Review of the manuscript submitted by Ann-Marie Ring and colleagues: "**Sub-daily dynamics of urban tree xylem water and ambient vapor"** (egusphere-2025-1444)

Short description: Monitoring sub-daily dynamics in stable water isotopic signatures in plant xylem (δ_{xyl}) and atmospheric water vapor (δ_v) reveal marked diurnal patterns in water cycling. In their study, the authors relate observed dynamics in isotopic signatures to several environmental drivers (radiation, vapor pressure deficit, soil moisture, ...). The main insights are summarized in figure 11, highlighting that dry season conditions mark a period of large δ_{xyl}differences between day and night, i.e., a 38‰ daytime enrichment. Diurnal differences in δ_{xyl} also manifest during the wet period, but to a lower extent (approx. half the observed dry period differences). Atmospheric isotope concentrations tell an opposite story, with daytime depletion in δ_v (~26‰) during the dry period, and mostly no differences observed during the wet season.

Appreciation: This is a very clear and convincing study providing an interesting and timely contribution to the body of research unveiling overlooked complexities in the use of stable water isotopes to assess water cycling and source contributions in plants and atmosphere. The study is very well executed. I am confident that this will be a seminal paper and will pave the way for many new and exciting research opportunities. I do have a few comments (listed below) that concern making the work more concise, diverting the current narrative to a broader one, and reducing the number of figures in the main text, which all stands to benefit the reader.

Main comments

The link between monitoring stable water isotopes in plant and atmosphere to the cooling effect and insights sought herein to inform urban green space planning must be strengthened or dropped altogether. The narrative of urban green spaces (UGS) and their vulnerability and cooling function with respect to climate change, feels rather tangential. It remains unclear how observed patterns (diurnal and dry-wet) in stable water isotopic signatures in xylem and atmospheric exactly relate to the cooling potential of urban trees and green spaces. The mechanistic link is not presented, nor is it apparent how using an isotope assessment strategy exceeds those simply relying on directly monitoring air humidity, thermal cooling, and/or plant transpiration rates (which would be logistically easier, cheaper, and can cover a higher temporal and spatial resolution). Consequently, the UGS narrative distracts from the fascinating and likely much broader insights this study holds for plant physiology, ecology, and stable water isotope assessment. I suggest presenting a very clear and mechanistic link between the obtained insights and how this informs UGS planning and functionalities (be very concrete, although I argue that following such narrative might undercut your key findings), or the authors could tone down/step away from such narrative and focus more on the potential causes and implications/opportunities of the observed dynamics for the broader scientific community.

Minor comments

[Introduction] Several of the paragraphs in the introduction can be removed or shortened when the authors step away from the UGS narrative, making the introduction more concise.

[r24] The PET abbreviation is not necessary since it is not repeated in the abstract.

[r26] Evapotranspiration should be written in full. Providing an ET abbreviation is not necessary since it is not repeated in the abstract.

[r44-45] Tree xylem water is the sap moving through the xylem tissue of a plant. Because multiple water flow paths exist within a plant (i.e., xylem, phloem and in-and out water storage tissue), the provided description is imprecise.

[r46] ET has been introduced in line 40, no need to reintroduce it here.

[r50] Be more concrete on what is understood under "water fluxes". Specifically, does this concern temporal patters, source water partitioning, … This is important because the stable water isotope analysis is generally used to inform on water uptake depth and the contribution of different water sources. Quantifying the amount of water lost to the atmosphere can more easily be obtained using other, logistically more convenient tools (i.e., porometer, gas exchange monitor such as a Licor or Ciras, flux towers, …).

[r73] Given the study approach presented in this study, it is important to credit the work of Volkmann *et al.* (2016) who pioneered in the development of the borehole technique.

[r103-104] The study currently does not live up to this claim. The true mechanisms underlying the emergence of these patterns and how these mechanistically link to UGS functionalities are not clear. Forecasting or trying to curtail the impact of a changing environment on UGS is therefore speculative at most, especially because the monitored trees do not show strong proof of being subject to water limitations (see comment below). Such goals require monitoring under clear water limitations as further climate change expects to acerbate droughts. Following my main comment, the authors should thus very clearly explain how their insight informs concrete UGS guidelines or should step away from this narrative.

[r118-119] The authors should use the more recent reference (DWD, 2023) used in their proceeding study (Ring *et al.* 2024).

[Table 1] With readers only skimming the paper in mind, full names of each parameter abbreviations should be provided in the table or its caption (i.e., GRnet, WS, …). For consistency within the table, provide the units for the stable water isotopes (‰) behind the respective parameters, and remove it from the subtitle. Where relevant, consistently write: *A. platanoides and B. pendula*. (i.e., at 'and' between species, and family can be abbreviated). Finally, consider moving the table to the supplementary to make the paper more concise.

[r190] Provide values for a, b, and c in the supplementary for completeness and reproducibility of the study.

[Fig 1 & 2] These figures can be combined.

[r214] Given that samples are obtained on the same tree, and present repeated measurements, assuming independence and randomness of observations is inappropriate. A Friedman test might be more appropriate.

[r220] Provide the values for *a* and *b* here for completeness and reproducibility of the study.

[r235] Since this specific data has been published before, best practice requires to cite that the figure is adapted from Ring *et al.* (2024).

[Fig4 & 5] These are excellent figures, clearly showing the main insight from this study. Can a similar figure be provided in the supplementary for ^{18}O? (supplementary figure S3 suggests that such data might be available).

