Response to Comments by Reviewer #2

The following changes have been made based on the Reviewer #2's comments to manuscript "Distributed modeling of land surface water and energy budgets in the inland Heihe river basin of China" authored by Y. Jia, X. Ding, C. Qin, and H. Wang. The manuscript number is HESS-PUC-09-M106.

This paper presented an improvement of a sophisticated distributed model and its application to the Heihe river basin, an inland basin of China characterized by significant spatial variations of topography, climate, land use and water use within the basin. I evaluated this paper is worthy of publication as the usefulness of this model was demonstrated well and the hydrological cycle in such a data-scarce basin with variable hydro-meteorological and surface conditions was quantified in detail.

Comments
However, I suggest authors to elaborate the application results while keeping the model description as brief as possible.
Response
  Thank the reviewer #2 for the suggestion. We have made further elaboration on the manuscript, both parameter estimation and application results.

Comments
Also it is better to elaborate the background related to the scenarios in this paper, i.e. construction of conservation forest and animal husbandry.
Response
  Related to the scenarios, some clarifications are made in the revised manuscript.

Comments
I also suggest directly showing the hydrological impacts due to increasing irrigation water consumption.
Response
  As commented by the reviewer #2, based on the following correlative research results: due to water allocation in the irrigated areas of the Middle Heihe River in 2002, the reduction of transformation of surface water to groundwater accounts for 45% of the total decrease, thus readjustment of the industrial structure and saving the agricultural water consumption are significant measures to hold all environments stably (Wei et al., 2008). In this study, we set the scenario that reducing the irrigation surface water consumption by 50% in 2002 while keeping the conditions unchanged in order to study the hydrological impacts. The comparison of monthly discharge at Zhengyixia under history and scenario conditions in 2002 is shown in Table 4 and Figure 1. The results show that, due to the reduction of irrigation surface water

consumption in the middle reaches, it has obvious impacts on the discharge at the Zhengyixia.

Table4 Monthly discharge at Zhengyixia under history and scenario conditions in 2002 (m³/s)

Condition	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
History	129.9	126.7	119.2	51.4	35.5	250.9	512.6	397.6	156.2	111.5	102.9	124.0
Scenario	129.9	126.7	135.6	111.5	131.3	471.7	728.4	588.3	260.5	201.7	151.2	134.2

Comments

P2196 L18: How did you formulate the wetness function beta? Please describe the function in this part.

Response

As commented by the reviewer #2, we describe the function as follows, and the corresponding revision has been made in the manuscript.

$$\beta = \begin{cases} 0 & \theta \le \theta_m \\ \left[1 - \cos(\pi(\theta - \theta_m)/(\theta_{fc} - \theta_m))\right]^2 / 4 & \theta_m < \theta < \theta_{fc} \\ 1 & \theta_{fc} \le \theta \end{cases}$$

where β is the wetness function; θ is the moisture volume content of surface soil ; θ_{fc} is the moisture holding rate of surface soil; θ_m is the soil moisture volume content corresponding to single molecule suction; and the other notations are the same as mentioned above.

Comments

P2202 L2: It seems an equation is missing between "…the second soil layer or" and "if Hu…".

Response

As commented by the reviewer #2, an equation is indeed missing here, and it has been added in the manuscript.

(Add the equation:

E=FSV(ES+Etr11+Etr12+Etr13+Etr21+Etr22)

Comments

P2202 L17: It seems that hydraulic conduction coefficient is not a commonly used terminology. Please consider to revise this.

Response

As suggested by the reviewer #2, the expression is not a commonly used terminology, maybe it is better to use "hydraulic conductivity coefficient". We have made correction in the manuscript.

Comments

P2202 L17: The value of Kf becomes larger than Ko when Ta is smaller than Tc. Is this formulation reasonable?

Response

This is not the case. For example, Tc=−5℃, a=0.05, and b=0.25 in the Heihe basin; when Ta = -6℃ (Ta<Tc), aTa+b=-0.05, Kf=K0 e-0.05=0.95123K0, thus Kf<K0.

Comments

P2205 L20: Antropogenic ! Anthropogenic

Response

  As commented by the reviewer #2, we have made correction in the manuscript.

Comments

P.2207: It is better to provide the general information of the basin such as location, the topographical condition (the range of elevation) and climatic conditions.

Response

  As commented by the reviewer #2, we have added the general information in the manuscript. (Add:

  The Heihe river basin is located between 37°50′ ~42°40′ N and 98°~102°E, and its area is 26,000 km^2. The Heihe river originates from the middle of the Qilian Mountain, it runs across Qinghai Province, Gansu Province and Neimenggu Province, the length of main stream is 821 km. In the upper reaches which refer to the section upping Yingluoxia, the vegetation is good, the average annual temperature is less than 2°C and the average annual precipitation is 350mm. In the middle reaches which refer to the section between Yingluoxia and Zhengyixia, the topography is flat and the average annual temperature is 6~8°C, and the average annual evaporation reaches 1410mm. In the lower reaches which refer to the section downing Zhengyixia, most of the region are deserts, the average annual temperature is 8~10°C,the average annual precipitation is 47mm while potential evaporation reaches 2250mm, which shows that the region belongs to extremely arid area.)

Comments

P2209 L26: Please check the unit of irrigation quota. m3/ha ! m3/ha/10days?

Response

  As commented by the reviewer #2, we have checked the unit of irrigation quota. It should be "m3/ha".

Comments

P2210 L17: In your model, do soil thermal properties depend on humidity, not on soil moisture?

Response

  As commented by the reviewer #2, we change "soil humidity" to "soil moisture".

Comments

P2213 L15: Fig.8 instead of Fig.5.

Response

  As commented by the reviewer #2, we have made correction in the manuscript.

Comments

P2215 L9: I could not find names of some areas or locations on any figures, such as the Shandan-Minle Plain and the Minle-Shandan irrigation areas. So, please clearly include the names of basin,

plain or any other geographic locations that are important to follow this paper into one figure.

Response

As commented by the reviewer #2, these areas could be found in figure2, figure3 and figure5.

Comments

P.2218 L2: Why are the hydrological changes so small in Table 4, although the construction of conservation forest changes the entire basin areas to forests?

Response

The area of soil conservation forest construction is 249.6 km2 (L26 on P2216), which is only 2.5% of the entire area of the upper reach watershed (9999 km2) (L11 on P2214) considering the practical feasibility. The related content is revised to clarify the meaning.

Comments

In figures 14 through 20: please include units.

Response

As commented by the reviewer #2, we have added the units in the manuscript.