Response to Reviewers #2

Title: Integrated hydrological modelling of small- and medium-sized water storages with application to the upper Fengman Reservoir Basin of China

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We express sincere appreciation for your comments and corrections on this paper. Responses and corrections for all the comments are listed below.

General comments:

This study has improved the SWAT2005 by representing small and medium-sized water storages in river basins, and then tested it for streamflow simulations in the upper Fengman basin of China. The major contributions of this manuscript are: (1) a realistic representation of the relationships between the water surface area and volume of water storages with satellite data (Landsat); and (2) water balance and transport through a network combining both sequential and parallel streams and storage links. The topic of this manuscript is quite important, since the human interference always exists in river basins but usually over-simplified or even neglected in hydrological modeling. However, the calibration of physical parameters by using monthly streamflows (before 1960; Fig.5) should be further improved. According to my experience, a calibrated monthly hydrograph should have a NSE (Nash-Sutcliffe efficiency) greater than 0.85 or even better. Only if the physical parameters are well calibrated, the comparisons of model performance with different scenarios (Figs.6-9) can be more convincing.

Response:

We could simulate streamflows with precipitation data from 1953 to 1960, and calibrate physical parameters by using monthly streamflows. However, we could only collect precipitation data in flood seasons from 1953 to 1955 because these years are far from now. Therefore, weather generator in SWAT must be used to interpolate the

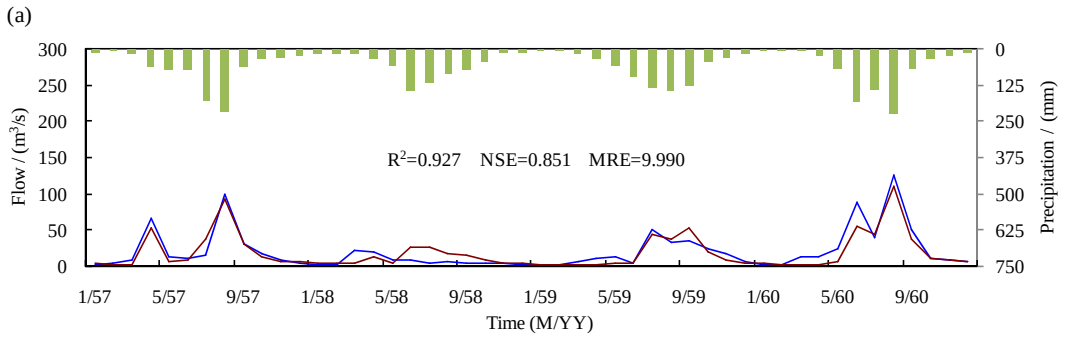
missing precipitation data from 1953 to 1955 when we simulate streamflows from 1953 to 1960. It has been proved that the calibration of physical parameters through the streamflow simulation from 1953 to 1960 unsatisfactory.

Therefore, we have simulated streamflows with precipitation data from 1956 to 1960, the monthly streamflows from 1957 to 1960 at Yangzishao Station and the monthly streamflows from 1956 to 1960 at Wudaogou Station have been used to calibrate physical parameters. We have improved the calibration of physical parameters, and revised Table 3 and Fig. 5 as follows.

Table 3 Calibrated physical parameters

Parameter Name	Original Value	Calibrated Value
ALPHA_BF	0.048	0.477
ESCO	0.950	0.968
GW_DELAY	31.000	5.541
SFTMP	1.000	0.73
SMTMP	0.500	4.441
SMFMX	4.500	3.136
TIMP	1.000	0.048
GWQMN	0.000	20.000
RCHRG_DP	0.050	0.100
CN2[a]		0.756
CANMX		2.8 (crop) 4.8 (forest) 4.1 (grass)

a Parameters are multiplicative factors used to simultaneously adjust all spatially variable base values of the CN2 parameter.



