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300-days of parallel gravity record with the gPhone-054 spring gravimeter and the GWR-C026 superconducting gravimeter in Strasbourg (France): a comparative study

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A wide set of geodynamical and hydrological phenomena, involving underground mass redistribution and/or change of the Earth's figure, affects the gravity field, sometimes inducing "slow" and "small" temporal gravity changes, the detection of which relies on instruments with high sensitivity, long-term stability and a very low drift. Here we report on the results of a comparative analysis carried out on more than ten months of co-located record collected with a new generation spring gravimeter, the gPhone-054, owned by the IGN of Madrid (Spain), and the GWR-C026 superconducting gravimeter (SG-C026) at the J9 gravity station in Strasbourg (France). The Microg-LaCoste gPhone is a portable Earth tide gravimeter equipped with a 0.1 μGal resolution feedback. The core sensor is the patented LaCoste & Romberg (LR) zero-length spring suspension system. The gPhone is essentially a LR, model G meter, but with significant upgrades: it has an improved thermal system (a double-oven) for increased temperature stability. Moreover the instrument should have a "true" vacuum seal making it almost insensitive to the buoyancy changes due to atmospheric pressure fluctuations.

We test the performances of the gPhone-054 in terms of resolution, accuracy, noise level and long-term stability (drift) with respect to the SG-C026. Our comparative analysis is performed in a wide spectral domain, ranging from the body tides to the seismic band. This study demonstrates that the SGs have better performances in the whole analyzed spectral band. Focusing on the gPhone-054 instrumental drift observed during this study, it still remains a critical point preventing the study of the long-term gravity changes. In fact the drift was large and even not linear, sometimes requiring a high degree (> 4) polynomial fitting to be reduced; the latter makes hard to distinguish real time gravity changes from the instrumental drift. We observed a drift rate evolution characterized by a decrease from 50 μGal/day to 15 μGal/day, after about 1 month of operation. Moreover we tried to improve the drift modeling by using frequent (about every 5 days) absolute gravity (AG) measurements collected within about forty days; the measurements have been carried out with FG5#211, but unfortunately during that time no significant gravity changes have been detected which would have helped us to discriminate short-term drift excursions from real gravity changes by superimposing the gPhone data onto the AG points.