Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SGD21-01 Room:413 Time:April 28 09:00-09:15

Long-baseline laser strainmeter in Kamioka

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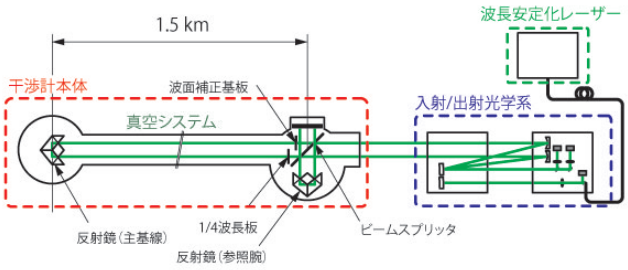
In order to facilitate the gravitational-wave astronomy, ‘ KAGRA project ’ has been proceeding under international collaboration hosted by the Institute for Cosmic Ray Research of University of Tokyo. The authors are constructing a long-baseline laser strainmeter with a 1.5 km long baseline in the Kamioka underground site as the part of the project (left figure). It will be the longest baseline laser strainmeter in Japan, and one of the largest instruments worldwide. The longer baseline was opted to achieve the superior sensitivity for the ground strain, more than 10 times better than the currently available 100 m strainmeter. The better sensitivity is anticipated to enable more detailed studies in the ground deformation caused by the fault activities and the Earth ’ s free oscillations.

The basic design of the long-baseline strainmeter is adopted from the 100 m strainmeter, consists of the highly asymmetric Michelson interferometer using the Iodine-stabilized laser as the standard of length (right figure). Nevertheless, there are some technical challenges required due to the gigantic scale of the new instrument. The outline of the instrument and the status of R&D will be reported in this presentation.

Keywords: laser interferometer, strainmeter, Kamioka



Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SGD21-02 Room:413 Time:April 28 09:15-09:30

Development of software for precise LLR data analysis, Part 2

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We are developing new analysis software for precise determination of lunar orbital/rotational motion and tidal deformation using lunar laser ranging (LLR) observation data.

As the first step of the study, we construct an LLR observation model. This model consists of the lunar orbit and libration obtained from DE430 (provided by NASA JPL), and the other newest physical models compatible with IERS Conventions (2010) such as Earth orientation, solid Earth/Moon tides, and some factors affecting propagation delay. For the purpose of calculating these components precisely, we use the modules of the geodetic data analysis software ”c5++” (Otsubo et al., 2011). LLR observation data are provided as normal points. In this calculation, there are 3577 points distributed from June 1996 to July 2013, obtained at Apache Point, Grasse, Matera and McDonald. Comparing the observed and calculated one-way ranges, the mean and the standard deviation of the residuals are about 5.7 cm and 4.8 cm respectively.

The presentation contains the result of the above-mentioned modeling and comparison, and the current status of the software development.

Keywords: lunar laser ranging, analysis software, ephemeris

Japan Geoscience Union Meeting 2014
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SGD21-03 Room:413 Time:April 28 09:30-09:45

Scale parameters of the Earth sensitive to the optical response of spherical SLR targets

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Recent technology upgrades in SLR technique, especially driven by kHz laser ranging systems, make it possible to measure the station-satellite distance at mm precision. The optical response of a sphere-shaped SLR target has been one of the major error factors in measuring the two-way distance, and, following the study on AJISAI, LAGEOS and ETALON (Otsubo and Appleby, JGR, 2003), we look into relatively smaller targets, STARLETTE and its twin STELLA. Based on the detailed optical response simulation adjusted by the actual kHz laser ranging data obtained at Herstmonceux and Potsdam, it is calculated that the standard centre-of-mass correction value for STARLETTE is too small by 3 mm. The impact can be up to 0.5 ppb for the terrestrial reference frame scale and up to 1.7 ppb for the gravity constant (GM) of the Earth.

Long-term worldwide technology upgrades can have a systematic impact on the long-term trend of such scale parameters. As the intensity of photons received at a given detector is reduced, the detection point (timing) goes rearwards and the center-of-mass correction gets smaller as listed in Appleby and Otsubo (LW18, 2013). This can map a non-negligible drift especially in the GM parameter.

