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# Time-frequency characterization of near-fault directivity pulses for structural and geotechnical analysis

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Characterizing and quantifying the level and variability in near-source strong-motions is one of the major challenges in seismology and earthquake engineering. Moreover, defining alternative, more powerful seismic intensity measures (IM) than the classical peak ground acceleration (PGA) or spectral acceleration (SA) has been a topic of recent research activities. Of particular interest are records from the forward directivity regions, which typically have shorter duration and contain a large velocity pulse at the beginning of the record. Although the response spectrum provides the basis for the specification of design ground motions in all current design guidelines and code provisions, it is not capable of adequately describe the seismic demands presented by a near-fault pulse. In this study, we seek to define waveform-based IM's that potentially can be applied in structural analysis and geotechnical studies.

We use the Next Generation Attenuation (NGA) strong-motion database, consisting of 3551 records from 127 earthquakes from tectonically active regions, as an initial "training data set" with uniformly processed and well documented strong-motion time histories. Considering a subset of NGA recordings, for which finite-source rupture models exist, we develop automated methods to measure IM's like pulse period and dominant frequency that can be correlated earthquake source parameters. By means of multi-variate regression analysis, we examine potential factors affecting the peak velocity and dominant period of directivity pulses: moment magnitude; hypocentral distance; directivity parameters X and $\theta$ as defined by Somerville (1997); kinematic

rupture parameters like rupture velocity and rise time. Additionally, we investigate the frequency distribution of the energy content of these records using a time-frequency analysis (spectrogram analysis); by quantifying the spectrogram properties we can relate those to the source and directivity parameters.