EGU2020-22578
https://doi.org/10.5194/egusphere-egu2020-22578
EGU General Assembly 2020

Forecasting M≥5.0 earthquakes in Italy using a new adaptive smoothing seismicity approach

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In this study we present five- and ten-year time-independent forecast of M≥5.0 earthquakes in Italy using only seismicity data, without any tectonic, geologic, or geodetic information. Spatially-varying earthquake occurrence rates are calculated using an adaptive smoothing kernel (Helmstetter et al., 2007) that defines a unique smoothing distance for each earthquake epicenter from the distance to the n-th nearest neighbor, optimized through the Collaboratory for the Study of Earthquake Predictability (CSEP) testing type likelihood methodology (Werner et al.,2007). We modify that adaptive smoothing method to include all earthquakes in the catalog (foreshocks, aftershocks and the events below the completeness magnitude) multiplying each smoothing kernel by a proper scaling factor that varies as function of completeness magnitude and the number of events in each seismic cluster. Our smoothing philosophy relies on the usefulness of all earthquakes, including also those with smaller magnitudes, in forecasting the future seismicity.
The smoothed seismicity Italian model, that provides the forecasted seismicity rates as an expected number of M≥5.0 events per year in each grid cell, 0.1°x0.1°, is constructed by using the complete instrumental catalog, spanning from 1960 to 2019 with a completeness magnitude that decreases with time (from M4.0 to 1.8). Finally, we compare our model with the real observations and with the Italian CSEP experiment models, to check their relative performances, using the official CSEP tests (Taroni et al., 2018). In the present study, the probabilities of occurrence of future large earthquakes in the next 5 and 10 years are calculated based on the assumption that earthquake processes have no memory, i.e., the occurrence of a future earthquake is independent of the occurrence of previous earthquakes from the same source (time-independent model).