Keywords: space geodesy, satellite laser ranging, terrestrial reference frame

Japan Geoscience Union Meeting 2014
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SGD21-04 Room:413 Time:April 28 09:45-10:00

VLBI application for Frequency Transfer and Development of GALA-V System (III)

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NICT is developing the frequency comparison technology using the VLBI as one of the remote frequency comparison technologies. The small broadband VLBI station, which is an important element of this project (Gala-V), is semi-compliant with the specification of the broadband geodetic VLBI system VGOS (VLBI2010 Global Observing System) specifications. Many VLBI observation stations compliant with the VGOS are under development several countries as an international standard specification for the next generation geodetic VLBI. Our Gala-V system is aimed for the comparison of the frequency standard, but of course this is useful for the geodetic observations too.

[broadband feeding development for large diameter antenna]
Most of the VGOS VLBI stations under development are adopting the special optical system so called ring-focus, That is because of wider beam width characteristic of wide frequency band (2-14GHz) feed, currently available. The receiver feed, that has sensitivity about 3 octaves of frequency, has generally wide beam angle, and therefore, existing Cassegrain reflector antenna is difficult to use it. We have been developing a new broadband feed for our 34m antenna. The first test feed become ready and it was mounted on the 34m diameter modified Cassegrain parabola in the end of 2013, and successfully we observed 6.7GHz, and 12.2 GHz emission line of the Methanol maser simultaneously.

[Zero redundant frequency array - Direct Sampler]
The Gala-V system, which is under the development at NICT, is designed to use four bands of the 1 GHz bandwidth with intervals of zero redundancy in the 2-14 GHz frequency range. This enables a fine delay resolution function without uncertainty (Ambiguity), and the precision of delay measurement could be improved by a one order higher than conventional.
In addition to a conventional analog frequency conversion method, we are experimentally adopting a method to acquire specific frequency band with a digital filter with a direct sampler, which acquires data without frequency conversion via a high-speed sampler. If a direct sampling method is established, system components and cost necessary for the system are simplified and reduced.

[development of the broadband signal composition technology]
The VGOS system is targeting to achieve high precision delay measurements by synthesizing 2-14 GHz broadband signal coherently. A new data processing software, which enables estimation of nonlinear phase change caused by the ionosphere and derivation of precise delay from the super broadband signal, and broadband stable phase calibration system are required.

Keywords: VLBI, VGOS, Frequency Comparison

Japan Geoscience Union Meeting 2014
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SGD21-05 Room:413 Time:April 28 10:00-10:15

Ishioka VLBI Observing Facility - Telescope Completion and Setting up the System -

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The Geospatial Information Authority of Japan (GSI) proceeded with construction of new VLBI station compliant with the next generation VLBI observing system (VGOS) promoted by the International VLBI Service for Geodesy and Astrometry (IVS). By March 2014, a VLBI telescope with a 13.2-m dish was completed in Ishioka, Ibaraki, now we are going on setting up and testing of the whole system from the telescope through data acquisition system toward. In this presentation I describe the completed VLBI observing facility and progress situation of its setting up and testing.

Keywords: IVS, VGOS

Japan Geoscience Union Meeting 2014
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SGD21-06 Room:413 Time:April 28 10:15-10:30

Development of a new precise positioning technique using multi-GNSS signals

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[1]GSI of Japan

Geospatial Information Authority of Japan (GSI) is developing and standardizing new precise positioning techniques which deal with multiple GNSS constellations, GPS, QZSS, GLONASS, and Galileo, in order to mainly encourage effective surveys at places where are currently difficult to carry out them using only GPS satellites.

In FY 2013, we examined analysis methods to correct Inter System Bias for using single/double differences between GPS and other GNSS. We developed the new analysis software named GSILIB based on RTKLIB developed by Mr. T.Takasu. In addition, we obtained multi-GNSS data in eight cities and evaluated the effects and problems using multi-GNSS signals.

This presentation shows results of FY 2013 and future plans from FY 2014.

