Interactive Comments and Responses on "Sub-daily runoff simulations with parameters inferred at the daily time scale" by J. E. Reynolds et al.

Anonymous Referee #3
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Review of "Subdaily runoff simulations with parameters inferred at the daily scale" by Reynolds et al.

The manuscript is concerned with the topic of exploring the dependence of model parameters and simulations on the time scale of the data. The paper is generally well written and easy to read.

Reply: Thank you for your positive evaluation of our paper in general.

I have the following comments:

- The topic of time scale dependence has received quite a bit of attention in the literature. The manuscript cites most of these papers, but it is not clear in what way the findings of this study enhance existing knowledge.

  For example, the impact of numerical time stepping artefacts has now been shown quite comprehensibly. Is the paper intended as an additional demonstration of this - which is useful in the sense of a case study for a specific location - or does it intend to go beyond - and if so in what way?

Reply: We realize that we failed to state clearly the novelty and contribution of the study in our original submission. In the revised version we will better explain the novel aspects, namely the analyses of the time scale dependencies by running the model always at the same time step but with input data series aggregated at different time scales. This is a simple approach to separate time step dependencies due to input resolution and due to numerical issues we have not seen in the literature before. This paper also provides an example of the erroneous conclusions that can be made when unsuitable numerical methods are used at large steps in hydrological model applications while at the same time gives insights of how to approach flood forecasting in catchments with sub-daily concentration times when daily data are available. From practical point of view, it was shown that the time scale dependence almost fully disappeared when the explicit Euler method was used for modelling in 1 h time steps internally irrespectively of the time scale of the input data, indicating that flood forecasting in watersheds with sub-daily concentration times may be possible with model-parameter values inferred from long time series of daily data.

In the revised version we will make the above points clearer in the abstract, introduction, discussion and conclusions.

Some of the stronger conclusions are assumed to hold under general conditions despite the case study being an empirical one based on a single model single catchment.

Reply: We agree. In the revised version, we will make it clearer that our results found herein are only valid for the study area and model structure chosen for this work. However, the methodology of course could be applied to other regions and models.

For example, while I agree that the use of robust time stepping schemes goes a long way towards alleviating many of the time scale dependencies, surely once you start averaging out the fine-scale features of high-resolution data, there has to be an impact on the identifiabilite/values of parameters, etc.

Where would the information about these processes come from? What about fast responding catchments? I think more care should be taken when distinguishing between estimating average vs instantaneous (peak) flows, etc - as these may behave very differently.

Reply: We agree. Many of the fine-scale physical processes that characterize catchments are hidden by the aggregation of the input and conditioning data at large steps. A loss of information or some limitations to reproduce fine-scale dynamics are expected by those parameter values inferred at large steps compared to those inferred at short steps. In the revised version we will make the above points clearer.

I think a lot of the nuances expressed in previous studies have been overlooked in this presentation, especially in the conclusions as listed in points 2-4.

Reply: Thanks for your comments and sorry that we missed to include some of the main arguments expressed in previous studies in our original submission. We will include a more detailed discussion of the literature review in the revised version of our manuscript.

- Some questions reguarding the technical aspect of the computations.

  For ekzample, See Fig7 - I do not understand why the width of the prediction limits decreases, to the extent that the simulations in panel d completely fail to capture the observed data. Something must have gone wrong in the uncertainty analysis, as predictive uncertainty appears grossly under-estimated.

Reply: You are correct. We realized that there was a mistake in the uncertainty analysis, which caused an error in panel b. Panels c and d were correct. The correct version of Figure 7 is shown below.

For clarification, panel b shows the predictive uncertainty bounds of the behavioural parameter sets inferred with input data at the 1-hourly scale during the conditioning period to simulate daily runoff; panel c shows the predictive uncertainty bounds when the parameter sets inferred with input data at the 6-hourly were used to simulate daily runoff but using input data at the 1-hourly scale instead; and panel d shows the predictive uncertainty bounds when the parameter sets inferred with input data at the daily scale were used to simulate daily runoff but using input data at the 1-hourly scale instead.

Panels c and d are examples of how the predictive uncertainty bounds would look if parameter sets inferred at a given condition (i.e. input data during conditioning at the 6- and 24-hourly time scales respectively) are used on other conditions in which they were originally inferred (i.e. both with input data at 1-hourly scale). Here is clearly shown that some loss of information occurs when this procedure is done, however the estimates were not far from reproducing the observations.

Regarding the predictive uncertainties appearing to be under-estimated, we think this may be aggravated when these are compared with the large uncertainties of the observed data, especially at the high flows. From a practical point of view, predictive uncertainties bounds as large as of the observed runoff may not be very informative.

Nevertheless, we have decided to remove the results regarding the ability of the model to produce mean daily runoff with input data at different time scales in the revised version of our manuscript since Referee #2 pointed out that those results are not relevant to the main objective of our study (i.e. to produce sub-daily runoff with parameters inferred at the daily scale).

