Analysis of Source Parameters relationships for clusters of similar events recorded in Central Apennines

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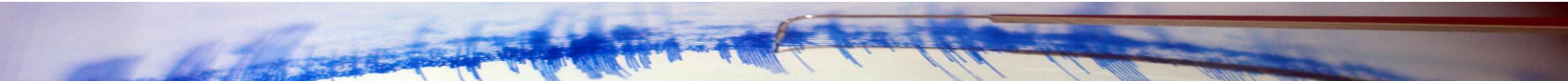
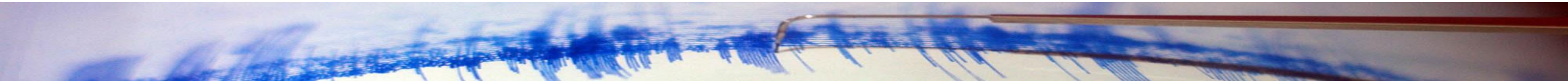


Motivations of the study

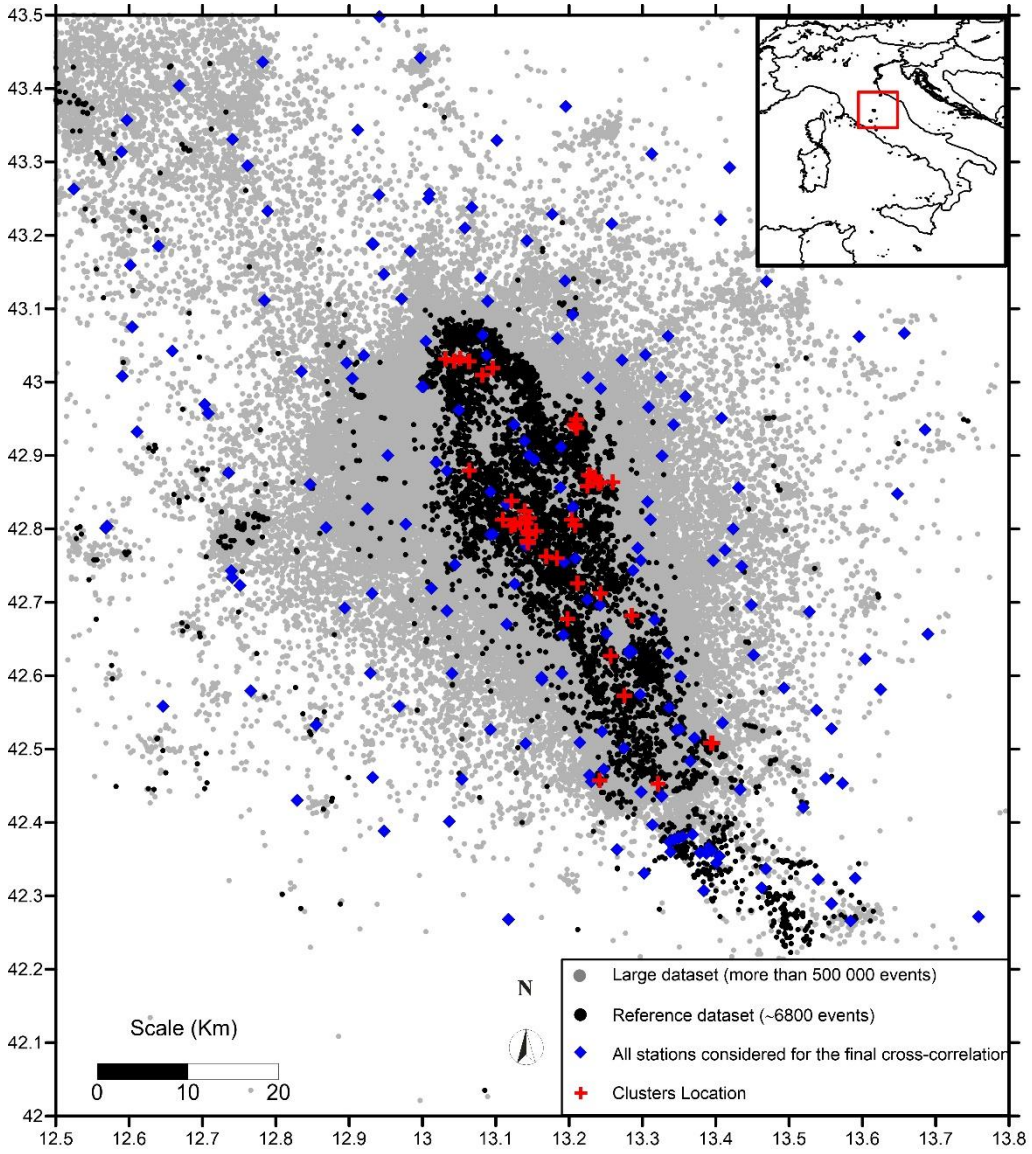
1) The availability of a large amount of good quality data with high-frequency content recorded in Central Apennines, allowed for a robust analysis of P-pulse durations to define source properties of small clustered events characterized by similar waveforms to understand the magnitude below which the corner frequency remain almost constant.

