Report of Current Activities of Japan for 1998-2000

Prepared by

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The following Japanese organizations / institutes have developed working programmes to conduct research and operational work in the Antarctic in the field of Geodesy, Photogrammetry, Remote Sensing, Geographic Information, and Cartography:

- Geographical Survey Institute, Ministry of Construction (GSI),
- Hydrographic Department, Maritime Safety Agency, Ministry of Transportation (JHD), and
- National Institute of Polar Research, Ministry of Education (NIPR).

Under the Fifth-Period Project of the Japanese Antarctic Research Expedition (JARE) Earth Science Programme for 1996-2000, comprehensive geodesy / solid earth geophysics studies have been carried out in and around Syowa Station. This report basically corresponds to the activity by JARE-39 and -40.

1. FIELD ACTIVITIES

1.1 Geodetic Surveys (GSI, NIPR)

a) GPS observations for International GPS service

GSI operates the permanent GPS station at Syowa Station in East Ongle Island (Lon. 39.5837deg, Lat. -69.0070 deg). The continuous data are provided to the International GPS Service (IGS) on a daily basis via IMMARSAT in cooperation with NIPR since 1995. These data are also used for GPS surveys around Syowa as well as for SCAR GPS campaigns. The equipment used is listed in Table 1. The receiver was replaced in Feb. 2000 to reduce the loss of data due to ionospheric disturbance.

Table 1. Equipment used for IGS station at Syowa

Periods	GPS receiver	Frequency standard
Mar.15, 1995 - Nov.15, 1999	Turbo Rogue SNR-8000	Rubidium
Nov.16,1999 - Feb.2, 2000	Turbo Rogue SNR-8000	Cesium
Feb.2, 2000 - current	Trimble 4000SSi	Cesium

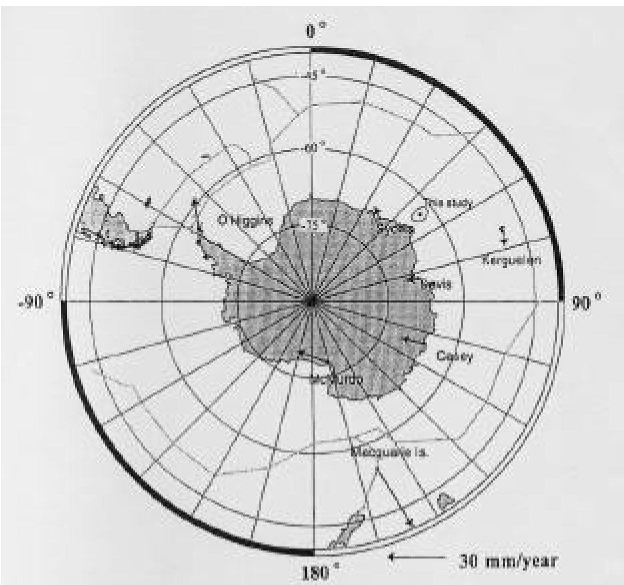


Fig.1 Velocity vector of IGS stations in Antarctica (Yamada et al., 1998)

Local tie surveys between geodetic points in Syowa, i.e. the IGS station, VLBI site, DORIS site, astronomical point (the origin of Japan's conventional ground control points), and benchmark at the tide gauge station, were carried out in 2000.

