Response to Reviewer 1

We would like to thank Reviewer 1 for the comments and remarks which will significantly improve the manuscript. Please find our replies to the general and specific comments, as well as suggestions for revisions, below.

General comments:

R1: Consider revising the title. I don't think the title starting with 'Best of both worlds?' makes sense in the context of the article. I would remove this because it's arbitrary and doesn't refer to the second part of the title. Is this about being the best of both worlds in terms of being a balance between field- and laboratory experiments or being about the recombination of monoliths?

Answer: We agree and suggest changing the title to "*Technical Note: Combining undisturbed soil monoliths for hydrological indoor experiments*".

R1: The article has a lot on chemical and statistical analysis, and I think this should be reflected in the title and abstract. Although the article discusses combining soil monoliths, there is a lot of material on chemical composition, so I believe the tracer experiments aspect should be stressed more.

Answer: The general aim of this study was to explore the possibility of combining small scale soil monoliths into larger scale soil monoliths for conducting soil hydrological indoor experiments; we understand the tracer experiments as one method among others to study the effects of this procedure. Therefore, we suggest to refrain from adding information about the tracer aspects into the title. However, we intend to stress the chemical aspects a bit more in the Abstract.
Suggested additions would read as follows: "*We conducted artificial runoff experiments and analysed the chemical composition and amount of the outflow from four flow pathways (surface runoff, subsurface interflow, percolating water, lateral flow flow). Furthermore, we studied surface runoff velocity parameters using a salt tracer.*".

R1: You refer to 'push-methods', but this isn't defined. Some clarity in the abstract, introduction or methodology on what this relates to would benefit the reader.

Answer: Push-methods are opposed to other methods for monolith sampling, such as drilling. Push-methods can be used for large or small monoliths, the difference being the dimensions of the sampling frame and the necessary force needed to push the frame into the ground, as well as the extent of the necessary soil excavation around the sampling frame. For large monoliths a front-end loader may be needed while for smaller monoliths a mallet and spade may be sufficient.
We will add a clarifying sentence to the Introduction that would read as follows: "*For smaller monoliths it is possible to use methods that require only minimal use of technical gear. For instance, push methods can be applied in which a sampling frame is driven into the ground with a mallet or a frame may be built around a pre-cut soil volume*".

R1: Having read the full article, I wonder if this work is better defined as a research article than a technical note, given the length of the discussion and appeal to lots of different laboratory experiments. Technical notes are typically a few pages in length. See https://www.hydrology-and-earth-system-sciences.net/about/manuscript_types.html.

Answer: We are aware that our manuscript is rather long for a Technical Note. Of course, we tried to be concise, but as we have used a quite extensive approach to examine if what we propose is a valid

method, our manuscript ended up being longer than the average 'Technical Note'. From the HESS manuscript types website:

"**Research articles** report on original research which clearly advances our understanding of hydrological processes and systems, and/or their role in water resources management and Earth system functioning …"

"Technical notes report new developments, significant advances, and novel aspects of experimental and theoretical methods and techniques …"

As we see it, we describe a novel experimental method/technique, which could be used for original research. Consequently, we would like to keep this paper as a Technical Note. However, if the Editor or Reviewers have strong objections against this, we are also happy to publish this as a Research Article.

Specific comments

Abstract

R1: Please use the multiplication symbol (×) rather than 'x' in the dimensions of soil monoliths

Answer: will be changed.

R1: Revise 'further research is needed for a definite conclusion' – please elaborate on this.

