High time-resolved multi-wavelength measurements of light absorption properties of atmospheric aerosol using a polar photometer

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Keywords: polar photometer, aerosol absorption, multi-wavelength measurements
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Black Carbon (BC) is the main absorber of solar radiation among the aerosol components, it influences cloud processes, and alters the melting of snow and ice cover. On global scale, it is currently identified as the second most important individual climate-warming component after CO_2, but uncertainties on the radiative forcing related to BC-radiation interaction still cover more than one order of magnitude. Moreover, weakly absorbing organic material (brown carbon, BrC) in the form of particle coating or as particle as-is can be considered a further important contributor to aerosol absorption. The peculiarity of BrC is that it is very effective in the absorption of short-λ radiation whereas its contribution to aerosol absorption is negligible in the red or near-IR bands. It is noteworthy that BC and BrC can also be used for source apportionment purposes (e.g. they can be helpful for the discrimination between fossil fuels combustion vs. biomass burning). Thus, work is currently ongoing to develop instrumentation able to give more and more detailed information on the absorption properties of atmospheric aerosol, possibly related to mixing and/or size information, and BC content.

Moving in this frame, a multi-λ polar photometer (PP_UniMI) has been developed at the Department of Physics of the University of Milan in the last years. The instrument is based on the measurement on the scattering plane of the light transmitted and scattered in the forward and back hemispheres by unloaded and loaded samples using a rotating photodiode. Data reduction aiming at the determination of the sample absorbance follows Petzold et al. (2004) and therein cited literature.

In its original version (see details in Vecchi et al., 2013) the PP_UniMI allowed measuring aerosol deposited on 47 mm diameter filters at a single wavelength (λ), then further upgraded to 4-λ (870, 633, 532, 405 nm).

In this work, we improved PP_UniMI to provide the absorption properties of the aerosol collected with high-time resolution using a streaker sampler. Such sampler collects aerosol segregated in two size-classes (fine and coarse) on a rotating frame with hourly resolution. The deposit corresponding to 1-hour sampling is collected on 1x8 mm^2 streaks. To analyse such deposits, suitable pairs of lenses were used to reduce the spot-size down to about 1 mm diameter (see Figure 1). A 1-mm diameter pinhole was added to the set-up in order to ensure that the spot was small enough to allow the single-streak measurement. It is noteworthy that some laser sources are placed at 90° respect to the incident direction on the filter, thus mirrors are present in the set-up.

The new set-up or the instrument was validated against independent measurements carried out using a Multi-Angle Absorption Photometer for what concerns the red-light results.

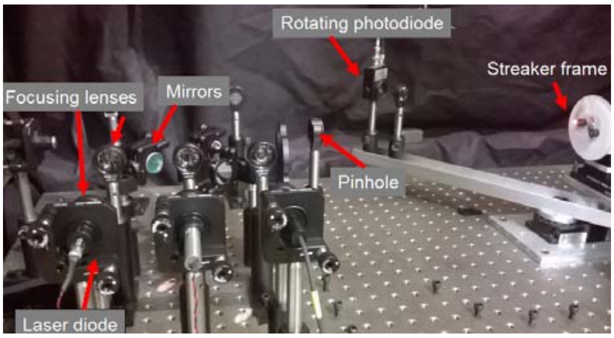

Figure 1. Multi-λ polar photometer set up for streaker sampler analysis. For sake of simplicity, components are evidenced for a single laser source.

The results presented here will include the validation of the instrumentation and the results of one-week winter campaign. Data reduction will aim at evidencing high time-resolved trends of multi-wavelength aerosol absorption. This is important both for gaining insight into aerosol absorption properties (still poorly known) and for source identification purposes.

This work was partially funded in the frame of the INFN-experiments NUMEN and MANIA.

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