

Interactive comment on “Hydrogen isotope fractionation affects the identification and quantification of tree water sources in a riparian forest” by Adrià Barbeta et al.

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In their manuscript submitted to HESS and currently in its discussion phase, Barbeta and colleagues investigate the water sources of *F. sylvatica* and *Quercus robur* (L.) on basis of water stable isotopic measurements in sap xylem, stream/groundwater, and soil water in a vertical profile. For this, they opt for the most commonly used method, which is inverting the isotopic data with statistical modeling. They choose MixSIAR, a mixing model embedded in a Bayesian framework. A particularity of this study is that xylem water isotopic samples of both species very often not plot on the soil evaporation line in a ($\delta^{18}\text{O}$, $\delta^2\text{H}$) coordinate system, which is explained by the authors as being due

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to a significantly higher hydrogen than oxygen isotopic fractionation during root water uptake.

The manuscript is generally well written (aside sometimes from the isotopic terminology – see my specific comments), easy to follow, and falls into the scientific scope of HESS.

My general concern is that there is a major contradiction between the first part of hypothesis H2 (“it is essential that all potential water sources are identified and accessible”) and the fact that the authors deliberately do not sample from the soil between 10 and 70 (or 110, “depending on the depth of the rocky layer”) cm depth. In a review article (Rothfuss and Javaux, 2017), a simple synthetic experiment showed how much the non-fulfillment of H2 could lead to biased estimates of the relative contributions to plant root water uptake across a set of potential sources. If the authors can provide proof that the “mid-soil” is isotopically not any different than another source (e.g., deep soil), then it can be pooled together with this other source (e.g., “mid-deep soil”). If this is not the case, the authors’ analysis might not be valid. For instance, we cannot say for sure that the observed hydrogen isotopic fractionation is not in fact partly due to the values of isotopic compositions in the missing soil water source.

Cheers,

Youri Rothfuss

Some specific comments follow below:

L12. “The stable isotopes are powerful tracers. . .”

L15. “that xylem water isotopic compositions effectively reflect source water isotopic compositions.” Same goes for the following sentence.

L17. “In this study, . . .”

L17-19. A biweekly temporal resolution does not qualify as “Highly resolved” (L16). It seems, however, that it is what the authors mean here.

L19. “Using a Bayesian isotope mixing model (MixSIAR), we then quantified the relative contribution to root water uptake of . . .”. It is important to emphasize the word “relative”.

L23. “Xylem water could always be interpreted as a mixture of deep and shallow soil waters from $\delta^{18}\text{O}$ data, but the $\delta^2\text{H}$ of xylem water was often lower than any other possible water source”. (1) Some isotopic composition value cannot be conceptualized as a water mixture and (2) cannot be depleted/enriched.

L25 and 27. “ $\delta^2\text{H}$ decrease” (or analogous) and not “depletion”.

L26. “we found that the localization of plant-water source. . .”

L43-60. There are other assumptions made for determination of relative contributions to RWU across potential sources than the authors H1 and H2, e.g., no sap tissue capacitance, perfect mixing in the sap and no xylem-phloem exchange at the output of the root system, etc. You say this, but the reader has to wait until the the discussion of your results.

L46-47. “The water isotope tracing methodology is commonly used to study plant water uptake. . .”. Here you may cite our review paper on the subject (Rothfuss and Javaux, 2017). It better illustrates your point than the study of Dawson et al. (2002) (which is not in the reference list) as it focuses on RWU solely.

L52. Why “However”?

L54. “the temporal variability in rainfall water isotopic compositions. . .”

L56-57. “or the relatively higher isotopic composition in fog compared to rain water”

L57-60. Not only. Laser-based spectrometers only allow for a retrospective (off-line) assessment of RWU. Do not forget the development of non-destructive methods for determination of δ_{soil} and δ_{RWU} (Volkman and Weiler, 2014; Oerter et al., 2016; Gaj et al., 2015; Rothfuss et al., 2013; Volkman et al., 2016).

L59. “hydrogen and oxygen isotope”.

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L81. You take too much liberty with terminology. How could “xylem water isotopes” match some “source”? You could write for instance “Plant water source studies in which the xylem water isotopic composition does not spread within the range of the sources’ isotopic compositions. . .”

