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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Multi-wavelength optical measurement to enhance thermal/optical analysis for carbonaceous aerosol" *by* L.-W. A. Chen et al.

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We thanks for the reviewers' comments. A table of abbreviation will be added to the supplemental information, along with pictures of the multi-wavelength module and transfer standards for retrofit. Figure 3 is expanded to include comparisons of OCT and ECT, and LR_λ and LT_λ are specified clearly in the new Figure S1.

The reason why EC2 is used in developing the $\tau_{a,\lambda}$−ATN_λ relationship is that for diesel soot, carbon evolved during EC2 is exclusively EC. Therefore, $d\tau_{a,\lambda}/dt$ can be derived from carbon measurement (Eqs. [4]-[6]). It should also be noted that EC1 and EC3 are very minor for the diesel exhaust samples tested (e.g., Figure S1[d]). For other samples, EC1 may not be entirely EC due to the existence of POC with an unknown mass

absorption efficiency. This reasoning has been clarified in the revised manuscript.

The 633-nm light in the Model 2001 carbon analyzer is provided by a Helium/Neon laser. Diode lasers are used in the multi-wavelength module to reduce the size and cost of the module. The selection of wavelengths has been limited by commercially available diode lasers. The 635-nm diode laser is the one closest to 633-nm. Other lasers were selected considering the spectral coverage (i.e., from near-infrared to near-ultraviolet wavelengths), size, power, and stability. Since only one photodiode detector is used for all lasers, laser intensity needs to be homogenized so that they all fall into the dynamic range of the detector. The lasers are turned on and off at a high frequency (i.e., 30 Hz) and so laser response time is critical. It was found that the 532-nm used in this module had a slower response time, leading to imperfect pulse shape and larger noises. In addition, the transmittance signals were the lowest for 532, 635, and 980 nm, as evidenced by the largest slopes in Fig. 2(d). These issues explain the relative large uncertainties in measured filter R and T at some wavelengths. It should be noted that conventional Model 2001 uses a completely different laser and lock-in amplification (including a physical chopper) which is suitable for its single-wavelength design. We have been continuously testing other lasers and algorithms to increase the signal-to-noise ratio of R and T measurements. These efforts will be documented in subsequent papers.

When high-quality R and T measurements are available, it is expected that using 7 wavelengths yields more information than using 3 wavelengths and certainly single wavelength. It could provide more constrains for fitting the spectral light absorption contributed by multiple components such as BC, BrC, POC, and mineral dust. Retrieval algorithms employing both R and T such as those in Petzold and Schönlinner (2004) should be developed in the future to utilize all the information available.

Reference

Petzold, A. and Schönlinner, M.: Multi-angle absorption photometry – a new method for the measurement of aerosol light absorption and atmospheric black carbon, J. Aerosol Sci., 35, 421–441, 2004.