2) Application of completely independent methodologies (GIT and Coda envelopes analysis) to the region allowed to define source parameters for small events facing the source scaling problem from different points of view.

3) The comparison of Ml-Mw relationships independently obtained for the same similar-waveform-clustered events give us a clue of the method influence on the scaling observed.



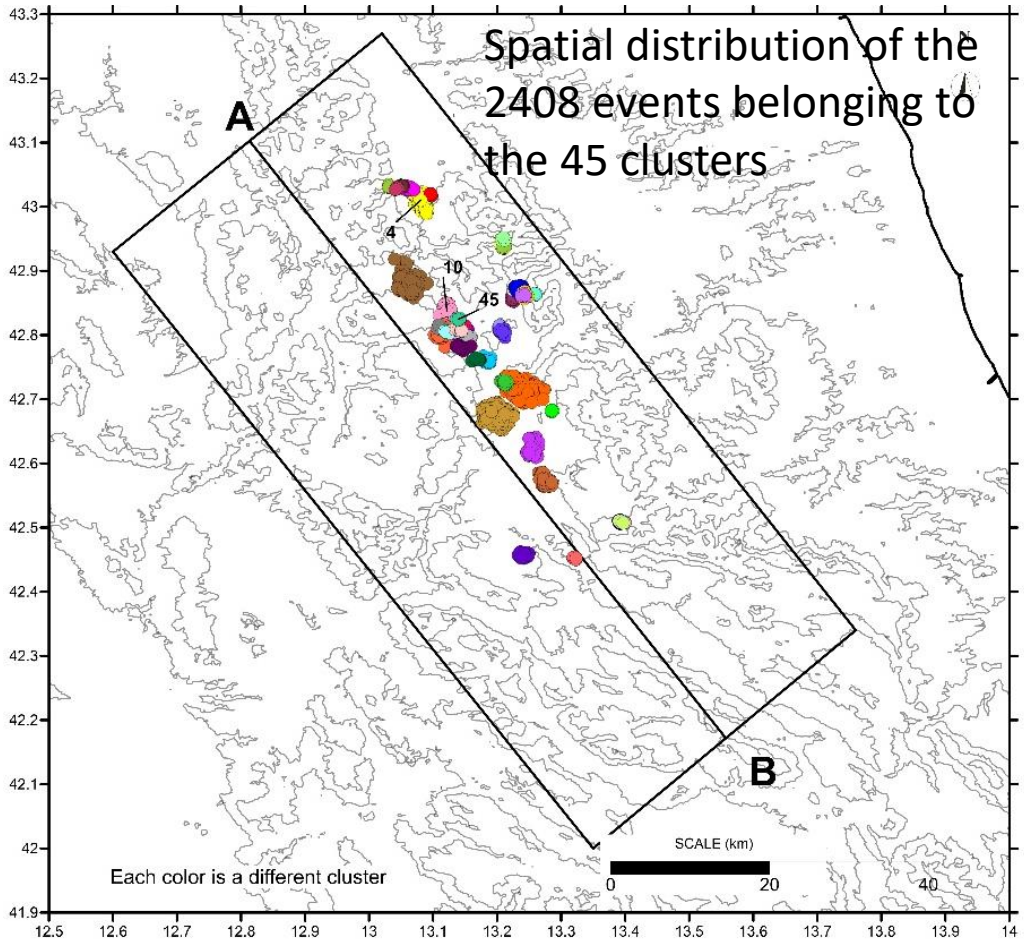
Central Apennines Data

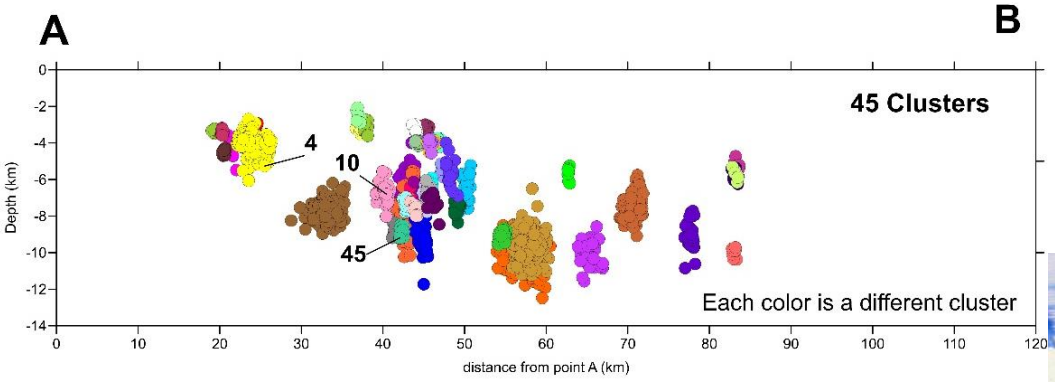


Large Dataset: ~ 500 000 events
time period: 2015-2019
Ml range ~1 – 6.5

Reference Dataset : ~ 6 800 events
time period: 2009-2019
Ml range ~1 - 6.5

Multi-step cross-correlation analysis





Cross-Correlation
on reference dataset (~ 6830 events)
