Geophysical Research Abstracts, Vol. 9, 10158, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10158

Pattern recognition techniques and time dependent neodeterministic seismic hazard assessment

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An integrated approach has been developed that combines different pattern recognition algorithms, designed for the space-time identification of strong earthquakes, with the procedures for the realistic modelling of ground motion. The integrated approach allows for a time dependent definition of the seismic input, through the routine updating of earthquake predictions. The scenarios of expected ground motion, associated with the alarmed areas, are defined by means of full waveforms modelling, based on the possibility to compute synthetic seismograms by the modal summation technique. A set of neodeterministic scenarios of ground motion is defined in this way, at regional and local scale, thus providing a prioritization tool for timely mitigation actions.

Constraints about the space and time of occurrence of the impending strong earthquakes are provided by the intermediate-term middle-range earthquake predictions, performed by means of the algorithms CN or M8, and by the pattern recognition of the areas prone to large events. The algorithms M8 and CN belong to a family of formally defined procedures for intermediate-term middle-range earthquake prediction. They allow for a diagnosis of the periods of time (TIP: Time of Increased Probability for the occurrence of a strong earthquake), when a strong event is likely to occur inside a given region of investigation. The results of the global real-time experimen-

tal testing indicate the possibility of practical earthquake forecasting, although with limited accuracy (i.e. with a characteristic alarm-time from a few months to a few years and a space uncertainty of hundreds of kilometres). A reduction of space uncertainty is feasible through the combined use of seismological, geological and morphostructural information. In fact, the pattern-recognition can be used to identify the sites capable to generate the strong events inside the alerted areas, independently from any transient seismic information. The pattern recognition of earthquake-prone areas, in common sense, does not belong to the family of earthquake prediction algorithms since it does not provide any information about the time of occurrence of the expected earthquakes. Nevertheless, it can be considered as the term-less zero-approximation, which restrains the alerted areas (e.g. defined by CN or M8) to the more precise location of large events. Among the possible developments towards a more accurate identification of the area of the impending earthquake, the analysis of real-time deformation patterns within alerted earthquake prone areas is expected to play a relevant role, where the newly available high quality positioning data (e.g., GPS and InSAR) would permit to compile real-time displacement/deformation maps within the alerted areas and to combine them with routinely updated seismic information.

An example of the integrated approach to time dependent scenarios of ground motion is provided considering the application of the mentioned methodologies to the Italian territory. Italy currently represents the only region of moderate seismic activity where the two different prediction algorithms CN and M8S (i.e. a spatially stabilized variant of M8) are applied simultaneously and a real-time test of predictions, for earthquakes with magnitude larger than 5.4, is ongoing since 2003. The possible extension of the application of the pattern recognition techniques to the surrounding regions, namely along the Adriatic Sea as well as in the Mediterranean area, is discussed depending on the specific level of knowledge and on the available data.