

***Interactive comment on* “The influence of precipitation and temperature input schemes on hydrological simulations of a snow and glacier melt dominated basin in Northwest China” by X. Ji and Y. Luo**

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Received and published: 15 April 2013

Dear Editor and anonymous reviewer,

We are very grateful for your valuable comments and suggestions. We revised the manuscript following the comments and suggestions as described below.

The authors

Comments: P811 L1 Due to the lapse rate general means that the element decrease with the elevation, it is Ok to air temperature. However, it is not always the truth to
C806

precipitation, we generally use "precipitation gradient". L22 suggest use "precipitation" as "rainfall" .

Reply: Agree. The SWAT model was used in this study. The SWAT model uses "precipitation lapse rate" (Neistch et al., 2011). We prefer to use the "precipitation rate" so that it is convenient for other SWAT users to follow the article. As you indicated, a single lapse rate cannot describe changes of precipitation with increase of elevation in the study basin. We changed "rainfall" in P812L22 into "precipitation".

Comments:P812 L16 what's means of "markedly seasonal precipitation and very abrupt orographic Variations"?

Reply: We rewrote the sentence as "Seasonal variation of precipitation is significant in this region. Meanwhile, the precipitation changes also remarkably with elevation rising from 150 m to more than 5000 m within a horizontal distance of 100 km approximately"(P6 L17,section2.1 in revised manuscript).

Comments:P813 L13 Validated by what or what method?

Reply: We restated the situation as "it is assumed that quality of the officially released meteorological data was guaranteed".

Comments:P814 L22 "Its also covered" replaced with "The corrected TRMM 3B42"; L28 "gage" replaced with "reference"

Reply: It was replaced. "Its also covered" is changed to "The corrected TRMM 3B43 also covers" (P9 L2,section2.3.2 in revised manuscript). "gage" replaced with "reference" (P9 L7,section2.3.3 in revised manuscript).

Comments:P 815 Equation 1 seems wrong, please check carefully; L10 needn't reference Neitsch et al., 2011; L15 "the altitudinal air temperature gradient" replace as "real air temperature lapse rate",and add one reference,such as Zhang et al. 2012

Reply: It is a typo. The subscript of the variable in equation was corrected (P9

L9,section2.3.3 in revised manuscript). The reference Neithsch et al., 2011 was deleted. We replaced "the altitudinal air temperature gradient" with "real air temperature lapse rate" (P9 L24,section2.3.3 in revised manuscript). We checked the article of Zhang et al. (2012) and found that their result was a valuable reference (P5 L15,section1 in revised manuscript).

Comments:P816 L4 The criteria in equation 5 probably $EL_n < EL_{n+1}$ and; L11 "The MRB spatial precipitation distribution was provided" is Chinese English, not "provided", should be "calculated from" or "obtained from" ; L15-L18 The two sentence are similar, reorganize to one sentence; L21 not "conditions", replaced as "criteria";

Reply: Appreciated. We changed " \leq " into "<" (P10 L8,section2.3.3 in revised manuscript). We changed "provided by" into "obtained from"(P10 L15,section2.3.4 in revised manuscript); "Temperature data are more stable and less noisy than precipitation data" has been changed to "Temperature data are less noisy than precipitation data" (P10 L19,section2.3.4 in revised manuscript). We changed "conditions" into "criteria" (P11 L2,section2.3.4 in revised manuscript).

Comments:P817 L3 use "Evapotranspiration" replace "PET method" ; L4 Why "Evapotranspiration" are in abbreviation as "PET"? I guess it is should be "Potential Evapotranspiration"

Reply: We used the "Potential Evapotranspiration" instead of PET in revision. We rewrote the sentence as "Evapotranspiration, one of the major hydrologic components, is very sensitive to climatic variability (Claessens et al., 2006; Wullschlegel and Hanson, 2006). There are many PET (Potential Evapotranspiration) calculation methods used in hydrologic models." (P11 L10,section2.4 in revised manuscript).

Comments:P818 L4 I'm not sure whether there are observed precipitation at KHS. If there have, it seems not need the virtual station at this elevation. If not, how to calculate MPLAPS in the scheme iii? So there need one explain in detail. L8 using the similar method as precipitation scheme, not the same precipitation scheme

C808

Reply: There are daily precipitation data at KHS (Kensitate Hydrological Station). Luo et al. (2012) and Luo et al. (2013) used the Shihezi Weather Station (SWS) as a base station in previous studies of the Manas River Basin. They used the base station SWS and a single precipitation lapse rate (SPLAPS) to derive precipitation at different elevation. In this study, we used the meteorological data from the Kenswat Hydrological Station (KHS) which is located right at the outlet of the basin. We derived the precipitation at KHS by the method of Luo et al. (2012) and compared the results to the records at KHS. The sentence in L8 was revised: "using the similar method as precipitation scheme".

