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Atmospheric Measurement Techniques Discussions

Interactive comment on "HAI – A new, airborne, absolute, twin dual-channel, multi-phase TDLAS-hygrometer" *by* Bernhard Buchholz et al.

Anonymous Referee #3

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Buchholz and co-authors present a thorough and well written description of a thoughtfully-considered 2x2 spectroscopic measurement of water vapor and total water. I recommend publication after they address a few issues detailed below:

My major criticism concerns the total water channels. The inlet design parameters of 80ïĆřC piping temperature and 100 liter/min flow rate (line 130) do not seem appropriate to ensure efficient conversion of condensed water to vapor prior to quantification in the closed-path cells. Any characterization of condensed phase sampling efficiency or comparison to other measurements during ESMVal would improve confidence in the accuracy of these measurements. If it is known that the total water channels have some inadequacies, this should be explicitly discussed at appropriate points within the manuscript, or alternatively, claims of multi-phase measurement capability should be tempered or removed.

More minor improvements are suggested below.

In the section 'Explanation of the term "calibration-free", the authors are encouraged to add a discussion of the criteria they use to determine when and how frequently they re-characterize the component calibrations within the 'unbroken chain of [metrological] measurements' to assure the continued traceability of direct absorbance measurements.

Reference lists of existing hygrometer publications exclude Zondlo [2010] in line 77 and in the reference cited in lines 94 and 645. Additionally on line 645, the American aircraft model is a Gulfstream-V (500).

In line 650 and following, the May et al. developed hygrometer has flown on many NASA missions, supported by May and Webster as well as by Robert Herman. See, for example, data publication and instrument description found in A Hallar, et al., 2004 JGR-Atmospheres and DE Hagan, et al., 2004 GRL.

In the sentence beginning on line 661, would the .6%/K temperature influence on uncertainty result in a +/- 3% effect on the open-path water vapor measurement (due to the 5K local temperature mesurement uncertainty)?

In line 663, did the authors mean to write Voigt width, rather than Gaussian?

In the paragraph beginning on line 667, the systematic mean difference of the 2.6 closed-path: 1.4 closed path channels is more highly variable during the in-cloud transect and visual inspection would seem to imply that the mean difference undergoes a shift or temporal trend. An effort to filter both data sets to the same sampling intervals and frequencies prior to difference calculation would perhaps allow a more meaningful comparison between the mean channel difference during clear sky and in-cloud operations. It would not be surprising to see that the increased turbulence of in-cloud operations has differential impact on components of the 2x2 hygrometer, increasing the variability and perhaps even the mean of systematic channel differences.

The authors claim in line 714 that the open-path and closed-path measurements show only a 2% difference in the same flight segment, however, Figure 10 shows larger differences, with instantaneous channel differences falling between +/- 3 to 5%.

Among the figures, it would be valuable to add a figure (after Fig. 8?) to show the fit quality of the open-path 2.6 um channel since it is the most likely channel to saturate.

Finally, it would be useful to add a plot of relative channel deviation as a function of water vapor concentration over the same time interval as Figure 10 (13:40-13:55) to show that the channel differences are not related to calibration errors.

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