EVIDENCING DISTANT AND LOCAL INFLUENCES OF INDUSTRIAL AND OTHER METAL SOURCES IN $PM_{2.5}$ IN A MEDIUM CITY

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Keywords: $PM_{2.5}$; metallurgy plant; glassmaking; tracers

Introduction

Health-related effects linked to the presence of metals in ambient air particulate matter (PM) is well recognized (Chen and Lippmann, 2009). Metals effects can vary from acute cardiac function alteration to an excess of short-term mortality, where some early stage mechanistic pathways in cells are oxidative stress and inflammation (Fortoul et al., 2015). The evaluation of metals concentration in PM is therefore an essential issue as well as their source identification. Metals in PM have multiple origins and even if natural sources cannot be neglected, anthropogenic sources appear as the main contributors of metals in urban areas (Gietl et al., 2010) and sites influenced by industrial activities as steel making or glassmaking (Apostoli et al., 1998; Dall'Osto et al., 2008). The North of France is one of the most densely populated area in Europe (326 inhabitants/km² in 2013) and is known as an industrialized region especially in the field of metallurgy, organic chemistry, and glassmaking. Furthermore, its strategic position in the heart of Europe means that this area is subject to major transportation activities by road and also by sea. In this context, the objective of this work was to acquire a better knowledge on the exposure level to metals in $PM_{2.5}$ (particles with size less than 2.5 µm) and on the identification of their sources in urban area influenced by particulate emissions from anthropogenic sources.

Methods

$PM_{2.5}$ were sampled using a Digitel®, DA80 high volume sampler (30m^3/h) during march - april 2011 in Saint-Omer, a medium city located in Northern France, on semi-daily basis. $PM_{2.5}$ chemical composition was determined using ICP-AES, ICP-MS, Ion Chromatography and elemental analysis for the quantification of major elements, trace elements, water soluble ions and total carbon respectively. Species concentrations were examined according to different ways including temporal evolution, concentration and pollution roses and enrichment factor analysis. Correlation between species and elemental ratios were also investigated to evidence the contribution of local and distant emission sources. The impact of such

sources on metal concentrations in $PM_{2.5}$ was then quantified using a weighted non-negative matrix factorization (WNMF) based receptor model that considers constraints on chemical profiles.

Results

The enrichment factor (EF) analysis revealed significant anthropogenic source influences for numerous elements such as Ag, As, Cd, Cu, Pb, Sb, Sn, Zn, as well as Cr, Ni and V in a lesser extent. Concentrations roses and metal ratios clearly indicated the contribution of the local glassmaking activity but also that of an integrated steelworks located 30 km to the sampling site. Therefore, anthropogenic origin of metals could be significantly ascribed to the main following sources: (i) local glass making industry for As, Cr, Sb, Cu and Sn, (ii) distant integrated steelworks for Ag, Cd and Pb, (iii) heavy fuel oil combustion for Ni and V and (iv) non-exhaust traffic for Sb, Cu and Zn. The evidencing and the distinction between steelworks and glassmaking emissions was made possible by the use of several metallic ratios. A combination of Zn/Fe, Zn/Mn, Cr/Cd and Pb/Cd ratios, appeared specific of steelwork emissions and the impact of glassmaking industry in Saint-Omer was identified by following the ratios of Sn/Cr, Sn/Sb, Cu/Cd and As/Ag. Despite their low contribution to $PM_{2.5}$ concentration, the latter sources were found as the main origin for these metals (>70%) from receptor modelling.

Conclusion

The origin of metals in ambient air particulate matter $PM_{2.5}$ in a medium city located in Northern France was evidenced and assigned mainly to industrial sources, as well as fuel oil combustion and non-exhaust traffic. Up to our knowledge, this study was the first to distinguish between glassmaking and steelworks metals sources in a site influenced by both emissions.

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