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Heterogeneous atmospheric degradation of organochlorine pesticides on ice particles

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The fate of organochlorine pesticides (OCPs) and other organohalogen chemicals in the environment has been a hot topic for a long time, leading to the Stockholm convention on persistent organic pollutants. Due to their low vapor pressure, they persist in the particle phase (adsorbed or absorbed) of the atmosphere in temperature- and surface-dependent equilibria. Field studies and laboratory experiments have been made to learn about the atmospheric degradation rates and pathways of those pesticides where the observed long-range transport often exceeded the expectations from the laboratory: In the Arctic and on cirrus clouds in the troposphere, OCPs could be adsorbed on ice particles but also be coated with ice and thus shielded against ozone and OH and other radicals. The present experimental study of degradation properties of OCPs on ice particles and ice-coated particles could then lead to recommendations for the modeling work on long-range transport.

The temperature of our Low Temperature Aerosol Simulation Chamber (LOTASC) can be adjusted to -25°C. At this temperature, experiments on the reaction of OH radicals with Aldrin (coated on SiO2 particles, made of Aerosil 380) have been performed to study the atmospheric reaction of semi-volatile organic compounds (Gavrilov, 2007). However, it was not clear whether ice particles are formed or not at this temperature and how the ice could have an impact on the whole reaction system. It is crucial to know whether ice particles could be formed.

Adopting a technique developed within the EU infrastructure EUROCHAMP at Karlsruhe Institute of Technology (Nicolet et al., 2010), a detector has been constructed for the LOTASC to identify the formation of ice particles based on depolarization. The detector consists of a He/Ne laser as a light source, a red-sensitive photomultiplier and a rotating polarization filter. By injecting the material into the chamber as aqueous suspension, we identified the formation of ice nuclei at 264 K in the presence of protein from pseudomonas syringae (the commercial Snomax) under slight vacuum (conditions of adiabatic cooling). Further experiments are planned to test the freezing point of other particles, such as Aerosil and montmorillonite, which are currently used as carrier aerosols for atmospheric chemistry studies.

Future work is to carry out atmospheric chemical simulation experiments at -25°C, after getting the conclusion whether ice particles could be involved into the system or not.

References:

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