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Are recent empirical directivity models sufficient in capturing near-fault directivity effect?

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It has been widely observed that the ground motion variability in the near field can be significantly higher than that commonly reported in published GMPEs, and this has been suggested to be a consequence of directivity. To capture the spatial variation in ground motion amplitude and frequency caused by the near-fault directivity effect, several models for engineering applications have been developed using empirical or, more recently, the combination of empirical and simulation data. Many research works have indicated that the
large velocity pulses mainly observed in the near-field are primarily related to slip heterogeneity (i.e. asperities), suggesting that the slip heterogeneity is a more dominant controlling factor than the rupture velocity or source rise time function.

The first generation of broadband directivity models for application in ground motion prediction do not account for heterogeneity of slip and rupture speed. With the increased availability of strong motion recordings (e.g., NGA-West 2 database) in the near-fault region,
the directivity models moved from broadband to narrowband models to include the magnitude dependence of the period of the rupture directivity pulses, wherein the pulses are believed to be closely related to the heterogeneity of slip distribution. After decades of
directivity models development, does the latest generation of models - i.e. the one including narrowband directivity models - better capture the near-fault directivity effects, particularly in presence of strong slip heterogeneity? To address this question, a set of simulated motions
for an earthquake rupture scenario, with various kinematic slip models and hypocenter locations, are used as a basis for a comparison with the directivity models proposed by the NGA-West 2 project for application with ground motion prediction equations incorporating a narrowband directivity model. The aim of this research is to gain better insights on the accuracy of narrowband directivity models under conditions commonly encountered in the real world.

Our preliminary result shows that empirical models including directivity factors better predict physics based ground-motion and their spatial variability than classical empirical models. However, the results clearly indicate that it is still a challenge for the directivity models to capture the strong directivity effect if a high level of slip heterogeneity is involved during the source rupture process.