Reviewer #1: Francesco Lezzi

The paper presents a new seismotectonic methodology for South-East France, the most seismically active region in metropolitan France. The study is based on the disaggregation of seismotectonic behaviour into three main components: the crustal/geological component, the seismological component, and the geodetic component. These three individual models are then integrated to produce a unified model that incorporates all the different datasets.

The manuscript has excellent scientific significance and overall quality, as well as a clear presentation of data, results, and conclusions. The amount of data used is very large and reflects the considerable effort carried out by the authors. The work represents an improvement over current approaches for mitigating seismic hazard in a critical region of France and in neighbouring areas such as north-west Italy, thanks to the integration of more recent datasets and the compilation of information that had not previously been considered.

In its current form, the manuscript would benefit from some clarifications, mainly listed below. I recommend publication once these points have been addressed:

-Clarification of the criteria adopted to build the unified model should be provided, and included also in the Methods section. It is not fully clear to me if the zone limit with the highest confidence level was selected to define the geometry of the unified zone. In general, I found it difficult to understand the role of the confidence levels associated with the zone boundaries, and how these were used later on. Perhaps more clarification on this matter should be provided.

Thank you, Pr. Lezzi, for the recognition of this hard work and for your constructive comments.

As required, section *2. Methodology* better explains how the Unified model is obtained:

To enhance the robustness of our zoning approach, we develop a confidence-based classification for zone boundaries which reflects data heterogeneity among adjacent zones, thereby allowing for an objective assessment of zone limit delineation. For each SZM we compute average values for the given set of features for each zone, giving contribution weights for the considered datasets (Table 1). Contribution weights are assigned after relative confidence on the considered data, and minor differences in final feature values are constated from varying the contribution weights. Large feature differences correspond to higher confidence limits, indicating that the two neighboring zones exhibit distinct seismotectonic behavior. A low confidence level indicates that the boundary is less robust than initially assessed, and that the adjacent zones potentially present similar seismotectonic behavior. The objective of this classification (CLZL = 1, 2, 3 for high, intermediate, and low, respectively) is to provide guidance on the order in which zone limits could be reconsidered for hazard modeling purposes.

At last, we develop a fourth model, the Unified Seismotectonic Zonation Model (U-SZM), which builds upon the three independent SZMs (St-SZM, Se-SZM, De-SZM). As a result, U-SZM integrates all three seismotectonic domains (crustal structure, observed seismicity, surface deformation) and therefore includes all the features listed in this work. To do this, we superpose St-SZM, Se-SZM, De-SZM and examine zone limits of significant confidence level (high and intermediate) and limits that appear consistent across models, which guide the delineation of zone boundaries for the U-SZM. This strategy avoids producing one model from the processing of a large variety of data at once, instead, it relies on spatial limits already determined and on their uncertainty.

- Some information should be provided on how the qualitative analysis of features of the structural model were quantified to calculate the normalized sum of differences.

As a matter of fact, qualitative analysis has been replaced in the revised version of the paper for quantitative analysis in order to obtain a numerical feature value to be compared among neighboring zones (Table 1).

- On a similar note, fracture numbers are defined as low, mean, high. What are these adjectives referring to? Which sources were used?

The analysis of feature *Faults* from the Structural model is revisited and presented as follows:

We guide the zone delineation after fault systems, alongside a further analysis on spatial variations in fault density and azimuth tendency. Moreover, we take into account the neotectonic index attributed to faults after the age of their last reported activity, to better distinguish regions presenting potentially active faults (Fig. 3). Because only one dataset is considered to characterize this feature no contribution weights are assigned (Table 1).

The fault density remains divided into low, mean and high. It is a relative evaluation in respect to the amount of surface mapped faults in a region (Figure 10c)

- The crustal model was built adopting one velocity, yet it is mentioned that two velocities for the Adriatic and European Moho are needed. Some justification on why you use only one velocity should be provided.

