

Twenty-year continuous operation of Syowa IGS station

Yoshihiro FUKUZAKI¹, Hiromi YAMAO¹, and Norihiko ISHIKAWA¹

¹*Geodetic Observation Center, Geospatial Information Authority of Japan*

1. Introduction

Syowa Station (39.6°E, 69.0°S), Antarctica, is now one of the core Global Geodetic Observing System (GGOS) stations. There are several geodetic technology facilities, Global Navigation Satellite System (GNSS) including Global Positioning System (GPS) maintained by the United States and Quasi-Zenith Satellite System (QZSS) by Japan, Very Long Baseline Interferometry (VLBI), Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS), Superconducting Gravimeter, and Tidal Gauge.

A GPS receiver with a GPS antenna was installed at Syowa Station in February 1995 by the 36th Japanese Antarctic Research Expedition (JARE). Acquisition of the GPS data started in March 1995, and automated transfer of the acquired data to Japan through a communication satellite started in January 1997. After that an operation of the Syowa GPS station has continued until today for more than twenty years. The Syowa GPS site was also registered as an International GPS Service (IGS) station in May 1999. In addition, replacement of the antenna and the receiver has been done in December 2013 to receive not only GPS but also other GNSS signals, GLONASS by Russia, GALILEO by Europe, BeiDou by China and QZSS. The Syowa GNSS station is now one of the important sites that are available to provide the real-time data of GNSS observations on Antarctica.

By analyzing the Syowa GNSS data a motion of the Antarctic plate was detected. The Syowa data have also contributed to establish the International Terrestrial Reference Frame (ITRF).

In this presentation, the history and the present status of the Syowa IGS station are introduced. The results of the data analysis are also reported.

2. History

The Geospatial Information Authority of Japan (GSI) has had responsibility for surveying the area of Syowa Station and its surroundings for the purpose of establishment of a control point network to make precise topographic maps of the Syowa area since 1956. By realization of the precise and global surveying by using GPS, GSI conducted GPS surveys in Syowa Station from 1991 to 1994 on a campaign basis. Then, in order to establish a global geodetic observation network, a permanent GPS observation facility (GPS antenna and receiver) was installed at Syowa Station in February 1995. Data acquisition started in March 1995 with manually-operated data transfer, and automated transfer to Japan through a communication satellite started in January 1996. The transferred data have been submitted to the IGS (present name is International GNSS Service) Data Center and used for satellite orbit determination and position estimation of Syowa Station. Because the Syowa GPS site was registered as an IGS station in May 1999, it has been called Syowa IGS station or SYOG, which is a registered name in IGS, since then. SYOG has been used as not only an IGS station but also the reference point of GPS surveys that were carried out in and around Syowa Station.

When the receiver was installed in Syowa Station, a rubidium (Rb) frequency standard was equipped to supply a reference signal of 5 MHz. However, because the estimated clock was so unstable, the Rb frequency standard was disconnected and switched to a Cesium (Cs) frequency standard in October 1998. Since then, the Cs frequency standard has been continuously used to supply the reference signal of 5/10 MHz.

In order to receive multi GNSS signals, the GPS antenna and receiver were replaced with those of GNSS in December 2013. At present, signals of GPS, GLONASS, GALILEO, BeiDou and QZSS can be received by SYOG. Real-time transfer of the data obtained every second started in August 2014.

3. Present Status

The GNSS antenna is located near the gravity measurement room. Its photo is shown in Figure 1. On the other hand, the receiving and data transfer system is installed in the gravity measurement room. Its configuration is described in Figure 2. The data obtained by the receiver 1 (main) are stored in the PC in the gravity measurement room and transferred to the IGS Data Center through the Intelsat communication line in real-time. The real-time SYOG data are used for the Real-time Service of IGS.



Figure 1. Photo of GNSS antenna (center), gravity measurement room (right), and radome of VLBI antenna (left)

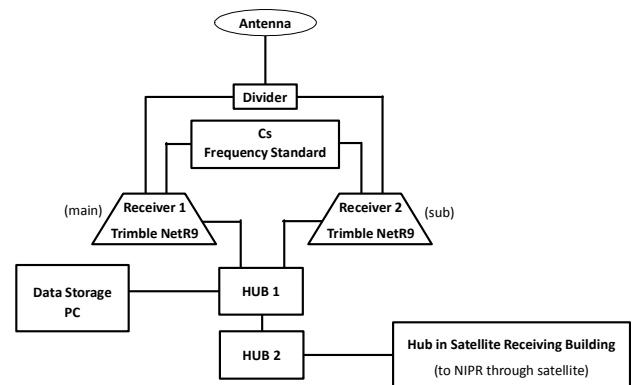


Figure 2. Configuration of the receiving and data transfer system

Global analysis has been done by the IGS Analysis Centers routinely and the analysis results have been employed for the calculation of the ITRF series. SYOG coordinates were listed in the ITRF tables from ITRF2000 to ITRF2014 (latest). In Syowa Station, there is not only GNSS but also VLBI observation facility (VLBI antenna) and DORIS antenna. Local-tie surveys were performed to obtain tie-vectors of SYOG-VLBI and SYOG-DORIS, and the obtained tie-vectors were also employed for the calculation of ITRF as a strong constraint condition of the local-tie.

4. Results of Data Analysis

The analysis of the SYOG data has been done by the Jet Propulsion Laboratory (JPL) routinely and the time series of the coordinates are obtained, which show a motion of the Antarctic plate. Especially uplift is detected and considered as one of the evidence of the Post-Glacial Rebound on Antarctica. The results analyzed by JPL can be browsed on its website. GSI also conducted the same analysis and obtained similar results to JPL's ones (Figure 3).

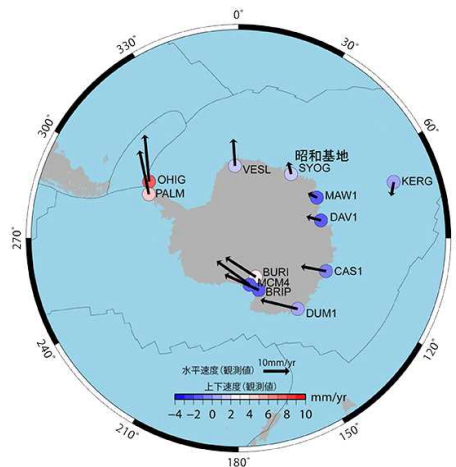


Figure 3. Velocities of the Antarctic IGS stations obtained by GSI's analysis.

5. Summary

The Syowa IGS station has been operated continuously for over twenty years since its installation in 1995. The obtained data have been submitted to the IGS Data Center to contribute to the satellite orbit determination and the establishment of the ITRF series. The analysis results of the data for twenty years show detection of the Antarctic plate motion and the uplift that is considered to be the evidence of the Post-Glacial Rebound.

Acknowledgments

The authors would like to thank all JARE members who worked for installing and maintaining the Syowa IGS station.

References

<https://sideshow.jpl.nasa.gov/post/series.html>

<http://www.gsi.go.jp/antarctic/11.html>