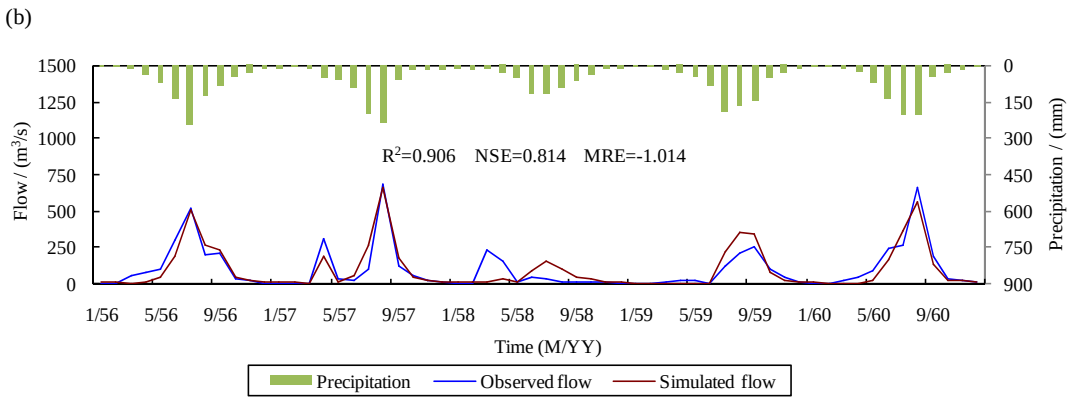
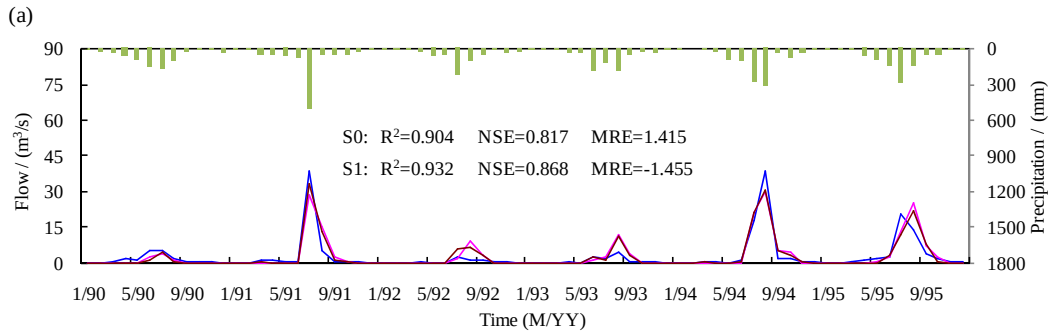


Fig. 5 Observed and simulated monthly streamflows during the physical parameter calibration period (before 1960) at two discharge gauges: (a) Yangzishao and (b) Wudaogou, where

R^2 is the coefficient of determination; NSE is the Nash-Sutcliffe efficiency; and MRE (%) refers to the mean relative error.

We have noticed that the stream flow in 1958 are unexpected, i.e., higher stream flow at fewer precipitation point while lower stream flow at more precipitation point. We have checked the original streamflow data, but the data were right. The unusual stream flow in 1958 caused that the NSE of calibrated monthly hydrographs were not good enough, i.e., the NSE of calibrated monthly hydrographs were not greater than 0.85, especially at Wudaogou Station.

We have revised Fig. 6 as follows.



