

Interactive comment on “Temporal variations and change of forest fire danger in Europe in 1960–2012” by A. Venäläinen et al.

P. Tarolli (Editor)

We would like to thank the Editor for good comments and would like to highlight some aspects of the manuscript. Our replies are given after each comment:

Comment: The topic discussed in this paper is really interesting and a challenge not only for the scientific community. Having said that the paper presents several critical issues that need to be fixed. Some of these can also mine the paper at its basis. I would like to thank the 3 referees and J. Martínez-Fernández for their reviews with different feedbacks, thus providing really a wide discussion. The authors provided detailed responses. However, at my eyes these are not enough to make this manuscript ready for publication.

Here I summarize only few critical issues:

- What about the effects of human activity of area burnt? I totally agree with the reviewer #3. This is the most important critical issue of this paper. If I'm thinking at newspapers, in the last decades they reported that several fires were due to humans. The question is: are the results presented in this paper suitable? Are we looking at a suitable discussion? Or the results are also affected by the issues related to human-forest interactions? The authors highlighted in the conclusion (very short) that “the results are in harmony with observed patterns of climate change”. I partially agree, but what about fires due to humans?

Reply: *The comment posed by reviewer 3 and your new intervention were, in our opinion, fully captured in our responses. We never inferred fire risk from fire danger. Yet, a change in fire danger can anticipate a change in fire risk. Definitely, fire agencies will not ignore a change in danger, and this is how warnings are issued, based on fire danger. So it makes all the sense to explore fire danger, even if it is not all that is needed to fully understand fire risk. Let us elaborate more on it:*

1. People and fire: Anyone working on forest fires in Europe knows that fires are mostly caused by people. Some of us published this long ago (Vázquez and Moreno 1993; Ganteume et al., 2013). So the comment by the reviewer is nothing new to us, even if we appreciate this being brought once again to our attention.

2. Trends in one (climate, fire danger) beget changes in the other (fires): We never said this. It may true that changes in danger affect risk but, as indicated, other factors come into play. This is clearly stated in the paper. Again this is not new to us: Please, see Moreno et al. (1998) (Large forest fires).

So by no means we ignore these facts. This has been known to us (i.e., disclosed by our research) since long. This is valid here and elsewhere where fires are mainly caused by people.

Are we inferring that changes in climate will imply changes in fire risk? Definitely no. Nevertheless, changes in fire danger can affect fires (number or area burned, that is, risk)? Definitely yes, it can, which does not mean that it will. So, this requires a number of caveats because fire risk (i.e., probability of occurrence and magnitude) rests on other factors, including ignitions (number, time, location), the landscapes that burn, which change through time, and firefighting capacity, among others.

We are aware that forest fires have been decreasing in some countries of southern Europe during the last years (San Miguel et al. 2013). It is this knowledge that prompted us to determine the relationship/or lack or it between fire risk (numbers, area burned) and fire danger. This is what we substantiate, i.e., demonstrate that a change in one may not imply a change in the other. This is a main contribution. Yet, the national analysis demonstrates that one cannot ignore fire danger in respect of fire risk. All studies done until now show that climate/weather accounts for a limited fraction of variance explained in climate/fire weather-fires models. Limited but not irrelevant. Our work is fully in line with the literature.

References:

Ganteaume, A., Camia, A., Jappiot, M., San-Miguel-Ayanz, J., Long-Fournel, M., and Lampin, C.: A review of the main driving factors of forest fire ignition over Europe. *Environmental Management*, 51(3), 651-662, 2013.

Moreno, J. M., A. Vázquez, and R. Vélaz. 1998. Recent history of forest fires in Spain, in JM Moreno ed., *Large forest fires*. Leiden, The Netherlands, Backhuys Publishers, p. 159-185, 1998.

Vázquez, A. and Moreno, J. M.: Patterns of fire occurrence across a climatic gradient and its relationship to meteorological variables in Spain, in: *Global Change and Mediterranean-Type 10 Ecosystems*, edited by: Moreno, J. M. and Oechel, W. C., *Ecological Studies 117*, Springer-Verlag, New York, 408-434, 1995.

San-Miguel-Ayanz, J., Moreno, J.M., Camia, A. Analysis of large fires in European Mediterranean landscapes: Lessons learned and perspectives. *Forest Ecology and Management*, 294, pp. 11-22, 2013.

Now we will consider the specific points raised by Reviewer 3:

Comment: The main issue in correlating FWI and burnt area is the role of human activity. We know very well that, especially in southern Europe (Italy, Spain, Greece) the role of human activity is predominant in determining both the number of fires and the total burnt area.

Reply: Yes, we are fully aware, as indicated above, and have contributed to demonstrate this. One of the main ways in which fires can interact with climate is that, even if ignitions remain the same, a change in climate will imply that a larger number of them will become fires that scape and that, for the same number of fires, these (all else equal) will spread more, i.e., will become larger. So no need to involve criminal actions. Just keeping ignitions constant and other factors as well, a change in climate can affect risk.

Comment: The effects and interactions of human activity with forest fires are numerous. I try to summarize the two most important. First: humans cause (directly or indirectly) most of the forest fires (80-90%).

