Hydrol. Earth Syst. Sci. Discuss., 10, C4931–C4950, 2013
www.hydrol-earth-syst-sci-discuss.net/10/C4931/2013/

Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Analysis of groundwater drought using a variant of the Standardised Precipitation Index" *by* J. P. Bloomfield and B. P. Marchant

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Received and published: 13 September 2013

Response to Interactive comment on "Analysis of groundwater drought using a variant of the Standardised Precipitation Index" by J. P. Bloomfield and B. P. Marchant J. P. Bloomfield & B. P. Marchant Hydrol. Earth Syst. Sci. Discuss., 10, 7537–7574, 2013 Anonymous Referee #2

We would like to thank Reviewer#2 for their comments. We found them to be perceptive and, along with those from Dr van Lanen (van Lanen, 2013), have caused us to revise the paper in such a manner that we believe that they have resulted in a much improved

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paper.

We have itemised our responses to the General and Specific comments of Reviewer #2 below.

General comment 1.1: Reviewer #2 states that the "authors seem not to be aware of them [previous studies on standardized drought indices based on variables other than precipitation] ... Reading such a literature would allow the authors to put their study into a broader context and build upon issues already encountered with continuous variables with more complex statistical distributions than monthly precipitation. It would therefore allow to avoid relying too much on the initial SPI studies by McKee et al. (1993) and benefit from advances made since then."

Response to General comment 1.1: We are aware of the literature and made limited reference to some of the papers in Section 1.1, but we felt that it was unnecessary to review them in the context of the current work. This comment is similar that made by van Lanen (2013) (comment 3) and we acknowledge that the paper would benefit from improved recognition of recent insights into the development of SPI-related indices for various hydrometric time series. Consequently, additional reference to the background literature has been added to Section 1.1 as follows:

"Consequently, variants of the SPI methodology have been applied to other aspects of the hydrological system such as surface flows, reservoir storage and soil moisture (e.g. Vincente-Serrano and Lopez-Moreno, 2005; Shukla and Wood, 2008; Lopez-Moreno et al., 2009; Nalbantis and Tsakiris, 2009; Sheffield et al., 2009; Vidal et al., 2010)"

and the new Discussion section includes a discussion of the pros and cons of SGI compared with existing groundwater and related drought indices.

General comment 1.2: Reviewer #2 notes that: "even if the SPI has been recently recommended by WMO for meteorological droughts (Hayes et al., 2011), it has been recognized that more complex indices were required for both agricultural and hydrolog-

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ical droughts, and the present study should be in line with such assessments (see the WMO/UNISDR expert meetings on agricultural and hydrological drought indices)".

Response to General comment 2: The text in Section 1.1 has been revised to include reference to Hayes et al., (2011) as follows:

"One of the most widely used indices is the SPI, (McKee et al., 1993; Edwards and McKee, 1997; Hayes et al., 2011)", and the wider point is acknowledged in the revised Discussion section (see response to General comment 1 above)."

General comment 1.3: Reviewer #2 notes that: "a study similar to this one commissioned by ONEMA and done by the BRGM has been recently performed in France. The corresponding report (in French) has unfortunately not been published yet, but it should be available shortly through the ONEMA website (www.onema.fr). The authors might want to compare results for Southern England aquifers that extend to the North of France."

Response to General comment 1.3: We would be very interested in extending the analysis over a larger geographical area, and in particular, extending it to groundwater level hydrographs in France (including the Anglo-Paris Basin where there are a number of aquifer systems that are of similar stratigraphic age to the Cretaceous Chalk of southern and eastern UK).

The work presented in the current paper is intended to establish a methodology for a groundwater level drought index. Work is currently underway to i.) extend the geographical range and density of observation sites within the UK, and ii.) hindcast groundwater levels at these sites back to ~1900 so that long-term spatio-temporal trends in groundwater levels in the UK can be quantified and examined in terms of changes in climate and other drivers, including recent changes in temperature. In this context being able to extend the analysis outside the UK, in a manner similar to the analysis of Hananford et al. (2011), is a longer term aspiration. No change has been made to the text.

General comment 2.1: Reviewer #2 states that: "The main issue in the manuscript is the use of the record length for standardizing groundwater levels, this record length being different across the studied sites. The authors seem to be aware of the problem of the length record identified by Wu et al. (2005) for the SPI, as shown P7552 L8-15 in the manuscript. This is not an issue as such when studying a given site, but several results from the present study are based on inter-sites comparisons. ... In conclusion, I would strongly suggest to compute the SGI by considering a period common to all sites, i.e. the period of the shortest record (29 yr)."

