I am reviewing the study entitled "New isotope-based evapotranspiration partitioning method using the Keeling plot slope and direct measured parameters" by Yuan and colleagues submitted for publication to HESS.

The authors propose a modification of the Keeling plot (KP) method, which originally consists in determining the evapotranspiration flux isotopic composition (δ_{ET}) from the value of the offset of the linear regression of the isotopic composition of atmospheric water vapor (δ_{atm}) with the reciprocal of the water vapor mixing ratio ($1/C_{atm}$). The KP method is often applied in the specific context of ET partitioning as it provides one of the three end-members (the other two being the isotopic compositions of evaporation and transpiration, δ_E and δ_T, respectively) of the water isotope partitioning equation and allows for determination of the transpiration-to-evapotranspiration ratio (T/ET). One of the challenges in the original method resides for instance in capturing in a short period of time strong dynamics in C_{atm} and δ_{atm} that would minimize the error made on δ_{ET}, and ultimately on the computed T/ET value.

The authors build on the original KP method concept and derive an expression for T/ET, which would exempt users to determine δ_{ET} in the first place. They find a good correlation between their model output and those of the original KP method.

Response: We thank the reviewer for the nice summary of our work and for acknowledging the importance of the work.

The manuscript fits the scope of HESS well and is of appropriate length for a technical note, (maybe a bit short for a scientific article). However, it did apparently not undergo internal review prior submission and should be checked for language mistakes! The text is on quite a few places difficult to understand (see my technical comments), which should not be the case, Lixin Wang being the corresponding author. There is a series of issues that the authors must address. I have, in general, a problem in grasping their method premises. They argue, for instance, that the y-value of the intercept between the two regression lines corresponding to cases ET=E and ET=T is equal to the isotopic composition of the background water vapor. However, this is a physical impossibility as it would require simultaneous determination of the two lines, yielding to a situation where both cases (ET=E and ET=T) co-exist. But more importantly, I found some inconstancies (errors? typos?) in their trigonometry exercise, which raise the question of the validity of their approach. Finally, the authors run a sensitivity analysis (to unknown parameters), on basis of which they highlight that most of the uncertainty associated with T/ET propagates from that of δET. But a sensitivity analysis does not inform on the model error, rather on its. . .sensitivity. In order to evaluate the relative extent, to which each parameter error contributes to the total error associated with T/ET, the authors should use the error propagation principle. They may refer themselves to the literature for this (e.g, for the theory, Phillips and Gregg, 2001; and one application example, Rothfuss et al., 2010, which the author already cite.)

- Phillips DL, Gregg JW. 2001. Uncertainty in source partitioning using stable isotopes. Oecologia 127:

171–179.

Response: We thank the reviewer's assessment. We agree "Technical Note" is a more appropriate article type for this contribution and we will change the article type during revision. We will clarify some methodology details to avoid further confusions. We agree with the reviewer that sensitivity analysis informs us the influence of parameter error to the model results, rather than informing us the model results error themselves. In the revised manuscript, in addition to sensitivity analyses, we will add analyses specifically targeting at the model uncertainty. We note that the uncertainty analysis of T/ET by Phillips and Gregg (2001) and Rothfuss et al (2010) was based on the theory of first-order Taylor series approximation of variance. This means all the parameters need to be independent. However, the parameters k, δ_v and $1/C_v$ are related to each other in the new method. Therefore, instead of using the traditional uncertainty analysis of T/ET by Phillips and Gregg (2001) and Rothfuss et al (2010), we used error propagation principle to analyze the uncertainty difference between the traditional F_T method and our method. The result indicated that the uncertainty of two methods was similar. Details are shown as follows. We will add this new addition after section 3.1.

"To compare the uncertainty between the traditional F_T method and our method, we first define,

$$b = -\overline{\frac{1}{c_v}}k + \overline{\delta_v} \quad , \tag{16}$$

such that:

$$F_T(\delta_v) = -\overline{\frac{1}{c_v}}\frac{k}{(\delta_T - \delta_E)} + \frac{\overline{\delta_v} - \delta_E}{\delta_T - \delta_E} = \frac{b - \delta_E}{\delta_T - \delta_E} \quad , \tag{17}$$

Here note that b, δ_E and δ_T are independent. If k is associated with an error σ_k, b will have an error σ_b propagated by σ_k.Then we will have:

$$b + \sigma_b = -\overline{\frac{1}{c_v}}(k + \sigma_k) + \overline{\delta_v} \quad , \tag{18}$$

Combining Eq. (16) and Eq. (18), we will have

$$\sigma_b = -\overline{\frac{1}{c_v}}\sigma_k \quad , \tag{19}$$

Additionally, the only difference between Eq. (1) and Eq. (17) is the item δ_{ET} in Eq. (1) and the item b in Eq. (17). To understand the error propagation principle from the slope to the intercept in the Keeling plot approach, we established two equations to describe point ($\overline{\frac{1}{c_v}}$, $\overline{\delta_v}$) on both the OLS fitting line and the OLS fitting line considering the error terms of k and δ_{ET} .

$$\overline{\delta_v} = k\overline{\frac{1}{c_v}} + \delta_{ET} \quad , \tag{20}$$

$$\overline{\delta_v} = (k + \sigma_k)\overline{\frac{1}{c_v}} + (\delta_{ET} + \sigma_{ET}) \quad , \tag{21}$$

where σ_{ET} is the variance of δ_{ET}.

