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A physical model for aftershocks triggered by dislocation on a fault

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We find the static displacement, strain and stress produced in an elastic medium by a finite size rectangular fault after its dislocation with a known distribution of dislocation or stress drop. The time-dependent rate of triggered earthquakes is estimated by a rate-state constitutive law applied to a uniformly distributed population of faults whose equilibrium is changed by the Coulomb stress change. The results of our simulations have shown some important consequences of this model. The rate of triggered events, immediately after the perturbation on an elementary volume of the medium, is exponentially proportional to the stress change but the time period over which the rate is maximum and relatively constant decreases exponentially by the same factor for increasing stress change. This period ranges from fractions of hour for positive stress changes of the order of some *MPa* up to tens of years for smaller stress changes. As a consequence, the total number of triggered events (obtained integrating the rate predicted by the model over infinite time) is proportional to the stress change in that point. This model, applied to the perturbation produced by slip with constant stress drop on a rectangular fault, predicts that the total number of events triggered on a plane containing the fault (supposing that this is the only active part of the whole volume surrounding the fault) is proportional to the 2/3 power of the seismic moment. As a consequence, the total number of aftershocks produced on the fault plane scales in magnitude as 10ˆ{M}. Including the negative contribution of the stress drop inside the fault surface itself, we obtain that the number of events inhibited on the fault is, at long term, nearly identical to the number of those induced outside, representing a sort of conservative natural rule. Our model doesn't match completely the popular Omori law,

that predicts a hyperbolic time decay of the overall aftershock rate. In fact, the model implies that the seismicity induced closely to the fault edges is intense but of short duration, while that expected at large distances exhibits a much slower decay. We applied our rectangular physical model to a real case, the 1984 Morgan Hill earthquake on the Calaveras fault, and we obtained a fairly good agreement between the expected and observed aftershock activity. From a statistical view point, the introduction of the algorithm to an epidemic aftershock model allows to give a physical constraint to the unknown parameters used in the algorithm. We show an application of this method to the seismicity of Japan observed from 1970 to 2003.