Comments:P820 L6 should "PLAPS" not "SPLAPS" L13 as noticed in Fig4, the air temperature in winter at more than 3000 m are less than -10 degree, so there is only very limited effect on winter snow/rainfall separation, and nearly no snow/ice melt in winter. L26 what is "the precipitation difference during the year"?

Reply: We changed the "SPLAPS" into "precipitation lapse rate". The temperature is low in winter, especially in high mountain area. But for "temperature inversion phenomenon" in the low mountain area, despite the rainfall and snowmelt are less, it is also possible; Fig4 represent the monthly average temperature, does not rule out high temperatures in some single-day. The sentence means "precipitation changes relatively small from month to month". We changed the original words in the revised manuscript (P15 L12,section3.2 in revised manuscript).

Comments:P821 L20 In central Asia, the glacier accumulation and melt mainly occur in summer (Fujita et al., 2008), which suggested that the snowfall in glacier areas are mainly in summer instead of cold season. Thus, the study of Wei et al. (2001) is not enough to further support the conclusion.

Reply: Precipitation falls as snow in winter usually in the zone below altitude of 3000m in the Tianshan Mountains (Wei and Hu, 1990). Above the snow line, winter snowfall account for only 6% of the annual precipitation; and winter snowfall accounts for 19% of

C809

the annual precipitation in the plain and the middle mountain areas (Wei et al., 2001). It was inferred that snowfall occurs more below the permanent snow line than above the snowline. In this study, multiple precipitation lapse rates (MPLAPS) were obtained based on corrected TRMM3B43 precipitation data. As using the MPLAPS, the 39-yr averaged snowfall in the non-glacier HRU is greater than in the glacier HRU (NGHRU) in the cold season. This simulation result is consistent with Wei et al. (2001). Results of the MPLAPS method show that there is more snowfall in the warm season than in the cold season in the glaciated area in the MRB, however, the results of SPLAPS method was contrary (Fig.1 of this document). In central Asia, glacier accumulation and melt mainly occur during the warm summer (Fujita et al., 2008; Aizen et al., 1997). The simulation results by using the MPLAPS revealed that glacier accumulation and melt occur mainly in summer too, which might have implied that the MPLAPS method gave a better description to the precipitation distribution along the elevation than the SPLAPS.

Comments:P822 L4 It is not very significant of glacier melt from Fig 7, thus it is better to give the number of glacier melt under different schemes ; L20 add "Table 4"

Reply: Figure 7 was modified. We used the "monthly average value" instead of "daily average value" for a more clear comparison. The annual amount of glacier melt was added into the legend.

Comments:P823 L5 The evaporation observed in China hydrological station always by using 20 cm evaporation pan, which are larger than the traditional pan evaporation which observed by 20 m open water body. The authors need explain this. L14 delete "distribution"

Reply: The 20cm pan is a standard for evaporative demand observation in meteorological stations of China. Measurement values of the pan are systematically large than that of other type of pans. We described the limitation of using the 20cm pan data in the revised manuscript. SWAT model provides quite a few of methods for calculating the potential evapotranspiration, e.g., the Penman-Monteith, the Hargreaves method,

C810

and the Priestly- Taylor formulas. The data requirement of the formulas varies significantly. The Penman-Monteith method requires more inputs than other methods, such as solar radiation, air temperature, relative humidity and wind speed; the Hargreaves method requires air temperature only. It is ready choice for scarcity of meteorological data in the high mountain area and was proved an effective method (Liu et al., 2011; Lemonds and McCray, 2007). We tried this less data requirement method in the MRB and found that it gave better evapotranspiration estimation seemingly. However, validation of evapotranspiration by the formulas is truly a great challenge for the remote and inaccessible high mountain basins. We deleted the word "distribution".

Comments:P825 L6 poor to understand.

Reply: The origin sentence should be changed to "Although the PBIAS is small, the NSE of the scenario 3 is still not satisfactory (NSE=0.52). It also could be seen in Figure 9, the simulated streamflow is low in summer and high in spring and fall compared with the observations." (P19 L29, section 3.3 in revised manuscript)

Comments:P837 the unit of air temperature lapse rate is wrong

Reply: The unit should be " $^{\circ}\text{C}/\text{Km}$ ", correction was made.

Comments:P838 It is better to add the real water yield get from discharge record

Reply: The real water yield was 234.8mm/yr on average of years of 1966-1999. It was explained in the caption of Table 4.

Comments:P844 Figure 2 It seems there is one value in each altitude, and the amount points are 20. Is it the average annual precipitation of the same altitude or else? It is only grids in MRB or includes neighbor areas? Needs more clearly in figure title

Reply: In this study, MRB was divided into 20 elevation bands with elevation increment 200m. Precipitation was averaged over each band. Caption of Figure 2 was revised for clarification.

