Observed displacements and gravity changes at Ny-Alesund, Svalbard, and the effect of the present-day glacial melting

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We analyzed the data obtained from the permanent stations of GPS and VLBI at Ny-Alesund, Svalbard in the Arctic and it is found to be 5.6+-0.9 mm/yr (+uplift) as a secular rate of the vertical displacement, which is a weighted mean of the results for two techniques. Beside the displace measurements, since 1998, the absolute gravity (AG) measurements have also been carried out four times by three different institutes using the FG5 absolute gravimeters, and we obtained a secular rate of -3.3+-0.8 microGal/yr (decreasing in gravity). The data obtained from a superconducting gravity at Ny-Alesund were used to correct for the gravity tides including the ocean tide effects and the air pressure. The observed uplift rates are far larger than the rate of at around 1 mm/yr to 2 mm/yr, which is predicted by using several models of the post glacial rebound (PGR) at the western Svalbard. The observed rate is also larger a mean rate of at about 3 mm/yr, which is suggested from studies for the raised shore deposit in Svalbard.

As a possible candidate to explain the remaining part of the observed rates, we have estimated the effect of the relative sea level (RSL) changes and of the present-day glacial melting in Svalbard. For the RSL changes, our estimations based on the monthly tide gauge data archived at Permanent Service for Mean Sea Level (PSML) are +0.09 mm/yr for the vertical displacement and -0.04 microGal/yr for the gravity at most. Therefore, its effect is too small to explain the observed differences. The observed uplift rate after correcting for the PGR effect and the regional rate is at an order of 2 mm/yr, and it indicates that the glaciers in Svalbard are melting at a rate of about 40 cm/yr as a mean over the Svalbard islands. The obtained rate is not inconsistent with the rate estimated from the glacial morphological studies. For the gravity, the rate after correcting for the PGR, the free air gravity gradient and the RSL effect is at an order of -1.5 microGal/yr that is about 2 times larger than the predicted rate. Although there are several points improved in both the observation and our modeling, our comparison between them strongly suggests that the geodetic data obtained at Ny-Alesund detect the effect of the present-day glacial melting in Svalbard.