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Biogeosciences Discussions

Interactive comment on "Reviews and syntheses: Gaining insights into evapotranspiration partitioning with novel isotopic monitoring methods" *by* Youri Rothfuss et al.

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The submitted manuscript reviewed the methods of measuring or estimating δE, δTand δET for identifying the possible challenges of these isotopic methods, and how they should progress in the future, especially novel non-destructive methods. While this study is meaningful for the use of isotopic partitioning methods, the current literature overview and methodological review did not offer enough supports for the foremen-tioned objectives. However, before the paper can be published, a major revision for this manuscript will be needed. The general and specific comments are showed as follows:

A: Dear Referee, On behalf of the co-authors, I thank you for these comments! Please find below a list of answers and foreseen changes to our manuscript.

General comments: 1. Literature overview: A literature overview was listed in the section 2 as a timeline for highlighting the important progresses made over the past 30 years, however, it might be helpful to classify and summarize these literature. If possible, suggest to add the topic sentences at the beginnings of each paragraphs for understanding easily.

A: Section 2 was, as a matter of fact, constructed as a pure timeline to underline new developments in isotopic sampling, analysis, and data interpretation techniques from 1990 up until today. We will give it a bit more "rhythm" in our revised manuscript, e.g., by using topic sentences, when possible, as suggested by you and Prof. John Marshall.

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2. Methodological review: Suggest adding a theoretical schematic diagram including the flux of soil evaporation (E), transpiration (T), evapotranspiration (ET), and their stable isotopic compositions, and the key points in the estimation of δE, δT, and δET in an ecosystem for understanding the calculation principle clearly.

A: Thank you for the suggestion. We will propose a general figure supporting text L55-79 in the introduction section.

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3. Methodological review: One of assumptions of Keeling plot approach is temporal

variations in the water vapor mixing ratio and δV are caused only by ET. However, rainfall, entrainment process of air, and so on can influence the variation in δV at hourly or daily time scales, and introduces biases in the Keeling plot estimates. Suggest to add the analysis of the related uncertainties for Keeling plot approach.

A: We will add to Section 3.1.2 these factors of variation of δv, thank you.

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4. Methodological review: Suggest to add the comprehensive comparisons of Keeling plot, flux gradient and EC isotopic flux method according to the calculation principle. Keeling plot and flux gradient methods can be agreement under certain conditions, and both calculation principles of flux gradient and EC isotopic flux methods is micrometeorological theory, however the discrepancy still exist among them (e. g. Hu et al., 2020 etc.). Hu, Y., Xiao, W., Wei, Z., Welp, L., Wen, X., Lee, X. (2020) Determining the Isotopic Composition of Surface Water Vapor Flux From High-Frequency Observations Using Flux-Gradient and Keeling Plot Methods. Earth and Space Science, DOI: 10.1002/es-soar.10501239.1.

A: Our objective was to provide the (non-specialist) reader with an overview of the methods for determination of δET, δE, δT and shortly highlight differences among them. An in-depth comparison of the micrometeorological methods for determination of δET seems out of focus here. Nevertheless, we will refer the reader, e.g., cite the above study, for more details on this.

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5. Methodological review: How about the uncertainty analysis of EC isotopic flux methods due to the loss of information during the covariance calculation between the isotopic compositions and vertical wind fluctuations?

A: Thank you. We will add this very important technical aspect section 3.1.2

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6. Methodological review: Suggest to clarifying the calculations and assumptions of converting δ value of water vapor into δ value of soil or xylem (liquid) water, and the analysis of possible uncertainty in detailed, for promoting the use of the novel non-destructive methods in the future.

A: As stated L514-518, all authors simply assume steady state between both liquid and vapour phases. Consequently, only temperature is needed to convert δ_soilˆvap into δ_soilˆliq values, e.g., using the equations of Majoube (1971) and Horita and Wesolowski (1994). We further note in the text that only Rothfuss et al. (2013) provided evidence of near-isotopic equilibrium conditions between liquid and vapour in the soil pore space.

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3. Possible ways forward: It might be useful to focus on the improvement of difficult problems of recommended methods, for example, how the plant-size measurements based on the chamber methods are scaled up for canopy-level estimations.

A: We argue L788-792 that chamber measurements should be replicated in space to "characterize the in situ natural lateral heterogeneity of δT, due to differences in root water uptake, plant physiological state, as well as lateral heterogeneity in soil water isotopic composition profiles". This is a prerequisite for any upscaling attempt. We will make this clearer in the text, thank you!

Specific comments: Line 405: if the describe of “the second relies on destructive sampling of the soil and offline analysis of the extracted water” is suitable, and the non-destructive collection and online monitoring of the water vapour isotopic composition of soil atmosphere also can be used.

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A: This is true, thank you! This will be revised accordingly.

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Line 640-670: Péclet effect is very important for these theoretical equations, however, its definition and quantification are not explicitly named here.

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A: To our knowledge and from our literature review, there is no study, in which Péclet effect values were determined for the specific purpose of ET partitioning. This stems certainly from the fact that calculations imply steady state in the first place (δT=δstem_water). This is why we did not explain the Peclet effect in Section 3.3.1. To make things clearer, we will remove mention to it L150 and not mention it in the manuscript.

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Line 735: For the cryogenic extraction methods of xylem water, new biases might be considered, because Chen et al. (2020) found that a dynamic exchange between organically bound deuterium and liquid water during water extraction can cause the stem water cryogenic extraction error, rather than deuterium fractionation occurs during root water uptake.

Chen, Y., Helliker, B.R., Tang, X., Li, F., Zhou, Y.and Song, X. (2020) Stem water cryogenic extraction biases estimation in deuterium isotope composition of plant source water. Proceedings of the National Academy of Sciences, 202014422

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A: We thank you for this nice new paper on issues related with extraction of water from plant tissues and will not omit citing it in our revised manuscript!

References

Horita, J., and Wesolowski, D. J.: Liquid-vapor fractionation of oxygen and hydrogen isotopes of water from the freezing to the critical-temperature, Geochim. Cosmochim. Acta, 58, 3425-3437, https://doi.org/10.1016/0016-7037(94)90096-5, 1994.

Majoube, M.: Oxygen-18 and deuterium fractionation between water and steam, J. Chim. Phys. Phys.-Chim. Biol., 68, 1423-&, 1971.

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