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3D Numerical Modeling of Effects of Complicated Rupture Geometries and Random Media on Earthquake Ground Motions

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In numerical modeling of ground motion close to an earthquake fault the source is often considered to be one perfectly planar rupture with constant strike and dip. In the case of geometrically very complicated ruptures this approach is simply extended by using a few planar rupture segments to approximate the overall geometrical structure. In the first part of this work we investigate the 3D effects of geometrically very complicated ruptures where the strike and dip vary locally following $k^{(-2)}$ distributions with various correlation lengths and standard deviations around a dominant average value. The perturbation of the rupture plane is chosen in a way to generally cover a major number of realistic fault structures as observed along fault traces of surface rupturing earthquakes. We validate our results by starting out from the well-established LOH.2 test case of the Pacific Earthquake Engineering Research Center and gradually add more complexity to the rupture plane. To this end we compare the results obtained by three different numerical methods, the discrete wave number method, the spectral element method and the ADER-Discontinuous Galerkin method. In the second part of this work we investigate the effect of scattering media surrounding the rupture fault. The heterogeneity of the random media follows a $k^{(-3)}$ distribution with various correlation lengths and standard deviations representing a 3D extension of 2D scattering media as found in the literature. In both parts we analyze and compare the influence of the rupture and media irregularities on the synthetic seismograms and study the consequent impact on the directivity and radiation-pattern effects.