TRICHLOROACETATELEVELS IN THE ATMOSPHERE AND IN CONIFER NEEDLES IN CENTRAL AND NORTHERN EUROPE.

H. Frank[1)], Y. Norokorpi[2)], H. Scholl[1)], and D. Renschen[1)]:

1) Institut für Toxikologie, Universität Tübingen, Wilhelmstraße 56, D-72074 Tübingen, Germany;
2) Finnish Forest Research Institute, Rovaniemi Research Station, SF-96800 Rovaniemi, Finland.

Trichloroacetate (TCA) is one of the major atmospheric degradation products of the C_2-chlorocarbon solvents 1,1,1-trichloroethane, tetrachlorethene, and trichloroethene. TCA and several of its derivatives are phytotoxic and have formerly been employed as herbicides; therefore the question arises as to the involvement of TCA (and other haloacetic acids) in the induction of widespread phytotoxicological symptoms commonly referred to as forest decline.

C_2-Chlorocarbons are emitted mainly on the northern hemisphere at annual rates of more than two million tons. They have largely different atmospheric lifetimes: 1,1,1-trichloroethane of about 7 years, tri- and tetrachloroethene of only a few weeks to three month, respectively. They occur in the atmosphere at concentrations between 2.5 and 10 $\mu g/m^3$ (trichloroethane, background vs. urban concentratrions), and between <0.1 µg and 50 µg (tri-, tetrachloroethene). Correspondingly, the formation of TCA and its steady-state levels in terrestrial plants should differ greatly, depending upon the representative levels of precursor compounds, on local atmospheric oxidation rates (which in turn depend upon local atmospheric OH-radical concentrations), on deposition velocities, and the plant metabolism of TCA. All these factors are not exactly known and seem to vary greatly, so predictive calculations on the TCA-levels are highly uncertain. Therefore, the actual determination of TCA in conifer needles may serve as an indicator for local rates of formation/deposition of secondary air pollutants.

Several monitoring campaigns have been performed to assess the TCA-levels in pine needles from South Central Europe to Northern Europe (Figure 1). The results of a data base of more than 600 analyses indicate that TCA occurs in conifer needles (fresh weight) throughout Europe at levels between 5 and 120 µg/kg (ppb). Ambient air levels of TCA are in the range between 0.5 and 5 ng/m^3 (0.5 - 5ng/kg). Thus, an accumulation factor of about 3.000 to 10.000 (based upon weight) is applicable.

Interestingly, the levels of trichloroacetate in Northern Finland tend to be higher than in Germany (Black Forest, Erzgebirge). Explanations can at present only be speculative: relatively faster atmospheric oxidation, a preferential cryogenic condensation of xenobiotics in colder climates, and slower metabolic elimination at lower ambient temperature may be some of the reasons.

Trichloroacetate in Conifer Needles (Pinus, Picea) min/max [ppb]

USA, West (L.A.) 1/5
East (Appal.) 5/15
(n = 8)