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PERSISTENT ORGANIC POLLUTANTS IN SNOW AND MELTWATER FROM BJØRNØYA (BEAR ISLAND)

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Introduction

Today, it is well known that snow and ice play an important role in the hydrological cycle of the Arctic. The presence of snow and ice strongly influence the behaviour of persistent Organc Pollutants (POPs) in the environment by modifying chemical cycling between the atmosphere and the Earth's surface. However, until today only few studies have been performed investigating the role of snow as deposition medium for persistent contaminants in Northern Environments. A first study on POB contamination of surface snow in the pristine valley of Dividalen (Troms county, North Norway) revealed considerable concentrations of polychlorinated biphenyls (PCB) in snow and melt water samples [1]. In 1998, Skotvold et.al [2] presented results from a sampling campaign in 1994 describing high contamination levels of persistent organic pollutants (POPs) in fresh water fish (*Salvelinus alpinus*) and sediment from Lake Ellasjøen (Bjørnøya). Based on these findings, a national research endeavour was started to gain scientific insight into the contamination status and distribution processes for POPs on Bjørnøya, specifically in the Lake Ellasjøen region. The still ongoing project is co-ordinated by Akvaplan-niva and jointly founded by the Research Council of Norway and the State Pollution Control Authorities of Norway (SFT). Snow and meltwater were collected in 1999/2000 in order to assess transport and deposition pathways of POPs within the Bjørnøya ecosystem. In the presented study, an assessment will be presented about the role of snow as carrier, deposition and storage medium for POPs at Bjørnøya.

Material and methods

Selected PCBs and chlorinated pesticides were analysed in snow and melt water samples from Bjørnøya. Samples were collected both close to the meteorological station and Lake Ellasjøen (table 1).

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

Sample type	Polychlorinated biphenyls (PCB)	Chlorinated pesticides
Snow and melt water	PCB 28/31, 52, 99, 101, 105, 118, 128, 138/163, 149, 153, 156, 169, 170, 180, 183, 187, 194.	γ-HCH, α-HCH, HCB,

During the first prelimary, sampling campaign 1999/2000, at the meteorological station, two melt water and one deposition snow samples were collected and analysed. At Lake Ellasjøen, two melt water and three snow deposition samples were quantified (see table 2). The quantification method for PCB and chlorinated pesticides is described in an earlier publication [1].
Melt water was sampled at the meteorological station and Lake Ellasjøen using a 1 m^2 meltwater collector (shown in Figure2A). The snow deposition samples was collected from a 0,4 m^2 wet deposition collector (shown in Figure2B). After storage at the Meteorological station at Bjørnøya, the gas tight stainless steel containers were shipped frozen to the laboratory of the Norwegian Institute for Air Research (NILU) for subsequent extraction, clean-up and quantification.
For gas chromatographic separation, a 30m DB5MS capillary column was used (id: 025 mm, film thickness: 0.25μm, J&W, Folsom, CA, USA). The main column was connected to a 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).

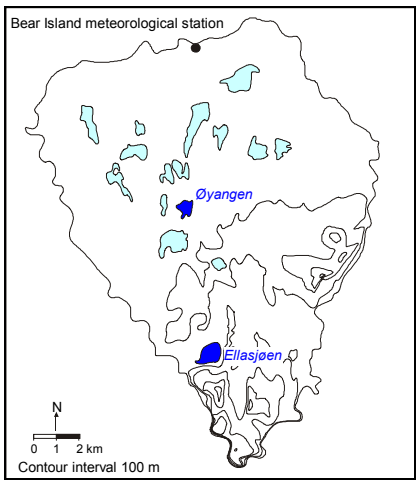

Figure 1 Bjørnøya (Bear Island, 74ºN, 19ºE) and the sampling sites Lake Ellasjøen and the meterological station

Helium (HE, 5.0 quality, Hydrogas, Porsgrunn, Norway) was used as carrier gas at a flow rate of 1 mL/min. A final volum of 2 µl of the sample extract was injected on-column into the gas chromatograph for separation. Mass spectrometric detection was used for the quantification (MD800, Finnigan, San Jose, CA). The low-resolution mass spectrometric measurements were performed in electron impact mode (LRMS-EI). The samples were quantified in Single Ion Monitoring (SIM). All compounds were quantified using ^{13}C labelled certified PCB internal standards added prior to extraction [1]. The concentration data are presented table 2.

