Reply on Reviewer Comment #2

This overall well written paper intends to relate the classical a and b recession parameters to stream network, rainfall and antecedent moisture conditions. As discussed in the review by Anonymous Referee #1, there is a methodological problem: the presented analysis investigates the relationship between the marginal distributions of the parameters and possible explanatory variables, i.e. the analysis omits that a and be are not independent; a solution would be to first model the relation between a and b but as far as I see from fig. 5, there is no evident relationship between a and b.

Reply:

We regret that Referee #2 did not see the true merits of our efforts behind the presentation with certain flaws. Referee #1 pointed out one methodological issue and a couple of weaknesses. The methodological issue is solvable. The weaknesses are basically suggestions to deepen the discussion in this revision. So, through Referee #1's insightful review and our thorough endeavor the significance of our study has been better manifested.

The goal of our study attempts to present landscape structure that can regulate the contrasting recession responses along rainfall amounts. Therefore, is there a simple and obvious relationship between a, b and landscape variables (Fig. 5), which is actually the question we are trying to explore. There have been many studies which pointed out the relationship between landscape and recession variables, but why can't we sort out a simple relation in our cases? After classifying the catchments via drainage area and L/G, we found that the catchments present clear contrasting responses (Fig. 8). Our findings might have two important implications. One is that the landscape properties should be primarily examined (e.g. drainage area in our case) for determining the direction of recession response as assessing recession at a regional scale. Otherwise, the biased direction would lead to an opposite inference. Secondly, the influence of drainage area on contrasting recession responses needs developments of a theoretical framework for physical interpretation.

We are aware that parameter, a, is strongly affected by the unit and concurrently changes with b as fitting the power law equation to observations. In this revision, we used the "decorrelation" method (Dralle et al., 2015) to resolve the independence between a and b (see revised section 2.2.2 [Line: 169-173]): "*Secondly, varying units of $\hat{a}$ with b make no physical meaning for comparison with other events or catchments. Since our target is to assess the response of dual parameters to rainfall, we used the decorrelation method (Drallet et al., 2015). This method assumes that observed flow Q consist of a scale-free flow $\hat{Q}$ and a constant k ($Q = k\hat{Q}$). Thus, the power law formula can be rewritten as $-dQ/dt = ak^{b-1}\hat{Q}^b$, where a is scale-free recession coefficient [h^{-1}]. For correcting $\hat{a}$ to a, the observed flow Q was divided by a constant Q_0 (ideally equal to 1/k, see detail in Drallet et al., 2015).*"

Besides, it is unclear what the main contribution of the paper is beyond a state-of-the-art case study (which is probably no enough to justify publication in HESS). A clear presentation of what we could learn from a case study in the selected hydroclimatic area would be of key importance. The paper would also strongly benefit from a concise synthesis of known factors influencing recession properties

and a better justified selection of the potential explanatory variables that are retained.
For all above reasons, I suggest rejecting the paper.
Reply: The main contribution of our study is to propose a hypothesis that the degree of landscape heterogeneity regulate the contrasting recession responses. Additionally, we identified that different responses of recession shape (parameter, a and b) to rainfall amounts appealing the connection of these different responses to landscape properties. This finding will bridge the gap between conceptual-physical model (Biswal and Marani, 2010 and 2013) to practical application.

Detailed comments:
There is a lack of references for the theoretical aspects of how recession properties depend on landscape properties
Reply: We included several theoretical papers in this revision, including aquifer/hillslope geometry, vertical heterogeneity of aquifer (Rupp and Selker, 2006), draining vadose zone (Luo et al., 2018), drainage network (Biswal and Marani, 2010), and inter-hillslope heterogeneity of celerity (Harman et al., 2009). In our paper, the drainage area and the ratio of flow path length to gradient are the most important landscape variables, which was discussed with the above theories. The discussion has been updated as follows:

1. Section 4.2.1, Line [299-306]: "*Outlining among theories, flow-path variables could be regarded as the aggregation of aquifers with various geometries, or vertical heterogeneity of aquifer (Rupp and Selker, 2006). Flow-path variables L, H, G can be the proxy of $B\cos\phi$, $B\sin\phi+D\cos\phi$, and $D/B+\tan\phi$, respectively. Large B and $\tan\phi$ aquifers have a small coefficient a (Fig. 3 in Rupp and Selker, 2006). Catchments with long total stream length could have a large coefficient. While the flow-path has large H or G, its vertical heterogeneity of aquifer is probably high, also implying that a steep hillslope has a high n value (i.e., high vertical heterogeneity). Our inverse relationship between H and a confirms the theory (Rupp and Selker, 2006). Our catchment-scale flow-path variables could confirm the hillslope-scale aquifer geometry from the groundwater hydraulic theory.*"
2. Section 4.2.2, Line [318-322]: "*Theoretical b increases with aquifer heterogeneity (Rupp and Selker, 2006), inter-hillslope heterogeneity (Harman et al., 2009), and the number of stream (Biswal and Marani, 2010), yet decreases with the total stream length (Biswal and Marani, 2010). As mentioned before, steep catchments may lead to higher heterogeneity in aquifer and inter-hillslope, increasing the value of b. Also, the relationship between DD and b is consistent with the theories. However, these theories could not be valid in our large catchments, suggesting that prior theories were developed in hillslope or small catchment scale.*"
3. Section 4.3.1, Line [346-351]: "*This phenomenon can be explained by Figure 12 in Rupp and Selker (2006). While the initial water table $h_0 <$ aquifer length × gradient ($B\tan\phi$), parameter a is negative to the water table; when the initial water table $> B\tan\phi$, parameter a is insensitive to the water table.*

