Aerosol optical properties by simultaneous nephelometer and aethalometer measurements

S. Romano[1] M. Calvello[2] F. Esposito[3] G. Pavese[2], P. Burlizzi[1], M. R. Perrone[1]

[1]Dipartimento di Matematica e Fisica *E. De Giorgi*, Università del Salento, Italy,

[2]IMAA, Istituto di Metodologie per l'Analisi Ambientale, CNR, Tito Scalo (Potenza) Italy,

[3]Scuola di Ingegneria, Università della Basilicata, Potenza, Italy,

Aerosol particles can scatter and absorb the solar and terrestrial radiation, leading to a cooling and/or warming effect of the surface-atmosphere system, depending on their optical properties. Therefore, quantitative information on the aerosol optical properties are essential to obtain a proper assessment of the aerosol direct radiative impact on climate. Note that the huge variety of aerosol sources and transformation processes leads to considerable uncertainties on the aerosol absorbing and scattering properties.

Simultaneous nephelometer (AURORA 3000 ECOTECH) and aethalometer (model AE31 Magee Scientific) measurements have been performed at the Mathematics and Physics Department of the Salento University in Lecce (south-eastern Italy) to characterize the aerosol optical properties at the ground level. The monitoring site of this study is representative of coastal sites of the Central Mediterranean away from large sources of local pollution [2]. Both devices have been equipped with a PM2.5 sampling head, since the fine mode particles represent on average the aerosol fraction most responsible for the light scattering and absorption processes. Aerosol scattering and backscattering coefficients (σ and β, respectively) at three wavelengths (450, 525, and 635 nm) in addition to scattering Ångström exponents (SAEs) and scattering and backscattering color ratios, CR_σ and CR_β, respectively, have been calculated from the integrating nephelometer measurements to characterize some of the aerosol optical properties. CR_σ and CR_β are linked to the spectral dependence of σ and β, respectively, which varies with the aerosol type. They have been calculated from the ratio of σ or β at two different wavelengths: $CR_\sigma(\lambda_1,\lambda_2) = \sigma(\lambda_1)/\sigma(\lambda_2)$ and $CR_\beta(\lambda_1,\lambda_2) = beta(\lambda_1)/\beta(\lambda_2)$ Aerosol absorption coefficients (α) at seven wavelengths have been retrieved from the aethalometer measurements, from which absorption Ångström exponents (AAE) and absorption color ratios (CR_α) for different wavelength pairs have been calculated. σ and α have also been used to calculate the single scattering albedo ($SSA = \sigma/(\sigma+\alpha)$), which represents the main optical parameter related to the warming or cooling effect of the aerosol particles.

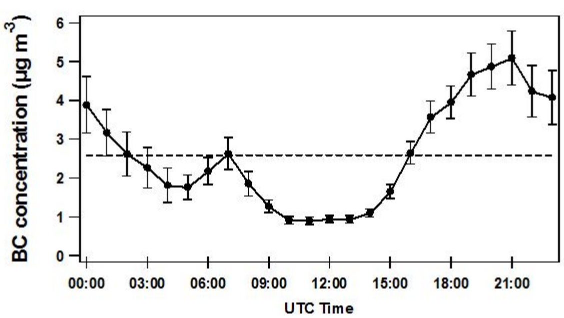

Figure 1. Daily evolution of the hourly-averaged black carbon concentration (± 1 standard deviation) from aethalometer measurements at the study site during the period January-February 2016. The dashed line represents the mean value (2.6 μg m^{-3}).

Note that σ, β, and α are extensive aerosol parameters, since they depend on both the aerosol amount and the aerosol properties. Conversely, SSAs, Ångström exponents (SAEs and AAEs), and color ratios, (CR_σ, CR_β, and CR_α, respectively) are intensive aerosol parameters and, consequently, they can allow identifying different aerosol types. Intensive aerosol parameters retrieved from nephelometer and aethalometer measurements have been used in this study to identify different aerosol types, and the change of the main aerosol types with the day hours, meteorological conditions, and advection patterns.

Aethalometer measurements have also been used to calculate the black carbon (BC) concentration. Figure 1 shows, as an example, the mean daily evolution of the hourly-averaged BC concentration (± 1 standard deviation) on winter, for the year 2016. The daily mean value of the BC concentration (2.6 ± 1.4 μg m^{-3}, dashed line in Fig. 1) is in agreement with the mean value (2.2 ± 1.1 μg m^{-3}) found by Perrone et al. [1], by analysing PM2.5 samples collected with a **Sunset Carbon Analyzer** at the same site of this study on the years 2008 and 2009. Results on the relationships between BC concentrations and aerosol extensive and intensive parameters will also be reported. In particular, we have found that BC concentrations have been linearly correlated with σ.

REFERENCES

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