Combining Eq. (20) and Eq. (21), we will have

$$\sigma_{ET} = -\overline{\frac{1}{c_v}}\sigma_k \quad , \tag{22}$$

Comparing Eq. (19) and Eq. (22), we can conclude $\sigma_b = \sigma_{ET}$. As Eq. (17) is the same as Eq. (1) whose δ_{ET} is replaced by b, the uncertainty of our method to quantify F_T is the same as that of traditional method."

The authors will find my specific comments below:

Specific comments

Highlights

Highlights 1 and 2 overlap. I suggest merging them.

Response: They will be merged as follows:

"A new method was developed to estimate the evapotranspiration partition using isotopes and we provided detailed theoretical derivation."

Abstract

Check where variable symbol is given however not further mentioned. Furthermore, I suggest a bit of streamlining, i.e., 1- don't bother mentioning the other partitioning method; 2- better detail the underlying concept of the modified keeling plot (KP) method; 3- mention the validation step; 4- close the abstract by explaining the benefits of using this new application of the KP method compared to the "traditional" use of the isotopic partitioning equation.

Response: We thank the reviewer for the constructive comment. The abstract will be revised as follows:

"To better understand water and energy cycles, numerous efforts to partition evapotranspiration (ET) into evaporation (E) and transpiration (T) have been made over the recent half century. One of the analytical methods is the isotopic approach. The isotopic composition of ET (δ_{ET}) is a crucial parameter in the traditional isotope-based ET partition model, which, however, has considerable uncertainty and sensibility. Here we proposed a modified method relying on Keeling plot slope (k), and relying on the direct measurements of atmospheric vapor concentration and isotopic composition of atmospheric vapor (δ_v), to avoid the direct use of δ_{ET}. Unlike using explorational intercept of Keeling plot in traditional method, our modified method utilized k and individual observations. Mathematical derivation of the modified method was provided, and field observations were used to evaluate the modified method. The same as the traditional method, we used Craig-Gordon model for the isotopic composition of evaporation (δ_E) and chamber method for the isotopic composition of transpiration (δ_T) in our modified model in the validation. The T fraction in total ET based on the modified method agreed well with those using the traditional isotopic method. The overall uncertainty of the modified method was the same as that of traditional method. However, the modified method eliminates the high sensitivity contribution parameter δ_{ET}, and redistribute the sensitivity of δ_{ET} into three parameters with two of them being directly measured. In addition, the new method can provide high frequency F_T values. Instead of producing one F_T value over each observation period (e.g., 30 mins), the new method can produce F_T for each individual observation when majority of the variance of the observations can be explained by an ordinary least square regression line."

L29-30. Strictly speaking, the partitioning of ET does not help you quantify fluxes. For this you need ET flux density absolute values. Please reformulate.

Response: Will revise it as shown above.

L32. "from the field scale to the global scale

Response: We thank the reviewer for the correction. We will delete this sentence.

L33. "often" is a too strong word. Rothfuss et al. (2020, BGD) show that barely ET isotopic partitioning studies were published over the period 1990-2019. . .Please revise - Rothfuss, Y., Quade, M., Brüggemann, N., Graf, A., Vereecken, H., and Dubbert, M.: Reviews and syntheses: Gaining insights into evapotranspiration partitioning with novel isotopic monitoring methods, Biogeosciences Discuss., https://doi.org/10.5194/bg2020-414, in review, 2020.

Response: We will revise it and remove "often".

L40. "Our study presents"

Response: We thank the reviewer for the correction. We will correct this.

1. Introduction

Check where acronyms are given however not further used in the text.

Response: We will thoroughly check these and delete acronyms not further used in the text.

L55-57. Check phrase construct. Also if you mention open water bodies evaporation, you may as well mention water intercepted by the vegetation. I suggest you restrain to ET=E+T to define your framework.

Response: We thank the reviewer for the constructive comment. The canopy-interception component to evaporation will be added as follows:

"Terrestrial evapotranspiration (ET) links water, energy, and carbon cycles on land surface (Jung et al., 2010), consisting of evaporation (E) from soil (Sprenger et al., 2016), open water (Gat et al., 1994) and canopy-intercepted water (Stockinger et al., 2017), as well as transpiration (T) from plants (Wang et al., 2012a; Wang et al., 2014)"

As annual precipitation our study site is less than 400 mm, we ignored the canopy-intercepted water. We will restrain to ET=E+T in our study.

L62. "Besides". Revise (colloquial).

Response: Will change to "in addition".

L70. Sap flow measurements are not “direct measurements”. Please rephrase.

Response: Will delete sap flow measurements here.

L75. Yepez et al. (2003) did not develop their own “isotope model”, they used the KP method for δET, the Craig and Gordon (1965) model for δE, and the steady state assumption for δT. Please revise.

Response: We thank the reviewer for the constructive comment. We will change it to “isotope method”. After a careful check of the origin of isotope-based T/ET model and Eq. (1), we think that it was first put forward by Moreira (1999) and Yakir (2000). We will update these citations.

