

EGUSPHERE-2025-3025

**Continuous *in situ* monitoring of the vertical and horizontal passage of a labeled-water pulse through a boreal Scots pine forest**

Review Response

Reviewer 1:

Review of Marshall et al., for HESS

This manuscript describes a study in which a deuterium tracer was added to soil during drought, allowing for the opportunity to see the timing and spatial pattern of trees using that added water. Continuous isotopic monitoring capabilities were crucial to observing the breakthrough of that tracer in a set of trees. Their differential distances from the location where the tracer was added demonstrated a) the relative timing of later transport from through roots to each tree stem and b) the likelihood that numerous trees' roots were taking up water from the 1m<sup>2</sup> location of tracer addition.

The results are simple and straightforward (with a few caveats described later), but the ability to conduct an experiment like this is a complex challenge. Consequently, it is a rare to have insights into a process such as this, and so I think this study will represent a valuable contribution to the field. While I find the discussion of the results to be framed in a way more appropriate to an ecophysiology audience than a hydrology audience, this work still fits within the scope of HESS. I enjoyed the writing style and I especially appreciate the blunt description of the challenges and mysteries; this sets a positive example that I would like to see more scientists follow.

**Thanks for appreciating the value and difficulty of performing this experiment.**

I think the greatest area for improvement would be to follow the suggestions of the first posted review, regarding more in-depth consideration of how to address mass conservation issues. I do not have specific suggestions beyond those.

**We have addressed the mass balance issues in the response to Richard Keim, the other reviewer.**

While I know the borehole method has been tested and described in other papers, my concerns with the method pertain to the hole implying a severing of the xylem transport pathway. Is it capturing water in transit up the tree, or some signal that has diffused from active xylem into this less active wood storage (after being drilled)? By focusing on the tracer arrival timing, interpretations seem robust to this issue. However, it could explain the

mass conservation failure. Can you elaborate on this further based on your experience in experimenting with this method?

**The question about hydraulic contact with flowing water in the xylem will be addressed in the discussion. In short, the xylem transport pathway is disturbed, but this disturbance is rather small in relationship to the entire sapwood area of the tree. The trees do respond to the wound, but we have found in our experiments that this does not hinder the isotopic equilibration of the air passing through the borehole with the xylem water isotope composition of the tree. As you mention, the disturbance is worrisome, but it seems to work. This question also arises, in a smaller way, with sap flux measurements, but they also seem to work. We will thoroughly discuss this in the revised version.**

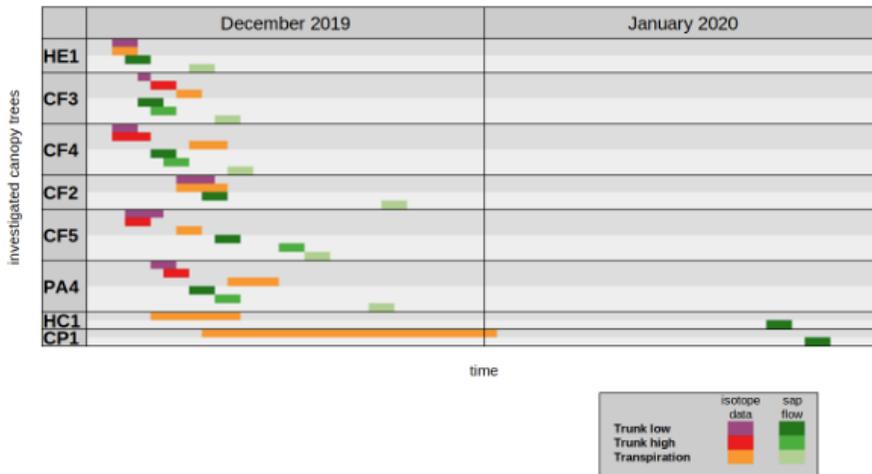


Figure 8.3: Comparison of estimated tracer arrival times from isotope and sap flow data for the different plant compartments investigated based on data from Publication V.

71-72 The need for quantifying overlap is mentioned here. I'd like to see elaboration later in the discussion, within the context of this ownership hypothesis.

**We discuss this on L423-429; however, we will modify the discussion of ownership to express degree of sharing as a continuous parameter (see below).**

Figure 1 might benefit from having the scales in meters rather than degrees lat / lon.

**Agreed. Will modify.**

**Commented [K1]:** We could add some of my experiences if you like:  
 In the studies conducted we in part observed a rapid response following labeling with clearly elevated d2H values at the day of labeling in the stem of Hibiscus tiliacea (Kuehnhammer et al. 2023) and the lateral root of Swietenia macrophylla (Kuehnhammer et al. 2021). Additionally, isotopic tracer was detected earlier in the boreholes than would be predicted from concurrent measurements of sap flow velocity (see figure below from my PhD thesis). Similarly, Mennekes et al (2021) observed that sap flow travel time estimations lagged behind estimations from isotope data in a study using a comparable in situ xylem isotope method.

**Commented [K2R1]:** Of course, I would anyway be careful with that as we cannot for sure say how the borehole affects tree water fluxes... And I also found instances were tracer arrival lagged behind sap flow estimations (SM1 and SM2 in Kuehnhammer et al. 2021)

**Commented [MB3]:** I proposed a small rephrasing

376-378 Inclusion of tree metrics would benefit the contextualization of findings. What are the crown sizes? Perhaps this could be shown in Figure 1.

**Unfortunately, we did not measure the diameters or crown widths of trees labelled in this experiment. We have been forced to rely on measurements of the stand characteristics made nearby. Fortunately, the stand is quite uniform.**

423 Can you clearly state the “ownership hypothesis”. If it’s simply that there exists “a continuum between complete domination of uptake by a single tree, analogous to owned and defended property, vs. complete sharing of the benefit”, I do not see how this is a useful hypothesis. It seems obvious that this continuum would exist and it is unclear how this hypothesis would be tested. I would hope to see a hypothesis rooted in what would drive the owning-to-sharing variation.

**Fair point. Perhaps degree of ownership is not a hypothesis at all, but rather an unknown parameter needing to be quantified. We guess this is what is meant by “unclear how it would be tested.” There are reasons why total lack of sharing might be favored (water conservation and/or hydraulic limits) on the one hand and why extensive sharing might be favored (mycorrhizal networks) on the other hand. We will modify our presentation of this concept in the introduction and our parameterization of it in the discussion, describing it as a continuum between the extremes described above.**

429-439 (including Figure 7): More elaboration would be useful here. I struggled with precisely understanding the point.

**We argue here that borehole orientation modified signal strength, but not label detection, and that future work should use boreholes facing the labelled plot. Furthermore, the lateral orientation of the roots at the trunk base should be considered. We will rework this text to make it clearer.**

**Commented [K4]:** Maybe we can also just not call it ownership hypothesis (as this seems confusing at least to this reviewer and only shows up in the discussion without clear definition). Degree of ownership/compartimentalization of soil water resources?

**Commented [MD5]:** I think we need to say specifically how we respond to his comment? Do we even change something in the text?