Response to General comment 2.1: The paper is primarily a methodological study describing a new drought index for groundwater level time series and is based on observational data from 14 sites. It also includes some initial analysis of relationships between features of the new groundwater level drought index and potential hydrogeological controlling factors. It isn't intended to be a systematic, comparative study of drought histories or characteristics between multiple sites (that task is planned for future work – see response to General comment 1.3 above). Notwithstanding this, we agree with the comment that record length may influence SGI as plotted and discussed in Fig.11 and will affect the estimated drought durations shown in and discussed in Fig. 12.

Fig. 11, a graphical presentation of the SGI for all sites, and Fig.12, a plot showing the relationship between mmax and drought duration, have been modified to show values based on both the full groundwater level time series and a common shorter 29 year time series. The values of mmax and qmax based on the 29 year record have also been added to Table 2. The associated discussion of the two figures and Table 2 in the text has also been modified to reflect the revisions as follows:

"Figure 11 is a re-presentation of the SGI data from Fig. 5 as a heat map, where non-drought periods, SGI > 0, are shown in grey, and drought periods, SGI < 0, are shown in shades of yellow through to red with decreasing SGI, i.e. with increasing drought intensity. Given that record length can influence SGI estimates (Wu et al. 2005; Mishra and Singh, 2010; Vidal et al., 2010; WMO, 2012), it shows SGI estimated using the entire record for each site as well as SGI estimated just for the last common 29 year period. Although there are small differences between in SGI estimated using the whole record and the more limited 29 year records, both sets of SGI estimates consistently show the development of similar patterns in groundwater drought across the sites and the following is a description of the full SGI drought records."

and as follows:

"Median and maximum drought durations are given in Table 2. Median durations range from 2 months at Chigrove House to 7 months at Thirfield Rectory, and maximum durations range from 12 months at Ashton Farm to 73 months at Llanfair DC respectively. Based on the common 29 year SGI record, the median drought duration appears to be insensitive to mmax (correlation coefficient 0.12), however, as postulated, maximum drought duration is positively linearly correlated with mmax with a correlation coefficient 0.81 (if the anomalous mmax for Dalton Holme is excluded. When the 29 year 1977-2005 Dalton Holme record is analysed the autocorrelation estimated is anomalously long, 50 months, due to the temporal proximity of two large drought episodes in that region, i.e. the 1989 to 1992 and the 1996-1997 droughts) Fig. 12."

However, we also note that in no instance do the inferences or conclusions drawn from analysis of each of the revised figures change.

General comment 2.2: In the context of groundwater level record length and temporal location, Reviewer #2 also notes: "groundwater levels that may show pluri-annual to multidecadal oscillations (possibly on top of annual oscillations), responding to climatic drivers at similar scales like the North Atlantic Oscillation (NAO) or the Atlantic Multi-decadal Oscillation (AMO). Correlations between such climate indices and hydrological drought indices have been previously found in several studies (see e.g., Stahl et al., 2001; Giuntoli et al., 2013). Identifying at least graphically and showing such oscillations would be possible by simply enlarging the y-axis of Fig. 2. This would give an idea of the importance of selecting one or another period for standardisation.

Response to General comment 2.2: As noted in our response to General comment 2.1 (above), this is primarily a methodological paper describing a new drought index for groundwater level time series. The SGI index, relationships between mmax, qmax and other variables, and inferences and conclusions that follow from the analysis of SGI in the paper are not dependent on the specific pattern of drivers of drought. Consequently, for the purposes of the paper we don't believe that it is necessary to target a specific period where particular circulation patterns may be dominant.

We also note that the relationship between groundwater level (and hence SGI) and circulation patterns isn't trivial. For example, Holman et al (2009; 2011) identified multiple atmospheric circulation patterns and teleconnections which may influence groundwater levels in the UK and concluded that interactions between such patterns may be just as or more significant than single patterns, such as the NAO, when influencing groundwater levels. No changes have been made to the text in response to this comment.

General comment 2.3: Finally, Reviewer #2 notes that: "It would even be better to consider times series ending more recently in order to increase the reliability of the standardisation. Considering the most recent period moreover allows to take the best known period (the one usually used for practical applications and decision-making) as the reference period."

