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Interactive comment

Interactive comment on "Assessment of climate change impact and difference on the river runoff in four basins in China under 1.5 °C and 2.0 °C global warming" *by* Hongmei Xu et al.

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Anonymous Referee #1: We appreciate the Referee #1's comments and suggestions on our manuscript. The following are our point-point replies, with reference to the order of the comments by the reviewer. Comment 1: Was the conformity assessment of meteorological characteristics (for example, air temperature, precipitation, and other input variables of the SWAT model) from the WFD dataset to the observed values on the meteorological monitoring network carried out? Response: Thanks for this suggestion. Gridded reanalysis climate datasets have been use for hydrological modeling widely. WFD are derived from the ERA-40 reanalysis product via sequential interpolation

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to half-degree resolution, elevation correction and monthly-scale adjustments based on CRU (corrected-temperature) and GPCC (precipitation) monthly observations. WFD has been compared with CRU data and GPCC data for monthly temperature, wet days, and precipitation totals etc. WFD is considered an acceptable dataset for forcing hydrological models in comparison with gridded observation database at global scale (Essou et al., 2016). Furthermore, WFD has been used in climate change impact assessment at regional or catchment scale in China (Hao. et al., 2018; Liu et al., 2017; Chen et al, 2017; Su et al., 2017). Table 1S1 and Figure S1 showed the comparison of mean annual and monthly temperature and precipitation based on WFD and meteorological observations. The annual mean temperature and annual precipitation from the WFD forcing data were 2.5âĎČ lower and 14.5% higher, respectively, than those observed in the Shiyang River in 961-2001; those were 4.1°C and 20% lower in the Chaobai River, respectively, and those were similar in the Huaihe and Fujiang Rivers. The distribution of monthly mean temperature and monthly precipitation showed lower values for the Shiyang and Chaibei rivers for each month, while showed good agreement in the Huaihe and Fujiang river. Previous research indicates that the gridded climate dataset can be used in hydrological modeling, and the performance of hydrological model will improve by model calibration and validation (Xu et al., 2011). Comment 2: Was the assessment of reliability of meteorological conditions reproduction according to the GCMs data for the baseline period 1976-2005 in comparison with the WFD dataset carried out? as well as the annual and seasonal water regime of the rivers according to the simulation results of the SWAT model? This can be extremely important for future calculations. 1) Considering the WFD covers the period of 1958-2001, we compared the downscaled climate simulation from 5 GCMs with WFD during 1961-2001. Table S2 and Figure S2 showed the agreement of WFD with the historical simulation of 5 GCMs at mean annual scale and monthly scale. The downscaled GCMs data showed very good agreement with WFD for both the mean annual temperature and precipitation. The differences in mean annual temperature between WFD and downscaled 5 GCMs output were -0.03âĎČ∼0.36âĎČ for the

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four river basins, while those of mean annual maximum and minimum temperature were -0.02âĎČ∼0.29âĎČ and -0.07âĎČ∼0.41âĎČ respectively. There were general overestimates for mean annual precipitation based on the downscaled historical climate simulation from 5 GCMs. The difference in mean annual precipitation were 5.2%∼14.8% between WFD and downscaled historical climate simulation from 5 GCMs in the Shiyang River, those were 6.3%∼9.7% in the Chaobai River, 3.9%∼5.4% in the Huaihe River, and 5.6%∼11.0% in the Fujiang River. The downscaled GCMs historical climate simulation fitted the distribution of mean monthly temperature with WFD very well during the 1961-2001. The most of month with precipitation were overestimated by the downscaled GCMs simulation than underestimated for the four river basins, especially for the precipitation in spring and autumn. However, those differences in monthly precipitation based on WFD and downscaling climate historical simulation from five GCMs didn't change the seasonal pattern of precipitation. The downscaled GCMs output from ISI-MIP were reliable unified set of climate drivers to allow a consistent analysis of climate change impacts on water resource at basin scale. 2) For subsequent hydrological simulation, this study adopted downscaled GCMs data derived from five GCMs and validated SWAT models, and projected the impact of climate change on river discharges. The detailed comparison in simulated annual runoff and evapotranspiration (ET) based on WFD and downscaling climate data from five GCMs showed in Table S6. The results indicated the difference in simulated runoff were large in the Shiyang River for all five GCMs and for two GCMs in the Chaobai River and one GCM in the Fujiang and Huaihe River. This maybe caused the relative poor performance of SWAT calibration and validation in the two northern river basins and contributed by the uncertainties in GCMs data downscaling. Runoff simulated based on GCM HadGem2-ES showed big difference with those of WFD for all the four river basin, which make the subsequent hydrological projection with big uncertainty. The simulated ET based on WFD and downscaling climate from five GCMs showed the similar conditions, however, there were generally underestimated ET for the overestimated runoff to keep the water balance. The monthly distribution of