Answer: We suggest to delete this sentence (also partly due to the word limit for the Abstract). It was supposed to echo the statement we had made at the end of the conclusions – "*Nevertheless, we encourage further research on this subject to better delimit the potential and possible limitations of this procedure, e.g., using X-ray imaging*" – shortened and paraphrased for the Abstract. At a second glance, we think this sentence is probably misleading and actually not really necessary here. We think that the wording (*our results suggest*…, *we propose*…) is defensive enough to clarify that there is still room for improvement.
Nevertheless, we will add a paragraph to the Discussion elaborating on this issue which would read as follows: "*We used an extensive approach, analysing runoff characteristics, chemical loadings, and flow velocity and are, thus, confident in our conclusions. Nevertheless, there is room for further research, for instance applying different boundary and initial conditions, such as other soil types and flow rates, or a higher sample size and number of blocks to be combined. Very interesting would also be a comparison of large monoliths taken with heavy machinery, compared to blocks of similar extent that are made up of combined smaller monoliths*.".

R1: I'm not sure the wording 'exported' within 'laterally exported water' makes sense. What does this refer to?

Answer: We were referring to water that infiltrated into the soil body but left the soil again (laterally). We intend to change the naming of this flow path to '*lateral flow*' throughout the text.

Introduction

R1: Line 19: Considering revising wording 'cardinal' to 'fundamental'.

Answer: We suggest changing the wording to "*important*", also following the suggestions of another reviewer.

*R1: Line 19 – 25: Are there any references which support this or discuss the shortcomings/advantages of laboratory and field experiments (*e.g. *Green, 2014, Modelling Geomorphic Systems: Scaled Physical Models or some of the references in the introduction of Green and Pattison, 2022: Christiansen Revisited)*

Answer: Admittedly, we found it more difficult than one would expect to find suitable citations for these seemingly obvious statements. Nevertheless, we agree that backing-up these claims with references would be beneficial and thank the referee for providing two citations. We intend to add at least one of them, together with another reference, more closely related to experimental soil studies (e.g., Katagi, 2013).

R1: Line 23: List these three-dimensional characteristics – are these vegetation, hydrological, soil-mechanics, etc.

Answer: We will list some examples. The proposed change in wording would read as follows: „*They are shaped by physico-chemical processes and biological activity and, thus, have developed three-dimensional characteristics (e.g., vertical gradients, macropore network, root system, etc.) that cannot easily be reproduced artificially.*".

R1: I feel as though Line 39, 'The collection of large monoliths (over 1m3) necessitates heavy machinery...' should be stressed in the Abstract, as this is a key reason for the study methods.

Answer: We intend to rephrase parts of the Abstract to stress this more clearly. The rephrased part of the Abstract would read as follows: "*Acquiring large monoliths necessitates the use of heavy machinery, which is time-, cost- and labour-intensive. Small- to medium-sized soil blocks, however, can be obtained using less demanding methods.*".

R1: Line 38: 'Advisable to use as large soil slabs as possible' – but this is quite generalised in the context of soil monoliths. How large, and when you refer to a soil 'slab', does this incorporate depth, width, and length? A reference here would be helpful to appreciate the scale or standard to use here.

Answer: The range of undisturbed monolith dimensions to be implemented into indoor studies is restricted to a few m width and depth, probably around 10 m² in area and depths < 2.5 m, even if very heavy gear is used. We do not think that it is feasible to provide a number or scale here above which a monolith is supposed to produce results that are representative.
However, we would change the wording here, so that it is clear that all three dimensions are meant and to avoid confusions about the term '*slab*' (which was used as a synonym for monolith/block). The proposed wording would read as follows: "*For upscaling purposes and a more accurate representation of soil processes and their variability, it would be desirable to use soil volumes that are as large as possible; however, the amount of work needed increases substantially with size*.".

R1: Line 42: 'Blocks below 300 kg are easier to handle…' – a reference here is provided, but more context would be helpful on why this figure. Is this because it can be handled using a particular type of machinery. This could relate to the previous comment – maybe 300 kg is a good balance between being small enough

that it is practical and easy to work with and large enough that edge effects are minimised. Some extra discussion on this point would be helpful.

Answer: The 300 kg were taken from the reference. We realise that this number appears to be quite arbitrary without context. We intend to rephrase the sentence to a more generalised statement, e.g.; "*Furthermore, the less heavy the monoliths are, the easier they are to handle, store, and discard*.".
We do not think that the manuscript would be improved by further discussion. It is obvious that smaller and lighter monolith are easier to handle and store, but how easy the handling is also depends on the resources of the laboratory (access to cranes, lift trucks, manpower, etc.).