Keywords: GNSS, Geodetic survey, ISB

Japan Geoscience Union Meeting 2014
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SGD21-07 Room:413 Time:April 28 10:30-10:45

Notes on the quality of GEONET coordinate solutions

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The routine solutions of geodetic coordinate of observation stations of GEONET, the continuous GNSS observation network operated by GSI, are fundamental data for the studies of crustal deformation and tectonics and widely utilized for a variety of purposes. As GEONET data is available freely, researchers can discuss the crustal deformation or tectonics without carrying out GNSS observation or baseline analysis. However, it should be noted that the coordinates provided by GEONET may include errors caused by various noise sources or factors, such as obstruction of observation signals by trees, multipath caused by site environment or um-modeled tropospheric noise. We present results of evaluation the effects of some of the error factors and introduce ways of examining the quality of coordinate solutions done for crustal deformation monitoring by GSI.

Keywords: GEONET, GNSS positioning, Data quality

Japan Geoscience Union Meeting 2014
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SGD21-08 Room:413 Time:April 28 11:00-11:15

Positioning error estimation due to snow accumulation on GNSS antenna using winter experimental data

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In research field of precise positioning using Global Navigation Satellite System (GNSS) such as GPS, it is well known that positioning error is caused by snow accumulation on GNSS antenna [1]. It is important to quantitatively evaluate the error taking account for shape of snow-cap and GPS satellite configuration, which are changing with time past. In this study, we performed two winter experiments in each winter of 2011/2012 and 2012/2013, which enabled us to quantitatively investigate reduction in receiving intensity and propagation delay due to snow accumulation on GNSS antenna. The experimental data was also able to use for positioning error estimation resulted by such effects. We installed a GPS antenna about 50 meters away from weather observational equipment, which measured pressure, temperature, humidity, wind direction and velocity, precipitation, snow depth, etc.), in observation field of Snow and Ice Research Center, National Research Institute for Earth Science and Disaster Prevention (NIED) in Nagaoka, Japan. To observe snow accumulation on GNSS antenna, a photograph of GNSS antenna was automatically took by an interval camera every 10 minutes during winter. To evaluate quantitative effects of snow accumulation on GPS signal measurement, we investigated drop events of snow-cap on GNSS antenna and analyzed gaps of rapid changes in both receiving intensity and carrier phase measurements[2]. Consequently, a snow-cap with a height of 40cm yielded reduction of several dB in receiving intensity (C/N0) and propagation delay of about 4 cm in slant range. We will show relationship between size of snow cap and positioning error based on the experimental data, including simulation analysis with range errors due to snow accumulation and satellite configuration. We will also show evaluation results to use water repellent paint on GNSS antenna radome for mitigation of snow accumulation.

References
[1] R. Jaldehag, J. Johansson, J. Davis and P. Elosegui, ”Geodesy using the Swedish permanent GPS network: Effects of snow accumulation on estimates of site positions”, Geophys. Res. Lett., vol.23, No. 13, pp.1601-1604, June 1996.
[2] T. Yoshihara, H. Motoyoshi, T. Sato, S. Yamaguchi and S. Saito, ”GAST-D integrity risks of snow accumulation on GBAS reference antennas and multipath effects due to snow-surface reflection”, Proc. ION ITM 2013, no.A1-5, pp.112-120, San Diego, CA, January 2013.

Keywords: GNSS, snow accumulation, positioning error, precise positioning, propagation delay, GPS

Japan Geoscience Union Meeting 2014
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SGD21-09 Room:413 Time:April 28 11:15-11:30

Periodic displacement on continuous GPS observation in coastal area due to long term sea level elevation

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Since 1999, Hydrographic and Oceanographic Department carried out continuous GPS observation to survey the crustal deformation at the stations collocated with tidal stations or lighthouse etc. of Japan Coast Guard in south Kanto area. And precise positions in earth centered coordinates of these GPS stations are automatically determined by long baseline analysis from Simosato GPS station. Several stations show significant unexpected annual oscillation in its daily position series. On the other hand, hourly sea level data are available via Japan Oceanographic Data Center from tidal stations of Japan Coast Guard and Japan Meteorological Agency in this area. To eliminate annual oscillation from crustal deformation observation, correlation functions between daily precise position series of GPS stations and sea level height series of tidal stations are calculated. And I tried to evaluate an error from weight variation of sea water on precise GPS observations in coastal area.

