UCSB Method for Broadband Ground Motion Prediction from Heterogeneous Earthquake Ruptures

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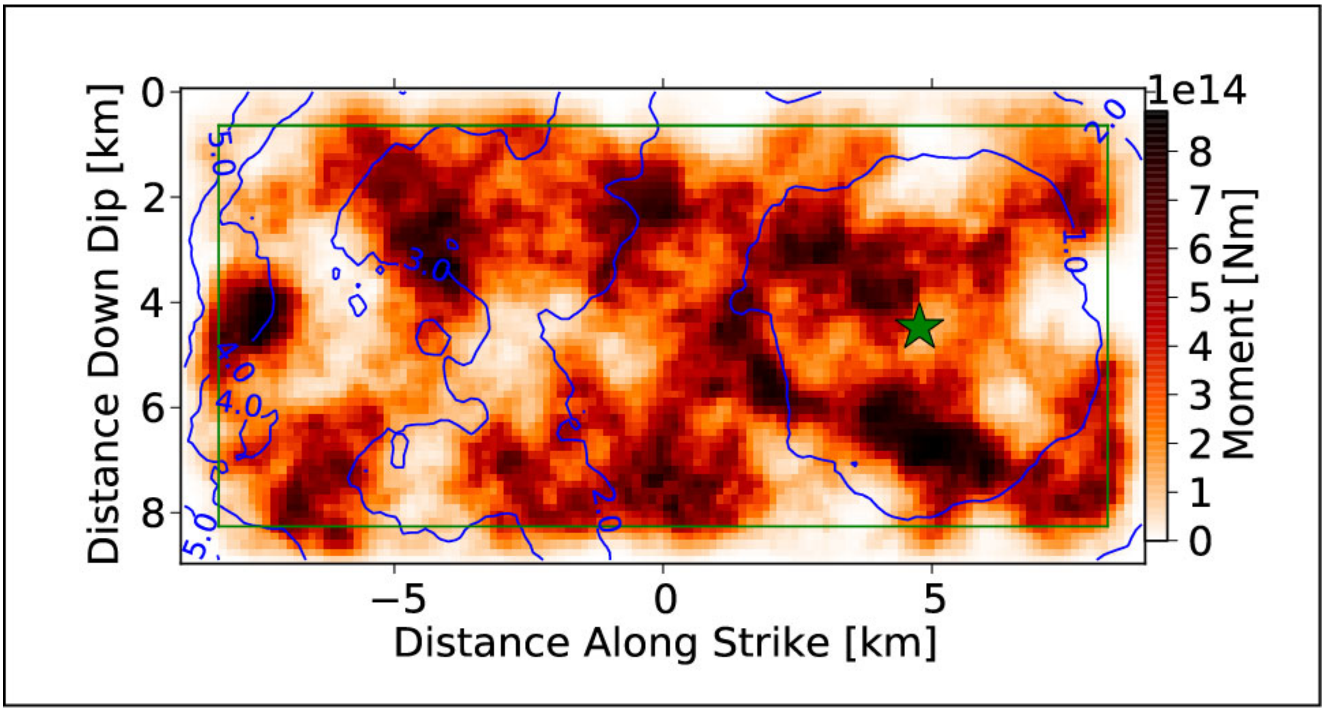
The UCSB method simulates earthquakes as heterogeneous kinematic ruptures to produce synthetic broadband ground motions (0-25Hz) for 5 **M** 8. A Kostrov-like slip-rate function is specified at a dense number of points on a finite fault. Each slip-rate function is specified by the total slip, time to reach the maximum slip-rate (peak-time), the total time of slipping (rise-time), and a rupture time, i.e., the time when the point first begins to slip. The rupture time is related to the local rupture velocity. The slip, peak time, rise time and rupture time are all characterized by their own marginal distribution (one-point statistic), and each parameter is correlated with the other. The heterogeneity of the slip distribution on the fault is determined by filtering white noise with a Von Karman wavenumber power spectrum. The Von Karman spectrum is determined from a correlation length and a spectral decay parameter for length scales shorter than the correlation length. The other kinematic parameters are also heterogeneous with different decay parameters--each functionally related to the decay of the slip. With a fault area and seismic moment (magnitude) the only remaining free parameter is average stress drop. The code will iterate on the kinematic parameters until the moment-rate spectrum of the simulated earthquake is similar to a Brune spectrum, with a low frequency level corresponding to the seismic moment and the corner frequency corresponding to the average stress drop.

We separate wave propagation at 1.0 Hz into low- and high-frequency components. The low-frequency ground motion is propagated using either a 1D or 3D velocity structure. The high-frequency Green's functions are computed for a layer over halfspace. The high-frequency amplitude is modified using the quarter-wavelength method using the detailed 1D velocity model of the velocity structure. The resulting high-frequency Green´s functions are then convolved with scattering functions, which are consistent with observed regional coda waves. We then merge the low- and high-frequency ground motion by stitching them in the wavelet domain. It is important to note that in the UCSB method, both the high- and low-frequency ground motion comes from a single source description even if the wave propagation is different.

We have successfully validated our method against well-recorded data produced by earthquakes in different tectonic regions such as California, eastern United States, and Japan. The validation metrics are bias between observed and synthetic acceleration response spectrum and direct comparison with ground motion prediction equations.

Keywords: Ground Motion, Earthquake, Heterogeneous Rupture



Distance Down Dip [km]
Distance Along Strike [km]
1e14
Moment [Nm]

