

***Interactive comment on* “Evaluation of three new laser spectrometer techniques for in-situ carbon monoxide measurements” by C. Zellweger et al.**

Anonymous Referee #2

Received and published: 18 August 2012

General Comment: Review of the manuscript ‘Evaluation of three new laser spectroscopic techniques for in-situ measurements carbon monoxide measurements’ submitted by C. Zelleweger with co-authors M. Steinbacher and B. Buchmann. The paper describes comparisons of CO measurements made by three relatively new spectroscopic techniques. Four commercially-available instruments are examined; all provide measurements at 1 Hz or better time resolution. The instruments optimal signal averaging times were first defined, followed by experiments designed to evaluate analytical precision, drift and linearity. Sensitivities to temperature and potential spectral interference from water vapor were also studied.

This is an excellent example of basic laboratory research. It will be valuable for the

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increasing numbers of laboratories initiating CO measurement programs. The material is suitable for AMT and recommended for publication. Below are a few comments the authors may consider in revision.

Specific Comments:

Title: One would more accurately say this paper has evaluated four instruments using three spectroscopic techniques rather than the techniques themselves

Section 2. Instruments

A sentence or two giving the analytical basis of each instrument would be valuable in later discussions. For example: 'The VURF is based on the fluorescence of CO at 150 nm (Gerbig et al, 1999). The discharge of a CO resonance lamp, excited by a RF discharge, is filtered and directed by two CAF2 lenses into the fluorescence chamber with a PMT.'

Section 3.1. Results

P.5, line 6: Do the authors mean the raw signal was converted to mole fraction using a subjective sensitivity? Please clarify this.

P.5, Figure 2: Both QCL instruments show small enhancements at 2300 and at 0400 hr. Any ideas why these occurred?

P.6, line 7, Figure 4: Are this daily averages?

P.6, line 15, Figure 5: It would be helpful if the plots showed the point chosen as the minimum Allan variation.

P.6, lines 16-18: Is the degradation of the optics a process occurring in hours, days or years?

Section 3.1.2: Temperature dependence

The authors should add a sentence explaining why these techniques are sensitive to

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temperature.

P.6, line 31: 'for' should be 'four'

Section 3.1.3: Linearity: The authors should note that the linearity of a system is defined in part by the uncertainties of the measurement. Therefore a system can only be considered linear within its measurement error.

Figure 6 caption: 'not' should be 'note'.

Section 3.1.4: Water vapor correction:

P.8, line 15: Note the Nafion drier is an internal part of the instrument.

P.9, Figure 8: The grey does not reproduce well. Choose another color.

P.9, line 17, Figure 9: The relationship between CO ratio and water vapor looks constant with any amount water vapor. The curve is somewhat deceiving. The water vapor effect needs additional comment.

P.9, lines 15-20: Were experiments conducted where an external dryer was used? How do the water vapor corrections compare to water vapor free air samples?

P.10, lines 1-3: I am not sure what the authors mean here. Could it be re-written more clearly?

P. 10, line 16: Was the CDRS instrument with the improved water vapor correction tested similarly to the first instrument for precision, linearity, etc? Performance of the improved model may be more useful to the reader.

P.10, line 21: 'implicates' should be 'indicates'

Section 3.1.5: Instrument summary. I suggest the authors remove all discussion of the FTIR instrument since its evaluation was not presented in sufficient detail.

Section 3.2: Ambient air comparison

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P.11, line 12: This sentence should be written as ‘The instruments described above measured ambient air ...’

P.11, lines 18-19, Figure 13. The top panel might show only the ICOS measurement as the bottom panel illustrates the differences among instruments much better than the overlay.

P.11, lines 31-32: Instead of ‘post calibrated’ I suggest the text read ‘...were calibrated after the comparison based on...’

P.12, lines 21-24: Instead of ‘...raw data was in a first step.’ this could be ‘...raw data was first...’. The following sentence ‘...in a second step adjusted to the working standards.’ is unclear. This should be re-written for better clarity?

P.12, line 29. ‘Precision/repeatability’ should be defined when first used in section 3.

P.13, lines 1-7: It should be noted that instrument drift can be accounted for with proper calibration.

P.13, lines: 27-29: This is not clear. Do the authors mean - ‘This clearly indicates that the frequency and temporal averaging of the instrument signal cannot be neglected in locations of high short term CO change.’

Table 1: I suggest using the terms ‘stronger and weaker’ rather than ‘good or poor’. Remove the FTIR results.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 4735, 2012.

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