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Experimentation of two coupled gravity meters in continuous recording with a high sampling rate at Etna volcano

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During the summer of 2005, we performed a 2-month lasting experiment (29 July - 29 September), using two spring gravimeters installed side-by-side at Mt. Etna. Two LaCoste & Romberg gravimeters were utilized (G594 and G1190), each equipped with an Aliod 100 electronic feedback system. Data were acquired at a sampling rate (2 Hz) higher than that normally used for gravimetric recordings. Besides the gravity signal from the two instruments, we also acquired the ground tilt along two perpendicular directions and the inner temperatures of the gravimeters. The continuously running gravity station was established on Etna's southern slope, at an elevation of 1700 m a.s.l. and about 10 Km south of the active craters. The location of the station was chosen due to logistic reasons (easy access, availability of mains electricity, relatively low volcanic noise). The instruments were installed inside a semi-underground box specifically build to accommodate continuously recording gravimeters.

Apparent fluctuations (i.e. instrumental, not due to actual changes of the gravity field) dominated by a component with period of about 20 seconds appear over the gravity recordings when both high-frequency (local earthquakes) and low-frequency (tele-seisms) components dominate the ensuing seismic wavefield.

In particular, on 14 August (between 21:09 and 23:05 GMT), during a seismic swarm of 18 earthquakes with epicentre on the northern flank of the volcano (about 15 Km from the gravity station), fluctuations with period of about 20 seconds, duration ranges between 60 and 120 seconds, and amplitude ranges between 200 and 1500 μGal peak-to-peak were observed. The correlation between the signals from the two instruments over the anomalous period remains poor (factor < 3).

Conversely, on 13 occasions, fluctuations with period of about 20 seconds, duration ranges between 1 and 2 hours, whose amplitude ranges between a few microGals up to 1500 μGal were observed simultaneously with high-energy teleseisms. In the latter case, the signal from the two instruments are strongly correlated ($0.5 <$ factor < 0.9).

The above observations, together with the fact that the meters were installed side-by-side and thus identical path- and site-effects over the seismic perturbation are to be assumed, imply that instrument-dependent effects (i.e. strongly dependent on the single gravimeter) are predominant when high frequency seismic waves excite the meters. Conversely, when perturbed by low-frequency seismic waves, the gravimeters react according to a more general feature, which, within the limits of an experiment conducted using only two meters, seems to be common to all LaCoste & Romberg spring gravimeters. Likely, the telesisms drive the gravimeters at their common resonant frequency.

Though it has only an instrumental character, the outcome of this study represent an important further step towards the development of any a-priori or a-posteriori system aimed at reduce the effect of seismic shocks on the signal from continuously recording gravimeters.