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Near-Field Geometrical Decay from Large Magnitude Earthquakes: Comparing Empirical and Simulation Approaches

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Earthquake ground motion characterisation is a vital input to seismic hazard models. This typically takes the form of ground motion prediction equations (GMPEs), which provide robust predictions in the model space adequately populated with empirical data. However, they suffer greatly from epistemic uncertainty, particularly at the edges of the model space (e.g., near-source, high shear wave velocity, etc.). Numerous studies, have shown empirical geometrical spreading models change non-linearly as a function of distance from the source. Deviations are particularly apparent in the range 50-100 km, where post-critical Moho reflections are often observed. These features seem to be region specific, and linked to the structure of the crust. Authors also typically note a stronger decay than would be expected for a homogeneous medium in the near source region ($R < 30$ km). However, due to the limited geographic area available, region-specific ground motion attenuation models are typically derived using small magnitude data. The effect of large faults on the overall attenuation characteristics is not fully accounted for and instead simple geometrical adjustments are made (e.g., using a pseudo-depth dependent on magnitude).

Using a database of Japanese Earthquakes (M_w 5.8 – 7.2) from the Kik-Net seismic network we empirically model characteristic attenuation properties and propose a new geometrical spreading model for large earthquakes in the near-field. In a subsequent step, full waveform simulations produced from a finite difference code using stochastic source parameters will be generated. The attenuation model will then be used to modify synthetic ground motion data. Finally, a geometrical spreading model will be determined using the synthetic ground motion data and a comparison between the empirical and synthetically produced models will be made. This study aims to investigate the near-fault region more closely, using both classic empirical and modern simulation approach. The results will be used to guide the generation of future empirical models, reducing the epistemic uncertainty in the near-source region where we have little data.