

Review of Steen-Larsen et al AMT manuscript.

1. Does the paper address relevant scientific questions within the scope of AMT? **YES**
2. Does the paper present novel concepts, ideas, tools, or data? **YES**
3. Are substantial conclusions reached? **YES**
4. Are the scientific methods and assumptions valid and clearly outlined? **Good, but can be improved.**
5. Are the results sufficient to support the interpretations and conclusions? **YES**
6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? **Generally yes, but could be more clear**
7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution? **YES**
8. Does the title clearly reflect the contents of the paper? **YES**
9. Does the abstract provide a concise and complete summary? **YES**
10. Is the overall presentation well structured and clear? **YES**
11. Is the language fluent and precise? **YES**
12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? **YES**
13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? **YES- See comments**
14. Are the number and quality of references appropriate? **YES**
15. Is the amount and quality of supplementary material appropriate? **YES**

General Comment:

This manuscript presents a comprehensive and detailed explanation of methods and apparatus that keenly solve some of the formidable challenges that have perplexed field scientists attempting to make and calibrate high quality measurements of water isotopes and water vapor concentration for some time. For those who can successfully implement the technical designs and concepts presented here and apply it to their research, I am convinced it will represent a step change in their ability to make more useful and reliable measurements in a variety of environments. It is clear that this represents a culmination and evolution of concerted efforts, both on the part of the authors, and many whom they cite, in a long term quest to address the challenge of stability in analytical systems of this type. I whole heartedly recommend its acceptance for publication, with some minor edits, mostly technical clarity, and slight improvements to 2 of the figures. If possible, a few photos would really help illuminate the not only the complexity of the system, but it's likely compact nature and portability.

One of the more important innovations is the advanced PID control of the headspace pressure in the vials by metering between pressurized air and vacuum, leading to remarkable steady metrics in both isotopes and water vapor concentration. An equally head-line worthy finding is

the speculation on the effects that cavity temperature control have on the precision of the Picarro instrument. This may not be surprising to some but seeing it here along with all the other metrics is compelling. Not only have the authors achieved in creating a remarkable instrument/inlet system, but they have tested the system thoroughly and produced metrics that quantify and demonstrate its stability in a convincing manner.

Detailed Line by Line:

Line 23: Typo: "... as a calibration system have been document to ..." -> should be "as a calibration system has been documented".

Line 25: Add ", assuming 1 hour/day for calibration" to the end of the sentence.

Line 42: Add parenthesis to the d-excess equation: $d\text{-excess} = \delta D - (8 \times \delta^{18}\text{O})$

Line 77: The use of a selector valve is mentioned, but is not shown in figure 2.

Line 180- 190: Mixed past and present tense (was and is).

Line 186: An explanation of why a PTFE fitting is used instead of stainless steel would help.

Line 196: The use of the term "oven" is a bit confusing or misleading. Consider using Heated assembly, or perhaps heated tees, or reaction vessels, or? The word oven connotes and enclosure of some kind, which is not really the case?

Line 202: "The water vapor is produced in the oven is routed toward the output of the system...." How? Stainless steel capillary or?. Specify here.

Line 208: Spacing issue in the word "different".

Line 209: "In a second modification..." Was there a first modification? Perhaps it could just be 'In a subsequent modification' or similar.

Line 233: Spacing issue in the word "analyzer".

Line 275: It is not clear what is meant by "...Suboptimal management of memory effect[s] during Allan Deviation tests." Is this in the Picarro instrument, or in the inlet system described here?

Line 289: The authors system really deserves a fancy acronym name of some type 😊 as opposed to “the vapor generation module”. Not just for cache, but to more easily distinguish it from the “vaporizer using the autosampler”. Perhaps one could refer to the Picarro vaporizer/autosampler combination, or similar?

Line 291: Consider adding something like: “The large difference in these values is discussed further in section 4.4 on memory”.

Line 320-324: This stable region at ~12,500 is a very interesting finding. Any speculation as to what may govern this (?) could be useful.

Line 342: Perhaps also include Rozmiarek et al. (2021). [<https://doi.org/10.5194/amt-14-7045-2021>].

Line 408: “A 1 m length of 3.125 mm OD copper tube”. Maybe explain why such a long length was needed?

Line 419: Typo “This support[s] the hypothesis...”

Line 430: Typo (?) “...in phase coherence between $\delta^{18}\text{O}$ and cavity [?] for periods...” I think you mean cavity temperature and/or pressure?

Line 439-441: This is a MAJOR finding that the precision for measurements could be improved by up to a factor of 2 if the PID driven cavity-temperature cycles could be dampened. Might deserve higher placement or highlighting some how. No doubt, manufactures will be very interested in this, along with the many other findings !

Line 493-494: The reader will greatly appreciate the honesty implicit in the statement “We do not have an explanation for why the stainless steel capillary was performing better”!

Line 495: “...we had partly success” should be ‘we had partial success’.

Line 496: “As we will discuss *in* details below[,]” Consider: ‘As we will discuss in detail below[,] the clogging...etc.’

Figures and Tables:

Figure 1: This needs some work. While schematically correct (after considerable time discerning this), it could be made far more accessible to the general reader, by including some more details and labels. For example,

- label (or describe in the caption) the type of compressed air (nitrogen, zero air, or?);

- labeling the 3-way metering valves as such (these are key to the design);
- Instead of the part number of the R/H probe, consider putting that information in the text or caption, and simply call it for what it is “Precision R/H probe or similar”.
- How do 4 “ovens” converge into a single outlet?
- Is there a selection valve missing from the diagram?
- Oven unit could use a foot note “See figure 2” in its label
- If AMT allows use of color(s), consider using them to further distinguish flows of air, water and water vapor, with thicker lines. Or use words on the lines.
- Label the 1-4 psi pressure regulator (?) as such.
- Use bigger font were possible
- Not clear what the dashed red lines are, other than T1 and Tn, indicating there could be multiple vials.
- Is the input to MFC 1 really an unregulated line to the compressed gas? I suspect a regulator is in there somewhere (in addition to the 1-4 psi).
- Output could include “open split to analyzer” or such.

Figure 2: Drawing of the heated tee sections is good. Some improvements could include:

- Consider adding the word “oven[s]” to the block of heated tees. (I know its in the caption, but will help the reader).
- Consider showing some type of dry air inputs on the left, H₂O on top, and vapor coming out the right side more clearly . Maybe add some capillaries?
- Arrow pointing to PTFE capillary is actually pointing to he Swaglok nut (picky, I know).
- Consider labeling the bottom of the assembly with “2 ml vials with water” or such.

Figure 3, 4, 5, 6, 7 & 9: All Good

Figure 8: Cosmetic improvement: Consider smaller fonts.

Tables

Table 1: Good. It may be obvious, but consider spelling out in the caption that BER is Bergen water and SP is South Pole water.

Table 2: Good. Need to widen 2nd column a tiny bit to better accommodate heading text. Consider defining RSD either here in the caption or in the text.

Table 3: Good.

