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Probing the state of stress using early aftershocks

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An earthquake is usually followed by a sequence of smaller earthquakes called aftershocks. If the frequency of these aftershocks decreases as a power law over long time scales, it is obviously not infinite at the end of the mainshock rupture. There is therefore a transient stage leading to the establishment of the power-law aftershock decay rate. All theoretical models show that the duration of this transition is potentially an important source of information to characterize the state of stress along active fault zones. In this context, we present new theoretical and observational results on the initial behavior of aftershock sequences.

Using early aftershock statistics and the EAST model, we first concentrate on short-term earthquake forecasting. In particular, we show how it is possible to use alarm-based models and earthquake catalogues to produce frequency-based earthquake forecast models. Thus, we can use alarm-based models to perform all standard comparison tests installed on interactive platforms developed by CSEP (Collaboratory for the Study of Earthquake Predictability). The current results show that EAST model has better predictive power than a stationary reference model based on smoothed extrapolation of past seismicity. Hence, we conclude that early aftershock decay rate may be a powerful diagnostic tool for earthquake activity at both, regional and local scales.

Second, we concentrate on earthquake mechanics as we try to infer the evolution of tectonic loading on a population of active fault using aftershocks. From Bayesian statistics for the Modified Omori Law, $\Lambda(t) \sim (c+t)^{-p}$, and K-means statistics for space-time c maps, we have access not only to the temporal evolution of the stress state on each fault but also on the phase portrait of their interactions. Then, we discuss stress exchange mechanisms within the seismogenic crust.