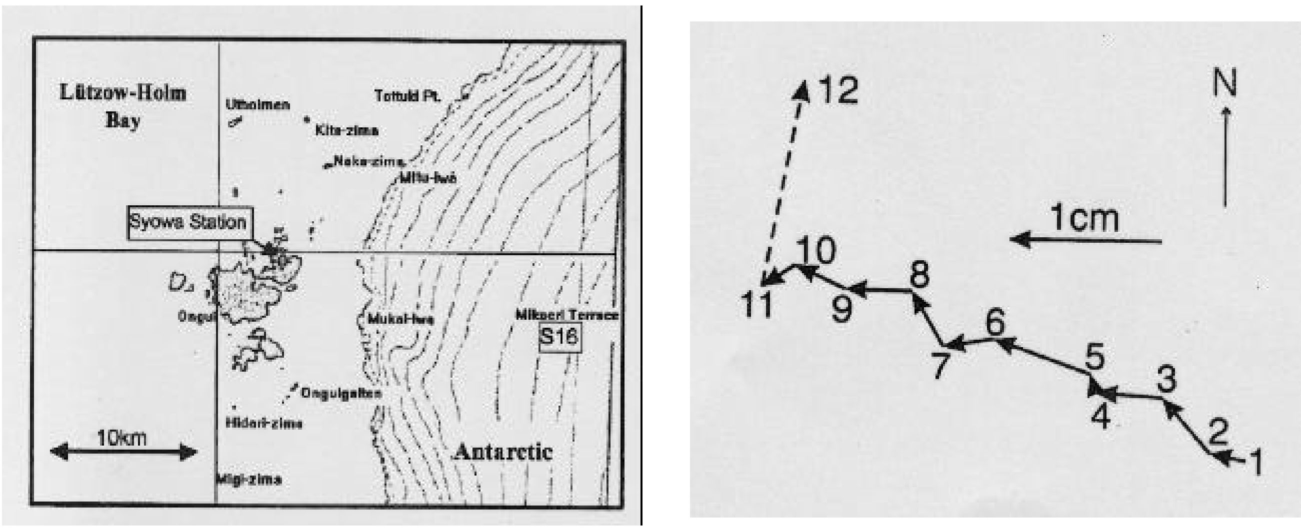
b) GPS surveys for ground control points

GSI newly established 18 ground control points in 1998 and 1999 by GPS surveys with reference to the Syowa IGS station.

GSI has established about 360 ground control points since 1957, but most of their coordinates were derived from the astronomical coordinates of the astronomical point at Syowa Station. In response to the recommendation of WG-GGI to SCAR XXV, GSI is revising these coordinates into ITRF. GPS surveys for this purpose were carried out at 5 points in 1998 and at 12 points in 1999.

c) GPS surveys for monitoring ice sheet movement

GSI has repeated GPS surveys at Mikaeri Terrace (S16) on the ice sheet near Syowa Station since 1992. These surveys show that the ice sheet movement at Mikaeri Terrace is about 13 mm per day and its direction is WNW, and that the drift rate and direction in summer season did not change in over two years.



(a) (b)

Fig.2 (a) Map around Syowa Station and Mikaeri Terrace. (b) The change of relative position of Mikaeri Terrace for each session (Ootaki and Fujiwara, 1998).

d) GPS surveys for crustal deformation monitoring

GSI has repeated GPS surveys between control points on the bare rock in Langhovde and the Syowa IGS station to detect crustal movement since 1996. These surveys show that crustal deformation in this area is smaller than the error level of GPS surveys.

e) GPS remote base station

GSI installed the initial GPS remote base station at Langhobde in 2000. Using a built-in battery and wind / solar power plant, it can perform continuous GPS observations at a remote site. The data are stored in PCs and retrieved by personnel who visit the station once a year. The specification is given in Table 2.

Table 2. Specification of GPS remote base station

Unit	Name of equipment	Specification
GPS receiver	Trimble 4000SSi-RC2	L1/L2, 10.5W, -20-75C°
Wind power supply	Windside FM910 (2 sets)	Propeller-type, 75W(10m/s)
Solar power supply	KYOCERA KC60S (12 sets)	60W, -40 - 90C°
Battery	SBS-300 (12 sets)	300AH, 2V, 20kg, -40 - 60C°
Data collector	XC6000-D-16	OS: Windows 3.1
	(IBM PC/AT compatible) (2 sets)	486XL50MHz, HD 340MB
		-20 - 60C°

