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Source fault parameters and slip distribution: the importance of crustal layering for the 1908 Messina Straits earthquake.

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The 1908 Messina earthquake is one of the strongest historical seismic events that ever occurred in Italy, with more than 60,000 casualties and extensive damage. It was felt by people in a radius of ∼300 km, with maximum damage (XII degree Mercalli intensity scale) occurring in the cities of Messina and Reggio Calabria. This earthquake occurred ∼3 years after another large event in the area, located at sea, and was followed by a tsunami with sea waves as high as 12 m, entering locally up to 200 m inland (Platania, 1909). Smaller earthquakes were felt in the Messina region from 1 month before the main event to ∼10 years after. The 1908 earthquake was also accompanied by visible ground cracks (Baratta, 1910): the coastline road close to Messina showed a graben-type collapse, with fractures up to 100 m long and slip around 0.6 m. It is not clear if these fractures are related to the seismogenic fault or are landslides, and there is no clear evidence of further surface breaking.
Precision double-run levelings were carried out a few years before the 1908 earthquake, and some lines were resurveyed just after the seismic event. Measurements were performed in 1898 - 1899 in Sicily, in 1907 - 1908 in Calabria, and in March 1909 both in Sicily and in Calabria. Data from leveling surveys have been used in the past to constrain source fault parameters. A non-linear unconstrained joint inversion of levelling data and first-motion polarities was firstly performed by Amoruso et al. (2002) and refined by Amoruso et al. (2006). All past studies have been carried out under the assumption of faulting in a homogeneous elastic half-space.
Despite the large number of published models, the seismic source for the 1908 Messina earthquake is still controversial, mainly because of the difficulty in explaining the tsunami features.
Here we show the results of the first (to our best knowledge) non-linear unconstrained inversion of levelling data under the assumption of faulting in a layered elastic half-space. The layered crustal model has been obtained from the 3D velocity model in Barberi et al. (2004). As in Amoruso et al. (2002) we model the earthquake using a single planar fault: slip is at first assumed to be uniform across the whole fault, then independent in a small set of coplanar subfaults, and finally smoothly variable across the fault. Differently from Amoruso et al. (2002), also the third step is accomplished using a global minimization technique.