Temporal Trends of Organochlorine Pesticides (OCs) in Canadian Arctic Air: Results from 3 Stations under the Northern Contaminants Program (NCP)

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Introduction

Under the Canadian-operated Northern Contaminants Program (NCP), air samples were collected at three Canadian Arctic locations, namely Alert (82° 30' N, 62° 20' W)(1992-ongoing); Tagish (60° 20' N, 134° 12' W)/Little Fox Lake (61° 21' N, 135° 38' W) (Tagish: Dec 1992 – Mar 1995; Little Fox Lake: Jul 2002 – Jul 2003) and Kinngait (64° 13' N, 76° 32' W) (Mar 1994 – Feb 1996, Oct 2000 – Sep 2002). Spatial comparison of the change in air concentrations of organochlorine pesticide (OC) between the early 1990s and 2000 observed at these three locations is presented in this study.

Materials and Methods

Weekly air samples were collected with a high volume air sampler at each site. Sampler operation, sample extraction, cleanup and analysis have been described elsewhere.[1] Briefly, ~13000 m^3 of air was aspirated through a glass fibre filter and two polyurethane foam plugs (PUFs) to collect the respective particle and vapour phases. All weekly samples were analyzed individually except for 1994-1996 samples from Kinngait and 2002-2003 samples from Little Fox Lake. Weekly air samples were taken at both locations and extracted separately. However, for Kinngait, only 19 samples were analyzed individually as weekly extracts while the rest were analyzed as four-week composites. At Little Fox Lake, all samples were analyzed as biweekly composites.

Results and Discussions

Alert (1993-2000)

Among the three locations, Alert is the only site where continuous long-term air monitoring was conducted. Figure 1 shows time series of the vapour phase air concentrations, expressed as the natural log of partial pressure, *P*, of g-HCH, *t*-chlordane and endosulfan I measured at Alert from 1993 to 2000. The time trends and seasonal cycles were developed using the digital filtration technique. This technique has been successfully used to derive long-term trends for polychlorinated biphenyls (PCBs) and OCs measured at Alert. Details of this technique are given elsewhere.[2,3] The air concentrations of g-HCH and *t*-chlordane showed decreasing trends through the 1990s with halflives of 5.6 and 4.8 years, respectively. Endosulfan I, which is a current-use pesticide, showed a very slow decline with a halflife of 21 years.

Tagish (Dec 1992-Mar 1995)/Little Fox Lake (Jul 2002-Jul 2003)

In 2000, Bailey et al.[4] studied the OC air concentrations measured at Tagish and found that high concentration episodes of OC correspond to transpacific transport from eastern Asia that generally occurred within 5 days. To further study the effect of potential trans-Pacific transport, air sampling was conducted at Little Fox Lake from Jul 2002 for 1 year. Little Fox Lake is located almost the same distance North of Whitehorse, Yukon, as Tagish is South of it. The Tagish site was not used in this later study due to the presence of a nearby settlement which may influence monitoring results. Due to the proximity of the two sites, sampling results from the two periods can be used to illustrate the change in OC air concentrations over time in this region although the generation of long term trends as those shown in Figure 1 are not possible. Figure 2 shows the vapour phase air concentrations of g-HCH, *t*-chlordane and endosulfan I measured at the two locations. It can be seen that in this region of the Canadian Arctic, g-HCH did

not show a decrease in air concentration in contrast to that observed at Alert. On the other hand, the air concentration of *t*-chlordane declined significantly in 7 years. Endosulfan I, as a current-use pesticide, did not show any decrease in air concentration.

Kinngait (Mar 1994 – Feb 1996, Oct 2000 – Sep 2002)

Comparisons of the change in OC air concentrations measured at Kinngait between 1994-1996 and 2000-2002 with those observed at Alert show that the decline rates are similar at the two locations for most OCs, with seemingly slightly faster decline rates at Kinngait. The air concentrations of endosulfan I apparently declined at a faster rate at Kinngait than at Alert. This difference could be the result of faster biotic and abiotic degradation at the former site, which is closer to temperate regions than Alert. Figure 3 shows the vapour phase air concentrations of γ-HCH, *t*-chlordane and endosulfan I measured at Kinngait during the two sampling periods.

Although the three locations are all in the Canadian Arctic and can all be considered as background sites, the changes in air concentrations of the same chemicals over time are site specific. The vast size and high variability of the Arctic region, in terms of climate, topography, air mass origin and human activities, suggests that contamination of the atmosphere with POPs varies in different parts of the Arctic. In order to determine whether atmospheric concentrations and deposition of these chemicals in the Arctic are changing in response to various national and international initiatives, as well as to gain a better understanding of the transport dynamics and removal mechanisms of POPs in the environment, the assessment of temporal trends at multiple locations in the circumpolar region is essential.

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