Response to general comment 2.3: Due to current restrictions related to the availability of groundwater level data, it isn't possible here to extend the period of the analysis to the present for all 14 sites. However, as noted in response to General comment 1.3, we are working to i.) extend the geographical range and density of observation sites within the UK, and ii.) hindcast groundwater levels at these sites back to $\sim$1900. In this context, we are also working to obtain groundwater levels for all sites to the present so that the most comprehensive analysis of SGI will be available for the long-term spatio-temporal trends in groundwater levels in the UK. No changes have been made to the the text in response to this comment.

Specific comment 1: Reviewer 2# states: “P7542, L5-17: Why using data only up to 2005? It would be great to have drought indices for the last few years as well when some interesting drought events took place. Moreover, such an additional analysis would possibly show the consequences of the recent increase in temperature and therefore on the water balance. It would therefore strongly suggest to include such recent data in the analysis if available.”

Response to Specific comment 1: Please see the response to General comments 1.3 and 2.3.

Specific comment 2: Reviewer #2 observers: “P7542, L9-14: There may be various potential issues in combining two sources of data for precipitation: homogeneity, difference in spatial scales, etc, consistency over a common period, etc. Could you please comment on all these aspects? What made you go for the CERF data instead of having continuous station data throughout the whole period? As the EA report does not seem to be available, there should be some detailed description of this CERF input precipitation dataset in the manuscript, like, e.g., in Dore et al. (2012).

Response to Specific comment 2: With regard to precipitation data used in the study, note that precipitation data is used only to derive SPI, which is in turn compared with SGI, primarily through qmax - the SPI accumulation period that gives rise to an SPI time series that shows the strongest correlation with SGI. In this context Fig. 10 a cross-plot of qmax v mmax, showing a linear relationship between the two variables is the only figure where the results of the SPI calculations are used quantitatively. The degree of consistency between the pre- and post-1961 precipitation data used to calculate SPI will contribute to uncertainty in the correlation between qmax v mmax, but will not change the interpretation of the figure and we assert that it will have no impact on any of the observations or conclusions, either specific or general, of the work. It should be noted that at no point in the paper do we quantitatively, or even qualitatively, explore temporal changes in the precipitation time series. Consequently, we believe that attempting to quantify the uncertainties associated with concatenation of the rain gauge and CERF precipitation data is peripheral to the study.

However, we acknowledge that more information about the CERF precipitation data and the bias correction procedure that was applied should be provided so the text has been revised to read as follows:

"Precipitation data has been derived from two sources. For 1961 to the end of 2005 precipitation data is taken from the Centre for Ecology and Hydrology's CERF 1km gridded precipitation dataset (Keller et al., 2005; Dore et al., 2012). CERF gridded precipitation data is generated from rain gauge data held in the UK Met Office national precipitation monitoring network. A triangular planes methodology is used to produce a daily 1km2 grid based on a weighted average (inverse distance) of the three nearest rain gauges. Daily rainfall is then summed to give monthly gridded rainfall. Pre-1961 monthly precipitation data has been taken from the Meteorological Office Integrated Data Archive System, MIDAS (BADC, 2013). MIDAS has been searched for the closest rain gauge to the observation borehole of interest that has a relatively long and continuous time series that coincides with the period of groundwater level observations prior to 1961. The equidistant quantile matching technique of Li et al., (2010) has then been applied to these records to remove bias associated with spatial differences and to maintain any non-stationarity in rainfall that might have occurred over time. The rainfall records are combined to give a continuous precipitation record at each site."

Specific comment 3: P7542, L9-17: It is not clear what kind of spatial scale you used for deriving a precipitation time series associated to each borehole. Did you consider a spatial average or a point value? How consistent is this estimation between the two different data sources? In the case of a point value, how representative is the local precipitation for the groundwater recharge at a specific borehole? And are they precipitation records located close to the borehole before 1961? Please provide some detailed comments on that."

Response to Specific comment 3: Understanding the recharge characteristics at each site is not the aim of the study and since recharge has not been estimated or modelled for these sites it is not possible to say how representative the local precipitation is in terms of effective precipitation and consequently how representative it is in terms of groundwater recharge at a specific borehole (also see response to Specific comment 2 above).

