1. **Inter-event distance is usually a term describing the distance between successive earthquakes. In the paper, it seems that this term is used to describe the distance between each event and all the other events in the catalogue. This point needs some further clarification in the part where Equation 2 is given. Apparently, only the coordinates of the epicentres are used to estimate inter-event distances. Is there a reason why depths are not used in the calculations? Please explain.**

ANSWER TO REVIEWER:

We agree with the reviewer that the term inter-event distance is confusing so instead event-event distance will be used when referring to Euclidean distance between any pair of events of the catalogue. The definition of this parameter is now explained in lines 122-125 as follows:

> *"First, it is necessary to study both the* ==event-event== *distance and the spatial cell-event distance distribution.* ==The event-event distance is the distance between any pair of events of the catalogue (in each of the case studies the distances between all the event pairs will be calculated), as for the spatial-cell event distance, it is defined as the distance between a spatial grid cell and an event from the catalogue (as in the former definition the distances between all the spatial cells and all the events will be calculated)."==

In the case of Spain, the seismicity is shallow and the hypocentral and epicentral distances are similar. For the region of Vrancea in Romania, the catalogue was filtered so only the intermediate-deep earthquakes remain. This way, the mean depth is assumed to be homogeneous, resulting in this component having no effect in the calculations.

2. **How exactly the weight function (Equation 3) works in the calculations? The authors cite the paper of Taroni and Akinci (2021), but some further clarifications and examples are needed to inform the reader how the weight function affects the b-value estimations.**

ANSWER TO REVIEWER:

We agree with the comment and the manuscript has been modified to elaborate in this matter:

$$W = W_{SK} \cdot W_{SS} \tag{3}$$

155   Where W_{SK} is the smoothing filter and W_{SS} is the function used to add foreshocks and aftershocks into the b-value calculus. This weight function operates inside the expression of the b-value as defined by Utsu (1965) and adapted by Taroni et al. (2021b):

$$\hat{b} = \frac{1}{\left(\sum_{i=1}^{N} W_i \cdot (M_i - M_{min}) + \frac{\Delta}{2} \right) \cdot \log 10} \tag{4}$$

     Where N is the total number of events in the catalogue, M is the magnitude of the event, M_{min} is threshold magnitude and

160   Δ is the binning of the magnitude in the catalogue. In these case studies the threshold magnitude does not change in a manner that can affect the b-value calculus, so no changes depending on time windows have been considered.

     The uncertainty of this b-value has been calculated following the procedure of Taroni et al. (2021b) and it was derived by these authors following Aki (1965) work and applying the delta method (Dorfman, 1938) to take into account the weight function used in the b-value calculation:

165    $$\hat{\sigma}_{\hat{b}} = \hat{b} \cdot \sqrt{\sum_{i=1}^{N} W_i^2} \tag{5}$$

