Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 6, 1231-1248, 2006
www.atmos-chem-phys.net/6/1231/2006/

Impact of the regional climate and substance properties on the fate and atmospheric long-range transport of persistent organic pollutants - examples of DDT and γ-HCH

V. S. Semeena[1,2], J. Feichter[1], and G. Lammel[1]
[1]Max Planck Institute for Meteorology, Centre for Marine and Atmospheric Sciences (ZMAW), Hamburg, Germany
[2]Meteorological Institute, University of Hamburg, Centre for Marine and Atmospheric Sciences (ZMAW), Hamburg, Germany

Abstract. A global multicompartment model which is based on a 3-D atmospheric general circulation model (ECHAM5) coupled to 2-D soil, vegetation and sea surface mixed layer reservoirs, is used to simulate the atmospheric transports and total environmental fate of dichlorodiphenyltrichloroethane (DDT) and γ-hexachlorocyclohexane (γ-HCH, lindane). Emissions into the model world reflect the substance's agricultural usage in 1980 and 1990 and same amounts in sequential years are applied. Four scenarios of DDT usage and atmospheric decay and one scenario of γ-HCH are studied over a decade.
The global environment is predicted to be contaminated by the substances within ca. 2a (years). DDT reaches quasi-steady state within 3-4a in the atmosphere and vegetation compartments, ca. 6a in the sea surface mixed layer and near to or slightly more than 10a in soil. Lindane reaches quasi-steady state in the atmosphere and vegetation within 2a, in soils within 8 years and near to or slightly more than 10a and in the sea surface mixed layer. The substances' differences in environmental behaviour translate into differences in the compartmental distribution and total environmental residence time, $\tau_{overall}$. $\tau_{overall}$≈0.8a for γ-HCH's and ≈1.0-1.3 a for the various DDT scenarios. Both substances' distributions are predicted to migrate in northerly direction, 5-12° for DDT and 6.7° for lindane between the first and the tenth year in the environment. Cycling in various receptor regions is a complex superposition of influences of regional climate, advection, and the substance's physico-chemical properties. As a result of these processes the model simulations show that remote boreal regions are not necessarily less contaminated than tropical receptor regions. Although the atmosphere accounts for only 1% of the total contaminant burden, transport and transformation in the atmosphere is key for the distribution in other compartments. Hence, besides the physico-chemical properties of pollutants the location of application (entry) affects persistence and accumulation emphasizing the need for georeferenced exposure models.

Final Revised Paper (PDF, 1621 KB)   Discussion Paper (ACPD)

Citation: Semeena, V. S., Feichter, J., and Lammel, G.: Impact of the regional climate and substance properties on the fate and atmospheric long-range transport of persistent organic pollutants - examples of DDT and γ-HCH, Atmos. Chem. Phys., 6, 1231-1248, 2006. Bibtex EndNote Reference Manager