using 100 stations

↓

Detection of 45 clusters
of similar events
using a bridge technique

↓

Extraction of ~5200 events from another dataset
including a large number of small events.
The events are selected within
2 km from central location of each cluster.

↓

New cross-correlation on the composed dataset
of ~12000 events (~6830 + ~5200)
using ~200 stations

↓

The bridge tecnique individuated the
same 45 clusters but this time including
more small events (Ml < 3.5)

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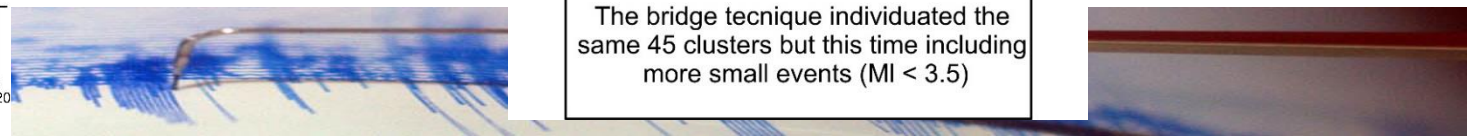
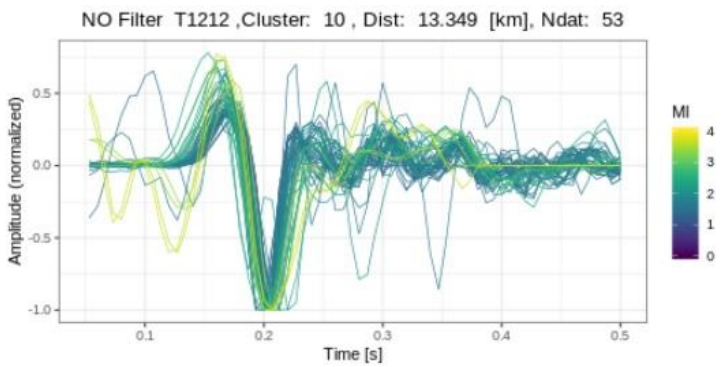
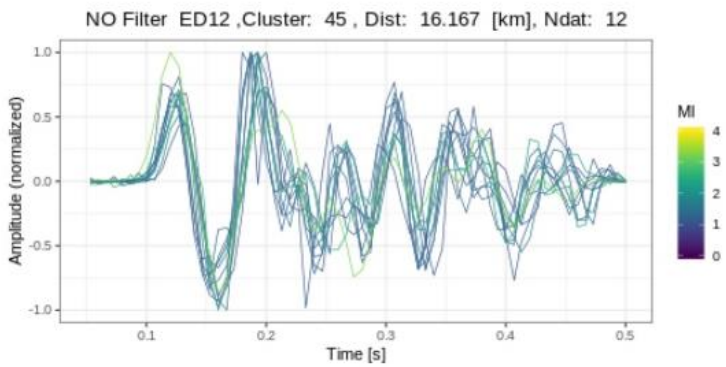
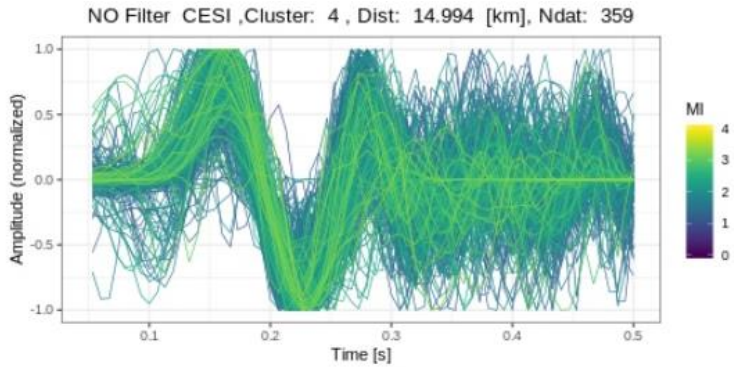
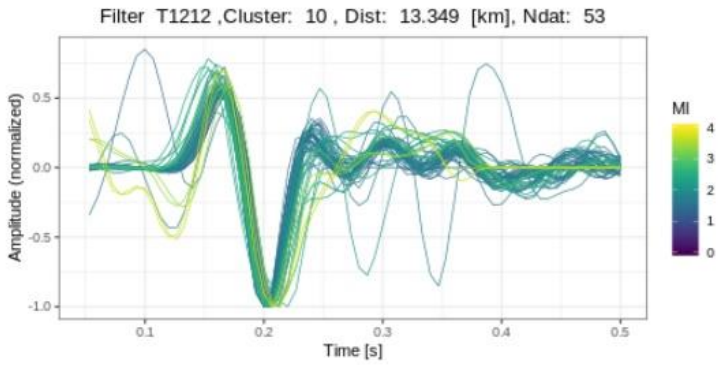