L78-79. A flux cannot “result” in a concentration ratio. Please rephrase. In addition, you may skip or edit the (quite vague) statement “Hydrogen and oxygen isotopes are natural components of the hydrological cycle”. Also: the physical principle driving the discrimination against water stable isotopes during E and T are the same (different in mass among the three isotopologues), only the boundary conditions and system state variables are different. Please rephrase.

Response: We thank the reviewer for the constructive comment and suggestions. We will delete the vague statement, and will rephrase the second sentence as follows:

“Hydrogen and oxygen isotopes are natural components of the water cycle. E and T have different isotopic compositions, which is caused by different boundary conditions and different system state variables (Rothfuss et al. 2020).”

L84. “suggested that . . .”

Response: Will change it as suggested.

L85-86. “resulting in either overestimation (Sutanto et al., 2012) or underestimation (Wu et al., 2017) of FT values compared to. . .”.

Response: Will change it as suggested.

L86-87. A model sensitivity analysis does not inform on model error. I suggest writing something like “Most of the error associated with isotope-derived FT estimates propagates from that made in estimating δET”. Also in the article of Cui et al. (2020), it reads something else, i.e., “Based on field observations, the uncertainties of end members δET, δT, and δE in the chamber method for δ18O (δ2H) were 0.7‰ (4.2‰, 1.1‰ (4.6‰, and 0.8‰ (4.7‰, respectively, while the uncertainties of δET (Keeling plot) and δE (C-Gmodel) in KeelingâA˘ RCG method for ˘ δ18O were 1.1‰ and 1.0‰˙” Please revise.

Response: We thank the reviewer for the constructive comment and suggestions. We apologize for the confusion of sensitivity analysis and uncertainties analysis. We will revise L86-87 as follows:

“According to model sensitivity analysis, most of the errors associated with isotope-derived F_T estimates propagate from δ_{ET}.”

L90. This is not the case for the study of Griffis et al. (2008). Please correct.

Response: We thank the reviewer for the correction. We will remove this citation here.

L93. ", which leads. . ."

Response: Will change it as suggested.

L97-98. Please check English (grammar). I don't understand.

Response: Will change this sentence as follows:

"Large δ_{ET} uncertainty in eddy covariance isotopic flux method is due to large uncertainty of the covariance between isotopic ratios and vertical wind speeds (Good et al., 2012)"

L99-100. Check English (grammar).

Response: Will change this sentence as follows:

"In some case, δ_{ET} may be underestimated by more than 20‰ using hydrogen isotopes, regardless the methods adopted (Good et al., 2012; Cui et al., 2020)"

L100-101. This is obvious; consider removing.

Response: Will remove it as suggested.

L102. So, is it new, or "modified from"? Wording here is important.

Response: We thank the reviewer for the note here. Our method is modified from the traditional model. We will change all the "the new method" to "the modified method". We will revise this sentence as follows:

"In this paper, we proposed a modified method to estimate F_T without the need of δ_{ET} parameter.

L103-104. Please detail what the "identical instrumental setting" means in the current context.

Response: We thank the reviewer for the comment. We will revise this sentence as follows:

"In this paper, we proposed a modified method to estimate F_T without the need of δ_{ET} parameter. This modified method relies on the same measurements used for the traditional Keeling plot intercept method."

L104-105. "the new method was evaluated against. . ."

Response: Will change it as suggested.

2. Materials and Methods

2.1 Isotope-based ET partition methods

2.1.1 Traditional method

L114-120. Language quality drops here substantially. The explanations are hard to follow, although the mass-balance principle behind the KP is rather simple. The reader may try to find a link between Eq. (1) and Fig. (1), although there is none. Make this explicit, by moving/merging the text about the KP method further down L121.

Response: We thank the reviewer for pointing out the language issue. We apologize for our ambiguous expression. We think the content in L114-120 is irrelevant to the traditional ET partition method. We will move this part into L153, and will rewrite this part as follows:

"The relationships between pure δ_E and pure δ_T were demonstrated by an imaginary graph in **Fig. 1,** which was first proposed by Moreira et al. (1997). Line 1 is idealized Keeling plot line resulting from pure evaporation, and line 2 is that of pure transpiration. The dashed area between line1 and line 2 represents all feasible Keeling plot lines mixed with E and T (i.e., ET). The intersection point of line 1 and line 2 indicated the source of background vapor. In other words, the y-axis of the intersection point represents the isotopic composition of background vapor (δ_{bg}), and the x-axis of the intersection point represents the inverse of background water vapor concentration ($1/C_{bg}$)."

L111-112. Check English (sentence construct).

Response: We will change this part to "By measuring δ_E, δ_T and δ_{ET}, F_T can be determined as:

$$F_T(\delta_{ET}) = \frac{T}{ET} = \frac{\delta_{ET} - \delta_E}{\delta_T - \delta_E} \quad , \qquad (1)"$$

L114. The "relationships of δE and δT" to what?

Response: We will change this sentence to "the relationships between δ_E and δ_T".

L117-120. The interception point between line 1 and 2 is not the point of coordinate δ_a, $1/C_a$ since the lines cannot exist simultaneously. The ensemble of scenarios leading to different values of δ_{ET} are not related at all.

Response: We apologize for our ambiguous expression of Figure 1. Lines 1 and 2 represent idealized pure evaporation and pure transpiration Keeling plot lines that occur simultaneously. Line 1 and 2 is also the upper and lower boundary of the dashed area, respectively. We will make this clearer in the revision.

