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 #1
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This paper compares various numerical methods for the implementation of the HBV light model, in order to analyze the time scale dependencies of model parameters. The paper concludes that the time scale dependencies can be eliminated through appropriate choices of numerical methods, and it suggests as one of the conclusions to run the model at the time step of its intended use (e.g. hourly), even when data are available at coarser (e.g. daily) time scales.
The paper is interesting, and it brings to the attention an issue that is often overlooked.

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

However, there are several problems, which can be overcome through a careful revision.

- The paper does not address its main motivation, which is to produce forecasts at subdaily time scales, when data are available at daily time scales.

  In fact, the case study uses available 15-min discharge data aggregated to 1-, 3-, 6-, 12- and 24-hourly time series. The Authors used the hourly data to construct the aggregated time series, which would not have been possible if the hourly data were not available.

  If the Authors wanted to conduct an analysis which complies with their motivation, they should have used daily streamflow readings (i.e. the streamflow at a particular time of a day), and see how the simulation using these data would work if hourly data were available.

Reply: Thanks for your comment and sorry that we failed to make it clearer in the original version. Yes, our main motivation was to produce forecasts at sub-daily time scales, when data are available at daily time scales. The goal was achieved in two steps, first, thanks to the availability of the short-scale data (which is a very rare case in Central America) which allow us to make cross scale comparison of model performance as well as the stability of model parameters with change of time scales in the paper; second, we examine the performance of sub-daily simulation using daily input data. In the revised version we will add some results (Figures and/or tables) to address more of the model performance on sub-daily scales when using daily input.

Just as reviewer mentioned this study takes the advantage of availability of short scale data, you are also right that it would not have been possible to perform the study if the hourly (or less than a hour) data were not available. These short scale data are necessary to perform the cross scale comparison of model performance as well as the variability of model parameters with change of scales, in the application of our results, no such data are needed.

- It is difficult to draw general conclusions from a single model / single catchment study.

  In fact, the conclusion that 'parameter sets inferred at one time scale (e.g., daily) could be used directly for runoff simulations at other time scales (e.g., 3 or 6 h) without any time scaling' may not be general. Such conclusions depend on the type of catchment and its associated processes, and on the difference between 'one time scale' and 'other time scales'.

Some catchment demonstrate processes that have a subhourly time scale, which would not be visible at daily resolution. Moving from daily to 6 hrs data is different than moving from monthly to hourly data. Arguably, it would be very difficult to reconstruct daily or hourly time series from monthly data.

The use of more catchments with different processes (e.g. fast reacting and slow reacting systems) and the comparison across a wider range of time scales could help to clarify this issue, and point to more specific and constructive conclusions.

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. Using more catchments with different processes (e.g. fast reacting and slow reacting systems) and comparing across a wider range of time scales could help to clarify more this issue, but this was not considered as a part of the current paper for two reasons. First, the current paper is mainly focused on methodological study rather than a cross comparative study involving more catchments and models, second, such a study is to be carried out in our on-going research when we have collected more data.

- The Authors state that the explicit Euler method at 1 h time steps is an adequate numerical method (abstract). This conclusion is largely empirical and related to the particular conditions of the case study. Earlier work discouraged the use of the explicit Euler for the implementation of hydrological models. In light of this, the Author should not present this as a general conclusion.

Reply: We agree. We will remove our statements about the explicit method at 1 h time steps is an adequate numerical method and will rephrase them as a practical numerical method if the size of the time interval used is sufficiently small, as shown in this work. As you pointed out in your comments, this may be related to the conditions of our study case, which we will state in our final presentation.

- This paper adds little to other papers in the literature. The issue of time scale dependencies has already been comprehensively discussed in earlier papers (cited in the Authors work).

  The authors should therefore put some efforts to bring out the novelty of their work.

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.