Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-430-AC2, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "Development of an incoherent broadband cavity-enhanced absorption spectrometer for measurements of ambient glyoxal and NO_2 in a polluted urban environment" *by* Shuaixi Liang et al.

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Received and published: 11 March 2019

Thank you for making valuable comments on this paper. It's our pleasure to address your comments in details below.

Reviewer # 2

Comments and suggestions: This paper describes the development of incoherent broadband cavity-enhanced absorption spectrometer (IBBCEAS) for simultaneously measuring CHOCHO and NO2 in a polluted atmosphere in extractive mode. The study

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Discussion paper

and is results are very interesting especially the continuous measurements made in the city of Beijing during summer of 2017. Also of interest is the use of measured absorption cross-section of NO2 to avoid non-linear absorption effects of the CCD array detector. The manuscript is suitable for publication in AMT. The following are my specific comments, and I suggest minor revision to address these queries before publishing the manuscript.

Reply: Thanks for recommending a publication of the paper with minor revisions.

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Comments and suggestions: 1. Page-4: In the experimental setup, more details of the components may be of benefit to readers, for eg., makes and models, LED power details, cavity high-reflective mirrors' diameter, radius of curvature, manufacturer specified reflectivity at a specified wavelength, was the ccd array TE cooled and if so to what temperature, etc. Cavity (mirror-to-mirror) length may also be indicated in the schematic figure (Fig. 1)

Reply: Thanks for your suggestions. These details will be described in the revised manuscript.

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Comments and suggestions: 2. In the experimental details, it may be specified whether the optical alignment was stable throughout or occasional alignments were necessary, and if so how calibrations were ensured each time.

Reply: Thanks to the reviewer's comment. In my opinion, the change in the mirror reflectivity can reflect the situation of optical alignment. We have added a sentence on line 7 of page 5 as "We measure and update the value of mirror reflectivity once every two days to ensure the reliability of the retrieval data".

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Comments and suggestions: 3. Page 5, line 16: Mention of any specific/standard non-linear fitting procedures used may be beneficial. Also did the analysis take care of any spectral shifts from different cross sections (from different sources)?

Reply: Thanks for your reminding. we re-write the sentence on line 2 of page 5 as “Finally, the absorber concentrations can be retrieved from the measured broadband spectrum via the DOASIS program (Kraus, 2006).”. The change in temperature has an effect on the gas absorption cross section. In the field test, we stabilize the indoor temperature at about 20 °C to reduce the change of the absorption cross section caused by the temperature change.

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Comments and suggestions: 4. In Fig. 3, the noise seems to be increasing from 475 nm up. Is it due to low light levels of LED in this region?

Reply: Yes. It can be seen from the spectrometer’s CCD trace of nitrogen or helium in figure 2 that the light intensity is already low in the range above 475 nm.

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Comments and suggestions: 5. Page 8, line 20: How often I0 spectrum was measured?

Reply: Thanks to the reviewer’s comment. By adjusting three mass flow controllers, we achieved measurement and replaced the I0 spectrum once an hour.

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Comments and suggestions: 6. On Fig.11, panel g, The CHOCHO concentration was not legible as it falls on the peak. Could this be shifted to the right or left side?

Reply: Thanks for your reminding. The corresponding change has been done in the revised version.

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Comments and suggestions: 7. Page 16, line 19: “Overall this 3% deviation: : :”. The 7.3% uncertainty in Section 3.5.3 was for glyoxal. For NO2 shouldn’t it be 6.9%? The comparison here is between CAPS and IBBCEAS measurements of NO2

Reply: Thanks to the reviewer’s comment. It should be 6.9% here. The corresponding change has been done in the revised version.

Comments and suggestions: 8. While NO2 line shape was measured by the CCD array used for measurements to cover for the shape differences (residuals) this was not done for glyoxal. Would it matter?

Reply: Thanks to the reviewer's comment. Since both the measured reference spectrum and the real atmospheric measurements share the same instrument (i.e. the grating spectrometer) function, the spectral fitting effect may be improved by using the measured glyoxal reference spectrum. However, the absorption due to NO2 (above 12 ppbv) is more than 100-fold higher than that due to a typical 0.1 ppbv glyoxal in the atmosphere. And it is difficult to obtain a known accurate concentration of glyoxal standard gas.

Comments and suggestions: 9. The last sentence of the conclusions section state that measurements under high load PM conditions are possible. Does this mean that presence of PM is OK because aerosol filter was used? Were there any quantitative measurements to characterize sampling losses against aerosol loadings in the surrounding atmosphere?

Reply: Thanks to the reviewer's comment. In the use of IBBCEAS technology, it is common to use the aerosol filter membrane to remove particulate matter from the sampled air, especially under high load PM conditions. Tests in the literature have demonstrated that glyoxal has negligible losses on Teflon surface and dirty filter membrane (K.-E. Min et al., 2016; Jingwei Liu et al., 2019). In the field test, we changed the filter membrane approximately once a day. In heavy polluted weather conditions, we will increase the frequency of replacing the filter membrane approximately twice a day.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-430, 2018.