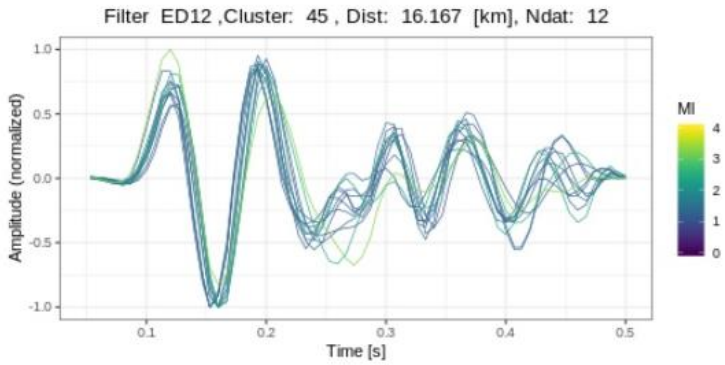
Examples of P-waves duration for the events belonging to clusters 10, 45 and 4

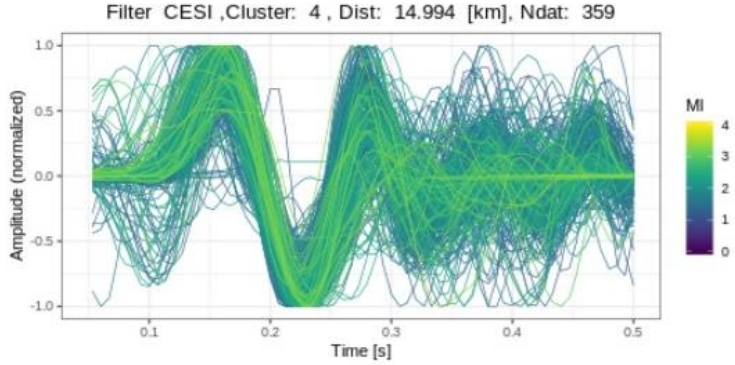


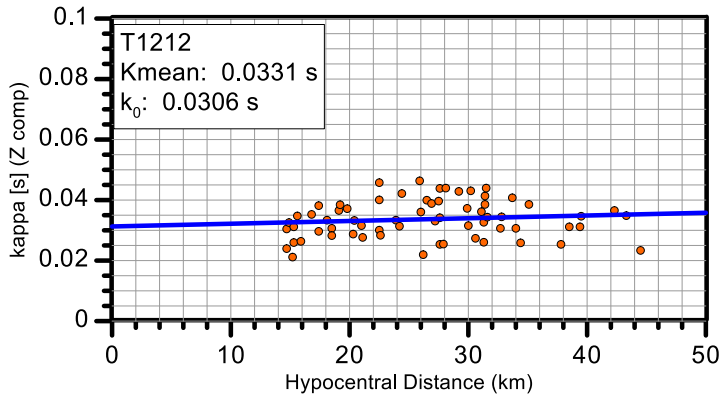


