This paper represents a valuable contribution to the understanding of tsunamis generated by earthquakes. On the one hand, it provides a global database of tsunami numerical simulations for more than 5,000 seismic events that occurred between 1976 and 2023. On the other hand, it defines a criterion to be implemented in an artificial neuronal-network model aimed at identifying which events can be considered tsunamigenic. In my opinion, both results are original and fall under the scope of the NHESS journal.

Regarding the first of the results, to the best of my knowledge, this is the first database of this kind. As stated in the paper, it provides an openly available resource for tsunami hazard studies and model validation and provides the training dataset for the second target of the paper. In addition, it constitutes a useful dataset for Tsunami Warning Systems. From my point of view, both the event selection and simulation methodology are appropriate.

The second result of this paper, the tsunami-occurrence criterion, is presented as a fundamental parameter of the AI-based decision model introduced in Gallego Jiménez (2025). This model is implemented on the online operational platform IH-Tsusy to evaluate the tsunamigenic potential of ongoing earthquakes. Once IH-Tsusy receives the earthquake's focal parameters, including de CMT solution, the AI-model produces a binary classification, labelling the event as either 'tsunami' or 'non-tsunami'. If the event is classified as 'tsunami', IH-Tsusy triggers a numerical simulation within approximately 10 minutes. The tsunami-occurrence criterion is derived from the statistical analysis of the database obtained in the first part of the paper and validated against the NOAA tsunami catalogue.

In my opinion, this binary classification, although scientifically interesting, has a limited applicability in the operational procedures of a TWS. A TWS must determine, for each monitored coastal segment, whether that specific area will be impacted by a tsunami. In other words, a TWS needs to know not only whether an event is tsunamigenic, but also whether the resulting tsunami will affect the coasts under its responsibility, and precisely which points along those coasts. For this reason, within the IH-Tsusy framework, the TWS must wait for the outcome of the numerical simulation before issuing any warning message. Consequently, the binary classification is only used to decide whether a simulation should be run for a given event. In practice, it seems that a simulation could be launched for all events with magnitude greater or equal than 6,0 in any case. An exploration of the possibilities of upgrading the AI-model to provide more detailed information about the tsunami impact of an event may be worthwhile.

Regarding the statistical analysis performed to obtain the tsunami-occurrence criterion, I believe that a more detailed analysis of the entire solution space is required. The validation against the NOAA catalogue is useful and generally adequate.

Overall, the draft is well structured and clearly written, with an appropriate number and quality of figures and tables.

I provide some specific comments associated with the lines of the draft below.

Answers to Referee 1:

30: *Please review: 'WANG and LIU'. Suggested: 'Wang and Liu'.*

Thank you for pointing this out. This has been corrected in the revised manuscript.

Some of the most recent examples of devastating earthquake-generated tsunamis include the 2004 Indian Ocean tsunami (Synolakis and Bernard, 2006; Wang and Liu, 2007; Satake, 2014)

38*: I suggest 'are not always included' instead of 'are not included'. Sometimes they are included (Mw and focal Depth are usually included).*

We thank the reviewer for pointing this out. The manuscript has been revised accordingly.

These parameters —such as magnitude (M_w), focal depth, and distance to the coast— are not always included in public warning messages, but are used as part of the decision-making process

45:

- *IGN also uses ETA for their tsunami alerts (Section 2.2.2 in IGN, 2021). ETA appear in all IGN tsunami alerts.*

  We appreciate this comment. The text has been added in the table:
  Focal depth/ M_w / Coastal distance/ ETA

- *Roudil et al., 2013 does not appear in References section.*

  Thank you for pointing this out. Added in the references section:

  Roudil, P., Schindelé, F., Bossu, R., Alabrune, N., Arnoul, P., Duperray, P., Gailler, A., Guilbert, J., Hébert, H., and Loevenbruck, A.: Science of Tsunami Hazards Journal of Tsunami Society International Volume 32 Number 1 2013 The French Tsunami Warning Center for the Mediterranean and Northeast Atlantic: CENALT, 32, 1, 2013.

- *Should not be 'JMA, 2025' the reference for Japan?*

  We thank the reviewer for pointing this out. The reference has been corrected accordingly.