L117-118. What is the source of ambient vapour? You mean background (local) water vapor, certainly.

L124. The distinction between "ambient" and "directly measured" is hard to make. I suggest referring to ambient air (what you measured) and background (local) air (what you could not directly measure).

Response: Yes, we mean "background vapor". We thank the reviewer for the suggestion. We will change all the original "ambient vapor" to "background vapor".

L125-130. I suggest simply saying that δ_v and C_v are the mean computed values of the calibrated readings of the laser spectrometer over a given period of time. And please indicate the value of that period of time (e.g., 1 hour).

Response: We thank the reviewer for the suggestion. As suggested, we provided the value of observation period (30 minutes). After a careful thought, we still consider that conceptual δ_v and C_v are adequate for Eq. 2. The Keeling-plot-based δ_{ET} is the intercept from ordinary least squares (OLS) regression of $1/C_{vi}$ versus δ_{vi}, which has no relationship with the mean δ_v and C_v values.

L130-131. The KP is a scatter plot of $1/C_v$ versus δ_v. It is not the regression line. This is why a "linear Keeling plot" does not make much sense. On a side note, if there is a way to measure C_a and δ_a, then one can determine δ_{ET} from k.

Response: We thank the reviewer for the comments. We agree that "linear Keeling plot" is not a proper expression. We will revise L125-L131 as follows:

"For a given time, with multiple directly measurements of C_{vi} and δ_{vi} (the individual measurement of the vapor concentration and isotopic composition of water vapor, respectively) collected at various heights during one observation period (e.g., 30 minutes, Good et al., 2012), the intercept δ_{ET} for this moment from ordinary least squares (OLS) regression of $1/C_{vi}$ versus δ_{vi} is able to be estimated (Zhang et al., 2011). The slope (k) of this OLS regression is defined as $k=C_{bg}(\delta_{bg} - \delta_{ET})$."

L132-151. Please revise English thoroughly.

Response: We will thoroughly improve English in this paragraph.

L136-137. How can be the evaporation located in an entire layer? You should say that the "evaporation front isotopic composition is approximated by that of the water in the soil layer (0-5 cm)".

Response: We thank the reviewer for the comments. The definition of δ_s will change to "δ_s is soil evaporation front isotopic composition approximated by that of the water in the soil layer (0-5 cm)".

L137. This is neither from a terminology standpoint nor a language standpoint correct: it should read something like "ε* and α are the liquid water-water vapor equilibrium fractionation value (‰ and fractionation factor (-), related by:. . ."

Response: We thank the reviewer for the suggestions. We will correct this sentence as below:

"ε* and α are the liquid to gaseous equilibrium fractionation value (‰) and fractionation factor (dimensionless), respectively, which are related by the equation $\varepsilon^*=1000(1-1/\alpha)$."

L142. "n" has nothing to do with water stable isotopes, rather with the overall aerodynamic conditions within and above the canopy (see e.g. Merlivat and Coantic, 1975).

Please explain why you consider laminar flow (n=0.67) here? This is quite unlikely to happen in the field.

- Merlivat, L., and Coantic, M.: Study of Mass-Transfer at Air-Water-Interface by an Isotopic Method, J Geophys Res-Oc Atm, 80, 3455-3464, doi:Doi 10.1029/Jc080i024p03455, 1975.

Response: We thank the reviewer for the constructive comments. We apologize for the incorrect definition of laminar flow (n), and we will change it as suggested. As for the n value, we referred a study conducted in a rice field (n=2/3). It was also explained by Merlivat and Coantic (1975) that n=2/3 for smooth surface (Reynolds number < 0.13) and n=0.5 for rough surface (Reynolds number > 2). As our study site was located in an arid region, we considered a smooth surface laminar flow is proper in our study. In addition, it was reported that ε_k occupied only 1.2% contributions to the variations of F_T (Cui et al., 2020). Therefore, some variations of n will have little influence on F_T.

L144-145. Values for the diffusivity ratio coefficients have been revised back to those of Merlivat (1978) by Luz et al. (2009). Therefore I strongly suggest that you run the calculations anew.

- Luz, B., Barkan, E., Yam, R., and Shemesh, A.: Fractionation of oxygen and hydrogen isotopes in evaporating water, Geochim. Cosmochim. Acta, 73, 6697-6703, doi:DOI 10.1016/j.gca.2009.08.008, 2009.

Response: We thank the reviewer for the constructive comments. Luz et al. (2009) stated that α_{diff} (diffusion fractionation factor) of ^{18}O is 1.02302 when the temperature is 20.1°C and D_i/D is 0.9732. We will update the Di/D in our study and re-run our calculations.

L146. Why "also".

Response: Will delete "also".

L149. I suggest that the authors also take into account the increase of flow rate due to transpiration in the chamber as by Simonin et al. (2013). - Simonin, K. A., Roddy, A. B., Link, P., Apodaca, R., Tu, K. P., Hu, J., Dawson, T. E., and Barbour, M. M.: Isotopic composition of transpiration and rates of change in leaf water isotopologue storage in response to environmental variables, Plant Cell Environ, 36, 2190-2206, https://doi.org/10.1111/pce.12129, 2013.

