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Potential impact of groundbased gravity gradiometer for subsurface reservoir monitoring

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Ground-based gravity measurements can provide accurate constrains on the water storage dynamics of subsurface reservoirs. At the scale of the measurements time-lapse gravity experiments allow to monitor the water mass balance taking into account both the saturated and the unsaturated zone. One major characteristic of the gravity measurement is the integration of all water masses across scales: gravity variations can be the effect of continental scale soil humidity or aquifer (such as seen by GRACE measurements) and of local effects (such as the umbrella effect of a building or reservoir heterogeneities).
The vertical gravity gradient is similar to gravity while showing a higher sensibility to local masses. The interest of the gradient for subsurface features such as caves is well known. The objective of the presentation is the specific potential of gravity vertical gradient monitoring for water reservoir studies. The study is first based on existing measurements of gravity gradients time series (with a relative spring gravimeter): can significant hydrological signals be detected? Then based on numerical simulations, the potential of future ground-based for reservoir monitoring is investigated. The capability of the gravity gradient method to detect heterogeneities (contrary to the classical gravity) is evident: for example the classical Bouguer plate approximation often used to convert gravity into equivalent water height (even in heterogeneous area such as karst) has no effect on the gravity gradient, hence new models need to be applied that combine gravity and gravity gradient measurements.