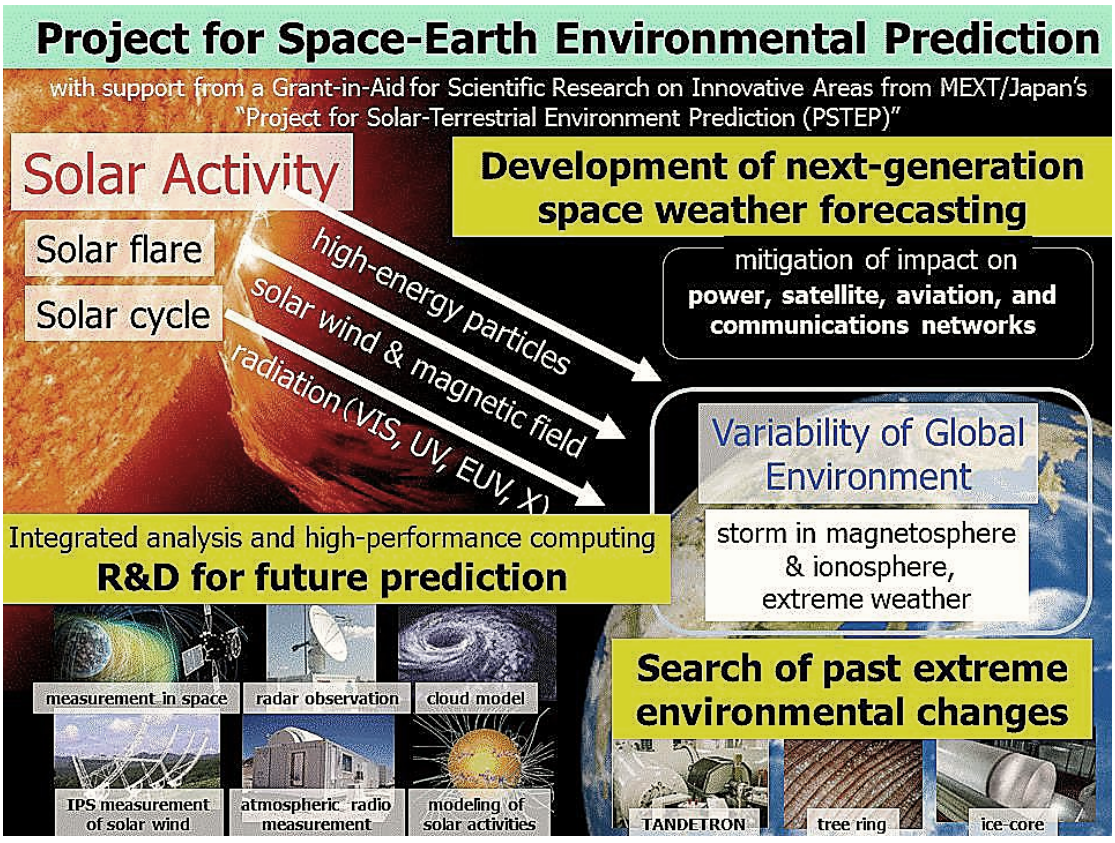
Project for the Space–Earth Envionmental Prediction

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



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

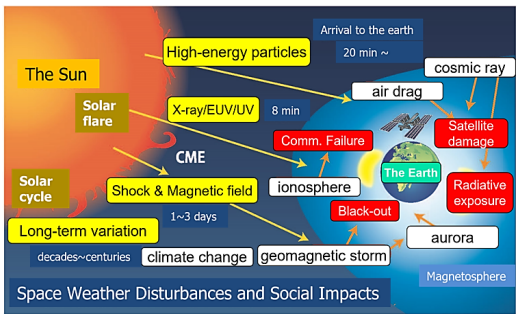
Main Activities in FY2020

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

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

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

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



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

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

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

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