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Hydrology and Earth System Sciences Discussions

Interactive comment on "The past and future changes of streamflow in Poyang Lake Basin, Southeastern China" *by* S. L. Sun et al.

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The manuscript deals with the possible impacts of climate change on streamflow in China. The topic is very interesting and addressed from a peculiar point of view, since the authors' intention is to identify the drivers of streamflow changes analyzing not only temperature and precipitation but also other meteo-climatic variables. However, there are some points that need to be clarified and/or further discussed: Answer: Thanks for the valuable comments of reviewer 1. We tried to address all comments.

1. Even if the authors declare their interest in several variables (such as radiation, wind, etc…) at the end the discussion is mainly limited to precipitation and evaporation. Answers: Thanks very much for the valuable comments! Seen from the title,

the paper can be separated into two main sections. The two main sections are that each climate variables' contributions to annual streamflow are evaluated with the observations, and the percent changes of annual streamflow in the future are estimated using precipitation and evaporation outputs of different GCMs from IPCC-4 datasets. The major reason of not estimation of other climate variables' contributions to annual streamflow in the future is that there are not outputs of GCMs (such as wind, etc…). Therefore, we will supplement why we did not estimate the contributions of other climate variables (except for precipitation and evaporation) to annual streamflow in the future in the revised manuscript.

2. Both the abstract and the introduction need to be reformulated. The authors have to clearly state the motivation beyond their research, its strength and its innovative aspect. Answers: Thanks for the suggestions. We will reformulate the abstract and the introduction to make the motivation, its strength, and its innovation aspect of this study more clear.

3. To me it is not clear how did the authors use the contemporary climate projected with 20C3M. Are these used to check and/or integrate station observations? And which is the difference between the variables projected by GCM and the variable projected by 20C3M (P 9406 L9-10)? Answers: The 20C3M is name of the contemporary climate datasets projected by different GCMs. These are not used to check station observations, but these are bridges for comparison between the future climate and observations. Firstly, the potential changes of climate variables from three future scenarios related to the contemporary climate (20C3M) can be calculated with the equation of (a1).

Lastly, the potential changes multiplied by station observations can be thought to be the differences between the future variable and the station observations. A number of domestic and foreign scientists have utilized this similar or the same method to evaluate the potential changes of streamflow or other scientific researches (Miller N.L., et al. 2003; Ju W.M., et al. 2007; Cramer W., 2001). I am sorry that this description in

2.3.4 section confused the referee, and we will reformulate this section in detail in the revised manuscript to reduce reader uncertainty of meaning.

4. Did the authors consider any non temporal trend that might affect the data? Answers: In this research, we didn't consider the non-temporal trend. However, we had tried to analysis the temporal trend of the five-year moving average series and found that there were not obvious differences for the trends between the original series and the five-year moving average series. In view of the little differences of trends and the length of original series, so we didn't consider the effects of non-temporal tend. Additionally, the non temporal trend in some research articles about streamflow changes are not considered, such as trends in Canadian streamflow (Zhang, X., Harvey, K. D., Hogg, W. D., and Yuzyk, T. R., 2001), and hydro-climatological trends in the Continental United States (Lettenmaier, D. P., Wood E. F., and Wallis J. R., 1994).

5. A discussion on the water balance parameter calibration is needed. How do the parameters obtained fit the values reported in the literature? There is an extensive discussion about a but not about the other parameters (i.e., b and c). Answers: This is a valuable suggestion. As the supplement, comparison of observed and calculated annual mean streamflow in the period of calibration is depicted in Fig.1. And, a discussion on the water balance parameter calibration is described as follow: The calibration using the climate and streamflow observations from 1961 to 1990 confirms that the calculated annual mean streamflow is in good agreement with observations in each watershed, with all r values above 0.90 and the significance level of 5 %, RME values in the range from −2.20 to 1.10 %, and RMSE values ranging from 10.75 to 55.24 m3 s−1. Yes, we have discussed the parameter of a in the literature. According the referee's suggestions, we will supplement the extensive discussion about the parameters b and c in the revised manuscript.

6. The authors stated that since the observation taken in different time periods are similar the parameters determined using historical data can be used also for future projection. This is maybe reasonable but not true and is an assumption that has to

be discussed. Answers: This method is developed from the water balance equation. Except for climate change, there are no considerations of the impacts of other driving factors (such as humanity activities, land use/cover changes, and so on) on annual streamflow. There should be some uncertainties in the results. I accept the referee's suggestions. The influences of other driving factors on annual streamflow should be discussed. So we had given the discussions (P9413 L25âĂŤP9414 L13) about the uncertainties of our results without consideration of other factors' influences.

