Geodetic monitoring of a karst aquifer in the Larzac region, South of France

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In this study we attempt to understand the hydrological behavior of a karst aquifer on the Larzac Plateau (South of France) using geodetic techniques. In this Jurassic plateau mainly formed of dolomite, the uppermost weathered zone, or epikarst, acts as a potential perched aquifer. Water then percolates down the infiltration zone to the saturated or vadose zone, which represents the main water reservoir and is connected to the outlet. On this studied karst aquifer (110 km2), water input is exclusively rainfall and draining occurs at the Durzon perennial spring in a karstic valley. Because the entire Larzac Plateau is drained by a few karstic springs, it constitutes a significant water resource. It is therefore important to understand the physical links between pluviometry, infiltration through the karst and the spring discharge.

Our basis assumption is that the transient water storage in the epikarst and in the infiltration zone has a Newtonian effect on the gravity signal and also deforms the earth surface. The karst aquifer is hence being monitored since January 2006 with monthly absolute gravity measurements at three sites, differential relative gravity measurements at the surface and at 60 m depth, continuous high resolution tiltmeters at two sites, continuous surface and underground rainfall recordings, pressure head variations in bore holes and underground natural caves and hourly Durzon spring flow.

Gravity measurements at the three sites are corrected for regional scale gravity using water storage models and exhibit an important seasonal trend (100-150 nm/s2 of amplitude). Heavy rainfall events are both seen by FG5 absolute gravimetry and tiltmeters. Global mass balance considerations linking rainfall, evapotranspiration and spring discharge provide a framework for the understanding of observed gravity variations. We find that water storage is not spatially uniform on the karst system and that it can be explained according to a geomorphologic model accounting for the degree of karstification of the studied area. Significant deformation in tilt (10-6 rad) is closely correlated to precipitation. During each event, tilt azimuth remains constant and tilt amplitude rises to a maximum and then slowly declines. The tilt azimuth points in the spring's direction, as if water convergence at the spring during high flow periods deformed the plateau reversibly. However, large observed tilt amplitude is not currently explained in the framework of an elastic behavior of the plateau loaded by a distributed water flow through the aquifer

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