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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Establishing the dominant source of uncertainty in drought indicators" *by* G. Naumann et al.

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Response to Review 1 of the paper: Establishing the dominant source of uncertainty in drought indicators. Authors: Naumann et al. Manuscript Number: 10, 13407–13440, 2013

This paper investigates the drought indicators using hydrometrological data from different sources. The five precipitation datasets are compared using four drought indicators. The study was performed for four river basins located in different climatic regions of Africa. In general the paper is well written and structured. It's worth to be published after some moderate changes. I have a few comments. I felt that the title is misleading. There is no thorough investigation of dominant source of uncertainty in the paper.

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Uncertainty is only mentioned at the very end of the result section (page 13419). The authors argued that precipitation datasets are the main sources of errors. What are the other sources of uncertainty in drought indicators? Why they are not so important? Unless the authors explicitly compare the different source of uncertainty, it is hard to draw the conclusion that the precipitation datasets are the main sources of errors. I highly recommend changing the title of the paper to something like assessment of drought indicators .... Too many acronyms are used in the paper. There are some acronyms (e.g. RFE, FEWSNET, TMPA, DMSP, IR, AIRS etc) which are not used in the paper at all. I recommend removing such acronyms and reducing its number. Some acronyms are not also defined, e.g. RMS, RSE etc. Figures are in general too small and poorly explained in the text. The texts in the figures are illegible. I suggest to enlarge figures and increase the font of text in the figures.

We would like to thank the reviewer for the positive comments and suggestions to improve the manuscript. Please note that the Reviewers' comments are shown in plain text and authors' replies in bold typeface.
Concerning the three general comments please find our reply below:

Title and uncertainty: Apart from the errors inherent to the precipitation datasets, which in our opinion are the main source of uncertainty in the computation of the indicators, there are other sources of uncertainty which are related with the methodology or algorithm that is used to compute the indicators. In this paper we focus on the uncertainty derived from the different precipitation datasets. We acknowledge however that we are not comparing the different sources of uncertainty and hence we have changed the title to: "Comparison of drought indicators derived from multiple datasets over Africa"

Acronyms: We've reduced the number of acronyms by writing in full those that were used only once and removing those that were not necessary. Those acronyms that had not been defined are now explained.

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Figures: Those figures that were too small were changed to improve the visualization by enlarging the figures and increasing the fonts. Furthermore, Figures 5 and 8 were redesigned to improve the clarity (see details in the specific response ahead).

P13410, L22: How Rainfall Estimation Algorithm works? One sentence or two require here to understand the algorithm.
We've added a sentence explaining how precipitation is estimated in ERA-I: "Three-hourly ERAI precipitation estimates are produced by 12 h model integrations starting at 00UTC and 12UTC daily from initial conditions provided by the data assimilation system. These short-range forecasts are therefore mainly constrained by the analysis of upper-air observations of temperature and humidity, from satellites and in situ instruments."

P13411, L16: resolution. The GPCC full reanalysis version 5 . . . (Missing full stop)
Changed

P13411, L16: Rudolf or Rudolph ? **Changed to Rudolf**

P13412, L18-L20: Be consistent while using acronyms, e.g. ERA-I vs ERAI, SPI vs SPI- 3 etc.
All acronyms were homogenized

P13412, L17-L20: I suggest rephrasing the sentence "The three drought indicators. . .. while the SMA are derived from ERA-I simulations." as in current form it is confusing. I understand why all indicators cannot be derived from all data sources but it might be worth describing here.
The original sentence was made clearer by replacing it with: "The SPI was computed with all the datasets (ERA-I, TRMM, and GPCP) since it only uses

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precipitation data. The SPEI was computed with precipitation and potential evapotranspitration from ERA-I, as well as with precipitation from GPCP and potential evapotranspitration from ERA-I. SMA and PET were directly obtained from the ERA-I reanalysis."

P13415, L9-L21: It is difficult to follow the text as I am unfamiliar with the regions described in the text (e.g. tropical savannahs, Sahel). I suggest labelling such regions in Fig. 1.

In order to better explain the location of the Sahel we have changed the paragraph as follows: "These datasets agree on the north-south gradient from the Sahara desert areas in the North to the tropical savannahs in the Sahel (an area centered at approximately 10°N spanning from the Atlantic Ocean in the west to the Red Sea in the east). The datasets also agree in the precipitation maximum over the African rainforests related to the location of the Inter-tropical Convergence Zone (ITCZ), as well as in the drier climate of the south-western part of Africa."

