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AN OVERVIEW OF ATMOSPHERIC ORGANOCHLORINE PESTICIDES (OC) UNDER THE CANADIAN ARCTIC NETWORK

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Introduction

Under the Canadian-managed Northern Contaminants Program (NCP), air samples were collected at three Canadian Arctic sites, namely Alert (1992-ongoing), Tagish (1993-1995) and Kinngait (1994-1995, 2000-2002), and two Russian Arctic sites, Amderma (1999-2001) and Dunai Island (1993-1995) to assess the levels, transport pathways and potential sources of persistent organic pollutants (POPs) in the Arctic. Multiple sites were operating simultaneously during two periods: (i) from March 1994 to April 1995, sampling at Kinngait and Alert in Nunavut, Tagish in Yukon and Dunai Island in Russia were simultaneous; (ii) from October 2000 to April 2001, concurrent sites include Amderma in Russia, Kinngait and Alert. Spatial comparisons of organochlorine pesticide (OC) air concentrations and profiles from these two concurrent sampling periods are 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 operationally defined particle and vapour fractions, respectively. All weekly samples were analyzed individually except for 1994-1995 samples from Kinngait which were combined to form monthly composites, each comprised of four weekly samples.

Results and Discussions

The average total concentrations (gas + particle phase) of selected OCs observed at the four stations during the 1994-1995 concurrent sampling period are presented in Figure 1. The relative concentrations of different OCs differ among seasons (Figure 1). The spring average concentrations of most OCs were similar at Kinngait, Alert and Dunai, with slightly higher concentrations at Dunai for some, such as oxychlordane, t-nonachlor, heptachlor epoxide and dieldrin, and the lowest concentrations were observed at Tagish. Among all four seasons, the atmospheric concentrations of most OCs were highest in spring at Alert and Dunai. High spring air concentrations of polybrominated diphenyl ethers (PBDEs) were observed in Southern Ontario and were attributed to chemicals deposited on the snowpack over winter and revolatilized during snowmelt in spring, resulting in elevated air concentrations.[2] This 'spring pulse' was most apparent at Dunai and least significant at Tagish. Lagrangian five-day back trajectories[3] calculated every 6 h at 700 hPa (corresponding to the elevation of Tagish at ~2200 m) for each of the four seasons of 1994-1995 has shown that 88 to 96 % of all trajectories arriving at Tagish originated across the Pacific Ocean. Air coming inland might have diluted revolatilization of OCs from terrestrial surfaces at this site.

The concentrations of most OCs were highest at Kinngait compared to other sites for both fall and winter (Figure 1). However, OC air concentrations at Kinngait were similar throughout the year with a slight summer minimum, probably the combined result of fast summer biotic and abiotic removal processes and the dilution effect of relatively clean air moving inland from the Arctic Ocean. Five-day back trajectories calculated once every 6 h at 925 hPa has shown that 53 % of the trajectories arriving at Kinngait in summer originated from across the Arctic Ocean. Yet, influence from N. America was most prominent in winter at this site. Due to its proximity to source regions in eastern N. America, OC air concentrations were highest at Kinngait in winter. Short travelling distances from source reduce the probability of removal by deposition, gaseous absorption and reactions along the transport pathway.

"Now to then" ratios of 2000-2001 to1994-1995 composite concentrations of the HCHs and chlordanes at Kinngait are presented in Figure 2. Similar ratios of 1998-1999 to 1994-1995 composite concentrations for Alert are also shown. Alert 2000-2001 air concentrations are still under analysis and are not available at this time. The ratios at Kinngait were generally much lower than those at Alert, implying faster OC removal at Kinngait. Despite the 2-year difference between the "now" data for the two sites, the atmospheric decline rates of OCs, expressed as halflives at Alert[4], cannot explain the difference between the "now to then" ratios of the two locations. To confirm this, air concentrations at Alert in 1998-1999 and 2000-2001 were estimated using measured concentrations in 1994-1995 and halflives determined from OC trends at Alert between 1993 and 1998. The corresponding halflife-estimated ratios are presented in Figure 2 for comparisons. It is believe that OC air concentrations seem to decline faster at Kinngait because it is closer to temperate source regions, where removal rates are usually faster.