Indeed, this information is misleading, as a matter of fact no tomographic model for the region combining both velocities is currently accessible. Therefore, we only use one, yet acknowledging that the Moho limit is interpreted using the isovelocity required for European crust. Consequently, we correct the misleading information and present the feature analysis as follows:

To characterize this feature we use a Moho depth proxy from a recent seismic tomography study (Nouibat et al., 2022, using the isovelocity 4.2 km s^{-1}) and a digital elevation model of continental Europe (Hengl et al., 2022; Fig. 4). This tomographic study is generally in agreement with other recent studies of the Alpine Moho depth (Lu et al., 2018, Braszus et al., 2025). Because only one dataset is considered to characterize this feature no contribution weights are assigned (Table 1).

- I did not find an explanation of how fine and coarse analysis are build. In some areas, multiple signals of one type appear to be present, with variable predominance, yet in the coarse analysis a different dominant color is shown.

In the case of the seismicity-based model each feature is analyzed using both fine and coarse grids. The analysis procedure is applied equivalently to each grid. Because the feature – seismic flux, rupture mechanism, and seismogenic depth- classification is considered equal to each grid the colors may change spatially, indicating a distinct sample of seismic events considered within each cell.

We examine seismic events using two grids with hexagonal cells of about 11 km and 55 km (0.1º and 0.5º in EPSG:4326 - WGS 84, respectively) of diameter, allowing us to decipher data patterns at both fine and coarse scale, and account for the heterogeneous location uncertainties of instrumental and historical data.

For the seismic flux, which is an annual rate of seismic moment per square km, the analysis within a 11 km wide hexagonal grid cells will be more precise and indicate smaller patterns. While the 55 km diameter hexagonal grid cells capture more regions of high seismic flux because more events are considered within each cell.

Idem for the rupture mechanism feature where the same procedure is applied to both grid cell sizes, and distinct results will appear from the seismic sample considered within each cell. The moment magnitude of each focal mechanism presents an impact in the final faulting style considered for the cell.

We use moment magnitude, dip, rake and strike values to compute the summed seismic moment tensor using the Kostrov (1974) approach (see also Sue et al., 2007b). We subsequently derive the eigenvalues of the strain-rate tensor and the T, P, and B axes representative of each grid cell. We at last determine the faulting style for each cell using the Fröhlich (1992) classification for both fine and coarse grids (Fig. 6b, 6c).

The seismogenic depth feature is also vulnerable to the seismic sample falling within each cell, therefore the size of the grid cell presents an impact in the final feature analysis. Moreover, in this case, we select the threshold of at least 10 seismic events falling within each cell in order to compute the D90, therefore, the coarse grid presents higher chances to propose D90 values for a larger region.

As for the case of the Deformation-based model, fine and coarse grids are applied depending on the density and resolution of each dataset. The horizontal deformation amplitude and mode features use two GNSS strain-rate solutions and apply different grid size to each:

To evaluate the spatial variation of horizontal strain-rate, we examine two different GNSS strain-rate solutions (GNSS s1: Piña-Valdés et al., 2022; GNSS s2: Lantmäteriet, 2023; Table 1, Fig. 8a, 8b). The first solution uses an interpolation method that captures small wave-length, large amplitude strain variations, but may also accentuate artefacts. The latter employs a smoother, lower-resolution interpolation method, revealing coarser spatial variations yet smaller strain-rate values, as high peaks are attenuated. These contrasting results reflect the impact of methodological choices. Contribution weights are attributed to each dataset after the corresponding confidence assigned after expert judgement (Table 1). To best represent each solution, we map the strain-rate amplitude in the fine and coarse grids, respectively for the high and low-resolution datasets.

In the case of the vertical displacement feature only the coarse grid is applied, as the spatial distribution of GNSS stations is already representative of a fine grid analysis. Therefore, only the coarse grid presents an added value for spatial pattern recognition.

- To build the seismogenic thickness, different sources with different uncertainties are used and kept distinct. How were the overlapping zones between the different models handled?

Indeed, three instrumental seismic catalogs are used to assess this feature because no unique catalog covers the entire region with enough precision. For this reason, we incorporate the three most reliable seismic records in terms of hypocentral location within the region. Overlapping regions across the extent of the three catalogs exist. In these cases, contribution weights of each dataset are applied, accounting for full contribution when only one dataset is present, and for combined contribution weights when multiple datasets are present.

