Responses to Editor and Reviewers

Editor:

Referees are quite satisfied with the manuscript, however one of them still asks to address several minor points, which is quite easy to do. The revision will be reviewed by editor only.

Reply:

We thank the Editor and the reviewers very much for the evaluation and constructive comments/suggestions. The issues raised in the reviews have been carefully considered, and the manuscript has been revised accordingly. Please see the point-by-point responses to Reviewer 2 shown below.

Reviewer #2:

The authors adequately addressed my previous comments. I still have minor comments:

1. Line 76: the term "continuity" must be defined in this context. At this point of the paper, it is unclear why this "continuity" is needed for hydrological modeling.

Reply:

Thanks for the comment. The term "continuity" is defined as "differences between the parameters in consecutive time steps should be small".

Some conceptual hydrological parameters reflect the catchment characteristics such as the soil water storage capacity. They can hardly change dramatically in a very quick time under climate change and human activities. On this basis, the parameter continuity is reasonable for hydrological modeling.

To avoid confusion, this point is clarified in the Revised Manuscript:

> Some conceptual hydrological parameters reflect the catchment characteristics. While climate change and human activities exert influence on these catchment characteristics, they can hardly change dramatically in a very quick time, such as the soil water storage capacity. **Hence, parameter continuity, defined as differences between the parameters in consecutive time steps to be small, is required for hydrological modeling.** However, few reports have considered the continuity of parameters in the SSC method. **(Page 5, Lines 76-82)**

2. Line 193: the terms "feasible parameters" and "nearly optimal" must be defined in this context.

Reply:

Here, the original "feasible parameters" means "near-optimal parameters". To avoid confusion, this term has been removed. Besides, the "nearly optimal" is corrected to “near-optimal” which means that the parameter sets have objective values close to the optimum.

In the Revised Manuscript, the sentence is modified as follows:

(2) **Generate an ensemble of near-optimal parameters**. **Multiple parameter sets having objective values close to the optimum** for each sub-period are obtained using Markov chain Monte Carlo (MCMC) sampling (Chib and Greenberg, 1995). **(Page 10, Lines 194-196)**

3. Line 220: the term “good model performance” must be defined in this context.

Reply:

Here, the “good model performance” is defined as “accurate streamflow simulations”. The sentence is moderated in the Revised Manuscript as follows:

(3) Optimize by using Dynamic programming. The goal is to find parameters that provide both **accurate streamflow simulations** and continuity. **(Page 11, Lines 202-203)**

4. Line 303: the term “accuracy of the estimated parameters” must be defined in this context.

Reply:

Thanks for the comment. The “accuracy of the estimated parameters” means “the overall agreement between the pre-determined parameters and their estimation in the synthetic experiments (see details in section 3.1)”.

To avoid confusion, the sentence is moderated in the Revised Manuscript as follows:

The estimated parameters are evaluated by the RMSE (Alvisi et al., 2006), MARE (Khalil et al., 2001) and R^2 (Kim et al., 2007) **in the synthetic experiments (see details in section 3.1)**. RMSE is more sensitive to high values than MARE, while R^2 is based on the linear assumption (Dawson et al., 2007). **(Page 16, Lines 303-306)**

Dawson, C.W., Abrahart, R.J., See, L.M., 2007. Hydrotest: A web-based toolbox of evaluation metrics for the standardised assessment of hydrological forecasts. Environmental Modelling & Software 22(7), 1034-1052.

5. Line 305: what is the definition of “true” and “estimated” parameters in this context?

Reply:

The “true” and “estimated” parameters are defined as “the pre-determined parameters and their estimations in the synthetic experiments (see details in section 3.1)".

In the Revised Manuscript, the sentence is moderated as follows:

The estimated parameters are evaluated by the RMSE (Alvisi et al., 2006), MARE (Khalil et al., 2001) and R^2 (Kim et al., 2007) in the synthetic experiments (see details in section 3.1). RMSE is more sensitive to high values than MARE, while R^2 is based on the linear assumption (Dawson et al., 2007). **(Page 16, Lines 303-306)**

6. Figure 5(e) and lines 382 to 390: these results ("temporal variations in the soil and water conservation measures") concern only the Wuding River basin and not the Xun River basin: it needs to be clearly stated in the figure caption.

