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Temporal gravity variations observed with the superconducting gravimeter at Metsähovi, Finland: interpreted by local hydrological sensors

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Metsähovi is a fundamental geodetic station with multiple observation techniques, including a superconducting gravimeter (SG). The SG no. T020 has been operating continuously at Metsähovi since August 1994. After corrections for known time-variable gravity effects, such as tides, atmosphere and the Baltic Sea are made, the remaining gravity residual (8 microgals peak-to-peak) is mostly due to variation in terrestrial water storage. The detection threshold of the SG corresponds to the attraction a hypothetical Bouguer slab of water 1-2 mm thick that extends below the instrument as well. The local hydrological effects in gravity are generated by the attractions: local water storage in the fractures of the crystalline bedrock, local water storage in sediments, local snow on the ground and on the laboratory roof. In addition, by the loading and attraction by regional and global water storage. If we want to use record of the SG for discriminating between different regional/continental hydrological models, or for validating GRACE observations, physical modeling of the local effects is required. The station stands on bedrock and surrounding sediments are thin (0.2 – to 4 meters) but geologically quite complex.

Since 1994 station is equipped with two borehole wells in the crystalline bedrock. In 2006 two arrays of Time Domain Reflectometer sensors of soil moisture were installed by the Finnish Environment Institute. In 2008–2009 several new instruments were installed within 100–150 m distance from the SG: Ten additional capacitive arrays for soil moisture, a 20 x 20 meter grid of 21 x 21=441 probes for soil resistivity. For observing groundwater level in the sediments, we lowered 11 tubes down to the bedrock surface. For radiometric measurements of soil moisture content and soil density we established 5 dry access tubes.
We present results of 3D-hydrological model of observed local water mass changes together with gravity observations with SG.