Title:	Surface and subsurface continuous gravimetric monitoring of groundwater recharge processes through the karst vadose zone at Rochefort Cave (Belgium)
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Abstract

Ground-based gravimetry is a non-invasive and integrated tool to characterize hydrological processes in complex environments such as karsts or volcanoes. A problem in ground-based gravity measurements however concerns the lack of sensitivity in the first meters below the topographical surface, added to limited infiltration below the gravimeter building (umbrella effect). Such limitations disappear when measuring underground. Coupling surface and subsurface gravity measurements therefore allow isolating hydrological signals occurring in the zone between the two gravimeters. We present a coupled surface/subsurface continuous gravimetric monitoring of 2 years at the Rochefort Cave Laboratory (Belgium). The gravity record includes surface measurements of a GWR superconducting gravimeter and subsurface measurements of a Micro-g LaCoste gPhone gravimeter, installed in a cave 35 m below the surface station. The recharge of karstic aquifers is extremely complex to model, mostly because karst hydrological systems are composed of strongly heterogeneous flows. Most of the problem comes from the inadequacy of conventional measuring tools to correctly sample such heterogeneous media, and particularly the existence of a duality of flow types infiltrating the

vadose zone: from rapid flows via open conduits to slow seepage through porous matrix. Using the surface/subsurface gravity difference, we were able to identify a significant seasonal groundwater recharge within the karst vadose zone. Seasonal or perennial perched reservoirs have already been proven to exist in several karst areas due to the heterogeneity of the porosity and permeability gradient in karstified carbonated rocks. Our gravimetric experiment allows assessing more precisely the recharge processes of such reservoirs. The gravity variations were also compared with surface and in-cave hydrogeological monitoring (i.e. soil moisture, in-cave percolating water discharges, water levels of the saturated zone). Combined with additional geological information, modeling of the gravity signal based on the vertical component of the gravitational attraction was particularly useful to estimate the seasonal recharge leading to temporary groundwater storage in the vadose zone.