Measurements of aerosol light-scattering enhancement factors at the urban environment of Granada (Spain).

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Microphysical and optical properties of aerosol particles present a strong dependence on relative humidity (RH). A better understanding of this RH effect is, therefore, very important for climate forcing calculations. Here, we present results from a campaign performed in an urban environment in southern Spain (Granada, 37.18ºN, 3.58ºW, 680 m a.s.l) during winter season. The aerosol light-scattering coefficient ($\sigma_{sp}(\lambda)$) was measured with two integrating nephelometers (TSI 3563) at dry (Dry-neph) and at a predefined RH (Wet-neph). The light scattering enhancement factor (f(RH) = σ_{sp}(RH)/ σ_{sp}(dry)) was used to quantify the dependence of σ_{sp} on RH. We defined two operation procedures: 1) Keep the RH of the Wet-neph at a constant value (85%) and 2) Scan the RH between 30-90%. Additionally, the aerosol light-absorption coefficient was measured with a MAAP (Multi-Angle Absorption Photometer) and an aethalometer AE-31. Filter samples were also collected in PM_1 and PM_{10} fractions for chemical analysis.

During the campaign, dry light-scattering and absorption coefficients showed a mean value (± standard deviation) of 40±40 Mm^{-1} at 550 nm and 17±18 Mm^{-1} at 637 nm, respectively. Both coefficients showed a high variability due to the diurnal changes in the local emissions (mainly caused by traffic) and in the meteorological conditions during the campaign. The dry scattering Angstrom exponent calculated between 450 and 700 nm was 1.7±0.4 and the single scattering albedo at 637 nm was 0.7±0.1, denoting a predominance of fine particles and a significant fraction of absorbing particles. These values are typical of our urban station during winter season (Lymani et al., 2010; Titos et al., 2012). f(RH=85%) at 550 nm presented a mean value of 1.5±0.2, reaching values up to 3.4. The mean value is in accordance with the value of 1.4 reported by Yan et al. (2009) at an urban station in Beijing. The average diurnal evolution of f(RH=85%) and the single scattering albedo is shown in Figure 1. f(RH=85%) presented two minima during morning and afternoon traffic rush hours, probably due to the relative increase of non-hygroscopic fraction (like black carbon) due to traffic emissions. This fact can be observed in the diurnal evolution of ω_0(637 nm) that also presented two minima denoting an increase in the relative contribution of absorbing particles during the traffic rush hours. The afternoon minimum in the f(RH=85%) is lower than the morning minimum in contrast with the single scattering albedo which presented the minimum value during the morning. This fact evidences that not only the increase in the contribution of BC to the total aerosol load is responsible of the decrease of f(RH=85%). In this sense, it could be related to aging processes that lead to lower f(RH) during the afternoon than during the morning. In the early morning (around 3-4 GMT) the f(RH=85%) reached it maximum value, probably due to the decrease in BC concentrations as a result of the reduction in local anthropogenic emissions and an increase in the water soluble fraction. This increase in the water soluble fraction can be related with higher levels of ammonium nitrate during the cooler time of the day (Park et al. 2005).

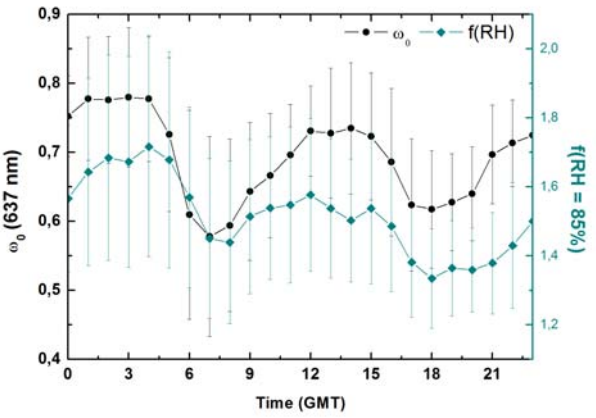

Figure 1. Average diurnal evolution of f(RH=85%) and single scattering albedo at 637 nm. The error bars represent the standard deviations.

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