Atmos. Meas. Tech. Discuss., 6, C2739–C2742, 2013
www.atmos-meas-tech-discuss.net/6/C2739/2013/

Atmospheric Measurement Techniques
Discussions

Interactive comment on "Cavity ring-down spectroscopy sensor for detection of hydrogen chloride" *by* C. L. Hagen et al.

Anonymous Referee #2

Received and published: 27 September 2013

This interesting manuscript outlines the development and characterization of a sensor for the detection of hydrogen chloride (HCl). The instrument is based on cavity ring-down spectroscopy (CRDS) and uses a reasonably strong absorption band in the near infrared (1742 nm) for HCl identification and detection. Hydrogen chloride plays an important role as reservoir species for halogens in the lower atmosphere and its main sources are not yet comprehensively understood, especially those associated with anthropogenic activity. Since HCl specific measurement techniques with sufficient sensitivity and time-resolution are sparse, this work is very timely to give this field renewed momentum.

The manuscript is well structured and written in a clear way. There are, nevertheless, a number of shortcomings which the authors should address before the final submission

to AMT. The comments are in order of occurrence:

P7221, L8-9: The authors should specify what is meant by 'periodic maintenance' and by the requirement of 'infrequent calibration'.

P7221, L14: The authors mention that commercial sensors based on CRDS have become available recently. A reference to these instruments must be provided here. Even though design and operational details are not available the key specifications of the commercial instruments should be quoted here and if possible reference to same should be made later in the discussion of the instrument's performance. Ideally the instrument described in this publication should be compared to the commercial sensor. I understand, however, that this may not be a realistic expectation.

P7221, L26-27: The authors cite Busch and Busch (1999) as well as Berden et al. (2000). Clearly by now newer books and reviews are available, e.g. book cavity rind down spectroscopy by Berden and Engeln (2009), Wiley, or Cavity enhanced spectroscopy and sensors, Gagliardi and Loock (2014), Springer.

P7222, L1-10: The first paragraph represents an overview of approaches in the literature, however, no reference to any publications is made here. Appropriate citations should be included here in several places.

P7222, L20-25: Explanations on P- and R-branch transitions, even though meant for the benefit of the reader, should be shortened.

P7223, L4: ". . . much stronger line strength. . ." -> ". . . much greater line strength. . ."

P7223, L12-14: The authors should specify the concentration used for the simulation.

P7223, L29: ". . . distributed-feedback diode laser. . ." -> ". . . distributed-feedback diode (DFB) laser. . ."

P7224, L5: What is meant by "when the system is first run,. . ."?

P7224, L10: ". . .and fit to a second order polynomial,. . ." -> ". . .and a second order polynomial is fitted to it,. . ." ->

P7224, L14: "these fit coefficients" -> "the calibration coefficients derived from the fit"

P7224, L29: ". . .causes noticeable instability. . ." -> ". . .causes noticeable instabilities. . ."

P7226, L8: what is meant by optically limited? Limited by the light propagation dynamics? Where does the value of 25 s come from?

P7227, L15-19: This is an interesting way to determine the effective sample length inside the cavity. I had not seen this before, in case that this is a well known approach in the community.

P7227, L29: artifact -> artefact

P7228, L18: "This section discusses . . .sensor." -> "In this section . . . sensor are discussed."

P7229, L8: The top panel in Figure 6 shows a HCl mixing ratio. How can that be determined from zero air measurements. Is the scale on the lower panel (Alan Dev.) logarithmic? That is not obvious. Does the improvement in the variance scale with the sqrt(time)? If not, what can the authors say about systematic errors affecting the longer term performance of their instrument?

P7230, L19: A reference for incoherent broadband cavity enhanced spectroscopy should be included.

P7232: Section 3.4 appears to be not detailed enough and too short considering the message that is to be conveyed here. Figure 10 is not discussed sufficiently. The instrumentation that CRDS is compared with is not outlined in sufficient detail. A general discussion on precision and detection limits (general specs of the other instruments) is missing. The data shown are not normalized to the same integration times. An additional figure or an additional panel in Figure 10 showing a correlation plot together with

an appropriate error discussion is missing here to improve the impact of this section, in my opinion.

P7233, L11: The statement "..is very adequate. . ." is too vague and should be better specified.

P7233, L24: aircraft -> aircrafts

P7235, L4: The commercial instrument is mentioned again here, see comment above.

P7241, Fig. 1: "Intensity" on the ordinate should read "line strength" or "integrated line strength". "Frequency" on the abscissa should read "Wavenumber".

P7243, Fig. 3: Include ROC = radius of curvature.

P7244, Fig. 4: What is shown on the ordinate? Unitless loss L/(c tau) (with L=effective sample length)? The term "Optical absorption" is not particularly appropriate due to the non-zero baseline. The authors may want to refer to Eq. (1) here and mention that the "empty cavity" losses have not been subtracted, rather than referring to the "cavity mirror loss". The abscissa title should read "Wavenumber" rather than "Frequency".

P7246, Fig. 6: Ordinate title not clear in comparison to the text on page 7229 (see comment above). Furthermore showing data up to 200 min (half the data) in the upper panel would have been sufficient to correspond to the Allan Deviation plot in the lower panel. I also suggest citing Lehmann and Huang in the caption.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 7217, 2013.