

## ***Interactive comment on “Water vapor $\delta^2\text{H}$ and $\delta^{18}\text{O}$ measurements using off-axis integrated cavity output spectroscopy” by P. Sturm and A. Knohl***

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We thank reviewer #2 for the comments and corrections and would like to respond as follows:

- 1) p2057, l8-14: We have added these references.
- 2) p2057, l15: We have included a discussion of the differences of our work to Wang et al., 2009.
- 3) p2058, l1: We have changed the wording to “...inkjet nozzle technology, similar to the system reported by Iannone et al. (2009b)”.
- 4) p2059, l2: The pressure controller is part of LGR’s current water vapor isotope

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analyzer.

5) p2059, l15,19-20: The isotopologue information has been corrected.

6) p2059, l21: Here we give the definition of the delta-notation, which is valid independent of the VSMOW/SLAP scale. However, as our results are indeed expressed on the VSMOW/SLAP scale we have added that “A second international reference standard SLAP (Standard Light Antarctic Precipitation) with a defined delta-value is then used to define the VSMOW/SLAP scale (Gonfiantini, 1984)”. We also changed the term “VSMOW scale” to “VSMOW/SLAP scale” throughout the paper.

7) p2059, l23: “ppm” has been replaced by “ppmv” throughout the paper.

8) p2061, l13-25: In the current set-up we use only one dispenser head connected to a 12mL vial. Therefore, switching between different water standards has to be done manually by attaching different vials to the dispenser head. The residual water in the tubing between the vial and the dispenser head can be pulled back into the vial with a syringe that can be connected to the headspace of the vial. If a new vial is attached the water needs to be pushed in the same way with a syringe to the tip of the nozzle. The droplet generator can then be restarted again. Apart from the time it takes to flush the dripping system (including the buffer volume and valves) we did not observe any memory effects when using this procedure to switch between different water standards. Overall it takes about ten minutes to switch between two different standards for calibration. For an automated span calibration two dispenser heads could be used. This would allow an automated sequential measurement of two different water standards. We have extended the discussion of our calibration procedure in the text.

9) p2063, l15: Yes, we think that this behavior is indeed related to the pressure control. A comparison with an earlier version of the analyzer without pressure control as well as from other instruments using controlled cell pressures indicates that the pressure control reduces the Allan variance at averaging times of up to several 10s of seconds.

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10) p2065, I18: The baseline structure affecting the fit might certainly be another explanation for concentration dependences. In contrast to the results by Iannone et al. we see strong deviations also for d18O. Moreover, our results show nonlinearities over the whole measurement range of mixing ratios and these nonlinearities cannot be modeled by a straight line fit.

11) p2065, I10: In our case we can unfortunately not use such a simple model to correct for the concentration dependence. We use a polynomial fit to account for this effect instead.

12) p2066, I21: The ring-down time seems to be a good indicator of a changing non-linearity curve and a changing mirror reflectivity appears to be a plausible explanation for that. We cannot rule out that other causes like alignment changes contribute to this effect. However, our analyzer was operated in a non-vibrating environment and we would expect alignment changes to be correlated with temperature variations. We could not observe such a behavior so far. For the case described in the text the nonlinearity curve returned to its original shape. The corrections derived from the nonlinearity calibration amount to up to several per mill and variations in this calibration curve can potentially be also in this range. Therefore, it is important to monitor that. A periodical determination of the concentration dependence allows us to account for changes in the instrument response and should thus not contribute to the error budget. Still, as also mentioned in comment 3 of the response to reviewer #1 it is likely that residual influences of such effects are limiting the measurement precision (in particular for d18O). We have extended the discussion of this effect and its implications in the text.

13) p2071, I23: “The resulting long-term precision estimated from repeated water standard measurements is...” has been replaced with “The resulting long-term precision estimated from repeated water standard measurements over 12 days is...”. We also clarified this in Table 1.

14) p2071, I24: One aim of our study was to point out that different sources of uncer-

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tainty can substantially contribute to the performance of a commercial water vapor isotope analyzer. Stating an overall accuracy would definitely be beneficial, but is currently beyond the scope of this study. Only continued calibration and test measurements over longer time spans (i.e. several months) would ultimately allow us to specify an overall accuracy. Also, as is pointed out in the Short Comment C648 by Douglas Baer new hardware and software updates will further improve the performance of the analyzer. The estimated uncertainties in the amount correction are given as a range (0-0.47 and 0-0.27 ‰ for d2H and d18O, resp.), because they depend on the measured range of mixing ratios. If the sample mixing ratio is close to the reference mixing ratio which is used for the correction then the correction and consequently also its error are small. This explains why the 12-day precision in Table 1 can be smaller than the maximum value of the amount correction error. The temperature correction also adds to the total error. The uncertainty of the WVIA against IRMS calibration results from both IRMS and WVIA uncertainties and is taken into account. The error from the calibration curves then translates to the estimated error which is given in Table 1. We cannot yet state how reproducible these errors are, but continual measurements of water standards will likely reduce this uncertainty. We have extended the discussion of Table 1 in the conclusions to clarify these issues.

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