

WP24: Analysis of network performance for investigations of earthquake statistics

Toward harmonized local magnitude attenuation function for Europe using massive events datasets

D. Bindi, R. Zaccarelli, A. Strollo, G. Di Giacomo, J. Quinteros and F. Cotton
 GFZ German Research Centre for Geosciences

Keywords

Earthquake ground motion, seismic source observations, harmonized magnitude scale, regional attenuation, engineering seismology.

Figures

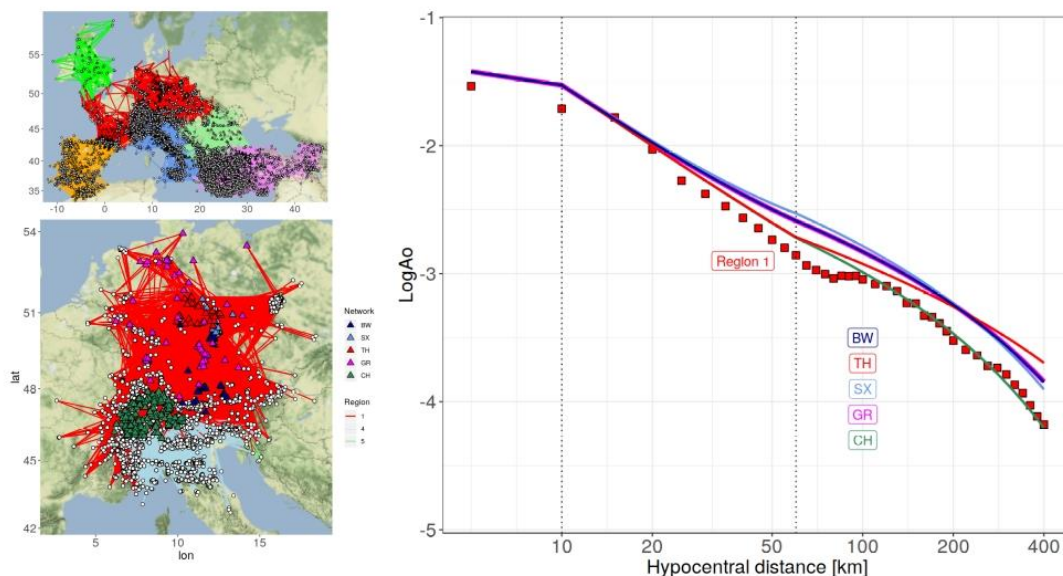


Figure 1. Harmonized local magnitude scale for Europe. *Top left*: source to station ray paths considered to derive the non-parametric attenuation models regionalized into six macro-domains indicated with different colours; points indicate the location of the analysed earthquakes (about 12 thousand). *Bottom left*: example of parametric analysis performed over 5 network, four operating on Germany (network codes TH, GR, SX, BW) and the fifth in Switzerland (network code CH). *Right*: comparison among the parametric magnitude functions obtained for the five considered networks (coloured lines) and the non-parametric model derived for central Europe (region 1, shown with red paths in the left panels). Figure modified from Bindi et al. (2019).

Main Results

In the last two decades, the development of international infrastructures for data sharing (e.g. EIDA- European Integrated Data Archive; IRIS- Incorporated Research Institutions for Seismology) and the standardization of the formats for data archiving and dissemination (FDSN- International Federation of Digital Seismograph Networks) allowed the seismological community to overcome the difficulties in merging data from different networks and countries. In this study, we took advantage of the EIDA to develop the first harmonized local magnitude scale for central and southern Europe, and to quantify regional differences in the attenuation models (Bindi et al., 2019). Using an open-source tool developed to carry out this task and similar (Zaccarelli et al., 2019), we created a local data base including about half million selected waveforms with related metadata, corresponding to about 12'000 earthquakes occurred in Europe in the magnitude range from 2 to 7. The calibration of regional non-parametric attenuation functions highlighted significant regional differences in the rate of attenuation among the six considered macro-areas. Within the macro-areas, crustal heterogeneity affects the propagation of seismic waves differently, for example later arrivals impact the ground motion at different distance ranges.

In order to compare the magnitudes provided by different seismological observatories in Europe, a parametric approach has also been developed considering adjustments to the attenuation coefficients at the level of each single network. Following this approach, more than 70 different parametric magnitude scales were derived following, for the first time in Europe, a harmonized approach without political or infrastructural borders. The possibility to refer to a harmonized magnitude scale makes easier the operation of comparing and merging catalogues provided by different networks. Furthermore, it allows to jointly analyse amplitudes recorded at stations belonging to different networks operating in adjacent regions. The newly derived magnitude scale can be used as reference magnitude scale for applications where local to moment magnitude scale conversions are required for seismic hazard assessment purposes. For this reason, future work will investigate the possibility to compare the magnitudes obtained from the homogenized calibration functions with those reported in the [ISC bulletin](#), as collected from several European networks.

List of Publications

- Bindi, D., Zaccarelli, R., Strollo, A., Di Giacomo, G. (2019). Harmonized local magnitude attenuation function for Europe using the European Integrated Data Archive (EIDA), *Geophysical Journal International*, 218, 1, 519-533. <https://doi.org/10.1093/gji/ggz178>
- Zaccarelli, R., Bindi, D., Strollo, A., Quinteros, J. and Cotton, F., (2019). Stream2segment: an open source tool for downloading, processing and visualizing massive event-based seismic waveform datasets, *Seimol. Res. Letters* 90 (5): 2028–2038, [10.1785/0220180314](https://doi.org/10.1785/0220180314)

Access to Data and Services

- The software stream2segment is free available at: <https://geofon.gfz-potsdam.de/software/stream2segment/>
- The attenuation coefficients of the calibrated magnitude models are available at: https://gfzpublic.gfz-potsdam.de/pubman/item/item_4224891

Only open data have been used to derive the models, available from EIDA <https://www.orfeus-eu.org/data/eida/>

Liability claim

The European Commission is not responsible for any use that may be made of the information contained in this document. Also, responsibility for the information and views expressed in this document lies entirely with the author(s).