Response to reviewer 2

The reviewer's comments are in normal font and **the authors' responses are in bold font.**

The manuscript by Pinos et al. was interesting and pleasant to read. The study is methodologically sound and the manuscript is comprehensive. The results enrich the scientific discourse and fit very well within the scope of HESS. The figures are descriptive and well-chosen.

Despite the solid status quo, I think the manuscript would benefit greatly from major revisions on the discussion and related sections as described below. Furthermore, I address specific text passages under "specific comments". I hope that my input and investment will motivate the authors to put the finishing touches on their work, and I look forward to the revised version of the manuscript.

We would like to thank reviewer #2 for all his/her comments and time spent reviewing the article. We are glad to hear that she/he sees the timeliness of the messages conveyed in our paper.

General comments:

Title: The title would benefit from rephrasing toward being more precise by naming the main outcome of the study.

We appreciate the observation. The title will be slightly modified as follows: "Routing stemflow water through soil via preferential flow: a dual labelling approach with artificial tracers". We believe that the new formulation of the title is the most appropriate.

Abstract: The abstract does not yet do justice to the manuscript. It should not only contain the most important information, but also highlight the strengths of the study. Instructions for a good abstract can be found, for example, in "How to construct a Nature summary paragraph" and in Jean-luc Doumont's work (e.g. https://www.principiae.be/pdfs/UGent-X-003-slideshow.pdf). I recommend to tackle the revision of the abstract as the last step to benefit from the improvement of the discussion.

Discussion: The discussion overall appears somewhat unfinished and incoherent, and the main messages are not clear. Basically, the necessary elements are contained, but the discussion lacks elaboration of the key process-oriented findings. In addition, the discussion of methodological aspects could also be improved by not only evaluating the methods' success, but by highlighting and framing observations based on methodological strengths and weaknesses. This could take the authors farther away from a methodological and case study. In this regard, the authors should also rethink the structure of the discussion, which in the current version is oriented toward result groups. Instead, they could formulate stronger contextual subsections, for example on the three main findings (messages), and then summarize the results that support those messages. A mixture of contextual and methodological subsections is also conceivable (however, the most important content-related insights should be clearly recognizable). The restructuring would also allow for more meaningful subsection headings, which I recommend (as for the manuscript title).

Conclusion: As the conclusion depends on the discussion, it also needs additional work. See in the specific comments for more detail.

Thank you for your comments, modifications have been added to the abstract, discussion and conclusion sections following the specific comments of reviewers 1 and 2.

Specific and technical comments:

8: Start with the motivation instead of the research gap.

We agree. The motivation of the study will be added to start the abstract.

12: “50 mm of rainfall”

Change accepted.

21: “A set of metrics” sounds somewhat diffuse. Either specify or be more general (e.g. “analyses”)

“A set of metrics” will be change to “Our analyses”

24: Delete “heavily”

Change accepted.

32: “Stemflow…” This sentence is difficult to read and the wording should be improved. In such cases, I will only write "rephrase" in the following.

Thank you for your observation. Following the suggestion of reviewer 1 in the previous sentence the concept of throughfall will be added, which makes the message of the present sentence clear.

37: “overland, preferential or subsurface flow” This combination is odd to me. Please reconsider what your point is.

We change the sentence to: “overland, preferential or subsurface matrix flow”.

42: Naming something a key topic, more citations should be given to prove that.

The citations of Levia et al. (2011) and Van Stan et al. (2020) are the latest published books on forest hydrology with emphasis on throughfall and stemflow effects. We do not think that more citations are needed.

47: “Several experimental techniques both invasive and non-invasive…”

Change accepted.

47: “the double-…” As this study is about the belowground part of double funneling, I find using the term in such context confusing and imprecise. Please keep this in mind throughout the manuscript.

We agree with the reviewer. Thanks for the observation. We will change “double funnelling” by “stemflow belowground funnelling”

76, 77: “catchment”

It is plural, since Vallcebre is composed of four catchments.

