Sources of ultrafine particles in Huelva industrial city

R. Fernández-Camacho[1], S. Rodríguez[1,2], J. de la Rosa[1]

[1]University of Huelva, Joint Research Unit to CSIC "Atmospheric Pollution", Campus El Carmen, E21071 Huelva, Spain.

[2]Izaña Atmospheric Research Centre, AEMET Joint Research Unit to CSIC "Studies on Atmospheric Pollution", La Marina 20, planta 6, Santa Cruz de Tenerife, E38071, Canary Islands, Spain.

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Air quality impairment due to ultrafine particles pollution UFP (diameter < 0.1 µm) is becoming matter of concern. This is due to the fact that recent studies have shown that exposure to ultrafine particles is associated with an increase risk to enhance atherosclerosis and to suffer cardiovascular ischemic events (Araujo et al., 2008). UFP pollution in ambient air is not properly quantified in PM_{10} and $PM_{2.5}$ (the current metrics for air quality standards). For this reason there is an open debate on the necessity to establish limits/target values for UFP in ambient air.

Here we present a work on industrial emissions of ultrafine particles. Most of ultrafine particles studies have focused on vehicle exhaust emissions and there is a lack of studies on the role of the contribution of the industrial activities on ultrafine particle pollution. The study has been performed in Huelva (SW Spain), where industrial activities that release important amounts of gaseous precursors are settled.

In order to quantify the process contributing to the UFP concentrations (N), two components were segregated by the methodology of Rodríguez and Cuevas (2007): N=N1 + N2. N1 accounted for those components directly emitted in the solid phase and those nucleating immediately after the emission (incomplete fuel combustion products like black carbon, condensed trace metals, unburned oil and a fraction of sulphate and organic compounds) and N2 accounted for those compounds involved in new particle formation by nucleation and subsequent particles growth by condensation, such as sulphuric acid and organic compounds. These new particles can be formed during the dilution, cooling and mixing of the vehicle exhaust with the ambient air (N2exa) or in the ambient air once the exhaust /plume is well diluted within the ambient air, very frequently linked to photo-oxidation of reactive species (N2amb). This latter scenario includes gaseous precursors not only linked to vehicle exhaust emissions, but also to other sources like industrial.

In order to identify the sources affecting UFP concentrations, a set of Principal Component Analysis (PCA) followed by varimax rotations was performed, using different variables and periods

In the morning, UPF originated from vehicle exhaust emissions. PC-1 (correlated with N1, NO_x, PM_{10} and the "road traffic intensity/wind speed ratio") represents exhaust emissions of solid carbonaceous compounds. PC-2 (correlated with N2 and SO_2) represents new particle formation due to nucleation processes during the dilution and cooling of the vehicle exhaust. In this period, N1 and N2 accounted for about the 50% of UPF particles each (Figure 1). The influence of the industrial emissions occurred during the noon-afternoon period, when the breeze blowing favored the transport of the SO_2 plumes from the industrial plants located in the shore to the city centre. In this period, the PCA showed high associations between N2, SO_2 and solar radiation intensity. The high correlations between SO_2 and N2 in this period evidence the new particle formation of UPF in the industrial SO_2 plumes. During the noon-afternoon, the N2 component of UFP accounted for 70% of the total number concentration (Figure 1). Observe in Figure 1 how the contribution of industrial derived UPF are higher than those linked to vehicle exhaust emissions.

The results of this study evidence the high potential of some industrial activity to result in high UFP concentrations. These results are significant given that much of the attention is currently focused only on vehicle exhaust emissions.

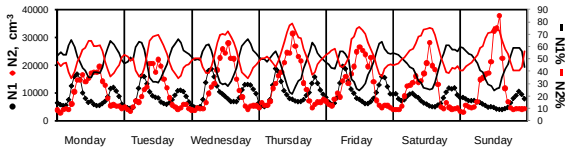

Figure 1. Hourly averaged concentrations of N1 and N2 concentrations and relative amounts in % for every day of the week.

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