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Interactive comment

Interactive comment on "Diagnosis toward predicting mean annual runoff in ungauged basins" *by* Yuan Gao et al.

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Reply to Referee #2: This manuscript tried to parameterize the two parameters of the mean annual balance equation by relating their values with the controlling factors, in order to develop a model to estimate mean annual runoff in ungauged basins. It is an interesting topic and suitable for HESS. However, I have several comments as follow.

Thank you very much for your comments and suggestions. Our replies are listed as follow:

(1) It isn't clear which equation is the water balance model that was developed for estimating mean annual runoff.

Thank you for pointing out the problem. The mean annual runoff is computed by the

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difference of mean annual precipitation and mean annual evaporation which is computed by aggregating the daily evaporation calculated by Equation (3). This will be clarified and the equation for mean annual runoff will be presented explicitly in the revised manuscript.

(2) As shown in Figure 5(b), there is a large difference and low correlation between the estimated shape parameter and the calibrated one. At the same time, Figure 5(a) shows that the model has a fair estimation of mean annual runoff with the estimated shape parameter. I guess that the model has a low sensitivity to the shape parameter. I suggest a sensitivity analysis on the parameter. Also, it is necessary to evaluate the improvement due to the parameterization from soil characteristics as given in Section 2.2.2, since it is a relatively complicated process. In addition, I suggest that some statistical indicators should be given in Figure 5. 3.

Thank you for your suggestion. The narrow ranges of the axes may give us the impression that the difference between the estimated shape parameter and the calibrated one are large, while actually the mean difference is 0.06 which is small considered that the range of the shape parameter is from 0 to 2. The sensitivity analysis of the mean annual runoff to the shape parameter will be conducted in the revised manuscript, and statistical indicators will also be calculated for Figure 5. For the parameterization in Section 2.2.2, it is a new method proposed in this study to quantify the spatial heterogeneity of the soil water storage capacity, which is then discussed in Section 3 on how to improve the estimation by considering more details of the bedrock information, therefore, the focus of this study is not the improvement of the shape parameter parameterization from the soil characteristics.

(3) In Lines 142-148, the authors pointed out the effect of climate variability on water balance, but it isn't clear how to deal with the effect of climate variability in the developed model. In addition, previous studies reported that many factors, such as vegetation, catchment slope and etc., have an impact on water balance. I am not sure whether such factors have more lager impact on water balance than the spatial

variability of storage capacity has. There is a possibility that their impacts can be attributed to the impact of the distribution of soil water storage capacity. More analysis and discussions are required.

We are sorry for the confusion. Different from traditional mean annual water balance models which take the mean annual precipitation (P) and potential evapotranspiration (Ep) as climate inputs, our model is forced by the observed daily P and Ep; therefore, the effects of the climate variability, including the intra-monthly, intra-annual, and inter-annual climate variability are automatically included. In the revised manuscript, we will clarify how to deal with the effect of climate variability when we introduce the structure of the developed model in Section 2.1. For the other factors such as vegetation and catchment slope, we agree that their impacts can attribute to the distribution of soil water storage capacity as a result of catchment coevolution. The land surface topography, i.e., DEM, is one of the controlling factors for determining the soil thickness in this study; therefore, the topographic characteristics including the catchment slope has been considered through DEM data. To further explore the impact of catchment topographic features, we will add a discussion in the revised manuscript on determining the shape parameter of the soil storage capacity through the spatial variability of the topographic wetness index. For the impact of the vegetation on the soil water storage capacity distribution, it will be included as a future scope of our work.

Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2020-353/hess-2020-353-AC2-supplement.pdf

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