**Airborne PAH transfer into soils – A comparison study in karstic mountain forests**

Marion Carteret1, Liliane Savoye1, Yves Perrette3, Jérôme Poulenard3, Emmanuel Malet3, Philippe Fanget1, Emmanuel Naffrechoux1.

1 Laboratoire de chimie moléculaire et environnement LCME, Université Savoie Mont Blanc, 73376 Le Bourget du Lac, France, emmanuel.naffrechoux@univ-smb.fr

2 EDYTEM, Université Savoie Mont Blanc, 73376 Le Bourget du Lac, France.

Among the Persistent Organic Pollutants (POP), Polycyclic Aromatic Hydrocarbons (PAH) are of great interest because of their widespread occurrence and mutagenic and carcinogenic effects for some of them. Previous studies have highlighted the role of mountain cold-trapping (Wania et al., 2008; Kallenborn et al., 2006) and forest filter effect (FFE) in the fate of POP (Kukucka et al., 2009; Wang et al., 2009). Airborne PAH could thus significantly be transferred to soil in mountainous forests, via throughfall and litterfall. The resulting enrichment of these compounds can lead to a potential groundwater contamination, especially in karstic mountain (Horstmann and McLachlan, 1996; Schwarz et al., 2011). Few comparative studies were conducted in mountain forest environments and have identified a variability of PAH accumulation by FFE according to tree species (Nizzetto et al., 2006; Schrijver et al., 2007). However, the flux of PAH deposition on forest soil by litterfall of specific tree species are not available.

In this study, we compare atmospheric PAH bulk deposition in the French Alps under *Pinus Sylestris*, *Picea Abies* and in a grass meadow, to quantify the FFE of airborne PAH. We took throughfall, litterfall and litter degradation into account, depending on seasonal variability, to better understand the PAH concentration and distribution in two types of forest soil characterized respectively by a low and a high content of organic carbone in Cambisol eutric and folic Leptosol and in an open-field soil (Cambisol eutric). The final aim of this study is to determine the role of forest (canopy and soil) in the transfer of airborne PAH to the karstic groundwater, which is in this case, as very often, a natural ressource for drinking water production.

Temporal accumulation of PAH by needles was pointed out, which is consistent with the study conducted by Lehndorff et al. (2009). A seasonal variability of PAH concentration is also observed, with the highest values measured during the cold season. This can be linked both to higher PAH emissions by wood or fuel burning, and to colder temperatures, which enhance adsorption of gaseous PAH onto needles' cuticle (Barber et al., 2004). Our results confirmed the FFE with a higher total PAH deposition flux under canopy than in open-field (about 1.3 times higher under spruce canopy and 2.5 under beech canopy), with Phenanthrene as the main PAH (35% of 14PAH) under spruce, whereas Fluoranthene and Pyrene account for 40% and 30% respectively both under beech and in the grass meadow. The spruce litterfall contributed for 70% of the total PAH flux to the soil as it was only 30% for beech litterfall. Soil analysis pointed out a major contamination at 2-4 or 6-8 cm depth for Cambisol eutric, and a different distribution in folic Leptosol leading to a possible transfer of PAH to groundwater. Soil characteristics lead to different quantity of stored PAH.

Thus, the PAH transfer to groundwater depends both of soil-type and forest tree-species. The monitoring of PAH concentration in seepage and groundwater is ongoing. Results would be of great interest to evaluate the karstic aquifer vulnerability to such toxic pollutants.

Barber, J.L., et al., Current issues and uncertainties in the measurement and modelling of air - vegetation exchange and within-plant processing of POPs. Environmental Pollution, 2004. 128(1-2): p. 99-138.

Horstmann, M. and M.S. McLachlan, Evidence of a novel mechanism of semivolatile organic compound deposition in coniferous forests. Environmental Science & Technology, 1996. 30(5): p. 1794-1796.

Kallenborn, R., Persistent organic pollutants (POPs) as environmental risk factors in remote high-altitude ecosystems. Ecotoxicology and Environmental Safety, 2006. 63(1): p. 100-107.

Kukucka, P., et al., Soil burdens of persistent organic pollutants - Their levels, fate and risk. Part II. Are there any trends in PCDD/F levels in mountain soils? Environmental Pollution, 2009. 157(12): p. 3255-3263.

Lehndorff, E. and L. Schwark, Biomonitoring airborne parent and alkylated three-ring PAHs in the Greater Cologne Conurbation I: Temporal accumulation patterns. Environmental Pollution, 2009. 157(4): p. 1323-1331.

Nizzetto, L., C. Cassani, and A. Di Guardo, Deposition of PCBs in mountains: The forest filter effect of different forest ecosystem types. Ecotoxicology and Environmental Safety, 2006. 63(1): p. 75-83.

Schrijver, A., et al., The effect of forest type on throughfall deposition and seepage flux: a review. Oecologia, 2007. 153(3): p. 663-674.

Schwarz, K., T. Gocht, and P. Grathwohl, Transport of polycyclic aromatic hydrocarbons in highly vulnerable karst systems. Environmental Pollution, 2011. 159(1): p. 133-139.

Wang, Z., et al., Distribution of PAHs in pine (Pinus thunbergii) needles and soils correlates with their gas-particle partitioning. Environmental Science & Technology, 2009. 43(5): p. 1336-1341.

Wania, F. and J.N. Westgate, On the Mechanism of Mountain Cold-Trapping of Organic Chemicals. Environmental Science & Technology, 2008. 42(24): p. 9092-9098.