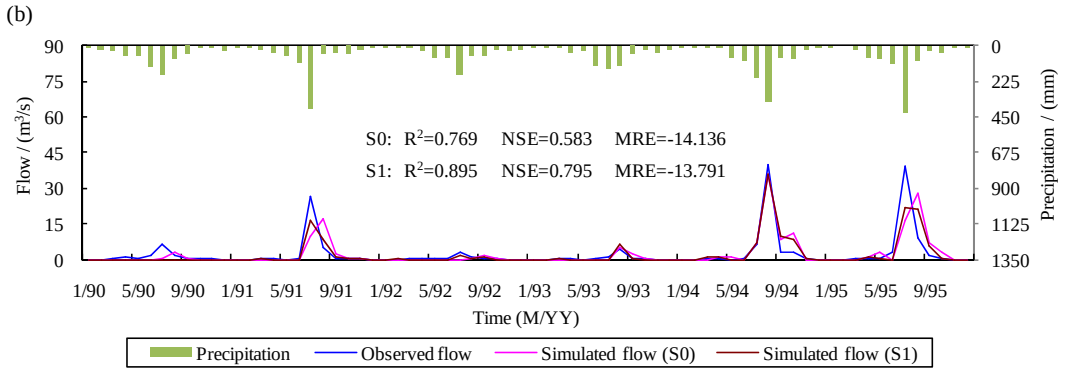
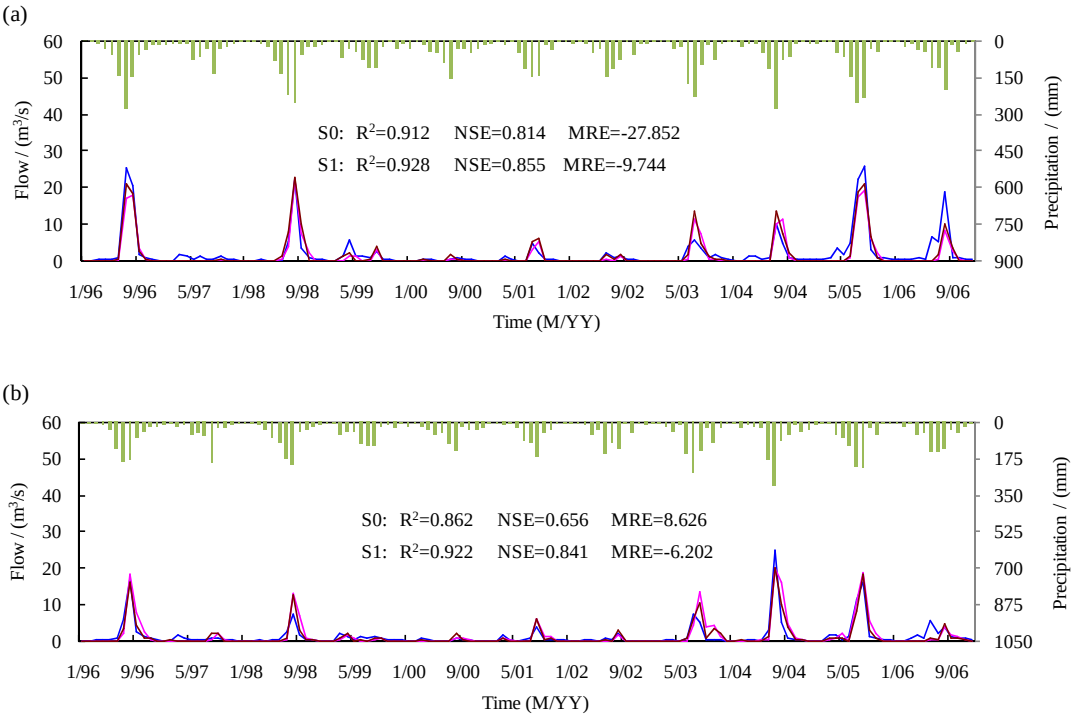


Fig. 6 Observed and simulated monthly streamflows during human interference parameter calibration period (1990-1995) at two discharge gauges: (a) Panshi and (b) Dongfeng.

S0 refers to the consideration of human activities by the original SWAT2005 with calibrated physical parameters, while S1 refers to the consideration of human activities by the improved SWAT2005 with the calibrated physical and human interference parameters described above.

We have revised Fig. 7 and the text as follows.



