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The progress of micro-gravity relative measurements accuracy

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Hydrology and continental ground water studies are now a major application field of all type of gravity measurements (relative or absolute; space- or ground-based). However, such measurements require a high accuracy both in time and space of about 1 microGal in order to detect subtle changes equivalent to water thickness of a few centimeters. From all ground-based gravimeters, spring gravimeters sensors are less accurate but also less expensive and the more convenient for field use. For hydrologic studies, spring gravimeter must therefore be able to provide accurate gravity time series or map. A relative spring gravimeter has typical repeatability of about 1 microGal and an accuracy around 5 microGal.
Spring gravimeters are characterized by a linear drift, a relaxation and hysteresis during the measurements. To enhance the accuracy of the relative measurements, they must be modelled or evaluated depending of the meteorological conditions and the transportation. If the linear drift can be simply evaluated by repeated measurements at the same place, the relaxation is instrumental and external parameters dependent and can also display some non-linearity.
In the present study, the impact of external temperature, transportation (duration, means: by feet or by car) are first described from experimental measurements. Experiments are both done in a controlled environment such as caves and laboratories and in real field conditions. Different strategies of measurements (time of measurements, number of repetitions) are proposed and tested to mitigate the decrease of the accuracy due to the non-modelled relaxation and jumps. Finally, a measurement strategy is proposed which permits the evaluation simultaneously of the gravity value and the linear drift, the non-linear relaxation and the uncertainty associated to the measurements. Such studies should permit to extend the use of relative gravimeters to the detection and monitoring of hydrogeologic processes and to expand the methodology to other fields of geosciences.