

Response Letter - R2

Potsdam, 10. January 2025

Seismica - Manuscript 1283

Dear Reviewers, Dear Editor,

Thank you for reviewing our manuscript, *Qseek: A Data-Driven Framework for Machine-Learning Earthquake Detection, Localization, and Characterization*. We appreciate the time and effort the reviewers took to provide a thorough review and constructive comments on our work. We are grateful for the opportunity to revise and resubmit our manuscript.

We have analysed all reviewers' suggestions carefully and incorporated them wherever possible. A point-by-point response is attached below. The scope and focus are now more precise, and the state-of-the-art and previous work is better considered, including references for the statistical analysis.

We drastically reduced the length of the manuscript by moving comparative earthquake catalog maps to the supplementary information and shortened the text by removing redundant information. Furthermore, we improved the manuscript's readability, grammar, and language. The revised manuscript is two pages shorter and now comprises 16 pages.

Additionally, we added figures illustrating the hypocenter uncertainty to the supplement.

With warm regards from Potsdam,

Marius Isken

Reviewer A

The authors have not satisfactorily addressed the comments raised by the reviewer. Many of the requested statistical analyses have been deemed "out of scope." The relationships between magnitude and PGA are said to be addressed in another study that is currently under review. If that study contains errors, this work may also be flawed and needs to be thoroughly described. Additionally, the length of the paper has not been reduced.

Based on the lack of engagement with the referee's comments and the inadequate revisions, I recommend that the paper is declined.

The relationship between magnitudes and peak ground motions (PGA/PGV/PGD) is now reviewed and published in another paper; please see:

Dahm, T., Kühn, D., Cesca, S., Isken, M., & Heimann, S. (2024). Earthquake Moment Magnitudes from Peak Ground Displacements and Synthetic Green's Functions. Seismica, 3(2). <https://doi.org/10.26443/seismica.v3i2.1205>

Therefore, we reference this paper but do not repeat the study's method development or testing results.

Motivated by your and other reviewer's suggestions, we have significantly reduced the length of the manuscript by two pages, shortened the text, and moved or revised figures to the supplement. We believe the manuscript is in an excellent stage and have considered the reviewer's constructive suggestions.

Concerning the statistical benchmarks and analysis, some clarifying words are needed. The machine-learning phase pickers for S and P wave direct arrivals are well established, described and tested in the literature. We have now further improved the references for this work. Our work does not develop ML pickers but focuses on associating first-arrival picks and detecting and localising seismic events by leveraging existing ML methods. The combination of established methods in this approach is novel. Consequently, we study the proposed method and its characteristics in our analysis but refrain from a detailed analysis of the phase pickers themselves. For such an analysis, we refer to the papers originally describing the phase pickers and later papers focussing on their analysis and benchmarking. We apologise if our short answer in the first revision caused a misunderstanding.

Reviewer B

The authors have addressed most of my comments in a satisfactory manner, implementing several improvements in the manuscript and supplementary materials. However, I find their response to the issue of localisation uncertainties somewhat lacking. While they have included horizontal uncertainty data for one dataset (the Eifel region) in the supplementary materials, they did not provide any information on vertical uncertainties or address the other datasets. I had expected a more systematic approach to this crucial aspect.

Given the importance of accurate localisation in the context of this study, I recommend including error distribution plots for each dataset analysed, as well as comparisons with existing catalogue localisations. These additions would significantly strengthen the manuscript and provide more comprehensive validation of the method.

While the current manuscript is of reasonable quality and demonstrates potential as a valuable contribution to the field, I believe that addressing the identified gaps would considerably enhance its robustness and impact.

Dear Reviewer,

Thank you for your time, appreciation, and constructive input to our work and manuscript. We now include more maps and statistical analyses displaying the location uncertainties in the supplementary information. We describe the procedure in subsection 2.5 and give examples of location uncertainties in the main manuscript in sections Results (Sec. 3) and Discussion (Sec. 4). Six additional figures and one table have been generated to display the uncertainties:

- Fig. S8: Event uncertainty map of events on Reykjanes Peninsula, Iceland, with no station corrections.
- Fig. S9: Event uncertainties with SSST correction terms.
- Fig. S10: Event uncertainties filtered to high-quality events with low uncertainties.
- Fig. S11: Horizontal and vertical uncertainties plotted against event semblance.
- Fig. S12: Probability distribution of horizontal/vertical uncertainties.
- Tab. S2: Event uncertainty statistics using different station corrections.
- Fig. S18: Map showing the horizontal uncertainties of events from the large-N network in the EVR, Germany.

Reviewer C

Thanks to the authors for considering the comments to improve the manuscript. My comments have been addressed, and I recommend publishing this work.

Dear Reviewer,

Thanks for your appreciation, time, and very constructive and thoughtful input in improving the manuscript.