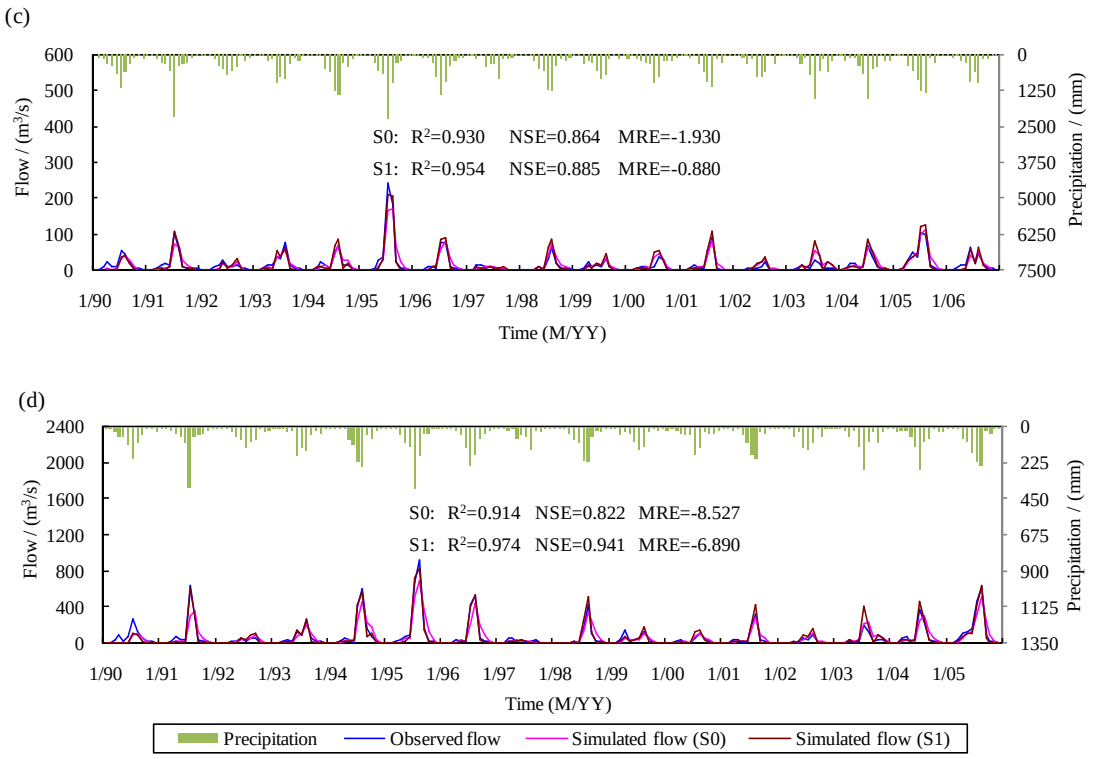


Fig. 7 Observed and simulated monthly streamflows over the validation periods at all four discharge gauges: (a) Panshi (1996-2006), (b) Dongfeng (1996-2006), (c) Yangzishao (1990-2006) and (d) Wudaogou (1990-2006).

We have revised the first paragraph of the Validation results Section in the revised manuscript from