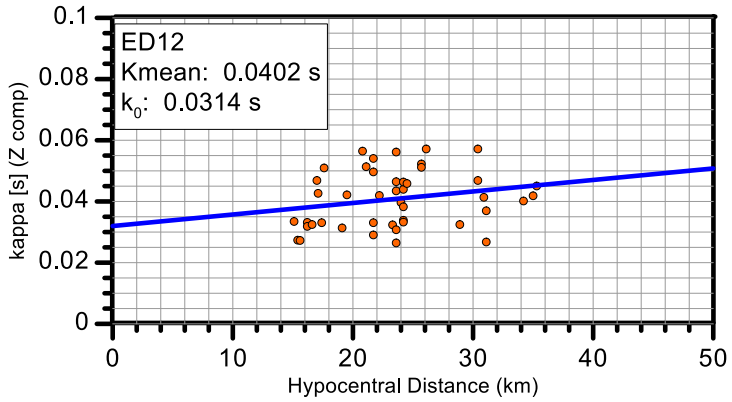


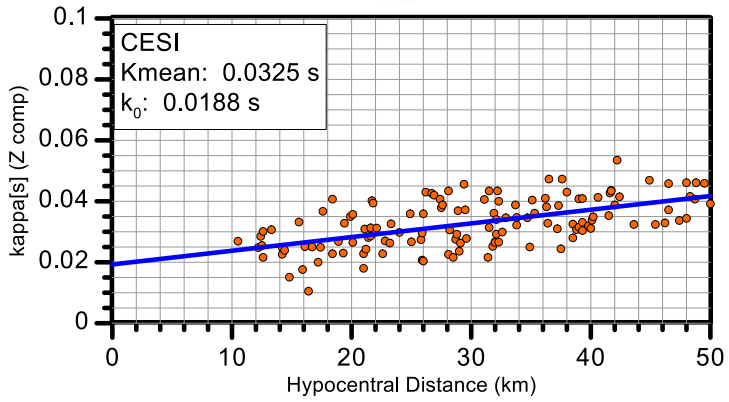










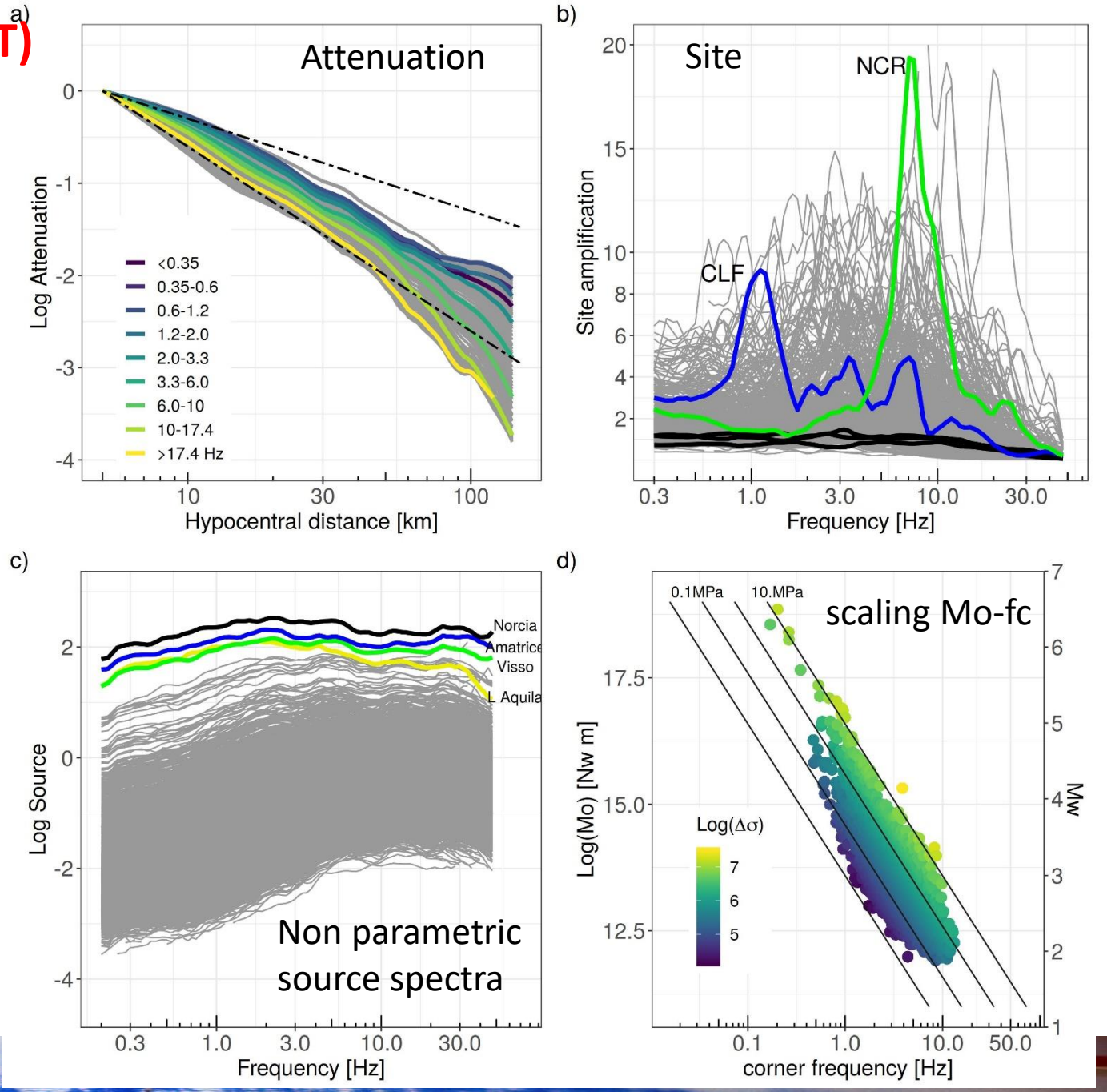


Generalized Inversion Tecnique (GIT)