  (Japan Meteorological Agency, 2025)

- *Is 'U.S. Indian Ocean Tsunami Warning System, 2007' the correct reference for Chile? It does not appear in Reference section.*

  We agree with the reviewer. The reference has been corrected accordingly:

  (Servicio Hidrográfico y Oceanográfico de la Armada de Chile, 2023)

74: *Please review: 'to label an event as a tsunami'. Suggested: 'to label an event as tsunamigenic'.*

We thank the reviewer for pointing this out. The manuscript has been revised accordingly:

[…] defining a consistent criterion to label an event as tsunamigenic and, therefore, trigger an alert—particularly for small disturbances, where impacts are less evident.

83: *'Reuters, 2016' appears in References section as 'Reuters, 2017'.*

The full reference is this one:

Reuters: Chilean court accepts settlement in failed tsunami warning case, 2016.

It shouldn't appear a 2017 in References section regarding this reference

120*: Please review: 'to Sect. 2.1-2.6'. Suggested: 'to Sect. 2.2-2.6'.*

We acknowledge this oversight and have corrected it. The manuscript has been revised accordingly:

The numbered blocks in Fig. 1 correspond to Sect. 2.2–2.6

133: *Please review: 'to Sect. 2.1-2.6'. Suggested: 'to Sect. 2.2-2.6'.*

We thank the reviewer for pointing this out. The text has been corrected accordingly:

The numbering of the boxes corresponds to the subsections in Sect. 2 (2.2–2.6), where each step is described in detail.

138:

- *Please review: 'tsunamis catalogue'. Suggested: 'tsunami catalogue'.*

  We appreciate this comment. This has been corrected in the revised version:
  The NOAA tsunami catalogue provides a comprehensive

- *NOAA tsunami catalogue should be cited as: 'National Geophysical Data Center / World Data Service: NCEI/WDS Global Historical Tsunami Database. NOAA National Centers for Environmental Information. doi:10.7289/V5PN93H7 [access date]'*

  We thank the reviewer for pointing this out. This has been corrected in the revised version:

National Geophysical Data Center / World Data Service: NCEI/WDS Global Historical Tsunami Database. NOAA National Centers for Environmental Information. doi:10.7289/V5PN93H7 [accessed: 12 Dec 2024]

139*: Please review: '2000 BC'. Suggested: '2100 BC'.*

Thank you for pointing this out. The manuscript has been revised accordingly:

The NOAA tsunami catalogue (National Geophysical Data Center / World Data Service, 2024) provides a comprehensive listing of historical tsunami source events and wave run-ups worldwide, extending back to 2100 BC

***145**: Please review: ‘of which 424 seismic origin events’. Suggested: ‘of which 424 events of seismic origin’.*

We thank the reviewer for pointing this out. The text has been corrected accordingly:

The period considered in this study, from 1976 to 2023, includes 601 recorded tsunamis, of which 424 events of seismic origin were selected…

***151**: Could you elaborate on the most common reasons why the remaining 47 tsunamis, with a probable or definite M>=6 seismic origin, are not associated with the USGS earthquake catalogue? I would have expected to match all 424 records with the USGS catalogue.*

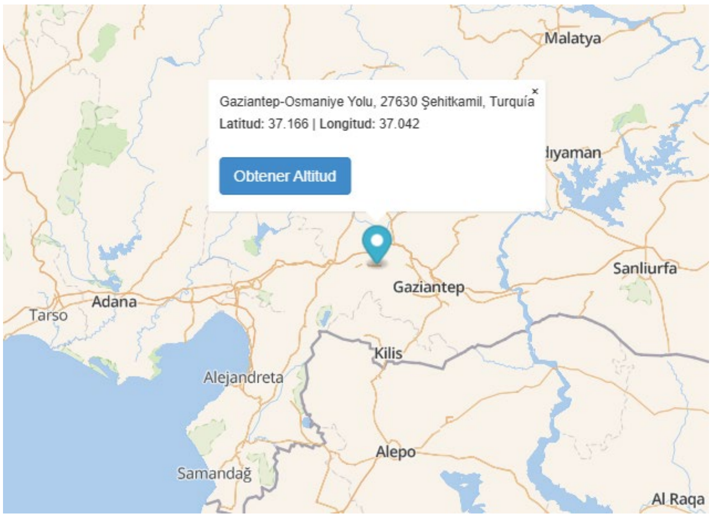
The authors thank the reviewer for this comment. The initial number of tsunami events satisfying the selection criteria (1976–2023, seismic origin with Mw≥6, and validity levels 1–4 in the NOAA catalogue) was 423. After applying the spatial (±3°) and temporal (±24 h) matching criteria between the NOAA tsunami catalogue and the USGS earthquake catalogue, 404 events were successfully associated with earthquakes in the USGS database.