7. How did the authors compute the significance of a trend? Answers: Thanks for the referee. We ignored to introduce the method to compute the significance of a trend. In the analysis of the significance of a trend, we apply the Student's t test to determine the significant level of a trend. In the revised manuscript, we will supplement the introduction of the method to compute the significance of a trend.

8. There are variables, such as the net radiation, that are not measured but computed. Do the authors think that this may imply some consequences in the temporal changes detection? Answers: This problem the referee mentioned has been considered by the authors. There are two reasons to interpret the problem. Firstly, there are less than 120 weather stations with the radiation observation in China, and even there exist only 2 stations with the radiation observation in Poyang Lake Basin. Secondly, the method proposed by Tong (1989) to calculate the radiation has been extensively applied in China, and subsequently the author has proved that it is suitable to calculate the temporal trends of radiation using the only 2 station observations (Nanchang and Ganzhou weather station located in Poyang Lake Basin) in the published paper (Sun et al., 2011, in Chinese with English Abstract). The errors analysis and the comparison of radiation trends between calculation and observation are shown in Table 1. This method is able to capture the long term trends of radiation and applied in this study due to shortage of measured radiation data in the study area.

9. Did the authors consider to use also soil use in their analysis? Moreover, the presence of hydropower stations and reservoir has been taken into account in the trend

analysis? If yes, how? If not, why? Answers: Honestly, I do not fully understand the first sentence. (1) Did the referee mean that we consider using also land use/cover in the analysis? In our analysis, we didn't consider the effect of land use/cover changes on streamflow. In this paper, we found that the land use/cover changes weren't significant through comparing the land use/cover of 1995 with one of 2000, and assumed that their impacts on the streamflow were small and can be ignored. Additionally, the shortcoming of this approach in Eq.6 which is unable to reflect the impacts of land use/cover on streamflow is acknowledged. (2) Did the referee mean that we consider using also soil water storage in our analysis? It is a pity that the observations of soil water storage is difficult to obtain or not observed in this study region. Of course, if we had the data, we will introduce the variable into Eq.6, and the results of our research are more convincing. Unfortunately, the data (i.e., actual storage capacity and water diversion form reservoir) about the hydropower stations and reservoir is difficult to obtain get in China. To constrain the effects of such factors on streamflow trends, we selected these four typical watersheds with few hydropower stations and reservoirs.

10. How can river level be considered a driver for streamflow changes? Answers: Thank the referee for the valuable comments! There are not any observations of water storage available at the watershed level. Therefore, we tried to use the intra-annual variability of river level (Delta WR) into Eq. (2) as the indicator of soil water storage to describe impacts of water storage interannual variations on water balance. We compared the results from the two models (the model proposed in this paper and the model without Delta WR), which are shown in Table 2. There are little differences in the parameters' values, RME and RMSE between these two models. However, we utilized the model with Delta WR in our research for calculating streamflow accurately. Of course, we must recognize this problem mentioned by the referee. There is tight linkage between long mean soil water storage and rive level at the outlet in a watershed. In wet periods, both soil water storage and river level increase, vice versa. Of course, the changes of soil water storage and river level might not be at the same phase. The main purpose of this study is to analyze the long term trends of annual stream flow and

their linkage with climate change. It is reasonable to take the change of rive level as the surrogate of the change of soil water storage under the situation without soil storage data available. Undoubtedly, this is an approximation and acknowledged in the revised manuscript. 11. Consider to change the X sign with a simple dot in the Equation since the X can be confused with a variable. Answers: Thanks the referee's suggestion. We will correct the X sign with a simple dot in the revised manuscript.

12. What do the authors mean with "water consumption" in Eq.2? Answers: "Water consumption" means the domestic water supply, industrial and agricultural water consumption, and so on. However, the item in Eq.2 (Rui, X., 2005, in Chinese) usually is less than other hydrometeorological variables, and then we assumed that it approximates to zero.

13. The definition of Delta WR looks really arbitrarily and should be explained. Answers: There is tight linkage between long mean soil water storage and rive level at the outlet in a watershed. In wet periods, both soil water storage and river level increase, vice versa. Therefore, the change in river level can indicate the change of soil water storage in a watershed to some extent. Of course, the changes of soil water storage and river level might not be at the same phase. There is intense low-frequency turbulence in daily WR observations. . So we use the difference between the mean water level of the last 10-day in December and that of the first 10-day in January in the same year to define Delta WR and approximate the change of soil water storage in a year.