The assessment is presented as follows in the paper:

The seismogenic depth is conditioned by crustal rheology, geodynamic processes and the location of structures accommodating the deformation (Zielke et al., 2020). We obtain this value from the distribution of hypocenter depths. A good resolution of hypocenter location is required, thus only instrumental catalogs are used. We consider grid cells containing at least 10 earthquakes, and compute the 90% depth quantile (D90) for the cell. We distinguish five seismogenic depth levels which allow to identify patterns for this feature and are representative of the uncertainty range for hypocenter location; < 5, 5 – 10, 10 – 15, 15 – 20 and > 20 (km).

Differences in catalog duration and depth uncertainty affect the spatial density of earthquakes at depth and, consequently, the estimated D90. We therefore constrain D90 using three seismic catalogs, each providing the most precise event locations for different parts of the study area: SISMALP (1987–2024; Langlais et al., 2024), BCSF-Rénass (1962–2021; BCSF-Rénass, 2022), and ISIDe (1985–2023; ISIDe Working Group, 2007). There where earthquake catalogs overlap contribution weights are applied for feature characterization (Table 1), the assigned weights correspond to the confidence granted to the precision of hypocenter location. D90 is assessed from each catalog using both fine and coarse grids (Fig. 7).

- The ranges of confidence levels for the three models differ considerably. How does this impact the building of the unified model? Two of them appear rather uneven; does this affect the unified model?

Surely, each model relies on distinct features, observables, and datasets, and the three models are therefore not directly comparable at the level of individual features. Consequently, the quantitative assessment of feature differences between neighbouring zones necessarily varies across models. Nevertheless, each model incorporates three features, which are assigned equal weights in the normalized sum of feature differences across zones. Thus, each analysed seismotectonic feature contributes equally to $\sum \Delta F_i$ within its respective model.

We acknowledge that applying identical thresholds across the three models (i.e., $\sum \Delta Fi < 0.15$, $0.15 \leq \sum \Delta Fi < 0.4$, and $0.4 \leq \sum \Delta Fi \leq 1$) would provide a more consistent basis for comparing confidence levels between models. However, the seismicity-based SZM generally exhibits smaller feature differences between neighbouring zones. Applying these common thresholds would therefore classify the majority of its zone boundaries as high confidence, causing the resulting unified SZM to be predominantly influenced by the seismicity-based model. Adjusting the thresholds to account for the $\sum \Delta F_i$ of each model instead aims to achieve a more balanced contribution of all three models to the final unified SZM.

Other minor comments are in the attached file:

1. The present-day geodynamics and seismotectonic framework are a complex and active topic of debate (e.g. Sternai et al., 2019; Mathey et al., 2021; Grosset et al., 2023), contrasted among the high Alpine belt -extension and trans-tension- and its peripheral basins -strike-slip and trans-pression- (e.g., Sue et al., 1999, 2007a; Delacou et al., 2004, 2005; Mathey et al., 2021) confirmed by GNSS surveys (Walpersdorf et al., 2015, 2018).

This period is quite difficult to follow, I suggest to simplify it

Paragraph changed to:
The present-day geodynamics and seismotectonic framework are an active topic of debate (e.g. Sternai et al., 2019; Mathey et al., 2021; Grosset et al., 2023). The high Alpine belt presents extensive and

trans-tensive focal mechanisms, contrasted against strike-slip and trans-pression mechanisms in the peripheral basins (Sue et al., 1999, 2007a; Delacou et al., 2004, 2005; Mathey et al., 2021). Both seismotectonic behaviors are consistent with GNSS surveys (Walpersdorf et al., 2015, 2018).

2. This framework, alongside the uneven distribution of geophysical monitoring efforts (Jenatton et al., 2007; Walpersdorf et al., 2015; Mathey et al., 2020; Guéguen et al., 2022; Langlais et al., 2024), is insufficient to confidently identify all active faults and determine associated seismic rates, in comparison to more seismically active contexts.

At what kind of geophysical data are you referring?

Is there a specific reason for the uneven distribution of monitoring efforts?

Seismic and geodesic networks.
Big monitoring efforts are placed along the western Alps, or temporary networks are placed for swarm detection. Moreover, one big issue here is the heterogeneity of the data, network density and recording periods due to cross-nation nature of the region, comprising also Italy and Switzerland.

