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Atmospheric Measurement Techniques Discussions

Interactive comment on "A broadband optical cavity spectrometer for measuring weak near-ultraviolet absorption spectra of gases" *by* J. Chen and D. S. Venables

Anonymous Referee #2

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The paper by Chen and Venables presents the coupling of a Xe-arc lamp with a UV cavity and IBB-CEAS retrievals to measure absorption cross section spectra of numerous gases. The paper is well within the scope of AMT, and should be published after the following comments have been addressed.

Detailed comments:

1) At UV wavelengths the absolute stability of Xe-arc lamps is limited. Since the lamp intensity in absence of absorbers affects the retrieval accuracy in this paper, the authors employ a separate spectrometer/CCD detector to reduce potential for such error.

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However, it remains unclear what the benefit of this rather expensive solution is for the absolute accuracy in the ultimate data products. Are such measures indeed needed? What benefit do they bring? How stable is the lamp a-priori? What is the relative accuracy at which I0 is characterized from measuring out-of-band light? What is the improvement in precision in the drift-corrected I0? The error in drift-corrected I0 is necessarily larger than the relative accuracy at which I0 is measured. Has this uncertainty been propagated into the final data product?

2) A geometrical description what portion of the measurement light is used for characterizing I0 would be interesting. Is the overall noise photon shot noise limited in this system, or what factors are limiting noise?

3) The authors measure R at 353nm, and specify the error as 7% based on the range of ozone cross-sections at that wavelength. It is further said that the error at other wavelengths can not be quantified, yet later it is said that the error can be up to 20%. The 7% are necessarily a lower limit. In principle the accuracy at other wavelength can be assessed from comparing with literature cross sections, or e.g., SO2. On reading on the authors later mention on P4850 l 11 about the potential use of SO2, but then do not appear to exploit this further. What attempts have been made to improve knowledge of the wavelength dependence of the mirror? To what degree is the fundamental need for such knowledge of R to calculate cross section values based on independent information measured here, vs. literature data.

4) How have the various error sources been propagated into the final error that is given as 10-15%? This seems somewhat low, given that the mirror alone is uncertain already to 7%. At which precision is the trace gas concentration known? And how certain is I0 (see comment 1)? What error sources are treated as systematic, and what sources of error are treated as statistical? Is retrieval error dealt with as the 1-sigma fit error, or at a 2-sigma absolute accuracy level, which is 6 times larger than the former?

5) P4579, l 27: How can a concentration of SO2 have units of % ?

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6) The discussion of UV LEDs is interesting. The authors seem to imply that in the UV Xe-arc lamps are advantageous over LEDs. How does the absolute accuracy of Xe-arc lamps compare to UV LEDs? See Thalman and Volkamer, 2010 AMT for a comparison at visible wavelengths. It would be timely to include a discussion about lamp stability and attainable noise levels at UV wavelengths, and compare them with the visible spectral range.

7) The paper would benefit from a quantitative argument based on theory that sets the experimental conditions probed (gas extinction) in context with the cavity extinction of the empty cavity. For each gas, how does the range of trace gas extinctions compare to that of mirror loss?

8) P4585, l 12: 'We note in passing that whereas our measurements were obtained under steady-state conditions with low BrO concentrations'. What do the authors mean to imply from this statement? How stable was their BrO concentration?

9) P4586, l24ff: 'In comparison to numerous literature spectra, the IBBCEAS spectra have significantly lower noise and also display linear absorption behaviour for weak absorptions.' This statement really is a claim of 'precision' and does not imply 'accuracy' of the measurements. However, the following statement, that 'the spectra reported here are to be preferred to most prior spectra' requires accuracy not precision to support. It hence remains to be supported by a fully transparent treatment of experimental error (comment 4). Unless the authors can make a credible claim for 'absolute accuracy' to be better than previous literature data, this claim should be removed.

10) Do the two caveats listed in the following sentences imply that the authors do not trust their characterization of I0? What use is then the separate hardware? And if indeed the mirror is off up to 20% at 330nm, how the authors claim an accuracy of 10-15% for most cases?

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 4571, 2010.

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