Using time-variable gravity data and hydrological models to assess the similarity of water storage variations at different scales

Andreas Güntner (1), Benjamin Creutzfeldt (1), Susanna Werth (2), Yeshewa Hundecha (1), and Hartmut Wziontek (3)

(1) GFZ German Research Centre for Geosciences, Section 5.4 Hydrology, Potsdam, Germany (guentner@gfz-potsdam.de, +49 331 2881570), (2) University of Potsdam, Institute of Earth and Environmental Science, Potsdam, Germany, (3) Federal Agency for Cartography and Geodesy (BKG), Frankfurt, Germany

Water storage may be a key state variable to assess similarity in catchment dynamics. However, time-variable gravity monitoring is the only tool to comprehensively assess variations in all water storage compartments on and below the land surface, integrating for water storage changes of surface waters, snow, soil moisture and groundwater. At the local scale, superconducting gravimeters are the state-of-the-art technique to estimate total water storage (TWS) variations at distances of a few 100 meters around the instrument. At regional up to continental and global scales, time-variable gravity data of the GRACE (Gravity and Climate Experiment) satellite mission are the unique source of TWS time series for large regions, river basins or aquifers. In this paper, we assess TWS variations at local scales using time-variable gravity data of the superconducting gravimeter at the station Wettzell (Bavarian Forest, Germany), extended by complementary observation data of clusters of soil moisture probes, groundwater wells, and a lysimeter. Regional and large-scale water storage dynamics in the surroundings of the gravimeter are assessed by GRACE water storage data and simulation results of large-scale hydrological models, in particular SWIM and WGHM. Considering event-based, seasonal and inter-annual variations, we identify common patterns of storage dynamics at all spatial scales as well as the specific TWS variations attributed to the local conditions around the gravimeter station. We also explore the similarity of catchment dynamics at the different scales by storage-discharge relationships derived from the observations and models.