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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A Framework for Automatic Calibration of SWMM Considering Input Uncertainty" *by* Xichao Gao et al.

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The study investigates the effects of rainfall errors and parameter uncertainty on SWMM rainfall-runoff simulation and calibration. It brings together existing methodologies (SWMM, DREAM, rainfall error model) and presents an application for a small urban catchment in China. This is an interesting topic but I have several critical comments on the current manuscript. -novelty: the presented methodology is not really new, but is mostly an application of existing methodologies to a SWMM modeling case study. The paper would be much more novel if the results would be used to gain new insights about the system's response and test additional model improvements. In other words, also bring in structural model errors, since they appear to be significant in the case study (see below).

Reply: we added a first-order autoregressive model to represent the autocorrelation of the residuals and thus to consider the structural uncertainty of the SWMM model in the revised manuscript. And deficiencies of SWMM are also discussed in the revised manuscript. Thank you.

-the main conclusion of the paper is that accounting for rainfall errors improves simulation of rainfall-runoff response with SWMM. For example on line 295: "The results show that the runoff simulated with considering both parameter uncertainty and input uncertainty captures peak flows much better than that only considering parameter uncertainty, especially for the validation period." This conclusion is not supported by the results in fig. 5 and 11, which show mixed results, i.e. both better and worse performance after accounting for rainfall errors.

Reply: Yes, you are right. The previous statement about the peak flow was not accurate. The figures about simulated flows show mixed results. To further evaluate the calibration results, we calculated the bias of peak flow (Figure 1) and total flow (Figure 2) in the revised manuscript. The performance of the two calibration approaches mixes in terms of peak flow bias, while the approach considering rainfall errors performs better than the approach not considering rainfall errors at least in the calibration period. Thank you.

-several modeling assumptions are not met. For example, the residuals are assumed iid gaussian. This assumption is clearly violated in figs. 5 and 11, which show significant systematic deviations between simulated and observed discharge, that indicate one or more aspects of the system are not captured in the model.

Reply: Yes, the assumption of the idd gaussian of the residuals is usually not realistic in hydrologic modeling. The time series of residuals are typically autocorrelated and nonstationary. We added a first-order autoregressive model to represent the autocorrelation of the residuals and thus to consider the structural uncertainty of the SWMM model in the revised manuscript. Besides, BOX-Cox transformation of the simulated and observed streamflow is used to reduce heteroscedasticity. Thank you.

Another example relates to assumed unbiasedness of the rainfall measurements, (line 152). Results of the case study show that estimated rainfall multipliers are all greater than 1 (fig. 9). So at least for the case study, the unbiasedness assumption needs to be revised. Indeed, if, as suggested by the authors, rainfall errors are caused by wind-related undercatch, then one can expect systematic underestimation of rainfall.

Reply: Yes, you are right. The posterior probability distribution of the rainfall multipliers shows the assumption of unbiasedness is inaccurate. However, since the Bayesian inference can find the posterior probability distribution of parameters through the prior probability distribution, the prior probability distribution of the parameter does not need to be very exact. We therefore consider the assumption of unbiasedness to be acceptable. Thank you.

-line 154: it sounds like the optimal value of sigma_m was obtained "manually", but such manual calibration was criticized earlier in the introduction. Why not automate the estimation of sigma_m? Either by jointly estimating sigma_m together with the other parameters, or if possible, integrating out sigma_m from the posterior before running MCMC.

Reply: as you suggest, σ_m was jointly estimated in the revised manuscript. Thank you.

-how was sigma_e (residual standard error) in eq.6 estimated?

Reply: The calibration efficiency is highly dependent on σ_e. We artificially assigned a value to this parameter weighing accuracy and efficiency. Thank you.

-line 170: empty parentheses, missing equation?

Reply: Sorry, the storm depth multiplier “m” was missed. Thank you.

-the case study considers a very small catchment, is spatial variability of rainfall an

important source of rainfall error here (as suggested in the introduction)?

