

Interactive comment on “In-situ unsaturated zone stable water isotope (^2H and ^{18}O) measurements in semi-arid environments using tunable off-axis integrated cavity output spectroscopy” by M. Gaj et al.

Anonymous Referee #1

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General comments

The study presents soil isotope depth profile data of a semi-arid region in Namibia measured in-situ via soil gas probes attached to an OA-ICOS. The manuscript is well written and structured as well as easy to read. The study is in the scope of the journal and I recommend the presented study for publication in HESS after revising the submitted manuscript based on the suggestions of the review process.

The introduction section is well written and the relevant processes and fundamentals

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of stable isotope hydrology for this study are addressed. However, I suggest shorten the introduction since a lot of basic information are given in extent.

The presented sampling approach and the methods used are well described. However, the data poses more questions than the authors can answer. The amount of samples taken from other water cycle components (e.g. rainfall, groundwater) is rather limited which makes it hard to interpret the measured soil isotope profile data on its own. More frequent rainfall isotope data would be helpful in this regard to answer the following question: What is the driver of the isotopic composition in the presented soil profiles? Given the fact that rainfall and groundwater isotope data are very limited, a more detailed discussion about the vegetation influence on soil water isotopes would be desired. It would further be desirable if the authors could make better use of the spatio-temporal isotope variability rather than just presenting depth profiles, which is nothing new.

The authors show soil moisture data for each profile. Did they correlate soil moisture versus isotopic signatures to proof the minor impact on the development of the isotope soil profiles in their study area?

When comparing the new in-situ method to the widely used cryogenic vacuum extraction technique, differences especially for isotope data of the upper soil profile were measured which could not be satisfactorily explained. Could these differences in the top soil be attributed to method issues rather than to kinetic processes? Could the new in-situ method after all be limited in terms of low water contents (<5%) as the differences between the cryogenic vacuum extraction and the in-situ approach occurred within the very dry top 15 cm of the profiles (<2% soil moisture) and enriched isotope values were likewise measured in the upper soil profile? For instance, Wassenaar et al. (2008) admitted a limitation of their method, which is likewise based on vapor-equilibrium measurements in this regard (not suitable for water contents <5%). The authors addressed this issue in its own section but still, the question remains why almost inverse isotope results were obtained from cryogenic extraction and the in-situ

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approach (Fig. 4) and further isotope results of which extraction method (in-situ vs. cryogenic extraction) are more reliable in the end. Finally, the authors should include a small paragraph on future research directions in the study area or further applications of the in-situ approach.

Specific comments:

Generally, the text should be checked for punctuation.

P6116 L17-25 and P6118 L1-16: shorten these sections

P6120 L15: Volkmann and Weiler (2014) not (2013)

P6122 L25: Consider deleting Equation (1), not necessarily needed

P6124 L7: How was the additional error for sandy soil extractions determined?

P6125 L1-3: Consider addressing this question in more detail in the discussion section: Atmospheric boundary conditions varied drastically between day and night. How does this affect the isotope results?

P6126 L1: To which variations are you referring to (these?)?

P6126 L8-10: Include this rainfall isotope data in Fig. 4

P6127 L21: With which method was deep soil water extracted and what does “deep” mean in terms of depth? Could you give the standard deviation for the local groundwater and deep soil water values as well?

P6128 L13: Could you explain why the method seemed to be less accurate for $\delta^2\text{H}$ (mean accuracy of 5.1‰)?

P6131 L20-21: Did the authors consider the fact that destructive soil sampling causes macropores with effects on the gas exchange and therewith on the isotopic composition in the soil profile measured in-situ after the destructive sampling?

P6133 L6-10: Present more recent studies as references

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Fig. 2: More detailed scheme would be helpful

Fig. 3: Redundant since texture was uniform throughout depth. The information given in the text is sufficient.

Fig. 4: Enlarge this figure and include rainfall isotope data in the plot (if available)

Fig. 7: Include rainfall isotope data (if available)

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