Reply to Referee #2 Comments

In this study, Chai et al. simulated future snow changes and their impacts on the upstream runoff in Salween. This is an important study for water resources in future. Overall, this study explained well. However, there are still some questions needing to be clarified.

Reply: Many thanks for the positive comments. For the questions raised by the reviewer, we will elaborate and supplement in detail as follows.

1. The abbreviation of US easily confused readers as United states.

Reply: We have changed the abbreviation of the Upper Salween River to "USR" in the revised manuscript.

2. ERA5 precipitation was better than that of CMFD. How about other CMFD variables compared to ERA5?

Reply: Following the reviewer's suggestion, we further verified other variables of ERA5 and CMFD based on six meteorological stations. Taking into account the availability of data (ERA5 hourly data on single levels have only temperature, pressure, wind), we chose the variables of the air temperature, air pressure and wind speed for verification during 1995-2018. The result is shown from the Fig. AC1.

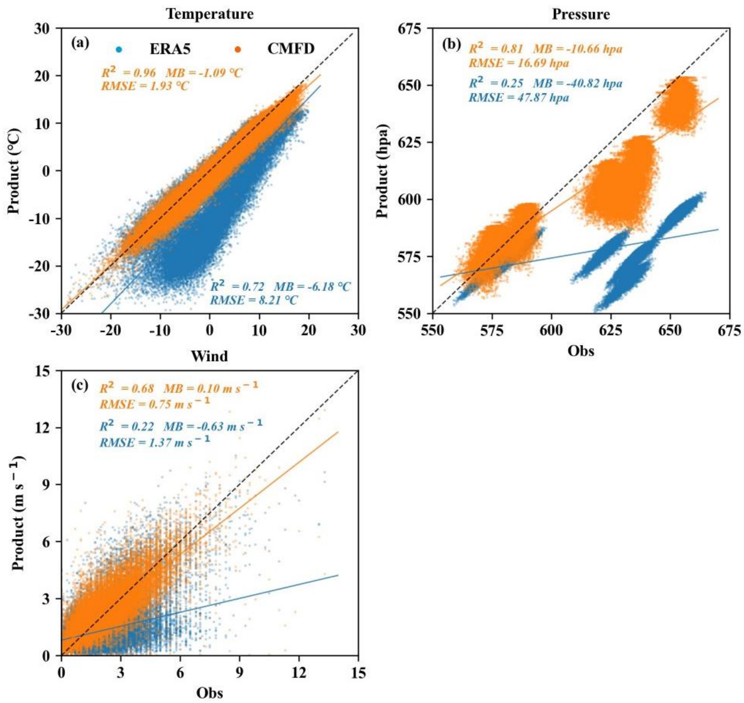

Fig.AC1 Comparison of the daily temperature, pressure, wind values between the CMA observation and different operational global products (CMFD, ERA5) during 1995-2018. The blue points are

ERA5-Obs, and the yellow points are the CMFD-Obs.

For the air temperature, the CMFD is closer CMA observation than the ERA5, its R^2, MB and RMSE are 0.96, -1.09 °C and 1.93 °C, respectively. For the air pressure, the R^2 MB and RMSE between the CMFD and observation data is 0.81, -10.66 hpa and 16.69 hpa, which is better than that of the ERA5 (0.25, -40.82 hpa, 47.87 hpa). For the wind, the CMFD have a higher R^2 (0.68), a lower MB (0.1 m s^{-1}) and RMSE (0.75 m s^{-1}) than that of the ERA5 (0.22, -0.63 m s^{-1}, 1.37 m s^{-1}) compared to the CMA observation. Overall, the CMFD dataset performed much better than ERA5.

3. How about the consistency using variables from different dataset to force the model?

Reply: The model input data were based on the CMFD dataset (precipitation, air temperature, air pressure, wind speed, specific humidity, as well as downward shortwave and longwave radiations). After that, we replaced the CMFD precipitation with other precipitation products (ERA5, GLDAS, MERRA2, MSWEP) and verified the simulation accuracy of different precipitation products by the basin outlet. To ensure the consistency of spatiotemporal resolution, all variables were resampled to 3 hours temporal resolution and interpolated to 5km spatial resolution. We finally found that the optimal combination of the ERA5 precipitation and the other CMFD meteorological variables performed very well in the USR basin (Fig. AC 2).

