

Interactive comment on “The European 2015 drought from a climatological perspective” by M. Ionita et al.

M. Ionita et al.

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We would like to thank the reviewer for the positive feedback on our manuscript and we are grateful for the comments on how it can be further improved. Here, we respond to each comment in turn – full details of the implementation will be provided in the revised manuscript.

Reviewer1

The European 2015 drought from a climatological perspective, by Ionita et al.

This article reviews the European Summer drought of 2015, describing in detail the larger scale climatological characteristics of the drought event, and trying to identify the key drivers that led to the establishing of drought conditions, particularly over the

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Southern and Eastern Europe. The article is well written and provides a very comprehensive review of the drought event. Additionally, a comparison is provided with the 2003 drought event, which showed some distinct differences in spatial extent and initiation, but also similarities with respect to larger scale circulation patterns and the occurrence of anomalously high SST's in the Mediterranean. I think this article, together with its companion paper that studies the 2015 drought event from the hydrological perspective, provide an important insight into the links between the climatological circumstances that lead to drought, the impacts these have on meteorological and hydrological conditions, and the impacts these have on society. I am sure these articles will provide a good reference both to studies that for example explore how climate change may affect the occurrence of drought over Europe, as well as more detailed studies of the 2015 drought and its impacts.

General Comments While reading the article I was intrigued by the pivotal role of the Mediterranean SST's. One of the objectives of the article is to identify the drivers that lead to the establishing of drought conditions, with the Mediterranean SST's being notes as an important driver. However, the causal relationship is not very clear. I am not a climatologist, so this may be a trivial question, but could the causal relationship be exactly the other way round – i.e. could it be that the warmer SST's in the Mediterranean is the result of the anomalously warm air temperatures. In particular, the authors note that in the 2003 event, which started in spring, the warmer SST's only established themselves in Summer. Also in the discussion, the authors note that the causal effect of the Mediterranean SST's are identified in some studies, but contradicted in others. My question is then if there is more information available from other studies on the causal effect of these warm SST's, or if the reverse causal relationship is possible. I think this is of particular interest to possible anticipation of drought conditions over Southern and Eastern Europe.

Response: We agree with this comment, i.e. the causal relationship is not clear, and it is not obvious what is driving what. In the manuscript, we have tried to emphasize that

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the Mediterranean SST does have a role in influencing the heat waves and droughts over Europe, but the real mechanism behind this relationship is not fully understood. There are some modelling studies (see references in the manuscript) that have tried to deal with this issue, but the results are not entirely conclusive or they are contradictory. From an observational point of view, the role of the Atlantic and Mediterranean SST and droughts, at European level, has been analyzed in various papers (see the references in the manuscript), but without model simulations and sensitivity studies it is rather difficult to have a clear picture of this relationship. The causality would require a complex model analysis that considers various factors. This is also commented on by Referee #2, highlighting the limitations of assessing causes from an observational-based study and the recommendations to make a follow-on modelling study. We will revisit the text with the aim to make these considerations clearer to the reader.

Related to this question, the authors have compared the 2015 and 2003 drought events, noting differences in spatial extent but also similarities. While a detailed analysis of other historical drought events would be beyond the scope of this paper, it may be of value if the authors provide any additional information on coincidence of those events with the anomalies in the climatological indicators (e.g. NAO, EA, SCA, Mediterranean SST's) found in 2003 & 2015.

Response: In the revised version of the manuscript, we will add some information regarding the influence of different teleconnection patterns on other drought events.

Detailed Comments: Page 2, Line5: Mention is made of drought impacts of 5000 Billion. I find this number somewhat large. A quick check of the table in the EEA publication reveals this should be about 5 Billion (4.94), or 5000 Million. Please correct (this number is also repeated later in the paper on page 3).

Response: Thank you for noting this error (will be corrected).

Page 2, Line 15: "was the warmest on record" from the context it is implicit that this is globally. To clarify I would add the word "globally".

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Response: The text will be modified accordingly.

Page 2, line 17: "air temperature record, which were broken" Page 2, line 19: "50 years, where only 2003 had lower rainfall" Page 3, Line 13: "precursor to dry" Page 3, Line 18: "was managed are described" Page 4, Line 24: I would rather use "values lower", as larger could be confusing.

Response: All of the above suggestions will be inserted in the revised version of the manuscript.

Page 6, section 3.2: The authors choose to analyse SPI3 and SPEI3. Whilst I agree that this is a good choice given the duration of the events studied, it may be worth commenting on the reason for choosing 3 monthly accumulations, and not 6 or 12 monthly. I would expect this may be relevant for some drought impacts, or even occurrence of hydrological drought (described in the companion paper). Perhaps the authors can add a short note motivation their choice.

Response: Thank you for highlighting this method question. We will add a sentence better supporting our decision to use a 3-month anomaly. In prior work (unpublished) leading up to Kingston et al. (2015), our team found only minimal differences between the atmospheric drivers for 3 months and 6-month SPI/SPEI drought events. In addition, a 3-month anomaly has been shown to be important for a broad range of drought-related impacts, including agricultural losses, water supply, and freshwater ecosystem impacts (Stagge et al., 2015 - Modeled drought impact occurrence based on meteorological drought indices in Europe). In this case, a 3-months accumulation period was seen as a practical compromise used in monitoring to capture seasonal patterns and to estimate many important drought-related impacts.

Page 7, line 25: It is noted that the SST's were the warmest in 160 years, shown also in Fig 5. What is the reference/source of this time series. This should also be added in section 2.3. Page 8, line 15: should this not be descending motions? Page 8: line 19: "throughout the summer" Page 10, line 6: either in "the western and central part

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of Europe” or “Western and Central Europe” Page 10, line 17: I would rephrase the sentence starting “In summer 2015”. It is confusing. I would suggest to change to “In 2015, the drought conditions became more evident and accentuated in summer, especially.. “. It is then clearer that the emphasis is on the timing. Page 10, line 34: “Mediterranean Sea alone could not produce the heat wave” Page 12, line 11: “of the blocking patterns over Europe” Page 12, line 20: “the summer 2015 event, was” Page 13, line 1: “The summer” Page 13, line 28: “caution should be taken”

Response: All the above suggestions/comments will be inserted in the revised version of the manuscript.

Figures: Figure 1: This figure seems somewhat redundant, and also the figure itself is not very informative. I would expect that the figure would be more relevant to the accompanying paper. Also the discharges of 2015 are compared against the Q80 discharge. It may be more informative to compare against the mean monthly discharges. I would suggest dropping this figure. The reference in the discussion to the accompanying paper should suffice.

Response: We agree with this comment. As such, we will remove Figure 1 in the revised version of the manuscript.

Figure 8: While this is included in the Supplementary material, it may be worth extending these figures to 2003 (or 2002) for reference purposes.

Response: We will extend the figures according to the suggestion.

Figure 11, caption: “The anomalies were computed”

Response: The text will be modified accordingly.

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