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Global distribution and Gas-particle Partitioning of Polycyclic Aromatic Hydrocarbons – a Modelling Study

G. Lammel (1,2,3) and A.M. Sehili (1,4)

(2) Max Planck Institute for Chemistry, Air Chemistry Dept., Mainz, Germany (lammel@mpch-mainz.mpg.de), (1) Centre for Marine and Atmospheric Sciences, Max Planck Institute for Meteorology, Hamburg, Germany , (3) Masaryk University, Research Centre for Environmental Chemistry and Ecotoxicology, Brno, Czech Republic , (4) Centre for Marine and Atmospheric Sciences (ZMAW), Universty of Hamburg, Meteorological Institute, Germany

Polycyclic aromatic hydrocarbons (PAHs) are emitted in all combustion processes. Some undergo re-volatilisation (multi-hopping). Little is known about degradation pathways and the processes determining gas-particle partitioning (Lohmann & Lammel, 2004). Distribution and fate have no been studied on the global scale so far (except for emissions in Europe and Russia; Sehili & Lammel, 2007).
Anthracene (ANT), fluoranthene (FLT) and benzo[a]pyrene (BAP) have been studied under present-day climate and each 3 scenarios of atmospheric degradation and gas-particle partitioning using an atmospheric general circulation model with embedded dynamic aerosol submodel, ECHAM-HAM (Stier et al., 2005) and re-volatilization from ground compartments (Semeena et al., 2006). 10 years were simulated with a time-step of 30 min and 2.8°x2.8° and 19 levels. Emissions were compiled based on emission factors in 27 major types of combustion technologies, scaled to 141 combustion technologies and their global distribution as of 1996 (1°x1°) according to fuel type and the PM1 emission factor (Bond et al., 2004). The emissions were entried uniformly throughout the entire simulation time. Scenarios tested: AD = adsorption (according to the Junge empirical relationship; Pankow, 1987), OB = absorption in organic matter and adsorption to soot (Lohmann & Lammel, 2004) without and DP = with degradation in the atmospheric particulate phase.
Gas-particle partitioning in air influences drastically the atmospheric cycling, total environmental fate (e.g. compartmental distributions) and the long-range transport potential (LRTP) of the substances studied. The LRTP is mostly regional. Comparison with observed levels indicate that degradation in the particulate phase must be slower than in the gas-phase. Furthermore, the levels of semivolatile PAHs (ANT and FLT) at high latitudes and a European mid latitude site cannot be explained by partitioning due to adsorption alone, but point to both absorption into organic matter and adsorption to black carbon (soot) to determine gas-particle partitioning.
PAHs are multi-hopping to some extent and volatilization from ground exceeds deposition over dry parts of the continents and some sea regions at least seasonally.

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