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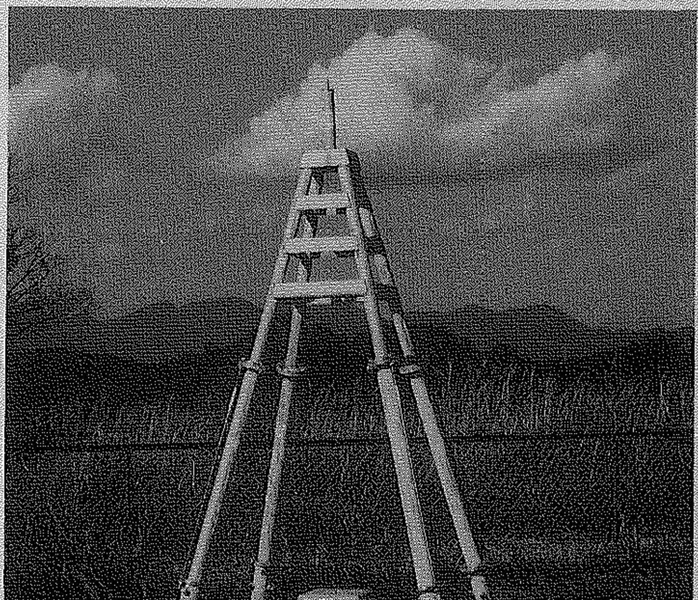

海上保安庁

DATA REPORT
OF
HYDROGRAPHIC OBSERVATIONS

SERIES OF SATELLITE GEODESY

No. 8, March 1995

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DATA REPORT
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SATELLITE LASER RANGING OBSERVATIONS IN 1993

Summary - Satellite laser ranging observations have been continued by a fixed type satellite laser ranging station at the Simosato Hydrographic Observatory (JHDLRS-1) and by a transportable one (HTLRS) at off-lying islands. The total numbers of returns obtained by the JHDLRS-1 in 1993 are 73,953 from 73 passes of Lageos-I, 143,859 from 100 passes of Lageos-II, 24,890 from 59 passes of Starlette, 206,444 from 203 passes of Ajisai, 18,950 from 48 passes of ERS-1 (European Remote Sensing Satellite-1), 51,828 from 67 passes of TOPEX/POSEIDON and 8,852 from 23 passes of Stella, respectively. Those obtained by the HTLRS at Hatizyo Sima in 1993 are 68 from 4 passes of Lageos-I, 19 from 2 passes of Lageos-II, 5,217 from 34 passes of Ajisai and 2,514 from 8 passes of TOPEX/POSEIDON, respectively. The range precisions of the JHDLRS-1 are 5.7cm for Lageos-I, 5.8cm for Lageos-II, 6.2cm for Starlette, 6.0cm for Ajisai, 5.8cm for ERS-1, 5.8cm for TOPEX/POSEIDON and 4.1cm for Stella, respectively. Those of the HTLRS at Hatizyo Sima are 5.4cm for Lageos-I, 7.0cm for Lageos-II, 4.2cm for Ajisai and 3.9cm for TOPEX/POSEIDON, respectively.

Key words: satellite laser ranging - global geodesy - Lageos-I - Lageos-II - Starlette - Ajisai - ERS-1 - TOPEX/POSEIDON - Stella - JHDLRS-1 - HTLRS

This is a report of the satellite laser ranging (SLR) observations made at the Simosato Hydrographic Observatory by a fixed type satellite laser ranging station called JHDLRS-1 (Sasaki et al., 1983) and by a transportable one called HTLRS (Sasaki, 1988) at off-lying islands. This report contains the lists of data obtained at these stations in 1993.

Previous data obtained by the JHDLRS-1 appear in the Series of Astronomy and Geodesy, Data Report of Hydrographic Observations for the period from 1982 to 1985, and in the Series of Satellite Geodesy from 1986 to 1992; those obtained by the HTLRS at off-lying islands appear in the Data Report of Hydrographic Observation, Series of Satellite Geodesy, No. 3, 4, 5, 6 and 7.

1. Observation

The routine ranging observation for Lageos-I, Starlette, and Beacon (BE)-C started in April 1982 by using a fixed type SLR station at the Simosato Hydrographic Observatory (the JHDLRS-1) under the mutual cooperation between the Hydrographic Department of Japan (JHD) and the National Aeronautics and Space Administration (NASA) of the United States of America. In August 1986, the Japanese first Geodetic Satellite "Ajisai" was launched and its tracking observation by the JHDLRS-1 started. In this place, the observation of BE-C was terminated in July 1986. Thereafter following 4 satellites were added in the routine observation after their launches: "ERS-1" in July 1991, "TOPEX/POSEIDON" in August 1992, "Lageos-II" in October 1992 and "Stella" in September 1993.

The range observation for Lageos-I, Starlette and Ajisai, by the HTLRS started in December 1987. Lageos-II, ERS-1, TOPEX/POSEIDON and Stella laser - ranging satellites have been observed by the HTLRS immediately after their launches. The range observations by the HTLRS at off-lying islands have been carried out as follows.

Jan. - Mar. 1988	: Titi Sima
Jul. - Sep. 1988	: Isigaki Sima
Jan. - Mar. 1989	: Minamitori Sima
Jul. - Sep. 1989	: Okinawa Sima
Oct. - Nov. 1989	: Tusima
Sep. - Oct. 1990	: Oki Shoto
Dec. 1990 - Feb. 1991	: Minami-Daito Sima
Aug. - Nov. 1991	: Tokati
Jan - Mar. 1992	: Iwo Sima
Aug. - Oct. 1992	: Wakkanai
Jan - Mar. 1993	: Hatizyo Sima

The major specifications of the JHDLRS-1 and the HTLRS are listed in Table 1 and Table 2 (Sasaki et al., 1983, Sasaki, 1988). The locations of the system and fiducial stone markers set up near the system are shown in Table 3 (Takemura, 1983) and Table 4.

The observation schedule of the JHDLRS-1 was made by selecting those passes whose maximum elevation was over 30 degrees for Starlette, Ajisai, ERS-1, TOPEX/POSEIDON and Stella, nighttime passes of Lageos-I and Lageos-II, over 35 degrees for daytime passes of Lageos-I, Lageos-II. The observation schedule of the HTLRS was made by selecting those passes whose maximum elevation was over 20 degrees at night. When the HTLRS was operational, the same criterion was applied to the JHDLRS-1. Routine observation was not carried out on Saturday and Sunday. The priority of the selection for simultaneous transits was in the order of Ajisai, Lageos, Starlette and ERS-1.

The SAO-formatted orbital elements of the satellites for the use of scheduling and tracking were sent from the Goddard Space Flight Center(GSFC) of NASA through INTERNET. The orbital elements of Ajisai were also calculated in the Headquarters of the JHD by using quick-look data sent from Simosato and from GSFC via INTERNET. For the satellite tracking, an analytical tracking program using the elements were used. The tracking was carried out when the elevation of satellites was above 20 degrees. The temperature, atmospheric pressure and relative humidity were measured once in a pass. Before and after ranging satellites, the ranging calibrations were made by using ground targets.

In order to improve ranging precision, the JHDLRS-1 have been upgraded several times. A Micro-Channel-Plate photomultiplier was introduced in the JHDLRS-1 in January 1985. A GPS clock was introduced into the JHDLRS-1 in December 1988 to monitor and correct the time of the atomic clock used in the system, and it has been in operation since April 1989. A GPS clock has been also used in the HTLRS. A laser subsystem of the JHDLRS-1 was upgraded to a Quantel YAG 460-5 at the beginning of July 1990.

The total numbers of returns and passes obtained by the JHDLRS-1 at Simosato and by the HTLRS at Hatizyo Sima in 1993 are listed in table 5 and Table 6.

2. Polynomial fitting and preliminary analysis of range data

False range data were removed by a visual rejection system. The system works on CRT screens by applying a filter of polynomial fitting to difference between measured range and predicted range or to measured range itself by use of the on-site computer. Preliminary values of standard deviation for each pass were estimated in this process.

A part of obtained data, named quick-look (QL) data, were sent to the GSFC from Simosato within one day through INTERNET. QL data of ERS-1 were also sent to the Deutsches Geodatisches Forschungsinstitut (DGFI) within 8 hours though INTERNET. All the range data, after application of the correction of the internal time delay of the SLR systems obtained by the ground target ranging, named full-rate (FR) data, were recorded on a magnetic tape in MERIT II Format (CSTG, 1987) together with the satellite ID, the station ID, the transmitted time corrected into UTC (USNO MC), the meteorological data, the preliminary measurement standard deviation and some preprocessing indications. The FR data on magnetic tapes for the above seven satellites were sent to the GSFC and the Centre d'Etudes et de Recherches Geodynamiques et Astronomiques (CERGA) of France. The FR data of ERS-1 and Stella were also sent to the DGFI.

The weighted mean range precisions estimated by using the polynomial fitting for all the data obtained by the JHDLRS-1 in 1993 are 5.7cm for Lageos-I, 5.8cm for Lageos-II, 6.2cm for Starlette, 6.0cm for Ajisai, 5.8cm for ERS-1 and 5.8cm for TOPEX/POSEIDON, and 4.1 for Stella, respectively, as shown in Table 5. The same for the HTLRS at Hatizyo Sima are 5.4cm for Lageos-I, 7.0cm for Lageos-II, 4.2cm for Ajisai, and 3.9cm for TOPEX/POSEIDON, respectively.

The QL data sent to the GSFC were used to update orbital elements. These data were transferred from the GSFC to the Center for Space Research(CSR) of the University of Texas and were used for the estimation of the polar motion and the variation of the angular velocity of the earth rotation by processing with the SLR data from other sites in the world. All the FR data were also analyzed in the CSR and other SLR analysis centers, and more precise values for the earth rotation parameters have been estimated. The FR data sent to the GSFC were used to detect crustal movements and global plate motions.

The JHD has been processing FR data obtained at Simosato and other SLR sites by using an orbital processor (Sasaki, 1984). A result of the geodetic coordinates for the cross point of azimuth and elevation axes of the JHDLRS-1, obtained as the Marine Geodetic Result (Tatsuno and Fujita, 1994), is 33° 34' 39."700N, 135° 56' 13."337E, 101.62 m for latitude, longitude and height above the reference ellipsoid of 6378137m semi-major axis and 1/298.257 flattening, respectively.

The observations of satellite laser ranging were made by K. Matsumoto, A. Suzuki, M. Suzuki, K. Tomii, K. Suzuki, S. Yosida, Y. Narita, K. Maeji, K. Kawai, T. Kawaguchi and H. Fukura of the Simosato Hydrographic Observatory and T. Kanazawa, A. Sengoku, M. Fujita, S. Murakami, Y. Takanashi, H. Noda and N. Ikeda of the JHD Headquarters.

Calculations and compilation for this report have been made by K. Terai, M. Fujita and Y. Narita of the JHD Headquarters and K. Muneta of the Simosato Hydrographic Observatory.

References

Abshire, J. B. , 1980: *NASA Report*, "Plan for Investigating Atmospheric Errors in Satellite Laser Ranging Systems".

CSTG, 1987: *Satellite Laser Ranging Newsletter SLR subcommission of the CSTG* (International Coordination of Space Techniques for Geodesy and Geodynamics), 2, No. 1, p. 5.

Marini, J. W., Murray, Jr. C. W., 1973: *NASA report*, X-591-73-351, GSFC, Maryland.

Sasaki, M., Ganeko, Y., Harada, Y., 1983: *Data Report of Hydrogr. Obs., Series of Astronomy and Geodesy,* **17**, p. 49.

Sasaki, M., 1984: *Report of Hydrogr. Res.,* **19**, p. 107.

Sasaki, M., 1988: *Data Report of Hydrogr. Obs., Series of Satellite Geodesy,* **1**, p. 59.

Takemura, T., 1983: *Data Report of Hydrogr. Obs., Series of Astronomy and Geodesy,* **17**, p. 44.

Tatsuno, T., Fujita, M., 1994: *Data Report of Hydrogr.obs., Series of Satellite Geodesy,* **7**, p.102

USNO, 1993, 1994: Daily Time Differences and Relative Phase Values, *Series 4*, **1353 - 1405**.

The reports of the SLR observations for the preceding years were presented in the following numbers of the Data Report of Hydrographic Observations.

Sasaki, M., Nagaoka, M., 1984: *Data Report of Hydrogr. Obs., Series of Astronomy and Geodesy,* **18**, p.55 (for 1982).

Sasaki, M., Sengoku, A., Nisimura, E., Nagaoka, M., 1985: *ibid.,* **19**, p. 50 (for 1983).

Sasaki, M., Sengoku, A., Nagaoka, M., Nisimura, E., 1986: *ibid.,* **20**, p. 44 (for 1984).

Kanazawa, T., Sengoku, A., Nagaoka, M., Nisimura, E., 1987: *ibid.,* **21**, p. 63 (for 1985).

Kanazawa, T., Sengoku, A., Nagaoka, M., Nisimura, E., 1988: *Data Report of Hydrogr. Obs., Series of Satellite Geodesy,* **1**, p. 19 (for 1986).

Kanazawa, T., Sengoku, A., Nagaoka, M., Nakagawa, H., 1989: *ibid.,* **2**, p. 1 (for 1987).

Sengoku, A., Nagaoka, M., Fuchida, K., Masai, S., Fujii, T., Nakagawa, H., 1990: *ibid.,* **3**, p. 1 (for 1988).

Sengoku, A., Kurokawa, S., Nakagawa, H., 1991: *ibid.,* **4**, p. 1 (for 1989).

Sengoku, A., Kurokawa, S., Ikeda, N., Matsumoto, K., 1992: *ibid.,* **5**, p. 1 (for 1990).

Sengoku, A., Murakami, S., Ikeda, N., Matsumoto, K., 1993: *ibid.,* **6**, p. 1 (for 1991).

Sengoku, A., Narita. Y., Matsumoto, K., 1994: *ibid.,* **7**, p. 1 (for 1992).

Table 1. Principal Specifications of Satellite Laser Ranging Station of the Simosato Hydrographic Observatory (JHDLRS-1)

Subsystem	Specification
Mount configuration	elevation over azimuth/Coude path
Angular resolution	20bits (1.2 arcsec)
Transmitter diameter	17 cm
Receiver diameter	60 cm
Laser wave length	532 nm
Output energy	125 mJ
Laser pulse width	100 ps
Repetition rate	4 pps
Receiver detector	Micro-Channel-Plate PMT (9% Q.E. and 300 ps rise time)
Flight time counter	20 ps resolution
Frequency standard	Rubidium oscillator
Time comparison	GPS(TRIMBLE, 5000A)
Computer	32-bits personal computer with hard disks, 3.5inch floppy disk drivers, printer, CRTs and a modem

Table 2. Principal Specifications of the Hydrographic Department Transportable Satellite Laser Ranging Station (HTLRS)

Subsystem	Specification
Mount configuration	elevation over azimuth/Coude path
Angular resolution	20bits (1.2 arcsec)
Transmitter diameter	10 cm
Receiver diameter	35 cm
Laser wave length	532 nm
Output energy	50 mJ
Laser pulse width	50 - 100 ps
Repetition rate	5 pps
Receiver detector	Micro-Channel-Plate PMT with 300 ps rise time
Flight time counter	20 ps resolution
Frequency standard	Rubidium oscillator (rate : 2×10^{-11})
Time comparison	GPS
Computer	two 16 - bits personal computers with hard disks 3.5 inch floppy disk drivers, printer, CRTs and a modem

Table 3. Geodetic coordinates of JHDLRS-1

Location	Site ID	Coordinates (Tokyo Datum)		
		°	′	″
Cross point of Az. and El. axes of JHDLRS-1	International 7838	33	34	27.496N
		135	56	23.537E
	Domestic SHO-L			62.44 m
		°	′	″
The fiducial stone marker at the Simosato Hydrographic Observatory	Domestic	33	34	28.078N
	SHO-H0	135	56	23.236E
				58.36 m

Table 4. Geodetic coordinates of HTLRS

Location	Site ID	Coordinates (Tokyo Datum)		
		°	′	″
Cross point of Az. and El. axes of HTLRS at Hatizyo Sima	International 7309	33	04	10.187N
		139	49	32.701E
				221.15m

Table 5. Data acquisition at the Simosato Hydrographic Observatory in 1993

Satellite	No. of ranges	No. of passes	RMS
Lageos-I	73,953	73	5.7 cm
Lageos-II	143,859	100	5.8
Starlette	24,890	59	6.2
Ajisai	206,444	203	6.0
ERS-1	18,950	48	5.8
TOPEX/POSEIDON	51,828	67	5.8
Stella	8,852	23	4.1

Observers : K. Matsumoto, A. Suzuki, M. Suzuki, K. Tomii, K. Suzuki, S. Yosida, Y. Narita, K. Maeji, K. Kawai, T. Kawaguchi, H. Fukura, Y. Watanabe*, S. Murakami* and M. Fujita*

* JHD headquarters

Table 6. Data acquisition at Hatizyo Sima in 1993

Satellite	No. of ranges	No. of passes	RMS
Lageos-I	68	4	5.4cm
Lageos-II	19	2	7.0
Ajisai	5,217	34	4.2
TOPEX/POSEIDON	2,514	8	3.9

Observers : T. Kanazawa, A. Sengoku, K. Kawai, Y. Takanashi, N. Ikeda, H. Noda, K. Suzuki* and S. Yoshida*

* The Simosato Hydrographic Observatory

Table 7. Observations and data fitting by JHDLRS-1

Explanation

Column

1 Serial number of passes ranged successfully for each satellite.

2 Serial number of passes ranged successfully from the beginning of SLR observation by the JHDLRS-1.

3 Observation time (UTC) of the first return and the last return observed in the satellite pass. D indicates a daytime pass.

4 Azimuth when the tracking of the satellite started at 20 degrees of elevation.

5 Elevations at the maximum, at the first return obtained and at the last return obtained in the satellite path. U means that the data are obtained through the maximum elevation.

6 Number of successful returns from the satellite in the pass.

7 Order of the polynomials applied and the root mean square deviation of the curve fitting to the difference between measured range and predicted range. Before the fitting application, an atmospheric correction (Marini and Murray, 1973) is added.

The range correction added to the measured range is

$$dR = -\frac{g(\lambda)}{f(\phi, H)} \cdot \frac{A+B}{\sin E + \dfrac{B/(A+B)}{\sin E + 0.01}},$$

where

$$g(\lambda) = 0.9650 + \frac{0.0164}{\lambda^2} + \frac{0.000228}{\lambda^4},$$

$$f(\phi, H) = 1\text{-}0.0026 \cos 2\phi - 0.00031H,$$

$$A = 0.002357\,P + 0.000141\,e,$$

$$e = 6.11 \cdot \frac{Rh}{100} 10^{7.5(T-273.15)/\{237.3+(T-273.15)\}},$$

$$B = (1.084 \times 10^{-8})\,PTK + (4.734 \times 10^{-8})\frac{P^2}{T} \cdot \frac{2}{(3-1/K)},$$

$$K = 1.163 - 0.00968 \cos 2\acute{E}'' - 0.00104\,T + 0.00001435\,P.$$

Here

dR : Range correction (meter),

E : True elevation of satellite,

P : Atmospheric pressure at the site (hecto pascal),
T : Atmospheric temperature at the site (degree kelvin),
Rh : Relative humidity at the site (%),
λ : Wavelength of the laser (micron),
ϕ : Latitude of the site,
H : Altitude of the site (kilometer),

This term is not corrected for the measured range in the final MT file, that is FR data.

8 Atmospheric temperature (degree centigrade).
9 Atmospheric pressure (hecto pascal).
10 Relative humidity (%).
11 Calibrated internal delay time of the SLR system obtained by the ground target ranging. The light velocity change in the air (Abshire, 1980) is used for the atmospheric correction. This term is corrected for the range data in the final MT file, FR data.

The group velocity of light in the air is given by

$$V = c \,/\, (1 + 10^{-6} N),$$

where

$$N = 80.343\,(0.9650 + \frac{0.0164}{\lambda^2} + \frac{0.00028}{\lambda^4})\,\frac{P}{T} - 11.3\,\frac{e}{T},$$

$$e = 6.11 \cdot \frac{Rh}{100} 10^{7.5(T-273.15)/\{237.3+(T-273.15)\}}.$$

Here
c : The speed of light in vacua,
P : Atmospheric pressure (hecto pascal),
T : Atmospheric temperature (degree kelvin),
Rh : Relative humidity (%),
λ : Wavelength of the light (micron).

12 Time correction: Transmitting time of GPS minus time of the clock used in the SLR system. This term is corrected for the transmitted time in the final MT file.
* not adopted because of an unrecoverable time bias in the data.
13 Time correction: UTC (USNO MC) minus transmitting time of GPS (USNO, 1993, 1994). This term is corrected for the transmitted time in the final MT file.

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Ajisai

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	4949	93 01 05	04 28 35	04 34 27 D	-122R	72	68	19	380	19	5.7	12.3	1015.8	47	7.2	2.9	0.1
2	4951	93 01 05	06 26 29	06 35 57 D	-68R	32	22	U 19	494	21	6.2	10.5	1017.5	42	7.4	2.9	0.1
3	4952	93 01 05	10 32 16	10 45 41	-41R	59	20	U 19	1572	31	6.3	4.1	1021.9	70	7.2	3.0	0.0
4	4962	93 01 08	05 46 25	05 53 51 D	-64R	31	22	U 24	192	13	8.9	13.4	1015.8	50	7.1	2.8	0.0
5	4965	93 01 12	02 12 36	02 19 25 D	-133R	82	88	20	105	9	9.8	11.6	1014.7	56	7.2	2.8	0.0
6	4975	93 01 19	06 08 36	06 13 39 D	-36R	42	42	22	210	13	9.1	8.3	1007.7	54	6.7	2.8	0.0
7	4976	93 01 29	05 14 09	05 20 07 D	-52L	80	72	U 31	121	10	11.3	10.0	1008.6	40	7.0	2.8	0.0
8	4998	93 02 04	01 47 33	01 56 43 D	-38R	42	27	U 24	291	17	8.1	12.9	1011.7	48	7.3	3.2	0.0
9	4999	93 02 04	03 49 23	03 51 25 D	-55L	70	31	U 48	151	12	6.6	14.5	1009.5	43	7.7	2.8	0.0
10	5006	93 02 04	18 41 43	18 53 25	198L	50	24	U 19	1395	31	9.0	5.2	1011.4	61	7.3	3.0	0.0
11	5008	93 02 04	20 42 32	20 55 27	-104R	53	20	U 19	1681	31	7.2	3.2	1011.7	70	7.4	3.1	0.0
12	5010	93 02 05	00 52 44	01 02 23 D	-37R	34	23	U 20	947	29	7.1	11.5	1013.4	44	7.4	3.1	0.0
13	5013	93 02 05	02 53 14	03 07 08 D	-47R	82	20	U 19	931	29	6.4	14.5	1011.2	32	7.3	3.1	0.0
14	5022	93 02 05	17 48 32	17 58 16	173L	32	20	U 20	988	30	6.9	10.0	1008.4	72	7.4	3.1	0.0
15	5024	93 02 05	19 47 46	20 01 42	-122R	71	19	U 19	2223	31	5.2	10.9	1007.7	73	7.3	3.2	0.0
16	5025	93 02 08	00 12 52	00 22 16 D	-34R	35	25	U 19	1043	31	5.7	6.9	1006.2	45	7.3	2.8	0.0
17	5033	93 02 08	17 08 56	17 18 06	179L	35	25	U 20	800	27	6.9	2.6	1011.2	59	7.4	3.1	0.0
18	5035	93 02 08	19 08 01	19 19 26	-118R	68	23	U 28	1714	31	7.0	1.3	1010.4	70	7.3	3.2	0.0
19	5040	93 02 09	16 16 05	16 22 25	155L	21	18	U 17	587	23	7.8	3.0	1010.6	69	7.3	3.0	0.0
20	5042	93 02 09	18 13 02	18 27 12	224L	86	19	U 18	1657	31	6.6	3.0	1010.6	68	7.4	3.0	0.0
21	5045	93 02 09	20 19 10	20 28 19	-82R	37	28	U 19	933	29	5.9	1.9	1010.8	75	7.3	3.1	0.0
22	5046	93 02 10	00 24 58	00 37 09 D	-39R	47	20	U 20	1139	31	7.2	8.0	1012.8	50	7.3	2.8	0.0
23	5054	93 02 10	17 19 51	17 32 01	205L	60	21	U 23	377	18	10.8	4.8	1011.9	56	7.4	3.2	0.0
24	5056	93 02 10	19 21 59	19 34 25	-98R	47	20	U 19	1368	31	5.6	3.6	1011.0	62	7.4	3.3	0.0
25	5059	93 02 12	15 35 54	15 41 59	160L	24	21	U 19	537	22	7.1	6.1	1013.2	49	7.2	3.3	0.0
26	5062	93 02 12	17 32 37	17 46 29	-132R	82	19	U 19	1679	31	5.6	4.9	1013.2	46	7.3	3.4	0.0
27	5064	93 02 12	19 38 48	19 47 48	-78R	35	27	U 20	637	24	6.2	3.3	1013.2	52	7.3	3.4	0.0
28	5071	93 02 15	14 55 13	15 02 01	165L	26	23	U 19	506	22	6.5	5.2	1014.9	60	7.1	3.0	0.0
29	5073	93 02 15	16 59 14	17 06 02	-128R	82	82	19	354	17	7.4	4.5	1014.1	61	7.2	3.0	0.0
30	5074	93 02 15	18 58 26	19 07 18	-74R	34	26	U 20	895	28	6.7	5.4	1013.6	58	7.3	3.1	0.0
31	5077	93 02 17	17 06 14	17 19 23	-106R	56	19	U 20	1926	31	6.2	8.3	1006.9	66	7.3	3.1	0.0
32	5078	93 02 17	19 12 05	19 21 04	-57R	28	20	U 19	1221	31	5.4	8.3	1008.0	61	7.3	3.1	0.0
33	5084	93 02 18	16 11 45	16 23 42	-125R	75	20	U 30	751	26	6.6	7.3	1011.7	59	7.1	3.0	0.0
34	5085	93 02 18	18 17 40	18 26 49	-69R	33	23	U 20	911	29	7.1	6.6	1011.9	59	7.3	3.1	-0.1
35	5087	93 02 18	20 21 43	20 30 41	-36R	29	20	U 19	1003	30	5.7	5.3	1012.5	62	7.3	3.1	-0.1
36	5092	93 02 19	15 24 43	15 31 24	217L	74	75	19	888	28	12.2	2.9	1016.0	59	7.4	3.1	0.0
37	5095	93 02 19	17 21 13	17 33 05	-88R	40	20	U 19	1679	31	7.0	2.8	1016.0	60	7.4	3.2	0.0
38	5096	93 02 19	19 27 05	19 35 30	-44R	27	20	U 19	1204	31	6.4	0.8	1015.8	70	7.4	4.2	0.0
39	5098	93 02 21	23 45 13	23 56 49 D	-66L	42	20	U 19	376	18	5.4	14.9	991.4	57	7.3	2.8	0.0
40	5103	93 02 22	14 44 46	14 49 13	220L	81	76	30	621	25	5.7	10.1	992.9	57	7.2	3.0	0.0
41	5107	93 02 23	13 43 36	13 56 34	202L	55	19	U 19	1770	31	8.0	1.9	1004.2	61	7.3	3.1	0.0
42	5109	93 02 23	15 45 46	15 58 27	-100R	50	20	U 19	1441	31	7.1	1.7	1004.9	64	7.3	3.2	0.0
43	5111	93 02 23	17 51 43	18 00 13	-55R	28	20	U 20	1068	31	7.1	1.4	1005.3	66	7.3	3.2	0.0
44	5113	93 02 23	19 55 00	20 05 45	-37R	35	20	U 20	1042	31	6.9	0.9	1006.0	67	7.3	3.3	0.0
45	5119	93 02 24	12 51 00	13 01 37	181L	35	20	U 20	1208	31	6.7	2.7	1010.6	66	7.2	3.1	0.0
46	5121	93 02 24	14 50 55	15 04 31	-118R	67	20	U 19	1384	31	6.6	1.8	1011.2	66	7.4	3.1	0.0
47	5122	93 02 24	16 56 12	17 05 51	-66R	31	20	U 20	1010	30	5.8	1.0	1011.0	68	7.3	3.1	0.0
48	5125	93 02 24	19 01 25	19 10 33	-36R	30	22	U 19	1273	31	5.8	1.0	1011.2	71	7.4	3.2	0.0
49	5127	93 02 25	12 00 37	12 04 57	151L	21	20	U 19	307	16	7.5	3.1	1014.5	66	7.1	2.9	0.0
50	5129	93 02 25	13 56 40	14 10 27	224L	82	20	U 20	1278	31	6.1	1.1	1014.3	78	7.3	3.0	0.0

Table 7. Observations and data fitting by JHDLRS-1
Satellite:Ajisai (continued)

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT		LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°		°			cm	℃	hPa	%	ns	μs	μs
51	5131	93 02 25	16 00 42	16 11 51	-80R	37	20	U	19	1309	31	6.7	0.4	1014.3	82	7.3	3.0	0.0
52	5133	93 02 25	18 06 26	18 14 46	-43R	27	20	U	20	885	28	5.7	2.0	1014.3	65	7.3	3.1	0.0
53	5136	93 02 25	20 08 20	20 20 48	-38R	47	19	U	20	1765	31	6.5	0.8	1014.5	71	7.4	3.1	0.0
54	5138	93 02 26	15 11 13	15 17 54	-96R	47	47	U	20	130	10	8.0	6.5	1013.8	60	7.2	3.0	0.0
55	5141	93 02 26	19 15 57	19 25 32	-35R	37	26	U	20	880	28	7.2	3.4	1013.4	70	7.2	3.1	0.0
56	5142	93 03 01	12 25 37	12 35 45	209L	65	41	U	20	974	31	10.4	4.0	1006.4	54	6.8	3.0	0.1
57	5146	93 03 01	16 35 30	16 39 36	-48R	27	27		19	427	19	7.2	1.8	1008.4	54	7.0	3.1	0.1
58	5149	93 03 01	18 34 31	18 45 08	-37R	38	22	U	20	1118	31	7.3	1.7	1008.6	59	7.2	3.2	0.1
59	5153	93 03 02	11 29 23	11 40 09	188L	43	20	U	24	1327	31	6.9	2.4	1015.4	65	6.9	2.9	0.1
60	5156	93 03 02	13 31 31	13 43 25	-110R	59	27	U	20	1845	31	6.1	0.8	1015.4	79	7.1	3.0	0.1
61	5158	93 03 02	15 36 33	15 45 04	-58R	29	22	U	19	862	28	6.8	1.4	1015.4	69	7.1	3.0	0.1
62	5161	93 03 02	17 39 55	17 49 53	-37R	32	20	U	20	1377	31	5.9	2.1	1014.5	63	7.2	3.1	0.1
63	5163	93 03 02	19 41 15	19 54 29	-45R	73	20	U	22	2186	31	5.4	2.5	1014.9	62	7.2	3.2	0.1
64	5164	93 03 03	10 37 29	10 45 13	168L	26	19	U	20	362	18	6.8	6.3	1011.9	60	7.0	3.0	0.1
65	5166	93 03 03	12 35 38	12 49 31	-128R	79	20	U	19	2160	31	7.1	5.1	1012.3	65	7.3	3.0	0.1
66	5168	93 03 03	14 41 37	14 48 05	-76R	34	25	U	29	122	10	8.0	5.0	1012.1	60	7.1	3.1	0.1
67	5170	93 03 04	11 42 15	11 46 57	214L	69	22		60	176	12	7.2	6.4	1012.8	88	7.1	3.0	0.1
68	5172	93 03 04	13 45 29	13 56 53	-91R	42	22	U	20	1659	31	7.2	6.2	1013.8	66	7.0	3.1	0.1
69	5174	93 03 04	15 50 54	15 59 15	-45R	27	20	U	20	962	29	6.1	6.4	1013.6	63	7.1	3.2	0.1
70	5177	93 03 04	17 53 25	18 05 05	-36R	40	20	U	20	1402	31	7.5	4.8	1013.6	70	7.0	3.2	0.1
71	5180	93 03 04	19 54 57	20 08 28	-53L	74	20	U	20	1436	31	7.6	4.3	1015.1	71	7.0	3.3	0.1
72	5184	93 03 05	10 48 38	11 00 46	193L	47	20	U	20	1496	31	7.4	9.3	1018.0	72	7.0	3.0	0.2
73	5185	93 03 05	12 50 05	13 02 57	-108R	56	21	U	20	1981	31	6.7	7.3	1018.0	75	7.2	3.0	0.1
74	5187	93 03 05	14 56 31	15 04 34	-60R	29	22	U	20	745	26	5.8	7.3	1016.9	81	7.2	3.1	0.1
75	5189	93 03 05	16 59 24	17 09 43	-39R	33	20	U	19	1362	31	5.5	8.1	1016.2	84	7.2	3.2	0.1
76	5192	93 03 05	19 00 46	19 14 32	-47R	76	20	U	19	2241	31	5.3	8.1	1015.4	84	7.2	3.3	0.1
77	5193	93 03 08	10 07 50	10 20 26	198L	51	20	U	20	992	30	8.0	5.4	1011.4	56	6.5	3.0	0.2
78	5195	93 03 08	12 09 32	12 22 27	-103R	53	20	U	20	1473	31	7.6	4.5	1013.0	59	6.6	3.1	0.2
79	5197	93 03 08	14 15 21	14 24 11	-56R	28	20	U	20	952	29	6.7	3.6	1013.2	66	6.6	3.2	0.2
80	5200	93 03 08	16 19 00	16 29 38	-37R	34	20	U	19	1324	31	7.1	3.9	1013.4	62	6.7	3.2	0.2
81	5202	93 03 08	18 20 21	18 34 03	-48R	82	20	U	19	1670	31	5.8	3.9	1013.4	61	6.7	3.3	0.2
82	5204	93 03 08	20 24 40	20 31 59	-81L	26	20	U	19	499	21	7.9	3.4	1014.1	64	6.7	3.4	0.2
83	5206	93 03 09	09 17 56	09 21 42	179L	32	29	U	31	468	20	7.2	9.5	1013.8	64	7.2	2.9	0.2
84	5207	93 03 09	11 16 13	11 23 42	-121R	71	28	U	56	95	9	7.5	6.1	1014.3	79	7.1	3.0	0.2
85	5209	93 03 10	10 21 15	10 34 26	221L	78	23	U	19	1736	31	7.2	9.2	1009.9	50	7.2	3.0	0.2
86	5211	93 03 10	12 24 22	12 35 52	-82R	38	20	U	19	1766	31	6.4	6.2	1010.8	63	7.2	3.0	0.2
87	5213	93 03 10	14 30 12	14 38 41	-44R	27	20	U	20	1068	31	6.3	4.5	1011.0	69	7.2	3.2	0.2
88	5215	93 03 10	16 33 01	16 44 35	-37R	45	23	U	20	1785	31	7.1	3.4	1011.0	75	7.2	3.2	0.2
89	5216	93 03 10	18 34 03	18 46 52	-56L	64	20	U	22	979	30	6.3	4.7	1011.0	70	7.1	3.3	0.2
90	5218	93 03 12	08 36 24	08 44 49 D	179L	36	27	U	21	541	21	7.5	10.5	1003.8	47	7.2	2.8	0.2
91	5219	93 03 12	10 34 26	10 47 47	-117R	67	20	U	21	927	29	7.3	8.1	1005.6	43	7.1	2.9	0.2
92	5222	93 03 12	12 39 49	12 49 26	-64R	31	20	U	19	614	23	8.0	5.9	1006.6	53	7.1	2.9	0.2
93	5224	93 03 12	14 44 25	14 53 46	-39R	30	20	U	20	821	27	6.1	5.2	1005.8	54	7.2	3.0	0.2
94	5227	93 03 12	16 46 08	16 59 13	-43R	63	22	U	19	1996	31	8.6	5.0	1005.3	55	7.2	3.1	0.2
95	5229	93 03 12	18 50 25	18 59 30	-71L	38	28	U	19	628	24	6.8	4.9	1004.9	51	7.2	3.2	0.2
96	5230	93 03 13	09 41 14	09 53 59	225L	87	26	U	19	1119	31	7.5	8.2	1009.7	47	6.9	2.9	0.2
97	5232	93 03 13	11 44 10	11 55 21	-82R	37	20	U	19	1598	31	7.5	6.8	1011.7	46	7.1	3.0	0.2
98	5233	93 03 13	13 49 49	13 58 26	-40R	27	20	U	19	1333	31	6.8	5.0	1012.3	51	7.1	3.0	0.2
99	5236	93 03 13	15 52 03	16 04 25	-40R	47	21	U	19	1732	31	7.5	4.6	1012.8	53	7.3	3.1	0.2
100	5237	93 03 13	17 54 05	18 06 42	-59L	59	22	U	19	1478	31	7.0	2.5	1011.9	64	7.3	3.2	0.2

Table 7. Observations and data fitting by JHDLRS-1
Satellite:Ajisai (continued)