Finally, events classified as *Very Doubtful Tsunamis* and *Questionable Tsunamis* in the NOAA catalogue were removed, resulting in the final set of 377 events used in this study.

The remaining unmatched events are mainly related to limitations in the available source information or differences between catalogues. The most common cases include:

- Earthquakes whose epicentres are located inland, so that the simplified rectangular rupture model used in this study does not intersect the ocean surface and therefore cannot generate a simulated tsunami.

Example: NOAA Tsunami: 6/2/2023 Turkey


Gaziantep-Osmaniye Yolu, 27630 Şehitkamil, Turquía
Latitud: 37.166 | Longitud: 37.042

- Events for which the necessary tectonic or focal-mechanism parameters required to compute the Okada source model are not available in the USGS database.
  Example:

https://earthquake.usgs.gov/earthquakes/eventpage/usp0001sa1/executive

170: *Please unify the notation in the whole text by using either 'Fig.' as in line 119 or 'Figure' as in line 170.*

We appreciate the reviewer's comment. The manuscript has been revised accordingly:

(119) The numbered blocks in Fig. 1 correspond

(170) nodal planes, and principal axes allowing for precise computation of seismic parameters and fault slip (Fig. 2)

171*: I do not understand the comments regarding the absence of M_0 in the early years of the GCMT catalogue. M_0 is part of the CMT solution, and it is available in https://www.globalcmt.org/CMTsearch.html for all records starting at 1976. Moreover, since Mw is computed directly from M_0, using Kanamori (1977) relation, I do not see practical difference between using M_0 or M_W to characterise seismic events, as they provide the same information.*

We agree with the reviewer and acknowledge the confusion in the manuscript.

Although the moment tensor data was available in the GlobalCMT catalogue for events since 1976 (Harvard CMT then), the data incorporated to the USGS database only reflected the orientation of the nodal planes of the double-couple and the earthquake magnitude for events between 1976 and 1989. See for example the Borah Peak Earthquake of 1983: https://earthquake.usgs.gov/earthquakes/eventpage/usp0001zbv/focal-mechanism

As Tsusy incorporates the data from the USGS database due to practical reasons, our working catalogue inherits its limitations. Nevertheless, as the reviewer mentions, using the Kanamori relation to obtain the Mo from the M_W is practically the same.

We have reworded that section:

From 1976 to 1989, events were described using focal-mechanism data originally in the GCMT catalogue (Global Centroid Moment Tensor) (Dziewonski et al., 1981; Ekström et al., 2012). Although the full moment tensor was available from the original source, the data incorporated in the USGS catalogue includes only the orientation of the nodal planes and rake of slip, but do not include the seismic moment (Mo) or the tensor components. In these events the scalar moment has been computed from the magnitude using the Kanamori (1977) equation.

Between 1990 and 1997, the data included in the USGS catalogue incorporated both nodal planes and moment tensors, the latter providing Mo directly for slip calculations.

The final period, spanning from 1997 to 2023, encompasses the most comprehensive information available for each event, including the W-phase Moment Tensor (M_{WW}), nodal planes, and principal axes (Figure 2).

188: *Please review: 'focal mechanisms data and (2) moment tensors data'. Suggested: 'focal-mechanism data and (2) moment-tensor data'.*

We thank the reviewer for pointing this out. The text has been corrected accordingly:

As mentioned, USGS database consists of two types of data: focal-mechanism data and (2) moment-tensor data

196: *Please indicate in the strike-slip ruptures which is the criterion used in this study to select the nodal plane as the rupture plane. Has it been selected manually considered the geology of the area where it has occurred?*

In the case of strike-slip ruptures, as the running of the code needs to be automatic, there is no chance to select manually the most appropriate nodal plane from the geological characteristics of the epicentral zone. In these cases the nodal plane with the greatest dip is the used as it should be the most compatible mechanically.

