research. Active organization of training courses, including drone operation, is a good activity to increase opportunities and access of the research community to airborne and satellite observation, and also useful to raise interest within the business sector. The committee sees their useful role as a hub for collaborations with national agencies of Earth observation satellite operation, i.e. MEXT, JAXA, NICT, MOE, JMA and others. They also delivered useful lectures and training courses of diagnosing the Earth's climate system open to all the graduate students in Japan, as part of MEXT's Virtual Laboratory (VL) program.

Office for the Development of Interdisciplinary Research Strategy

This office was established in 2022 to promote interdisciplinary studies within and outside Nagoya University. It currently supports four interdisciplinary research projects led by ISEE faculty and 13 research-strategy projects selected from submitted proposals. These projects are successfully strengthening interdisciplinary research within Nagoya University and broadening it far outside the university. Research projects include the use of novel "paleo-detectors" to search for dark matter and superheavy elements, understanding the impact of atmospheric circulation on climate variability, rescuing ancient records of space weather storms, and understanding the pathways and impacts of energetic particles from the Sun and space on Earth's atmosphere. This office has been highly successful at promoting ISEE's goal of interdisciplinary research.

Office for the Promotion of Transdisciplinary Network

The newly launched Office for the Promotion of Transdisciplinary Networks has acted as a hub connecting natural and human sciences since September 2024. Their outreach activities engaging society are impressive, as is the platform they provide for obtaining radiometric dates. The collaborative effort with other institutes, including AMS (Accelerator Mass Spectrometry) facilities and museums, seems to be an effective mechanism, and this will continue to be strengthened in the future.