Dear Editor,

We are thankful to the reviewer and the editor for your constructive commentaries and suggestions.

According to your suggestions, we added several sentences to explain and highlight the novelty of this work, both in the Abstract and in the Conclusions, and the importance of our results for increasing the knowledge in fire science.

All of the reviewer's suggestions, comments, and questions deserved our best attention. Please check our responses and comments to the reviewer in the file “Answer to reviewer”. Finally, we took the opportunity to proofread the entire manuscript and correct a small number of typos and grammatical errors.

We firmly believe that the novelty and importance of our results for the improvement of scientific knowledge are now explained much more clearly and that all the reviewer's observations, queries, suggestions and comments have been properly addressed. Thus, we hope that the manuscript can be considered acceptable for publication.

Best regards,

Tomás Calheiros (on behalf of the Authors).

Anonymous referee #4

Summary: Overall, this manuscript presents sound scientific ability and strong technical analytical skills, however, I have some significant doubts about the contribution to new science and the bridging of knowledge gaps to the field. Not only are the differences between this study and previous research not strongly argued but the lack of further contextual information about fire behaviour is an issue. The largest is the lack of consideration of local scale conditions on relatively small-scale fires ~100ha. This study uses regional scale weather inputs to assess potentially local scale drivers and influences. There is also a lack of understanding fuel characteristics that drive fire behaviour and their relationship to occurrence. The authors make an effort to address purpose of this research (through its relevance to Portugal) but it fails to outline the significance of its work in relation to other similar fire prone regions internationally and there is a lack of reference material to the broader fire science community, to which have produced similar work (conceptually). There are many missing definitions and structural issues with this manuscript, I’d strongly suggest that the authors thoroughly revise the manuscript to improve the communication of the aims and objectives. The conclusions are also not strongly supported nor adequately explained. I’d also suggest that there needs to be some further work to highlight the novel nature of the work, particularly when LULC and fire occurrence is so broadly researched internationally.

**Answer:** We thank and appreciate all the constructive reviewer’s comments and suggestions, that aimed to increase substantially the clarity, quality and suitability of this manuscript for publication. We modified

the document accordingly. In particular, regarding the objectives, conclusions and novelty of the work, we changed and add several sentences in the Abstract (lines 35-39 and 47-54 of the track-changes file), Introduction (lines 160-163 and 168-173), Discussion (lines 698-703) and in the Conclusion (lines 719-727).

We want to refer that all the lines indicated in this document are related for the track-changes file.

Since the Summary is mostly divided into the Major comments, we answer those comments in the following lines. In addition, the commentaries in the PDF file are also answered or explained in the next lines.

Major Comments:

Line 40: The DSR is actually never properly addressed in terms of its composition and its strength/weaknesses versus other fire weather indices. There is a lack of depth when considering other potential metrics as well as almost no discussion about how these are produced or applied.

**Answer:** The manuscript already includes information on the DSR composition and how is produced and applied in sections 2.3 and 2.5, and also in Table 1 and Table 2. However, we agree with the reviewer that DSR was not properly addressed and compared with other indices. Consequently, we added some sentences to clarify these subjects and to explain that the DSR is widely used in Portugal, both for research and operational purposes, in lines 95-97. We also inserted a few more references to validate our statements.

Line 60: The understanding of vegetation and its role in driving large scale fires is poorly discussed. There is no reference to grasslands or ephemeral grasses, as well as many other prominent vegetation types. Further to this, I'd be certain that on the 100ha scale that Eucalypts behave very differently than other native vegetation. It is also mentioned that Eucalypts are not a significant driver in the change in fire regime, however it makes up the largest percentage of fuels in Portugal. This needs to be explained better.

**Answer:** In general, we agree with the reviewer's observations. However, it is important to emphasize that:

1- In particular, grasslands or ephemeral grasslands are not an important vegetation type in Portugal, covering only 7% of the territory;
2- Grasslands are present mostly in the south of the country (Alentejo), a region that is almost unaffected by wildfires;
3- Our purpose in this work was not to study the fire proneness or the fire behavior in different types of vegetation. Additionally, we only aimed to analyze burnt areas in five major land use types, including forest, but not any shrub or forest type, including Eucalypts. We added a phrase regarding this subject in lines 258-259.

Line 90: I'm not convinced about the gaps in knowledge. I don't think there has been enough effort to explain the differences between what is proposed and previous studies.

**Answer:** We agree with the reviewer that the gaps in knowledge are not properly developed in this part of the Introduction. Therefore, we modified the manuscript to clarify the gaps in knowledge, precisely in lines 160-163.

Line 95: There has been almost no effort to discuss vegetation cover and what metric will be used to assess it.

**Answer:** The vegetation data used in the study is only presented in Section 2.4, in the Data and Methodology section. We discuss the vegetation cover and its influence on the relationship between fire and weather in Section 3.3, based on several metrics including Burnable area (BNA), Forest/Shrubland burnable area (BNAF/BNAS), Forest/Shrubland total burnt area (TBAF/TBAS) and Burnt area (BA) in three major land use types. All the metrics are defined in section 2.4 "Vegetation and land use data" and in Table 2.

