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A ground based gravity network for monitoring water mass movements in the Classical Karst region

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The Classical Karst is a limestone plateau stretching between Italy and Slovenia over an area of about 600km^2. The aquifer of Classical Karst contains a complex network of conduits, shafts and large voids that are fed by the autogenic recharge and allogenic input of the Reka River. The Reka River sinks underground in the Škocjan Caves and continues its underground flow for almost 40km until it reaches the Adriatic Sea at the Timavo Springs. The river shows high discharge variations; with minimal discharge below 0.3 m^3/s and maximal discharge reaching over 350 m^3/s. As the conduit system cannot efficiently drain large discharge, huge water masses are stored in the epiphreatic voids of the aquifer during flood events. Škocjan Caves present such storage, where a vast amount of water is temporary stored during intense rain. Further evidences of the impressive water movements in this system could be found in the geodetic time-series recorded by the Grotta Gigante horizontal pendulums, which show deformation transients during Reka flood events.

Gravimetry could be a useful tool to obtain local mass balances of such complex system, contributing together with the other classical hydrologic prospections in depicting the water dynamics in this karstic environment. In addition to this gravimetry represents the ideal completion to the already set up geodetic instrumentation in the Classical Karst region.

In the last year, we installed two continuous recording gravity stations, near the Škocjan caves and inside the Grotta Gigante cave. The Škocjan caves serve as a test site because the cave geometry and the hydraulic system here are well known. The Grotta Gigante site offers a quiet place and long term geodetic time-series but on the other hand, the hydrodynamics here are less clear.

In this contribution, we present the simulations in support to the placement of the instruments and the first analysis conducted on the observed gravity time-series. For the Škocjan caves our simulations estimate that this mass accumulation could generate gravity signals up to 30 microGal for extreme events with peak discharge over 250m^3/s lasting for 1-1.5 days, accumulating over 35 10^6 m^{3}of water. The recorded data in Škocjan supports our simulations: a prominent peak up to 5 microGal of amplitude was recorded during a 14 10^6 m^3 flood event on October 2018.

We believe that the Classical Karst represents an interesting study case for both the geodetic and hydrologic communities; the Škocjan cave offers a natural laboratory to optimally assess the contribution of gravimetry as a tool for monitoring underground fluid mass movements.