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

SGD21-P01 Room:Poster Time:April 28 18:15-19:30

Evaluation of uncertainty in distance measurement by GNSS surveying instrument and EDM

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GSI has conducted research to establish traceability for distance measurement by GNSS surveying instrument to international standard. The international standard of distance is defined based on speed of light. In order to measure a distance based on the standard, it is necessary to use Electro-optical Distance Meter (EDM) for which the traceability to the standard is established. On the other hand, the traceability for GNSS surveying instrument used in various surveys is not established, because it is difficult and complex to estimate the uncertainty in distance measurement by the instrument. Therefore, we conducted an experiment to compare results of distance measurement by GNSS surveying instrument and EDM on a 2 km baseline.

Although the EDM measurement in this experiment should have been conducted indoors to reduce an affect of meteorological condition change, it was almost impossible to find an indoor 2 km baseline. We therefore divided an outdoor 2 km baseline into 10 short baselines and measured them by EDM. After that, the distance and uncertainty of the whole baseline were estimated from the results of measurements on the short baselines. The 2 km baseline was also measured by GNSS, and the estimated distance and uncertainty was compared to the results of EDM measurements.

The distances and uncertainties estimated by the measurements of EDM and GNSS survey instrument were 1,999.9828 $\pm$ 0.0014 m and 1999.9828 $\pm$ 0.006 m respectively. As a result of the experiment, we verified that the traceability for GNSS surveying instrument can be established on the 2 km baseline.

Keywords: GNSS surveying instrument, EDM, Uncertainty, Traceability

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Changes of E-W observed by the Quartz-tube Extensometer in the Matsushiro extending after the 2011 Tohoku Earthquake

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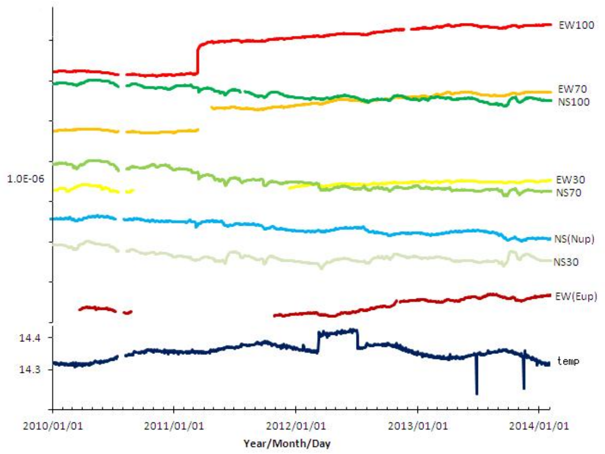
We observed a coseismic step of 5.8×10^{-7} strain in the E-W direction by the quartz-tube extensometer at Matsushiro during the 2011off the Pacific coast of Tohoku earthquake. After that, an aftereffect of 0.4×10^{-7} strain continued extending in the E-W direction about 1 month. And more, the E-W extension has continued since October, 2011 and it becomes over 0.5×10^{-7} strain. Similar phenomena were observed by superconducting gravity meter in Matsushiro and Kamioka (Imanishi, personal communication). Therefore, we think that these data of the E-W extension indicate true crustal deformation.

Figure shows data of the quartz-tube extensometer, water-tube tiltmeter, thermometer, and the other points of the extensometer. The air temperature in the tunnel heated up 0.03 ℃ in this range. But the influence of the temperature change hardly caused the extension, because it is very small extension of 1.6×10^{-8} as 5.4×10^{-7} of the temperature response of the quartz-tube. And more, the tiltmeter and the other point data of the extensometer show a similar change, therefore, the change seems to be true. We can catch geophysical phenomena such as the seismic waves (not shown in the figure) of the 2011 off the Pacific coast of Tohoku earthquake, the coseismic step, the aftereffect and continuing extensive change by the one device. This extensive change may indicate a part of crustal upheaval in a geological meaning.

Acknowledgement: We thank Yuichi Imanishi Associate Professor of ERI for teaching us about the continuity of decreasing gravity by the superconducting gravity meters in Matsushiro and Kamioka after the Tohoku earthquake.

Keywords: extensometer, tiltmeter, aftereffect, the 2011 off the Pacfic coast of Tohoku Earthquake



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Equqtorial flattening of the cylindrical outer core

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Zhong et al.(2007),showed that the Africa supercontinent was formed after the Pangea(330Ma)in an initially by a spherical harmonic degree-1 form with the Pacific superplume. They suggested that the degree-1structure is responsible for supercontinent assembly with downwellings(Africa) and upwellings(Pacific).Recent studies show that light elements are transferred from the mantle to the outer core (OC) through the core-mantle boundary(CMB) and that the stably stratified layer are formed in the OC beneath the CMB. The stable layer shows the superadiabatic gradient, 1 Kkm-1 and its thermal conductivity is 150Wm-1K-1. The heat flux is over 100mWm-2.The heat flux of the mantle near the CMB is 100mWm-2 in the high temperature region (Perovskite) and 50mWm-2 in the low temperature region(Post-Perovskite). The heat flux flows into the low temperature region from the OC. We assume that the OC is a thin cylindrical rotating fluid around the rotating axis. The fluid shows a low frequency motion and the effects of flow pressure fluctuations on the density is ignored (Subseismic Approximation;Smylie and Rochester, 1981). The heat flux in the OC is expressed in the form of the exponential function of the central distance which decreases outward near the CMB. We derive the 1st order variations of the Potential. The azimuthal variation of the potential shows the variation of the equatorial flattening. The maximal value of its variation relative to the mean gravitational potential at the CMB is 1.1x10-5 (flattening). This value can be compared with the value of the equatorial flattening of the OC to be 6x10-6 obtained by Szeto and Xu(1997).

Keywords: thin cylindrical outer core, heat flux, heat flux in the mantle, potential, variation of potential, equatorial flattening of core

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A bias correction method for improving regularized solution in linear inverse ill conditioned models

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Geodetic downward continuation and inverse problems are often ill conditioned, and regularization is used for deriving stable and better solutions. However, the regularized estimates of parameters and residuals are well known to be biased. Theoretically the biases of the estimated parameters and residuals can only be computed with the true values of parameters. Since we do not know the true values of parameters in practice, we attempt to improve the regularized estimates by using the regularized estimates themselves to replace the true parameters for estimating the biases and then removing the computed biases from the regularized estimates. Furthermore the biases are also removed from the residuals, and then the variance of unit weight of the observation noises is estimated with the bias-reduced residuals. We derive the analytical conditions for bias correction and show that the bias-corrected regularization performs better than the ordinary regularization in terms of mean squared errors. However, for estimating the variance of unit weight, the biases still need to be full removed from the residuals. We then present the numerical examples of gravity downward continuation to demonstrate the performance of our bias correction method for improving regularized solution. The results show that our bias correction method can successfully reduce the absolute biases of the regularized estimates, and improve the accuracies with more than 5 per cent. Moreover, by removing the biases from the residuals, the derived variance of unit weight is almost unbiased.

Keywords: Linear ill-conditioned model, Regularization solution, Bias correction, Gravity downward continuation, Variance of unit weight