Fig.3 GPS remote base station at Langhovde. GPS antenna is mounted on a nearby separate pilar.

f) Gravity surveys

GSI carried out gravity surveys with Sintrex gravimeter and LaCoste & Lomberg gravimeter at 4 ground control points in 1998 and at 18 points in 1999.

g) Geomagnetic surveys

GSI carried out geomagnetic surveys with proton magnetometer and DI-meter with flux-gate sensor at 2 ground control points in 1998 and at 5 points in 1999.

h) VLBI

A K-4 geodetic VLBI observation system was integrated to an 11 m diameter multipurpose antenna at Syowa Station in January-February 1998, and three station campaigns with Hobart (Australia) and Hartebeesthoek (South Africa) started (Jike et al., 1999). At the beginning stage, fringe detection for X-bands was not successful although that for S-bands was all right. Erroneous setting of polarization in LNA, antenna pointing problem, etc., within the Syowa system was suspected. The problem was found later to be in the time-tag control system and copier-aided pre-processing was found effective to accomplish the correlation. Syowa antenna participated in the International VLBI Service for Geodesy and Astrometry (IVS) from March 1, 1999 (Shibuya and Doi, 1999). Different to 48-hour observations by JARE-39 (Jike et al., 1999), 24-hour observations were conducted by Y. Fukuzaki of JARE-40 (Feb.1999 - Jan.2000).

Table 3. VLBI observations by JARE-39 and JARE-40

campaign name	date	start (UTC)	obs. period	obs. number	stations
SYW981	1998/Feb/09	08:00	48 h	318	Ho, Hh, Ka(24h)
SYW982	1998/May/11	08:00	48 h	347	Ho, Hh, Ka(24h)
SYW983	1998/Aug/09	08:00	48 h	337	Ho, Hh
SYW984	1998/Nov/09	08:00	48 h	398	Ho, Hh, Pk
CRF07	1999/Feb/15	10:00	24 h	118	Ho,Hh,Kb,Ft,Oh,Wz
SYW991	1999/Feb/17	05:00	24 h	123	Ka
COHIG6	1999/Feb/18	12:00	24 h	227	Ho,Hh,Ft,Oh,Kk
SYW992	1999/May/13	06:00	24 h	172	Ho,Hh
SYW993	1999/Jul/15	08:00	24 h	163	Ho,Hh
SYW994	1999/Aug/26	08:00	24 h	180	Ho,Hh
SYW995	1999/Sep/09	08:00	24 h	189	Ho,Hh
SYW996	1999/Oct/07	08:00	24 h	199	Ho,Hh
COHIG7	1999/Nov/08	15:00	24 h	182	Ho,Hh,Ft,Oh,Kk
COHIG8	1999/Nov/10	19:00	24 h	181	Ho,Hh,Ft,Oh,Kk
COHIG9	1999/Nov/11	20:00	24 h	191	Ho,Hh,Ft,Oh,Kk
SYW997	1999/Nov/18	08:00	24 h	22	Ho,Hh

Ho:HOBART26, Hh:HartRAO, Ft:FORTLEZA, Kk:KOKEE, Oh:OHIGGINS, Ka:KASHIMA
Pk:PARKES

SYW991 test experiment gave a geodetic solution to fulfil the K4-K4 performance, but the error ellipsoid is rather large (3-17 cm component) as expected from a single baseline which is comparable to the Earth's diameter. The obtained baseline vector is not shown here. Because of hybrid observation systems between K-4 Syowa and S-2 Hobart or HartRAO, and because of the first trial for correlator processing for a geodetic mode at the Mitaka VSOP facility, some trial-and-error improvement of the correlator/analysis software has to be made. The analysis for the SYW984 experiment is in a final stage but the geodetic results are not obtained yet. As for MarkIII mode experiments, CRF07 and COHIG06 were found failure. As for COHIG7 through 9, dubbing from K-4 tapes to MarkIII tapes was done at the Geographical Survey Institute, and the converted MarkIII tapes were sent in May 2000 to the Bonn VLBI-Correlator Center for subsequent correlation.

