

***Interactive comment on* “Intra-annual variability of the Western Mediterranean Oscillation (WeMO) and occurrence of extreme torrential rainfall in Catalonia (NE Iberia)” by Joan Albert Lopez-Bustins et al.**

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Received and published: 31 May 2020

Anonymous Referee #1 "Author's response"

Overview:

This manuscript addresses the occurrence of extreme torrential precipitation episodes in Catalonia (Northeast Spain). These episodes are considered as 24-hour periods with total precipitation amounts over 200 mm, rather than the commonly considered 100 mm threshold. The analysis is carried out from 1951 through 2016 (66 years) and

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using 70 weather stations covering Catalonia. A total of 50 episodes was identified and their occurrence was subsequently related to a teleconnection pattern index, the Western Mediterranean Oscillation index (WeMOi). These relationships are assessed not only at the monthly timescale but also at two-week and 10-day timescales.

“We are very grateful for the reviewer’s comments and for the revision of our manuscript. The paper has been revised in accordance with the referee’s comments and suggestions, which are addressed below. Our answers appear within quotation marks”.

General comments:

The manuscript is clearly presented and the results are generally sounding and in line with previous studies. A satisfactory state-of-the-art is provided, giving credit to the most relevant preceding studies. Nonetheless, I found that the manuscript does not add significant new information to this topic of research. As it is currently, the manuscript is mostly a statistical description of the connections between extremes and WeMOi. From my viewpoint, the study lacks a more detailed analysis of the mechanisms underlying the occurrence of these events in Catalonia. The use of a single teleconnection index is too simplistic and does not bring any added value to both the forecast of these events and to their understanding. More focus should be given to mesoscale processes and dynamical features, also highlighting singularities.

“The main contribution of the paper involves an accurate database of extreme torrential episodes. It was a painstaking task to select the appropriate episodes, as well as to review several databases and handwritten cards. Indeed, we consider this to constitute the most reliable extreme torrential database existing for this region”.

“We agree with the reviewer in that dynamical mechanisms are lacking; we have therefore included new analyses that consider the temporal evolution of sea temperature from one specific high-quality series on the coast covering several decades (1973-2017) (please see tables 2 and 3, and figures 10, 11 and 12). The results show a

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statistical relationship between changes in the WeMOi and SST trends. Furthermore, we have added a long text explaining the dynamical mechanisms in the introduction on L88-114 and we have included many new references. We have also added three references from 2020”.

“We agree with the reviewer that it is too simplistic to use only one teleconnection index. We have added NAOi values for figures 4 and 5 in order to demonstrate the better fit of the WeMOi in comparison to the NAOi, and these are commented on in the text on L323-331 and L404-411”.

Specific comments:

1. I recommend replacing "rainfall" with "precipitation" throughout the text, as e.g. hailfall may have occurred on some occasions.

“We agree with the reviewer. We have replaced it throughout the manuscript”.

2. Keywords are too vague. Please revise.

“We have changed some of them. The current keywords are Mediterranean, sea temperature, teleconnection indices, torrential precipitation, WeMO”.

3. Lines 93-101: The authors state that: "The main aim of the study involves establishing a period of high potential torrentiality in Catalonia at daily resolution" and below that "Therefore, the present research attempts to go beyond the monthly timescale in order to determine the period with the highest accumulation of heavy rainfall according to fortnights 99 and 10-day periods. The intra-annual variability of the daily WeMOi values may help to establish the period with the highest propensity for torrential events in Catalonia". As previously mentioned, from my point of view this single objective of the study is not enough to justify the publication of the study. A much more detailed analysis should be provided, including an analysis of dynamical precursors, which would be very important for improving weather forecasts and the general understanding of these events.

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“We have rewritten the main aim of the study on L123-125 to highlight the importance of the creation of the catalogue. Furthermore, new analyses involving SST have been added (Tables 2 and 3, and Figures 10, 11 and 12)”.

4. Ln 108: the authors mention several times "south of France", but the weather stations located in France only cover a very limited area of southern France. Hence, this terminology is a bit misleading and should be revised. Furthermore, the analysis for the French stations does not bring any significant new information and should be discarded from the study. Further, a different threshold is used (100 mm), as is said in Ln 471, thus not allowing a comparison.

“We agree with the reviewer and we have discarded it from the study”.

5. Fig. 3: The use of NCEP reanalysis is not the best option. The ERA5 dataset should be used instead. Also, the quality of the panels should be considerably improved.

“ERA5 is a better (higher resolution and a more complete global circulation model), updated reanalysis in comparison with the NCEP/NCAR reanalysis, but ERA5 currently only covers the time period from 1979. Therefore, we are unable to redesign figure 3 (a) and figures 8 (a) and 8 (b). Moreover, the definition of spatial resolution is not relevant with regard to shaping the WeMO phase occurring on these days. Nonetheless, we have improved the quality of all figures with NCEP/NCAR reanalysis”.

6. Ln 368: five consecutive days? Fig. 6 shows 5 instead of 4. Please clarify.

“For clarity, we have modified the sentence as follows “The greatest accumulation of cases can be observed in 1971, when a long-lasting torrential episode exceeded the threshold of 200 mm in 24 h during four consecutive days in September, with another one-day episode occurring in October” (L417-420)”.

7. Fig. 7 and subsequent: the means of the bars and lines are not explained in the panels. Please revise.

“To clarify it we have modified the sentence in the caption of the figures 7 and 10

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as follows “WeMOi calendars (lines) and frequency of the extreme torrential episodes (bars) at several timescales””.

8. The 2-order polynomial fitting is not duly explained. What is the purpose of these adjustments? What can be concluded from them?

“We have checked why we used the 2nd-order polynomial fitting. We did so following a simple visual inspection, but it makes little physical sense. There is no atmospheric reason for an increase in extreme torrential events with positive WeMOi values. We have therefore calculated the regression line for only the WeMOi negative values, after verifying the statistically significant correlation between episodes and the WeMOi. In Figure 7 (d, e, and f) we have replaced the quadratic fit with the linear fit, and accordingly, we have done the same in the caption of the figure and in the text L497-504. The linear fit is especially significant at 10-day resolution. There is an evident increase in the occurrence of events with a decrease in WeMOi values”.

9. Ln 584-586: The authors mention that "Further research on this theme 584 is required and SST temporal trends might provide a better understanding of these changes in extreme torrential events and WeMOi calendars". This type of analysis should not be left to a forthcoming study. This is a good suggestion to improve the manuscript.

“We have included new analyses considering the temporal evolution of SST from one specific high-quality station on the coast which covers several decades (1973-2017) (please see Tables 2 and 3, and Figures 10, 11 and 12)”.

Technical comments:

1. Please replace "furnished" by "provided" or similar throughout the text.

“Done”.

2. The overall quality and resolution of the figures should be improved.

“To this end we have redesigned all the figures”.

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2019-374>, 2019.

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