RC2: 'Comment on egusphere-2026-3012', Anonymous Referee #2, 12 Jul 2026

In this manuscript, the authors propose the combined use of DBSCAN and PCA to identify fault planes and compute the maximum moment magnitude associated with them. Although the study addresses an interesting topic with relevant implications for seismic hazard assessment, in my opinion there are several weak points that should be addressed before publication.

Major concerns

Comments 1: First, I have some concerns about originality. The combined use of DBSCAN and PCA to illuminate faults has already been proposed in the literature: Jian and Wang (2022) successfully used the unsupervised algorithms to characterize the 2018–2022 Hualien earthquake sequence and validated planar geometries from PCA using focal mechanisms and the two-dimensional back-projection method; Piegari et al. (2024) iteratively applied DBSCAN and PCA, with support from OPTICS, to illuminate faults and their hierarchical segmentation.

In the present manuscript, differently from previous study, the authors propose using the Silhouette score to evaluate clustering quality. However, the Silhouette score is an internal validation index that measures how compact a cluster is and how well it is separated from the others. Therefore, if the spatial distribution of earthquakes results in asymmetric or non-spherical clusters, the Silhouette score may not be the optimal choice. The authors should therefore better highlight the novelty of their approach by showing the advantages of using the Silhouette score, especially since, in at least one case, they do not use it to make their cluster selection. In my opinion, the authors should consider using at least a couple of validation indices to strengthen their approach and present it as a robust alternative to existing methods in the literature.

Response 1: We appreciate the constructive comments. In DBSCAN approach, the Silhouette Score (SS) serves as the primary clustering validity index, accounting for both ε and *MinPts* parameters. Selecting the highest SS value generally yields the optimal clustering result; however, the number of clusters must also be considered to ensure the delineation of potential fault planes.

For instance, in the EQ2018 case (Figure 3a), the maximum SS value ($\varepsilon = 0.08$, *MinPts* = 11) produces only two clusters, grouping both inland and offshore seismic events together within the same cluster. By contrast, the second-highest SS value ($\varepsilon = 0.07$, *MinPts* = 10) increases the number of clusters to four, thereby enhancing the identification of potential fault planes.

In addition to SS, we will incorporate supplementary indices for comparative evaluation, including Density-Based Clustering Validation (DBCV), Davies–Bouldin Index (DBI), and Calinski–Harabasz Index (CHI). These results will be integrated into the revised manuscript to strengthen the robustness of the clustering assessment.

Comments 2: The second weak point is related to the estimation of the maximum seismic moment magnitude, Mw, associated with the rupture planes derived from PCA. The authors should report the formula used to calculate the length and width of the fault plane and clearly state the hypotheses and validity of the underlying assumptions. Since the maximum magnitude has important implications for hazard assessment, its computation must be rigorous and uncertainties should be quantified. Furthermore, since the PCA plane simplifies the rupture zone into a single planar surface, the discussion must explicitly acknowledge that actual faults possess intricate 3D geometries with segmented and branching structures. Such structural complexities can severely bias the estimation of the fault rupture area, which is a critical parameter in the accurate computation of Mw.

Response 2: In this study, the fault is idealized as a rectangular plane, whose orientation is determined using the leading principal components (PC1, PC2, and PC3). The spatial length and width of the plane are estimated from the distribution of clustered seismicity, effectively representing the best-fit plane to the earthquake locations. Wells and Coppersmith (1994) established empirical scaling laws linking earthquake magnitude to fault parameters such as length, width, and area. In this work, we adopt the magnitude–area scaling relationship to infer the maximum potential magnitude from the estimated fault area.

To strengthen methodological transparency, the revised manuscript will provide additional details on the computational procedure for plane fitting and the assumptions underlying the rectangular fault representation. This clarification will highlight how clustering-derived geometries are systematically translated into quantitative estimates of seismogenic potential. Accordingly, the discussion section will be updated to reflect the intricate 3D geometries of fault.

Comments 3: Another weak point is the lack of a quantitative comparison with studies analyzing the same seismicity. Although the authors devote a section to comparing their results with known fault systems, they fail to compare their findings with those of other studies, which are mentioned only as a list of references. A quantitative comparison of fault orientations and locations is therefore missing and should be added.

Response 3: We appreciate the reviewer's valuable comment. In response, we will incorporate an additional figure that integrates mapped faults, PCA-derived planes, clustering results, and relevant findings from previous studies. This figure will provide a more comprehensive visualization of the structural framework, enabling readers to directly compare our results with established tectonic interpretations. Corresponding revisions will also be made in the text to ensure consistency between the graphical presentation and the narrative discussion.

Minor comments

Comments 4: The choice to consider the same 30-day aftershock window to the two mainshocks, EQ2018 and EQ2024, despite their different moment magnitudes, should be motivated.

Response 4: We appreciate the reviewer's observation regarding the use of a uniform 30-day aftershock window for both EQ2018 and EQ2024, despite their different moment magnitudes. In the revised manuscript, we will clarify the motivation for this choice.

Comments 5: Fig. 1 is not clear because too many symbols are overlaid. The authors could consider splitting Fig. 1b into two figures, showing separately the seismicity related to the two large earthquakes.

Response 5: We will revise Figure 1b in accordance with the reviewer's comments.

Comments 6: Section 4.1 is redundant in many parts, with several lines that repeat the content of the legends of Fig. 3 and 4, which are unnecessary and should be removed.

Response 6: We will revise Figure 3 and Figure 4 in accordance with the reviewer's comments.

Comments 7: The use of transparency in the histograms in Fig. 4b is strongly recommended, otherwise it is impossible to observe changes in the distribution over time.

Response 7: We will revise Figure 4b in accordance with the reviewer's comments.

Comments 8: The acronym PCA is defined in the Introduction, and its definition is repeated at the beginning of Section 3, in Section 3.2, in Section 4.2, and in Section 5, resulting in unnecessary redundancy.

Response 8: We will revise words in accordance with the reviewer's comments.

Comments 9: The characteristic of each plane from PCA, not only in terms of strike and dip angles but also length and width, should be included in the text, and the use of tables is strongly suggested.

Response 9: We will add a table in accordance with the reviewer's comments.

Comments 10: Section 4.3 should be rewritten to include a quantitative comparison between the obtained results and those reported in the literature.

Response 10: We appreciate the valuable comment. In response, we will include an additional figure that integrates mapped faults, PCA-derived planes, clustering results, and focal mechanism solutions. Wherever possible, focal mechanism solutions will be displayed for each cluster, accompanied by explanatory text to ensure consistency between graphical and textual presentation.

This enhancement will provide a more comprehensive visualization of the structural framework, allowing readers to directly compare clustering-derived geometries with both mapped tectonic features and focal mechanism interpretations. By presenting these elements together, the revised manuscript will strengthen the interpretive link between statistical clustering, PCA-derived planes, and seismological observations, thereby improving the clarity and robustness of the analysis.

Comments 11: The Discussion and Conclusions sections are redundant and can be shortened and merged.

Response 11: We will update the text in the revised manuscript.