Spatial and temporal variations of the size distribution of the atmospheric particulate persistent organic pollutants (POPs) and Persistent Bioaccumulative Substances (PBTs) in the Czech Republic

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Introduction

High volatility (CFC/HCFC)

Relatively high volatility (HCB/HCH)

Polar region

Relatively low volatility (DDT)

Temperate region

Low volatility (Benzo[a]pyrene)

Warm emission area

Earth's Surface (soil, water, vegetation)
Introduction
Size of particles

Size of particles will determine:
- Residence time in the atmosphere
- Potential for LRAT
- Deposition efficiency
- Human health exposure from inhalation
Methodology
Sampling sites

Data from the Czech Hydrometeorological Institute, 2010  www.chmi.cz

Pole 36. nejvyšší 24hod. koncentrace PM$_{10}$ v roce 2010
Methodology
Sampling sites

Telnice (15km from Brno)
Rural site

Kotlařska (Brno city centre)
Kerbside/Urban site
Methodology

Air sampling

High volume air sampler equipped with a cascade impactor

Fractions collected on QFFs:
- < 0.49 µm
- 0.49-0.95 µm
- 0.95-1.5 µm
- 1.5-3.0 µm
- 3.0-7.2 µm
- 7.2-10.0 µm

1 year sampling (Oct 2009-Oct 2010)
Seasonal data corresponding of 3 weeks of sampling
Methodology
Extraction
Methodology

Clean-up
Methodology

GC-MS/LC-MS

- PAHs: GC-MS Agilent 6890/Agilent 5972
- PCDD/Fs, dl-PCBs, PBDEs and nBFRs: GC-HRMS Agilent 7890/Micromass AutoSpec Premier (sector MS)
- CUPs and HBCDs: LC-MS Agilent 1290-ABSCIEX5500
RESULTS
Higher PM$_{10}$ concentrations at the urban site

- At both sites, higher concentrations were observed in winter (about 50 µg.m$^{-3}$) than in summer (20 µg.m$^{-3}$).
- 54-59% of particles have a diameter < 0.95 µm
Combustion-related compounds

PAHs

PCDD/Fs

dl-PCBs

- **Sources:**
  - Natural sources (forest fires, volcanic eruptions, products of biosynthesis of phytoplankton and bacteria)
  - Anthropogenic sources (fossil fuel combustion, residential heating, waste incineration, traffic, oil refining, steel and iron manufacturing, coke and asphalt production and metal reclamation processes)

- **Long-half-life in the air, soil, sediment or biota**

- **Health effects:**
  - Carcinogenic and/or mutagenic properties for PAHs and high toxicity for PCDD/Fs and dl-PCBs
PAHs, PCDD/Fs and dl-PCBs
Total particulate concentrations

- Higher concentrations in cold seasons for all of the compounds at both sites
- Higher concentrations at the rural site for PAHs and PCDD/Fs in winter, which might reflect the spatial difference in domestic heating
PAHs, PCDD/Fs and dl-PCBs

Size distribution

- **PAHs**: 71% of PAHs < 0.95 µm
- **PCDD/Fs**: 73% of PCDD/Fs < 0.95 µm
- **dl-PCBs**: 60% of dl-PCBs < 0.95 µm

- **Strong accumulation in the fine fraction** for all compounds regardless the site or the season
- **Higher contribution of the 0.95-1.5 µm fraction** for PAHs in winter
- **Increase of coarse particles in summer** for PCDD/Fs and dl-PCBs
Cancer risks from inhalation exposure

- Cancer risks were lower than the carcinogenic benchmark level
- Higher risks in winter
Most of the risks are due to fine particles. However, the cancer risks can be overestimated by up to a factor of 2 in situations where there is a large amount of coarse particles.
Flame retardants additives used in electronics (computers, mobile phones, kitchen appliances), textiles, building materials, plastics, paints.

Due to the restriction of some of PBDEs, nBFRs use has increased consistently for the last decade.

Sources in the air: Release during production, volatilization during the use of products and inappropriate disposal.

Bio-accumulative, persistent and toxic
PBDEs (without BDE-209)

- Higher concentration at the urban site
- 4x higher winter concentrations compared to summer concentrations
- 55% of PBDEs were associated to fine particles
- Increase of coarse fraction in summer due to volatilization and condensation onto coarse particles
10 target compounds
3 were not detected at all (TBCO, p-TBX and HCDBCO)
In general, higher summer concentrations due to indoor emissions
Higher concentrations at the urban site
In some cases, higher n-BFRs concentrations than PBDEs reflecting the growing use of alternative flame retardants
4/7 n-BFRs (TBECH, PBT, HBB and BTBPE) showed strong affinity toward fine particles.

3/7 n-BFRs (s-DP, a-DP and PBEB) showed similar concentrations across size fractions.
Higher concentrations in summer
Higher concentrations at the rural site (-> influence of the construction of new houses?)
Strong accumulation in the fine fraction (57-74%)
Estimation of the wet and dry deposition
Thanks for your attention
Any questions?