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Rapid determination of the energy magnitude Me

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The magnitude of an earthquake is one of the most used parameters to evaluate the earthquake's damage potential. However, many magnitude scales developed over the past years have different meanings. Among the non-saturating magnitude scales, the energy magnitude Me is related to a well defined physical parameter of the seismic source, that is the radiated seismic energy ES (e.g. Bormann et al., 2002): Me = 2/3(log10 ES – 4.4). Me is more suitable than the moment magnitude Mw in describing an earthquake's shaking potential (Choy and Kirby, 2004). Indeed, Me is calculated over a wide frequency range of the source spectrum and represents a better measure of the shaking potential, whereas Mw is related to the low-frequency asymptote of the source spectrum and is a good measure of the fault size and hence of the static (tectonic) effect of an earthquake.

The calculation of ES requires the integration over frequency of the squared P-waves velocity spectrum corrected for the energy loss experienced by the seismic waves along the path from the source to the receivers. To accout for the frequency-dependent energy loss, we computed spectral amplitude decay functions for different frequenciesby using synthetic Green's functions (Wang, 1999) based on the reference Earth model AK135Q (Kennett et al., 1995; Montagner and Kennett, 1996). By means of these functions the correction for the various propagation effects of the recorded P-wave velocity spectra is performed in a rapid and robust way, and the calculation of ES, and hence of Me, can be computed at the single station.

We analyse teleseismic broadband P-waves signals in the distance range 20°-98°. We show that our procedure is suitable for implementation in rapid response systems since it could provide stable Me determinations within 10-15 minutes after the earthquake's origin time. Indeed, we use time variable cumulative energy windows starting 4 s after the first P-wave arrival in order to include the earthquake rupture duration, which is calculated according to Bormann and Saul (2008). We tested our procedure for a large dataset composed by about 750 earthquakes globally distributed in the Mw range 5.5-9.3 recorded at the broadband stations managed by the IRIS, GEOFON, and GEOSCOPE global networks, as well as other regional seismic networks.

Me and Mw express two different aspects of the seismic source, and a combined use of these two magnitude scales would allow a better assessment of the tsunami and shaking potential of an earthquake..

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