



Improved GIA Correction and Antarctic Contribution to Sea-level Rise Observed by GRACE

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Measurement of continent-wide glacial isostatic adjustment (GIA) is needed to interpret satellite-based trends for the grounded ice mass change of the Antarctic ice sheet (AIS). This is especially true for trends determined from the Gravity Recovery and Climate Experiment (GRACE) satellite mission. Three data sets have matured to the point where they can be used to shrink the range of possible GIA models for Antarctica: the glacial geological record has expanded to include exposure ages using ^{10}Be , ^{26}Al measurements that constrain past thickness of the ice sheet, modelled ice core records now better constrain the temporal variation in past rates of snow accumulation, and Global Positioning System (GPS) vertical rate trends from across the continent are now available. The volume changes associated with Antarctic ice loading and unloading during the past 21 thousand years (21 ka) are smaller than previously thought, generating model present-day uplift rates that are consistent with GPS observations. We construct an ice sheet history that is designed to predict maximum volume changes, and in particular, maximum Holocene change. This ice sheet model drives a forward model prediction of GIA gravity signal, that in turn, should give maximum GIA response predictions. The apparent surface mass change component of GIA is re-evaluated to be $+55 \pm 13$ Gt/yr by considering a revised ice history model and a parameter search for vertical motion predictions that best-fit the GPS observations at 18 high-quality stations. Although the GIA model spans a wide range of possible earth rheological structure values, the data are not yet sufficient for solving for a preferred value of upper and lower mantle viscosity, nor for a preferred lithospheric thickness. GRACE monthly solutions from CSR-RL04 release time series from Jan. 2003 through the beginning of Jan. 2012, uncorrected for GIA, yield an ice mass rate of $+2.9 \pm 34$ Gt/yr. A new rough upper bound to the GIA correction is about 60-65 Gt/yr. The new correction increases the solved-for ice mass imbalance of Antarctica to -57 ± 34 Gt/yr. The revised GIA correction is smaller than past GRACE estimates by about 50 to 90 Gt/yr. The new upper bound to sea-level rise from AIS mass loss averaged over the time span 2003.0 - 2012.0 is about 0.16 ± 0.09 mm/yr. We discuss the differences in spatio-temporal character of the gain-loss regimes of Antarctica over the observing period.