Reply: This figure is rather very low. Published figures are in the range of 95%, with small variations between number of fires and area burned (Ganteuma et al., 2013).

Reference:

Ganteaume, A., Camia, A., Jappiot, M., San-Miguel-Ayanz, J., Long-Fournel, M., and Lampin, C.: A review of the main driving factors of forest fire ignition over Europe. *Environmental Management*, 51(3), 651-662, 2013.

Comment: Importantly this influence is variable in relation to climate: when conditions are critical (very high FWI) very often people aimed at criminal actions are more tempted to act because the effect of their actions will be much severe then in “normal conditions”. Thus the burnt area increases disproportionately. Second: due to higher criminal activity in the worst days the system of fire fighter can’t withstand such “stressful” conditions (to many fires to control) and the effect will be, again, that the burnt area will increase much more than predicted by FWI.

Reply: The reviewer is not providing any reference to support this claim. While some studies have shown an increased in criminal activities in relation to weather (Prestemon & Butry, 2005), evidence of autocorrelational relationships for arson fires is only from one area (Galicia, NW Spain [Díez et al. 1994; Prestemon et al. 2011]). (Note, however, that voluntary fires are decreasing in Europe (Ganteaume et al. 2013)). We showed above that criminal activities need not be modified in a changed climate to produce a different fire outcome.

References:

Díez E.L.G., Soriano L.R., Dávila F.D. y Díez A.G. 1994. An objective forecasting-model for the daily outbreak of forest-fires based on meteorological considerations. *Journal of Applied Meteorology* 33: 519-526.

Ganteaume, A., Camia, A., Jappiot, M., San-Miguel-Ayanz, J., Long-Fournel, M., and Lampin, C. 2013. A review of the main driving factors of forest fire ignition over Europe. *Environmental Management*, 51(3), 651-662.

Prestemon JP and Butry DT 2005. Time to Burn: Modeling Wildland Arson as an Autoregressive Crime Function. *Am. J. Agr. Econ.* (2005) 87 (3): 756-770. doi: 10.1111/j.1467-8276.2005.00760.x

Prestemon JP, Chas-Amil ML, Touza JM and Goodrick SL 2011. Forecasting intentional wildfires using temporal and spatiotemporal autocorrelations. *International Journal of Wildland Fire* 21(6) 743-754 <http://dx.doi.org/10.1071/WF11049>.

Comment: These two conditions are completely neglected in the manuscript (as in many other papers within the similar subject) and I couldn't find nothing except some very rough qualitative sentences like "forest fires have not necessarily followed suit, presumably due to other factors affecting them" (end of conclusion). This, in my opinion is too vague and put the manuscript within the category of "standard research on forest fires and FWI".

Reply: *We did not attempt to do anything of this, which does not invalidate the research, i.e., showing that despite increasing trend in danger no trend or negative trend in fires. Actually, the argument of the reviewer is not substantiated by our findings since greater FWI would have implied more criminal activities, etc., showing that the above argumentation is weak and not tenable.*

Comment: I realize that analyzing the effects of human activity on area burnt is rather difficult but, at our stage of knowledge, urges to go ahead in this direction.

Reply: *We appreciate the recommendation, but research is multifaceted and one focus does not invalidate another one provided the relevant caveats, as we do.*

Comment: Otherwise one again we have to take note that the variation of FWI is not able to predict the total burnt area in a certain region. But this information is already well clear to all involved in such topics (fire fighters, fire modellers etc).

Reply: *Neither variation in any fire weather index nor any single variable alone is able to explain fires anywhere in the world. This, however, does not invalidate research to understand their limitations, geographically, temporally, or whichever. The comment is rather dismissive, and does not contribute to the debate. Projecting future climate impacts on fires rest on a few variables, fire weather danger being among the most widely used to estimate future fire activity. Is the reviewer implying that we should not do this anymore? Moreover, is the reviewer suggesting that fire fighters ignore fire danger values? All fire services are using the ones reported here or similar ones!*

Comment: Why considering only Spain and Greece? The authors did not provide a satisfactory reply. The title should be different if only two countries are considered: "Temporal variations and change of forest fire danger in Spain and Greece in 1960-2012".

Reply: *The trend of FWI is calculated for the whole Europe, not only for Greece and Spain. Like mentioned earlier the cross-correlations were to demonstrate how FWI can explain fires. To make this comparison more comprehensive we have added to the analyses also Finland that represents very different climate. The correlations are about as high as in case of Greece and Spain. So we believe that our case is clear: 1) General levels at gross scale; 2) Case studies including relevant countries are lower scales.*

Comment: The sub-division of Europe is really rough and the given explanation related to climate is not satisfactory.

Reply: Our subdivision of southern Europe is compatible with many such subdivisions in relation to climate, including those used by the IPCC. Of course we adapted the information to our goals: 1) southern Europe, central Europe divided between a more Atlantic and a continental area, and Northern Europe. This is sufficient to provide a gross picture and gross trends. To take into account the detailed spatial variation of trend we have calculated the trend also for each grid square (see Figure below).

