Japan’s Antarctic Research Highlights 2021- 22

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***Summary***

Among various research activities carried out by the Japanese Antarctic Research Expedition (JARE) in the Japanese Antarctic Syowa Station area, three topics are introduced; (1) High-resolution observations of the Antarctic atmosphere with the PANSY radar and complementary instruments; (2) Start of year-round observation of precipitation in the vicinity of Syowa Station using precipitation radar; (3) Demonstration of the Antarctic Mobile Base Unit during the Antarctic winter.

1. ***Introduction***

The headquarters of the Japanese Antarctic Research Expedition (JARE), Japan’s national Antarctic program, was established in 1955 by the Ministry of Education, Science and Culture (now the Ministry of Education, Culture, Sports, Science and Technology, or MEXT). The headquarters comprises departments and agencies of various government ministries, including the Ministry of Foreign Affairs; the Ministry of the Environment; the Ministry of Defense; the Ministry of Land, Infrastructure, Transport and Tourism; and the Ministry of Agriculture, Forestry and Fisheries. The scientific research and observation programs of JARE are considered and adopted as midterm research plans at general meetings of the headquarters.

This Information Paper introduces selected highlights from scientific projects carried out by overwintering and summer members of the 62nd and 63rd JAREs, respectively, at and around Syowa Station (69°00′ S, 39°35′ E) during the 2021 - 22 season. Although there was a significant reduction in the number of scientists and projects in the summer activities in the 2020-21 Antarctic season because of preventive measures against the COVID-19 pandemic, the JARE 62nd wintering team is conducting as many year-around science projects at Syowa Station as in previous winters. The JARE 63rd summer activities in the 2021-22 Antarctic season were almost back to the pre-pandemic level.

1. ***Selected Research Highlights***

Year-round observations have been carried out by overwintering JARE personnel at and around Syowa Station. Seasonal observations are also carried out by summer expedition personnel aboard the *Shirase* of the Japan Maritime Self-Defense Force for oceanographic observations and in the vicinity of Syowa Station. In addition, the small seasonal team was deployed by the air bridge provided by DROMLAN. After completing the appropriate MIQ, all expeditioners departed to the Antarctic, and no COVID-19 case was reported throughout the 2021-22 Antarctic summer season.

* 1. **High-resolution observations of the Antarctic atmosphere with the PANSY radar and complementary instruments**

A study on the global atmosphere system based on high-resolution observations of the Antarctic atmosphere is subtheme 1 of the prioritized project of JARE’s term IX (2016-2022) which was planned and lead by the headquarters of JARE. This project aims at understanding the atmospheric teleconnection in the vertical and meridional (i.e., inter-hemispheric) through intensive observations with the large-aperture atmospheric radar PANSY (Program of the ANtarctic SYowa Mesosphere, Stratosphere, and Troposphere/Incoherent Scatter [MST/IS] Radar), resonance scatter lidar, millimeter-wave radiometer, etc. at Syowa Station and the international observation network composed of radars, lidars, imagers, etc. from the Antarctic to the Arctic.

The PANSY radar has continued its standard observation of the troposphere, stratosphere, and mesosphere, which reached six years with the full system and 10 years with the partial system. The 7th Inter-hemispheric Coupling Study by Observations and Modeling (ICSOM6; see http://pansy.eps.s.u-tokyo.ac.jp/icsom/) campaign was successfully conducted from January 22, 2022, to January 31, 2022. The ICSOM7 campaign was based on a combination of GCM simulations and simultaneous observations by several MST/IS radars around the world, including PANSY (Fig. 1), with some complementary instruments at Syowa Station, such as medium-frequency (MF) and meteor radars, lidars, imagers, etc. This campaign was approved as a project for ROSMIC (Role Of the Sun and the Middle atmosphere/thermosphere/ionosphere In Climate) of the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) under the International Science Council (ISC). International collaborative studies based on the four ICSOM campaigns are ongoing.

*Figure 1. PANSY radar (left) and Global MST/IS radar network participating in the ICSOM7 campaign (right).*

屋外, 光, 夜, ストリート が含まれている画像

自動的に生成された説明 ダイアグラム

自動的に生成された説明

* 1. **Advanced balloon-borne observations of the Antarctic upper troposphere and lower stratosphere**

The first observation of atmospheric gravity waves using a super-pressure balloon was conducted during the JARE 63rd summer period. Atmospheric gravity waves are responsible for momentum transport in the atmosphere and play an important role in determining temperature and mass distribution in the stratosphere and mesosphere. Super-pressure balloons can float at a fixed altitude (18 km in this case) for more than ten days and can quantitatively measure the momentum transport of gravity waves over the entire frequency band and its horizontal distribution through 2D wind speed and pressure observations. This time, three super-pressure balloons were released from Syowa Station, and observations were successfully made by levitating at a certain altitude (level flight). Through these observations, we have established the balloon release procedure and confirmed that the observation equipment has sufficient performance and reliability.

*Figure 2. Launching of a super-pressure balloon at the Syowa Station.*

屋外, 道路, 男, 火 が含まれている画像

自動的に生成された説明 雪の上にいる人たち

低い精度で自動的に生成された説明

* 1. **Hot water drilling at Langhovde Glacier**

During the 63rd summer, from December 16, 2021 to February 6, 2022, field observations were made at Langhovde Glacier, located 20 km south of Syowa Station. The project aims to elucidate the glacier flow mechanism by using hydrothermal drilling of the ice and observing the base and interior of the glacier. The team of an average of six expeditioners spent about six weeks in the field and conducted five drilling at three sites. In particular, the team successfully drilled three times in the upper reaches where the glacier is aground and installed equipment to measure ice flow and water pressure on the 550-meter-thick glacier bottom. In addition, the team measured ice flow using GPS and seismometers, conducted ice thickness surveys using radio waves and obsearvations by drones and automated cameras. This hydrothermal drilling has allowed us to make measurements at the base of glaciers, which is almost unprecedented in Antarctica. The results indicate that glacier base hydraulic pressure fluctuates due to glacial melting and ocean tides, affecting glacier sliding. These results are essential for predicting future changes in the Antarctic ice sheet, losing ice due to oceanic and atmospheric influences.

*Figure 3.* *Hot water drilling (right) at Langhovde Glacier(left).*

雪の上を飛んでいる

中程度の精度で自動的に生成された説明 スキー場にいる人たち

自動的に生成された説明