Modelling fire frequency and area burned across phytoclimatic regions in Spain using reanalysis data and the Canadian Fire Weather Index System

Response to Anonymous Referee #3
RC C1209

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Dear Referee,

First of all, we would like to thank you for the time devoted to the revision of our manuscript and the positive feedback provided, leading us to re-think some parts of our study and resulting in a new version with significant improvements. We are also grateful to the referee for pointing to some grammatical mistakes and writing inconsistencies. We have undertaken a thorough revision of the manuscript in order to correct them.

Following your comment/suggestions, and also considering the feedback received from the other two referees, we have undertaken substantial modifications to the original version. These are the most important new points addressed:

- The focus of our article is now more explicitly done on the daily predictability of wildfire occurrence from an operational point of view, although we also make some complementary analyses of burned area. This has lead to a new title of the article: *Assessing the predictability of fire occurrence and area burned across phytoclimatic regions in Spain.*
- The three referees have coincided in pointing to the importance of anthropogenic factors in wildfire occurrence, not considered in the previous version. In the revised manuscript, we have included socio-economic and land use / land cover covariates in our analyses, in order to ascertain their contribution to the improvement of model performance.
- This has led to a new version in which the mechanisms behind the performance of the models at each phytoclimatic zone are more deeply analysed and discussed.

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- Finally, extended information has been included in the Supplementary Material, including Fig. 3 which was too complex and whose caption was too lengthy to be included in the main body of the article, but that in our opinion provides an extremely helpful visual overview of the modelling approaches tested.

In the following, we perform a point-by-point answer to the comments and questions posed by the referee. Note that the referee comments have been literally reproduced and indicated in boldface throughout the text.

General comments

The study is an interesting example of using advanced statistical methods for the prediction of occurrence of fires. However, the results of the study are not very unforeseen; Fire Weather Index (FWI) and air temperature explain the occurrence of fires relatively well and the other parameters not that well In spite of the relatively abundant literature applying FWI for fire modelling applications, the validation of FWI within an operational context, assessing its capability for the daily prediction of fire occurrence is certainly scarce and geographically sparse (see e.g. Viegas et al., 1999), specially in Euro-Mediterranean countries, where the FWI system is routinely applied to issue daily fire danger maps in the context of the EU's EFFIS system (Camia et al., 2006; Camia and Amatulli, 2009). In our opinion this is one of the most important contributions of our study, apart from the different methodological aspects tested.

In addition, regarding a previous comment of the referee (not posted in the open discussion), we agree in the low ecological emphasis of our work. However, we want to remark that the main objective of this study is the assessment of the predictability of fires. In this context, we deemed more appropriate to make an emphasis on the methodological aspects related with fire modelling and its potential applicability in prediction. To this aim, we introduce the phytoclimatic regions as a convenient territorial unit for spatial aggregation, although the main phocus is made on the operational fire prediction rather than the analysis of its broad ecological implications, which would deserve a separate study out of the scope of NHESS. Regarding the use of other alternative spatial units (which could have also served to the aims of our study), there are many possibilities. In a early version of the manuscript we used hydrological basins (see e.g. Pausas and Paula, 2012), obtaining comparable results in terms of model skills and variable contributions. Other possibilities (not explored) are using political/administrative units (e.g. Spanish Provinces, NUTS2), or even smaller administrative units (NUTS3) provided a climatic information source of and adequate resolution (ERA-Interim data is too coarse for such an approach). However, this last approach would be not as adequate in order to obtain homogeneous areas in terms of fuel/climate relationships, but on the other hand it would allow to ensure a better homogeneity in terms of fire alert and suppression means, whose action is strongly determined by administrative boundaries.

Specific comments

The impact of socioeconomic factors on fires should be discussed to complement the discussion on the applicability of this model As stated above, we have now included socio-economic and LULC covariates in our models.

In some regions in Spain the climate and vegetation are obviously favorable to the occurrence of fires during fire season, i.e. it is quite sure that certain time of the year there is a fire (or several) inside the region. In that sense modeling the probability that inside a certain relatively large region there is a fire(s) does not create much new information. Authors should justify why to model this kind of phenomena We fully agree with the referee on his/her appreciation. The point here is to assess the predictability of wildfire occurrence within a defined region, and to test this predictability considering different area thresholds. The performance of these models is then translated to their ability to reproduce inter-annual variability of fire occurrence, which we believe does provide quite relevant new information, specially in the case of climate change studies, as we better explain in the new version of the manuscript. In the framework of future climate impact assessment, the projections of future fire danger scenarios are most often based on the simulation output of GCMs (either downscaled or not) run in transient mode. This implies that model predictions do not have a day-to-day correspondence with real climate, and their value lies in the ability of the models to represent the mean state of climate, its variability, trends . . . throughout relatively large climatological periods. This suggests that the estimation of inter-annual fire frequencies from simulated model outputs for sufficiently long time slices (typically 30-year periods) is able to provide a more robust estimation of future impacts than area burned, the latter often yielding too inflated, unrealistic future estimations, as shown in several previous studies (Amatulli et al., 2013; Balshi et al., 2009; Carvalho et al., 2010; Flannigan et al., 2005).

Figure 3 contains lot of information but as such it is very difficult or almost impossible to read. This figure should be redesigned and authors should consider are all the panels (especially the "zebra" ones) providing essential new information We believe that the information contained in this panel is extremely useful for the explanation of the data structure and the modelling strategies, including panels **c.** and **d.**, although we agree on the big size of the figure and its lengthy caption. For this reason, we have moved this figure to the supplementary material in the new revised version, with an extended explanation.

Technical comments

Authors should check the manuscript to ensure that the use e.g. names of variables is consistent in the whole document. Like for example the names of climatic variables (see Table 2, Table 5 and Figure

6). [...] We have corrected this inconsistency in the new revised version of the manuscript. We also thank the referee for the spelling corrections.

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