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Atmospheric Measurement Techniques Discussions

Interactive comment on "A lightweight balloon-borne mid-infrared hygrometer to probe the middle atmosphere: Pico-Light H_2O. Comparison with Aura-MLS v4 and v5 satellite measurements" *by* Mélanie Ghysels et al.

Anonymous Referee #2

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GENERAL COMMENTS:

This paper presents results from two flights of the Pico-Light H2O hyrgrometer, a lightweight ballloon-borne mid-IR diode laser spectrometer developed at the University of Reims. The launches took place in February and October 2019 at the CNES flight facility at Aire-sur-l'Adour, Nouvelle-Aquitaine, achieving float altitudes of 27.4 and 29 km, respectively. Temperature as well as water vapor measurements for each flight are reported. (The former are presumably derived from radiosondes incorporated into the Pico-Light instrument package, though this is not stated explicitly; see Specific

Comments below). In any case, the Pico-Light measurements are compared with both Aura MLS satellite measurements as well as the ECMWF ERA5 reanalysis. In the case of water vapor, comparisons are also made with MS v5 since it incorporates significant changes from v4. All of these comparisons are presented in figures showing profiles of Pico-Light measurements overlain by the corresponding MLS and ERA5 along with profiles of sonde/MLS and sonde/ERA5 biases. Bias calculations are made after kernel-averaging the full-resolution Pico-Light profiles. (The water vapor comparisons are limited to the descent profiles to avoid potential balloon-wake contamination.)

My first concern is that the temperature comparisons add little to the understanding of the performance of the Sippican VIZ sonde, certainly not without comparison against another in situ sonde temperature.

With regard to the water vapor mixing ratio measurements, the MLS v4 water vapor comparisons suggest that the Pico-Light H2O hygrometer in these two flights is comparable to other in situ instruments. The MLS v5 comparison is of some interest, but the two flights present do not present the same story in the below-100 hPa region where v4 is understood to have an instrumental bias.

More significantly, it goes without saying that two flights – and two flights in significantly different meteorological settings - are a very slim basis upon which to make a judgement of the performance of an instrument measuring any atmospheric trace constituent, and water vapor with its strong vertical gradients particularly so. Thus I don't see great value in the profiles presented; what would be of considerably greater interest would be head-to-head intercomparison with a reference-quality in situ hygrometer.

Overall, the paper suffers from a lack of a clear purpose. While it certainly shows that the Pico-Light H2O hygrometer can make in situ measurements that are not inconsistent with other in situ water vapor instruments, it falls well short of presenting significant new findings, not withstanding the comparison to the relatively new MLS v5 water vapor.

Technically, the paper suffers a great deal from a very uneven logical and narrative flow, not to mention its need for considerable copy-editing quite beyond what can be expected from a review.

SPECIFIC COMMENTS, by section:

A. “Pico-Light H2O” (lines 84-150)

This section is poorly organized and confusing as a result. I have listed below several passages in the section that really threw me off at first and even upon re-reading, did not present a clear picture of the components comprising the instrument package, how they operate together and, most importantly, how the science data are processed:

o The section begins by restating that Pico-Light H2O is an hygrometer. However, the instrument as flown, and as reported here, provides measurements of temperature as well as water vapor mixing ratio.

o The package is assembled with two Sippican VIZ sondes are “to measure ambient temperature”. That clearly suggests that these sondes are used to produce the reported “Pico-Light” temperature, but here is no discussion of how the sonde data are processed to yield the temperatures reported in the Results and Discussion section.

o A little further on it is mentioned that an (Intermet USA?) Imet-4 is included in the payload as a “PTU sonde”. While it is stated that this additional sonde is for lower tropospheric humidity comparisons, the reference to it as a “PTU sonde” suggests some distinction between it and the Sippican sondes. What that distinction might be is not explained.

o Ambient pressure is measured by a Honeywell PPT2 pressure transducer; a precision of 0.03% is stated, though accuracy is not.

o There is a fairly detailed discussion of the means by which Pico-Light H2O processes the individual water vapor spectra into instantaneous (10-ms) mixing ratio values. Since no further processing is described, it must be assumed that these 100 Hz data are the

input to the kernel-averaging described three sections later.

B. “Method for intercomparison with Aura-MLS retrievals” (lines 170-189)

This begins with a discussion of the 1-Hz effective response time of the instrument resulting from the pressure and temperature transducers. While the response time of those transducers had not previously been addressed, this estimate seems reasonable. What is a bit confusing however is what bearing this has on the averaging kernel calculation that immediately follows. As mentioned in the previous comments, is it the 100 Hz profile that is input to the averaging kernel calculation? Or a 1-Hz smoothing?

C. “Results and discussion - Temperature” (lines 191-224)

This section finally provides the unequivocal statement that the Sippican VIZ sondes provide the Pico-Light temperature measurement. Although again, how the two temperature data streams are combined is not described – or at what rate the temperature is sampled.

D. “Results and discussion – Water vapor ” (lines 225-279)

Here the authors present water vapor profiles in Figure 8 (?) and 7 that, as expected, show that MLS v4 water vapor mixing ratios are on the order of 20% and lower than the hygrometer at the higher stratospheric levels, come into closer agreement as the 100 hPa level is approached, but then swing much drier in the lowermost stratosphere and upper troposphere. This is in line with results reported with other in situ hygrometers. Reported here are some of the first comparisons with MLS v5, and the results are somewhat interesting but hardly compelling given that only two flights are presented.

E. “February 19th flight ” (lines 280-308)

This section attempts to explain the differences between the October and the February flights in terms of the very different meteorological situations obtaining in the winter of 2019 and the autumn nine months later. The analysis is somewhat interesting but not particularly relevant to the rest of the paper.

TECHNICAL COMMENTS:

As noted above the text is both poorly organized and replete with grammatical as well as other kinds of errors. Both beyond the scope of journal review.

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