i) DORIS

After the DORIS pylon tower had been blown down by a heavy blizzard at end of April 1998, a new pillar was constructed in January 1999. It became operational from 1 February 1999 again. The local geodetic tie for the new pillar from the SCAR GPS point has an accuracy of 2-3 mm, in place of a 1-3 cm uncertainty for the pylon tower. The ITRF94 coordinates of the DORIS beacon were adopted to obtain a 20-30 cm accuracy geoid height (22.37 m on the WGS84 ellipsoid) at Syowa Station (Shibuya et al., 1999).

j) PRARE

A PRARE tracking antenna at Syowa Station was operational from March through September 1997. However, because of cabling problems under harsh conditions, it has not been operational thereafter. Installation of the antenna and the pass reception status based on a D-PAF weekly report are give by Shibuya et al. (2000).

1.2 Remote Sensing (NIPR)

a) SAR

Syowa 11 m antenna has been used for receiving SAR data from the JERS-1 and ERS-1/-2 satellites. Although JERS-1 ceased operation after October 12, 1998, while ERS-1 also stopped observation at March 10, 2000, ERS-2 SAR data are still regularly acquired under the MOU between NASDA/NIPR and ESA. For the ERS-1/-2 tandem mission over Antarctica, Syowa antenna received tandem pairs extensively during February 15 - June 3, 1996. Data archiving for the received passes and processed scenes is going on, and the list is available upon request (web site is under construction). Doi et al. (1998a) and Doi et al. (1999) describe overview of the reception. Comparison of the InSAR derived vertical motion of the ice shelf with that predicted by a global ocean tide model indicated a promising capability in the marginal ice zone (Ozawa et al., 1999a). Studies for generating a DEM are going on (Doi et al., 1998b) and JERS-1 InSAR with a repeat cycle of 44 days is shown to produce a 50 m by 50 m grid DEM with an rms error of 15.3 m (Ozawa et al., 1999b) and a reasonable estimate of ice flow velocity, maximum shear strain and dilatation (Ozawa et al., 2000) for the scenes over the Soya Coast area.

1.3 Tide Observations (JHD, NIPR)

a) Tide observations

The tidal observation at Syowa Station was originated in JARE-1 in 1956. A pressure-type tide gauge was installed in 1961, however no good data were obtained. The location of the tidal station was shifted to Nishi-no-ura in 1971. The sensor was changed to the type of strain gauge to convert the signal into electric signal that is recorded on land in 1975 and finally good and continuous data were to be obtained. In 1987 A type of quartz oscillation sensor was also installed and stable observation is continued since then. Pressure gauges were installed in the bottom in stead of a well type tidal observation system, and its signals are sent through the cable protected from ice hazard and recorded in tidal observation house. Obtained tidal data are sent to Japan in semi-real-time through INMARSAT.

As for the tidal data, the sum of the amplitudes of the main four component tide amounts to near 90cm and the diurnal tide (K1+O1) is greater than semi-diurnal tide (M2+S2) from the tidal characteristics at Syowa Station. An outline of the seasonal variations of monthly mean sea level are as follows : the lowest in January, rapid raise from February to April, the highest in May and June, slowly decreasing from July to October and rapid decreasing in November and December. The annual mean sea level has been decreasing by 15cm in 15 years from 1981 to 1996. The variations of monthly mean sea level and the annual mean sea level are given in the following figures.

