

Supplementary Information to
Improving detection of micro-earthquakes
in the Val d'Agri region (Southern Italy)
using deep learning algorithms

Caredda E., Isken M.P., Cesca S., Errico M., Zerbinato G., Morelli A.

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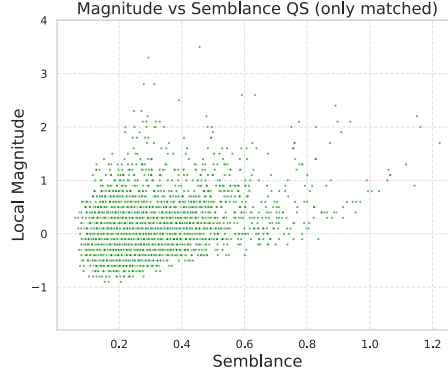


Figure S1: Magnitude vs Semblance for earthquakes in the QS catalog that appear also in the reference catalog (CMS). This plot illustrates how TP (green dots) are clustered within a specific region of the graph, where the semblance correlates with the magnitude.

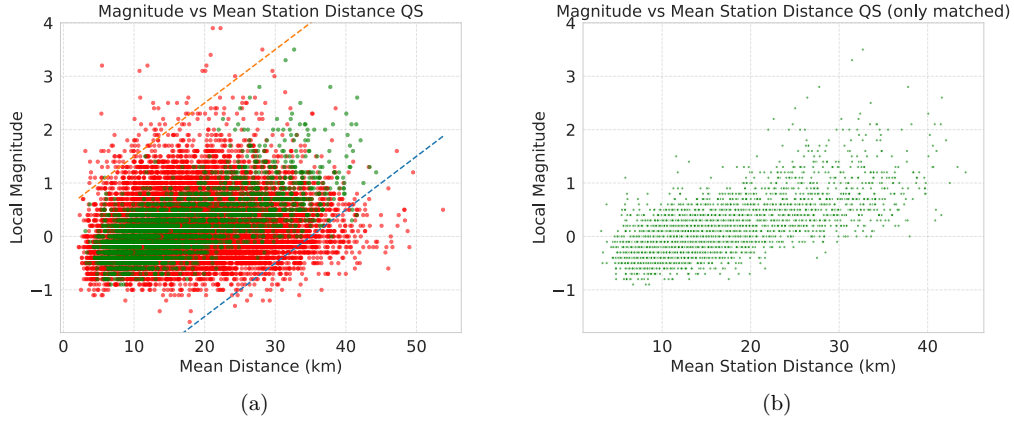


Figure S2: a) Magnitude vs average station distance from the epicenter for the QS catalog first output. Green dots indicate the earthquakes found also in the reference CMS catalog, red dots are those that do not match in the reference catalog. b) same plot but with green dots only for a clearer visualization.

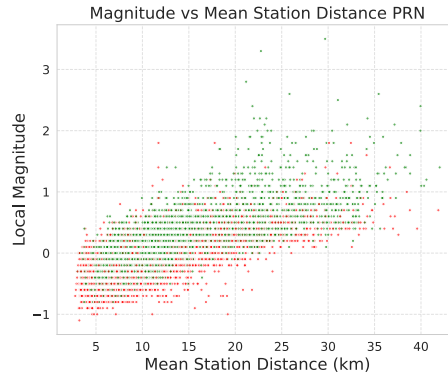


Figure S3: Magnitude vs average station distance from the epicenter for the PRN catalog. Green dots indicate the earthquakes found also in the reference CMS catalog, red dots are those that do not match in the reference catalog.

In Figure S5 we compare only the events above a cutoff magnitude of the CMS catalog. To provide