The next figure has been added so there's a visual comparison of the weight each event is given depending on the distance:
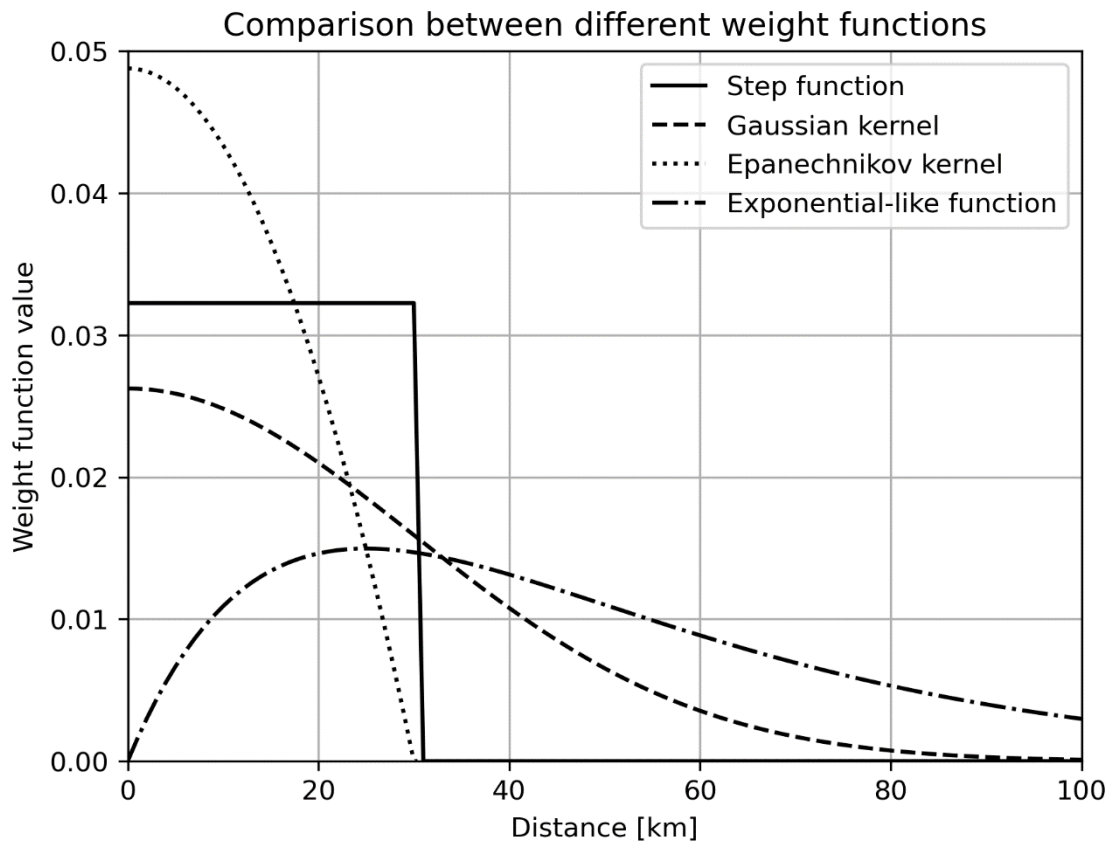
3. **Provide some more information regarding the Italian seismic catalogue (source etc.)**

ANSWER TO REVIEWER:

The information about the Italian Seismic Catalogue has been complemented in the first paragraph in which is mentioned:

> "... by means of the maximization of the likelihood of the seismicity contained ==in half of the Parametric Catalogue of the Historical Italian earthquakes (CPTI15 - Release v1.5- July 2016- from Rovida et al. (2020))== and obtained a smoothing parameter of 30 km for central Italy."

And the information about the events in this catalogue can be found when the case study is presented:

> "The Italian catalogue comprises the events from 1960 to 2019 for all Italy. It amounts up to 56309 events, which can be described in terms of magnitude and depth. The depth of the events ranges from 0 to 30.0 km, so the seismicity considered for this area is shallow. As for the magnitudes, the minimum is 1.81 Mw, and the maximum is 6.81 Mw."

Reference:

Rovida, A., Locati, M., Camassi, R., Lolli, B., and Gasperini, P.: The Italian earthquake catalogue CPTI15, Bulletin of Earthquake Engineering, 18, 2953–2984, https://doi.org/https://doi.org/10.1007/s10518-020-00818-y, 2020.

4. **In Figure 3, the inter-event distance histograms are shown for different time periods. How were these time periods chosen by the authors? For instance, we see a 50-years interval followed by a 4-years and 1-year interval.**

ANSWER TO REVIEWER:

The time periods were chosen so the number of events in each histogram is equivalent (roughly the same order) so the trend can be analysed. The conclusions drawn about the distance distribution have been made over the stacked histogram which was the combination of all four histograms.

5. **The authors consider two functions, the Gaussian and exponential functions, to obtain the smoothing kernel. However, power-law functions (e.g., Abe and Suzuki, 2003 and Corral, 2006) have also been considered in the literature, with their significance on the spatial clustering of earthquakes. Did the authors check the adequacy of such functions? A histogram in log-log axes will assist to show if power-law regimes exist.**

ANSWER TO REVIEWER:

The functions chosen as smoothing kernels have been considered based on existing literature for the exponential-like function (Tormann et al., 2014) and mathematical significance, as the Gaussian kernel has direct relationship with the distance distribution by means of the π and σ parameters. The power-law functions are interesting in order to study the distance distribution and worth a broader study regarding the application of the proposed methodology. The scope of this work was to showcase the methodology and a couple of examples (case studies and functions) but perhaps in the future a work focused on a single case study with several functions could be written.

