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Generating stochastic fractal surface rupture on non-planar faults

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We propose a technique for producing k^2 stochastic slip distributions that contain slip histories for each cell on an unstructured mesh that describes a fault plane. Using Huygen's principle, distance and time are calculated across a non-planar surface using a trilateration scheme. From this scheme, stochastic slip distributions containing fractal amplitude spectra are generated using the composite source model which involves the placement of numerous circular dislocations called 'subevents' on the fault plane. With a prescribed rupture velocity model for a given earthquake, complex source time functions can also be calculated for each element on the fault plane.

Generally, surface rupture in the stochastic source models are not discussed in much detail. We demonstrate that using the standard composite source model will produce a family of slip distributions that contain a systematically lower amount of slip near the surface. We propose two different fixes for this problem both of which are based on the principle of reflecting subevents back onto the fault plane from the free surface. The first involves the method of images and can be easily applied to planar faults. The second involves multiple applications of the trilateration technique in order to calculate distance to and from the free surface. The details and examples of both techniques will be presented.

Additionally, we discuss how the choice of probability density function, used in the placement of subevents on the fault plane, should be carefully considered in light of their permanence in the final result (e.g. for seismic hazard or kinematic slip inversion).