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
101	5242	93 03 16	17 13 25	17 26 03	-62L	54	21 U	19	1726	31	6.2	2.4	1005.1	62	7.8	3.3	0.1
102	5245	93 03 17	10 15 39	10 21 04	-93R	44	43	19	717	25	5.7	5.2	1005.3	58	7.9	3.1	0.2
103	5249	93 03 18	13 23 26	13 33 40	-39R	32	20 U	19	1053	31	6.2	5.5	1009.1	67	7.6	3.1	0.1
104	5253	93 03 19	14 30 58	14 43 46	-41R	53	21 U	19	1995	31	5.7	4.9	1014.1	64	7.7	2.9	0.1
105	5255	93 03 23	06 54 22	06 58 01 D	217L	74	48	21	169	12	7.3	15.9	1009.9	65	7.7	2.7	0.0
106	5257	93 03 25	13 18 03	13 22 52	-43R	60	53	21	576	22	8.1	10.8	1005.1	83	6.8	3.2	0.0
107	5258	93 03 29	07 28 49	07 35 24 D	-80R	37	24 U	33	366	18	6.7	8.1	1007.7	41	7.9	2.9	0.0
108	5259	93 04 07	09 34 16	09 46 46	-40R	57	18 U	16	1328	31	7.7	12.4	1000.3	53	7.5	*	*
109	5261	93 04 08	10 43 58	10 54 46	300L	69	31 U	16	185	12	10.7	7.9	1009.3	57	7.8	*	*
110	5269	93 05 07	17 47 30	17 51 07	194L	47	41 U	34	236	14	5.9	15.2	1004.9	91	7.8	*	*
111	5273	93 05 12	17 17 02	17 28 13	222L	82	31 U	16	525	22	5.7	20.3	1006.2	88	8.0	*	*
112	5276	93 05 14	15 28 43	15 39 04	181L	36	17 U	15	666	24	6.2	12.8	1005.6	70	7.9	*	*
113	5277	93 05 14	17 28 29	17 42 03	-117R	66	16 U	14	1590	31	5.4	10.8	1006.6	75	7.8	*	*
114	5280	93 05 20	14 12 13	14 16 09	190L	43	39 U	27	566	23	4.6	20.4	1004.0	57	7.9	*	*
115	5282	93 05 25	13 38 38	13 52 10	218L	77	15 U	16	1355	31	5.7	17.5	1002.5	80	8.0	*	*
116	5283	93 05 26	12 45 30	12 57 56	199L	52	17 U	15	1430	31	8.1	17.0	1003.6	89	7.8	*	*
117	5284	93 05 26	14 49 53	14 57 30	-102R	51	31 U	28	627	24	5.7	15.6	1003.4	89	8.2	*	*
118	5286	93 05 27	11 53 30	12 02 47	176L	33	18 U	15	856	27	6.9	17.7	1000.1	88	8.0	*	*
119	5288	93 05 27	13 58 13	14 05 06	-120R	70	62 U	19	572	22	6.4	14.9	1000.1	92	7.9	*	*
120	5290	93 05 28	12 58 10	13 11 48	222L	83	16 U	15	1028	30	7.0	14.8	999.0	84	7.3	*	*
121	5291	93 05 31	14 24 11	14 32 26	-78R	36	25 U	16	611	24	6.0	16.7	1003.2	87	7.9	*	*
122	5292	93 06 03	11 37 12	11 50 59	-131R	85	16 U	15	1005	31	6.4	20.5	988.1	66	7.8	*	*
123	5294	93 06 03	13 42 14	13 52 11	-74R	35	18 U	15	936	29	5.8	17.9	989.0	76	7.9	*	*
124	5295	93 06 04	10 43 23	10 55 52	211L	67	16 U	19	51	14	5.7	19.0	993.3	74	7.9	*	*
125	5296	93 06 04	12 48 47	12 58 00	-92R	43	28 U	16	557	23	5.5	17.4	994.9	79	7.8	*	*
126	5298	93 06 05	11 51 39	12 04 20	-109R	58	22 U	19	1368	31	5.8	17.3	997.5	75	7.8	*	*
127	5300	93 06 06	13 07 24	13 11 30	-71R	33	33	20	187	13	10.1	16.6	1002.9	85	7.8	*	*
128	5302	93 06 06	17 10 29	17 20 36	-40R	54	32 U	22	1031	31	5.3	17.8	1003.8	80	7.9	*	*
129	5303	93 06 14	13 59 19	14 10 26	-35R	36	20 U	19	1507	31	6.6	23.2	998.8	96	8.0	*	*
130	5304	93 06 14	16 00 38	16 14 27	-50L	89	19 U	19	1689	31	5.2	23.3	998.4	96	7.9	*	*
131	5307	93 06 15	11 01 45	11 09 54	-62R	30	23 U	21	377	19	6.3	24.6	996.0	91	8.1	*	*
132	5308	93 06 16	08 12 42	08 14 28 D	226L	89	33	21	60	7	8.0	27.4	996.2	79	8.0	*	*
133	5309	93 06 16	10 06 40	10 15 28 D	-78R	36	25 U	22	398	18	7.0	24.9	997.3	77	8.2	*	*
134	5312	93 06 17	15 20 21	15 33 59	-51L	84	20 U	19	1627	31	5.8	23.6	1000.5	92	7.5	*	*
135	5313	93 06 21	07 44 18	07 47 28 D	-109R	58	41	21	69	7	9.8	23.9	997.5	85	7.8	*	*
136	5319	93 08 11	15 14 29	15 20 26	172L	31	30 U	19	139	11	8.8	22.4	997.9	82	8.1	*	*
137	5320	93 08 11	17 11 05	17 23 38	-123R	74	25 U	20	374	18	7.6	22.4	998.1	80	8.2	*	*
138	5321	93 08 18	14 57 32	15 07 28	227L	89	37 U	27	293	16	8.0	25.4	1005.3	96	8.0	*	*
139	5326	93 08 20	15 11 00	15 22 19	-112R	61	32 U	19	2002	31	4.9	23.4	1007.1	94	8.0	*	*
140	5329	93 08 24	13 33 57	13 47 44	-126R	79	20 U	20	1993	31	5.4	23.6	1003.2	97	7.7	*	*
141	5332	93 08 25	12 41 43	12 53 23	215L	74	30 U	20	1077	31	5.7	24.6	1001.2	80	8.1	*	*
142	5333	93 08 25	14 44 57	14 55 05	-87R	41	27 U	20	1377	31	4.8	24.2	1000.5	84	8.0	*	*
143	5334	93 08 26	11 49 24	11 56 32	196L	49	34 U	33	747	25	6.5	24.8	992.5	84	7.9	*	*
144	5337	93 08 30	10 18 18	10 23 14	177L	34	34 U	21	173	12	11.0	24.7	1006.6	93	7.3	*	*
145	5338	93 08 30	12 21 51	12 25 13	-119R	69	55	28	169	12	5.5	23.6	1007.3	93	7.6	*	*
146	5340	93 08 30	14 22 30	14 25 43	-64R	31	31 U	27	72	8	6.9	23.0	1007.3	94	7.4	*	*
147	5342	93 08 31	11 20 25	11 31 29	223L	85	29 U	26	329	17	7.7	24.8	1005.8	92	7.2	*	*
148	5347	93 09 09	11 24 38	11 26 54	-70R	33	28 U	33	52	15	6.6	24.3	1001.8	93	8.1	*	*
149	5351	93 09 09	15 30 04	15 40 04	-40R	55	25 U	30	757	26	8.1	22.5	1002.3	95	8.1	*	*
150	5352	93 09 09	17 32 36	17 35 34	-65L	47	27 U	43	262	15	8.2	22.2	1001.8	95	8.3	*	*

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Ajisai (continued)

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT		LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°		°			cm	℃	hPa	%	ns	μs	μs
151	5354	93 09 10	14 35 17	14 45 02	-37R	42	21	U	28	371	20	5.8	21.2	1004.2	87	8.1	*	*
152	5355	93 09 10	16 45 23	16 48 59	-55L	71	56		26	66	20	7.9	20.4	1004.2	90	8.1	*	*
153	5358	93 09 11	15 44 31	15 54 29	-47R	81	32	U	30	875	29	4.4	20.8	1007.7	93	8.1	*	*
154	5361	93 09 14	13 00 30	13 10 55	-35R	35	19	U	21	993	30	4.1	20.9	1006.4	95	7.9	*	*
155	5364	93 09 25	11 13 23	11 19 43	-41R	56	25	U	54	406	19	6.2	19.1	1005.8	89	8.2	*	*
156	5365	93 09 25	13 19 34	13 24 05	-65L	47	45	U	34	65	11	6.9	19.3	1005.6	69	8.2	*	*
157	5367	93 10 01	12 01 51	12 04 58	-70L	39	34		21	132	11	5.6	17.0	1004.7	80	7.8	*	*
158	5369	93 10 04	09 15 13	09 23 38	-44R	67	51	U	24	736	26	4.8	20.1	1007.5	86	7.9	2.7	-0.1
159	5370	93 10 04	11 17 26	11 22 48	-73L	36	34	U	26	70	8	7.3	18.3	1008.2	96	7.9	2.7	0.0
160	5406	93 11 03	17 21 15	17 32 17	205L	59	32	U	19	1629	31	4.8	11.5	1015.2	81	7.8	2.0	0.1
161	5407	93 11 03	19 26 13	19 33 41	-97R	47	44	U	21	1107	31	4.4	10.9	1015.2	84	7.8	2.0	0.1
162	5414	93 11 04	16 27 18	16 37 24	184L	38	24	U	19	1307	31	4.5	15.3	1012.3	91	8.0	2.5	0.1
163	5417	93 11 04	18 30 38	18 40 05	-114R	64	46	U	19	1147	31	4.6	16.0	1011.7	86	8.0	2.5	0.1
164	5425	93 11 09	15 57 49	16 11 08	213L	70	19	U	21	993	30	4.6	15.8	1019.5	76	7.9	2.4	0.1
165	5430	93 11 16	13 43 45	13 55 58	201L	55	22	U	20	1762	31	4.6	18.7	1015.2	85	7.8	2.9	0.0
166	5433	93 11 18	13 56 15	14 09 56	224L	86	20	U	20	2256	31	4.5	15.0	1013.4	95	7.8	2.6	0.0
167	5437	93 11 22	12 27 21	12 35 28	209L	65	59	U	19	1214	31	4.6	7.5	1012.3	82	8.0	2.6	0.0
168	5442	93 11 24	12 35 22	12 48 56	-129R	82	20	U	20	1889	31	4.6	3.5	1019.9	80	8.1	3.0	0.0
169	5447	93 11 25	11 41 21	11 54 52	213L	70	20	U	19	1950	31	5.0	7.0	1020.4	80	7.8	2.9	0.0
170	5451	93 11 29	10 07 52	10 19 53	197L	51	22	U	20	535	22	6.3	9.0	1021.3	71	7.8	2.1	0.1
171	5452	93 11 29	12 10 06	12 21 58	-103R	53	25	U	19	1668	31	4.6	7.3	1021.7	68	7.8	2.1	0.1
172	5455	93 12 06	07 54 37	08 04 22	184L	39	26	U	20	1192	31	3.9	10.1	1013.0	59	7.9	2.5	-0.1
173	5457	93 12 06	11 59 03	12 08 26	-61R	30	20	U	20	1328	31	3.5	8.1	1014.9	55	7.9	2.5	0.0
174	5460	93 12 06	14 03 16	14 13 19	-35R	31	19	U	19	1530	31	3.7	7.8	1015.2	65	8.1	2.3	0.0
175	5462	93 12 06	18 07 34	18 18 06	-74L	35	19	U	20	840	27	4.0	7.6	1014.9	59	8.0	2.2	-0.1
176	5464	93 12 07	15 10 43	15 23 32	-39R	50	19	U	19	1534	31	4.8	7.6	1017.3	80	8.0	2.3	0.1
177	5465	93 12 07	17 12 49	17 25 40	-61L	54	20	U	19	1546	31	4.2	9.6	1016.2	72	8.0	2.4	-0.1
178	5466	93 12 08	08 08 50	08 18 47	209L	65	43	U	19	1793	31	3.8	12.6	1014.3	73	8.0	2.6	0.0
179	5469	93 12 08	10 08 15	10 20 23	-93R	45	20	U	20	1674	31	4.5	9.6	1015.6	83	7.9	2.4	0.0
180	5471	93 12 08	12 14 53	12 22 38	-46R	27	22	U	19	869	29	4.1	9.6	1016.5	60	7.8	2.5	0.0
181	5474	93 12 08	14 17 04	14 28 20	-36R	39	20	U	19	1726	31	4.4	7.1	1016.5	76	7.8	2.5	0.0
182	5475	93 12 08	16 18 28	16 32 01	-52L	80	20	U	20	2258	31	4.3	5.5	1016.7	84	8.0	2.4	0.0
183	5478	93 12 09	07 14 18	07 24 15 D	189L	43	29	U	19	1439	31	4.0	13.8	1015.8	67	8.1	2.6	0.0
184	5481	93 12 09	09 13 16	09 26 39	-111R	60	20	U	19	1896	31	4.0	8.5	1016.5	85	7.9	2.5	0.0
185	5483	93 12 09	11 20 33	11 27 55	-58R	29	25	U	20	400	19	4.0	7.9	1016.9	85	7.8	2.4	0.1
186	5486	93 12 09	13 22 55	13 31 19	-35R	32	20	U	25	885	29	4.5	8.0	1015.6	82	7.8	2.5	0.1
187	5487	93 12 15	07 54 06	08 04 38	-103R	53	28	U	23	798	27	3.8	7.6	1019.5	58	7.8	2.6	0.0
188	5490	93 12 15	12 01 59	12 12 28	-35R	34	20	U	19	1666	31	3.4	5.3	1021.7	61	8.0	2.5	-0.1
189	5492	93 12 15	14 03 22	14 15 14	-48R	83	20	U	30	1364	31	4.1	3.9	1022.8	71	8.0	2.4	-0.1
190	5494	93 12 17	12 15 21	12 27 34	-38R	45	20	U	20	1307	31	4.7	5.1	1015.6	57	7.8	2.9	-0.1
191	5497	93 12 17	14 17 01	14 30 21	-57L	64	20	U	19	1838	31	4.5	4.2	1016.0	62	7.9	2.8	-0.1
192	5499	93 12 20	13 36 50	13 49 40	-59L	59	21	U	19	1877	31	4.0	8.6	1012.3	90	7.8	2.4	-0.1
193	5500	93 12 21	06 38 01	06 44 01 D	-96R	47	47	U	21	229	14	2.9	13.3	1003.4	58	8.0	2.6	0.1
194	5502	93 12 21	10 40 50	10 52 03	-36R	37	19	U	20	1653	31	3.2	7.5	1005.1	61	7.9	2.4	-0.1
195	5506	93 12 22	05 43 41	05 49 51 D	-114R	63	63		23	496	21	3.6	6.8	1006.0	47	8.0	2.7	0.0
196	5507	93 12 22	07 42 38	07 51 51 D	-61R	30	20	U	20	754	26	3.5	5.5	1005.8	46	7.9	2.6	0.0
197	5509	93 12 22	09 46 55	09 56 20	-35R	31	20	U	20	1070	31	3.2	5.1	1005.3	53	7.9	2.6	0.0
198	5510	93 12 22	13 52 30	13 58 44	-74L	35	25	U	30	207	14	6.4	6.7	1003.8	56	8.0	2.5	0.0
199	5511	93 12 24	05 54 48	05 59 12 D	-93R	44	35	U	42	312	16	4.5	11.8	1012.3	52	7.9	2.8	0.0
200	5513	93 12 24	12 01 48	12 15 29	-52L	80	20	U	20	1728	31	4.4	5.3	1014.9	72	7.8	2.5	0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Ajisai (continued)

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
201	5515	93 12 27	09 21 16	09 31 48	-37R	41	26 U	19	1299	31	3.8	7.9	1010.6	77	7.5	2.5	0.0
202	5517	93 12 27	11 21 20	11 34 55	-54L	75	20 U	20	1234	31	4.0	7.1	1011.0	74	7.5	2.4	0.1
203	5520	93 12 28	04 18 12	04 29 21 D	-107R	56	30 U	20	625	23	4.2	13.2	1011.7	45	8.0	2.8	0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:ERS-1

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	4954	93 01 05	13 47 07	13 51 41	-149R	30	20	U 22	326	17	6.5	4.4	1022.8	62	7.1	3.0	0.0
2	4972	93 01 18	13 39 14	01 00 00	-156R	37	27	U 20	464	20	6.3	5.3	1007.5	75	7.1	3.1	0.0
3	4981	93 01 29	12 52 02	12 58 41	157L	72	20	U 25	475	25	6.9	3.1	1010.6	59	7.1	2.9	0.1
4	4988	93 02 01	12 57 39	13 03 34	163L	81	20	U 34	307	19	8.7	1.9	1008.0	73	7.3	3.0	0.1
5	4992	93 02 02	12 31 30	12 32 59	130L	40	34	22	108	10	5.4	1.9	1018.1	54	7.3	2.8	0.1
6	4996	93 02 03	13 36 17	13 41 21	-158R	39	28	U 19	136	13	8.7	5.0	1014.3	53	7.3	2.9	0.1
7	5004	93 02 04	13 03 18	13 10 38	-191R	82	20	U 19	958	30	8.8	8.0	1012.5	50	7.3	3.0	0.1
8	5011	93 02 05	01 20 48	01 22 55 D	30R	47	31	U 48	190	13	4.1	12.3	1013.2	45	7.4	3.1	0.0
9	5018	93 02 05	12 32 33	12 38 35	139L	46	20	U 24	729	26	5.2	10.2	1009.5	61	7.3	3.0	0.0
10	5051	93 02 10	13 15 40	13 21 55	-181R	63	28	U 19	427	19	8.3	5.3	1012.3	54	7.3	3.1	0.0
11	5070	93 02 15	12 19 01	12 24 43	126L	33	20	U 18	489	21	6.8	5.6	1014.5	69	7.2	2.9	0.0
12	5083	93 02 18	12 24 27	12 26 13	128L	38	20	U 33	68	8	5.4	8.5	1011.4	53	7.2	3.0	0.0
13	5114	93 02 24	01 23 38	01 25 46 D	31R	50	32	U 51	247	15	8.0	5.9	1007.3	51	7.3	2.8	0.0
14	5118	93 02 24	12 36 42	12 42 03	139L	48	32	U 20	361	18	6.9	2.3	1010.3	71	7.3	3.0	0.0
15	5128	93 02 25	13 45 42	13 47 55	-154R	32	29	U 29	140	11	6.3	1.4	1014.5	75	7.2	3.0	0.0
16	5144	93 03 01	13 18 10	13 24 38	-179R	59	24	U 20	242	18	10.8	3.7	1006.9	54	7.0	3.0	0.1
17	5155	93 03 02	12 48 43	12 49 44	153L	66	48	U 65	60	7	7.2	2.2	1015.8	65	7.1	3.0	0.1
18	5165	93 03 03	12 16 13	12 21 34	119L	31	20	U 19	362	18	6.9	5.8	1012.1	61	7.2	3.0	0.1
19	5196	93 03 08	13 00 35	13 04 56	163L	78	68	U 19	334	17	6.5	4.6	1013.2	59	6.6	3.1	0.2
20	5212	93 03 10	13 35 20	13 41 13	-159R	38	21	U 20	543	22	6.8	5.3	1011.0	67	7.3	3.1	0.2
21	5221	93 03 12	12 35 26	12 37 58	140L	46	46	U 29	206	13	8.1	6.1	1006.6	53	7.2	2.9	0.2
22	5246	93 03 17	13 15 15	13 21 18	-179R	61	24	U 24	385	18	6.3	4.0	1006.4	59	7.8	3.3	0.2
23	5248	93 03 18	12 43 38	12 50 42	151L	61	20	U 19	983	31	6.2	6.0	1009.0	70	7.5	3.1	0.1
24	5263	93 04 08	13 25 16	13 30 06	190R	51	34	U 16	265	15	7.5	7.4	1010.1	59	7.9	*	*
25	5274	93 05 14	12 51 56	12 59 13	158L	75	16	U 15	861	29	5.8	13.5	1003.4	75	7.8	*	*
26	5279	93 05 20	13 08 13	13 10 28	-191R	83	46	16	165	12	12.1	20.5	1003.6	60	7.9	*	*
27	5287	93 05 27	12 47 41	12 50 37	150L	61	52	15	183	13	6.7	17.3	1000.3	90	8.1	*	*
28	5293	93 06 03	12 27 16	12 30 28	130L	38	34	14	206	13	5.2	18.5	988.5	76	7.8	*	*
29	5297	93 06 04	13 34 04	13 37 28	-163R	42	31	U 23	109	9	8.8	16.7	995.1	82	7.9	*	*
30	5315	93 07 05	12 19 45	12 24 37	124L	33	25	U 19	330	17	6.1	21.0	996.8	94	8.1	*	*
31	5327	93 08 23	13 23 23	13 24 01	-178R	59	33	26	102	10	3.5	23.8	1003.6	98	8.2	*	*
32	5335	93 08 26	13 23 58	13 30 30	-172R	51	23	U 18	502	22	5.0	25.3	992.0	82	8.0	*	*
33	5339	93 08 30	12 59 44	13 04 56	163L	85	45	U 20	286	16	7.6	23.3	1007.5	95	7.3	*	*
34	5343	93 08 31	12 28 24	12 31 44	133L	41	30	U 33	184	12	8.7	24.5	1005.6	94	7.3	*	*
35	5357	93 09 11	13 21 52	13 26 42	-175R	55	31	U 27	581	22	3.1	21.0	1008.0	91	8.1	*	*
36	5362	93 09 14	13 26 31	13 33 04	-169R	48	20	U 20	526	23	4.6	20.4	1006.6	96	7.9	*	*
37	5368	93 10 01	12 52 07	12 59 19	158L	75	20	U 19	744	26	6.2	17.0	1005.1	74	7.8	*	*
38	5378	93 10 19	13 28 05	13 33 10	-169R	48	35	U 19	165	17	8.4	13.0	1008.8	96	7.8	2.7	0.0
39	5385	93 10 23	13 00 56	13 03 46	166L	88	23	77	43	21	3.1	10.8	1004.7	70	7.8	2.5	-0.2
40	5390	93 10 25	13 38 20	13 44 06	-157R	36	21	U 20	733	27	3.6	12.3	1011.0	76	7.8	2.3	0.1
41	5395	93 10 27	12 35 19	12 42 04	142L	50	20	U 19	1084	31	3.2	15.1	1024.1	57	7.8	2.5	-0.1
42	5402	93 11 01	13 17 36	13 24 46	-178R	59	19	U 19	850	28	4.1	13.8	1017.8	65	7.8	2.7	0.1
43	5432	93 11 18	12 43 39	12 50 36	150L	61	20	U 19	216	18	5.8	15.5	1012.8	96	7.9	2.6	0.0
44	5436	93 11 22	12 19 41	12 24 35	123L	33	25	U 19	639	24	4.0	7.5	1012.1	83	7.9	2.6	0.0
45	5459	93 12 06	13 17 36	13 24 28	-178R	59	20	U 20	441	20	3.8	8.1	1015.2	62	8.0	2.4	0.0
46	5491	93 12 15	13 36 50	13 40 58	-160R	39	34	U 21	440	21	2.8	3.7	1022.3	72	8.0	2.6	-0.1
47	5495	93 12 17	12 33 45	12 37 50	139L	46	32	U 29	394	19	3.3	5.1	1015.8	58	7.8	2.8	-0.1
48	5505	93 12 21	13 48 48	13 52 00	-146R	30	29	U 19	361	19	2.4	4.0	1007.1	53	7.8	2.3	-0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Lageos-I

(1)	(2)	(3) Obs. Time(UTC)				(4)	(5) Elev				(6)	(7)		(8)	(9)	(10)	(11)	(12)	(13)
	No.	date	caught	lost		Azst	MX	CT		LT	RTN	N	RMS	TMP	PRESS	HUM	IDT	DTS	DTG
		Y M D	h m s	h m s		°	°	°		°			cm	℃	hPa	%	ns	μs	μs
1	4948	93 01 05	02 26 07	02 35 23	D	112L	55	55		42	79	8	6.8	10.6	1017.1	58	7.2	2.8	0.1
2	4961	93 01 07	15 22 15	15 59 32		44R	42	24	U	20	540	22	7.2	15.2	1005.3	69	7.2	3.2	0.1
3	4964	93 01 11	17 01 57	17 39 05		27R	82	42	U	24	619	24	5.7	7.0	1010.4	79	7.1	3.1	0.0
4	4973	93 01 18	14 30 39	14 56 45		51R	33	23	U	26	216	14	5.9	5.2	1007.7	67	7.1	3.1	0.0
5	4997	93 02 03	13 53 29	14 22 23		50R	34	27	U	20	643	25	4.8	3.8	1014.3	64	7.2	2.9	0.1
6	5005	93 02 04	15 53 24	16 41 11		27R	83	21	U	19	2316	31	6.0	7.7	1011.9	52	7.3	3.0	0.1
7	5012	93 02 05	02 28 52	02 44 32	D	141L	83	77		31	127	10	7.9	13.8	1011.9	38	7.3	3.1	0.0
8	5021	93 02 05	14 32 24	15 13 30		38R	52	21	U	25	1783	31	5.2	8.5	1009.3	72	7.3	3.0	0.0
9	5023	93 02 05	18 06 05	18 45 42		18L	50	23	U	20	1274	31	6.0	10.7	1008.2	69	7.3	3.1	0.0
10	5031	93 02 08	13 59 38	14 40 22		43R	42	20	U	19	977	31	7.1	2.1	1011.9	64	7.2	3.1	0.0
11	5034	93 02 08	17 31 14	18 03 40		20L	58	23	U	40	590	23	10.3	0.8	1011.0	74	7.4	3.2	0.0
12	5041	93 02 09	16 26 48	16 55 04		25R	85	75	U	19	742	27	6.4	3.7	1010.8	62	7.3	3.0	0.0
13	5044	93 02 09	19 41 24	20 10 50		17L	30	19	U	19	723	26	5.7	2.5	1010.6	69	7.4	3.1	0.0
14	5052	93 02 10	14 45 19	15 17 31		33R	62	20	U	50	445	21	6.6	5.3	1012.1	53	7.3	3.1	0.0
15	5055	93 02 10	18 19 02	18 55 04		18L	44	20	U	23	584	23	8.3	4.0	1011.7	60	7.4	3.2	0.0
16	5060	93 02 12	15 44 03	16 18 30		27R	83	47	U	25	1760	31	7.7	6.3	1013.2	47	7.4	3.4	0.0
17	5063	93 02 12	19 07 32	19 30 14		17L	34	20	U	31	544	23	6.0	3.4	1013.2	53	7.2	3.4	0.0
18	5072	93 02 15	15 05 45	15 47 04		30R	73	35	U	19	2290	31	7.1	5.6	1014.9	60	7.2	3.0	0.0
19	5076	93 02 17	15 55 55	16 35 22		25R	85	42	U	19	1893	31	5.5	8.8	1006.4	64	7.3	3.1	0.0
20	5091	93 02 19	13 08 44	13 42 41		50R	34	21	U	20	683	26	6.4	3.6	1016.5	54	7.3	3.0	0.0
21	5094	93 02 19	16 38 41	16 55 05		21L	66	27		64	907	29	10.8	3.2	1016.0	56	7.4	3.1	0.0
22	5108	93 02 23	14 47 12	15 21 50		30R	73	39	U	30	1235	31	6.7	1.7	1004.7	64	7.2	3.2	0.0
23	5112	93 02 23	18 13 54	18 48 25		18L	38	21	U	20	723	27	7.7	1.4	1005.3	66	7.2	3.3	0.0
24	5120	93 02 24	13 23 49	13 59 46		43R	43	27	U	20	599	24	6.3	2.7	1010.6	58	7.3	3.1	0.0
25	5123	93 02 24	17 09 56	17 31 44		20L	57	57	U	23	1311	31	5.4	1.1	1011.0	70	7.4	3.1	0.0
26	5130	93 02 25	15 27 09	15 50 04		25R	85	20	U	84	443	20	9.2	1.6	1014.5	69	7.3	3.0	0.0
27	5135	93 02 25	19 01 42	19 29 56		18L	30	20	U	20	446	21	6.2	1.3	1014.1	70	7.3	3.1	0.0
28	5139	93 02 26	17 52 07	18 08 50		18L	44	40	U	34	393	19	10.7	4.1	1013.4	66	7.1	3.0	0.0
29	5145	93 03 01	13 54 44	14 05 08		38R	52	52		41	402	20	8.2	3.5	1006.9	51	7.1	3.0	0.1
30	5147	93 03 01	17 29 51	17 40 47		18L	50	47		29	139	11	12.4	1.4	1008.4	58	7.2	3.1	0.1
31	5154	93 03 02	12 21 23	12 35 52		62R	26	23	U	25	236	15	9.3	1.5	1015.8	70	7.1	3.0	0.1
32	5159	93 03 02	15 52 09	16 28 22		22L	75	46	U	19	774	28	6.5	-0.7	1015.4	85	7.2	3.1	0.1
33	5171	93 03 04	13 02 18	13 40 11		43R	43	25	U	20	1211	31	7.1	5.8	1013.6	72	7.0	3.1	0.1
34	5175	93 03 04	16 33 33	17 13 46		20L	57	27	U	19	610	24	10.1	5.9	1013.6	66	7.0	3.2	0.1
35	5188	93 03 05	15 11 20	15 28 41		24R	85	30		80	874	29	7.5	8.1	1017.1	80	7.1	3.1	0.1
36	5198	93 03 08	14 34 39	15 21 09		27R	84	24	U	20	983	31	6.1	4.3	1013.6	62	6.7	3.2	0.2
37	5214	93 03 10	15 26 18	16 00 27		22L	74	31	U	38	732	27	6.5	4.4	1011.0	71	7.1	3.2	0.2
38	5223	93 03 12	12 57 45	13 20 17		43R	43	43	U	20	768	27	6.5	5.8	1006.6	50	7.0	2.9	0.2
39	5226	93 03 12	16 38 27	16 44 01		20L	57	50		39	176	12	7.5	5.1	1005.3	54	7.1	3.1	0.2
40	5235	93 03 13	14 47 09	15 09 59		24R	84	20	U	84	1277	31	6.8	4.4	1012.5	55	7.1	3.1	0.2
41	5240	93 03 16	14 32 22	14 36 42		27R	84	73	U	84	372	18	5.6	3.0	1005.6	58	7.8	3.2	0.2
42	5243	93 03 16	17 49 00	18 18 54		17L	34	22	U	20	690	25	6.6	2.0	1004.5	64	7.9	3.4	0.1
43	5252	93 03 19	13 39 30	14 22 15		30R	74	21	U	30	1880	31	5.5	5.1	1014.3	64	7.6	2.9	0.1
44	5268	93 05 07	13 51 22	14 07 42		20L	56	18	U	49	425	20	4.5	15.5	1004.5	92	7.8	*	*
45	5272	93 05 12	10 32 59	11 07 58		36R	54	18	U	33	932	30	6.4	20.1	1007.3	84	7.8	*	*
46	5311	93 06 16	12 34 46	12 37 39		20L	55	54		50	66	7	12.7	23.7	998.1	83	7.9	*	*
47	5341	93 08 31	11 03 36	11 11 51		19L	32	32		27	68	7	12.1	25.0	1005.8	92	7.2	*	*
48	5346	93 08 31	14 18 06	14 35 34		67L	32	31	U	19	251	15	12.8	23.6	1005.1	94	7.7	*	*
49	5372	93 10 08	15 17 45	15 22 11		129L	70	70	U	67	68	7	13.2	15.5	998.4	83	7.4	2.5	0.2
50	5375	93 10 09	17 20 06	17 35 38		-184R	57	47	U	51	215	14	10.4	15.5	1007.5	93	7.8	2.7	-0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Lageos-I (continued)

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT		LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°		°			cm	℃	hPa	%	ns	μs	μs
51	5384	93 10 23	12 16 47	12 50 00	79L	36	20	U	20	891	29	5.6	11.2	1004.5	68	7.8	2.6	-0.2
52	5389	93 10 25	13 06 50	13 28 04	100L	47	34	U	39	1617	31	4.8	11.9	1011.0	78	7.8	2.3	0.1
53	5392	93 10 26	08 49 02	08 57 36	19L	32	29		20	209	14	4.0	14.7	1014.9	61	7.8	2.6	0.0
54	5397	93 10 27	13 44 33	14 27 43	120L	62	23	U	19	1468	31	5.1	16.1	1023.7	62	7.7	2.5	-0.1
55	5403	93 11 01	13 56 24	14 41 36	129L	71	21	U	21	1419	31	5.0	13.1	1018.4	68	7.8	2.6	0.0
56	5412	93 11 04	13 35 28	14 07 09	120L	62	47	U	21	2591	31	4.5	17.5	1012.8	84	7.7	2.6	0.0
57	5415	93 11 04	17 00 45	17 37 02	-161R	37	21	U	19	1406	31	4.7	15.8	1012.1	88	7.8	2.4	0.1
58	5421	93 11 05	15 34 25	15 52 23	-193R	67	26	U	65	1590	31	4.5	13.7	1012.5	76	7.7	2.8	0.0
59	5424	93 11 09	13 42 39	14 22 36	130L	71	35	U	19	2367	31	4.2	15.7	1019.5	73	7.7	2.2	0.0
60	5427	93 11 15	12 31 28	13 13 24	110L	54	21	U	19	3127	31	4.6	13.7	1011.9	84	7.7	2.6	0.1
61	5440	93 11 24	10 56 39	11 25 04	80L	36	20	U	27	1952	31	4.2	4.6	1019.3	75	7.8	2.9	0.0
62	5445	93 11 24	14 17 03	15 04 17	-202R	77	20	U	20	2351	31	5.0	5.3	1019.9	66	7.9	3.0	0.0
63	5450	93 11 25	12 57 43	13 23 28	130L	71	24	U	65	2164	31	4.4	6.8	1020.2	81	7.8	2.8	0.0
64	5461	93 12 06	15 41 43	16 16 58	-160R	37	22	U	19	297	17	4.8	7.5	1015.2	66	7.8	2.3	0.0
65	5463	93 12 07	14 17 54	14 58 03	-192R	66	33	U	20	1303	31	4.7	7.5	1017.5	80	7.7	2.5	0.1
66	5472	93 12 08	12 50 01	13 20 22	140L	81	22	U	62	2275	31	4.3	9.0	1016.7	65	7.7	2.5	0.0
67	5484	93 12 09	11 37 13	12 05 49	111L	55	33	U	35	428	21	5.3	8.1	1016.7	83	7.8	2.4	0.1
68	5489	93 12 15	10 28 38	11 03 08	91L	42	22	U	22	746	27	4.7	5.6	1021.5	67	7.8	2.5	-0.1
69	5493	93 12 17	11 12 36	11 49 20	111L	55	24	U	28	2589	31	4.1	5.9	1014.9	53	7.8	1.8	-0.1
70	5498	93 12 20	10 43 13	10 44 50	101L	48	28	U	31	56	7	3.6	11.1	1010.8	79	7.8	2.5	-0.1
71	5504	93 12 21	12 53 50	13 31 17	149L	87	47	U	19	2655	31	3.9	4.7	1006.9	50	7.8	2.4	-0.1
72	5514	93 12 24	12 23 21	12 50 14	140L	82	57	U	34	1732	31	3.9	4.7	1014.7	77	7.7	2.4	0.1
73	5518	93 12 27	11 43 07	12 06 58	131L	72	37	U	57	686	26	5.0	7.2	1011.2	75	7.4	2.5	0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Lageos-II