Paragraph changed to:
This framework is insufficient to confidently identify all active faults and determine associated seismic rates, in comparison to more seismically active contexts. Moreover, geophysical data, including seismic and geodesic networks and records, present uneven and heterogeneous spatial and temporal distributions (Jenatton et al., 2007; Walpersdorf et al., 2015; Mathey et al., 2020; Guéguen et al., 2022; Langlais et al., 2024), enhanced by differing study purposes and transborder regions.

3. The current regulatory seismic zoning in France, used in building codes, is based on seismic hazard maps obtained from applying the Probabilistic Seismic Hazard Assessment (PSHA) method (seminal articles by Cornell, 1968; McGuire, 1976; hazard calculations for France by Martin et al., 2002). These hazard calculations produced over 20 years from now used the seismotectonic zones from the EPAS model (Autran et al., 1998). Several SZM for France have been produced since, both by the private sector and by state operators (Terrier et al., 2000; Martin et al., 2002; Baize et al., 2013; Le Dortz et al., 2019). They assess and incorporate mainly structural, seismotectonic, and seismic data. Hence, other geophysical data, such as geodetic observations, have not been widely exploited in this purpose previously.

As above, what are the geophysical data available? Only geodetic observations? Are the geological data better distributed?

GNSS and InSAR surveys were not exploited because they were either not available or not reliable enough due to short temporal recordings. Here we emphasize in the fact that we are innovating seismotectonic zonation models with the incorporation of emerging geophysical data that is becoming more reliable with time. Geological maps are produced at the scale of nations and therefore present a homogeneous distribution within countries, yet studies on active tectonics, geomorphology and paleoseismology are not covered homogeneously.

Paragraph changed to:

They assess and incorporate mainly structural, seismotectonic, and seismic data. Hence, other geophysical data, including GNSS and InSAR surveys, have not been widely exploited in this purpose previously due to their emerging applicability. Only recently do these observations allow to further interpret the crustal movements and deformation, thanks to longer observation periods and improved data interpretation.

4. The deformation model reflects strain accumulation by analyzing crustal deformation (horizontal deformation amplitude and mode, and vertical displacement) inferred from geodetic interpretations (GNSS acquisitions ~25 y, InSAR acquisitions ~5 y).

Are these episodic or continuous records?

Continuous.

Paragraph changed to:
The deformation model reflects strain accumulation by analyzing crustal deformation (horizontal deformation amplitude and mode, and vertical displacement) inferred from continuous geodetic interpretations (GNSS acquisitions ~25 y, InSAR acquisitions ~5 y).

5. We then evaluate the difference for the three key features among neighboring zones in order to attribute confidence levels to zone limits (CLZL). These levels reflect high confidence (CLZL = 1) when the combination of differences is high, intermediate confidence (CLZL = 2) when it's average, and low (CLZL = 3) when the differences are small.

Perhaps better to elaborate why the large difference reflects high confidence?

How did you use this information then? I do not clearly understand the point to this. If the confidence levels are high, it strenghtens your zoning, if it is low then it tells you that something is off?

You should describe here also your unified zoning model, it is in the results

Differences in feature values among adjacent zones provide a basis for defining confidence levels for zone limits (CLZL). Large feature differences correspond to higher confidence limits, indicating that the two neighboring zones exhibit distinct seismotectonic behavior and potential. A low confidence level indicates that the boundary is less robust than initially assessed, and that the adjacent zones potentially present similar seismotectonic behavior. The objective of this classification (CLZL = 1, 2, 3 for high, intermediate and low) is to provide guidance on the order in which zone limits could be reconsidered for hazard modelling purposes.

6. I think you should explain what you mean with qualitative analysis in Table 1. What data you looked at? which criteria did you use?

This table has been changed as some of the structural data has been replaced, consequently, no qualitative analysis is applied.

