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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Novel Keeling plot based methods to estimate the isotopic composition of ambient water vapor" *by* Yusen Yuan et al.

Anonymous Referee #2

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The manuscript "Novel Keeling plot based methods to estimate the isotopic composition of ambient water vapor" presents two methods to use existing Keeling plot data not only to calculate the isotopic composition of a source (here ET), but also that of ambient water vapor delta_a. Using these two methods might provide new insights into the variability of delta_a, but a rigorous evaluation and discussion of the limitations and biases of these methods would be needed.

I cannot recommend publication of the submitted manuscript in this form. The paper lacks detailed and clear descriptions of methods and evaluation steps in many points. Due to the small number of data points that fulfilled the quality criteria, it is not clear which significance the results have and if the strong conclusions of the manuscript are justified.

In particular I am worried about the following points:

- The sparsity of the data is a major problem of the submitted manuscript. Out of four months of data, only 4 days were used for data evaluation.

- Further, many data points had to be removed because they produced contradictions with the assumption. (line 197 ff). If both methods produce so many data points that are obviously wrong, it is not clear to me why we should trust the other data points. At least it needs a detailed discussion why there are roughly 50% respectively 80% of obviously wrong values. Is the used data set inaccurate and/or are limitations of the methods producing these values? Are we sure that these problems do not occur for the remaining data points?

- The conclusion in line 39 (consistency between results and HYSPLIT modelling) and the statement in line 235 ff ("The calculated delta_a values on 11th June and 12th August . . . were higher than on the other days") is not very well supported by the data. Firstly there are only four data points. Secondly, the data is not that clear for the IP method: In line 204 it is written that the values were -12.95permil on 19th of May and -12.77permil on 12th of August. This is a difference of only approximately 0.2 permil. As there are so few data points for the comparison to modelling, the conclusion in line 39 is far to strong.

- The diurnal averages of the methods (lines 202ff and line209ff) are quite different between the two models (up to 1 permil but in both directions). The difference between day and night values is app. -1.6 permil for the IP method and 0.02 permil for the IVT method (lines 205 and 211 resp.) Thus, on a daily scale, the method comparison (Fig. 4) is much worse than on a point to point scale. Without providing a time series, it is hard to understand what is the problem here and to see e.g. in how far the diurnal means are uncertain and contain more or less data points. Thus, the conclusion in line 239 is not very well supported by the data.

- The manuscript generally lacks a careful discussion of the (propagated) uncertainties

and limitations of both methods as well as of the used data (e.g. Fig. 4 is without errorbars)

- Throughout the manuscript, there are many unclearities/missing details that makes it hard for the reader to understand what has been done and makes it hard to assess the results. For many of these points it might indeed help to use more references.

— In the methods section, there is barely no detail about the calculation of the Keeling plots such as the following: How many data points were used for one Keeling plot calculation? Which data points were used (spatial and temporal) in a single Keeling plot)? Was the calibration procedure a) a standard procedure that has been used elsewhere(if so, please provide a reference) or b) carefully evaluated?

— For the IP method, there are more details needed such as: What is the time step between the two Keeling plots that are used? Which of them are used as delta_v and c_v? If all of them are used, you get 8 different delta_a from one single Keeling plot. What did you do with them? Are they treated as individual measurements or are they averaged or did you pick one of them?

— In the conclusion, it is written "The results show an evidence that delta_a was constant . . . among different heights". I would like to see the data on which this conclusion is based.

— Please provide a time series of all results and indicate the 14 points used for the comparison. The boxplots in Figure 1 can hide interesting features of delta_a. A time series would help to discuss potential problems of the methods e.g. to test the assumption that delta_a is constant at a sufficient timescale.

— The results are presented as showing "four typical days" without any indication how the term "typical" is used here and in particular no data driven evidence for the claim that there four days are "typical".

—In Fig 4, there is no statistics given on the deviation between these models - such

as sqrt(mean(delta_IP -delta_IVT)^2)). This would give helpful additional information. Additionally, slope and Offset of the regression line in Fig. 4 could be discussed separately. Thus, there seems to be an offset of 0.748 between the two methods. Please discuss this offset.

— The derivation of the IVT method lacks some clearity. As it is not a direct implementation of the intermediate value theorem, it would be good to add references here and/or explain it more direct. E.g. the six cases in Figure 1 are not clearly written somewhere. It would be helpful to put headlines above the graphs mentioning the order. So for example it is not clear to me, why the Figure did not contain a case that is delta_a1<deltav1<deltav2<delta_a2, because this would also fulfill k1*k2<0

- I would recommend a detailed language check and in general a more careful usage of definitions, because there are some language related unclearities that might be avoided by a more precise description.

Some minor comments:

- It is not clearly written how Eq. 6 is used. I guess delta_ET is taken from two adjacent Keeling plots, but which c_v and delta_v are taken. One more sentence would help here. - The calibration procedure is not explained. E.g. it is not clear to me, what is meant in line 173. If this refers to a standard procedure, a reference would help. - Line 270: I am not sure if the IVT method really gives an explanation for the figure as stated here, or if it is rather the other way arround, that the figure can be used to understand the IVT method and in particular the change of slope. - I think the reference to equation 1 in line 197 is wrong.

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