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	4953	93 01 05	11 51 40	12 39 57	176L	48	19 U	20	1316	31	6.4	4.7	1022.3	64	7.3	3.0	0.0
2	4958	93 01 05	16 12 47	16 47 50	-108R	62	57 U	20	1364	31	6.5	3.7	1022.3	61	7.9	3.1	0.1
3	4963	93 01 11	16 42 11	16 56 43	-84R	53	26	47	100	9	11.4	7.2	1010.1	79	7.4	3.1	0.0
4	4970	93 01 18	11 26 19	12 02 46	193L	64	39 U	31	1666	31	6.9	5.4	1007.5	90	7.1	3.0	-0.1
5	4974	93 01 18	15 25 51	16 10 55	-92R	55	25 U	30	2029	31	7.3	4.5	1007.7	59	7.2	3.1	0.0
6	4979	93 01 29	10 30 48	11 17 54	201L	72	23 U	31	2100	31	6.3	4.1	1010.6	54	7.2	2.9	0.1
7	4983	93 01 29	14 39 05	15 32 23	-85R	53	20 U	21	1871	31	6.8	3.2	1010.4	58	7.3	3.0	0.0
8	4986	93 01 31	10 42 08	11 37 41	209L	81	20 U	20	568	24	6.3	5.6	1008.2	60	7.3	2.9	0.1
9	4989	93 02 01	13 11 38	13 35 02	-109R	63	55 U	44	555	23	5.3	1.9	1008.0	73	7.4	3.0	0.1
10	4995	93 02 03	13 22 00	13 28 46	-101R	59	44	55	126	11	6.2	4.4	1014.3	58	7.3	2.9	0.1
11	5002	93 02 04	11 13 00	12 03 11	-135R	82	27 U	25	2786	31	5.8	7.9	1012.3	49	7.2	2.9	0.1
12	5007	93 02 04	19 34 48	20 28 34	-48L	72	19 U	20	2735	31	5.7	4.2	1011.7	64	7.3	3.1	0.0
13	5016	93 02 05	09 16 32	10 10 21	192L	63	19 U	19	2588	31	6.0	10.7	1009.1	49	7.4	2.8	0.0
14	5020	93 02 05	13 23 05	14 18 55	-94R	56	19 U	19	2521	31	5.4	8.6	1009.3	69	7.3	3.0	0.0
15	5027	93 02 08	08 09 24	08 22 34 D	163L	38	37	24	43	12	5.4	6.4	1010.4	43	7.3	2.9	0.0
16	5030	93 02 08	11 39 08	12 07 03	-119R	69	22 U	69	1012	31	5.9	3.7	1011.7	55	7.4	3.0	0.0
17	5032	93 02 08	15 55 34	16 46 05	-55R	59	20 U	28	866	29	6.8	2.1	1011.4	63	7.3	3.1	0.0
18	5037	93 02 09	09 42 41	10 30 12	208L	80	20 U	35	2873	31	6.6	6.2	1008.8	49	7.3	2.9	0.0
19	5039	93 02 09	13 55 16	14 48 47	-77R	52	21 U	20	1279	31	5.8	4.0	1010.4	64	7.3	3.0	0.0
20	5043	93 02 09	18 52 00	19 02 55	-47R	88	43	20	639	25	6.4	3.1	1010.6	64	7.4	3.1	0.0
21	5050	93 02 10	11 54 12	12 46 48	-110R	63	22 U	23	2889	31	6.4	5.1	1012.1	54	7.1	3.1	0.0
22	5053	93 02 10	16 11 29	17 05 50	-53R	63	22 U	20	2821	31	6.0	5.1	1011.9	53	7.4	3.2	0.0
23	5058	93 02 12	12 47 00	13 02 28	-102R	59	47	21	822	28	6.8	5.3	1011.7	54	7.1	3.3	0.0
24	5061	93 02 12	16 42 13	17 20 56	-50R	68	53 U	20	2815	31	6.4	5.4	1013.2	47	7.3	3.4	0.0
25	5065	93 02 12	20 34 19	21 04 03	-58L	39	21 U	34	510	22	10.7	2.1	1013.6	64	7.5	3.4	0.0
26	5069	93 02 15	10 24 47	11 20 30	-127R	76	21 U	20	3071	31	5.6	7.8	1014.1	68	7.1	2.9	0.0
27	5075	93 02 17	10 47 10	10 58 31	119R	69	37 U	60	242	17	7.9	12.6	1002.5	54	7.5	2.9	0.0
28	5079	93 02 17	19 25 13	19 35 02	-51L	56	54 U	52	696	26	6.4	7.6	1008.0	66	7.3	3.1	0.0
29	5082	93 02 18	09 07 10	09 31 58	208L	80	76 U	32	322	17	8.1	10.8	1010.1	61	7.2	2.9	0.0
30	5090	93 02 19	10 57 32	11 48 48	-111R	64	27 U	20	2250	31	6.9	5.5	1015.8	53	7.3	3.0	0.0
31	5093	93 02 19	15 37 28	16 05 12	-52R	63	62 U	21	1719	31	6.9	3.0	1016.0	57	7.5	3.1	0.0
32	5097	93 02 19	19 40 31	20 05 18	-55L	47	47 U	20	425	20	7.2	0.6	1016.0	73	7.4	4.2	0.0
33	5102	93 02 22	09 14 51	10 07 05	-136R	83	29 U	19	2383	31	6.1	13.2	992.7	55	7.8	2.9	0.0
34	5106	93 02 23	11 23 40	12 18 50	-94R	56	19 U	20	2164	31	7.1	2.1	1003.2	57	7.2	3.1	0.0
35	5110	93 02 23	16 09 43	16 35 50	-48R	74	73	20	289	16	7.4	1.4	1004.9	65	7.2	3.2	0.0
36	5117	93 02 24	09 24 08	09 56 07	-128R	76	20 U	71	458	21	7.3	3.2	1008.2	70	7.2	3.0	0.0
37	5124	93 02 24	17 52 26	18 43 05	-49L	65	25 U	19	2622	31	6.9	0.8	1011.0	70	7.4	3.2	0.0
38	5126	93 02 25	11 41 51	11 54 09	-87R	54	24	43	548	23	7.0	3.2	1014.5	61	6.9	2.9	0.0
39	5132	93 02 25	16 18 49	16 50 06	-47R	81	76 U	20	1400	31	5.9	0.4	1014.3	75	7.3	3.0	0.0
40	5137	93 02 26	09 41 55	10 20 29	-119R	70	26 U	47	408	19	8.1	6.9	1013.4	63	7.4	2.9	0.0
41	5140	93 02 26	18 36 10	18 54 20	-51L	56	51	20	437	20	5.2	4.0	1013.4	66	7.0	3.1	0.0
42	5143	93 03 01	12 39 42	13 04 39	-71R	52	52	20	1390	31	7.5	4.0	1006.6	54	7.0	3.0	0.1
43	5152	93 03 02	10 08 52	10 54 34	-103R	60	20 U	36	2119	31	9.0	3.5	1014.7	60	6.8	2.9	0.1
44	5157	93 03 02	14 26 01	15 17 08	-50R	67	21 U	28	1650	31	7.4	0.5	1015.8	80	7.1	3.0	0.1
45	5162	93 03 02	18 34 12	19 10 07	-58L	40	20 U	29	736	27	7.9	0.6	1014.7	73	7.1	3.1	0.1
46	5167	93 03 03	13 01 47	13 15 37	-66R	53	48	27	437	20	6.9	5.4	1012.3	61	7.2	3.0	0.1
47	5169	93 03 04	10 24 33	11 19 04	-95R	56	20 U	20	1681	31	6.6	7.8	1012.1	80	6.8	3.0	0.1
48	5173	93 03 04	14 40 46	15 25 05	-48R	74	22 U	42	2761	31	7.1	6.4	1013.6	64	6.9	3.1	0.1
49	5179	93 03 04	18 55 59	19 22 26	-63L	33	26 U	24	344	18	6.8	4.7	1014.3	69	7.0	3.3	0.1
50	5183	93 03 05	08 56 01	09 14 59 D	-128R	76	72	31	924	28	6.8	11.5	1016.5	66	7.1	2.9	0.2

Table 7. Observations and data fitting by JHDLRS-1
Satellite:Lageos-II (continued)

(1)	(2)	(3) Obs. Time(UTC)			(4)	(5) Elev			(6)	(7)		(8)	(9)	(10)	(11)	(12)	(13)
	No.	date	caught	lost	Azst	MX	CT	LT	RTN	N	RMS	TMP	PRESS	HUM	IDT	DTS	DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
51	5186	93 03 05	13 07 05	13 33 52	-61R	55	55	U 23	1612	31	6.1	7.8	1018.0	75	7.2	3.1	0.1
52	5190	93 03 05	17 24 27	17 43 03	-49L	65	57	20	480	21	6.9	8.1	1016.2	86	7.1	3.2	0.1
53	5194	93 03 08	10 55 13	11 49 36	-79R	52	20	U 20	2828	31	6.6	4.9	1012.5	59	6.6	3.1	0.2
54	5199	93 03 08	15 31 44	16 04 21	-47R	88	75	U 20	1624	31	6.7	4.1	1013.6	62	6.6	3.2	0.2
55	5208	93 03 10	07 37 29	07 48 15 D	215L	87	53	29	92	8	7.1	13.4	1008.0	57	7.8	2.9	0.2
56	5210	93 03 10	11 10 44	12 04 47	-72R	52	19	U 20	3060	31	5.8	7.8	1010.6	56	7.1	3.0	0.2
57	5217	93 03 12	07 45 21	07 48 57 D	-137R	84	69	59	51	6	7.6	12.1	1002.7	42	7.2	2.8	0.2
58	5220	93 03 12	11 26 31	12 17 48	-66R	53	20	U 24	1541	31	6.8	6.9	1006.2	54	7.1	2.9	0.2
59	5225	93 03 12	15 36 31	16 25 01	-48L	74	20	U 31	2724	31	6.5	4.7	1005.8	57	7.0	3.1	0.2
60	5231	93 03 13	09 56 44	10 19 57	-96R	56	54	19	1268	31	7.8	8.0	1009.7	49	6.8	2.9	0.2
61	5234	93 03 13	14 01 35	14 36 35	-48R	73	64	U 20	2571	31	7.1	4.8	1012.3	52	7.1	3.1	0.2
62	5238	93 03 13	18 18 28	18 27 32	-64L	33	29	19	228	14	7.2	3.3	1011.7	60	7.2	3.2	0.2
63	5251	93 03 19	10 11 18	11 05 25	-73R	52	20	U 19	3854	31	5.0	6.8	1013.0	61	7.7	2.9	0.2
64	5256	93 03 23	10 45 56	11 22 59	-61R	55	26	U 42	127	10	15.4	12.8	1010.6	69	7.5	2.7	0.0
65	5262	93 04 08	12 40 15	12 59 56	310L	76	21	U 65	349	18	6.3	7.0	1010.1	64	7.9	*	*
66	5266	93 04 13	11 23 28	11 34 26	310L	86	45	U 75	292	17	5.8	11.0	1017.1	57	7.8	*	*
67	5316	93 07 05	16 16 32	16 31 44	174L	46	22	43	299	17	3.8	21.7	998.4	92	7.6	*	*
68	5322	93 08 19	11 48 12	12 01 31	172L	43	38	20	68	8	9.2	25.3	1007.7	93	7.9	*	*
69	5325	93 08 20	13 31 47	14 10 47	215L	86	48	U 24	1135	31	6.1	23.3	1007.5	96	7.9	*	*
70	5331	93 08 25	12 12 08	12 32 39	198L	68	59	U 45	1060	31	6.2	24.4	1001.2	88	8.0	*	*
71	5344	93 08 31	12 43 07	12 50 30	222L	85	41	U 61	160	12	7.4	24.4	1005.6	94	7.4	*	*
72	5348	93 09 09	11 57 32	11 58 59	222L	86	80	84	116	10	9.4	23.8	1001.8	93	7.8	*	*
73	5366	93 09 25	13 47 38	14 09 13	-74R	52	42	U 44	135	11	12.8	19.0	1005.6	70	8.1	*	*
74	5373	93 10 08	17 23 56	18 01 04	-48L	70	44	U 29	44	29	8.4	14.7	1000.5	80	7.7	2.5	0.2
75	5374	93 10 09	15 16 33	16 06 14	-48R	77	20	U 31	61	16	7.0	15.8	1008.4	91	7.8	2.6	-0.1
76	5377	93 10 19	12 20 29	13 07 30	-58R	56	21	U 28	773	28	5.2	13.9	1008.8	93	7.8	2.4	0.0
77	5381	93 10 21	13 10 24	13 20 21	-55R	59	50	33	48	6	6.9	14.2	1008.4	93	7.8	2.7	-0.2
78	5382	93 10 22	10 36 16	11 25 08	-76R	51	22	U 21	1867	31	4.7	15.9	1005.6	69	7.8	2.6	0.0
79	5383	93 10 23	08 39 51	09 23 09	-108R	62	32	U 24	2974	31	4.5	13.9	1002.7	59	7.8	2.5	-0.1
80	5387	93 10 25	08 48 49	09 40 40	-99R	57	20	U 20	3873	31	4.4	15.9	1008.4	58	7.8	2.4	0.0
81	5394	93 10 27	09 03 39	09 55 46	-91R	54	19	U 19	3033	31	4.6	13.2	1021.9	74	7.7	2.7	0.0
82	5398	93 10 28	11 19 54	11 25 59	-59R	56	19	30	91	9	6.2	16.1	1024.5	70	7.8	2.7	0.1
83	5400	93 11 01	11 48 59	12 31 43	-52R	64	19	U 41	2914	31	5.1	13.3	1016.9	65	7.7	2.7	0.1
84	5405	93 11 03	16 12 42	16 53 10	-59L	38	22	U 20	844	29	5.0	12.1	1015.6	76	7.8	2.0	0.0
85	5408	93 11 04	10 13 10	10 33 10	-64R	53	32	U 53	1457	31	4.0	17.2	1013.0	90	7.7	2.7	-0.1
86	5413	93 11 04	14 13 49	15 07 23	-48L	71	21	U 20	2178	31	4.9	16.5	1012.8	87	7.8	2.6	0.0
87	5418	93 11 05	08 21 29	08 55 38	-92R	54	48	U 20	2795	31	4.2	18.5	1012.1	74	7.8	2.8	0.0
88	5423	93 11 09	13 00 13	13 34 16	-47L	89	52	U 33	2186	31	4.5	15.8	1019.5	71	7.7	2.2	0.0
89	5426	93 11 15	09 21 42	10 05 31	-59R	55	21	U 32	2746	31	4.4	15.8	1010.8	77	7.7	2.6	0.0
90	5431	93 11 18	11 46 20	12 31 16	-47L	89	20	U 41	1799	31	4.2	15.9	1012.5	97	7.8	2.7	0.0
91	5434	93 11 19	10 17 29	10 36 26	-52R	63	63	33	213	14	4.9	15.2	1018.0	75	7.8	2.5	0.0
92	5454	93 12 02	09 19 52	09 59 09	-48R	74	21	U 50	3069	31	4.5	13.8	1009.5	90	7.8	2.4	0.0
93	5456	93 12 06	09 47 02	10 15 45	-47L	89	20	U 85	2291	31	4.5	7.9	1014.3	68	7.7	2.6	0.1
94	5470	93 12 08	10 32 18	10 54 48	-47L	82	74	21	653	26	4.8	9.7	1016.0	78	7.7	2.5	0.0
95	5480	93 12 09	08 18 51	08 58 58	-50R	67	47	U 21	2788	31	4.2	10.5	1016.5	78	7.8	2.6	0.0
96	5488	93 12 15	08 48 48	09 29 14	-47L	88	22	U 48	1167	31	4.4	6.9	1019.9	61	7.7	2.4	-0.1
97	5501	93 12 21	09 31 00	10 21 50	-49L	65	22	U 20	3063	31	3.7	9.3	1004.2	67	7.7	2.4	-0.1
98	5508	93 12 22	07 53 54	08 28 57 D	-47R	80	66	U 20	1858	31	4.1	5.4	1005.8	48	7.9	2.6	0.0
99	5512	93 12 24	08 03 43	08 40 23 D	-47L	88	56	U 24	2114	31	3.8	9.2	1013,2	61	7.9	2.7	0.0
100	5516	93 12 27	10 16 52	10 54 51	-58L	41	25	U 22	916	30	3.9	7.7	1011.0	67	7.3	2.5	0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Stella

(1)	(2)	(3) Obs. Time(UTC)			(4)	(5) Elev			(6)	(7)		(8)	(9)	(10)	(11)	(12)	(13)
	No.	date	caught	lost	Azst	MX	CT	LT	RTN	N	RMS	TMP	PRESS	HUM	IDT	DTS	DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	5371	93 10 08	13 29 11	13 34 57	-167R	45	24 U	22	32	15	3.7	16.0	996.8	86	8.4	2.5	-0.1
2	5376	93 10 18	12 28 58	12 32 46	133L	41	40 U	19	178	13	4.2	14.6	1009.3	91	7.9	2.6	0.0
3	5379	93 10 19	13 42 05	13 45 56	-155R	35	33 U	19	88	13	9.8	12.9	1008.8	96	7.8	2.6	0.0
4	5380	93 10 21	12 47 38	12 50 13	154L	68	28 U	67	200	13	4.2	14.5	1008.6	92	7.8	2.7	-0.2
5	5386	93 10 23	13 35 37	13 40 52	-161R	39	27 U	20	179	14	8.1	11.1	1004.7	66	7.8	2.4	-0.2
6	5388	93 10 25	12 42 20	12 49 02	149L	60	25 U	19	653	24	3.7	12.3	1010.8	76	7.9	2.2	0.1
7	5396	93 10 27	13 29 18	13 35 59	-166R	45	20 U	19	924	29	3.8	15.7	1023.9	61	7.8	2.5	-0.1
8	5401	93 11 01	12 58 27	13 05 07	163L	86	28 U	19	844	30	4.4	13.6	1017.5	64	7.8	2.7	0.1
9	5404	93 11 03	13 46 35	13 51 13	-148R	31	23 U	20	120	10	6.6	11.8	1015.6	82	7.8	2.0	0.0
10	5411	93 11 04	13 18 57	13 25 53	-177R	58	21 U	20	602	23	4.2	17.3	1012.8	84	7.9	2.6	0.0
11	5420	93 11 05	12 53 27	12 59 53	159L	77	29 U	19	883	28	3.2	14.7	1013.0	88	8.0	2.7	0.1
12	5422	93 11 09	12 47 33	12 53 50	154L	68	21 U	28	421	19	4.3	15.8	1019.5	71	7.8	2.1	0.1
13	5428	93 11 15	13 30 32	13 36 45	-166R	44	24 U	18	197	13	3.3	14.3	1012.3	79	7.8	2.6	0.0
14	5429	93 11 16	13 03 32	13 10 41	-192R	83	21 U	20	336	19	6.0	18.7	1015.4	85	7.9	2.9	0.0
15	5439	93 11 22	13 49 40	13 51 57	-149R	31	30	20	230	14	3.3	7.5	1012.3	82	8.0	2.7	0.0
16	5443	93 11 24	12 53 50	13 00 28	159L	77	26 U	20	611	26	3.6	3.5	1019.9	79	8.0	3.0	0.0
17	5449	93 11 25	12 29 20	12 33 53	133L	41	34 U	19	455	20	3.9	6.9	1020.4	80	7.9	2.8	0.0
18	5458	93 12 06	12 39 04	12 45 03	144L	53	29 U	19	624	24	3.4	8.1	1015.2	60	8.0	2.4	0.0
19	5473	93 12 08	13 25 58	13 32 11	-171R	50	25 U	19	755	26	4.0	8.9	1016.7	62	7.8	2.6	0.0
20	5485	93 12 09	13 03 48	13 05 22	164L	86	52	27	84	8	5.0	8.0	1016.0	81	7.8	2.4	0.1
21	5496	93 12 17	12 54 25	12 55 35	154L	68	35	22	130	12	2.9	5.0	1016.0	58	7.8	2.8	-0.1
22	5503	93 12 21	12 45 12	12 49 33	149L	60	36 U	31	223	31	3.4	4.7	1006.9	52	8.0	2.3	-0.1
23	5519	93 12 27	13 26 30	13 31 58	-171R	50	25 U	26	83	8	7.0	6.8	1011.2	76	7.7	2.5	0.1

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Starlette

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	4956	93 01 05	15 33 35	15 41 20	-116R	61	20 U	19	794	26	6.2	4.3	1022.6	59	7.2	3.0	0.0
2	4959	93 01 07	14 23 16	14 31 07	224L	83	21 U	19	420	20	10.2	16.1	1004.2	82	7.2	3.2	0.1
3	4969	93 01 18	10 40 13	10 48 08	218L	72	20 U	19	720	26	6.1	6.6	1007.5	85	7.1	3.0	-0.1
4	4977	93 01 29	07 00 19	07 04 06 D	214L	65	58 U	30	217	14	6.2	9.4	1008.8	37	7.2	2.8	0.0
5	4982	93 01 29	14 18 15	14 25 54	-40R	62	20 U	20	1046	31	7.7	3.1	1010.4	59	7.3	3.0	0.0
6	4984	93 01 31	07 39 58	07 43 47 D	-98R	44	44 U	19	310	16	6.1	11.3	1007.7	36	7.3	2.8	0.1
7	4987	93 01 31	13 08 14	13 15 08	-30R	40	20 U	19	855	28	5.4	5.0	1006.9	63	7.4	2.9	0.1
8	4994	93 02 03	12 18 23	12 24 22	-33R	45	28 U	19	312	17	4.7	4.2	1015.2	62	7.3	2.9	0.1
9	5003	93 02 04	12 36 44	12 44 19	-46R	75	23 U	19	1267	31	7.8	8.2	1012.5	48	7.3	3.0	0.1
10	5014	93 02 05	05 39 33	05 42 34 D	-114R	60	55	22	343	17	7.0	14.3	1008.6	44	7.5	3.1	0.0
11	5017	93 02 05	11 07 26	11 13 23	-24R	31	20 U	19	680	25	6.0	10.4	1009.5	55	7.3	2.9	0.0
12	5019	93 02 05	12 56 10	13 03 20	-63L	56	22 U	20	598	23	7.6	9.1	1009.5	65	7.3	3.0	0.0
13	5029	93 02 08	10 16 18	10 22 40	-26R	34	19 U	19	666	24	6.5	4.1	1011.4	52	7.3	2.9	0.0
14	5038	93 02 09	10 35 22	10 42 57	-38R	55	20 U	19	1214	31	6.1	6.0	1008.8	50	7.3	2.9	0.0
15	5047	93 02 10	03 38 50	03 41 54 D	-129R	81	55	19	296	16	6.3	10.6	1011.0	36	7.2	2.9	0.0
16	5049	93 02 10	10 54 35	11 02 09	-51L	75	20 U	22	804	27	9.2	5.5	1011.9	53	7.2	3.1	0.0
17	5057	93 02 12	09 44 18	09 52 11	-41R	61	20 U	19	685	24	7.3	7.3	1010.1	49	7.4	3.0	0.0
18	5066	93 02 15	01 37 13	01 40 38 D	217L	72	56	19	201	13	5.6	10.9	1015.8	39	7.3	2.8	0.0
19	5068	93 02 15	08 53 59	09 01 19	-43R	66	25 U	19	576	23	5.5	9.6	1013.2	66	7.1	2.9	0.0
20	5080	93 02 18	00 47 00	00 49 37 D	221L	78	46	20	74	7	7.4	12.1	1011.2	47	7.3	3.3	0.0
21	5081	93 02 18	08 02 20	08 06 19 D	-46R	71	20 U	76	281	15	12.6	13.0	1009.5	51	7.2	2.9	0.0
22	5088	93 02 19	06 35 51	06 39 38 D	-24R	33	32 U	20	143	11	6.4	11.7	1012.1	42	7.2	2.9	0.0
23	5089	93 02 19	08 21 48	08 29 39 D	-58L	60	20 U	20	141	15	4.8	8.7	1013.4	51	7.3	2.9	0.0
24	5099	93 02 22	00 14 18	00 15 18 D	-112R	60	53	43	96	9	5.3	15.1	991.8	56	7.0	2.9	0.0
25	5100	93 02 22	05 43 57	05 48 53 D	-33R	36	31 U	20	207	13	7.1	17.6	990.5	43	7.3	2.8	0.0
26	5101	93 02 22	07 36 46	07 38 35 D	-61L	53	37	20	160	11	7.1	16.1	991.4	47	7.3	2.9	0.0
27	5104	93 02 23	00 32 31	00 37 06 D	-92R	40	40 U	19	234	14	5.1	6.0	997.0	40	7.3	2.8	0.0
28	5105	93 02 23	06 01 29	06 09 14 D	-38R	56	23 U	19	479	22	6.0	7.3	996.6	43	7.4	2.9	0.0
29	5116	93 02 24	06 20 58	06 24 14 D	-51L	80	25 U	77	149	11	4.5	7.1	1005.8	45	7.1	2.9	0.0
30	5150	93 03 02	02 51 23	02 56 50 D	-28R	33	29 U	18	212	14	6.3	7.5	1012.1	44	7.4	3.4	0.1
31	5151	93 03 02	04 45 35	04 47 12 D	-56L	70	32	18	58	7	8.1	9.0	1010.8	43	7.3	2.7	0.1
32	5178	93 03 04	18 38 23	18 43 42	176L	30	26 U	21	269	15	7.0	4.6	1014.1	70	7.0	3.3	0.1
33	5181	93 03 05	02 02 12	02 05 35 D	-28R	36	36 U	21	209	13	9.3	13.8	1017.5	58	6.8	2.7	0.1
34	5203	93 03 08	19 54 47	20 01 34	-93R	42	28 U	26	593	23	5.8	3.4	1014.1	62	6.6	3.4	0.2
35	5228	93 03 12	17 32 01	17 42 01	-128R	79	23 U	19	862	28	7.2	5.0	1004.9	55	7.2	3.2	0.2
36	5241	93 03 16	17 01 37	17 10 08	-102R	49	27 U	19	665	24	7.0	2.6	1005.3	60	7.7	3.3	0.1
37	5260	93 04 08	09 57 08	09 59 43	270R	36	31 U	26	140	11	7.2	9.1	1008.4	51	7.8	*	*
38	5264	93 04 12	14 53 53	15 01 52	310L	79	17 U	31	641	24	6.7	8.0	1018.2	60	7.8	*	*
39	5299	93 06 05	12 58 11	13 06 07	208L	59	32 U	19	570	22	4.7	16.3	997.9	78	7.9	*	*
40	5301	93 06 06	13 17 22	13 20 27	-130R	84	34 U	82	250	15	3.9	16.4	1003.4	87	7.9	*	*
41	5305	93 06 14	17 48 02	17 54 26	-46R	77	42 U	19	528	22	6.3	23.3	998.1	95	7.8	*	*
42	5306	93 06 15	10 45 15	10 50 47	-118R	66	44 U	33	329	17	5.2	24.9	995.7	89	8.0	*	*
43	5310	93 06 16	11 02 50	11 11 33	-97R	44	22 U	20	521	21	6.2	24.4	997.7	79	8.0	*	*
44	5314	93 07 05	11 49 22	11 52 43	-62L	54	27	53	142	11	5.9	21.5	996.8	92	8.1	*	*
45	5323	93 08 19	12 26 38	12 29 22	209L	58	53 U	37	45	7	5.8	25.1	1008.0	93	8.1	*	*
46	5324	93 08 20	12 44 51	12 46 36	-125R	77	43 U	76	51	9	4.9	23.7	1007.7	94	8.0	*	*
47	5328	93 08 24	12 14 26	12 18 40	-96R	41	38 U	20	219	15	4.0	24.7	1003.6	95	8.0	*	*
48	5336	93 08 27	11 23 41	11 25 18	-92R	37	36 U	35	122	10	5.5	26.4	990.9	82	7.8	*	*
49	5350	93 09 09	13 48 56	13 52 56	-58L	63	28 U	51	157	12	11.9	23.1	1002.5	94	8.0	*	*
50	5356	93 09 11	12 37 45	12 43 01	-46R	79	20 U	51	430	20	3.8	21.4	1008.8	90	8.2	*	*

Table 7. Observations and data fitting by JHDLRS-1

Satellite:Starlette (continued)

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
51	5360	93 09 14	11 46 46	11 53 04	-49R	88	20 U	36	424	19	3.5	21.6	1006.2	95	8.0	*	*
52	5391	93 10 25	14 43 09	14 49 47	223L	83	48 U	23	479	21	4.1	12.1	1011.2	77	7.8	2.2	0.0
53	5399	93 11 01	11 30 48	11 37 11	185L	37	24 U	21	214	13	4.3	13.5	1016.9	66	7.8	2.6	0.1
54	5409	93 11 04	10 40 46	10 46 01	190L	40	32 U	23	524	22	3.5	16.9	1013.0	89	7.9	2.7	0.1
55	5410	93 11 04	12 31 52	12 36 17	-101R	47	47	19	533	21	4.3	16.2	1013.0	89	7.9	2.5	0.1
56	5416	93 11 04	18 01 20	18 08 41	-37R	50	30 U	24	499	21	4.0	15.5	1011.7	87	7.9	2.5	0.1
57	5419	93 11 05	11 03 41	11 06 11	217L	73	47	21	166	12	3.9	15.3	1012.5	90	7.8	2.8	0.1
58	5444	93 11 24	13 35 32	13 40 43	-74L	36	34 U	20	307	16	4.5	4.8	1019.9	67	7.9	3.0	0.0
59	5467	93 12 08	08 59 11	09 06 12	-77L	34	20 U	18	763	26	3.7	10.4	1014.9	85	7.9	2.6	0.0

Table 7. Observations and data fitting by JHDLRS-1

Satellite:TOPEX

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	4950	93 01 05	06 07 21	06 13 04 D	-135R	59	59	20	754	26	6.0	10.9	1017.3	41	7.2	2.9	0.1
2	4955	93 01 05	14 01 44	14 11 45	-4R	36	20	U 19	1546	31	7.3	4.2	1022.8	62	7.2	3.0	0.0
3	4957	93 01 05	15 57 18	16 07 52	-47L	44	20	U 20	804	27	6.6	4.0	1022.3	60	7.7	3.1	0.1
4	4960	93 01 07	14 54 10	14 58 05	-28R	86	57	21	230	14	7.1	16.1	1004.9	75	7.2	3.2	0.1
5	4966	93 01 12	02 56 59	03 02 35 D	155L	31	29	U 19	476	21	5.7	12.3	1014.5	57	7.3	2.8	0.0
6	4967	93 01 12	04 55 08	04 59 29 D	-130R	50	47	20	357	18	6.9	13.3	1014.1	59	7.3	2.8	0.0
7	4968	93 01 12	14 46 29	14 53 27	-49L	38	31	U 22	305	16	6.0	6.9	1016.5	89	7.3	3.0	0.0
8	4971	93 01 18	13 12 08	13 19 16	-41L	54	51	U 18	99	9	13.0	5.3	1007.5	78	7.0	3.1	0.0
9	4978	93 01 29	09 32 51	09 44 07	-13R	49	20	U 20	945	29	6.7	5.3	1010.6	48	7.0	2.9	0.1
10	4980	93 01 29	11 29 49	11 38 17	-58L	31	20	U 20	285	15	10.0	3.2	1010.6	60	7.2	2.9	0.1
11	4985	93 01 31	10 18 02	10 29 38	-36L	63	21	U 20	1676	31	4.7	6.6	1008.6	54	7.4	2.9	0.1
12	4990	93 02 02	01 11 19	01 18 16 D	-101R	32	27	U 20	494	21	6.0	5.5	1011.4	57	7.3	3.2	0.0
13	4991	93 02 02	09 09 23	09 17 12	-20R	68	35	U 33	862	28	6.6	2.6	1016.2	53	7.4	2.7	0.0
14	4993	93 02 03	09 29 44	09 40 25	-32L	75	20	U 29	1821	31	5.1	6.9	1015.6	50	7.3	2.9	0.1
15	5000	93 02 04	07 58 26	08 07 09 D	-2R	36	25	U 20	912	29	6.3	12.4	1010.1	40	7.4	2.9	0.0
16	5001	93 02 04	09 52 45	10 03 37	-45L	45	19	U 19	1551	31	6.1	9.4	1011.7	44	7.3	2.9	0.0
17	5009	93 02 05	00 21 10	00 30 38 D	-112R	37	22	U 20	1401	31	6.0	10.0	1013.6	42	7.4	3.1	0.0
18	5015	93 02 05	08 19 12	08 31 10 D	-16R	58	20	U 19	2044	31	5.4	12.0	1009.0	50	7.3	2.8	0.0
19	5026	93 02 08	07 32 31	07 42 52 D	-12R	50	26	U 19	1571	31	5.6	8.0	1009.5	38	7.5	2.9	0.0
20	5028	93 02 08	09 28 15	09 36 48	-54L	31	20	U 20	891	29	5.9	4.6	1011.2	54	7.3	2.9	0.0
21	5036	93 02 09	07 53 36	08 05 52 D	-24R	79	20	U 19	1135	31	6.5	8.6	1007.1	44	7.4	2.8	0.0
22	5048	93 02 10	08 16 40	08 28 03 D	-37L	63	22	U 20	1221	31	6.0	9.2	1010.8	44	7.2	2.9	0.0
23	5067	93 02 15	06 17 48	06 29 26 D	-17R	58	20	U 20	832	28	5.3	13.0	1012.1	48	7.3	2.9	-0.1
24	5086	93 02 18	20 00 44	20 08 34	188L	62	51	U 20	1261	31	7.3	5.7	1012.3	59	7.2	3.1	-0.1
25	5115	93 02 24	03 56 20	04 04 08 D	-3R	36	29	U 20	659	24	8.1	8.0	1005.8	50	7.2	2.9	0.0
26	5134	93 02 25	18 45 29	18 55 14	195L	74	37	U 19	632	24	5.7	0.8	1014.3	74	7.4	3.1	0.0
27	5148	93 03 01	18 27 37	18 29 42	-150R	79	35	20	208	13	6.5	1.6	1008.6	57	7.2	3.2	0.1
28	5160	93 03 02	16 49 20	16 54 59	154L	31	29	U 20	519	21	7.3	1.0	1014.7	67	7.2	3.1	0.1
29	5176	93 03 04	17 30 45	17 41 33	202L	82	27	U 21	415	19	9.0	4.9	1013.6	70	7.1	3.2	0.1
30	5182	93 03 05	03 27 14	03 30 46 D	-32L	74	33	72	393	18	6.8	14.5	1016.9	58	6.9	2.7	0.1
31	5191	93 03 05	17 52 26	18 04 16	-135R	59	20	U 19	1654	31	5.6	7.1	1015.8	86	7.2	3.2	0.1
32	5201	93 03 08	17 07 14	17 16 19	-142R	69	42	U 20	1028	31	6.4	4.0	1013.4	61	6.7	3.3	0.2
33	5205	93 03 09	03 00 05	03 03 34 D	-42L	53	20	U 43	90	9	7.1	11.4	1014.9	55	7.2	3.6	0.2
34	5239	93 03 16	14 25 05	14 29 10	171L	44	41	19	353	17	9.1	3.1	1005.3	58	7.8	3.2	0.2
35	5244	93 03 17	00 13 36	00 19 29 D	-16R	58	21	U 58	732	26	6.1	7.1	1005.6	49	8.0	3.6	0.2
36	5247	93 03 17	14 40 39	14 52 17	195L	74	23	U 19	777	26	6.2	3.7	1006.4	64	7.9	3.3	0.1
37	5250	93 03 19	00 58 59	01 10 06 D	-41L	53	22	U 19	541	22	7.1	12.1	1012.1	50	7.8	3.3	0.1
38	5254	93 03 23	00 39 43	00 43 39 D	-51L	37	36	19	130	10	10.0	14.6	1013.6	63	8.4	2.9	0.0
39	5265	93 04 13	09 28 06	09 36 04 D	200L	86	58	U 15	406	18	10.1	12.8	1016.0	47	7.8	*	*
40	5267	93 04 14	09 50 46	09 56 21	230R	59	47	U 28	280	16	4.4	14.5	1013.4	55	8.0	*	*
41	5270	93 05 10	14 11 23	14 14 54	-37L	64	42	15	366	18	9.9	15.0	994.0	77	7.8	*	*
42	5271	93 05 11	14 28 33	14 34 59	-52L	37	25	U 21	592	23	5.6	16.2	1007.7	79	7.6	*	*
43	5275	93 05 14	13 39 53	13 48 43	-46L	45	25	U 16	394	19	6.3	13.7	1004.0	71	8.0	*	*
44	5278	93 05 20	12 03 50	12 12 45	-37L	64	30	U 19	769	27	4.2	21.0	1003.4	61	8.2	*	*
45	5281	93 05 21	10 29 43	10 39 23	-8R	43	20	U 16	1060	31	5.6	18.4	1006.0	89	8.3	*	*
46	5285	93 05 27	10 50 28	10 52 42	-41L	54	29	U 45	174	12	5.1	18.8	999.9	86	8.0	*	*
47	5289	93 05 28	11 11 57	11 20 49	-58L	31	15	U 14	1012	31	5.6	17.7	998.4	76	7.6	*	*
48	5317	93 07 05	16 50 01	16 58 34	-143R	69	47	U 20	392	20	7.1	21.2	998.6	93	7.9	*	*
49	5318	93 07 13	14 07 49	14 11 29	171L	44	39	19	368	18	7.5	25.9	995.5	92	7.7	*	*
50	5330	93 08 25	05 11 50	05 17 02 D	163L	37	37	U 20	282	16	8.6	27.7	1001.4	85	8.0	*	*

Table 7.Observations and data fitting by JHDLRS-1

Satellite:TOPEX (continued)

(1)	(2)	(3) Obs. Time(UTC)			(4)	(5) Elev			(6)	(7)		(8)	(9)	(10)	(11)	(12)	(13)
	No.	date	caught	lost	Azst	MX	CT	LT	RTN	N	RMS	TMP	PRESS	HUM	IDT	DTS	DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
51	5345	93 08 31	13 28 37	13 36 05	-4R	36	30 U	20	477	20	6.9	24.0	1005.6	94	7.6	*	*
52	5349	93 09 09	12 57 45	13 08 07	-32L	75	23 U	27	1199	31	8.5	23.6	1002.1	91	8.1	*	*
53	5353	93 09 10	13 27 19	13 28 32	-46L	45	40	33	42	6	4.6	21.6	1004.8	90	8.2	*	*
54	5359	93 09 14	11 02 06	11 08 23	-12R	50	39 U	30	319	16	4.1	22.5	1005.8	87	8.2	*	*
55	5363	93 09 16	01 54 30	01 56 34 D	-150R	81	79	51	184	12	3.4	25.4	1008.8	84	8.2	*	*
56	5393	93 10 27	02 05 08	02 15 51 D	-8R	43	20 U	19	1358	31	4.2	17.9	1021.3	51	8.0	2.2	0.0
57	5435	93 11 22	10 54 45	11 03 50	163L	37	23 U	19	865	29	5.6	8.0	1011.4	81	7.8	2.7	-0.1
58	5438	93 11 22	12 50 48	13 00 05	-120R	43	27 U	19	1391	31	4.0	7.7	1012.3	80	8.0	2.6	0.0
59	5441	93 11 24	11 38 48	11 43 27	-150R	81	26	79	906	28	3.4	4.0	1019.5	78	8.0	2.9	0.0
60	5446	93 11 25	10 06 58	10 13 47	153L	31	20 U	25	712	25	4.1	7.3	1019.9	79	7.9	2.8	0.0
61	5448	93 11 25	12 02 28	12 06 07	-128R	51	29 U	50	418	19	4.6	6.8	1020.4	80	8.0	2.9	0.0
62	5453	93 12 02	08 52 29	09 02 33	163L	37	19 U	19	1232	31	4.1	14.3	1009.8	88	8.1	2.5	0.0
63	5468	93 12 08	09 12 36	09 22 58	-135R	59	29 U	19	1478	31	3.6	10.3	1015.2	86	8.0	2.6	0.0
64	5476	93 12 08	17 12 15	17 21 23	-4R	36	23 U	20	1176	31	3.9	4.9	1016.7	87	8.0	2.3	0.0
65	5477	93 12 08	19 10 29	19 17 49	-46L	45	39 U	19	970	29	4.1	6.9	1016.2	73	7.9	2.3	0.1
66	5479	93 12 09	07 39 16	07 49 28 D	172L	44	23 U	19	1053	30	4.2	12.3	1016.0	67	8.0	2.7	0.0
67	5482	93 12 09	09 36 32	09 41 57	-111R	37	27 U	32	349	17	4.0	8.5	1016.5	85	7.9	2.4	-0.1

Table 8. Observations and data fitting by HTLRS

Explanation

Column

1	Serial number of passes ranged successfully for each satellite.
2	Serial number of passes ranged successfully from the beginning of SLR observation by HTLRS at Hatizyo Sima.
3	Observation time (UTC) of the first return and the last return observed in the satellite pass.
4	Azimuth when the tracking of the satellite started at 20 degrees of elevation.
5	Elevations at the maximum, at the first return obtained and at the last return obtained in the satellite path. U means that the data are obtained through the maximum elevation.
6	Number of successful returns from the satellite in the pass.
7	Order of the polynomials applied and the root mean square deviation of the curve fitting to the measured range.
8	Atmospheric temperature (degree centigrade)
9	Atmospheric pressure (hecto pascal).
10	Relative humidity (%).
11	Calibrated internal delay time of the SLR system obtained by the ground target ranging. The light velocity change in the air (Abshire, 1980) is used for the atmospheric correction. This term is corrected for the range data in the final MT file, FR data.
12	Time correction: Transmitting time of GPS minus time of the clock used in the SLR system. This term is corrected for the transmitted time in the final MT file.
13	Time correction: UTC (USNO MC) minus transmitting time of GPS (USNO, 1993). This term is corrected for the transmitted time in the final MT file.

