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Independent component analysis of gravity data observed by gPhone gravimeters

ITAKURA, Matomu[1*] ; FUKUDA, Yoichi[1] ; WAHYUDI, Eko januari[2] ; KAZAMA, Takahito[1]

[1]Graduate School of Science, Kyoto University, [2]Bandung Institute of Technology

We tested ICA (Independent Component Analysis) for detecting the gravity signals due to various geophysical phenomena. ICA is one of the multivariate analysis methods that decomposes mixed data into uncorrelated components assuming that the original signals are non-Gaussian. Thus far, it has been mainly used for the researches of sound and brain waves because those signals are uncorrelated and non-Gaussian.

Since the signals of gravity changes also can be considered non-Gaussian, we tried to separate those signals using ICA. Using pseudo gravity data sets that were composed by mixing sinusoid waves with different periods, we first conducted numerical tests to decompose the signals. The results showed that the signals can be separated if the length of data is enough longer than its wavelength. However the separation was not satisfactory in the following cases; the signals was shorter than their wavelength, and the signals contained trends. In those cases, the separation can be improved by removing the trend components in advance.

Based on these results, we applied ICA for the analysis of the gravity data obtained by three gPhones #123, #126 and #127 at a gravity base station (Kyoto A) in Kyoto University. The observations were conducted from January to February, 2014 and the data period is 300 hours. The Earth tide signals were removed in advance by using BAYTAP-G program, and the instrumental drift for each gravimeter was corrected by fitting an exponential functions. Since we did not correct the effects of atmospheric pressure, the residual gravity signals, which were used as the input data for ICA analysis, may contain the atmospheric, trends and other common effects. The results of ICA show the effects of the atmospheric pressure and trends have been detected with P-P amplitudes of 5.8$\sim$16.0 micro-Gal and 3.5$\sim$14.8 micro-Gal, respectively. Moreover the correlation coefficient between the atmospheric components and the data observed by a barometer was 0.7. However the estimated amplitudes varied within the factor of three, although the reason was not clear.

Keywords: Independent Component Analysis, gravity