NILUF 14/2001

NILU: F 14/2001
REFERANSE:
DATO: 20. september 2001

Persistent organic pollutants in ambient air and fog at Bjørnøya (Bear Island)

Dioxin 2001, Korea 9-14 September 2001

Roland Kallenborn, Guttorm Christensen, Ellen Katrin Enge, Dorte Herzke, Martin Schlabach and Trond Skotvold

PERSISTENT ORGANIC POLLUTANTS IN AMBIENT AIR AND FOG AT BJØRNØYA (BEAR ISLAND)

Roland Kallenborn[1], Guttorm Christensen[3] Ellen Katrin Enge[1], Dorte Herzke[1], Martin Schlabach[2], and Trond Skotvold[3]

[1] Norwegian Institute for Air Research, The Polar Environmental Centre, NO-9296 Tromsø, Norway, roland.kallenborn@nilu.no
[2] Norwegian Institute for Air Research, P.O. Box 100, NO-2027 Kjeller, Norway
[3] 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 (*Salvelinus alpinus*) and sediment from lake Ellasjøen (Bjørnøya) were presented [1]. 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. The main questions to be answered in this still ongoing research project were formulated. How strong is the influence of atmospheric long-range transport on the POP levels in the Southern Barents Sea region? Where are the sources of the persistent organic pollutants found in the Southern Barents Sea region? Based on information given by the Norwegian Meteorological institute, in average, more than 30% of the summer time, fog events are occurring. Therefore, in addition to ambient air and snow samples, also fog water was collected in order to assess fog as medium for transport and deposition pathways at Bjørnøya.

Material and methods

Selected polychlorinated biphenlyls (PCB) and chlorinated pesticides were analysed in ambient air and fog water from Bjørnøya (table 1).

Table 1: Persistent chlorinated contaminants selected for analysis in ambient air and fog water.

Sample type	Polychlorinated biphenyls (PCB)	Chlorinated pesticides
Ambient air	PCB 101, 105, 118, 138, 153, 156, 180	Hexachlorobenzene (HCB), α-HCH (hexachlorocyclohexane, a-HCH), γ-HCH (g-HCH), *trans*-chlordane (tr-CD), *cis*-CD, *trans*-nonachlor (tr-NO), *cis*-NO, chlordene, *cis*-heptachlorepoxide, *oxy*-chlordane
Fog water	PCB 28/31, 52, 99, 101, 105, 118, 126, 128, 138/163, 149, 153, 156, 169, 170, 180, 183, 187, 194.	α-HCH, γ-HCH, HCB

Ambient air

Due to the needed access to electric power supply, one mobile high volume air sampling device only was installed in a sampling hut, close to the meteorological station at Bjørnøya, 16 km North of lake Ellasjøen. A total of 20 samples (average volume: 1000 m^3) were collected every second week in 1999 and spring 2000. Sampling, clean-up procedures and quantification methods used are described in an earlier publication [2].

Fog water

A modified fog water collector with a collecting surface of 1 m^2 was installed for sampling deposition samples both at lake Ellasjøen and near the meteorological station (figure 1). The sampling device, proposed by Schemenauer and Cerceda, was adapted to the needs of fog water sampling for the determination of POP trace levels in Arctic regions [3]. Within a period of 24 hours with foggy weather the fog sampler at the Ellasjøen catchment collected in average 700 ml/m^2 condensed fog water. The fog water was collected in a 50L gas tight stainless steel container and stored at the Bjørnøya meteorological station frozen (-20ºC).

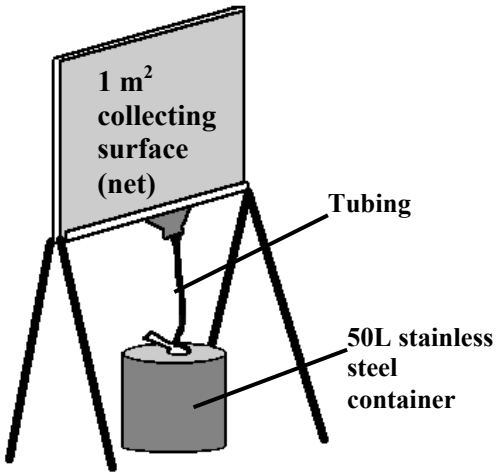

Figure 1: Fog water collector modified to the needs for sampling and trace analysis in Arctic environments [3].

In the lake Ellasjøen catchment area and the meteorological station, four fog water samples were collected during the summer sampling campaign 2000. The steel containers were locked gas tight and shipped to the laboratory of the Norwegian Institute for Air Research (NILU) for clean-up and trace analysis. The fog water samples was prepared for analysis and quantified according to [4]. The final volume of 2 µl sample extract was injected in the high-resolution gas chromatograph. For gas chromatographic separation, a 30 m DB5MS capillary column was used (id: 025 mm, film thickness: 0.25µm, J&W, Folsom, CA, USA). The main column was connected to a 2 m deactivated guard column (J&W). The following temperature program was applied for the GC/MS analysis: Initial temperature 70ºC (2 min isotherm), heating rate 15ºC/min to 180ºC, heating rate 5ºC /min to final temperature 280ºC (10 min isotherm).

