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Atmospheric Measurement Techniques Discussions

Interactive comment on "The ICAD (Iterative Cavity Enhanced DOAS) Method" *by* Martin Horbanski et al.

Anonymous Referee #3

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Horbanski et al present a new processing technique for cavity-enhanced DOAS, termed iterative CE-DOAS (ICAD), which accounts for the change in the optical path length due to absorption in the cavity. This significantly reduces the required light source and instrument stability and thus enables a more compact, lower power CE-DOAS instrument to be built. The authors evaluate the performance of the technique with numerical simulations as well as intercomparisons with chemiluminescence detectors. They also show the advantage of the compact instrument by doing some vehicle-based measurements. Overall, the paper provides a good summary and characterization of the technique and is appropriate for publication in AMT.

Specific comments:

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Discussion paper

1. Have you run two of these instruments side-by-side? If so, it would be nice to have some of these data in this paper.

2. Suggested reference for cavity-enhanced equations: Zheng et al. Review of Incoherent Broadband Cavity-Enhanced Absorption Spectroscopy (IBBCEAS) for Gas Sensing SensorsÂă2018,Âă18(11), 3646; doi:10.3390/s18113646

3. How often does the path length calibration using He and dry air need to be performed? Was this included for all of the measurements presented? If so, then the text on P23, L15 "without compressed gas cylinders" needs to be revised.

4. In Figure 5, what causes the increasing error and residuals with increasing concentration? It seems like if you are fitting with the same cross section as used for the simulation, everything should be self consistent. Is it because the saturation occurs on lines that are narrower than the instrument resolution?

5. For the ICAD measurements with calibration gas, how do you know that the 2.6 ppb offset is due to the zero air? Also, can you compare the observed discrepancy without path length correction to the prediction from Fig 3/6?

6. On p18, L20 a 4s trend is subtracted from each data point. I don't understand what is happening here. The time resolution of the CLD is 44s, so where does the 4s trend come from?

7. What causes the offset in the ICAD vs APNA 370 measurements? If there is residual NO2 in the zero air, this should still be measured by both systems.

8. It also looks like there is a deviation between the ICAD and APNA 370 at 30-40 ppb. How does the linear fit change if you do not include the permeation source points? Any idea what would cause this?

Technical corrections: There were several typos throughout, please run one more round of copy editing. I've noted some below but may have missed a few.

P1, L4: The phrase "opposite to classical Long Path DOAS measurements" is confusing. Perhaps saying "in contrast to classical Long Path DOAS measurements where the light path is fixed"

P2, L28-29: I'm not sure that ships or medium size airplanes would be considered "laboratory similar conditions". Perhaps it would be better to say "medium to large fixed or mobile platforms (e.g., ships and medium size airplanes)." Perhaps also add the Zheng et al ref here

Eq 5: Should the σ_i be σ_i'?

P6, L8: Should the reference to Fig 9 be to Fig 3?

P11, L2-3: I think that some text was inserted in the middle of a word.

P11, L29: "too" should be "to" and "good" should be "well"

P17, L6: Not sure what the "(a)" refers to

P18, L9: Change "recorded" to "record"

P18, L20: Missing "." after "deviation"

Figure 2: Add curves showing Rayleigh scatting and O4.

Figure 14: Please add a scale bar and maybe increase the figure size. The details of the measurement route and text on the map are both hard to see.

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