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An evaluation of magnitude-rupture area scaling relationships for earthquakes in the Mediterranean region

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Either a probabilistic or deterministic approach to seismic hazard assessment requires knowledge of the maximum earthquake magnitude in a given region. This is in most cases estimated by using empirical relationships of moment magnitude and rupture length or area. It is usual practice to apply such relationships developed from global datasets to specific regions without however, any warranty that the result obtained is accurate. In this study a dataset of moment magnitudes and rupture areas is compiled for 53 earthquakes that have occurred in the Mediterranean region in the period 1976-2013. Moment magnitudes range from 4.45 to 7.56 and the rupture areas are determined from the extent of early aftershocks. Any other available infomation such as finite-fault and geodetic modeling studies is also utilized in order to assess the consistency of the determined rupture areas. Three magnitude-area relationships that have been determined from global datasets namely Wells and Coppersmith (1994), Hanks and Bakun (2002, 2008) and Shaw (2009) are examined in order to decipher if they could fit this Mediterranean dataset. Statistical tests show that the bilinear relationship of Hanks and Bakun (2002, 2008) has the best fit provided that the stress drop for events smaller than Mw $\sim$6.6 is 15 bar, rather than 26 bar assumed for the global dataset. The Shaw (2009) relationship fits the dataset as well, however, it has two additional parameters and an F-test reveals that it does not fit the data significantly better at a confidence level of 95%. A plot of seismic moment versus rupture area shows that most events smaller than Mw 6.6 exhibit stress drops between 9-15 bar while for larger events the stress drop increases to about 60 bar. These results are important both in terms of seismic hazard assessment in the Mediterranean region and for earthquake physics, as it implies a stress drop variation from smaller to larger events.