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Atmospheric Measurement Techniques Discussions

Interactive comment on "A single-beam photothermal interferometer for in-situ measurements of aerosol light absorption" *by* Bradley Visser et al.

Anonymous Referee #1

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In situ aerosol absorption measurements are necessary to understand the climatic and health impacts of BC and BrC aerosols. For decades, aerosol absorption has been measured by filter-based methods that are inexpensive, but suffer from artifacts due modification of the particles collected on the filter and optical interactions between the absorbing particles, non-absorbing particles, and the filter material. Photoacoustic and photo-thermal instruments that measure aerosol absorption while the particles are suspended in the sample air and avoid these artifacts. However, the photoacoustic and photo-thermal methods currently are complex and expensive preventing their broader use. Visser et al. demonstrate an innovative prototype photo-thermal instrument that is simpler than previous designs and could contribute to the broader deployment of

more accurate absorption measurements. The novel optical arrangement of this PTI instrument make is appropriate for publication in AMT, although it is at a mid-point in its development, and further work to improve it detection limit, eliminate artefacts due to laser mode hopping, improve acoustic isolation, and optimize operational parameters (i.e. modulation frequency) will determine its ultimate usefulness.

General Comments: 1) The phase shift as a function of heating time (Figure 5) is nonlinear as the author correct point out, but then they proceed to analyze with a linear fit. The authors should use a nonlinear fit routine and eq. 8 to fit the data. The justification of the linear fit in the supplemental merely demonstrate at the linear fit slope is proportion to the absorption coefficient for a narrow set of conditions. The proportionality could change with bath gas, pressure and possibly RH.

2) This instrument could be understood in the framework of a thermal nonlinear optical effect (Boyd, Nonlinear Optics 3rd Edition 2008, section 4.5). The interferometer measures the self-phase modulation of due to the heating of the aerosol. There will also be a thermal lens. Is it a significant? How would a thermal lens (which could change the path of active arm of the interferometer) affect the phase measurement?

3) Plots of the sensitivity (Figs 9 and 10) are presented in units of radian-seconds. Scaling these plots so the y-axis is in units of absorption (cm-1, Mm-1) would be a more natural unit and help the reader easily compare with other absorption measurements.

4) At times in the manuscript, the instrument is are presented as a measurement of BC concentration, but given the variability and uncertainty of the BC MAC in the ambient atmosphere and the contributions of BrC, it would be better to frame instrument as a quantitative measurement of the absorption coefficient rather than a semi-quantitative measurement of BC concentration.

5) It is not clear why the authors chose to modulate at low frequencies where the heating curve is nonlinear rather than modulate a higher frequencies and avoid the nonlinearity. Are there limitations due to the laser or AOM?

Specific Comments:

Line 49: The MAC =10 is reasonable, but it is not extrapolated with AAE = 1.

Lines 155-185: rather long explanation, could be tightened up a bit.

Figure 5: the dotted line looks like a solid line to me.

Line 293: what is the sensitivity to non-50:50 BS. Typically, precision on commercial BS is not great and can vary with polarization and angle of incidence.

Line 421: Does the filter give a pressure drop between the sample and reference cells? Is this accounted for in the PC volumes?

Figure 9: maybe color the points differently for the ramp up and down in NO2 concentration, so the outset is clear.

Line 439: The need to monitor the baseline drift negates the advantaged pointed out in the previous paragraph (Lines 416 -431).

Figure 11: Maybe this should be replaced with an Allan deviation plot which is appropriate to differentiate between short-term precession and long-term drift

Line 492-495: Several photoacoustic absorption measurements use active charcoal scrubbers very effectively to remove gas-phase absorbers before measurement of the aerosol absorption.

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