

EMISSION, FATE AND RESPIRATION EXPOSURE RISK OF POLYCYCLIC AROMATIC HYDROCARBONS IN CHINA

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Emission of 16 Polycyclic Aromatic Hydrocarbons (PAHs) listed as USEPA priority pollutants from major sources in China were compiled. Geographical distribution and temporal change of the PAH emission, as well as emission profiles are discussed. It was estimated that the total quantity of 16 PAHs emitted from China was 116,000 tons in 2003, more than half of which was from biomass burning. Although vehicular emission contributed to a relatively small percentage of the total emission, it was one of the major sources in urban areas. The emission profile featured a relatively higher portion of high molecular weight (HMW) species with carcinogenic potential due to large contributions of domestic coal and coking industry. The emission increased continuously for four decades starting from 1950 but fluctuated since 1990 due to variation in the production of small-scale coke ovens.

A potential receptor influence function (PRIF) model, based on air mass forward trajectory calculations, was applied to simulate the atmospheric transport and outflow of PAHs emitted from China. With a ten day atmospheric transport time, most neighboring countries and regions, as well as remote regions, were influenced by PAH emissions from China. Of the total annual PAH emission of 116 Gg, 93% remained within the boundary of mainland China. Of the PAH outflow from China (8092 tons or 7.1% of the total annual PAH emission), approximately 69.9% (5655 tons) reached no further than the offshore environment of mainland China and the South China Sea. Interannual variation in the eastward PAH outflow was positively correlated to cold episodes of El Niño/Southern Oscillation. However, trans-Pacific atmospheric transport of PAHs from China was correlated to Pacific North America index (PNA) which is associated with the strength and position of westerly winds.

An Euler atmospheric transport model CanMETOP was modified and applied to model the atmospheric transport and multimedia fate of PAHs in China based on the emission inventory. The model results were validated by the field observations for concentration levels in atmosphere and soil. The results showed that the spatial distributions of PAHs levels in atmosphere are greatly controlled by emission and meteorological conditions. Elevated concentration levels in both atmosphere and soil were observed in Shanxi, Guizhou, North China Plain, and Sichuan Basin. Significant seasonal variation was found for the transport pattern of PAHs in China with greatly elevated transport flux in winter.

The model calculated ambient PAH concentrations were used to evaluate lung cancer risk for the Chinese population due to inhalation exposure to PAHs. The uncertainties of the transport model, exposure and risk analysis were assessed using Monte Carlo simulation, taking into consideration the variation in PAH emission, aerosol and OH radical concentrations, dry deposition, respiration rate and genetic susceptibility. The average benzo[a]pyrene equivalent concentration (BaP_{eq}) was 2.43 (1.29~4.50 as interquartile range, IR) ng/m^3 . The population-weighted BaP_{eq} was 7.64 (IR, 4.05~14.1) ng/m^3 because of the spatial overlap of the emissions and population density. It was estimated that 5.8% (IR, 2.0~11%) of China's land area, where 30% (IR, 17~43%) of the population lives, exceeded the national ambient BaP_{eq} standard of 10 ng/m^3 . Taking into consideration the variation in exposure concentration, respiration rate and susceptibility, the overall population attributable fraction (PAF) for lung cancer due to inhalation exposure to PAHs was 1.6% (IR, 0.91~2.6%), corresponding to an excess annual lung cancer incidence rate of 0.65×10^{-5} . While the spatial variability was high, the lung cancer risk in eastern China was higher than in western China and populations in major cities had a higher risk of lung cancer than rural areas.