Table 8. Observations and data fitting by HTLRS at Hatizyo sima

Satellite:Ajisai

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	1	93 02 05	19 52 00	20 01 36	250R	61	40	U 22	25	7	40.8	15.3	988.8	67	50.7	-2.5	0.0
2	2	93 02 08	17 15 17	17 16 41	190L	44	39	32	13	7	3.7	7.8	989.3	59	50.7	-1.7	0.0
3	3	93 02 08	19 12 33	19 13 20	250R	57	45	51	48	7	3.1	7.3	989.2	56	50.7	-1.4	0.0
4	4	93 02 09	18 14 49	18 25 26	230R	79	25	U 33	326	21	4.1	8.4	988.2	53	50.8	-1.8	0.0
5	5	93 02 15	14 55 23	15 00 57	170L	33	27	U 29	28	13	3.2	10.6	992.8	58	50.6	-1.8	0.0
6	7	93 02 15	16 53 48	17 05 51	240R	70	24	U 24	504	21	4.1	10.5	992.5	71	50.6	-1.4	-0.2
7	8	93 02 15	19 00 04	19 06 40	300R	30	25	U 24	84	9	3.2	10.5	993.1	76	50.7	-1.2	0.0
8	9	93 02 17	15 06 15	15 17 56	200L	57	25	U 21	375	21	4.3	13.8	982.2	70	50.6	-2.2	-0.1
9	11	93 02 17	17 08 21	17 19 02	260R	48	24	U 24	217	21	3.7	12.2	983.7	79	50.7	-1.8	0.0
10	12	93 02 17	19 17 58	19 20 43	320R	26	26	22	16	7	2.5	11.5	985.5	70	50.6	-1.8	0.0
11	15	93 02 18	20 25 34	20 29 51	330R	29	27	U 25	62	11	2.7	9.9	989.4	65	50.6	-1.6	0.0
12	16	93 02 19	15 19 38	15 29 17	230L	89	27	U 38	199	21	4.1	7.5	991.3	66	50.6	-2.2	-0.1
13	17	93 02 19	17 25 34	17 31 01	290R	35	31	U 29	74	17	3.8	7.3	991.1	74	50.6	-1.9	-0.1
14	18	93 02 19	19 33 40	19 34 39	330R	26	25	24	7	5	3.3	8.1	991.8	65	50.6	-1.9	-0.1
15	19	93 02 23	13 45 59	13 54 30	210L	67	32	U 38	128	20	3.1	6.6	978.7	53	50.7	-1.8	0.0
16	20	93 02 23	15 52 15	15 56 08	270R	43	42	U 33	120	15	4.5	6.3	979.7	49	50.6	-1.8	0.0
17	21	93 02 23	17 55 22	18 00 18	320R	26	25	U 22	11	4	14.7	6.6	980.3	48	50.7	-2.5	0.0
18	22	93 02 24	12 53 07	12 58 13	190L	44	31	U 41	88	20	5.7	7.3	985.3	40	50.7	-1.7	-0.1
19	24	93 02 24	14 54 10	15 04 34	250R	57	32	U 22	482	31	3.3	6.2	986.0	42	50.7	-1.6	0.0
20	27	93 02 25	18 10 14	18 15 02	330R	27	26	U 22	31	7	4.0	9.1	990.4	33	50.8	-1.8	0.0
21	29	93 03 01	12 23 30	12 26 57	220L	78	23	51	15	5	3.5	9.7	983.7	54	50.7	-1.8	0.1
22	30	93 03 02	19 47 35	19 54 04	310R	81	66	U 30	158	16	4.7	9.1	993.2	47	50.8	1.8	0.0
23	31	93 03 03	12 41 39	12 44 01	240R	69	59	U 67	5	3	0.5	11.0	992.1	53	50.8	-1.8	0.1
24	33	93 03 05	10 49 41	10 58 16	200L	57	25	U 41	402	23	4.0	11.5	998.2	63	50.9	-15.0	0.0
25	34	93 03 05	12 51 32	13 02 31	260R	48	22	U 24	648	31	3.4	12.5	998.2	64	50.8	-1.8	0.1
26	35	93 03 05	14 59 12	15 04 29	320R	27	25	U 22	110	20	3.4	10.9	997.1	69	50.8	-1.5	0.0
27	38	93 03 05	17 01 46	17 08 12	330R	34	25	U 30	109	15	12.6	10.6	996.0	81	50.8	-1.8	0.1
28	41	93 03 05	19 02 34	19 15 07	310R	87	25	U 21	714	31	3.7	11.7	995.8	79	50.8	-1.8	0.1
29	42	93 03 10	10 24 33	10 33 10	230R	84	42	U 31	83	20	5.0	9.7	988.3	68	50.9	-3.3	0.2
30	43	93 03 10	12 29 02	12 31 08	290R	34	31	U 34	26	10	5.2	10.1	989.0	60	50.8	-1.8	0.2
31	44	93 03 10	14 34 07	14 38 08	330R	27	26	U 24	31	23	1.5	9.9	989.1	51	50.8	-1.7	0.0
32	46	93 03 10	16 36 16	16 44 34	320R	49	36	U 26	66	31	6.5	7.3	989.1	72	50.8	-2.3	0.0
33	47	93 03 10	18 43 39	18 44 09	300L	55	46	43	8	4	4.7	9.2	989.4	61	50.8	-1.8	0.2
34	48	93 03 11	17 50 24	17 51 07	310L	81	50	43	4	3	0.0	9.1	986.7	80	51.0	-1.8	0.2

Table 8. Observations and data fitting by HTLRS at Hatizyo sima

Satellite:Lageos-I

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	6	93 02 15	15 44 10	15 44 25	30R	79	24	24	4	2	6.3	10.2	992.8	59	50.4	-1.8	0.0
2	10	93 02 17	16 10 51	16 14 18	20L	79	78	71	13	5	8.1	12.8	983.3	75	50.4	-1.7	0.0
3	23	93 02 24	13 31 49	13 46 31	40R	48	43 U	43	12	10	3.7	6.5	985.5	35	50.5	-1.7	0.0
4	36	93 03 05	15 36 51	15 44 18	20L	78	64	42	39	10	4.9	9.6	995.8	84	50.6	-1.8	0.1

Table 8. Observations and data fitting by HTLRS at Hatizyo sima

Satellite:Lageos-II

(1)	(2)	(3) Obs. Time(UTC)			(4)	(5) Elev			(6)	(7)		(8)	(9)	(10)	(11)	(12)	(13)
	No.	date	caught	lost	Azst	MX	CT	LT	RTN	N	RMS	TMP	PRESS	HUM	IDT	DTS	DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	13	93 02 18	13 37 39	13 40 33	290R	51	40	36	14	7	9.1	9.9	990.1	77	50.3	-1.9	-0.1
2	39	93 03 05	17 34 47	17 37 47	310L	60	36	31	5	3	1.1	11.0	996.0	80	50.7	-1.8	0.2

Table 8. Observations and data fitting by HTLRS at Hatizyo sima

Satellite:TOPEX

(1)	(2) No.	(3) Obs. Time(UTC) date	caught	lost	(4) Azst	(5) Elev MX	CT	LT	(6) RTN	(7) N	RMS	(8) TMP	(9) PRESS	(10) HUM	(11) IDT	(12) DTS	(13) DTG
		Y M D	h m s	h m s	°	°	°	°			cm	℃	hPa	%	ns	μs	μs
1	14	93 02 18	19 58 32	20 07 10	200L	79	31	U 32	248	21	3.6	10.4	989.7	63	50.6	-1.6	0.1
2	25	93 02 24	18 24 22	18 27 26	180L	57	42	U 56	263	31	2.7	6.5	986.4	41	50.7	-1.2	0.0
3	26	93 02 24	20 23 56	20 25 35	270R	29	29	25	86	12	4.8	7.4	982.0	43	50.8	-0.9	0.0
4	28	93 02 25	18 46 44	18 53 35	210R	87	48	U 33	241	20	4.3	8.5	990.3	38	50.8	-1.8	0.0
5	32	93 03 03	17 12 32	17 13 51	190L	68	63	U 67	27	10	6.7	10.2	990.6	54	50.8	-1.8	0.1
6	37	93 03 05	15 59 38	16 07 34	150L	33	24	U 20	351	31	3.5	9.9	996.4	84	50.9	-1.8	0.1
7	40	93 03 05	17 53 45	18 04 09	240R	47	22	U 20	1035	31	3.7	10.8	995.8	81	50.8	-1.8	0.2
8	45	93 03 10	15 56 12	16 03 41	200L	79	36	U 36	263	31	6.2	8.8	989.2	64	50.8	-2.0	0.0

PHOTOGRAPHIC DIRECTION OBSERVATIONS OF AJISAI IN 1993

Summary - Photographic direction observations of Ajisai by satellite cameras at Hatizyo Sima and the Simosato Hydrographic Observatory(SHO) were made in 1993. 5 photographs were taken by the fixed satellite camera at SHO, while 1 by the transportable camera at Hatizyo Sima.

Key words : satellite camera-Ajisai-photographic direction observation

1. Observation

Photographic direction observations of Ajisai by satellite cameras at Hatizyo Sima and the Simosato Hydrographic Observatory(SHO) were made in 1993. The fixed type satellite camera at the SHO is an astronomical telescope with a plate holder controlled by a personal computer (Kanazawa, 1989). The transportable camera is an astronomical telescope with a manually controlled plate holder. The plates used in these observations were Kodak professional plates Type TMAX100.

The observation schedule was determined by considering the status of flashing, the elevation of the satellite, its distance from the Moon and the possibility of common view. Each plate was exposed 10 seconds and about 30 flashes of the satellite were taken together with the image of the stars.

2. Directional data of Ajisai's flash

The positions of images on the developed photographic plates were measured with a comparator by a contractor. The positional data of flashes and star images were converted into right ascension and declination by the Satellite Data Analysis Computer System (Nagamori, 1989). The star catalogue used for this computation is the SAO. This computation were based on J2000.

The observed and computed data are shown in Table 1. Right ascension and declination are described in apparent places. Note that a correction of atmospheric reflection is not applied and the direction of Ajisai's flash is sightly different from the direction of the center of Ajisai.

Table 1. Directional data of Ajisai's flashes

Explanation

Column

1 Serial number,

2 Observation date,

3 Observation time (UTC, Epoch of the exposure),

4 R. a. (right-ascension) of satellite flash,

5 Decl. (declination) of satellite flash,

6 Stn (Station ID);

- 7838: The Simosato Hydrographic Observatory,
- 7309: Hatizyo Sima,

7 Meteorological data;

- tmp : Atmospheric temperature (degree centigrade),
- hum : Relative humidity (%),
- press : Atmospheric pressure (hecto pascal).

Table 1. Directional data of Ajisai's flashes

(1) No.	(2) date			(3) time			(4) R.A.			(5) Decl.				(6) Stn	(7) tmp	hum	press
	Y	M	D	h	m	s	h	m	s		°	′	″	ID	℃	%	hPa
1	93	2	9	18	23		15	26	23.0	+	57	17	13.8	7309	10.6	58.0	992.8
2	93	2	9	18	23		15	25	3.9	+	57	15	7.3	7309	10.6	58.0	992.8
3	93	2	9	18	23		15	24	28.6	+	57	14	9.1	7309	10.6	58.0	992.8
4	93	2	9	18	23		15	23	58.1	+	57	13	16.1	7309	10.6	58.0	992.8
5	93	2	9	18	23		15	22	38.8	+	57	11	3.1	7309	10.6	58.0	992.8
6	93	2	9	18	23		15	22	3.6	+	57	10	1.5	7309	10.6	58.0	992.8
7	93	2	9	18	23		15	21	32.8	+	57	9	11.4	7309	10.6	58.0	992.8
8	93	2	9	18	23		15	20	13.1	+	57	6	47.7	7309	10.6	58.0	992.8
9	93	2	9	18	23		15	19	37.9	+	57	5	47.1	7309	10.6	58.0	992.8
10	93	2	9	18	23		15	19	7.0	+	57	4	48.6	7309	10.6	58.0	992.8
11	93	2	9	18	23		15	17	47.6	+	57	2	24.3	7309	10.6	58.0	992.8
12	93	2	9	18	23		15	17	12.0	+	57	1	17.6	7309	10.6	58.0	992.8
13	93	2	9	18	23		15	16	41.5	+	57	0	18.1	7309	10.6	58.0	992.8
14	93	2	9	18	23		15	15	21.8	+	56	57	48.9	7309	10.6	58.0	992.8
15	93	2	9	18	23		15	14	46.1	+	56	56	38.1	7309	10.6	58.0	992.8
16	93	2	9	18	23		15	14	15.5	+	56	55	38.2	7309	10.6	58.0	992.8
17	93	2	9	18	23		15	12	55.8	+	56	52	59.0	7309	10.6	58.0	992.8
18	93	2	9	18	23		15	12	20.7	+	56	51	46.2	7309	10.6	58.0	992.8
19	93	2	9	18	23		15	11	49.7	+	56	50	47.1	7309	10.6	58.0	992.8
20	93	2	9	18	23		15	10	30.3	+	56	48	2.1	7309	10.6	58.0	992.8
21	93	2	9	18	23		15	9	55.4	+	56	46	47.2	7309	10.6	58.0	992.8
22	93	2	9	18	23		15	9	24.7	+	56	45	37.3	7309	10.6	58.0	992.8
23	93	2	25	20	16		25	16	30.7	+	3	48	28.9	7838	0.8	71.0	1014.5
24	93	2	25	20	16		25	17	23.9	+	3	32	44.2	7838	0.8	71.0	1014.5
25	93	2	25	20	16		25	18	40.6	+	3	10	1.2	7838	0.8	71.0	1014.5
26	93	2	25	20	16		25	19	15.2	+	2	59	41.2	7838	0.8	71.0	1014.5
27	93	2	25	20	16		25	19	41.3	+	2	51	46.3	7838	0.8	71.0	1014.5
28	93	2	25	20	16		25	20	50.1	+	2	30	59.9	7838	0.8	71.0	1014.5
29	93	2	25	20	16		25	21	8.5	+	2	25	20.6	7838	0.8	71.0	1014.5
30	93	2	25	20	16		25	21	34.7	+	2	17	7.9	7838	0.8	71.0	1014.5
31	93	2	25	20	16		25	21	47.4	+	2	13	6.5	7838	0.8	71.0	1014.5
32	93	2	25	20	16		25	22	13.3	+	2	4	34.9	7838	0.8	71.0	1014.5
33	93	2	25	20	16		25	22	19.5	+	2	2	22.7	7838	0.8	71.0	1014.5
34	93	2	25	20	16		25	22	24.2	+	2	0	35.4	7838	0.8	71.0	1014.5
35	93	2	25	20	16		25	22	30.2	+	1	58	4.3	7838	0.8	71.0	1014.5
36	93	2	25	20	16		25	22	31.7	+	1	57	10.3	7838	0.8	71.0	1014.5
37	93	2	25	20	16		25	22	32.3	+	1	56	31.0	7838	0.8	71.0	1014.5
38	93	2	25	20	16		25	22	30.0	+	1	56	13.9	7838	0.8	71.0	1014.5
39	93	3	2	19	49		17	16	49.1	+	35	59	2.7	7838	2.5	62.0	1014.9
40	93	3	2	19	49		17	17	4.5	+	35	54	40.4	7838	2.5	62.0	1014.9
41	93	3	2	19	49		17	17	31.3	+	35	46	51.1	7838	2.5	62.0	1014.9
42	93	3	2	19	49		17	17	58.1	+	35	39	47.8	7838	2.5	62.0	1014.9
43	93	3	2	19	49		17	18	13.9	+	35	35	2.3	7838	2.5	62.0	1014.9
44	93	3	2	19	49		17	18	41.0	+	35	27	23.2	7838	2.5	62.0	1014.9
45	93	3	2	19	49		17	19	7.8	+	35	19	59.4	7838	2.5	62.0	1014.9
46	93	3	2	19	49		17	19	22.9	+	35	15	44.2	7838	2.5	62.0	1014.9
47	93	3	2	19	49		17	19	50.9	+	35	7	58.4	7838	2.5	62.0	1014.9
48	93	3	2	19	49		17	20	16.4	+	35	0	39.3	7838	2.5	62.0	1014.9
49	93	3	2	19	49		17	20	31.1	+	34	56	13.6	7838	2.5	62.0	1014.9
50	93	3	2	19	49		17	20	58.9	+	34	48	22.2	7838	2.5	62.0	1014.9

Table 1. Directional data of Ajisai's flashes (continued)

(1) No.	(2) date			(3) time			(4) R.A.			(5) Decl.				(6) Stn	(7) tmp	hum	press
	Y	M	D	h	m	s	h	m	s		°	′	″	ID	℃	%	hPa
51	93	3	2	19	49		17	21	30.7	+	34	39	12.2	7838	2.5	62.0	1014.9
52	93	3	2	19	49		17	21	44.7	+	34	35	19.2	7838	2.5	62.0	1014.9
53	93	3	2	19	49		17	22	6.6	+	34	28	49.7	7838	2.5	62.0	1014.9
54	93	3	2	19	49		17	22	38.2	+	34	19	43.7	7838	2.5	62.0	1014.9
55	93	3	2	19	49		17	22	50.9	+	34	15	49.9	7838	2.5	62.0	1014.9
56	93	3	2	19	49		17	23	13.0	+	34	9	24.5	7838	2.5	62.0	1014.9
57	93	3	4	18	0		18	16	51.5	+	61	20	18.35	7838	4.8	70.0	1013.6
58	93	3	4	18	0		18	17	5.6	+	61	12	1.428	7838	4.8	70.0	1013.6
59	93	3	4	18	0		18	17	16.7	+	61	5	59.09	7838	4.8	70.0	1013.6
60	93	3	4	18	0		18	17	34.0	+	60	53	42.33	7838	4.8	70.0	1013.6
61	93	3	4	18	0		18	17	49.6	+	60	43	52.89	7838	4.8	70.0	1013.6
62	93	3	4	18	0		18	18	0.7	+	60	35	35.38	7838	4.8	70.0	1013.6
63	93	3	4	18	0		18	18	11.5	+	60	29	37.38	7838	4.8	70.0	1013.6
64	93	3	4	18	0		18	18	17.2	+	60	25	56.05	7838	4.8	70.0	1013.6
65	93	3	4	18	0		18	18	30.0	+	60	17	38.42	7838	4.8	70.0	1013.6
66	93	3	4	18	0		18	18	38.4	+	60	11	33.18	7838	4.8	70.0	1013.6
67	93	3	4	18	0		18	18	44.7	+	60	7	45.02	7838	4.8	70.0	1013.6
68	93	3	4	18	0		18	18	57.1	+	59	59	28.59	7838	4.8	70.0	1013.6
69	93	3	4	18	0		18	19	6.7	+	59	53	33.92	7838	4.8	70.0	1013.6
70	93	3	4	18	0		18	19	11.7	+	59	49	35.46	7838	4.8	70.0	1013.6
71	93	3	4	18	0		18	19	23.8	+	59	41	20.23	7838	4.8	70.0	1013.6
72	93	3	4	20	3		16	8	34.4	+	9	57	50.32	7838	4.3	71.0	1015.1
73	93	3	4	20	3		16	8	50.6	+	9	54	7.939	7838	4.3	71.0	1015.1
74	93	3	4	20	3		16	9	12.7	+	9	48	42.74	7838	4.3	71.0	1015.1
75	93	3	4	20	3		16	9	42.4	+	9	41	27.34	7838	4.3	71.0	1015.1
76	93	3	4	20	3		16	9	58.3	+	9	37	36.69	7838	4.3	71.0	1015.1
77	93	3	4	20	3		16	10	20.1	+	9	32	7.249	7838	4.3	71.0	1015.1
78	93	3	4	20	3		16	10	50.6	+	9	24	58.67	7838	4.3	71.0	1015.1
79	93	3	4	20	3		16	11	5.9	+	9	21	22.55	7838	4.3	71.0	1015.1
80	93	3	4	20	3		16	11	28.6	+	9	15	57.51	7838	4.3	71.0	1015.1
81	93	3	4	20	3		16	11	55.3	+	9	9	18.33	7838	4.3	71.0	1015.1
82	93	3	4	20	3		16	12	13.0	+	9	4	55.31	7838	4.3	71.0	1015.1
83	93	3	4	20	3		16	12	35.8	+	8	59	39.95	7838	4.3	71.0	1015.1
84	93	3	4	20	3		16	13	4.8	+	8	52	31.26	7838	4.3	71.0	1015.1
85	93	3	4	20	3		16	13	42.5	+	8	43	29.17	7838	4.3	71.0	1015.1
86	93	3	4	20	3		16	13	54.1	+	8	40	30.01	7838	4.3	71.0	1015.1
87	93	3	4	20	3		16	14	17.1	+	8	35	2.400	7838	4.3	71.0	1015.1
88	93	3	4	20	3		16	14	26.8	+	8	32	35.94	7838	4.3	71.0	1015.1
89	93	3	8	12	15		5	12	28.9	+	49	59	29.85	7838	4.5	59.0	1013.0
90	93	3	8	12	15		5	12	7.1	+	49	49	41.06	7838	4.5	59.0	1013.0
91	93	3	8	12	15		5	11	28.4	+	49	34	43.84	7838	4.5	59.0	1013.0
92	93	3	8	12	15		5	11	17.8	+	49	30	22.05	7838	4.5	59.0	1013.0
93	93	3	8	12	15		5	10	55.4	+	49	22	1.372	7838	4.5	59.0	1013.0
94	93	3	8	12	15		5	10	39.5	+	49	15	25.93	7838	4.5	59.0	1013.0
95	93	3	8	12	15		5	10	6.6	+	49	2	43.34	7838	4.5	59.0	1013.0
96	93	3	8	12	15		5	9	50.3	+	48	56	17.77	7838	4.5	59.0	1013.0
97	93	3	8	12	15		5	9	39.5	+	48	52	5.84	7838	4.5	59.0	1013.0

The computer programs were made by K. Asai and the data analysis were made by H. Noda of the Satellite Geodesy Office. This report was written by H. Noda.

References

Kanazawa, T., 1989: *The new satellite camera for geodesy, Data Report of Hydrogr. Obs., Series of Satellite Geodesy,* **2**, p. 50.

Nagamori, K., 1989: *Satellite data analysis computer system, ibid.,* **2**, p. 59.

The reports of photographic direction observations for the preceding years were presented in the following numbers of the Data Reports of Hydrographic Observations.

Kawai, K., 1990: *Photographic direction observation of Ajisai at Titi Sima and Simosato Hydrographic Observatory, ibid.,* **3**, p. 36.

Kawai, K., 1991: *Photographic direction observation of Ajisai in 1988,1989 , ibid.,* **4**, p. 38.

Kawai, K., 1992: *ibid.* (in 1990), **5**, p. 30.

Kawai, K., 1993: *ibid.* (in 1991), **6**, p. 36.

Takanashi, Y., Noda, H., 1994: *ibid.* (in 1992), **7**, p. 30.

海洋測地網一次基準点の位置決定
稚内，八丈島

POSITIONING OF THE FIRST ORDER CONTROL POINTS
(Wakkanai and Hatizyo Sima)
IN THE MARINE GEODETIC CONTROL NETWORK

Summary - As a step to establish the marine geodetic control network around Japan, we performed a simultaneous observation program of Ajisai and Lageos at Wakkanai, Hatizyo Sima and the Simosato Hydrographic Observatory (SHO) in 1992 and 1993. The positions of the two first order control points are connected to the fiducial point located at SHO.

Key words : satellite laser ranging - satellite photography - Ajisai - Lageos - marine geodetic controls

1. はじめに

水路部では，領海等我が国の管轄海域の確定と，海洋における測位精度の向上を目的として，1980年より，海洋測地網の整備を推進している（Kubo, 1988）．この中で，一次基準点は本土基準点（下里水路観測所）と主要な島を結合して，海洋測地網の骨格を形成する役割を担っており，1988年から観測が行われている．1991年以前に行われた一次基準点観測の成果は，父島，石垣島については水路部観測報告衛星測地編第4号（福島他，1991）を，南鳥島，沖縄，対馬については同第5号（仙石他，1992）を，隠岐諸島，南大東島については同第6号（仙石他，1993）を，十勝，硫黄島については同第7号（仙石・内山，1994）をそれぞれ参照していただきたい．また，これら一次基準点の海洋測地成果（辰野・藤田，1994）は本号別稿（藤田，1995）に一括してまとめられている．

本報告では，1992年と1993年に実施した「あじさい」（Sasaki, 1987）による稚内，八丈島（Fig. 1）の一次基準点の観測およびその成果について報告する．観測方法，解析手法等については，同第4号（福島他，1991）を参照されたい．

2. 稚内一次基準点観測

2.1. 概要

2.1.1. 作業経過

1992年8月初旬から10月下旬にかけて，下里および稚内において「あじさい」(Sasaki, 1987)の同時観測を実施した．なお，この同時観測前の1992年7月下旬に，下里において比較観測を実施した．

2.1.2. 主な作業

(1) 基準点標識等の設置
　一次基準点標石（22cm角）　標識名：稚内．
(2) 「あじさい」の同時観測による位置決定
　稚内を決定．
(3) 地上測量
　稚内で実施．

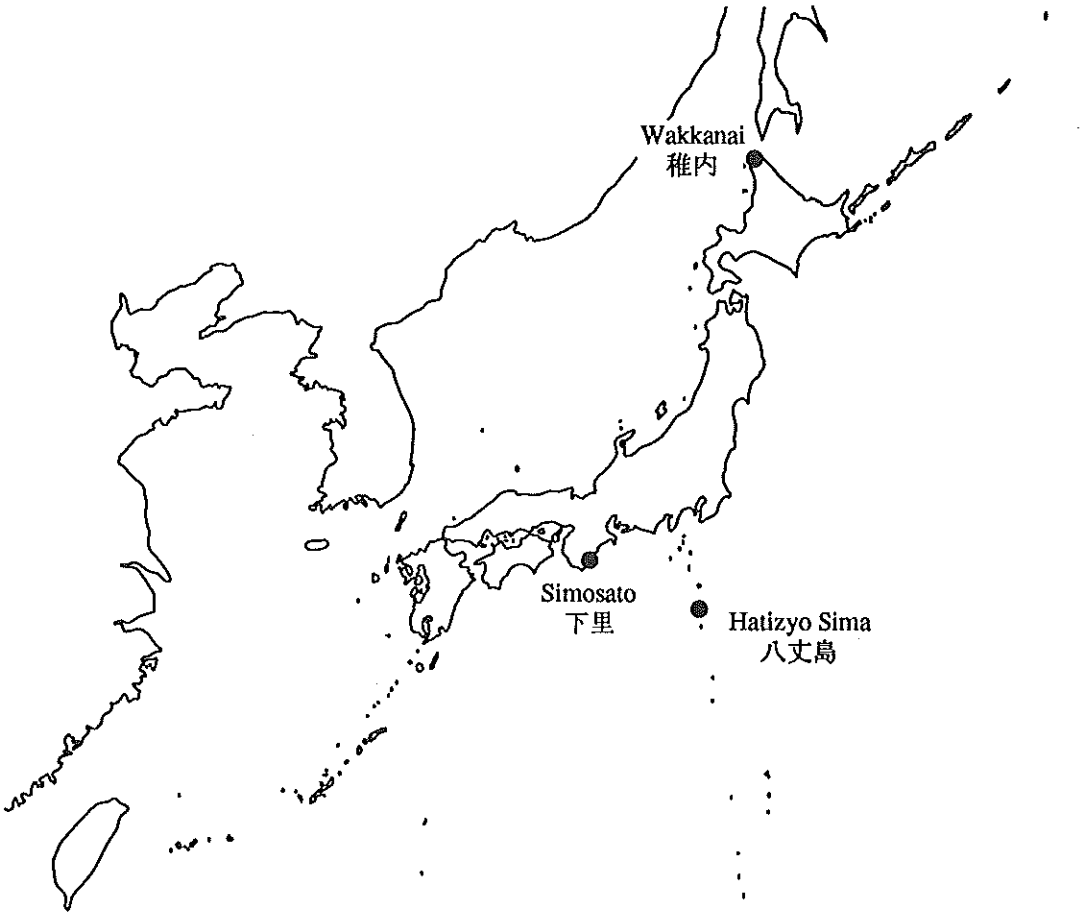


Figure 1. Satellite Laser Ranging (SLR) observations reported in this issue.

2.1.3. 使用装置等

(1) 一次基準点

可搬式レーザー測距装置（Sasaki, 1988），可搬式衛星方位測定装置.

(2) 本土基準点

固定式レーザー測距装置（Sasaki et al., 1983），固定式衛星方位測定装置（Kanazawa, 1989）.

2.1.4. 観測データ

稚内と下里の同時観測において得られたレーザー測距データは，水路部観測報告衛星測地編第7号（Sengoku et al., 1994）に，また写真観測については同号(Takanashi and Noda, 1994）に報告されている.

2.2. 観測

2.2.1. 観測地点

(1) 一次基準点「稚内」

北海道稚内市萩ケ岡送信所（北海道東部統制通信事務所管理）構内 (Fig.2,3).

(2) 本土基準点

和歌山県東牟婁郡那智勝浦町下里 第五管区海上保安本部下里水路観測所.

2.2.2. 観測班

(1) 一次基準点

前半：内山丈夫，村上修司，野田秀樹（衛星測地室）
鈴木充広（下里水路観測所）

後半：澤雅行（航法測地課），河合晃司，高梨泰宏（衛星測地室）
成田誉孝（下里水路観測所）.

(2) 本土基準点

第五管区海上保安本部 下里水路観測所職員.

2.2.3. 作業期間

1992年8月2日～10月21日（うち設営 8月4日～10日，撤収10月16日～19日）.

