Geophysical Research Abstracts,
Vol. 11, EGU2009-2885, 2009
EGU General Assembly 2009

Local hydrological mass effects in gravity observations at the Geodetic Observatory Wettzell, Germany

B. Creutzfeldt (1), A. Güntner (1), T. Klügel (2), H. Wziontek (3), and H. Wilmes (3)

(1) GFZ German Reseach Centre for Geosciences, Section 5.4 Hydrology, Potsdam, Germany (benjamin.creutzfeldt@gfz-potsdam.de / +49 331 2881570), (2) Federal Agency for Cartography and Geodesy (BKG), Section Geodetic Observatory Wettzell, Bad Kötzting, Germany (kluegel@fs.wettzell.de), (3) Federal Agency for Cartography and Geodesy (BKG), Section National Reference Systems for Gravity, Frankfurt am Main, Germany (hartmut.wziontek@bkg.bund.de; herbert.wilmes@bkg.bund.de)

By measuring temporal variations of gravity, superconducting gravimeters (SGs) are a promising tool for hydrological sciences to monitor water storage changes. Temporal gravity observations contain information about the vadose zone, groundwater, snow and surface water storage and thus, provide information about the hydrological system state. For hydrological modelling this implies that these system state observations may be used as an additional observational constraint to calibrate hydrological models. In particular, the combination of hydrological models based on the mass conservation equation and temporal gravity variations will be a coherent approach for model calibration.
In this study we focus on the influence of water masses on the SG at the Geodetic Observatory Wettzell. As SGs measure an integral signal, a fundamental question from the hydrological perspective is: What is the local (attraction) and what is the large scale hydrological effect (dominated by deformation) in SG observations? We analyze which part of the SG signal can be explained by the Newtonian attraction of local water storage changes.
For this task, we installed a hydrological measurement system at the Geodetic Observatory Wettzell. This system is designed to observe the relevant water storage changes close to the SG. For groundwater monitoring, boreholes were drilled and disturbed and undisturbed soil and rock samples were retrieved. Surface and profile soil moisture variations over depth are measured by an extensive TDR array. The snow mass is measured by a snow pillow and an ultrasonic distance sensor to estimate snow density and snow water equivalent. For the estimation of the water storage change in the unobserved vadose zone, a physically-based hydrological model (HYDRUS 1D) is used. The model is parameterised by in-situ and laboratory measurements.
Results show that local water storage changes – short-term as well as long-term variations – correspond very well to the SG observations if all storage compartments are added up. Water storage variations in the vadose zone make up an important part of the integral water storage change signal. SG observation can be used to improve the parameterization of local groundwater and vadose zone models. Independent observations of, e.g., surface soil moisture, help in separating the contribution of single storage compartments to the SG signal and, thus, in the calibration process of the models.