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Complexity of the Mw6.3, 2009 L'Aquila (Central Italy) earthquake rupture

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Strong ground motion recordings of the Mw6.3, 2009 L'Aquila earthquake are analyzed by a newly proposed slip inversion technique. The source model consists of Multiple Finite-Extent (MuFEx) subsources. The slip amplitude, rupture velocity, rake and rise time are assumed constant within each subsource. The size and location of the MuFEx subsources have to be inferred independently from other methods, preferably those free of strong constraints (such as a constant rupture velocity over the whole fault, position of the hypocenter, etc). We use two published approaches with only weak constraints: the truncated singular value decomposition and the iterative multiple-point source deconvolution. Each MuFEx subsource is characterized by an individual set of trial nucleation points, rupture velocities and nucleation times, which are grid-searched. For each combination of these parameters, the subsources' slip is determined by the least-squares method. Final adjustment of the MuFEX model can be performed by repeating the analysis while varying the dimensions and locations of the subsources. Besides the best-fitting model, the grid-search approach provides also a range of acceptable models. The family of the acceptable models is further limited by comparison with the observed GPS data. The resulting set of models is analyzed in terms of the uncertainty of the source parameters. Both the best-fitting model and the uncertainty analysis suggest that the event consisted of two major episodes, one with the rupture propagating immediately after the nucleation in the up-dip direction, while the other being delayed by 3-4s and characterized by the dominant propagation towards SE along the deeper part of the fault. We point out that the data cannot distinguish between a temporal rupture arrest and a partial slow-down of the rupture, the latter suggested in other published 'smooth' models.