Hydrol. Earth Syst. Sci. Discuss.,
doi:10.5194/hess-2016-46-RC1, 2016

Hydrology and Earth System Sciences
Discussions
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Interactive comment on "Evaluating Hydrological Model Performance using Information Theory-based Metrics" *by* Y. A. Pachepsky et al.

Anonymous Referee #1

Received and published: 2 March 2016

This is my review of the paper "Evaluating Hydrological Model Performance using Information Theory-based Metrics" (doi: 10.5194/hess-2016-46) by Pachepsky et al., which is currently under Discussion in the HESS journal.

The paper investigates the potential of four information theory-based metrics as diagnostic tools to guide towards selection of a hydrological model structure. The authors calculated the four info-theory metrics and the Nash-Sutcliffe efficiency (used as a benchmark metric to indicate the added value on information extraction from the info-metrics) for eight hydrological models (of different complexity) and five basins (of different climatic conditions). A period of 10-years was used to evaluate the models.

By reading the title, I had high expectations since various (both old and recent) investigations have pointed towards the use of metrics rooted in information theory (Amoro-

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cho and Espildora, 1973; Chapman, 1986; Weijs et al., 2010; 2013; Gong et al., 2014; Pechlivanidis et al., 2014; 2015). However, to my disappointment, the investigation did not meet my hopes.

Firstly, the article needs very serious revisions given the numerous grammatical/structural mistakes that are present. More importantly, I have pointed several major limitations, which I list below:

1. The title is very general. Note that the fact that you used information-based metrics in hydrological modelling is not innovative. This has been done since the 70s (see Amorocho and Espildora, 1973). In addition, by reading the title, someone should expect to build on performance metrics rooted in info-theory to enhance model calibration/validation. However, after reading the article, the use of info-metrics is rather to select model structures.

2. Abstract: the abstract does not point towards the new insights from this research. Info-based metrics have been used in characterising time series (1D approach; according to Gong et al., 2014) and also as performance measures (2D approach). For the latter, info-metrics have been used as single metrics (with results showing limited potential as standalone metrics) and multi-objectives (with results overcoming single-objectives and traditional multi-objective approaches). Given all these insights, I see limited contribution.

3. Material and Methods

a. You do not mention anything about the modelling experiment! Which period was used for warm-up and which for calibration (and validation if any)? Once again, you have used single objectives, which generally show limited potential, but no effort on multi-objectives.

b. One point that I found confusing relates to the need of transforming the discharge values into a string of symbols. It is not clear why this necessary was necessary,

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particularly given that the probability distribution function can be derived from the observed/modelled discharge values.

4. Results and Discussion

a. Subsection 3.1 is very general and its analysis is very basic to be listed in the Results section. You have not analysed any data in here, but you simply visualised them.

b. Subsection 3.2: I do not believe that this analysis and hence conclusions are robust enough. It is known that the physical processes (with longer memory as for precipitation) will result into flow dynamics that differ from precipitation dynamics. If you want a deeper understanding of how information is transfer within the river system, you should repeat this using data of soil moisture and other state variables depending on the model structure.

c. Subsection 3.3: Important analysis is missing on how you identified the models. Have you run any identifiability or sensitivity analysis? This is important to be presented given that the models, in 50% of their applications, perform poorly (NSE < 0.5; see Table 3). It is then an easy task for a different metric to show an added value. Also, I believe that you should have shown modelled streamflow time series using all the metrics. Only then you can visualise the characteristics of the flow signal that these info-metrics can capture.

Having those major comments in mind, in addition to the poorly written manuscript, and inadequate figures, my decision is to reject this article from publication to the HESS journal. I hope that the authors will take my suggestions into account in an effort to substantially improve their investigation and manuscript. (Note that I uploaded a file with all the minor comments)

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Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-46/hess-2016-46-RC1-supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., doi:10.5194/hess-2016-46, 2016.