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Atmospheric Measurement Techniques Discussions

Interactive comment on "Correcting atmospheric CO_2 and CH_4 mole fractions obtained with Picarro analyzers for sensitivity of cavity pressure to water vapor" *by* Friedemann Reum et al.

Anonymous Referee #2

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The manuscript "Correcting atmospheric CO2 and CH4 mole fractions obtained with Picarro analyzers for sensitivity of cavity pressure to water vapor" of F. Reum et al. studies the sensitivity of the pressure sensor to changes in water vapor of Picarro CRDS instruments. In some cases, this might be relevant, since changing humidity between calibration and measurement can affect the accuracy of the measurements.

The manuscript is well written and concise. The arguments are sound, and the topic is relevant for the community doing highly accurate measurements of CO2 and CH4. I therefore recommend publication in AMT after addressing the following concerns.

General comments

The paper is certainly relevant for users aiming at highest accuracy of their measurements. However, I miss a little bit the context to other potential sources of uncertainty. The effect seems to be small and less than the WMO compatibility goal. The proposed alternative water vapor correction will too complicated to implement for most users, and therefore the authors are encouraged to give guidance on how the effect can be avoided. This could be a recommendation that drying to very low humidity might be necessary if highest accuracy is required. I also think that a setup using Nafion dryers can be used if the calibration gases also pass over the dryer. The authors point out that the effect on the pressure sensor readings is also relevant for measurements made using a Nafion dryer. This certainly holds true if the calibration gas is not passing over the dryer. However, if the calibration gas is also passing over the Nafion dryer it will be humidified, which results in very small humidity changes between sample and calibration gas, and the effect might be neglected.

Could the Picarro software correct this "internally"? If all pressure sensors have the same or a similar water vapor dependent bias, a correction should be possible.

Section 3.1 is difficult to understand. I suggest adding a few words of explanation to the numbers given in Table 2, and discuss their meaning and relevance. Why are the water vapor readings not sensitive to pressure changes?

There is a large difference between droplet experiments shown in section 3.2.2. Experiments 2-4 shows a much faster decrease in H2O compared to experiment 1. Were the conditions different for those experiments?

The WMO compatibility goal is interpreted by the authors as a allowed bias of $\pm$0.05 ppm for CO2 and $\pm$1.0 ppb for CH4. However, the compatibility goals of WMO are a "maximum allowed bias", and should therefore be $\pm$0.1 ppm for CO2 and $\pm$2.0 ppb for CH4. Please correct this in the text and figures.

Specific comments

Page 4, lines 24-25: You state that the pressure of the external sensor was adjusted to be within a few hPa the same as inside the cavity by a needle valve. Please be more specific. How close was it? The optimal position for an external pressure measurement would be either between the cavity and the inlet or outlet valve, which would allow for the measurement of the same pressure as in the cavity without the influence of the loop feedback. Would that be feasible, and if yes, why was it not realized?

Page 5, line 31: What was the reason for the drift of the external pressure sensor? Could this be identified?

Page 18, section 3.4.3: Why is Picarro 4 performing better than others? Is it newer? Is it a different model (according to Table 1 G2401-mc; I could not find any information on a G2401-mc model on the Picarro website, only for G2401-m).

Technical corrections

Page 15, Table 6: Should the range for CH4 be 0.41 –(-0.86) = 1.27 (instead of 1.30)?.

Page 28, line 29: Reference of Stavert et al. is incomplete (journal is missing).

Page 29, line 5: Link to report is wrong.

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