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The spatiotemporal distribution of triggered earthquakes

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Quantification of the spatiotemporal probability of earthquake triggering is essential for understanding the physics behind earthquake interactions as well as being a critical component of statistical earthquake likelihood models such as the ETAS and STEP models. Here we present a revised method to determine the earthquake pair correlation function in terms of distance and time. We calculate the difference in distance and time between earthquakes, using a complete catalogue and treating every earthquake as a potentially triggering event and every subsequent earthquake as a potentially triggered event. The distribution of time-dependent triggering is then calculated as the residual signal when compared against a null-hypothesis of temporally-randomized, spatially clustered, background activity. This background activity is optimized on the basis that minimal triggering is expected at long distances. The technique is applied to catalogues from Europe, Sumatra and Southern California and results reveal a spatial probability best described by a gamma function, incorporating a power-law near-field behaviour with an exponential tail, with triggering observed up to distances of tens to hundreds of kilometres. The peak frequency is typically at a finite distance from the trigger event, revealing a minimum at short-distances consistent with local stress relaxation. In general, the position of the peak frequency, correlation length, L, and the mean inter-event distance, $\langle r \rangle$, increase with time in a manner consistent with anomalous diffusion in a non-homogenous medium. The approach can also be used to assess the efficiency of declustering routines, and a significant residual earthquake triggering signal is found at short distances for a declustered Southern California catalogue.