6. **In line 181, the authors say, "For this function to be fitted, the count distribution has been normalized". How exactly it is normalized?**

ANSWER TO REVIEWER:

In order to avoid using a parameter for the normalization of the exponential function, the counts of the distance distribution for each bin of the histogram have been divided by the sum of all the counts. That is how we normalized the counts for the distance distribution. We decided to point this out, as the second y axis in the figure depicts different scale for the values of the exponential-like function. Now the text reads:

> *"For this function to be fitted, the count distribution ==has been normalized by dividing the counts of each bin by the sum of counts in all the bins so the parameters can be used for the weight function calculus without the need of a normalization constant==."*

7. **With which method exactly are the b-values and their uncertainties calculated?**

ANSWER TO REVIEWER:

We agree with the comment and the manuscript has been improved to clarify that the maximum likelihood method using Utsu's formula (1966) has been used. Now lines 91 to 93 are written as:

> *"Another issue that has to be addressed is the method chosen for the estimation of the cut-off magnitude calculus. Recent work (Zhou et al., 2018) has shown that the characteristics of the seismic catalogue determine which algorithm suits better the cut-off or threshold magnitude calculus which is needed to calculate the b-value ==according to maximum likelihood method proposed by Aki (1965) and improved by Utsu (1966)==."*

The uncertainty of this b-value is taken from Taroni et al. (2021) and it was derived by these authors following Aki's (1965) work and applying the delta method (Dorfman, 1938) to take into account the weight function used in the b-value calculation. The text has been modified so this information is clearly indicated:

References:

Aki, K. Maximum likelihood estimate of b in the formula $logN = a - bM$ and its confidence limits, Bull. Earthq. Res. Inst. 43, 237–239, 1965.

Dorfman, R. A note on the δ-method for finding variance formulae, Biometrics Bull. 1, 129–137, 1938.

8. **Is the difference between the b-value spatial distribution for Italy obtained in this work (Figure 6) within the confidence limits with that of Taroni et al.? The authors provide only the percentage change.**

ANSWER TO REVIEWER:

The algorithm that generates the figure has been changed so only the spatial cells whose b-values are within the confidence limits defined by Taroni et al. uncertainty are plotted. Out of the 4074 points in the array of b-values only 10 are out of this 95 % confidence interval. The Figure 6 has been changed although no visible changes appear. The text has been modified so the explanation about 95 % the confidence interval is visible:

b-value spatial distribution   b-value difference with Taroni et al. 2021b
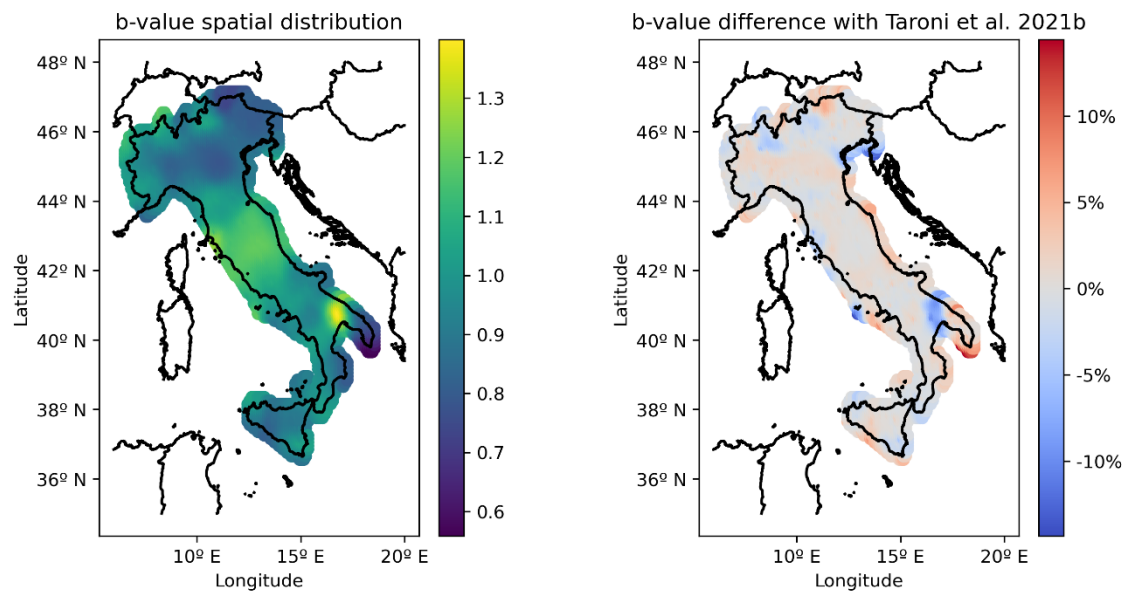
"Only the spatial cell grids whose b-value is in the 95 % Confidence Interval (CI) with that of Taroni et al. (2021b) are plotted (only 10 spatial cells out of 4074 where outside of the 95 % CI). The difference between the two spatial maps is lower than 2 % in most of the country except for border areas in which the difference can rise up to a 15 % as it can be seen in Figure 7. This can be due to less data being available for the b-value calculus (border effect)."

9. **For the Lorca case, are the coordinates in Figure 7 and 9 the same? In the first figure we see positive values and in the second negative values for Longitude. In addition, the authors say that they selected the events at 40 km radius circumference centered at Lorca's earthquake epicenter. However, in Figure 7 we only see a fraction in a much smaller area. The text and the figures should be consistent.**

ANSWER TO REVIEWER:

We agree that the format of the coordinates should be the same for all the figures in the text and that the map should showcase the area in which the b-value calculus is being made. For this reason, the map in the Figure 7 has been remade so there is consistency between all the representations of the area of interest.