Response: We thank the reviewer for the constructive comments. We assumed that transpiration rate of a plant was constant during the measurement, as the measurement time period in our study is 225s. The absolute value of coefficient of variations of C_v and C_m were both less than 0.002. We will add clarifications in our revised manuscript.

2.1.2 New ET partition method

L153-158. I would name the corners of the triangles "E", "T", and "ET" and the segments e.g., "EET" instead of "(δET-δE)". The latter is a segment length, not its geometrical representation.

L161. "Combining Eq (7) and Eq (8) yields to:"

Response: Will change them as suggested.

L162. Eq. (9) means that π-γ-β=γ+β, which leads to β+γ=π/2, therefore the remaining angle opposite to side "EET" is equal to 90 degrees (isosceles triangle), ultimately conditioning the positioning of the point of coordinate ($1/C_v$, δ_v) on the linear regression (thus cannot be randomly selected). Or am I missing something?

Response: We thank the reviewer for the comments. Eq. (9) actually means that sin(π-γ-β) = sin(γ+β), rather than π-γ-β=γ+β. It is based on sin(π-θ) = sinθ, here θ = γ+β.

L165. This equation implies that sin(γ)=1, which means that γ is now 90 degrees, thus the regression has slope k=0?? I am lost here. . .

Response: We thank the reviewer for the comments. Line 165 means that reduction of a common factor "sin(γ)" from line 164. "sin(γ)" cannot be zero, as 0 < α < γ < π-β < π. When 0 < γ < π, sin(γ) must be greater than zero. To make the derivation more clearly, the derivation steps will be added as follows:

$$"\frac{x}{y} = \frac{\sin\beta\cos\alpha\sin\gamma - \sin\beta\sin\alpha\cos\gamma}{\sin\alpha\sin\beta\cos\gamma + \sin\alpha\cos\beta\sin\gamma}$$

$$= \frac{-\sin\alpha\sin\beta\cos\gamma - \sin\alpha\cos\beta\sin\gamma + \sin\alpha\cos\beta\sin\gamma + \sin\beta\cos\alpha\sin\gamma}{\sin\alpha\sin\beta\cos\gamma + \sin\alpha\cos\beta\sin\gamma}$$

$$= \frac{-\sin\alpha\sin\beta\cot\gamma - \sin\alpha\cos\beta + \sin\alpha\cos\beta + \sin\beta\cos\alpha}{\sin\alpha\sin\beta\cot\gamma + \sin\alpha\cos\beta}$$

$$= \frac{\sin(\alpha+\beta)}{\sin\alpha}\frac{1}{\sin\beta\cot\gamma+\cos\beta} - 1"$$

2.2.2 Field Experiment

Please revise this section for language mistakes, e.g. "The switch process between two independent measurements were self-acting", "within the circulation.", "Our vapor calibration procedure was mainly corresponding to the study by Yuan et al. (2020)." "The isotopic compositions values relative to the Standard Mean Ocean Water (SMOW)."

Response: We thank the reviewer for the constructive comments. These sentences will be rephrased as follows:

"The switch process between two independent measurements were automatic. Since the analyzer records data every 0.9–1s, about 259–264 values for each inlet were recorded within one measurement cycle. Our vapor calibration procedure was mainly following Yuan et al. (2020). The isotopic compositions values in our study were reference to the Standard Mean Ocean Water (SMOW)."

L197-198. Give information about the sensors used.

Response: We thank the reviewer for the comments. Information about the sensors will be added as follows: "The soil temperature (CSI109, Campbell Scientific Inc., USA) was monitored at 5cm depth. Relative humidity (CSI215, Campbell Scientific Inc., USA) was measured at 2-meter-height with 10-min intervals."

L199. Define "atmospheric vapor and mixed vapor" again here. It is not clear to what both expressions refer to.

Response: We thank the reviewer for the comments. We apologize for unclear expression here. The definition of atmospheric vapor and mixed vapor are in L203 and L206, respectively. We consider that the explanation of vapor in parenthesis is redundant. We will delete it here.

L214. "avoid residual issue". Do you mean "memory effects"? Please revise

Response: We thank the reviewer for the comments. Yes, we mean "memory effects". Will correct this.

L219. "minor acrylic glass frame"?

Response: We will use "the chamber" here to replace "minor acrylic glass frame".

L220. Soil was drilled, not its samples.

Response: Will correct this.

L223. "in liquid water mode"

Response: We thank the reviewer for the comments. The description of water vapor/liquid water isotope analyzer will be merged as follows:

"The sampling of vapor and soil water were conducted from June to August in 2017 and 2018 (sampling time points are shown in **Table 1**, which is specified hereinafter), and was measured using a water vapor/liquid water isotope analyzer (L2130-i, Picarro Inc., Sunnyvale, CA, USA). Vapor was collected by four gas traps from 7:00 am to 7:00 pm with two-hour interval."

Fig. 3. This is not needed, really... can you give the model name and part of the pump for sampling atmospheric air at canopy height, 2, and 3 meters height? What was the air sampling flow rate value?

Response: We thank the reviewer for the comments. We will add the information of the pump (Rocker R410, Rocker Scientific Co., Ltd, Taiwan) in this figure. The air sampling flow rate is 20L/min.