Reply: Generally speaking, the spatial variability of rainfall in small natural catchments is not obvious. But in urban areas, the local wind field is unevenly distributed caused by complex terrain. As a result, the rainfall intensity is also unevenly spatial distributed affected by the local wind field. Therefore, the spatial variability cannot be ignored even in a relatively small urban catchment.

-line 191: why are these rainfall events selected and why so few? The small number of events considered here limits robustness of any conclusions drawn from the analysis.

Reply: So far, we have only collected these data, limited by the meteorological conditions and the measurement facilities. We will supplement rainfall events data and further analyze the results in the future. Thank you.

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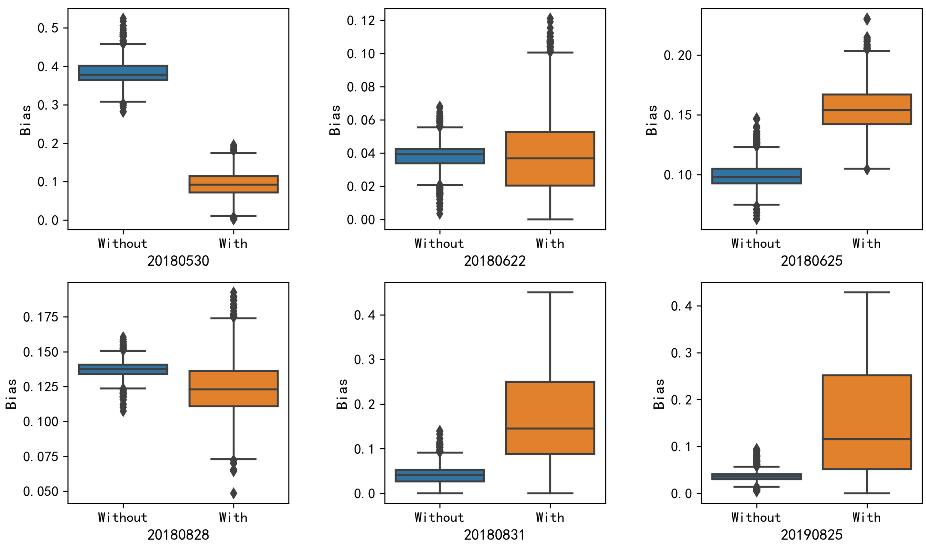

Fig. 1. Peak flow bias of simulations obtained through the two different calibration approaches.

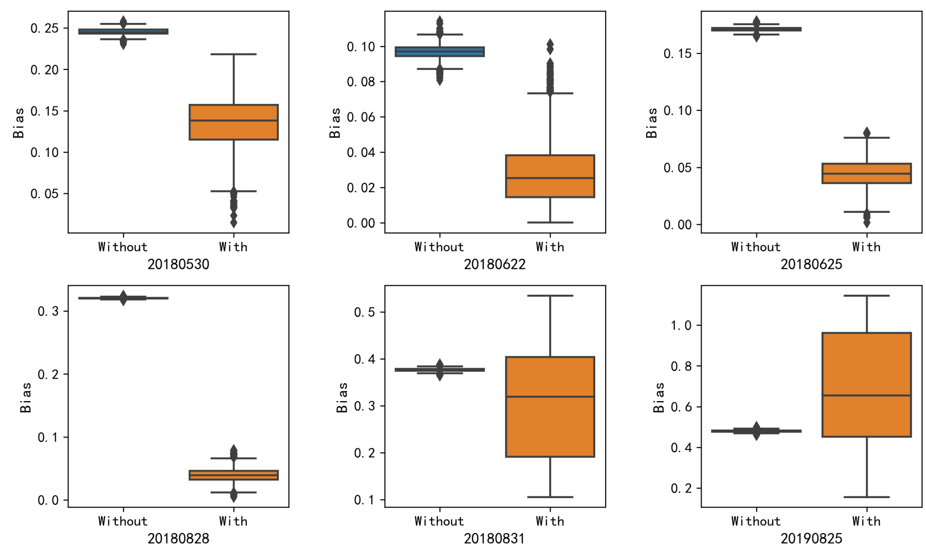

Fig. 2. Total flow bias of simulations obtained through the two different calibration approaches.