Model	Feature		Dataset	References	Contribution weight
	F1	Geology	Geological map	Chantraine et al., 2003	0.6

St-SZM			3D Geological models	Bienveignant et al., 2024 GeoMol Project Team, 2019	0.4
	F2	Faults	SEFF database	Mowbray et al., submitted	1
	F3	Crustal thickness	Seismic tomography model	Nouibat et al., 2022	1
Se-SZM	F1	Seismic flux	FCAT – BCSF catalogs	Manchuel et al., 2018 BCSF-Rénass, 2022	0.8
			ESHM20 catalog	Danciu et al., 2021	0.2
	F2	Rupture mechanism	Focal mechanisms	Mathey et al., 2021 Mazzotti et al., 2021	1
	F3	Seismogenic depth	SISMALP catalog	Langlais et al., 2024	0.5
			BCSF Rénass catalog	BCSF-Rénass, 2022	0.1
			ISIDe catalog	ISIDe Working Group, 2007	0.4
De-SZM	F1	Horizontal deformation amplitude	GNSS s1	Piña-Valdés et al., 2022	0.8
			GNSS s 2	Lantmäteriet, 2023	0.2
	F2	Horizontal deformation style	GNSS s 1	Piña-Valdés et al., 2022	0.8
			GNSS s 2	Lantmäteriet, 2023	0.2
	F3	Vertical displacement	GNSS v 1	Piña-Valdés et al., 2022	0.3
			GNSS v 2	Sternai et al., 2019	0.3
			InSAR solution	Mathey et al., 2022	0.3

7. In order to integrate the current state of knowledge on faults as locus where future earthquakes may occur, we take into account the following observables: fault azimuth tendency, amount of fracture per region, estimated seismogenic potential and main faults considered for a fault-based seismic source model.

I saw in appendix that fracture is classified as high, mean, low. What does this refer to? what is high, what is low?

Here, instead of amount of fracture, the term should be fault population, in order to speak about the density of mapped structures in a region or another.

Paragraph changed to:
In order to integrate the current state of knowledge on faults as locus where future earthquakes may occur, we analyse structures from the "South East France Faults" database (Mowbray et al., submitted). We guide the zone delineation after fault systems, alongside a further analysis on spatial variations in fault density and azimuth tendency.

*8. In order to integrate the current state of knowledge on faults as locus where future earthquakes may occur, we take into account the following observables: fault azimuth tendency, amount of fracture per region, estimated seismogenic potential and main faults considered for a fault-based seismic source model. We define homogenous ensembles assessing these four observables from the structural standpoint using SEFPAF database (South-East France Potentially Active Faults, Mowbray et al., 2025, Fig. 3a) and its associated selection of faults for a fault-based source model (Fig. 3b). The **latter** presents idealized fault geometries and gives composite seismogenic sources (Basili et al., 2008).*

Usually these information are not reported on geological maps, nor in maps of active faults. What is the source?

You should explain what is the seismogenic potential index and how it is calculated. It is likely all defined in Mowbray et al 2025, but you should say something here.

I see that faults with Seismogenic Potential Index between 20-40 were not included in b), yet I see some with index 0-20 being included in b) (for instance, Li). You should explain the criteria adopted for defining the fault-based source model.

This section has completely changed as Mowbray et al., 2025 also changed. We now assess faults after fault systems and spatial patterns on fault density and azimuth tendency. We no longer mention the seismogenic potential nor the fault-based model.

9. Crustal thickness may provide insight on maximum expected depth for large earthquakes (Spooner et al., 2019). To characterize this feature we use a Moho depth proxy from a recent seismic tomography study (Nouibat et al., 2022 after Nouibat 2024, using the isovelocity 4.2 km s^{-1}) and a digital elevation model of continental Europe (Hengl et al., 2022) in order to obtain the crust thickness (Fig. 4). This tomographic study is generally in agreement with other recent studies of the Alpine Moho depth (Lu et al., 2018, Braszus et al., 2025). However, the isovelocity criterion differs between Moho domains - the Adriatic Moho along the Ivrea mantle body (see Fig. C1 for geographical reference) requires a Vs = 3.8 km s^{-1} while the European Moho, a Vs = 4.2 km s^{-1} -, therefore, a fully three-dimensional model on the crust-mantle boundary along the Alpine range would ideally be required.

A 2022 paper after a 2024 paper? Sounds odd

Sorry, I do not understand this passage very well.