Results and discussion

Bjørnøya (Bear Island, 74ºN, 19ºE) is situated about 500 km south-west of Svalbard. The Norwegian Institute for Air Research is performing continuous POP monitoring in ambient air at the "Zeppelin Mountain" atmospheric research station (Ny-Ålesund, Svalbard) since the early 1990s using the same sample sampling and analytical techniques as employed for the Bjørnøya air samples. Therefore, a comparison of POP levels and patterns was performed to investigate POP patterns and atmospheric long-range transport events. Typical POP distributions in air samples

from Bjørnøya (meteorological station) and the Zeppelin Mountain measuring station are presented in figure 2. In general, the POP concentration levels are similar in ambient air collected

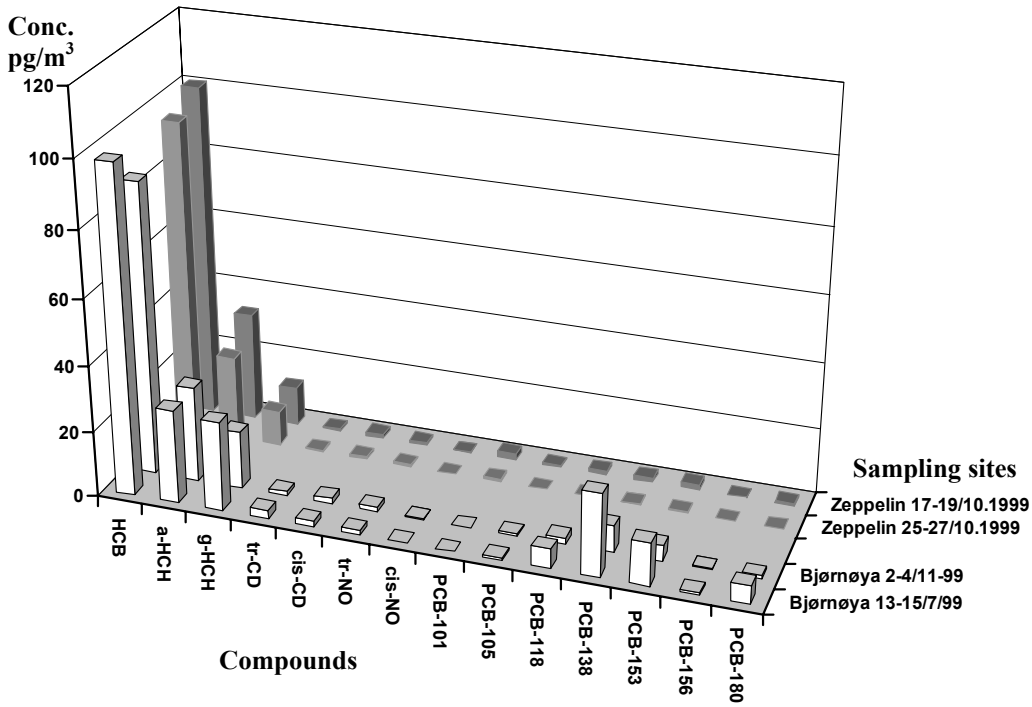

Figure 2: Typical POP levels in ambient air from Bjørnøya (Bear Island) and the "Zeppelin Mountain" atmospheric research station (Ny-Ålesund, Svalbard), abbreviations, see table 1.

at the Zeppelin station and at Bjørnøya. HCB is dominating all air samples from both stations. However, the comparison of the PCB patterns reveals remarkable differences.

PCB concentrations in air from the "Zeppelin Mountain" station are low, and the low chlorinated congeners are usually dominating. However, the medium chlorinated PCB congeners dominate the Bjørnøya air samples. Usually, such a PCB pattern is a characteristic feature for biological samples. In addition, the dominance of the medium chlorinated PCBs (PCB 153, 138) is especially expressed in the sample taken in summer 1999 (13. - 15/7-99). During this period of the year, the cliffs, mainly south of Lake Ellasjøen, are populated from thousands of nesting seabirds. Therefore, one hypothesis for the unusual POP pattern is that the guano and remainings of seabirds redistributed into the air around Bjørnøya, contribute significantly to the elevated POP air levels at Bjørnøya as the dominating local source during summertime.

