Dependence of GIA-induced gravity change in Antarctica on viscoelastic Earth structure

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The Antarctic ice mass loss is accelerating due to recent global warming. Changes in Antarctic ice mass have been observed as the gravity change by GRACE (Gravity Recovery and Climate Experiment) satellites. The gravity signal includes both the component of the ice mass change and the component of the solid Earth response to surface mass change (Glacial Isostatic Adjustment, GIA). Therefore, estimates of the ice mass change from GRACE data require subtraction of GIA model predicted gravity rates (GIA correction).

Antarctica is characterized by lateral heterogeneity of seismic velocity structure. West Antarctica shows relatively low seismic velocities, suggesting low-viscosity regions in the upper mantle. On the other hand, East Antarctica shows relatively high seismic velocities, suggesting thick lithosphere. Here we examine the dependence of GIA correction on lithosphere thickness and upper mantle viscosity.

Figure 1 shows GIA correction based on the ice history model ICE-6G_D (Peltier *et al.*, 2018). The GIA correction for the average viscoelastic structure of West Antarctica (red diamond in Figure 1) is nearly identical to that for the average viscoelastic structure of East Antarctica (blue diamond in Figure 1). There is a trade-off between the lithosphere thickness and the upper mantle viscosity. This trade-off may reduce the effect of the lateral variations in viscoelastic Earth structure beneath Antarctica on the estimate of Antarctic ice mass change.

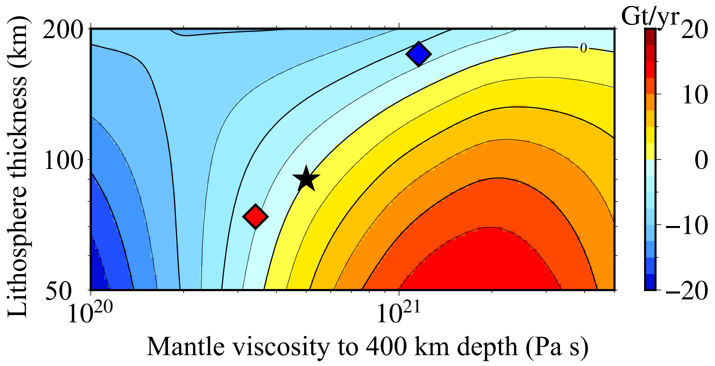

Figure 1. Predicted GIA corrections as a function of lithosphere thickness and mantle viscosity to 400 km depth using the ice history model ICE-6G_D (Peltier *et al.*, 2018). The values are plotted relative to the optimum viscoelastic Earth model of ICE-6G_D (black star), which is 90 Gt/yr. The warmer (colder) color indicates a larger (smaller) GIA correction than that for the optimum model. Red and blue diamonds are the averages of seismic-based viscoelastic Earth model $V3D_{RH}$ (Pan *et al.*, 2021) over West Antarctica and East Antarctica, respectively.