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Using indirect information to constrain uncertain, real-time earthquake locations

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Providing rapid and valid information on earthquake source parameters is today an urgent service that socio-economic systems require for improving their safety, reliability and sustainability. Earthquake source parameters are a key input to different Early Warning (EW) systems developed to cope with different geohazards. For example, reliable fast estimations of earthquake's location, size and source mechanism are fundamental data for the mitigation of the potential impact of ground motions caused by earthquakes, for assessing the likelihood of triggering tsunami waves (and the related impact), and even as one of the most informative sets of parameters used for interpreting unrest episodes preceding volcanic eruptions.

When an earthquake is located in an area well-covered by a dense monitoring network, uncertainties in earthquake locations are usually low enough to have quick and reliable location estimations. Nevertheless, when the event is located at the margins or out of the coverage provided by a monitoring network (as for example off-shore events, or events around Island volcanoes), the uncertainty of fast event location solutions dramatically increase.

In such a case, using multidisciplinary information is a strategy that may strongly benefit the trade-off between a rapid response and the accuracy of the provided information. We investigate the possibility of testing and validating early earthquake locations by using data coming form different indirect sources of information as the characteristics of known seismic sources and knowledge about local tectonic features, data from local hazard quantifications, as well as the information from early event location solutions provided by automated systems and their uncertainty. Bayesian data analysis techniques are used to calculate updated earthquake source location taking into account all the available sources of information.

The performance of the proposed approach is studied through synthetic modelling emulating the real case of an earthquake sequence occurred in Summer 2017 in Ischia, Italy. A swarm of seismic events was recorded by both local and regional networks; the incipient coverage offered by the operating instruments resulted in a strongly uncertain initial event location. This case provides us the opportunity to test the developed procedure, reprocessing the initial automated locations provided by the monitoring systems taking into account available indirect information.