80: delete “throughout the year”

Change accepted.

80: “spring and autumn being the wettest season”

Change accepted.

88: delete “respectively” (“…stand density is x and basal area is y.”)

Change accepted.

89: “representative” is a statistical term which should rather not be used out of statistical context. If it was indeed a statistical process leading to the selection of the tree, describe this process. Otherwise, I recommend using “exemplary” instead. Some words on the selection of the tree would be interesting also in that case and make the matter more clear.

Change accepted. Following the reviewer's suggestion, "representative" will be changed to "exemplary".

109: The geometrical details of the installation remain unclear. Why are the depth intervals different? How were sensors installed vertically at depth?

Thanks for the observation. The depth intervals were different because the probes had different electrode lengths. Details of the vertical installation of the sensors will be added.

112: “measure” instead of “sample”

We correct this to “to measure and sample”

124: delete “what was done”

Change accepted.

136: Please check with HESS if this is the way they want online sources to be cited.

There are no specific guidelines on how to cite this type of source.

148: delete “closer to the tree”

Change accepted.

149: delete “throughout the day”

Change rejected. It should be noted that all excavation and sampling was carried out in one day (the day after the experiment). T**he sentence will be modified for clear understanding.**

151: delete “roughness”

Change accepted.

154: replace “, and then transported to the laboratory” by “for transport”

Change rejected. We think the original version is clearer.

156: The justification is unnecessary because it is obvious and can be omitted. If desired, an abbreviated version can be retained in subordinate clause. Either way, the procedure should always be given first and then the reason, not the other way around.

Thanks for the observation, the sentence will be modified and move below.

159: What about the used camera? Since the photos had to be digitized, was it not a digital camera?

Thanks for the observation. We will remove "digitized" from the sentence. In addition, the following sentence will be added at the beginning of the paragraph: "Photographs of the soil profiles were taken using a cell phone with a dual-lens camera system of 12MP (iPhone 11, Apple Inc., CA, USA)."

167 and following: I would prefer using correct mathematical symbols and equations, meaning that one metric can not be symbolized by several letters (e.g. As instead of TSA). In any case, however, the quantities used in equations should be consequently printed in italics also outside of the equations.

We agree that the symbols should be all in italic, in both equations and text. However, it is not true that math symbols cannot have several letters. There is no such rule, indeed, the Cauchy number is an example of a symbol that has 3 letters. We have changed to upper and lower letters as suggested: for instance: DC to Dc.

200: "extracted by cryogenic extraction" repetition, rephrase

We rephrased to "Soil samples were subjected to cryogenic extraction and …"

206: "on the area…" very diffuse formulation, maybe just too complicated, rephrase

We rephrased the sentence to : "To characterize the soil at the experimental site, six vertical 30-cm depth profiles were dug in the vicinity (< 1 m) around the monitored tree."

207: "no relevant…" What does that mean, what are the implications for this study? No change in soil physical properties does not mean that no differences in hydrological processes will occur or nothing interesting will happen below this depth?

We chose 30 cm because it was the maximum depth chosen for the excavation of the soil profiles after the experiment. Yes, no change in soil physical properties does not mean no differences in hydrological processes. However, we do not expect to find different results at deeper depths in the vadose zone. We changed "no relevant" to "no significant".

209: One steel cylinder sample per depth interval and profile?

"Soil cores were taken with steel cylinders (100 cm^3) in 5-cm depth intervals from the soil surface down to 30 cm" which means 6 steel cylinders per profile. We rewrote to: "Six soil cores were taken with steel cylinders (100 cm^3) in 5-cm depth intervals from the soil surface down to 30 cm …"

220: Outliers are statistically defined. "Obvious outliers" do not exist. Please give more detail about the process.

Thank you for your comment. We will modify the sentence for better understanding.

223: Why was Rosetta chosen? There has been much discussion about the problems of PTFs and work invested on how to improve them. Using them, this should be addressed, especially when choosing maybe not the best suited PTF.

