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Real time estimation of earthquake magnitude

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A prototype system for seismic early-warning (SEW) and rapid shake-map evaluation is being developed and tested in southern Italy. This is based on a highly dynamic and dense seismic network (accelerometers + seismometers) that is being installed in the Apennine belt region (Irpinia Seismic Network). This system can be classified as a regional SEW system as it will consist of a wide seismic sensor network that covers a portion of, or all of, the area that is under threat of an earthquake strike.

Due to the great dynamic range and high density of the seismic network under installation in the seismogenetic area of the Campania region, we investigate the possibility of measuring different observed quantities in real-time signals acquired by this seismic network, including the dominant period parameter, that can be used as magnitude-moment estimators.

Assuming a moderate to large potential event that occurs at shallow crustal depths ($<$20 km) beneath the seismic network, the signals from the first P-waves and S-waves are expected to be detected within 1.5 to 3.5 sec and 2.6 to 6.0 sec, respectively, after the origin time. These rather short time windows will provide the opportunity to integrate the P-wave and early-S-wave information for both fast earthquake localization and magnitude estimation.

In this work, we analyzes the Italian strong-motion database, the data type of which is more closely related to that expected to be recorded by the Campania region SEW system, from both the instrumental and seismotectonic points of view. The analysis of the near-source strong-motion records primarily shows that 3 Hz low-pass filtered peak velocity and displacement parameters measured in a rather short time window (2-4sec) after the inital P-wave and S-wave arrivals correlate with earthquake moment. The regression analysis applied to the predominant period parameter introduced by

Allen & Kanamori (2003) shows less stable results than the PGVt and PGDt in the post-P-wave windows.

This study indicates that a significant improvement in the reliability and robustness of earthquake size estimations in real-time procedures can be obtained by combining magnitude estimations obtained from different ground-motion quantities measured at different stations as functions of time from the first P-wave detections at a strong-motion dense network. The research will be extended to overall European strong-motion database, that will provide the integration of data uniformly covering the magnitude range under investigation and the records of the strong earthquakes ($M>7$) of the Anatoly region. We will further explore the implications for earthquake-source physics and plausible rupture process models that can be derived from confirmation of the results of the present study.