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Mw5.5 Aftershock of the 2009 L'Aquila, Italy, Earthquake: Broadband Composite Source Modeling with 1D Deterministic Green's Functions

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We perform an extended study of the largest aftershock of the Mw6.3 2009 L'Aquila, Italy, earthquake, based on low-frequency inversion and broadband simulation of strong-motion data. The Mw5.5 aftershock occurred on April 7 and was recorded by ∼30 permanent and temporal accelerometric stations located within 50km from the epicenter. Using ISOLA software we perform a CMT inversion, finding the centroid at 15km depth in agreement with previous studies. Distribution of relocated small aftershocks by Valoroso et al. (2013) suggests that the event ruptured a normal fault dipping NE at 60 degrees, antithetic to the major L'Aquila fault. To better constrain the source model, we invert strong-motion data in the frequency range 0.1-0.5 Hz, considering a finite-extent fault with homogenous slip and radial propagation at constant speed. We estimate fault dimension of 6x6km, static stress drop of 10 MPa (relatively low with respect to other studies), and find a weak indication of bilateral rupture propagation. These features are used to setup a broadband (0-10Hz) composite source model with fractal number-size distribution of overlapping subsources. The Green's functions are calculated in 1D layered medium in the full frequency range, assuming shallow site-specific structure, wherever available, and an average profile for generic rock stations; no stochastic Green's functions are used. At stations with not very strong site effects, the fit between synthetic and observed waveforms is generally good. Careful analysis of S-wave group polarization at high frequencies reveals that while some stations retain the predominantly linear polarization in accordance with the 1D modeling, other stations show a peculiar mismatch. The high-frequency mismatch appears either as the occurrence of random circular polarization, or as a variation of the angle characterizing the linear polarization. We discuss these observations in terms of crustal heterogeneity and azimuthally dependent site amplification.