We thank the reviewer for taking the time to review our manuscript and for providing valuable comments to further improve the manuscript. Below, we give a response (in blue in 'normal' font) to the reviewer comments (included in italic).

Comments

1. wflow_sbm simulates multiple hydrological processes with different time scales using flexible temporal discretization. Modeling time steps can vary from daily to sub-daily, depending on the size and characteristics of the catchment of interest (and that's good). However, without proper disaggregation or aggregation of temporal variables, a potential problem may arise, where changing time steps can lead to unreliable model responses. Except for the sub-daily Rutter interception model, it remains unclear whether varying model time steps are available or not for most of the other hydrological components. In particular, temperature-related variables, such as soil temperature, infiltration and snow melting, may be sensitive to the selection of the model time step. For instance, the infiltration through multiple soil layers described in sub-sections 2.4.1 and 2.4.2 is a sub-daily process, which may lead to over- or under-estimation of the process if a daily time step is applied. Therefore, it is recommended to specify how different hydrological processes with varying temporal scales can be integrated within wflow_sbm and to outline the precautions that should be taken to avoid potential drawbacks.

Good point. The Rutter interception model is indeed used for sub-daily model time steps. For kinematic wave river flow and overland flow routing sub model time steps (within the model time step) are possible (see also Lines 521-527). For the infiltration through multiple soil layers a maximum change in soil water is allowed (to prevent "overshooting") and thus smaller time steps than the wflow_sbm model time step are possible. This information is actually missing in sub-section 2.4.2 and we will add it in the revised version of the manuscript. Additionally, we propose to add this information also to section 2.1 of the revised version of the manuscript, including precautions that should be taken (for example for the lateral subsurface flow routing component the model timestep is not yet adjusted, for certain grid size and model time step combinations this may result in loss of accuracy (also related to comment 4), and the use of an explicit scheme means that results from a daily time step model may be different from those with an hourly time step).

2. In most of the example simulations, especially in Fig. 12, significant mismatches between observations and simulations are found in the timing of flood peaks. Although not clearly evident since hydrographs are drawn for several months or a year, the peak timing differences seem to exceed several days, which is a drawback for a hydrologic model. It is uncertain whether the multiplication parameters, f_Kh0 and f_v0, are properly calibrated for example cases. In my view, inadequate integration of hydrologic processes with different time scales may also affect the timing errors of flood peaks.

We agree, there are mismatches between observations and simulations in the timing of hydrograph peaks. The main purpose of the first two model cases is to illustrate the model sensitivity to model parameters f_{Kh0} and f_{Kv} and how this affects the contribution of lateral subsurface and overland flow to river discharge and the water table depth dynamics, and not so much to perform a (full) calibration. This is also the case for the other simulations, based on the a-priori parameter estimation we show the wflow_sbm performance by only changing the model parameter f_{Kh0} or L_{max}. Additionally, we make use of global available forcing datasets (except for the model case in sub-section 4.2.2) for the simulations, that very likely also contribute to mismatches between observed and simulated hydrograph peaks. Finally, to get a better match it is in our view required to also include other model parameters (for example manning's roughness) as part of a calibration procedure.

3. While improving overall model performance, considering constant groundwater loss seems to significantly reduce the volume of small to mid-size runoff events, potentially causing another problem. As shown in Fig. 14, different from observations, the runoff simulation with groundwater loss for small events before Aug 2010 is nearly zero.

Yes, the applied uniform maximum groundwater loss value of 0.6 mm/d for the catchment results in an underestimation of observed discharge before August 2009. This is not a "constant groundwater loss", but a maximum groundwater loss value. The actual groundwater loss (computed by wflow_sbm) is controlled by the vertical hydraulic conductivity at the soil bottom and the saturated store (see also Eq. 81) and may vary spatially and in time. The maximum groundwater loss value is based on literature. Thanks for pointing this out, we propose to add this to the revised version of the manuscript, including some recommendations for possible further improvement. For example, by using a lower uniform maximum groundwater loss value (we use 15% of 4 mm/day, and this is the upper range value (10-15%) reported by Séguis et al. (2011)), or by using the discharge observations of the different stations within the catchment for deriving upstream maximum groundwater loss values within the reported range by Séguis et al. (2011).

4. While using a global data set, wflow_sbm seems to target local applications. The size of application cases ranges between 434 and 28,000 square kilometers. For those local applications, a typical spatial resolution of 1 km may not be considered high resolution. Even for small-sized catchments, wflow_sbm seems not to be tested for a spatial grid finer than 1 km. Please describe the potential challenges of the model when applying the high-resolution grid finer than 1 km.

The focus of the manuscript is indeed on local applications using a global dataset, however local data (that may be more accurate) can of course also be used to setup a wflow_sbm model and wflow_sbm has been applied to larger basins (for example the Rhine basin) and at the continental scale (Europe (not reported yet)). When applying wflow_sbm at a higher resolution than 1 km, computational time, memory usage and data storage (depending on gridded output) will increase. Finally, as for the lateral subsurface flow routing component the model timestep is not yet adjusted (see also our response to comment 1), a high-resolution grid may result in loss of accuracy depending on the model time step and model parameters related to lateral subsurface flow (e.g. land slope and horizontal saturated hydraulic conductivity). With a daily model time step, we estimate to use a minimum grid resolution of 200 m for generally accurate lateral subsurface flow results. For more information with regard to using wflow_sbm on different spatial resolutions, we refer to the paper by Aerts et al. (2022).

5. Please check "groundwater loss" in the sub-section 4.2.5 is the correct expression. When the water is lost in the stream to the groundwater, it is usually called channel (transmission) loss or river water leakage.

The term "groundwater loss" is the correct term, as it is water that is lost from the saturated store. To clarify, we will add this to sub-section 4.2.5 in the revised version of the manuscript.

6. typos

Line 812: 1) improve -> 1) to improve

Thanks for catching this typo, we will change this in the revised version of the manuscript.

References

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