Three types of catchments follow a pattern that parameter a drastically decreases until approx. 250 mm and changes to constant. Interestingly, Type C has a higher intercept in the rainfall-a relationship like the theorical curve of h0/D=1, suggesting that the lower H of type C tends to be saturation and have a quick recession."

4. Section 4.3.2, Line [367-370]: "*Notably, the contrasting response of b to rainfall was only found in Biswal and Nagesh Kumar (2013) that attributed the change in subsurface flow contribution along the channel to the response direction of b. Our empirical data showed that drainage area regulates different responses of b to rainfall, implying the area could be a proxy of subsurface flow contribution to the channel.*"

There is no discussion of active drainage density (the actual drainage network can vary strongly seasonally)

Reply: We have included the drainage network theory in this revision. This theory states that the recession parameter b is positive to the number of stream and negative to the total stream length (Biswal and Marani, 2010). In their revised model (Biswal and Nagesh Kumar, 2013), the Strahler stream order number was included; they used the bifurcation ratio and length ratio replace the original ones. In temporal variation, they attributed the response of b to the difference of flow contribution in various order stream. In our case, drainage area might be the apparent landscape variable for the difference of flow contribution. We updated our introduction [Line 41] and discussion [Line 367-370].

the literature review should be improved; the previous findings are summarized but not yet synthesized; we also do not know where the previous work has been done (catchments size, climate, region etc); is this study the first in a tropical area?

Reply: As suggested, we compiled recent recession studies into Table 1 of this revision. We collected additional 11 empirical and 5 theorical papers involved power law recessions since 2013 and tabulated the relationship between recession parameters and various environmental factors. From this table, most of the studies focus on the relationship between catchment centrality of parameters and environmental settings. All six inter-event variability studies are located in the USA, which means other landscape regimes have not been surveyed. As we know, only Biswal and Nagesh Kumar (2013) found the contrasting response of b to rainfall. They explained this contrasting response by the gradient of subsurface storage along the channel. Thus, our paper aims to (1) explore environment factor under different landscape regimes; and (2) investigate how landscape variables can explain the contrasting response of b to rainfall. Besides, this study is indeed the first study that explored the influence of environmental factors to the inter-event variability of recession in subtropical/tropical catchments

When talking about travel times, it is important to be more specific weather this is in the channeled or the unchannelled state (i.e. in-stream or in the hillslopes), (e.g. Rinaldo et al., 2006)

Reply: The travel time of our previous work is defined as the time water traveling through a control volume (i.e., catchment) from the sky to the outlet. Yes, specifying travel time within different geomorphic states (i.e., hillslope or channel) may be greatly beneficial for understanding rainfall patterns controlling travel time distributions (Rinaldo et al., 2006). This comment is important for travel time studies, whereas it is not much relevant to our manuscript.

1: attention some units are wrong, the same units should be on both sides of the equation
Reply: Thanks for reminding. We checked the units in equations and text.

There are not enough details on how the explanatory variables of Table 1 are computed for the 260 events (what is total precip, what is Qtot (including or excluding baseflow?), how is peak flow identified if there are several peaks etc. etc.)
Reply: In this revision, the clear information of all variables is replenished in Table 2. Besides, we also added the descriptions associated with calculation for all variables for clarification [in Sect. 2.1]: "AP_{7day} (mm) is antecedent 7-day rainfall. D (hr) is the duration of rainfall event defined as the elapse time from 6 hr before the rising flow to the peak flow. P (mm) is the total rainfall during rainfall event. I_{avg} (mm hr^{-1}) is the total rainfall divided by duration of rainfall event. Q_{tot} (mm) is total discharge (including baseflow) during the rising flow to the end of recession. Q_{ant} (mm) is antecedent discharge at before 1h of rising flow. Q_p (mm) is the maximum discharge over the rainfall event. Q_{tot}/P (-) is total discharge divided by total rainfall."