Nevertheless, we understand the reviewer's doubts and, consequently, we add more information about the data to clarify this subject, together with a new reference, in Section 2.4, in lines 254-259.

Line 135: Is 1200UTC the most suitable reference time for Portuguese fires? Peak conditions are typically around 1400 local time? This has not been discussed at all.

**Answer:** We agree with the reviewer that 1200UTC is not the hour of the most fire-prone conditions in Portugal during summer. However, according to Van Wagner and Pickett (1975), the indices of the CFFWIS should be computed with meteorological daily data registered at noon, namely air temperature and relative humidity, wind speed, and accumulated total precipitation, as explained in section 2.3 of the manuscript.

Line 140: 9km is big when considering 100ha fires. Your weather data is roughly 9 times more course than the ignition data? I know this study is generally considering regional drivers, however, this is not robustly considered or discussed. Perhaps but is probably not a good dataset for considering regional scale fire weather and ignitions. Also, you have listed just two "worldwide" studies.

**Answer:** We understand the reviewer's worries regarding the weather and fire data resolution. However, it is important to clarify that:

1. We did not study wildfires with 100 ha, but wildfires with the burnt area above 100 ha. The burnt area median of the 2016 wildfires is 303 ha.
2. Climate reanalysis combines past observations with models to generate consistent time series of multiple climate variables. This is why reanalysis is among the most-used datasets in the geophysical sciences.
3. ERA5 is the latest climate reanalysis produced by ECMWF.
4. The ERA5-Land is the database with the highest spatial resolution, providing all the meteorological data needed to compute the fire weather indices for Portugal and for the study

period. This reanalysis dataset is used in weather and climate research and is frequently used in fire weather studies.

5. Observed datasets with time series of meteorological variables measured in weather stations have much lower resolution. Downscaling the ERA5-Land or another dataset to the same resolution of the wildfires dataset would add considerable uncertainty, due for instance the local impacts of topography, with limited added value for this work.
6. Meteorological conditions are similar in relatively large areas, at municipal scale or higher, considerably much higher that burnt areas, especially on days when large wildfires occur.

Therefore, we modified some sentences to clarify the text and added more references, in lines 245-250.

**Comments of the reviewer provided in the PDF file and respective answer:**

Line 2: Why is this important and what about other indicies?

**Answer:** This subject is detailed in the answer to the Major Comments of Line 40 (in previous lines of this document).

Line 3: Is the DSRp only used at the macroscale? What's smaller scale?

**Answer:** We regret this lack of attention from us. We modified the sentence to “spatial smaller scale” to increase clarity.

Line 4: Now there is a reference to "large" burnt areas?

**Answer:** We corrected and clarified the sentence.

Line 5: poorly worded. rephrase

**Answer:** We agree with the reviewer and rephrased this sentence.

Line 6: through what metric?

**Answer:** The abstract has a word limit and we consider that the space needed to explain this part is better placed in Section 2.4. Please also see the answer for the Major Comment of line 95, in the previous lines of this document.

Line 7: Portuguese land management departments

**Answer:** We agree that the reviewer’s suggestion could increase the clarity and changed the line.

Line 9: 100ha isn't particularly large

**Answer:** 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. Additionally, we explained in the manuscript and justified this 100 ha limit in lines 216-223.

Line 10: What's an extreme day for Portugal?

**Answer:** An extreme event is also a statistical concept. Usually, an extreme event is defined for values above a high percentile, e. g. 90$^{th}$ percentile. In Portugal, extreme fire weather days correspond to days when the DSR is greater than the 90$^{th}$ DSR Percentile. This limit was previously used by several authors (please see lines 97-102). Additionally, as stated in lines 300-303 of the manuscript: "We considered the correspondent 80% and 90% of FTBA as sufficient to classify DSRp as the extreme threshold, justified by the results of Pereira et al., (2005), which showed that 80% of TBA occurs in 10% of summer days."

Our results confirm that this limit is adequate, as said in lines 603-604: "According to our results, only 6% of the TBA occurs with DSRp<80 and 12% of TBA are registered in wildfires with DSRp<90".

Line 13-14: Is this not just due to the potential differences in rate of spreads between the two vegetation types?

**Answer:** We agree with the reviewer and recognize his pertinent observation. Effectively, meteorological conditions influence the Rate Of Spread (ROS). With a lower DSR, the ROS in shrublands should be higher than in the forest species, while a higher DSR allows higher ROS in forests. Nevertheless, we did not study the rate of spread, only analyzed the final area burned by the wildfire. We consider that is advisable not to make any consideration about ROS because we did not study this fire behavior characteristic.

Line 17: Semi-arid and arid landscapes?

**Answer:** The Mediterranean Climate corresponds to the Csa and Csb type of climate according to the Koppen climate classification. We add this information in the manuscript, in line 61.

Lines 19-20: Name the Koeppen climate classification or perhaps just use that definition

**Answer:** We accept the reviewer's suggestion and add the Koppen climate classification (Csa and Csb).

Lines 21: increasingly evident

**Answer:** We accept the reviewer's suggestion and modified the sentence.