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Intra-event ground motion variability: Source Process of the 6th April 2009 L'Aquila, central Italy, Earthquake

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The accurate evaluation of a ground motion intensity measure for future earthquakes is necessary to inform earthquake-engineering decision.
One widely adopted strategy is the probabilistic approach that uses the ground motion predictive equations to assess a ground motion intensity measure. Nevertheless at present the available empirical models are not able to comprehensively predict the high spatial heterogeneity of the observed ground motion. One key issue is related to the fact that the contribution of each explanatory variable to the ground motion variability is still unclear.
In this work we investigate the ground motion variability through a posteriori analysis of a well instrumented past earthquake, the 2009 L'Aquila (central Italy) Mw 6.3 earthquake. The joint inversion of strong motion, GPS and DInSAR data allowed us to image the coseismic rupture history on the fault plane. The retrieved source model not only features the slip distribution, but also provides an entire ensemble of models (N=2000) generated during the search stage of the inversion and a rupture velocity field, which reflects the mechanical properties of the fault.
This information is valuable in order to investigate the ground motion variability. The differences between the selected model and the discarded models allow us to investigate the robustness and sensitivity of model parameters to the ground motion estimation; moreover, in order to quantify the source parameters contribution to the ground motion variability we fix the rupture velocity field and the seismic moment (Mo = 3.5E18 Nm) to model scenarios for a single fault plane (the same of the 2009 L'Aquila earthquake) on a 'virtual' grid (800 sites) of observers around the fault. We vary the slip distribution and the nucleation position by considering a heterogeneous rupture time distribution for each nucleation point. The amount of models guarantees the statistical consistency of the dataset. The huge quantity of synthetic data is then treated statistically to recognize local features of the ground motion (e.g. directivity) and to try to answer key questions such as: was the L'Aquila earthquake expected? Was it the worst-case scenario?