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Effective stress drop as a possible tool for assessing stress drop of earthquake clusters

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The static stress drop is a standard measure of unloading the shear stress on a fault during an earthquake that is averaged along the whole rupture. It has been observed that stress drop does not vary significantly for different earthquakes and may be regarded as an invariant parameter of the rupture process at different scales. Stress drop scales with seismic moment, but is inversely proportional to the third power of characteristic rupture dimension, which introduces large error in its estimates. The average stress drops of earthquakes range in units of MPa and systematic difference in stress drops of interplate and intraplate earthquakes was found. Much smaller stress drops in fractions of MPa are reported for slow earthquakes and in some cases also for earthquake swarms. To this purpose an alternative parameter, the effective stress drop has been proposed, which makes use of the cumulative seismic moment and total activated area of seismic cluster. This way additional errors in seismic locations and simplifications of the adopted rupture model were introduced, which increase the uncertainty of the resulting stress drop.
Using simple theoretical assumptions we analyze how the effective stress drop is comparable to the static stress drop in case of a seismic cluster and test the influence of synthetic errors in utilized parameters. We examine the evolution of effective stress drop with time and its absolute magnitude using seismic data of injection induced seismicity, earthquake swarms and aftershock sequences.