Dear Referee #2,

Thank you for your insightful comments and suggestions. The followings are our responses to each of your comments.

GENERAL ASSESSMENT

This ms addresses catchment-scale storage dynamics and their interactions with evapotranspiration in a set of catchments in the US. Specifically, the authors infer rates of evapotranspiration from streamflow recessions and compare them to estimates based on satellite remote sensing. The authors use the discrepancies between the two estimates of evapotranspiration to infer the fraction of catchment storage that is actively contributing to streamflow. They propose that the changing fraction of "active" catchment storage is one explanation for the multi-valued storage-discharge relation.

Thank you for the summary.

Over the last few years, the study of storage dynamics has become a key focus of research in the catchment hydrology community, and the linkage between evapotranspiration and streamflow recession behaviour has also been a focus of recent research. The topic of the ms is, therefore, of current interest to the readership of HESS. However, the ms requires revision to address the specific comments, below, before it should be considered for publication.

Thank you for your constructive comments which are helpful to improve the manuscript.

SPECIFIC COMMENTS

1. In its current form, the introduction does not make a compelling case for the originality and significance of this contribution. The original contribution of this work would be clearer if the introduction were revised to provide a more focused review of the literature to identify specific gaps in our existing understanding, which could then be used as a context for framing clearly articulated questions or hypotheses.

Thank you for the suggestion. The introduction will be revised to state the significance of the contribution and to provide a more focused review of the literature to identify specific gaps in our existing understanding.

2. The underlying conceptual model needs to be introduced more clearly and explicitly. For example, the parameters b1 and b2 are referred to before they are formally defined, which makes it difficult for the reader to follow the description of the analysis.

Thank you for the specific suggestion. The Methodology section will be revised to have a better introduction of the model and its parameters.

3. In addition to explaining the underlying conceptual model more clearly, the authors need to identify the key assumptions it is based upon, and then to address the validity of these assumptions – and the sensitivity of the results to violations of the assumptions – as part of the discussion.

Thank you. The key assumptions of the conceptual model will be summarized: (1) The storage in unsaturated and saturated zones is treated as one storage component; (2) The recession event includes early recession and late recession, which can be presented by two-line lower envelope system; (3) The contributing storage-discharge function is fixed and can be estimated by the lower envelope of the plot of $-dQ/dt \sim Q$; (4) At individual recession events, the initial value of β is assumed to be equal to the average value of α during the event; (5) The partitioning during recession can be described by the mass balance equation: $dS/dt = -Q - E$. The impact of the initial value of β on the analysis (discussed in the responses to the reviews by Referee #1) will be included into the discussion.

4. As one specific example of point 3, above, the authors assume that, in the absence of evapotranspiration, the storage-discharge relation (as expressed in the plot of |dQ/dt| vs Q) should be single-valued and be defined by the lower envelope of the observed values. However, multiple-reservoir models can generate multi-valued storage discharge relations even in the absence of evapotranspiration (Moore, 1997). As far as I can tell, the validity of the estimates of both α and β, and hence of the inferences from the analysis, hinges on the validity of the underlying assumption of a single-valued storage-discharge relation.

Thank you for your comments. We agree that "multiple-reservoir models can generate multi-valued storage discharge relations even in the absence of evapotranspiration" because different combinations of initial reservoir storages in the multi-reservoirs can generate the same discharge. This does not contradict with the argument in our paper. The two straight lines fitted to the lower envelope can be interpreted as two non-linear reservoirs model. The argument of this paper is that the storage-discharge function derived from recession analysis is the relation between contributing storage and discharge. Even though this contributing storage-discharge relation is single-valued, the relation between watershed storage and discharge is not single-value because the initial storage and its spatial distribution vary among recession events.

5. A major goal of this study was to examine the role of connectivity between the stream and upslope area. The authors should cite Ewen and Birkinshaw (2007), who made an important contribution to the understanding of the role of connectivity as a control on the form of the storage-discharge relation.

Thank you for the interesting reference. We found that the reference is very important for connectivity and storage-discharge function.

6. In addition to the potential errors in the values of E inferred from the recession analysis, the authors need to consider uncertainties in the "observed" values of evapotranspiration.

Thank you for your constructive suggestions.