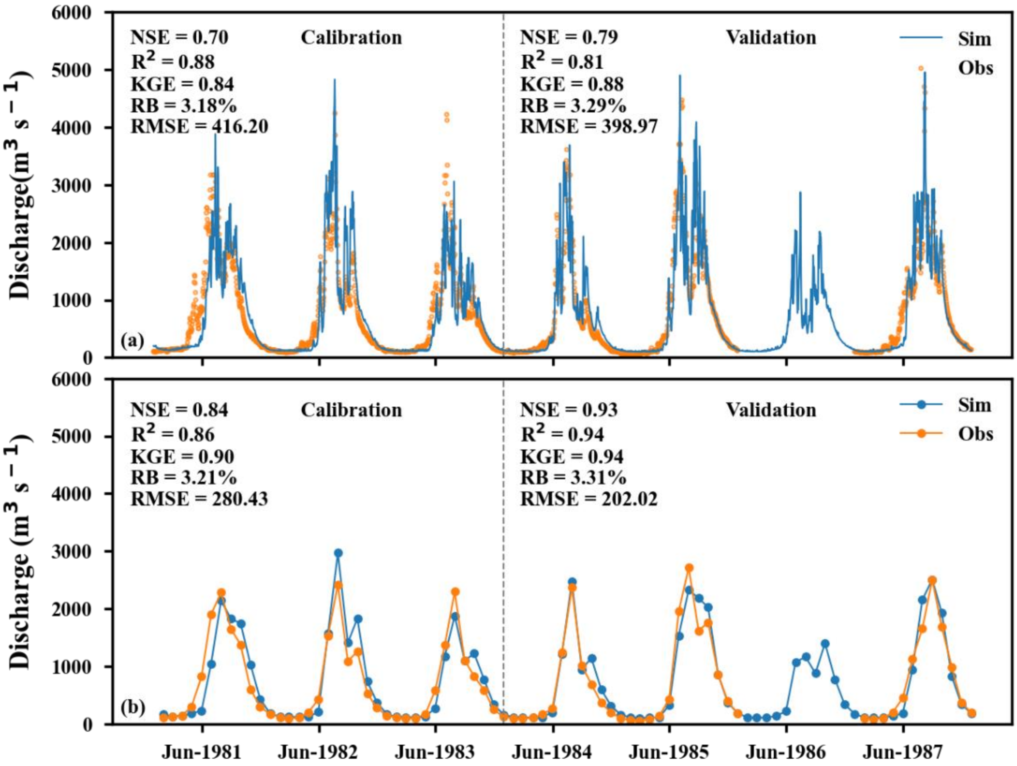

Figure. AC2 Simulated and observed (a) daily and (b) monthly discharges at Jiayuqiao (JYQ) station from 1981 to 1987. The calibration and validation periods were 1981–1983 and 1984–1987, respectively.

4. There were too many kinds of data in section 3.2. Suggest to give subtitles to make them clear.

Reply: We did this in the revised manuscript.

5. The discharge was partly the result of the snow change. Why was the discharge evaluated before snow and temperature?

Reply: First, we calibrated and validated the soil hydraulic parameters of the model through the observed discharges. After the model parameters determined, we verify the process-based variables of the model (e.g., the snow by FSCA, and the temperature by LST).

6. The LST RMSE between Modis and the simulation was high as 6.11 K in the day. The bias and RMSE in winter night was higher than that shown in Figure 3b. Is the precision of the simulation acceptable? Could you improve the simulation? As you said, the difference was caused by CMFD data. How about results using other forcing data, such as ERA5 that has better precipitation data than CMFD?

Reply: Although the RMSE and bias between Modis and the simulation was not perfect, the simulated value could better reflect the variation trend of LST during the daytime

($R^2 = 0.69$) and the nighttime ($R^2 = 0.91$). Following the reviewer's suggestion, we used the GLDAS temperature (Tair) to drive the model. The result was shown in Fig. AC3, the simulated LST by the GLDAS Tair also shown that the simulation results of nighttime are better than that in the daytime, and the simulation results of LST are not improved comparing to the CMFD Tair. As we can see from the Fig. AC3 and Fig. 3, the accuracy of Tair has a great impact on the simulated daytime LST (CC ≥ 0.85), but there is a bias between GLDAS Tair and observed Tair (Fig. AC4). In addition, factors such as complex terrain and cloud coverage in the USR basin may also cause misjudgment of the MODIS LST, which also may lead to bias in the 8-day MODIS LST product.