Hydrographic and Oceanographic Department continuously observes 30 sec interval data at GPS stations in Izu islands area from 2002. And long baseline analysis from Simosato hydrographic observatory is performed with Bernese GPS Software and IGS final ephemerides. Calculated daily precise positions are utilized for crustal deformation monitoring. However, time series of calculated positions contains unexpected component other than crustal deformation. Particularly, Izu O-Shima station shows significant oscillation in a north-south direction. This oscillation is synchronous with four GPS stations of GSI in Izu O-Shima, and these show annual apparent cycle of expansion and contraction. Some oscillation of local load is suspected as cause of this deformation and move of sea water is considered as major component of these in coastal area. Analyzed positions of these stations are obtained as daily value, thus influence of major component of tide (diurnal or semidiurnal) is negligible, but long term component, for instance, annual change of sea level is inadequately considered. According to the sea level observations at adjacent tidal stations, annual oscillation of sea level shows its amplitude in tens of centimeters, thus long term component of sea water load change is expected as considerable.

To eliminate annual oscillation from GPS monitoring of crustal deformation, I tried to analyze strain caused by load change from sea level elevation. This analysis is performed with the time series of daily precise positions of four GPS stations: Izu O-Shima, Miyake Shima, Kozu Shima, Hachijo Shima, from 2002. Because of Miyake Shima, Kozu Shima and Hachijo Shima stations are collocated with tidal stations of JCG, correlation functions are calculated with time series of sea level in place of stations. And the Izu O-Shima station is collocated with lighthouse, thus analyzed with the Okada tidal station of JMA in Izu O-Shima.

Keywords: GPS, tidal observation, crustal deformation, sea level change, annual oscillation

Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SGD21-10 Room:413 Time:April 28 11:30-11:45

Seismic waves detected by 50Hz sampled GNSS observations

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Application of frequently sampled GNSS data is getting increasingly attractive research field, in particular, in the field of seismology (e.g., Larson et al.; 2003, Miyazaki et al., 2004; Yokota et al., 2009; Ohta et al., 2012). As most of GEONET (GNSS Observation NETwork) sites are now archiving 1Hz sampled data, such application research will be more active in the future. Analysis of ground shake may require higher frequency observation such as 5Hz, 10Hz or higher. However, it is known that amplitude and phase of observed ground displacements show fluctuations due to characteristics of data acquisition in the receiver electric circuits (e.g., Ebinuma and Kato, 2012). Thus, we need to be careful in applying such highly sampled GPS data for geoscientific researches.

We have used commercially available GNSS receivers to record 50Hz sampling to tackle above problems. We are introducing a record of ground shake due to an earthquake of 50Hz sampled data. We used three NetR8 (Trimble Co. Ltd.) GNSS receivers and they were established at Shizuoka University (Shizuoka Prefecture) since October 2011, Katono Elementary School (Fukushima Prefecture; KTNO) and Daido-higashi Elementary School (Ibaraki Prefecture; DDHG) since March 2012. We chose latter two locations as they are among the most active aftershock area due to 2011 Tohoku-Oki earthquake (Mw9.0).

About two weeks of 50Hz sampled data are stored in the internal memory of the receiver which are refreshed automatically in the receiver. Data at KTNO and DDHG are remotely archived through internet and data at Shizuoka University are downloaded manually, after a large earthquake occurred. Several data sets due to large earthquakes have been archived so far, all of which registered at least bigger than or equal to JMA Intensity 5- at nearby GPS sites. These data are analyzed using RTNet GPS software.

Among the archived data sets, a seismic wave was detected for the 2013 September 20 Fukushima-Hamadori earthquake, whose hypocentral parameters are as follows: latitude= N37.1deg, longitude=E140.7deg, depth=20km, M5.9, and the biggest JMA Intensity was 5+ at Iwaki, which is nearly immediately below the KTNO site. We used IGS final orbits and estimated the position of KTNO by putting the reference site at Daido-higashi (Baseline distance is about 106km to south) and Shizuoka University (Baseline length is about 308km to south east). Clear seismic wave was obtained for the baseline KTNO-DDHG for three components. Also, clear seismic wave was obtained for the baseline KTNO-Shizuoka Univ., though vertical component was not very clear, probably because the baseline distance was longer.