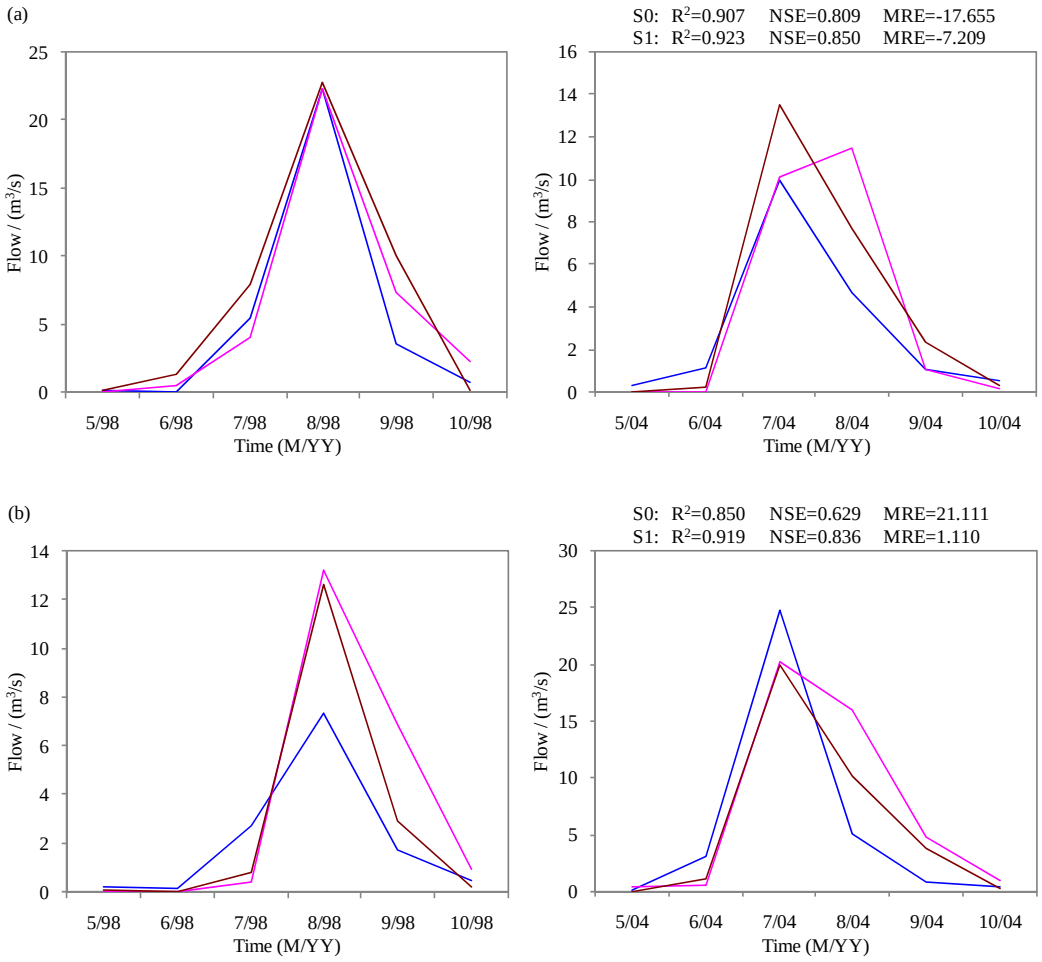
"Fig. 7 shows the observed and simulated monthly streamflows by S0 and S1 over the validation periods at the Panshi, Dongfeng, Yangzishao and Wudaogou hydrologic stations. There is a clear improvement in the simulation at the Panshi and Dongfeng hydrologic stations, while the simulation at the Yangzishao and Wudaogou hydrologic stations improved less significantly. Over the validation periods, the mean model performance rises from 0.855 (R^2) and 0.665 (NSE) to 0.914 and 0.816 at the Panshi and Dongfeng hydrologic stations, respectively, while the mean model performance rises from 0.922 (R^2) and 0.829 (NSE) to 0.953 and 0.903 at the Yangzishao and Wudaogou hydrologic stations, respectively."

to

"Fig. 7 shows the observed and simulated monthly streamflows by S0 and S1 over the

validation periods at the Panshi, Dongfeng, Yangzishao and Wudaogou hydrologic stations. There is a clear improvement in the simulation at the Panshi and Dongfeng hydrologic stations, while the simulation at the Yangzishao and Wudaogou hydrologic stations improved less significantly. Over the validation periods, the mean model performance rises from 0.887 (R^2) and 0.735 (NSE) to 0.925 and 0.848 at the Panshi and Dongfeng hydrologic stations, respectively, while the mean model performance rises from 0.922 (R^2) and 0.843 (NSE) to 0.964 and 0.913 at the Yangzishao and Wudaogou hydrologic stations, respectively."

We have revised Fig. 8 and the text as follows.



