Elastic deformation due to present-day mass change at GNSS measurements sites in East Antarctica

Akihisa Hattori[1], Yuichi Aoyama[1,2], Jun'ichi Okuno[1,2] and Koichiro Doi[1,2]

[1]*The Graduate University for Advanced Studies, SOKENDAI*

[2]*National Institute of Polar Research*

In Antarctica, the crustal movement due to the viscoelastic response of the solid Earth to the past ice mass change from the last glacial maximum is still ongoing, which is called as glacial isostatic adjustment (GIA). Monitoring the current crustal deformation with geodetic observation helps to constrain and evaluate GIA models by comparing the observed uplift rate with the GIA model predictions. Although GNSS observation sites in East Antarctica are fewer than those in West Antarctica, there are several continuous GNSS stations in IGS (International GNSS Service) network, and we can investigate their deformation change rates. In addition, the Japanese Antarctic Research Expedition (JARE) has conducted GNSS measurements on the outcrop rocks around the Lützow-Holmbukta, Dronning Maud Land for about 20 years.

The time series of crustal deformation observed by these GNSS measurements contains not only the viscoelastic component of GIA but also the elastic component due to the current mass change. GRACE (The Gravity Recovery and Climate Experiment) clearly detects the mass gain in Dronning Maud Land and Enderby Land in East Antarctica, which is assumed to be associated with recent increasing snow accumulation. Such a positive mass balance induces the crustal subsidence due to increased mass loading. For accurate detection of the vertical change rate due to GIA, it is necessary to evaluate this elastic component induced by recent ice mass change on the Antarctic continent.

The purpose of this study is to evaluate the influence of the elastic response to the recent ice mass change on GNSS observations in East Antarctica. We analyzed the GNSS observation data obtained from IGS stations in East Antarctica: Syowa, Mawson, Davis, and Casey, and JARE's outcrop sites: Tottsuki Misaki, Langhovde, Skarvsnes, Skallen, Rundvågshetta, and Padda, during 2007-2018 with precise point positioning (PPP) procedure using the multi-technique space geodetic analysis software "c5++". Figure 1 shows the time series of estimated vertical displacement of each IGS site. Next, we calculated the elastic deformation based on the mass variation obtained by the GRACE mascon solution (Figure 2). These results indicate that the trends of vertical crustal motion at IGS sites are a clear correlation to the calculated deformation rates based on the GRACE data. In this presentation, we show the detail of GNSS analysis and the estimated elastic deformation. We also snow the comparison of the obtained vertical deformation rate after correcting the elastic deformation with GIA model predictions.

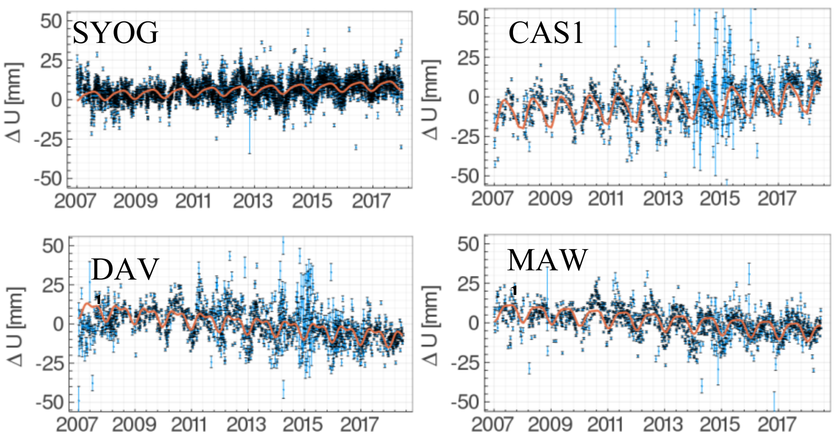

Figure 1. The time series of observed vertical displacement of each IGS station in East Antarctica; Syowa, Mawson, Davis, and Casey, estimated by PPP.

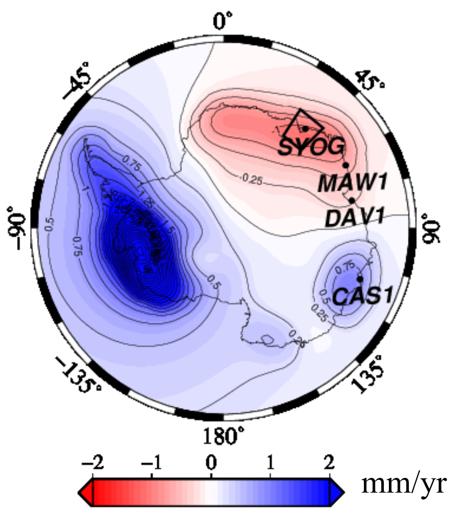

Figure 2. Spatial distribution of the estimated vertical elastic deformation rate due to recent snow mass change. The snow mass change is estimated from GRACE.