In this manuscript, Yuan et al. proposed two new methods for estimating isotope ratio of background air vapor (delta_a) based on data collected from standard keeling-plot setups. The study is timely given that delta_a is an important variable that can yield insights into certain aspects of water cycling, but nonetheless remains underexplored as its estimation is not possible with the traditional keeling plot approach. After going through the manuscript, I feel that both of the proposed methods are interesting, theoretically well-grounded and based upon realistic assumptions. Nevertheless, I have some comments that may be of help for strengthening this manuscript, as the following.

Response: We thank the referee for the positive feedbacks.

Although the theoretical framework underlying the IP method is sufficiently sound, I feel that the authors' presentation of this method lacks clarity in several aspects. For example, one thing that I don't fully understand is why the method was named as the "intersection point" method in the first place. I understand that the proposed method was based on Yamanaka and Shimizu (2007) in which delta_a was estimated through the y (or delta_v) value of the point at which two keeling-plot lines intersect. However, it is clear from Equations 4 and 5 (L108, L109) that the method is based on a regular procedure of solving two equations for two unknowns, and that it actually does not have much to do with calculating an intersect point (this typically would involve calculation of a x (or 1/cv) value that would render equality between two y (or delta_v) values predicted from the two different keeling plots). So maybe a different name should be used to describe this method, so to represent the underlying mathematical mechanism more accurately.

Further, the so-called IP method was developed with a vertical-profile based keeling plot as a context, but it is unclear to me what data should be used for parameterizing Cv1, Cv2, delta_v1, and delta_v2 in order for calculating delta_a from Eqn.6 (L112). For example, would the authors recommend parameterizing Cv1 using vapor concentration measured at a particular height at t1? If yes then which level of height would you prefer to use and why?

Strictly speaking, if delta_a is estimated from Eqn. 6 based on vapor concentration and isotope measurements at a particular height, then the resultant delta_a could be inevitably subject to some error the degree of which may likely depend on how much the difference (or the residual not explained by the regression equation) exists between the measured concentration value (i.e. Cv1) at this height and that predicted from the keeling plot (i.e. the regression line derived from measurements from all heights). To reduce this estimation error, I would suggest that the following calculation equations be used instead:

Ca(delta_a – delta_ET1) = k1 (Eqn.1)

Ca(delta_a – delta_ET2) = k2 (Eqn.2)

Where k1 and delta_ET1 denote values for KP1 (keeling plot at time 1) derived slope and intercept respectively, and k2 and delta_ET2 correspond to KP2 derived values. Combining Eqns. 1 and 2 yields an equation for calculating delta_a, as:

delta_a = (k2*delta_ET1 – k1*delta_ET2)/(k2 – k1) (Eqn. 3)

The eqn.3 shown above may be more advantageous than the originally presented Eqn. 6, due to that it is simpler in structure, and does not require isotope measurement at a particular height.

Response: We are grateful for the constructive comments from the reviewer. We apologize that we mistakenly thought that the original Eq. 4 and 5 were able to represent the process that δ_a was estimated through the y (or δ_v) value of the point at which two Keeling-plot lines intersect. In fact, the result of IP method was exactly based on intersection point of two adjacent moments Keeling plots. That was the reason why we called it "intersection point" method. Original Eq. 4 and 5 were actually not used in our study. We revised the IP method component as suggested. The following is our newly added description of IP method. Since the actual calculations in the original manuscript followed the revised procedure, there are no changes in our results.

"**Intersection point (IP) method**. Note that for two nearby time points t_1 and t_2, we could use local constant approximation to estimate δ_a within this time interval since it remains relatively constant over a short period of time. By assuming local constant for C_a and δ_a within this time interval, we have

$$k_1 = C_a(\delta_a - \delta_{ET_1}) \quad , \qquad (4)$$

$$k_2 = C_a(\delta_a - \delta_{ET_2}) \quad , \qquad (5)$$

where k_i and δ_{ET_i} represent the value at t_i for i=1, 2. From (4) and (5), we can solve δ_a as:

$$\delta_a = \frac{k_1\delta_{ET_2} - k_2\delta_{ET_1}}{k_1 - k_2} \quad . \qquad (6)$$

The local constant approximation idea was first described in Yamanaka and Shimizu (2007) as an assumption to quantify the contribution of local ET to total atmospheric vapor. "

It seemed that the new Eq. 4 and 5 had nothing to do with C_v and δ_v. However, δ_{ET_1} and δ_{ET_2} were estimated by clastic Keeling plots, which replied on C_v and δ_v measurements from all eight heights.

More specific comments as below:

L36: change "replying" to "relying"

Response: Corrected.

L45: Maybe I missed it, but I did not see anywhere in the text that evidence is presented to support the constant delta_a assumption. A possible route that I could image towards proof of this concept would be to first use Eqns. 6 or 7 to calculate delta_a at different heights using height-specific Cv and delta_v measurements. However, these calculations would have to be based on keeling plot derived delta_ET values, and thus already involve assuming that delta_a remains constant across different heights. In other words, the constant delta_a assumption is already a prerequisite for performing calculation of delta_a, and so one would easily fall into the trap of circular reasoning if the calculated delta_a values are further used as a test of the constant delta_a assumption.

Response: We thank the reviewer for pointing this out and we apologize for the oversight. The reviewer is correct, we did not show evidence in the text to support the constant δ_a assumption. We just used this assumption in our study. We will delete the related description to correct this oversight and avoid confusion.

L57-60: This sentence reads awkward and requires some re-writing. i.e., may be better off beginning the sentence with something like: "With the advent of laser isotope spectrometry capable of continuous and high-frequency measurements of...."