L83. “hypothesis (H2) is not met”

L86. What does “carry an isotopic signal” mean? I suggest sticking with an “isotopic composition” which is “lower”/“higher”. . .

L90-91. It reads as if “the isotopic composition of rock water” is “a relevant, alternative plant water source”. Please revise grammar.

L101. Do you mean “discrimination increased with decreasing soil water content”?

L104-105. “In fact, a growing number of studies are observing lower xylem water isotopic compositions compared to those of the considered sources”

L108. “The effect of deuterium fractionation on quantification of sources’ relative contributions to plant water uptake. . .”

L109. “hydrogen isotopic composition only. . .”

L114-121. This belongs to Material and Methods.

L128. What do you mean by “extensive” here? Be more precise in the description of this objective already in the introduction.

L154. Of which two plots?

L155. “In order to measure the xylem water isotopic composition”

L159-160. To “Each soil core was split into top soil (0-10 cm) and deep soil (from 70-80 to 110-120 cm depending on the depth of the rocky layer): even though you underline in the introduction the importance of identifying all water sources (i.e., hypothesis H2), you deliberately omit to sample the soil between 10 and 70(110) cm.

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L178-179. I suggest to move this at the end of the §(L148).

L185. I propose: “the pressure in the extraction line. . .”

L208. Which “significant difference”?

L209-214. A “mismatch” is not precise enough. You may write that you want to “assess if the isotopic compositions of the xylem water samples fall onto the evaporation line in a dual isotopic space”. Also I would only present the concept of SW-Excess you are introducing and say that it is an adaptation of the LC-Excess.

L211-212. To “However, because the source water for a tree is more likely to be made of soil water than rain water directly”: it is a strange thing to say that trees would directly extract rain water just “less likely” than soil water.

L215. σ and Λ does not seem appropriate symbols, e.g., σ normally stands for standard error. I suggest other symbols like “c” and “d” or “A” and “B”, “a” and “b” etc.

L218. To “ $\delta^{2}\text{H}$ separation”. Since by “ $\delta^{2}\text{H}$ ”, you mean a numerical value, you shouldn’t use “separation”, rather “offset”, “difference” etc.

L223-227. Why “models” (plural)? MixSIAR is one single model that has different scripts interacting with each other. To “Models were ran in the script version of the package”: what other versions of MixSIAR are available? To “the number of Markov chain Monte-Carlo iterations was increased until convergence was reached”: did you do this yourself, or was the number of runs optimized automatically? To “Gelman and Geweke diagnostics”: what are these? To “residual error term in the isotope mixing models”: what is this?

L228. Please define “top” and “deep soil water”.

L231-241. You only test the sensitivity of the isotopic mixing model to the definition of the “product”, meaning the sap xylem isotopic composition. What about the definition of the “sources”? I am afraid that, since you do not fully characterize the ensemble of

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potential water sources, you cannot assess their contributions to tree RWU (see my general comment).

L257. To “3.2. Stable isotopes of tree water sources”: do the tree water sources have distinct “stable isotopes” than other sources:)? You might write something like “Stable isotopic composition distribution across tree water sources”. Same goes for 3.3.

L258-259. Belongs to M&M.

L266. A slope value of 9.99? Is this a typo? If not, what is the p-value of the linear regression?

L275. “in both hydrogen and oxygen heavier isotopes”

L277. “The isotopic composition of rock moisture”. In general, I suggest that you avoid use of “signal” throughout the MS.

L281. No comma in “. . .budburst), was. . .”

L284. “had a lower $\delta^2\text{H}$ ”

L289. “*F. sylvatica* presented higher $\delta^{18}\text{O}$ values ($P < 0.05$)”. Same goes for the rest of the MS: a value cannot be enriched/depleted.

L305-333. You are using the same Bayesian inference model with different parameterization, not a series of different mixing models. This might be confusing to the readers.

L338. “to identify plant water sources and quantify their relative contributions to tree RWU. . .”

L338-341. I propose something like “lower xylem water isotopic composition than any combination of those of the identified water sources would give”

L341-342. To “The diversity of methodologies used for the extraction of waters and their isotopic determination in all these studies, including ours, rules out potential analytical bias.”. Why could these methods not all be biased? Orlowski et al. (2016a) and

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Orlowski et al. (2016b) have shown discrepancies between the different methods for water extraction.

