This is the Authors' reply to comments from Referee #2. We will use blue color for our reply and black color for Referee #2 comments.

First of all, the Authors want to thank the Referee for the work and comments which without doubt will help to improve the paper.

It should be noted that the comments of the Referee #2 make reference to pages and lines of the production paper. We will use the same criteria in this reply.

Interactive comment on "Searching for the optimal drought index and time scale combination to detect drought: a case study from the lower Jinsha River Basin, China" by Javier Fluixá-Sanmartín et al.

Anonymous Referee #2

Received and published: 29 May 2017

General comments

This is an interesting paper thanks to the region of interest, the compilation of historical documents, the use of station data and the comparison of various drought indices.

We want to thank Referee #2 for the General comments.

Specific comments

While the ODE and ODI indexes proposed are indeed relevant in this context, I don't think they can be presented as extremely innovative, as similar indices have been used to study drought area and intensity.

As indicated by Referee #2 (and also Referee #1), some works (Bhalme and Mooley, 1980; Fleig et al., 2011; Mitchell et al., 1979) have already developed and used drought area indices, although without specifically using the SPI, RAI, PN and DEC indices for their definition. Consequently, the authors will mention these references in the manuscript and avoid presenting the ODE and ODI indices as newly developed. Instead, they will indicate that these indices (ODE and ODI) are an adaptation of existing ones.

Second, a big caveat is that the skill scores are computed on the same period than the one chosen to determine the ODE thresholds for detection. The fact that only 13 events have been documented is an understandable limitation; however, this method will likely create an overestimation of the power of the index to detect droughts. A more rigorous "cross-validation" procedure is needed (e.g. segmenting the record period and perform the study leaving one segment out each time?).

The fact that only 13 events have been documented is indeed an important limitation and the authors realize that an optimization of the ODE threshold based on this limited sample is not robust. Any meaningful cross-validation of this optimization would require a larger sample. Instead, the authors no longer search for an optimal threshold but explore the effect of varying the threshold in a reasonable range. Since the general findings turn out to be independent of the specific threshold, we consider them robust.

Same answer applies to the corresponding comment of Referee #1.

Moreover, while it is absolutely true that drought measures such as the SPEI and PDSI have shortcomings – in particular the reliance on PET rather than ET, they do capture features that precipitation-only indices cannot see. It is absolutely fine if data is not available to compute such indices, but it should be the main reason for not comparing what these other indices would say

relative to the historical data. It may not be very useful, but I wonder if global PDSI/SPEI datasets capture anything in that region during the drought events mentioned (even if they have a much lower resolution).

We have only used precipitation-based indices for several reasons:

- The availability of measured meteorological data was limited; precipitation was found as the single most reliable type of information.
- It is true that the use of integrated drought metrics such as PDSI or SPEI could improve the scope and quality of the study and enrich the procedure. However, potential evapotranspiration (PET) data is required to compute these indices, and no reliable PET data was available for the study region. PET calculation depends on solar and longwave radiation, temperature, wind speed, and humidity. Although approximations may be used to estimate this variable, for example by only using temperature data, some studies (Jeevananda Reddy, 1995; Shaw and Riha, 2011; Staage et al., 2014) showed a high sensitivity of the PET to the chosen approximation method. A deeper analysis that helps selecting and applying such methods is needed.
- While this study is specific for the lower Jinsha River Basin, the procedure proposed is intended to serve as a basis for further studies in other regions where only precipitation data is available. This study should be seen as a test for other cases to validate whether precipitation-based indices can be used to predict droughts at a basin scale.

As already suspected by Referee #1, we have not used PDSI/SPEI datasets because of their too low resolution for properly capturing the spatial detail of the events.

The authors will present these considerations more clearly in the manuscript to justify the only use of precipitation-based indices.

Same answer applies to the corresponding comment of Referee #1.

Furthermore, for clarity, it may be useful for the authors to develop a little more the compilation process of documents relative to drought in the paper itself, and explain in a little more detail why they consider that the spatial distribution of the stations and the quality of the records are good enough for the study they want to perform. It would also be nice if the question the bias introduced by station locations was treated with more detail. Related to this, how was the grid resolution chosen (p.12)?

The compilation process of information relative to historic drought events will be described in more detail in the manuscript. Particular focus will be set on the type and form of information which was available and used. And the authors will discuss the availability and accuracy of the information on the drought characteristics (such as date, duration, area, etc.).

We consider that the spatial distribution of the stations is adequate for the purposes of the study: stations are distributed more or less evenly both in the X- and in the Y-axis. There are no zones with a significantly denser presence of stations that could overestimate their importance.

Regarding the quality of the records, it should be mentioned that all the precipitation data used have been provided by the China Meteorological Administration (CMA) and downloaded from the “China Meteorological Data Sharing Service System” (http://cdc.nmic.cn/gx/web/yqlj.jsp). A preliminary quality check and correction of datasets (including data gap-filling) was already done by CMA before uploading them to the system.