L224. Remove practical consideration ("As our water vapor isotope analyzer was occupied due to maintenance and other experiments"). It is not relevant to the reader.

Response: Will remove this sentence.

L229. "A quantity control filter"?? You mean a "quality control filter. . .", certainly. Excluding values outside of range [0,1] is not part of a quality management procedure. It is the sign that, to the contrary, you failed at selecting the valid data prior calculation of FT! In other words, you are merely saying that you did not filtered your data.

Response: We thank the reviewer for the comments. We apologize for the oversight. We will convert the word into "quality control filter". In our study, the absolute value of coefficient of variations of C_v and C_m were less than 0.002, which was far below the critical value of 15% (Lovie, 2005) for an isotopic steady state in the chamber. To make more rigorous quality control, we have removed 11 data sets with standard deviations of C_m being more than twice (more than 28.94 ppm) of the average standard deviations of C_v (13.97 ppm).

This part will be revised as follows:

"Twelve days were chosen to conduct ET partition observation. In each day, the observation started at 7:00 am and end up with 7:00 pm, conducting in a 2-hour interval. Overall, we have 84 experimental data sets (Table 1). To avoid the influence of erratic transpiration flow rate in the chamber on the accuracy of δ_T, a quality control filter was used for the chamber method, measurements with standard deviations of C_m being more than twice (more than 28.94 ppm) of the average standard deviations of C_v (13.97 ppm) were removed. After the quality control, 73 experimental data sets remained."

2.2.3 Global Sensitivity Analysis

L231. "for both methods"

Response: Will remove "two".

L233. This does not make sense. You mean certainly something like: "quantify the contribution of change in each input parameter value to the overall change in modeled FT value."

Response: We thank the reviewer for the comments. We will revise the sentence as suggested.

L234. What does "The parameter interactions were considered in this approach" mean exactly?

Response: We thank the reviewer for the comments. The sensitivity analysis we use here is Sobol-based global sensitivity analysis. Generally, in a model, parameters control the outcome. Traditional local sensitivity analysis cannot consider the situation that all parameters change simultaneously, while Sobol-based global sensitivity analysis can.

L237. Please list the parameters, to which you tested the model sensitivity, with ranges of variations.

Response: We thank the reviewer for the comments. The parameters to test the model sensitivity were listed below:

	δ_{ET}(‰)	δ_T(‰)	δ_E(‰)	k(ppm*‰)	δ_v(‰)	C_v(ppm)
mean	-11.79311628	-8.496886599	-28.75105471	-32317.81763	-13.46759392	19284.02092
stdev	2.339046162	1.981848063	6.955747383	48437.76936	2.002301191	5281.896129

The mean values and standard deviation values were based on all data passed quality control filter in Table 1. The ranges of variations were (mean value-stdev value, mean value+stdev value). We will add this part in the supplement.

Results and Discussion

3.1 Comparisons of the new method with the traditional method

L245. Choose a more explicit title (this goes as well for titles of sections 2.1.1 and 2.1.2)

Response: We thank the reviewer for the comments. We will change the title 2.1 to "The validation of the modified method".

L250-252 and Fig 4. This is surprising considering the set of equations above. . .Can you report the RMSE of the linear model? Explain the "***" in Fig. 4. Does the R2 value applies when the Y-intercept is set to 0?

Response: We thank the reviewer for the comments. After the quality control being applied to the chamber method, we obtained 73 data sets. We also removed three datasets with F_T value larger than one. In the end 70 data sets were used. In the linear model (new **Fig. 4**), we defined intercept=0. Then RMSE=0.047. "***" in Fig. 4 indicates $p < 0.001$. Some regression parameters are shown as follows:

Equation	y = a + b*x
Plot	B
Weight	No Weighting
Intercept	0 ± --
Slope	1.00035 ± 0.00794
Residual Sum of Squares	0.19649
Pearson's r	0.99783
R-Square (COD)	0.99567
Adj. R-Square	0.99561

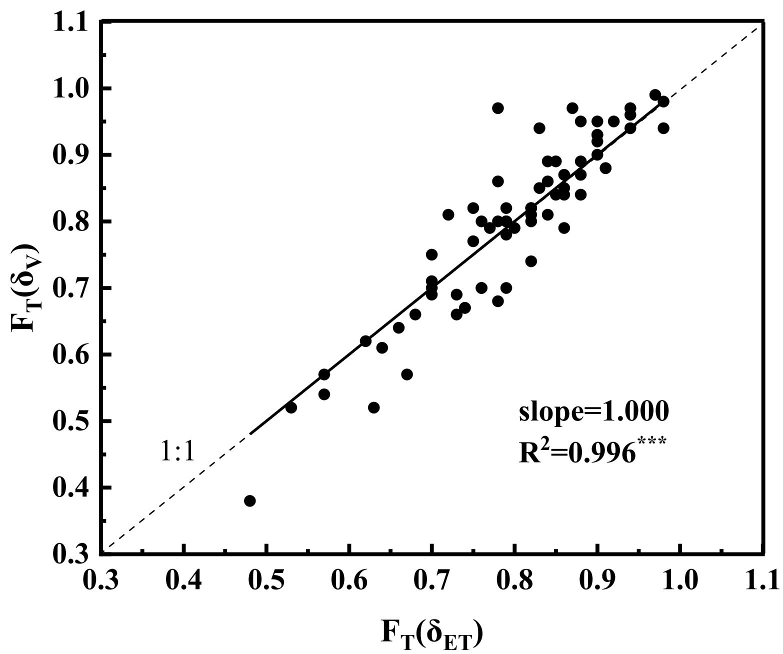

Fig. 4 Comparison of transpiration fraction in the total evapotranspiration between traditional $F_T(\delta_{ET})$ method and the modified $F_T(\delta_v)$ method.

