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Characterization of near source effects in ground motion numerical simulations

Sergio Del Gaudio, Maria Lancieri, and Sebastien Hok
IRSN, Paris, France (sergio.delgaudio@irsn.fr)

Prediction of realistic ground motion for potential future earthquakes is the main objective of seismic hazard assessment. To do so, one of the steps is to make an estimation of the expected ground motion level and this is commonly done by the use of ground motion prediction equations (GMPEs). Nevertheless GMPEs do not represent the whole variety of source processes and this can lead to incorrect estimates for some specific case studies, such as in the near-source range because of the lack of records of large earthquakes at short distances. In such cases, ground motion simulations can be a valid tool to complement prediction equations for scenario studies, provided that both source and propagation are accurately described.
Even for numerical simulations, near source effects (such as the effect of finite extent of the source, the presence of strong velocity pulse especially on the vertical components, the strong rupture directivity effect, etc.) are often not properly addressed. We present here a systematic study of these characteristics starting from simple synthetic tests to check the influence of different degrees of knowledge of the source process and different types of parameterizations.
We also checked the limits of the empirical Green's function (EGF) technique in reproducing the correct wave field for large earthquakes recorded in very near fault conditions. This technique consists in using records of small earthquakes as the medium transfer function provided the availability of small earthquakes located close to the target fault and recorded at the target site. The main advantage of this technique is that it does not require a detailed knowledge of the propagation medium, which is not always possible, but requires availability of high quality records of small earthquakes in the target area.
At the end, we present a preliminary application to the Mw 7.8 Tocopilla earthquake (Chile, 2007). This earthquake represents a unique case because it is the first large Chilean event recorded by a large network of digital accelerometers and broad-band stations. Source and tectonic environment have been largely studied in literature and also an aftershocks database of more than 500 events is available, giving us the possibility to make a very refined selection of EGF.