Specific comment: P 9396 L 14-15: restate, it is not clear; P 9396 L 23: non including the SRESB1 in: : : this sentence is confusing, I don't understand what does it means; P 9397 L 1: I would say that the environment is affected by changes in water resources but not vice versa; P9397 L 5: what do the authors mean with "component of the water cycle" (if precipitation, evaporation etc should be excluded)? P 9397 L 17: forces? P9398 L 6: to decrease; P 9398 L 14: as temperature and precipitation increased; P 9398 L 15: why obviously? P 9398 L 20-23: restate the sentence; P 9399 L 15: I suggest to insert a reference; P 9400 L 6: change in season with seasonally; P 9400

L 19: which is the DEM resolution? P 9400 L 27-29: check the verb tense; P 9404 L 15: set to Eq. 8 is very long, maybe it can be derived in an appendix; P 9406 L 5: streamflow Eq.10 What is D? P 9407 L 20 Mean Square Error; P 9408 L 1-2: already said; P 9408 L16: characteristics; P 9408 L 19: if wind is higher; P 9408 L 22: Figure 4b shows the monthly annual means.... P 9408 L 26: interception; P 9409 L 12: atmosphere. Answer: Through reading the paper carefully, we found the problems and errors mentioned in the "Specific comment". Then, we will correct the errors and invite some teachers to check the revised paper carefully for reducing the same errors in the revised manuscript.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/8/C5789/2012/hessd-8-C5789-2012-supplement.pdf

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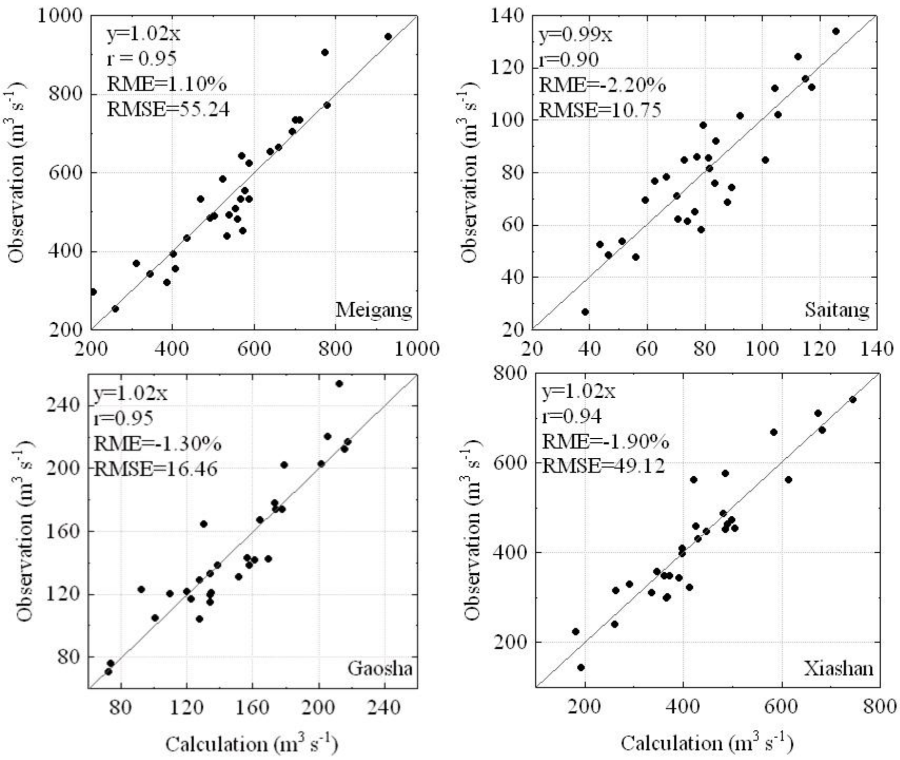

Fig. 1. Fig.1 Comparison of observed and calculated annual mean streamflow during the period from 1961 to 1990

Equation of (a1) is expressed as $\frac{var_i^k}{var_i^{20C3M}}$.

Table 1 The errors analysis and the comparison of radiation trends between calculation and observation

Weather stations	RME (%)	RMSE (MJ m^{-2})	Trend (MJ m^{-2} $year^{-1}$)	
			Observation	Calculation
Nanchang	2.48	164.56	-31.48	-32.20
Ganzhou	-0.29	190.99	-10.78	-5.60

Table 2 Comparison of the results from the model proposed in this paper and ones from the model without **Delta WR** during 1961-1990

	Meigang		Saitang		Gaosha		Xiashan	
	With Delta WR	Without Delta WR	With Delta WR	Without Delta WR	With Delta WR	Without Delta WR	With Delta WR	Without Delta WR
a	0.96	0.92	0.82	0.73	0.82	0.82	0.85	0.83
b	0.38	0.33	0.30	0.21	0.33	0.33	0.34	0.32
c	-0.15	/	-0.32	/	-0.19	/	-0.11	/
RME	-1.11%	-1.22%	-2.19%	-2.26%	-1.26	-1.50%	-1.94%	-2.18%
RMSE	55.24	55.77	10.45	10.77	16.46	17.31	49.92	50.66

Fig. 2.