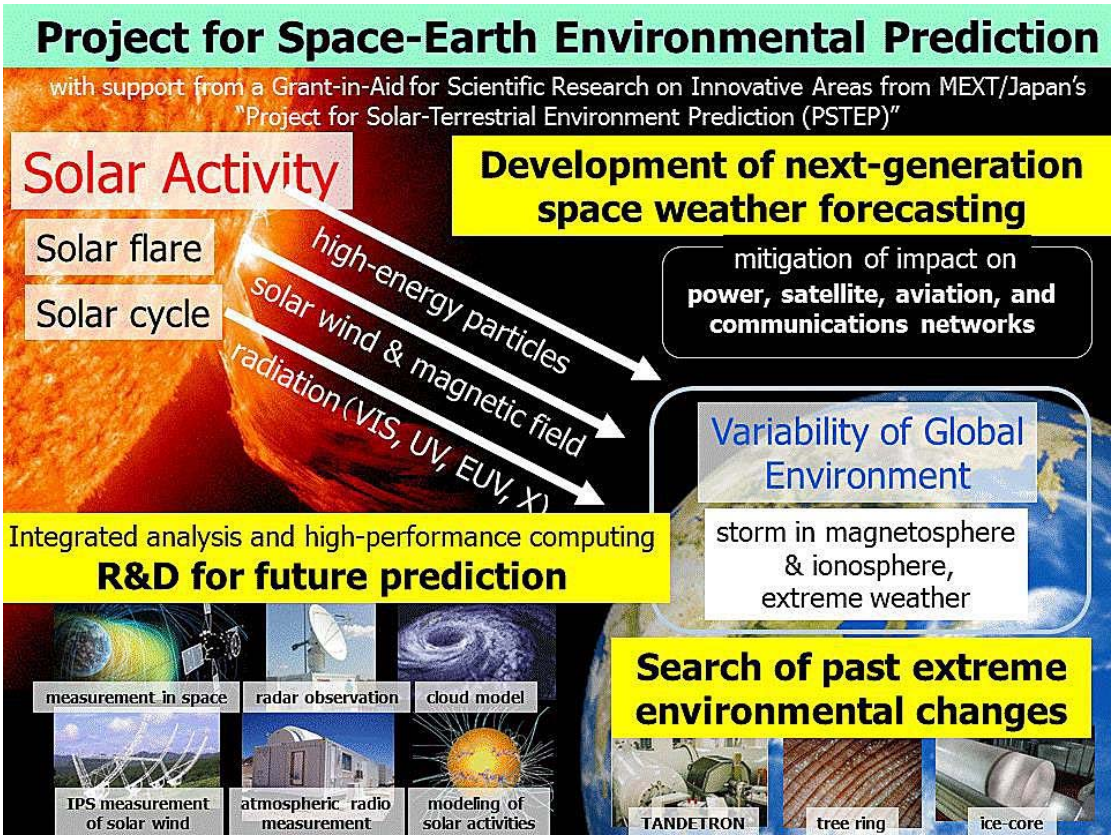
Project for the Space–Earth Envionmental Prediction

Over the past 50 years, space exploration has expanded rapidly and now gone past the edge of the heliosphere. Consequently, it is known that solar activity and the dynamics of the space environment can significantly impact human socio-economic systems as well as the global environment. For example, the giant solar flare observed by the British astronomer Richard Carrington in 1859 caused powerful magnetic storms, called the Carrington Event. If such an event occurred in the modern era, power, satellite, aviation, and communication networks could possibly be damaged on a global scale. Moreover, analyses of the latest stellar observations and of cosmogenic isotopes in tree rings suggest even larger solar flares. However, the mechanisms of the onset of solar flares and their subsequent processes have not yet been fully explained. Thus, modern society is at risk from severe space-weather disturbances, caused by such solar explosions, and understanding and predicting variations in the space–Earth environment is both an important scientific subject and a crucial issue for modern society. Furthermore, because the accurate prediction of complex phenomena is a common problem in science, the prediction is also a crucial subject for various scientific disciplines. The Project for Space–Earth Environmental Prediction is a new joint research project aimed at synergistically developing our predictive capability for the space–Earth environment through the cooperation and interaction of solar physics, geomagnetism, 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)."

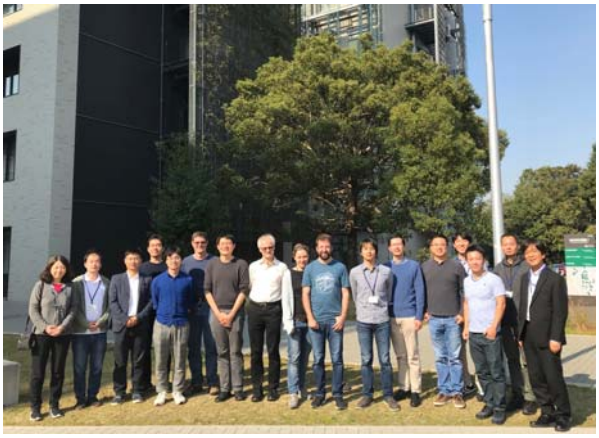


The objectives and subjects of the Project for Space–Earth Environmental Prediction.

Main Activities in FY2018

ISEE/PSTEP International Workshop on Data-Driven Models of the Solar Progenitors of Space Weather and Space Climate

T The increasingly dense observational coverage of the solar atmosphere has led to many important insights into the origins of solar activity. Simultaneously, the increasingly sophisticated numerical models of the interaction between plasma and magnetic fields have provided important lessons on the basic physical mechanisms underlying the observed behavior. State-of-the-art MHD models can now yield observational diagnostics that are in general agreement with the observations. Yet, if we wish to apply these lessons to forecasting space weather and space climate, many challenges remain. First, even with the aforementioned advances in MHD modeling, there remains a wide gap between numerical models and reality, as revealed by observations. As observational capacity – in terms of spectral, temporal, and spatial coverage – improves, so does the number of observables not explained by the current generation of models. One possible reason is the lack of certain physical ingredients in the models. In this ISEE/PSTEP International Workshop (November 6th to 9th 2018), many experts joined from Japan, US, Europa, and China, and we address the key problems remaining in using observational data to constrain and to drive MHD models of solar eruptions. Several new projects resulted from the discussions at this Workshop. We foresee more publications resulting from this effort appearing in late 2019 and in 2020.



The participants of ISEE/PSTEP International Workshop on Data-Driven Models of the Solar Progenitors of Space Weather and Space Climate.

ISEE/PSTEP Science Meeting on “Modeling Study for Solar-Terrestrial Environment Prediction”

We conducted the ISEE/PSTEP Science Meeting on “Modeling Study for Solar-Terrestrial Environment Prediction” from January 17 to 18, 2019 at NICT, Tokyo, in cooperation with PSTEP. This meeting is to review the present status and prospects for the modeling prediction of the solar-terrestrial dynamics and has been held every year since 2017 for inter-disciplinary discussion.

In this year, we mainly discuss about what type of prediction is required to develop a space weather hazard map for public, based on the survey report of the social needs for each subject (electric power grid, satellite operation (charging/air drag), radio wave utilization, and aviation operation). We also organized a solar and heliospheric session in which the recent research results of the latest forecasting model of solar flares and CMEs were discussed. In particular, we confirmed that great progress has been made in research on the onset mechanism of solar flares and the realistic simulations of flares and CMEs using the real data. Because the next fiscal year (FY2019) is the final year of PSTEP, we will summarize the efforts for inter-connection of the element models and the advanced development of the prediction model in the future.

Science Meeting on “Modeling Study for Solar-Terrestrial Environment Prediction.”