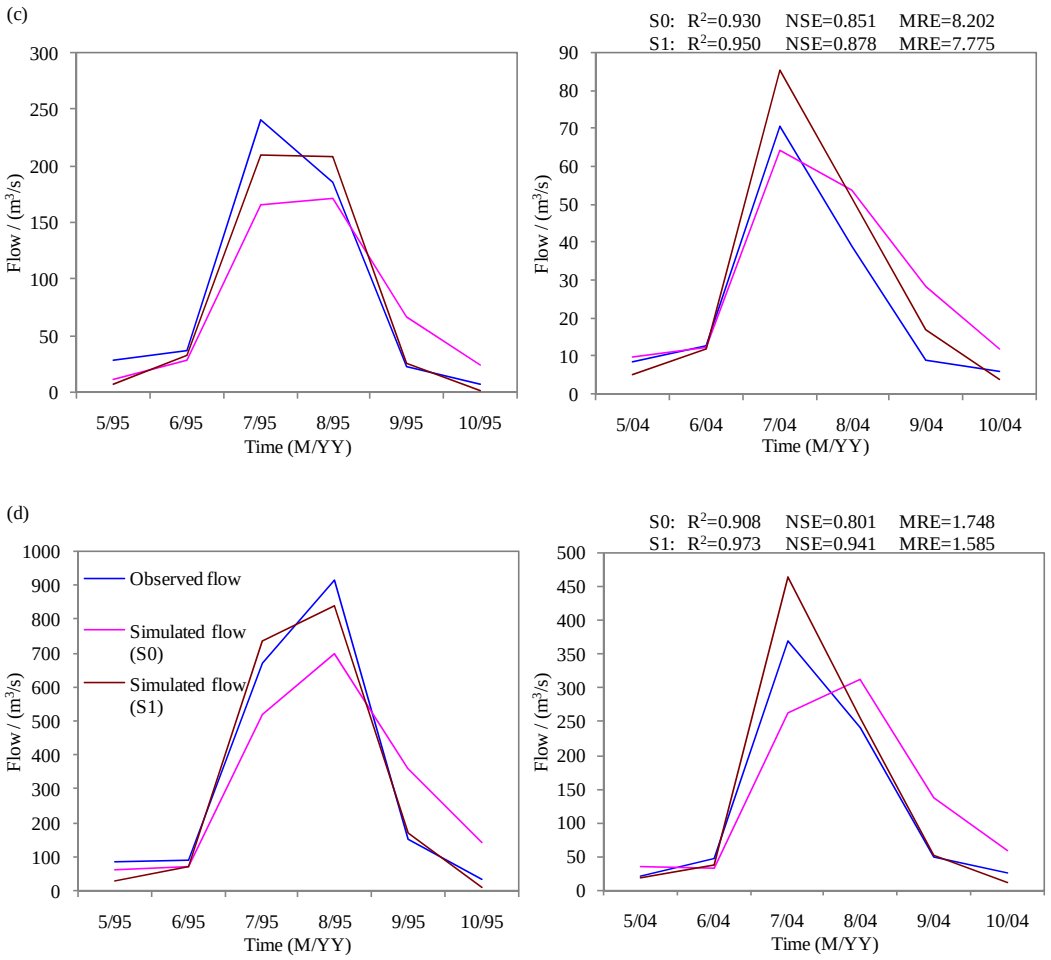


Fig. 8 Observed and simulated monthly streamflows for the 1998 and 2004 flood seasons at two discharge gauges: (a) Panshi and (b) Dongfeng, and observed and simulated monthly streamflows for the 1995 and 2004 flood seasons at two discharge gauges: (c) Yangzishao and (d) Wudaogou, where

the evaluation criteria (R^2, NSE, and MRE) within each sub-figure refer to all of the flood seasons over the validation periods.