GNSS antennas at KTNO and DDHG sites are placed at the roof of the school buildings and at the roof of observation hut of Shizuoka University. Therefore, we may have to investigate the effects of swing of the building by comparing the record with nearby recorded strong motion. Moreover, the method of correction for amplitude and phase due to receiver characteristics should be investigated, which is left for future studies.

Keywords: GNSS, high-frequency sampling, GPS, GPS seismology, 50Hz

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SGD21-11 Room:413 Time:April 28 11:45-12:00

Detection of eruption column by using the kinematic precise point positioning

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We investigate the ability of kinematic precise point positioning to detect volcanic plumes at Minami-dake of Sakurajima Volcano. In Houli$\acute{e}$ et al. [1], the authors processed the GPS data obtained during the eruption of Miyakejima volcano, occurred in 2000, and found anomalous values in the ionosphere-free linear combination of the L1 and L2 phase measurements (LC). They related these anomalous values to the path delay effects caused by the presence of a hot volcanic plume; by applying techniques of seismic tomography. Another test was carried out during the eruption of Mt. St. Helens on March 9, 2005, and again the GPS signal showed a clear signature of the volcanic plume presence [2].

In this study, we describe the July 24, 2012 activity at Minami-dake of Sakurajima Volcano. We analyzed the data from 18 continuous GPS stations (3 GEONET sites and 15 Kyoto University sites), which located on the volcano flanks. For the GPS analysis, we used GIPSY-OASIS II version 6.1.4 software [3]. We estimated the post-fit phase residual in the ionosphere-free linear combination for each pair of GPS satellites and ground stations for the detection of eruption column. We applied absolute IGS phase center corrections for satellite and receiver antennas. The wet zenith tropospheric delays and its gradient at all the GPS sites were estimated at all processing epochs (every 30 seconds) under the assumption of a random walk stochastic model. Firstly, we analyze the all of the GPS data in July 21, 22 and 23, 2012 for the reference. Obtained post-fit phase residual of the reference days showed the noise-level for the path delay effects caused by the volcanic plume. This reference post-fit phase residual contained many noise sources such as multipath effects, local atmospheric disturbance, and so on. The noise level of the post-fit phase residual strongly depends on the each GPS satellite and ground station pair. Finally, we analyzed the data of the July 24, 2012. The post-fit phase residual clearly shows large disturbance just after the eruption. For example, the phase residual between SVN34 satellite and GEONET 0720, which located in the east coast of Sakurajima, suddenly increased just after the eruption. The obtained residual amount reached 80mm. It is clearly larger than the noise level measured on the reference days. Furthermore, other GPS satellite and ground station pairs also clearly showed significant amounts of disturbance. These results suggest that the eruption column moved to the westward by the wind after the eruptive event.

[1] Houli$\acute{e}$ et al. GRL, 2005. [2] Houli$\acute{e}$ et al. Eos Trans, 2005. [3] Lichten and Border, JGR, 1987.

Japan Geoscience Union Meeting 2014
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SGD21-12 Room:413 Time:April 28 12:00-12:15

Airport survey method for transition to the new CNS/ATM systems in east Mekong area

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The project by the name of ”Capacity Development for Transition to the New CNS/ATM Systems in Cambodia, Lao PDR and Vietnam” (Jan.2011-Dec.2015) was officially announced by Japan International Corporation Agency (JICA) on April 2011, and Nippo got the order, after that we got the orders five times for two years. We would like to introduce the procedure of surveying airport coordinates.

The concept of New CNS/ATM System (Communication, Navigation and Surveillance/Air Traffic Management) utilizing satellite technologies was developed by International Civil Aviation Organization (ICAO) in 1991 for globally harmonized implementation in order to cope with the expected increase of air traffic. All the Contracting States of ICAO are required to move from the conventional air navigation systems to the New CNS/ATM Systems in accordance with ICAO Global Plan.

