Atmospheric monitoring for organochlorine contaminants at the Zeppelin mountain clean air station (Ny-Ålesund, Svalbard, Norway)

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Introduction

Since 1993, the atmospheric composition of selected persistent organics monitored are analysed and quantified as an integrated part of the Arctic Monitoring and Assessment Programme (AMAP) at the Zeppelin mountain clean-air research station [1]. The Zeppelin mountain clean-air research station is located near Ny-Ålesund, Svalbard (78°54′ N, 11°53′ E) around 474 m above sea level (figure 1). Persistent organic pollutants (POP) like selected thirty -three polychlorinated biphenyl congeners (PCBs), Hexachlorobenzene (HCB), two hexachlorocyclohexane isomers α- and γ-HCH), cyclodiene pesticides (*trans-/cis*-chlordane and *trans-/cis*-nonachlor) as well as six dichlorodiphenyltrichloroethane derivatives (*p,p'-/o,p'*-DDT, DDD and DDE) are measured on a weekly basis. The major aim of this long-term monitoring effort was to · act as a control tool, with the focus on ascertaining whether the governmental regulations show an effect in the environment, · estimate and survey "natural" and ubiquitous background levels as an important basis for regulations, · act as an indicator and ?early warning? tool. Even minimal changes in level and distribution may be a first signal for larger global changes at a later stage. The data obtained during the past 12 years of monitoring are used for a comprehensive empirical and statistical evaluation with regards to pattern distribution, source elucidation and temporal trend assessment.

Materials and Methods

Standard trace analytical methods for quantification of 33 PCBs, HCB, 2 HCH-isomers, 4 cyclodiene pesticides and 6 DDT -derivatives were applied for the monitoring program as already described earlier [2,3]. A comprehensive quality control and quality assurance protocol was followed including field and laboratory blank determination, application of internal standard quantification and determination of recovery rates for all samples analysed. For the temporal trend analysis, additionally to a direct graphical presentation and evaluation, the non -parametric "Mann-Kendall Test" has been used on annual means for detecting and estimating trends for POP concentrations at the Zeppelin station[4]. In parallel to this basic statistical treatment, the Sens slope estimator has been used to quantify the scale of potential trends. The Mann -Kendall test and Sens slope estimator have been carried out using the MAKESENS software [5], which is today an important tool for EMEP (European Monitoring and Assessment Programme). Air mass trajectories are calculated using the FLEXTRA trajectory model [6,7] and using meteorological data provided from ECMWF (European Centre for Medium Range Weather Forecasts).

Results and discussion

Organochlorines have been subject for long-term circum Arctic monitoring of atmospheric pollutants within the frame of AMAP [8,9]. Atmospheric long-range transport is today known to be one of the major sources for POP pollution in Polar regions >sup>1. However, due to the persistent character of this type of environmental pollutants, relative long-response times on regulative counter measures are expected. Therefore, a first effort to establish information on temporal trends and atmospheric long-range transport events into the Norwegian Arctic has been made in the here presented study. Based upon a comprehensive stat istical evaluation, a clear temporal trend was established for HCH isomers, demonstrating, that international regulatory measures, in place since the early 1990s, lead ultimately to a continuous reduction of atmospheric loads and transport to the European Arctic (figure 2). No comparable trends have been established yet for PCBs, DDTs and cyclodiene pesticides. However, the cis -nonachlor contributions seems to follow a seasonal distribution pattern in the Zeppelin air data (figure 3) in contrast to the trans isomer, where no seasonal behaviour was observed during the twelve years monitoring period. Atmospheric long -range transport events are important contributions to the contaminant POP loadings of the Arctic environment. For

the sum PCB concentrations, several long-range transport events have been identified (figure 4) and evaluated with back trajectory modeling. Long-term atmospheric monitoring programmes for anthropogenic contaminants in the Arctic contribute to day significantly to the scientific understanding of the global transport and distribution processes for chemical pollution. In addition, unique databases are produced supporting modeling approaches and scenario assessment with urgently needed data for validation and quality assurance.

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