Ultrafine and fine Black Carbon in Rome

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Keywords: Black Carbon, Ultrafine particles, airport, aerosol.
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In this work, we present Black Carbon (BC) measurements in Rome, and evaluate conditions when the bulk aerosol is dominated by ultrafine BC particles.

Optical and microphysical aerosol properties were measured in 2011-2012 at an urban airport site (ARPT), an urban background site (UBG), and a regional background site (RBG) in Rome. Experimental BC data were interpreted through measurement-constrained Mie simulations of BC microphysics and optical properties.

BC diurnal cycles are shown in the Figure 1; the total number concentration of particles having diameter >7nm (N_7) is also shown. BC is plotted as the equivalent mass concentration (BC [$\mu g \cdot m^{-3}$]); the corresponding BC absorption coefficient at 530 nm, σ_{aBC}, is: $\sigma_{aBC}[Mm^{-1}]=10 \cdot BC [\mu g \cdot m^{-3}]$.

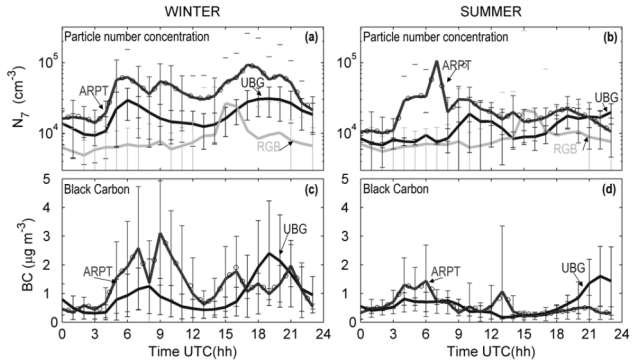

Figure 1. Diurnal cycles of (a,b) total particle number concentration (N_7), and (c,d) Black Carbon (BC).

A theoretical "scheme" to separate the ultrafine BC was experimented (Costabile et al., 2015). It is based on how the bulk aerosol optical properties vary with varying the BC partitioning between Aitken and accumulation mode particles. The ultrafine BC dominated aerosol shows: (i) large values of the ratio, $\sigma_{aBC\ (1\text{-}2)}$, of the Aitken mode absorption coefficient ($\sigma_{aBCAitken}$) to accumulation mode absorption coefficient ($\sigma_{aBCAccumulation}$) of BC particles; (ii) low values of the Single Scattering Albedo ($SSA_{530} < 0.8$). Moreover, low absorption and scattering coefficients can be found. These conditions, applied to experimental data, proved useful to reveal the impact of airport and road traffic emissions. This is shown in the Figure 2: the decrease of BC measured at approx.8:00 a.m. (same as in the Fig.1) is associated to median aerosol diameter, $D_{p(median)}$ <100nm, large $\sigma_{aBC\ (1\text{-}2)}$, $SSA_{530} < 0.8$, low BC accumulation mode N. It was explained by ultrafine BC emissions from the airport.

Findings may have important atmospheric implications. Indeed, separating the ultrafine BC from the fine BC can help separating different BC sources (fossil fuel BC, biomass burning BC, aged BC) when BC size distributions may be very difficult to obtain (columnar observations, routine monitoring, satellite).

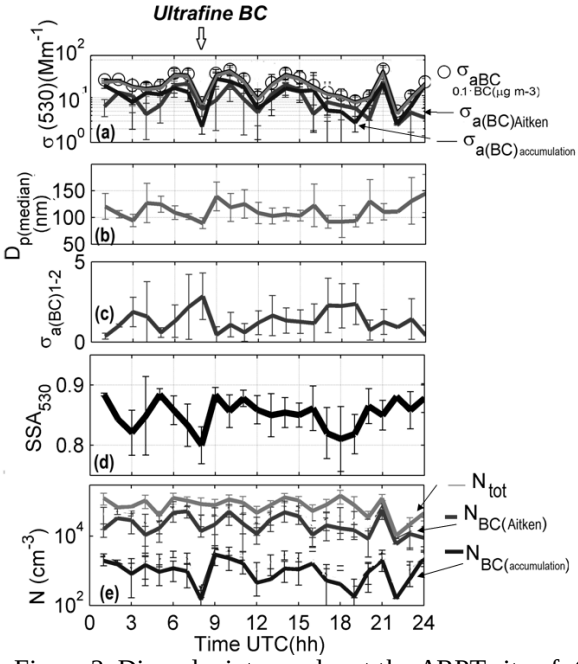

Figure 2. Diurnal winter cycles at the ARPT site of: (a) absorption coefficient of BC (σ_{aBC}), Aitken mode ($\sigma_{aBCAitken}$), and accumulation mode BC particles ($\sigma_{aBCAccumulation}$); (b) median aerosol diameter, $D_{p(median)}$; (c) $\sigma_{aBCAitken}/\sigma_{aBCAccumulation} = \sigma_{aBC\ (1\text{-}2)}$; (d) Single Scattering Albedo (SSA_{530}); (e) number concentration (N) of total (N_t), BC Aitken mode ($N_{BC(Aitken)}$), and BC accumulation mode ($N_{BC(accumulation)}$) particles.

Measurements at UBG were carried out in the framework of the project "DIAPASON" funded by EC (LIFE 2010 ENV/IT/391). Measurements of particle numbers were supported by the Italian Ministry of Health, and the Department of Epidemiology of the ASL RM/E in the framework of the project "Impact of atmospheric pollution by airports on citizens health".

Costabile, F., Angelini, F., Barnaba, F., & Gobbi, G. P.: *Partitioning of Black Carbon between ultrafine and fine particle modes in an urban airport vs. urban background environment.* Atmos. Environ., 102, 136-144, 2015.