Dear Editor,

We are very thankful to the editor for your decision to accept our manuscript for publication and for the opportunity to answer another reviewer. Indeed, this reviewer made very pertinent questions, comments and suggestions, some already considered in the previous review, but others new that helped to clarify some parts of the manuscript.

Best regards,

Tomás Calheiros (on behalf of the Authors).

Review for "Drivers of extreme burnt area in Portugal: fire weather and vegetation" of T.

Calheiros et al.

In this paper, the relation between Daily Severity Rating percentile (DSRp) and the total

burned area (BA) in Portugal is studied, with the aim of understanding its smaller scale

(municipal scale) behaviour. The Authors tried to 1) assess if the performance of 90th DSRp

(DSR90p) threshold in BA prediction in mainland Portugal; 2) identify and characterise regional

variations of the DSRp threshold that justifies the majority of Burned Area ; and 3) analyse if

the DSRp spatial variability could be explained with broad classification of land cover (forested

vs agricultural vs shrubbed).

As a dataset, weather reanalysis data from ERA5-Land as well as wildfire and land use data

from official Portuguese authorities for an extended summer period (15th May to 31st October)

from 2001 to 2019 were used.

The treated topic is exceptionally relevant, since fire weather indices can and should be coupled

by info on vegetation for optimal wildfire management procedures.

However, the paper should be refined in some parts before being considered for publication.

- Line 43 Define DSR (or at least specify that is a simple reformulation of FWI). This can be done here or at line 135.
  Answer: Another reviewer also pointed out this issue and, consequently, we added information to clarify this aspect.

- Line 43 The reader needs to understand what a DSR percentile is. In order to get a

threshold based on percentiles, we need a set of elements to be sorted in ascending order. On which set were the percentile classes defined? This needs clarification.
Answer: In the last revision of the version of the manuscript we clarify how the DSRp is computed including the sorting and the dataset used in Section 2.5.

- Line 115: how the burnt area dataset is derived? Polygons retrieved from ground assessments? Satellite?
  Answer: We agree with the reviewer that this information is needed. We modified the text to explain that burnt area polygons are derived from satellite data.

- Line 115: of course, the threshold of 100 ha applies to European fire regime and not to, e.g., North American one.. Maybe this thought can be added in the text.
  Answer: Another reviewer also discussed this subject. The concept of large or extreme wildfires is statistical and depends on the sample and the study region. The objective of this study is not to establish the 100 ha limit to define a large wildfire. The objective is to find a limit that allows us to consider the minimum number of wildfires that explains a large part of the burnt area. We explained this in the manuscript and justified this 100 ha limit, in the previous review.

- Line 130 Why is air temperature and not air humidity the driver for fires?
  Answer: A previous study cited in the manuscript (Amraoui et al., 2015) shows that while the summer season peak of fire incidence is more dependent on air temperature higher values, the winter peak is much more dependent on low values of air humidity because in this season the air temperature is usually the lowest. This is also already explained in the manuscript.

- Line 145 How was the original classification of COS2018? How was the aggregation performed?
  Answer: We agree with the reviewer and clarify this in the new revised manuscript (in Section 2.4).

- Line 157 : "was allocated to this administrative unit". What unit are they talking about? The sentence can be reformulated.
  Answer.: We agree with the reviewer that the sentence was not clear. Consequently, we modified it to clarify the administrative unit.

- Line 160: Still not clear what BA percentages is.
  Answer.: We agree with the reviewer and clarified the text.

- Line 163: So for each fire event at municipal scale, the maximum DSR is selected in the days of the event and the whole extent of the municipality?
  Answer.: Of course, we could have used other statistics (e.g. the mean). However, it is important to underline two aspects. The first is that the weather conditions on each day are very similar in relatively large regions, large than the municipalities. The second is that we are interested in identifying extreme fire weather associated with large wildfires. We already mentioned in the manuscript that "The selection of the maximum value of DSR to associate with wildfires is justified

by the low spatial variability of the DSR, the small size of administrative units and the native reanalysis data resolution (C3S, 2020)".

