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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluation of a cavity ring-down spectrometer for in-situ observations of $^{13}CO_2$" *by* F. R. Vogel et al.

Anonymous Referee #2

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This paper by Vogel et al. evaluates and characterizes a cavity ring-down spectrometer for in situ δ^{13}C measurements in different aspects: 1) assessing the short-term and long-term performance of the spectrometer; 2) characterizing the dependence of δ^{13}C measurements on CO_2 and CH_4 concentrations; 3) estimating the uncertainty for ambient measurements. This contributes to the technical expertise for atmospheric measurements of in situ δ^{13}C. I recommend the publication of the paper after addressing my concerns below.

General comments

1) This paper has somehow a narrow view, which only mentions the cavity ring-down spectrometer. An immediate question would be that how does the cavity ring-down

spectrometer compare with other available techniques, such as a quantum cascade laser based absorption spectrometer (QCLAS) by Tuzson et al. 2011 in ACP, an analyzer based on off-axis integrated cavity output spectroscopy (ICOS) by McAlexander et al. 2011 in analytical chemistry, and a FTIR trace gas analyzer by Griffith et al. 2012 in AMT. Note that all these alternatives provide similar or significantly higher precision for δ^{13}C measurements at shorter time scales. With the current precision of the cavity ring-down spectrometer of 0.15‰ at 20 minutes scale or even improved precision in a later version, the statement in the abstract "emergence of wide-spread application of cavity ring-down spectrometers to monitor δ^{13}C in atmospheric CO_2" is not justified.

2) I do not see a significant value of the 10 minutes measurements of a target gas every 30 minutes. The validation of the calibration frequency can be fully determined by the every 7 h calibrations. If the purpose was to identify situations of unusual instrument behavior changes within the 7h calibration interval, the authors should be able to figure out whether this is necessary based on the results from the one-year operation.

Detailed comments

P6039/L1 3: correct references according to the rules of AMT, e.g. Yakir et al., 1996

P6039/L24: the effective optical path length of the cavity is an estimated value, and is not an exact one. I can imagine it varies from one cavity to the other. Furthermore, the value of about 14km seems small, please double check the value. Besides these, one important parameter, the wavelength, is missing.

P6041/L1-3: The CRDS technique detects the ring-down time instead of the absorption strength, and therefore is not very sensitive to the performance of the detector. The laser precision is one of the limiting factors for the measurement precision, but isn't the low signal/noise ratio of δ^{13}C measurements mainly due to the weak absorption signal in the near-infrared region?

P6042/L16-17 what does "average 4 injections" mean?

P6042/"3.3 Concentration dependence" the CO_2 concentration dependency of IRMS does not suggest CRDS may have a CO_2 concentration dependency. I do not see a good reason to perform such a test.

P6043/4.1 Scale offset and cross-sensitivity: the calculations for Xsens are hard to follow because of the use of $\delta^{13}C_{VPDB*}$ and $\delta^{13}C_{VPDB}$, and the use of $\delta^{13}C_{res}$. I recommend starting with an equation that already includes the CH_4 sensitivity term, and derive an equation for calculating Xsens based on $\delta^{13}C_{raw}$, not based on $\delta^{13}C_{res}$ ($\delta^{13}C_{res}$ is not a directly measured term).

P6046/L4: "the data is flagged if water levels exceed 0.1%", was the data corrected for water effects when water levels were below 0.1%? Using the default water corrections?

P6048/L23-27 There is no point claiming them as "the fundamental approach". These are well known in the community. Especially Allan variance has been widely used to evaluate the stability of instrument measurements, and the authors should cite available publications for this.

P6049/L3 I cannot agree with "using at least two target cylinders" until more convincing results are shown.

P6053 the label on the y-axis should be "Allan deviation" instead of "Standard deviation". Note that the definitions of the two terms are different. And in the caption, should be "Allan deviation plot" instead of "Allan-variance plot".

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 6037, 2012.