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Atmospheric Measurement Techniques Discussions

Interactive comment on "Airborne in situ vertical profiling of $HDO/H_2{}^{16}O$ in the subtropical troposphere during the MUSICA remote sensing validation campaign" *by* C. Dyroff et al.

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Comment: In my opinion, presenting the very infrequent measurement of the airborne bubbler output as a calibration measurement is a bit of misnomer. After all, the data are not rescaled using frequent in-flight measurements of water vapor standards of different isotopic composition and different humidity levels. Rather, the in-flight measurement serves as a check on proper instrument operation and validation. The overall calibration of the data still relies heavily on the pre- and post flight calibration measurements.

Reply: In the introduction Par. 6 we have rephrased the according sentence to: "With the exception of Herman et al., 2014, these measurements were performed without what we believe is a critical component especially for a validation experiment: in-flight instrument-performance analysis by measuring a calibration-gas standard.". Sec. 2.2 was rearranged, and it was highlighted that the in-flight measurements of the calibration gas were in fact for instrument-performance analysis. Sec. 2.2, last Par.: "calibration spectrum" was changed to "calibration-gas spectrum". Sec. 2.4, Par. 3: First sentence was rephrased to "In addition we have used the in-flight calibration-gas measurements to verify that our uncertainty estimate was justified.". Fig. 4: Caption rephrased to "In-flight calibration-gas measurements are depicted as the difference to the daily mean (absolute value) by the blue symbols.". Fig. 9: Caption was rephrased to "Black symbols denote the respective quantities of the in-flight calibration-gas measurements.".

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Comment: BTW: why is the headspace pressure of the on-board bubbler not regulated? The current configuration leads to the surprising condition of a higher humidity level of the reference at higher altitude, whereas the sampled air is normally becoming dryer with increasing altitude.

Reply: For simplicity reasons, and because it was not necessary in this case. The sentence "The pressure in the bubbler thereby corresponded to the ambient air pressure." was added to Par. 1 of Sec. 2.2.

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Comment: You extensively discuss sources of systematic errors, but I am still missing some: The large change in external pressure (450 – 1000 mbar) may very well induce mechanical distortion of the gas cell and/or displacement of optical elements. Do you observe fringe walking during (rapid) altitude changes? These may not well be accounted for by the in-flight calibration/verification measurement, as this measurement is carried out very infrequently, and most likely during level flight only.

Reply: Calibrations (or rather the in-flight performance checks) have purposely been performed in all likely flight conditions, including rapid altitude changes, tight 1g+ curves, as well as high vibration and shock phases etc. We did not observe performance degradations under these conditions. We have changed the first sentence of Par. 2 (now Par. 5) in Sec. 2.2 to "The calibration gas was fed into ISOWAT II 2 to 5 times per flight in a variety of situations, including relatively rapid ascends or descends, and high turbulence at lower flight levels in order to ensure instrument performance in these conditions.".

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Comment: The air inlet appears to be different from the 2010 paper. Whereas the CARIBIC inlet collects total water, sampling both gas phase and particles, the present rear-facing inlet on the C-212 airplane is likely sampling the gas phase only. Has fractionation induced by this inlet been investigated, e.g., by flow modeling?

Reply: We have not performed flow modeling. We believe that heating of the inlet line – which was made of electro-polished stainless steal – to a temperature well above the H2O saturation temperature at any time has prevented sizable isotope fractionation. Cloud droplets/particles are nor sampled with this rearward facing inlet, which further relaxes concerns of fractionation.

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Comment: Do you measure the gas temperature in the inlet line just before the MPC in order to be sure that the gas has completely thermalised?

Reply: Yes, this is done. A sentence has been added to the end of Sec. 3.2.

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Comment: I presume that the measurement precision is not sufficiently high to see such effects, but have you verified that the different matrices used for in-flight validation (molecular sieve dried outside air, also depleted in CO2, but still containing Ar) and pre-

and post flight calibration (synthetic air, no CO2, no Ar, possibly a different O2/N2 ratio) does not affect the results?

Reply: Laboratory test of the calibration bubbler with H2O standard on VSMOW scale and dried air (by molecular sieve), and comparison with a Picarro analyzer showed no measureable effects beyond the overall uncertainty.

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Comment: The fact that you make the fringe walk through temperature modulation of the bulk material of the f=1" focusing lens, suggests that the fringe is caused by internal reflection in the lens (otherwise, a simple translation of the lens would have been sufficient to reveal the fringe origin). Knowing the spacing between the lines in the spectrum (0.5 cm-1 between the H16OH and H18OH lines, over which range I count âĹij4 fringes), I estimate the corresponding optical thickness (2L) equal to about 4 cm. That appears to be much more than the lens thickness (also after correction for n>1). Also, tilting the lens should reduce the fringe in this case. Can you clarify this?

Reply: With Δf = c$\Delta\nu$ = 3E10 cms-1 0.5 cm-1 / 4 = 3.75E9 s-1 and FSR = c/(2nL) => L = c/(2nFSR) = 3E10 cms-1/ (2 1.4338 3.75E9 s-1) => L = 2.8 cm. The lens has a thickness of 2 mm at the edge and 11 mm at the center, so the estimated 28 mm may well agree with the observations in case of multiple internal reflections. Par. 3 of Sec. 2.5 was extended to present these numbers.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 121, 2015.