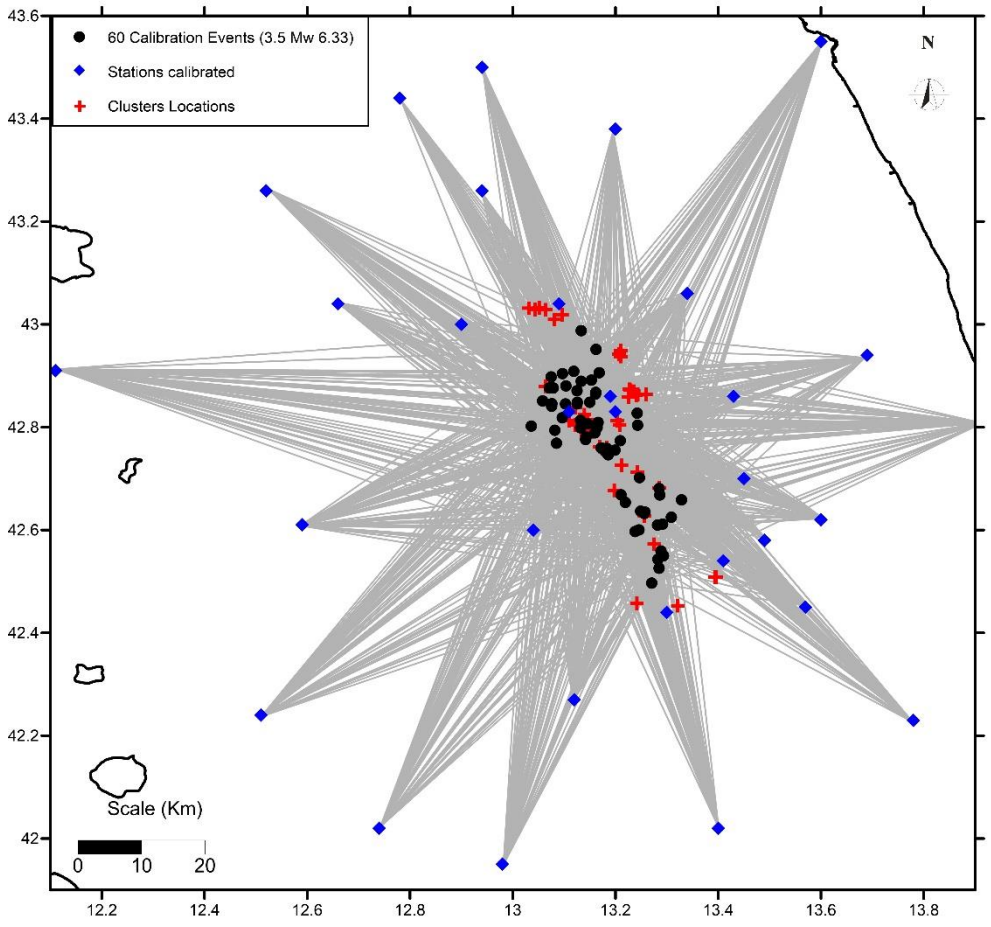
In order to retrieve source parameters, a spectral decomposition approach was applied to the reference dataset of ~ 6830 events (Bindi et al. 2020)

