ADAPTING THE IMPROVE_A PROTOCOL FOR MULTIWAVELENGTH ELEMENTAL AND ORGANIC CARBON MEASUREMENTS

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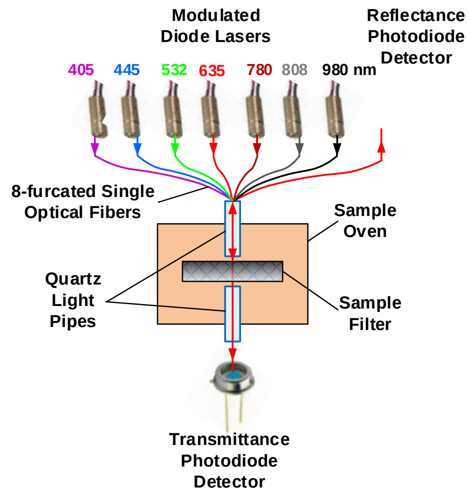
Organic and elemental carbon (OC and EC) are operationally-defined by the measurement process, so long-term trends may be interrupted with instrumentation changes. A modification to the U.S. IMPROVE carbon analysis protocol and hardware is examined that replaces the 633 nm laser light used for OC charring adjustments with seven wavelengths ranging from 405 to 980 nm, including one at 635 nm. Reflectance (R) and Transmittance (T) values for each wavelength are made traceable to primary standards through transfer standards consisting of a range of aerosol deposits on filter media similar to that of the analyzed samples. R and T values are assigned to these filters using a UV/VIS spectrophotometer calibrated with these standards. Using ambient and source (e.g., diesel exhaust, flaming biomass, and smoldering biomass) samples, it is demonstrated that R and T calibration is independent of the sample type. Total carbon (TC), OC, and EC comparisons with the earlier hardware design for urban- and non-urban samples demonstrate equivalence, within precisions derived from replicate analyses, for the 633 and 635 nm wavelengths. Several uses of the additional multiwavelength information include: 1) ground-truthing of multi-spectral remote sensors; 2) improving estimates of the Earth's radiation balance; 3) associating specific organic compounds with their light absorption properties; and 4) source apportionment for black and brown carbon.



This figure shows the optical configuration for making multiwavelength R and T measurements during thermal/optical carbon analysis. This system replaces the 633 nm helium-neon (He-Ne) laser in current use with seven powerful diode lasers. The aerosol deposit faces the incident radiation and optical fibers transmit the light to the surface and direct the reflected and transmitted light to the detectors. Laser signals are rapidly modulated to minimize stray light interferences and cross-talk among the different wavelengths. The 635 nm signal is used to separate EC from OC and the other signals are used to determine the mixture of black and brown carbon. Full T and R spectra are obtained by calibrating the laser signals against Spectralon standards and normalizing the initial signal to the final signal after all carbon has evolved from the filter.