Persistent organic contaminant levels in atmospheric samples from Bjørnøya (Bear island) and the Zeppelin Mountain research station (Ny-Ålesund, Svalbard)

Roland Kallenborn[1], Martin Schlabach[1], Guttorm Christensen[2], Trond Skotvold[2] & Stein Manø[1]

[1] Norwegian Institute for Air Research, The Polar Environmental Centre, NO-9296 Tromsø and NO-2027 Kjeller, Norway
[2] Akvaplan-niva, The Polar Environmental Centre, NO-9296 Tromsø, Norway

Introduction

In 1994, alarming results concerning the contamination levels of persistent organic pollutants (POPs) in fresh water fish and sediment from lake Ellasjøen (Bjørnøya) were reported (Skotvold et al. 1998) Based on these findings, a comprehensive and multidisciplinary national research endeavour co-ordinated by Akvaplan-niva and jointly funded by the Research council of Norway and State Pollution Control Authority of Norway (SFT) was started in 1999 to gain scientific insight about the contamination status for persistent pollutants at the Ellasjøen area on Bjørnøya. Within this initiative, a year around air sampling campaign was carried out in order to investigate the atmospheric transport and deposition of persistent organic pollutants into the Bjørnøya (Bear island) region.

Background

As a part of the ongoing Monitoring of persistent organic pollutants (POPs) in the Arctic atmosphere, the Zeppelin Mountain Research Station close to Ny-Ålesund (79ºN, 12 ºE, 476 m.a.s.l.) at Svalbard (Norway) delivers continuously data on POP levels to the AMAP database since 1993. A similar air sampling device is installed at the Bjørnøya meteorological station (74 ºN, 19 ºE, 18 m a.s.l.) as a integrated part of the above mentioned national Norwegian research project. Selected POPs: 33 polychlorinated biphenyls (PCB), 2 hexachlorocyclohexane isomers (HCH), 6 dichlorodiphenyltrichloroethanes (DDT) and pollutants like brominated flame retardants were monitored. The geological and meteorological conditions at both sampling sites are relatively different. The location of the Zeppelin mountain research station is just insignificantly influenced by human activities, or possible natural contamination sources (e.g., breeding or resting seabirds, mammal activities etc.). Thus, atmospheric long-range transport is the major source for the presence of POPs in the atmosphere around the Zeppelin station. At the other hand, locations around the Bjørnøya meteorological station (situated close to the shore at the northern plains) are important resting and breeding areas for seabirds (e.g., ducks, auks and gulls). Thus, a direct influence of contaminated particulate material originating from bird guano and food items cannot be excluded for Bjørnøya air samples. In addition, re-volatilisation of POPs from the surrounding sea and subsequent adsorption on marine aerosols and/or salt particles will have a direct influence on the atmospheric POP burden at Bjørnøya but not at the Zeppelin station. The distance between both stations is estimated to approximately 500 km (figure 1).

Figure 1: Location (arrows) of the Zeppelin station and the Bjørnøya sampling site.

A first comparison of the data available for both sampling sites from the sampling campaigns in 1999 and 2000 revealed, that the general POP levels in atmospheric samples are found in the same concentration range. However, typical pattern differences indicate influences of other significant POP sources than solely atmospheric long-range transport on the contaminant levels in ambient air from Bjørnøya. The proportion of tri- and tetra chlorinated biphenyls (PCB) is considerably higher in atmospheric samples from the Zeppelin station (ca. 85%) compared to the Bjørnøya samples (75%). In addition, the α–/γ-hexachlorocyclohexane (HCH) ratio can be used as a indicator for primary or secondary sources. A high proportion of γ-HCH indicates direct long-range transport into the target region (figure 2). A relatively low average α/γ-HCH ratio (Bjørnøya: ≈ 2-3, Zeppelin: ≈ 5-6) and dominant levels of tetra- and penta chlorinated PCB congeners support the assumption that also biogenic sources may have a significant influence as local sources on the POP levels in Bjørnøya ambient air.