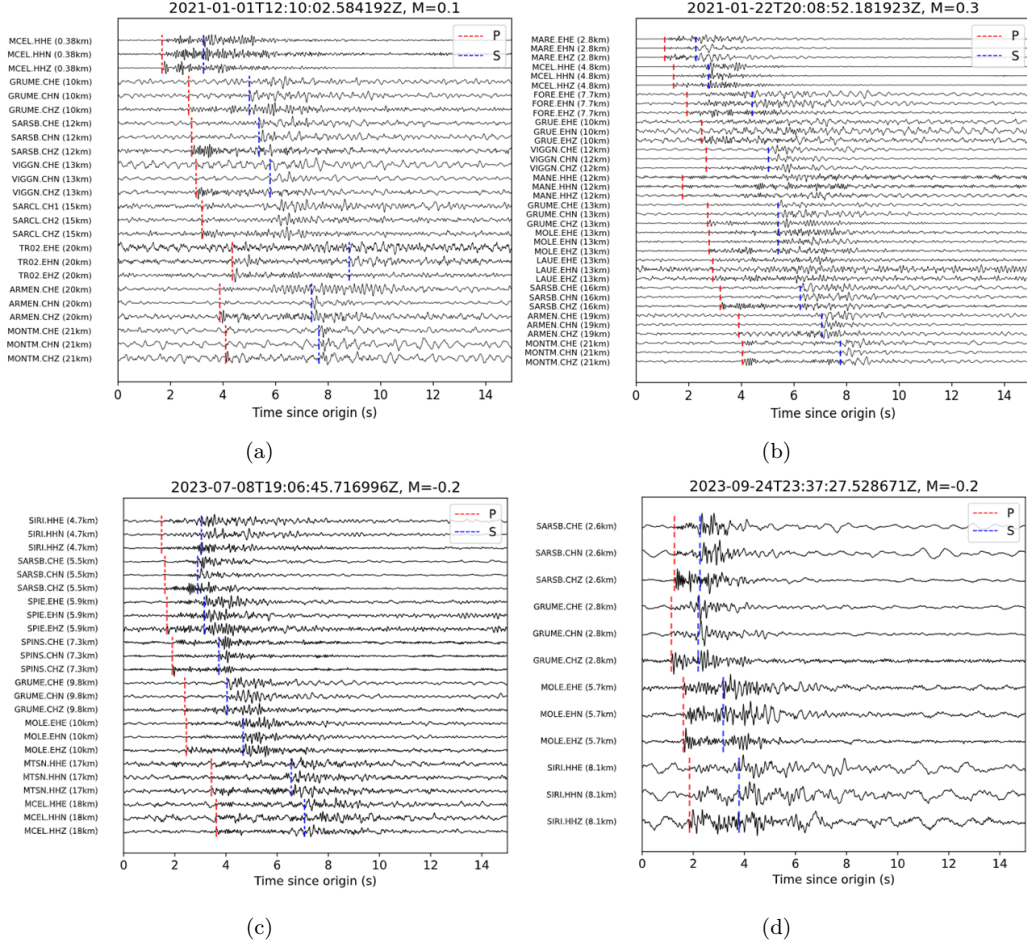


Figure S4: Waveform examples of low-magnitude earthquakes that passed the magnitude-semblance filter in the QS workflow described in the Methods section.

a more robust magnitude threshold for comparing the catalogs, we estimated the detection probability function using the [Ogata and Katsura \(1993\)](#) model. From this, we derived the magnitude corresponding to a 99% probability of detection ($M_{99}=0.6$), which we used to filter the events in the supplementary figure. This approach provides a more objective and statistically efficient estimate of the magnitude of completeness than commonly used empirical methods such as the Maximum Curvature, which tend to underestimate the completeness level (e.g., [Woessner and Wiemer \(2005\)](#)). Limiting the CMS catalog to $M \geq$ the recall increases to 94% (PRN) and 81% (QS).

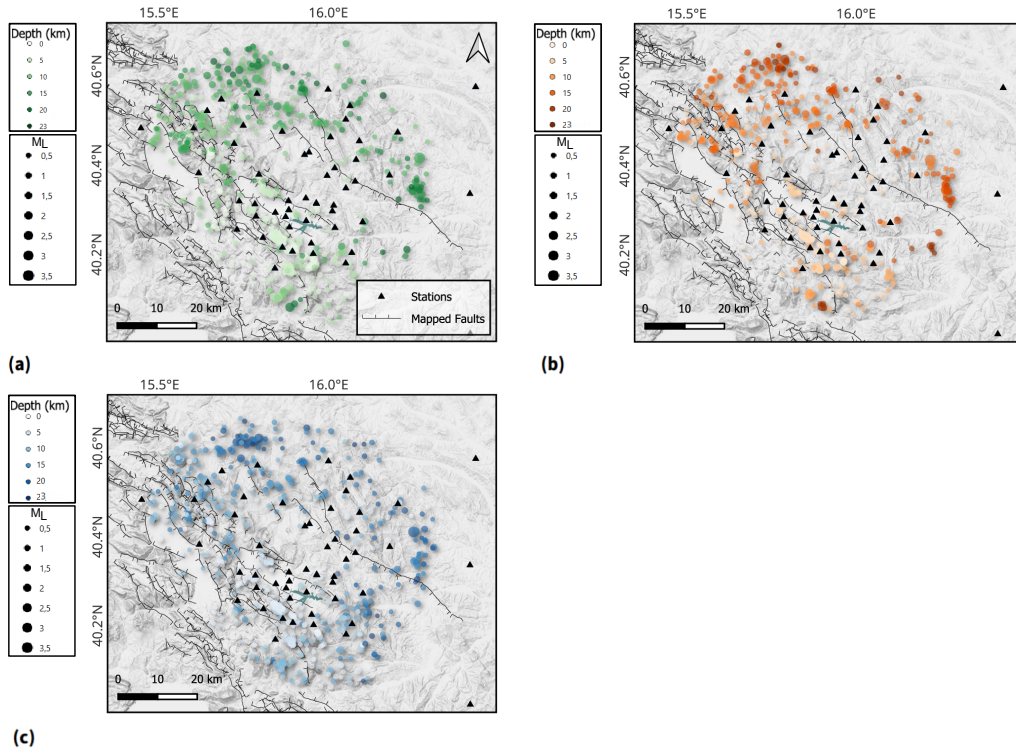


Figure S5: Distribution of epicenters of only the events above the $M=0.6$ of the CMS catalog for a) CMS catalog, b) PRN catalog, c) QS catalog. The dot size is proportional to Magnitude, while the color scales with the depth.