R1: *Line 44: 'Combination of two or more…' – are these equally sized blocks? Change to a 'combination of two or more equally sized, smaller monoliths'. State here that the material should also be comparable, as presumably, you wouldn't want to combine different materials.*

Answer: We were thinking that the monoliths would all be taken from the same site and with the same sampling gear and method, thus being equally sized. We will rephrase the sentence to include this, which would read as follows: "*A promising approach for runoff research appears to be taking two or more equally sized smaller monoliths at a site and combining them to a single large block, thereby optimizing cost and labour efficiency as well as representativity and upscaling potential*.".

R1: *Line 49: Multiplication symbol rather than 'x'. Add in 'equally sized monoliths' before the dimensions.*

Answer: will be changed accordingly.

R1: *Line 54: 'Done properly – the recombination procedure has no directional effect on runoff properties'. Discussing the correct procedure or recombination methods would be beneficial to support this statement.*

Answer: We agree and will add some more details on a '*proper re-combination*' in the M&M section. The new wording would read as follows: "*For a proper re-combination, it is essential that the blocks are of equal width and depth. Furthermore, the monoliths, and the soil used for the soil-water mixture, need to be taken from the same site in close proximity to one another*.".

R1: *Line 55: Wording unclear '…do not differ regarding the (share of) outflow at…'. Please clarify the wording here. I think you are referring to separate outflows on combined monoliths, but the wording could be changed to make this clearer to the reader.*

Answer: What we wanted to express is that re-combined monoliths do not differ regarding the amount of outflow of the different flow pathways, as well as their proportional share. We will change the wording here for clarification into: "*Accordingly, we hypothesized that (1) re-combined monoliths do not differ regarding the amount of outflow at the different flow pathways and their proportional share, […]"*.

R1: *Line 57: Runoff velocity? Please clarify as this is in the supplementary material to the main text…are you expressing runoff as a speed m s-1, or is it discharge (volume/time). This needs to be made more apparent here.*

Answer: The unit of a velocity is distance per time (usually m s^{-1}), the unit of a discharge is volume per time. As we speak of '*runoff velocity*' we do not think that there is an ambiguity. However, we will add the unit for clarity.

Methods

R1: *Line 71: '…the soils occasionally dried up to some extent at the surface' – this is quite vague. I would consider removing this or putting more detail on this point.*

Answer: We suggest to remove this sentence.

R1: *Line 77: I don't know whether SRF is a good abbreviation for surface runoff. Also, please define what laterally exported water refers to. I don't think the word 'exported' is clear – maybe this should be reworded to lateral flow or lateral spread/transmission. You mention these abbreviations later in the text (Line 120), so I would either remove these abbreviations from the text/tables altogether or not refer to the longer wording in the text again, as these have already been defined in Line 77. I would recommend removing these abbreviations from the text/tables for clarity.*

Answer: We agree. We intend to remove all abbreviations for the flow pathways and will instead refer to the full wording throughout the text and tables.
We would also add a better description for laterally exported water, which would read as follows: "*The runoff experiments were carried out in two experimental sets. During the first set, two flow pathways were recorded at the lower end of the monolith, the surface runoff and subsurface interflow. For the second set, we further sampled and distinguished between percolating water that went through the whole soil body vertically and water that infiltrated into the soil body, but left the monolith again at the side due to lateral flow pathways.".*
Furthermore, we will change the wording from "laterally exported water" to "*lateral flow"* throughout the text as suggested.

R1: *Line 85: Why were the slopes of 3% and 4% decided upon, and why did these change between runs.*

Answer: Based on our data from established VFS in Austria, 3-4 % are commonly found slopes of VFS. We will add some text to clarify this, which would read as follows: "*The inclination was based on typical slopes of VFS in Austria and were adjusted to 3 % during the first set and 4 % during the second set.".*
The first monolith of the second set was adjusted to 4 % because we erroneously thought we also used 4 % during the first set. The 4 % were than kept for the rest of the second set to have equal conditions within a set. As the switch from 3 to 4 % is rather negligible, we would refrain from further explanations in the text.