A simultaneous increase of the α-HCH in the period week 30-39/2000 for both stations indicates transport of re-evaporated HCH from secondary sources (remobilisation of HCH deposited in marine sediments or sweater due to favourable temperature conditions and reduced ice-cover in former oversaturated sink regions of the central Arctic ocean). This phenomenon was firstly described by Jantunen and Bidleman (1995). The results presented here confirm the above reported mechanisms.

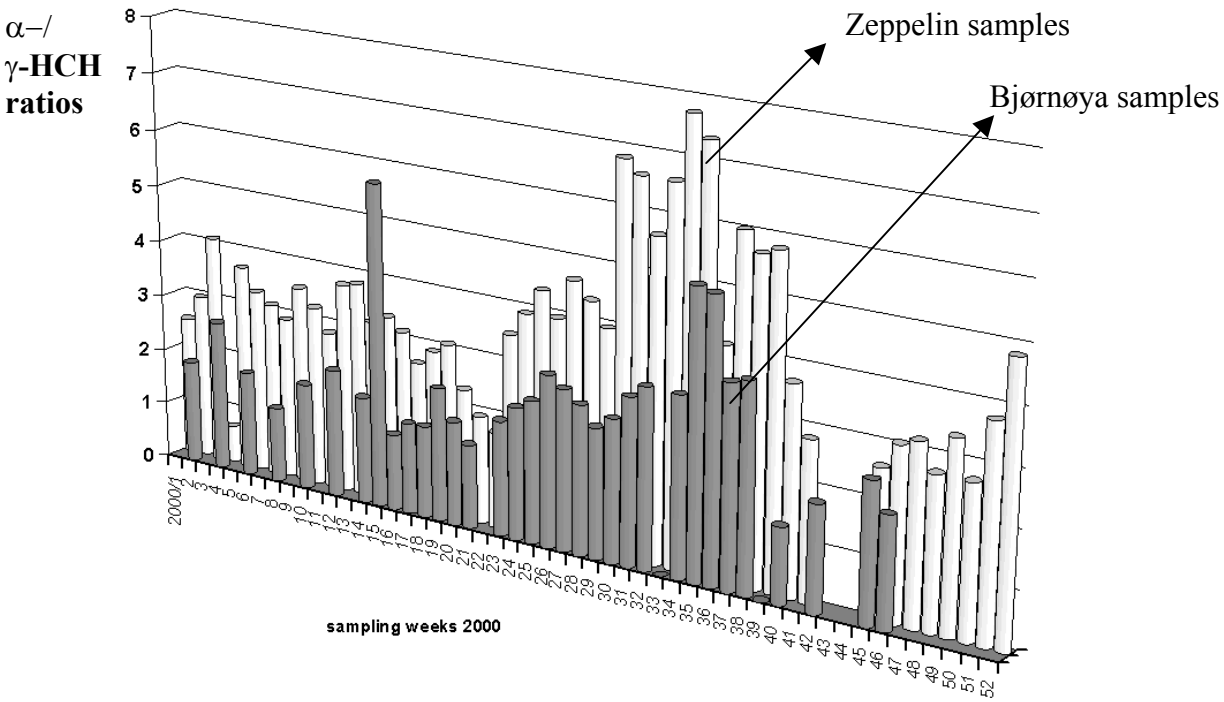

Figure 2: Comparison of weekly α–/γ–HCH ratios in atmospheric samples from Zeppelin station (Svalbard) and Bjørnøya.

Remarkable differences were also found in the distribution of chlordane related compounds. The levels of *trans*-nonachlor were clearly higher in Bjørnøya atmospheric samples (≈ 3times) compared to the Zeppelin air samples from 2000. More in-depth information including DDT derivatives and compound specific patterns as well as method information and quality control measures will be given in the presentation.

References

Jantunen LM, and Bidleman TF (1995) Reversal of the air-water gas exchange direction of hexachlorocyclohexanes in the Bering and Chukchi Seas. *Environ. Sci. Technol.* 29: 1081-1089.

Skotvold T, Wartena EMM and Schlabach M (1998) Persistent organic contaminants in Arctic char (Salvelinus alpinus) on Bear Island *Organohalogen Comp.* 39: 411-414.