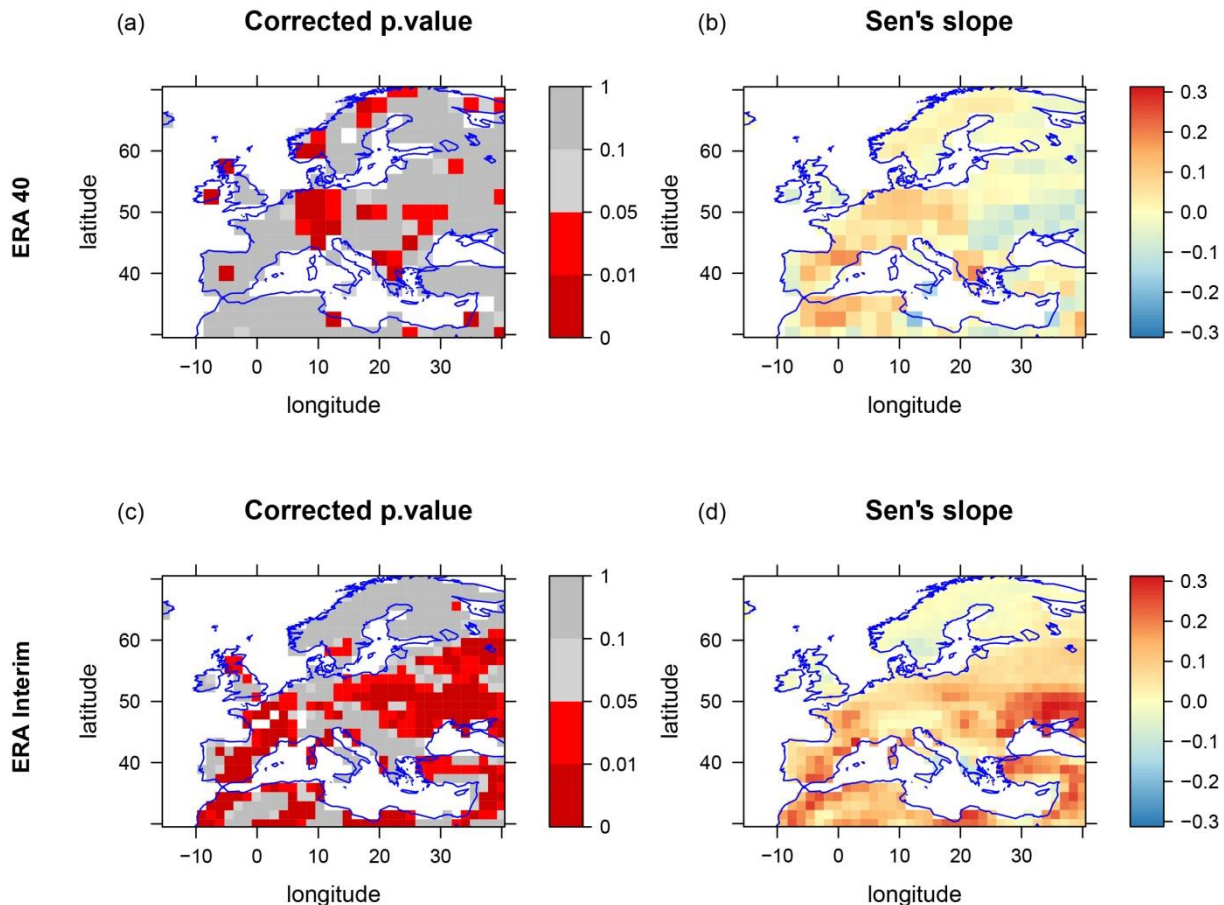


Figure 1. Trend of March-September mean FWI calculated using ERA 40 data set for 1960-1999 (b) and ERA Interim data set for 1980-2012 (d). The statistical significance (α) is shown at levels 0.01, 0.05 and 0.1 for ERA-40 (a) and ERA Interim (c).

Comment: The authors replied to an interesting issue raised by J. Martínez-Fernández about burned areas. They argued that a number of studies have shown that area burned is less sensitive to artifacts, if compared with the “number of forest fires”. Well, I suggest to make this reply stronger, referencing such studies.

Reply: The point that we were making refers to the well-known fact that statistics do not account equally well through the years for fires of all sizes. Small fires were not probably equally represented in the statistics of any country the older the data series. Normally, with time, and changes in laws, more and more fires of smaller size have been included. But disregarding small fires is not meaningful for area burned since smaller fires account for a minor percentage in area burned (See Vazquez and Moreno 1995). Since the statistics we are using involve several countries, it is common to express this caveat. Anyhow, we have calculated the cross-correlations also using the number of fires data (supplementary material).

References: Vázquez, A. and Moreno, J. M.: Patterns of fire occurrence across a climatic gradient and its relationship to meteorological variables in Spain, in: *Global Change and Mediterranean-Type 10 Ecosystems*, edited by: Moreno, J. M. and Oechel, W. C., *Ecological Studies* 117, Springer- Verlag, New York, 408–434, 1995.