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Interactive comment on “Fire danger rating over Mediterranean Europe based on fire radiative power derived from Meteosat” *by* Miguel M. Pinto et al.

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R2.1: My main concern is that, in its current state, the manuscript provides only limited general overview of the issues addressed. I think that the manuscript would gain from more detailed introduction and discussion sections and it would help to reach a broader readership. I would appreciate an introduction that provides more information about the methodologies that have been developed so far and the rationale behind the development of such hybrid methods as yours. Reply: We agree with the reviewer and the third paragraph (lines 11-20) was considerably expanded into three paragraphs. It now provides an overview of previous approaches as well as of the advantages brought

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by the rationale behind our approach: "The role played by meteorological factors in the occurrence of severe fire episodes is conveniently assessed by means of indices of meteorological fire danger that rate the likelihood of a fire event (Finney, 2005). Early examples include the Nesterov Index for use in the former Soviet Union (Nesterov 1949), the Forest Fire Danger Index (FFDI) for Eastern Australia (McArthur 1967) and the National Fire Danger Rating System for the USA (Deeming et al., 1977). One of the most reliable and globally applied fire rating methodologies is the Canadian Forest Fire Weather Index System (CFFWIS). The system consists of six components that account for the effects of fuel moisture and wind on fire behavior (Van Wagner 1974). The first five components are based on empirically derived relationships between meteorological variables and the stress of different components of typical fuels that are present in jack pine forests of Canada (Stocks et al. 1989). The last component, the Fire Weather Index (FWI), results from the combination of the preceding five and may be viewed as a general index of fire danger (Van Wagner 1987). FWI provides a numeric rating of fire intensity and is particularly suitable as a general index of meteorological fire danger, namely for the ecosystems of Mediterranean Europe (Viegas et al., 1999). Currently FWI is on the basis of the Fire Danger Forecast module of the European Forest Fire Information System (EFFIS) that is one of the components of the Emergency Management Services in the EU Copernicus program (San-Miguel-Ayanz et al., 2012) as well as of the Fire Risk Map (FRM) product disseminated by the Satellite Application Facility for Land Surface Analysis (LSA SAF) that is part of the EUMETSAT application ground segment (Trigo et al., 2011). However, FWI was specifically designed for the Canadian forest and therefore should be calibrated to the vegetation cover and meteorological conditions over the Mediterranean region. The calibration process involves defining a set of break points in indices of fire danger that are in turn used to delimit classes of fire danger from low to extreme conditions. Several approaches have been proposed involving different techniques to rate indices of fire danger against fire history over a given period and study area. Examples of such techniques include logistic regression and percentile analysis (Andrews et al., 2003), cluster analysis (Dymond et al., 2005) and threshold setting based on a geometric progression (Van Wagner 1987) or on values of probability (DaCamara et al., 2014). Fire history traditionally consists of ground observations of fire occurrence (Anderson and Englefield 2001), fire load (Merrill and Alexander 1987), suppression difficulty (Kiil et al., 1977) and area burned (San-Miguel-Ayanz et al., 2012). The current availability of remote-sensed data of fire activity using information derived from instruments on-board geostationary satellites and polar orbiters has opened new perspectives for calibration procedures that are consistent in space and time, continuously monitorable on a daily basis and easily tuned at the end of the fire season. Information about fire activity consists of location and time of detection of hot spots, which is accompanied by quality flags and confidence level, and, in certain cases, by the amount of energy released per unit time (fire radiative power). Data are either global or cover vast continental areas and time series usually span more than a decade. Examples of remote-sensed databases of fire activity include the World Along Track Scanning Radiometer (ATSR) Fire Atlas (Arino et al., 2001), the MODIS and the VIIRS Active Fire Products (Giglio et al., 2003) and the LSA SAF Fire Products (Trigo et al., 2011). The EFFIS product relies on a traditional calibration approach where the lower threshold of the class of highest fire danger is estimated from FWI values associated with burned areas of more than 500 ha and the subsequent thresholds are defined by a geometric progression (San-Miguel-Ayanz et al., 2012). In the case of the LSA SAF FRM product, calibration is performed by fitting a Generalized Pareto model to the duration of fire episodes derived from hot spot observations from space (DaCamara et al., 2014). When calibrating indices of fire danger over large areas such as the Mediterranean basin, the spatial and temporal consistency of historical records of fire activity derived from remote-sensed information provided by the same sensors present an important advantage over ground-based data where the data about time and location of the fire event and the associated burned area are usually obtained by visual inspection and the information recorded depends on policies that change from country to country as well as on criteria that may vary in time (Pereira et al., 2011). Use of data of fire radiative power derived from satellite measurements presents the additional advantage of calibrating the indices of fire danger against a physical quantity that is especially useful in fire management and firefighting (Roberts and Wooster, 2008)".

