

Response to reviewers

Manuscript for Hydrology and Earth System Sciences Manuscript number: hess-2015-393 2

Old title: Assessment of the influence of bias correction on meteorological drought projections for Poland

New title: Trends in projections of Standardized Precipitation Indices in a future climate in Poland

Authors: M. Osuch, R. J. Romanowicz, D. Lawrence, and W. K. Wong

Response to the Editor

Editor Decision: Publish subject to minor revisions (Editor review) (16 Mar 2016) by Jamie Hannaford

Comments to the Author:

Dear authors,

Many thanks for your revised version. The referees have considered this new version and appear to be largely satisfied with your responses to their major comments. However, there are a few minor comments which require addressing prior to acceptance for publication - please pay particular attention to referee #1's outstanding concerns.

I would be grateful if you could respond to these modest issues before I appraise the final manuscript.

with best regards

Jamie Hannaford

***Answer:** We thank the reviewers and the editor for the time taken to review and process our manuscript. In response, we have made the revisions, clarifications, and/or additions to parts of the manuscript, as outlined in this document. In the following sections, we respond to each of the reviewers' remarks or questions.*

Reviewer 1

General Comments

Thank you for your response to our review comments. As with your original submission, this update is well-written and clear, providing an interesting analysis of projected trends in normalized precipitation/meteorological drought for Poland. This update addresses many of the original comments; however, there are a few remaining issues which I would like to see addressed before final publication. I therefore recommend a minor revision.

Major comments

Addressing the original major comments:

1. The new title is much clearer and more accurate. I appreciate this change. It is ok to refer to the SPI as a meteorological drought index in the text, I simply wanted to clarify that you are not specifically measuring drought. This now comes through clearly in the paper.

2. I remain uncomfortable with the description regarding the effect of bias correction on SPI1 in the Results. You do a very good job in the Discussion section of explaining that the effect on SPI trends decreases from choice of GCM >> choice of RCM >> bias correction. But, the Results section still describes bias correction as playing a significant role, particularly in the last 2 paragraphs of page 48. For instance, line 17 states that the number of grid cells with statistically significant trends "... strongly depends on the month, climate model, and also on whether or not bias correction has been applied".

Including a test of Pearson correlation (Page 52) is interesting, but this test uses $H_0: r = 0$, $H_a: r \neq 0$. When this test is statistically significant ($p < 0.05$), it means that it is highly unlikely there is no relationship between raw SPI and bias-corrected SPI. You are not testing whether the time series are the same, but rather if they have any similarities. With 128 years of data (1971-2099, depending on accumulation period), the Pearson correlation need to produce $p < 0.05$ is only 0.173.

It is ok to include this p-value test, but you should not lose sight of the extremely high correlation >0.9 for most models (Table 3) and nearly identical spatial patterns among model pairs (Fig. 8 to 9). Also, there doesn't appear to be any consistent change (increasing vs. decreasing) due to bias correction among the models in Fig. 10. This is why I am concerned with the statement on Page 38, Lines 22-24 that "the use of bias correction slightly decreases the area with statistically significant trends in summer months (June, July and August) and slightly increases in the other months." This could be confirmed with a paired t-test, but the models in Fig. 10 appear to be randomly distributed around 0, except for February, when they all show positive differences.

The effect of bias correction is an interesting topic, which is appropriate to highlight in this paper. But, given the analysis and the fact that this is only a minor portion of this paper, I recommend softening the language in the Results section and instead including a sentence or two in the Conclusions that recommends further study of this effect in the future.

Answer: Corrected. Following the recommendation we softening the language in the Results section and we included a sentence in the Conclusion that indicates the need for further research.

Minor Comments

I have only 2 additional minor comments that should be addressed in a revision:

1. The Methods section introduces the principles behind the modified Mann-Kendall test for serially correlated data. Based on your text, I assume you use the standard Mann-Kendall approach for SPI1, 3, 6, and the modified Mann-Kendall for SPI12 and 24. But, in the Results and Discussion it appears that you use the modified Mann-Kendall for all variables. Please add a short sentence in the Methods clarifying exactly which test you used for which time series/variables (SPI1-24).

Answer: Corrected. The modified Mann-Kendall test was used for all aggregation scales (1-, 3-, 6-, 12- and 24- months).

2. The data in Table 1a. and Figure 10 do not match. Based on their descriptions, I believe they should. It appears that Figure 10 is actually plotting $(\text{corr} - \text{raw})$ divided by approximately 11.7. Using the high and low values in February as an example, Bias - Raw for KNMI-ECHAM and SMH-BCM are $427 - 240 = 187$ and $38 - 10 = 28$, respectively. These instead appear in Fig 10 as approximately 16 and 3. If you instead calculate relative difference by dividing this by Raw area, as described in the Figure 10 caption, the numbers change to 77.9% and 280%. This changes the

relative order, making the previous highest peak the smallest value and vice versa. Please check this figure/Table 1a.

Answer: Thank you very much for this comment. Figure 10 shows the differences in the percentage of grid cells with a statistically significant trend for data with and without bias correction. The values of these differences were calculated as $[(\text{corr}-\text{raw})/1166*100]$. Corr and raw denotes number of grids with statistically significant trend for corrected and raw data, 1166 denotes total number of grid cells. The caption to Figure 10 was updated.

Reviewer 2

Review:

This revision addresses all my earlier comments well. My major concerns and comments were addressed and changed. However, some minor comments are listed below.

Minor Comments:

P3: All paragraphs start with "This analysis..." or "Analysis of...", which is not very elegant.

Answer: Corrected

Suggestion: L23: "Another study of drought projections on a continental scale was carried out by Bleckinsop and Fowler (2007). In this paper six climate models..." L30: "Orlowsky and Seneviratne (2013) presented an investigation on future SPI12 characteristics, again on a continental scale."

Answer: Corrected

P4, L4: "Meteorological drought was estimated using the SPI at..."

Answer: Corrected

P4, L7-9: Delete sentence: "The analysis of change..." It is not relevant at that section.

Answer: Corrected

P10, L5: "was one of the major aims of this work."

Answer: Corrected

P10, L15-17: Some general comment: I don't see the problem in the SPI ranging at values beyond [-3,+3]. If you have a change in precipitation in the future and you compare it to present day climate, then you might reach more extreme values of the SPI (either dry or wet). The uncertainties are growing of course, moving towards the tails of the distribution. But there is no justification to say that an SPI must not be below -3 or above +3, since a unit normal distribution does not stop at these values.

Answer: Corrected. The sentence was deleted.

Please reconsider your formulations.

P21, L2: delete "as a measure of goodness of fit."

Answer: Corrected

P22, L9-10: "and considerable inter-model variability"

Answer: Corrected

P22, L13: "showing considerable differences between climate model simulations."

Answer: Corrected

P22, L13-14: "In general, our study also confirms the results..."

Answer: Corrected

P22, L18: "Our results indicate that the..."

Answer: Corrected

P22, L25: "We also noticed that..."

Answer: Corrected