$$Log[FAS_{ij}(f)] = Log[Source_i(f)] + Log[Attenuation(R_{ij};f)] + Log[Site_j(f)]$$

We follow a non-parametric approach where any a-priori functional form is used to describe the three terms when solving the linear system of equations.



Coda – derived source spectra based coda envelope calibration and processing



Taking advantage of the averaging nature of coda waves, we calibrated path parameters, S-to-Coda transfer functions and site effects for coda envelopes in the Central Apennines region using 60 selected events following the methodology developed by Walter and Mayeda, 1996 and Mayeda et al, 2003.

Once the region was calibrated we focused on coda-envelopes of the events belonging to the three selected clusters (4,10 and 45) to obtain source parameters to be compared each other and with results derived from GIT analysis.

Methodology: Mayeda and Walter, 1996; Mayeda et al. 2003

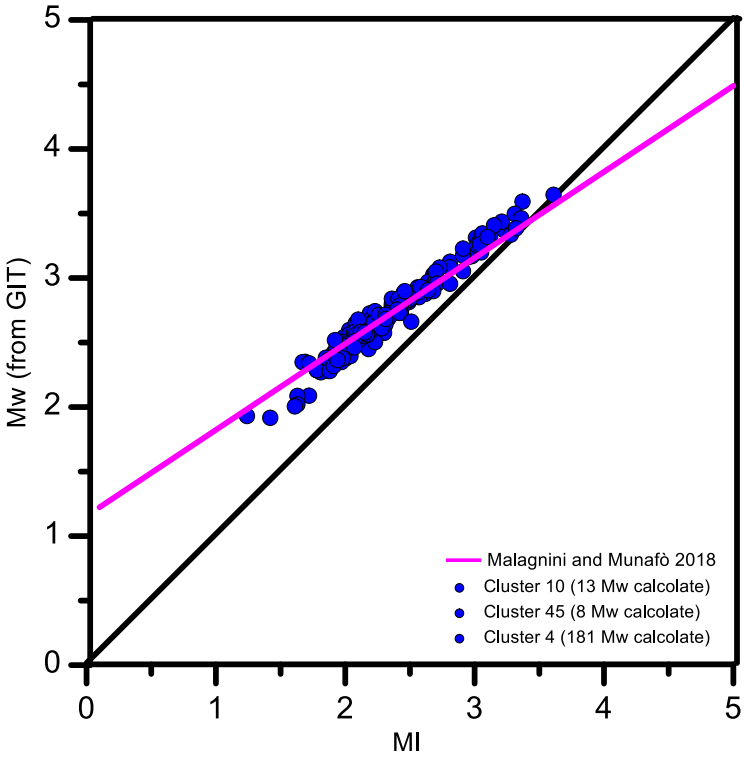
Software: CCT (Coda Calibration Tool, https://github.com/LLNL/coda-calibration-tool)
(please, see also D1677 - EGU2020-5874 for reference)

