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New insight on the dynamic of the Fontaine de Vaucluse karst hydrosystem from tilt measurements

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The deformation of natural systems in response to subsurface water storage and redistribution provides insights into the main water flow path within heterogeneous systems, including the role of faults or fractures. A long baseline tiltmeter was installed in the low-noise underground laboratory of Rustrel (LSBB) to study the response of the Fontaine de Vaucluse (FDV) karst hydrosystem to water cycle. Tilt data and piezometric levels recorded in a borehole close to the LSBB show a strong correlation with the discharge of the system observed at the FDV spring 30 km away. Over several months, tilt data were recorded on three base lines, thus allowing, for the first time, to study the tilt gradient variation that appears homogeneous. Such information provides a significant constraint on hydrological processes leading to the measured deformation. Several deformation models were tested using the ADELI code to estimate the type of hydro-mechanical structure that could reproduce the measured tilt and its gradient. On one hand, models show that uniform loading at the surface produces a much smaller signal than observed on measured data. On the other hand, the deformation related to the filling of a fracture following a precipitation event requires unrealistic fracture size. Finally, we found that a suitable hydro-mechanical model corresponds to the loading of numerous fractures at the interface between the saturated and unsaturated zones. Such a configuration predicts a tilt distribution in agreement with observations. This study suggests that tilt networks into a karst system should provide key observation for deciphering hydrological processes.