Fog water samples collected in Bjørnøya were also dominated by medium chlorinated PCB congeners and indicate the strong influences of local biological sources (e.g., seabird guano) on the POP patterns (figure 3). The influence of possible biological sources is also supported by the dominating γ-HCH in Bjørnøya fog. Seasonal differences are even more expressed in fog samples as found for ambient air probably due to the vicinity of bird cliffs and hatching areas in the lake

Ellasjøen catchment area. The September sample from lake Ellasjøen (2000) showed low PCB concentration levels, whereas about 10 times higher concentrations of PCB (PCB 118) was found

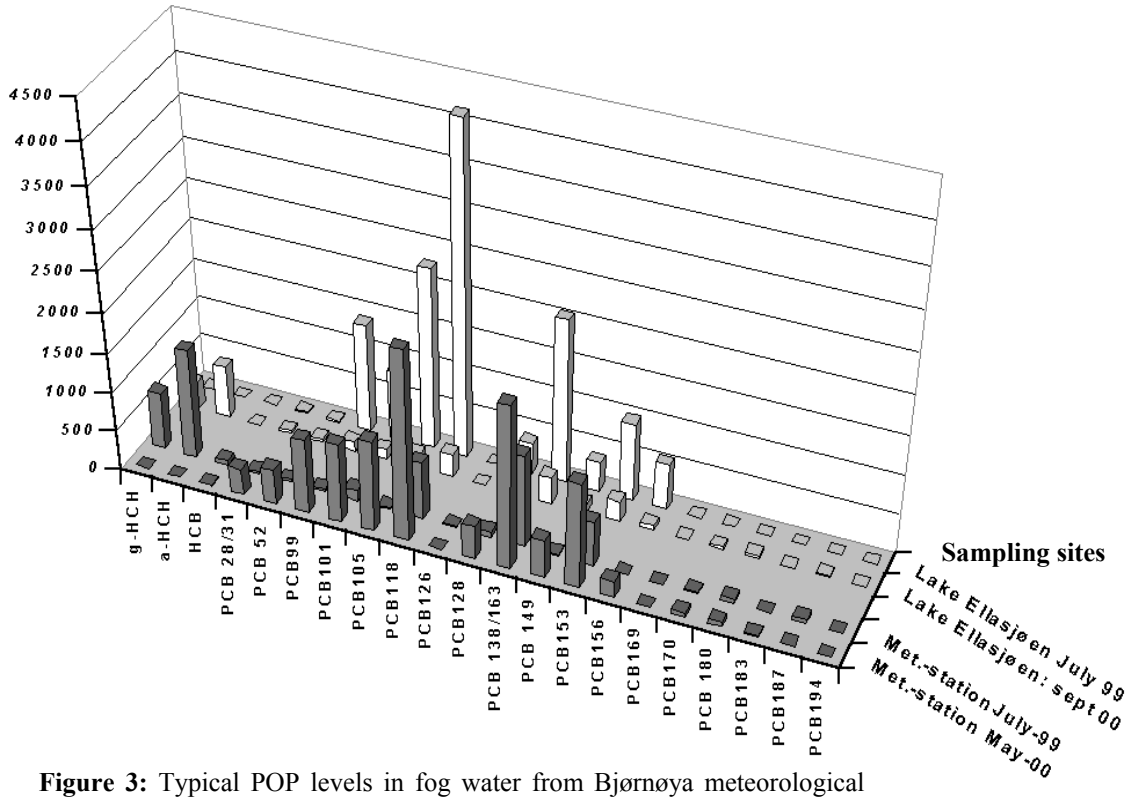

Figure 3: Typical POP levels in fog water from Bjørnøya meteorological station (met.-station) and the lake Ellasjøen catchment area.

in the fog samples collected in July 1999 (lake Ellasjøen) at the end of the hatching season at Bjørnøya.

Comparable seasonal differences could not be found in the fog water samples from the meteorological station (16 km North of Lake Ellasjøen) probably due to the absence of large seabird colonies. However during the summer sampling campaign in spring/ summer 2001 more samples will be collected in order to investigate the above mentioned indications.

Acknowledgement

We thank Gro Hammerseth and Sissel Planting (NILU) for the support during analysis and quantification of the samples. Geir W. Gabrielsen (Norwegian Polar Institute) and Ivan C. Burkow (NILU) are thanked for the administrative support during the sampling campaigns and fruitful discussions. The here presented study is a part of a project jointly funded by the Research Council of Norway 135632/720 and the State Pollution Control Authority of Norway (SFT).

References

1. Skotvold T, Wartena EMM and Schlabach M (1998) *Organohalogen Comp.* 39: 411.
2. Oehme M, Haugen JE and Schlabach M (1995) *Sci. Tot. Environ*. 161: 139.

3. Schemenauer RS and Cereceda P (1994) *J. Appl. Meteorol.*, 33: 1313.
4. Enge EK, Heimstad ES, Kallenborn R (1998) *Organohalogen Comp. 39: 435*