Geophysical Research Abstracts
Vol. 13, EGU2011-9305, 2011
EGU General Assembly 2011

1D versus 3D velocity models for earthquake locations: a case study in Campania-Lucania region (Southern Italy)

Emanuela Matrullo (1), Ortensia Amoroso (1), Raffaella De Matteis (2), Claudio Satriano (1,3), and Aldo Zollo (1)

(1) University of Naples Federico II, Naples, Italy (matrullo@na.infn.it), (2) Università del Sannio, Benevento, Italy (dematteis@unisannio.it, (3) Institut de Physique du Globe, Paris, France (satriano@ipgp.fr)

Simplified one-dimensional velocity models are generally used both for monitoring and for research purposes in geologically complex seismogenic areas. In these situations the use of 1D models to represent the true three-dimensional velocity distribution can lead to systematic errors in the estimated earthquake locations and focal mechanisms. This is the case of Campania-Lucania region (Southern Italy) where the geological and geophysical knowledge reveal a significant lateral variation of the elastic properties of the medium.
The aim of this work is to determine the 1D P-wave velocity model of the study area and compare it with a 3D model in order to investigate possible systematic effects on earthquake locations obtained using the 1D model.
We analyze the last five years (August 2005 - April 2010) of the instrumental seismicity recorded by AMRA and INGV networks deployed in Southern Italy. We manually picked P- and S- wave arrival times for a total of 8663 P- and 4358 S- phases on an high-quality waveform dataset from 980 earthquakes with a local magnitude range of $0.1 \leq ML \leq 4.8$.
Following the approach of Kissling et al. (1994), a P-wave “minimum 1-D velocity model” is computed by a joint inversion of layered velocity model, station corrections and hypocenter locations, using a selected set of high-quality events. The retrieved station corrections show a very coherent spatial pattern correlated with the expected velocity variation due to the geological features of the area. This observation calls in question the adequacy of a 1D velocity model to represent such strong crustal heterogeneities.
In order to interpret the observed station corrections pattern a three-dimensional crustal velocity model has been obtained from the inversion of the same data set of P first-arrival travel times, using a linearized, iterative tomographic algorithm (La Torre et al, 2004) in which delay travel times are inverted for both earthquake locations and velocity model parameters at each step of the inversion procedure.
The tomographic results clearly indicate, in the first 5-6 km of the crust, the presence of a strong velocity variation along the direction orthogonal to the Apenninic chain defining two domains characterized by relatively low (3.5 - 4.8 km/s) and high (5.2 - 6.5 km/s) velocity respectively. The comparison of retrieved Vp anomalies with the spatial distribution of 1D derived station corrections confirms that the latter reflect the large-scale geological changes rather than local effects such as topography or site geology. This is consistent with the evidence for the transition between the carbonate platform outcrops at South-West and the Miocene sedimentary basins at North-East. Furthermore we observe a strong correlation of the larger negative values of station corrections with the top increase of the Apula carbonate platform.
We finally compare earthquake locations determined in the 1D and 3D velocity models for the area and we observe a systematic shift in the earthquake positions due to the lateral velocity variation. This effect is not fully taken into account by including the station corrections in earthquake locations using 1D layered velocity model.