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Atmospheric Measurement Techniques Discussions

Interactive comment on "Initial investigation of the wavelength dependence of optical properties measured with a new multi-pass aerosol extinction differential optical absorption spectrometer (AE-DOAS)" *by* R. T. Chartier and M. E. Greenslade

Anonymous Referee #2

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The submitted article details the results obtained from a multi-pass AE-DOAS (aerosol extinction–differential optical absorption spectrometer) using both gaseous and particulate samples. The major advantage of this instrument over more sensitive single wavelength cavity-enhanced instruments is its ability to provide aerosol extinction data over a wide spectral range (effectively 250-750 nm) with good wavelength resolution. For me, the major issue is whether this instrument is (or at least will be in the future with possible upgrades) suitable for measuring ambient concentrations of particles or

is limited to laboratory use. Before I recommend publication, I have two major issues, which should be addressed by the authors.

1. As noted by Referee 1, the issue of particle flow through the system is a serious issue and not well addressed. It is difficult to ascertain how the particles flow through this system. The fact that there is a 8.5-10.5 minute delay between the peak of the extinction measurement and the peak of the particle concentration measured by a CPC at the output of the monitor indicates to me that the particle concentration is not uniform throughout the cell, at least for a fairly long period of time. Thus, how exactly were the measured particle extinction cross sections calculated from the raw data? My guess is that after some period of time, a steady state is reached where the measured extinction matches the measured number density at the output of the cell. If so, what implications would this have for sensitivity and time response (see next section)? A plot of some data accompanied by a clearer explanation of how the extinction cross sections are calculated would be useful.

2. The description of the noise characteristics of the instrument is somewhat lacking. It is unclear to me how the reported levels of detection were established. It appears that the authors simply accumulate 6 minutes of data before introducing sample and compare two 3 minute averages to one another. If so, that is not particularly reassuring.

The authors also ignore the issue of baseline drift which could be significant, especially when using an arc lamp source. Must particle-free baselines be taken every other measurement period (with minimal duty cycle once time has been allotted for cell purging which can take 6-8 minutes at the flow rates quoted) or can this restriction be relaxed in the absence of gas phase interferences? Recording data using particle-free zero air for several hours and then using an Allan analysis would provide a much more complete picture.

A related issue is whether the LOD is a function of wavelength resolution. I assume that the data in Figure 6 is taken at 0.5 nm resolution. However, for the measurement

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of atmospheric aerosol extinction, this level of resolution is not required – 10 nm or less is probably sufficient. How does the sensitivity of the instrument scale with decreasing resolution? If it scales as the square root of the inverse of the resolution, the instrument becomes far more useful as a field measurement tool.

Minor Points

1. Figure 2, as plotted, is not particularly useful except to let the reader know that the instrument does not work well past 750 nm. I would suggest that the wavelengths range be restricted to 250-750 nm which would allow the reader to see wavelength sensitivity variation over the monitor's useful range. I also suggest that the sensitivity be plotted in Mm-1 since that nomenclature is used in the text and is considered standard anyway.

2. Figure 6 is also quite difficult to decipher. Most of the error bars could be eliminated to allow for easier inspection of the actual experimental data and comparison with the French, et al. model. Also, why not plot the abscissa as extinction efficiency as are the other plots that follow? If you wish to use absolute units, why not stick with square micrometers.

3. Another issue is that of mirror contamination. Is there a purge flow to protect the mirrors from contamination? My assumption is that there is not. If so, this should be stated. It is possible that under high particle loadings, and long data accumulation periods, mirror reflectivity could degrade to the point where sensitivity was affected.

4. As part of the Introduction or Discussion sections, the authors might want to make note of the introduction of "cavity-enhanced" broad band absorption monitors which utilize ICOS techniques over 50-100 nm wavelength ranges. Another possible point is that there are now high power LEDs (up to 1 W) that cover the 360-680 nm range that might offer an upgrade with respect to the use of an arc lamp. LEDs are extremely stable and might increase the

5. At the current sensitivity levels, Rayleigh scattering of air is not much of an issue.

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However, at 250 nm, it is almost 300 Mm-1 per standard atmosphere. If one uses a particle filter which introduces a pressure drop of 2-3%, this could be a problem if instrument sensitivity increases (e.g., by averaging wavelength bins). Of course, monitoring for pressure and temperature in the sampling cell allows one to correct for this.

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