You adopted a isovelocity of 4.2 km/s based on Nouibat et al. Then you say that the different moho domains require two different velocities.
So why did you decide on using only one? could you not adapt your model with the two different velocities?

This was a mistake. I only cite Nouibat et al., 2022 now because it is a published paper, while the other was the PhD thesis with the final results. I no longer mention the distinct Moho domains and isovelocities required, as it is out of the scope of this study.

10. Figure 5: Seismic data used to characterize F1 (seismic flux) of the seismicity-based SZM. A, B) Seismic records showing events falling within each catalog completeness range (A: FCAT (1356 – 1961) + BCSF Rénass (1962 – 2021), Mw > 2; B: ESHM20 Unified catalog (1356 - 2014), Mw > 3.5); C), D) seismic flux computed on A) and B) respectively, within the fine grid; E), F) seismic flux computed on A) and B) respectively, within the coarse grid; C) to F) are superposed with the resulting zone limits of the Se-SZM.

How is the coarse grid defined? I did not find mention of this in the text

As above, it is not clear how you move from the fine analysis to the coarse one. I assume you make a buffer area and collect the most representative datum within it.

But here, I see area with mulitple blue points in the fine analysis turning green in the coarse analysis. How does this happen? I mean this for instance in the top-right corner of the figure and slightly below.

For both fine and coarse analysis, the only distinction is the size of the cells of the grids (0.1º or 0.5º diameter). The same analysis procedure is done in both cases, from the raw data. It is therefore not a conversion from the fine grid to the coarse grid. They are independent analysis which represent different scales of characterization, allowing for seismic event location uncertainties, as well as identifying different scale spatial patterns.

11. We consider all events in the instrumental catalogs SISMALP (1987 – 2024; Langlais et al., 2024), BCSF-Rénass (1962 – 2021; BCSF-Rénass, 2022) and ISIDe (1985 – 2023; ISIDe Working Group, 2007) to constrain the D90, for both sizes of grid cells (Fig. 7). However, the temporal extension of the three catalogs and the depth uncertainties differs, affecting the density of events at depth and consequently the D90.

How did you manage the difference in uncertainties?

I see you maintained the three catalogs separate, but how you deal with overlapping areas of the database?

I did not manage difference in uncertainties. I here mention it to make the reader aware of the heterogeneity in location precision.

Paragraph changed to:
Differences in catalog duration and depth uncertainty affect the spatial density of earthquakes at depth and, consequently, the estimated D90. We therefore constrain D90 using three seismic catalogs, each providing the most precise event locations for different parts of the study area: SISMALP (1987–2024; Langlais et al., 2024), BCSF-Rénass (1962–2021; BCSF-Rénass, 2022), and ISIDe (1985–2023; ISIDe Working Group, 2007). D90 is assessed from each catalog using both fine and coarse grids (Fig. 7).

12. Hence, we assess geodetic deformation considering separately horizontal strain rates from vertical displacement rates. The features analyzed in this model are horizontal deformation amplitude (F1), horizontal deformation mode (F2) and vertical displacement rate (F3). As in the previous model, the data is represented in hexagonal grid cells, applying the fine or coarse grid (hexagonal grid cell diameters of 0.1º and 0.5º in EPSG:4326 - WGS 84, respectively) depending on the density and resolution of each dataset.

I assume still displacement rates?

Yes.

13. (Eq. 2; Jeandet et al., submitted)

not sure if this is admitted by the journal

The paper " Jeandet,L., et al. (2026) Present-day tectonics in mainland France and nearby regions based on GNSS & earthquake focal mechanism, Tektonika." Has been accepted. It is only a matter time for it to be published.

14. Figure 8: Geodetic data used to characterize F1 (horizontal deformation amplitude) and F2 (horizontal deformation mode) of the deformation-based SZM. A), B) Maximum and minimum strain axes from the GNSS strain solutions 1 and 2, respectively (GNSS s1: Piña-Valdés et al., 2022, GNSS s2:

Lantmäteriet, 2023). C), D) Horizontal deformation amplitude for both respective GNSS solutions, for cells of the fine and coarse grid, respectively; E), F) Horizontal deformation mode for both respective GNSS solutions, for cells of the fine and coarse grid, respectively. C) to F) are superposed with the resulting zone limits of the De-SZM.

