# Center for Orbital and Suborbital Observations (COSO)

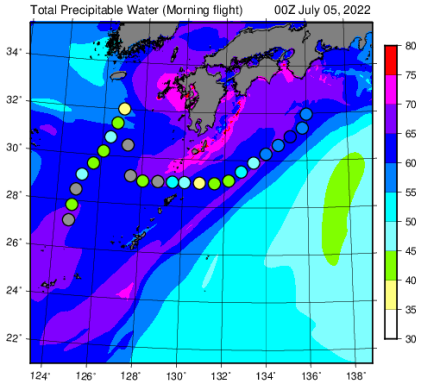
- Establishment of an aircraft observing system
- Aircraft observations of cloud, aerosol and typhoon
- Solar observation missions using micro satellites
- Studies of multiple small satellite operations for future space science exploration programs
- Human resource development for space applications
- Promotion of Earth observing satellites

Based on ISEE research objectives, which encompass natural phenomena ranging from the Earth's surface to outer space, the Center for Orbital and Suborbital Observations (COSO) is expected to perform empirical and advanced research through observation, especially through collaboration among industry, academia, and government, leading to remarkable technological developments for aircraft, balloons, sounding rockets, and spacecraft observations. COSO aims to be the core of aircraft observation in Japan and investigates and promotes future space exploration missions to obtain new knowledge of physical phenomena in cooperation with domestic and foreign research institutions. By promoting interdisciplinary activities and efficient common technology development, COSO can improve observation capabilities for future orbital and suborbital observations. The Hydrospheric Atmospheric Research Laboratory contributed to the Virtual Laboratory with four universities using X- and Ka-band radars, together with numerical model studies. The Space Exploration and Research Office (SERO) is undertaking nanosatellite and human resource development programs for space applications. The Aircraft Observation Promotion Office was established in FY2021 to further promote aircraft observations in Japan.

## Main Activities in FY2022

### Promotion of aircraft observations

Aircraft observations of Typhoon Nanmadol were performed using dropsondes on September 16 and 17, 2022. Nanmadol was a super-typhoon that rapidly intensified and made landfall in Kagoshima at its fourth lowest pressure. We made penetrating observations of the eye twice daily, and 50 dropsondes were launched. A detailed analysis is currently underway. As part of the SIP program, we performed aircraft observations of water vapor and optimized the aircraft observation system on July 5, 2022, over the East China Sea. High-frequency observations of the horizontal and vertical water vapor profiles on the upwind side of the precipitation area were performed. Although the numerical model forecast demonstrated a large area of precipitable water around East China Sea, the aircraft observation results indicated that the amount of precipitable water was considerably lower than the numerical model results. Observations also indicated that the variability of precipitable precipitation was large in fine scales. Drop sonde observations were also performed on these flights within the framework of the joint usage program of the ISEE. In the research project under the MLIT program, aerosol measurement system, cloud nuclei counter, and ice nuclei counter were installed on NASA/DC-8, and observations were performed in Florida and Cape Verde. They participated in simultaneous aircraft and ship observations of aerosols and clouds in the western North Pacific during the summer of 2022. New analytical methods have been introduced, particularly for solid aerosols, which act as important ice nuclei.




Precipitable water computed by CReSS at 09:00 JST on July 5, 2022, and the precipitable water (circles with color) obtained from drop-sonde observations.

## Aircraft Observation Promotion Office

A proposal was submitted as a joint proposal by the Meteorological Society of Japan, the Atmospheric Chemistry Society of Japan, and the Japan Society for Aeronautical and Space Sciences to the "Future Science Promotion Initiative," the successor to the Science Council of Japan's Master Plan. Additionally, ten aircraft observation seminars were held.

## Hydrospheric Atmospheric Research Laboratory

From June to August 2022, joint observations of the Baiu fronts and typhoons were performed on Yonaguni Island jointly with the United States (Colorado State University) and Taiwan. Synchronized observations were performed using C-band radar by the U.S. and X-band radar by ISEE, and continuous sonde observations were performed jointly by Japan and the U.S.

## Investigations on the ground operation system realizing the formation flight observations of multiple satellites by the orbital controls due to the aerodynamics

Multiple satellite missions performing formation flight observations are required to modify the conventional ground operation system to control and maintain the formation flight configurations of multiple satellites. Functions of the ground system need to be incorporated to accomplish quick satellite orbit determination based on GPS data and the precise prediction of satellite orbit corrections by computing atmospheric drag characteristics during perigee passage based on a precise model of the terrestrial upper atmosphere and the accurate control of satellite attitudes. The modified ground operation system is also used to generate onboard programs, so-called "timelines," to implement accurate satellite attitude control for the required precise satellite orbit corrections. System functions newly incorporated to the current ground system for multiple satellite missions should perform the above procedures within three days.

## 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. Although we planned to launch an engineering prototype in October FY2022 in the framework of the JAXA Innovative Satellite Technology Demonstration-3 program and it was unsuccessful due to a failure of the launch vehicle. Subsequently, we submitted a new proposal for a scientific instrument to the JAXA Innovative Satellite Technology Demonstration-4 program. We added functionality to send quick information on the space weather detected by the instrument via low-power, wide-area network technology. This proposal was not selected for the program partly because many proposals from the previous failed launch were selected. Currently, we are developing an engineering model which will be proposed for the JAXA Innovative Satellite Technology Demonstration-5 program.

## 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 and promote hardware development and observational research for space exploration and science. The development of nanosatellites is one of the most critical SERO research activities. Educational activities are also important in SERO. We held a basic 2-week training course in August/September and an advanced 2-week training course in March. There were 61 applicants for the basic course and 53 for the advanced course. More than 85% of the applicants were from outside Nagoya University and more than 50% of the applicants were from industries.

## Promotion of observations using Earth-observing satellites

Led the algorithm development team for GPM/DPR and promoted the development of PMM mission of JAXA as a project scientist. An algorithm for estimating phytoplankton species was developed and used to identify red tides. Regarding future missions, mission proposals (precipitation and oceanographic observations) were made to the TF Remote Sensing subcommittee.