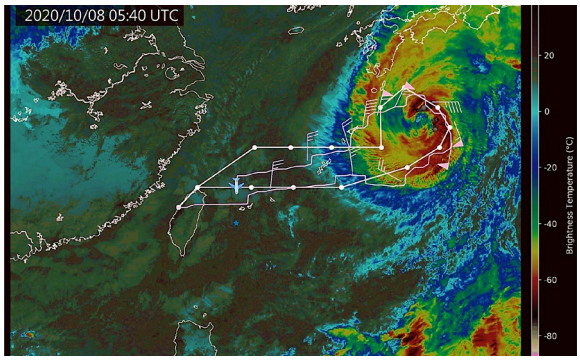
Center for Orbital and Suborbital Observations (COSO)

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

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

Main Activities in FY2020

Promotion of aircraft observations



Flight path for the typhoon Chan-Hom observation.

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

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

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

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

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

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

Solar observation mission using nanosatellites

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

SERO

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

Promotion of observations using Earth-observing satellites

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