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Empirical Evidence of Topographic Site Effects: A Systematic Approach

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The effects of surface topography geometry on seismic ground motion have been recognized for a long time, and have been the topic of many instrumental and numerical investigations over the last four decades. However, their complexity, combined with the limitations of both geophysical investigation techniques and numerical simulation, made it impossible till now to include such effects in earthquake hazard assessment and risk mitigation policies. Nevertheless, the recent growth of seismic networks allows for systematic studies of such effects as a number of sites with pronounced topography were also instrumented. We applied a terrain classification method to identify these sites within Swiss and Japanese networks and compiled dataset of high quality earthquake recordings. As a number of recent studies found the topographic site effects to be directional, polarization analysis of particle motion was performed and azimuthally dependent resonant frequencies were estimated. Same procedure was applied also for available ambient vibration recordings. Moreover, average residuals with respect to ground motion prediction models were calculated estimating the average amplifications. The observed amplifications are found to be tightly linked with the ground motion directionality as estimated by polarization analysis of the both earthquake and ambient vibration recordings. On the other hand, we have found no clear relation between the local surface geometry and the amplification, so the local sub-surface structure seems to play a key role.