198: *Please explain the effects of selecting the wrong nodal plane.*

We added details for the previous two comments of the reviewer on lines 196-199:

In the case of strike-slip ruptures, with near-vertical nodal planes, there is no physical criterion that can be used a priori without knowing the geology of the area where it has occurred. The algorithm chooses the nodal plane with the greatest dip, but the selected nodal plane does not necessarily correspond to the earthquake rupture plane. The vertical deformation in strike slip events tend to be located at the tips of the rupture plane; consequently, although the amount of vertical deformation is limited for this kind of ruptures, sensible differences between the tsunamis generated by both nodal planes can arise, specially in the near field.

221-224: *I do not follow this reasoning. Why 'location and depth parameters were adjusted to ensure the entire source remained on land'? There are well-known cases of shallow earthquakes with onshore epicenters that generated tsunamis. In my view all offshore epicentres must be considered, as well as onshore epicentres whose simplified rectangular rupture surfaces extend offshore.*

We acknowledge that the wording of the paragraph may be confusing. We have reworded it to better explain the idea:

Following a conservative approach, an event was classified as a potential tsunamigenic source if any part of this rectangle intersects with the sea. In shallow events the simplified rectangular geometry obtained from the dimensions of the empirical relations may extend part of the rupture above the earth surface taking into account the original hipocentral depth. In such cases, the depth parameters were adjusted to ensure the entire source remained into the crust.

254-255: *This sentence is confusing for me. Why are only simulations of the historical tsunami events (377 events) mentioned? In line 269, it is clearly stated that simulations were conducted for the 5,315 seismic events described in section 2.3.*

The authors thank the reviewer for pointing out this ambiguity. The reference to the section was incorrect in the original manuscript. The simulations were performed for the complete set of 5,315 seismic events described in Sect. 2.3, while the subset of 377 events corresponds to earthquakes matched with the NOAA tsunami catalogue and is used for validation purposes. The manuscript has been revised to clarify this distinction.

The process begins with the selection of seismic sources as input data, which is crucial for accurately predicting tsunami generation and propagation. The seismic events included in the dataset described in Sect. 2. 3 have been used to simulate all historical tsunami events.

292: *TSUSY Database does not have a hyperlink in the footnote.*

The authors thank the reviewer for noting this issue. The link has now been corrected and is fully functional:

Accessible at: IH-TSUSY Tsunamis&Earthquake Data

298-299: *I do not fully agree with the statement that 'Operational tsunami warning systems ultimately require a binary decision: for a given earthquake, should the event be considered as tsunamigenic or not'. In practice, a TWS must determine, for each monitored coastal segment, whether that specific area is going to be impacted by a tsunami or not.*

We agree with the reviewer that operational tsunami warning systems ultimately assess tsunami impact at specific coastal segments rather than making a purely global binary decision. In this study, the binary classification refers to the tsunamigenic potential of the earthquake source itself, which constitutes a preliminary step before local impact assessments. This first-level classification allows the system to rapidly decide whether a full tsunami simulation should be launched, which is computationally more demanding. The manuscript has been revised to clarify this distinction.

Although operational tsunami warning systems ultimately evaluate tsunami impact at specific coastal segments, an initial step is to determine whether the earthquake source is capable of generating a tsunami. In this study, this first-level decision is represented as a binary classification of the earthquake as tsunamigenic or non-tsunamigenic.

369-413: *I consider these lines dispensable, as Figure 7 is self-explanatory. The summary provided in lines 414-417 should be sufficient.*

Although we partially agree with the reviewer, and figure 7 could be considered self-explanatory, we believe that the main characteristics of the different distributions should be mentioned. If the length of the article were to be reduced, it would be understandable that we would be asked to revise it.

452: *Please review: 'within the analysed historical dataset'. Suggested: 'within the analysed dataset of simulations'.*

We thank the reviewer for pointing this out. The text has been corrected accordingly:

suggesting that wave heights exceeding 2 m are extremely rare within the analysed dataset of simulations.