Reply:

Thanks for the reminder. This point has been added in the caption of Figure 5(e) in the Revised Manuscript:

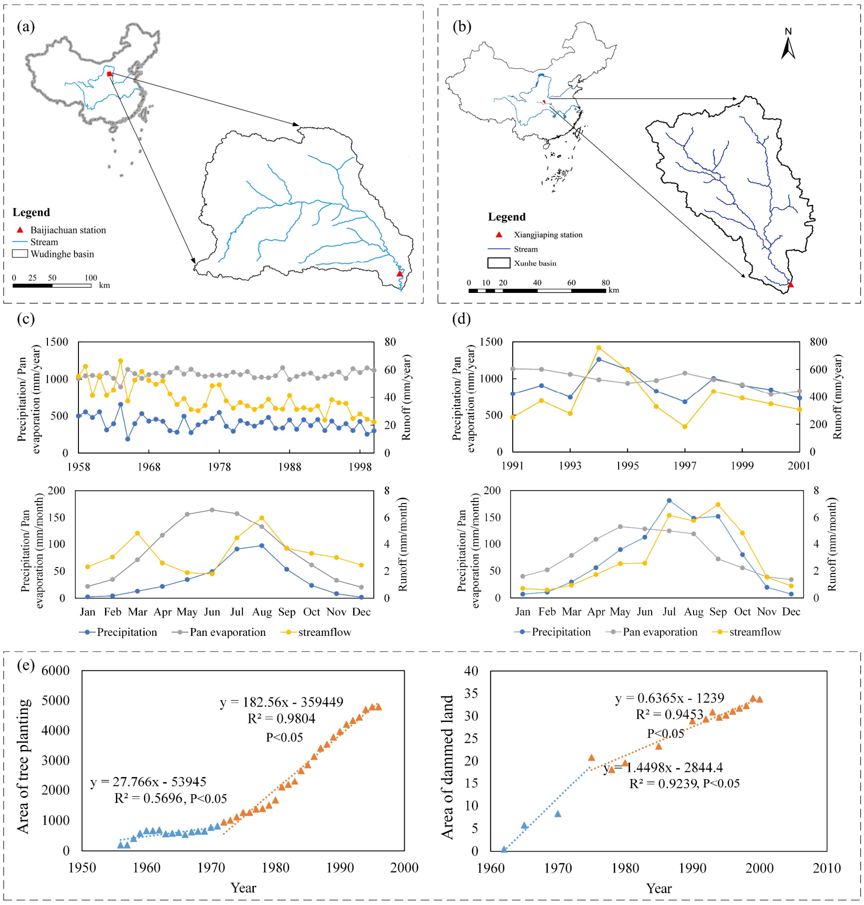

Figure 5 Location of (a) Wuding River basin and (b) Xun River basin. The plots (c) and (d) show the average yearly and monthly variations of precipitation, pan evaporation and streamflow in the Wuding River basin and Xun River basin, respectively. The plot (e) shows the temporal variations in the soil and water conservation measures **undertaken in the Wuding River basin**.

7. Figure 9: please state in the figure caption that these results concern the Xinanjiang model.

Reply:

In the Revised Manuscript, this point has been added in the caption of Figure 9:

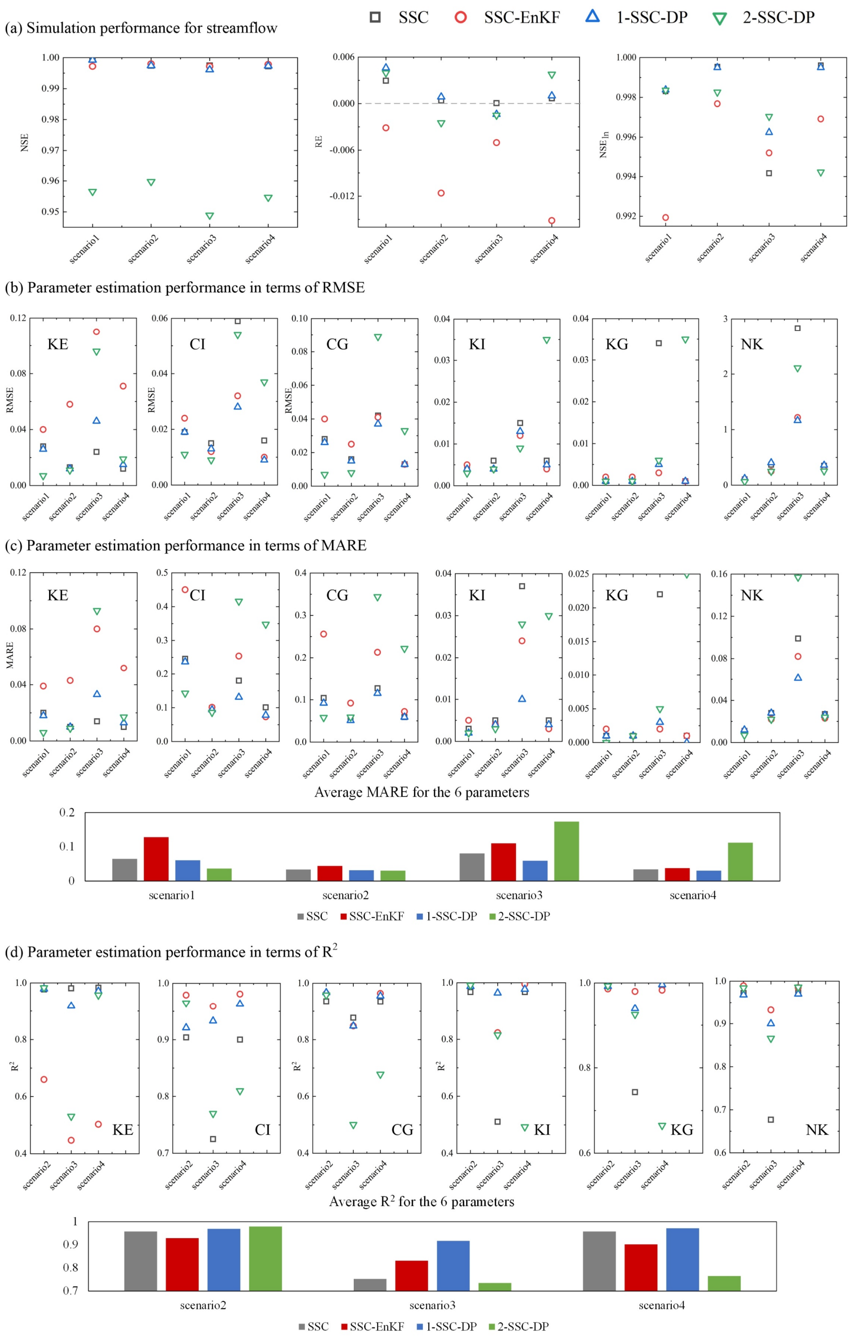

Figure 9 Comparison among the SSC, SSC-EnKF and SSC-DP methods **in the synthetic experiment with the Xinanjiang model** for (a) streamflow simulation and parameter identification in terms of (b) RMSE, (c) MARE and (d) R^2.

8. Figures 12 and 15: please state in the text/in the figure caption how "RE" bars are constructed?

Reply:

Thanks for the comment. The description of RE is presented in the text as follows:

The streamflow simulations from the proposed method are verified by using the NSE, relative error (RE) and NSE on logarithm of streamflow (NSE_{ln}) (Hock, 1999). RE evaluates the error of the total volume of streamflow, while NSE and NSE_{ln} evaluate the agreement between the hydrograph of observations and simulations. NSE is more sensitive to high flows, but NSE_{ln} focuses more on low flows. Higher values of NSE, NSE_{ln} and lower absolute values of RE indicate better streamflow simulations. The NSE, RE and NSE_{ln} are expressed as followed:

$$NSE = 1 - \frac{\sum_{t=1}^{m}(Q_t - \hat{Q}_t)^2}{\sum_{t=1}^{m}(Q_t - \overline{Q}_t)^2} \tag{15}$$

$$RE = \frac{\sum_{t=1}^{m}(Q_t - \hat{Q}_t)}{\sum_{t=1}^{m}Q_t} \tag{16}$$

$$NSE_{\ln} = 1 - \frac{\sum_{t=1}^{m}(\ln(Q_t) - \ln(\hat{Q}_t))^2}{\sum_{t=1}^{m}(\ln(Q_t) - \ln(\overline{Q}_t))^2} \tag{17}$$

