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Source parameters of the 2011, Mw 5.2 Lorca earthquake (Spain)

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On May 11^{th} 2011, a magnitude Mw 5.2 earthquake hit the city of Lorca, causing significant damage and nine fatalities. We analyze seismograms from a dense network to characterize the source of this earthquake. From moment tensor inversion, we estimate an oblique reverse faulting mechanism (strike N240°E, dip 54°, rake 44°) with seismic moment M_0= 6.5×10^{16} Nm (M_w= 5.2). The M_w4.6 foreshock and a M_w3.9 aftershock on the same day have similar mechanisms. Double difference relocations of the Lorca earthquake and the aftershock sequence place the mainshock at shallow depth (4.6 km) at only 5.5 km epicentral distance from the city center, and shows a NE-SW trending distribution of aftershocks. We attribute the earthquake to the Alhama de Murcia fault, with consistent orientation and oblique reverse kinematics in this sector. The mainshock hypocenter is situated near the NE end of the sequence, suggesting a scenario of rupture propagating predominately from NE to SW, with rupture length of ∼4 km. We look for directivity effects in apparent source durations, extracting apparent source time functions from the mainshock waveforms through empirical Greens function deconvolution. Apparent source durations are systematically longer towards NE and shorter towards SW, varying by a factor of ∼2. We model apparent durations with a unilateral and asymmetric bilateral rupture, in both cases obtaining rupture directivity of ∼N220°E, towards Lorca. The best fit corresponds to 70% of the rupture propagating in SW direction, and a fault length of 3.4 km. In addition to the near epicenter and shallow depth, directivity may have contributed to the significant impact of this relatively small earthquake.