Airborne ^{210}Pb and trace elements as tracers for atmospheric pollution in Helsinki metropolitan area

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Over a 44-year period (1962–2005), 16,070 daily and 608 weekly air filters from metropolitan area of Helsinki, Finland, were analyzed to assess long-term atmospheric pollution trends. Daily filters were used to measure the radioactive isotope ^{210}Pb, while weekly filters assessed concentrations of 17 different trace elements (Na, Al, Si, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, Pb). The determination of the concentrations of the radioactive isotope was completed with the appropriate automatic alpha and beta radiation analyzer. In addition, the weekly filters were properly prepared and measured using the Epsilon 5 high-resolution X-ray spectrophotometer. Most elements showed significant decrease in concentration, with Pb declining by 95%, followed by large reductions in Al (86%), Si (88%), S (82%), and Ca (89%), and smaller reductions in Cu (37%), Br (32%), and Cl (22%); ^{210}Pb decreased by 51.6%. Source analysis based on Positive Matrix Factorization Analysis, using SoFi software, identified four main pollutant origins: road dust (linked to leaded fuel), heavy oil/secondary sulfate combustion, traffic emissions, and natural dust (soil). For the total of 44 years studied, significant decreases in concentrations were observed for all elements, most of which were over 50%: Na(-74%), Al(-86%), Si(-88%) , S(- 82%), K(-82%), Ca(-89%), Ti(-80%), V(-89%), Cr(-82%), Mn(-77%), Fe(-77 %), Ni(-61%), Zn(-72%) and Pb(-95%).

To understand the spatial origin and potential sources of pollutants, Potential Source Contribution Function (PSCF) analysis was applied, which calculates the probability for each potential pollutant source area, based on the frequency of high concentrations. From the trajectory analysis, it emerged that Finland is an area directly affected by transboundary pollution, mainly from air masses coming from its eastern border (air masses coming from Russia), but also from areas of Northern Europe. In these source areas there are intense industrial activity and energy production facilities, with the result that the air masses coming from there are enriched with several gaseous pollutants, containing both trace elements and radioactive isotopes.