

Responses to Anonymous Referee #2

The study is based on the comparison of two well-known models. It seems that the objective is truly very narrow and does not contribute significantly to enhancing our understanding of hydrological system functioning. As such, I find it of very limited relevance to HESS. It might be more suitable to an application- or mathematically oriented Journal, even as I am not sure that there are significant advancements in terms of mathematical developments.

Reply: We thank Referee #2 for his/her suggestions and comments, which helped improving the manuscript. The Nash cascade model is a widely used flow routing model in hydrology. To make a higher precision of the model, many hydrologists have made a great effort to improve the model in different ways. The discrete linear cascade model (DLCM) and the generalized Nash model (GNM) are such models to improve the original Nash cascade model by considering the initial state. Based on the physical interpretation of the GNM, with the initial state included, the outflow can be thought to be generated by two parts, one is the initial storage water stored in river or watershed, and the other is the input (upstream inflow or precipitation). In the comparison of these two models, the reconstruction as well as the interpretation of the DLCM was made, which makes it more conceptual in hydrology and not only a mathematical formulation any more. We hope this comparison can help the model users make a clearer understanding of these two models and also the process of the outflow generation. The goal of this technical note is not only about the solution to a mathematical problem, but also about the physical interpretation of the flow routing process, which the hydrologists concern more.

A point which is not entirely clear to me is the basis for statements of the kind “The results show that the GNM provides a unique solution while the DLCM has multiple solutions depending on the estimate accuracy of the current state”. They then state that observed values do not need to be estimated, thus implying that observed values are not associated with uncertainties. If a key difference is related to GNM being associated with observations (and not estimates), one could also claim that observations are always associated with measurement uncertainty/error. How do the Authors reconcile this aspect? There seem to be no mention of this aspect in the study.

Reply: This sentence is not clear and we have rewritten it as follows:

The results show that the GNM provides a unique solution while the DLCM has multiple solutions, whose forecast precision depends upon the estimate accuracy of the current state.

There seems to be a misunderstanding of the Referee #2 to our manuscript. The main purpose of this paper is to clarify the relationship and difference not the uncertainty analysis for these two models. So the measurement errors are not considered in this

paper. In hydrologic modeling, uncertainties can be classified into three primary types: structural errors, parameter errors, and data errors. Even for the uncertainty analysis, the difference between these two models is mainly from the model structure.

In the example section, the Authors mention relying on an optimization approach to estimate model parameters. It seems to me that parameter estimation uncertainty is neither quantified nor considered and I am not sure why.

Reply: As we have claimed, the purpose of this paper is to clarify the relationship and difference not the uncertainty analysis for these two models. So the parameter uncertainty is also not considered.

With reference to non-uniqueness of the solution, I am not sure why this is not compatible with typical uncertainty propagation analyses that are performed in environmental systems. Since there is uncertainty in some quantities, the latter should propagate to model outputs. Such an uncertainty can also be associated with initial conditions. The Authors should also comment on these aspects in future works.

Reply: The uncertainty propagation analysis is a good idea. With the initial state included in the two models, especially for GNM with an explicit expression of the initial state, uncertainty propagation of the initial state we think can be easily analyzed by Monte Carlo simulation. We will make such study in our future works. Thanks for the Referee's suggestion.

In terms of comparisons, I am not sure about the point raised by the Authors. They claim that the results obtained by the DLCM approach are approximated (I guess when considering results obtained through the continuous counterpart of an otherwise discretely sampled signal). I am not sure about what elements we learn from this exercise with respect to other studies on signal analysis that are available in the literature.

Reply: There seems to be a misunderstanding of the Referee #2 to this conclusion. Actually, all the models including the DLCM and GNM in this study are approximations to the real world. In our conclusion, the DLCM is said to be an approximation of the Nash cascade model mathematically not because it is sample-data based but because its initial state is estimated. In comparison, the initial state in the GNM is implicitly written in a form of derivative strictly based on the linear reservoir assumption and does not need to be estimated separately. Hence, the GNM is an exact solution to the Nash cascade model.

Finally, it should be noted that the quality of the English is really substandard, thus posing difficulties to the reviewer. I am not providing specific examples simply because they are widespread throughout the text.

Reply: The manuscript was carefully reread to check for language issues. We have replaced the initial mistakes and edited the sentences carefully. Thanks again!