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# Repeated relative gravity measurements between surface and underground stations resolve the local variation in subsurface water storage

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The present work had its origin in the study of Fennoscandian postglacial rebound using repeated absolute gravity (AG) measurements. The AG station in Riga is situated about 10 m underground, at the bottom of a silo-like concrete structure on the limestone basement. During the first AG measurement in 1995 by the FGI two excenter stations were established on the surface and tied to the AG station by relative measurements. The immediate purpose was to provide easier access to the AG value for practical gravity surveys, but it was also realized that repeating the relative ties at every AG measurement would give an opportunity to isolate the gravity effect of the variable water storage in the sediment layers for correcting AG. At the AG station at bottom the attraction is upwards, at the surface stations downwards, and in the gravity difference it appears approximately double. During absolute measurements by the BKG and by the National Geospatial Intelligence Agency (NGA, St.Louis, USA) in 1996 and by the FGI in 2007 the relative ties were re-measured; BKG also established an additional station halfway down the silo and another on its roof 5 m above the ground surface.

The relative measurements during the AG campaigns were too few for validating the results. Therefore after the fifth AG measurement performed by the FGI in 2013, a monthly series of relative campaigns was started by the LGIA, using two Scintrex CG-5 gravimeters. The variation in the gravity difference top-to-bottom is 16 microgal (peak-to-peak). The terrain is flat and the assumption of laterally homogeneous 2-D local hydrology (only perforated by the silo and the piers of the surface stations) is a reasonable first approximation. Then we can invert the relative gravity series for both variation in subsurface water mass and for the mean depth of the layers with variable water content, without any hydrological observations at all. At the second stage we combine the inversion results with the observations of groundwater level in an on-site access tube. Comparison shows that in addition to the groundwater, soil moisture content contributes appreciably to the variation in water mass and in gravity.