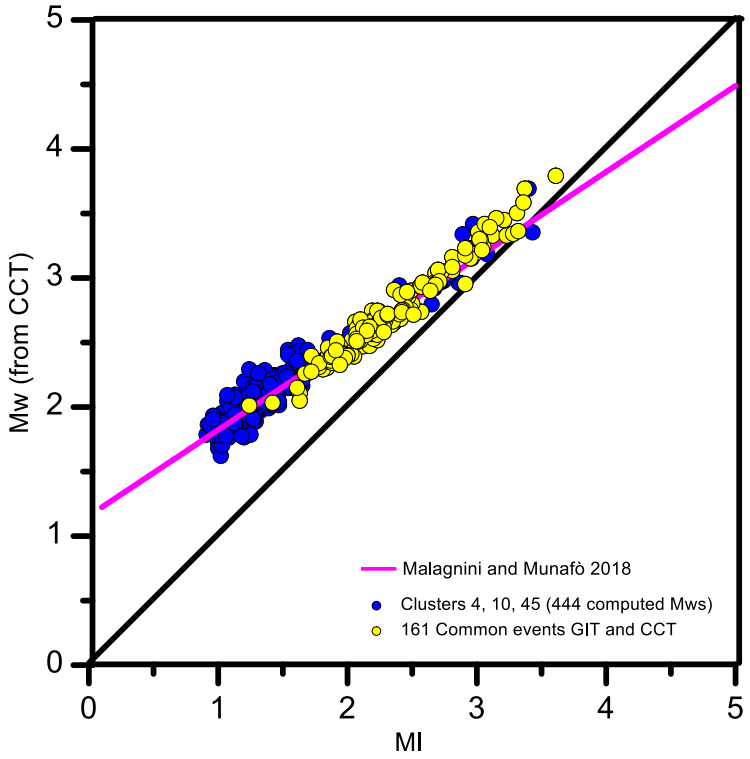
Calibration Data: 60 events for which we have independent Mw values ranging between 3.5 and 6.33 (from Saint Louis University web page, http://eqinfo.eas.slu.edu/eqc/eqc_mt/MECH.IT/) .

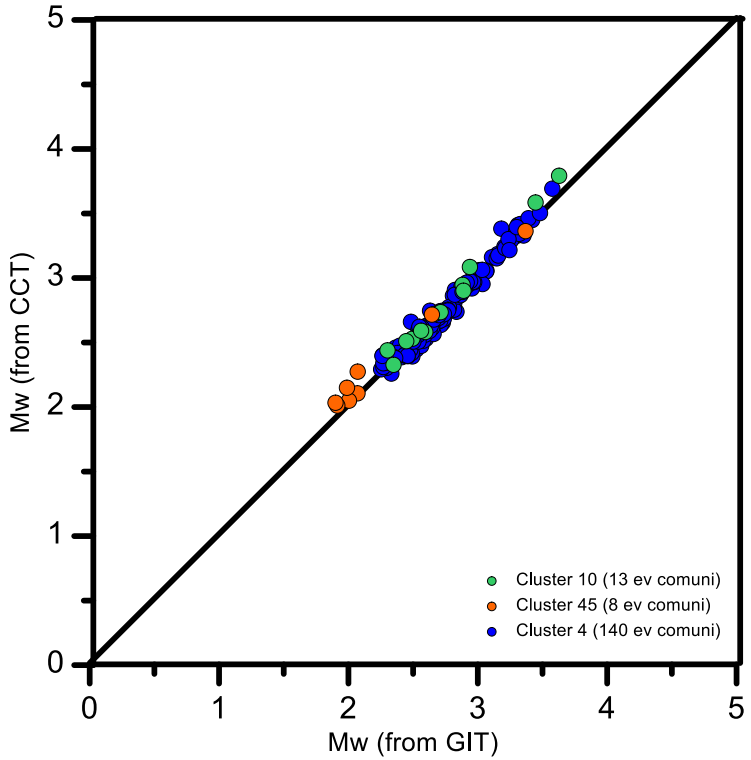
Calibration Stations: 31 velocimeters with high sampling rate (100 sps) well covering the region of interest.

Results and comparisons

For the common events belonging to clusters 4, 10 and 45 we compared Mw independently derived from the GIT and Coda – envelopes analysis observing a very good agreement. In both cases we also observed the same deviation from 1:1 scaling for Ml-Mw. A comparison with Malagnini and Munafò (2018) strengthens our findings.







Conclusions

1) Analyzing a large amount of data recorded in Central Italy (~12000 events) including very small events (Ml ~1) using a multi-step cross-correlation procedure, we individuated 45 clusters of similar events.

2) Studying the P-pulse-duration (i.e. corner frequency) of small earthquakes belonging to three clusters (used as examples) the variation gradually becomes negligible for magnitudes below 2 in all cases.

3) Independent GIT inversion analysis was performed in this area including the events belonging to the analyzed clusters to derive source parameters.

4) Independent Coda-calibration methodology (Walter and Mayeda, 1996; Mayeda et al 2003) allowed to obtain stable coda-derived source spectra for events belonging to the analyzed clusters

5) A comparison between source parameters obtained with the two different techniques for the common events of the analyzed clusters are in good agreement. The level of agreement gives an information about the suitability of these techniques for estimating source parameters of small events recorded by regional networks.

6) The independent methodologies leads to the same Ml-Mw scaling that is in agreement with Malagnini and Munafò (2018) for the same region.