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Pollutant source contribution estimates to PM10 and PM2.5 measurements in Barcelona (Catalonia, NE Spain) by Positive Matrix Factorization (PMF)

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The demand of a more efficient control of pollutant emissions, especially in urban and industrialized areas, considerably increased in the last years mainly as a consequence of the demonstrated correlation existing between the levels of atmospheric particulate matter (PM) and the daily number of human disease responses. The European Commission air quality directives focus on PM10 and PM2.5 (particles with diameter < 10 and 2.5 μm respectively) limit values as a consequence of the adverse health effects the particles emitted within these size ranges have. The extent in which the control of the emissions can be accomplished strongly depends on both the identification of the pollutant sources and the estimation of their contribution to PM levels and composition. The chemical speciation of the measured ambient PM coupled with source-receptor modelling revealed as a powerful tool to estimate the origin of the sources and their abundances in the PM10 and PM2.5 fractions. The worldwide effort of the scientific community dealing with air pollution monitoring in characterizing the pollutant sources in terms of chemical markers is behind the aforementioned method.

In this study, the Positive Matrix Factorization (PMF) factor analytical model was applied to the PM10 and PM2.5 particles measurements and chemical analysis continuously performed during a two-years period (March 2003 – April 2005) at the urban site of Barcelona (Catalonia, Spain). Barcelona together with 32 surrounding towns makes up the Metropolitan area giving hospitality to about a half of the entire population of Catalonia (NE Spain). The results showed that road traffic and the wide range of industrial activities such as gas power stations, smelters, as well as demolition and construction activities, constitute the major sources of air pollution in the area. The contribution of the man-made activities to the ambient PM10 and PM2.5 levels in Barcelona was estimated in about 80% for both fractions. Six sources were found to contribute to the PM10 and PM2.5 measurements from the PMF analysis. Secondary sulphate and secondary nitrate sources dominated the PM2.5 fractions with an overall contribution of about 42%. Both sources showed a clear seasonal dependence with secondary sulphate and nitrate peaks observed in summer and winter respectively. The traffic source traced mainly by carbonaceous aerosol, Sb, Sn, Cu and Ba from brake wear was clearly identified in both fractions. A crustal factor enriched in the typical crustal elements (Al, Ca, K, Ti, Rb, Sr) was also identified in both PM10 and PM2.5. The extreme values observed in the time series of the crustal source contributions were related to Saharan dust outbreaks affecting the crustal loads of both PM10 and PM2.5 at the same time, this demonstrating that a fraction of Saharan mineral dust was present in the fine fraction as well. The conditional probability function (CPF) was used to couple the retrieved source contributions with the mean daily wind directions in order to locate the possible particles source points. The results of the source apportionment performed on the considered Barcelona PM database were compared with the results obtained by applying the PMF model to PM data collected at a rural station located in NE Spain. The comparison allowed to segregate the particulate pollutants with a regional influence from those having a major local influence.