South-eastern Spain seismic catalogue (2000 - 2020)
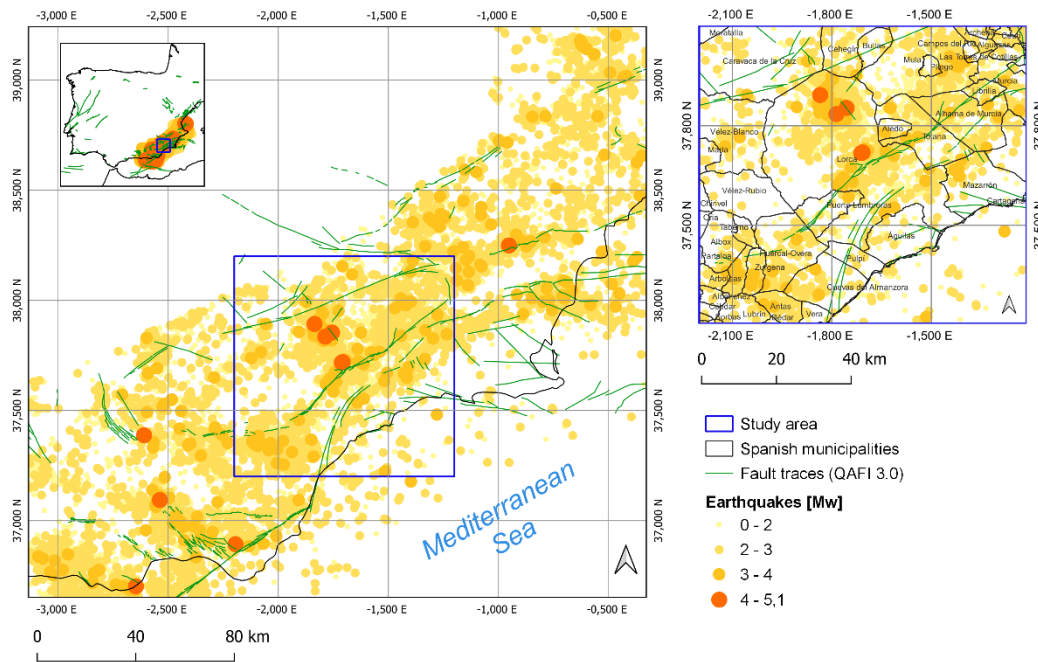
10. Why do the authors show the 1579 – 2021 seismicity in Figure 7 after all? Only 2000 – 2021 seismicity is studied.
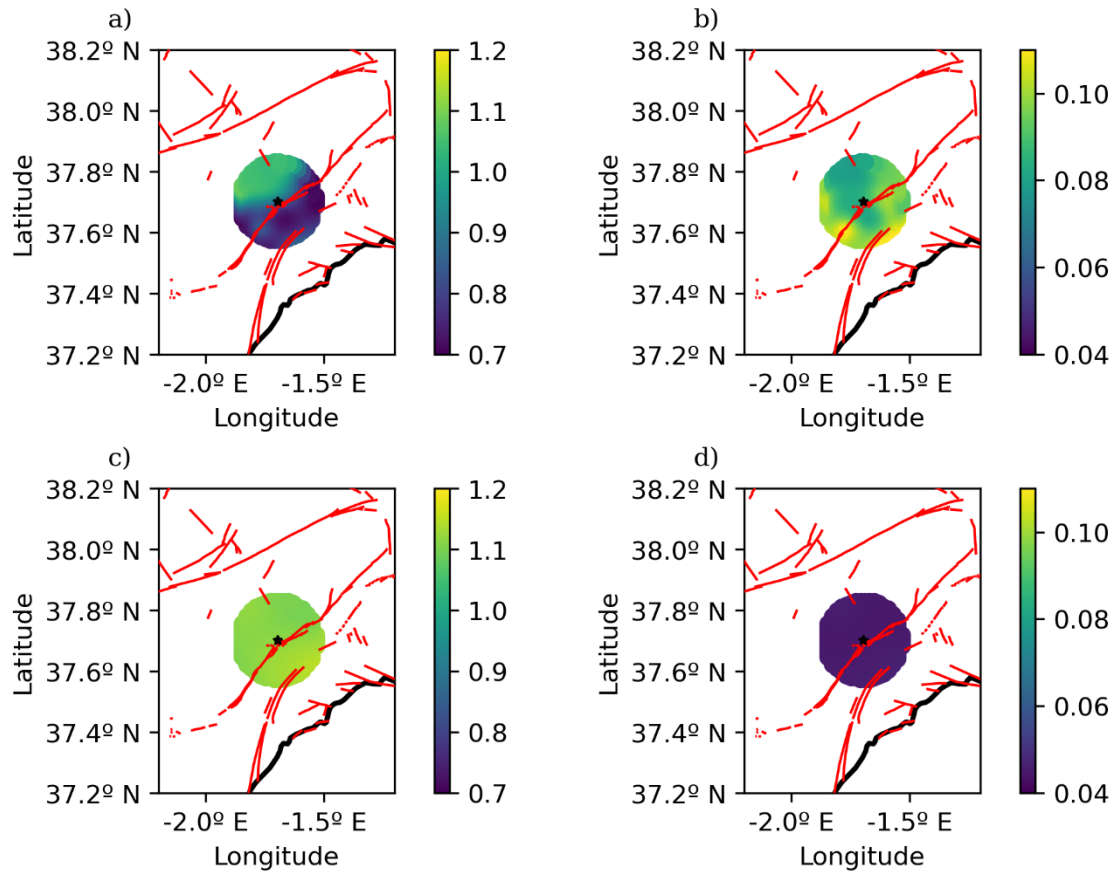
ANSWER TO REVIEWER:

We agree that the representation of the whole catalogue is not relevant, so the figure has been changed in order to only show the part of the catalogue that is important to the case study. The figure is the one shown in the previous question.

