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Real-time short-range earthquake forecasting in Italy

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We apply an earthquake clustering epidemic model to real-time data at the Italian Earthquake Data Center operated by the Istituto Nazionale di Geofisica e Vulcanologia (INGV) for short-term moderate and large earthquakes forecasting in Italy based on smoothed seismicity. The forecast uses earthquake data only, with no explicit use of tectonic, geologic, or geodetic information. In this model every earthquake can be regarded at the same time as triggered by previous events and triggering following earthquakes. The occurrence rate density, at any instant of time and geographical point, is computed by the contribution of every previous events using a kernel function that takes in proper account: (a) the magnitude of the triggering earthquake, (b) the spatial distance from the triggering event, and (c) the time interval between the triggering event and the instant considered for the computation. The magnitude distribution adopted here is the Gutenberg-Richter law. Although the learning data set fort the best fit of the model parameters goes from July 1, 1987 to December 31, 2005, the application of this clustering model developed for short-term forecasting gives much stronger weight to recent events than to older ones. Retrospective tests on real seismicity of Italy,California, Greece, Japan and comparison with a plain time-independent Poisson model through likelihood-based methods were made, proving the validity of this model. The results are displayed as time-dependent maps showing both the expected rate density of $M_l \geq$4.0 earthquakes and the probability of ground shaking exceeding Modified Mercalli Intensity VI (PGA$\geq$0.01g) in an area of 100 km^{2}around the zone of maximum expected rate density in the next 24 hours. For testing purposes, the overall probability of occurrence of a $M_l \geq$4.5 earthquake in the same area of 100 km^{2}is also estimated. The whole procedure is tested in real time, for internal use only, at the INGV Earthquake Data Center.

Forecast verification procedures have been carried out on the 2006 INGV data set

by means of statistical tools as the Relative Operating Characteristics (ROC) and Molchan's error diagrams. A few preliminary results are reported. These procedures show that the clustering epidemic model performs several hundreds times better than a simple random forecasting hypothesis.

The seismic hazard modeling approach so developed, after a suitable period of testing and refinement, is expected to provide a useful contribution to real time earthquake hazard assessment, even with a possible practical application for decision making and public information.