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Near-Field Scattering due to Topography and Lateral Velocity Heterogeneity

Walter Imperatori (1) and Martin Mai (2)

(1) KAUST, Saudi Arabia (walter.imperatori@kaust.edu.sa), (2) KAUST, Saudi Arabia (martin.mai@kaust.edu.sa)

The scattering of seismic waves traveling in the Earth is not only caused by velocity heterogeneity, but also by rough surface topography. Both factors are known to play an important role on ground motion complexity even at short distances from the source. In this study, we simulate ground motion with a 3D finite-difference wave propagation solver in the frequency band 0-5 Hz using different rough topography models and realistic heterogeneous media characterized by Von Karman correlation functions. We analyze the characteristics of the scattered wavefield, focusing in particular on coda waves.

Our study shows that topography and velocity heterogeneity scattering generate coda waves with different characteristics. We notice that, while coda waves originated by velocity heterogeneity have a more diffusive nature presenting envelope broadening as a result of forward scattering, coda waves caused by topography scattering are composed of more coherent body and surface waves reflected and diffracted by irregular topography surface. Results indicate that, for shallow sources, topography scattering can generate more intense early-coda waves at short and intermediate distances from the source. As distance increases, velocity heterogeneity scattering starts to dominate. However results show a rather high degree of variability as topography scattering is very sensitive to source position and features of the topography model. On the other hand, velocity perturbations generate more intense late-coda waves We conclude that topography scattering cannot be used as a proxy for velocity heterogeneity scattering.