3.2 The advantages of the new method compared with the traditional method

3.2.1 The elimination of high sensitivity contribution parameter δET

Please revise titles 3.2 and 3.2.1.

I have a fundamental problem with this section. You are investigating the sensitivity of a model to a set of parameters. It does not inform on the error you make. These are two different things! Therefore the statement "This result indicated that Keeling-plot-related parameters (δET and k) brought most of the uncertainty to estimate FT." is not valid.

Response: We agree with the reviewer about the sensitivity and uncertainty analyses. We added a new section for uncertainty analyses.

3.2.2 The new method avoids extrapolation of Keeling plot

Please revise title.

Response: We will revise the title.

L274-275. Maybe mention that this study was performed in the lab, so the conditions do not reflect nature.

Response: We thank the reviewer for the constructive comments. We will revise the 3.2 section thoroughly:

"3.2 The uncertainty and sensitivity of both two methods

3.2.1 Uncertainty analysis

This means all the parameters need to be independent. However, the parameters k, δ_v and $1/C_v$ are related to each other in the new method. Therefore, instead of using the traditional uncertainty analysis of T/ET by Phillips and Gregg (2001) and Rothfuss et al (2010), we used error propagation principle to analyze the uncertainty difference between the traditional F_T method and our method. The uncertainty analysis of traditional method was based on the theory of first-order Taylor series approximation of variance (Phillips and Gregg, 2001). All parameters need to be independent. However, the parameters k, δ_v and $1/C_v$ are related to each other in the modified method. Therefore, instead of using the traditional uncertainty analysis of T/ET by Phillips and Gregg (2001) and Rothfuss et al (2010), we used error propagation principle to analyze the uncertainty difference between the traditional F_T method and our method. To compare the uncertainty between the traditional F_T method and our method, we first define,

$$b = -\frac{\overline{1}}{c_v}k + \overline{\delta_v} \quad , \tag{16}$$

such that:

$$F_T(\delta_v) = -\frac{\overline{1}}{c_v}\frac{k}{(\delta_T - \delta_E)} + \frac{\overline{\delta_v} - \delta_E}{\delta_T - \delta_E} = \frac{b - \delta_E}{\delta_T - \delta_E} \quad , \tag{17}$$

Here note that b, δ_E and δ_T are independent. If k is associated with an error σ_k, b will have an error σ_b propagated by σ_k.Then we will have:

$$b + \sigma_b = -\frac{\overline{1}}{c_v}(k + \sigma_k) + \overline{\delta_v} \quad , \tag{18}$$

Combining Eq. (16) and Eq. (18), we will have

$$\sigma_b = -\frac{\overline{1}}{c_v}\sigma_k \quad , \tag{19}$$

Additionally, the only difference between Eq. (1) and Eq. (17) is the item δ_{ET} in Eq. (1) and the item b in Eq. (17). To understand the error propagation principle from the slope to the intercept in the Keeling plot approach, we established two equations to describe point ($\frac{\overline{1}}{c_v}$, $\overline{\delta_v}$) on both the OLS fitting line and the OLS fitting line considering the error terms of k and δ_{ET} .

$$\overline{\delta_v} = k\frac{\overline{1}}{c_v} + \delta_{ET} \quad , \tag{20}$$

$$\overline{\delta_v} = (k + \sigma_k)\frac{\overline{1}}{c_v} + (\delta_{ET} + \sigma_{ET}) \quad , \tag{21}$$

where σ_{ET} is the variance of δ_{ET}.

Combining Eq. (20) and Eq. (21), we will have

$$\sigma_{ET} = -\frac{\overline{1}}{c_v}\sigma_k \quad , \tag{22}$$

Comparing Eq. (19) and Eq. (22), we can conclude $\sigma_b = \sigma_{ET}$. As Eq. (17) is the same as Eq. (1) whose

δ_{ET} is replaced by b, the uncertainty of our method to quantify F_T is the same as that of traditional method."3.2.2 Global sensitivity analysis

Global sensitivity analysis was conducted for both traditional method (**Fig. 5a**) and modified method (**Fig. 5b**). As for the traditional method, δ_{ET} contributed to 59% of the sensitivity of F_T, significantly larger than those of δ_T and δ_E. The high sensitivity contribution of parameter δ_{ET} was also reported by a previous study (Cui et al., 2020). Generally, great uncertainty of δ_{ET} was revealed in Keeling plot method, flux-gradient method and eddy covariance isotopic flux method (Good et al., 2012), which resulted in large F_T uncertainty when δ_{ET} was used in the traditional method on the basis of sensitivity analysis in our study and others' research (Cui et al., 2020). While in the modified method, the parameter with the largest sensitivity contribution was k (46%). This result indicated that Keeling-plot-related parameters (δ_{ET} and k) brought most of the uncertainty to estimate F_T. The modified method eliminates the high sensitivity contribution parameter δ_{ET}, and separated the sensitivity of δ_{ET} into more primitive three parameters k, δ_v and C_v. Meanwhile, the sensitivity contributions of parameter δ_E and δ_T were reduced using the new method (7% and 18%) compared with the traditional method (12% and 29%)."