With regard to scale of observation, the pre-1961 precipitation data is based on point data from individual rain gauges. In each case the nearest rain gauge with a continuous record was used for the pre-1961 precipitation data. This was typically within a few kilometres of the observation borehole. Post-1961 the CERF gridded precipitation data was used and consists of spatially averaged data. Each groundwater level observation borehole lies within a 1km2 grid cell from the CERF dataset. The CERF precipitation data for that corresponding grid cell was used for each observation borehole. Note that the CERF dataset contains the same rain gauges that were used as the basis of the pre-1961 precipitation time series augmented with more recent rain gauges.

Specific comment 4: Reviewer #2 notes "Fig. 3: I am not sure that this figure is relevant, as it provides very little useful information. Plus, it is partly redundant with Fig. 1. Moreover, it serves as a basis for only one comment (P7543, L18-19) which is discussed in the general comment 1."

Response to Specific comment 4: See also comment 29 from van Lanen (2013): "Fig. 3 (7565). van Lanen (2013) notes that "Low monthly precipitation (drought) is hard to see in such a long record (top panel). It is better to choose a shorter period with a clear drought (e.g. 1980-2005). It would still support the text on pg. 7542 (lines 14-17) and pg. 7543 (lines 17-19)." We believe that Fig.3 is useful and it has been revised in line with the comment of van Lanen (2013) and now shows the period 1977 to 2005.

Specific comment 5: Reviewer #2 notes: "P7543 L16-17: Even if groundwater level is a continuous variable, some applications may be interested in having SGI values computed over a given accumulation period ... Even if such a choice was not made in this study, it should be specified that calculating standardized groundwater indices over time scales larger than 1 month could be of interest for some practical applications."

Response to Specific comment 5: Agreed. Text has been modified to include the following:

"(this normalisation routine is equally applicable to over time scales larger than one month)."

Specific comment 6: Reviewer #2 observers: "P7543 L18 – P7544L6: This paragraph describes the use of monthly distributions in the computation of a standardized index as an innovation of the present paper. However, ... it should be made clear in the paper that this is a common practice, not an innovative feature of this study."

Response to Specific comment 6: Agreed. Text revised to read:

"The SGI, however, may still be unduly influenced by deviations of the data from a simple periodic model and a more effective, and common (e.g. Bhuiyan et al., 2006; Mendicio et al., 2008) way to remove the seasonal effect is to estimate the SGI separately for each calendar month and then merge the resulting SGIs to form a continuous time series."

Specific comment 7: Reviewer #2 comments: "P7543 L28 – P7545 L10: The need for flexible distributions has long been recognized for calculating standardized indices from variables other than precipitation: Sheffield et al. (2004) for example used the Beta distribution for soil moisture indices, Vidal et al. (2010) adopted the non-parametric kernel density approach for indices derived from precipitation, soil moisture and river flows, and there are numerous other examples in the literature. The paper should acknowledge such experiments."

Response to Specific comment 7: Agreed. Text added revised to read as follows:

"We note that a related non-parametric method, the plotting position method, has previously been used by Osit et al. (2008) to estimate standardised precipitation for comparison with SPI, and Vidal et al. (2010) have also used a non-parametric kernel density fitting routine to normalize data to estimate a soil wetness index."

Specific comment 8: Reviewer #2 notes: "P7545 L21-23: this is not good practice to compute the SPI directly from the entire time series, unless all months show similar moments of precipitation, which I doubt is the case, even in Southern England. I would thus strongly recommend to compute the SPI by considering independent monthly distributions, as recommended by the WMO (2012)."

Response to Specific comment 8: We thank the reviewer for highlighting this mistake in the text. We confirm that SPI is estimated using the normal scores transform applied to accumulated precipitation data for each calendar month and then the normalised monthly values merged to form a continuous SPI. The text has been revised to read:

"At each site, SPI is estimated with accumulation periods of 1,2,. . .,24 months. To ensure consistency between groundwater and precipitation indices SPIs are also estimated using the normal scores transform applied to accumulated precipitation data for each calendar month".

Specific comment 9: Reviewer #2 notes "P7549 L11-15: It would be good to mention here that the relation between mmax and other drought or hydrogeological characteristics will be discussed in Section 5."

Response to Specific comment 9: Agreed. Text added as follows:

"Relationships between mmax and other drought and hydrological characteristics are presented and discussed in sections 4.4 and 4.5".