-Rosetta is one of the most applied models and its version 3 is the most updated and improved version for pedotransfer functions. Regardless of which function is used, the Ks estimate is only an informative parameter of soil characteristics, and only used comparatively to show differences in K_s with depth.

233: Please use WRB instead of US SoilTax. When using a classification system, do not forget the reference.

We are actually not using US SoilTax, but the USDA Soil Texture Classification. This is not the same.

235: "As…" rephrase

We changed "As" to "Because"

238: Please elaborate which metrics were attained using Rosetta and which measured directly and also discuss the values within this context.

In the M&M section it is described what was measure directly and what was estimated with empirical equations and Rosetta. Only K_s was estimated with Rosetta.

245: Please refer also to the amount/intensity of applied stemflow and the tree and soil characteristics it refers to in order to compare in an informed way.

The following sentence will be added at the end of the paragraph: "The stemflow infiltration area found in this study should be interpreted with caution, as it corresponds to a specific amount (50 mm) and discharge (7 L h^{-1}) and to specific antecedent moisture conditions and soil physical properties, and we suspect that it may vary as any of these conditions change."

246-247: Please, here also, give more details about the studies.

We do not agree. This is not the focus of the study and details of these studies are also found in Carlyle-Moses et al. (2020) which is cited at the beginning of the paragraph.

251: It would be great to have some measure of variance to being able to characterize and compare.

Thanks for the suggestion, but as we only have one sensor per location and the water flow pattern is spatially variably, we do not have replicated measurements, and the variance for measurements cannot be calculated. Figure 5, Figure S1 and Table 1 provide an idea about the differences in water contents among sensors.

258: "earlier" instead of "rather"

Change accepted.

259: Please set the maximum difference in SWC in relation to pre-stemflow values.

This is what was done. "the maximum difference in SWC (i.e., difference between the max SWC and the pre-stemflow SWC" is shown in Table 1.

264 ff.: Please give absolute additional to relative values.

These values are listed in Table 1.

270: "…driven by throughfall rather than stemflow during a stemflow dye tracer experiment using natural rain events" or similar - give detail about the study!

The sentence will be modified according to the reviewer's suggestions.

270: “Metzger…” Compare also Metzger et al. (2021) on stemflow infiltration areas - maybe that study would fit better here.

Thanks for this observation. We will provide more details about the study of Metzger et al. (2021).

270: “during rainfall events” Not during, but after rainfall. I think there is no explicit information about SWC during rain events, only about SWC increase, which was a little higher in the vicinity of tree stems depending on event size. Also, "vicinity" is defined as <1 m, which differs from the measure you seem to apply here (not defined explicitly).

Change accepted. Thanks for this comment and correction. Also, we have already included “vicinity” definition in a previous comment.

272: “because…” This is a good thought. Maybe you can find more references to compare stemflow infiltration with and without throughfall and go into more detail here.

Thank you for this wonderful suggestion, however, we are not aware of any studies that analyze stemflow infiltration with and without throughfall. If the reviewer is aware of any, please let us know as it would be of great interest.

276: “Thus,…” This is also an interesting point, which you should set in relation to the results of the other studies you mentioned above and the root architecture of their studied trees (being deciduous hardwood species). You should also check for other studies on (Scots) Pine and compare their results for water redistribution in the soil (e.g. Carlyle-Moses et al. 2018?).

Thanks for the suggestion. This is discussed in more detail in section 3.5. We will include Carlyle-Moses et al. 2018 in the discussion.

280: “SWC” Pre-stemflow, post-stemflow, and the difference? Please be more specific.

Thanks for the comment. The sentence will be modified for better understanding.

281: “For instance,…” This would be a safe indicator for bypass flow, yet it depends on the place of infiltration (did water infiltrate directly above the measured location? Otherwise, it could also be a stronger lateral flow component in the deeper soil (due to what)? Please elaborate more on this.