In addition, we will add 3.3 section to show the advantage of the modified method. Details are shown as follows:

"3.3 The advantages of the modified method

Our method has two advantages. First, after we use k and point ($1/C_v$, δ_v) to replace δ_{ET}, the sensitivity contributions of δ_{ET} are distributed into k, C_v and δ_v. Importantly, the uncertainty of C_{vi} and δ_{vi} is relying on the precision of the isotope analyzer, which has the potential to keep improving in the future. As a result, our method potentially reduces the uncertainty of isotope-based ET partition approach. Second, we are able to insert each individual point of ($1/C_{vi}$, δ_{vi}) into our method to obtain a high frequency F_T distribution (the output frequency of F_T could be as same as the output frequency of *in situ* isotope analyzer) when assumed that k is a constant during an observation unit (e.g., 30 min). There is no need for additional assumptions for such calculations. Based on F_T distribution during each observation unit, we are able to calculate a confidence interval of F_T based on our method rather than traditional method. To assess the variation of F_T due to the approximate calculation of Keeling plot relationship, residual sum of squares (RSS) in linear regression of the Keeling plot, was considered. By ensuring the least RSS, each individual point of ($1/C_{vi}$, δ_{vi}) will then regard as ($1/C_{vi}$, $\widehat{\delta_{v_i}}$), where $\widehat{\delta_{v_i}}$ stand for the y-axis value of ($1/C_{vi}$, $\widehat{\delta_{v_i}}$) which on the Keeling plot regression line. We defined F_{Ti} is an idealized F_T value substitute into δ_{vi} as δ_v, and $1/C_{vi}$ as $1/C_v$, which is described as follows:

$$F_{T_i} = -\frac{1}{C_{v_i}(\delta_T - \delta_E)}k + \frac{\delta_{v_i} - \delta_E}{\delta_T - \delta_E} \quad , \tag{17}$$

As each individual point ($1/C_{vi}$, $\widehat{\delta_{v_i}}$) on the Keeling plot regression line must meet the relationship in Eq.

(14), we have:

$$\widehat{F_{T_i}} = F_T = -\frac{1}{C_{v_i}(\delta_T - \delta_E)}k + \frac{\widehat{\delta_{v_i}} - \delta_E}{\delta_T - \delta_E} \quad , \tag{18}$$

where $\widehat{F_{T_i}}$ stands for the estimated value of F_{T_i} which is exactly equal to F_T. Then the residual error of F_{Ti} (R_i) is shown as:

$$R_i = F_{T_i} - \widehat{F_{T_i}} = (\delta_{v_i} - \delta_v)\frac{1}{\delta_T - \delta_E} = \frac{R_{\delta_{v_i}}}{\delta_T - \delta_E} \quad , \tag{19}$$

where $R_{\delta_{v_i}}$ represents the residual error of y-axis value on Keeling plots. Then we have:

$$F_{T_i} = F_T + R_i = -\frac{1}{C_v(\delta_T - \delta_E)}k + \frac{\delta_v - \delta_E}{\delta_T - \delta_E} + \frac{R_{\delta_{v_i}}}{\delta_T - \delta_E} \quad , \tag{20}$$

as R_i is derived from the least squares regression of ($1/C_{vi}$, δ_{vi}), then we have a normal distribution $R_i \sim N(0, \frac{\sum_{i=1}^{n} {R_{\delta_{v_i}}}^2}{n})$ (Hogg et al., 2005). Then we have another normal distribution $F_{T_i} \sim N(F_T, \frac{\sum_{i=1}^{n} {R_{\delta_{v_i}}}^2}{n(\delta_T - \delta_E)^2})$ based on the properties of normal distributions (for a defined function $y = ax + b$, where a and b are constant real numbers, if $x \sim N(\mu, \sigma^2)$, we have $y \sim N(a\mu + b, (a\sigma)^2)$ (Hogg et al., 2005)), which is the distribution of F_T based on the variation of C_{vi} and δ_{vi} in one observation period. As a result, 95% confidence interval of F_T should be $(F_T - \frac{3}{\delta_T - \delta_E}\sqrt{\frac{\sum_{i=1}^{n} {R_{\delta_{v_i}}}^2}{n}},\ F_T + \frac{3}{\delta_T - \delta_E}\sqrt{\frac{\sum_{i=1}^{n} {R_{\delta_{v_i}}}^2}{n}})$, which means that F_T value will be 95% possibility on this interval (3σ principle) (Hogg et al., 2005). The item $\sum_{i=1}^{n} {R_{\delta_{v_i}}}^2$ is as well as RSS in the OLS regression of the Keeling plots. The length of the confidence interval (l) is then defined as $\frac{6}{\delta_T - \delta_E}\sqrt{\frac{\mathrm{RSS}}{n}}$ (Hogg et al., 2005). More than a specific point of F_T, the new method provided a distribution of F_T for each observation unit, which contains a 95% confidence interval. The confidence interval of F_T will be shown in the revision."

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