Can dynamic stress changes trigger aftershocks?

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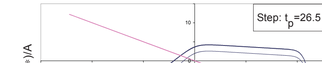
Abstract

The modeling of earthquake triggering requires to adequately compute the induced stress field as well as to account for the fault constitutive properties. The basic assumption that motivates earthquake-triggering studies through stress transfer is that coseismic stress changes can perturb the mechanical conditions of the neighboring faults. We use the rate- and state- dependent laws and a spring-slider dynamic system to model the fault response, including inertia, to induced stress perturbations. In this framework, the fault mechanical conditions are specified by the parameters characterizing the dynamic state of the system at the time of application of the induced load. The stress transferred by the earthquakes occurred nearby modifies the fault mechanical conditions and this is sufficient to change the time of subsequent failures. Our results show that this effect is typical of permanent static stress changes. Static stress changes can, in fact, produce a broad interval of triggering delays, so that they are suitable to model the rate of aftershock production. On the contrary, dynamic transient stress perturbations are unable to significantly change the mechanical conditions of neighboring faults, unless they can produce nearly instantaneous triggering (a very short triggering delay). As a consequence, dynamic stress perturbations are unable to significantly advance earthquakes with respect to the unperturbed conditions, or they produce only instantaneous triggering. In the first case the dynamic stress perturbations are not relevant for triggering studies, while in the second they can be associated only to the short-term aftershock production.

Goals

2. The effect of the initial conditions

Physical interpretation of the difference bet
The mechanical conditions of the slider are
velocity, the initial value of the state variabl
triggering delay and the unperturbed time w
Our simulations clearly show that, for most
evolution. This means that dynamic transien
t_D does not differ significantly from t_U (fig. 4
immediately after the stress perturbation. O
delay. Unlike static stress changes, dynamic
demonstrate that in order to have a significa
is in close to failure conditions (fig.5).