Summer-autumn air pollution in León (Spain): changes in the aerosol size distribution and effects on the respiratory tract

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In urban areas there are important sources of fine and ultrafine particles: traffic, industrial activity, residential wood and/or coal combustion, etc. León, Spain, is characterized by the absence of large emitting industries and the main source of particulate emissions is considered to be vehicular traffic during all the year. However, an important number of residential devices that use coal as fuel are still present, also natural gas and gasoil are used for heating and hot water during all the year. As a consequence, in autumn, winter and even spring there are remarkable emissions from this source. The aim of this study is to analyze the temporal variation of aerosol size distribution in León, Spain, from August to October 2012 in order to identify changes in the aerosol concentration associated with the summer-autumn transition. Furthermore, the influence of these aerosols in the respiratory tract by the study of inhalable, thoracic, respirable and tracheobronchial fractions was analyzed.

The aerosol sampling was carried out in the Secondary School IES Ordoño II, in the San Juan de Sahagún Avenue. The measuring probe was installed 1.5 m above the floor, directed towards a street. The study period comprises from 1th August to 23rd October, 2012. The particle number size distributions were measured using a passive cavity aerosol spectrometer probe (PCASP-X).

The total number of particle increased from August to October, (1000± 600 to 1500± 1000 particles cm^{-3}, respectively) mainly due to smaller traffic intensity during summer holidays and the absence of heating emissions. Furthermore, in summer, a lower concentration of some elements was registered due to an increase in the boundary layer thickness that enhances dispersion.

The particle size distribution shows a bimodal profile, with a first fine or accumulation mode (Count Median Diameter CMD < 1 μm) and a small fraction corresponding to a second fine mode or a coarse mode (CMD ≥ 1 μm). This last mode is less important because the particles concentration is less than one particle per cubic centimeter in this study. The monthly evolution of the particle numbers shows that 99% of the particles have diameters less than 0.5 μm, which may indicate that the main source of aerosol is road traffic. As summer progresses to autumn the number of particles of fine mode increases and the CMD decreases. There are more particles between 0600 and 1000 UTC and between 1700 and 1900 UTC, probably due to a greater presence of traffic in both hourly intervals. The number of particles N_t was higher on weekdays (between 700 and 1900 particles cm^{-3}) than on weekends (between 800 and 1500 particles cm^{-3}) (Figure 1).

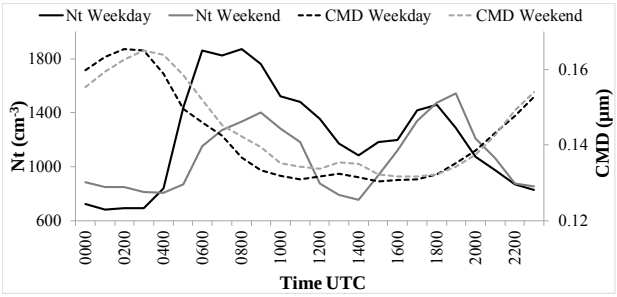

Figure 1. Hourly variation of the number of particles N_t and Count Median Diameter CMD.

The inhaled mass of aerosols was greater on August and September (41 and 45 μg m^{-3} respectively); and was greater on Thursday and Friday (45 and 53 μg m^{-3} respectively). The percentage of particles that does not traverse any non-ciliated airway and they reached the trachea and bronchi varied between 20% and 38%, with the lowest value in October. For the respirable fraction, in the high-risk population like children, elderly and weak people, the best month is August with 6 μg m^{-3} and the worst is October with 9 μg m^{-3} of particles that came to reach the alveolar zone.

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