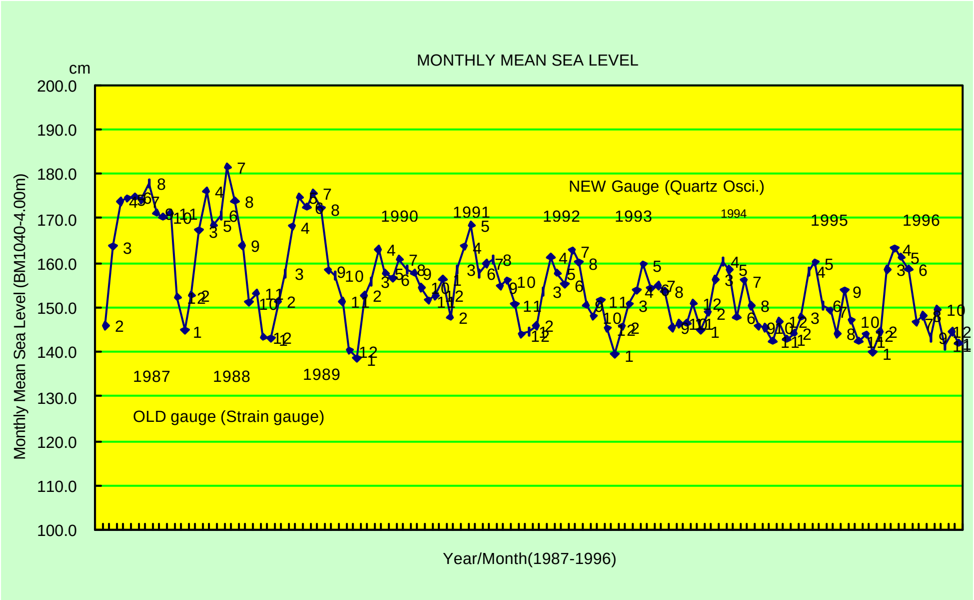


Fig.4 Seasonal variations of monthly mean sea level

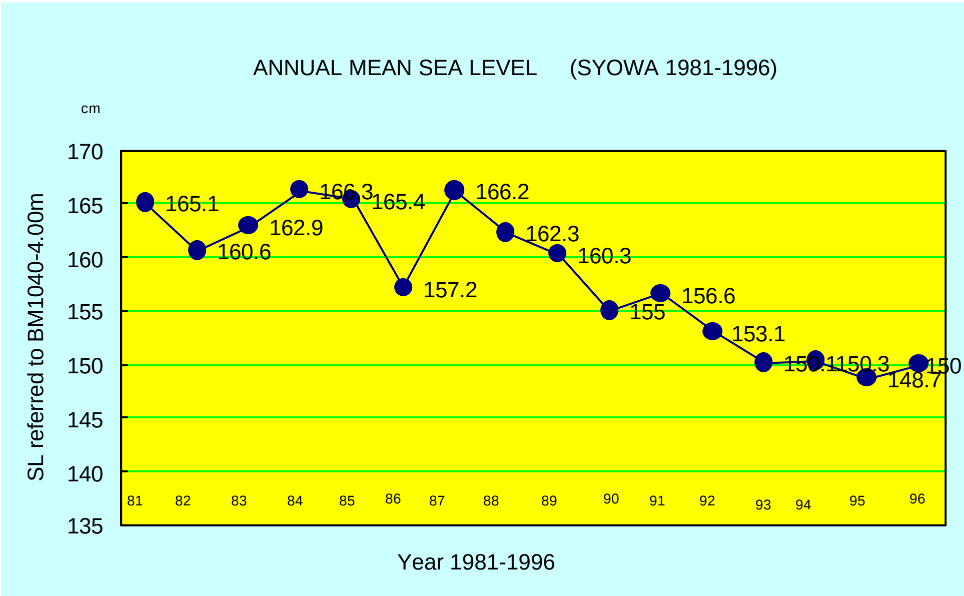


Fig.5 Annual mean sea level from 1981 to 1996

b) DGPS for ocean tide study

In order to verify utilization of GPS technique to ocean tide study, differential GPS observations were conducted on the fast ice near Syowa Station (Aoki et al., 2000a). The observations were carried out intermittently from April to December in 1998. The vertical displacement, which is a combination of oceanic tidal variation and high frequency variations of 3-6 minutes period, was detected. Eight hours' comparison of the height variation derived from GPS with that from a video monitoring system showed good agreement with a standard deviation of 2.2 cm. The high frequency fluctuations of about 1 cm were obvious in both observations and had significant correlation with each other. The low-pass filtered variations agreed well with a standard deviation of 1.7 cm. Tidal constituents derived from the GPS observations for the entire period showed good agreement with those from the seven years of bottom pressure gauge (BPG) observations. Thus, GPS has demonstrated the ability to observe 2 cm accuracy sea level variations.

Parallel observations of both GPS and BPG showed seasonal variations of the ice surface height (Aoki et al., 2000b). Potential sea level derived from the GPS ice surface height and ice thickness measurements revealed the seasonal variation of about 15 cm with its maximum in April-May and minimum in November-December. The predicted ice thickness variation agreed well with the observed one within a standard deviation of 6 cm. Seasonal variation of the tidal range and "sensitivity ratio" increased from the Antarctic winter to spring, and then it decreased. The variation of the ratio is qualitatively consistent with the thickening of the ice. It is demonstrated that GPS is powerful for monitoring the long-term sea level variation in ice-covered regions.

1.4 Oceanographic Observations (JHD)

JHD has continued the oceanographic observations onboard in a round trip between Syowa Station and Tokyo as the Regular Observation Program of the Japanese Antarctic Research Expedition (JARE) since 1965 (JARE-7). The observation items are water temperature, salinity, current velocity, chemical components and contaminated materials in sea water in use of the conductivity, temperature and depth profiling system (CTD), the expendable bathythermograph (XBT), surface drifting buoys, surface water sampling and serial observation. The observed results are published in the Annual Report of the JARE Data Report (Oceanography).

