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Near-real time 3D probabilistic earthquakes locations at Mt. Etna volcano

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Automatic procedure for locating earthquake in quasi-real time must provide a good estimation of earthquakes location within a few seconds after the event is first detected and is strongly needed for seismic warning system. The reliability of an automatic location algorithm is in[U+FB02]uenced by several factors such as errors in picking seismic phases, network geometry, and velocity model uncertainties.
On Mt. Etna, the seismic network is managed by INGV and the quasi-real time earthquakes locations are performed by using an automatic-picking algorithm based on short-term-average to long-term-average ratios (STA/LTA) calculated from an approximate squared envelope function of the seismogram, which furnish a list of P-wave arrival times, and the location algorithm Hypoellipse, with a 1D velocity model.
The main purpose of this work is to investigate the performances of a different automatic procedure to improve the quasi-real time earthquakes locations. In fact, as the automatic data processing may be affected by outliers (wrong picks), the use of a traditional earthquake location techniques based on a least-square misfit function (L2-norm) often yield unstable and unreliable solutions. Moreover, on Mt. Etna, the 1D model is often unable to represent the complex structure of the volcano (in particular the strong lateral heterogeneities), whereas the increasing accuracy in the 3D velocity models at Mt. Etna during recent years allows their use today in routine earthquake locations.
Therefore, we selected, as reference locations, all the events occurred on Mt. Etna in the last year (2011) which was automatically detected and located by means of the Hypoellipse code.
By using this dataset (more than 300 events), we applied a nonlinear probabilistic earthquake location algorithm using the Equal Differential Time (EDT) likelihood function, (Font et al., 2004; Lomax, 2005) which is much more robust in the presence of outliers in the data. Successively, by using a probabilistic non linear method (NonLinLoc, Lomax, 2001) and the 3D velocity model, derived from the one developed by Patanè et al. (2006) integrated with that obtained by Chiarabba et al. (2004), we obtained the best possible constraint on the location of the focii expressed as a probability density function (PDF) for the hypocenter location in 3D space.
As expected, the obtained results, compared with the reference ones, show that the NonLinLoc software (applied to a 3D velocity model) is more reliable than the Hypoellipse code (applied to layered 1D velocity models), leading to more reliable automatic locations also when outliers are present.

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