P13416, L25: "There is a generally good spatial correspondence between all the indicators over the study period". I do not agree with this. SPI indicators show that there is no drought in the middle region of the Africa (first rows in Fig. 4) whereas SPEI indicators show that these regions are in severe drought (4 th and 5th rows).

The original sentence was changed to: "Although there is in general a good spatial correspondence between all the indicators over the study period, there are also areas where there is no agreement between some indicators, such as in Central Africa between SPI and SPEI."

Fig 5: It is difficult to get the clear message from Fig. 5. Authors are mixing indicators and datasets in one figure. I suggest to compare drought indicators for a given data set at once. E.g. first row will be SPI, second row – SPEI, third row – PET, and fourth row – SMA. Then first column will be between ERAI vs GPCP, second column – ERAI

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vs TRMM, third column – GPCV vs TRMM (?). Do not compare both at once i.e. panel d in Fig 5.

We agree that Figure 5 was difficult to understand. Hence Figure 5 was redrawn keeping only the comparison between indicators computed with ERA-I, since it is the only dataset that provides all the 4 indicators. However the information on how the different datasets can affect the computation of a single indicator is still available in table 4 where the SPI was compared for all regions and datasets.

P13416, L 28: Since authors are referring to a value of 0.6, it would be useful to have another line showing 0.6 in Fig 5. What does box and whisker plot represent here? Is this sampling uncertainty?

The box and whisker are representing the Sampling distribution of all possible values of d at each region. We have changed Figure 5 according to the previous comment and the 0.6 is now 0.5. The original sentence was hence replaced with the following: "Figure 5 shows the index of agreement (d) between all the drought indicators computed with ERA-I. Overall, the index of agreement shows that there is a good correspondence between indicators in all regions with mean d values greater than 0.5 for almost all the comparisons. PET seems to be uncoupled with the other indicators with low values of d. However the effect on the computations of the SPEI is not major, since the agreement of this indicator with the others is still high. Only the inner Niger Delta is characterized by a weaker agreement, where d is often below 0.5."

P13416, L27-L28: "Overall, the index of agreement (d) shows that ..... greater than 0.6 for almost all the comparisons (Fig. 5)". I do not agree with this statement as d values are less than 0.6 for about 40

Figure 5 was changed and simplified in order to keep a comparison of different indicators computed with the same dataset (ERA-I). In the new figure the index of agreement is over 0.5 for almost all the comparisons and regions. We adapted

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the text accordingly.

Fig7: Use the consistent acronym in the legend as well. Are SPI, SPI3 and SPI-3 same? (why 3?).
The acronyms were changed to be consistent with the other definitions. SPI-3 is related to the aggregated precipitation of 3 months. The caption of Fig. 7 was changed in order to make this clear.

P13417, L16: How do you compute duration of dry spells?
The text was modified to better explain how the dry periods were computed: "The individual drought episodes were computed from the time series of all indicators considering as dry periods all values of standardized indicators below zero. The duration of each dry event was determined as the number of consecutive months with negative values (positive for PET) for the period 1998-2010. The average duration of dry episodes lasted between 2 to 6 months for all indicators, with the largest differences in duration for different indicators being found in the Niger basin and in the GHA (Figure 7)."

Fig 8: I suggest removing plot of TRMM from first row in Fig 8 as you are comparing four drought indicators with single data set ERAI and combining four drought indicators in one figure using line plots (each line for each indicator). So you will have 5 (OER, NIG, ENL, LIM and GHA) by 1 plots.

We appreciated the comment and we changed the Figure accordingly

P13417, L20-L24: I suggest swapping these two sentences (first refer to the Fig before describing it).
We agree with the suggestion and we swapped the sentences presenting first the Figure.

P13418, L28- P13419, L2: The problem with zero or near zero precipitation can be solved treating zero value occurrences as censored data having unknown precise

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values but known to be below or equal to zero.
In fact the normal way to compute the SPI using the Gamma distribution when there are zero values is to compute the probability of having zeros separately. However this reduces the sample size used to compute the gamma probability density function and hence reduces the confidence of the SPI values obtained.

P13420, L8: . . . including the Greater Horn of Africa where there. . .(replace were with where)
Changed

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