487: *The choice of threshold values of 0.1 m and 0.4 m appear somewhat arbitrary. A quantitative justification would strengthen the rationale for adopting these particular values.*

We thank the reviewer for this comment. In the revised manuscript, the methodology used to determine the tsunami-occurrence threshold has been substantially updated following the reviewer's suggestion. Instead of relying on a predefined intermediate range to derive the threshold, we now perform a quantitative evaluation of candidate thresholds by comparing the simulated classifications with the tsunami records reported in the NOAA catalogue.

The manuscript has been revised accordingly (Sect. 2.6 and 3.3).

510: *A commonly used benchmark is a wave amplitude of 0.2 m, not a run up of 0.2 m.*

We thank the reviewer for pointing this out. However, following the revision of the methodology for threshold selection, the section where this sentence appeared has been removed from the manuscript, and therefore this specific issue no longer applies.

513: *'Japan Meteorological Agency, 2023' appears in References section as 'Japan Meteorological Agency, 2025'.*

We thank the reviewer for this comment. However, following the revision of the methodology for threshold selection, the section where this sentence appeared has been removed from the manuscript, and therefore this specific issue no longer applies.

516: *Please clarify what 'the value obtained through the literature review' refers to. Is it equivalent to 'The value obtained from the NOAA catalogue'? However, line 150 states that the number of tsunamis extracted from the NOAA catalogue is 377, which contrasts with the number 340 indicated in line 516. The comparison of the number of events labelled as 'tsunami' and the number of actual tsunami occurrences appears to provide limited insight.*

We thank the reviewer for pointing this out. However, following the revision of the methodology for threshold selection, the section where this sentence appeared has been removed from the manuscript, and therefore this specific issue no longer applies.

520: *Why 'this result aligns more closely with the NOAA catalogue'?*

The revised analysis now evaluates the performance of different thresholds using classification metrics derived from the confusion matrix. The threshold of 0.15 m corresponds to the value that maximizes the F1-score, which balances precision (minimising false positives) and recall (minimising false negatives). In this sense, the 0.15 m threshold provides the best agreement with the NOAA catalogue when considering both types of classification error.

522: *I feel that the choice of 0.15 m over 0.2 m or any other value is not sufficiently supported. Beyond reporting the number of events labelled as 'tsunami', it would also be useful to compare, for each threshold value, (i) the number of events labelled as 'tsunami' that correspond to a NOAA catalogue record and (ii) the number of events labelled as 'nontsunami' that are associated with* *a NOAA catalogue record. This would provide a more robust indication of the adequacy of the selected threshold.*

We thank the reviewer for this valuable suggestion. Following this recommendation, we have revised the methodology used to determine the tsunami-occurrence threshold in order to provide a more robust and quantitative justification.

The manuscript has been revised accordingly (Sect. 2.6 and 3.3).

525*: I would have expected that combining the 99.98th-percentile value with the number of grid cells exceeding the threshold would provide a better estimate than using only the value of the 99.98th-percentile. Did you attempt to develop a threshold based on such a combination?*

The authors explored the potential use of a combined metric including both the 99.98th percentile value and the number of grid cells exceeding the threshold. However, preliminary tests indicated that the percentile value alone provided a sufficiently robust indicator of tsunami occurrence, while the additional metric mainly helped identify isolated numerical artefacts rather than improving the classification performance. For simplicity and interpretability, the final criterion was therefore based solely on the percentile value.

***553-554:** Why not provide the exact rounded percentages (63% and 37%).*

We agree with the reviewer. The text has been corrected accordingly:

In relative terms, about 63 % of the NOAA events are also labelled as tsunamis when applying the proposed threshold. The remaining 37 % correspond to earthquakes that NOAA reports as tsunamis but that do not exceed the 0.15 m threshold or do not meet the spatial consistency condition

***555:** It would also be informative to mention that 55 % of the TSUSY events labelled as 'tsunami' correspond NOAA events, while the remaining 45% are not included in the NOAA catalogue, even though an explanation is provided in section 4.2.*

We appreciate this insightful comment. The manuscript has been corrected accordingly:

In relative terms, about 63 % of the NOAA events are also labelled as tsunamis when applying the proposed threshold. The remaining 37 % correspond to earthquakes that NOAA reports as tsunamis but that do not exceed the 0.15 m threshold or do not meet the spatial consistency condition. This mismatch is concentrated in magnitude ranges and source configurations where the tsunami potential is intrinsically uncertain. Conversely, about 55 % of the events labelled as tsunamis in the TSUSY Database correspond to tsunamis reported in the NOAA catalogue, while the remaining 45 % are not included in the NOAA database. These cases are discussed in Sect. 4.2.