2.2.4. 観測数

(1) レーザー測距観測

	衛星	パス数	リターン数
一次基準点	あじさい	32	16,225
	TOPEX	3	3,557
本土基準点	あじさい	62	53,705
	TOPEX	16	10,760

(2) 写真観測

	衛星	パス数	枚数
一次基準点	あじさい	2	2
本土基準点	あじさい	0	0

2.2.5. 観測状況

(1) 一次基準点

北海道稚内市萩ケ岡送信所構内に機器を設置した．あらゆる方位について，高度20度以上の視界を確保できた．

「あじさい」のレーザー測距と衛星方位観測，及びTOPEXのレーザー測距観測を実施した．

(2) 本土基準点

「あじさい」のレーザー測距と衛星方位観測，及びTOPEXのレーザー測距観測を実施した．

2.2.6. 基準点標識等の設置

北海道稚内市萩ケ岡送信所構内に基準点標石「稚内」を設置した．

2.2.7. 地上測量

(1) 基準点標石「稚内」

基準点標石「稚内」Hの位置は，三等三角点「宇遠内」F1を測量原点，四等三角点「宇遠峠」F2を方位基準として，トータルステーションを用いて測定した（Fig. 4）．

(2) 観測点

可搬式レーザー測距装置の不動点T，衛星方位測定位置の不動点Kの位置は，三等三角点「宇遠内」F1を測量原点，四等三角点「宇遠峠」F2を方位基準として，トータルステーションを用いて測定した（Fig. 4）．

2.3. 解析成果

稚内と下里水路観測所において同時に観測された「あじさい」のレーザー測距データを，SPORT法により解析した．用いたプログラムは，人工衛星レーザー測距データ解析プログラムHydrangea(Sasaki,1990) である．1992年9月9日12h～14h，9月10日15h～17hの2セットについて解析を行った．SPORT法では，未知点である稚内の座標と「あじさい」の元期における位置と速度の初期値を未知量として推定する．下里の座標は，海洋測地成果（辰野・藤田，1994）を採用した．

$$U_s = -3822388.272 \text{ m}$$
$$V_s = 3699363.582 \text{ m} \qquad .....(1)$$
$$W_s = 3507573.187 \text{ m}$$

解析の結果，稚内における可搬式レーザー測距装置の送受信望遠鏡の不動点Tの世界測地系座標は，

$$U_T = -3522928.950 \pm .037 \text{ m}$$
$$V_T = 2779243.627 \pm .014 \text{ m} \qquad .....(2)$$
$$W_T = 4517637.385 \pm .027 \text{ m}$$

となった．

2.4. 座標変換

上記の解析によって得られる成果は，世界測地系（海洋測地成果）で表示した一次基準点の本土基準点に対する相対位置である．この相対位置から日本測地系における一次基準点の絶対位置を求めるには，まず，下里において世界測地系（海洋測地成果）と日本測地系の変換パラメーターを求め，次にこのパラメーターを用いて一次基準点の座標を世界測地系（海洋測地成果）から日本測地系へと変換する必要がある．

下里水路観測所の固定式レーザー測距装置の日本測地系における位置（緯度ϕ，経度λ，標高h）は測量から，

$$\phi_S = 33° \ 34' \ 27.496''$$
$$\lambda_S = 135° \ 56' \ 23.537'' \quad .....(3)$$
$$h_S = 62.44\text{m}$$

と求められている（竹村，1983）．日本測地系の準拠楕円体であるベッセル楕円体の諸元（a=6377397.155m および 1/f=299.152813）を用いて直交座標系（u,v,w）に変換すると，

$$u_S = -3822242.04 \text{ m}$$
$$v_S = 3698856.02 \text{ m} \quad .....(4)$$
$$w_S = 3506891.33 \text{ m}$$

ただし，ここでは Ganeko(1977) の結果を用いて，下里における日本測地系の準拠楕円体からのジオイド高を0mと推定している．(1)と(4)から，世界測地系（海洋測地成果）から日本測地系への原点変換量は，

$$\triangle u = u_S - U_S = 146.23 \text{ m}$$
$$\triangle v = v_S - V_S = -507.57 \text{ m} \quad .....(5)$$
$$\triangle w = w_S - W_S = -681.86 \text{ m}$$

となる．

一次基準点の位置を日本測地系で求めるためには，世界測地系（海洋測地成果）で求められた地心直交座標に原点変換量（(5)式）を加え，さらにベッセル楕円体の諸元を用いて緯度ϕ，経度λ，楕円体高Hに直せばよい．

稚内の可搬式レーザー測距装置の不動点Tの位置は，日本測地系に変換すると，

$$\phi_T = 45° \ 23' \ 01.442''$$
$$\lambda_T = 141° \ 44' \ 02.305'' \quad .....(6)$$
$$H_T = 12.24 \text{ m}$$

となる．ただし，楕円体高については，日本測地系準拠楕円体からのジオイド高h_gと標高hの和になることに注意する必要がある．

地上測量により，三角点成果に基づいた局所測地系における各点の位置をTable 1に示す．Table 1と(6)の比較から，稚内の三角点成果に加えるべき補正量は，

$$\Delta\phi = \phi_T（一次基準点観測） - \phi_T（地上測量） = 0.141''$$
$$\Delta\lambda = \lambda_T（一次基準点観測） - \lambda_T（地上測量） = 0.256'' \quad .....(7)$$
$$h_g = H_T（一次基準点観測） - h_T（地上測量） = -53.54 \text{ m}$$

となる．ただし，h_gは日本測地系準拠楕円体からのジオイド高である．

これを用いて一次基準点標石「稚内」Hの日本測地系における位置は，

$$\phi_H = 45° \ 23' \ 01.758''$$
$$\lambda_H = 141° \ 44' \ 02.038'' \quad .....(8)$$
$$h_H = 64.00 \text{ m}$$

となる．ただし，h_Hは標高である．一次基準点標石の日本測地系準拠楕円体からの楕円体高H_Hは，

$$H_H = 10.46 \text{ m} \quad .....(9)$$

である．

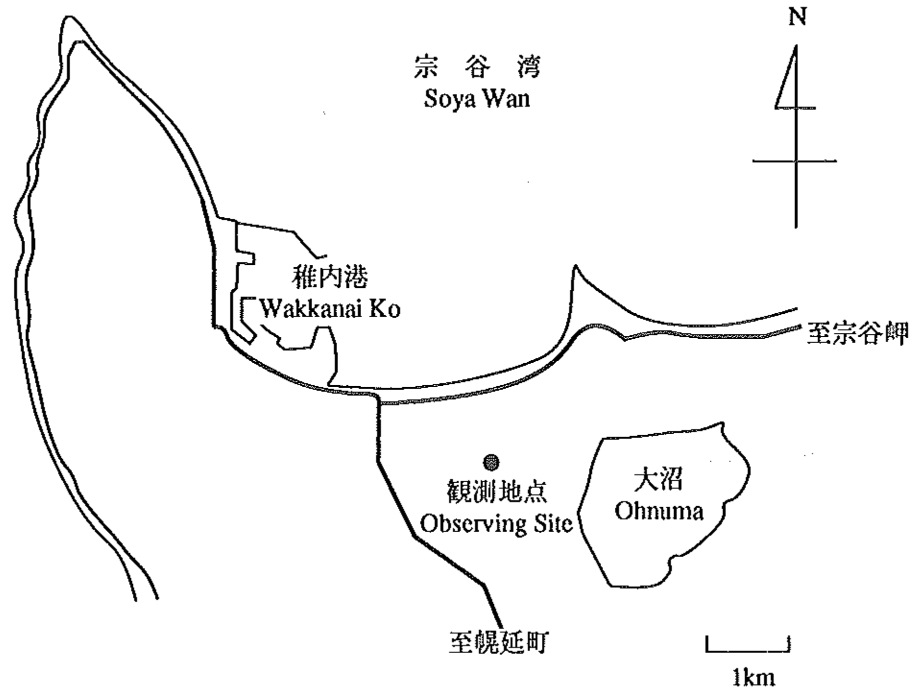


Figure 2. Wakkanai.

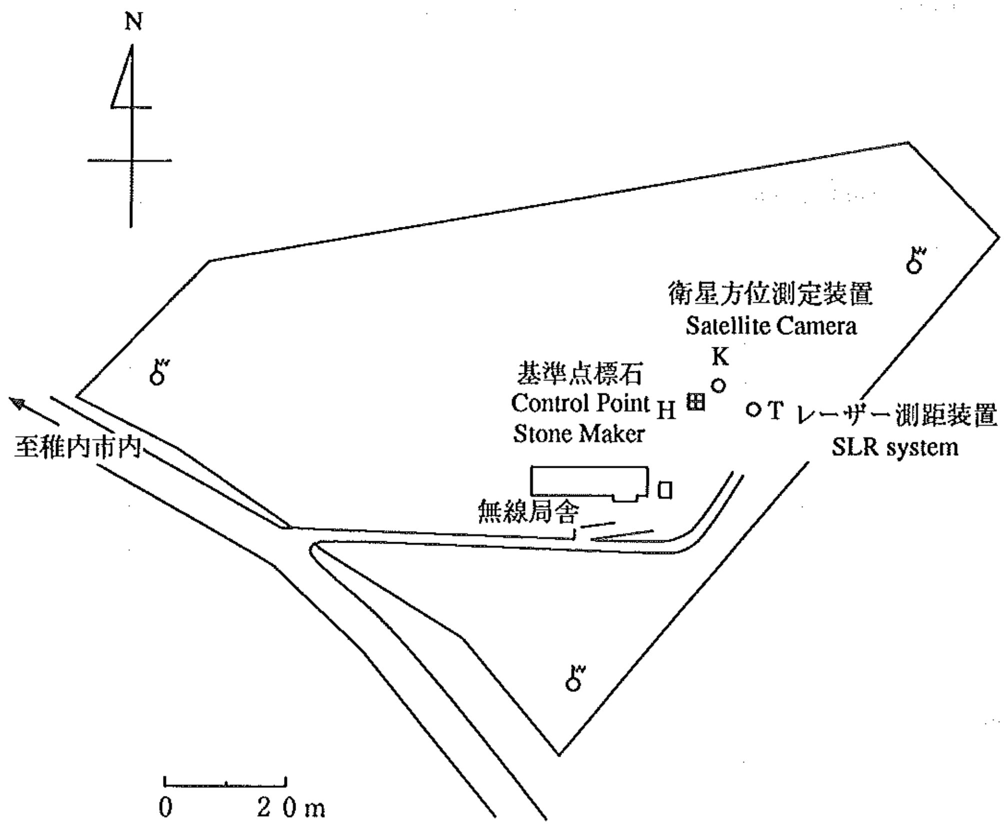
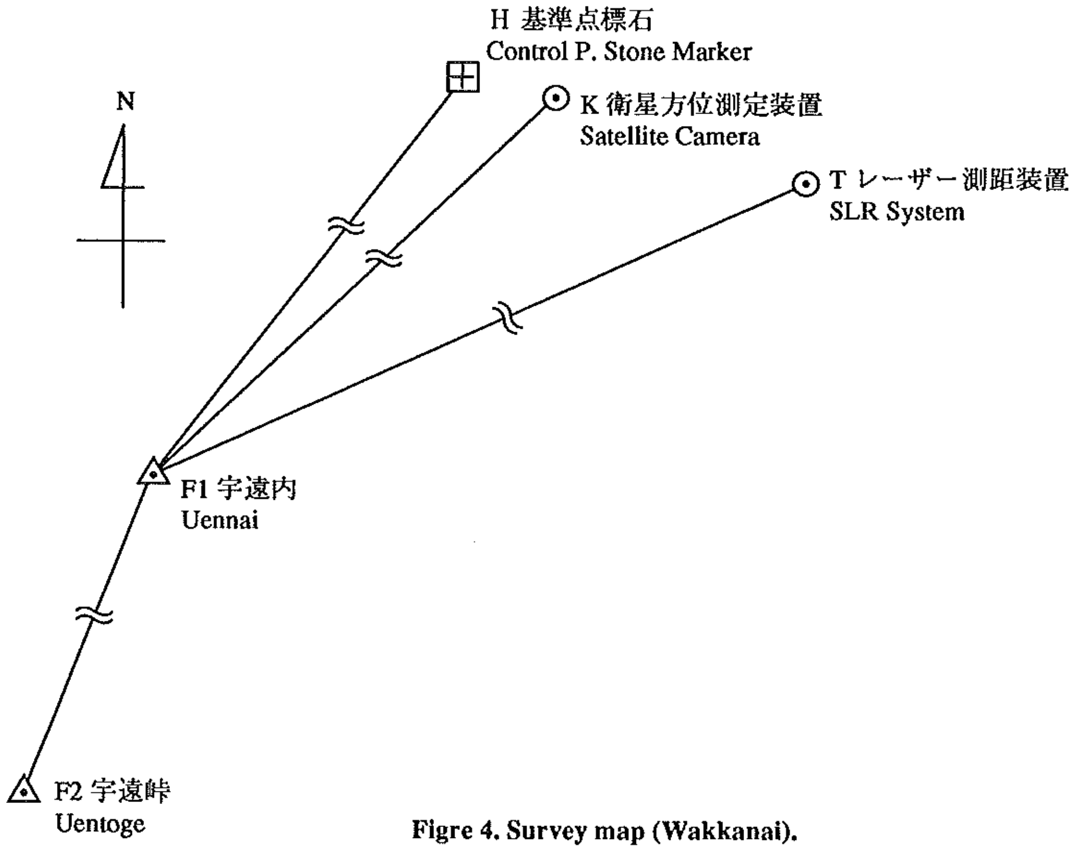


Figure 3. Observing Site at Wakkanai.



Figre 4. Survey map (Wakkanai).

Table 1. The Ground Survey results at Wakkanai in Tokyo datum

Station	ϕ	λ	h	Note
	° ′ ″	° ′ ″	m	
三等三角点「宇遠内」 F1 Triang. P. Uennai	45 22 57.557 N	141 43 56.743 E	65.01	GSI result
四等三角点「宇遠峠」 F2 Triang. P. Uentoge	45 22 12.492 N	141 43 10.342 E	57.94	ibid
基準点標石「稚内」 H Control P. Stone Marker	45 23 01.617 N	141 44 01.783 E	64.00	
レーザー測距装置 T SLR System	45 23 01.301 N	141 44 02.050 E	65.78	
衛星方位測定装置 K Satellite Camera	45 23 01.542 N	141 44 01.912 E	64.85	
H - T	+0.316	-0.267	-1.78	Relative

3. 八丈島一次基準点観測

3.1. 概要

3.1.1. 作業経過

1993年1月下旬から1993年3月中旬にかけて，下里および八丈島において「あじさい」の同時観測を実施した．なお，この同時観測前の1992年12月初旬に，下里において比較観測を実施した．

3.1.2. 主な作業

(1) 基準点標識等の設置

一次基準点標石（22cm角） 標識名：八丈島．

(2) 「あじさい」の同時観測による位置決定

八丈島を決定．

(3) 地上測量・GPS測量

八丈島で実施．

3.1.3. 使用装置等

(1) 一次基準点

可搬式レーザー測距装置，可搬式衛星方位測定装置．

(2) 本土基準点

固定式レーザー測距装置，固定式衛星方位測定装置．

3.1.4. 観測データ

八丈島と下里の同時観測において得られたレーザー測距データについては，水路部観測報告衛星測地編第８号（Terai et al., 1995）に，また写真観測については，同号（Noda, 1995）に報告されている．

3.2. 観測

3.2.1. 観測地点

(1) 一次基準点「八丈島」

東京都八丈島 第三管区海上保安本部八丈水路観測所（Fig. 5, 6）．

(2) 本土基準点

和歌山県東牟婁郡那智勝浦町下里 第五管区海上保安本部下里水路観測所．

3.2.2. 観測班

(1) 一次基準点

前半：金沢輝雄（航法測地課），河合晃司，野田秀樹（衛星測地室）
吉田茂（下里水路観測所）

後半：仙石新，高梨泰宏，池田信広（衛星測地室）
鈴木和則（下里水路観測所）．

(2) 本土基準点

第五管区海上保安本部下里水路観測所職員．

3.2.3. 作業期間

1993年1月27日～3月20日（うち設営1月29日～2月3日，撤収3月14日～18日）．

3.2.4. 観測数

(1) レーザー測距観測

	衛星	パス数	リターン数
一次基準点	あじさい	37	5,285
	LAGEOS I,II	6	87
	TOPEX	8	2,514
本土基準点	あじさい	80	91,298
	LAGEOS I,II	79	102,066
	TOPEX	19	18,417.

(2) 写真観測

	衛星	パス数	枚数
一次基準点	あじさい	1	1
本土基準点	あじさい	5	5.

3.2.5. 観測状況

(1) 一次基準点

第三管区海上保安本部八丈水路観測所構内に設置した.

「あじさい」のレーザー測距，衛星方位観測，および「LAGEOS I,II」と「TOPEX」のレーザー測距観測を実施した.

(2) 本土基準点

「あじさい」のレーザー測距，衛星方位観測，および「LAGEOS I,II」と「TOPEX」のレーザー測距観測を実施した.

3.2.6. 基準点標識等の設置

第三管区海上保安本部八丈水路観測所構内に基準点標石「八丈島」を設置した.

3.2.7. 地上測量・GPS測量

(1) 基準点標石「八丈島」

基準点標石「八丈島」Hの経緯度は，四等三角点「休戸」F1を測量原点とし，GPS観測によって測定した.

(2) 観測点

可搬式レーザー測距装置の不動点T及び衛星方位測定装置の不動点Kの位置は，基準点標石「八丈島」Hを測量原点とし，上記三角点F1を方位の基準として，トータルステーションを用いて測角，測距を行った（Fig. 7）.

3.3. 解析成果

八丈島と下里水路観測所において同時に観測された「あじさい」のレーザー測距データを，SPORT法によって解析した. 5セットについて解析を行った. 下里の採用座標値は，稚内と同様海洋測地成果を用いた.

解析の結果，可搬式レーザー測距装置の送受信望遠鏡の不動点の世界測地系座標は，

$$U_T = -4087880.246 \pm .016\ \mathrm{m}$$
$$V_T = 3451764.230 \pm .026\ \mathrm{m} \qquad .....(10)$$
$$W_T = 3460902.451 \pm .017\ \mathrm{m}$$

となった. 原点変換量(5)によって日本測地系に変換すると，

ϕ_T = 33° 04′ 10.534″
λ_T =139° 49′ 32.657″ .....(11)
H_T = 244.69 m

となる．ただしH_Tは日本測地系準拠楕円体からの楕円体高である．

地上測量により，三角点成果に基づいた局所測地系における各点の位置をTable 2に示す．Table 2と(11)の比較から，八丈島の三角点成果に加えるべき補正量は，

$\Delta\phi = \phi_T$（一次基準点観測）- ϕ_T（地上測量）= 0.347″
$\Delta\lambda = \lambda_T$（一次基準点観測）- λ_T（地上測量）= - 0.044″ .....(12)
$h_g = H_T$（一次基準点観測）- h_T（地上測量）= 23.54m

となる．ただし，h_gは日本測地系準拠楕円体からのジオイド高である．

これを用いて一次基準点標石「八丈島」Hの日本測地系における位置は，

ϕ_H = 33° 04′ 10.036″
λ_H = 139° 49′ 33.449″ .....(13)
h_H = 219.88m

となる．また，日本測地系準拠楕円体からの楕円体高H_Hは，

H_H = 243.42m .....(14)

である．

本報告は，鈴木晃，藤田雅之が作成した．

参 考 文 献

福島登志夫，内山丈夫，西村英樹，仙石新，1991：水路部観測報告衛星測地編，**4**，p.60.

藤田雅之，1995：同，**8**，p.83.

Ganeko, Y., 1977 : *J. Geophys. Res.*, **82**, p.2490.

Kanazawa, T., 1989 : *Data Report of Hydrogr. Obs., Series of Satellite Geodesy*, **2**, p.50.

Kubo, Y., 1988 : *ibid.*,**1**, p.1.

Noda, H., 1995 : *ibid.*, **8**, p.30.

Sasaki, M., 1987 : *Data Report of Hydrogr. Obs., Series of Astronomy and Geodesy*, **21**, p.90.

Sasaki, M., 1988 : *Data Report of Hydrogr. Obs., Series of Satellite Geodesy*, **1**, p.59.

Sasaki, M., 1990 : *Report of Hydrogr. Researches*, **26**, p.99.

Sasaki, M., Ganeko, Y., Harada, Y., 1983 : *Data Report of Hydrogr. Obs., Series of Astronomy and Geodesy*, **17**, p.49.

Sengoku, A., Murakami, S., Ikeda, N., Matsumoto, K., 1993 : *Data Report of Hydrogr. Obs., Series of Satellite Geodesy*, **6**, p.1.

仙石新，内山丈夫，西村英樹，1992：水路部観測報告衛星測地編，**5**，p.43.

仙石新，内山丈夫，西村英樹，1993：同，**6**，p.45.

Takanashi, Y., Noda, H., 1994 : *Data Report of Hydrogr. Obs., Series of Satellite Geodesy*, **7**, p.30.

竹村武彦，1983：水路部観測報告天文測地編，**17**，p.44.

辰野忠夫，藤田雅之，1994：水路部観測報告衛星測地編，**7**，p.102.

Terai, K., Fujita,M., Narita,Y., Muneda,K., 1995 : *Data Report of Hydrogr. Obs., Series of Satellite Geodesy*, **8**, p.1.

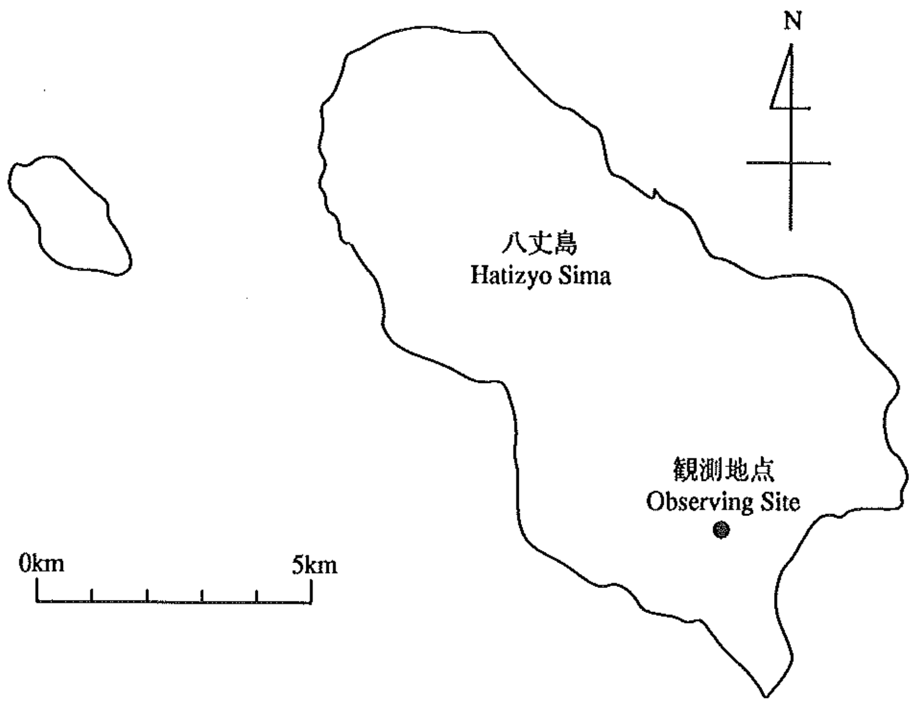


Figure 5. Hatizyo Sima.

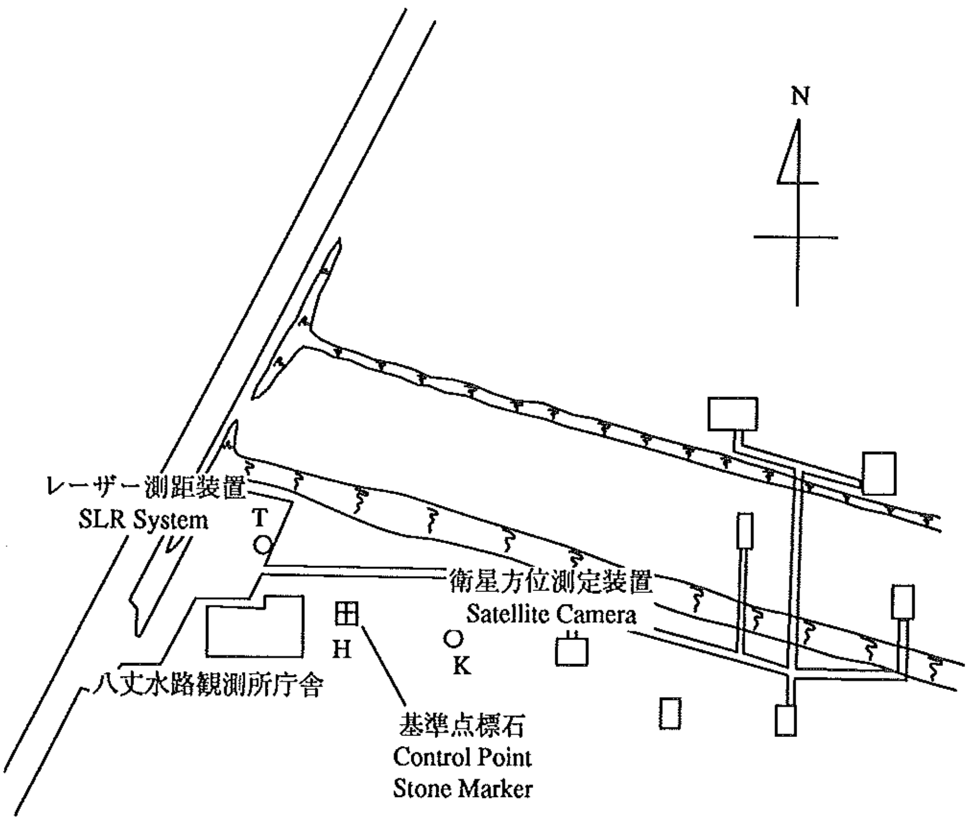


Figure 6. Observing Site at Hatizyo.

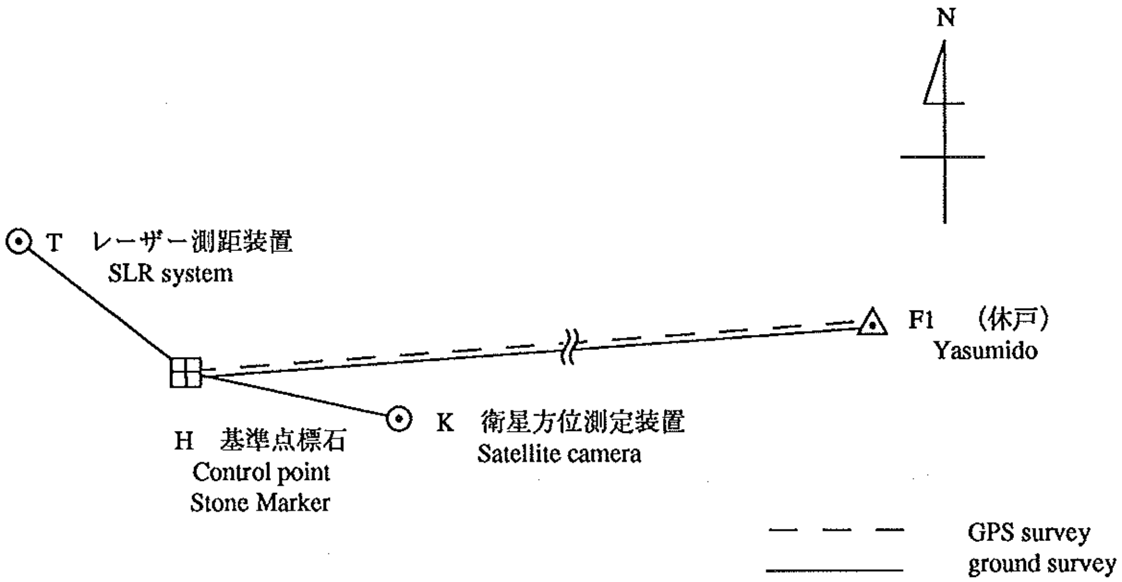


Figure 7. Survey map (Hatizyo Sima).

Table 2. The GPS and Ground Survey results at Hatizyo Sima in Tokyo datum

Station	φ	λ	h	Note
	° ′ ″	° ′ ″	m	
四等三角点「休戸」 F1 Triang. P. Yasumido	33 04 04.023 N	139 50 03.888 E	288.20	GSI result
基準点標石「八丈島」 H Control P. Stone Marker	33 04 09.689 N	139 49 33.493 E	219.88	
レーザー測距装置 T SLR System	33 04 10.187 N	139 49 32.701 E	221.15	
衛星方位測定装置 K Satellite Camera	33 04 09.748 N	139 49 33.905 E	220.59	
H - T	- 0.498	0.792	-1.27	Relative

人工衛星のドップラー観測による離島の位置決定
1 9 9 3

SATELLITE DOPPLER POSITIONING OF OFF-LYING ISLANDS IN 1993

Summary - This paper is a continuation of the series of report on the satellite Doppler positioning of the off-lying islands around Japan. The results of the observations made by the JHD in 1993 are given in this report.

Key words : satellite Doppler positioning - marine geodetic controls

水路部では，1980年以降海洋測地網の整備として，人工衛星を利用して本土から遠隔地にある島嶼の経緯度の測定を行っている．本稿では，1993年に実施した米国海軍航行衛星（NNSS）による離島の経緯度観測の成果について報告する．観測方法，整約方法等については水路部観測報告天文測地編第17号（竹村・金沢，1983）を参照されたい．

NNSSの観測から求めた測点の位置の成果をTable 1に示す．経緯度は日本測地系で，海洋測地成果（辰野・藤田，1994）に基づいている．また，高さは標高である．

Table 1. The position of the fiducial markers expressed in the Tokyo Datum by means of the satellite Doppler observations

Station	Marker	ϕ (° ′ ″)	λ (° ′ ″)	H (m)
伊豆鳥島 (Izu Tori Sima)	H1	30 28 48.720 N	140 17 33.353 E	131.64

H : the height above the reference ellipsoid of the Tokyo Datum

1. 概　要

1.1. 作業経過

1993年6月7～22日にかけて下里，八丈，伊豆鳥島において同時観測を実施した．観測点の配置をFig. 1に示す．

1.2. 主な作業

(1) 測点標識の設置

伊豆鳥島．

(2) 航行衛星の同時観測による経緯度の決定

伊豆鳥島．

1.3. 使用機器等

(1) 航行衛星受信機 3台

機　　種　マグナボックス社 MX-1502

機械番号　HD1, HD3, HD4.

(2) テープ変換器　MFE5000, No.01219.

(3) 整約プログラム　MAGNET.

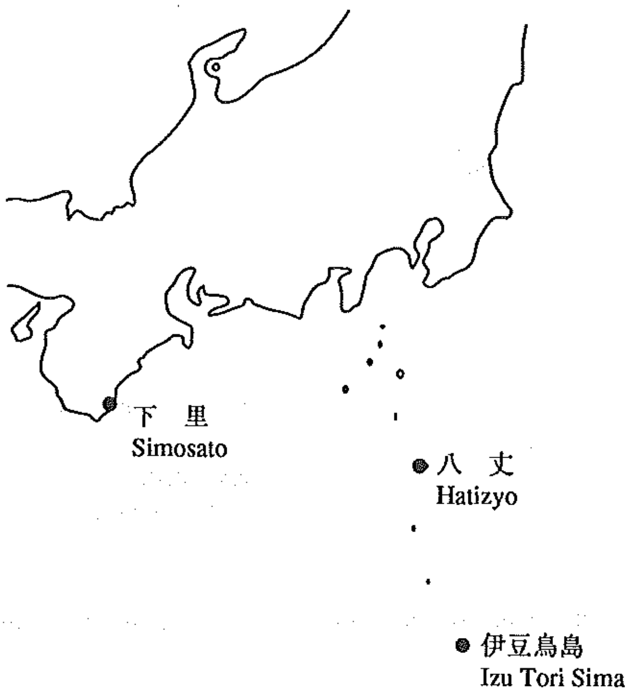


Figure 1. Doppler positioning in 1993.

2. 観　測

伊豆鳥島観測には測量船「海洋」を使用した.

2.1. 観測地点と担当者

下　　里	下里水路観測所庁舎屋上（Fig. 2）	第五管区海上保安本部 下里水路観測所職員
八　　丈	八丈水路観測所庁舎屋上（Fig. 3）	第三管区海上保安本部 八丈水路観測所職員
伊豆鳥島	気象庁旧観測所庁舎屋上（Fig. 5,6）	鈴木晃，高梨泰宏，成田誉孝.

2.2. 観測期間と観測数

	受信機	期　　　間	受信パス数
下　　里	HD1	1993年 6月 7日 ～ 6月 21日	206
八　　丈	HD3	1993年 6月 7日 ～ 6月 22日	221
伊豆鳥島	HD4	1993年 6月 7日 ～ 6月 21日	57.

2.3. 観測状況と地上測量

下　　里：下里水路観測所庁舎屋上のNNSS受信点において観測を行った.

八　　丈：八丈水路観測所庁舎屋上の測位点より偏心した点にアンテナを設置し，観測を行った. 受信アンテナ高は偏心点上1.82mで，偏心点は測位点上0.43mである(Fig. 4).

伊豆鳥島：伊豆鳥島には測点標識が過去に２ヶ所設置されている（森・金沢，1979）. 標識1976は気象庁旧鳥島気象観測所南百葉箱踏石上にある. 標石が外れていたため，固定し直した. 以前の位置とは±1cm以内で合っていると思われる. この点は視界が悪いため，観測は行わなかった. 標識1957は旧観測所屋上にある. 標石は亡失しており，ほぼ同位置に釘により新点を設置した. 新点直上にアンテナを設置し，観測を行った. 受信アンテナ高は点上 1.86mである(Fig. 7).

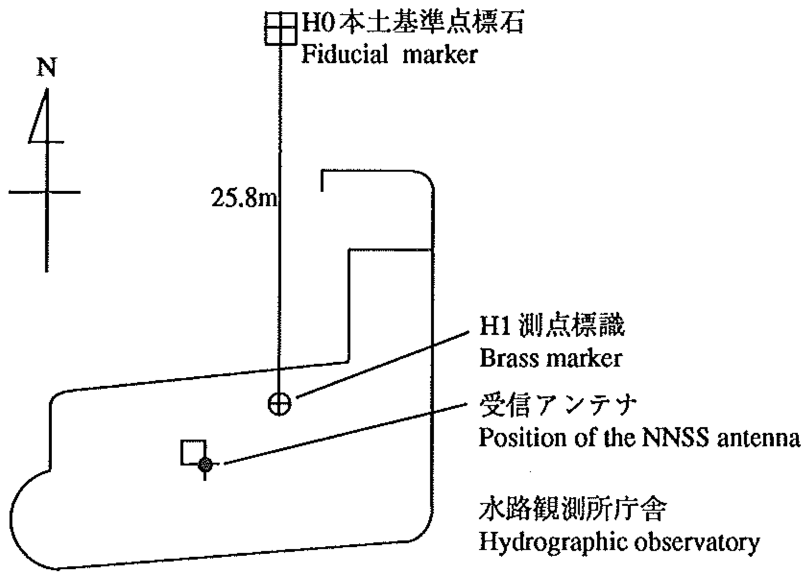


Figure 2. Site sketch for the Simosato Hydrographic Observatory.

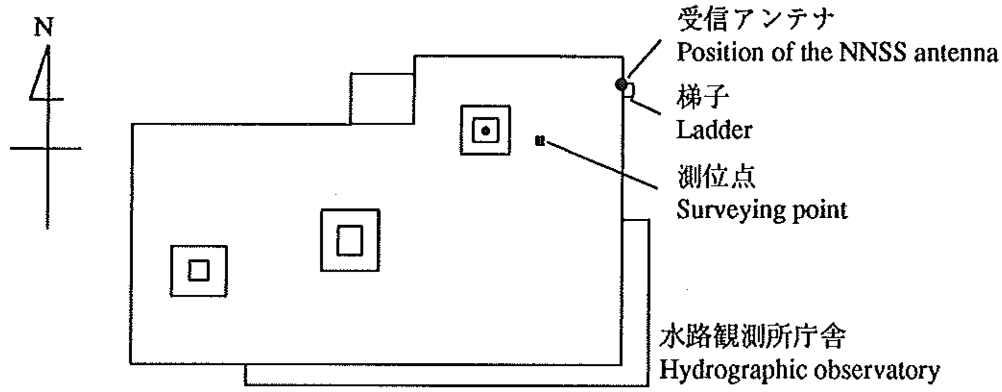


Figure 3. Site sketch for the Hatizyo Hydrographic Observatory.

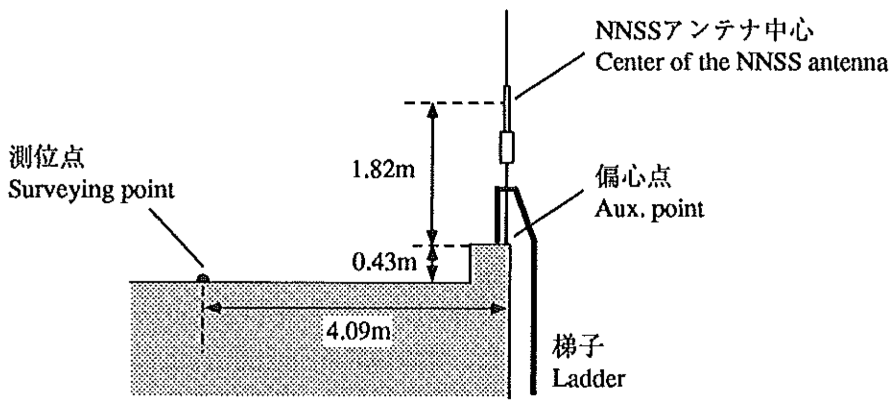


Figure 4. Antenna of Hatizyo.

Figure 5. Izu Tori Sima.

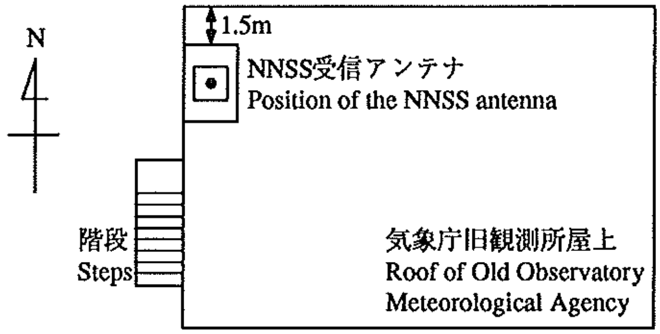


Figure 6. Site sketch for Izu Tori Sima.

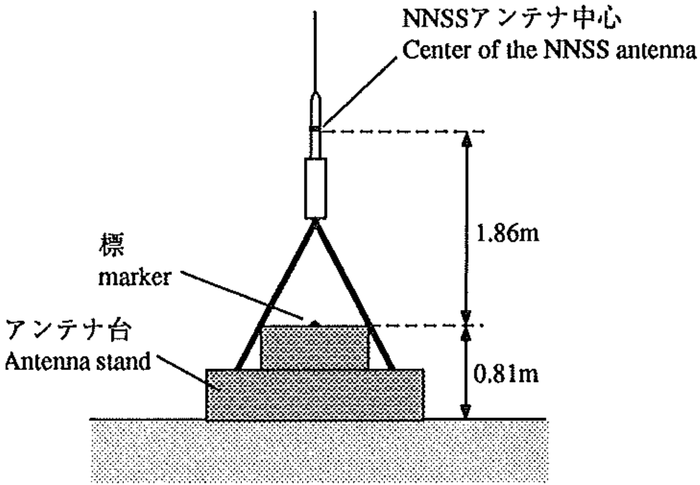


Figure 7. Antenna of Izu Tori Sima.

