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Smoothed Seismicity Models for the Development of the 2016 Italian Probabilistic Seismic Hazard Maps

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In this work anticipation of the update of the 2016 Italian seismic hazard maps (MPS16), we report progress on the comparison of smoothed seismicity models developed using fixed and adaptive smoothing algorithms, and investigate the sensitivity of seismic hazard to the models. Recent developments in adaptive smoothing methods and statistical tests for evaluating and comparing rate models prompt us to investigate the appropriateness of adaptive smoothing for the Italian Hazard Maps. The smoothed-seismicity methods simply assume that future earthquakes will occur in the vicinity of the past earthquakes. The approach of using spatially-smoothed historical seismicity is different from the one used previously by Working group MSP04 (2004), and Slejko et al. (1998) for Italy, in which source zones were drawn around the seismicity and the tectonic provinces and is the first to be used for the new probabilistic seismic hazard maps for Italy.

We develop two different smoothed seismicity models using fixed and adaptive smoothing methods and compare the resulting models by calculating and evaluating the joint likelihood test. The smoothed seismicity models are constructed by using the new historical CPTI15 and instrumental Italian catalogues and associated completeness levels produced for the MPS16 to produce a space-time forecast of the future Italian seismicity. The fixed smoothing model follows the method of Frankel (1995) uses spatially uniform smoothing parameters (i.e. fixed smoothing), such that the kernels used to smooth catalog-derived seismicity rates are invariant to spatial variations in seismicity rate. However, the adaptive smoothing method (Helmstetter et al., 2007) defines a unique smoothing distance for each earthquake epicenter from the distance to the nth nearest neighbor. Thus the smoothing constant becomes very small in areas of dense seismicity, allowing for fine delineation of major active faults, while allowing for broad smoothing in areas of low seismicity. We follow guidance from previous studies to optimize the neighbor number (n-value) by comparing model likelihood values, which estimate the likelihood that the observed earthquake epicenters from the recent catalog are derived from the smoothed rate models. We compare likelihood values from all rate models to rank the smoothing methods. We also compare these two models with the Italian CSEP experiment models, to check their relative performances. Finally we create an ensemble with our two models, to try to improve the forecast capability.