- Line 162: Why normalise by logarithm? Is this common practice or was a tentative normalisation procedure that ended up in good results?
  Answer.: The logarithm (of burnt area) should be computed for several reasons. One is when the relationship between two variables is not linear but exponential. Another is when you want to apply a method that can only be used on normally distributed data and your data does not fulfil this requirement. All these situations apply in this case. In addition, we note that the accumulated BA (after sorting the BA time series from lower to higher DSR values), varies exponentially with the DSR percentile. It is also worth mentioning that the use of the logarithm is a common practice in burnt area distribution studies.

- Line 173: a percentage is always between 0 and 1. So you might do the difference starting by 1 ... otherwise you need a factor 100 of scaling. I am convinced that a numerical example of FTBA would greatly help the reader.
  Answer.: The reviewer presents an important question. Indeed, we started this analysis precisely following the reviewer's suggestion. However, after a long discussion about how to present these results, we decide that the adopted one was the best and simple way for the readers to visualize and understand the DSR percentile limit that corresponds, for example, to 90% of burnt area. But we agree that it is a debatable decision.

- Line 180: The section 2.6 is quite cumbersome .Some definitions, such as "p" and "q", are given and never used in any formula or text. To do some clustering between elements, the elements need to be compared by a distance function (which may need to respect some mathematical constraints.) If I have understood correctly, every element of your set is a series [DSRp_i,FTBA_i], with the several fixed points for DSRp that are common for every municipality and FTBA_i that change accordingly (That is, a disaggregated version of figure 4). The distance is then the correlation between the set of FTBA_i of one municipality and the corresponding set FTBA_j of another one. If that so, please state in line 194 who is m (number of analysed municipalities I guess) and n (the number of (equi-distant?) sampling points in the DRSp scale, I guess).
  Answer.: We agree with the reviewer that "p" and "q" should not appear in this text, because they are not necessary in our case. We corrected the manuscript. We thank the other reviewer's suggestions and added that information, in lines 326-332 of the new version of the manuscript (in the track changes version).

- Formula 3: specify the upper range of any sum.
  Answer.: We appreciate the reviewer's suggestion but we believe that is sufficient in the formula the letter j. These formulas were obtained in Matlab software and also in the Mathworks website, as referred in the manuscript.

- Line 200: this kind of practical example is what makes at least the last part of 2.6 understandable.

Answer.: We thank the reviewer's comment.

- Line 395: does this apply to the Portugal / Southern Mediterranean area? I remind of EUCPM activation of the Czech- German border of July 27 when the FWI was not so high in the area yet several hecteareas of forest burned triggering the european activation. https://reliefweb.int/report/czechia/czech-republic-forest-fire-dg-echo-hzs-ustecky-jrc-effis-media-echo-daily-flash-26-july-2022 and https://erccportal.jrc.ec.europa.eu/ECHO-Products/Echo-Flash#/daily-flash-archive/4551
  Answer: Our results clearly show that large wildfires can occur with relatively low DSR. However, the largest and most extreme wildfires only occur under extreme fire weather and DSRp. In addition, as mentioned in lines 395-397, our results also show that "forests tend to burn only under extreme DSR values, typically caused by simultaneous drought and heatwave, while shrublands (and also agricultural areas) can burn with lower DSRp". However, these results were obtained for Portugal. We suppose that similar results can be obtained for the Mediterranean Basin. Nevertheless, this relationship must be detailed checked in other European regions with a different type of climate.

- Table 3: Nearly all the mathematical formulas need revision. (for example, "x" is a variable, not the LaTeX symbol "\times" which produces the right operator; Log(Accumulated BA) description is wrong; BNA writings are in formula format, not in text mode, and they therefore appear stretched; the same for BAF, BAS, BAA.
  Answer: We accept the reviewer's suggestions and modified the LaTeX program, replacing all the "x" with "\times". Additionally, we altered the formula writings to text mode in BNA, BAF, BAS and BAA formulas, also in the LaTeX program.