

## GGOS Network and Syowa Station, Antarctica

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GGOS is one of the principal components of GEOSS. GGOS network station is defined to be equipped with DORIS, GNSS, VLBI and SLR at the same site. Although Syowa Station (SY) does not have SLR, operation of other instruments has been continuing for 15 years. Other than space geodesy programs, precise gravimetry and tidal observations have been done at the same site. I present mainly history of these observations and briefly describe perspective for future developments.

Geographically Syowa Station is located at 39°35' E, 69°00' S, in East Ongul Island at the mouth of Lutzow-Holm Bay, Eastern Antarctica. Geologically it is placed on the bedrock of metamorphic granitic gneiss of 500 myr in age. Sedimentary layer which induces unfavorable groundwater effect does not exist; this provides very stable geodetic observation environments.

Japanese Antarctic Research Expedition (JARE) is a long-term national project. NIPR organizes geodesy/geophysics program with one (+1-2 depending on season) winter-over geophysicist from NIPR, one summer-season surveyor from GSI, and one summer-season hydrographer from JHOD, every year for the maintenance including the above facilities.

Modern facility installation actually started from 1990 (JARE-32) by the construction of the gravity observation hut (GOH), and ended in 1997 (JARE-39) at the start of the regular VLBI observation. After this first-epoch, there were step-wise progresses to strengthen Syowa status every 7 year. To realize installation/start of SLR observation, now is a planning stage. We present history and current of each component below.

VLBI: Construction of an 11 m S/X band antenna, and installation of a front-end (including 22GHz) was made in 1989. Preliminary experiment between Syowa, Tidbinbilla and Kashima was made by CRL in 1990. Integration of a K4 back-end and H-maser was made in 1997. The first regular VLBI experiment (1998) was SYW. Syowa participated in the OHIG session under the coordination of IVS in 1999. Data processing has been done by the Bonn correlator afterwards. SYW session ended in 2004 and a K5 back-end was integrated.

Observation itself became a routine. Syowa-Hobart, Syowa-HartRAO, Syowa-O' Higgins baseline solutions have been obtained regularly without severe problems. In 2015 February, OHIG96 session was finished normally.

Syowa IGS SYOG: Syowa participated in the SCAR GPS campaign at SYOW (geodetic marker No.23-16) during 1993-1999. In 1995, a permanent pillar was constructed by GSI. Data acquisition is being made by a Dorn Margolin T antenna placed at 28.933 m above asl.

Sporadic outlier solutions appeared frequently until 1999 when rubidium frequency standard was used, but change from rubidium to cesium solved this problem dramatically. Formal registration to IGS network (named SYOG) was made in 1999. Near-real-time data transfer of 30 s sampling raw data via Intelsat link to GSI, and then to IGS Center was realized in 2004. 1 Hz sampling by dual Trimble NetRS is continuing from 2008.

Syowa DORIS SYPB: The first generation SYOB was installed on a 10 m pylon tower in 1991. The tower might have been declined gradually WSW under the prevailing ENE winds; the tower was broken down in May of 1998 by a heavy blizzard. The second-generation

SYPB on a concrete pillar was installed in Feb. 1999. It has the best stability (<3 mm) among the DORIS network (>40) stations. Replacement of the beacon transmitter was made twice until 2012.

SLR: To satisfy the GGOS requirements, JARE-57 which departs Japan this year (November 2015), will make feasibility study to install the SLR site. Because of optical instruments, SLR favors non-cloudy condition. The initial stage may be to perform observations for one month in the summer season when day-time is 24 hours and weather condition is mild. Preparation for winter-over observation to accumulate return shot counts to obtain sub-cm variability of the geo-center location is considered.

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