Spatiotemporal gradients of PAHs in Greek urban environments and subsequent health impacts

I. Tsiodra[1], K. Tavernaraki[1,2], G. Grivas[1], K. Papoutsidaki[2], D. Paraskevopoulou[1,2], E. Liakakou[1], C. Parinos[3], A. Gogou[3], A. Bougiatioti[1] and N. Mihalopoulos[1,2]

[1]Institute for Environmental Research and Sustainable Development, National Observatory of Athens, P. Penteli, 15236, Greece

[2]Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, Heraklion, Crete

[3] Institute of Oceanography, Hellenic Centre for Marine Research, Anavyssos, 19013, Greece

During seasonal campaigns in six contrasting urban environments in Greece, $PM_{2.5}$ filter samples were collected and analyzed to study the spatiotemporal variability of polycyclic aromatic hydrocarbon (PAH) levels and examine the link to toxicity and subsequent long-term health impacts expressed by carcinogenic risk estimates. Sampling sites included a variety of urban background and traffic (Athens, Heraklion and Ioannina with approximately 3,5M, 0.2M and 0,15M inhabitants, respectively), rural (Xanthi, 0,05M inhabitants) and port locations (Piraeus and Volos with 0,5M and 0,15M inhabitants respectively). When considering the 16 EPA priority PAH members, quite homogeneous levels were observed across locations during summer, almost independently of the population (from 0,4 ng m^{-3} at Xanthi and Ioannina to 0,6 ng m^{-3} at Heraklion and 0,8 ng m^{-3} in Athens). The highest levels during summertime (2,2 ng m^{-3} and 1,2 ng m^{-3}, respectively) were observed in Piraeus and Volos, known for their industrial and harbor activities. On the other hand, during winter, levels are significantly higher compared to summer, with the enhancement ranging from ~12 times for most of the sites to a striking 95 times for Ioannina, indicating the significant role of local emissions, especially heating. When solely considering B[a]P, an IARC Group 1 carcinogen and the only EU-regulated PAH, the winter/summer ratios are ~22 in Athens, Volos and Xanthi, 50 in Piraeus, and 366 in Ioannina that is afflicted by severe wood burning pollution events. The identified spatiotemporal contrasts, which are explored for the first time for PAHs at such a scale in the Eastern Mediterranean, provide important insights into sources and controlling atmospheric conditions, and reveal large deviations in exposure aggravation among cities, which raises also an issue of environmental injustice on a national level.