

Interactive comment on “Understanding the potential of climate teleconnections to project future groundwater drought” by William Rust et al.

Anonymous Referee #2

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The manuscript links inter-annual variations in groundwater levels across the UK a to large scale climate influence. I appreciated the well structured, data-driven approach and mainly agree with the well discussed findings. Nevertheless, some claims that the authors try to express are formulated stronger than supported by the presented results. The manuscript is generally well written and a significant new contribution to understanding climate influence on groundwater droughts. In my opinion, it would make a valuable contribution to HESS after implementing some changes and addressing the following points:

Major comments: - In general the interpretation of trends by aquifer type is tricky for Oolite and Greensand sites as there are only 2 and 3 observation boreholes. I recommend clearly stating the number of observation boreholes in the introduction (somewhere in

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the introduction between line 110 and 117) and afterwards avoiding (over)interpretation of statistic measures in these two aquifer types (e.g. lines 262, 277-278, 290-292, 325-326 ...). Furthermore there is no strong differences between the aquifer types, at least I don't see these e.g. in Figure 6, in my opinion these differences are not shown in your results (line 365 – 369). Consider rephrasing to make a less strong claim. - The drought events used for comparison, do not occur in the 7-year cycles that are proposed for potentially predicting groundwater droughts in the UK. These drought events occur in different time intervals. To support teleconnection influences of larger scale climate phenomena you need to further elaborate on this. The claims in the discussion on the relation of NAO and EA to the 7 year and 16-32 year cycles of droughts are very strong considering the results; consider reformulating it - Key for the interpretation of section 3.2 is additional information on the drought periods you are referring to (green bands in Figures 4&5). It would be helpful to provide some background on these events (on magnitude and durations), this potentially also helps to improve the discussion on climatic teleconnections. - The discussion can be (and should be) considerably shortened by removing the first, very general and summarizing paragraph, also the last parts of the discussion are a little more messy than the rest of the manuscript, please consider re-organizing the discussion a little bit (see also minor comments) - In my opinion, the quality of the Figures is not sufficient for publication: please change size of labels, axis labels, legends e.g. in Figures 2, 3, 4 and 5. Add a scale bar to all GB maps (Figure 1, Figure 6 and sup. Figure 1) - Also in the conclusions we find some very strong statements that are in my opinion only partially supplied by your results: line 509 “we quantify, for the first time globally” (as pointed out before this is not the first time, see interactive comments); line 517 – 523 “... allowing the estimation of future drought. ...” (I would suggest changing this very strong claim accordingly, you show potential control of NAO and EA on groundwater droughts in the UK); line 527-529 “it is clear from our results ... drought prediction and its management across the North Atlantic region” (inn my opinion you cannot say that from your results, you mostly qualitatively analyze the coinciding timing of drought and climate across the UK); I'd skip

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line 524 – 527 at it is not very informative;

Minor comments: line 102 formatting error, change 5 to 2 line 104 – 106 how many boreholes did you consider for your analysis in the end? There is 59 in total, according to supplementary. In Table 1, 9 have gaps longer than 24 months? Please be more explicit. line 120 – 121 consider rewording caption of Figure 1: “Location of the observation borehole locations. . .” “denoted on a grey cycle” not clear, change to “denoted on one grey cycle” line 124 – 128 consider rewording: why are you mentioning data from prior 1950 if you only use data from 1950 onwards? line 152 “data gaps of greater than two years” you do not report in which time series these data gaps exist, previously you mentioned that gw data had “data gaps no longer than 24 months” (line 105) line 149 – 152 is that a well-established thing to do? Can we read about this somewhere? line 165 mention that this is a package for R line 172-173 “good definition in the frequency domain” not clear, please be more explicit line 230 / Figure 4: y-axis “PET residuals” line 265 – 271 there are indeed distinct differences in the driving forces of periodicity, maybe you can be more explicit in describing these? line 283 – 284 this is a very strong statement, can be more explicit? What do you mean by “likely driven externally”? line 313 – 316 long sentence, unclear, consider rephrasing, splitting line 321 Figure 6 instead of Figure 4 lines 335-338 consider rewriting to “in the sandstone aquifers of central England”, and so forth line 360 refer to Figure 6 line 365 – 369 I don’t see the “strong” differences between the different “hydrogeological processes” in the presented data (see also major comments) line 428 – 448 this paragraph is a little messy, consider re-writing (NAO and EA control climate variability across Europe, NAO by . . . EA by . . . ; what is their temporal resolution; how are they linked; how does that refer to your findings;) remove “(“ in line 432; line 448 – 450 this is a very strong claim, you might want to reformulate this line 458 – 463 consider removing this sentences as they are repetitive; line 456 Rodda & Marsh (2011) line 468 “Van Loon, 2015” is a review paper, it does not talk about UK droughts particularly, throughout the manuscript this reference is used very often but it is not always suitable; line 465 – 477 this is not very well structured, see comments above, consider rephrasing the exceptionality of the 1975-

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76 drought line 487 – 495 I would remove these two paragraphs, again very strong claims (especially regarding the predicted future drought dates); there might be larger uncertainties than expected, considering non linearity, changing climatic conditions, . . . line 516-517 the 7-year cycle accounted. . . and the 16-32 years cycle. . . (also: consider using past tense in this sentence and the next one) line 520 (and the EA is the secondary control) There are minor inconsistencies in the wording you use: e.g. mean (line 257, 282) vs. average (line 274, 291), wavelet power vs. wavelet strength; There are typos in: line 158 Proportion; line 203 indicate; line 307 became; There are many commas missing throughout the manuscript e.g. in: line 100 , however; line 114 sands, silts and muds; line 192 , that; line 214 , the percentage; lines 247 & 252 , respectively; line 307 ,and to; Please double check and be more careful! Please also double-check the References section for inconsistencies: e.g. line 577, line 585 (webpage?); line 611;

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