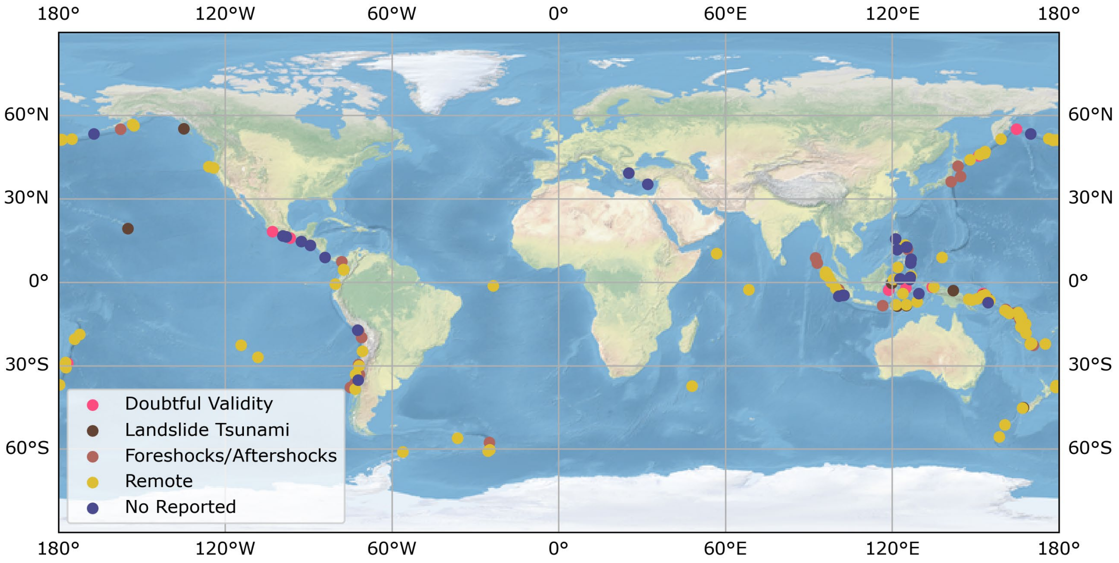
***588**: It would also be informative to indicate whether there are high-impact tsunamis that have been labelled as 'non-tsunami' or to state explicitly that no such cases exist.*

We appreciate the reviewer's suggestion. We have verified this aspect and confirm that no high-impact tsunamis are classified as "non-tsunami" by the proposed criterion. This clarification has been added to the revised manuscript.

Taken together, these results confirm that the 0.15 m threshold is consistent with current operational practice. It reproduces nearly all large tsunamis ($M_w \geq 7$) in the NOAA catalogue, while strongly reducing the number of low-magnitude or deep events labelled as tsunamis. Importantly, no high-impact tsunami events in the NOAA catalogue are classified as non-tsunami by the proposed threshold. In the following subsection we move from the shared events to those that are labelled as tsunamis only in the TSUSY Database, examining why they are absent from the NOAA catalogue.

***623:** Please review the word 'Replica' in Figure 14 legend. Suggested: 'Aftershocks/Foreshocks'.*

We thank the reviewer for this comment. The figure has been corrected accordingly:



629: *I do not follow this reasoning: ‘Landslide-related and doubtful events are scattered along active margins, reflecting their dependence on local geological conditions and catalogue uncertainty’. Why should these types of events be located along active margins?*

The authors thank the reviewer for this observation. After reconsidering the paragraph, we agree that the reasoning was not sufficiently supported by the analysis presented. The sentence has therefore been removed from the revised manuscript.

824: *Tsunami Inundation Database Portal, 2024, is not in alphabetical order.*

We appreciate the reviewer highlighting this issue. The reference list has been corrected accordingly.

835-836: *Please review the letter case.*

We thank the reviewer for pointing this out. The reference has been corrected accordingly:

Wang, X. and Liu, P. L.-F.: Numerical simulations of the 2004 Indian Ocean tsunamis-coastal effects, Journal of Earthquake and Tsunami, 01, 273–297, https://doi.org/10.1142/S179343110700016X, 2007.