In order to shift air navigation from the ground-based facility use to the satellite use, it is essential to have accurate and updated data of latitude and longitude of airports and air navigation facilities based on WGS-84 coordinates as ICAO Standard. However, in Cambodia, Lao PDR and Vietnam it has not been made known whether airport survey has been conducted, applying long-baseline analysis by using International GNSS Services (IGS) points in accordance with ICAO WGS-84 Manuals (Doc9674 2nd edition).

The purpose of the project is transferring survey method and surveyed airport coordinates in accordance with WGS84 coordinate system.

Airport survey procedure and recommendation

1.Confirmation of required survey points and facilities

Runway ends, ILS, VOR/DME, control tower, TV antenna, etc.

2.Reconnaissance of Primary Airport Control Station (PACS) and Secondary Control Station (SACS). Installed two PACS survey markers near runway ends and seven or eight SACS survey markers at a regular distance.

3.Set up receivers at two PACS and one SACS and surveyed 24 hours at PACS for three days, at SACS for 1.5 hours simultaneously by differential GPS satellite surveying. (when prepared three receivers. if prepared four receivers, observe two PACS and two SACS simultaneously)

4.Install GPS receivers at other SACS points over lapping the base line on every session.

5.Install total station (TS) at every PACS and SACS and observe each other to verify the coordinates surveyed by GPS receivers.

6.Survey runway ends, radio navigation facilities (ILS, VOR/DME, etc.) and obstacles like control tower, big Buddha stature, tall building. If the obstacle cannot seen from coordinates known points PACS, SACS, set up receivers at PACS and auxiliary two points in the vicinity of the obstacle.

7.Determine the coordinates of PACS using long baseline analysis software (Bernese) by down loading ultra rapid orbit. Coordinates of SACS using short baseline analysis software.

8.Survey runway ends, radio navigation facility and obstacles by TS using SACS and PACS.

9.We surveyed a fiducial point which have x, y coordinates and above sea level height, and compared the result which obtained by Earth Gravitational Method (EGM) 2008 software in Cambodia. (The result of EGM2008 is higher than our survey by about 80cm, but we could not confirm the accuracy of the height of fiducial point.)

10.Lecture on how to choose the PACS and SACS location, how to use the long baseline software and how to maintenance the result data including process of calculation.

Keywords: WGS84, GPS, CNS/ATM, Airport coordinates, East Mekong area

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Vertical deformations revealed by laser scanning surveys in the Murono mud volcano

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In order to reveal the land surface deformation in the Murono mud volcano area located in Tokamachi city, Niigata prefecture, we have conducted the laser scanning surveys two times in June and October 2013, using TOPCON Imaging Station IS-301, which can obtain 3D point cloud data by the automatic laser scanning mode without reflector. In the same survey area, Toyama University has been conducting successive leveling surveys at 61 benchmarks so far. We also conducted the height measurements at the benchmarks using the precise ranging mode.

The obtained cloud data have been interpolated on regular grids for the two data sets, respectively, and the surface deformation has been calculated by comparing the gridded data. The obtained result showed a clear concentric uplift pattern in a part of the survey area. We thus modeled the uplift using the Mogi source model. The maximum amplitude estimated from the model was about 1.5 cm and it was almost coincident with the uplift obtained at the nearest benchmark. The result showed that the scanning mode was really beneficial to search for the spatial deformation pattern and the source of the deformation as well, even though its accuracy would be lower than the one of the precise ranging mode.

Keywords: LaserRangeFinder, LaserScanningSurvey, Mud Volcano, Vertical Deformation, Mogi Model

Japan Geoscience Union Meeting 2014
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Asymptotic solutions to the quasi-static spheroidal and toroidal deformation of the SNREI earth

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Asympotic solutions to the quasi-static deformation of SNREI earth are essential to compute Green's functions, i.e., deformations due to a point load and a point dislocation. So far, only the surface deformations have been presented by previous authors. That is, internal stress/strain fields are not left uncalculated because of lack of asymptotic solutions to the internal deformation fields. In this talk, we present complete sets of spheroidal/toroidal deformations when spherical harmonic degree n increases to infinitiy.

Keywords: Internal elastic deformation, Green's function, SNREI earth, Asymptotic expansion