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Discussions

Interactive comment on "Technical note: Pitfalls in using log-transformed flows within the KGE criterion" *by* Léonard Santos et al.

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We would like to thank Dr Lieke Melsen for her detailed analysis of the article. It helped us to clarify some points in the manuscript.

Major

- Page 6, line 3-4: "Furthermore, this result can be completed by making the same plot for other transformations giving more weight on low flows. Figure 4 shows that square rooted (Fig. 4 (a) and (b)) and inverse (Fig. 4 (c) and (d)) transformations do encounter the same problems as with the logarithm for catchments that have an average log-transformed flow around zero." This statement is incon-

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sistent with the figures. The square root transformation does show a completely different pattern. Please clarify

This statement is clearly inconsistent as we forgot a word. Instead of “do encounter”, we meant “do not encounter”. We apologize for this mistake that totally change the meaning of the sentence.

However, we can discuss a little this point: Dr Lieke Melsen is right when saying that the square rooted flows show a completely different pattern but, to a lesser degree, it is also the case for the inverted flows. Indeed, if the KGE’ on inverted values shows negative values for catchments that have an average log-transformed flow around zero, it also shows negative values for a significant part of the other catchments (Fig. 4 (c) and (d)). These negative values are more due to the difference between inverted flows and the untransformed flows than to some numerical flaws in the KGE’.

- Related to that; table 1 states that square root transformation does not increase low flow weight, but to me it seems that it diminishes the weight of high-flows, thereby somehow increasing the weight of low flows. Please clarify.

  The reviewer is right, by decreasing the high-flows weight, the square root transformation indirectly increases the low-flows weight. We stated this for the square root transformation in order to highlight the fact that this transformation increases low-flow weights to a lesser extent compared to the inverse, Box-Cox or logarithmic transformations.

  Instead of using two columns, namely about low and high flows columns, we propose to keep only one column named “Increases low-flow weight” and to use a different number of + signs as an intensity representation (+ for square root, ++ for logarithm, Box-Cox and the inverted square root, added following Dr John Ding comment and +++ for inverse).

- Page 8, line 3: I understand “optimistic” refers to a higher model performance for

KGE' when evaluated in l/s compared to m3/s. However, I don't really understand how Eq. 5 automatically implies this. In Eq. 5 I see that log(1000) is always added, but whether this leads to an improved or decreased model performance seems to me dependent on the bias in the model. Please clarify.

To clarify the impact of the added $\log(1000)$ we can calculate the bias ratio of log-transformed flows in $\mathsf{l} \cdot \mathsf{s}^{-1}$ regarding the average of log-transformed flows in $\mathsf{m}^3 \cdot \mathsf{s}^{-1}$. Using Eq. 5, the bias ratio is equal to:

$$\beta_{\mathsf{log}}[\mathsf{l} \cdot \mathsf{s}^{-1}] = \frac{\log(1000) + \mu_{\mathsf{log,s}}[\mathsf{m}^3 \cdot \mathsf{s}^{-1}]}{\log(1000) + \mu_{\mathsf{log,o}}[\mathsf{m}^3 \cdot \mathsf{s}^{-1}]} \quad (1)$$

In the tested data set, $\mu_{\mathsf{log,s}}[\mathsf{m}^3 \cdot \mathsf{s}^{-1}]$ and $\mu_{\mathsf{log,o}}[\mathsf{m}^3 \cdot \mathsf{s}^{-1}]$ (the log-transformed flows averages of respectively the simulated and observed flows in $\mathsf{m}^3 \cdot \mathsf{s}^{-1}$) are in majority between -4 and 4. Because $\log(1000)$ is higher than the flows averages (≈ 6.9), it will have a greater impact on the ratio calculation than the average flow itself which leads to a tendency to improve the ratio. As we use the KGE', the γ ratio is also affected and, because of the interaction between the average and the standard deviation of flows it is even more complicated to predict the ratio difference between $\mathsf{m}^3 \cdot \mathsf{s}^{-1}$ and $\mathsf{l} \cdot \mathsf{s}^{-1}$.