The detailed uncertainty assessment is provided in *Zhang et. al.,* [2010] and not included in this paper. As discussed in P5777 L19~21, even if the RMSE of 1.2 mm/d of the remote-sensed evaporation from *Zhang et. al.*, [2010] is considered as overestimation, the underestimation of evaporation from recession analysis is still significant. For Spoon River watershed, the estimated multi-year mean annual ET based on remote sensing data (denoted as ET_{RS}) is compared with ET estimated from water balance (denoted as $ET_{Inferred}$), i.e., Figure 8 in Zhang et al. (2010). The percent difference between ET_{RS} and $ET_{Inferred}$ is within $\pm$10%. Zhang et al.

(2010) also compared estimated daily latent heat based on remote sensing data with observed tower fluxes, and the correlation coefficient between them is around 0.85 (USBO1 station, which is located in Illinois, shown in Figure 3 of Zhang et al., (2010)). Two other performance indicators (MR and RMSE) are also shown in Figure 5 of Zhang et al. (2010). The accuracy of ET estimation is acceptable in Illinois. Detailed validation of the ET estimation is referred to Zhang et al. (2010).

We also validate by comparing mean annual ET values for the Spoon River watershed. For example, the multi-year (i.e., 1983-2003) averaged ET estimated based on remote sensing data is 642 mm for the Spoon River watershed. Based on soil water balance, Yeh et al. (1998) estimated the average annual ET for the state of Illinois and the value is 659 mm. Assuming negligible mean annual storage change $\overline{\Delta S}$, the multi-year averaged ET can also be estimated by water balance, $\overline{ET} = \bar{P} - \bar{Q}$ where $\overline{ET}$, $\bar{P}$, $\bar{Q}$ are mean annual evaporation, precipitation, and runoff, respectively. Based on MOPEX dataset, the mean annual rainfall $\bar{P}$ is 922 mm and the mean annual runoff $\bar{Q}$ is 272 mm. Then, the estimated $\overline{ET}$ by water balance is 650 mm. Therefore, the estimated ET by Zhang et al. (2010) is correct in the study watershed if compared with water balance data. This conclusion is consistent with the validation presented by Zhang et al. (2010).

Yeh et al. (1998) estimated the mean monthly evaporation based on atmospheric water balance and soil water balance for the state of Illinois. The mean monthly evaporation during the period of April to October estimated by Zhang et al. (2010) in Spoon River watershed is compared with that estimated by Yeh et al. (1998) as shown in Figure 1. The root mean square error is 15 mm. The mean monthly ET_{RS} is 127 mm and the mean monthly estimated by Yeh et al. (1998) is 118 mm.

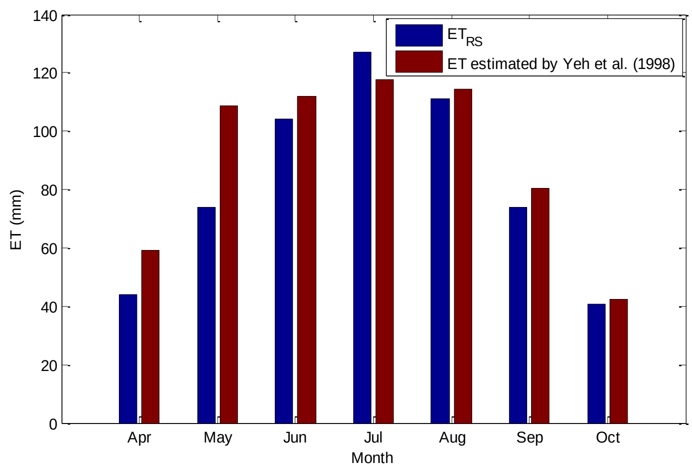

Figure R1: Mean monthly evapotranspiration estimated from remote sensing data (Zhang et al., 2010) and soil water balance (Yeh et al., 1998)

Yeh, P. J.-F. and J. S. Famiglietti (1998), Regional Groundwater Evapotranspiration in Illinois, *Journal of Hydrometeorology*, 10, 464-478. DOI: 10.1175/2008JHM1018.1

Zhang, K., Kimball, J. S., Nemani, R. R., and Running, S. W.: A continuous satellite-derived global record of land surface evaporation from 1983–2006, *Water Resour. Res.*, 46, W09522, doi:10.1029/2009WR008800, 2010.

TECHNICAL POINTS
7. p. 5015, line13. comma splice: "headwaters, however ..."
8. p. 5032, line 23. insert "is" to follow "but also"

Thank you.

REFERENCES

Moore RD. 1997. Storage–outflow modelling of streamflow recessions, with application to a shallow-soil forested catchment. Journal of Hydrology 198, 260–270

Ewen, J. and Birkinshaw, S.J. 2007. Lumped hysteretic model for subsurface stormflow developed using downward approach. Hydrological Processes 21, 1496–1505.