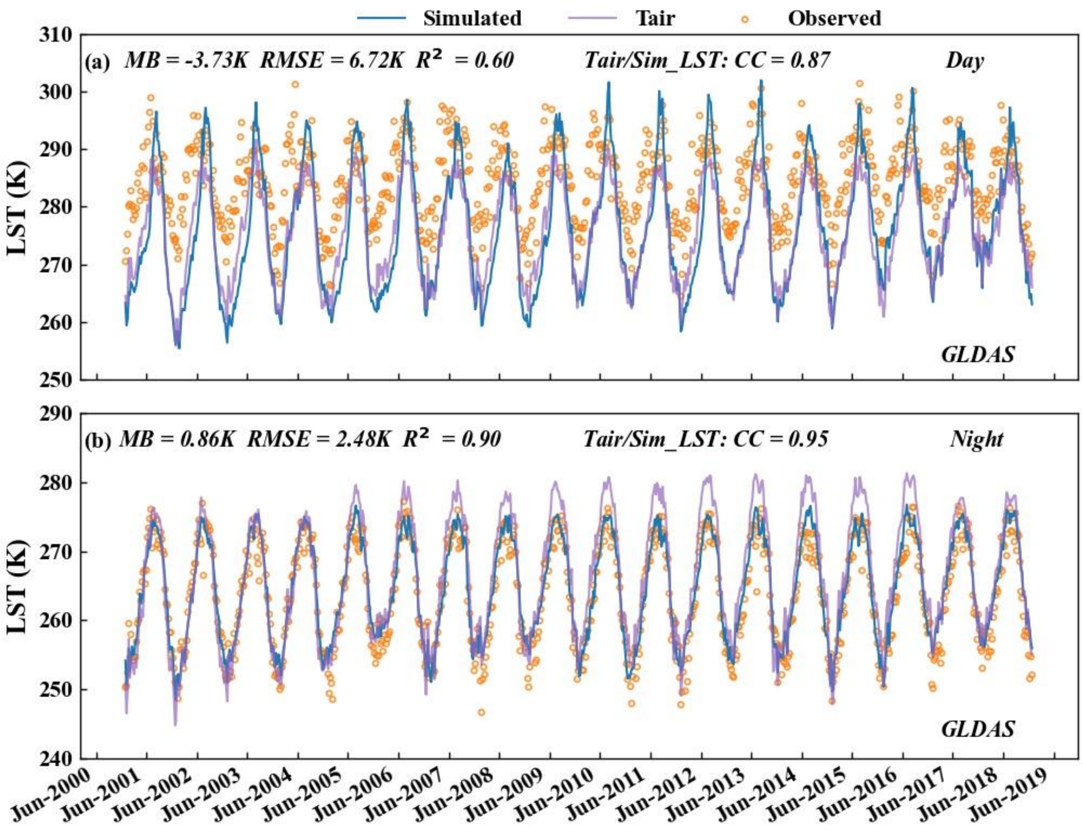

Figure. AC3 Comparison of 8-daily LSTs between model simulations (simulated) and MODIS observations (observed) during daytime (upper) and nighttime (lower) averaged for the URS from 2001 to 2018. Here, the input air temperature (Tair) has been compared with simulated LST (Purple line).