L343 and after. If you mean by “offset” the “SW-Excess”, then say so. Otherwise, define each time what are these offsets (e.g., is offset the same as in the study of Evaristo et al., 2017?)

L344. “Sternberg”

L380. How do you define a “similar offset” for $\delta^{2}\text{H}$ and $\delta^{18}\text{O}$? Stating that both are linearly linked (e.g., $\delta^{2}\text{H} = a \cdot \delta^{18}\text{O} + b$), would it mean that $\Delta\delta^{2}\text{H}$ is similar as $\Delta\delta^{18}\text{O}$ if $\Delta\delta^{2}\text{H} = a \cdot \Delta\delta^{18}\text{O}$??

L416. Rothfuss and Javaux (2016) is the discussion paper, not the actual article (Rothfuss and Javaux, 2017), please edit this.

L419. Define “SWexcessx” (i.e., already in the M&M).

L422-424. Using both $\delta^{18}\text{O}$ and $\delta^{2}\text{H}$ values does not mean you work in a bi-dimensional space. This is strictly speaking a 2x1D space since $\delta^{18}\text{O}$ and $\delta^{2}\text{H}$ across water sources are linearly linked. To be able to assess relative contributions to RWU in a 2D space, you need to break this linear bond (via isotopic labeling; e.g., Beyer et al., 2016), so that these water sources spread on some area rather than on some line in a ($\delta^{18}\text{H}$, $\delta^{2}\text{H}$) coordinate system.

L427. “deuterium fractionation”

References

Beyer, M., Koeniger, P., Gaj, M., Hamutoko, J. T., Wanke, H., and Himmelsbach, T.: A deuterium-based labeling technique for the investigation of rooting depths, water uptake dynamics and unsaturated zone water transport in semiarid environments, *J. Hydrol.*, 533, 627-643, 10.1016/j.jhydrol.2015.12.037, 2016.

Gaj, M., Beyer, M., Koeniger, P., Wanke, H., Hamutoko, J., and Himmelsbach, T.: In-situ

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unsaturated zone stable water isotope (2H and 18O) measurements in semi-arid environments using tunable off-axis integrated cavity output spectroscopy, *Hydrol. Earth Syst. Sci.*, 20, 715-731, 10.5194/hess-20-715-2016, 2015.

Oerter, E. J., Perelet, A., Pardyjak, E., and Bowen, G.: Membrane inlet laser spectroscopy to measure H and O stable isotope compositions of soil and sediment pore water with high sample throughput, *Rapid Commun Mass Spectrom.*, 10.1002/rcm.7768, 2016.

Orlowski, N., Breuer, L., and McDonnell, J. J.: Critical issues with cryogenic extraction of soil water for stable isotope analysis, *Ecohydrology*, 9, 3-10, 10.1002/eco.1722, 2016a.

Orlowski, N., Pratt, D. L., and McDonnell, J. J.: Intercomparison of soil pore water extraction methods for stable isotope analysis, *Hydrol. Process.*, 30, 3434-3449, 10.1002/hyp.10870, 2016b.

Rothfuss, Y., Vereecken, H., and Brüggemann, N.: Monitoring water stable isotopic composition in soils using gas-permeable tubing and infrared laser absorption spectroscopy, *Water Resour. Res.*, 49, 1-9, 10.1002/wrcr.20311, 2013.

Rothfuss, Y., and Javaux, M.: Reviews and syntheses: Isotopic approaches to quantify root water uptake: a review and comparison of methods, *Biogeosciences*, 14, 2199-2224, 10.5194/bg-14-2199-2017, 2017.

Volkman, T. H., Kühnhammer, K., Herbstritt, B., Gessler, A., and Weiler, M.: A method for in situ monitoring of the isotope composition of tree xylem water using laser spectroscopy, *Plant Cell Environ.*, 10.1111/pce.12725, 2016.

Volkman, T. H. M., and Weiler, M.: Continual in situ monitoring of pore water stable isotopes in the subsurface, *Hydrol. Earth Syst. Sc.*, 18, 1819-1833, 10.5194/hess-18-1819-2014, 2014.

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