11. Why is year 2011 excluded from the analysis for the Lorca case?

ANSWER TO REVIEWER:

Yes, we avoided using data from the year in which the earthquake occurred in order to have the most representative results on the tectonic stress setting. Nevertheless, in this case after a careful consideration we have decided to include all the data before the earthquake in 2011 (excluding the seismic series in which this main shock belongs) so more events are available to the b-value calculus. Also, the events after this seismic series have been used in the latter b-value maps. The periods are now 2000-2011 and 2011-2020. The figures have been changed accordingly:

a)　　　　　　　　b)

c)　　　　　　　　d)

12. In the caption of Figure 11 in c), what is "down" stands for?

ANSWER TO REVIEWER:

It should have been deleted as the figure was changed from a previous configuration. It has been deleted now.

13. In Line 210, the 0 – 100 km distance range is mentioned, but the radius for the seismicity selection is 40 km. Please be precise.

ANSWER TO REVIEWER:

We agree that this sentence should be corrected as the maximum possible distance is 80 km for a 40 km radius circle:

> *"As it can be seen, there is no clear distribution for the 0 – 80 km interval…"*

14. In Line 214 correct date with data.

ANSWER TO REVIEWER:

The line has been corrected:

"…for this reason, the functions that have been fitted in d) use all the available data."

15. The use of the words "in each spatial cell" in the caption of Figure 9 adds some confusion. Do the authors mean the total number of events used in the analysis?

ANSWER TO REVIEWER:

The total number of events is also the number of events we use for calculating the b-value in each spatial. Instead of using a cut-off distance (which is equivalent to the event window in the b-value time series) as Tormann et al. (2014) did, we use the spatial kernel, i. e. the Gaussian or exponential-like function to weight down the influence of the events based on their distance to the spatial grid cell in which the b-value is being calculated. In short, the total number of events used in the analysis and the number of events used for the b-value calculus is the same, although the weight of most of the events in the b-value calculus of a certain spatial grid cell will be negligible. For the sake of avoiding confusion, now in the captions in which "*in each spatial cell*" now it will read "*n events have been used in the b-value calculus*" and how the weight function operates can be found in the methodology section following the comment 2.

16. In Line 230, the authors say, "Taking into consideration that the region has suffered three earthquakes with Mw 5.5 in the last decade, then we have chosen the events from 2016 to 2020 in the Vrancea region." This sentence does not make much sense and the selection is not justified. Probably the sentence needs rephrasing.

ANSWER TO REVIEWER:

Yes, we agree that this sentence indeed makes no sense, as the time periods considered range from 2000 to 2018. This is a mistake that has been corrected so it is coherent with subsequent figures.

"Taking into consideration that the region has suffered two earthquakes with Mw 5.5 in the last decade, we have chosen the events from 2000 to 2018 in the Vrancea region. The b-value mapping area is comprised inside the blue frame Figure 10, in which all the events of the catalogue for this period are shown."

17. Add the b-values in Figure 11 or discuss them in the text. Why not similar plots are shown for the Lorca case, or the G-R fitting for the Italian catalogue?

ANSWER TO REVIEWER:

The b-values for all the G-R law fits have been added. In the cases of the Italian and Spanish catalogue they have not been considered as both catalogues have been already filtered so only shallow seismicity is considered. In the case of the Vrancea region the catalogue contains all the depth spectra, and the most representative seismic activity is the one of intermediate and deep depth, that is why the G-R fitting was calculated

for each group of depths. This information has been added in the text as clarification in the Vrancea case as it should have been done:

"The events can be plotted in the frequency-magnitude graph depending on their depth. In this case deep seismicity accounts for intermediate and deep events (> 50 \unit{km} depth) and shallow seismicity for those with depth lesser than 50 \unit{km}. In this case, the catalogue has not been filtered prior calculus (the Italian and Spanish only contain shallow seismicity; hence they do not require a G-R fit to discriminate the different seismic settings)."

