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Time-dependent neo-deterministic seismic hazard scenarios for the 2016 Central Italy earthquakes sequence

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Predicting earthquakes and related ground shaking is widely recognized among the most challenging scientific problems, both for societal relevance and intrinsic complexity of the problem. The development of reliable forecasting tools requires their rigorous formalization and testing, first in retrospect, and then in an experimental real-time mode, which imply a careful application of statistics to data sets of limited size and different accuracy. Accordingly, the operational issues of prospective validation and use of time-dependent neo-deterministic seismic hazard scenarios are discussed, reviewing the results in their application in Italy and surroundings.
Long-term practice and results obtained for the Italian territory in about two decades of rigorous prospective testing, support the feasibility of earthquake forecasting based on the analysis of seismicity patterns at the intermediate-term middle-range scale. Italy is the only country worldwide where two independent, globally tested, algorithms are simultaneously applied, namely CN and M8S, which permit to deal with multiple sets of seismic precursors to allow for a diagnosis of the intervals of time when a strong event is likely to occur inside a given region.
Based on routinely updated space-time information provided by CN and M8S forecasts, an integrated procedure has been developed that allows for the definition of time-dependent seismic hazard scenarios, through the realistic modeling of ground motion by the neo-deterministic approach (NDSHA). This scenario-based methodology permits to construct, both at regional and local scale, scenarios of ground motion for the time interval when a strong event is likely to occur within the alerted areas.
CN and M8S predictions, as well as the related time-dependent ground motion scenarios associated with the alarmed areas, are routinely updated since 2006. The issues and results from real-time testing of the integrated NDSHA scenarios are illustrated, with special emphasis on the sequence of destructive earthquakes that struck Central Italy starting on August 2016. The results obtained so far evidence the validity of the proposed methodology in anticipating ground shaking from approaching strong earthquakes and prove that the information provided by time-dependent NDSHA can be useful in assigning priorities for timely and effective mitigation actions.