Acknowledgements
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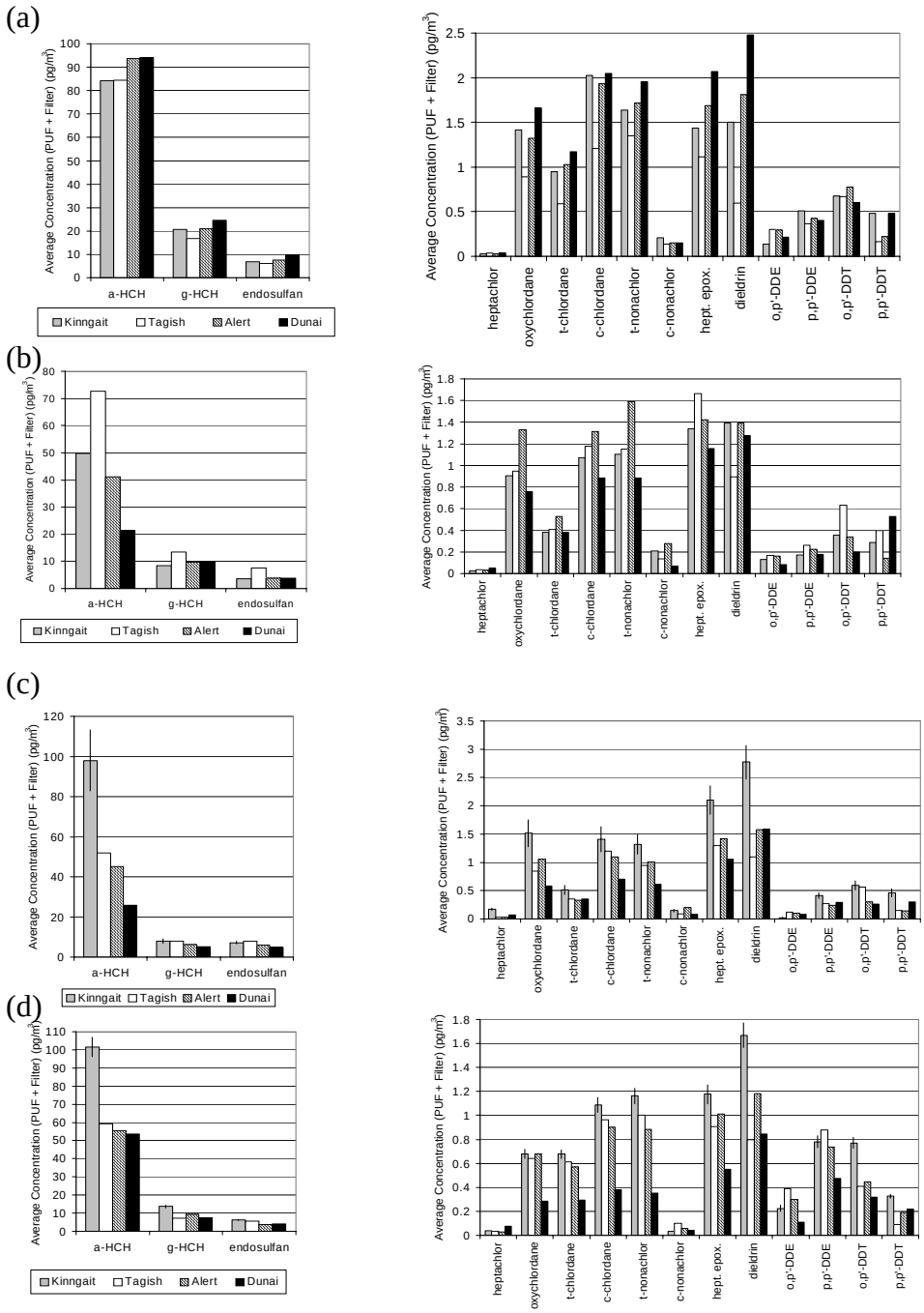

Figure 1. OC seasonal average concentrations (a) spring (week 13-21 of 94), (b) summer (week 22-30 of 94) (c) fall (week 31-42 of 94) and (d) winter (week 43 of 94 - week 16 of 95).

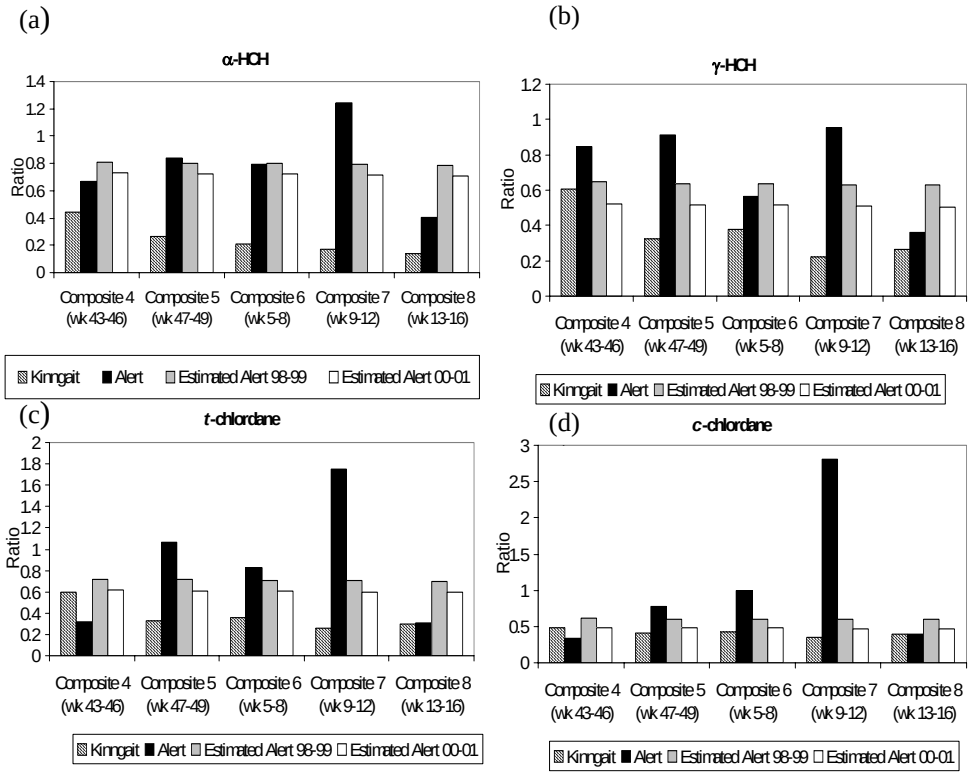

Figure 2. "Now to Then" Ratios for (a) α-HCH, (b) γ-HCH, (c) *t*-chlordane and (d) *c*-chlordane