We have revised the second paragraph of the Validation results Section in the revised manuscript from

“From fig. 7, there are six larger flood processes in the validation periods, which are in 1996, 1998, 2003, 2004, 2005, and 2006, and the years before 1998 and 2004 are drier and wetter, respectively, than average. Therefore, fig. 8 shows the evaluation criterion for the flood seasons over the validation periods as well as the observed and simulated monthly streamflows by S0 and S1 for the 1998 and 2004 flood seasons at

the Panshi, Dongfeng, Yangzishao and Wudaogou hydrologic stations. Fig. 8 also shows that there is a clear improvement in the simulation at the Panshi and Dongfeng hydrologic stations, while the simulation at the Yangzishao and Wudaogou hydrologic stations improved less significantly for the flood seasons over the validation periods. For the flood seasons over the validation periods, the mean model performance rises from 0.842 (R^2) and 0.638 (NSE) to 0.916 and 0.826 at the Panshi and Dongfeng hydrologic stations, respectively, while the mean model performance rises from 0.921 (R^2) and 0.812 (NSE) to 0.956 and 0.909 at the Yangzishao and Wudaogou hydrologic stations, respectively."

to

"From fig. 7, there are six larger flood processes in the validation periods at Panshi and Dongfeng Stations, which are in 1996, 1998, 2003, 2004, 2005, and 2006, and there are eleven larger flood processes in the validation periods at Yangzishao and Wudaogou Stations, which are in 1991, 1993, 1994, 1995, 1996, 1998, 2001, 2003, 2004, 2005, and 2006. Fig. 8 shows the evaluation criterion for the flood seasons over the validation periods, the observed and simulated monthly streamflows by S0 and S1 for the 1998 and 2004 flood seasons at the Panshi and Dongfeng hydrologic stations, as well as the observed and simulated monthly streamflows by S0 and S1 for the 1995 and 2004 flood seasons at the Yangzishao and Wudaogou hydrologic stations. Fig. 8 also shows that there is a clear improvement in the simulation at the Panshi and Dongfeng hydrologic stations, while the simulation at the Yangzishao and Wudaogou hydrologic stations improved less significantly for the flood seasons over the validation periods. For the flood seasons over the validation periods, the mean model performance rises from 0.878 (R^2) and 0.719 (NSE) to 0.921 and 0.843 at the Panshi and Dongfeng hydrologic stations, respectively, while the mean model performance rises from 0.929 (R^2) and 0.826 (NSE) to 0.961 and 0.910 at the Yangzishao and Wudaogou hydrologic stations, respectively."

We have revised Fig. 9 and the text as follows.

