Source apportionment of $PM_{2.5}$ in the Balkan region: Identification of major emission sources and variability of source chemical profiles

E. Diapouli[1], M. Manousakas[1], V. Kantarelou[1], N. Civici[2], K. Sega[3], I. Beslic[3], S. Davila[3] and K. Eleftheriadis[1]

[1]Environmental Radioactivity Laboratory, N.C.S.R. "Demokritos", Athens, 15310, Greece
[2]Institute of Applied Nuclear Physics, State University of Tirana, Tirana, Albania
[3]Environmental Hygiene Unit, Institute for Medical Research and Occupational Health, Zagreb, 10001, Croatia
Keywords: EPA PMF5, $PM_{2.5}$, Balkan region, source chemical profiles.
Presenting author email: ldiapouli@ipta.demokritos.gr

Despite the air pollution abatement strategies implemented during the last decades, particulate matter (PM) remains a challenging environmental problem for many European countries. Several cities in the Balkans are considered among the most polluted in Europe. A number of factors are contributing to air quality degradation in the region, such as unregulated anthropogenic activities, both local and regional, a hot and dry climate which promotes built-up of pollutants and a significant impact from natural sources. While new strategies are called for in order to improve air quality in the area, there is a lack of quantitave knowledge on source contributions to PM concentration levels. This work compares results on $PM_{2.5}$ source apportionment by receptor modeling for three large urban centers in the Balkan area: Zagreb (Croatia), Tirana (Albania) and Athens (Greece). The comparison of source contributions and chemical profiles for the three cities provides significant insight into the local and regional sources affecting air quality in the Balkan area.

24-hr $PM_{2.5}$ samples were collected at urban background sites in Athens, Zagreb and Tirana, during 2014-2015. Samples were analysed by XRF for the following metals and elements: Na, Mg, Al, Si, S, Cl, K, Ca, Ti, V, Mn, Fe, Ni, Cu, Zn, Pb. Black carbon (BC) concentrations were calculated for the Tirana samples through light attenuation coefficient measured by EEL reflectometer. Elemental (EC) and organic carbon (OC) concentrations were recorded in Athens by means of a Semi-continuous OCEC Field Instrument (Sunset Lab., Inc.). The chemical composition datasets obtained were analysed by Positive Matrix Factorization (PMF EPA5).

In total 7 sources were identified in Athens and Tirana and 6 sources in Zagreb. Heavy Oil Combustion, Biomass Burning, Secondary Sulfates, Sea Salt and Mineral Dust were identified in all three cities. In Athens, Traffic Exhaust and Non-Exhaust (Road dust) emissions were found as two separate sources, while in Zagreb and Tirana only one Traffic source profile was obtained, including both exhaust and non-exhaust emissions. In addition, a Ca-rich Dust source was obtained for Tirana.

Traffic contributed the most to $PM_{2.5}$ concentrations in Tirana (42%), while lower contributions were observed for Athens (20%) and Zagreb (10%). Traffic source profiles were identified by the high abundance in carbonaceous species, with minor contributions from other elements, such as Al, Si, Na, K and Ca (Spencer et al., 2006; Zielinska et al., 2004). Fe, Cu and Zn, trace elements connected to brake and tire wear, were also found in traffic and road dust profiles. The absence of Cu and Zn from the Ca-rich Dust found in Tirana suggests that this source may be connected to construction activities and/or a cement industry located at a distance of around 15 km, rather than road dust.

Heavy oil combustion presented relatively low contributions (0.8 – 2.2 μg m^{-3}). The main components in the source chemical profiles were OC, EC/BC, S and Na (Figure 1). The latter indicates significant contribution from shipping emissions for all sites.

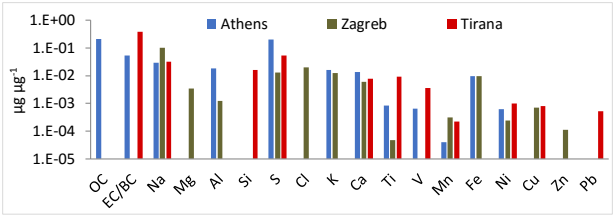

Figure 1. Comparison of chemical profiles of heavy oil combustion obtained for the three cities

The main components in the Secondary Sulfates profiles were S and OC, with smaller contributions from EC/BC. Secondary Sulfates accounted for a large fraction of $PM_{2.5}$ at all three sites, with very similar mass and relative contributions (3 – 4 μg m^{-3} and 25 – 29%), pointing towards a regional source of secondary aerosol affecting the Balkan region.

Biomass Burning was another important contributor to $PM_{2.5}$ (46% in Zagreb, 20% in Athens and 13% in Tirana). The highest concentrations were calculated for the cold period, reflecting the effect on air quality of wood burning for residential heating. Biomass burning profiles were identified by the presence of K and carbonaceous species, while Na and Cl were also present in much lower concentrations. Small contributions from trace metals in the source profiles, such as Zn (at all sites) and Pb (mainly in Zagreb and Tirana), indicate the burning of waste and/or treated wood as well.

This work was supported by the IAEA Technical Cooperation Project RER/1/013.

Spencer, M.T., Shields, L.G., Sodeman, D.A., et al. (2006) *Atmos. Environ.* **40**, 5224–5235.
Zielinska, B., Sagebiel, J., McDonald, J.D., Whitney, K., Lawson, D.R. (2004) *J. Air Waste Manage. Assoc.* **54**, 1138–1150.