3. 成　果

当庁で推進している海洋測地において，NNSSによる離島（二次基準点）観測成果は，本来レーザー測距観測によって求められた一次基準点成果から相対的に算出されるべきものであるが，前号までは各点の基準となるべき近傍の一次基準点が未観測，または成果が暫定値であったため，下里を基準とした暫定成果を報告してきた．

これに対して本報告で掲げる伊豆鳥島の成果値（Table 1）は，基準となるべき一次基準点八丈の海洋測地成果（鈴木・藤田，1995）が既に算出されているため，この値を用いて伊豆鳥島の海洋測地成果を算出したものである．

具体的な計算は，八丈NNSSアンテナの海洋測地成果による座標値を求め，これに本観測により求めた八丈NNSSアンテナから伊豆鳥島NNSSアンテナへのベクトルを加えた後，最後に標H1までのアンテナ高補正(Fig.7)を行う方法によっている．以下にその過程を示す．

Table 2に，受信データをMAGNETプログラムにより整約し，WGS-84の楕円体上で求めたNNSS受信アンテナ中心の経緯度を示す．高さは楕円体上の高さを表す．また，Table 3に，八丈と伊豆鳥島についてその地心直交座標値を示す．

Table 2. Positions of the NNSS antennas (1993) : the solutions of the translocation of the Doppler observations in the reference system of NNSS

Station	ϕ	λ	H	Note
	° ′ ″	° ′ ″	m	
下　　里 (Simosato)	33 34 39.132 N	135 56 12.853 E	105.61	伊豆鳥島観測
八　　丈 (Hatizyo)	33 04 22.795 N	139 49 21.686 E	268.21	
伊豆鳥島 (Izu Tori Sima)	30 29 02.288 N	140 17 22.246 E	132.44	

H : the height above the WGS-84 ellipsoid (a=6378137m, f=1/298.257)

Table 3. The transformed results of Table 2 into geocentric rectangular coordinates

Station	U	V	W	Note
	m	m	m	
八　　丈 (Hatizyo)	-4087893.09	3451763.39	3460891.09	伊豆鳥島観測
伊豆鳥島 (Izu Tori Sima)	-4232091.06	3514858.45	3216789.47	

Table 3の値を用いて，八丈NNSSアンテナから伊豆鳥島NNSSアンテナへのベクトル量を求めると，

$$\Delta U\ (伊豆鳥島-八丈) = -144197.97\ \mathrm{m}$$
$$\Delta V\ (伊豆鳥島-八丈) = 63095.06\ \mathrm{m} \quad \ldots\ldots (1)$$
$$\Delta W\ (伊豆鳥島-八丈) = -244101.62\ \mathrm{m}$$

となる．

Table 4に近傍の三角点から求めた八丈NNSSアンテナの地上測量成果（小野他，1981）を，Table 5に海洋測地成果における三角点成果への補正量（鈴木・藤田，1995）で補正した海洋測地成果を示す．緯経度は日本測地系で，高さはそれぞれ標高とベッセル楕円体高である．

Table 4. Positions of the NNSS antenna : the ground survey result in the Tokyo Datum

Station	ϕ	λ	h	Note
	° ′ ″	° ′ ″	m	
八丈NNSSアンテナ	33 04 09.908 N	139 49 33.013 E	225.51	1981年地上測量

h : the height above the (local) mean sea level

Table 5. Position of the NNSS antenna : Marine Geodetic result in the Tokyo Datum

Station	ϕ	λ	H	Note
	° ′ ″	° ′ ″	m	海洋測地成果八丈補正量
八丈NNSSアンテナ	33 04 10.255 N	139 49 32.969 E	249.05	Δ ϕ = 0.347"
				Δ λ = - 0.044"
				ジオイド高 = 23.54 m

H : the height above the reference ellipsoid of the Tokyo Datum

後者を，日本測地系から世界測地系への原点補正量（辰野・藤田，1994）を用いて地心直交座標に変換すると，八丈NNSSアンテナの海洋測地成果による座標値は，

U = - 4087891.85 m
V = 3451763.43 m ..... (2)
W = 3460897.63 m

と求まる．

Table 1に示した伊豆鳥島の標H1の成果は，(1)+(2)の結果を日本測地系に変換した後，アンテナ高補正を行って求められたものである．

なお，伊豆鳥島には三角点がないため，これまでの報告で掲載されてきた補正量（NNSS観測成果と三角点成果の差）は求められていない．

本報告は，渡辺由美子が作成した．また電子計算機による観測成果の算出は，鈴木晃，成田誉孝が担当した．

参 考 文 献

森 巧，金沢輝雄，1979：水路部観測報告天文測地編，**13**，p.64.
小野房吉，松本邦雄，富安義昭，1981：八丈水路観測所の経緯度（保水編第13号 昭和56年3月11日）.
鈴木晃，藤田雅之，1995：水路部観測報告衛星測地編，**8**，p.34.
竹村武彦，金沢輝雄，1983：水路部観測報告天文測地編，**17**，p.61.
辰野忠夫，藤田雅之，1994：水路部観測報告衛星測地編，**7**，p.102.

人工衛星のドップラー観測による離島の位置決定に関する従前の報告は，以下の水路部観測報告に収録してある．

竹村武彦，金沢輝雄，1983：水路部観測報告天文測地編，**17**，p.61.
竹村武彦，金沢輝雄，1984：同，**18**，p.42.

竹村武彦，1985：同，**19**，p.85.
竹村武彦，1986：同，**20**，p.72.
竹村武彦，1988：水路部観測報告衛星測地編，**1**，p.46.
仙石新，浅井光一，1990：同，**3**，p.77.
河合晃司，浅井光一，政井悟，1992：同，**5**，p.65.
河合晃司，高梨泰宏，池田信広，1993：同，**6**，p.60.
河合晃司，渡辺由美子，高梨泰宏，池田信広，1994：同，**7**，p.49.

GPS OBSERVATIONS
AROUND SAGAMI BAY
IN 1993

Summary - The Hydrographic Department of Japan has been monitoring crustal movements around Sagami Bay by using GPS since the beginning of 1990. Dual frequency GPS receivers were installed at O Sima, Manazuru and Tsurugi Saki in 1990, and at Sirahama in 1992. These receivers have been controlled through telephone line from the head office of the Hydrographic Department in Tokyo. Observations have been carried out about once or twice a week except for some intensive observation periods. The analysis has been made on the basis of the triple difference technique.

Key words : GPS - Sagami Bay - crustal movements - transition at O Sima

Crustal movements are active around Sagami Bay since there is a triple junction point of three plates, the North American plate, the Eurasian plate and the Philippine sea plate near this region. It is a generally accepted idea that there is an active fault in Sagami Bay off Odawara. The detection of crustal movements might offer valuable information for prediction of future earthquakes and volcanic activities in this area. The purpose of our observation is to monitor velocity field around Sagami Bay in relatively large scale (several tens of kilometers) and abrupt changes between stations, and to clarify the characteristics of crustal movements in plate boundary region.

This is a report of GPS observation at O Sima, Manazuru, Turugi Saki and Sirahama in 1993. This report contains the list of the data obtained at these four stations and the analyzed results. Previous data and results appear in the Data Report of Hydrographic Observations, Series of Satellite Geodesy, No.5,6 and 7(Sengoku and Kawai, 1992; Sengoku et al., 1993: Utiyama et al., 1994).

1. Observation

Test observations in this area were carried out in 1989 (Sengoku, 1991), and it was shown that repeatability of baseline length was about 1ppm or less.

The observation has been continued since Feb., 1990 and the analyzed results have been reported to the Coordinating Committee for Earthquake Prediction.

After a test period for evaluating repeatability of baselines (from Feb. to Mar., 1990), 6 hour observations have been made once or twice a week except for some intensive observation periods. Table 1 shows observation schedules in 1993.

2. Observation sites and the control system

Dual frequency GPS receivers were set at O Sima (the Izu O Sima Aids to Navigation Office), Manazuru (the Fire Service Office of Manazuru Town), Tsurugi Saki (the Radio Station of Tsurugi Saki Light House) and Sirahama (the Sirahama Hydrographic Observatory) from 1989 to 1992 (Fig.1). Hereafter, the station names will be abbreviated as OSIM for O sima, as MANA for Manazuru, as TURU for Turugi Saki and as SIRA for Sirahama.

Receiver types having been used until 1992 are summarized in the previous reports (e.g. Uchiyama et al., 1993). In 1993, Some of the receivers were exchanged to the new types: TRIMBLE 4000 SLD to 4000 SST-IIP at MANA in Jan.12, 4000 SLD to 4000SSE at OSIM in Dec.2 and at TURU in Dec.8.

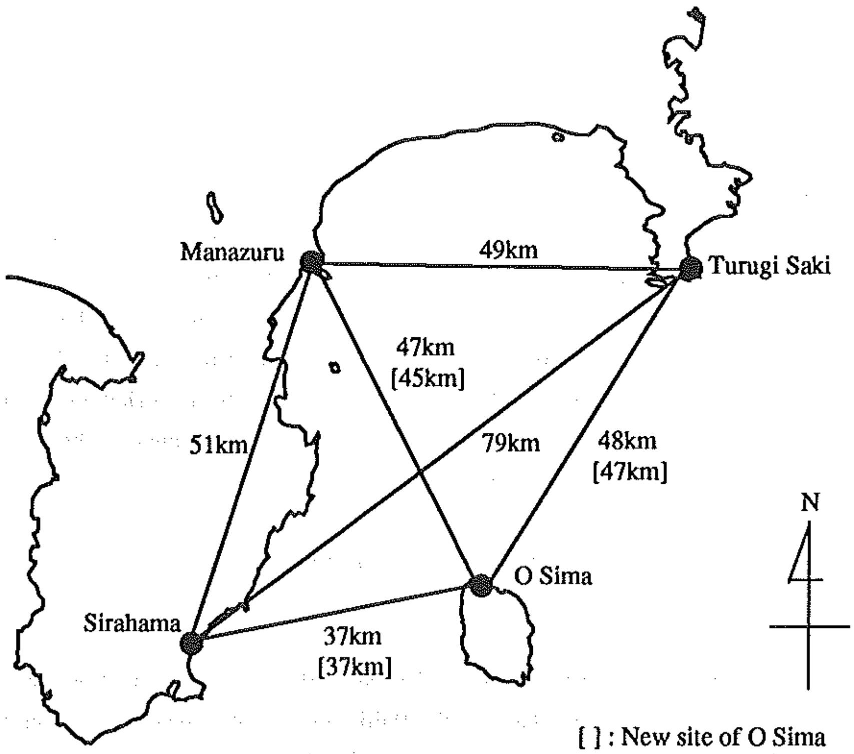


Figure 1. Observation sites.

The control system, DS/7400 (Nippon Data General Inc.) until Apr. and Quarter-L (SONY k.k.) from May, was set at the head office of the Hydrographic Department in Tokyo. Observation schedules of the four GPS receivers have been controlled by this system though NTT telephone line. The control program is 4000 (TRIMBLE NAV ltd., Ver. 2.00).

3. Baseline analysis

Each baseline is analyzed by TRIMVEC (TRIMBLE NAV ltd., Rev.E) with triple difference analysis mode at the control system. Broadcast ephemerides and standard atmospheric model are used in the analysis.

In order to avoid inconsistency in analyzed baseline lengths, which might be introduced by inaccuracy of the fixed coordinate in the analysis, the fixed station and the given coordinate are always kept the same for the same baseline: in the analyses of the lines MANA-OSIM, TURU-OSIM and SIRA-OSIM, the coordinate of OSIM is fixed to the value derived by the test GPS observations (Sengoku, 1991). In the same way, MANA is fixed for the lines TURU-MANA and SIRA-MANA, and TURU is fixed for SIRA-TURU.

The estimation errors of geocentric rectangular coordinates are estimated by TRIMVEC. The estimation errors of latitude, longitude and height difference are also calculated by transforming covariance matrix from geocentric coordinates to topocentric coordinates (Sengoku et al., 1990).

Analyzed results of baseline length, latitude difference, longitude difference, height difference and difference in geocentric rectangular coordinates (u, v, w) are listed in Table 2. There are graphs of baseline length changes in Fig.6.

4. Survey of Observation site of O Sima

In Dec. 2, 1993, the survey position of O Sima was changed from "the Izu O Sima Aids to Navigation Office" to "the O Sima Light House"(Fig.2). The GPS antenna was set up on the roof of the radio station (Fig.3,4). It was mounted on the top of a pole which was directly fixed to the east side of the house. The GPS receiver(TRIMBLE 4000 SSE) and a modem (MD96FB5V, Omron Corp.) were installed in an office room of the house (Fig.5). Speed of communication of the modem was set to be 9600bps.

In order to obtain the position of the new antenna relatively to the old one, a GPS survey was carried out from Sep.26 to Oct.2, 1993, by A.Sengoku, M.Fujita and Y.Narita. During this period, simultaneous GPS observations were made between the old and new antennas, which includes 8 sessions with 6 hours each. The receivers used are TRIMBLE 4000 SLD for the old site, and TRIMBLE 4000 SST-IIP for the new site, respectively. The analysis was made by using TRIMVEC on the basis of the single frequency (L1) and double difference technique.

Summarizing the results, we obtained the vector from the old to the new antenna positions (Δ U, Δ V, Δ W) in geocentric coordinate system and its slope distance D as follows;

$$\Delta U = 1387.749 \text{ m}$$
$$\Delta V = 44.470 \text{ m}$$
$$\Delta W = 1454.081 \text{ m}$$
$$D = 2010.517 \text{ m}.$$

This vector will be used for retaining temporal consistency in baseline results between OSIM and other sites over the transition.

In order to assure the result, we also made a simple EDM survey during the same period to measure the slope distance, D. As a result, the obtained EDM value is 2010.495m, consequently the difference in D between the GPS and EDM survey being 2.2cm, which is comparable to the measurement accuracy of both methods. So, it should be concluded that the GPS result was confirmed by the EDM result.

The absolute position of the new antenna in WGS84 was determined from the old reference coordinate as follows, which will be used as our new reference coordinate at OSIM;

$$\phi = 34^\circ\ 47'\ 50.720''\ \text{N}$$
$$\lambda = 139^\circ\ 22'\ 20.760''\ \text{E}$$
$$h = 143.87 \text{ m}.$$

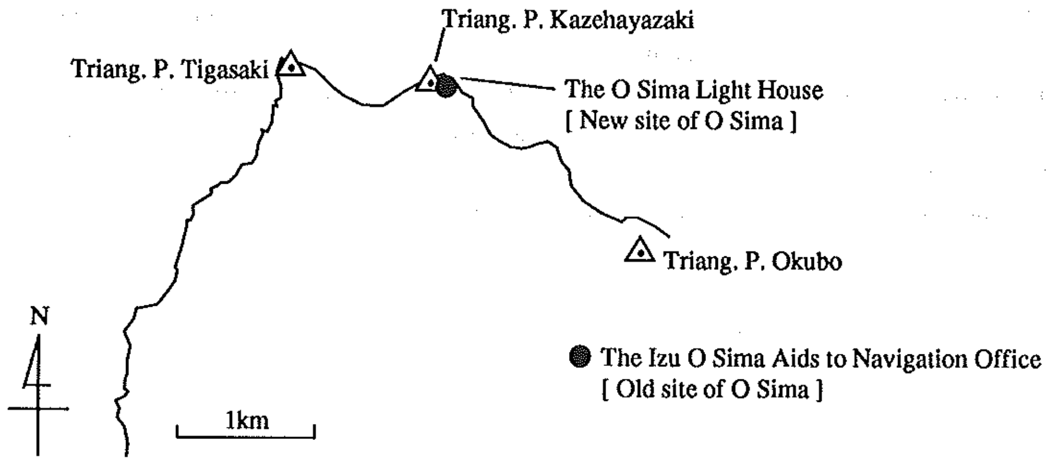


Figure 2. Site sketch for O Sima.

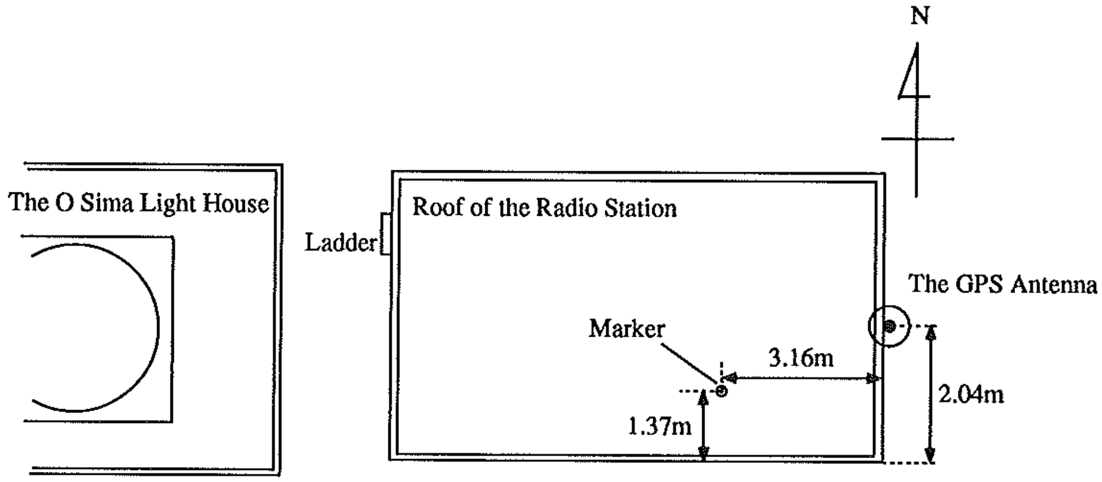


Figure 3. The O Sima Light House.

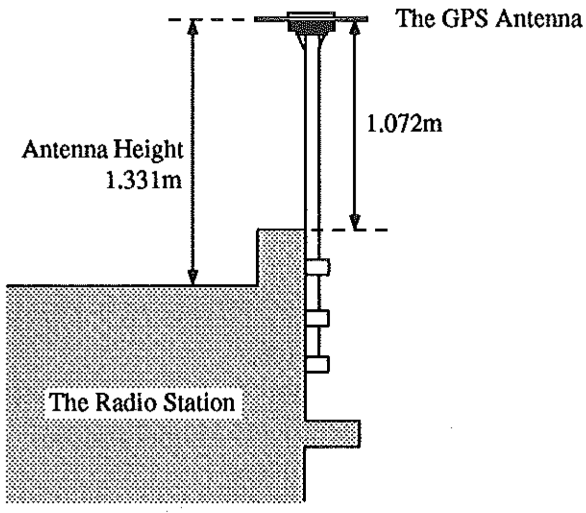


Figure 4. The GPS Antenna at O Sima.

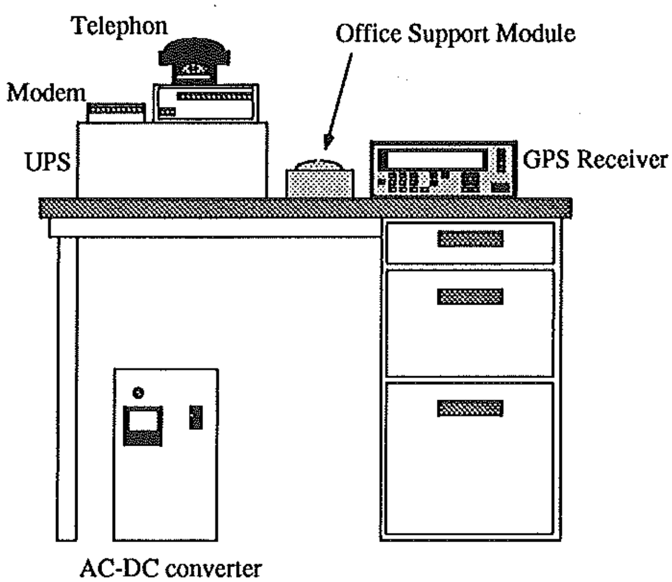


Figure 5. System configuration at O Sima.

Authors would like to greatly appreciate the kind assistance of Manazuru Town, the Izu O Sima Aids to Navigation Office, the Yokosuka Aids to Navigation Office and the Sirahama Hydrographic Observatory.

This report is written by K. Matsumoto, Y. Watanabe, Y. Takanashi and Y. Sumiya.

References

Sengoku, A., 1991: *GPS test observations around Sagami Bay in 1989, Data Report of Hydrographic Observation, series of Satellite Geodesy*, **4**, pp.96-108.

Sengoku, A., Fukushima, T., Kawai, K., Asai, K., Kawai, T., Fujii, T., 1990 : *GPS observation around Sagami Bay*, Jour. Japan Soc. Mar. Surv. Tech., **2**, pp.17-23. (in Japanese)

Sengoku, A., Kawai, K., 1992: *ibid.*, **5**, pp.95-114 (for 1990).

Sengoku, A., Kawai, K., Noda, H., 1993: *ibid.*, **6**, pp.70-81 (for 1991).

Uchiyama, T., Sengoku, A., Watanabe, Y., Takanashi, Y., 1994: *ibid.*, **7**, pp.61-78 (for 1992).

Reports on the GPS observations around Sagami Bay to the Coodinating Committee for Earthquake prediction appear in the following volume.

Hydrographic Department 1991a: *GPS observations around Sagami Bay* (Feb. - Nov., 1990), *Report of the Coordinating Committee for Earthquake Prediction*, **45**, pp.122-126. (in Japanese)

Hydrographic Department 1991b: *ibid.*(Apr.,1990-Apr.,1991), **46**, pp.108-113.

Hydrographic Department 1992a: *ibid.*(Apr.,1990-Nov.,1991), **47**, pp.144-149.

Hydrographic Department 1992b: *ibid.*(Apr.,1990-Apr.,1992), **48**, pp.167-173.

Hydrographic Department 1993a: *ibid.*(Apr.,1990-Nov.,1992), **49**, pp.169-173.

Hydrographic Department 1993b: *ibid.*(Apr.,1990-May,1993), **50**, pp.192-196.

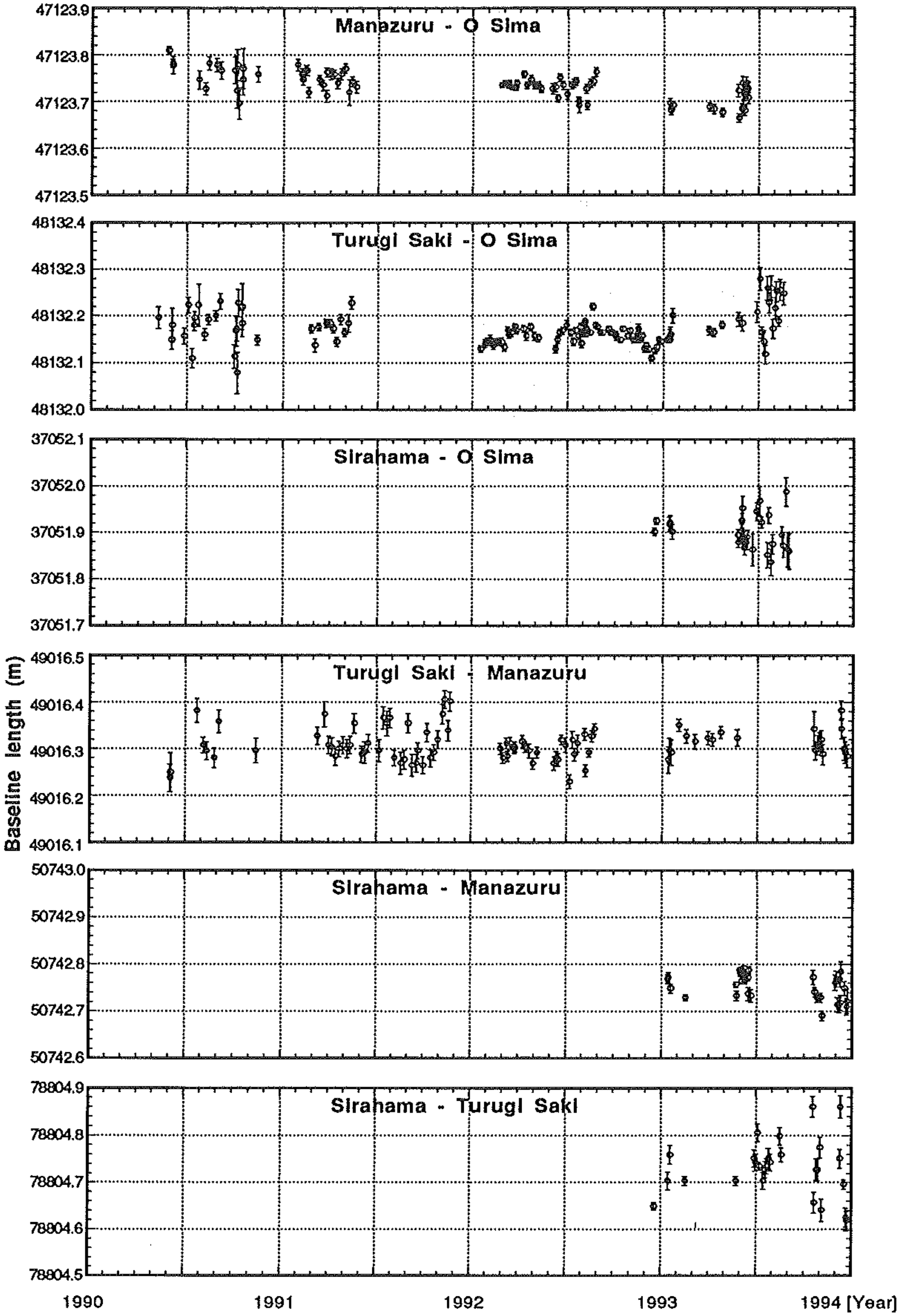


Figure 6. Baseline length

Table 1. Observation data

Explanation

Column

1	Serial number
2	Session number
3	Observation start date
4	Observation start time (UT)
5	Observation stop time (UT)
6	Observed satellites in PRN number
7	Acquired data size in byte (unit:k byte)

OSIM : O Sima
MANA : Manazuru
TURU : Turugi Saki
SIRA : Sirahama.

Table 1. Observation data

(1) No.	(2) session	(3) date		(4) start		(5) stop		(6) observed PRN#	(7) data size (K Byte)			
		M	D	h	m	h	m		OSIM	MANA	TURU	SIRA
1	007-1	1	7	21	48	4	8	3,13,16,17,18,19,24,26,27	820	0	815	0
2	011-1	1	11	21	32	3	30	3,13,16,17,18,19,24,26,27	785	0	778	0
3	012-1	1	12	18	30	23	30	2,13,14,16,18,19,24,29	693	448	691	742
4	014-1	1	14	18	22	23	22	2,13,14,15,16,18,19,24,29	694	465	686	780
5	018-1	1	18	18	6	23	6	2,13,14,15,16,18,19,24,29	696	466	688	781
6	032-1	2	1	20	8	2	8	3,13,16,18,19,24,26,27,29	0	585	809	0
7	039-1	2	8	19	40	2	0	3,13,16,17,18,19,24,26,27	0	0	802	791
8	043-1	2	12	4	0	5	0	1,12,20,21,23,25	0	103	0	163
9	046-1	2	15	19	12	1	12	3,13,16,18,19,24,26,27,29	0	586	807	1,002
10	063-1	3	4	18	4	0	24	3,13,16,17,18,19,24,26,27	0	588	804	1,002
11	074-1	3	15	17	20	23	40	3,13,16,17,18,19,24,26,27	0	584	803	722
12	088-1	3	29	16	24	22	24	3,13,16,18,19,24,26,27,29	427	584	774	1,002
13	097-1	4	7	15	48	21	48	3,16,17,18,19,24,26,27,29	422	586	798	722
14	113-1	4	23	14	44	20	44	3,16,17,18,19,24,26,27,29	432	581	802	1,002
15	144-1	5	24	12	40	18	40	3,13,16,18,19,24,26,27,29	834	581	0	1,010
16	145-1	5	25	12	36	18	36	3,13,16,18,19,24,26,27,29	717	767	805	1,009
17	149-1	5	29	23	50	6	0	1,3,14,17,20,22,25,28,29	0	0	807	1,239
18	151-1	5	31	12	12	18	12	3,13,16,18,19,24,26,27,29	836	581	0	1,013
19	152-1	6	1	12	8	18	8	3,13,16,18,19,24,26,27,29	837	583	823	1,011
20	153-1	6	2	12	4	18	4	3,13,16,17,18,19,24,26,27	833	581	823	585
21	154-1	6	3	12	0	18	0	3,13,16,18,19,24,26,27,29	834	581	0	1,010
22	155-1	6	4	11	56	17	56	3,13,16,17,18,19,24,26,27	837	581	0	713
23	156-1	6	5	11	52	17	52	3,13,16,18,19,24,26,27,29	843	582	0	1,010
24	157-1	6	6	11	48	17	48	3,13,16,17,18,19,24,26,27	833	583	0	713
25	158-1	6	7	11	44	17	44	3,13,16,18,19,24,26,27,29	835	583	0	0
26	159-1	6	8	11	40	17	40	3,13,16,18,19,24,26,27,29	834	585	0	1,009
27	160-1	6	9	11	36	17	36	3,13,16,18,19,24,26,27,29	838	582	0	715
28	162-1	6	11	11	28	17	28	3,13,16,17,18,19,24,26,27	831	579	0	1,001
29	163-1	6	12	11	24	17	24	3,13,16,18,19,24,26,27,29	835	578	0	0
30	164-1	6	13	11	24	17	24	7,13,16,18,19,24,26,27,29	51	219	0	0
31	167-1	6	16	11	8	17	8	3,7,13,16,18,19,24,26,27	0	383	0	1,045
32	168-1	6	17	11	4	17	4	3,7,13,16,18,19,24,26,27	0	602	0	679
33	172-1	6	21	10	48	16	48	3,7,13,16,18,19,24,26,27	811	725	0	1,010
34	180-1	6	29	10	16	16	16	7,13,16,18,19,24,26,27,29	852	693	639	1,045
35	182-1	7	1	10	8	16	8	7,13,16,18,19,24,26,27,29	0	771	655	1,044
36	186-1	7	5	9	52	15	52	3,7,13,16,18,19,24,26,27	844	752	656	1,038
37	189-1	7	8	11	0	17	0	3,13,16,17,18,19,24,26,27	851	765	636	1,012
38	193-1	7	12	9	24	15	24	3,7,13,16,18,19,24,26,27	837	765	657	0
39	196-1	7	15	9	12	15	12	7,13,16,18,19,24,26,27,29	839	739	654	1,045
40	200-1	7	19	8	56	14	56	7,13,16,18,19,24,26,27,29	839	748	657	1,046
41	203-1	7	22	8	44	14	44	7,13,16,18,19,24,26,27,29	845	744	690	1,106
42	207-1	7	26	8	28	14	28	7,13,16,18,19,24,26,27,29	836	751	692	556
43	210-1	7	29	8	16	14	16	7,13,16,18,19,24,26,27,29	837	777	690	1,107
44	214-1	8	2	8	0	14	0	7,13,16,18,19,24,26,27,29	845	707	335	0
45	217-1	8	5	7	48	13	48	7,13,16,18,19,24,26,27,29	846	744	692	0
46	221-1	8	9	8	10	14	10	3,7,13,16,18,19,24,26,27	844	754	691	0
47	224-1	8	12	7	20	13	20	7,13,16,18,19,24,26,27,29	847	773	685	0
48	228-1	8	16	7	4	13	4	7,13,16,18,19,24,26,27,29	846	721	690	1,110
49	231-1	8	19	6	52	12	52	7,13,16,18,19,24,26,27,29	834	0	700	1,110
50	236-1	8	24	6	32	12	32	7,13,16,18,19,24,26,27,29	831	0	0	1,112

Table 1. Observation data (continued)

(1) No.	(2) session	(3) date M	D	(4) start h	m	(5) stop h	m	(6) observed PRN#	(7) data size (K Byte) OSIM	MANA	TURU	SIRA
51	239-1	8	27	6	20	12	20	7,13,16,18,19,24,26,27,29	831	0	0	1,112
52	242-1	8	30	6	8	12	8	7,13,16,18,19,24,26,27,29	831	0	0	1,097
53	291-1	10	18	2	48	8	48	7,13,16,18,19,24,26,27,29	0	609	828	1,057
54	294-1	10	21	2	36	8	36	3,7,13,16,18,19,24,26,27	0	608	854	1,061
55	298-1	10	25	2	20	8	20	7,13,16,18,19,24,26,27,29	0	607	837	1,057
56	301-1	10	28	2	8	8	8	3,7,13,16,18,19,24,26,27	0	608	839	1,059
57	305-1	11	1	1	52	7	52	7,13,16,18,19,24,26,27,29	0	607	836	1,058
58	308-1	11	4	1	40	7	40	3,7,13,16,18,19,24,26,27	0	608	836	1,058
59	333-1	11	29	23	56	5	56	4,7,16,18,19,24,26,27,29	0	603	0	1,013
60	334-1	11	30	23	52	5	52	4,7,16,18,19,24,26,27,29	0	626	0	1,080
61	335-1	12	1	23	48	5	48	4,7,16,18,19,24,26,27,29	0	590	0	1,080
62	336-1	12	2	23	44	5	44	4,7,16,18,19,24,26,27,29	682	621	0	1,079
63	340-1	12	6	23	24	5	24	4,7,16,18,19,24,26,27,29	681	625	0	1,080
64	341-1	12	7	23	20	5	20	4,7,16,18,19,24,26,27,29	721	650	0	1,144
65	342-1	12	8	23	16	5	16	4,7,16,18,19,24,26,27,29	721	664	710	1,147
66	343-1	12	9	23	12	5	12	4,7,16,18,19,24,26,27,29	721	666	713	909
67	348-1	12	14	22	56	4	56	4,7,13,16,18,19,24,27,29	758	706	751	0
68	351-1	12	17	22	48	4	48	2,3,9,12,16,17,24,26,27	361	698	747	1,204
69	354-1	12	20	22	32	4	32	4,7,13,16,18,19,24,27,29	760	709	749	1,215
70	355-1	12	21	22	28	4	28	4,7,13,16,18,19,24,27,29	760	675	752	1,215

Table 2. Analyzed results

Explanation

Column	
1	Serial number
2	Session number
3	Slope distance between two stations with estimated RMS (unit:m)
4	Latitude difference with estimated RMS (unit:arc sec.)
5	Longitude difference with estimated RMS (unit:arc sec.)
6	Height difference with estimated RMS (unit:arc sec.)
7,8,9	Difference in Earth-fixed rectangular coordinate with estimated RMS (unit:m)
10	RMS of residuals (unit:cycle)

Table 2. Analyzed results (Manazuru - Old site of O Sima)

No.	Session	slope distance		d φ		d λ		d h		d x		d y		d z		rms
1	12-1	47123.6942	0.0104	1347.9560	0.0002	-877.0829	0.0009	-64.3890	0.0120	32599.396	0.011	1286.553	0.023	34003.922	0.008	0.086
2	14-1	47123.6805	0.0080	1347.9555	0.0002	-877.0829	0.0008	-64.4105	0.0103	32599.403	0.010	1286.547	0.019	34003.897	0.006	0.074
3	18-1	47123.6897	0.0086	1347.9554	0.0002	-877.0839	0.0008	-64.3894	0.0117	32599.405	0.010	1286.578	0.021	34003.906	0.007	0.077
4	88-1	47123.6869	0.0091	1347.9551	0.0002	-877.0843	0.0004	-64.3298	0.0157	32599.371	0.013	1286.622	0.011	34003.933	0.010	0.075
5	97-1	47123.6820	0.0103	1347.9550	0.0003	-877.0841	0.0004	-64.3796	0.0174	32599.397	0.014	1286.592	0.013	34003.902	0.011	0.087
6	113-1	47123.6776	0.0090	1347.9550	0.0002	-877.0838	0.0004	-64.3318	0.0146	32599.362	0.012	1286.613	0.011	34003.929	0.009	0.073
7	144-1	47123.7215	0.0135	1347.9557	0.0003	-877.0860	0.0008	-64.3392	0.0162	32599.412	0.018	1286.643	0.019	34003.941	0.008	0.084
8	145-1	47123.6658	0.0099	1347.9550	0.0003	-877.0828	0.0005	-64.2929	0.0155	32599.322	0.014	1286.614	0.016	34003.952	0.007	0.079
9	151-1	47123.6853	0.0116	1347.9555	0.0003	-877.0833	0.0007	-64.3204	0.0136	32599.353	0.015	1286.602	0.017	34003.949	0.007	0.078
10	152-1	47123.7374	0.0143	1347.9560	0.0003	-877.0865	0.0008	-64.2486	0.0161	32599.369	0.019	1286.697	0.019	34004.002	0.007	0.088
11	153-1	47123.6886	0.0145	1347.9550	0.0003	-877.0847	0.0008	-64.3067	0.0173	32599.362	0.019	1286.643	0.021	34003.944	0.008	0.098
12	154-1	47123.7176	0.0134	1347.9562	0.0003	-877.0844	0.0008	-64.4020	0.0152	32599.431	0.017	1286.571	0.019	34003.920	0.007	0.093
13	155-1	47123.7134	0.0116	1347.9556	0.0003	-877.0854	0.0007	-64.3082	0.0138	32599.382	0.015	1286.648	0.017	34003.958	0.007	0.082
14	156-1	47123.6798	0.0102	1347.9548	0.0003	-877.0845	0.0006	-64.2558	0.0149	32599.323	0.014	1286.668	0.017	34003.967	0.007	0.084
15	157-1	47123.7207	0.0118	1347.9557	0.0003	-877.0857	0.0007	-64.3087	0.0138	32599.390	0.015	1286.653	0.017	34003.961	0.007	0.083
16	158-1	47123.7154	0.0119	1347.9558	0.0003	-877.0851	0.0007	-64.3084	0.0138	32599.380	0.015	1286.639	0.017	34003.964	0.007	0.085
17	159-1	47123.7379	0.0130	1347.9563	0.0003	-877.0859	0.0008	-64.3200	0.0146	32599.407	0.017	1286.644	0.018	34003.969	0.007	0.084
18	160-1	47123.7257	0.0128	1347.9559	0.0003	-877.0858	0.0008	-64.3224	0.0156	32599.401	0.017	1286.645	0.019	34003.957	0.008	0.092
19	162-1	47123.7273	0.0144	1347.9560	0.0003	-877.0857	0.0008	-64.2951	0.0156	32599.385	0.018	1286.658	0.020	34003.975	0.008	0.091
20	163-1	47123.7064	0.0122	1347.9560	0.0003	-877.0839	0.0007	-64.3219	0.0146	32599.371	0.016	1286.608	0.018	34003.961	0.007	0.081
21	164-1	47123.7885	0.0584	1347.9556	0.0006	-877.0916	0.0047	-64.2659	0.0569	32599.459	0.064	1286.790	0.112	34003.983	0.031	0.059
22	172-1	47123.7707	0.0235	1347.9551	0.0006	-877.0914	0.0019	-64.1884	0.0336	32599.401	0.028	1286.834	0.054	34004.013	0.012	0.092
23	180-1	47123.6935	0.0154	1347.9551	0.0007	-877.0849	0.0014	-64.2875	0.0413	32599.354	0.024	1286.656	0.051	34003.957	0.013	0.098
24	186-1	47123.7297	0.0203	1347.9552	0.0004	-877.0878	0.0017	-64.3812	0.0283	32599.461	0.024	1286.659	0.046	34003.905	0.012	0.096
25	189-1	47123.6870	0.0099	1347.9559	0.0003	-877.0826	0.0005	-64.3044	0.0145	32599.337	0.014	1286.595	0.014	34003.967	0.008	0.072