We modified the sentence to: “However, there is indication of bypass flow, as shown by the faster response of deeper TDR probes, i.e., in the east profile the TDR probe at 30-60 cm and in the south profile the TDR probe at 30-40 cm reacted to the stemflow more quickly than the other probes did (Figure 6b, c, d).”

283: “(1) preferential flow” This now reads like a summary, but was not mentioned before. It is especially interesting as you applied stemflow artificially and thus regularly around the tree stem. If you want to make this point, more information/discussion is needed.

The sentence will be rewrite as "(1) preferential flow of stemflow on the trunk itself (as shown in Pinos et al., 2021). Although stemflow was evenly discharged around the trunk at a height of 1.3 m, preferential flow was observed when water flowed down the trunk."

284: "(2) preferential flow" In this point, it is unclear to me if this refers to infiltration (into the soil) or percolation (within the soil) or a mix of both. Especially, "infiltration...due to...coarse roots" sounds odd, because the roots are within the soil and not at the surface. Or do you refer to where the stem and the soil meet? Please rephrase to be more clear.

We rephrased this sentence to be clearer: "(2) non-uniform infiltration of preferential stemflow into the soil and preferential flow in the soil due to the presence of coarse roots that redistribute water flow both vertically and horizontally."

286: "water table" It would be nice to have a reference here as well.

(Liang et al., 2011) will be added.

290: "in…piezometers" How is "in" meant here?

What we mean here is that the water in the lysimeters was blue. We are not sure what the reviewer means here, the sentence seems clear to us.

294: "SWC" Please again also give absolute numbers.

Again, what would be the point of adding these values? The absolute values are listed in Table 1.

306: "Figure 8…" This reads bumpy as beginning of the section as well as only the sentence itself. I would recommend to begin the section with a statement (the most important and a rather general statement previewing what the section is about). A reference to the figure in brackets is enough.

We modified the sentence to: "Dye coverage observed in the different soil profiles for the four cardinal directions show clear indications of preferential flow (Figure 8)."

307: "Trend" Is it actually a (statistical) trend? Was a regression analysis made? If not, that would be great.

Thanks for the observation. "trend" will be change to "pattern". No robust regression analysis can be performed since there are only three points for each profile, which represents insufficient data for this type of analysis.

307 ("The distribution…") – 313: I find this paragraph too long and the statement rather trivial. The flow mainly taking place laterally due to the low (non-existent) slope inclination can be said in one sentence and does not need to be compared with studies located on stronger slopes, because this is comparing apples with oranges.

The sentences will be modified and shortened for better understanding as follows: "We observed the greatest dye coverage in the immediate vicinity of the tree (at 10-cm distance), which suggests that the majority of the stemflow infiltration water was directed vertically. This is likely a consequence of the flat area and absence of a slope at our experimental site"

316: Make clearer that these are pre-defined terms for those readers who skipped the methods section. You can use quotes and/or references.

Thanks for the observation. We will refer to section 2.5.

319: Please here refer to the thought I mentioned above: the location of the water input in horizontal reference to the measurement location. It is an important observation that the soil water flow directly below the input is more regular.

The soil water does not necessarily have to flow directly below the input, but has more interaction with the soil closer to the tree trunk (10-cm distance) where direct infiltration is occurring.

329 ff: "Increased…" This is an interesting thought referring to a potential ecological meaning and fate of stemflow. As the ecological aspect is often unclear in stemflow studies (except for double-funneling in more arid climates), I think it would be worthwhile to discuss this effect in more detail.

Following the reviewer's suggestion, the following text will be added: "This is of great ecohydrological importance, as it may affect processes such as increased moisture, increased element deposition, and increased contamination in deeper soil layers, where increased dye-matrix interaction has been evidenced."

331: "the soil matrix" The matrix... or the next-smaller pore fraction only. This is pretty much a question of continuity.

The sentence will be modified as: "Moreover, the soil matrix between macropores (i.e., the next-smaller pore fraction)….."

