

Review of: "Pico-Light H₂O: Intercomparison of in situ water vapour measurements during the AsA 2022 campaign." by Ghysels et al.

General comments

The manuscript is well written and structured and presents an impressive instrument development and intercomparison. The topic and the quality of the manuscript fit very well into the scope of AMT. However, I still have some comments or questions about the manuscript that should be answered before publication. However, only minor changes to the manuscript are necessary. In general, it would also be good for the manuscript to be read by a native speaker. There are still some minor linguistic errors in the text which should be corrected before publication.

Specific comments/questions:

- Lines 70-73: Here, the rather good agreement of the PICO-SDLA is mentioned in comparison to the other intercomparison campaigns. It should be mentioned in the manuscript that in your study from 2016 only **mean differences averaged over large height ranges** of several kilometers were used. The other studies cited here used mostly a direct comparison on a high resolution (mostly on 1Hz), which automatically leads to larger discrepancies from time to time. If you would do it in the same way (high resolution) for the PICO-SDLA you would find similar deviation around 10% as reported by others. Therefore this comparison is not fair.
- Lines 125-126: " Like all optical absorption hygrometers": That's a bit too general. For example, there are absorption hygrometers that measure at a wavelength of 1.4μm and are not sensitive to small concentrations of water vapor. I recommend replacing the "all" with "many".
- Line 167-168: It should be better explained that PICO-Light is using two absorption lines for different atmospheric conditions and also why (Just with one sentence). Otherwise, it is not clear why the electronic should switch to another absorption line. You wrote the detailed explanation in Section 3.4
- Line 175: It is not clear to me, why you do not see any outgassing of the electronics during ascent of the balloon. The laser is installed downstream and there could be potentially some mixing of artificial water vapor into the atmospheric air volume. I agree for the descent of the balloon, that the measurements are not

affected by outgassing. If you just measuring during descent, you should probably better mention that in the text. In addition, you mentioned in lines 368-369 that PICO-Light provides reliable measurements during ascent and decent. This brings me to the question, if the uncertainties in Table 2 are the same for ascent and descent ?

- Line 333-342: This paragraph could be potentially removed because it is not essential for this particular study as no MLS data are used here.
- Sections 4 and 5: This two sections describe the two other instruments used for the intercomparison to the PICO-Light. It would be helpful for the reader to also state the final water vapor uncertainties of both instruments in the text. This allows to better interpret the results from the comparison and would complete the instrument description in terms of performance.
- Line 427: Meteorological data are here mentioned the first time without any explanation. There should be at least a very brief introduction of ERA5 in text before.
- Line 435-436: The relatively thick water structure is mentioned to be seen in the ERA5 data. But there are no ERA5 data shown. So I would recommend to state (not shown) somewhere in this sentence.
- Line 471-472: I do not understand why the water vapor profile is affected by outgassing during descent. As you mentioned before outgassing should not be a problem for the measurements during descent.
- Figure 8: Which saturation mixing did you choose in case of the PICO-Light ? Is the entire profile showing S_{ice} or S_{liq} or was the same procedure applied as for the FPH ?
- Line 476-479: Actually I cannot really believe that in the entire altitude range of 7.5 to 13 km you will still find a mixed-phase cloud with both S_{ice} and S_{liq} below 1. In case there are ice particles actually all droplets would quickly evaporate and increase the size of the ice particles. In addition below -38°C all liquid droplets would freeze instantaneously and form ice particles. And typically ice should not yield to large contamination. I guess the contamination is just coming from the small layer where you reach also the S_{liq} close to 1. There I agree that this might be a mixed phase cloud. Could be from convective origin ? Another thing which I do not understand is, why you still see contamination of during descent down to 18km? Is it because of the optical cell is contaminated by water ?
- Lines 545-547: Can you please explain how you calculated RH in part of the profile for each instrument/sonde. The radiosonde typically just give RH wrt. water for the entire profile. When comparing to the PICO-Light or FPH the mixing ratio should also be converted just to RH wrt. water. So you actually do not need to calculate RH wrt. ice using the Goff–Gratch equation for the comparison.

Technical comments/suggestions:

- The space between numbers and units appears sometimes to large and both are in additional sometimes wrapped in the text at the end of the lines.
- Line 41: Please write units without a dot in between: +0.3 W.m-2 .K-1.
- Line 64: (Rollins et al., 2014) compares aircraft- and balloon-based... You should cite studies incorporated in the text without brackets. There are several places in the text where the citation style should be changed like line 67 or line 70. The bracket citation style should only be used, if studies are not incorporated in the sentence like you did in line 35 for example.
- Line 72: I suggest to rephrase "multiplying" by "increasing the amount of "
- Line 78-79: "where absolute modulation of the local mixing ratio scales are within 10 to 20% of the typical mixing ratio." I suggest to skip the "are".
- Line 88: "meteorological sonde" should be plural.
- Line 127: "at the difference of other" should be replaced by "in contrast to other".
- Line 291: I suggest the word "of" here: "uncertainty is of reduced to 0.1%".
- Line 296: I suggest to change to: "From about 15 km downward,"
- Table 2: I suggest to put the "hygro" flag on one of the first two columns. Or is there a reason for choosing the random error to flag ?
- Line 366: Skip the word "sondes".
- Figure 4: It seems that FPH flight train also contained an ozone sonde ? Or what is the white box between radiosonde and FPH ? I suggest to either label it or remove it from the schematics.
- Line 408: ", the only the mechanical" Please skip "the" after the comma.
- Figure 6: PICO-Light profile from the September 21 is not shown in grey. It is shown in purple. Please change the caption here.
- Figure 7: I recommend to improve the scaling of the PV maps. All color-codes should range from the same values. I suggest to go from 1 to 13 PVU for all four plots.
- Line 454: "In this last". Please add here "range" before the comma.
- Line 487: "reduce" -> "reduced"
- Line 538: "y" ? Maybe it should mean "range"
- Figure 10: It would be great, if you could include the regression and r² values in each panel.
- Line 547: "sondes" -> "sonde"
- Figure 12 is missing !