"Figure 11 represents the magnitude-frequency distribution of the earthquakes at different depths and the tendency of the G-R law. A b-value of 2.00 for the shallow seismicity has been found and a b-value of 0.91 has been calculated for the deep seismicity. The different slopes indicate that separate catalogues should have been used to compute the spatial b-value distribution for each depth range. As the moderate to large earthquakes have a depth greater than 50 km, then we will consider only intermediate and deep seismicity for the study."

18. Again, the authors exclude year 2016 for Vrancea. Is this a form of "manual declustering" excluding major aftershock sequences?

ANSWER TO REVIEWER:

Yes, we avoided using data from the year in which the earthquake occurred in order to have the most representative results on the tectonic stress setting. Nevertheless, in this case after a careful consideration we have decided to include all the data before the earthquake in 2016 (excluding the seismic series in which this main shock belongs) so more events are available to the b-value calculus. Also, the events after this seismic series have been used in the latter b-value maps. The periods are now 2000-2016 and 2016-2018. The results are now updated and shown in the remark number 20.

19. Rephrase the sentence "Both b-value maps (with the different kernels) depict an increase of the b-value in zone where the earthquake of 2016 (Figure 13c and Figure 13d)

ANSWER TO REVIEWER:

We changed the phrasing as it was confusing and tried to make a comparison using Figure 13 and Figure 14 so the b-value changes can be identified in a more direct way.

"The b-value maps in Figure 13c and Figure 14c when compared with those in Figure 13a and Figure 14a allow to identity an increase in the b-value near the epicentre of the earthquake of 2016 which could indicate tectonic stress relief and a slight b-value decrease towards the SW part of the area."

20. Which could indicate tectonic stress relief and a slight b-value decrease towards the SW part of the area." I am not sure if I can see this b-value

increase. The figures that are mentioned show the 2018 epicenter, while Fig.13a that shows the 2016 event, this increase is not clear.

ANSWER TO REVIEWER:

