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A study on the relationship between mass concentrations, chemistry and number size distribution of urban fine aerosols in Milan, Barcelona and London

S. Rodríguez[1,2,3,*], R. Van Dingenen[1], J.-P. Putaud[1], A. Dell'Acqua[1], J. Pey[3], X. Querol[3], A. Alastuey[3], S. Chenery[2], K.-F. Ho[5], R. Harrison[4], R. Tardivo[6], B. Scarnato[7], and V. Gemelli[7]

[1]European Commission – DG Joint Research Centre, Institute for Environment and Sustainability, T.P. 290, Ispra (VA) 21020, Italy
[2]British Geological Survey, Keyworth, Nottingham, NG12 5GG, UK
[3]Institute of Earth Science "Jaume Almera", CSIC, Solé i Sabarís, S/N, 08028, Barcelona, Spain
[4]University of Birmingham, Division of Environmental Health and Risk Management, Edgbaston, Birmingham B15 2TT, UK
[5]Hong Kong Polytechnic University, Department of Civil and Structural Engineering, TU418, Hung Hom, Kowloon, Hong Kong
[6]Politecnico di Milano, Piazza Leonardo da Vinci, 32-20133 Milan, Italy
[7]ARPA-Lombardia, Viale Francesco Restelli, 3/1, 20124 Milan, Italy
[*]currently at: University of Huelva (Spain) at the Izaña Atmospheric Observatory, INM-CSIC, La Marina 20, 6a planta, 38071, Santa Cruz de Tenerife, Canary Islands, Spain

Abstract. A physicochemical characterization, including aerosol number size distribution, chemical composition and mass concentrations, of the urban fine aerosol captured in MILAN, BARCELONA and LONDON is presented in this article. The objective is to obtain a comprehensive picture of the microphysical processes involved in aerosol dynamics during the: 1) regular evolution of the urban aerosol (daily, weekly and seasonal basis) and in the day-to-day variations (from clean-air to pollution-events), and 2) the link between "aerosol chemistry and mass concentrations" with the "number size distribution".

The mass concentrations of the fine $PM_{2.5}$ aerosol exhibit a high correlation with the number concentration of >100 nm particles N>100 (nm) ("accumulation mode particles") which only account for <20% of the total number concentration N of fine aerosols; but do not correlate with the number of <100 nm particles ("ultrafine particles"), which accounts for >80% of fine particles number concentration. Organic matter and black-carbon are the only aerosol components showing a significant correlation with the ultrafine particles, attributed to vehicles exhausts emissions; whereas ammonium-nitrate, ammonium-sulphate and also organic matter and black-carbon correlate with N>100 (nm) and attributed to condensation mechanisms, other particle growth processes and some primary emissions. Time series of the aerosol DpN diameter (dN/dlogD mode), mass $PM_{2.5}$ concentrations and number N>100 (nm) concentrations exhibit correlated day-to-day variations, which point to a significant involvement of condensation of semi-volatile compounds during urban

pollution events. This agrees with the observation that ammonium-nitrate is the component exhibiting the highest increases from mid-to-high pollution episodes, when the highest DpN increases are observed. The results indicates that "fine $PM_{2.5}$ particles urban pollution events" tend to occur when condensation processes have made particles grow large enough to produce significant number concentrations of N>100 (nm) ("accumulation mode particles"). In contrast, because the low contribution of ultrafine particles to the fine aerosol mass concentrations, high "ultrafine particles N<100(nm) events" frequently occurs under low $PM_{2.5}$ conditions. The results of this study demonstrate that vehicles exhausts emissions are strongly involved in this ultrafine particles aerosol pollution.

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