

Interactive comment on “Increased incidence, duration and intensity of groundwater drought associated with anthropogenic warming” by John P. Bloomfield et al.

Anonymous Referee #2

Received and published: 7 October 2018

Overview

First of all, I would like to thank the authors for providing such an interesting manuscript. I really enjoyed reading that.

This manuscript investigates changes in groundwater droughts associated with anthropogenic warming with no significant trend in precipitation. For this, the authors applied three standardized indices of SGI, SPI, and STI to two interestingly unique groundwater level time series in the UK covering 1891-2015. The major conclusions are: (1) the first evidence for an increase in the frequency, duration, and intensity of groundwater drought in response to anthropogenic warming; and (2) Such increases are mainly

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inferred to increases in ET.

General comments

As this research analyses long-term (125 years) groundwater levels, precipitation, and temperature to explain changes in the groundwater drought under global warming, the topic of the paper is relevant for publishing in Hydrology and Earth System Sciences Discussions (HESSD). The introduction section sufficiently provides info related to groundwater drought, the approach used, and the study objectives. Description of the study area, data, and methodology applied in this manuscript are explained well. The “Results” Section is well structured, adequate for the purpose of the study, and the figures and tables are very informative (particularly Fig. 4 and 5). The “Discussion and Conclusions” Section gives an interesting explanation for results obtained. Hence, I recommend this manuscript for publication after some revisions.

Specific comment

To improve the manuscript, I suggest the authors include or respond to the followings:

1. In Line 58-60, the authors mentioned that such analyses requisite needs no systematic changes in precipitation. Did the authors analyze the trends in precipitation at the site studied for different time steps: full length (1891-2015), first third (1891-1932), second third (1933-1973), and last third (1974-2015)? I asked this question because the authors explained about changes in temperature at the sites (that follow the Central England Temperature, Lines 147-152) and provided Figure S2 in supplementary materials (to confirm it). However, there is no such explanation or figure for precipitation referring to the sites studied. The authors only mentioned that annual mean precipitation shows no trends since 1766 and also no attribution of changes in it to anthropogenic factors (Lines 152-156). Referring to the country-scale precipitation is not support that there are not any systematic trends in precipitation at two sites, even considering a 5km * 5km grid for each. I think the manuscript needs to clarify this issue to be more compelling.

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2. In Lines 175-176, the authors mentioned they considered three periods for their analyses (1891-1932, 1933-1973, and 1974-2015) because each of these periods cover a considerable groundwater drought episode. At first, there is almost no text about the second third period (1933-1973), but it is included in all figures and tables. Then, in my opinion, the authors need to do the regime shift analysis for STI to identify the change point of the temperature time series as the authors are primarily looking for anthropogenic warming effects. Finally, based on these changing points, the groundwater droughts and SPI should be investigated.

Minor remarks

1. Line 279, "blue" should be revised to "red"
2. Figure 3, the numbers in the x-axis (1, 2, and 3) needs to be referred to the first (1891-1932), second (1933-1973), and last (1974-2015) third periods in the caption or legend.
3. Line 379, please remove of "anomalies"
4. Line 403, please remove "the" in "given the that"
5. Line 431, it should be "(Maxwell and Condon, 2016)"
6. Line 454, it should be "(Doble and Crosbie, 2017)"
7. Figure S4 in the supplementary materials, please provide the name of the site to the corresponding plot, in caption or legend.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2018-244>, 2018.