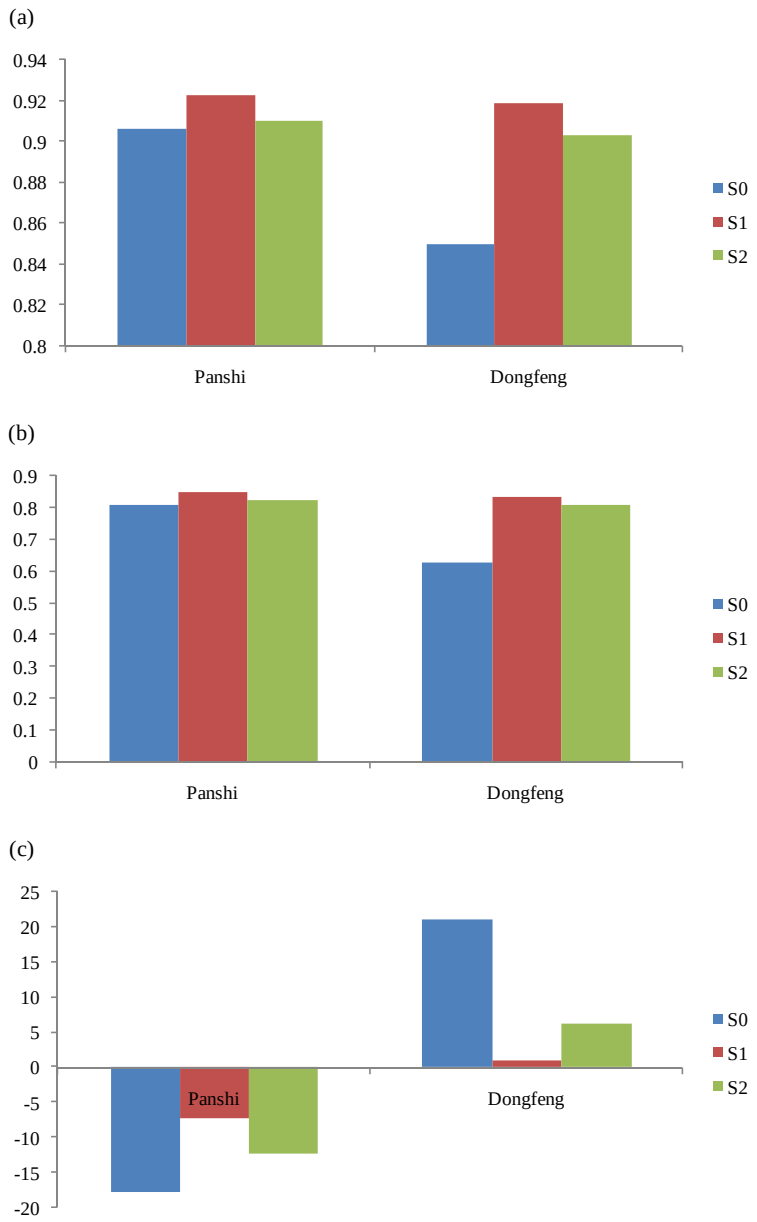


Fig. 9 Comparisons of the evaluation criterions for the flood seasons over the validation periods: (a) R^2, (b) NSE and (c) MRE. In S2, considering the water balance and transport through a network combining both sequential and parallel streams and storage links while ignoring the human interference parameters.

We have revised the third paragraph of the Validation results Section in the revised manuscript from

"Fig. 9 compares the evaluation criterions of S0, S1, and S2 for the flood seasons over the validation periods at the Panshi and Dongfeng hydrologic stations. For the flood

seasons over the validation periods, the mean model performance rises from 0.842 (R^2) and 0.638 (NSE) by S0 to 0.885 and 0.774 by S2 at the Panshi and Dongfeng hydrologic stations, respectively, and the R^2 and NSE in S2 are improved by 58.122% and 72.208%, respectively, compared to those in S1."

to

"Fig. 9 compares the evaluation criterions of S0, S1, and S2 for the flood seasons over the validation periods at the Panshi and Dongfeng hydrologic stations. For the flood seasons over the validation periods, the mean model performance rises from 0.878 (R^2) and 0.719 (NSE) by S0 to 0.907 and 0.818 by S2 at the Panshi and Dongfeng hydrologic stations, respectively, and the R^2 and NSE in S2 are improved by 66.824% and 80.114%, respectively, compared to those in S1."

Specific comments:

(1) Fig.4 What do you mean by noting "9" , "11", "12", "14" in rectangles? The figure should be better self-explained, by improving the figure caption.

Response:

We have added information on Fig.4 in the caption as follows.

"Additionally, "9", "11", "12" and "14" in rectangles (individual sub-basins) mean the numbers of individual sub-basins."

(2) Page 4008, line 16 Suggest revising "simulate large catchments" to "describe the hydrological processes in large catchments".

Response:

We have revised as suggested.

(3) Page 4024, lines 4-6 I am confusing with the sentence "the years before 1998 and 2004 are drier and wetter, repectively, than average". Please clarify this. And, why don't you mention the large floods before 1996 (e.g., the 1995 floods for both Yangzishao and Wudaogou)?

Response:

From fig. 7, there are six flood processes in the validation periods at Panshi and Dongfeng Stations, and eleven flood processes in the validation periods at Yangzishao and Wudaogou Stations. Because both large flood and small flood are needed to present the performance of the model in flood season visually, we have chosen the 1998 and 2004 flood seasons at the Panshi and Dongfeng hydrologic stations, and the 1995 and 2004 flood seasons at the Yangzishao and Wudaogou hydrologic stations.

Additionally, due to A. Zhang has done a lot with the modification of this paper, we add A. Zhang to the author list of this paper.