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Antarctic glacio isostatic adjustment from an inversion of satellite and in-situ observations.

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Glacio Isostatic Adjustment has, until recently, been estimated using forward models that attempt to determine how the mantle and lithosphere respond to changes in ice loading through time. These models require knowledge of the Earth structure, including mantle viscosity, and ice load history, both of which have large uncertainties for Antarctica. Furthermore, 3-D Earth models are required to adequately accommodate the substantial variations in crustal thickness between West and East Antarctica.

An alternative approach is to use observations of crustal motion from GPS, combined with mass trends from GRACE to invert for GIA. However, this is an undetermined problem. Here, we present a novel solution to this problem using the latest methods in statistical modelling of spatio-temporal processes. We use Bayesian hierarchical modelling and employ stochastic partial differential equations to allow us to solve, simultaneously, for ice mass trends and GIA. Here, we focus on the GIA solution derived from a combination of ICESat, ENVISAT, GRACE, InSAR, GPS and regional climate model output data for the period 2003-2009, assuming that GIA is time-invariant over this time frame.

We estimate the total GIA-induced mass change to be 62 $\pm$ 6 Gt/yr. Being this an intermediate value, our regional rates differ substantially compared with the latest forward model solutions. For Pine Island basin, for example, we obtain a relatively large uplift over 3 mm/yr as opposed to values below 1.5 mm/yr for the models IJ05v2 and AGE1. Over East Antarctica our rates are generally higher than forward models and we obtain positive values over a large area of Dronning Maud Land, where subsidence is predicted from forward modelling. Over the Antarctic Peninsula we predict a strong GIA uplift (rating between 3 and 6 mm/yr over the entire region) which doubles forward models predictions. They seem to be a consequence of present day changes in ice loading and the lower viscosity of the lithosphere in this region.