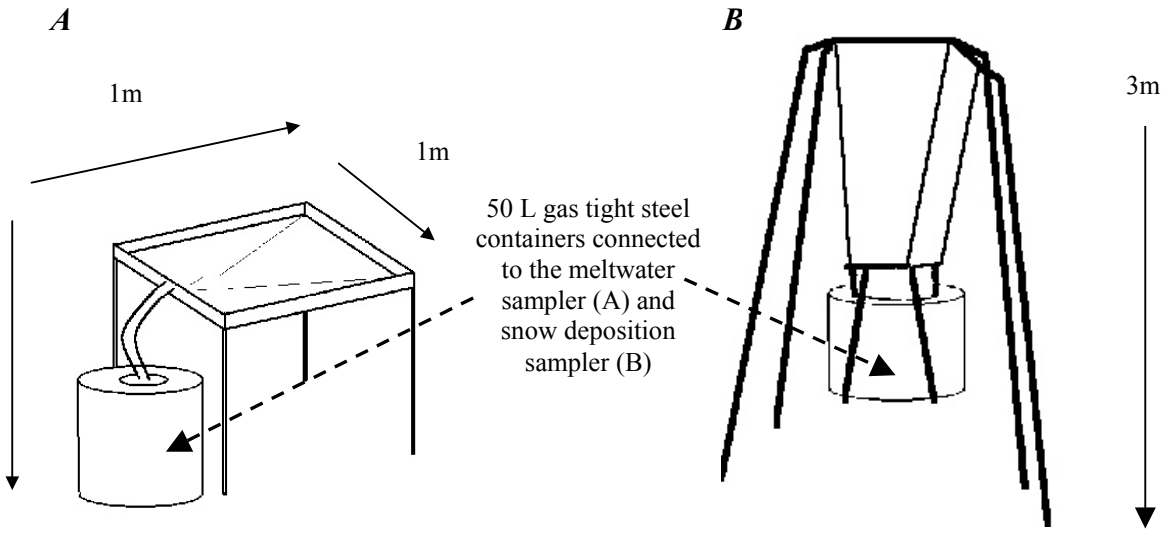

Figure 2: Snow deposition - and melt water collectors used for sampling of snow and melt water at Bjørnøya.

Results and discussions

In all deposition snow samples, PCB levels are dominating. HCHs are the main contributors for the chlorinated pesticides whereas HCB is a minor contaminant in snow and melt water from Bjørnøya. In two melt water samples (MW2 and MW 4) HCH is the dominating compound class (table 2). Due to his high volatility, HCB probably re-evaporate very into atmosphere, therefore in HCB dominates Bjørnøya ambient air samples [3]. The highest PCB concentrations were found for snow deposition, collected close to the meteorological station at the North coast of the island (figure 1). The DS1 sample contained 7.2 ng/L PCB. The highest HCH content was determined in a melt water sample collected close to the Bjørnøya meteorological station (MW 2 = 1.8 ng/L). These findings already indicate the characteristic differences found for the distribution of HCHs and PCBs in snow deposition and melt water. In all snow deposition samples, only minor contribution of the HCHs was determined. However, the contribution of HCH to the overall contamination is significantly higher in melt water samples, in to cases even exceeding the PCB levels considerably (figure 2). This may partly be caused be re-evaporation of low chlorinated PCBs into the atmosphere and the parallel continuous uptake of water

soluble α- and γ-HCH from the atmosphere. However, the number of the samples analysed is to small to draw final conclusions about this hypothesis on snow surface/ atmosphere exchange processes. In addition, during the summer season, both rain and snow deposition is collected and therefore, a clear correlation between melt water properties and POP contamination is not possible.