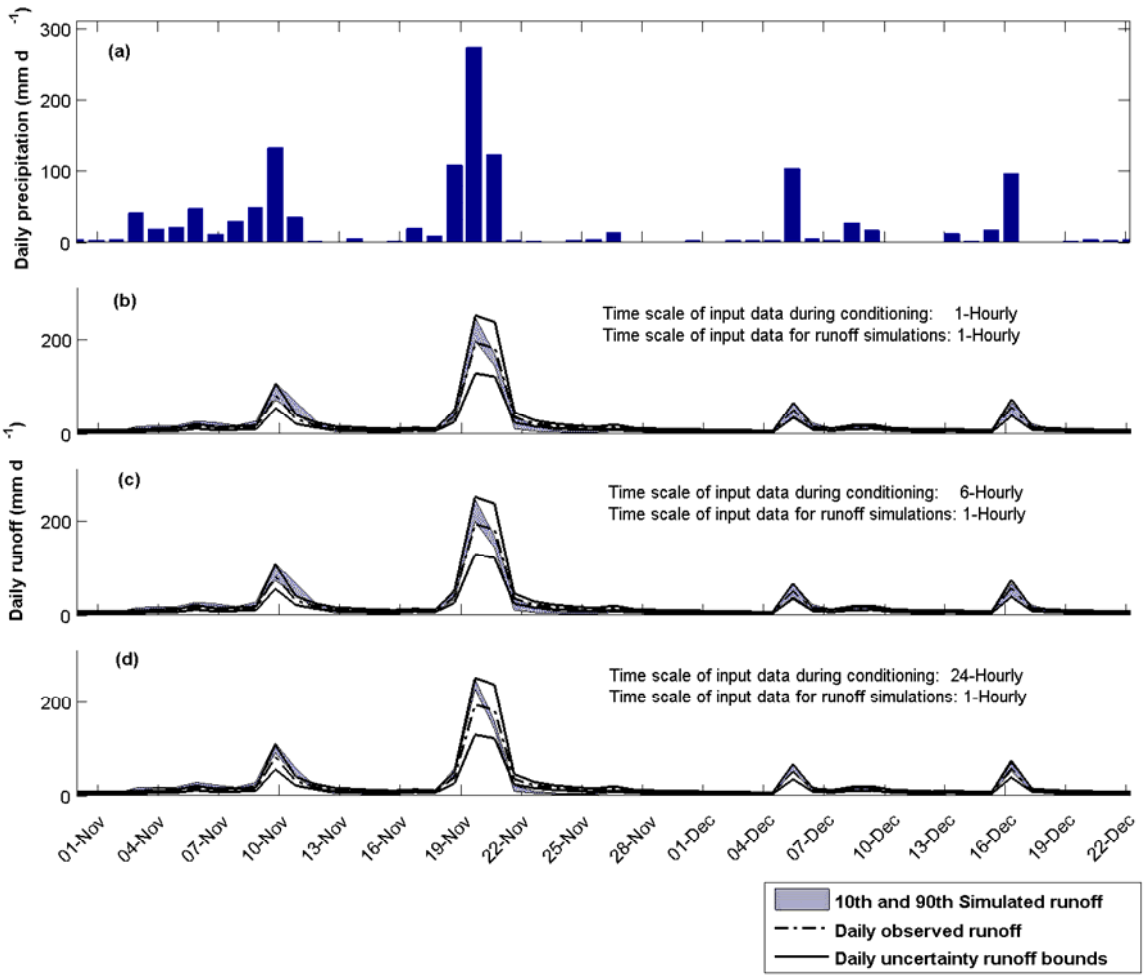

Figure 7. Daily precipitation (a) and uncertainty limits (10th and 90th percentile) of observed and predicted daily runoff (b-d) in the conditioning period using parameter sets inferred against daily observed runoff ($MC_{EED,Q=24\,h}$). The period shown is towards the end of 2004.

> The lack of diagnostics of predictive uncertainty is a fairly major omission. Looking at the hydrographs, maybe the Authrs forgot to account for residual error uncertainty in the predictions. I would recommend the authors use some basic least squares statistical analysis packages and they would obtain much better uncertainty estimates (probably at a fraction of the current computing cost).

Reply: You are correct. We did not include diagnostics of predictive uncertainty since we did not make assumptions of the model residuals that could impact the predictive uncertainty bounds. Within the GLUE uncertainty analysis framework, residual errors are generally treated implicitly, and assumptions about the nature of the model residuals and diagnostics to check these assumptions are not required explicitly to be made. For this study, the predictive uncertainty bounds are defined by the probability limits made by the behavioural parameter sets.

- In terms of nomenclature/terminology - it would be clearer to avoid the acronym EXP in reference to "experiment" in a study that talks a lot about the Explicit Euler scheme. I found this a bit confusing/distracting when going throu the presentation.

Reply: Thanks for your comment. In the revised version we will remove the acronym EXP.

If these issues above could be convincingly clarified, the contributions and validity of the study would be more apparent.

Thank you. We will try our best to revise the paper in accordance with reviewers' comments and suggestions.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 7437, 2015.