On the right hand column, I see that many data are lost and you have data only on the eastern part of the map. Why does it happen?

I am not losing data. The GNSS strain rate solution 2 (GNSS s2: Lantmäteriet, 2023) employs a smoother, lower-resolution interpolation method, revealing coarser spatial variations yet smaller strain-rate values, as high peaks are attenuated. As mentioned in the text, to best represent each solution, we map the strain-rate amplitude in the fine and coarse grids, respectively for the high and low-resolution datasets. So GNSS s2 is analyzed using only the coarse grid (cell diameter of 0.5º). Moreover, because the two solutions present variations in the deformation mode, particularly in areas of low strain, where artefact influence can dominate, we consider only cells with strain-rate amplitudes higher or equal to 3 nanostrain yr^{-1}. Therefore, GNSS s2 presents low horizontal deformation amplitudes (E), and only cells presenting E ≥ 3 nanostrain yr^{-1} are considered to evaluate the horizontal deformation mode.

15. We characterize zones after the most representative values for each observable (Fig. 10, Table 3); for geology (F1) we identify the main geological era corresponding to the units observed on surface, and the thickness of the Mesozoic - Cenozoic basin cover; for faults (F2), we note the most illustrative azimuth, the quantity of fracture - low, mean, high -, the maximum seismogenic potential index given by SEFPAF, and the presence of a major structure according to the fault source model derived from SEFPAF; for crustal thickness (F3), we note the most representative Moho depth range. Subsequently we compute the normalized sum of differences of the three key features ($\sum \Delta F_i$, see Supplementary material) among neighboring zones in order to attribute confidence levels to zone limits. With the intention of obtaining an equitable distribution of the three levels of confidence we establish, for this model, low confidence levels when $\sum \Delta F_i < 0.15$, intermediate confidence levels when $0.15 < \sum \Delta F_i < 0.4$, and high confidence levels when $0.4 < \sum \Delta F_i < 1$.

For F1 you adopted a qualitative analysis. I think you should explain how these have converted this into a numerical value to then do the sum of differences.

F1 from Structural-based model is atr last considered a quantitative analysis. As a matter of fact, the surface geology is combined with the basin cover thickness numerically. In this line older geological units follow low numerical values and younger geological units present higher numerical values. Basin cover thickness represents the thickness of Cenozoic units; therefore, it adds higher numerical value to the final F1.

```
# F1: Surface Geology
polygons["F1: Surface Geology"] = polygons["F1: Surface Geology"].map({
  "Paleo": 0,
  "Paleo-Prote": 0,
  "Paleo-Meso": 2.5,
  "Meso": 5,
  "Meso-Ceno": 7.5,
  "Ceno": 10,
```

```
    "Paleo-Ceno": 7.5
})

# F1: Cover thickness (km)
polygons["F1: Cover thickness"] = polygons["F1: Cover thickness"].map({
    "0 km": 0,
    "2 km": 0.5,
    "4 km": 1,
    "5 km": 1.2,
    "8 km": 2,
    "10 km": 2.5,
    "12 km": 3
})
```

16. We obtain 44 zones for this model with 13 zone limits with associated high confidence level, 45 limits associated with intermediate confidence level and 25 limits with low confidence level (Fig. 10). The data and feature values per zone are captured in the database of the Structure-based SZM (Table B1).

how are these confidence levels determined?

the confidence levels of the limits are still not clear to me

In text:
We characterize zones after the most representative values for each observable (Fig. 10, Table 3); for geology (F1) we identify the main geological era corresponding to the units observed on surface, and the thickness of the Mesozoic - Cenozoic basin cover; for faults (F2), we note the fault system that populates each zone, as well as the fault density and azimuth tendency; for crustal thickness (F3), we note the most representative Moho depth range. The string values used to categorise each observable are discretized into numerical values representing quantitative ranges (see Supplementary Material) which are subsequently applied to derive feature values for each zone. We then calculate the normalized sum of differences between the three key features (∑ΔFi; see Supplementary Material) for each pair of neighbouring zones to assign confidence levels to their shared boundaries. We define low, intermediate, and high confidence levels for ∑ΔFi < 0.15, 0.15 < ∑ΔFi < 0.4, and 0.4 < ∑ΔFi < 1, respectively.

