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An inversion method for the separation of present-day water transport and glacial isostatic adjustment and its results

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The analysis of recent changes in continental water storage has been facilitated by Gravity Recovery and Climate Experiment (GRACE) data. While the trend of present-day continental mass change has been successfully estimated in most part of the world, this has been hindered in North America, northern Europe and polar areas by the strong overlapping background signals of glacial isostatic adjustment (GIA). To overcome this problem, the effects of GIA are currently estimated by using dedicated GIA models, however, those estimates have large discrepancies and uncertainties as those models eventually depend upon details of glacial history and mantle viscosity which are far from perfect.

In this study, we propose an inversion method that by combining GRACE data with GPS measurements or satellite altimetry can clearly separate the hydrology or ice-meting signals from the GIA-affected areas without involving any model assumptions. Applying the method, we show that Central North America including Lake Michigan experiences a strong water storage increase of 43 Gt/yr. The mass gain in the Lake Michigan area questions recent altimetry measurements, which show a constant lake level. Water storage also increases, though much smaller, in southern Fennoscandia by about 2.3 Gt/yr. In a last step, we also successfully apply our approach for Antarctica.