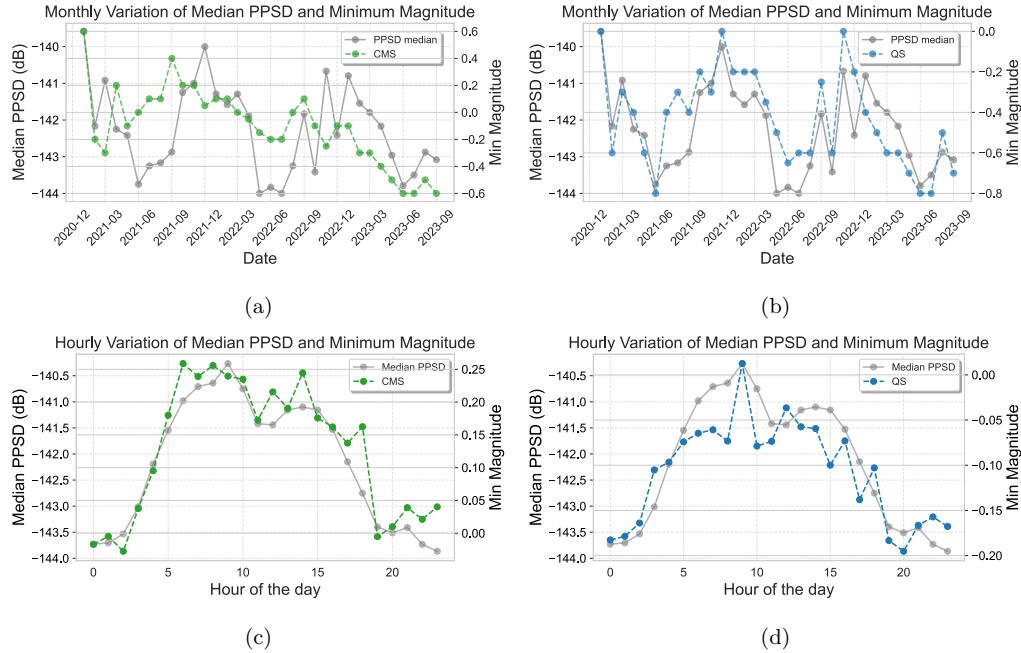


Figure S6: a,b) Monthly and c,d) hourly PPSD 50th percentile on a sample station (GE.MARCO) averaged over the three components (E, N, Z) vs minimum magnitude detected day by day for the CMS (a,c) and QS (b,d) catalogs respectively. It is averaged over each month and hour, respectively.

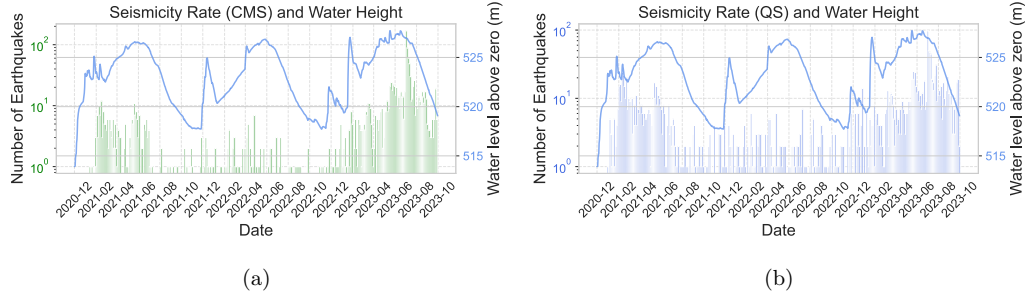


Figure S7: Pertusillo lake water level over time (blue line) vs number of earthquakes every 3 days in the a) CMS (green) and b) QS catalog (blue), i.e., seismicity rate. Water level data starts in December 2020, considering the delayed effect of seismicity.

References

- Ogata, Y. and Katsura, K. Analysis of temporal and spatial heterogeneity of magnitude frequency distribution inferred from earthquake catalogues. *Geophysical Journal International*, 113(3): 727–738, 1993. doi: <https://doi.org/10.1111/j.1365-246X.1993.tb04663.x>.
- Woessner, J. and Wiemer, S. Assessing the Quality of Earthquake Catalogues: Estimating the Magnitude of Completeness and Its Uncertainty. *Bulletin of the Seismological Society of America*, 95(2):684–698, 04 2005. doi: 10.1785/0120040007.