Table 2. Analyzed results (Manazuru - Old site of O Sima) (continued)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
26	193-1	47123.7087	0.0167	1347.9557	0.0003	-877.0848	0.0014	-64.3361	0.0214	32599.391	0.020	1286.621	0.036	34003.944	0.009	0.074
27	196-1	47123.7038	0.0309	1347.9559	0.0005	-877.0839	0.0024	-64.3406	0.0331	32599.382	0.034	1286.599	0.061	34003.948	0.015	0.101
28	200-1	47123.7074	0.0205	1347.9557	0.0004	-877.0847	0.0016	-64.2595	0.0259	32599.342	0.025	1286.661	0.042	34003.988	0.011	0.086
29	203-1	47123.6873	0.0097	1347.9556	0.0003	-877.0833	0.0008	-64.3271	0.0201	32599.359	0.015	1286.599	0.025	34003.946	0.007	0.062
30	207-1	47123.7152	0.0231	1347.9549	0.0004	-877.0871	0.0018	-64.2805	0.0279	32599.384	0.029	1286.704	0.046	34003.957	0.011	0.084
31	210-1	47123.7107	0.0109	1347.9561	0.0003	-877.0840	0.0010	-64.3670	0.0208	32599.402	0.015	1286.584	0.029	34003.938	0.008	0.072
32	214-1	47123.7004	0.0107	1347.9561	0.0003	-877.0833	0.0008	-64.3994	0.0212	32599.410	0.016	1286.555	0.025	34003.917	0.009	0.060
33	217-1	47123.7024	0.0106	1347.9560	0.0003	-877.0835	0.0009	-64.3527	0.0209	32599.384	0.016	1286.584	0.026	34003.943	0.009	0.070
34	221-1	47123.7019	0.0119	1347.9567	0.0004	-877.0820	0.0006	-64.4271	0.0221	32599.414	0.019	1286.507	0.020	34003.917	0.010	0.084
35	224-1	47123.6591	0.0110	1347.9552	0.0003	-877.0818	0.0010	-64.2872	0.0247	32599.304	0.015	1286.596	0.031	34003.960	0.011	0.078
36	228-1	47123.6624	0.0116	1347.9555	0.0003	-877.0814	0.0009	-64.3308	0.0224	32599.329	0.017	1286.561	0.028	34003.942	0.009	0.071

Table 2. Analyzed results (Manazuru - New site of O Sima)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	336-1	45113.2028	0.0084	1290.2379	0.0003	-840.2175	0.0009	-52.8213	0.0244	31211.696	0.013	1242.092	0.030	32549.782	0.010	0.059
2	340-1	45113.2009	0.0082	1290.2378	0.0003	-840.2177	0.0008	-52.8334	0.0237	31211.704	0.013	1242.091	0.029	32549.771	0.010	0.056
3	341-1	45113.1988	0.0088	1290.2374	0.0003	-840.2183	0.0009	-52.7655	0.0262	31211.668	0.014	1242.144	0.032	32549.801	0.011	0.062
4	342-1	45113.2182	0.0081	1290.2371	0.0003	-840.2207	0.0008	-52.7376	0.0237	31211.686	0.013	1242.208	0.029	32549.809	0.010	0.058
5	343-1	45113.2302	0.0082	1290.2382	0.0003	-840.2191	0.0008	-52.8026	0.0238	31211.716	0.013	1242.131	0.029	32549.800	0.010	0.058
6	348-1	45113.2039	0.0094	1290.2376	0.0003	-840.2184	0.0010	-52.8039	0.0245	31211.696	0.011	1242.123	0.032	32549.783	0.012	0.054
7	351-1	45113.1908	0.0218	1290.2379	0.0005	-840.2166	0.0009	-52.7780	0.0260	31211.654	0.032	1242.100	0.017	32549.805	0.012	0.074
8	354-1	45113.2166	0.0099	1290.2380	0.0003	-840.2184	0.0010	-52.8020	0.0255	31211.701	0.012	1242.119	0.034	32549.796	0.012	0.058
9	355-1	45113.2372	0.0128	1290.2373	0.0004	-840.2219	0.0016	-52.7628	0.0270	31211.723	0.017	1242.216	0.046	32549.799	0.012	0.055

Table 2. Analyzed results (Turugi Saki - Old site of O Sima)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	7-1	48132.1471	0.0059	1296.2487	0.0001	1058.3655	0.0003	-78.5929	0.0107	35.064	0.008	-35325.400	0.010	32692.789	0.006	0.069
2	11-1	48132.1481	0.0061	1296.2486	0.0001	1058.3658	0.0003	-78.5659	0.0112	35.041	0.008	-35325.390	0.011	32692.802	0.006	0.069
3	12-1	48132.1552	0.0137	1296.2490	0.0002	1058.3655	0.0008	-78.5844	0.0108	35.064	0.010	-35325.399	0.020	32692.802	0.007	0.077
4	14-1	48132.1599	0.0151	1296.2486	0.0002	1058.3666	0.0009	-78.5474	0.0116	35.017	0.011	-35325.396	0.022	32692.813	0.007	0.084
5	18-1	48132.1980	0.0151	1296.2489	0.0002	1058.3688	0.0009	-78.5559	0.0122	34.989	0.011	-35325.446	0.023	32692.814	0.007	0.086
6	88-1	48132.1699	0.0092	1296.2481	0.0003	1058.3681	0.0005	-78.4168	0.0227	34.904	0.018	-35325.351	0.017	32692.876	0.013	0.091
7	97-1	48132.1636	0.0088	1296.2478	0.0003	1058.3684	0.0005	-78.4360	0.0228	34.907	0.018	-35325.362	0.017	32692.855	0.013	0.087
8	113-1	48132.1782	0.0078	1296.2485	0.0003	1058.3681	0.0004	-78.3496	0.0199	34.866	0.016	-35325.319	0.015	32692.922	0.011	0.078
9	145-1	48132.1900	0.0146	1296.2480	0.0003	1058.3699	0.0008	-78.4188	0.0209	34.874	0.017	-35325.384	0.023	32692.870	0.010	0.099
10	152-1	48132.1818	0.0168	1296.2493	0.0004	1058.3670	0.0011	-78.4659	0.0205	34.969	0.023	-35325.367	0.026	32692.876	0.010	0.112
11	180-1	48132.2082	0.0218	1296.2498	0.0004	1058.3679	0.0011	-78.6140	0.0229	35.054	0.016	-35325.469	0.032	32692.804	0.010	0.093
12	186-1	48132.2787	0.0243	1296.2507	0.0004	1058.3713	0.0014	-78.7060	0.0230	35.067	0.020	-35325.594	0.037	32692.774	0.009	0.098
13	189-1	48132.1659	0.0118	1296.2488	0.0003	1058.3667	0.0006	-78.5786	0.0168	35.037	0.017	-35325.417	0.015	32692.799	0.009	0.089
14	193-1	48132.1426	0.0243	1296.2501	0.0004	1058.3626	0.0015	-78.5669	0.0228	35.115	0.022	-35325.347	0.038	32692.840	0.009	0.089
15	196-1	48132.1168	0.0196	1296.2499	0.0003	1058.3612	0.0012	-78.5870	0.0188	35.148	0.019	-35325.327	0.030	32692.823	0.008	0.075
16	200-1	48132.2593	0.0257	1296.2508	0.0004	1058.3696	0.0014	-78.5902	0.0248	35.024	0.022	-35325.502	0.039	32692.844	0.009	0.095
17	203-1	48132.2247	0.0213	1296.2502	0.0004	1058.3683	0.0011	-78.6109	0.0236	35.050	0.017	-35325.481	0.032	32692.816	0.010	0.100
18	207-1	48132.2573	0.0259	1296.2509	0.0004	1058.3694	0.0015	-78.6294	0.0240	35.053	0.022	-35325.519	0.039	32692.823	0.010	0.102
19	210-1	48132.1734	0.0201	1296.2500	0.0003	1058.3651	0.0011	-78.6535	0.0219	35.126	0.017	-35325.439	0.031	32692.786	0.009	0.090
20	214-1	48132.2149	0.0224	1296.2498	0.0004	1058.3683	0.0012	-78.5902	0.0241	35.030	0.020	-35325.466	0.034	32692.818	0.010	0.094
21	217-1	48132.2495	0.0217	1296.2500	0.0004	1058.3705	0.0011	-78.6295	0.0236	35.023	0.017	-35325.530	0.033	32692.800	0.009	0.100
22	221-1	48132.1885	0.0106	1296.2484	0.0003	1058.3690	0.0005	-78.5381	0.0150	34.969	0.014	-35325.435	0.014	32692.813	0.008	0.078
23	224-1	48132.2546	0.0226	1296.2499	0.0004	1058.3710	0.0012	-78.6036	0.0279	34.997	0.017	-35325.525	0.037	32692.812	0.012	0.098
24	228-1	48132.3274	0.0221	1296.2518	0.0004	1058.3726	0.0011	-78.6889	0.0245	35.049	0.019	-35325.624	0.033	32692.812	0.011	0.108
25	231-1	48132.2457	0.0240	1296.2505	0.0003	1058.3692	0.0013	-78.6211	0.0220	35.046	0.019	-35325.507	0.036	32692.819	0.009	0.094

Table 2. Analyzed results (Turugi Saki - New site of O Sima)

No.	Session	slope distance		d φ		d λ		d h		d x		d y		d z		rms
1	342-1	47209.2913	0.0088	1238.5313	0.0001	1095.2350	0.0004	-67.0320	0.0106	-1352.688	0.006	-35369.950	0.013	31238.663	0.005	0.030
2	343-1	47209.2650	0.0102	1238.5312	0.0002	1095.2334	0.0005	-66.9948	0.0124	-1352.688	0.007	-35369.899	0.016	31238.681	0.005	0.035
3	348-1	47209.2530	0.0107	1238.5307	0.0002	1095.2334	0.0005	-66.9935	0.0124	-1352.695	0.006	-35369.893	0.017	31238.670	0.006	0.032
4	351-1	47209.2596	0.0048	1238.5306	0.0002	1095.2340	0.0003	-66.9729	0.0098	-1352.719	0.011	-35369.892	0.007	31238.680	0.005	0.031
5	354-1	47209.2525	0.0105	1238.5306	0.0002	1095.2336	0.0005	-66.9364	0.0125	-1352.736	0.006	-35369.864	0.017	31238.699	0.006	0.031
6	355-1	47209.2528	0.0127	1238.5303	0.0002	1095.2342	0.0006	-66.9569	0.0151	-1352.736	0.007	-35369.882	0.020	31238.679	0.008	0.038

Table 2. Analyzed results (Sirahama - Old site of O Sima)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	12-1	37051.9188	0.0158	-234.7241	0.0001	-1428.6563	0.0006	58.7564	0.008	20595.418	0.008	30228.247	0.016	-5909.867	0.005	0.058
2	14-1	37051.9205	0.0156	-234.7242	0.0001	-1428.6563	0.0006	58.7260	0.009	20595.436	0.008	30228.233	0.016	-5909.886	0.005	0.063
3	18-1	37051.9028	0.0160	-234.7244	0.0001	-1428.6556	0.0006	58.7049	0.009	20595.434	0.007	30228.209	0.016	-5909.903	0.005	0.063
4	144-1	37051.8940	0.0131	-234.7248	0.0002	-1428.6551	0.0005	58.7187	0.010	20595.412	0.011	30228.213	0.013	-5909.906	0.005	0.062
5	145-1	37051.8807	0.0111	-234.7244	0.0002	-1428.6547	0.0004	58.6983	0.012	20595.422	0.011	30228.189	0.013	-5909.909	0.006	0.076
6	151-1	37051.9021	0.0164	-234.7253	0.0002	-1428.6553	0.0007	58.7397	0.013	20595.395	0.013	30228.234	0.017	-5909.908	0.006	0.082
7	152-1	37051.9266	0.0155	-234.7248	0.0002	-1428.6564	0.0006	58.7799	0.012	20595.397	0.013	30228.271	0.015	-5909.870	0.006	0.075
8	153-1	37051.9538	0.0251	-234.7252	0.0003	-1428.6574	0.0010	58.7692	0.017	20595.414	0.018	30228.289	0.025	-5909.888	0.008	0.102
9	154-1	37051.8914	0.0145	-234.7247	0.0002	-1428.6550	0.0006	58.7131	0.012	20595.415	0.012	30228.207	0.015	-5909.907	0.006	0.070
10	155-1	37051.8772	0.0143	-234.7245	0.0002	-1428.6545	0.0006	58.7119	0.011	20595.410	0.012	30228.194	0.014	-5909.903	0.006	0.069
11	156-1	37051.8889	0.0130	-234.7253	0.0002	-1428.6548	0.0005	58.6893	0.012	20595.418	0.011	30228.197	0.014	-5909.936	0.006	0.075
12	157-1	37051.8682	0.0153	-234.7250	0.0002	-1428.6540	0.0006	58.7494	0.011	20595.371	0.012	30228.211	0.015	-5909.895	0.005	0.073
13	159-1	37051.8807	0.0158	-234.7254	0.0002	-1428.6544	0.0006	58.7836	0.012	20595.352	0.013	30228.242	0.016	-5909.885	0.006	0.078
14	160-1	37051.8770	0.0152	-234.7251	0.0002	-1428.6544	0.0006	58.7220	0.011	20595.394	0.012	30228.204	0.015	-5909.911	0.006	0.070
15	162-1	37051.8910	0.0144	-234.7251	0.0002	-1428.6549	0.0006	58.7350	0.012	20595.395	0.012	30228.221	0.015	-5909.904	0.006	0.073
16	172-1	37051.8645	0.0349	-234.7241	0.0004	-1428.6541	0.0013	58.6813	0.024	20595.428	0.018	30228.165	0.039	-5909.909	0.008	0.087
17	180-1	37051.9454	0.0197	-234.7256	0.0003	-1428.6570	0.0008	58.7706	0.017	20595.400	0.011	30228.286	0.023	-5909.898	0.007	0.072
18	186-1	37051.9675	0.0327	-234.7266	0.0003	-1428.6576	0.0013	58.8133	0.021	20595.371	0.017	30228.332	0.035	-5909.898	0.008	0.090
19	189-1	37051.9215	0.0117	-234.7248	0.0003	-1428.6562	0.0004	58.7331	0.013	20595.421	0.012	30228.242	0.012	-5909.899	0.008	0.077
20	196-1	37051.7595	0.0340	-234.7240	0.0003	-1428.6499	0.0014	58.6667	0.021	20595.368	0.019	30228.076	0.036	-5909.916	0.009	0.094
21	200-1	37051.8508	0.0273	-234.7248	0.0003	-1428.6534	0.0010	58.7266	0.017	20595.378	0.014	30228.184	0.029	-5909.902	0.007	0.074
22	203-1	37051.9362	0.0170	-234.7246	0.0002	-1428.6568	0.0006	58.7225	0.015	20595.441	0.010	30228.246	0.020	-5909.900	0.006	0.064
23	207-1	37051.8352	0.0287	-234.7241	0.0003	-1428.6529	0.0011	58.6928	0.017	20595.400	0.016	30228.149	0.029	-5909.904	0.008	0.076
24	210-1	37051.8758	0.0206	-234.7247	0.0002	-1428.6544	0.0008	58.7398	0.015	20595.389	0.011	30228.209	0.023	-5909.891	0.006	0.069
25	228-1	37051.8955	0.0181	-234.7247	0.0002	-1428.6552	0.0007	58.7022	0.015	20595.426	0.010	30228.204	0.021	-5909.912	0.007	0.071

Table 2. Analyzed results (Sirahama - Old site of O Sima) (continued)

No.	Session	slope distance		d φ		d λ		d h		d x		d y		d z		rms
26	231-1	37051.8701	0.0243	-234.7241	0.0003	-1428.6543	0.0009	58.6944	0.016	20595.423	0.013	30228.177	0.026	-5909.904	0.006	0.068
27	236-1	37051.9865	0.0307	-234.7249	0.0003	-1428.6588	0.0012	58.7866	0.018	20595.431	0.015	30228.321	0.032	-5909.869	0.007	0.079
28	239-1	37051.8633	0.0379	-234.7251	0.0004	-1428.6538	0.0015	58.5955	0.024	20595.462	0.020	30228.126	0.040	-5909.985	0.010	0.102
29	242-1	37051.8599	0.0385	-234.7240	0.0004	-1428.6539	0.0015	58.6012	0.025	20595.476	0.019	30228.118	0.042	-5909.953	0.010	0.096

Table 2. Analyzed results (Sirahama - New site of O Sima)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	336-1	36527.0241	0.0204	-292.4435	0.0003	-1391.7890	0.0008	70.3259	0.0204	19207.669	0.011	30183.768	0.026	-7364.039	0.009	0.056
2	340-1	36527.0997	0.0204	-292.4436	0.0003	-1391.7921	0.0008	70.3052	0.0204	19207.732	0.011	30183.817	0.026	-7364.053	0.009	0.058
3	341-1	36526.9659	0.0211	-292.4426	0.0003	-1391.7869	0.0008	70.2381	0.0212	19207.701	0.012	30183.671	0.027	-7364.066	0.009	0.058
4	342-1	36527.0283	0.0203	-292.4429	0.0003	-1391.7894	0.0008	70.3174	0.0203	19207.688	0.011	30183.764	0.026	-7364.029	0.009	0.056
5	343-1	36527.1047	0.0238	-292.4443	0.0004	-1391.7920	0.0009	70.2922	0.0302	19207.729	0.016	30183.818	0.034	-7364.080	0.012	0.057
6	351-1	36527.0205	0.0120	-292.4423	0.0003	-1391.7893	0.0005	70.2372	0.0166	19207.744	0.019	30183.711	0.011	-7364.059	0.009	0.053
7	354-1	36526.9804	0.0230	-292.4430	0.0003	-1391.7874	0.0009	70.2605	0.0213	19207.689	0.010	30183.697	0.029	-7364.064	0.010	0.053
8	355-1	36527.0422	0.0231	-292.4432	0.0003	-1391.7898	0.0009	70.3172	0.0215	19207.692	0.010	30183.776	0.029	-7364.037	0.010	0.052

Table 2. Analyzed results (Turugi Saki - Manazuru)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	12-1	49016.2782	0.0283	-51.7079	0.0002	1935.4508	0.0011	-14.1433	0.0146	-32564.386	0.014	-36611.982	0.028	-1311.113	0.009	0.105
2	14-1	49016.2969	0.0268	-51.7078	0.0002	1935.4515	0.0011	-14.1104	0.0146	-32564.418	0.013	-36611.980	0.027	-1311.092	0.009	0.093
3	18-1	49016.2940	0.0270	-51.7070	0.0002	1935.4514	0.0011	-14.1029	0.0154	-32564.410	0.013	-36611.984	0.028	-1311.066	0.009	0.106
4	32-1	49016.3497	0.0131	-51.7075	0.0002	1935.4536	0.0005	-14.1793	0.0170	-32564.405	0.011	-36612.061	0.018	-1311.123	0.008	0.091
5	46-1	49016.3277	0.0143	-51.7070	0.0002	1935.4527	0.0006	-14.1406	0.0192	-32564.408	0.012	-36612.030	0.020	-1311.088	0.009	0.099
6	63-1	49016.3177	0.0162	-51.7067	0.0003	1935.4524	0.0006	-14.1018	0.0215	-32564.422	0.013	-36612.005	0.023	-1311.058	0.010	0.102
7	88-1	49016.3227	0.0139	-51.7067	0.0003	1935.4526	0.0006	-14.1130	0.0192	-32564.418	0.012	-36612.015	0.020	-1311.064	0.009	0.097
8	97-1	49016.3196	0.0138	-51.7073	0.0002	1935.4524	0.0005	-14.0143	0.0200	-32564.486	0.012	-36611.953	0.020	-1311.023	0.010	0.093
9	113-1	49016.3365	0.0127	-51.7062	0.0002	1935.4531	0.0005	-14.0962	0.0172	-32564.432	0.011	-36612.023	0.018	-1311.043	0.008	0.087
10	145-1	49016.3251	0.0182	-51.7073	0.0004	1935.4526	0.0007	-14.1098	0.0237	-32564.430	0.018	-36612.007	0.024	-1311.080	0.011	0.103
11	180-1	49016.3092	0.0183	-51.7088	0.0006	1935.4519	0.0007	-14.1346	0.0306	-32564.424	0.028	-36611.990	0.025	-1311.131	0.013	0.115
12	182-1	49016.3671	0.0215	-51.7066	0.0003	1935.4543	0.0009	-14.1995	0.0224	-32564.392	0.017	-36612.097	0.027	-1311.111	0.009	0.089
13	186-1	49016.3879	0.0172	-51.7080	0.0003	1935.4551	0.0007	-14.0979	0.0206	-32564.487	0.018	-36612.040	0.020	-1311.090	0.010	0.102
14	189-1	49016.2924	0.0165	-51.7067	0.0004	1935.4514	0.0007	-14.2303	0.0226	-32564.326	0.021	-36612.054	0.020	-1311.133	0.012	0.109
15	193-1	49016.3397	0.0164	-51.7077	0.0003	1935.4532	0.0007	-14.1301	0.0198	-32564.432	0.018	-36612.024	0.019	-1311.101	0.010	0.104
16	196-1	49016.3624	0.0173	-51.7076	0.0003	1935.4541	0.0007	-14.1592	0.0221	-32564.427	0.018	-36612.059	0.021	-1311.114	0.011	0.091
17	200-1	49016.4516	0.0234	-51.7054	0.0004	1935.4577	0.0009	-14.3078	0.0242	-32564.364	0.018	-36612.233	0.029	-1311.144	0.010	0.084
18	203-1	49016.4300	0.0258	-51.7061	0.0005	1935.4568	0.0010	-14.2168	0.0297	-32564.416	0.021	-36612.160	0.035	-1311.109	0.011	0.098
19	207-1	49016.3154	0.0154	-51.7064	0.0004	1935.4523	0.0006	-14.2127	0.0238	-32564.348	0.022	-36612.067	0.018	-1311.114	0.011	0.093
20	210-1	49016.3445	0.0214	-51.7062	0.0003	1935.4535	0.0009	-14.2722	0.0233	-32564.327	0.017	-36612.123	0.027	-1311.143	0.010	0.092
21	214-1	49016.4705	0.0275	-51.7059	0.0003	1935.4585	0.0011	-14.3282	0.0252	-32564.370	0.020	-36612.252	0.031	-1311.168	0.012	0.072
22	217-1	49016.3933	0.0176	-51.7062	0.0004	1935.4554	0.0007	-14.2245	0.0246	-32564.389	0.021	-36612.134	0.022	-1311.118	0.011	0.093
23	221-1	49016.3052	0.0185	-51.7082	0.0005	1935.4518	0.0008	-14.1226	0.0282	-32564.420	0.025	-36611.988	0.025	-1311.108	0.012	0.110
24	224-1	49016.4450	0.0293	-51.7063	0.0004	1935.4574	0.0012	-14.3444	0.0288	-32564.349	0.019	-36612.236	0.036	-1311.188	0.013	0.108
25	228-1	49016.4271	0.0252	-51.7058	0.0004	1935.4568	0.0010	-14.2786	0.0258	-32564.372	0.020	-36612.193	0.030	-1311.139	0.011	0.088

Table 2. Analyzed results (Turugi Saki - Manazuru) (continued)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
26	291-1	49016.3421	0.0366	-51.7055	0.0005	1935.4534	0.0014	-14.2933	0.0340	-32564.303	0.022	-36612.141	0.045	-1311.138	0.015	0.073
27	294-1	49016.2965	0.0195	-51.7062	0.0004	1935.4515	0.0008	-14.1373	0.0227	-32564.380	0.020	-36612.014	0.022	-1311.067	0.012	0.068
28	298-1	49016.3090	0.0209	-51.7059	0.0004	1935.4521	0.0008	-14.2180	0.0238	-32564.335	0.021	-36612.070	0.024	-1311.106	0.012	0.071
29	301-1	49016.3169	0.0200	-51.7066	0.0004	1935.4524	0.0008	-14.2226	0.0237	-32564.345	0.021	-36612.071	0.023	-1311.125	0.012	0.068
30	305-1	49016.3192	0.0198	-51.7067	0.0004	1935.4524	0.0008	-14.2457	0.0234	-32564.333	0.021	-36612.083	0.023	-1311.140	0.011	0.067
31	308-1	49016.2884	0.0224	-51.7045	0.0004	1935.4513	0.0009	-14.3318	0.0253	-32564.232	0.023	-36612.133	0.025	-1311.135	0.013	0.078
32	342-1	49016.3829	0.0206	-51.7062	0.0003	1935.4550	0.0008	-14.2760	0.0229	-32564.349	0.012	-36612.154	0.028	-1311.145	0.010	0.057
33	343-1	49016.3441	0.0216	-51.7060	0.0003	1935.4534	0.0009	-14.1991	0.0249	-32564.371	0.013	-36612.085	0.030	-1311.098	0.011	0.060
34	348-1	49016.3010	0.0245	-51.7075	0.0003	1935.4517	0.0010	-14.1830	0.0239	-32564.371	0.011	-36612.026	0.032	-1311.125	0.011	0.055
35	351-1	49016.2936	0.0236	-51.7075	0.0005	1935.4514	0.0009	-14.1713	0.0259	-32564.374	0.032	-36612.014	0.017	-1311.119	0.012	0.076
36	354-1	49016.2842	0.0246	-51.7079	0.0003	1935.4510	0.0010	-14.1415	0.0238	-32564.392	0.011	-36611.986	0.032	-1311.112	0.011	0.055
37	355-1	49016.2032	0.0412	-51.7086	0.0004	1935.4478	0.0016	-14.0908	0.0272	-32564.379	0.017	-36611.889	0.047	-1311.099	0.012	0.056

Table 2. Analyzed results (Sirahama - Manazuru)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	12-1	50742.7694	0.0097	-1582.6805	0.0002	-551.5744	0.0008	123.1601	0.0112	-12003.986	0.011	28941.708	0.021	-39913.788	0.007	0.085
2	14-1	50742.7734	0.0097	-1582.6807	0.0002	-551.5743	0.0008	123.1608	0.0111	-12003.991	0.011	28941.708	0.021	-39913.792	0.007	0.084
3	18-1	50742.7500	0.0097	-1582.6803	0.0002	-551.5725	0.0008	123.1071	0.0119	-12003.983	0.010	28941.640	0.021	-39913.814	0.007	0.083
4	43-1	50742.7417	0.0172	-1582.6797	0.0004	-551.5737	0.0016	123.0993	0.0231	-12003.948	0.032	28941.652	0.034	-39913.805	0.010	0.078
5	46-1	50742.7291	0.0063	-1582.6798	0.0002	-551.5719	0.0004	123.1112	0.0122	-12003.989	0.009	28941.624	0.012	-39913.797	0.006	0.080
6	144-1	50742.7591	0.0052	-1582.6805	0.0002	-551.5728	0.0003	123.1209	0.0117	-12003.989	0.010	28941.657	0.010	-39913.812	0.006	0.079
7	145-1	50742.7357	0.0098	-1582.6801	0.0003	-551.5713	0.0005	123.0166	0.0169	-12003.944	0.015	28941.567	0.016	-39913.861	0.008	0.090
8	151-1	50742.7888	0.0053	-1582.6811	0.0002	-551.5747	0.0003	123.0622	0.0109	-12003.929	0.009	28941.667	0.010	-39913.860	0.006	0.084
9	152-1	50742.7825	0.0052	-1582.6814	0.0002	-551.5727	0.0003	123.0532	0.0110	-12003.960	0.009	28941.628	0.010	-39913.871	0.006	0.083
10	153-1	50742.7854	0.0094	-1582.6813	0.0003	-551.5733	0.0005	123.1528	0.0161	-12004.012	0.012	28941.691	0.017	-39913.813	0.008	0.095
11	154-1	50742.7883	0.0054	-1582.6812	0.0002	-551.5741	0.0003	123.1384	0.0111	-12003.989	0.009	28941.697	0.010	-39913.819	0.006	0.087
12	155-1	50742.7654	0.0060	-1582.6809	0.0002	-551.5721	0.0004	123.0535	0.0112	-12003.965	0.009	28941.611	0.011	-39913.860	0.006	0.078
13	156-1	50742.7862	0.0054	-1582.6814	0.0002	-551.5732	0.0003	122.9927	0.0111	-12003.916	0.009	28941.604	0.010	-39913.907	0.006	0.084
14	157-1	50742.7803	0.0064	-1582.6814	0.0002	-551.5721	0.0004	123.1136	0.0112	-12004.008	0.009	28941.649	0.011	-39913.838	0.006	0.077
15	159-1	50742.7925	0.0057	-1582.6814	0.0002	-551.5738	0.0004	123.1236	0.0113	-12003.986	0.009	28941.688	0.011	-39913.833	0.006	0.090
16	160-1	50742.7637	0.0062	-1582.6808	0.0002	-551.5724	0.0003	123.1050	0.0107	-12003.991	0.008	28941.642	0.011	-39913.828	0.006	0.076
17	162-1	50742.7757	0.0053	-1582.6811	0.0002	-551.5728	0.0003	123.0706	0.0109	-12003.966	0.009	28941.636	0.010	-39913.855	0.006	0.082
18	167-1	50742.7737	0.0068	-1582.6812	0.0002	-551.5723	0.0004	123.0407	0.0117	-12003.957	0.009	28941.611	0.012	-39913.873	0.006	0.072
19	168-1	50742.7908	0.0067	-1582.6816	0.0002	-551.5730	0.0004	123.1183	0.0115	-12003.997	0.009	28941.671	0.012	-39913.839	0.006	0.075
20	172-1	50742.7357	0.0132	-1582.6799	0.0004	-551.5725	0.0007	123.0034	0.0245	-12003.913	0.019	28941.578	0.024	-39913.861	0.010	0.094
21	180-1	50742.7886	0.0164	-1582.6815	0.0005	-551.5731	0.0008	123.1341	0.0295	-12004.005	0.026	28941.680	0.026	-39913.828	0.012	0.118
22	182-1	50742.7510	0.0129	-1582.6807	0.0003	-551.5709	0.0008	123.1217	0.0217	-12004.025	0.016	28941.621	0.026	-39913.816	0.009	0.089
23	186-1	50742.7771	0.0101	-1582.6814	0.0003	-551.5717	0.0006	123.1859	0.0180	-12004.060	0.016	28941.679	0.017	-39913.797	0.009	0.087
24	189-1	50742.7549	0.0134	-1582.6806	0.0004	-551.5722	0.0006	123.0547	0.0207	-12003.959	0.020	28941.609	0.018	-39913.850	0.012	0.107
25	196-1	50742.8018	0.0119	-1582.6818	0.0004	-551.5737	0.0007	123.1376	0.0229	-12004.002	0.019	28941.696	0.022	-39913.834	0.010	0.090

Table 2. Analyzed results (Sirahama - Manazuru) (continued)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
26	200-1	50742.7480	0.0153	-1582.6806	0.0004	-551.5712	0.0009	123.0312	0.0253	-12003.961	0.019	28941.577	0.030	-39913.864	0.010	0.090
27	203-1	50742.7690	0.0154	-1582.6809	0.0004	-551.5728	0.0008	123.0792	0.0252	-12003.968	0.018	28941.638	0.029	-39913.844	0.009	0.081
28	207-1	50742.7921	0.0163	-1582.6810	0.0005	-551.5758	0.0011	123.0829	0.0338	-12003.922	0.034	28941.697	0.028	-39913.844	0.014	0.117
29	210-1	50742.7563	0.0137	-1582.6808	0.0003	-551.5712	0.0009	123.1056	0.0241	-12004.011	0.017	28941.620	0.028	-39913.828	0.010	0.094
30	228-1	50742.7848	0.0126	-1582.6813	0.0003	-551.5733	0.0008	123.1168	0.0227	-12003.989	0.017	28941.672	0.026	-39913.833	0.009	0.071
31	291-1	50742.7733	0.0155	-1582.6807	0.0004	-551.5742	0.0010	123.0638	0.0279	-12003.933	0.016	28941.654	0.034	-39913.848	0.012	0.074
32	294-1	50742.7438	0.0100	-1582.6803	0.0003	-551.5718	0.0006	123.0004	0.0197	-12003.929	0.014	28941.568	0.020	-39913.874	0.010	0.069
33	298-1	50742.7321	0.0101	-1582.6799	0.0003	-551.5717	0.0006	123.0849	0.0207	-12003.976	0.015	28941.609	0.021	-39913.816	0.010	0.070
34	301-1	50742.7295	0.0100	-1582.6798	0.0003	-551.5717	0.0006	123.0662	0.0196	-12003.965	0.014	28941.597	0.020	-39913.825	0.010	0.070
35	305-1	50742.7298	0.0099	-1582.6798	0.0003	-551.5719	0.0006	123.0165	0.0198	-12003.931	0.014	28941.573	0.020	-39913.852	0.010	0.068
36	308-1	50742.6913	0.0101	-1582.6789	0.0003	-551.5705	0.0006	122.9890	0.0206	-12003.925	0.014	28941.520	0.021	-39913.844	0.011	0.070
37	333-1	50742.7615	0.0161	-1582.6807	0.0004	-551.5726	0.0009	123.0768	0.0277	-12003.967	0.015	28941.631	0.033	-39913.840	0.012	0.068
38	334-1	50742.7686	0.0166	-1582.6808	0.0004	-551.5729	0.0010	123.1033	0.0290	-12003.980	0.016	28941.653	0.035	-39913.829	0.012	0.070
39	335-1	50742.5823	0.0377	-1582.6775	0.0007	-551.5605	0.0025	122.9451	0.0402	-12004.047	0.021	28941.290	0.074	-39913.835	0.012	0.071
40	336-1	50742.7160	0.0157	-1582.6798	0.0004	-551.5701	0.0009	122.9843	0.0276	-12003.940	0.015	28941.521	0.033	-39913.870	0.012	0.066
41	340-1	50742.7137	0.0162	-1582.6796	0.0004	-551.5705	0.0010	123.0074	0.0276	-12003.945	0.015	28941.540	0.034	-39913.852	0.012	0.068
42	341-1	50742.7684	0.0162	-1582.6807	0.0004	-551.5736	0.0010	123.0924	0.0280	-12003.960	0.015	28941.658	0.034	-39913.831	0.012	0.068
43	342-1	50742.7206	0.0159	-1582.6799	0.0004	-551.5699	0.0010	123.0585	0.0273	-12003.991	0.015	28941.560	0.033	-39913.832	0.012	0.067
44	343-1	50742.7857	0.0212	-1582.6814	0.0005	-551.5729	0.0011	123.1697	0.0417	-12004.029	0.022	28941.695	0.045	-39913.806	0.016	0.068
45	351-1	50742.7502	0.0146	-1582.6805	0.0006	-551.5719	0.0010	123.0627	0.0287	-12003.968	0.036	28941.606	0.019	-39913.843	0.014	0.084
46	354-1	50742.7123	0.0180	-1582.6801	0.0004	-551.5679	0.0012	123.0187	0.0294	-12004.002	0.014	28941.503	0.039	-39913.860	0.014	0.067
47	355-1	50742.7227	0.0259	-1582.6801	0.0005	-551.5697	0.0019	123.0173	0.0299	-12003.970	0.019	28941.536	0.053	-39913.859	0.013	0.059

Table 2. Analyzed results (Sirahama - Turugi Saki)

