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# Large earthquake triggering, clustering, and the synchronization of faults

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Large earthquakes are sometimes observed to trigger other large earthquakes on nearby faults. The magnitudes of the calculated Coulomb stress transfers presumed to cause the triggering are $10^{-2} - 10^{-3}$ of the earthquake stress drops and the triggering delay times are similarly small with respect to the natural recurrence time of the earthquakes. This requires that both faults be simulaneously very close to the ends of their seismic cycles. Paleoseismological data show that for the same regions prior large earthquakes have occurred on nearby faults in clusters in space and time separated by long quiescent periods. Both observations suggest that synchronization is occurring between faults. Theory and observations indicate that synchronization can occur between nearby faults with positive stress coupling and intrinsic slip velocities within an entrainment threshold. In the south Iceland seismic zone, the central Nevada seismic belt, and the eastern California shear zone, several synchronous clusters, that apparently act independently, can be recognized. This behavior is the equivalent, in three dimensions, of the phase locking of fault elements that results in the seismic cycle of individual faults being dominated by large "characteristic" earthquakes, and for synchronization of fault segments along a given fault. Rupture patterns of repeated individual earthquakes or earthquake clusters are not identical in either the two or three dimensional cases. The state of this system, which exhibits strong indications of synchrony without exact repetition, may be called fuzzy synchrony.