R1: *Line 90: 'Fully saturated and left to dry for 24 hours' – why? To reach field capacity? Please justify does this relate to a standardised methodology (i.e. BS).*

Answer: The monoliths were saturated (and left to drain) in order to reach comparable soil moisture levels for all monoliths. The aim of the drainage procedure was to obtain conditions of field capacity for the soil water content. Previous work has shown, that for this type of soil monoliths (soil depths of about 30 cm), field capacity is reached after 1 day of free drainage (Tiefenbacher et al., 2021).
We will add a clarification, which would read as follows: "*Before each experiment, the monoliths were transferred to a water pool until fully saturated and then left to drain for 24 h, to obtain comparable conditions of field capacity for the soil water content (see Tiefenbacher et al., 2021).".*

R1: *Line 92: 'A constant flow of 5 l/m was adjusted via a valve and water meter' – reword this to ...' was applied using a valve and water meter'.*
Line 92: Remove 'we used' and change it to 'deionised water spiked with ortho-phosphate was applied…'

Answer: We will change both sentences as suggested.

R1: *Line 93: When you refer to 'mimic agricultural runoff', why these concentrations? Are they specific to regulations in Austria for farming practices?*

Answer: This concentration was based on a previous (unpublished) study, which analysed the runoff from fields using artificial rainfall. Data for typical (Lower) Austrian agricultural soils ranged from 0.2 – 0.9 mg DP l^{-1}. The used value of 0.5 mg l^{-1} is more or less a mean value. We will add the wording "*typical local*" to clarify this a bit better.

R1: *Line 106: Reword 'we conducted' and subsequent use of 'we' pronoun.*

Answer: We will change the wording accordingly.

R1: *Line 108: 'We used the quotient of outflow (of the respective flow pathway) to actual inflow' – please reword for clarity.*

Answer: Sentence will be rephrased for clarity and would read as follows: "*To account for slightly different inflow rates between monoliths, a standardized outflow value was used, which was calculated by dividing the measured outflow rate at a flow pathway by the actual inflow rate*.".

R1: *Line 114: Are the scripts in the Appendices/supplementary materials?*

Answer: We did not introduce any new formulas or functions. We only used already existing libraries and the functions therein. Thus, we do not see much benefit for the reader of including the scripts to the Appendix. Nevertheless, as stated in the Section "*Code and data availability: [..] raw data and codes are available upon reasonable request from the corresponding author*."

Results

R1: *Line 121: How much earlier? State this in the text.*

Answer: We will add mean numbers to the text. The rephrased text would read as follows: "*Both treatments had a similar beginning of surface runoff outflow at around 69 s, but re-combined blocks had an on average 38 s earlier onset of lateral flow and 35 s later onset of percolating water.".*

R1: *Line 134: High heterogeneity in the data – what might cause this? Some extra discussion on this would be helpful.*

Answer: We will add a more detailed discussion on the sources of soil variability to the Discussion section 4.2. The addition would read as follows: "*Sources of this natural variability of the soil are manifold, including vegetation patterns, edaphon activity, (micro-)relief, soil aggregation, and their often complex interactions with runoff (Boix-Fayos et al., 2006; Bryan and Luk, 1981). Furthermore, there may be anthropogenic impacts before, during, and after the monolith collection (Luk and Morgan, 1981; Rüttimann et al., 1995).".*

Discussion

R1: *Discussion is good. Because this is a technical note, do you have any 'lessons learned' or reflections that you could add if someone tried to replicate these experiments, how would they be able to improve their design?*