L60-61: Same as above. May be re-organized into something like: "the number of studies...was continuously increasing, generating new insights into processes that affect dv."

Response: We revised this sentence as suggested.

"With the advance of laser isotope spectrometry capable of continuous high frequency (1 Hz) measurements of the isotopic composition of atmospheric water vapor (δ_v) and atmospheric water vapor content (C_v) (Kerstel and Gianfrani, 2008; Wang et al., 2009), the number of studies based on continuous ground level isotope measurements was continuously increasing, generating new insights into processes that affect δ_v (Wang et al., 2010; Galewsky et al., 2011; Steen-Larsen et al., 2013; Sprenger et al., 2015)."

L76-78: I would suggest that the authors add one or two sentences here to highlight why delta_a is important, or how and why accurate estimation of delta_a would benefit ecohydrolgocial studies.

Response: We thank the reviewer for the constructive comment. As suggested, we added more information below about how and why accurate estimation of δ_a would benefit ecohydrolgocial studies.

"ET is a crucial component of water budget among field (Wagle et al., 2020), regional (Hobbins et al., 2001), watershed (Zhang et al., 2001) and global (Jung et al., 2010) scales. The water isotopic composition of ET (δ_{ET}) was generally estimated by Keeling plot approach (Keeling, 1958). It was first used to explain carbon isotope ratios of atmosphere CO_2 and to identify the sources that contribute to increases in atmospheric CO_2 concentration, and has been further used to estimate δ_{ET} in recent two decades (Yakir and Sternberg, 2000). Keeling plot analyses can be applied using δ_v and C_v output by laser-based analyzer either from different heights (Yepez et al., 2003; Zhang et al., 2011; Good et al., 2012) or at one height with continuous observations (Wei et al., 2015; Keppler et al., 2016). Although the intercept of the curve was commonly used as estimated δ_{ET}, the slope of the Keeling plot was also used to estimate δ_{ET} by re-arranging the Keeling plot equations (Miller and Tans, 2003; Fiorella et al., 2018). Keeling plot approach was based on isotope mass balance and two-source assumption using two equations with three unknowns. As a result, the isotopic composition of other potential sources (e.g., water vapor not from ET), as well as isotopic composition of ambient water vapor (δ_a), should be as essential as δ_{ET}, were not able to be estimated directly using the Keeling plot approach. That is the reason why field scale moisture recycling is difficult to estimate to date."

Hobbins, M. T., Ramirez, J. A., and Brown, T. C.: The complementary relationship in estimation of regional evapotranspiration: An enhanced advection-aridity model, **Water Resources Research**, 37, 1389-1403, doi: 10.1029/2000WR900359, 2001.

Jung, M., Reichstein, M., Ciais, P., Seneviratne, S. I., Sheffield, J., Goulden, M. L., Bonan, G., Cescatti, A., Chen, J., and De Jeu, R.: Recent decline in the global land evapotranspiration trend due to limited moisture supply, **Nature**, 467, 951-954, doi: 10.1038/nature09396, 2010.

Wagle, P., Skaggs, T. H., Gowda, P. H., Northup, B. K., and Neel, J. P.: Flux variance similarity-based partitioning of evapotranspiration over a rainfed alfalfa field using high frequency eddy covariance data, **Agricultural and Forest Meteorology**, 285, 107907, doi: 10.1016/j.agrformet.2020.107907, 2020.

Zhang, L., Dawes, W., and Walker, G.: Response of mean annual evapotranspiration to vegetation changes at catchment scale, **Water Resources Research**, 37, 701-708, doi: 10.1029/2000WR900325, 2001.

L106: "it is changing smoothly over time" – maybe change into sth like "it remains relatively constant over a short period of time"?

Response: Changed as suggested.

L152: change "isotope and gas concentration analyzer" to "water vapor isotope analyzer".

Response: Corrected.

L236/238: "immediate intermediate theorem" – no need to spell out the full name here, can just replace with IVT.

Response: Changed as suggested.

L276: What about arid ecosystem? Which method would you recommend for use? From what I understand, the IVT method may also be less favored, due to that it relies on more stringent criteria for data filtering (meaning higher percentage of data loss?), but I could also have missed some strengths/advantages related to this method. Further, can these two methods also be extended to time-based keeling plot cases? Maybe some additional discussion on these topics would be helpful.

Response: We thank the reviewer for the constructive comment. We overlooked the comparation of two methods. The IP method has a wide applicability among various ecosystem and has less criteria for data filtering. While IVT method requires less parameters to estimate δ_a that may cause less errors. The following is the newly added.

"It also reflected that IVT method could only be used in non-arid ecosystems. On the contrary, IP method may not be restricted by the type of ecosystems."

"Although IVT method relies on more stringent criteria for data filtering, this method requires a very simple expression which only need two parameters to be measured according to Eq. (7)."

L280: Your method is similar to Y&Z (2007) in that both require two keeling plot-based equations for solving for two unknowns. However, the two methods are not entirely the same, as for your method, the two unknowns to be solved are delta_a and Ca (having little to do with an intersection point), whereas for Y&Z, the two unknowns to be solved are delta_v and Cv, with the resolved delta_v considered the same as delta_a because of the meaning imbedded within an intersection point.

Response: We thank the reviewer for the constructive comment. We apologize for our oversight for the expression of Eq. (4) and (5). In reality, IP method also had two unknowns (C_v and δ_v) to be solved. We think Y&Z's method was spatial based. They assumed local constant C_a and δ_a within nearby sites. However, IP method in our study was temporal based. We assumed local constant for C_a and δ_a within 30-minute time interval.

L287: change "is consisted of" to "consists of"

Response: Corrected.

L303: See my previous comment on L45.

Response: Please refer to our response to L45 and the same changes have been implemented.