C811

Comments:P849 Figure 7 Need to give the glacier coverage of two HRU

Reply: The HRUs represent different combinations of soil and land-use types. The HRU is not geo-referenced within a subbasin of SWAT model. The selected two glaciers are located within the subbasin 11 and subbasin 21, respectively, Figure 1. GHRU011076 is the 76th HRU and located within the subbasin11 with an area 15.79km² and accounting for 5% of the subbasin area. GHRU021122 is the 122th HRU located within to the subbasin 21 with an area 25.28km² which accounts for 24% of the subbasin.

References:

Aizen, V. B., Aizen, E. M., Melack, J. M., and Dozier, J.: Climatic and hydrologic changes in the Tien Shan, central Asia, *Journal of Climate*, 10(6), 1393-1404, 1997.

Fujita, K.: Influence of precipitation seasonality on glacier mass balance and its sensitivity to climate change, *Annals of Glaciology*, 48(1), 88-92, 2008.

Lemons, P. J., and McCray, J. E.: Modeling Hydrology in a Small Rocky Mountain Watershed Serving Large Urban Populations, *JAWRA Journal of the American Water Resources Association*, 43(4), 875-887, 2007.

Liu, T., Willems, P., Pan, X. L., Bao, An. M., Chen, X., Veroustraete, F., and Dong, Q. H.: Climate Change impact on water resource extremes in a headwater region of the Tarim basin in China, *Hydrol. Earth Syst. Sci.*, 15, 3511–3527, 2011.

Neitsch, S. L., Arnold, J. G., Kiniry, J. R., and Williams, J. R.: Soil and Water Assessment Tool Theoretical Documentation, Version 2009, available at: <http://twri.tamu.edu/reports/2011/tr406.pdf>, last access: July 2012.

Wei, W., and Hu, R.: Precipitation and climate conditions in Tianshan Mountains, *Arid Land Geography*, 13(1):29-36, 1990. (In Chinese)

Wei, W. S., Qin, D. H., and Liu, M. Z.: Properties and structure of the seasonal snow

C812

cover in the northwest regions of China, *Arid Land Geography*, 24, 310–313, 2001. (In Chinese)

Zhang, S., Ye, B., Liu, S., Zhang, X., and Hagemann, S. A modified monthly degree-day model for evaluating glacier runoff changes in China. Part I: model development. *Hydrological Processes*, 26(11): 1686-1696, 2012.

Please also note the supplement to this comment:

<http://www.hydrol-earth-syst-sci-discuss.net/10/C806/2013/hessd-10-C806-2013-supplement.zip>

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, 10, 807, 2013.

C813

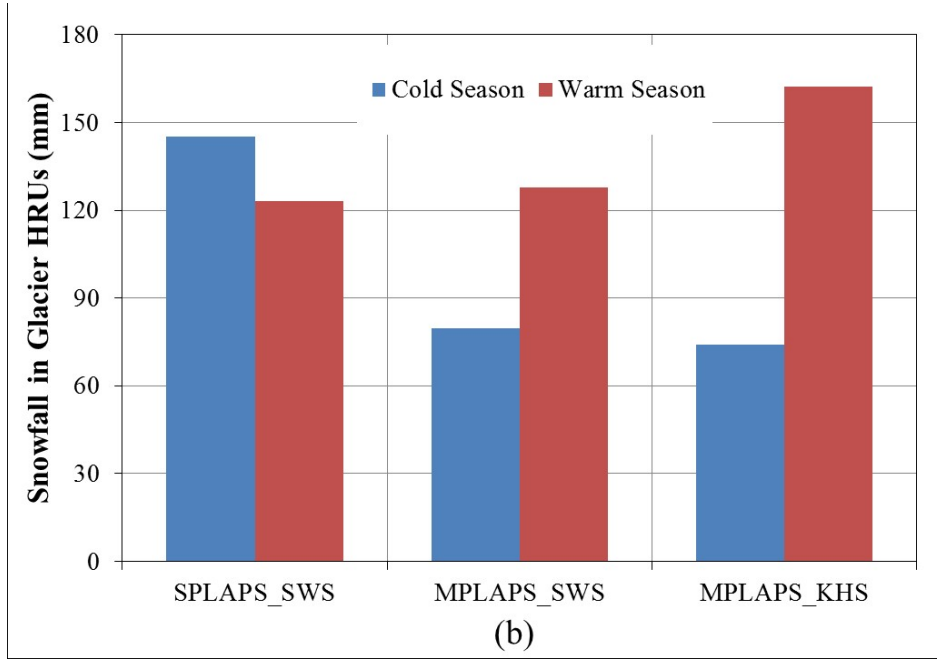


Fig. 1.