Note these sections have been moved from the discussion, section 5, to the results section, section4 in response to the comment from van Lanen (2013), comment 2.

Specific comment 10: Reviewer #2 notes: "P7549 L13-15: This should be reformulated in a proper statistical way (see Ambaum, 2010 for a discussion on this)".

Response to Specific comment 10: Reviewer #2 highlights an issue of some contention between Frequentist and Bayesian statisticians. We have followed a frequentist approach and quoted a p-value alongside the observed correlation coefficient. The p-value is the probability that a correlation as extreme as that observed would have arisen if the variables were unrelated. We disagree with the suggestion that it is not 'proper' to quote a p-value. However we acknowledge that many authors (e,g. Ambaum, 2010) have expressed a concern that the reader might incorrectly assume that the probability that the variables are related is equal to 1-p. These authors generally advocate that the probability that the variables are related is calculated by a Bayesian approach. However this requires (a) a 'prior probability' that the variables are related and (b) the probability that a correlation as extreme as that observed would have arisen if the variables were related. These probabilities are generally not known for environmental systems and therefore subjective judgement is required. We are minded to include the p-value since this is the more standard convention in scientific literature. However we acknowledge that the p-value is not the be-all and end-all when it comes to assessing relationships between variables and we are willing to adopt an alternative convention that is preferred by the journal or editor.

Specific comment 11: Reviewer #2 comments: "Fig. 11: ... this figure plots jointly (truncated) SGI time series from different sites, standardized with reference to different time periods. Even if this choice of different reference periods will presumably do not affect much the timing of SGI droughts, the magnitude of each event could be much different if a common reference period had been selected."

Response to Specific comment 11: Fig. 11 is a qualitative plot and qualitative inferences have been drawn about how known drought episodes are highlighted or not in the SGI record. However, given Specific comment 2 above, Fig. 11 has been revised to show SGI based on both the full records and for the common 29 year period.

Specific comment 12.1: Reviewer #2 notes: "Section 4.3: The section comparing groundwater droughts identified with the SGI to other sources is one of the most interesting one in my opinion, and it would be great to gather reports other than only the ones from Marsh et al. (2007), if existing of course."

Response to Specific comment 12.1: Agreed. See also response to comment 19 from van Lanen (2013). Additional contextual text has been added to the start of section 4.3 as follows:

"A number previous studies have documented major drought episodes in the UK including studies of hydrological impacts (Cole and Marsh, 2006; Marsh et al, 2007; Lloyd-Hughes et al, 2010) and societal impacts (Taylor et al, 2009). Of these, Marsh et al. (2007) is the most pertinent with respect to the present study in that Marsh et al (2007) identified major drought episodes on the basis of inspection of long river flow, groundwater level, and ranked rainfall deficiency time series and explicitly identified those episodes with a significant groundwater component".

Specific comment 12.2 Reviewer #2 notes: "I would also suggest to map one or two major and distinct droughts (for example 1976, issuing mainly from a precipitation deficit, and 2003, mainly due to high evaporation) through their development over the course of each event. This would interestingly allow to see the geographical and geological specificities of each event, and would be an added value to the analysis presented in the manuscript. However, this requires to compute the SGI with a common reference period as detailed in the general comment 2 and previous minor specific comments."

Response to Specific comment 12.2: We agree that such an analysis would have great value in providing additional insights into the underlying processes controlling groundwater level response to droughts. Such an extension to the work will be undertaken once more SGI time series are available for analysis (see response to comment 1.3 above). No change to the text.

Specific comment 13: Reviewer #2 notes: "P7551 L20 – P7552 L7: This consideration of climatological homogeneity in space would be much more suited in the following section about hydrogeological controls."

Response to Specific comment 13: In considering this comment we realise that justifying the assumption of climatological homogeneity is equally important for both the investigation of the relationship between SGI autocorrelation and drought duration, Section 5.1, and of the analysis of hydrogeological controls on mmax, Section 5.2. Consequently, we have moved the text to the end of Section 4.3, prior to both these sections. Note, Sections 5.1 and 5.2 have been moved to the Results after Section 4.3 (see also response to comment 18 below and response to comment 2 from van Lanen (2013) related to restructuring the paper).

Specific comment 14: Reviewer #2 notes: "P7552 L8-15: Even "simple" measures of drought characteristics, like drought duration are sensitive to the record length/reference period. Examples are provided by Vidal et al. (2012) that compare spatio-temporal characteristics (including drought duration) of standardized indices based on a reference period for standardisation different from the previous study by Vidal et al. (2010)."