No.	Session	slope distance		d ϕ		d λ		d h		d x		d y		d z		rms
1	14-1	78804.7012	0.0188	-1530.9729	0.0002	-2487.0239	0.0008	137.2922	0.0110	20560.422	0.011	65553.659	0.021	-38602.691	0.007	0.081
2	18-1	78804.7549	0.0195	-1530.9735	0.0002	-2487.0260	0.0009	137.2758	0.0122	20560.461	0.010	65553.698	0.023	-38602.715	0.007	0.087
3	46-1	78804.7024	0.0098	-1530.9735	0.0002	-2487.0234	0.0004	137.2758	0.0148	20560.417	0.011	65553.648	0.014	-38602.715	0.008	0.094
4	145-1	78804.7014	0.0094	-1530.9733	0.0002	-2487.0236	0.0004	137.1258	0.0149	20560.516	0.011	65553.568	0.014	-38602.796	0.008	0.086
5	180-1	78804.7533	0.0178	-1530.9747	0.0003	-2487.0248	0.0007	137.3535	0.0193	20560.376	0.011	65553.730	0.024	-38602.702	0.009	0.104
6	182-1	78804.7403	0.0179	-1530.9742	0.0003	-2487.0245	0.0007	137.3104	0.0198	20560.404	0.012	65553.698	0.024	-38602.715	0.009	0.106
7	186-1	78804.8085	0.0183	-1530.9756	0.0003	-2487.0266	0.0008	137.4341	0.0202	20560.345	0.012	65553.820	0.025	-38602.679	0.009	0.113
8	189-1	78804.7314	0.0086	-1530.9742	0.0002	-2487.0242	0.0004	137.3254	0.0158	20560.391	0.014	65553.698	0.012	-38602.704	0.008	0.102
9	196-1	78804.7033	0.0176	-1530.9739	0.0003	-2487.0230	0.0007	137.3005	0.0198	20560.390	0.012	65553.660	0.024	-38602.711	0.009	0.109
10	200-1	78804.7232	0.0172	-1530.9739	0.0003	-2487.0240	0.0007	137.2662	0.0184	20560.427	0.011	65553.660	0.023	-38602.733	0.008	0.109
11	203-1	78804.7367	0.0166	-1530.9737	0.0003	-2487.0248	0.0007	137.2875	0.0175	20560.429	0.011	65553.685	0.022	-38602.716	0.008	0.099
12	207-1	78804.7465	0.0215	-1530.9746	0.0003	-2487.0245	0.0009	137.3024	0.0205	20560.403	0.014	65553.697	0.027	-38602.730	0.009	0.109
13	210-1	78804.7434	0.0182	-1530.9744	0.0003	-2487.0245	0.0007	137.3861	0.0206	20560.354	0.012	65553.739	0.025	-38602.677	0.009	0.111
14	228-1	78804.7934	0.0183	-1530.9752	0.0003	-2487.0262	0.0008	137.4082	0.0203	20560.358	0.012	65553.794	0.025	-38602.684	0.009	0.112
15	231-1	78804.7597	0.0145	-1530.9744	0.0002	-2487.0253	0.0006	137.3128	0.0152	20560.412	0.009	65553.716	0.019	-38602.719	0.007	0.087
16	291-1	78804.8620	0.0216	-1530.9760	0.0003	-2487.0289	0.0009	137.3303	0.0216	20560.443	0.014	65553.813	0.028	-38602.747	0.010	0.085
17	294-1	78804.6569	0.0222	-1530.9736	0.0003	-2487.0210	0.0009	137.1109	0.0218	20560.477	0.014	65553.516	0.029	-38602.814	0.010	0.056
18	298-1	78804.7288	0.0229	-1530.9742	0.0003	-2487.0239	0.0009	137.3336	0.0221	20560.381	0.015	65553.699	0.029	-38602.701	0.010	0.055
19	301-1	78804.7301	0.0234	-1530.9744	0.0003	-2487.0238	0.0010	137.3367	0.0227	20560.373	0.015	65553.701	0.030	-38602.705	0.010	0.055
20	305-1	78804.7716	0.0220	-1530.9748	0.0003	-2487.0255	0.0009	137.3728	0.0210	20560.374	0.014	65553.757	0.028	-38602.694	0.009	0.053
21	308-1	78804.6420	0.0239	-1530.9726	0.0004	-2487.0212	0.0010	137.2033	0.0239	20560.436	0.016	65553.558	0.031	-38602.735	0.011	0.060
22	342-1	78804.7516	0.0190	-1530.9744	0.0003	-2487.0249	0.0008	137.3042	0.0192	20560.411	0.011	65553.704	0.025	-38602.723	0.008	0.054
23	343-1	78804.8567	0.0231	-1530.9761	0.0004	-2487.0285	0.0009	137.3891	0.0291	20560.396	0.015	65553.838	0.034	-38602.718	0.011	0.055
24	351-1	78804.6984	0.0100	-1530.9724	0.0004	-2487.0242	0.0006	137.2168	0.0172	20560.481	0.020	65553.619	0.012	-38602.721	0.009	0.056
25	354-1	78804.6231	0.0204	-1530.9726	0.0003	-2487.0202	0.0008	137.2396	0.0197	20560.397	0.010	65553.559	0.027	-38602.715	0.009	0.050

Table 2. Analyzed results (Sirahama - Turugi Saki) (continued)

No.	Session	slope distance		d φ		d λ		d h		d x		d y		d z		rms
26	355-1	78804.6166	0.0207	-1530.9728	0.0003	-2487.0198	0.0008	137.1805	0.0202	20560.424	0.010	65553.520	0.027	-38602.753	0.010	0.051

可搬式レーザー測距装置用時刻信号発生装置検定観測

CALIBRATION OF THE CLOCK SYSTEM OF THE TRANSPORTABLE LASER RANGING STATION

Summary - The clock system of the transportable laser ranging station installed in 1993, was compared with the central standard clock at the National Astronomical Observatory in Mitaka,Tokyo. In this report, the calibration result is reported.

可搬式レーザー測距装置に用いられている原子時計による時刻と，協定世界時[UTC]とのずれの補正を行う装置の更新機種として，1993年新たにGPSを利用した時刻信号発生装置（Magnavox社製MX4200D）を導入した．この装置の精度を検定するため，国立天文台（三鷹）において保持されている中央標準時[NAOT]との精密比較観測を行った．

なお，これまでの時刻補正に用いられてきた装置は，1988年父島ではロランC受信機，1988年石垣島から1991年十勝まではロランC受信機とJRC製のGPS受信機，1992年硫黄島から1993年八丈島まではJRC製のGPS受信機である．

1. 概　要

可搬式レーザー測距装置用時刻信号発生装置MX4200D（以後本機と呼ぶ）の出力時刻（以後[MAG]とする）は，本来[UTC]との関係が明らかな米国海軍天文台（USNO）が保時している時刻（以後[USNO]とする）が出力されるはずであるが，実際には各GPS衛星が放送している時刻（以後[GPS]とする，[GPS]は各衛星に依存する）と[USNO]との誤差と，受信機固有の偏差（[MAG]と[GPS]の差）が含まれている．

このうち前者の[GPS]と[USNO]との誤差は，後述の定期刊行物を参照することによって知ることができる．本観測の目的は，後者の本機固有の偏差を求めることによって本機を検定することにある．なお，この検定に求める精度は0.1μsecである（鈴木，1994）．

国立天文台では，セシウム周波数標準器によって中央標準時[NAOT]を保持している．[NAOT]と[GPS]との差は，上記と同様定期刊行物によって知ることができるので，[NAOT]と[MAG]とを比較することにより，間接的に[MAG]と[GPS]の差を求めることができる．以下に，この方法に基づく観測及び検定結果について報告する．

1.1. 作業経過

1993年12月21日から22日にかけて国立天文台（三鷹）において，GPS観測による時刻比較を行なった．

1.2. 機器構成

時刻信号発生装置	Magnavox　MX 4200D
カウンター	HP　5370A
データ記録装置	NEC　PC9801E.

2. 観　測

2.1. 観測状況

国立天文台の屋上に本機アンテナを，同建物の2階に受信機を設置し，60mのケーブルにより保時室（1階）のカウンターに入力した（Fig.1）．また，同室内にある[NAOT]を出力するセシウム周波数標準器から7.4mのケーブルで，カウンターに接続した（Fig.2）．両装置より出力されている毎秒信号（以後1PPSとする）の差をカウンターにて計測し，毎分収録を行った．本機では衛星のマニュアル選択と6衛星自動選択の切替ができるため，両方の衛星選択モードで1セッションずつ観測した．

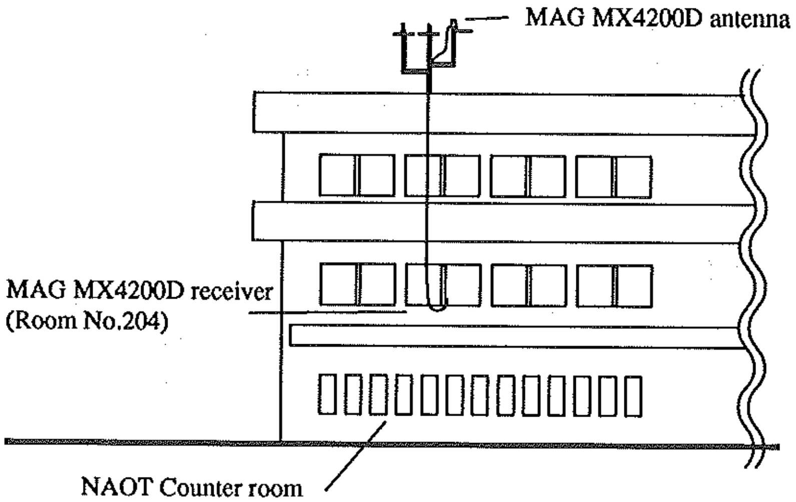


Figure 1. Site sketch of the National Astronomical Observatory.

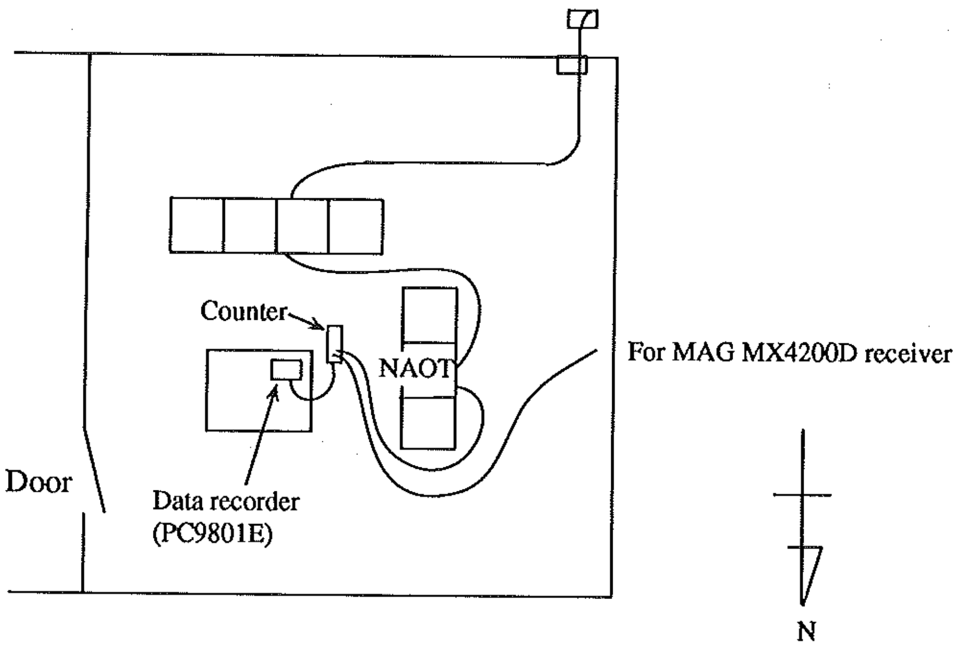


Figure 2. System setting at the NAOT counter room.

2.2. 観測地点と担当者

国立天文台（東京都三鷹市）　高梨泰宏，成田誉孝．

2.3. 観測期間と使用衛星

	観測時刻(JST)	衛星番号(PRN)
セッション1	1993年12月21日15:35～21日16:45	21
セッション2	1993年12月21日17:10～22日14:03	1 2 3 4 5 7 9 12 13 14 15 16 17 19 20 21 22 24 25 26 27 28 29 31.

2.4. 初期設定データ

60m(MAG) 1PPSケーブル遅延量　240 nsec（実測値）

7.4m(NAOT) 1PPSケーブル遅延量　30 nsec（実測値）

アンテナ設定座標値(WGS84)　ϕ　35° 40′ 31.420″ N

λ　139° 32′ 14.960″ E

h　106.5m．

上記アンテナ設定座標値は，国立天文台のGPS観測に使用している値である．ただし，高さについては本機は標高で入力する必要があるため，日本測地系における東京付近のジオイド高がほぼ0mであることを考慮して（e.g.Ganeko,1977），上記座標値を日本測地系に変換し，その楕円体高（68.4m）を近似的に標高とみなして与えた．この近似及び本機内のWGS84ジオイド高補正における誤差は数mを超えないと考えられるので，本検定観測の精度上問題はない．

3. 整　約

整約値をTable 1に示す．なお，表中の値は以下のそれぞれ異なった時刻系(注)の差を指す．

Table 1.Calibration results(Unit : μ sec)

session	NAOT-MAG	UTC-NAOT	UTC-USNO	USNO-GPS
1 (PRN 21)	3.19	-2.682	0.047	-0.003
2 (PRN AUTO)	3.14	-2.648	0.047	0.005

(1) NAOT - MAG

国立天文台が保時している時刻[NAOT]と，本機出力時刻[MAG]の差．今回の観測により得られたデータの平均を用いた．

(2) UTC - NAOT

協定世界時[UTC]と，国立天文台が保時している時刻[NAOT]との差．BIPM circular-T (BIPM, 1994) に掲載された値を観測中央時刻において補間して用いた．

(3) UTC - USNO

協定世界時[UTC]と，米国海軍天文台が保時している時刻[USNO]の差．BIPM circular-T (BIPM, 1994) に掲載された値を観測中央時刻において補間して用いた．

(4) USNO - GPS

米国海軍天文台が保時している時刻[USNO]と，GPSにより放送されている時刻[GPS]との差．USNO series4 (U. S. Naval Observatory, 1993) に掲載された値を観測中央時刻において補間して用いた．

注：[UTC]とは，世界中の約200台のセシウム周波数標準器により協定世界時として保持されている時刻系である．[NAOT]はその中の国立天文台で運用しているセシウム周波数標準器分の時刻系であり，[USNO]は米国海軍天文台の運用している複数のセシウム周波数標準器によって保持されている時刻系を指す．

4. 成　果

Table 2およびFig. 3, 4は，セッションごとの遅延量の平均値と標準偏差をまとめたものである．

Table 2. Summary of calibration results (Unit : μ sec)

session	GPS-MAG	rms
1 (PRN 21)	- 0.254	0.076
2 (PRN AUTO)	- 0.230	0.044

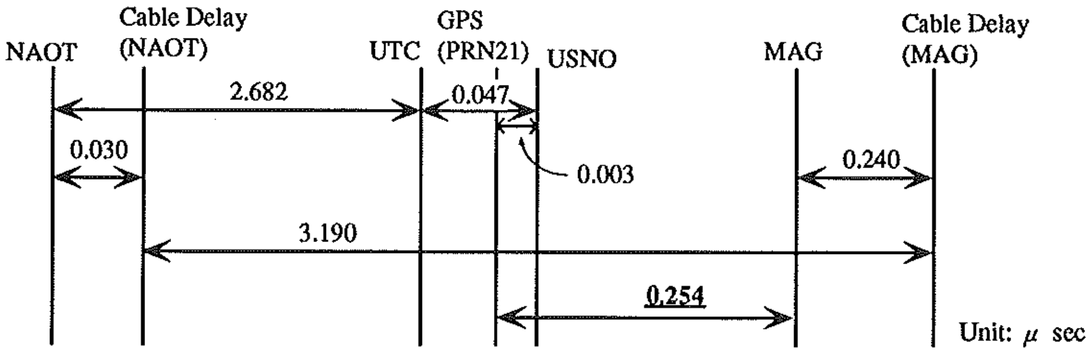


Figure 3. Time chart (session 1).

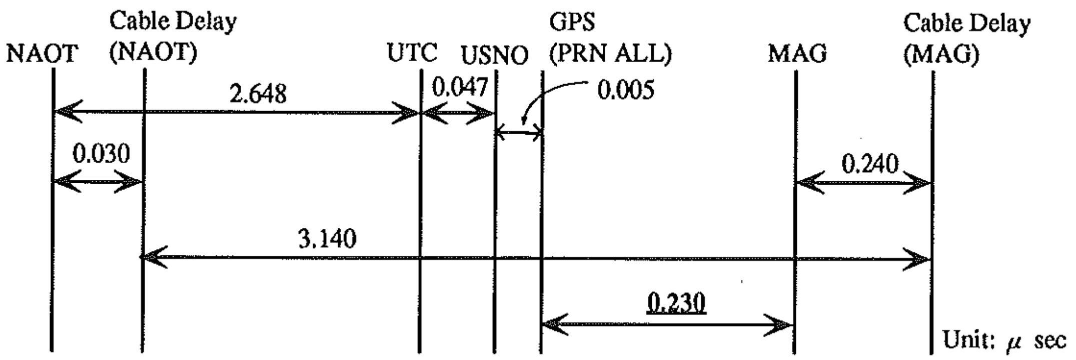


Figure 4. Time chart (session 2).

今回の検定の結果，本機固有の偏差としてTable 2に示す値が得られた．本検定に必要な精度は0.1μsecであるからセッション1及び2の差は無視できる量である．実際の観測では衛星選択は自動を選択するためセッション2の値を採用し，本機の出力が0.2μsec進んでいるものとして，これに-0.2μsecの偏差補正を行い，可搬式レーザー測距装置の原子時計の時刻補正に用いることとする．

5. 謝　辞

本検定観測を行うにあたり，国立天文台の福島登志夫氏，松田浩氏，および下里水路観測所にご協力頂きました．ここに深く感謝します．

本報告は，高梨泰宏が作成した．また，観測成果の算出は，渡辺由美子及び高梨泰宏が担当した．

参　考　文　献

Ganeko, Y., 1977 : *J.Geophys. Res.*, **82**, p.2490.
鈴木晃，1994：水路部観測報告衛星測地編，**7**，p.95.
BIPM,1994 Jan. 26 : *Circular T*, **72**.
U.S. Naval Observatory,1993 Dec. 29 : *Daily Time Differences, Series 4*, **1404**.

海洋測地網一次基準点座標値の再計算（海洋測地成果）

RE-COMPUTATION
OF
POSITIONS OF THE FIRST ORDER CONTROL POINTS
IN
THE MARINE GEODETIC CONTROL NETWORK

Summary - In the marine geodetic control network around Japan, positions of the first order control points are determined relatively to the position of the mainland control point, the Simosato Hydrographic Observatory (SHO). Since the precise position of SHO was re-determined lately on the basis of the ten-year observation with the satellite laser ranging technique (Marine Geodetic Result; Tatsuno and Fujita, 1994), positions of the first order control points were consequently re-computed.

Key Words : satellite laser ranging - Ajisai - Lageos - marine geodetic controls - first order control points

1. はじめに

水路部では，領海等我が国の管轄海域の確定と，海洋における測位精度の向上を目的として海洋測地網の整備を推進している(Kubo, 1988). この中で，一次基準点は本土基準点（下里水路観測所）と主要な島を結合して，海洋測地網の骨格を形成する役割を担っており，1988年から人工衛星レーザー測距（SLR）観測が行われている．これまでの観測に基づく成果は，水路部観測報告衛星測地編に報告されている（福島他，1991；仙石他，1992，1993;仙石・内山，1994;藤田・鈴木，1995）．

一次基準点座標値を求めるためのSLRデータ解析では，本土基準点座標値を固定値として与える．これまでの解析では，本土基準点の固定座標値として，その時々の暫定的なものが用いられてきたため，結果として得られた一次基準点座標値も暫定的なものであった．今般，下里水路観測所における約10年間のレーザー測距観測の成果を総合し，世界測地系による本土基準点座標値（海洋測地成果）が求められたので（辰野・藤田，1994），これに基づき一次基準点座標値の再計算を行い，統一された成果（海洋測地成果）を求めた．

今回再計算された基準点は，父島，石垣島，南鳥島，沖縄，対馬，隠岐諸島，南大東島の7点である．また，十勝，硫黄島，稚内，八丈島の4点については，個別報告の中に既に海洋測地成果が記載されているが（仙石・内山，1994;藤田・鈴木，1995），本稿成果表に一括して再掲した．次号以降に新たに報告される予定の一次基準点成果は，各号個別報告の中で同形式の海洋測地成果表を掲載する．

2. 再計算

今回の再計算に用いたデータ及び解析方法等は，一部を除き基本的に以前の報告に示されているとおりなので，詳しくはそれぞれの号を参照されたい．

変更点は，以下の２点である．

(1) 下里の固定座標値を海洋測地成果（辰野・藤田，1994）とした．座標値をTable 1に示す．
(2) Geopotential モデルをTEG-2 (Tapley et al., 1990) とした．

海洋測地成果は，原則として「あじさい」のデータをSPORT法で解析した結果に統一する方針

としたが，石垣島と南鳥島についてのみ，解析に十分な「あじさい」の測距データが得られなかったため，「LAGEOS」のGLOBAL解析結果を採用した．

Table 2からTable 12に，一次基準点11点のレーザー測距装置不動点及び標石の海洋測地成果座標値を示す．また同表には，参考のために三角点成果を再掲した．但し，南鳥島については経緯度の三角点成果がないため，別途求められた標高のみを示した．表中，WGSは世界測地系（海洋測地成果），TDは日本測地系を意味する．なお、世界測地系と日本測地系の準拠楕円体の諸元は以下のとおり。

	WGS	TD
a	6378137m	6377397.155m
f	1/298.257	1/299.152813

本報告は藤田雅之が作成した．また，再計算は仙石新，藤田雅之が行った．

参　考　文　献

福島登志夫，内山丈夫，西村英樹，仙石新，1991：水路部観測報告衛星測地編，**4**，p.60.

Kubo, Y., 1988: *Data Report of Hydrogr. Obs., Series of Satellite Geodesy*, **1**, p.1.

仙石新，内山丈夫，1994：水路部観測報告衛星測地編，**7**，p.35.

仙石新，内山丈夫，西村英樹，1992：同，**5**，p.43.

仙石新，内山丈夫，西村英樹，1993：同，**6**，p.45.

鈴木晃，藤田雅之，1995：同，**8**，p.34.

Tapley , B.D., Shum, C.K., Yuan, D.N., Ries, J.C., Eanes, R.J., Watkins, M.M., Schuts, B.E., 1990 : *EOS Trans. AGU*, **71**, p.1276.

辰野忠夫，藤田雅之，1994：水路部観測報告衛星測地編，**7**，p.102.

Table 1. Marine Geodetic Result in Simosato

Items	Values
レーザー不動点座標値(WGS)	U_S = - 3822388.272 m V_S = 3699363.582 m W_S = 3507573.187 m
原点のシフト量 (WGS to TD)	ΔU = 146.23 m ΔV = - 507.57 m ΔW = - 681.86 m
標石座標値(WGS)	U = - 3822373.312 m V = 3699359.898 m W = 3507585.859 m

Table 2. Summary of Results in Titi sima

		Coordinates		Comments
海洋測地成果	レーザー不動点	U_T = - 4491072.428 m V_T = 3481527.941 m W_T = 2887391.869 m	WGS	再計算結果
	標　石	ϕ_H = 27° 05′ 31.335″ λ_H = 142° 13′ 00.413″ 楕円体高 = 261.13 m		
		ϕ_H = 27° 05′ 16.174″ λ_H = 142° 13′ 11.723″ 楕円体高 = 296.96 m	TD	
	(三角点成果への補正量)	$\Delta\phi$ = - 3.891″ $\Delta\lambda$ = + 22.584″ ジオイド高 = 85.88 m		
三角点成果	レーザー不動点	ϕ_T = 27° 05′ 19.104″ λ_T = 142° 12′ 49.099″ 標　　高 = 212.81 m	TD	衛星測地編 No.4, p.83
	標　石	ϕ_H = 27° 05′ 20.065″ λ_H = 142° 12′ 49.139″ 標　　高 = 211.08 m		

Table 3. Summary of Results in Isigaki sima

	Coordinates			Comments
海洋測地成果	レーザー不動点	U_T = - 3265753.884 m V_T = 4810000.974 m W_T = 2614265.544 m	WGS	再計算結果
	標　石	ϕ_H = 24° 22′ 09.183″ λ_H = 124° 12′ 51.466″ 楕円体高 = 100.16 m		
		ϕ_H = 24° 21′ 54.105″ λ_H = 124° 12′ 57.302″ 楕円体高 = 90.15 m	TD	
	(三角点成果 への補正量)	$\Delta\phi$ = + 4.686″ $\Delta\lambda$ = + 7.242″ ジオイド高 = 16.86 m		
三角点成果	レーザー不動点	ϕ_T = 24° 21′ 00.966″ λ_T = 124° 10′ 27.048″ 標　高 = 57.05 m	TD	衛星測地編 No.4, p.93
	標　石	ϕ_H = 24° 21′ 49.419″ λ_H = 124° 12′ 50.060″ 標　高 = 73.29 m		

Table 4. Summary of Results in Minamitori sima

	Coordinates			Comments
海洋測地成果	レーザー不動点	U_T = - 5227180.000 m V_T = 2551882.420 m W_T = 2607609.872 m	WGS	再計算結果
	標　石	ϕ_H = 24° 17′ 40.851″ λ_H = 153° 59′ 03.193″ 楕円体高 = 35.28 m		
		ϕ_H = 24° 17′ 23.767″ λ_H = 153° 59′ 17.095″ 楕円体高 = 160.70 m	TD	
	(三角点成果 への補正量)	ジオイド高 = 152.55 m		
三角点成果	レーザー不動点	標　高 = 7.60 m	TD	衛星測地編 No.5, p.62
	標　石	標　高 = 8.15 m		

Table 5. Summary of Results in Okinawa sima

<table>
<tr><th></th><th colspan="3">Coordinates</th><th>Comments</th></tr>
<tr><td rowspan="4">海洋測地成果</td><td>レーザー不動点</td><td>U_T = - 3505323.710 m
V_T = 4532741.038 m
W_T = 2792253.203 m</td><td rowspan="2">WGS</td><td rowspan="4">再計算結果</td></tr>
<tr><td rowspan="2">標　石</td><td>ϕ_H = 26° 07′ 54.707″
λ_H = 127° 42′ 56.938″
楕円体高 = 125.97 m</td></tr>
<tr><td>ϕ_H = 26° 07′ 40.135″
λ_H = 127° 43′ 03.952″
楕円体高 = 111.86 m</td><td rowspan="2">TD</td></tr>
<tr><td>(三角点成果への補正量)</td><td>$\Delta\phi$ = - 0.416″
$\Delta\lambda$ = + 0.310″
ジオイド高 = 16.94 m</td></tr>
<tr><td rowspan="2">三角点成果</td><td>レーザー不動点</td><td>ϕ_T = 26° 07′ 40.986″
λ_T = 127° 43′ 04.332″
標　高 = 96.48 m</td><td rowspan="2">TD</td><td rowspan="2">衛星測地編
No.5, p.63</td></tr>
<tr><td>標　石</td><td>ϕ_H = 26° 07′ 40.551″
λ_H = 127° 43′ 03.642″
標　高 = 94.92 m</td></tr>
</table>

Table 6. Summary of Results in Tusima

<table>
<tr><th></th><th colspan="3">Coordinates</th><th>Comments</th></tr>
<tr><td rowspan="4">海洋測地成果</td><td>レーザー不動点</td><td>U_T = - 3344473.875 m
V_T = 4087076.356 m
W_T = 3564512.460 m</td><td rowspan="2">WGS</td><td rowspan="4">再計算結果</td></tr>
<tr><td rowspan="2">標　石</td><td>ϕ_H = 34° 11′ 47.402″
λ_H = 129° 17′ 37.091″
楕円体高 = 33.29m</td></tr>
<tr><td>ϕ_H = 34° 11′ 35.947″
λ_H = 129° 17′ 45.226″
楕円体高 = - 32.54 m</td><td rowspan="2">TD</td></tr>
<tr><td>(三角点成果への補正量)</td><td>$\Delta\phi$ = + 0.419″
$\Delta\lambda$ = - 0.079″
ジオイド高 = - 35.42m</td></tr>
<tr><td rowspan="2">三角点成果</td><td>レーザー不動点</td><td>ϕ_T = 34° 11′ 35.408″
λ_T = 129° 17′ 45.263″
標　高 = 4.57 m</td><td rowspan="2">TD</td><td rowspan="2">衛星測地編
No.5, p.64.</td></tr>
<tr><td>標　石</td><td>ϕ_H = 34° 11′ 35.528″
λ_H = 129° 17′ 45.305″
標　高 = 2.88 m</td></tr>
</table>

Table 7. Summary of Results in Oki syoto

<table>
<tr><th></th><th colspan="3">Coordinates</th><th>Comments</th></tr>
<tr><td rowspan="4">海洋測地成果</td><td>レーザー不動点</td><td>U_T = - 3536204.351 m
V_T = 3749974.249 m
W_T = 3744418.446 m</td><td rowspan="2">WGS</td><td rowspan="4">再計算結果</td></tr>
<tr><td rowspan="2">標　石</td><td>$\phi_H = 36^\circ\ 10'\ 48.343''$
$\lambda_H = 133^\circ\ 19'\ 09.773''$
楕円体高 = 121.91 m</td></tr>
<tr><td>$\phi_H = 36^\circ\ 10'\ 37.425''$
$\lambda_H = 133^\circ\ 19'\ 19.452''$
楕円体高 = 57.08 m</td><td rowspan="2">TD</td></tr>
<tr><td>(三角点成果への補正量)</td><td>$\Delta\phi = +0.095''$
$\Delta\lambda = +0.100''$
ジオイド高 = - 30.73m</td></tr>
<tr><td rowspan="2">三角点成果</td><td>レーザー不動点</td><td>$\phi_T = 36^\circ\ 10'\ 37.545''$
$\lambda_T = 133^\circ\ 19'\ 19.691''$
標　高 = 89.48 m</td><td rowspan="2">TD</td><td rowspan="2">衛星測地編
No.6, p.57</td></tr>
<tr><td>標　石</td><td>$\phi_H = 36^\circ\ 10'\ 37.330''$
$\lambda_H = 133^\circ\ 19'\ 19.352''$
標　高 = 87.81 m</td></tr>
</table>

Table 8. Summary of Results in Minamidaito

<table>
<tr><th></th><th colspan="3">Coordinates</th><th>Comments</th></tr>
<tr><td rowspan="4">海洋測地成果</td><td>レーザー不動点</td><td>U_T = - 3786331.320 m
V_T = 4320316.213 m
W_T = 2761963.909 m</td><td rowspan="2">WGS</td><td rowspan="4">再計算結果</td></tr>
<tr><td rowspan="2">標　石</td><td>$\phi_H = 25^\circ\ 49'\ 40.771''$
$\lambda_H = 131^\circ\ 13'\ 52.557''$
楕円体高 = 50.24 m</td></tr>
<tr><td>$\phi_H = 25^\circ\ 49'\ 25.903''$
$\lambda_H = 131^\circ\ 14'\ 00.621''$
楕円体高 = 50.11 m</td><td rowspan="2">TD</td></tr>
<tr><td>(三角点成果への補正量)</td><td>$\Delta\phi = -12.133''$
$\Delta\lambda = +18.802''$
ジオイド高 = 35.90 m</td></tr>
<tr><td rowspan="2">三角点成果</td><td>レーザー不動点</td><td>$\phi_T = 25^\circ\ 49'\ 38.739''$
$\lambda_T = 131^\circ\ 13'\ 42.198''$
標　高 = 15.83 m</td><td rowspan="2">TD</td><td rowspan="2">衛星測地編
No.6, p.58</td></tr>
<tr><td>標　石</td><td>$\phi_H = 25^\circ\ 49'\ 38.036''$
$\lambda_H = 131^\circ\ 13'\ 41.819''$
標　高 = 14.21 m</td></tr>
</table>

Table 9. Summary of Results in Tokati

<table>
<tr><th></th><th colspan="3">Coordinates</th><th>Comments</th></tr>
<tr><td rowspan="4">海洋測地成果</td><td>レーザー不動点</td><td>U_T = - 3788457.804 m
V_T = 2820918.030 m
W_T = 4271798.271 m</td><td rowspan="2">WGS</td><td rowspan="6">衛星測地編
No.7, p.39-42</td></tr>
<tr><td rowspan="2">標　石</td><td>ϕ_H = 42° 19′ 04.133″
λ_H = 143° 19′ 42.461″
楕円体高 = 45.44 m</td></tr>
<tr><td>ϕ_H = 42° 18′ 54.819″
λ_H = 143° 19′ 56.427″
楕円体高 = - 14.72 m</td><td rowspan="2">TD</td></tr>
<tr><td>(三角点成果
への補正量)</td><td>$\Delta\phi$ = + 0.028″
$\Delta\lambda$ = + 0.218″
ジオイド高 = - 37.09 m</td></tr>
<tr><td rowspan="2">三角点成果</td><td>レーザー不動点</td><td>ϕ_T = 42° 18′ 54.528″
λ_T = 143° 19′ 55.684″
標　　高 = 24.22 m</td><td rowspan="2">TD</td></tr>
<tr><td>標　石</td><td>ϕ_H = 42° 18′ 54.791″
λ_H = 143° 19′ 56.209″
標　　高 = 22.37 m</td></tr>
</table>

Table 10. Summary of Results in Iwo sima

<table>
<tr><th></th><th colspan="3">Coordinates</th><th>Comments</th></tr>
<tr><td rowspan="4">海洋測地成果</td><td>レーザー不動点</td><td>U_T = - 4522801.756 m
V_T = 3622640.494 m
W_T = 2656232.034 m</td><td rowspan="2">WGS</td><td rowspan="6">衛星測地編
No.7, p.45-47</td></tr>
<tr><td rowspan="2">標　石</td><td>ϕ_H = 24° 46′ 18.336″
λ_H = 141° 18′ 20.246″
楕円体高 = 135.11 m</td></tr>
<tr><td>ϕ_H = 24° 46′ 02.447″
λ_H = 141° 18′ 31.094″
楕円体高 = 185.89 m</td><td rowspan="2">TD</td></tr>
<tr><td>(三角点成果
への補正量)</td><td>$\Delta\phi$ = - 25.388″
$\Delta\lambda$ = + 5.694″
ジオイド高 = 99.52 m</td></tr>
<tr><td rowspan="2">三角点成果</td><td>レーザー不動点</td><td>ϕ_T = 24° 46′ 29.091″
λ_T = 141° 18′ 27.571″
標　　高 = 88.20 m</td><td rowspan="2">TD</td></tr>
<tr><td>標　石</td><td>ϕ_H = 24° 46′ 27.835″
λ_H = 141° 18′ 25.400″
標　　高 = 86.37 m</td></tr>
</table>

Table 11. Summary of Results in Wakkanai

	Coordinates			Comments
海洋測地成果	レーザー不動点	U_T = - 3522928.950 m V_T = 2779243.627 m W_T = 4517637.385 m	WGS	衛星測地編 No.8, p.40
	標　石	ϕ_H = 45° 23′ 09.529″ λ_H = 141° 43′ 47.884″ 楕円体高 = 91.06 m	WGS	
		ϕ_H = 45° 23′ 01.758″ λ_H = 141° 44′ 02.039″ 楕円体高 = 10.46 m	TD	
	(三角点成果への補正量)	Δ ϕ = + 0.141 ″ Δ λ = + 0.256″ ジオイド高 = - 53.54 m	TD	
三角点成果	レーザー不動点	ϕ_T = 45° 23′ 01.301″ λ_T = 141° 44′ 02.050″ 標　高 = 65.78 m	TD	
	標　石	ϕ_H = 45° 23′ 01.617″ λ_H = 141° 44′ 01.783″ 標　高 = 64.00 m	TD	

Table 12. Summary of Results in Hatizyo Sima

	Coordinates			Comments
海洋測地成果	レーザー不動点	U_T = - 4087880.246 m V_T = 3451764.230 m W_T = 3460902.451 m	WGS	衛星測地編 No.8, p.44
	標　石	ϕ_H = 33° 04′ 22.776″ λ_H = 139° 49′ 22.134″ 楕円体高 = 263.44 m	WGS	
		ϕ_H = 33° 04′ 10.036″ λ_H = 139° 49′ 33.449″ 楕円体高 = 243.42 m	TD	
	(三角点成果への補正量)	Δ ϕ = + 0.347″ Δ λ = - 0.044″ ジオイド高 = 23.54 m	TD	
三角点成果	レーザー不動点	ϕ_T = 33° 04′ 10.187″ λ_T = 139° 49′ 32.701″ 標　高 = 221.15 m	TD	
	標　石	ϕ_H = 33° 04′ 09.689″ λ_H = 139° 49′ 33.493″ 標　高 = 219.88 m	TD	

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