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An earthquake rate forecast for Europe based on smoothed seismicity and smoothed fault contribution

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The main objective of project SHARE (Seismic Hazard Harmonization in Europe) is to develop a community-based seismic hazard model for the Euro-Mediterranean region. The logic tree of earthquake rupture forecasts comprises several methodologies including smoothed seismicity approaches. Smoothed seismicity thus represents an alternative concept to express the degree of spatial stationarity of seismicity and provides results that are more objective, reproducible, and testable. Nonetheless, the smoothed-seismicity approach suffers from the common drawback of being generally based on earthquake catalogs alone, i.e. the wealth of knowledge from geology is completely ignored.
We present a model that applies the kernel-smoothing method to both past earthquake locations and slip rates on mapped crustal faults and subductions. The result is mainly driven by the data, being independent of subjective delineation of seismic source zones.
The core parts of our model are two distinct location probability densities: The first is computed by smoothing past seismicity (using variable kernel smoothing to account for varying data density). The second is obtained by smoothing fault moment rate contributions. The fault moment rates are calculated by summing the moment rate of each fault patch on a fully parameterized and discretized fault as available from the SHARE fault database.
We assume that the regional frequency-magnitude distribution of the entire study area is well known and estimate the a- and b-value of a truncated Gutenberg-Richter magnitude distribution based on a maximum likelihood approach that considers the spatial and temporal completeness history of the seismic catalog.
The two location probability densities are linearly weighted as a function of magnitude assuming that (1) the occurrence of past seismicity is a good proxy to forecast occurrence of future seismicity and (2) future large-magnitude events occur more likely in the vicinity of known faults. Consequently, the underlying location density of our model depends on the magnitude. We scale the density with the estimated a-value in order to construct a forecast that specifies the earthquake rate in each longitude-latitude-magnitude bin. The model is intended to be one branch of SHARE's logic tree of rupture forecasts and provides rates of events in the magnitude range of 5 <= m <= 8.5 for the entire region of interest and is suitable for comparison with other long-term models in the framework of the Collaboratory for the Study of Earthquake Predictability (CSEP).