Response to Specific comment 14: The text has been revised to read as follows:

"Wu et al. (2005) and Vidal et al. (2010; 2012) have previously cautioned against quantitative comparisons of drought characteristics based on drought indices for different sites that are based on different length records. Consequently, using the common 29 year SGI time series presented in Fig 11, simple measures of drought duration, i.e. median and maximum duration, have been estimated for each site".

In addition, Fig. 11, Fig. 12 and Table 2 have been revised to show SGI time series and derived parameters based on the full records and a common 29 year record (see also response to comment 2.1 above).

Specific comment 15: Reviewer #2 notes: "P7552 L16 – P7552 L19 and Table 2: Related to the previous comment, the maximum (and to a lesser extent the median) drought duration may be heavily influenced by the choice of the reference period for standardisation. Again, such measures are only valid across sites if a common period is selected."

Response to Specific comment 15: Table 2 has been revised to show SGI time series and derived parameters based on the full records and a common 29 year record (see also response to comment 2.1 above).

Specific comment 16: Reviewer #2 notes: "Fig. 12 a): This figure and the distinction between fractured and intergranular aquifers is potentially quite interesting. However, with different reference periods for standardisation, one cannot exclude the influence of this factor on drought event characteristics, superimposed on the effect of hydrogeological characteristics."

Response to Specific comment 16: Fig. 12 has been revised to show SGI time series based on the common 29 year record (see also response to comment 2.1 above).

Specific comment 17: Reviewer #2 notes: "Fig. 12 b) and c): I would rather see these two subplots independently from Fig 12 a) as they tell another part of the story and because one may mix up the maximum drought duration with mmax."

Response to Specific comment 17: Agreed – Figs. 12b and 12c are presented independently as new Fig. 13.

Specific comment 18: Reviewer #2 notes: "Section 5.2: The most innovative part of the study in my view is the analysis of the hydrogeological controls on SGI autocorrelation, and it would maybe deserve another place in the paper than only one part of the discussion section."

Response to Specific comment 18: Agreed – See also response to comments 1 and 2 from van Lanen (2013) related to restructuring the paper, and minor comments 20, 23 and 24 from van Lanen (2013). This section has now been moved to the Results section of the paper and extended to include additional comments related to a.) a previous study discussing underlying causes of autocorrelation in hydrological time series, b.) extension of the discussion of (new) Fig. 13a to include reference to the work of Peters (2005), and c.) additional discussion of the implications of (new) Fig. 13b, specifically why hydraulic diffusivity, D, and not just S is an important control on the development of autocorrelation in groundwater levels.

Technical corrections

Technical correction 1: Fig. 2. It would be much better to have the number or the site name in this figure instead of having to rely on the correspondence proposed in the legend. Response to TC1: Site numbers added as suggested

Technical correction 2: Fig. 4: It would be appropriate to have the name (or at least the site number on each graph). Please also indicate the name of the best-fitting distribution. Response to TC2: Site numbers and distribution names added

Technical correction 3: Fig. 5: same comment as for Fig. 4: please indicate the names or site number. Please also draw a line at y = 0 to indicate drought periods. Response to TC3: Site numbers added and plot re-drawn with line at y=0

Technical correction 4: Fig. 6: please indicate the corresponding site number in the legend, and draw a line at y = 0. Response to TC4: Changes made as suggested

Technical correction 5: Fig. 7: In order to increase the readability, please indicate the site names on top of each column. Please also draw a vertical line indicating the accumulation period with the maximum correlation (instead of a cross) and complete the legend accordingly. Response to TC 5: Changes made as suggested

Technical correction 6: Fig. 9: same comment as for Fig. 4. Response to TC 6: Site number added as suggested

Technical correction 7: Fig. 8, legend: "is been highlighted" to "is highlighted" Response to TC 7: Correction made as suggested.

Technical correction 8: Fig. 11: The colour scale does not show any numbering. Moreover, no definition is provided for the 4 drought classes identified here. If a classification has to be adopted, I would recommend not to use the original SPI classes based on round index values, but rather classes based on round frequency/return period values. And the sites should be identified on this plot as well. Response to TC 8: Figure re-plotted using numbered key and defined SPI classes

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