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INTERMEDIATE-TERM MIDDLE-RANGE EARTHQUAKE PREDICTION: A REAL TIME EXPERIMENT IN ITALY

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The process of preparation of a large earthquake usually involves a system of faults rather than a single fault; hence the seismic precursors have to be searched within regions of several hundred kilometres in linear dimensions. Even if, based on the observed precursors, we know that an earthquake is in preparation, it is not clear where and when it will occur inside the considered region. As the time approaches a catastrophic event, the precursory activation of smaller earthquakes tends to cluster around the impending source zone of a big one. At present, the most developed approach appears to be represented by the intermediate-term middle-range earthquake predictions (i.e. with a characteristic alarm-time from a few months to a few years and a space uncertainty of hundreds of kilometres), based on certain variations of the background seismic activity preceding large earthquakes.

The algorithms M8 and CN belong to a family of formally defined procedures for intermediate-term middle-range earthquake prediction. The general methodology common to the two different algorithms makes use of general concepts of pattern recognition that permit to deal with multiple sets of seismic precursors, and allows 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. These methods make use of detectable inverse cascade of seismic process, at different space and time ranges, to reduce consecutively space and time limits where a strong earthquake has to be expected. By the algorithms definition, the dimensions of the monitored area increase proportionally to the length L of the source of the events to be predicted, in order to account for possible long-range interactions. Consequently, in agreement with a multi-scale seismicity model, the CN and M8 algorithms make use of the information carried by small and moderate earthquakes, following the Gutenberg-Richter law, to predict the stronger earthquakes, which are rare and possibly characteristic events inside the delimited region.

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 for the routine monitoring of seismicity. For the application of the algorithm CN in Italy, a regionalization based on the seismotectonic zoning and taking into account the main geodynamic features of the Italian area, is currently used. For the application of M8S algorithm seismicity is analysed within a dense set of overlapping circles, with radius increasing with the magnitude of the target events and covering the monitored area. Several experiments have been dedicated to assess the robustness of the methodology against the unavoidable uncertainties in the data and significant efforts have been made to minimize the intrinsic space uncertainty of predictions and the subjectivity of the definition of the areas where precursors should be identified. With these results acquired, an experiment has been launched in July 2003, aimed at a real-time test of M8S and CN prediction for earthquakes with magnitude larger than 5.4 in the Italian region. The results of the intermediate-term middle-range predictions in Italy are regularly updated every two months and a complete archive of predictions is made available on-line to a number of scientists, thus allowing for a real-time testing of the predictive capability of the applied algorithms. The results obtained up to the end of 2004 show that the algorithm CN predicted 12 out of the 13 strong events occurred within the monitored regions (4 out of 5 predicted in real time), with a space-time volume occupied by alarms of about 32%. The algorithm M8S, predicted 62% of the strong of the events occurred in the monitored zones in Italy, i.e. 16 out of 26 events occurred within the area alerted for the corresponding magnitude range, with a space-time volume of alarms around 38%. The alarms declared by the prediction algorithms suggested performing, in advance with respect to the planned time, a GPS campaign a few days before the Bovec earthquake (July 12, 2004) just in the epicentral area, thus permitting to obtain particularly interesting pre and post earthquake measurements.