2. MAPPING ACTIVITIES

2.1 Topographic Mapping (GSI)

GSI published color ortho-photomaps of Langhovde, Breivagnipa, and Skarvsnes in 1999 and 2000 as shown in Table 4. Raster data of these are also available with TIFF format.

Table 4. Color ortho-photomaps produced in 1999 and 2000

Year	Area	Scale	No.of sheets
1999	Langhovde south	1/2,500	6
		1/10,000	2
2000	Breivagnipa, Skarvsnes	1/10,000	8

2.2 Navigational Charting (JHD)

In order to make navigational charts in the scale of 1/500,000 in the region of the Antarctic Ocean, JHD has been conducting the hydrographic surveys in the cruises of SIRASE from 1987 in the area from the offing of Breid Bay to the offing of Kronprins Olav Kyst every year as a role assigned by the International Hydrographic Organization in SP-59. The surveyed area amounts to 125,000km^2.

3. GEOGRAPHIC INFORMATION ACTIVITIES

3.1 Global Mapping (GSI)

In order to address global environmental problems, globally consistent scientific information on the status and the change of environment is inevitable. The Agenda 21 stresses the importance of such information for decision making. In this context, Ministry of Construction of Japan proposed Global Mapping concept in 1992. Global Mapping Project has been promoted through International Steering Committee for Global Mapping (ISCGM) which was established in 1996. GSI of Japan takes secretarial role of the Committee.

The need of the Global Map has been well confirmed at the United Nations. The report of Special Session of the United Nations General Assembly on the Implementation of Agenda 21, held in June 1997, includes a section on the development of an information infrastructure accessible to anybody, using technology of geographic information systems including the Global Map. In November 1998, the UN sent a letter of Prof. Estes, Chairperson of ISCGM, inviting National Mapping Organizations (NMOs) to Global Mapping Project and recommendatory letter of Mr. Habermann, Director of the UN Statistics Division, to heads of NMOs. There has been remarkable increase of participation in the Project. As of 17 March 2000, seventy-seven countries and regions, including SCAR WGGGI, have participated in the project, and more than thirty-six countries and regions are waiting approval from their governments.

