Gravity Effect of Local Snow Accumulation obtained from Superconducting Gravimeter and UAV survey at Syowa Station

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Continuous gravity observation has been conducted with a superconducting gravimeter (SG) at the Japanese Antarctic station, Syowa Station (69°0.2646’S, 39°34.9074’ E) since 1993. The first SG, TT70#016, was replaced by the second SG, CT#043, in 2003, then CT#043 was replaced by the third OSG#058 in 2010, and OSG#058 is in operation. It is considered that the gravity observations with SGs, which have a high sensitivity, are detecting the gravitational signal of local snow accumulation in Syowa Station. It is necessary to correct the accumulated snow effect for monitoring the geophysically important but weak signals, such as one associated with Glacial Isostatic Adjustment (GIA).

The distribution of snow depth in Syowa Station was estimated from digital surface models (DSMs) made from unmanned aerial vehicle (UAV) photographic survey by applying structure from motion (SfM) processing methods to the aerial photographs. In the 59th Japanese Antarctic Research Expedition (JARE-59) activity (2017-2019), we conducted aerial photogrammetry by the fixed-wing drone “senseFly eBee Plus,” which has dual-frequency GNSS receiver, over Syowa Station in January (austral summer season). Besides, we have conducted aerial photogrammetry by the rotary wing drone "DJI Inspire 2" and “DJI Phantom” in the same area, about every one month from May to November (austral winter season). The DSM and the orthomosaic photo were generated from each set of the geotagged photos using the SfM software “Pix4D.”

For improving the accuracy of DSM, we used the geodetic triangulation survey points operated by GSI (Geospatial Information Authority of Japan) as GCP (ground control points) in SfM analysis. We also calibrated the height of DSM by using the ground area uncovered by snow characterized by Brown color as fixed height sites. Thereby, we obtained the time-series of snow depth distributions by calculating height differences among DSMs.

We calculated the attractive changes on OSG#058 estimated from the obtained snow depth distribution. Consequently, it was revealed that the local snow accumulation changes in the Syowa Station caused a seasonal gravity variation of at least 0.1-0.3 μGal (1 μGal = 10^{-8} m/s^2).

In this presentation, we show the details of observed changes in snow distribution, and discuss the comparison between the estimated gravity effect of local snow accumulation and the gravity change observed by OSG#058.

Keywords: Superconducting gravimeter, Unmanned aerial vehicle (UAV), Structure from Motion (SfM)