17. With the aim of building a single model which integrates all three seismotectonic aspects (crustal structure, observed seismicity, geodetic deformation) and thus includes all the features listed in this work, we produce a model named "Unified Seismotectonic Zonation Model" which integrates the zone limits of the previous three.

this is not mentioned in the methods, it should be

Paragraph added to methods:

At last, we develop a fourth model, the Unified Seismotectonic zonation Model (U-SZM), which builds upon the three independent SZMs (St-SZM, Se-SZM, De-SZM). As a result, U-SZM integrates all three seismotectonic aspects (crustal structure, observed seismicity, geodetic deformation) and thus includes all the features listed in this work. To do this, we superpose St-SZM, Se-SZM, De-SZM and examine zone limits of significant confidence level (high and intermediate) and limits that appear consistent across models, which guide the delineation of zone boundaries for the U-SZM. This strategy avoids producing one model from the processing of a large variety of data at once, instead, it relies on spatial limits already determined and on their uncertainty.

Paragraph added to "4. Zone delineation and zone limit confidence levels » :

For each model (St-SZM, Se-SZM, and De-SZM), we first describe the sequence of data and seismotectonic feature analyses used to guide zone delineation. We then present the methodology for assessing feature heterogeneity between neighboring zones and deriving confidence levels for the proposed zone boundaries (CLZL). As each model relies on different datasets, the approach used to assess CLZL is tailored to each model. Finally, we describe the procedure used to integrate the three independent models into a single Unified SZM.

18. Following this confidence-based zone limit merge we improve efficiency and ensure the reflection of the strongest signals from the 3 seismotectonic feature classes: crustal structure, observed seismicity and surface deformation. The unified model is a robust SZM, especially where relevant signals are available. However, where geophysical data acquisition is sparse and seismicity and deformation rates are low, the zone delineation remains questionable. Nevertheless, it is important to note that the procedures applied to derive CLZL differ for each model, making their direct horizontal merging debatable. This implies a preferential weight towards models presenting a larger amount of intermediate and high CLZL.

So if I understood correctly, you overimposed limits from the three zone, when these matched, you kept them. when they did not, you adopted those with larger CLZL?

Yes.

19. This model presents 42 zones with 37 limits of high confidence, 52 limits of intermediate confidence and 7 limits of low confidence (Fig. 13a).

why the spread of values is so unbalanced?

We do not seek a balanced or uniformly distributed number of zone limits among the three confidence levels. Instead, we report the proportion of zone limits assigned to each confidence level to demonstrate the consistency of the model: the greater the proportion of high- and intermediate-confidence limits, the more robustly the model is considered to represent the underlying seismotectonic behavior.

20. Figure 13: A) Unified seismotectonic zonation model with zone id values and 3 different levels of zone limit confidence; B), C) and D) Structure, Seismicity and Deformation-based seismotectonic zonation models, respectively showing zone limits in green with CLZL hierarchization, all three superposed with the Unified seismotectonic zonation model limits in solid black.

this green scale is very difficult to understand. I suggest to modify it

I think that section 5.1 should be before the Unified model, or the unified model being placed here. To give some consistency

Figure has been modified for better visualization.

21. In the following we discuss and illustrate the differences among three previously compiled seismotectonic zonation models (Autran et al., 1998; Baize et al., 2013; Le Dortz et al., 2019) and the unified SZM proposed in this study (Fig. 14). We identify main structural elements along most of the models (e. g. Eastern Cevennes, Rhone valley, Western Alpine front, Rhine graben, Jura Mountain range, Swiss Molasse basin, Po plain, Ligurian fault zone, Digne arc, Var region, Gulf of Lyon; Fig. 14), yet many of the boundaries differ where the geological structure is less clear and where seismicity and deformation rates are low.

Is this already comparison between older and new zonation models?

Yes. This is the major observation. The following paragraphs enter more in detail on each model.

Thank you again Pr. Lezzi for your constructive comments on this work.