LEVELS AND DISTRIBUTION OF POLYCHLORINATED BIPHENYLS IN THE ATMOSPHERE NEAR THE CHINESE GREAT WALL STATION, ANTARCTICA

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Introduction

Persistent organic pollutants (POPs) have aroused great concern due to their adverse effect to the environment and human health. POPs are highly toxic, persistent and can bioaccumulate in fat tissues via food webs. Atmospheric transport plays a key role in the transportation of POPs from source regions, urban areas to rural, remote and polar regions. The Antarctica is considered to be a clean and pristine area due to less anthropogenic activities. However, more and more studies have reported the detection of various POPs in the Antarctic environment, including atmosphere, moss, fish species and marine mammals. In this study, both high volume air samplers and PUF-disk based passive air samplers were employed in the vicinity of the Chinese Great Wall Station on the King George Island, Antarctica, in the austral summer between December 2009 and February 2010. The main aim was to investigate the current contamination levels, distributions and potential sources of polychlorinated biphenyls (PCBs) in the atmosphere of the remote Antarctica islands.

Materials and Methods

For air monitoring program, two high volume (active) air samplers (AAS) and five PUF-disk passive air samplers (PAS) were located in the King George Island, Antarctica. The sampling site of the high volume sampling was 300m in the southwest of Chinese Antarctic Research Station (Great Wall Station, 62°13S', 58° 58'W). Sampling time was from December 11th, 2009 to February 5th, 2010, during the 26th Chinese Antarctic Expedition. Fourteen high volume air samples were obtained with sampling volumes of ~2000 m^3 over each seven days period.

Sample extraction, cleanup and chemical analysis followed our previously established method [1,2]. Briefly, 1 ng of $^{13}C_{12}$-labeled surrogate standards of PCBs (Wellington Laboratories, Canada)) were spiked into the samples before an ASE extraction with organic solvents (hexane: dichloromethane=1:1). The extracts were concentrated and followed by a cleanup with acid silica gel and multilayer silica columns. The final extract was spiked with 1 ng $^{13}C_{12}$-labeled injection standards of PCBs for recovery quantification prior to the injection into a high resolution gas chromatography-high resolution mass spectrometry (HRGC/HRMS) equipped with a 60 m DB-5MS column.

Results and Discussion

Air Concentrations of PCBs

The air concentrations of 6 PCBs (CB-28, 52, 138, 153, 180) and total PCBs (∑206 PCBs) were reported. The total PCBs exclude three mono-PCB congeners due to low sample recoveries. The

concentrations of ∑6 PCBs and total PCBs were in the range of 1.8-3.4 pg m^{-3} and 82-167 pg m^{-3}, respectively. The air concentrations of total PCBs (∑206 PCBs) in the Korean Antarctica Stations, which is ~10 km from the Great Wall Station, were reported in the range of 0.18-0.91 pg m^{-3} and 45-118 pg m^{-3}, respectively, derived from XAD passive air sampling in 2005-2006 [3]. This result is consistent with the measurements in this study. The PCBs in the atmosphere of King George Island in the austral summer of 1995-1996 were reported as < 4.6-3.3 pg m^{-3} (CB-52), < 4.0-12 pg m^{-3} (CB-153) and < 2.3-10.4 pg m^{-3} (CB-153) [4], respectively, which is higher than the PCBs concentrations in our results.

The air samples were dominated by light homologues. Di-PCBs, Tri-PCBs and Tetra-PCBs were the dominate contributor to the total PCBs concentrations, which was responsible for an average contribution of 12%, 7.2% and 80%, respectively. However, the heavy PCBs account for very small contributions. This result is consistent with the results from the Korean Antarctic station and can be explained by the long range transportation and global cold trap effect [5].

Comparison between AAS and PAS Data

Figure 1 compares the PCBs concentrations from AAS and PAS. Figure 2 shows the PCBs distribution in the atmosphere of each PAS sampling site. The PAS derived air concentrations were calculated by using a daily sampling volume of 3.5 m^{-3} d^{-1}. There was a 1-3 folds deviation of PCB concentrations between the active and passive sampling data. Therefore, PUF-disk passive air sampling can be used to assess PCBs distributions in the atmosphere of the Antarctica, although the wind speed are always high during the sampling campaigns. The three sampling sites, which are close to several Antarctic Stations, showed higher PCB concentrations than the other two sites. This result may reflect potential influences of PCBs contamination from human activities.

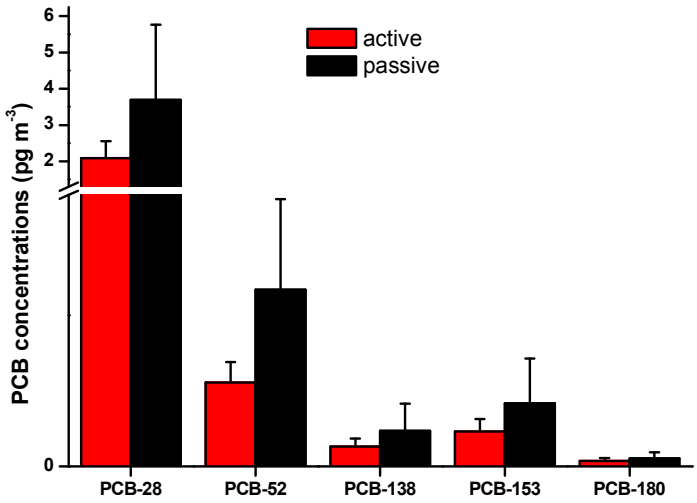

Figure 1 Comparison between active air sampling and passive air sampling

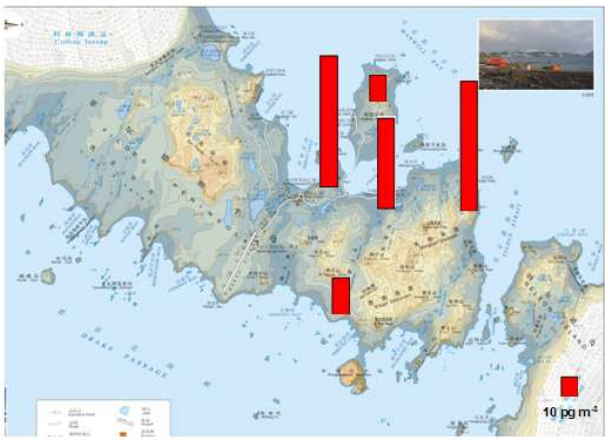

Figure 2 Concentrations of total PCBs in various PAS sampling site

Acknowledgements

This work was supported by the Chinese Arctic and Antarctic Ministration.

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