R2.2: For instance, the description for the need new estimations of fire danger (Page 2, 18-20) is quite brief. Reply: An overview of techniques for estimation of fire danger is now included in the Introduction and the added value of an approach such as the one proposed is also discussed (see R2.1).

R2.3: Another example is that the description of the fire radiative power derive from remote sensing does not appear until discussion (P20, line 21-26). Reply: The authors acknowledge the existence of this caveat in the original manuscript. Fire radiative power is now briefly described in the Introduction and the advantages of this quantity for calibration of indices of fire danger are also indicated (see R2.1).

R2.4: Similarly, the discussion would gain from a more thorough description of the limits and future developments of this method as well as its comparison with other methods. Reply: This point was also raised by the other reviewer (see R1.12).

R2.5: Page 2 lines 7-9: I am not sure there is a consensus about this assertion, especially in the Mediterranean where recent studies tend to point out towards a drought-limited fire regime. Reply: This point was also raised by the other reviewer (see R1.3).

R2.6: Page 3 line 9: What is the averaged size of these pixels over the Mediterranean? Reply: The average pixel size is about 15.7 km2. The sentence now reads: “Both satellite and meteorological data are gridded in the Normalized Geostationary Projection (NGP) of MSG (EUMETSAT, 1999) with an average pixel size of about 15.7 km2 over the land regions in the study area".

R2.7: P6 line 15-21. I wonder how much does the results of the daily models depend on the estimations of P(E/0) and FWI* that in turn depends on the calibration period This seems particularly the case for P(E/0) where the calibration period is relatively short.

Reply: This is a very important point that was also raised by the other reviewer. We have fully addressed this issue by significantly extending the analyzed period January 2010 – August 2017 (almost 8 years) to January 2004 – September 2017 (almost 14 years). This implied redoing all the computations and changing Tables 1 and 2, and Figures 4 to 14 with the new results. (see R1.1).

R2.8: Besides, It might be not relevant but I failed to understand the purpose of using the FWI anomalies instead of the raw FWI values (P4, lines 23-27). I agree that FWI is influenced by numerous factors (topography, distance to the sea. . .) but there are also large-scale patterns involved in these processes. For instance, a one Standard Deviation from the FWI mean in southern Greece is not equivalent in terms of fire danger to a one standard deviation in northern Spain. Reply: As stated in P4, lines 26-27, the main reason for the use of FWI anomalies is just to mitigate the delay in solar time that may introduce a zonal bias in the estimations of probability. The text was slightly changed as follows: "Use of anomalies instead of values of FWI aims at reducing all the above-mentioned factors that regionally affect FWI over Mediterranean Europe. Given that FWI is defined at 12 local standard time (LST) use of anomalies also mitigate the impacts associated to the delay in solar time (1 hour every 15° towards the east) given that all meteorological fields are defined at 12 UTC (DaCamara et al., 2014)".

R2.9: Fig 6 and Fig 8: maybe provide a statistical test to support your conclusions on these figures. Reply: The following sentences were added in P10, L4 and P11, L5: "Differences among the distributions for the three land cover types were assessed by means of the two-samples Kolmogorov-Smirnov test (Massey, 1951); for each pair of the three considered distributions, the null hypothesis that the distributions are identical is rejected with a p-value lower than 0.0001". "As in the case of daily energy released by fires, the two-sample Kolmogorov-Smirnov test corroborates the significance of the results indicating that, for each pair of the three distributions, the null hypothesis that the distributions are identical is rejected with a p-value lower than 0.0001". Reference:

Massey, F. J.: The Kolmogorov-Smirnov Test for Goodness of Fit, Journal of the American Statistical Association, Vol. 46, No. 253, pp. 68–78, 1951.

R2.10: Figure 14: This figure is interesting and relevant for your study but not easy to follow because of the different sources of information provided. Maybe provide more details within the figure and subpanels descriptions. Reply: The following text was included at the beginning of the last paragraph of the Results section (P18, L18): “Results obtained for the two 2017 case studies of Pedrógão Grande-Góis (Portugal) and Marseille (France) are summarized in Fig. 14 that is subdivided into two main vertical panels, the left one respecting to Pedrógão Grande-Góis and the right one to Marseille. For each event a map covering the study area is presented on the top, showing the geographical distribution of values of P(2000|200) for Pedrógão-Góis and of anomaly values of P(2000|200) for Marseille. At the bottom of each panel, at the left hand side, a map is shown of the geographical distribution of classes of danger and active fires detected over the region affected by the fire event; finally, at the right hand side, there is a diagram showing the distribution of active fires detected in the domain G of P(2000|200) versus respective anomalies A”.

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