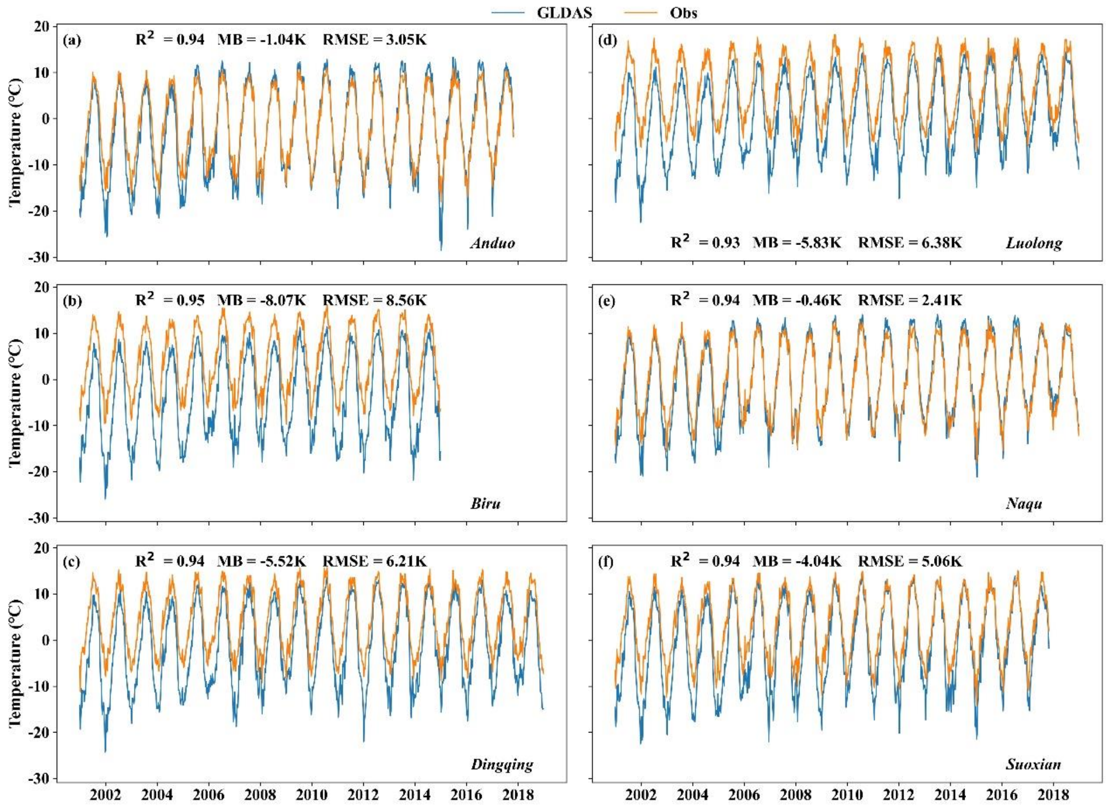

Figure AC4 Comparison of 8-daily temperature between GLDAS and CMA observations averaged for the URS from 2001 to 2018.

7. The title of 4.2.1 was too vague.

Reply: We have revised this title in the revised manuscript.

Line 379: "4.2.1 Evaluation of projected precipitation and temperature"

8. Temperature and precipitation were directly from SSP126 and SSP585 dataset. Should they appear before the simulated discharge in section 4.2?

Reply: We do this because we have to evaluate the performance of the corrected GCM forcing data in the USR basin before the projection of future climate change.

9. How about the significance level of the trend of each analyzed variable?

Reply: The trend significance level of each analyzed variable is determined by Sen's slope (Sen, 1968) and the non-parametric Mann-Kendall (MK) test (Mann, 1945; Kendall, 1975) at a 5% significance level. The "*" in figures of each analyzed variable represents the 95% confidence level and denotes that the trend is statistically significant. We have supplemented the legend for Figs.10, 11 and 15.

10. What's your novelty compared to others' studies?

Reply: As can be seen from the Table AC1, the main novelty of this study can be summarized below:

1) For the model simplification and the available scarce observations, most of the studies have utilized existing hydrological models linked with a simple temperature-index model (or day-degree model) for the simulation of snow and glacier melting in the USR basin. However, the hydrological model used in this study not only considers snow and glacier modules based on energy balance, but also coupling the frozen soil parameterization schemes based on energy balance (Shrestha et al., 2010; Wang et al., 2010, 2016, 2017).

2) Previous studies used the CMIP5 dataset, and this study uses the new CMIP6 dataset (ISIMIP3b) that defined by optimal combinations of SSPs and RCPs.

3) Previous studies did not consider the internal snow change processes in the USR basin, which may lead to a partial understanding of the snow-hydrology processes. However, we predicted the change of snowfall, snow cover, SWE, total snowmelt, snowmelt runoff under different SSP scenarios.

Table AC1 Comparison of the major studies in snow hydrological simulations at the USR basin

Authors	Study periods	Precipitation data source	Future forcing data	Model	Energy-balance snow and glacier module?	Frozen module?	Internal snow processes
Lutz et al. (2014)	1998–2007	APHRODITE	CMIP5	SPHY	No	No	Snowmelt
Su et al. (2016)	1971–2000; 2011–2040; 2041–2070	APHRODITE	CMIP5	VIC-glacier	Yes(snow)/No (glacier)	Yes	Snowmelt
Zhao et al. (2019)	1971–2100	CMA	CMIP5	VIC-CAS	Yes(snow)/No (glacier)	Yes	Snowmelt
Khanal et al. (2021)	1979–2100	ERA5	CMIP6	SPHY	No	No	snowmelt
Kraaijenbrink et al. (2021)	1979–2100	ERA5	CMIP6	temperature index (TI) melt model	No	No	SWE, Snowmelt
Yang et al. (2021)	1980–2018	ERA5, MSWEP	—	GBHM	No	No	Snowmelt
Yang et al. (2001)	1979–2019	CMA	—	WEP-C	Yes	Yes	Snowmelt
This study	1995-2100	ERA5	CMIP6	WEB-DHM	Yes	Yes	Snowfall, snow cover, SWE,

							snowmelt, snow runoff

11. Some paragraphs were too long. Some errors, such as “would be ere more” in Line 500. Maybe it’s better to ask a native English speaker to polish the English before acceptation.

Reply: We have done this in the revised manuscript.

Reference

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