Answer: Some considerations can already be found in the Discussion section 4.1, to which we would add additional paragraphs (e.g., regarding what is necessary for a successful combination; different soil types, etc.).
The intended added paragraph would read as follows: "*For a successful combination, it is vital that the single blocks they are of equal width and height. While the width is usually fixed by the sampling device, acquiring similar heights may be more difficult. Uneven soil surfaces produce small barriers or ridges when monoliths are combined, which can interfere with runoff patterns. Furthermore, monoliths will have different heights at the front and back end if they are not taken at a right angle to the soil slope. Some adjustments can be made in the laboratory (e.g., different bottom plates to even out height differences). Nevertheless, we strongly advise to avoid such issues in the first place by an a priori assessment of site conditions and careful sampling. This also includes a sampling design that allows the extraction of monoliths in close proximity to another, limiting the effects of larger scale gradients.*". Note that we also intend to delete some sentences and paragraphs from the discussion following suggestions by other reviewers.

R1: *Line 167: 'Blocks need to be watered regularly to avoid drying up' – please state why this is important. Is this because drying up will cause the blocks to dissociate from each other and thus affect the experiments, or is there another reason for this?*

Answer: Drying would change the porosity within the soil, which affects runoff properties, but would also impede a proper 'repair' of the contact zone in combined monoliths. In addition, it will negatively affect plant growth of the monoliths.
We would add a sentence to clarify this, which would read as follows: "*Blocks need to be watered regularly for plant vitality and to avoid drying and an emergence of cracks in the soil structure that would affect runoff properties and impede a repair of the combined monoliths.".*

R1: *Line 191: 'Nevertheless, there was a trend of higher LAT outflow at re-combined blocks – does this refer to the monolith as a whole or just the interface at the contact area between the combined monoliths.*

Answer: This refers to the whole (re-combined) block. We can only speculate what happens at the interface at the contact area (what we do in the following paragraph).

Conclusion

R1: *The conclusion is reasonable, but given the number of tracer experiments that the monoliths were subjected to in the manuscript results/discussion sections, I would summarise these key findings in the conclusions. Specifically, what were the take-home messages of this study and what are the implications of each experiment? For example, recombining monoliths to conduct salt tracer experiments. Bare in mind that this is a technical note when summarising the conclusions.*

Answer: We understand that the importance of our study is the finding that the method we used is a valid procedure. In this respect, the results of the different experiments are just a way to test the procedure and are not of primary interest as such. We have structured the take-home messages: in the first paragraph, we state what is important for the sampling and combination procedure; in the second paragraph, we describe why we think the results support the application of this method. Thus, we still think that the take-home messages are outlined sufficiently and are fit for a Technical Note. If we are missing something, we kindly ask R1 for further clarifications.

Figures/Tables

R1: *Figure 1: Annotate arrows to show slope direction (from overflow tank to outflow at the bottom) for clarity. Also, it would be helpful to annotate key hydrological processes (surface runoff, sub-surface interflow, percolation, laterally exported water) as arrows.*

Answer: We will change Fig. 1 accordingly, e.g.:

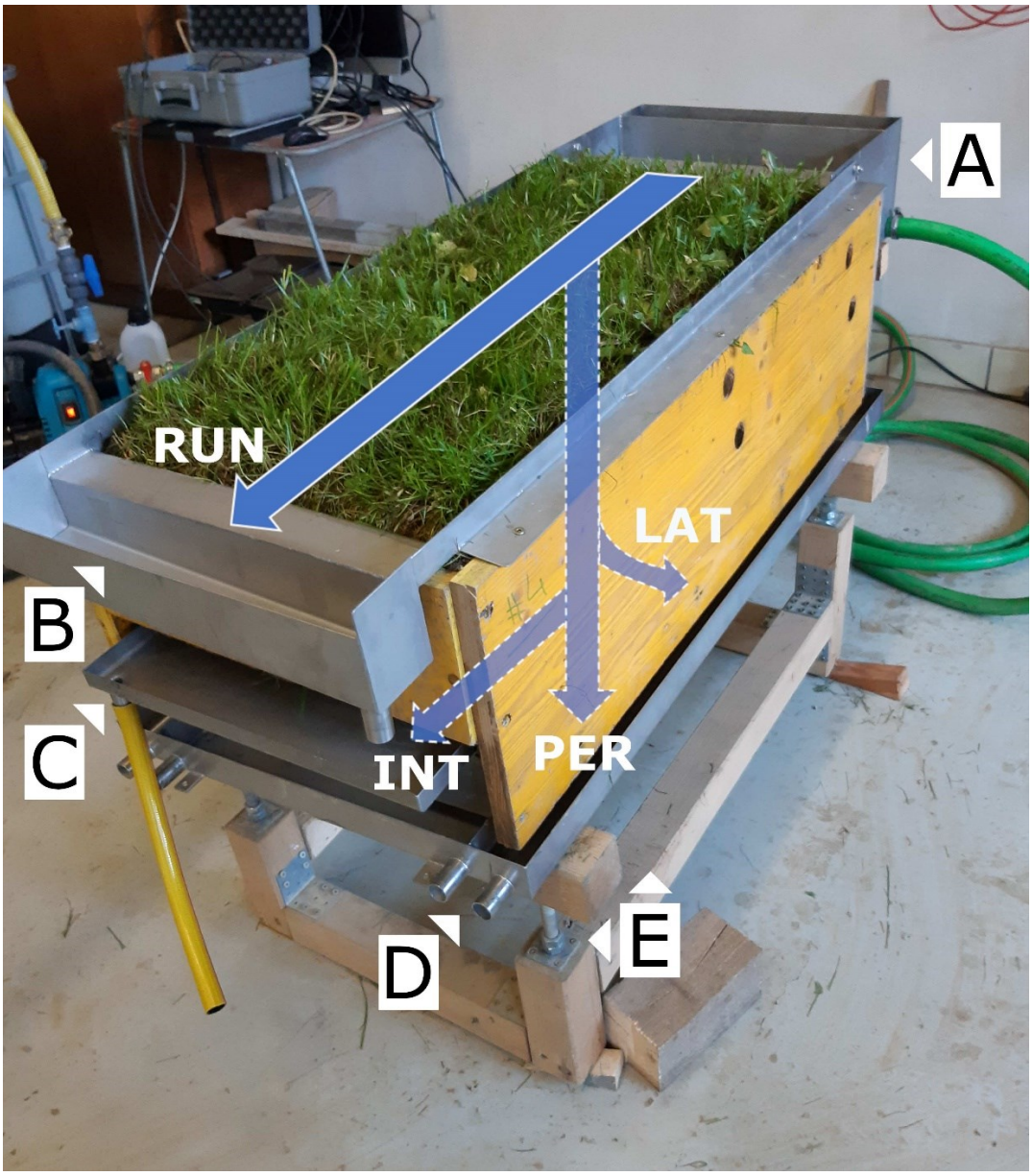

Figure 1: Fig. 1: Setup of runoff experiments with flow pathways (arrows). [A] Overflow tank; [B] metal frame with surface runoff (RUN) collector; [C] metal plate for subsurface interflow (INT) collection; [D] bottom frame with collectors for percolating water (PER; inner outlets) and lateral flow (LAT; outer outlets); [E] rack with slope-adjustable gear.

R1: *Table 1: Reword caption 'Site and material characteristics. Add size factions for clay, silt and sand (i.e. > 2.0 mm) – are these according to BS or an international specification.*

Answer: We will reword the caption and add size factions. The size factions are based on national standards (ÖNORM). The revised table header would read as follows: "*Table 1: Site and material characteristics. TOC – total organic carbon; $CaCO_3$ – calcium carbonite. Coarse material > 2 mm; Sand 2–0.063 mm; Silt 0.063–0.002 mm; Clay < 0.002 mm.*".

R1: *Table 2: Confusing layout…? Maybe plot the water budget…?*

Answer: Plotting the water budget would result in an additional figure. We think that the advantage of providing this information in one table row is about saving space. Thus, we suggest keeping the table as it is.