The Global Map is the map data in digital format covering the whole land area of the earth at 1 km ground resolution, or resolution equivalent to conventional maps at the scale of 1:1,000,000, and is to be revised every five years. The Global Map contains vector data (transportation, boundaries, drainage and population centers) and raster data (elevation, vegetation, land cover and land use). And the Global Map is produced using existing materials such as paper map and digital data set. Satellite images are also considered for revising the existing materials.

Global Map Specifications version 1.0 which was adopted at the Fifth ISCGM Meeting in 1998 are in the most part consistent with ISO/TC211 recommendations for geographic data standards. In Seventh ISCGM Meeting, some minor amendments were adopted, to designate Global Map Specifications version 1.1, which is found at http://www.auslig.gov.au/mapping/global_m/specv1_1.htm. In the specifications, for example, geodetic datum and ellipsoid, data format and data management are described.

Global Mapping Project is promoted by ISCGM whose secretariat is located at GSI, Japan. ISCGM is composed of 17 members of 14 countries and international activities including Mr. Drew Clarke who represents SCAR WG-GGI, and seven advisors from UN Statistic Division, UNEP, UNU, ICA, National Geographic Society etc. Besides, ISCGM keeps close relationship with GSDI, CEOS, ISO/TC211 and other related international organizations.

Production of Global Map Data of some countries (e.g. Japan, Philippines, Thailand) has been already completed. ISCGM distributes such completed Global Map Data free of charge to researchers for their study. All the results of their study will be presented at "Global Mapping Forum 2000" scheduled 28-30 November in Hiroshima, Japan. Furthermore, ISCGM discusses the possibility that ISCGM will distribute the Global Map to public in the world through CD-R and Internet after the Forum 2000.

SCAR WG-GGI participated in the Global Mapping Project on March 9, 1999, and Mr. Drew Clarke, Chairman of SCAR WG-GGI is one of ISCGM members. To produce the Global Map of the Antarctic, British Antarctic Survey (BAS) is simplifying the revised Antarctic Digital Database (ADD) to a 1:1,000,000 scale version. ISCGM Secretariat received the Antarctic Data produced by BAS, and are checking the data contained in it. It will be returned to BAS, and revised until 2001.

4. SCIENTIFIC PAPERS PUBLISHED / PRESENTED

Aoki, S., T.Ozawa, K.Doi, and K.Shibuya (2000a): GPS observations of the sea level variation in Lutzow-Holm Bay, Antarctica, Geophys. Res. Lett., in press.

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Yamada, A., K.Maruyama, O.Ootaki, A.Itabashi, Y.Hatanaka, S.Miyazaki, H.Negishi, T.Higashi, Y.Nogi, M.Kanao, and K.Doi (1998): Analysis of GPS data at Syowa station and IGS tracking station, Polar Geoscience, 11, 1-8.

5. PLACE NAMES

NIPR published the Gazetteer of eastern Dronning Maud Land, Antarctica, where JARE has been active since 1957 (NIPR, 2000). The Gazetteer lists 709 place names with maps and description.

During 1998 - 2000, no names have been newly approved by the Antarctic Place-names Committee of Japan and submitted to the Composite Gazetteer of Antarctica.

6. GROUND CONTROL POINT LIBRARY

No major activities concerning Ground Control Point Library were done in 1998-2000.

Although no repeated positioning is made yet after the traverse survey along the 24 deg E meridian by the JARE-28 Asuka wintering team in 1987, data catalog of the satellite Doppler positioning and the gravity survey was useful and summarized as the JARE Data Report No. 237 (Shibuya and Fukuda, 1999).

