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Comment on hess-2021-170

Anonymous Referee #2

Referee comment on "If a Rainfall-Runoff Model was a Hydrologist" by John Ewen and Greg Martin O'Donnell, Hydrol. Earth Syst. Sci. Discuss.,
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Review of the manuscript "If a Rainfall-Runoff Model was a Hydrologist" of Ewen and O'Donnell

Summary

In the manuscript "If a Rainfall-Runoff Model was a Hydrologist" by Ewen and O'Donnell, a set of parameterless rainfall-runoff models are developed in an experiment which aims to quantify the importance of the knowledge contained by the model itself. To make this knowledge explicit, the rainfall-runoff model is personified as a layman with an interest in the weather and river flows. The model is parameterless and relies on time-matching based on the similarity of the simulation day with a set of other days from the historical data record. The model performance of the developed KERR model is overall just slightly lower than the GR4J model performance for a set of UK catchments. A main finding of the paper is the strong relative importance of the temporal pattern of antecedent rainfall. This concrete model development example supports a broader and more philosophical discussion on hydrologic knowledge and laws within rainfall-runoff models.

The manuscript addresses relevant scientific questions on the role of hydrologic knowledge contained in rainfall-runoff models on model performance. However, at first read, I found the manuscript to be confusing in how it is structured and in its balance between the broader philosophical discussion and the very concrete, simple and specific modeling experiment. Which aspects of the specific example should or can we apply in more complex traditional rainfall-runoff modeling, is it the knowledge documentation through personification of the rainfall-runoff model?

I hope that the comments below will help improving the manuscript.

General comments:

1) The aim of the paper is not clearly stated in the abstract, I would suggest to explicitly add it. The aims are described in L70 and later L110 and in L174, however, throughout the manuscript it remains unclear what is exactly meant by 'corruption' of hydrologic knowledge flows within RR modelling. Could you clarify this further?

2) The manuscript does not contain a dedicated Conclusion section. Concluding remarks are provided in the Summary of Section 8. However, I think it would help the reader to include a dedicated conclusion section which specifically links back to the aims of the study. This would help to clarify the main message/focus of the manuscript.

3) The experiment was performed for a set of UK catchments. Could you discuss the application of the developed parameterless models and the conclusions drawn on the importance of wetness in the light of different climatic zones?

4) How could the proposed methodology of quantifying the importance of hydrologic knowledge held by the MH on model performance be applied in more traditional rainfall-runoff modeling?

5) Hydrological modeling is often used in practice to quantify the effect of change in a catchment (e.g. land use). In science, hydrological modeling is often used to increase our

understanding of catchment functioning. Both would be difficult using the proposed approach of the parameterless model, could you please elaborate on this?

6) The manuscript includes several references to the study of Jakeman and Hornberger (1993). However, a short summary of the main aspects of this paper in relation to the current paper seems to be lacking.

7) The way the work is presented is sometimes confusing. For example, in Section 4.2, the Trivial and Seasonal RR models are presented. Later in Section 6, an additional Wetness model is mentioned. In Table 6, also the KERR model is presented. Perhaps, it would be good to clarify this in Section 4.2 and in the Method section 3 so that the reader has a better understanding of the main approach.

Specific comments

L5: Could you add here why personification can also be instructive?

L10: Simplification of complex systems is inherent to modeling, but I guess you want to quantify how and which of the knowledge contained in the model mostly affects model performance?

L11: What do you mean by classic MH?

L17: I found the sentence with "the relative importance is measured as 1 and 6" rather confusing. Do you mean: antecedent wetness is 6 times more important than seasons in simulating runoff in a time-matching modeling approach? I would suggest rephrasing this sentence (also in the Summary section).

Figure 1: Although mentioned in the caption, it was at first read not entirely clear to me that the numbers refer to the knowledge statements of the different Tables, I would suggest rephrasing the caption to clarify.

L66-67: Could you elaborate further on this?

L70: As mentioned before, what do you exactly mean by 'lost or corrupted' hydrologic knowledge flows within RR modeling?

L72: What do you exactly mean by science is an "activity and attitude"?

L73: Could you elaborate further what you mean by the significant deficits, difficulties or dangers?

L85: It is not clear to me what you mean by "not well behaved", could you clarify?

L111: aim (3) is not entirely clear, could you elaborate on "the need to draw valid hydrologic conclusions"?

L134: In 'traditional' hydrological modeling, would you also recommend describing equations in the form of statements in everyday English? How does this relate with the more commonly provided model descriptions and equations?

L138: with "Here," do you mean: in the models being developed in this study?

L141: could you specify conclusion 3 in Sect. 1, it is unclear to me to which point you are specifically referring to.

L174: when you mention "one of the aims", I would find it helpful to also have a recap of the other aims of the research.

L198: I am not sure to fully understand what you mean by “the MH should know why”, could you clarify this part?

L201: “from such an experiment”, do you mean an experiment without data fitting?

L259: in contrast to the Trivial and Seasonal models, the Wetness model was not introduced earlier.

Fig2: Rain is a flux and should therefore have unit [L/T], I assume here it is mm/d. It is somewhat confusing to show negative values on the y-axis of the top panel. It would be clearer for the reader if *rainfall pattern difference* was also explained in the text describing Fig 2.

In the paragraph 313-319, the horizontal alignments around 1996 are explained twice.

Table 6: is the KERR model a general name for the Trivial, Seasonal and Wetness models and a fourth model? Could you please clarify?

L355: could you elaborate: "when drawing conclusions" on what?

Table 9: conclusion based on the third statement "Unpredictability" are not explained in the text of Section 7.1. This statement only comes back in the Summary of Section 8. Could you please elaborate on this finding already in Section 7.1?

L429: Here, I would suggest to explicitly mention "wetness, seasonality and unpredictability" to clarify: "the three pieces of hydrologic knowledge given in 8 and 9".

L449: Could you elaborate further on what you mean by the wetness kernel and discuss more in detail the related hydrologic law?

Discussion: how important is personification of RR models? This seemed to be an important focus point at the start of the manuscript.

Typos:

L14: a MH instead of an MH

L228: meteorological instead of metrological