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Methodology for generating high resolution GIA and ice-mass change estimates over Antarctica using GRACE, ICESat, RACMO, and GPS data

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In this study, we outline a methodology designed to fully exploit the Gravity Recovery and Climate Experiment (GRACE) data for deriving the highest spatial resolution possible for glacial isostatic adjustment (GIA) and ice-mass change signals in Antarctica with the least possible noise level. The limited horizontal resolution of GRACE data represents a major challenge when combining them with data featuring a higher spatial resolution, such as ICESat (Ice Cloud and land Elevation Satellite) altimeter measurements and climate data. To address this, a so-called 'dynamic patch approach' was developed that consistently combines GRACE data with fine scale signal features from ICESat and the Regional Atmospheric Climate Model (RACMO). Independent GPS observations are used to define the spatial pattern of estimated present-day GIA. The spatial resolution of estimated ice-mass changes is determined using an ICESat-RACMO 2.3 combination. To solve for GIA and ice-mass changes, a weighted least-squares adjustment is applied while taking into account the full noise covariance information of GRACE data, as well as the variances of other datasets involved in the combination, without using any additional constraints. The results demonstrate the capability of the developed approach to retrieve the complex spatial pattern of present-day GIA, such as a pronounced subsidence in the proximity of the Kamb Ice Stream. Furthermore, the suggested method recovers ice-mass changes with extremely high spatial resolution, providing a more complete, and self-consistent, assessment of the overall mass changes taking place over the Antarctic continent.