7. PLANNED ACTIVITIES FOR THE NEXT TWO YEARS

7.1 Field Activities (GSI, JHD, NIPR)

Syowa Station is acting as one of the key observatory for global geodesy and geodynamics. The observations described above will be basically continued for the coming next two years.

a) Absolute gravity measurement

Absolute gravity measurement with FG-5 gravimeter will be carried out at the Syowa IAGBN (A) site in 2001. Absolute gravity measurements at Syowa were carried out three times in 1991, 1992 and 1994.

b) Levelling survey

A levelling survey will be carried out in 2002 on East Ongul Island to detect crustal deformation. Levelling surveys in the Ongul Islands were carried out four times in 1979, 1982, 1992 and 1996.

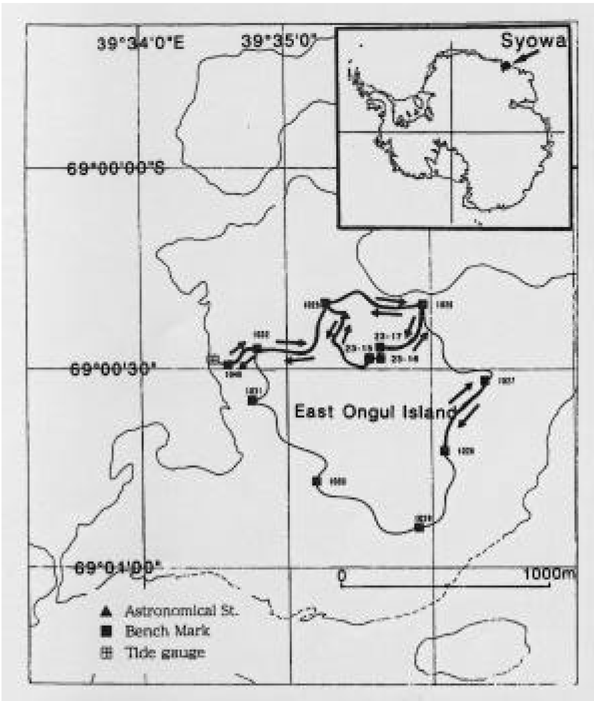

Fig.6 Levelling survey route on East Ongul Island

c) Other geodetic surveys

The Syowa IGS site and the GPS remote base station at Langhovde will be maintained. Reobservation and establishment of ground control points by GPS, as well as gravity surveys, geomagnetic surveys, measurements of glacial velocity, and other geodetic observations will also be continued. A new GPS remote base station with wind / solar power plant will be established in Skallen in future.

7.2 Mapping Activities (GSI, JHD)

a) Topographic Mapping

GSI plans to publish color ortho-photomaps listed in Table 5 in future. Aerial photography for Kronprins Olav Kyst is also planned.

Table 5. Color ortho-photomaps planned

Area	Scale	No.of sheets
Kjuka, Telen, Skallen, Berrodden, Rundvagshetta,	1/10,000	12
Instekleppane, Rundvagskollane, Strandnibba	1/20,000	2

b) Navigational Charting

JHD plans to publish 1/500,000 charts of the Antarctic Ocean listed in Table 6 in future.

Table 6. Charts planned

No.	Name	Area (surrounding by the four lines of)	Year	Note
No.3921	TBD	67° 35´ S, 70° 30´ S, 22° 30´E and 34° 30´ E	after 2001	
No.3923	TBD	63° 50´ S, 68° 40´ S, 42° 40´E and 51° 00´ E	after 2003	148,000km^2

*TBD: to be determined

7.3 Geographic Information Activities (GSI)

a) Global Mapping Project

Although Global Map version 1.0 will be disclosed in 2000, it is important to revise and update the data periodically. It was agreed that the Global Map would be revised every five years. ISCGM is discussing future plan for the phase II period of the Project starting 2001. Secretariat of ISCGM and SCAR WG-GGI will continue to communicate concerning the production, evaluation and revision of Global Map Antarctica, and if necessary, GSI will make effort to contribute such activities as a member of WG-GGI.