

Interactive comment on “Do changes in climate or vegetation regulate evapotranspiration and streamflow trends in water-limited basins?” by Q. Liu et al.

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General comments The paper by Liu et al. states an interesting question in its title. The authors attempt to answer this question based on the Budyko-Choudhury-Porpatto model and apply this to the Yellow River basin. I think this is a potentially interesting experimental set up. However, there is crucial information missing in the methods section. Namely, how α , κ , and especially Z_e are calculated. The effective rooting depth Z_e appears to be crucial in their methodology, but only some vague notions about a decreasing P resulting in a decreasing Z_e , without any formulas are given in the paper. The reader

C5608

is left puzzled whether and how Z_e this in itself relates to climate or NDVI in their methodology. Knowing this dependency, however, is crucial to assess the value of the study. A recent paper, for example, showed how Z_e mainly relates to dry spells (Gao et al., 2014) and I suspect that this paper is at odds with that conclusion. Having said this I feel that it would be good if a revised version would again be reviewed in open discussion or, at least by 1-2 new referees. Besides, I have several specific and technical comments. Response: Changes in climate, vegetation and soil regulate the hydrological processes, especially in the water-limited regions. Due to the response of vegetation to climate, changes of vegetation can impacts the partitions of P into E and Q . In this paper, we wanted to explore the temporal trends in E and Q ; and to assess the relative contribution of climate and vegetation change on E and Q in a large water-limited basin, Yellow River Basin, China. In order to give a compact structure, the methods were address in the simple way. The key method of BCP model was address as method section. In order to give a more specific information, some information was added in the improved version, especially how to obtain the Z_e , α and κ . Furthermore, some new references were cited in the revised version, e.g., Gao et al. (2014). Furthermore, according to your comments, the paper was improved and response note were addressed as followed.

Specific comments Abstract and introduction: the study appears to be about the Yellow River Basin, but this is strangely enough not mentioned here. Response: According to your comments, abstract and introduction sections have been improved to present the Yellow River Basin, China. Abstract section has inserted “Hydrological processes regulate by the interactions between climate, vegetation, and soil, especially in the water-limited region. In this study, we conducted to investigate the causes for the changes for evapotranspiration and streamflow in the water-limited regions, the Yellow River Basin, China.” Introduction section also presented the study basin.

11184 - L3: “In this study, it was assumed : : : ” I would expect the authors first to explain what they are doing in the paper, rather than beginning with the assump-

C5609

tions. This assumption, by the way, has to be defended as I expect rather big land-use changes in the Yellow River Basin in the study period. Response: Thanks for your comments. According to your comment, "In this study, we conducted to investigate the causes for the changes for evapotranspiration and streamflow in the water-limited regions, the Yellow River Basin, China" has been inserted in the introduction section to explain the objective. Followed by the method, it was assumed.

11184 - L5: "Budyko's hydrological model" I would in first instance rather call it the Budyko framework or Budyko curve, but later it appears to be the Budyko-Choudhury-Porpatto model, so why not call it that? Response: "Budyko's hydrological model" was used to highlight the model, and contrast with spatial distributed model. That should be more specific using the Budyko framework in the first instance. That has been improved in the revised version.

11184 - L15-L17: "Ze scenarios were able : : : on water resources" It is quite logical than changing an important parameter affects the partitioning of precipitation into evaporation and runoff. For that conclusion it was not necessary to perform the study. I agree that rooting depth should be able help to regulate climate change impacts. However, in contrast to what is shown in this paper, I would expect plants to root deeper when precipitation goes down. Response: Generally, under water-limited conditions, the higher the precipitation the deeper rooting depth and the higher the precipitation intensity and/or seasonality under a given P, the deeper roots become in order to maintain the same E. mostly model captures the first in calculating the effective rooting depth. In our study, we also calculated effective rooting depth using the model provided by Guswa (2008), that also mainly reflect the first condition. BCP model incorporated the ecohydrological parameter can used to reflect the sensitivity of Q and E to changing in climatic and ecohydrological parameter. Using the different Ze scenarios, we also can reflect the causes for the changes in Q and E.

11185 – L3-L4: "which the Grain for Green program has shown to exist." Is there a proper reference for this claim? Response: The reference has been added. McVicar,

C5610

T.R., Van Niel, T.G., Li, L.T., Wen, Z.M., Yang, Q.K., Li, R., Jiao, F., 2010. Parsimoniously modelling perennial vegetation suitability and identifying priority areas to support China's re-vegetation program in the Loess Plateau: Matching model complexity to data availability. *Forest Ecology and Management* 259 (7), 1277–1290.

