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Atmospheric
Measurement
Techniques
Discussions

Interactive comment on “Development of a cavity enhanced absorption spectrometer for airborne measurements of CH$_4$ and CO$_2$” *by* S. J. O’Shea et al.

Anonymous Referee #2

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This paper by O’Shea et al. focuses on the development of airborne measurements of CO2 and CH4 using the cavity enhanced absorption spectroscopy technique, and have improved/discussed several important aspects that are essential for making high accuracy airborne measurements of CO2 and CH4: 1) design of the inlet system and characterization of the flow system; 2) application of gas standards and calibration system; 3) development of correction functions to convert wet mole fractions of CO2 and CH4 to dry mole fractions; 4) validation from comparison between in situ and whole air sample measurements. Although similar work for several other techniques has been done and published, it is particularly useful for researchers who are interested in implementing the cavity enhanced absorption spectroscopy technique. This paper is well

written and needed, and I can recommend publication after addressing my comments below.

General comments

1) The characterization of the uncertainty of 1Hz measurements should include not only the uncertainty of the measurements of calibration/target gases, but also the uncertainty in the water corrections in the case of wet air measurements. Besides this, it should also include the uncertainty of the calibration scale.

2) the introduction gives sufficient background for why airborne CO2 and CH4 measurements need to be made. However, no information about available techniques is mentioned. As this is a technical paper, it will read better if some basic discussions of available techniques are briefly discussed.

3) the units for CO2 and CH4 should be ppm and ppb, not ppmv and ppbv because the WMO scales for CO2 and CH4 are defined in ppm and ppb, not ppmv and ppbv.

Specific comments

P2/L8-11: please refer to the general comment #1

P7/L7-9: how was the flow controlled at constant volumetric flow rate of 0.8 Lpm? Was it not mass flow rate?

P7/L9: at 9150 m, the ambient pressure is still much higher than the cavity pressure setting of 50 torr, I wonder why the cavity pressure cannot be controlled without opening the throttle valve?

P9/L5-8: Again about the flow rate, if it was maintained at a constant mass flow rate, the theoretical inlet lag time (assuming plug flow) at 287 mb should be 3.5 times smaller than that at 1007 mb, and experimental results showed only two times smaller, but with a relatively large uncertainty. Will it be better to just use the theoretical inlet lag time? It does not make sense if it was maintained at a constant volumetric flow rate.

P11/L15: please double check the use of the term “certification”. “calibration” should be sufficient.

P12/L6-8: has any correction been applied to the measurements to account for the drift of the cylinder? And how?

P15/L19-21: It is interesting to see there is such a high linear correlation between the water vapor measurements from the dew point generator and the FGGA analyzer. Can the author give any explanation about why the intercept is -0.65%, not close to 0%? What will be the water vapor reading if gas from a cylinder is provided to the FGGA analyzer? I understand the dew point generator is not highly accurate, but the uncertainty on the temperature measurements by the dew point generator should be relatively small, not enough to explain such a big intercept.

P16/L14-17: when comparing to similar test results on the CRDS analyzers shown in Chen et al., 2010, Winderlich et al., 2010, Nara et al., 2012, the residuals here are relatively large. Do the authors understand what caused the relatively large residuals?

P16/L17-19: this sentence has been said in L10-12

P18/L3: remove “precision” as this does not need to be estimated from examining the difference . . .

P18/L17: remove “The FGGA system was remarkably robust” / give objective numbers to show the robustness.

P18: after reading the section 3.1, I have no idea what is the standard deviation of the FGGA measurements for CO2 and CH4 under lab conditions and during flight calibration measurements. Can the authors provide such information?

P21/L19-22: please refer to the general comment #1

P31/Table 1: “A 6 month mixture stability check showed the standards were stable over

this period” is not accurate. Please indicate the relatively large drift of 0.17 ppm for the Low gas.

P38/Fig. 5: clarify that the data shown in this figure are averaged values, not 1 Hz response . . .

P39/Fig.6: precision is not estimated from the differences, and please refer to the general comment #1 for the accuracy discussion

Technical corrections

1) P2/L2, P5/L15, P21/L16: “onboard” → “on board” or “aboard”

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 1, 2013.