# An attempt to detect the variation of attractive forces from deep belowground using the Vertical Gravimeter Array.

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The author has conducted continuous gravity observations at both aboveground and belowground (Vertical Gravimeter Array, VGA) in the Mizunami Underground Research Laboratory (MIU) in order to detect underground mass fluctuations related to seismic activity. The VGA observation was completed in October 2019 for backfilling the MIU, and approximately 5 years of the data has been accumulated. The sum of the aboveground and belowground gravity values, after the atmospheric corrections, reflects the gravitational effect from below the underground gravimeter position (Tanaka and Honda, 2018, ESS). I hereinafter refer to it as SUM. Tanaka (2019, JgGU) introduced the Local-scale objective analysis (LANAL) for atmospheric correction of VGA observation data for 90 days from May 21, 2018. The statistical values in the abstract were too large due to an accidental time lag and are corrected as follows: the simultaneous values between MANAL and LANAL is 0.13 (not 0.66) microGal, the maximum amplitude from the median is 0.6 (not 2.4) microGal. Therefore, the migration from MANAL (3-hour value) to LANAL (1-hour value) is an appropriate evolution. As for the amplitude ration of atmospheric corrections, the gravitational effect near the observation point was calculated as 97% (14 microGal peak-to-peak), and the other effects were calculated as 3% (0.4 microGal peak-to-peak, the correlation coefficient with the former was 0.48). Therefore, we adopted the latter as a product of the former multiplied by 0.03 for convenience. The conclusion of the following discussion did not change even if the admittance factor method was used for atmospheric correction. And, the gravity step caused by the Osaka-Fu Hokubu Earthquake (17 June 22:58 UTC) was manually corrected. As a result, the SUM (Fig. A) and the "de-tide" confined-groundwater level of TGR350m Borehole (Fig. B) showed an inverse correlation and had the correlation coefficient -0.95. The interpretation of the inverse relationship was described in Tanaka et al. (2006, Gcubed). Therefore, the SUM correctly reflects underground mass fluctuations. Next, the author removed the groundwater-level correlated component from the SUM and tried to extract gravity changes other than groundwater. Here, the residual gravity value was obtained by linear regression using the least-squares method (Fig. C). In late June, a slow slip event occurred in the Tokai region (Monthly Report on Earthquake and Volcano in Japan, JMA), but no particular change looks observed. The gravity change in Mizunami caused by a M5-class slow slip event of the Tokai region is on the order of sub-microgals, and it might be difficult to separate it from background noises.

Keywords: gravity, groundwater, Vertical Gravimeter Array, Local-scale objective analysis