11185 – L7-L11: same comments as for the abstract 11185 – L22-L25: "While numerous studies : : : to climate change" The study period of this paper, 1961-2010, is also in the past Response: The sentence has been improved as "While numerous studies have investigated impacts of climate and vegetation on hydrological processes, few have explored impacts of vegetation on hydrological processes from the point of view of the response of vegetation to climate change".

Section 2: The study area should be discussed separately. Baseline figures and numbers for evaporation, runoff, precipitation, potential evaporation, effective rooting depth, etc. should be given. Response: The study area has been separated in the improved version. Some information about the basin also provided.

Section 2: A detailed tabulated overview of the two scenarios applied would help the reader. Response: Static and dynamic Ze scenarios were used to calculate the E using the BCP model, and then used the slope of different E to assess the influences of climate and vegetation change on E. Some information was added in the improved version.

Section 3.1: The negative trend for potential evaporation came as a surprise to me. In general, potential evaporation is expected to increase with climate change. It would be good if the authors could indicate which factor, radiation, temperature, humidity, windspeed, is mainly responsible for this unexpected negative trend. Response: In general, E_p presented slightly decreasing trends with an average slope -0.13 mm a^{-2} , while it presented increasing trends in most part of the basin, especially in the upper and middle regions of the basin. Temporal trends of E_p reflect the combined effects of net radiation, wind speed, relative humidity and air temperature. This study results are

C5611

consistent with the study results with Liu and McVicar (2012).

11188 – L1: “Ep and P exhibited increasing trends” The sentence before was that they had decreasing trends. Something is wrong here. Response: It is a mistake in this sentence. “Ep and P exhibited increasing trends” has been corrected as “Ep/P exhibited increasing trends with an average increase of 0.004 mm a⁻²”.

11188 – L2-L4: The vegetation fractions : : : for calculating Ze.” This should be thoroughly explained in methods! Response: The vegetation fraction for trees (Fig. 1c) and grass (Fig. 1d) were calculated using the fPAR, which mainly used to outline vegetation type and extent. According to assumption, the vegetation type and extent in our study is fixed, which used to calculate the Ze. By the static and dynamic scenarios of Ze, we can obtain the change in partition of P into E and Q. The vegetation fraction were presented here as results.

Section 3.1: As said in the general comments, it is a complete black box how Ze is calculated. Response: Generally, under water-limited conditions, the higher the precipitation (or lower Ep/P) the deeper rooting depth and the higher the precipitation intensity and/or seasonality under a given P, the deeper roots become in order to maintain the same E. mostly model captures the first in calculating the effective rooting depth. In our study, we also calculated effective rooting depth using the model provided by Guswa (2008), that also mainly reflect the first condition. “According to conclusions that state that the higher the P the deeper the Ze (Schenk and Jackson, 2002; Donohue et al., 2012), Ze was calculated for YRB using the effective rooting depth model of Guswa (2008), a large water-limited basin (data provided in Fig. 2)”. Some materials were added in the improved paper to explain the Ze calculation.

11189 – L13-L15: “The relative contribution : : : was obtained (Fig. 6b)” Could this for clarity be written down in a formula? Response: According to your comments, the relative contribution was addressed as followed formula:

$$E_c = (S_{sz} / S_{dy}) \times 100\% \quad E_v = ((S_{dz} - S_{sz}) / S_{dz}) \times 100\%$$

C5612

where, E_c is relative contribution resulted from climate on E; E_v is relative contribution resulted from vegetation on E; S_{sz} and S_{dz} is the trend ($p < 0.05$) of modeled E under the static Ze and dynamic scenario, respectively. According to the formula, the relative contribution of climate (Fig. 6a) and vegetation (Fig. 6b) for each grid cell were obtained.

11192 – L9-L11: “Ze Response to : : : this water-limited region” I do not understand this sentence. I think something is wrong with its structure and to which hydrological processes is referred? Response: As anticipated, although climate change regulates changes in E and Q, Ze response to climate change contributed greater to changes in E and Q for this water-limited region.

11187 - “Along with climate : : : topic to date” This is a redundant repetition of the introduction. Response: This sentence has been deleted from the revised version.

