Hydrology and Earth System Sciences Discussions

Interactive comment on "Distributed hydrological modeling in a large-scale watershed of Northern China: multi-site model calibration, validation, and sensitivity analysis" *by* S. Wang et al.

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Anonymous Referee #2

The authors investigated the effect of two calibration protocols (single-site calibration and multi-site calibration) on the performance of MIKESHE model for simulating hydrological processes within a large mountainous watershed in China. The topic is of interest and importance since the model calibration is a complex process for distributed hydrological model. Generally, the paper was well written and presented. The research presented in this paper represents a valuable contribution to the MIKESHE modeling

studies. I suggest that this paper be accepted with minor revisions.

Response:

We would like to thank reviewer 2 for the valuable suggestions and comments. According to the reviewer's suggestion, we have revised the manuscript, and we tried to answer the questions raised by the referee. We believe that, all of the suggestions and questions are beneficial to improving our manuscript, and greatly enhance the quality of the publication.

1. There are a number of typos in the paper.

Response:

We have read through the whole manuscript to examine the errors of typos in the paper. Also one of our co-authors who are familiar with foreign language has helped to polish the manuscript.

2. Page 5708, line 6-9: "the model generally underestimated the streamflow of flow regime ranging 1 to 10 m3.s-1 around, whilst over-predicted when the flow regime was lower than 1 m3 s-1 around. The systemic underestimations of low flow suggested that there existed errors on ground water simulation." – it is unclear what is the range of "low flow" in this paper. Is it meaning flow between 1 and 10 m3.s-1? In fact, it can be observed from Fig. 2 that the model had a consistent underestimation for the three stations when the flow was greater than 1 m3 s-1 except for the Dage station during the 1991-1996 period. If the "low flow" was meaning "flow less than 1 m3.s-1", then the statement should be "systemic overestimations".

Response:

The "low flow" in our modeling analysis mainly refers to the flows below 10 m3.s-1. The model generally underestimated the flows of 1 to 10 m3.s-1, whilst overestimated the flows of below 1 m3.s-1. In order to clearly and accurately explain our modeling results without confusion, we have rephrased the statement of "The systemic underestimations

of low flow suggested there existed", and the revised expression was "The systemic underestimation for the flows of 1 to 10 m3.s-1 suggested that there existed". Also, in the whole manuscript, we have tried to clearly define the "flows" with a specific regime range when we were talking about discharge simulation results.

3. As compared with the single-site calibration protocol, the multi-site calibration protocol is generally associated with lower "R" and "EF" values for the three stations during the validation period as observed from Table 2. Therefore, the conclusion "We conclude that to account for the different hydrological process of watershed with large heterogeneity, it is necessary to employ a multi-site calibration protocol to reduce prediction errors" seems not very strong although Fig. 4 shows that the EF value was improved for two years (1997, 1999) during the validation period of 1996-1999. In fact, by comparing Fig. 2 with Fig. 3, it can be found that the multi-site calibration protocol had a worse performance than the single-site calibration protocol in simulating the recession limbs of hydrographs for almost every year during the 1991-1999 period for all of the three stations. This may need further discussions or explanations.

Response:

We agree that the applied multi-site calibration protocol in the analysis did not reduce the modeling errors resulting from the spatial variability. And we have removed the statement i.e. "to account for the different hydrological process of watershed with large heterogeneity, it is necessary to employ a multi-site calibration protocol to reduce prediction errors". In fact, in our modeling analysis, except for the Dage station in the calibration period, both R and EF from the multi-site calibration protocol was slightly decreased when compared to the single-site protocol. Although we have examined the varied hydrological process mainly according to sensitivity analysis, and emphasized that it was necessary to employ multi-site calibration protocol to account for the spatial varied geo-hydrological properties, we acknowledged that it was just because of the errors and uncertainties with the representation of the spatial varied geo-hydrological properties, the modeling results from multi-site calibration protocol was not improved.

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Nevertheless, considering that the model performance from the multi-site calibration protocol has reached a compromise between the three stations, and performance measures were generally satisfied for all the examined stations, we generally concluded that the applied multi-site calibration protocol in the watershed has advantages to the single-site calibration protocol.

4. For both calibration protocols, it can be found that the MIKESHE model cannot well simulate the hydrological processes in the first half of 1991 for all of the three stations. This may need a brief explanation in the text.

Response:

Thanks for the suggestion. Generally, the model can not well simulate the recession limbs of the hydrograph. As part of the recession limbs of the hydrographs, model behavior for the first half of 1991 was thus poor as well, even though a warming up modeling exercise was carried out for 1990. In the revised manuscript, we have given a short explanation on the poor model behavior with respect to recession limb simulation.

5. It would be great if there is a Table to list the values of the calibrated parameters under the two calibration protocols.

Response:

Thanks for the suggestion. We have added a table, in the revised manuscript, to present the calibrated parameter values of the single-site calibration protocol (Please see the Table 1 in the revised MS). As only the Ks exhibited different calibrated value between the single-site and multi-site calibration protocols, we did not list the parameter values of the multi-site calibration protocol. In the revised manuscript, we have given a short explanation of the difference between the two calibration protocols.