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ET were not changed for the most simulated runoff based on WFD and downscaling GCMs climate data. The simulated ET was underestimated for the Shiyang River, especially during the summer, with the peak of ET earlier based on the simulation of GCM HadGem2-ES. The simulated monthly ET based on GCH MIROC-ESM_CHEM also showed earlier peak in the Fujiang River. Generally, the hydrological simulations based on downscaling climate data from five GCMs for baseline period compared well with those based on WFD, and were acceptable subsequent hydrological projection. The annual and monthly runoff changes were calculated using 30 years of projected monthly runoff over each simulation under all climate scenarios of five GCMs and four RCPs, and then compared with the discharge simulated based on downscaling climate data derived from five GCMs for baseline period rather than the actual observed discharge data or simulated discharge data based on WFD. This technique was used to avoid systematic errors that the SWAT model would introduce in comparing the projection period with the baseline period. We have supplemented the comparison of WFD and downscaling climate data from five GCMs, and the further runoff and ET simulation based on these dataset in the revised manuscript. Comment 3: Probably, the low values of the Nash-Sutcliffe efficiency for gauges with a smaller catchment area (the Shiyang and Chaobai rivers) than for larger ones are explained by the insufficiently detailed grid of the meteorological data (0.5 degree). ResponseëijŽI really appreciate this comment. 3) I agreed with the reviewer's comment that high resolution climate forcing maybe improve the hydrological model performance. To avoid the uncertainty caused by the inhomogeneity of the spatial distribution of meteorological stations, the gridded climate dataset with 0.5 degree resolution was used to force the SWAT hydrological model in this study. I prefer to do further investigate using available high resolution climate forcing to calibrate and validate SWAT hydrological model the four river basins to compare the hydrological model performance with forcing with 0.5 degree WFD dataset in the future research. 4) Furthermore, whether the hydrological model structure can reflect the specific hydrological process is the key factor to determine the hydrological model performance. There was a few cases showed that SWAT

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could be used in snowmelt-dominated streamflow (Wang and Melesse, 2005; Tolston and Shoemaker, 2007; Grusson et al., 2015), a few previous researches have indicate that SWAT model did not adequately predict winter flows or snowmelt-dominated runoff in several watershed (Peterson and Hamlett, 1998; Srivastava et al., 2006; Chanasyk et al., 2003; Benaman et al., 2005) , which could be one reason that the low values of the Nash-Sutcliffe efficiency for the Shiyang and Chaobai rivers in the northern China with cold winter. We have explained the reason for the low values of the Nash-Sutcliffe efficiency for Shiyang and Chaibai rivers in the revised manuscript. Comment 4:How were the threshold values of 1.5âĎČ and 2âĎČ determined according to GCMs? at the end of the XXI century or during? Response: Future time horizon of global warming of 1.5°C and 2°C is derived based on 30-year running mean of global mean temperature (GMT) for each one of the 20 combinations of four RCPs (RCP2.6, RCP4.5, RC6.0 and RCP8.5) and five GCMs. When the GMT anomaly of 30-year running mean relative to pre-industrial level reaches the threshold of 1.5°C or 2°C, the 30-year window is sampled as corresponding time horizon of global warming scenario. Then year in Table S5 is estimated by averaging all center-years of the 30-year samples for all GCMs under each RCP and under each global warming scenario. Among these 20 combinations, 16 scenarios show mean GMT increases exceeding the threshold of 2°C above pre-industrial level, and 18 scenarios exceed the threshold of 1.5°C. But the changes in projected variables (annual temperature and precipitation) are quantified relative to present day (1976 – 2005) instead of pre-industrial period in this research. We have supplemented the methodology about define the 1.5âĎČ and 2.0âĎČ warming in the revised manuscript. Comments 5: How different are the sets of calibrated parameters of the SWAT model for the four study rivers? ResponseïijŽUsing sensitivity analysis procedures embed in SWAT resulted in the six most sensitive parameters (Table S1) in the hydrological model for each of the four rivers and then used for model calibration. The consistent sensitive parameters among all four river basins included parameter "CN2" and "GWQMN" which control the runoff process and soil water moving process respectively. The consistent sensitive parameters

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for the two river basins located in the northern China was parameter “ALPHA_BF” which reflect the groundwater flow response to changes in recharge; for the two river basins located in southern China, the common sensitive parameter was “RCHRG_DP” which was a coefficient that define the aquifer percolation fraction. However, because the differences in meteorological and hydrological conditions, topography and soil properties, there was specific sensitive parameters for each river basin, such as for the Shiyang River, the specific sensitive parameters were “SMTMP” and “TIMP” which are temperature related parameters for snow; for the Chaobai River, the specific sensitive parameter “GW_DELAY” which control the delay time or drainage time of the overlying geologic formations; for the Huaihe River, the specific parameter was “GW_REVAP” which define the amount of water moving into the soil zone from the shallow aquifer; for Fujiang river, the specific sensitive parameter was parameter “CANMX” which control the canopy storage of water. The definition of parameters showed in Table S2.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2018-448/hess-2018-448-AC1-supplement.pdf

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