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Simulating the influence of water storage changes on the superconducting gravimeter signal at the Geodetic Observatory Wettzell, Germany.

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Superconducting gravimeters (SG) measure the temporal changes in the Earth's gravity field. Variations in local water masses have been reported to have a significant correlation with SG measurements. However, the open question remains: How do local water storage changes (WSC) quantitatively influence the SG signal and what are the hydrological processes causing this effect?

Earlier studies concentrated on empirical relationships between WSC and SG measurements. Our study, in contrast, aims at investigating the theoretical relationship of gravity and hydrology. A spatially distributed physical model has been developed to transform WSC into the SG signal at the Geodetic Observatory Wettzell operated by the Federal Agency for Cartography and Geodesy (BKG), Germany. We incorporate the topography of the study area into the model by using digital elevation models (DEM) and investigate the effect of different DEM resolutions on the simulation results. The earth curvature effect and the radius of influence of WSC on the SG signal were analysed. In addition, gravity signal variations caused by different storage components, namely groundwater, soil moisture, snow, surface water and water stored in the vegetation cover were analysed. In the first part of the study, we investigate the theoretical relation between WSC and gravity. In the second part, real hydrological data (ground water, soil moisture, snow and precipitation) are used in the simulation process and are finally compared to SG observations.

Preliminary results show that not only temporal but also spatial variations of water masses have a significant influence on the SG signal. Here, the real topography plays an important role. We know that near-surface water mass change of one meter in a flat terrain with a radius of 10 km results in a change in gravity of 42 μGal. Taking the real topography into account, the same water mass change amounts to 52 μGal. Soil moisture and groundwater have the most important influence on the SG (up to several tens of μGal), but also snow cover variations have an impact on the SG signal in the order of several μGal. Water changes in surface water bodies and in the vegetation cover, on the other hand, are negligible. On the basis of these results, a hydrological measurement system was installed at the Geodetic Observatory Wettzell which allows further investigation of the interrelation of hydrology and gravity.