334 ff: This paragraph is a bit lost here and should go up to where I commented to have just this discussion. Also, there is room for differentiation here: Especially preferential flow does not only depend on the root network architecture, but also on soil physical and chemical properties (which themselves also are affected by tree species) and initial wetness.

The previous paragraph mentioned by the reviewer refers to stemflow infiltration areas, here it refers to the belowground funneling process. The first sentence will be modified to include the soil properties mentioned by the reviewer.

361: "The double…" You strongly refer to the double funneling phenomenon in the introduction and now shortly pick it up again here, but it is totally missing in the discussion. You want to work on your red thread. Chose you focus and signal words (can be double funneling or other) and make sure it is represented in all chapters relevant to content (abstract, introduction, discussion. conclusion).

We agree with the reviewer. Thanks for the observation. We will change "double funnelling" by "stemflow belowground funnelling"

366: "has proven to be" instead of "is"

Change accepted.

370 ff: The conclusion should wrap up the study in summarizing the most important aspects of the discussion and bringing them together to an overall outcome. This is neglected here, there is rather an unambitious "the method worked" and "further work is needed". I think you can

really strengthen your paper by putting more effort into the conclusion (ideally after revising the discussion).

Thank you for this comment. The two first paragraphs in the Conclusion section summarize the main results, as suggested by the reviewer. We will write the last paragraph (370ff) to bring the results together by pointing out the implications of this work, as follows:

"We infer from our dye tracing analysis of a single tree that stemflow belowground funnelling is a dominant hydrological feature in humid Mediterranean mountainous areas. The root architecture of trees leads to preferential flow and thereby non-unform distribution of water in the soil profile. The funnelling effect allows water to infiltrate along roots and macropores near the soil surface and deeper in the soil, water will distribute into the soil matrix. This preferential infiltration of stemflow water has important ecological implications, as water is moved quickly into the subsoil, where it can be stored and made available for root uptake."

376: "Further studies are needed" I would avoid this wording, it sounds a bit hackneyed.

We deleted this sentence, please see our previous response.

376 ff: The outlook is ok content-wise, but it reads a bit sloppy and more like a brainstorming. Please rephrase in a more focused, coherent and professional way.

We deleted this sentence, please see our previous response.

379: "hot topic" too much!

We deleted this sentence, please see our previous response.

570: Figure 1: Avoid red and green colored symbols within one figure for reasons of accessibility. The symbols could logically build on each other. The axis names could be more informative (e.g. "local x-coordinate"). All figures: Different units of length are used (mm, cm, m). It would be great to choose only one and use it consequently. It does not make sense to use a mm scale when the scale of interest is much larger.

We will modify the colors (red and green and blue to black and magenta and green) and the axis names as suggested by the reviewer. The units will not be modified because most of the figures use cm but small scales like the one in Figure 1 cannot be represented by using cm.

570-571: "photograph" instead of "picture", "stemflow application" instead of "stemflow set-up"

Thanks for the suggestion. "photograph" will be used while "stemflow application" will not be used because the photographs represent the design or set-up but not the application.

683: Figure 7: The color code of "no water level detected" is too hard to differentiate from the lower parts of the water level color scale. "No data" should be simply left plane and does not need to appear in the legend (it is more intuitive and matches the area in the middle and around the circles, where there is also implicitly no data).

Good comment. The colors will change but "No data" will remain within the figure. We will use hashmarks to denote the no data sections.

712: Figure 8: As cardinal directions are given directly in the figure as headings (the columns of the panel), it would be consistent to also give the profile distance in the figure (the rows of the panel) instead of in the figure caption. To make it less noisy, x-axis labels and names should be deleted where they are unnecessary (just like with the y-axis).

Change accepted.

750: Figure 10 would be even more consistent and self-explanatory if the first y-axis and the deuterium label in the legend would be in red (as the symbols, and as is for the brilliant blue). Maybe choose a slightly darker red in order to improve readability.

First y-axis color will be changed.