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Atmospheric Measurement Techniques Discussions

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Interactive comment on "Testing and evaluation of a new airborne system for continuous N_2O, CO_2, CO, and H_2O measurements: the Frequent Calibration High-performance Airborne Observation System (FCHAOS)" *by* Alexander Gvakharia et al.

Anonymous Referee #2

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Review of Gvakharia et al.:

This work presents airborne data of an in-situ QCL absorption spectrometer measuring greenhouse gases N2O, CO2, CO, and H2O with a commercial Aerodyne spectrometer. Such instruments tend to show strong drifts due to changing pressure and/or temperature inside the aircraft cabin. This holds particular during ascent and descent and for unpressurized platforms.

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Discussion paper

To reduce the effect of the drift, the authors apply a calibration system, which is new according to the authors - the frequent calibration high performance airborne observation system (FCHAOS). Basically the absorption cell of the IR-spectrometer is frequently flushed with a high flow of calibration cylinders with ambient mixing ratios of the target gases tracable to the NOAA WMO scale. The authors apply a duty cycle of 120 s and purge the cell for 10 s with additional 5 s latency before measuring. The output frequency is 1 Hz. The authors show, that by applying this calibration procedure the effect of the drift is accounted for. In-flight comparisons with a PICARRO CRDS system confirms this. The correction is shown for N2O data during a research flight and demonstrates the effect of the procedure.

The paper is well written and documents the calibration procedure allowing to reduce instrumental drift particularly during ascent and descent. I fully acknowledge a clear documentation of instrumental performance and data processing. However, I can't see the novelty of the approach. Fast flow and frequent short calibration with subsequent linear drift correction is basically, what has been applied here. Note, that 1.5 slpm are not novel (e.g. Korrmann et al., 2005 used 1-1.5 slpm at 56 hPa, cell < 0.5 l) as well as linear drift correction is standard.

If the authors could show, that the regulation of mass flow (MFC) upstream the cell (and downstream the cal switch valve) is the key to guarantee short calibration times by reducing pressure pulses (as suggested in the conclusions) I would see a potential new aspect. For this they should provide e.g. comparisons between pressure and flow controlled approaches (see below). It is not shown, why a pressure controlled system should not have the same performance.

As the paper currently stands, it is a well documented calibration procedure of a commercial instrument with standard methods. Therefore I don't see the paper in AMT in its current form.

Main point:

If the use of an MFC is the key novelty this should be clearly documented in the analysis. The current Fig.1. and the text states, that three-way solenoid valves are used (p.4, l.16/17). In case of a calibration I expect a direct connection between the pressure transducer (calibration tank) and the MFC controlling the cell flow and thus a pressure pulse. The inlet line is probably closed during calibration. In case of switching from ambient to calibration I still expect a short pressure pulse perturbing MFC and cell pressure. This will probably stabilize after a few seconds since the MFC limits the flow, but I do not see the advantage or novelty over a calibration using overflow of calibration gas by flushing the inlet at ambient pressure, which has been applied since years to GHG measurements by TDLAS (or QCLAS).

Note, that many QCLAS or TDLAS systems often are calibrated by flushing the inlet line with higher flow rates than the cell flow. The calibration gas tube is directly connected to the inlet and thus ambient pressure solely via a t-connector in the inlet line. Calibration gas is just switched via an open/close valve. This ensures a minimum pressure perturbation of the cell due to the open connection of the calibration line to the inlet.

This has been established over a long time (e.g. Wienhold et al., 1998) and a potential advantage - if existing - via the proposed procedure in Gvakharia et al., should be documented.

p.7. l.10-20: Would be good to see a highly resolved single calibration signal with individual data points and the cell pressure for a ground test and in-flight conditions at lower ambient pressure.

p.13, l.5: How do the respective Allan variance plots look like for the Nulltest? How do they compare to a lab test?

Fig.4: y-Axis: mixing ratio instead of concentration (also check the main text).

References: Wienhold et al.: TRISTAR – a tracer in situ TDLAS for atmospheric research, Applied Optics B, 67, 1998.

Kormann et al., QUALITAS: A mid-infrared spectrometer for sensitive trace gas measurements based on quantum cascade lasers in CW operation, Rev. Sci. Instr., 76, 2005.

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