Contribution ID: **73** Type: **not specified**

High resolution vertical profiles of black carbon over Italian basin valleys: dispersion, radiative forcing and heating rate

Vertical profiles of black carbon (BC), aerosol number size-distribution and chemistry, aerosol radiative forcing and heating rate were determined over three Italian basin valleys (Po Valley, Terni Valley and Passiria Valley).
They were measured in winter 2010 by means of a tethered balloon equipped with: a micro-Aethalometer (AE51, Magee Scientific), an optical particle counter (OPC 1.107 Grimm), a cascade impactor (Sioutas, SKC) and a meteorological station (LSI-Lastem).
The aerosol optical properties were calculated from experimental data: 1) the aerosol refractive index was calculated using the effective medium approximation applied to aerosol chemistry [1]; 2) the OPC number-size distribution was corrected for the ambient aerosol refractive index [2]; 3) Mie calculations were performed on the base of previous calculations and were validated with AERONET data.
Finally, the model libRadtran allowed the calculation of vertical profiles of aerosol radiative forcing from which the atmospheric absorption and heating rate were derived.
Results evidenced common behaviours: in particular, a marked a concentration drop of both BC (from -48.4±5.3% to -69.1±5.5%) and aerosol concentration (from -23.9±4.3% to -46.5±7.3%) was present at the mixing height (MH). Moreover, across the MH, the percentage decrease of BC was higher than that measured for aerosol and thus, the BC fraction of aerosol fell determining a Single Scattering Albedo increase along height (from +4.9±2.2% to +7.4±1.0%).
Consequently, the highest atmospheric absorption was observed below the mixing height (from +0.5±0.1 W m-2 to +2.5±0.2 W m-2) generating heating rate profiles characterized by a vertical negative gradient (from -0.5 K day-1 km-1 to -6.8 K day-1 km-1): a situation able to promote the weakening of the ground-based thermal inversion [3].

[1] Aspnes DE. Am. J. Phys. 1982; 50(8): 704–9
[2] Heyder J, Gebhart J. Appl. Opt. 1979; 18(5):705–11
[3] Ferrero et al. Atmos. Chem. Phys. Discuss. 2014, In Press.

Working group IAS (WG1, WG2, WG3) o sessione speciale (SPR)

WG3

Tipo di presentazione (orale o poster)

Orale

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