Reviewer #2

Review of manuscript "A REVISION OF THE COMBINED DROUGHT INDICATOR (CDI) AS PART OF THE EUROPEAN DROUGHT OBSERVATORY (EDO) by Carmelo Cammalleri, Carolina Arias-Muñoz, Paulo Barbosa, Alfred de Jager, Diego Magni, Dario Masante, Marco Mazzeschi, Niall McCormick, Gustavo Naumann, Jonathan Spinoni and Jürgen Vogt

This manuscript aims to propose and evaluate the new version of the existent Combined Drought Indicator (CDI), implemented at operational way within the European Commission's European Drought Observatory (EDO). The revised CDI aims to better represent a set of events that are currently not reliably represented. In this manuscript, the authors proposed two main changes to the current CDI and they aim to show the ability of the revised CDI to reproduce major drought evolution, in particular for long lasting events. The CDI performance was tested by comparison with the current version of the index, considering 4 significant events of the last 2 decades. The overall context of the subject seems to be appropriate for this journal. Despite the crucial role of this type of indices for operational processes, the paper has a very marked technical character, as only shows impacts of the two modifications on the new version of CDI and lacks comparison with other (hybrid or not) indices. Therefore, I consider that this paper could be published in Natural Hazards and earth System Sciences after the authors considering my next comments.

We thank the reviewer for these comments, which will be addressed in the revised manuscript as described in the following point-by-point replies.

1. Introduction

The introduction is short and based in a short number of papers, some of them from co-authors, being based mainly on information of the current CDI. As said before the technical character of the manuscript and the absence of the most recent state of art on drought studies is a caveat of this manuscript. Several recent indices were proposed aiming to include the evaporative demand of vegetation. The importance of these type of drought indicators and their possible inclusion on CDI may be included.

We will expand the introduction to include reference to other hybrid and combined indicators. We will also highlight better how the paper focuses only on revisiting the structure of the index, without altering the input datasets. Future studies may evaluate the possible inclusion of other indicators in the modelling framework.

2. Writing and Figure of the manuscript

The paper is very descriptive, and the reading is sometimes monotonous. The manuscript is based on several schematic figures, with not very distinguishable colours, namely for black and white versions. Numbers in Figure 5, 6 and 11 are very small.

The colour schemes used in the Figures are in line with those currently used in the operational EDO system. We think that keeping these schemes consistent is important for readers. Regarding the font size, we will revisit the Figures to improve readability.

3. Danger Levels

Figures 7 to 10 highlight the increasing of area affected by drought in ALERT stage. Is this realistic? In particular in case of 2003, 2005 and 2018 the increase of ALERT stage area is obvious in fall (Figure 11). Why? The increase of area affected by ALERT stage seems to be compensated by the decrease of area affect by WATCH stage in the case of 2003, 2011 and 2008. However in 2005 a strong increase of ALERT stage is observed in fall, but this is not compensated by the decrease of the other stages. Why? Is this a realistic feature? As far as I know the drought event of 2005 in Iberia started in November 2004 and is ending in summer 2005.

The increase in area for ALERT observed in the later stage of the droughts (peak and after) is realistic if we follow the assumption that drought propagates from rainfall to soil moisture to vegetation, as conceptualized by the model.

Regarding the data in Figure 11, we would like to point out that these show the relative changes, so even if it is true that the transition from WATCH to ALERT occurs mostly in autumn, it is also worth to point out that the area under drought is overall smaller in autumn compared with summer (e.g. see previous Figures 7-10). Hence, overall, the new index shows that after the peak the area under drought reduces in size and its mostly constituted by ALERT (as expected), whereas in the previous version of the index there where still sub-areas that were under WATCH even when the drought was almost over.

In the revised version of the manuscript we will highlight more clearly how these results support a more realistic depiction of a drought evolution, under the new version of the index.

Finally, the Iberian peninsula was indeed affected by a METEOROLOGICAL drought roughly between October 2004 and August 2005, as the reviewer correctly points out. However, our index captures also the propagation of the drought into soil moisture and vegetation, and it is likely that the vegetation in August, after a full hydrological year under drought, did not recover immediately but remained under drought conditions after that date and into autumn (when significant rainfall arrived in the Mediterranean). This case study actually highlights quite well one misinterpretation of the old CDI version, which reports a recovery in August due to the return to normal conditions of SPI, even if fAPAR anomalies are still strongly negative. In this case, the increase in ALERT is compensated by the reduction in recovery classes, not reported in Figure 11 but visible in Figure 8 in the map for August.

We will improve the discussion of these results in the revised version of the manuscript to incorporate these considerations.

4. Comparison with other hybrid indices

In the case of drought is difficult to know when an event starts or ends. The classification of drought is also a challenging task.
Therefore, a validation of CDI or another drought indicator is challenging. However, in my opinion it is not enough to evaluate an indicator without an exhaustive comparison with other indicators (multiscalar indicators, vegetation indicators, among others). A comparison of the new version with the previous version of the same index seems to be

not sufficient, namely in the case of a product that is produced and disseminate operationally.

As the reviewer correctly points out, the absence of reference information for the start/end of a drought makes validating the performance of the index quite challenging. This is why we focused on highlighting how the new version of the index is an improvement of the previous one, rather than on an absolute validation of the index. Validation of the original version of the index has been done in previous studies by comparing agricultural yields of regions dominated by croplands with the CDI. Since the proposed changes do not alter completely the index behaviour, we can expect that the new method will give more or less similar results.

Similarly, we do not consider a comparison with other indicators as a valid approach to highlight how the new version improves over the previous one, since no other index can be reasonably assumed as a target reference. Instead, we are planning to explore alternative independent sources of information on the impacts of drought on vegetated land in order to highlight further the more realistic representation of drought by the revised index.