[r269] Consider adding this information to the abstract as this hammers down a very important insight which has huge implications for the interpretation of stable water isotope assessments based on point sampling. This is an excellent argument why the community should shift toward in-situ, high resolution measurements (i.e., like Volkmann *et al.* 2016; Kühnhammer *et al.* 2021, 2023), or to try to adopt a more adequate sampling protocol and/or interpretation strategy (i.e., similar to Magh *et al.* 2020; De Deurwaerder *et al.* 2020). (for the latter citation, note that part of the author's name, i.e., 'De', is missing in [r465]).

[Fig 6 & Fig 7]

- The x-axis is not great and should be redone.
- What is the black dark line in the VPD graph? (if this is simply to highlight zero, a similar marking should be considered in all other panels, although that would confound with the soil depth line of 70cm and the maple growth line)
- Redirect the left panels (boxplots) to the supplementary
- Combine all lines belonging to a specific category (general ecohydrology, soil depths, sap flow & growth, and water isotopes). There is no reason to have temperature as a standalone panel.
- Redirect the lc-excess panel to supplementary and provide the delta ^{18}O in the supplementary for completeness.

These adjustments will support larger panels, which benefit improved readability as this figure contains a lot of information. In addition, there are interesting patterns in the figures that have not received much attention in the manuscript: (i) Figure 6 shows stronger fluctuations in δ_{xyl} amplitude at 1.5m compared to 2.5m, suggestive of a dampening effect at 2.5m. When looking at Figure 7, (ii) this amplitude dampening seems to be gone, however, now a consistent shift in isotope depletion establishes at 2.5m. While this setup might not support characterizing what exactly underlies these patterns, they are interesting and deserve some attention in the document.

[r325-326] This is very interesting. Any reasons why this might be, and how the proposed hypothesis should be verified?

[Fig 8.] While interesting and important, this figure could be moved to the supplementary materials. In addition, do the same observations also hold for ^{18}O? Provide this analysis for ^{18}O in the supplement.

[Fig 9 & 10] These figures can be combined. Similarly to the comment on figure 8, while an important visualization, this paper can be provided as a supplement, and the analysis should be repeated with ^{18}O.

[Fig 11] This is an excellent and beautiful summary of the findings. Make certain that all the abbreviations are clarified in the caption (i.e., define δ_{xyl}, δ_v, and δ^2H) to benefit readers skimming the paper.

[r383-388] That midday water potential at the twig level is more negative than the morning leaf water potential is expected from a plant physiological perspective. In the morning, the driving force of water movement through the plant is low, as stomates are generally closed with no photosynthetic activity as there is no light. At midday, the need for water is greater because sunlight allows photosynthesis. This might suggest water limitations if leaf (or twig) water potentially drops below the P50 value, which could trigger stomatal closure. However, having a minimal twig water potential around -1.2MPa, and no clear reduction in sapflow activity (10L/h), there seems to be no obvious indication that the trees suffer water limitation. The observed isotopic signature dynamics suggest that the plant water needs are met by tapping different soil water sources. Similarly, a shift between radiation, sapflow, and VPD have been observed in the plant physiological research and are not sufficient proof that a tree experiences drought stress. Additionally, it is unclear how the provided reference (Kraemer and Kabisch, 2022) is in any way supporting such a statement, as that study does not monitor sapflow. In conclusion, the presented physiological/mechanistic drivers of the observed isotopic trends within the trees are not well laid out, obscuring a clear link between observations and how this might inform UGS decision making. This paragraph should be made stronger and provided arguments should be supported with plant physiological theory.

[paragraph 5.3] Following my main comment, it remains unclear how the authors envision their presented observations to guide UGS planning and management efforts. For instance, in [r594] the authors' state:' *Our findings provide novel insights on the cooling potential of urban vegetation.*'. What specific insights are implied here, and, how exactly do the presented observations link to USG cooling capacity? This sentence remains rather cryptic.
Besides, restricting the importance of this study in support of UGS planning almost feels like an injustice to the likely broader importance of the observations for the fields of stable water isotope assessments, and plant physiology and ecology. As such, I suggest refocusing the storyline to reflect a broader picture, which would (i) attract a wider scientific interest, and (ii) would strengthen conveying the key observations to the reader.

References

De Deurwaerder, H.P.T., Visser, M.D., Detto, M., Boeckx, P., Meunier, F., Kuehnhammer, K., *et al.* (2020). Causes and consequences of pronounced variation in the isotope composition of plant xylem water. *Biogeosciences*, 17, 4853–4870.

Kühnhammer, K., Dahlmann, A., Iraheta, A., Gerchow, M., Birkel, C., Marshall, J.D., *et al.* (2021). *Continuous in situ measurements of water stable isotopes in soils, tree trunk and root xylem: Field approval*. *Rapid Commun. Mass Spectrom.*

Kühnhammer, K., van Haren, J., Kübert, A., Bailey, K., Dubbert, M., Hu, J., *et al.* (2023). Deep roots mitigate drought impacts on tropical trees despite limited quantitative contribution to transpiration. *Sci. Total Environ.*, 893, 164763.

Magh, R.-K., Eiferle, C., Burzlaff, T., Dannenmann, M., Rennenberg, H. & Dubbert, M. (2020). Competition for water rather than facilitation in mixed beech-fir forests after drying-wetting cycle. *J. Hydrol.*, 587, 124944.

Ring, A.M., Tetzlaff, D., Dubbert, M., Freymueller, J. & Soulsby, C. (2024). Assessing the impact of drought on water cycling in urban trees via in-situ isotopic monitoring of plant xylem water. *J. Hydrol.*, 633, 131020.

Volkmann, T.H.M., Kühnhammer, K., Herbstritt, B., Gessler, A. & Weiler, M. (2016). A method for in situ monitoring of the isotope composition of tree xylem water using laser spectroscopy. *Plant. Cell Environ.*, 39, 2055–2063.