Besides, we agree with the reviewer that the "RE" bars are difficult to read in Figures 12 and 15. Thus, the "RE" bars are constructed after "NSE/NSEln" bars, and the details are added in the caption of Figures 12 and 15 in the Revised Manuscript as follows:

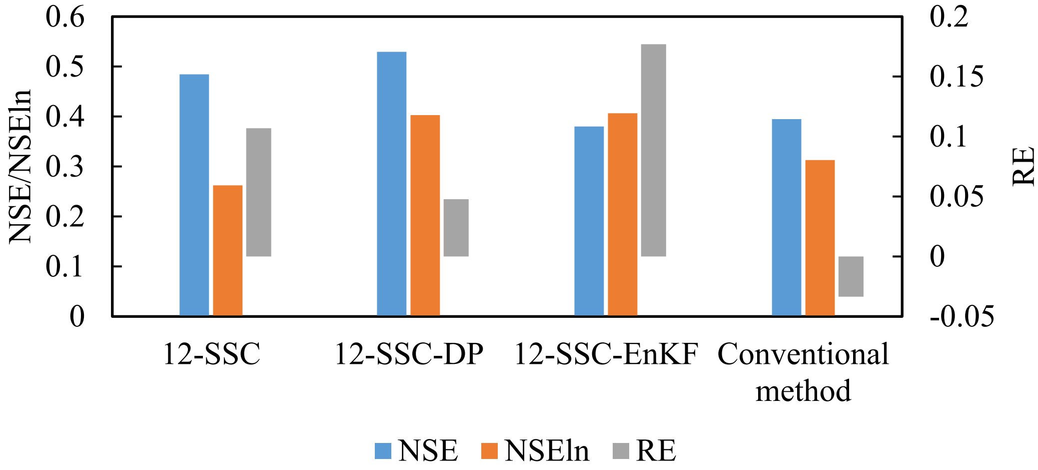

Figure 12 Simulation performance for streamflow in the Wuding River basin. **The results of NSE and NSEln are shown on the primary axis, while the values of RE are shown on the secondary axis.**

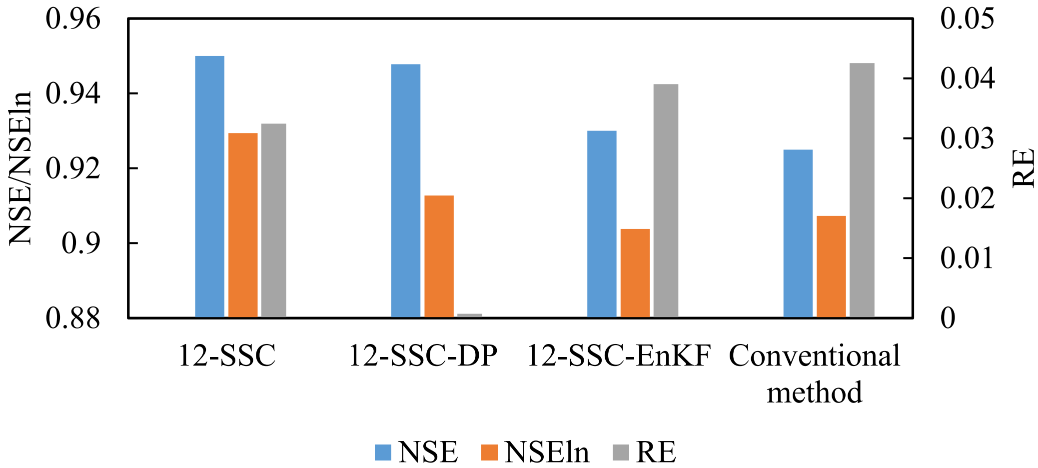

Figure 15 Simulation performance for streamflow in the Xun River basin. **The results of NSE and NSEln are shown on the primary axis, while the values of RE are shown on the secondary axis.**