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Energy-dependent magnitude-frequency distribution for seismic events

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We propose the energy-dependent magnitude-frequency (EDMF) model as an alternative of the classical (tapered or not) Gutenberg-Richter (G-R) law for the magnitude of seismic events, the most widely used in earthquake forecasting and seismic hazard applications. The model we present is a modification of the Kagan's tapered G-R law: the corner moment parameter is assumed to be an energy-varying function, changing with respect to the size of the area under analysis, and to the seismic history occurred in the area itself.

The basic rationale behind our model rests in the criticism to the applicability of the G-R law on small space-time windows, many times raised in the literature and already tackled for some operational forecasting projects, as for example in the UCERF3 for California.

The EDMF model is built in such a way to decrease the probability of large events in a small area where a strong shock has just occurred and to reobtain the classical G-R when enlarging the analyzed region. We do not account for a parental connection between events, neither for an order relation between their magnitudes. We simply condition to the elastic energy available in the area considered, which depends on the time elapsed since the last strong event that is assumed to have resetted the energy available, as well as on the length of the longest fault included in the area.

The applicability of the proposed EDMF model is shown for the Californian seismic catalog; we obtain results that support the validity of the EDMF model and its potential to improve large earthquake forecasting at different time scales.