Size specific distribution of the atmospheric particulate persistent organic pollutants (POPs) on a seasonal scale

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Persistent organic pollutants (POPs) such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), perfluorinated compounds (PFCs), organochlorine pesticides (OCPs), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) and novel brominated flame retardants (nBFRs) are of high interest due to their persistence and accumulation in the environment and to their possible toxicity.

Seasonal particle size fraction distributions have been investigated for a wide range of POPs, ranging from pollutants banned under the Stockholm Convention to current-use flame retardants. Recent studies have suggested that better characterization of the size-distribution of the particulate POPs is useful for two reasons. First, it improves our understanding of the transport of those compounds from emission sources to remote areas, and second, it permits better characterization of the potential human exposure to POPs via inhalation.

Weekly atmospheric samples from urban and semi-rural sites in the Czech Republic were collected between October 2009 and October 2010 using a high volume air sampler equipped with a cascade impactor (separating particles into 6 size fractions: <0.49 µm; 0.49-0.95 µm; 0.95-1.5 µm; 1.5-3.0 µm; 3.0-7.2 µm; 7.2-10 µm). Individual samples of each fraction were combined into 4 composite seasonal samples.

Target analyte concentrations (PCBs, PBDEs, dioxin-like PCBs, nBFRs, PFCs, OCPs, CUPs (current use pesticides) and PCDD/Fs) were quantified using automatic solvent extraction, fractionation techniques and GC-MS or LC-MS instrumental analysis.

The data suggest that proximity to primary sources drives particulate POPs concentrations, as the concentrations measured at the urban site were significantly higher than those measured at the semi-rural site for combustion or consumer products-related pollutants (Figures 1 and 2). Concentrations measured for different pesticides were higher at the semi-rural site and higher during warm seasons, while PAHs, PCDD/Fs and PBDEs concentrations were higher in cold seasons.

Most of the target compounds were associated with the two finest particle size fractions (<0.49 µm, 0.49-0.95 µm), together accounting for more than 50% of the particle-bound POPs (Figures 1 and 2).

In summer, lower-molecular weight compounds were distributed more evenly amongst size fractions, which may suggest volatilization and redistribution of POPs amongst aerosols at warmer temperatures. Generally, the proportion of finest particles was higher at the urban site than at the semi-urban site. The distribution of size-specific particulate POPs has shown to be strongly related to local and seasonal sources and influenced by the temperature changes.

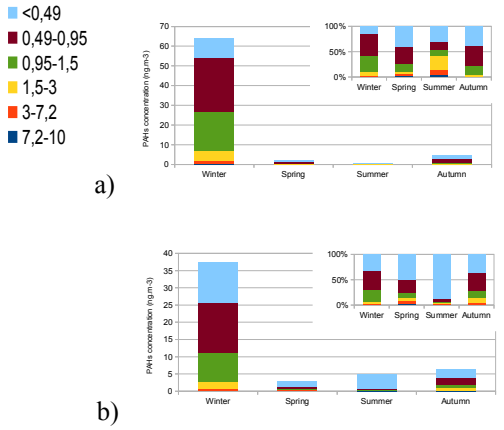

Figure 1: Seasonal size distribution of ΣPAHs at Telnice (a) and Kotlařska (b)

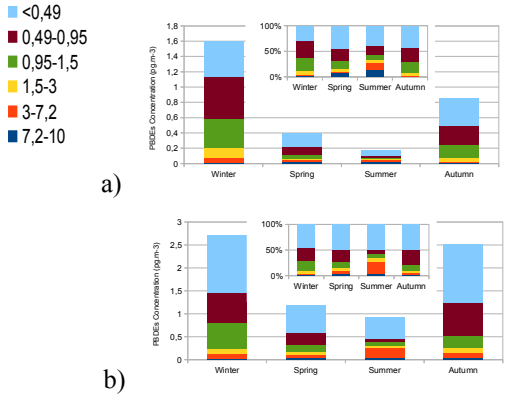

Figure 2: Seasonal size distribution of ΣPBDEs at Telnice (a) and Kotlařska (b)