Gravity observation using a superconducting gravimeter at Ishigakijima, Japan

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Since 2012, we have been operating a superconducting gravimeter at the VERA Ishigakijima Station, National Astronomical Observatory Japan, with the aim of detecting possible gravity changes associated with the long-term slow slip events (SSE) taking place beneath the Yaeyama Islands. Before the move to Ishigakijima, we refurbished the gravimeter (Ikeda et al., 2013), which used to be in operation at the Inuyama Observatory, Nagoya University until 2011. In the eight years of observations, the gravimeter has been producing an almost homogeneous and continuous dataset of temporal gravity changes, except for several times of breaks due to power failure caused by typhoons.

Superconducting gravimeters have rarely been installed at such an oceanic island as Ishigakijima, and investigation of several interesting phenomena characteristic to this site have contributed to deeper understanding of the properties of the gravity sensor. Horizontal ground acceleration excited by the movements of a nearby VLBI antenna induces systematic step noise in the gravity recordings. It was found that this is effectively modeled by the coupling between the horizontal and vertical components in the gravity sensor (Imanishi et al., 2018a). It was also found that the mechanical eigenfrequency for horizontal translation of the levitating sphere is approximately 3 Hz. Gravity tends to increase when the level of microseismic noise is extremely enhanced in stormy weather. Possible nonlinearity in the vertical component of the gravity sensor was investigated in detail, resulting in the conclusion that such changes are not of instrumental origin but real gravity signals (Imanishi et al., 2019).

In order to clarify gravity changes related with the SSE, observed gravity data must be precisely corrected for the effects of the atmosphere, ocean, and underground water. At Ishigakijima, these components of earth fluid are closely combined with each other to constitute a complicated system, making the correction difficult. In particular, effects of underground water are important for gravity correction. Evidences show that the groundwater level is related with the sea level. To address these problems, we installed a gPhone gravimeter at an F-net station near the VERA station in 2016 (Mochizuki et al., 2017). Also, we have proposed and applied a new method of gravity survey using both a superconducting gravimeter and an Scintrex gravimeter, called a superhybrid gravimetry (Imanishi et al., 2018b). Based on available observational data, we will present results of modeling the interactions between the atmosphere, ocean, and underground water, and discuss possible detection of gravity signals from the deep interior of the earth.

Keywords: superconducting gravimeter, slow slip, Ishigakijima, superhybrid gravimetry