Table 2: Persistent organic pollutant levels in snow deposition and melt water samples from Bjørnøya [pg/L]. SUM PCB = 17 polychlorinated biphenyl congeners, SUM HCH = α and γ-hexachlorocyclohexane, HCB = hexachlorobenzene, MW = Melt water, DS = deposition snow, I = interference in the chromatogram, n.a. = not analysed.

Meteorological station					**Lake Ellasjøen**				
Sampl. period	**Sample type**	**SUM PCB**	**SUM HCH**	**HCB**	**Sampl. period**	**Sample type**	**SUM PCB**	**SUM HCH**	**HCB**
May 00	DS 1	7219	78	2	Summer 99	DS 2	2737	n.a.	n.a.
Jul-Sept.* 00	MW 1	1178	491	I	Summer 99	DS 3	2485	n.a.	n.a.
Sept-Nov. 00	MW 2	845	1799	I	Summer 00	DS 4	3200	32	1
					July 99	MS 3	2438	n.a.	n.a.
					Juni-sept 00	MS 4*	391	921	I

*) During the summer period of the year, a substantial amount of rain deposition was collected in addition to snow.

The same method was used for melt water samples collected at the Dividalen valley and at Bjørnøya.he concentration levels in Bjørnøya melt water was comparable with the samples from the Norwegian mainland. For the two melt water samples from Dividalen valley sum PCB concentrations of 3.6 and 1.5 ng/L were determined.

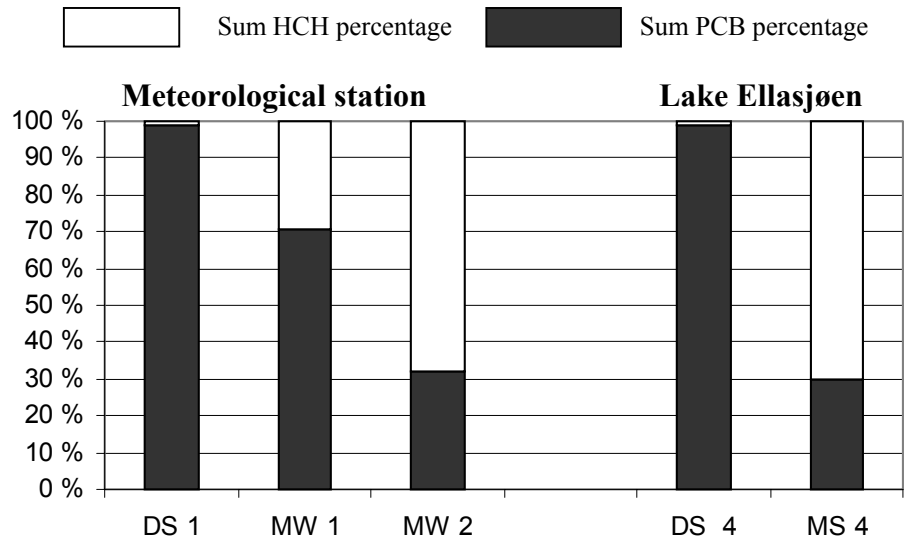

Figure 2: Percentage distribution of sum HCH and sum PCB in snow and melt water samples from Bjørnøya (Bear Island). SUM HCH and PCB = 100 %

The two melt water samples taken at the Bjørnøya meteorological station, were slightly lower contaminated as the Lake Ellasjøen and the Dividalen valley samples. No distinct difference in the PCB levles between the Bjørnøya samples and the melt water taken at the Norwegian mainland were found. This is a surprising result, since no local PCB source is known for the Bjørnøya region, whereas, several sources closer to the Dividalen valley sampling site are known. However, to what extent biological sources like Sea bird guano [4] influence the PCB levels, patterns and distribution of other persistent organic pollutants in snow (deposition and surface) remains to be found and will be subject for further studies within the ongoing Norwegian research initiative. Indications for pattern differences in melt water and deposition snow were found and will be further investigation during the sampling season 2001. Isomer and congener specific pattern distributions will be discussed in the final presentation.