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Inter-comparison of receptor models for source apportionment of particulate matter in an industrialized ceramic area in Eastern Spain

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Daily ambient PM_{10} (particles with aerodynamic diameter less than 10 μm) concentrations were sampled at two selected sites in a industrialized ceramic urban area in Eastern Spain during April 2002 – December 2005. The data were obtained using manual gravimetric PM_{10} high volume captors, and the resulting filters were analysed for mass, total carbon, nitrate, sulfate, ammonium and up to 40 major and trace elements. Source identification and contribution analyses were performed for PM_{10} by using three receptor models: Principal Component Analysis (PCA), Positive Matrix Factorization (PMF) and Chemical Mass Balance (CMB). The three models provided rather similar results. It was found that the main sources contributing to ambient PM_{10} are (1) soil dust represented by Ca, Fe and Al, (2) sea salt dominated by Na and Cl, (3) traffic described by the high concentrations of total carbon (TC), (4) sulfate and nitrate of secondary origin, namely regional background, (5) clay, used as raw material in the ceramic industry, represented by Al, Fe, Ti, Y, La, Pr and Nd, and (6) dust emitted from the frit making process described as a miscellaneous of toxic elements like As, Zn, Rb, Zr and Tl. In the case of PMF, a 5-factor solution provided the most satisfactory source profiles. The fractional abundances of chemical species in the emission sources, i.e. the source profiles, were obtained from measurements by the Institute of Ceramic Technology (ITC, unpublished data) for different types of clays and frits emitted from the ceramic industries. These source profiles were then compared with the same fractional contributions derived from PCA and PMF analyses, which were then introduced in the CMB model as input data for consecutive runs of

the model. The contributions from the different sources derived from PMF and PCA were quantified and compared with the source contributions calculated by CMB.

The results show that the measured PM_{10} levels are dominated by the crustal components accounting on average for more than 40 % of the estimated PM_{10} mass with contribution from soil, road dust and clay. Regional background and traffic were found to be the second and third contributors to measured PM_{10} with average values of about 25 % and 15 % respectively, followed by the contribution from marine aerosol and frit dust. This analysis allowed us to study the amount of potentially toxic material emitted from ceramic production activities due to the use of substances like pigmentation agents in the frit composition.

Finally, the seasonal evolution of the source contributions was analysed, and a clear seasonal pattern was found for the regional background and marine aerosol factors (higher values in summer with respect to winter). On the contrary, the seasonal pattern of both crustal and traffic factors showed a slight increase during winter. The seasonal evolution of the source contributions helped consolidate the interpretation of the nature of the sources.