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Present-day ice mass changes and glacial-isostatic adjustment in Antarctica from GRACE, ICESat / Envisat, GPS and viscoelastic modelling

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Determining the mass balance of the Antarctic ice sheet from satellite gravimetry (GRACE), and, to a lesser extent satellite altimetry (e.g. CryoSat), relies on corrections of the mass transport in the Earth's mantle and surface deformation related to the glacial isostatic adjustment (GIA). Due to the scarcity of observational constraints on the ice sheet evolution, as well as the lack of knowledge on the Earth's rheological structure, GIA corrections remain ambiguous. Therefore, signatures of GIA derived from contemporary space-geodetic measurements are valuable new constraints. Here, we present our most recent advances of the ESA-STSE Project REGINA (www.regina-science.eu) in estimating Antarctic GIA from space-geodetic measurements; namely, gravity field trends recovered with GRACE, GPS surface displacements, and ice sheet topographic change from ICESat/Envisat satellite altimetry. We show that even though recent GIA predictions reconcile with geodetic estimates at the continental scale, considerable regional deviations exist. A prominent example is the Amundsen Sea Sector, where GPS data indicate GIA-induced uplift of tens of mm/yr. Using forward modeling simulations, we show that, in principle, this signature reconciles with recent mass loss and very low viscosity of the Earth's mantle. We conclude with estimating the impact of such small-scale GIA signals on space-geodetic estimates of the regional Antarctic mass balance.