11191: L2-L4 “In this study : : : and McVicar (2012)” Details for this calculation should be given transparently elsewhere in the paper, before this discussion could make sense. Response: Here, BCP model with dynamic n can reflect the influences of ecohydrological parameter on partitions of P into E and Q. n also were address in the result section as “Modeled time series of E using the BCP model with the dynamics n (average n is 1.81 at basin scale)”.

Table 1: What is the left and what is the right part of this table? Response: The table 1 here been improved, left and right of the table 1 is the summaries for E and Q sensitivities to changes in ecohydrological variables, respectively.

Figure 1: in (a) I would write “Temporal trend in P” and in (b) “Temporal trend in Ep”. I would also write in the caption that the Yellow River Basin is shown. Response: According to your comments, the figure 1 and its caption have been improved.

Figure 1: The information about grass and trees should be in a separate figure, which should be discussed in methods. Also, it is not very clear what exactly is done

C5613

with that information. Moreover, this is a quite simple land-use classification, i.e., not even crops are included. This choice should be defended in the paper. Response: The cover fraction of grass and tree were addressed here to outline the extent of the vegetation for the calculation of Z_e . The calculation for Z_e has been moved to method section. The fraction of grass and tree mainly used to calculate Z_e , were deleted from the paper.

Figure 3: The very small differences between the static and dynamic scenario make it hard to judge whether the changes in the Z_e parameter even make sense. In the text an NSE of 0.85 for the dynamic scenario is mentioned, but what is the NSE for the static scenario? Response: The changes of Z_e contribute slight influence on the changes of E . The NSE is 0.83 for the static scenarios, which also has been added in the revised manuscripts.

Figure 4: It took me some time to understand this figure. After a while I think I understood that it is not about temporal changes, but about relative differences between the two scenarios. A formula would be helpful. Response: Figure 4 presented the modeled percent differences in mean annual total E (a) and Q (b) between static Z_e (Z_e for 1961 was fixed throughout the 1961–2010 simulation period) and dynamic Z_e (Z_e was influenced by specific water and energy conditions for each grid cell in accordance with specific climate change conditions). According to your comments, the formula was added in caption for fig. 4. $E_change = ((E_d - E_s) / E_d) \times 100\%$, where, E change is percent differences in mean annual total E , E_d and E_s is mean annual total E between static Z_e and dynamic Z_e . $Q_change = ((Q_d - Q_s) / Q_d) \times 100\%$, where, Q change is percent differences in mean annual total Q , Q_d and Q_s is mean annual total Q between static Z_e and dynamic Z_e .

Figure 5: In Figs. 1 and 2 the static scenarios are shown in (a) and the dynamic in (b). In this figure the opposite is true. Moreover, the panels are very similar and relative differences as in Figure 4 would be easier to interpret. Response: OK, the figure 5 is improved consistent with fig. 1 and 2. The manuscript also has been improved to

C5614

consistent with the changes in Figure. Fig. 5 wanted to address the slope of E with static and dynamic Z_e and also that with significant changes in slope. The changes in slope were used to reflect the influence of changes in Z_e on the E . The figure 4 used to reflect the changes of value of E due to changes in Z_e .

Figure 6: If I understand correctly, the assumption is that E is 100% explained by climate when the changes in E for the static scenario are equal to the changes in the dynamic scenario. Some more text could be spent on why some regions are 100% explained by vegetation. Is that perhaps related to very low evaporation values? Response: In this paper, the contribution of climate on E is regarded as the slope of E with static Z_e scenarios was divided by the slope of E with dynamic Z_e scenarios; while the 100% - contribution of climate on E was regarded as the influences of vegetation on E . In the long term, slopes of E with static and dynamics are consistent with each other, the changes of Z_e are mainly resulted from climate, on the contrary, it's regarded as the changes in E mainly influenced by the vegetation. In order to explain this trends, the Figure 6 were improved, the extent with significant trends of E with dynamic Z_e scenarios were showed.

Figure 6: Why is there not a figure for runoff as well? Response: In this paper, E is influenced directly by the changes of climate and vegetation, and then Q ($P - E$) was calculated. The slope of E with static and dynamic Z_e used to reflect the influences of climate and vegetation on E .

Technical corrections 11184 - L22: resource -> resources Response: Corrected.

11185 - L25: was -> is Response: Corrected.

11191 L3: calculated -> calculate Response: Corrected.

Figure 3: E_a -> E Response: Corrected.

Please also note the supplement to this comment:

C5615

<http://www.hydrol-earth-syst-sci-discuss.net/11/C5608/2014/hessd-11-C5608-2014-supplement.pdf>

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C5616