To illustrate this on the data set used in the article we plotted the values of the three KGE' components for the log-transformed flows in $\mathsf{m}^3 \cdot \mathsf{s}^{-1}$ and $\mathsf{l} \cdot \mathsf{s}^{-1}$ (Fig. 1 of this answer). Fig. 1 (c) shows that the bias ratio tends to be improved in $\mathsf{l} \cdot \mathsf{s}^{-1}$ especially for the catchments that have a bad bias ratio in $\mathsf{m}^3 \cdot \mathsf{s}^{-1}$. The difference between the two flow units is more complicated in the case of the coefficient of variation ratios (Fig. 1 (b)).

In a nutshell, the KGE' value tends to be higher because of the artificial improvement of the bias ratio but the coefficients of variation ratio can vary differently and lead to a decrease of the KGE' value.

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In the manuscript, we will replace “optimistic” by “higher model performances” and add some sentences to better explain the reasons of this apparent improvement of performances.

Minor

- Page 4, line 13 It would be good if the order of Box-Cox and adding a constant is changed in order to be consistent with results.

  It will be done.

- Figure 2 is relevant and insightful, but it takes some time to understand all information. Perhaps, it can be stressed in the caption that left, simulated in shown in red and right observed is shown in red (as is also done for a figure later in the manuscript).

  Regarding this remark, we propose to replace “ The red dots represent the catchments where the average of the log-transformed simulated (a) or observed (b) flows is around 0.” by “In plot (a), the axis values represents the observed log-transformed flows averages and the color represents the simulated ones while in the plot (b), it is the opposite.”

- Page 6, line 7 “remain correct”. Correct seems a vague term in this context (what is a correct objective function value?). Please consider rewording.

  The reviewer is right, the word “correct” is not well chosen, particularly because some of the NSE values in question are around zero which denotes a bad simulation. It will be replaced by “positive or around zero”.

- Consider to include the original KGE equation in Section 2 as well, especially because this information is relevant in the discussion of the modified Box-Cox. E.g. p. 9 l. 20, it will not affect the KGE because μ_s is not in the denominator

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in the original KGE (perhaps help the reader on this as well, e.g. on p. 10 just above the section Summary).

It is a good suggestion, an equation will be added replacing the γ term of Eq. 1 by an α. The E_{KG} in Eq. 1 will be denoted E'_{KG} and proper reference to the KGE equation in page 9 and 10.

- Page 3, line 19 conversation -> conversion

  It will be fixed

Léonard Santos, on behalf of co-authors

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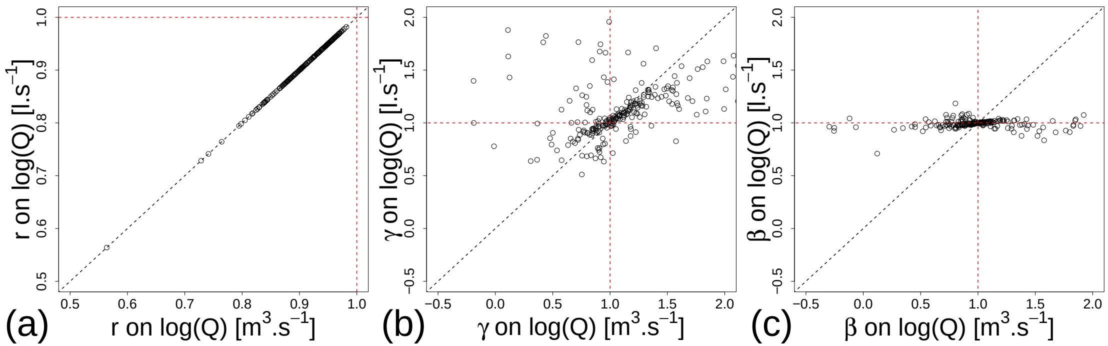

Fig. 1. Values difference between cubic metres and litres per seconds of the three components of the KGE' calculated on log-transformed flows.

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