We agree that the mark for all the epicenters should be present in all the subfigures, so the comparison is clear. The figure 13 has been modified so the shift in the tectonic stress build-up area and the slight increase in the b-value around the 2016 epicenter can be seen:
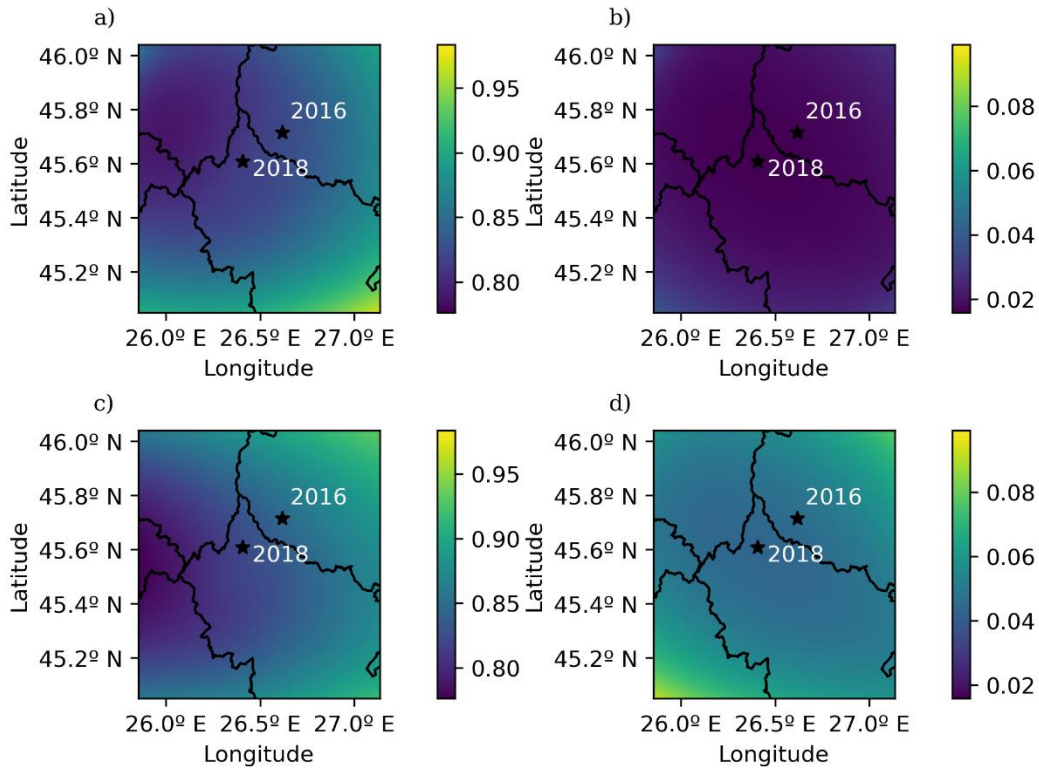
The figure 14 has been changed as well so the symbology is coherent:
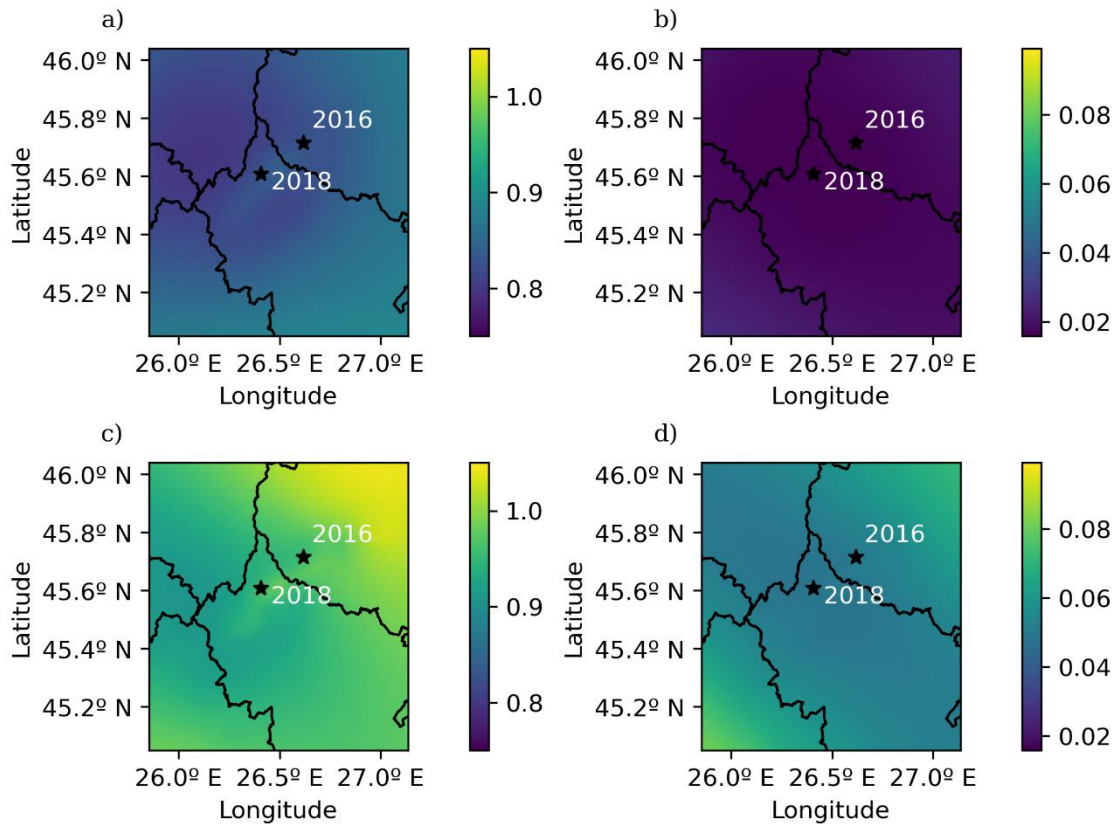
21. Rephrase the sentence "which in also retrieves the smoothing parameters for it."

ANSWER TO REVIEWER:

We agree that the phrasing is confusing, so the manuscript has been changed as follows:

> *"Moreover, it avoids the arbitrary selection of a smoothing kernel by fitting a function to the distance distribution and obtaining the parameters for it."*