Regarding the grid resolution, we have chosen a 400x300 cells grid as a trade-off between the density of points and the computational requirements. The grid density used corresponds more or less to 1 cell/3.2 km^2, which is certainly adequate for the purposes of the study. However, this choice must be adapted to the needs of potential other cases: computation time, data availability, variations of precipitation patterns, changing topography, etc.

Finally, the sensitivity of the ODE thresholds chosen to the classifications proposed in table 6 and to the definition of the beginning and end of droughts should be discussed briefly.

Authors will include a summary of the sensitivity analysis performed on the ODE thresholds that will show that their variation hardly affects the overall findings on the best performing index/timescale combinations.

Concerning the thresholds of Table 6, these are based on standard criteria (Jain et al., 2015; McKee et al., 1993; Tsakiris et al., 2007) and supported by follow-up literature. A sensitivity analysis of these particular thresholds could be interesting for a supplementary work but may exceed the scope of this paper.

Technical corrections

I have found that the paper should undergo significant editing. However, I am not a native English speaker myself you may not want to follow exactly the suggestions given below. In the following, I suggest replacements:

English writing improvements will be carried out before submission of the revised manuscript. All further technical corrections of Referee #2 will be taken into account in this process.

p.1:

l.25: “Historical drought events which occurred”?

l.27” “that best reproduce”

p.2:

l.7 : “in agriculture” by “to the agriculture sector”?

l.16: “that is the case of” by “an example is”?

l.17: “the China’s National Climate Change” by “China’s National Development and Reform Commission”?

l. 26: “Main advantages” by “the main advantages”?, “the ease of use” by “their ease of use”, “the limited need of data “ by “the limited data requirements”,

l.27: “capacity to an early detection of drought events” by “capacity for early detection of drought events”?

l.33: “is depending on” by “depends on”

p3:

l.2: “more exhaustive work” “more time-consuming work”

l.4 “This allows identifying” by “This enables on to the identify”

l.10: “do not imply necessarily” by “do not necessarily imply”

l.23-24 “fall” by “discharge”?

l.31 “are susceptible to be affected” by “can be affected”?

p.4:

l.3 ‘location” by “locations”

p.5

l.8: “For the last 20 years, detailed information is available regarding all drought events” by “Detailed information is available for all drought events over the past 20 years”

l. 18: “The use of meteorological indices allows analyzing the influence” “allows one to analyze”

p.7

l.5: “This allows characterizing” “This allows for the characterization of... and thus facilitates”

l. 6: “each station surroundings” by “each station’s surroundings”

l.19: “This allows defining” by “This allows us to define”

l.25: “it helps defining” by “it helps define”

p.13

l.8: “completing the collected historical records for little information regarding the magnitude of the events has been found” by “complete the collected historical records which include little information on the magnitude of the events

l. 9 “Not defined values” by “Undefined values”

l.11: “On purpose, only cells under drought conditions have been considered for the definition of this indicator by” Only cells under drought conditions have been considered to define this indicator” “If the ODI was calculated as an average value for the entire basin (as adopted for instance in Trambauer et al. 2014)) higher (or lower) indicator values in a part of the basin may compensate lower (or higher, respectively) indicator values in the rest of the basin, offering an overall value close to normal precipitation.” by “If the ODI had been calculated as an average value for the entire basin (as adopted for instance in Trambauer et al. 2014)) higher (or lower) indicator values in a part of the basin may have compensated for lower (or higher, respectively) indicator values in the rest of the basin, yielding an overall value close to normal precipitation.”

p.14

l23-24: “have been” by “were”

p.15

l.3-4: idem

p.17

l.1: “that correspond with” by “that correspond to”

l.7: “the droughts occurred” by “the droughts which occurred”

p.19:

l.1: “higher” by ”highest”

l.2: “false positives” by “false positive”

l.4: “quite” by “well”

l.5: “in relation” by “in comparison”

l.7: ‘droughts have been chronicled” by “drought has been chronicled”

l.10: ‘not wide’ by ‘spatially concentrated’

l.12: ‘have been’ by ‘were’

l.13 ‘identifying these events is possible, although it is difficult to disentangle them”

l.16: ‘by the use’ by ‘using’

l.27: “some considerations are recommended” by “caution is advised”

l.29: delete “some”, “proved by ‘proven’

l.30: “The variability of temperature, for instance, may have an important impact on the crop water availability and then in the assessment of agricultural droughts, although it has not been taken into account” by “temperature variability, not considered here, can play a significant role in the onset of agricultural drought”

p.20

l.10: “This work represents an attempt at building a tool...”

l.13: “was compiled”

l.14: “were identified and catalogued”

l.23”indexes and time scales”

l.25” “consecutive or “clustered in time’ rather than “more consecutive”

l.28” supposes” by “represents”

l.32” facing” by “for”

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